



Do consumers correctly expect price reductions? Testing dynamic behavior☆



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ABSTRACT

The assumption that consumers are fully rational and hold correct price expectations is demanding in dynamic settings. We claim that it is testable provided that market-level data on prices and purchases are available. We find that consumers hold simple expectations regarding the timing of promotions for music albums: consumers act as if they were aware of reductions but did not revise their beliefs over time. The anticipation effect, due to strategically delaying purchase, amounts to 1/5 of the decision to purchase during regular periods. These results have implications in terms of demand estimation, optimal pricing and welfare computations.

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1. Introduction

The importance of taking agents' dynamic behavior into account has been well established by the literature on industrial organization (IO). Closely related is the role of consumer anticipation in the formation of demand. In the presence of promotions (for either durable goods or storable goods), consumers have to make a purchase decision that requires them to determine not only whether to buy but also when to

buy the good. They may strategically delay their purchases if they correctly anticipate promotions, which in turn affects demand during regular price periods. Though perfect foresight is often taken for granted, this assumption is rather demanding in dynamic settings because it requires agents to hold perfect expectations over the future state of the world to solve complex, dynamic programs.

This paper argues that the nature of consumers' expectations is testable using market-level data. It explains that markets with sticky prices and occasional price changes (including promotions) are particularly appropriate for performing such tests. Having a flat price allows us to relate more easily the evolution of demand with the expectations of consumers. Markets with highly volatile prices are less adequate since it would be hard to disentangle the price effect from what will be called the "anticipation effect" (see *infra*). A simple method is proposed here to determine whether consumers hold correct beliefs over the price process. We exploit variations in both price and quantity to infer the nature of consumer behavior in a dynamic setting. More precisely, we test (i) whether consumers have perfect foresight, (ii) whether they are myopic, and (iii) whether they hold time-independent beliefs. We show that these three *scenarii* correspond to distinct patterns of demand, which yields testable predictions. Our application is based on data on the album sales of a French chain of retailers from 2003 to

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2006. Overall, we find that consumer behavior is consistent with the latter scenario.

From these observations of prices and purchases, we first document several empirical facts regarding promotions and consumer behavior. The price process is composed of the establishment of a regular price followed by occasional price reductions (sales and durable price changes). Price stickiness makes a repeated static game à la *Varian* (1980) less likely than intertemporal price discrimination motives. As in *Pesendorfer* (2002), the probability of a price reduction increases as time passes, which shows that the timing of promotions is not random and that price reductions can be roughly predicted. We also observe a peak in demand when promotions begin, and this peak is higher when the time elapsed since the last promotion increases, which indicates that there is an accumulation of consumers in the market. Interestingly, during the regular price period, the pattern of demand is not decreasing but flat. If consumers correctly expect prices and delay their purchases accordingly, then demand must decrease *ceteris paribus* because the gain from waiting increases. Even if *some* (loyal) customers had perfect foresight, a decreasing pattern should still be observed. By contrast, the flat pattern indicates that consumers somehow do not correctly update their beliefs.

Second, we present a stylized theoretical model that relates the nature of consumer anticipation about prices to demand in a durable-goods setting. Consumers awaiting occasional promotions accumulate in the market, which generates a decreasing pattern of purchases during sales. Consumers with correct expectations anticipate that a sale is increasingly likely as time passes. On the contrary, myopic consumers are indifferent to an approaching sale. Consumers with time-independent beliefs differ from the latter in that they care about the gap between the regular and discounted prices when they make purchase decisions during regular price periods. The observed pattern of purchases is consistent with the accumulation of low-valuation consumers waiting for discounts, but it does not account for (at least some) consumers being endowed with correct foresight; rather, it would benefit consumers holding time-independent beliefs.

Third, we use our data to test whether consumers have perfect foresight, are myopic or hold time-independent beliefs. Empirical evidence suggests that consumers are aware of promotions and wait for them, but they have the wrong timing in mind or they form “simple” expectations that they do not update accordingly as time passes. Demand at the regular price is higher when the price gap increases. It is also decreasing with the ratio between this price gap and the time between promotions, as if consumers strategically delayed their purchases based on time-independent beliefs. By introducing both randomness and heterogeneity into the previous model, we estimate demand using a fixed-effect Poisson model that permits us to reject both perfect foresight and myopia. Finally, we find that the purchase decision results from an intertemporal trade-off that depends 4/5 on the current price (the “price effect”) and 1/5 on a time-independent expected gain from waiting for a lower price, which we call the “anticipation effect.”

This paper is organized as follows. *Section 2* relates the paper to the literature. *Section 3* presents our data. *Section 4* documents empirical facts about prices and demand patterns before, during and after price reductions. In *Section 5*, a stylized model explains how demand is formed from expectations in the different *scenarii* of consumer behavior and derives some testable predictions. *Section 6* is devoted to the estimation of a model of demand that enables us to test previous predictions, to discriminate among the multiple *scenarii* and to measure the anticipation effect. *Section 7* summarizes our main findings, discusses the limitations of the paper and emphasizes its implications for researchers, firms and competition authorities.

2. Literature review

The theoretical literature devoted to durable goods and to promotions attempts in particular to determine optimal pricing, which

depends crucially on the nature of consumer expectations. Numerous papers rely on the assumption of perfect foresight. For instance, when proving the Coase conjecture, *Stokey* (1981) requires consumers to be perfectly forward-looking to construct a unique perfect equilibrium that implements the Coasian outcome. In *Conlisk et al.* (1984), a durable-goods monopolist faces incoming cohorts of consumers who are also endowed with perfect foresight about the price schedule. The equilibrium is characterized by price cycles in which the price decreases continuously. In the presence of both high- and low-valuation consumers, the firm has an incentive to cut prices at some point because low-valuation consumers who are waiting for a promotion have accumulated in the market. The same argument applies after the price cut, which yields cycles. In addition, the firm must make high-valuation consumers indifferent between buying upon arrival or waiting for the sale, which yields the decreasing price path.¹

However, the literature devoted to search costs (including *Stigler*, 1961; *Varian*, 1980) relies on the idea that information is costly to gather and that not everybody is informed about prices, which calls into question the assumption of perfect foresight in a dynamic framework. *Villas-Boas and Villas-Boas* (2008) rationalizes promotions in a setting in which informed consumers forget their preferences, while uninformed consumers are willing to experiment with new products. Other forms of bounded rationality have been invoked to relax the assumption of correct expectations, including loss aversion (see, e.g., *Kahneman and Tversky*, 1979; *Heidhues and Köszegi*, 2014).

The empirical IO literature has generally considered consumers to be perfectly forward-looking. The estimation of dynamic games (see, e.g., *Aguirregabiria and Mira*, 2007; *Bajari et al.*, 2007; *Pesendorfer and Schmidt-Dengler*, 2008) requires agents to be fully rational and to have perfect foresight. Intertemporal models of demand that were developed by *Nair* (2007) and by *Esteban and Shum* (2007), for example, also rely on the assumption that consumers are perfectly forward-looking, which involves complex dynamic programs. In a storable-goods setting with occasional promotions, *Liu and Balachander* (2014) also consider forward-looking consumers and explicitly model the time since the last purchase in the expectation process.

However, structural dynamic models of demand, such as those estimated by *Erdem et al.* (2003), *Hendel and Nevo* (2006a) and *Gowrisankaran and Rysman* (2012), assume that while consumers are fully rational, firms fix prices according to some Markov process. The latter is a simplifying assumption or an approximation of the supply side's actual behavior. This assumption yields an estimated demand that is similar to the demand that would be obtained under a different assumption, namely, “firms fix prices optimally, and consumers expect a Markov price process.” However, the corresponding optimal pricing and welfare computations would be different. In the same vein, *Ishihara and Ching* (2012) depart from the assumption of perfect foresight, assuming instead that consumers use a Markov process to forecast future prices. *Hendel and Nevo* (2013) consider two hypotheses about consumer expectations – perfect foresight and rational expectations – and estimate a model of demand under these different assumptions.

Determining whether consumers are correctly forward-looking is thus an empirical issue. The main contributions of this paper consist of explicitly testing for perfect foresight, myopia and time-independent beliefs. Using a different methodology based on possibilities of resale, *Chevalier and Goolsbee* (2009) found that in a US market for college textbooks, students were forward-looking and revised their probability of resale over time. However, recent empirical evidence calls into question the assumption of perfect foresight. *Ching et al.* (2009) show that consumers may not consider a product every period. *Clerides and Courty* (forthcoming) also document consumer inattention by looking at specific sales resulting in quantity surcharges. According to *Seiler*

¹ In that same setting, however, if consumers were myopic or if they held time-independent beliefs, the firm would still hold occasional promotions, but it would not continually decrease prices.

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