Overview: The adoption of Internet-based commerce has provided academic researchers with a wealth of new data on demand and pricing in a number of industries. The availability of these data and their growing use in empirical studies of electronic commerce has also raised a number of new statistical and econometric issues. In this abstract, we briefly describe our program of research that explores theories of price rigidity and empirically estimates menu costs of price changes faced by retailers, the search costs of price information faced by consumers and the underlying consumer demand curve. The validation of this research program will be based on a data set we are gathering from Amazon & Barnes and Nobles (BN).

Search Costs and Consumer Demand: In a seminal piece of work, Stiglitz (1989) suggested that when the underlying consumer demand function is kinked, the demand elasticity for price decreases is different from the demand elasticity for price increases. In fact, the shape of the demand function is determined by the magnitude of consumers’ search cost. When search cost is high, consumers are only aware of the price of the store they visit, but are unaware of the prices for the same product in the retailers they do not visit. So when a retailer increases its price, its own immediate customers (who know about the increase) are induced to search for prices amongst rival retailers, and the store loses customers accordingly. But when a retailer decreases its price, its action induces no new customers to launch a search. Hence, while it will able to keep its existing customers, it does not gain a proportionate number of new customers. This leads to a lower price elasticity for price decreases. On the other hand, when search cost is low, a reduction in product price by a retailer has the potential to attract customers from its competitors, but a price increase only affects the firm’s current customers and that too, adversely. This leads to a higher price elasticity for price decreases. Thus, by studying the characteristics of consumer demand function and sensitivity to price changes, we can infer the level of search costs in online markets.

Menu Costs of Price Changes: From the firm’s point of view, they change prices to attract price sensitive consumers periodically, and establish good will (Slade 1998), which requires it to run price promotions as part of the optimal pricing strategy. In a series of studies using data from online retailers, Bergen, Kauffman, and Lee (2005) have found that internet retailers use several pricing strategies and that prices are far more rigid that conventional wisdom suggests. The frequency of price changes made by retailers in many ways, is a function of their managerial and menu costs. Since there exists an intricate relationship between the extent of search costs faced by consumers in electronic markets and the frequency and magnitude of price changes by firms, it becomes interesting to quantify menu costs as well.

We use product-level price and demand data to measure menu costs of online retailers. We define menu cost broadly as the total cost of changing the price of a product, which includes the physical cost of making the change as well as the managerial cost in making the price change decision. The firm makes a trade-off between the menu cost and the value of price change, which is in turn determined by change to profit margin, demand elasticity, demand level and the expected time until the next price change. Using price and demand data, we are able to identify all parameters of the model including the menu costs.

Contribution and Statistical Challenges: The central objective of our study is therefore to empirically investigate the existence of search costs and menu cost in electronic markets as predicted by widely-used economic theory, and quantify the magnitude of each of these costs. We do so using a large panel data of...
books, CDs and DVDs on Amazon and Barnes and Noble. Our research aims to make the following two contributions:

**Search Cost.** We will provide the first known empirical analysis of the nature of the consumer demand curve in electronic markets using demand and pricing data. We econometrically incorporate the fact that demand elasticity for price decreases can be different from that for price increases. We show that as predicted by Stiglitz (1989), consumer demand is indeed kinked, and this highlights that consumers do face positive search costs even in online markets. The *statistical challenge* lies in quantifying the magnitude of search cost from e-commerce price and demand data. We construct an empirical model of consumer search where consumers make search decisions based on expected benefits of search and individual idiosyncratic search costs. We estimate expected benefits of search by assuming that consumers hold rational expectation on price dispersion between Amazon and BN. The trade-off between the benefits and cost determines a consumer’s search activity, which means that changes in consumer search activity can be used to infer distribution of search costs. An additional statistical challenge is that we do not directly observe a consumer’s search activity. Instead, using demand and pricing data from electronic commerce, we estimate the number of consumers who switch retailers as a result of search and use this to identify the distribution of search costs.

The presence of search costs also implies that it takes time for price information to dissipate among consumers. This leads to lower short-term price elasticity and higher long-term price elasticity especially for information on price decreases. To quantify this information diffusion process, we estimate the time it takes for pricing information to percolate in the market and show how the distribution of search cost evolves dynamically over time. We find that this is consistent across books, CDs and DVDs.

**Menu Cost.** Using a stochastic discrete choice problem and non-linear least squares estimation techniques, we will provide the first study that econometrically estimates and quantifies the magnitude of menu costs faced by firms in changing prices in electronic markets. The *statistical challenge* lies in exploring competition between Amazon and BN to identify their respective menu costs. We develop an empirical model where consumers have heterogeneous search costs, which results in price randomization. We then fit the observed price changes to the mixed pricing strategy and use it to identify parameters in the menu cost model. In addition, menu costs take two forms – the opportunity costs due to delay in decision making, and the physical costs of making the decisions and implementing them. To measure the two effects separately, we resort to a new empirical strategy that explores the timing of price changes as well as changes in price magnitude.

We will further describe some of the statistical and econometric challenges we have faced during the course of our preliminary analysis of these data, and some research contributions we have made towards addressing them that may generalize towards future empirical research in electronic commerce.

**Reference:**

