Persuading Customers to Buy Early

Retailers frequently employ dynamic pricing to effectively match supply with demand. Some retailers such as Amazon change prices very frequently, whereas others, especially those in fashion retail, change prices less frequently. In such scenarios, customers face both a price risk, i.e., that product price may decrease, and a quantity risk, i.e., the product may not be available in the future. At any given time, customers must make a *buy now* or *buy later* decision by suitably weighting their estimates of these risks with their own value for the product. As one expects, a firm tends to have more information about its supply and aggregate demand, than its customers, and thus is better informed of the potential future product availability. This leads to a natural information provision question: *How can a firm communicate this information in a profitable manner?*

One option is for firms to incorporate availability information into their pricing decision and use prices to signal it. Unfortunately, this leads to unprofitable price distortions. Another option is to use an additional communication channel to signal the availability information, for instance, an e-tailer may place a message “*Limited Stock*” next to the product under consideration. In this paper, we follow this latter approach, and use a Bayesian Persuasion framework to model the information provisioning game.\(^1\) In this framework, the firm commits to its signaling mechanism a priori, before realization of the underlying uncertainty. Our goal is to characterize the optimal signaling mechanism and evaluate its value for the firm. We consider both the cases in which prices may be optimized by the firm or fixed due to other considerations. In all our analysis, we

focus on posted/public prices. Motivated by e-tail settings in which firms may possess detailed information about each customer, we extend our signaling mechanisms to include the case of personalized information provisioning, by allowing the retailer to potentially provide different signals to different customers.

For most of our analysis we consider the following model: a monopolistic firm sells a product to a market of customers who are differentiated in their willingness-to-pay for the product (their valuation). The market size is fixed and known to both customers and the firm. The sales season comprises two discrete periods and the firm commits to a price trajectory and signaling mechanism before sales begin. Further, prior to the sales season, both the firm and customers are uncertain about the actual quantity the firm will have on hand to sell; there is a common public prior on its distribution. At some point in time after committing to prices and before the start of the sales season, the firm (only) gets fully informed about its quantity. At this point, the firm sends a signal to its customers based on its committed signaling mechanism. In the public signal case, the firm’s signal is identical for all customers, whereas in the private signaling case, the firm’s signal can be different for different customers. Figure 1 summarizes these events in a chronological sequence, with periods one and two denoting the sales periods. We have intentionally kept our base model succinct to illustrate many of the nuances of this problem in an intuitive fashion. The fundamental trade-offs that we identify apply to uncertainty in availability, and thus we can generalize the quantity uncertainty to also include demand uncertainty.

We prove that under some technical conditions the optimal signaling mechanism is binary and
involves the firm sending one of two signals. Under the optimal mechanism, these signals can be interpreted as “recommendations” of buy now and buy later signals, and the customers find it incentive compatible to follow the firm’s recommendation. That is, customers receiving buy now signal weakly prefer to purchase in period one, whereas those receiving buy later signal prefer to purchase in period two.

We further find that public information provisioning has limited value in this setting. However, personalized information provisioning has significant value. Specifically, we prove that public information sharing can lead to an increase in firm’s revenues only when the prices are exogenously fixed. That is, if the firm could optimize prices, there would be no additional value to providing public information. In contrast, the firm is able to significantly improve its revenue when it signals in a personalized manner to customers.

Somewhat surprisingly, we find that personalized information provisioning has attributes very similar to personalized pricing. Specifically, by customizing its probability of sending buy now or later signals, the firm is able to extract the entire valuation of the customer with some probability. It turns out that if this customer is indifferent between purchasing in periods one and two under the personalized signaling mechanism, then the firm cannot extract greater revenue from this customer even by using a personalized price in period one! In this fashion, for many problem parameters, personalized information sharing can reap the entire benefits of personalized pricing when persuading customers to buy early.

We discuss extensions to our base model to consider situations in which the firm may not have full information at the time of signaling, or there may be information leakage across customers. We find that personalized pricing can continue to provide benefits even in these situations.

In conclusion, our work suggests that personalized strategic information provisioning has potential, especially in e-tail scenarios where firms have information on customer willingness-to-pay as well as product attributes (such as availability), but are restricted to posted price mechanisms.