Estimating Demand Stickiness Due to Rationally Inattentive Consumers

Introduction: With the availability of transaction data and the computing power to process these data, retailers become increasingly sophisticated in setting prices dynamically to match supply and demand (Elmaghraby and Keskinocak 2003). A basic assumption in research on dynamic pricing is that consumers respond to current prices ignoring previous prices and purchase quantities. However, for frequently purchased products, this assumption may not hold. If consumers remember previous prices and purchase quantities, and the price adjustment from the previous period is small enough, consumers may not want to re-optimize. This consumer inertia is consistent with the notion of rational inattention whereby economic agents do not immediately respond to small shocks in the market (Reis 2006; Sims 2003; Monroe 1971). In a retail environment, the existence of rationally inattentive consumers implies demand stickiness. In other words, demand may not shift as much as a simple demand curve would suggest in the case of small price adjustments. The current research estimates this demand stickiness using weekly grocery sales and price data and explores its implication for dynamic pricing.

Demand model: We derive an aggregated demand model based on individual consumer’s utility. Suppose a myopic consumer needs to decide the purchase quantity of a product that she needs in every period. She incurs a cost whenever she exerts mental efforts to calculate the optimal quantity by maximizing her net utility of consuming the products. In the initial period, there is no prior, so she always incurs the optimization cost, creating the classic, textbook-version simple demand. However, in the subsequent periods, she has two choices: she can either incur the optimization cost again to re-calculate her quantity based on the current price, or she can avoid this cost by continuing to use the quantity she obtained in the previous period. Naturally, she chooses the latter when the price change from the previous period is sufficiently small relative to her optimization cost.
With the assumption that consumers are heterogeneous in their optimization costs but homogeneous otherwise, in any subsequent period the aggregated demand becomes sticky – those consumers with bigger optimization costs purchase the quantities corresponding to the price in the previous period and those with small enough optimization costs update their quantities based on the current price. In other words, this *sticky demand* is a weighted average of two simple demand functions, one (the other) corresponding to the current (the previous) price. The weight is dictated by the distribution of the optimization costs in the population. We use one parameter, L, to represent the scaled upper bound of this distribution. The smaller the L is, the less sticky the demand is. As L approaches 0, the sticky demand degenerates into the simple demand.

**Demand estimation:** Using Dominick's scanner data, we estimate the magnitude of demand stickiness econometrically with a structural model. The data set contains price and sales quantities for each product at one of the 100 stores for 400 weeks. We pre-process data by adjusting prices for inflation and excluding holiday sales. We identify the sticky demand in two steps. We first group the data into two sub-samples: Sub-sample 1 contains data in weeks whose prices are the same as those in the previous week; and Sub-sample 2 contains the rest. We first use standard econometric techniques to estimate the simple demand using Sub-sample 1 in which there are no price changes from the previous period. We then apply the estimated simple demand from the first step to Sub-sample 2 to obtain the sticky demand parameter L.

We then use a linear regression model to uncover the relationship between the sticky demand parameter L and various consumer- and store-characteristics. We find that the demand is stickier if the average household income is higher and if shopping environment in a store is more pleasant. In contrast, the demand is less sticky if there is a higher percentage of non-working women with children in a store’s consumer base and if the store faces tougher competition.
Finally, stores with consumers who are more likely to redeem coupons experience less demand stickiness.

**Implication of demand stickiness on dynamic pricing:** A counterfactual analysis shows that a retailer can increase its revenue by about 1-4% if it considers demand stickiness when setting its prices dynamically to clear inventory. Counter to the conventional wisdom in the dynamic pricing literature, we find that when the demand is very sticky and the planning horizon is short, a retailer is worse off setting price dynamically than statically if it mistakenly uses the simple demand. In addition, the optimal dynamic price path that is set according to the sticky demand includes many small prices increases and few large price drops, a result that is consistent with the empirical observations made in Chen et al. (2008).

**Contribution:** To the best of our knowledge, this paper is among the first to empirically estimate the magnitude of demand stickiness in a grocery retail environment. Our findings have important theoretical and practical implications regarding how to better leverage dynamic pricing for higher profits. This paper also contributes to the growing literature concerning the effect of rational inattention on consumption behaviors.

**Reference:**