

Conspicuous Consumption and Sophisticated Thinking

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Consumers purchase conspicuous goods to satisfy not only material needs but also social needs such as prestige. In an attempt to meet these social needs, producers of conspicuous goods like cars, perfumes, and watches, highlight the exclusivity of their products. In this paper, we propose a monopoly model of conspicuous consumption using the rational expectations framework, and then examine how purchase decisions are affected by the desire for exclusivity and conformity. We show that snobs can have an upward-sloping demand curve but only in the presence of consumers who are (weakly) followers. Laboratory tests lend support for this model prediction and for the rational expectations framework. The experimental results suggest that subjects used some degree of sophisticated thinking to arrive at their first-period decisions. Their behavior in the subsequent trials, however, can be adequately captured by a purely adaptive learning mechanism. We discuss the implications of consumer learning for optimal dynamic pricing policy by a monopolist.

Key words: strategic thinking; experimental economics; game theory; rational expectations; conspicuous consumption; learning in games

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1. Introduction

It is generally accepted that the decision to purchase a “conspicuous” product depends not only on the material needs satisfied by the product, but also on social needs such as prestige (see, for example, Belk 1988). Recognizing such social needs, firms highlight the exclusivity of their products. For example, Ferrari promises that it will not produce more than 4,300 vehicles despite more than a two-year waiting list for its cars (Betts 2002). This strategy of limiting production quantity is also practiced in other categories such as coins, watches, and jewelry. Alternatively, firms restrict the availability of their products by using exclusive distribution channels and even legal action. For instance, fearing that wide availability could hurt its exclusive image, Christian Dior sued supermarkets for carrying its products (*Marketing Week* 1997).¹ These strategies are in part driven by the belief that some consumers might find a product less valuable if it is widely available, and that exclu-

sivity will enable the firm to charge a high price and potentially earn higher profits.²

In this paper, we examine how consumers’ purchase decisions are affected by the desire for exclusivity or conformity. Toward this goal, we develop a monopoly model of conspicuous consumption using the rational expectations framework. We capture consumers’ desire for exclusivity and conformity by allowing the utility derived from a product to depend not only on its intrinsic value but also on consumption externality. Consistent with the classic work of Leibenstein (1950), we model *snobs* as consumers whose utility from a product decreases as more people consume the same product. For example, a BMW in every driveway could dilute the value of the car to potential buyers (cf., Bagwell and Bernheim 1996).³ In a similar fashion, we model *followers* as consumers whose utility from a product increases as more people consume the product (Ross et al. 1975, Jones 1984;

¹ Luxury goods manufacturers are also advised not to sell their products over the Internet because this will dilute their image (*Marketing* 2000).

² Research has shown that rarity of products can increase the perceived value of products even for items such as cookies (see Worchel et al. 1975).

³ See also Nagel and Holden (2002, p. 92) who say that exclusivity adds to the objective value of a product.

also see Becker 1991 for a similar formulation).⁴ For instance, teenagers often view MTV because their friends watch it (Sun and Lull 1986). We also see evidence of conformism in the purchase of books, toys, and garments.

Our theoretical analysis suggests that if the market is comprised of only snobs or followers, then consumers would not demand more as price increases. However, if the market is comprised of both snobs and followers, then more snobs might buy as price increases.⁵ Corroborating evidence for these results is found in an empirical study of visible status goods purchased by women (Chao and Schor 1998). We also show that the profits of a firm increase as the desire for conformity increases.

At the heart of our model is the concept of rational expectations, which assumes that *all* players think strategically. Consequently, consumers should instantaneously be able to arrive at the equilibrium solution. The empirical evidence in support of rational expectations is mixed. Individual-level studies comparing forecasts made by subjects of stochastic variables against the actual outcomes suggest that people might not be good at forming rational expectations (Schmalensee 1976, Garner 1982, Williams 1987, Smith et al. 1988). On the other hand, experimental asset markets seem to converge toward the predictions of rational expectations equilibria (Sunder 1995). In the context of our model, we theoretically show that adaptive learning mechanisms can also lead to the rational expectations equilibrium. Thus, agents could converge to the equilibrium because of sophisticated thinking, adaptive learning mechanisms, or a combination of both. We test the model predictions in a laboratory setting where we can track both the actions and beliefs of subjects. Further, using the sophisticated experience-weighted attraction (SEWA) model proposed by Camerer et al. (2002) we attempt to unravel the learning mechanism that can account for the behavior of our subjects. The SEWA learning model nests within it both adaptive mechanisms such as belief learning and reinforcement learning mechanisms and sophisticated mechanisms such as quantal response equilibrium (QRE) and Nash equilibrium.

⁴ Leibenstein (1950) uses the term “bandwagon effect” to describe what we call the “follower effect.” We prefer to use the terms followers and conformists (Bagwell and Bernheim 1996) because bandwagon effects are often associated with adoption in large blocks (see, for example, Farrell and Saloner 1985), which is not our focus here.

⁵ In fact, we can observe an upward-sloping demand curve for snobs even if there is a segment of consumers whose utilities are unaffected by consumption externalities. In other words, the result goes through if the market is comprised of snobs and consumers who are (weakly) conformists.

The experimental results are qualitatively consistent with the model predictions for both snobs and followers. On average, the expectations are closely aligned with the actual outcomes and the equilibrium solution. But we observed variation in the expectations of individual subjects. The experimental investigation shows that more snobs buy as price rises, even though the products have neither quality differences nor any signal value. Furthermore, we find some support for the rational expectations framework at the aggregate level. An analysis of the first trial data shows that subjects’ behavior is qualitatively consistent with model predictions, and on average subjects were probably capable of three to four steps of iterative reasoning. Their behavior in subsequent trials, however, can be explained using adaptive learning mechanisms.

1.1. Related Literature and Contributions

Researchers have long studied the role of products as a means of self expression (see, for example, Belk 1988). This research has identified the existence of two competing social needs among consumers: a need for uniqueness and a countervailing need for similarity (Brewer 1991, Fromkin and Snyder 1980). These needs form the basis of what we refer to as the desire for exclusivity and conformity. Prior research examines from a psychological perspective how these needs influence consumer choice processes (Lynn 1991, Snyder 1992, Simonson and Nowlis 2000). Unlike our research, the behavioral literature does not examine the effect of social factors on aggregate demand or firm behavior.

Our research is related to the work in economics that incorporates social factors in formal economic analysis. Leibenstein (1950) highlights the importance of social factors in consumption (see also Veblen 1899). Becker (1991) uses conformism to show why similar restaurants might eventually experience vastly different sales patterns. According to his model, in equilibrium the demand curve for followers could be upward sloping but the equilibrium is not stable. Our work is also related to research on network goods (see, for example, Katz and Shapiro 1994). In contrast to the network goods literature, the motivation for consumption externality in our model is social, not technological. Further, we simultaneously consider the presence of two segments of consumers with different social needs: snobs who desire exclusivity and followers who desire conformity. The presence of both these segments could lead to a unique and stable rational expectations equilibrium in which snobs have an upward-sloping demand curve. We show that such a result is not possible if the market is comprised of only snobs or only followers.

There are several signaling models on conspicuous consumption which are also related to our work.

Bernheim (1994), for example, showed that when status is sufficiently important relative to intrinsic utility, many individuals conform to a single standard of behavior, despite heterogeneous underlying preferences. Bagwell and Bernheim (1996) and Corneo and Jeanne (1997a) suggest that consumers could engage in conspicuous consumption to signal their wealth. However, Corneo and Jeanne (1997a) find that the demand curve for a conspicuous product is downward sloping for snobs. The intuition for this result is that if more consumers buy the good, then the signal value of the good must decrease for snobs. Consequently, the firm needs to decrease prices to increase demand, implying a downward-sloping demand curve. Thus, they show that under a signaling framework, snobbish behavior cannot lead to an upward-sloping demand curve.

Our research is different from the prior research in several important ways. First, in contrast to the signaling models in economics, we model snobs and followers using a consumption externality. Second, unlike the extant literature, we show that in the context of a monopoly, snobs can have an upward-sloping demand curve, but only in the presence of both snobs and followers. Third, we demonstrate the existence of an upward-sloping demand curve for snobs in the laboratory. Fourth, unlike most of the prior experimental research, we tracked both the actions and beliefs of the subjects (see Nyarko and Shotter 2002 for tracing beliefs in mixed strategy games). This enables us to test both the consequences as well as the assumptions of the rational expectations model. We show that stated expectations and purchase decisions are consistent with the rational expectations equilibrium. In subsequent research, we have extended the monopoly model of this paper to examine how social effects influence firm's pricing decisions in the context of a duopoly (Amaldoss and Jain 2005). However, there we do not address issues of rational expectations and learning in games as we do in this paper. Instead, we focus on issues related to pricing, quality differences, and horizontal differentiation.

The rest of this paper is organized as follows. In §2, we describe a model of conspicuous consumption and examine its implications. Section 3 discusses a laboratory test of the model. Section 4 presents our analysis of learning in the game. Finally, §5 concludes the paper.

2. Model

We assume that the market consists of two groups of consumers: snobs and followers. Snobs value exclusivity, and consequently the utility derived from a product depends not only on its base value, but also on the expected number of people who will buy the

product. Thus, the expected (indirect) utility of purchasing a product is given by

$$U(z^e, p) = v - p - g(z^e), \quad (1)$$

where v is the base valuation, p is the price for the product, and z^e is the expected number of buyers. Assume that $g(0) = 0$, $g(z^e) \geq 0 \forall z^e > 0$, $g(1) < \infty$, and $g'(\cdot) \geq 0$.⁶ These conditions capture an important characteristic of snobs: They value the product less as more people buy it. We assume that each consumer buys at most one unit of the conspicuous good at a time. Such an assumption is tenable for many conspicuous goods like cars. Suppose that v is distributed in the population according to a continuous distribution $F_1(\cdot)$ with probability density function (p.d.f.) $f_1(\cdot)$. We assume that $F_1(\cdot)$ is common knowledge.

We model followers as consumers who are not looking for exclusivity, but instead like to follow others. The expected (indirect) utility of such a consumer is given by

$$U(z^e, p) = v - p + h(z^e), \quad (2)$$

where $h(0) = 0$, $h(1) < \infty$, $h(\cdot) \geq 0$, and $h' \geq 0$. Therefore, followers value a product more as more people purchase it. We assume that the value distribution for followers is given by a continuous distribution $F_2(\cdot)$ with p.d.f. $f_2(\cdot)$. Note that we allow the two groups to have different value distributions.⁷

The proportion of snobs in the market is $\beta \in [0, 1]$, while $(1 - \beta)$ consumers are assumed to be followers. We normalize the total market size to be 1. Given the above formulation, the number of snobs who will buy the product is given by

$$x = \beta(1 - F_1(p + g(z^e))), \quad (3)$$

where z^e is the expected sales of the product. Similarly, the number of followers who buy the product is given by

$$y = (1 - \beta)(1 - F_2(p - h(z^e))). \quad (4)$$

⁶ Note that we are assuming that this group of consumers is "weakly" snobbish. If $g(\cdot) \equiv 0$, then the consumers do not care how many others buy the product.

⁷ An alternate formulation would be to assume that snobs dislike followers adopting the product and therefore $g(z^e)$ should be replaced by $g(y^e)$, where y^e is the expected number of followers buying the product. Also, it is possible that followers look at the snobs as their aspirational group and, therefore, $h(z^e)$ should be replaced by $h(x^e)$, where x^e is the expected number of snobs that will buy the product. This alternate formulation is consistent with the notion of reference groups and less so with the notions of exclusivity and conformity, which is the main focus of this paper. Also, this alternate formulation would require consumers to have more precise estimates of segmentwise demand, which may be more difficult. Nevertheless, the qualitative implications of our results would remain unchanged if we use this alternate formulation.

Using (3) and (4), we obtain the total demand z for the product:

$$z = \beta(1 - F_1(p + g(z^e))) + (1 - \beta)(1 - F_2(p - h(z^e))). \quad (5)$$

Each consumer is assumed to have the same expectation about the number of people who will buy the product. Further, these expectations are rational, implying that they are correct in equilibrium. Such assumptions are fairly common in the literature (see, for example, Becker 1991, Katz and Shapiro 1985). Thus,

$$z - z^e = 0. \quad (6)$$

Using (5) and (6), we can derive the rational expectations equilibrium. The relevant equation is

$$\Lambda_1(z) = z - \beta(1 - F_1(p + g(z))) + (1 - \beta)(1 - F_2(p - h(z))) = 0. \quad (7)$$

Equation (7) implicitly describes the total demand $z(p)$ under the rational expectations condition. Note that if (7) defines a unique z for a given p , then from (4) and (5) we can see that for any given price p , there will be unique numbers x and y which will define the sales to the snobs and the followers, respectively. The next lemma establishes the condition for existence and uniqueness.

LEMMA 1. *There exists a rational expectations equilibrium that satisfies (7). The equilibrium is unique if and only if*

$$h'(z)f_2[p - h(z)] < \frac{1 + \beta f_1[p + g(z)]g'(z)}{(1 - \beta)}, \quad (8)$$

where z is the equilibrium total demand at price p .

Proofs of all the results are in Appendix A and are available at <http://mansci.pubs.informs.org/ecompanion.html>.

The condition included in the lemma places a useful restriction on the size of the follower effect. If the follower effect is very large, then the system can become unstable, leading to multiple possible solutions.⁸ However, if there are no followers, then there always exists a unique rational expectations equilibrium. It is useful to note that the condition places no upper bound on the magnitude of the exclusivity effect. In fact, a higher exclusivity effect helps in that condition (8) is more likely to be satisfied. For the remainder of the analysis, we will assume that the condition specified in Lemma 1 holds.

On investigating how changes in price affect the aggregate demand, as well as the demand from snobs

and followers, we have the following result:

PROPOSITION 1. *If the market consists of only snobs or followers, then the market demand always decreases with price. However, if the market consists of both followers and snobs, then the demand from snobs will increase with price iff*

$$(1 - \beta)f_2[p - h(z)](h'(z) + g'(z)) > 1. \quad (9)$$

Yet, the demand curve for the followers and the total demand curve is downward sloping.

Proposition 1 shows that snobs can have an upward-sloping demand curve. But this can only happen in the presence of consumers who are (weakly) followers.⁹ Note that this result is significantly different from the findings reported in the network externality or congestion externality literature which has traditionally looked at only one type of externality. As Proposition 1 clarifies, if only one type of externality is present, then we will only observe a downward-sloping demand curve. However, in a model which includes both negative and positive externalities, consumers with negative externalities (i.e., snobs) can have an upward-sloping demand curve. To better appreciate the intuition for this proposition, we systematically examine first a market consisting only of snobs ($\beta = 1$). Then, we consider a market consisting of both snobs and followers, that is, $\beta \in (0, 1)$.

According to Proposition 1, if the market is comprised of only snobs ($\beta = 1$), then demand would decline as price rises. When $\beta = 1$, we have $z^e = x^e$. Further, the utility that a snob receives from consuming the product is given by

$$U_s = v - p - g(x^e). \quad (10)$$

The impact of price on the consumer's utility is

$$\frac{\partial U_s}{\partial p} = -1 - g'(x^e) \frac{\partial x^e}{\partial p}. \quad (11)$$

Probably based on everyday observation of the demand pattern for fast-moving consumer goods, consumers could potentially expect $\partial x^e / \partial p$ to be negative. Then, for a sufficiently large $g'(\cdot)$, it is possible for consumer utility to increase with price. This outcome, however, implies that as the price increases, the total number of consumers who will buy the product would increase, thus giving rise to an upward-sloping demand curve, that is, $\partial x / \partial p > 0$. Such a line of reasoning could potentially form the basis of naïve intuition, which suggests that more snobs would buy as price rises.

⁸ This is due to the possibility of bandwagons in which all consumers decide either to buy or not buy the product.

⁹ In Amaldoss and Jain (2005) we show that the result extends to a duopoly using linear forms for the $g(\cdot)$ and $h(\cdot)$ functions.

However, if we impose the condition that consumers form rational expectations, then demand would not grow as price increases. This is because if consumers expect $\partial x^e/\partial p < 0$, then in a rational expectations equilibrium we must have $\partial x/\partial p < 0$. Note, however, from (11) that $\partial x^e/\partial p > 0$ implies that $\partial U_s/\partial p < 0$ which, in turn, suggests that $\partial x/\partial p < 0$, contradicting the requirements for a rational expectations equilibrium. Therefore, the only equilibrium which is consistent with the rational expectations equilibrium in this case is the one in which demand is downward sloping ($\partial x/\partial p < 0$). A similar argument can establish that if the market consists of only followers, then the demand curve again will be downward sloping.

Next, we turn our attention to a market that consists of both snobs and followers, that is, $\beta \in (0, 1)$. On examining the effect of price on utility derived by snobs, we have

$$\frac{\partial U_s}{\partial p} = -1 - g'(z^e) \frac{\partial z^e}{\partial p}. \quad (12)$$

If the consumer expects the total demand to drop as price increases, then for sufficiently large $g'(\cdot)$, it is possible for consumer utility to increase with price, thus giving rise to an upward-sloping demand curve for snobs. Indeed, it is possible that the total demand curve is downward sloping ($\partial z^e/\partial p < 0$), while the demand from snobs is growing as price increases, when there are enough followers.^{10, 11}

It is commonly believed that snobs, rather than followers, would demand more as price increases. Proposition 1 offers a potential explanation for this perception: *The demand curve can be upward sloping at the equilibrium price for snobs, but not for followers.* Further, an upward-sloping demand curve for snobs is likely to be observed only when the market includes a group of consumers whose utilities do not exhibit negative consumption externality, that is, when there is a group of consumers who are (weakly) followers.¹²

¹⁰ To illustrate the possibility that there will exist situations in which (8) and (9) are satisfied, consider the case where $f_1(\cdot)$ and $f_2(\cdot)$ are uniform with range $(0, 1)$, $\beta = 1/2$, and $g(\cdot)$ and $h(\cdot)$ are linear with $g' \equiv \lambda_1 = 0.8$ and $h' \equiv \lambda_2$. Then, (8) is always satisfied and (9) is satisfied as long as $\lambda_2 > 1.2$. That is, if the snob effect is large enough, then these consumers will demand more as price increases.

¹¹ We derived Proposition 1 using the implicit function theorem (which requires local differentiability). The continuity assumptions were useful to prove the uniqueness and the existence of rational expectations equilibrium. But as our discussion of the intuition using Equations (11) and (12) shows, the proof would go through even if $F_1(\cdot)$ and $F_2(\cdot)$ were not continuous. Also, it is easy to see that the arguments would hold even if demand was discrete. For example, in the empirical section, we consider a discrete version of this model.

¹² It is important to note that the result does not *require* the presence of followers. In particular, the demand curve for snobs could

This finding runs counter to Leibenstein's claim (1950) that the demand curve for snobs would always be downward sloping. However, our result is consistent with anecdotal and empirical evidence.

There is support for our results in an empirical study conducted by Chao and Schor (1998). They find that the demand curve for conspicuous cosmetics like lipsticks, mascara, and eyeshadow is upward sloping for college-educated women. To the extent that these women are more likely to be status conscious and desire exclusivity, these results are consistent with our theoretical results. Yet, the overall demand curve is downward sloping. With interest, we note that the demand curve for women who have not graduated from college is downward sloping as we would expect. Further, Chao and Schor find that non-conspicuous products, such as facial cleanser, have downward-sloping demand curves for all segments. This is also congruent with our results.¹³

2.1. Impact on Profits

Next, we examine how a monopolist's profit is affected by snobbishness and the follower effect. Without any loss in generality, assume that the marginal cost of the product is zero. The profit function is

$$\Pi(p) = z(p)p. \quad (13)$$

We assume that the profit function is concave in price, and we focus on situations where there is an interior solution. To evaluate the impact of the snobbish behavior, we define $g(\cdot) = \lambda_1 \tilde{g}(\cdot)$, where $\tilde{g}(\cdot) \geq 0$ and $\tilde{g}' \geq 0$. Thus, as λ_1 increases, consumers become more snobbish. Similarly, we define $h(\cdot) = \lambda_2 \tilde{h}(\cdot)$, $\tilde{h}(\cdot) \geq 0$, and $\tilde{h}' \geq 0$. Therefore, when λ_2 grows, conformism becomes stronger.

We have the following result:

PROPOSITION 2. *Firm's profits decrease with snobbishness, but increase with the follower effect.*

It is commonly believed that manufacturers of luxury goods earn supranormal profits, and the reason for this is intimately related to consumers' desire for exclusivity. Our result shows that at least in a monopoly setting with rational consumers this is not true. To understand the reason for this result, note

be upward sloping even if $h' \equiv 0$; that is, there exists a segment of consumers whose utility is unaffected by the choices of other consumers.

¹³ For example, the price coefficient for lipsticks equals -0.19 for women with a high school diploma, but for women with a college degree the price coefficient is $+0.117$. However, the overall price coefficient is -0.157 . Chao and Schor (1998) also find that the correlation between quality and price in this category is zero. Therefore, price could not be a credible signal of quality in this case. Similar results were observed in the case of mascara and eyeshadow.

that as snobbishness increases, the demand decreases. This is because each additional sale exerts a negative externality on the sale of other units. Consequently, the firm sells less as snobbish behavior increases. On using the envelope theorem, we have

$$\frac{\partial \Pi^*}{\partial \lambda_1} = p \frac{\partial z}{\partial \lambda_1} < 0. \quad (14)$$

This inequality is formally established in Appendix A. Thus, firm's profits are hurt by the negative impact of snobbish behavior on the demand. Similarly,

$$\frac{\partial \Pi^*}{\partial \lambda_2} = p \frac{\partial z}{\partial \lambda_2} > 0. \quad (15)$$

Again, this inequality is formally established in Appendix A. Thus, the follower effect has a positive impact on firm profits, and it is in direct contrast to the effect of snobbishness discussed earlier. This result is consistent with the observation that some firms employ marketing strategies to create a bandwagon effect for their products. Often such companies are able to charge high prices and make higher than normal profits.¹⁴ To understand the intuition, note that each additional unit that the firm sells exerts a positive externality on the sale of other units. Consequently, as the follower effect increases, the total sales and thereby the total profits are higher.¹⁵

2.2. Discussion

Propositions 1 and 2 appear to crucially hinge on the assumption that consumers form rational expectations. Furthermore, in our single-period framework consumers *immediately* reach the rational expectations equilibrium using introspection. Now consider the possibility that consumers can play the game for a finite number of times. Even in this case, if agents form rational expectations, our earlier theoretical analysis will hold.

With little reflection, we can see that it not easy for individuals to form rational expectations. Indeed, individual-level studies reject the possibility that people can form rational expectations (Schmalensee 1976,

¹⁴ For example, Corneo and Jeanne (1997b) discuss the case of a French company which introduced an object called POG which is a plastic disk with little usefulness or aesthetic quality. However, with some clever marketing campaign the company started a craze among French children for POGs. The company sold more than 15 million POGs in a month, at a price which far exceeded the production cost.

¹⁵ In Amaldoss and Jain (2005) we show that if the market is fully covered and the value distributions are uniform, then the result may not hold in a duopoly. Although conformity has a positive effect in a monopoly, it increases price competition in a duopoly. In the case we study in Amaldoss and Jain (2005), the competitive effect is strong enough to reverse the results obtained in the monopoly setting. Thus, the results crucially depend on the market structure.

Garner 1982, Williams 1987, Smith et al. 1988). But market-level experimental studies suggest that subjects can form adaptive expectations and still move toward the rational expectations equilibrium (see Sunder 1995 for a review). This raises an interesting question: If individuals formed adaptive expectations, would they then converge to the rational expectations equilibrium that we have derived? In an attempt to theoretically answer this question, we consider the case where consumers form adaptive beliefs using the Cournot learning process. We assume that the value distributions of snobs and followers are uniform with range (0, 1). Further, $g(\cdot)$ and $h(\cdot)$ are linear, that is, $g(z^e) = \lambda_1 z^e$ and $h(z^e) = \lambda_2 z^e$. On considering only situations with interior solutions, we obtain the following result:¹⁶

RESULT 1. If consumers play according to the Cournot dynamics, then the equilibrium demand converges to that under the rational expectations equilibrium.

More recent experimental evidence suggests that consumer learning is often not a pure belief-based mechanism and could well be guided by reinforcement of past choices. The experience-weighted attraction (EWA) learning model proposed by Camerer and Ho (1999) is a hybrid model that includes features of both reinforcement and belief learning. Figure 1 shows that when we allow for a more general learning structure, as in the EWA model, the process still converges to the rational expectations equilibrium.¹⁷ A comparison of Figures 2 and 3 indicates, as expected, that convergence will be slower if the decisions are primarily guided by reinforcement learning.

Now, let us examine whether Proposition 2 would hold if subjects formed adaptive expectations based on Cournot dynamics. We assume that the firm sets a fixed price with the goal of maximizing its total profit for the duration of the finitely repeated game.¹⁸ We have the following result:

RESULT 2. If consumers play a finitely repeated game according to the Cournot dynamics, then a firm's optimal profits are decreasing in snobbishness and increasing in the follower effect.

These two results raise the possibility that over several iterations of the game adaptive decision makers could potentially come to behave as predicted by the

¹⁶ If the parameters are such that the demand hits the boundary, i.e., 0 or 1, then it is possible that the Cournot dynamics will never converge and will instead cycle.

¹⁷ For illustrative purposes, we used the EWA parameter estimates of 4×4 constant sum games reported in Camerer and Ho (1999, p. 852, column 3). The value distributions that we used for plotting the figures is the same as in the empirical model that will be discussed later.

¹⁸ Dynamic pricing implications are discussed later.

Figure 1 Convergence to REE Based on EWA Learning (Hybrid Learning)

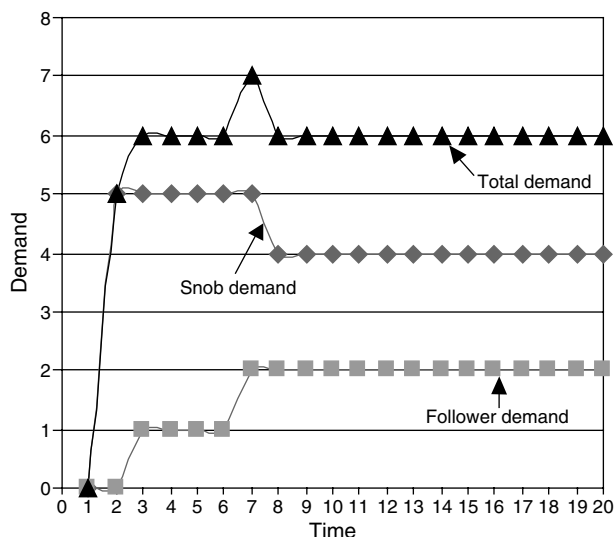


Figure 2 Convergence to REE Based on Primarily Reinforcement Learning

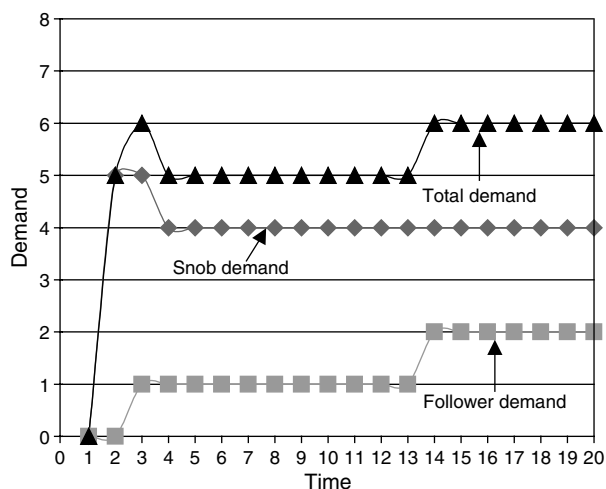
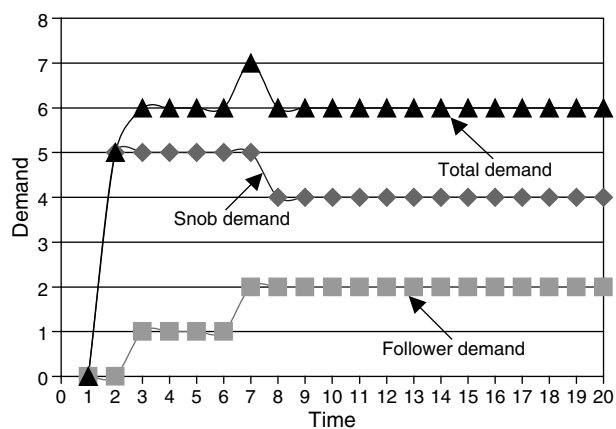


Figure 3 Convergence to REE Based on Belief Learning



rational expectations equilibrium. Whether subjects indeed behave as predicted by our model is an empirical question, and we examine that in the next section.

3. Empirical Investigation

We subject the model to a laboratory test to assess whether financially motivated subjects will behave as predicted by the equilibrium solution. By letting subjects play for several iterations of the one-period game, we allow for the possibility that subjects can potentially learn to conform to the equilibrium prediction. The experimental investigation addresses two key questions:

(1) *Do more snobs buy as price increases?* In our laboratory test, more snobs purchased the product when price increased. In addition to finding strong support for the qualitative predictions of the model, we have moderate support for the point predictions. Relatedly, theory predicts that the demand curves for followers and the total market should be downward sloping, and we also find support for this claim.

(2) *Are the expectations of subjects consistent with the rational expectations model?* We tracked the beliefs that guided the purchase decisions of subjects in every trial of the experiment. On average, the expected demand was consistent with the actual demand and the rational expectations equilibrium predictions. We observe variation in the behavior of individual subjects, implying that the model prediction survives at the aggregate level rather than at the individual level.

The details of the experimental investigation are presented below.

3.1. Empirical Model

Our analytical model assumes a continuous distribution in values. It is difficult to validate such a model in a laboratory setting with a small sample of subjects. However, the analytical results do not crucially depend on the continuity assumption as can be seen in the discussion of the intuition for the results and in footnote 11. Hence, we use a discrete distribution of valuations that is conducive to test the model with a population of 20 subjects. The approach of testing a continuous model using a discrete version is common in experimental economics (e.g., Smith 1982). Table 1 presents the distribution of valuations for 10 snobs (labeled Type A buyers in our experiment) and 10 followers (Type B buyers in our experiment).¹⁹ We used $g(z) = 0.5z$ and $h(z) = 0.6z$. The resulting equilibrium demands for the snobs, the followers, and the total market are shown in Figure 4. We see that the demand curve for snobs is (weakly) upward sloping, while it

¹⁹ We named the two types of buyers as Type A and Type B buyers, rather than as snobs and followers, so that the behavior of subjects is purely guided by the negative and positive externality captured in our model.

Table 1 Value Distribution for the Empirical Model

Type A	S_1^A	S_2^A	S_3^A	S_4^A	S_5^A	S_6^A	S_7^A	S_8^A	S_9^A	S_{10}^A
	2	3	4	5	6	9.5	10.1	10.6	11.2	11.4
Type B	S_1^B	S_2^B	S_3^B	S_4^B	S_5^B	S_6^B	S_7^B	S_8^B	S_9^B	S_{10}^B
	0.1	0.2	0.5	0.55	0.7	1.5	2	2.5	3.5	5

Note. S_j^i refers to Subject j of Type i .

is (weakly) downward sloping for followers and the total market. In our initial study, we use two price points to trace the slope of the demand curve. Later, in Studies 2 and 3, we will use three price points to trace the demand curve.

Subjects. The subjects who participated in the experiment were business school students. They were paid a show-up fee of \$5 in addition to a monetary reward contingent on their performance. All transactions were in an experimental currency called “francs” which were converted into U.S. dollars at the end of the experiment.

Experimental Design. We used a within-subject design with two levels of prices: 5.9 and 6.9 francs. Using these two price points we traced the changes in demand among snobs and followers. We ran two groups comprised of 20 subjects each. In Group 1, the price was low in the first 30 trials and high in the next 30 trials. In Group 2, the order of price presentation was reversed.

Procedure. In our experiment, subjects played the role of buyers, while the computer played the role of a seller. The instructions that we provided to the subjects are in Appendix B. In keeping with the spirit of the complete information theoretical model, subjects were informed of $g(z)$, $h(z)$, and the value distribution.

Seller. We simulated the retail market environment, where a seller posts price and promises to supply its product to all buyers who are willing to pay the posted price (see Smith 1982 and Holt 1995 for a discussion on the posted-price market and its implications for market efficiency). In this posted-price market, buyers cannot negotiate the price with the seller.

Buyers. Each subject was randomly assigned to play the role of either a Type A or Type B buyer.

Type A Buyers. Type A buyers value the product *less* when more people own the product. Consequently, the actual value of the product systematically drops below the base value when more people choose to buy the product. For example, consider the Type A buyer whose base valuation for the product is 9.5 francs. If a total of five Type A and Type B buyers purchase the product, the actual value of the product will fall to 7 francs (that is, $9.5 - 0.5 \times 5 = 7$).

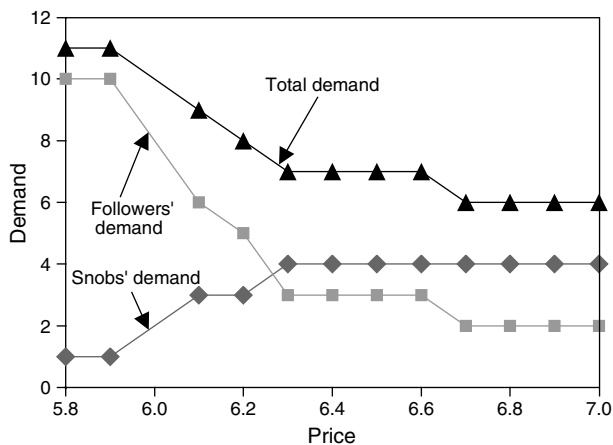
Type B Buyers. Type B buyers value the product *more* when more people own the product. Hence, the actual value of the product rises above the base value when more people choose to buy the product. For example, consider the Type B buyer whose base valuation is 2 francs. If a total of five Type A and Type B buyers purchase the product, the actual value of the product will increase to 5 francs (that is, $2 + 0.6 \times 5 = 5$).

At the beginning of each trial, subjects were endowed with 7 francs so that they had sufficient funds to pay for the product if they decided to buy it. Consistent with our theoretical model, subjects were informed of their valuation, the distribution of valuations, and the price of the product. The type of subjects, the total number of subjects, and the base valuations remained fixed in all trials.

In every trial, each subject had to decide whether or not to purchase the product. Subjects were asked to provide demand projections. Then, using these demand projections, the computer showed the expected value of the product. Subjects could revise their demand projections and obtain new estimates of the likely value of the product. We used the demand projections to track the expectations that guide the decisions of the subjects.

After all the buyers made their decisions, the computer counted the total number of subjects who purchased the product. Then, based on the total number of subjects who bought the product, the actual value of the product for each subject was assessed. The payoff to a subject who bought the product is: endowment + actual value of the product – price paid. The subjects who did not buy the product kept the endowment. At the end of every trial, each subject was informed of the number of Type A and Type B

Figure 4 Demand as a Function of Price



buyers who purchased the product, and the payoff for the trial.

To make subjects familiar with the structure of the game, they were allowed to play three practice trials for which they received no monetary reward. Then, they played 60 trials, and the price condition changed after 30 trials. At the end of 60 trials, subjects were paid according to their cumulative earnings. Finally, they were debriefed and dismissed.

3.2. Results

In this section, we assess the descriptive power of the rational expectations equilibrium. We begin our analyses by examining the quantity demanded by snobs and followers. Thereafter, we investigate the expectations that could have guided the behavior of our subjects. Qualitatively, the experimental results are consistent with the predictions of the model. We observe an upward-sloping demand curve for Type A buyers (snobs), and a downward-sloping demand curve for Type B buyers (followers). On average, the expected demand is also consistent with the rational expectations equilibrium solution. However, we observe variations in the beliefs and actions of individual subjects.

Analysis of Demand. Table 2 presents the mean quantity demanded by the two types of buyers and the corresponding equilibrium predictions. The empirical results are consistent with the qualitative predictions of the equilibrium solution. However, we see some departures from the point predictions of the model. Also, there is a significant trend in the demand pattern over the several iterations of the game.

Qualitative Predictions. The model makes four qualitative predictions. First, the demand for the product among Type A buyers (snobs) should grow as the price increases. The average demand was 1.53 units when the product was priced at 5.9 francs. But when the price increased to 6.9 francs, the demand rose to 3.57 units. We can reject the null hypothesis that these demand levels are the same ($F_{(1,118)} = 92.83, p < 0.0001$). We obtain similar results in each of the two groups. In Group 1, the average demand grew from 1.33 to 3.43 units, as the price rose from 5.9 to 6.9 francs, and this difference in demand is significant ($F_{(1,58)} = 94.25, p < 0.0001$). In Group 2, the

mean demand correspondingly increased from 1.93 to 3.7 units ($F_{(1,58)} = 27.66, p < 0.0001$).

Second, in equilibrium the Type B buyers (followers) should demand less as the price increases. In actuality, the average demand of Type B buyers across the two groups declined from 9.12 to 3.08 units when the price rose from 5.9 to 6.9 francs. This shift in demand is significant ($F_{(1,118)} = 573.31, p < 0.0001$). We see similar results at the level of individual groups. In Group 1, on average the demand dropped from 9.03 to 2.9 units ($F_{(1,58)} = 749.48, p < 0.0001$). In Group 2, the demand declined from 9.2 to 3.26 units, as the price increased ($F_{(1,58)} = 171, p < 0.0001$).

Third, the model predicts that the overall demand should fall as price increases. The mean actual demand dropped from 10.65 to 6.65 units when price rose from 5.9 to 6.9. This change in average demand is significant ($F_{(1,118)} = 199.93, p < 0.0001$). We obtain similar results in each of the two groups (Group 1: $F_{(1,58)} = 134.81, p < 0.0001$; Group 2: $F_{(1,58)} = 89.67, p < 0.0001$).

Fourth, when the price is 5.9 francs, followers should demand the product more than snobs. Consistent with this prediction, the followers demanded on average 9.12 units across both groups. On average, snobs demanded only 1.53 units. A paired comparison of the units demanded by snobs and followers reveals that the observed difference in demands is significant ($t = 42.15, p < 0.0001$). We observe similar results in both Groups 1 and 2. In Group 1, the average demand of followers was 9.03, which is more than the 1.13 units demanded by snobs ($t = 45.10, p < 0.0001$). In Group 2, the followers and snobs bought on the average 9.2 and 1.93 units, respectively ($t = 23.69, p < 0.0001$).

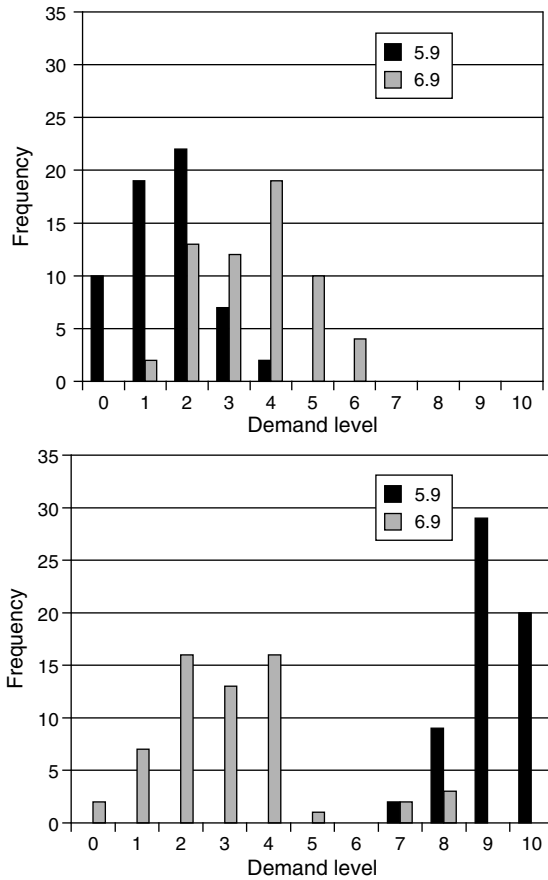
Finally, when the price is 6.9 francs, snobs should demand more than followers. On average across the two groups, snobs and followers bought 3.56 and 3.08 units, respectively. We cannot reject the null hypothesis that these quantities are the same ($t = 1.5, p > 0.13$). On closer examination, we note that the difference in demand is marginally significant in Group 1, but not in Group 2. In Group 1, the mean quantity purchased by snobs and followers is 3.43 and 2.9 units, respectively ($t = 1.97, p < 0.058$). In Group 2,

Table 2 Mean Demand

Price	Type A buyers (snobs)				Type B buyers (followers)			
	Actual demand			Prediction	Actual demand			Prediction
	Group 1	Group 2	Both		Group 1	Group 2	Both	
5.9	1.33 (0.78)	1.93 (1.08)	1.53 (1.02)	1	9.03 (0.67)	9.2 (0.87)	9.12 (0.78)	10
6.9	3.43 (1.04)	3.70 (1.49)	3.57 (1.28)	4	2.90 (1.02)	3.26 (2.31)	3.08 (1.79)	2

Note. Standard deviations are in parentheses.

Figure 5 Top: Distribution of Demand of Snobs;
 Bottom: Distribution of Demand of Followers

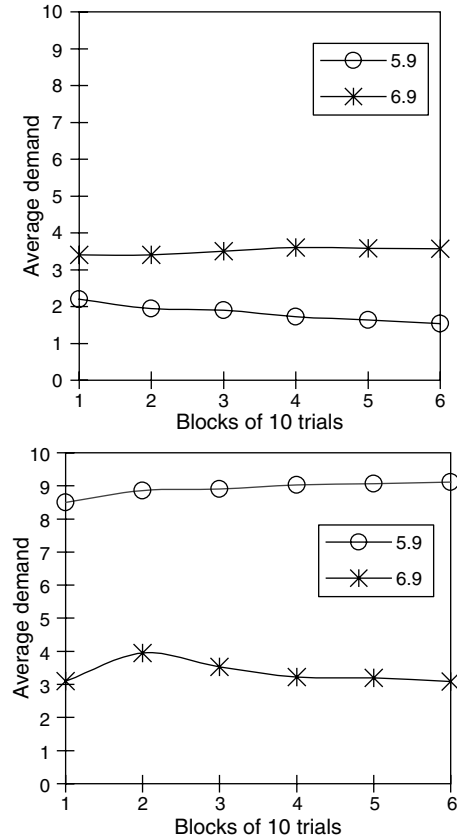


snobs and followers purchased 3.7 and 3.26 units, respectively ($t = 0.73, p > 0.2$).

Distribution of Demand. The equilibrium solution provides point predictions about demand, but the actual demand varies over the several trials of the experiment. Figure 5 presents the empirical distribution of product demand among snobs and followers. The model predicts that if the price is 5.9 francs, then one snob should buy the product. Over the 60 trials across the two groups, the actual quantity demanded ranges from 0 to 4, with mean = 1.53, median = 2, and mode = 2. But if the price rises to 6.9 francs, then in theory four snobs should buy the product. We observe that the actual demand ranges from 1 to 6, with mean = 3.56, median = 4, and mode = 4.

In equilibrium, the followers should demand 10 units when the price is 5.9 francs. The actual demand ranged from 7 to 10 units, with mean = 9.11, median = 9, and mode = 9. If the price is increased to 6.9 francs, then in theory the demand should drop to 2 units. The observed demand ranged from 0 to 8 units, with mean = 3.08, median = 3, and mode = 2. This suggests that, although the observed behavior is consistent with the qualitative predictions of the

Figure 6 Top: Trends in Demand of Snobs;
 Bottom: Trends in Demand of Followers

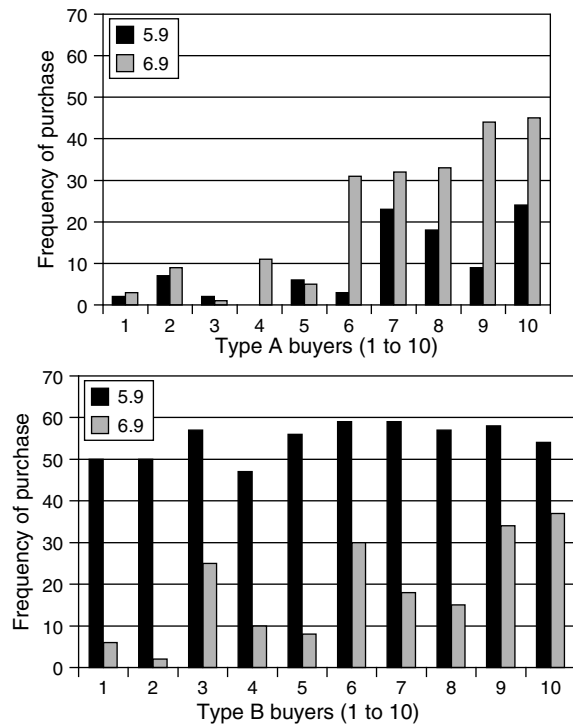


model, there are departures from the point predictions of the equilibrium solution.

Trends in Demand. In the analyses discussed above, we have aggregated the demand across groups and trials, and it could mask the trends in demand. In Figure 6 we present the moving average for blocks of five trials. These block means were computed across the two groups. Statistical analysis of the block means suggests that followers evince a significant trend in demand, when the price is 6.9 francs ($F_{(5,20)} = 9.76, p < 0.0001$), but only a marginal trend when the price is 5.9 francs ($F_{(5,20)} = 2.34, p < 0.08$). The trends in the demand pattern of snobs are much weaker. It is marginally significant at 6.9 francs ($F_{(5,20)} = 2.87, p < 0.05$), and not significant at 5.9 francs ($p < 0.2$). This suggests that we observe some learning in the experiment.

Variation by Valuation. Whether a subject buys the product depends on her base valuation and the number of people she expects to buy the product. In equilibrium, each player should play a pure strategy, and that strategy changes with the base value of the product. For instance, when the price is 5.9 francs, only the Type A buyers with a base value of 11.4 francs should buy the product. All others should not buy the product. On the other hand, when the price is

Figure 7 Top: Variation in Purchase Frequency Among Snobs;
 Bottom: Variation in Purchase Frequency Among Followers



6.9 francs, only the Type A buyers with the four top base valuations should buy the product. Figure 7 presents the number of trials in which the different Type A buyers purchased the product. The players are arranged by their base valuations, in the ascending order. Hence, player 1 has the lowest base valuation, and player 10 has the highest valuation. We see that subjects did not always play the predicted strategies. Yet, the aggregate behavior is directionally consistent with the model prediction. We observe similar behavior among Type B buyers as well.

Analysis of Expectations. Thus far we have examined how purchase behavior conforms to the rational expectations equilibrium solution. In every trial of the experiment, subjects were asked to guess the number of Type A and Type B buyers who might purchase the product. Using these demand projections, we can explore whether the expectations of our subjects are consistent with the outcomes and the equilibrium solution. Table 3 presents the mean expected demand, along with the rational expectations equilibrium solution.²⁰ It is reassuring to observe that the expected demand is congruent with the observed outcomes and the qualitative predictions of the model, but there is a wide variation in expectations. Further,

²⁰ Each subject forecasts the number of Type A and Type B buyers who will purchase the product. The mean expected demand is computed by averaging the expectations of all the subjects.

we discern a trend in expectations over multiple iterations of the game.

Qualitative Predictions. In keeping with the theory, our subjects expected snobs to buy more when the price was high. Across the two groups, the mean expected demand of snobs increased from 1.63 to 3.38 units as the price rose from 5.9 to 6.9 francs ($F_{(1, 2,398)} = 853.65, p < 0.0001$). On the other hand, followers were expected to buy less as the price rose. The average expected demand dropped from 8.08 to 3.52 units as the price increased ($F_{(1, 2,398)} = 2,126.39, p < 0.0001$). The changes in expected demand follow a similar pattern within each group. Finally, consistent with theory, the mean aggregate demand was expected to drop as price increased ($F_{(1, 2,398)} = 554.01, p < 0.0001$). The results are similar within each group.

The model assumes that expectations are correct; that is, the actual demand and the expected demand are the same. Indeed, the mean observed demand and the expected demands are similar. When the price was 6.9 francs, the average actual and expected total demand were 6.65 and 6.89 units, respectively. We cannot reject the null hypothesis that these demands are the same ($t = 0.11, p > 0.2$). When the price dropped to 5.9 francs, the actual and expected demand were on average 8.45 and 9.11 units, respectively. Again, we cannot reject the null hypothesis that these demands are the same ($t = 0.39, p > 0.2$).

Distribution of Expectations. Figure 8 shows the distribution of expected demand across the two groups. In equilibrium, one snob should buy if the price is 5.9 francs. The expectations range from 0 to 10, with mean = 1.63, median = 1, and mode = 1. In theory, the demand should be four units, if the price is increased to 6.9 francs. We note that the expectations range from 0 to 10, with mean = 3.38, median = 3, and mode = 4. Thus, although the expectations vary widely, they conform to the qualitative predictions of the model.

Our subjects expected anywhere from none to all of the followers to buy the product at both prices. Yet, as before, the distributions of expectations are qualitatively consistent with the equilibrium solution. If the price is 5.9, all followers should buy. The corresponding expectations followed a distribution with mean = 8.86, median = 9, and mode = 9. But if the price is 6.9, then two followers should buy. The expectations were distributed with mean = 3.51, median = 3, and mode = 3.

Trends in Expectations. Figure 9 traces the trend in expected demand over blocks of five trials. An analysis of variance suggests that the block means are significantly different for snobs (price = 5.9: $F_{(5,780)} = 66.79, p < 0.001$; price = 6.9: $F_{(5,780)} = 4.35, p < 0.001$). The results are similar for followers.

Table 3 Mean Expected Demand

Price	Type A buyers (snobs)				Type B buyers (followers)			
	Expected demand			Prediction	Expected demand			Prediction
	Group 1	Group 2	Both		Group 1	Group 2	Both	
5.9	1.40 (1.19)	1.86 (1.59)	1.63 (1.42)	1	8.82 (1.34)	7.35 (3.52)	8.08 (2.76)	10
6.9	3.56 (1.24)	3.20 (1.72)	3.38 (1.51)	4	3.17 (1.40)	3.86 (2.47)	3.52 (2.04)	2

Note. Standard deviations are in parentheses.

Discussion. The experimental results show that in a market comprised of *both* snobs and followers we could observe an upward-sloping demand curve as predicted by the rational expectations equilibrium. In this study, we used two price points to trace the demand curve. Assessing the demand at three price points using a within-subject experimental design could add to the robustness of the experimental finding. In Study 2, we use three price points to trace the demand curve. Furthermore, in contrast to Study 1, we provided subjects additional monetary incentive for making accurate demand forecasts.²¹ Another interesting implication of the theory is that, if the market is comprised of *only* snobs, then it exhibits a downward-sloping demand curve. We test this prediction in Study 3. Below we briefly discuss these two additional studies.

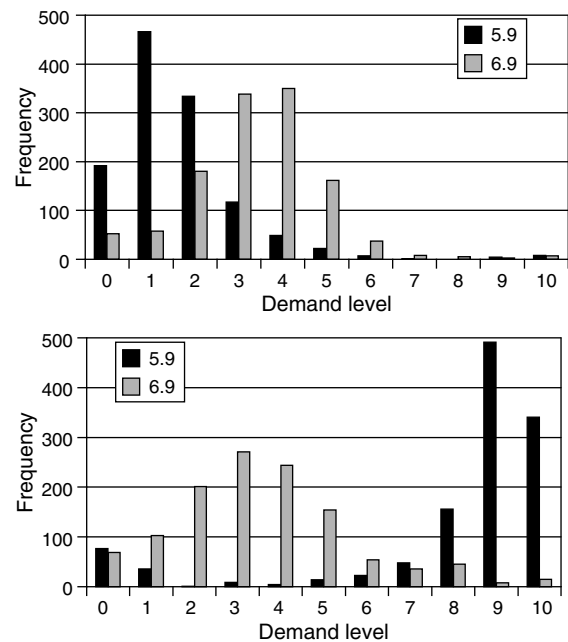
Study 2. In contrast to Study 1, we used three price points to further assess the robustness of the experimental finding. Subjects played 20 trials at each of the three price points, namely 5.9, 6.2, and 6.9, so that the total number of trials was identical to that in Study 1. The number of Type A and Type B buyers, their value distribution, and $g(z)$ and $h(z)$ were all the same as in Study 1.

The results of this study are in keeping with the model predictions. In theory, Type A buyers should demand 1, 3, and 4 units at prices 5.9, 6.2, and 6.9 francs, respectively. In actuality, on average they demanded 2, 2.95, and 3.9 units, and thus the demand grew among Type A buyers (snobs) as price increased ($F_{(2,24)} = 36, p < 0.0001$). The Type B buyers, on the other hand, should demand 10, 6, and 2 units, respectively, at the three price points. They actually purchased on average 9.05, 5.85, and 1.7 units, and so the demand among Type B buyers (followers) declined as price increased ($F_{(2,24)} = 628, p < 0.0001$). According to model prediction, the total demand should decrease as price increased. In actuality, the total demand declined with price as predicted ($F_{(2,24)} = 524, p < 0.0001$). Shifting attention to expected demand,

we note that on average subjects expected the total demand to be 10.9, 9.23, and 6.04 units at the three price points. Thus, expectations also declined as price rose ($F_{(2, 1,140)} = 517, p < 0.0001$).

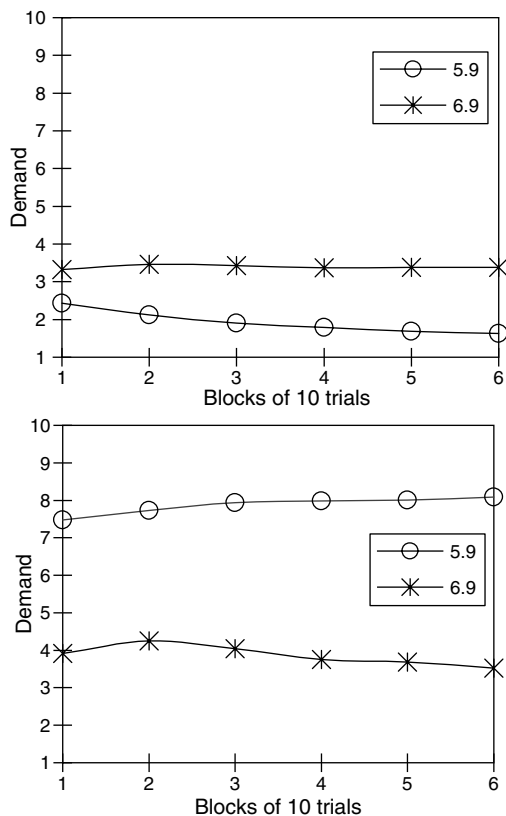
Study 3. The market was comprised of only snobs in this study. Twenty subjects played the role of Type A buyers, with two subjects at each of the points in the value distribution presented in Table 1. As before, we let $g(z) = 0.6$. Further, subjects played 20 trials at three price points, namely 5.9, 7.4, and 8.9 francs. The null hypothesis that the actual demand is the same at the three price points can be rejected ($F_{(2,24)} = 22, p < 0.0001$). The actual demand at prices 5.9, 7.4, and 8.9 francs was 7.05, 6.1, and 4.2 units, respectively. The corresponding equilibrium prediction is 8, 6, and 4 units. Thus, the observed demand pattern is directionally consistent with equilibrium prediction. Further, the actual demand and equilibrium point predictions are not significantly different at prices 7.4 and 8.9 francs (price = 7.4: $t = 0.427$ and $p > 0.2$; price = 8.9: $t = 0.62$ and $p > 0.54$). The

Figure 8 Top: Distribution of Expected Demand of Snobs; Bottom: Distribution of Expected Demand of Followers



²¹ The payoff based on purchase decision was similar to the experiment described earlier. The additional payoff was based on accuracy of the total demand projection = $5 - |e|/2$, where e is the difference between actual and forecasted demand.

Figure 9 Top: Trends in Expected Demand of Snobs;
 Bottom: Trends in Expected Demand of Followers



observed demand at price 5.9, however, is different from the equilibrium prediction ($t = 3.47$ and $p < 0.01$). On examining the expectations of subjects, we find that the average expected demand was 7.5, 6.37, and 4.59 units at prices 5.9, 7.4, and 8.9 francs, and thus expected demand decreased as price rose ($F_{(2, 1,140)} = 203, p < 0.0001$).

In sum, these two additional studies reaffirm that subjects can behave in a manner that is consistent with the predictions of the rational expectations equilibrium. The theoretical analysis in §2 highlights that subjects could arrive at the rational expectations equilibrium even when their behavior is guided by adaptive learning. In the next section, we examine the adaptive learning mechanisms that can possibly account for the observed trends in the behavior of our subjects ($F_{(2, 24)} = 22, p < 0.0001$).

4. Sophisticated Thinking and Learning

4.1. Sophisticated Thinking

The theoretical model assumes that consumers form rational expectations. This implies that subjects will play the rational expectation equilibrium in the very first trial of each price condition! On examining the first trial data, we note that three Type A buyers and

two Type B buyers bought the product at 6.9 francs in Group 1. In the other group, three buyers of each type purchased the product at 6.9 francs. Thus, the actual aggregate demand was quite close to the predicted total demand of six units. When the price was 5.9, we find that one Type A buyer and nine Type B buyers bought the product in the first trial in Group 1. Correspondingly, three Type A and eight Type B buyers purchased the product in Group 2. Again, the actual total demand is not very different from the predicted demand of 11 units. On examining the segment-level demand, we see some discrepancies from the predicted behavior. However, the demand patterns are directionally consistent with the predictions of the theory. In particular, the average demand from Type A buyers (snobs) increased from 2 to 3 units as price increased, while the demand from followers decreased from 8.5 to 2.5 as price increased. Thus, the informal analysis of the first trial data suggests that, through introspection, subjects were able to behave in a manner consistent with the aggregate equilibrium predictions.

Recent literature has attempted to unravel the depth of strategic thinking in experimental games using several *step-k* models of bounded rationality (e.g., Stahl and Wilson 1995, Stahl 1996, Camerer et al. 2004). To examine the levels of thinking that could account for the observed first trial data, we fitted a modified version of the Camerer et al. (2004) model. In particular, we assumed that level 0 subjects randomly make their decisions. A Step 1 thinker is strategic to a limited extent in that she chooses the strategy which maximizes her payoffs, under the assumption that all other players are 0-step thinkers. Similarly, a *step-k* thinker maximizes her payoffs by choosing a strategy which maximizes her utility under the Cournot-like assumption that all other players are *step-k - 1* thinkers. As in Camerer et al. (2004), we assumed that the parameter k for the level of thinking is distributed across subjects according to a Poisson distribution with mean τ . For each level of τ , we generated 200 sets of k for each of the 20 subjects and estimated the squared deviations between the predicted and observed data. The simulations reveal that the τ at which squared deviations are minimized is 3.3. Thus, our analysis suggests that on average subjects were possibly using between three and four steps of thinking to arrive at their first trial decision.²²

4.2. Learning

The average demand over the several iterations of the game is even closer to the theoretical prediction. Further, the demand fluctuated from trial to

²² On average, in the one-shot games reported in Camerer et al. (2004) the estimated value of τ is 1.5, implying that the depth of thinking was between one and two steps in those games.

trial, and as discussed earlier there are some discernible trends. Thus, the data point to not only some degree of sophisticated thinking, but also some learning during the repeated trials of the game. To examine which type of learning mechanisms can account for the observed behavior of the subjects, we estimate the SEWA model proposed by Camerer et al. (2002). SEWA allows for both adaptive learning mechanisms, such as reinforcement learning and belief learning, and sophisticated learning mechanisms, such as QRE and the Nash equilibrium concept. Thus, using the SEWA model it is possible to understand which class of the commonly known learning mechanisms can track the purchase decisions of our subjects. We first provide a brief description of the SEWA model (for more details the reader is referred to Camerer et al. 2002). Next, we discuss the overall model fit, interpretation of parameter estimates, and performance in validation samples.

4.3. The SEWA Learning Model

The model allows for both adaptive and sophisticated players. The adaptive players best respond to past actions, whereas the sophisticated players form expectations of the behavior of others, and then best respond to this expectation.

Adaptive Players. In every trial of the game, each player has to decide whether or not to purchase the product. The probability of adaptive player i choosing strategy j from the m available strategies on trial $t + 1$ is given by the logit function

$$p_i^j(a, t + 1) = \frac{e^{\lambda A_i^j(a, t)}}{\sum_{k=1}^m e^{\lambda A_i^k(a, t)}}, \quad (16)$$

where $A_i^j(a, t)$ is the attraction for an adaptive player i to choose strategy j at time t , and λ is a measure of payoff sensitivity. At the end of every trial, a player updates the attractiveness of a strategy based on the actual payoff and also the expected payoffs corresponding to strategies that were not chosen. The attraction of choosing strategy j , namely $A_i^j(a, t)$, is a weighted average of the payoff for period t and the previous attraction $A_i^j(a, t - 1)$:

$$A_i^j(a, t) = \frac{\phi N(t-1)A_i^j(a, t-1) + [\delta + (1-\delta)I(s_i^j, s_i(t))]\pi_i(s_i^j(t), \mathbf{s}_{-i}(t))}{N(t)}, \quad (17)$$

where $\pi_i(s_i^j(t), \mathbf{s}_{-i}(t))$ is the payoff received by player i by choosing strategy j in period t given that the other players chose $\mathbf{s}_{-i}(t)$ in time period t , and δ is the weight given to foregone payoffs. The $I(s_i^j, s_i(t))$

function is an indicator variable, which is 1 if $s_i(t) = s_i^j$ and 0 otherwise. The experience at time t is given by

$$N(t) = (1 - \kappa) \cdot \phi \cdot N(t - 1) + 1, \quad t \geq 1, \quad (18)$$

where ϕ and κ are depreciation parameters.

Sophisticated Players. In contrast to the adaptive learners, these players form an expectation of the likely behavior of other players, and then best respond to this forecast. Let an α fraction of the players be sophisticated. While forming expectation about the likely behavior of other players, the sophisticated players assume that $(1 - \alpha')$ proportion of players are adaptive, where α and α' can be different. These players update attractions of strategies as follows:

$$A_i^j(s, t) = \sum_{k=1}^{m_{-i}} [\alpha' P_{-i}^k(s, t + 1) + (1 - \alpha') \cdot P_i^k(a, t + 1)] \pi_i(s_i^j, s_{-i}^k), \quad (19)$$

where s_{-i}^k is the strategy vector $k \in \mathbf{S}_{-i}$ chosen by all players except i , where \mathbf{S}_{-i} is the available strategy space for all players except i , m_{-i} is the cardinality of \mathbf{S}_{-i} , $P_{-i}^k(s, t + 1)$ is the probability that the sophisticated players (except i) will choose strategy vector k at time $(t + 1)$ and $P_i^k(a, t + 1)$ is the corresponding probability for adaptive players. Note that $P_{-i}^k(a, t + 1)$ can be easily derived from (16). Camerer et al. (2002) define the probability of a sophisticated player i using strategy j on period $t + 1$ as

$$p_i^j(s, t + 1) = \frac{e^{\lambda A_i^j(s, t)}}{\sum_{k=1}^m e^{\lambda A_i^k(s, t)}}. \quad (20)$$

Note that (19) and (20) define a set of recursive equations which need to be solved at every time period to derive the probabilities that a player would choose strategy j at time $(t + 1)$ and to determine the updated attractiveness.

4.4. Results

We estimated the SEWA model using the maximum likelihood method. Following Camerer et al. (2002), we used the purchase decisions made in the first trial of each price condition to initialize the model.²³ The model was calibrated on the next 15 trials, and validated on the last 14 trials of each price condition. We conducted separate analyses for Groups 1 and 2 across the two price conditions of Study 1, and they are summarized below. Table 4 presents the parameter estimates and the fit statistics.

²³ For a detailed discussion of the computation of initial attractions, see Camerer et al. (2002, p. 18).

Table 4 Learning Model Calibration and Validation

Sample	Parameter	SEWA	Reinforcement	Weighted fictitious	Cournot
Group 1					
Calibration (15 trials)	κ	1	1	0	0
	ϕ	0.743	0.743	0.789	0
	δ	0	0	1	11
	λ	0.088	0.088	0.652	0.302
	α'	0	0	0	0
	α	0	0	0	0
	LL	-277.505	-277.505	-383.966	-401.335
	AIC	-283.505	-279.505	-385.966	-402.335
	BIC	-302.696	-285.902	-392.363	-405.533
	pseudo- R^2	0.333	0.333	0.077	0.034
	χ^2 (p -value, dof)			106.460 (0.00, 4)	123.829 (0.00, 4)
Validation (14 trials)	LL	-219.551	-218.551	-342.898	-358.03
	AIC	-225.551	-220.551	-344.898	-359.029
	BIC	-244.535	-226.879	-348.096	-362.228
	pseudo- R^2	0.434	0.437	0.117	0.078
Group 2					
Calibration (15 trials)	κ	0.772	1	0	0
	ϕ	0.493	0.595	0.398	0
	δ	0.553	0	1	1
	λ	0.297	0.115	0.758	0.680
	α'	0	0	0	0
	α	0	0	0	0
	LL	-281.067	-285.092	-348.696	-353.187
	AIC	-287.067	-287.092	-350.696	-354.187
	BIC	-306.257	-293.489	-357.093	-357.385
	pseudo- R^2	0.324	0.314	0.162	0.151
	χ^2 (p -value, dof)			4.025 (0.4, 4)	67.629 (0.00, 4)
Validation (14 trials)	LL	-199.857	-191.705	-336.760	-344.392
	AIC	-205.857	-193.705	-338.760	-345.392
	BIC	-224.840	-200.033	-341.959	-348.591
	pseudo- R^2	0.485	0.506	0.132	0.113

Note. The estimated parameters are significant at $p < 0.001$.

Overall Model Fit. For model comparison, we use log-likelihood (LL), Akaike information criterion (AIC), Bayesian information criterion (BIC), and pseudo- R^2 (ρ^2).²⁴ Because the QRE does not perform better than the random model, we only report the fit statistics for SEWA, reinforcement learning, and belief learning. The pseudo- ρ^2 for the SEWA model is 0.33 and 0.32 for Groups 1 and 2, respectively. The corresponding values for reinforcement learning are 0.33 and 0.31. However, the pseudo- ρ^2 for belief learning is only 0.07 and 0.16 for Groups 1 and 2, respectively. Thus, pure reinforcement learning can explain the purchase decisions of our subjects. This observa-

tion is consistent with other research (e.g., Roth and Erev 1995, 1998; Rapoport and Amaldoss 2000; Amaldoss and Jain 2002).

Interpretation of the Parameter Values. The parameters of the SEWA model are κ , ϕ , δ , λ , α , and α' . In discussing the implications of the estimated values of these parameters, we label them as in Camerer et al. (2002).

Depreciation Parameters ϕ and κ . The parameter ϕ measures the extent to which attractions of strategies wear out over trials. On the other hand, κ indicates the extent to which past experience accumulates. We note that ϕ is 0.74 and 0.55 in Groups 1 and 2, respectively, suggesting that attractions wear out more in Group 2. The estimated value of κ is 1 and 0.77 in Groups 1 and 2 implying again that experience accumulates more in Group 1. The estimated values of κ and ϕ imply that decision making in Group 2 is less stationary and subjects are possibly more adaptive.

²⁴ The pseudo- ρ^2 of a model indicates the extent to which the model can perform better than the null model. More precisely, the pseudo- ρ^2 is the difference between the AIC measure and the log-likelihood (LL) of a model normalized by the random model log-likelihood. $AIC = LL - k$ and $BIC = LL - (k/2)\log(M)$, where k is the number of degrees of freedom and M is the sample size.

Imagination Parameter δ . This parameter measures the relative weight given to foregone payoffs, compared to actual payoffs, in updating the attraction for a particular strategy. It can also be interpreted as a kind of “imagination” of foregone payoffs. Reinforcement learning is the special case where $\delta = 0$ and $\kappa = 1$. Thus, in reinforcement learning subjects do not consider foregone payoffs and past reinforcement accumulates over trials. However, in belief learning the same weight is placed on both actual and foregone payoffs ($\delta = 1$ and $\kappa = 0$). The estimated value of δ is zero. Thus, the purchase decisions of our subjects were possibly influenced by reinforcement-based learning.²⁵

Payoff Sensitivity Parameter λ . This parameter indicates the extent to which subjects are sensitive to payoff. An alternative interpretation is that it measures the level of noise in the choice process. The estimated value of λ is lower in Group 1 (0.08), indicating that subjects in this session were probably less payoff sensitive.

Sophistication Parameters α and α' . Note that if $\alpha = \alpha' = 1$, then we obtain the QRE model as a special case. The Nash equilibrium is a special case of SEWA where $\alpha = \alpha' = 1$ and λ is infinitely large. We find that $\alpha = \alpha' = 0$ in both groups. This implies that the learning pattern of subjects could be summarized by an adaptive mechanism.

Model Validation. We assessed the predictive accuracy of the model in the last 14 trials of the same group. Table 4 reports the log-likelihood, AIC, BIC, and pseudo- ρ^2 for the validation sample. The model performs well in the validation sample. For example, the pseudo- ρ^2 is 0.43 and 0.48 for the SEWA model in Groups 1 and 2, respectively. On average, subjects in Group 1 demanded 10.07 units and 6.5 units at prices 5.9 and 6.9, respectively. The corresponding SEWA prediction for the validation sample is 9.71 and 5.57, and we cannot reject the null hypothesis in both cases ($p > 0.2$). In Group 2, the mean actual demand was 11.13 and 7.86, while the SEWA prediction is 11.8 and 8.13 at prices 5.9 and 6.9, respectively ($p > 0.2$).

Discussion. In sum, the behavior of subjects in the first trial of the game seems to be quite close to the equilibrium prediction. This implies that subjects are capable of sophisticated thinking. However, purchases in the subsequent trials were possibly guided by adaptive decision making. Subjects who participated in Studies 2 and 3 were also adaptive in their decision making.²⁶

²⁵ It is useful to note that individual-level differences could potentially dampen the estimated value of δ . We thank an anonymous reviewer for pointing out this possibility.

²⁶ On analyzing the data from Study 2, we found that $\kappa = 0$, $\phi = 0.79$, $\delta = 0$, and $\lambda = 0.42$ with a pseudo- $\rho^2 = 0.44$. In Study 3,

The learning analysis raises an interesting managerial question: Can firms exploit their understanding of the learning process by dynamically adjusting prices to maximize profits? To theoretically answer this question, we assume that the value distributions for both snobs and followers are uniform with range $(0, 1)$ and there is no discounting. Further, consumers form adaptive expectations as implied by Cournot dynamics. Then, we have the following result.

RESULT 3. If the follower effect is large, then the optimal price strictly increases over time, implying that the firm uses a penetration pricing strategy.²⁷

The optimal price paths for various parameters when the follower effect is dominant is shown in Figure 10.²⁸ The result is intuitive. Because consumers form expectations on the basis of last period sales, when the follower effect is dominant, the firm needs to provide discounts early on to induce trial. As the sales increase, the firm can find it profitable to increase prices.

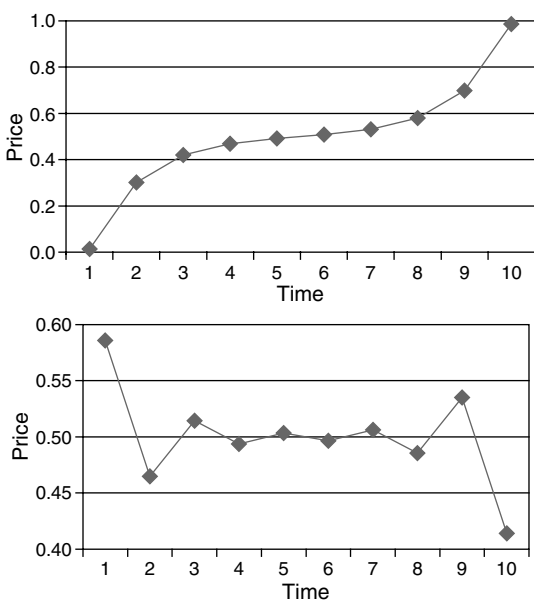
However, when the snob effect is dominant, the optimal price path is nonmonotonic and cyclical as illustrated in the right panel of Figure 10. This observation implies that when the snob effect is large, the firm can make more profits if it charges a high price and offers periodic promotions. When the firm charges a high price in the first period, then its demand from both snobs and followers is low. This low demand, however, makes the product more attractive to snobs in the subsequent period and less attractive for the followers. The firm can then increase its sales by decreasing price and thereby selling to both snobs and followers. It turns out that such a hi-lo pricing policy yields more profit than constant pricing or monotonic pricing.

we found the estimated value of $\kappa = 0$, $\phi = 0.58$, $\delta = 0$, and $\lambda = 0.39$ with a pseudo- $\rho^2 = 0.53$. For completeness, we also estimated the SEWA model parameters by pooling the data from Studies 1, 2, and 3. Like before, we used the first trial data in each price treatment for initializing the model. Then, we calibrated the model using one half of the trials in each treatment, and validated the model using the remaining trials. The estimated values of the model parameters were $\kappa = 0$, $\phi = 0.50$, $\delta = 0$, and $\lambda = 0.12$ with a pseudo- $\rho^2 = 27.73$. The pseudo- ρ^2 in the validation sample was 37.5. Thus, the learning analyses performed on Studies 2 and 3 data, as well as the data obtained by pooling all three studies, suggest that adaptive learning can account for the behavior observed in the experiments.

²⁷ The exact condition for this to hold is $\lambda_2 \geq (\sqrt{5} - 2 + 2\beta\lambda_1) / 2(1 - \beta)$. See Appendix A for a formal proof. This is a sufficient, but not necessary, condition. Our numerical results show that the result holds for a much wider range of parameters. Note that the presence of a large follower effect does not rule out the possibility of a substantial number of snobs in the market.

²⁸ The figures are drawn under the assumption that the value distributions are uniform with range $(0, 1)$ and that the game lasts for 10 periods.

Figure 10 Top: Dynamic Price Pattern When Follower Effect Is Large ($k = 0.7$);
 Bottom: Dynamic Price Pattern When Snob Effect Is Large ($k = -0.7$)



5. Conclusion

In this paper, we developed a parsimonious model of conspicuous consumption using the rational expectations framework. Our theoretical and empirical investigation provides useful insights on a few questions about conspicuous consumption and sophisticated thinking.

(1) *Would consumers buy a conspicuous product more as price increases, even if the product has neither quality difference nor signal value?* We show that if the market consists of only snobs or only followers, then the demand curve is always downward sloping. However, in the presence of both segments, the demand curve of snobs could be upward sloping. Note that our result does not rely on *signaling* either product quality or wealth of consumers.²⁹ This finding is consistent with anecdotal evidence and also with a study conducted by Chao and Schor (1998). They find that the demand for visible women’s cosmetics grows as price increases in a subsegment of the market, although the overall demand curve has a downward slope. We also find support for our result in a laboratory setting.

(2) *What is the implication of social externalities on the profits of a monopolist?* Our analysis suggests that as the follower effect increases, profits of a monopolist increase. Conversely, the profits decrease as snobbishness among consumers increases. A practical implication of these results is that in the presence of social

effects, a monopolist can potentially increase his or her profits by employing marketing strategies to create a bandwagon effect for his or her products.

(3) *What is the descriptive validity of the rational expectations framework?* Our subjects’ expectations seem to converge to the rational expectations equilibrium and the actual demand. Thus, the empirical analysis adds to the body of experimental literature on rational expectations models.

(4) *How do subjects learn to play the game in a fashion that is consistent with equilibrium predictions?* The purchase decisions of our subjects in the very first trial of the game suggest that they are capable of some degree of sophisticated thinking. However, their behavior in the later trials could be explained by adaptive learning. Thus, subjects seem to use both sophisticated thinking and adaptive learning to behave as predicted by the rational expectations equilibrium.

(5) *What is the implication of consumer learning for firm’s optimal prices?* Our theoretical analysis suggests that when the follower effect is large, a monopolist can benefit by using a penetration pricing strategy. However, as implied by our numerical analysis, it is profitable for a firm to use a hi-lo pricing strategy when the snob effect is large.

In this paper, we have taken only a small step toward incorporating social factors into economic models of marketing phenomena. There are several avenues for future research. The theoretical model can be extended to examine the effect of other marketing mix variables, such as advertising and distribution, on conspicuous consumption. Future theoretical research can examine how competition can possibly affect conspicuous consumption (see, for example, Amaldoss and Jain 2005). It would also be useful to replicate the findings of our three studies under varied experimental conditions.

An online appendix to this paper is available at <http://mansci.pubs.informs.org/ecompanion.html>.

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²⁹ In fact, an explanation based on signaling status cannot account for an upward-sloping demand curve for snobs (see Corneo and Jeanne 1997a).

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