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The increasing popularity of loyalty programs and related marketing promotions has resulted in the introduction of several new currencies (e.g., frequent flier miles, Diner's Club "Club Rewards") that consumers accumulate, budget, save, and spend much as they do traditional paper money. As consumers are increasingly able to pay for goods and services such as airline travel, hotel stays, and groceries in various combinations of currencies, an understanding of how shoppers respond to "combined-currency pricing" is important for marketers. This research is the first to explore how consumers evaluate transactions that involve combined-currency prices, or prices issued in multiple currencies (e.g., \$39 and 16,000 miles). The authors present a formal mathematical proof that outlines the conditions under which a price that comprises payments delivered in different currencies can be superior to a standard, single-currency price, either by lowering the psychological or perceived cost associated with a particular revenue objective (i.e., price) or by raising the amount of revenue collected given a particular perceived cost. Three studies, in which respondents evaluate and choose among prices issued in single and combined currencies, offer both experimental and empirical support.

## Using Combined-Currency Prices to Lower Consumers' Perceived Cost

"The world has a new international currency: frequent flyer miles."

—*The Economist*, 2002b

"For millions of Americans, frequent-flier miles have become a second currency. In addition to piling them up by hopping on a plane, you can get them by making phone calls, buying toys, investing in mutual funds, taking out a mortgage, or renting cars."

—Leonhardt, 1999

"Meanwhile, don't be tempted by airline offers to sell you a ticket for a combination of miles and money. The deals are usually terrible."

—Leonhardt, 1999

Money has existed in some form since at least 9000 BCE. Cigarettes, cattle, stones, eggs, salt, and porpoise teeth have each served as negotiable instruments (Davies 1996). For currency to be most useful, economists argue that it needs to

be divisible, uniform, and storable. Today, although almost all economies run on fiat money, or paper notes that the government claims are worth something, the immense popularity of marketing promotions and loyalty programs has resulted in the introduction of several new exchange media that meet these criteria. From hotels (e.g., Marriott Rewards, Hilton HHonors) to credit cards (e.g., American Express Membership Rewards, Diner's Club "Club Rewards") and even sports teams (e.g., San Antonio Spurs Rewards), consumers accumulate assets in various novel currencies, which they then budget, save, and spend much as they do paper money.

Undoubtedly, the most ubiquitous alternative currency is frequent flier miles. Around the globe, 100 million people, including one in three adults in the United States, collect the nearly 500 billion miles distributed annually (*The Economist* 2002a; WebFlyer.com 2002). As of April 2002, the cumulative number of unredeemed miles worldwide was estimated to be approximately 8.5 trillion, which at current redemption rates (with no new miles being distributed) would take almost 23 years to clear (*The Economist* 2002a). In 2000 alone, airlines issued 13 million free award tickets (WebFlyer.com 2002). Given a comparison of the relevant figures with all the notes and coins in circulation around the globe, frequent flier miles could be considered the world's second largest currency after the dollar, according to *The Economist* (2002b). Although loyalty programs are growing

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at 11% per year, the fastest growing segment is that of "mileage consumers," not frequent fliers; more than 18,500 U.S. businesses, from telephone companies to car-rental agencies, distribute half of all earned miles to customers who never leave the ground (*The Economist* 2002b; Leonhardt 1999; WebFlyer.com 2002).

A direct consequence of the ubiquity of rewards programs is that consumers are increasingly able to pay for goods and services in a combination of currencies, not just in dollars. For example, in the summer of 2002, Hilton HHonors offered members the opportunity to exchange either 600,000 points or 10,000 points and \$4,125 for an 18-carat gold, 1-carat solitaire diamond ring from the program's Diamond Collection. MilePoint.com, an Internet exchange site backed by a group of prominent airlines, allows consumers to apply frequent flier miles as partial payment toward the purchase of more than 20 million products offered at participating merchants' sites.<sup>1</sup> MileShopper is an online catalog that offers more than 300,000 brand name items from companies such as Toshiba, Samsonite, and Spalding for which shoppers can apply miles for up to 30% of the cost of their purchases. Online malls and catalogs that make similar offers include MileSource.com and MyPoints.com.

Perhaps most familiar to frequent fliers are the deals offered by the airlines themselves. American Airlines AAdvantage, the first and largest frequent flier program in the world with more than 45 million members, is one of several programs that routinely offer airline tickets for a combination of money and miles. For example, a fare advertised on the airline's Web site during winter 2003 allowed fliers to purchase any ticket normally priced at \$189 either for \$189 or for a combined-currency price of \$39 and 16,000 miles.

Despite the growing popularity of prices issued in more than one currency, we know of no research that examines how consumers evaluate what we label "combined-currency pricing" per se. In this research, we explore how consumers respond to prices offered in multiple currencies, and we determine the conditions under which a combined-currency price can be superior to a price charged in a single currency. We define a *superior price* as either lowering the psychological cost to the customer associated with a particular revenue objective by the firm or raising the amount of revenue that can be collected given a particular psychological cost. Consider the following illustration: A consumer is indifferent between spending \$500 or 25,000 miles on an airline ticket but prefers paying \$400 and 5000 miles to either single-currency alternative. At \$.02 per mile, the combined-currency price brings in the equivalent revenue to the airline, yet inflicts a smaller psychological cost to the consumer. When no miles have been expended, consumers may perceive the 5000 miles as relatively trivial and worth cashing in to save \$100.

It is important to note that the consumer's preference for the combined-currency price indicates that each mile or dollar spent is not valued equally; the disutility of paying more

dollars and/or miles increases as the payment in that currency increases. Accordingly, two essential requirements emerge for a combined-currency price to be superior: (1) The consumer does not value each unit in a currency equally, and (2) the perceived-cost function for one of the currencies is convex for at least part of the range at issue. In the preceding example, it follows that the consumer does not spontaneously convert charges issued in one currency to increments of the other currency at a constant rate; otherwise, the flier would either be indifferent to the three choices or prefer to pay exclusively in dollars (miles) if his or her exchange rate is higher (lower) than the firm's. Consequently, if the firm understands the basic shape of the perceived-cost functions for each currency (e.g., dollars and miles) within the applicable range of prices, by using its own transfer function it can determine whether a price that combines currencies is superior to a price issued in a single currency. Our research proves this mathematically and demonstrates it empirically.

### CONCEPTUAL BACKGROUND

#### *The Value of Money and Other Currencies*

In classical economics, it is a truism that the utility of money marginally decreases; therefore, that utility is concave (Fennema and van Assen 1999). The principle of diminishing marginal utility (Stigler 1950) provides a rational argument for decreasing utility from equivalent incremental gains and increasing disutility from equivalent incremental losses (a "convex perceived-cost function," in our terms). However, since prospect theory (Kahneman and Tversky 1979) popularized the view that people evaluate changes in wealth relative to a reference point in much the same way the Weber-Fechner law of psychophysics posits that people respond to changes in physical stimuli, such as light or sound, many psychologists have come to accept that the utility of losses is prone to diminishing marginal sensitivity (a "concave cost function," in our terms). Thus, although the concavity of utility for gains is rarely challenged, there is still widespread debate on whether utility is concave or convex for losses (e.g., expenditures).<sup>2</sup>

Although we do not explicitly test goal setting in this article, we believe that it may be a common explanation for the convexity in the cost function that is necessary to make combined-currency prices appealing. Heath, Larrick, and Wu (1999) show that people are willing to exert more effort as they approach their goal and less effort as they move away from a goal. Just as someone whose goal is to do 40 sit-ups would be expected to exert more effort to complete their 39th sit-up than their 35th, 4000 miles means more to someone with 20,000 miles than to someone with 10,000

<sup>1</sup>This claim was made on MilePoint.com's Web site in July 2001. At the time, MilePoint.com was a partner with Delta Air Lines, Northwest Airlines, Continental Airlines, US Airways, America West Airlines, Midwest Express Airlines, Hawaiian Airlines, Hilton Hotels, and American Express Membership Rewards. Members could spend their miles at online retailers including Amazon.com and Skymall and at such premium retailers as Hamacher Schlemmer and The Sharper Image.

<sup>2</sup>Historically, utility functions have not been measured extensively (Farquhar 1984), but researchers who have attempted to do so have found empirical evidence that supports both concave and convex utility functions for losses (Abdellaoui 2000; Davidson, Suppes, and Siegel 1957; Fishburn and Kochenberger 1979; Friedman and Savage 1948; Green 1963; Officer and Halter 1968; Swalm 1966; Tversky and Kahneman 1992). After reviewing the evidence on both sides, Fennema and van Assen (1999, p. 277) concluded: "Hence for losses one of the most basic aspects of utility, that is, whether marginal utility is increasing or decreasing, is as yet an unsettled question." Although our work appears to support the economic prediction, the contradiction between diminishing marginal utility and prospect theory's conjecture of diminishing marginal sensitivity is well beyond the scope of this article.

miles when the amount needed for a free ticket is 25,000 miles. Suppose that a consumer pays American Airlines' NetSAver fare of \$39 and 16,000 miles rather than \$189. The consumer receives \$.0094 per mile, or \$.0023 per mile more than someone who chooses to pay \$39 and 7000 miles rather than \$89 and receives only \$.0071 per mile. This premium is similar to effort in the sit-up example, because someone who spends 16,000 miles is much closer to earning a free ticket (25,000 miles) than is someone who spends 7000 miles. At the same time, American offered quantity discounts to fliers who wanted to buy miles, so that members could "reach the awards [they] want[ed]—faster than ever before." Someone who needed 10,000 miles would pay significantly less per mile (\$250 or \$.025 per mile) than someone who needed only 1000 miles (\$27.50 or \$.0275 per mile). These buy-and-sell rates are consistent with consumers' ascribing a higher value to miles the closer that they bring them to their goals.

Recognizing that the opportunities for consumers to spend miles or points are more limited than opportunities to spend dollars, we expect that salient goals or reference points (e.g., change in membership status, free flights and upgrades) will introduce convexities into the perceived-cost function for the alternative currencies more readily than they do for money. However, this is not to say that goals will never introduce convexities into the perceived-cost function for money, as is the case for someone who saves for a big-ticket purchase; each dollar the person accrues means progressively more as he or she nears the goal. When the consumer has surpassed the necessary savings to achieve the goal, it might be expected that the perceived-cost function becomes concave, with little incremental value to each additional dollar or mile accumulated (i.e., an S-shaped function).

Although we mention goals as a plausible mechanism for the introduction of convexities into the perceived-cost function, we must clarify two points about our research upfront. First, our mathematical results depend on only the perceived-cost function being convex for *one* of the currencies (it can be both) for at least *part* of the range at issue. Second, the underlying cause for the convexity of a perceived-cost function (e.g., goal setting, wealth effects, relativistic processing, mental accounting and budgeting, risk aversion) has no impact on whether an optimal combined-currency price or its derivation can exist. In this research, we do not attempt to determine why the convexity occurs; what matters is only that some region of convexity in the perceived-cost function exists within the range of the expenditure for at least one of the currencies involved.

In practice, however, for combined-currency prices to be truly useful to the firm, two other conditions should be met. First, the firm should possess a transfer function or rate at which the firm values each mile surrendered that it uses to optimize globally over thousands of exchanges. This value has been reported to be \$.017 (WebFlyer.com 2002), but consumers most often believe that it is \$.02, the standard selling price for most airlines (Leonhardt 1999). Because airlines redeem more than one billion miles every day and there is a relatively small number of miles associated with any single promotion, we assume that there is a linear transfer function for ease of exposition, although a nonlinear function can work as well.

Second, consumers should not spontaneously convert charges issued in one currency to increments of the other currency, nor should they convert both charges simultaneously to some third currency. Nunes and Park's (2003) research on "incommensurate resources" suggests that consumers react to changes in alternative currencies much as they do to changes for money, yet they often do not spontaneously encode one currency in terms of another (e.g., frequent flier miles in dollar terms). Nunes and Park found that consumers made the conversion only when it was extremely easy to do so (e.g., a stable and salient exchange rate) or when they were extremely motivated to do so, as they might be for big-ticket expenditures. Consequently, just as mental accounting and mental budgeting (Heath and Soll 1996; Thaler 1985) demonstrate, consumers often behave as if their money were not perfectly fungible, and we expect that assets accounted for in different currencies have their own mental accounts and are similarly noninterchangeable. Raghubir and Srivastava (2002) suggest that even when an exchange rate between monetary currencies is transparent and overtly provided, consumers are still susceptible to biases in their conversions; although experience may attenuate a bias, it does not eliminate it.

Furthermore, differences in the aforementioned buy-and-sell rates and among various combined-currency prices (see Table 1) support the assumptions that (1) consumers do not always use the value of a mile to the seller or the value at some stable market rate when they evaluate combined-currency prices, and (2) a consumer's subjective value for miles is likely to change depending on the quantity to be acquired or surrendered. Taken together, previous research and observed real-world practices suggest that the necessary conditions exist for opportunistic sellers to use combined-currency prices to shift the balance of payments among currencies (i.e., combined-currency pricing). They can do so to minimize the psychological "pain" that consumers associate with a purchase.

Table 1  
SOME COMMON REWARDS AND THEIR VALUE IN DOLLARS ON 11/28/2001

Reward	Provider	Miles	Dollars	Exchange Rate
Palm Pilot VII	American Airlines/America Online	78,500	\$227 <sup>a</sup>	\$.0029
Admirals club membership (add a spouse)	American Airlines	40,000	\$300	\$.0075
\$500 of closing	American Airlines	25,000	\$150	\$.0060
Time magazine	Citibank Home Mortgage	25,000	\$500	\$.02
Upgrade award	MilePoint.com	900	\$24.95 <sup>b</sup>	\$.027
	United Airlines	2,000	\$125	\$.0625 <sup>c</sup>

<sup>a</sup>Average price on CNET.com.

<sup>b</sup>Subscription price for a half year at Time.com and price in miles for 27 issues.

<sup>c</sup>United's selling price for four 500-mile upgrades.

The remainder of this article is organized as follows: We present a formal mathematical proof that outlines the conditions in which a combined-currency price is superior and the conditions in which a price issued in one currency is superior. We outline how convexity in the perceived-cost functions for one of the currencies involved opens the door for a superior combined-currency price, either by minimizing the psychological cost associated with a given revenue objective or by maximizing the revenue collected given a particular psychological cost. The three studies that follow demonstrate that it is possible for consumers to prefer combined-currency prices, and the studies support the predictions derived from our proofs.

More specifically, in Study 1, results from a laboratory study imply that consumers may prefer a combined-currency price, particularly for prices that involve relatively small amounts of dollars and miles. In contrast, consumers favor single-currency prices for relatively high prices. In Study 2, we asked actual airline travelers to evaluate and choose among prices issued in single and combined currencies. The results illustrate how combined-currency prices can indeed be superior and how preferences shift systematically on the basis of the price magnitude. Study 1 is limited, in that respondents chose between a combined-currency price and one single-currency alternative, and we aggregated the results across respondents. In Study 2, we offered actual fliers a complete range of choices, yet prices varied by respondent and we aggregated the results across the range of prices. In Study 3, we replicated the principal results from Studies 1 and 2 using a within-subjects design and an identical, complete menu of pricing options. In addition, we applied a more rigorous test of the assumption of convexity for at least one of the currencies involved. We conclude by pointing out some of the limitations of our research, offering some managerial implications, and suggesting avenues for further research.

#### COMBINING CURRENCIES TO REDUCE PERCEIVED COST

In this section, we show how nonlinear valuations result in many cases in which marketers should charge prices in a mixture of currencies (i.e., combined-currency pricing) to secure a particular revenue objective with the least amount of psychological pain. We also describe situations in which a price charged in a single currency is optimal. We begin by examining the case in which the perceived-cost function for both currencies is concave, followed by the case in which both cost functions are convex. We extend the discussion by describing the case in which one is concave and the other is convex, and we conclude by describing the expected results when one currency's perceived-cost function is S-shaped.

For simplicity and ease of exposition, we work with only two currencies:  $C_1$  and  $C_2$ . We assume that the perceived-cost function for each increases monotonically (i.e., giving up more miles or dollars is worse; less of either is better) and that the company possesses a linear transfer function (i.e., exchange rate) for the two currencies (i.e., one unit of  $C_1$  is worth  $\alpha$  units of  $C_2$ ). Without loss of generality, we set  $\alpha = 1$ .<sup>3</sup> The firm's target price or revenue objective can be described as a combination of  $C_1$  and  $C_2$ , such that

$$(1) \quad c_1 + c_2 = r,$$

where  $c_i \geq 0$  is the amount to be paid in currency  $C_i$ . From the consumer's perspective, on the basis of our assumption that consumers do not convert the two currencies to any meaningful common unit of measurement, the subjective value of  $c_1$  and  $c_2$  vary independently. Thus, the subjective loss or psychological cost ( $E$ ) associated with surrendering some combination of  $c_1$  and  $c_2$  can be written as follows:

$$(2) \quad E = f(c_1) + g(c_2),$$

where  $f$  and  $g$  are strictly monotonically increasing continuous functions of  $c_1$  and  $c_2$ , respectively, defined over the interval  $[0, \infty)$  (i.e.,  $f' > 0$  and  $g' > 0$ ). Furthermore,  $f(0) = g(0) = 0$ , and  $f'$ ,  $g'$ ,  $f''$ , and  $g''$  exist over their whole domain.

Assume that the goal of the firm is to set a price that secures its revenue objective and minimizes the psychological cost to the consumer. Just as easily, the goal could be to maximize the revenue received given a fixed psychological cost, but practically speaking, we expect that firms begin with established revenue objectives, not perceived values, when developing combined-currency prices. Thus, the firm must solve the optimization problem:

$$(3) \quad \text{Min } E = f(c_1) + g(c_2), \text{ subject to: } c_1 \geq 0, c_2 \geq 0, \text{ and}$$

$$c_1 + c_2 = r.$$

A well-known mathematical result is that for any given  $r$ , the solutions  $(c_1^*, c_2^*)$  to Equation 3 are such that  $f'(c_1^*) = g'(c_2^*)$  for an interior solution, and  $f'(0) > g'(r)$  or  $g'(0) > f'(r)$  for a corner solution.<sup>4</sup> An interior solution gives rise to the combination of currencies, and a corner solution gives rise to a price assessed in only one currency. Therefore, the firm must determine when it is facing a corner solution and when it is facing an interior solution, which depends on the subjective valuations of consumers (i.e., the shape of their perceived-cost functions) for  $C_1$  and  $C_2$ .

We show mathematically when a firm should charge a combined-currency price issued in some combination of currencies  $C_1$  and  $C_2$ , rather than a price issued in one currency ( $C_1$  or  $C_2$  alone), to extract the revenue objective,  $r$ , with the minimum psychological cost to the consumer. We assume that  $f(r) \leq g(r)$ , purely for expositional purposes, because all claims can be transposed for situations in which  $g(r) < f(r)$ . We proceed by examining the case in which the perceived-cost functions for both currencies are concave and then examining the case in which both are convex. We then examine the case in which  $f$  is strictly concave and  $g$  is strictly convex over  $[0, r]$  as well as the case in which  $f$  is strictly concave and  $g$  is S-shaped over  $[0, r]$ .

#### Case 1: Both $f$ and $g$ Are Strictly Concave over $[0, r]$

Consider the case of John, a project engineer who travels frequently for work and has traveled more than 100,000 airline miles in the past year. He lives comfortably on his \$100,000 annual salary. For John, paying 5000 miles or \$50 more or less for most things does not likely mean much. In other words, whether he buys an airline ticket using dollars or miles, in general, he is less sensitive to the marginal value attached to changes in both currencies (i.e., in this case, both perceived-cost functions are concave).

<sup>3</sup>We can always set  $c_1 = c_2 = \alpha c_2$ .

<sup>4</sup>A formal proof of this is available from the authors.

Proposition 1: When both  $f$  and  $g$  are strictly concave (i.e.,  $f' > 0$ ,  $g' > 0$  and  $f'' < 0$ ,  $g'' < 0$ ), there exists a corner solution  $(r, 0)$ ; the price should be assessed entirely in one currency ( $C_1$ ).

We proceed in two steps to prove Proposition 1. First, we show that when both  $f$  and  $g$  are strictly concave, there are no interior solutions. Second, we show that when  $f(r) \leq g(r)$ ,  $(r, 0)$  is optimal.

Step 1. There are no interior solutions. If there were an interior solution,  $(c_1^*, c_2^*)$ , then

$$\begin{aligned} f'(c_1^*) &= g'(c_2^*); \\ f'' < 0 &\Rightarrow \forall \epsilon > 0, f'(c_1^* - \epsilon) > f'(c_1^*); \\ g'' < 0 &\Rightarrow \forall \epsilon > 0, g'(c_2^* + \epsilon) < g'(c_2^*) \\ &\Rightarrow f'(c_1^* - \epsilon) > g'(c_2^* + \epsilon) \\ &\Rightarrow f(c_1^* - \epsilon) + g(c_2^* + \epsilon) < f(c_1^*) + g(c_2^*). \end{aligned}$$

The last inequality contradicts the premise that  $(c_1^*, c_2^*)$  minimizes  $E$ , because  $(c_1^* - \epsilon, c_2^* + \epsilon)$  is a better solution, and  $c_1^* - \epsilon + c_2^* + \epsilon = c_1^* + c_2^*$ . Thus, no interior solutions exist when both  $f$  and  $g$  are strictly concave. Q.E.D.

Step 2. If  $f(r) \leq g(r)$ , then  $(r, 0)$  is optimal. If there are no interior solutions, then either  $(r, 0)$  or  $(0, r)$  is optimal. It follows that  $(r, 0)$  is optimal when  $f(r) \leq g(r)$ .

Thus, when the psychological costs associated with each currency are strictly concave, the seller's decision is simple. For any given desired revenue, the price charged should be in one currency, the one that customers value least for the associated level of expenditure  $r$ . For any level of revenue, one currency will always weakly dominate the other. However, the best currency may differ depending on the desired level of revenue, because the concavity of the cost functions need not be the same. In Figure 1,  $C_2$  should be used for amounts less than 30, the point at which  $f(r) = g(r)$ , and  $C_1$  should be used for amounts greater than 30. In other words, if John is faced with a choice of paying \$189, \$39 and 16,000 miles, or 20,160 miles, we expect that he would prefer to pay in either all dollars or all miles, depending on which currency he values less in that price range.

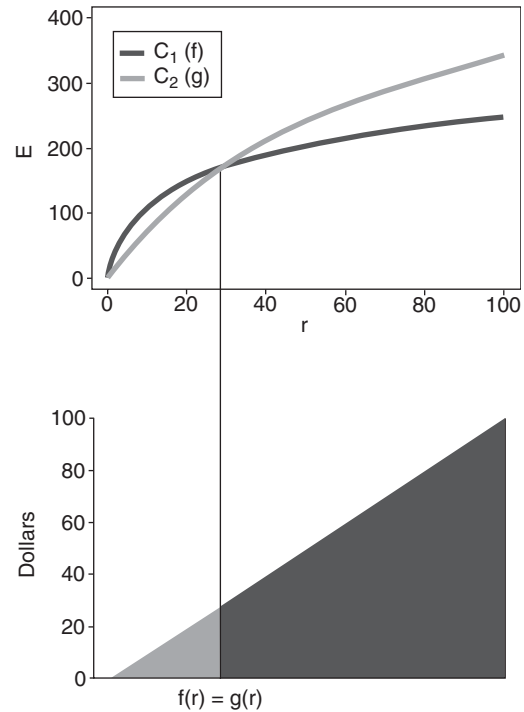
A corollary to this result is the following: For a consumer to prefer a combined-currency price to a pure payment (one made in either currency alone), the psychological cost for the consumer must be convex over at least part of  $[0, r]$ . Therefore, we now examine cases in which the perceived-cost function of either both currencies or only one currency is convex.

*Case 2: Both  $f$  and  $g$  Are Strictly Convex over  $[0, r]$*

Suppose that John plans to get engaged in a few months and begins to divert discretionary funds toward saving to buy his fiancée a sizable diamond engagement ring (\$9,000). Simultaneously, he begins his quest to accumulate enough miles to upgrade the couple from coach to first class on a honeymoon trip to Brazil (100,000 miles). Suddenly, he is more sensitive to spending either an additional \$50 or 5000 miles, because relinquishing either might hinder or thwart his progress toward his goals. John now attaches increasing marginal disutility to expenditures in both currencies.<sup>5</sup>

<sup>5</sup>Although we discuss how goals can create increasing marginal sensitivity, we note that similar effects may stem from changes in income or mileage accruals.

Figure 1  
CONCAVE-CONCAVE (PSYCHOLOGICAL COSTS AND OPTIMAL PRICES)



Proposition 2: When both  $f$  and  $g$  are strictly convex, a corner solution exists only if  $g'(0) \geq f'(r)$ .

When  $g'(0) \geq f'(r)$ , a price issued in a single currency is optimal.

Situation 1: If  $g'(0) \geq f'(r)$ , then  $(r, 0)$  is a corner solution.

$$\begin{aligned} \text{Proof: } g'' > 0 &\Rightarrow g'(\epsilon) > f'(r), \forall \epsilon > 0; \\ f'' > 0 &\Rightarrow f'(r - \epsilon) < f'(r), \forall \epsilon > 0 \\ &\Rightarrow g(\epsilon) + f(r - \epsilon) > f(r). \text{ Q.E.D.} \end{aligned}$$

When  $g'(0) < f'(r)$ , a combined-currency price is optimal.

Situation 2: If  $g'(0) < f'(r)$ , there are no corner solutions.

$$\begin{aligned} \text{Proof: Because } g(r) > f(r), &(0, r) \text{ is not an optimal solution. Furthermore, } (r, 0) \text{ is not optimal either} \\ &\text{because } g'(0) < f'(r) \Rightarrow \exists \epsilon > 0 : g(\epsilon) + f(r - \epsilon) < \\ &g(0) + f(r). \text{ Q.E.D.} \end{aligned}$$

Thus, when  $g'(0) < f'(r)$ , the optimal solution is to use both currencies to minimize the perceived or psychological cost (see Figure 2).

In this case, it is not known whether John would prefer to pay in a single currency or to split his payments. He may want to preserve miles because they are relatively harder to come by (he receives a regular paycheck but flies intermittently) and favor paying in all dollars whenever he can. In contrast, he may not quibble about small amounts of miles if he flies often and favor combined prices that do not tax his frequent flier account. The important point is that unlike the

Figure 2

CONVEX-CONVEX (PSYCHOLOGICAL COSTS AND OPTIMAL PRICES)

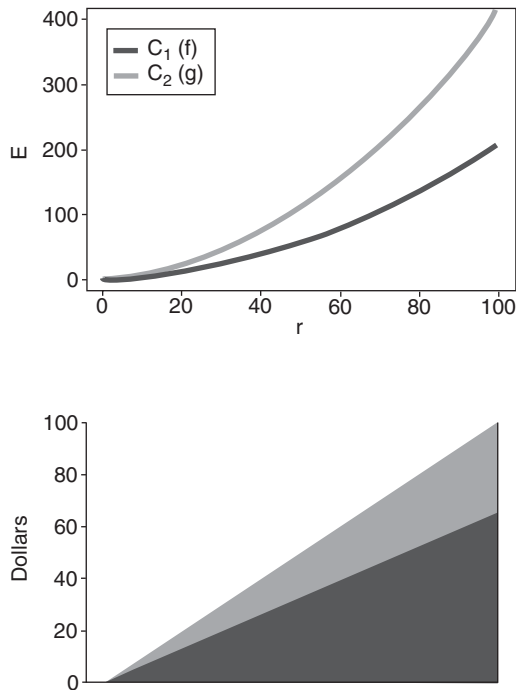
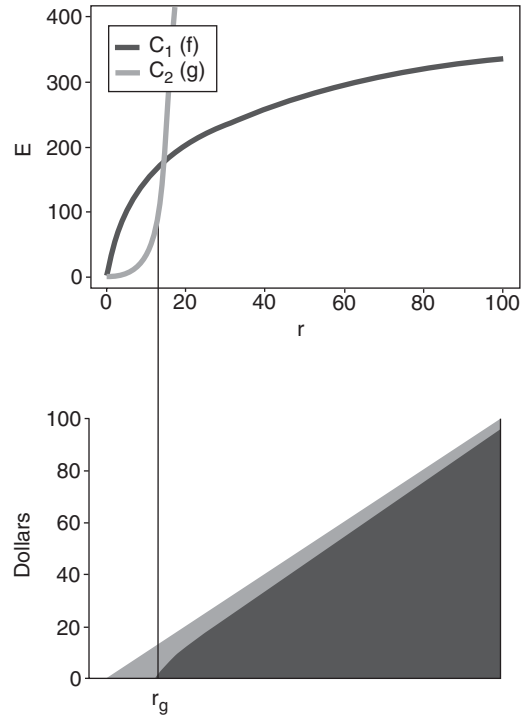


Figure 3

CONCAVE-CONVEX (PSYCHOLOGICAL COSTS AND OPTIMAL PRICES)



concave-concave case, even if he behaves optimally, he may prefer a combined price.

*Case 3: Either f or g Is Concave but the Other Is Convex over [0, r]*

Consider now that John has purchased the ring but is still several thousand miles short of being able to redeem miles for the first-class upgrades to Brazil. His fiancée’s parents are paying for the wedding, so the disutility of each dollar he spends has diminished, but the psychological cost of each mile spent (taking him away from his goal) continues to increase as he nears the 100,000-mile mark that is necessary to receive the upgrades.

We examine the case in which  $f$  is strictly concave and  $g$  is strictly convex over  $[0, r]$ . When one of the two functions is concave ( $f$ ) and the other is convex ( $g$ ), there are three possible optimal situations: (1) a corner solution  $(0, r_g) \forall r_g : g'(r_g) \leq f'(0)$ , (2) a corner solution  $(r_f, 0) \forall r_f : f'(r_f) \leq g'(0)$  and  $f(r_f) \leq g(r_f)$ , and (3) an interior solution in all other cases.

To understand more fully when each situation might apply, we examine what happens to  $E$  as  $r$  increases. At 0, no payment is made in either currency. If  $f'(0) \leq g'(0)$ , all payments are always made in  $C_1$  (Situation 2), because  $f(r) < g(r)$  and  $\int_0^r g'(x)dx > \int_{r-\epsilon}^r f'(x)dx$  for  $\forall \epsilon < r$ . This is a rather uninteresting case. In contrast, when  $f'(0) > g'(0)$ , Situation 1 applies, in which all payments are made in  $C_2$ . As  $r$  increases, Situation 3 applies, in which payments are made in some combination of  $C_1$  and  $C_2$ , and then progresses into Situation 2, in which all payments are made in  $C_1$ .

When  $r$  moves away from zero, the firm will be better off asking for payment in only  $C_2$ , because  $g'(x) < f'(0), \forall x < r_g$ . This holds true until  $g'(r_g) = f'(0)$  (because  $g'' > 0$ , this cannot hold indefinitely). As is shown in Figure 3, after  $r_g$ , the firm minimizes the psychological cost to the consumer by asking for payments in a combination of both currencies ( $C_1$  and  $C_2$ ), because  $f'(\epsilon) < g'(r - \epsilon)$ . As  $r$  increases, the firm reduces the amount to be paid in  $C_2$  and increase the amount to be paid in  $C_1$  until  $r_f$ , the point at which the portion of the payments made in  $C_2$  shrink to zero. For any amount larger than  $r_f$ , firms should request payment only in  $C_1$ .

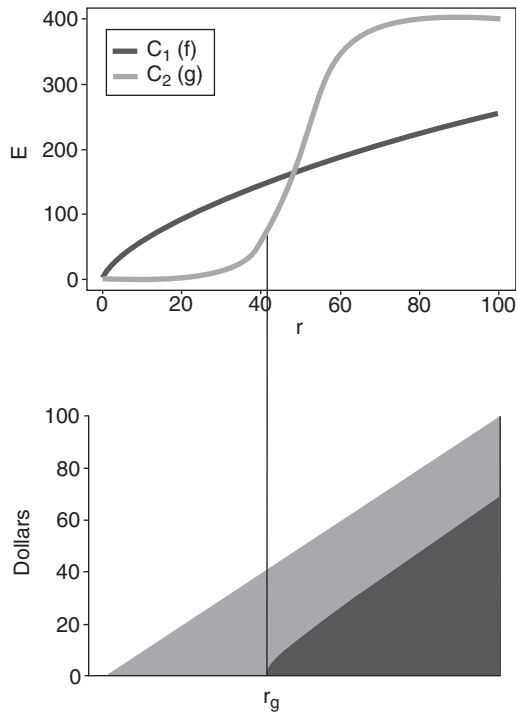
In this case, John may prefer to part with small amounts of miles (e.g., 1000) but to pay cash for a shuttle ticket rather than give up 25,000 miles, which would seriously affect his progress toward the free first-class upgrades. If he had accumulated the necessary miles but not paid off the ring, we would expect the opposite: He would prefer to use miles and apply the equivalent sum in cash toward the ring.

*Case 4: Either f or g Is S-Shaped but the Other Is Concave or Convex over [0, r]*

In Case 4, we examine two extensions: (1) when  $f$  is strictly concave and  $g$  is S-shaped over  $[0, r]$  (see Figure 4) and (2) when  $f$  is S-shaped and  $g$  is strictly convex over  $[0, r]$ . When  $f$  is concave and  $g$  is S-shaped over  $[0, r]$ , the form of payment depends on the derivatives of  $f$  and  $g$  at 0.

Situation 1: If  $f'(0) \leq g'(0)$ , we revert to the concave-concave situation, that is, corner solutions in which payments are made exclusively in

Figure 4  
CONCAVE-S-SHAPED (PSYCHOLOGICAL COSTS AND OPTIMAL PRICES)



$C_1$  or  $C_2$ , depending on whether  $f(r)$  is smaller than  $g(r)$ .<sup>6</sup>

Situation 2: If  $g'(0) < f'(0)$ , there is a situation analogous to the concave-convex case, in which there is (1) a corner solution  $(0, r_g) \forall r : g'(r_g) \leq f'(0)$ , (2) a corner solution  $(r_f, 0) \forall r_f : f(r_f) < g(r_f)$  and  $f'(r_f) < g'(0)$ , and (3) an interior solution in all other cases.

When  $f$  is S-shaped and  $g$  is strictly convex over  $[0, r]$ , the solution depends on the derivative of  $g$  at its inflection point. If  $g'(\text{inflection}) \leq f'(0)$ , the situation is analogous to the concave-convex case, in which  $f'(0) < g'(0)$ . All payments should always be charged in  $C_1$ . If  $g'(\text{inflection}) > f'(0)$ , there are three payment schedules: (1) split payment increases in both  $C_1$  and  $C_2$  (à la the convex-convex case) up to the point at which  $f'(c_{1r}) = g'(c_{2r}) = g'(\text{inflection})$ , (2) split payment increases in  $C_1$  and decreases in  $C_2$  (à la the concave-convex case) up to the point at which  $f'(r_f) = g'(0)$ , and (3) payment in  $C_1$  only (corner solution) for  $r_f : f'(r_f) < g'(0)$ . We also point out that when both  $f$  and  $g$  are S-shaped over  $[0, r]$ , the situation is analogous to the S-shaped convex case.

<sup>6</sup>Situation 1 is a special case in which even though  $g$  is S-shaped, its slope at the origin is steeper than the slope of  $f$  at that point ( $f'(0) \leq g'(0)$ ). This results in the convex portion of  $g$  to be greater than  $f$ . Thus,  $f'(x)$  in the convex portion of the S is always greater than  $g'(y)$ , regardless of the value of  $y$ . This yields a result such that it will never pay to split payments between  $C_1$  and  $C_2$ .

A primary goal of our research is to show that in many cases, the optimal price in terms of minimizing the perceived cost to the consumer entails setting a price that combines  $C_1$  and  $C_2$ . This can easily occur when the amount charged in  $C_1$  falls in the concave region of its S-shaped perceived-cost function and the charge in  $C_2$  falls in the convex region. In Study 1, we illustrate how the subjective value that consumers ascribe to different amounts of an individual currency (i.e., money and miles) appears not to be linear, resulting in a situation in which both interior and corner solutions can exist at different points over the range of prices for the same two currencies.

### STUDY 1

As we described previously, given two currencies, if the consumer's perceived-cost function includes a convex region for one currency, the firm can impose the minimum psychological cost associated with a particular revenue objective through the use of a combined-currency price. Study 1 is designed to illustrate two key points. First, for dollars and frequent flier miles, we show that an interior solution can exist such that consumers prefer a combined-currency price. We expect to observe signs of increasing marginal disutility for miles and/or money when consumers prefer this type of pricing structure. Second, we show that a corner solution can also exist in which a price in one of the currencies dominates.

### Method

*Subjects.* Study 1 participants were 670 undergraduate business students enrolled in an introductory marketing course at a major West Coast university. Of the 670 students, 363, or 58% of participants, reported possessing an active frequent flier account that contained miles. We limited our analysis to these participants' responses in an attempt to ensure that our results would reflect choices only from airline loyalty program members who had experience collecting miles.<sup>7</sup>

*Stimuli and design.* Participants completed a scenario-based, paper-and-pencil study in which they were asked to imagine that they were purchasing an airline ticket with either dollars or frequent flier miles. At the onset of the experiment, each respondent was asked whether he or she had a frequent flier account and, if so, to indicate how many miles were in the largest account possessed. This enabled us to control for experience with the alternative currency.

Participants were subsequently instructed to disregard their personal accounts and to assume that they possessed enough miles and money to accommodate whichever pricing option they preferred. The cost of the ticket was either low (\$250 or 25,000 miles) or high (\$1,000 or 100,000 miles). The base price did not include a mandatory surcharge, which could be paid in either dollars (\$50) or miles (5000). A pilot test found that respondents from the same sample population valued 5000 miles at approximately \$50, or \$.01 per mile, which was consistent with our expectations. Respondents' task was to choose between pricing schedules, which included the surcharge in either dollars or

<sup>7</sup>An analysis of the data that includes all respondents gave equivalent results.

miles. The scenario with miles as the base cost read as follows:

You are on the phone with an airline, securing a round-trip ticket across country to attend the funeral of an uncle you really liked and admired. While you can't leave town for two days, you must pay for the ticket today. The price of the ticket is 25,000 [100,000] miles. The agent on the phone tells you that in order to have your ticket request expedited, which would be necessary to receive your ticket in time for your departure, you will need to surrender either an additional 5000 miles or pay \$50. How would you prefer to pay?

25,000 + \$50 \_\_\_\_\_      25,000 + 5000 miles \_\_\_\_\_

An additional choice scenario required respondents to choose between paying entirely in dollars and entirely in miles. The basic scenario read as follows:

You are on the phone with an airline, securing a round-trip ticket across country to attend the funeral of an uncle you really liked and admired. While you can't leave town for two days, you must pay for the ticket today. There are two possible price combinations with which you can pay for your ticket. First, you can pay \$250 [\$1,000] for the ticket plus an extra \$50 to have your ticket order expedited, which would be necessary to receive your ticket in time for your departure. Or you can surrender 25,000 [100,000] miles for the ticket and an additional 5000 miles to have your ticket expedited. How would you prefer to pay?

The remaining two choice combinations were included for completeness, which forced respondents to choose between paying either \$250 + 5000 miles or 25,000 miles + \$50 and \$1,000 + 5000 miles or 100,000 miles + \$50. Several participants received more than one of the choices, which we rotated and counterbalanced.

If respondents possessed a linear transfer function between money and miles and the exchange rate was constant at 1 mile = \$.01, they should have always been indifferent between the two pricing schedules. If the perceived-cost function was linear and, on average, respondents valued each mile at more (less) than \$.01, they should always prefer to pay the price that includes more (less) money. However, we predicted that for relatively small revenue objec-

tives or prices (\$250 or 25,000 miles), respondents would prefer a combination of miles and dollars to payments exclusively in one currency, requiring convexity for one of the currencies in the range. This implies an interior solution. In contrast, when the revenue objective was relatively large (\$1,000 or 100,000 miles), we expected respondents to prefer paying in one currency alone, which would imply concavity in this region. This implies a corner solution. Note that this pattern of results is consistent with an S-shaped perceived-cost function for miles, money, or both.

### Results

The results are summarized in Table 2. As we predicted for Part 1, for payments in the "relatively low total cost" conditions, a significant majority of respondents preferred the combined-currency prices to charges issued in a single currency. This suggests that for expenditures that involve only 5000 miles, respondents preferred to pay in miles, but for expenditures that require from 25,000 to 30,000 miles, respondents preferred to pay in dollars. This result suggests that the marginal value of miles increases at an increasing rate (convexity).

Conversely, in the "relatively high total cost" conditions, respondents preferred to pay in a single currency (i.e., \$1,050 and 105,000 miles, respectively), which implies that the incremental 5000 miles is worth more alone than it is when added to 100,000 miles, or that the value of miles increases at a decreasing rate (concavity). These results conform to the predictions from our mathematical proofs and are consistent with an S-shaped perceived-cost function for miles. If the perceived-cost function is convex over small amounts of miles, and the perceived-cost function for money is assumed to be concave, we expect an interior solution (respondents prefer to pay in bundles of money and miles) rather than a corner solution (respondents prefer to pay solely in either money or miles). Indeed, a combined-currency price is preferred in this range. Given that the perceived-cost function appears concave for large amount of miles, we expect that a single currency is preferred in the \$1,000 and 100,000 mile conditions. In this range, most respondents prefer prices in one currency alone (a corner solution). We should point out that this pattern of results is also consistent with two S-shaped cost functions or two con-

Table 2  
STUDY 1: PERCENTAGE PREFERRING PURE VERSUS COMBINED-CURRENCY PRICES

Condition	Percentage Preferring Payment Option		
	Part 1	Part 2	Part 3
<i>Relatively Low Total Cost (\$300 or 30,000 miles)</i>			
\$250 and \$50	30%	75%	
\$250 and 5000 miles	70% (63)*		75%
25,000 miles and \$50	65%		25% (59)*
25,000 and 5000 miles	35% (63)**	25% (55)*	
<i>Relatively High Total Cost (\$1,050 or 105,000 miles)</i>			
\$1,000 and \$50	79%	18%	
\$1,000 and 5000 miles	21% (63)*		16%
100,000 miles and \$50	30%		85% (61)*
100,000 and 5000 miles	70% (63)*	82% (63)*	

Notes: Numbers in parentheses indicate the number of responses for each pair. Responses exceed the number of participants, because many responded to more than one choice question. Pairs with \* differ significantly at  $p < .01$ . Pairs with \*\* differ significantly at  $p < .05$ .



vex cost functions, in which the value of money increases more quickly than that of miles.

Note that when people are limited to single-currency prices for relatively small amounts (\$300, 30,000 miles), they prefer to pay entirely in dollars. In contrast, for relatively high prices (\$1,050, 105,000 miles), people prefer to pay exclusively in miles (see Table 2, Part 2). This implies that respondents' valuation for dollars increased more quickly than for miles as the amount to be spent increased. When respondents were forced to choose between combined-currency prices (see Table 2, Part 3) for relatively small amounts, they favored the payment that principally comprised dollars (75% versus 25%). The converse was true when the combined-currency prices were relatively high (\$1,000 and 5000 miles versus 100,000 miles and \$50), and far more respondents preferred the pricing schedule that principally comprised miles (85% versus 15%). Although the exact point at which people switched from a preference to paying in dollars to a preference to paying in miles may have depended on the exchange rate we used (\$.01), we expect that the general result holds: The exchange rate between the two currencies among consumers is not constant.

To rule out the possibility that subjects' current frequent flier mile holdings influenced our results, we ran a separate analysis of variance for each choice, in which we compared the average number of miles held by respondents who favored one option with the average number held by respondents who favored the other option. None of the comparisons was significant ( $p$ -values ranged from .12 to .96; average  $p$ -value = .58), suggesting that the decision did not depend on the number of miles in respondents' accounts.

### Discussion

The results from Study 1 illustrate how an interior solution can exist and result in a case in which consumers prefer a combined-currency price. Although we are not certain that the perceived-cost function is convex for miles, money, or both, we have mathematically demonstrated that convexity must exist for one or both currencies in the low-cost (\$300/30,000 mile) range. This convexity may continue into the relatively high-cost range (\$1,050/105,000 mile), though the preference for single-currency prices among most subjects is also consistent with both functions being concave in this range, which suggests an S-shaped perceived-cost function for one of the currencies, which we suspect is miles.

A potential alternative explanation for the results is "relativistic processing."<sup>8</sup> If we assume that 5000 miles appears equal to or greater when evaluated simultaneously with \$250 than with \$500, the reversal in Part 1 of Table 2 (a preference to pay 5000 miles rather than \$50 on top of \$250, yet \$50 rather than 5000 miles on top of \$1,000) may be because \$50 appears to be worth more on top of \$250 than it is on top of \$500. Similarly, if we assume that \$50 appears to be greater when it is evaluated simultaneously with 25,000 miles than with 100,000 miles, the choice shifts can be explained by either the increasing disutility of money or the decreasing disutility of miles. It follows that the necessary condition for the results from Part 2 to be consistent with this explanation is that the shrinkage from relativistic

processing must be larger for miles than for money. In turn, for the results for Part 3 to remain consistent, the cross-currency shrinkage must be larger for money than for miles. However, the findings that Nunes and Park (2003) report contradict the necessary assumptions that respondents evaluate incremental charges in miles in terms of a base expense in dollars, and vice versa.

### STUDY 2

In Study 1, respondents were undergraduates, albeit business students, whose relative inexperience with transactions involving miles may have affected their decision making. Respondents chose among price schedules similar to those that airlines offer (e.g., \$189 or \$39 and 16,000 miles) and not a full range of options, which would include both single-currency prices and the combined-currency price. In Study 2, we extend the results of Study 1 by (1) surveying members of a particularly relevant test population, (2) allowing respondents to choose between the combined-currency price or *either* of the two currencies involved (money or miles), and (3) examining how their preferences shift as the revenue objective represented by the pricing options changes. We determined the revenue objective by the actual price of the ticket held by the flier surveyed.

Given our findings from Study 1, we hypothesized that people's preferences for combined-currency prices diminishes as the revenue objective increases and that consumers who favor a single-currency price prefer to pay in dollars for relatively low-priced tickets but in miles for relatively high-priced tickets. Recall that in Study 1, when people were limited to single-currency prices, they preferred to pay entirely in dollars for small amounts but entirely in miles for large amounts, which suggests that their valuation for miles diminished more quickly than for dollars as the amount to be spent increased.

### Method

*Subjects.* We ran this experiment in a real-world setting in an attempt to ensure external validity. Participants were 164 passengers on commercial flights that were scheduled to depart from a major West Coast airport. The passengers were approached at the airport before their departure and asked to participate voluntarily in an academic study of airline-ticket purchasing behavior. Participants were screened on the basis of whether they maintained a frequent flier account in which they accrued miles: Only those who possessed frequent flier accounts participated. Again, we expected a significant proportion of fliers to favor a combined-currency price.

*Stimuli and design.* At the onset of the experiment, respondents were asked to recall what they had paid for the ticket that brought them to the airport at the time of the survey (all participants were waiting to take a flight when asked to participate). After they stated the price paid in either dollars or miles (only two fliers redeemed miles), the experimenter, unbeknownst to the respondent, converted this amount to both an equivalent price in the opposing currency at a rate of \$.02 per mile (e.g., \$200 and 10,000 miles) and a combined price with 50% paid in each currency (e.g., \$100 and 5000 miles). For simplicity, we limited the choices to dollars only, 50% dollars/50% miles, or miles only. The participant was then asked which of the three prices they would have preferred to pay if they had been offered the choice (i.e., \$200, \$100 and 5000 miles, or 10,000 miles).

<sup>8</sup>The authors thank an anonymous reviewer for raising this alternative explanation.

## Results

Overall, we found that 24% of respondents preferred to pay in dollars only; 34% preferred to pay in miles only; and 42%, or the largest segment of travelers surveyed, preferred to pay in a combination of currencies (see Figure 5). A primary goal of Study 2 was to explore how and when people's preferences shift among pricing options (dollars only, a combined-currency price, or miles only) across the various amounts to be paid. Therefore, we examined the probability that a person surveyed would choose a particular pricing option as a function of the price paid. We analyzed the data by fitting a multinomial logit model using choice, or the probability of choosing a particular pricing schedule, as the dependent measure and price as an independent variable. The choice of one payment option over the others varied significantly with price ( $\chi^2 = 18.23, p < .001$ ).

To interpret the results more easily, we computed the choice probability for tickets ranging from \$0 to \$2,500, the highest price reported among people we surveyed, and we graph them in Figure 6. As is shown in Figure 6, for small dollar amounts (price < approximately \$300), straight dollar payments were the most likely option. For intermediate ticket values (\$300 < price < \$1,200), respondents preferred mixed payments. Finally, for relatively more expensive tickets (price > \$1,200), respondents preferred to purchase the tickets using miles alone. Thus, we found support for our hypothesis, which is consistent with the results from Study 1 and our general framework.

We note two caveats about the interpretation and generalization of the results. First, we used an exchange rate of \$.02 per mile, which will affect the relative attractiveness of paying in miles rather than in dollars. A lower value, such as \$.01 per mile, would likely shift the curves depicted in Figure 6 to the right, such that respondents would prefer strict dollars payments over a larger domain and strict miles payments over a smaller domain. We would also expect that the net impact on mixed payments would shift to the right, but it is not possible to determine whether they would be preferred over a wider or narrower range of ticket prices without collecting more data. Second, the only form of combined-currency prices we investigated were equally bal-

Figure 5  
STUDY 2: COUNT OF CHOICES BY TICKET PRICES

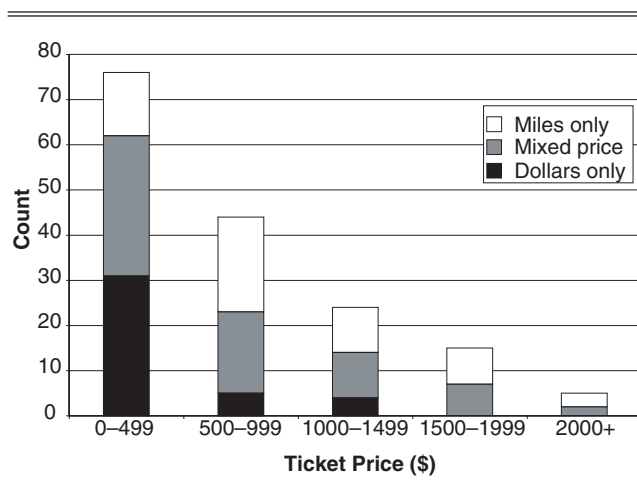
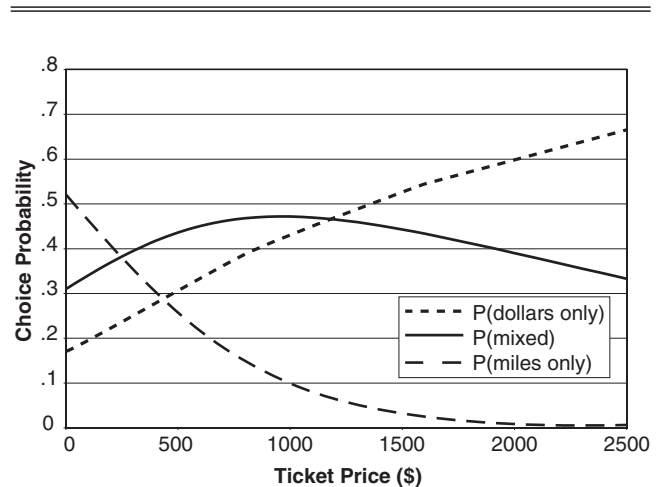


Figure 6  
STUDY 2: PROBABILITY OF CHOOSING A PARTICULAR PRICING PLAN AS A FUNCTION OF PRICE



anced, or a 50%/50% split. It is possible that respondents would prefer other forms (e.g., 80%/20%) to any of the three forms tested (we investigate this further in Study 3). Thus, it is likely that the range of prices over which consumers prefer a combined-currency price is wider than is highlighted by our experiment.

## Discussion

The results from Study 2 reinforce the notion that a combined-currency price can be the preferred option among consumers. The results also suggest that preferences among competing price schedules can depend on the amount consumers intend to spend. Just as in Study 1, the preference to pay primarily in dollars is at the low end, and the preference to pay primarily in miles is at the high end. In the middle range, combined-currency prices are most widely favored. However, in Studies 1 and 2, the results emerge from data aggregated across decision makers. Therefore, we are not certain that the same patterns hold at the individual level.

## STUDY 3

Study 3 addresses many of the limitations of Studies 1 and 2 by using a within-subjects design in which respondents, who were all frequent fliers with sizable mile accounts, rank-ordered the same set of price schedules, including both single-currency price options and several different combined-currency options. Although we do not explore how the revenue objective (i.e., price level) affects choice in this study, we apply a far more rigorous test of the assumption of convexity for each consumer's set of preferences.

## Method

**Subjects.** Participants in this study were 113 full-time MBA students at a major West Coast university. Of the surveyed participants, 14 did not possess frequent flier accounts, and thus we excluded them from the analysis. The average number of programs in which the remaining 99 respondents were enrolled was 2.5 (median = 3), and they had accrued miles for an average of 7.5 years (median = 6).

At the time of the survey, participants possessed an average of 58,000 miles (median = 35,000) in their largest frequent flier account. At one time or another, each one of the 99 participants had flown using a ticket secured with miles. Consequently, our analysis includes only experienced fliers familiar with dealing in transactions involving frequent flier miles. All respondents participated voluntarily.

*Stimuli and design.* Respondents were first-year MBA students who were scheduled to participate in an overseas program at the conclusion of the spring 2002 semester in which they would visit one or more countries in the Asia Pacific region. The students had already purchased their travel packages through the university. Their package price did not separate out the charge for airfare (i.e., they did not know what they paid for their airfare), but the survey asked students to imagine that in the future, successive student groups (e.g., next year's class) would be offered the opportunity to buy their ticket separately.

In addition, participants were told that future groups might be able to choose from various prices that included payments made in frequent flier miles and/or dollars and that the program office wanted to gauge their preferences as an indicator for how to handle travel arrangements in the future (i.e., which price schedules to offer). Participants were instructed to assume that the flier would own enough miles to cover any option and that future participants would be able to travel on their preferred airline, no matter which option they favored. Respondents then ranked five price schedules in terms of their preferences (1 = "most preferred price" and 5 = "least preferred price"). The five price schedules presented were \$700, \$560 and 7000 miles, \$350 and 17,500 miles, \$140 and 28,000 miles, and 35,000 miles.

We intentionally set the design of Study 3 to reflect perfect colinearity between the two attributes (miles and dollars), because Equation 3 of our mathematical derivations depends on it. Our goal is to minimize the psychological cost to the consumer under the constraint that the revenue to the firm is constant ( $c_1 + c_2 = r$ ). Consequently, given a fixed exchange rate between miles and money for the firm (in our case, \$.02 per mile), we must keep the combination of dollars and  $$.02 \times$  miles equal to \$700, a price that is entirely in line with what the school actually paid for most tickets. Only by maintaining equivalency among the choices will an interior preference indicate convexity in the cost function.

*Results*

A straightforward way to test whether consumers have strictly concave valuations for both miles and money is to examine the sequence of the choices that people made. The rankings collected in Study 3 fall into 24 distinct response profiles (see Table 3). Consumers with strictly concave perceived-cost functions should pick one of the pure price options, either all miles (35,000) or all money (\$700), as their first choice. For example, a respondent who picks \$700 as the most preferred option must then choose between \$560 and 7000 miles, \$350 and 17,500 miles, \$140 and 28,000 miles, or 35,000 miles. The only options consistent with concavity are \$560 and 7000 miles and 35,000 miles. Note that \$560 and 7000 miles becomes a corner solution when we remove the all-dollar option; the other two combinations are still interior solutions. If the participant picks all miles as his or her second choice, he or she makes the subsequent choice from among \$560 and 7000 miles, \$350 and 17,500 miles, and \$140 and 28,000 miles, whereby \$560 and 7000

Table 3  
STUDY 3: RESPONSE PROFILES

Profile	\$700	\$560 and 7000 Miles	\$350 and 17,500 Miles	\$140 and 28,000 Miles	35,000 Miles	Number of Respondents	Interior	Concave-Concave
1	3	1	5	2	4	25	Y	N <sup>a</sup>
2	5	4	3	2	1	20	N	Y
3	4	2	5	1	3	11	Y	N
4	1	2	3	4	5	7	N	Y
5	4	1	3	2	5	7	Y	N
6	5	1	4	2	3	4	Y	N
7	5	4	3	1	2	3	Y	N
8	2	1	3	4	5	2	Y	N
9	3	1	2	4	5	2	Y	N
10	5	1	2	3	4	2	Y	N
11	5	1	2	4	3	2	Y	N
12	5	4	1	2	3	2	Y	N
13	1	3	4	5	2	1	N	Y
14	2	3	4	5	1	1	N	Y
15	2	4	1	3	5	1	Y	N
16	3	2	1	4	5	1	Y	N
17	3	2	4	5	1	1	N	N
18	3	4	2	1	5	1	Y	N
19	3	5	4	1	2	1	Y	N
20	3	5	4	2	1	1	N	Y
21	4	3	2	1	5	1	Y	N
22	4	3	5	2	1	1	N	N
23	5	2	1	4	3	1	Y	N
24	5	4	2	1	3	1	Y	N
First Choice	8 <sup>b</sup>	44	5	18	24	99		

<sup>a</sup>25 respondents rank-ordered the five prices from most favored to least favored as \$560 and 7000 miles, \$140 and 28,000 miles, \$700, 35,000 miles, and \$350 and 17,500 miles. The preferred price bundle is an interior point. For optimal choices, it cannot occur if both currencies exhibit concave utility functions.

<sup>b</sup>8 of 99 respondents chose \$700 as their preferred form of payment.

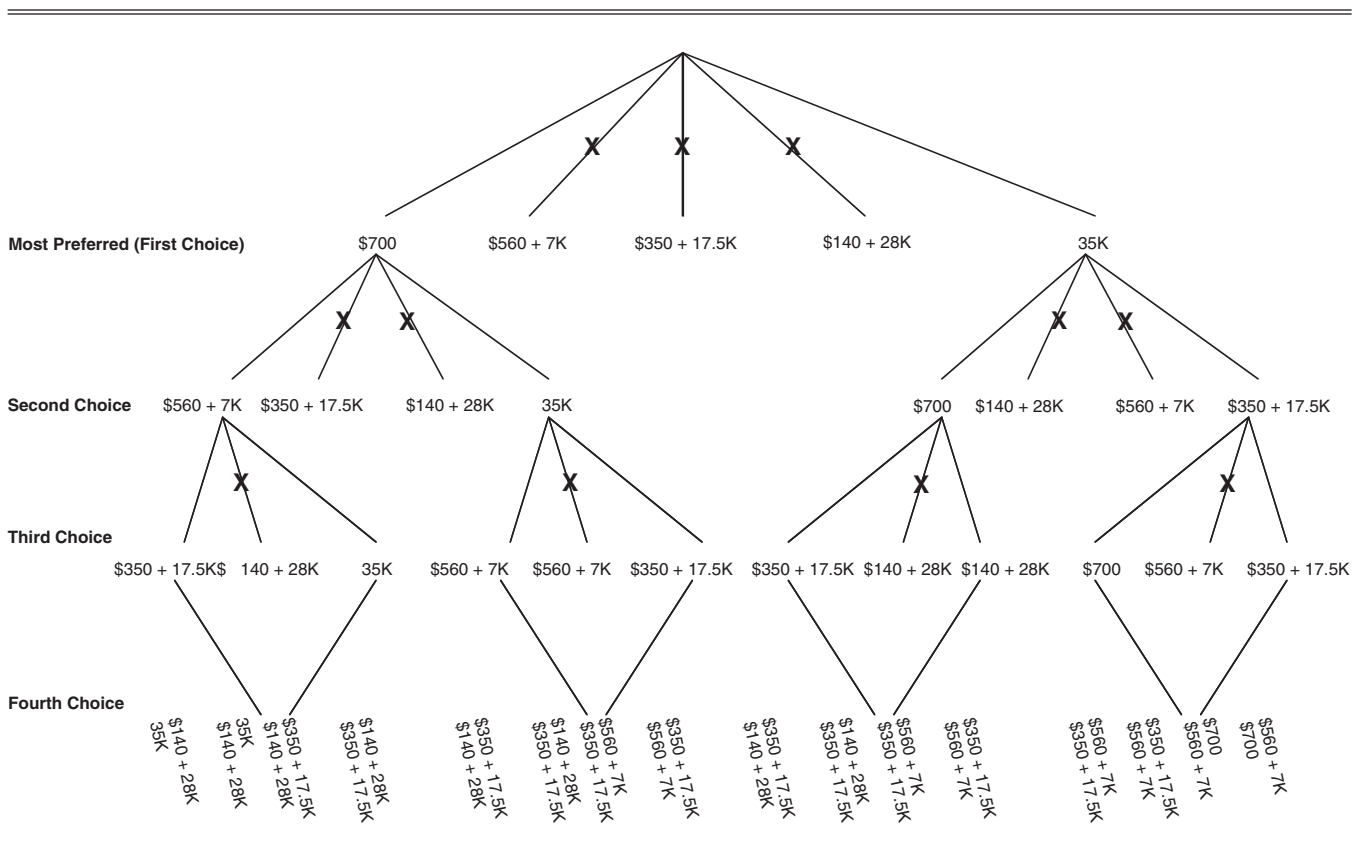
miles and \$140 and 28,000 miles are consistent with concave-concave perceived-cost functions, and \$350 and 17,500 miles is not.

Although there are 5! or 120 different possible rankings, the decision tree in Figure 7 enumerates the orderings that are consistent with concave-concave perceived-cost functions. Of the 120 patterns, only 16 (the bottom of the decision tree) conform to strict concave-concave value functions. As is shown in the top row of the decision tree, when participants are presented with the five price options, if they have concave perceived-cost functions for both miles and money, their first choice must be either all dollars or all miles, because the other three options (mixed payments) are inconsistent with the assumptions (thus, the Xs on those branches in Figure 7). As is shown in Table 3, only 32 respondents (Profiles 2, 4, 13, 14, 17, 20, and 22) exhibit a corner solution (i.e., respondents' most preferred price involves payment in a single currency), whereas the majority (67 of 99) prefer a combined-currency price. Comparing the decision tree to the response profiles in Table 3, we determined that only five profiles (2, 4, 13, 14, and 20), comprising 30 respondents, conform entirely to the requirements for concave-concave perceived-cost functions. The respondent in Profile 17 was inconsistent in his or her second choice, and the Profile 22 respondent was inconsistent in his or her third choice. Therefore, the pattern of choices for 69 of the 99 respondents (70%) is inconsistent with concave perceived-cost curves for both currencies, which implies convexity.

Note that even if we apply a more lenient and thus conservative test in which we allow respondents to have one inconsistency in their rankings, we still find that only 38 people's profiles conform to orderings that indicate concave-concave perceived-cost functions. In other words, 60% of respondents have two or three inconsistencies in their rankings, and three is the maximum number of inconsistencies a respondent can make, because the last two choices are inherently consistent (i.e., de facto corner solutions). In addition, the results are inconsistent with the notion of a constant \$.02 per mile valuation and with linear perceived-cost functions in general. If respondents valued each mile at exactly \$.02, they should be indifferent, because all five are equivalent at that exchange rate, and thus all pricing options should be picked in approximately the same proportion. We can safely reject the possibility that people were indifferent ( $p < .0001$ ) if we examine the distribution of first choices (see the last row of Table 3). If people have linear perceived-cost functions and an exchange rate such that they value each mile at more than \$.02, they will pick \$700 as their first choice and sequentially favor the pricing option with the majority to be paid in dollars (Table 3, Profile 4 [7 people]). Conversely, if they value each mile at less than \$.02, they will pick 35,000 miles as their first choice and sequentially favor the pricing option with the majority in miles (Table 3, Profile 2 [20 people]).

Given the options presented to respondents, their choices enable us to infer whether they have strictly concave perceived-cost functions, linear perceived-cost functions, or

Figure 7  
DECISION TREE



perceived-cost functions with some convexity. The results lead us to reject the hypothesis that respondents possessed strictly linear or concave perceived-cost functions. There is ample evidence that most of them exhibited convexity. We should point out that the data are also consistent with an S-shaped cost function for miles, but many more choice options would be required to distinguish between a convex and an S-shaped perceived-cost function for miles, which is unnecessary for our purposes. Furthermore, as a testament to respondents' adhering to the instructions and as a sign that individual wealth effects do not appear to drive choice in this case, the average number of miles owned by respondents did not differ depending on whether they exhibited a corner solution or an interior solution ( $p = .21$ ).

### *Discussion*

In summary, the results from this study reveal a strong preference for an interior solution among experienced fliers, who chose from the identical, richer set of pricing options. Within the range of miles and dollars used, we can rule out concave-concave perceived-cost functions for the two-thirds of respondents who favored a combined-currency price. In addition, although a concave-concave scenario can apply to 30 of the 32 respondents who favored a corner solution, a concave-convex scenario can apply to the entire sample. Recall from Case 3 of our mathematical proofs that even when the perceived-cost function for one currency is concave and the other is convex, a corner solution (a preference to pay in a single currency) is entirely possible. This is true because we test five possible prices combinations rather than the continuous range from 0% to 100% dollars. It is worth pointing out that whereas the 50%/50% option was the preferred pricing schedule in Study 2 (it was the only combined-currency price available), the same mix was the least-favored option among the broader set of pricing schedules available in Study 3. This highlights the importance of determining the correct mix among currencies in a combined-currency price offer.

### *CONCLUSION, LIMITATIONS, AND FURTHER RESEARCH*

The objective of this research was to determine the conditions in which a combined-currency price can be superior to a price charged in a single currency. In doing so, we attempt to help explain the recent emergence and increasing proliferation of combined-currency prices in the marketplace. Our mathematical proofs show how nonlinear value functions result in many cases in which marketers should charge combined-currency prices, specifically when the perceived-cost function for one of the currencies is convex within the range in question. In this case, a combined-currency price can maximize the amount of revenue collected given a set psychological cost or can minimize the psychological cost associated with a given price. Both the anecdotal real-world evidence and our experimental evidence illustrate how people often prefer to pay prices that comprise payments in more than one currency.

More specifically, in Study 1, we offer evidence that both a combined-currency price (i.e., interior solution) and a single-currency price (i.e., corner solution) can be superior in the same population of consumers, and we simultaneously demonstrate a pattern of choice that is consistent with

a convex perceived-cost function for one of the currencies involved. In Study 2, we demonstrate how choices made by actual fliers conform to the general predictions in our proofs and are consistent with the results of Study 1. In Study 3, we collect more-detailed individual-level data and provide more direct evidence that people who favor a combined-currency price must have convexity in the perceived-cost function for at least one of the currencies involved. Taken together, the studies provide convergent evidence that supports the expected requirements for and benefits from combined-currency pricing.

The studies are not without their limitations. Studies 1 and 2 both rely on aggregate data, and Studies 1 and 3 rely on students as respondents. None of the studies specifies for which currency the consumer's perceived-cost function is convex, and we never attempt to document the underlying cause for the shapes of the perceived-cost functions. However, we were careful to (1) ensure that the results of Study 1 hold, using the responses from only those participants who were frequent flier members, and (2) qualify students in Study 3 on the basis of their experience accumulating and transacting in miles.

In Study 1, respondents may have favored a single-currency price because as the payment became larger in one currency, the perceived cost of tracking a transaction in the other currency appeared larger. We recognize that the existence of transaction costs and their relative magnitude can affect the relative attractiveness of combined-currency prices. This would occur most often with prices that include extremely small amounts in one of the currencies, and thus a firm may be well served to avoid strategically such highly skewed offerings.

Although this research emphasizes the importance of combined-currency prices and illustrates the advantages to firms that implement them well, it is also limited in that it does not detail how the firm can derive a precise price for a particular customer or set of customers. We test the general shape of respondents' perceived-cost functions in Study 3, but we did not measure the functions with a great degree of precision. Practically speaking, a firm can better ascertain the shape of a particular consumer's perceived-cost function for specific currencies using a more complete design. This process would be far more burdensome in terms of the time required by each participant and thus far more costly than what we have studied herein. Development of a cost-effective way to ascertain this directly for a population or segment of interest appears to be an important avenue for further research.

Combined-currency prices are designed to minimize the psychological cost associated with a particular revenue objective by taking advantage of people's inability, reluctance, or lack of desire to convert amounts assessed in one currency to denominations of the other currency (Nunes and Park 2003). However, important individual differences may moderate the effectiveness of combined-currency prices. It may be that certain consumers who are contemplating spending miles, dollars, or any mix of two currencies have difficulty recalling or constructing a value for different amounts of either currency or both. In addition, for certain consumers, the relevant information may be unavailable or inaccessible. This research did not explore the process by which consumers assess the perceived cost associated with various increments of each currency or compare price schedules. Further research might be directed toward devel-

opment of a process-level model of choice that involves prices in combined currencies with a focus on the factors that mediate or moderate their attractiveness.

The process consumers use is likely to be affected by the comparability of the currencies and consumers' knowledge or experience with each. In the same way that Johnson (1984) suggests that experts should be more likely to use within-attribute strategies for comparing alternatives, we expect that people who fly all the time possess or construct some sort of exchange rate to make the relevant comparisons across price schedules. Because within-attribute strategies call for comparing attributes directly, we expect that regular fliers compare \$39 and 16,000 miles with \$189 by simply matching dollars to dollars and miles to miles. Thus, they would determine whether paying \$150 or 16,000 miles is preferable. They might do so by applying their idiosyncratic exchange rate or a well-known exchange rate (\$.02) or by considering how long it takes to accumulate each (converting units in each to time). Conversely, nonexperts (i.e., infrequent fliers) may use what Johnson calls an "across-attribute" process and perform an overall evaluation in which they make comparisons at an abstract level. This would end in the consumers simply asking themselves, "What hurts more, \$189 or \$39 and 16,000 miles?" The latter process seems more in line with the choice patterns we have observed, which leads us to suspect that our results are consistent with the behavior of most nonexpert consumers who do not fly regularly.

With increased exposure and experience, the conversion between two or more particular currencies can, in theory, become second nature. If this were the case, we would expect that combined-currency prices across the currencies lose their efficacy. However, the multitude of buy-and-sell rates in the marketplace suggests that this type of flawless interchangeability is unlikely, though further research might explore how firms can further obfuscate the value of alternative currencies, such as miles or points, in terms of other currencies. Perhaps firms already do this intentionally through their offerings, but practices that increase or decrease the ease with which consumers compare price schedules seem ripe for work by researchers who are interested in pricing. In addition, airlines might affect the relative worth of their miles, increasing or decreasing their worth by making more or less mileage tickets available (Elliott 2003).

In this research, we have focused on the perceived cost that is associated with surrendering various amounts of currencies. The mathematics should apply whether a consumer is surrendering or acquiring the amounts in question. Another avenue for further research is the investigation of any asymmetries in valuation based on whether a consumer expects to give or to receive payments in more than one currency. The wife of one of the authors of this article recently inquired as to whether giving a \$100 gift certificate from a particular restaurant would be perceived as more generous than a \$50 restaurant certificate and \$50 in movie passes. She was convinced that one \$100 certificate would seem more generous. Her idea has not gone unnoticed, and we have begun exploring this question in more detail. In addition, although we have speculated that goals can cause local convexities in the perceived-cost functions for currencies, we do so in the absence of wealth effects. It would be interesting to examine not only how expenditures are perceived

in relation to goals but also how asset levels in the relevant currencies can affect decision making. To this end, exploration of how goals and asset levels interact to affect choice seems to be a particularly relevant and important area for further research, one that we have already begun studying.

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