Online Price Competition within and between Heterogeneous Retailer Groups

Cenk Kocas

Department of Marketing and Supply Chain Management, Michigan State University
kocas@msu.edu

Abstract
This study presents a model of price competition in a market for a homogenous good with many asymmetrically positioned retailers, a typical example of which could be the online markets for books, music, movies, or software. These markets are highly competitive oligopolies served by hundreds of active retailers and that have been affected by Information Technologies such as price comparison engines and shopping bots. In these markets, firms can only identify broad group memberships to clusters of firms, and compete within and across clusters based on this information, due to the incompleteness of information on the characteristics of firms. The characteristics of the firms that shape their competitive behavior are their established loyal segment sizes and potential comparison shopper segment sizes. To analyze such markets, we develop and solve a static game of price competition in an asymmetric oligopoly with numerous clusters of firms. In our analysis we see that the firms with the smallest loyal segment sizes and the largest switcher segment sizes engage in a fierce price competition while the members of all other groups prefer to price at their reservation price points. We also test and provide empirical support for our model predictions using pricing data on three categories. Our data set contains prices on 112 printers from 20 retailers, 95 cameras from 53 retailers and 1388 books from 15 retailers.

Keywords: Price Comparison Shopping; Price Competition; Oligopoly; Internet Economics.

1. Introduction
Online markets are increasingly populated with almost countless numbers of retailers that offer identical products to their customers. The online markets for software, music, movies, computers, electronics, appliances, and books are typical examples. The lack of entry barriers also contributes to the abundance of retailers in online markets. Entry into any of these markets is only as costly as setting up an e-commerce enabled site, resulting in many small players offering their services to the online buyers.

When customers compare prices of a given identical product across retailers, these retailers are in direct competition for the business of that customer regarding that particular product. The proliferation of price comparison engines and shopping agents contributes to the practice of price comparison shopping and has potential to increase competition. Evidence of such competition is provided in recent research on competition between conventional retailers ([19]), conventional retailers and mail order stores, ([23]), conventional retailers and online stores ([5],[12]) as well as online stores ([14],[7],[22]). Therefore, there is heightened attention to competitive strategies that could emerge as information technologies change the way people shop.

We make a distinction between comparison shoppers who may use information sources such as price comparison engines and shopping agents and loyal customers who prefer a single retailer for their shopping in a particular category. We refer to the customers, who can compare prices of some products across stores as informed customers or switchers as in [21], [24] and [18]. Smaller retailers, or new entrants, in the online markets, rely on the price comparison shoppers as their sole segment of potential customers. We consider such firms to be more interested in and dependent on switchers rather than established loyal segments. Selling to this segment of informed customers requires that the firms compete with all other firms that are similarly accessible from the price comparison engine utilized by the customers. Therefore, firms that place a higher emphasis on price comparing shoppers are more likely to operate in more competitive environments.
On the other hand, the more established firms also compete in the same market. However, having served the market for a while, the more established firms also enjoy the loyalty of a larger segment of its customer base and can extract monopoly profits from these customers who are uninformed of, or perhaps simply uninterested in the offerings of other retailers. We refer to these customers as the loyal customers. These more established firms also wish to sell to the switcher segments. However, since the targetability, the ability to predict if the customer is a loyal or a switcher as well as the addressability, the ability to contact customers individually, is imperfect, retailer have no way of price discriminating ([8],[3]). Moreover, whereas the more established firms enjoy having considerable loyal segment sizes, the loyal customers of a new entrant, or a small player are negligibly small, which is a source of positional asymmetry that is typical of especially online markets.

Therefore, one important characteristic of the online markets under inspection so far is that they are markets with many asymmetrically positioned firms competing for the business of the potential customers. An analysis of markets with many asymmetrically positioned firms therefore becomes a necessary next step given previous works that dealt with the many and asymmetrical components separately. [24] examines the many component analyzing a symmetric oligopoly and [18] examines the asymmetrical component analyzing an asymmetric duopoly. However, neither the [24] nor the [18] models are sufficient to analyze a market with many asymmetrically positioned firms. Our work analyzes an asymmetric oligopoly by introducing groups of retailers with various levels of loyal and price comparing customers. Although we work with similar modeling assumptions, our model of asymmetrical many firms is neither a direct interpolation of these previous models, nor a simple extension of either.

More specifically, our model assumes that there are many firms that may or may not have similar sizes of loyal and switcher customer segments. This is an oligopoly of many asymmetrical firms with incomplete information. Noticing the fact that neither the loyal nor the switcher segment sizes are publicly available information across firms, our model recognizes that firms can group any other firm as either a firm with possibly larger, the same or smaller loyal/switcher segment size. We also assume that firms can correctly classify themselves with at least some other firms in the same group and observe at least some firms within each other group. Hence, we have an oligopoly with firms that have incomplete information on the sizes of loyal and switcher segments of each other.

In order to analyze the emerging price competition with many retailers, we develop a stylized model of price competition in this asymmetric oligopoly and solve it as a static, one shot model with incomplete information. While cooperation, learning, reputation and punishment may be issues that shape strategies in games played repeatedly, we believe the costs of including these complicated strategies by adapting a repeated games framework would outweigh the benefits. As a result we resort to a one shot static game and demonstrate how firms classify themselves as price promoters or regular price stores given the abundance of competition.

We assume that, although firm level loyal and switcher segment sizes are unknown, firms can identify clusters of firms with similar loyal and switcher segment sizes. In this work we analyze a market with basically four clusters of firms, whereas the results can easily be extended to markets with finer levels of clustering. We categorize each firm as having a small or large number of switcher customers and as having a small or large number of loyal customers. This categorization results in four clusters. We refer to the clusters as LL, LS, SL, SS clusters, where the first letter refers to the number of loyal customers (Large vs. Small) and the second letter refers to the number of switcher customers. Therefore, LS cluster, for example, is the group of firms with a large number of loyal customers and a small number of switcher customers, a typical firm in which can be a niche click- and -mortar firm that has an established loyal segment but relatively negligible online presence. Typical examples from the online book market could be powells.com and wordsworth.com. On the other hand a typical firm belonging to the SL cluster would be a pure online player with no established loyal segment but a motivation to attract switcher segments by utilizing traffic generation strategies online. Typical examples, again from the online book market could be textatcost.com and ecampus.com. Firms that belong to LL cluster can be established online firms that have already invested into building loyalty while simultaneously competing for the business of switchers in a hope to retain them as loyal customers in the future. A typical example could be a firm like Amazon.com. Bigger click-and mortar firms such as Barnes and Noble
also belongs to this cluster because of their high traffic generation and loyalty potentials. Finally, a firm from the SS cluster would be a fringe player with neither a significant number of loyal customers nor an effective attempt to be found by switcher customers. There are possibly hundreds of pure online booksellers that could be categorized in this cluster.

Whereas loyal customers are exclusive to each firm, switcher customers are not. Hence, we also assume that all the switchers that an LS and SS cluster firm can sell to are as well reachable by any firm in the LL and SL cluster. To put it another way, the switchers that the LL and SL clusters can serve only partially know firms within the LS and SS clusters (We make this assumption to ascertain that if firms within the SL cluster are the only ones competing for switchers offering low prices, as our analysis shows in the model section, then all switchers are served by these firms and no switcher remains who does not know any of the firms in the SL cluster.).

Our objective in specifying groups of retailers is rather simple. In our analysis that will follow we demonstrate that, in a market with many asymmetrically positioned firms, only those firms that have a higher interest in the switcher segment engage in price promotional behavior by offering any price discounts at all. Our analysis shows that, there are two diverse strategies that emerge in this market, one adapted by the firms in the LL, SS and LS clusters, and one adopted by firms in the SL cluster. The firms in the SL cluster compete for the switchers and their competition results in randomized prices ranging from the reservation price to almost down to the marginal cost of the item. Driven away by this fierce price competition, firms in the other clusters do not price promote at all. Also notice that, our choice of S and L sizes are somewhat random, but this choice is sufficient enough to demonstrate the fact that only the firms with the highest proportion of switcher customers, or with the lowest Switcher/Loyal ratio will be offering price promotions.

Our findings also provide an operational explanation to the observed price dispersion that has received widespread research attention. Research streams in economics and marketing have reported and attempted to explain the sources of dispersed prices where a one-price rule was expected to apply ([21], [6], [5], [9], [2], [15], [19] and [11]). Our model shows that, asymmetrically positioned firms may engage in competitive behavior that results in a variety of promotional patterns, which in turn displays price dispersion for the homogenous product examined.

Literature review

Economics, marketing and economics of information systems literatures have rich research streams on pricing in a competitive environment. The research streams in pricing in a competitive environment are either game theory based models that seek equilibria in stylized models of profit maximizing firms ([24], [18], [17], [16], [20] and [19]) or empirical papers ([4] and [13]). Some key findings of the game theoretical models is that (i) loyal and switcher segments and their sizes affect firms’ pricing strategies ([24], [18]); (ii) brands stronger vs. weaker in terms of brand/store loyalty and brand/store positioning develop relatively diverse optimal pricing strategies. However, conflicting results are reported for such promotional activity. Whereas [20] conclude that the average discount offered by the stronger brand is larger than the average discount offered by the weaker brand, [19] conclude on the contrary. Similarly, there are inconsistencies in findings relating to the frequency of price promotions. [18] and [20] conclude that the frequency of promotions for the stronger brand is less than the frequency of promotions for the weaker brand. With theoretical and empirical evidence, again [19] concludes on the contrary. Uniquely, [19] also conclude that traffic building and consumer retention are important considerations in determining the depth and frequency of price promotions.

The recent works on pricing strategies in online markets have generally attempted to explain the reasons for dispersed prices and explore the nature of pricing strategies ([11], [2], [5], [14], [9], [15] and [10]). One important consideration is on the existence of collusive and competitive pricing strategies that may coexist in online markets. [14] show that industry and firm specific attributes may lead to either collusive or competitive pricing in an online market. The results of this study parallel our findings where firm strategies are either collusive or competitive based on the relative segment sizes of the firms.

The rest of the paper is organized as follows. In the next section we present our model with the solution. Then we provide empirical validation for the basic predictions of our model. We further explore some aspects of our model and its empirical validation in the discussion section. We wrap up with the conclusions section.
MODEL

The assumptions and characteristics of our model are similar to those in [24] and [18]. However, as mentioned before, neither the [24] model nor the [18] model suffice to analyze a market with many retailers, some with symmetric some with asymmetric loyal segment sizes. Therefore our model is neither a direct interpolation of these previous models, nor a simple extension of either. Introducing groups of retailers with various levels of loyal customers, our model analyzes an asymmetric oligopoly. We assume a market for a homogenous good, such as a book, CD, DVD, a brand name computer, electronics or an appliance. On the demand side, there are two segments of customers, loyal customers and comparison shoppers, and each customer wishes to purchase a single unit of the good.

On the supply side of our model there are \( k \geq 8 \) Firms; Firm 1 thru Firm \( k \). The loyal customers are loyal to only one firm, and we represent the number of customers who are loyal to Firm \( i \) as \( n_i \). We assume that \( n_i \) can take either of the two values, large \((L)\) and small \((S)\). This is not a strict assumption and can be restated with a larger set of values without any change on the results. The comparison shoppers, \( s_i \), (switchers) are not loyal to any firm and buy from the lowest priced firm. The potential number of comparison shoppers, or switchers that consider a firm can as well take either of the two values, large \((L)\) and small \((S)\). Again, this assumption could as well be restated with a larger set of values without any change on the results. Moreover, the values large \((L)\) and small \((S)\) need not be identical for loyal and switcher segments, but we assume them as identical across segments for simplicity. Consequently, each firm belongs to any of the four clusters, LL, LS, SL, SS clusters, where the first letter refers to the number of loyal customers \((\text{Large vs. Small})\) and the second letter refers to the number of switcher customers. We assume that there are at least two firms in each cluster\(^1\).

Customers buy from any firm only if the price they are given is less than their reservation price, \( r \). While the sizes of the segments L and S and the reservation price \( r \) are common knowledge, firms cannot price discriminately because of imperfect addressability and targetability. All firms face cost functions with fixed and marginal costs that we assume to be zero without any loss of generality. The profit functions of the firms are given by

\[
\pi_i = \begin{cases} 
  p_i(n_i + s) & \text{if } p_i = \min(p_j) \\
  p_i(n_i + s/v) & \text{if } p_i = p_v = \min(p_j) \\
  p_i n_i & \text{if } p_i > p_j
\end{cases}
\]  

where \( p_i \) represents the price quoted by Firm \( i \) and \( p_{-i} \) represents the vector of prices quoted by all other firms.

As is evident from the profit function, we assume that in the event of a tie in prices, the firms in the market serve switchers equally. In the analysis that follows we first show that there is no Nash equilibrium in pure strategies in this game. However, there exists a mixed strategy Nash equilibrium and we sketch this mixed strategy equilibrium later in our analysis.

The Analysis

As usual, we first define the upper and lower boundaries of firms’ supports. The upper bound of the feasible price set is the reservation price. Prices higher than the reservation price will result in no sales at all, while positive profits are possible when the reservation price is quoted. Therefore, the highest price that any firm can charge is the common reservation price, \( r \). The lowest price any firm will ever consider charging is given by \( p_i^{\text{min}} = n_i r/(n_i + s) \). To see this, note that Firm \( i \) can have a motivation to reduce its price down to a level where, if it successfully captures the switchers, it makes at least the same profit it would get from selling to its loyal customers at \( r \). That is; \((n_i + s)\) \( p_i^{\text{min}} = n_i r \). Since for all firms in a given cluster the segment sizes are assumed to be identical, the minimum prices are also identical. Moreover, bigger loyal segment size will mean higher potential loss in profit due to price reductions, and consequently, the lowest price at which the firm can still benefit from serving the

\(^1\) This assumption is also made for simplicity purposes and is not crucial to the results. In fact, only for the SL cluster this assumption is somewhat more crucial. However, although we do not present the details of such an analysis here, even if SL cluster had only one firm in it, the overall results would remain the same. The only difference in this case would be that the firm in SL cluster along with the firm(s) in either SS and LL clusters would price promote while firms in the LS cluster would price at the regular price. For sake of simplicity we assume at least two firms in each cluster. However, also note that this assumption has greater face validity in a typical online market given the large number of retailers.
switchers will be higher for firms with larger loyal segments. If we refer to the common minimum price shared by the member firms of the AA cluster as \( p_{AA}^{\min} \), it is straightforward to notice that \( p_{SL}^{\min} = Sr \) \((L + 1) \) will be lower than \( p_{LL}^{\min} \) and \( p_{SS}^{\min} \). Therefore, firms in the SL cluster will have the lowest minimum price. Since any firm assumes that all firms are in the same cluster with share the identical segment size characteristics, they will assign the identical minimum prices to those other firms. We first show the non-existence of a pure strategy Nash equilibrium.

**Proposition 1:** There is no Nash equilibrium in pure strategies.

The technical proof is similar to those in [18] and [24] and hence omitted here. However, we provide an intuitive exposition. Notice that, the motivation to undercut the price of other lower priced firms in order to capture the switchers result in a downward push in prices. This force is especially active among all firms within the SL cluster, since they are the firms that can undercut all other firms. Simultaneously, the motivation to increase the price to the reservation price, if the switchers are not served with a lower price, pushes prices up. The result is a lack of pure strategies.

Before presenting the existence of a mixed strategy equilibrium by construction, we also need to establish the equilibrium profits of all the firms.

**Proposition 2:** The equilibrium profits of all firms in this game will be equal to their reservation utilities which are the lowest profits that a firms opponents can hold it to by any choice of their own prices.

**Proof:** For this game, the reservation utilities, or minmax profits of all the firms are given by \( n_r \). Therefore, all firms in LL and LS clusters have reservation utility \( Lr \) while all firms in the SS and SL clusters have reservation utility \( Sr \). These are the lowest profits Firm \( i \)'s opponents can hold it to by any choice of \( p_{-i} \) provided that Firm \( i \) correctly foresees \( p_{-i} \) and plays a best response to it. That is;

\[
\pi_{im} = \min_{p_{-i}} \left[ \max_{p_i} \pi_i(p_i, p_{-i}) \right] = n_r \quad \forall i
\]

(2)

Next we show that the equilibrium profits of these firms will be equal to their minmax profits. To see that this indeed is the case, note that all \( k \) firms have a loyal segment that will buy from them irrespective of the price, as long as the price they quote is lower than or equal to the reservation price. Hence, all firms can guarantee the profit \( n_r \) by choosing to price at \( r \). In terms of undercutting all other firms and serving the switcher segment, only firms in the SL cluster have an advantage. However, since there are more than two of these firms with the small loyal segment sizes, they can also at most guarantee a profit of \( n_r = Sr \). That is, no single firm has an absolute advantage to cut down prices to capture the switcher segment for sure. Hence, the highest attainable profits for the firms in this game are their minmax profits.

Now that we have established the characteristics of the supports over the feasible range of prices, we can solve the equilibrium pricing strategies of the firms. Any firm will serve its loyal segments with the price it chooses as long as the price is below the reservation price, and any firm can capture the switcher segment if the price it quotes is lower than all the prices quoted by the competing firms. Therefore, for any price \( p \), except for any point where firms may have mass points, such as \( p = r \), the equilibrium conditions for this pricing game for \( k \) firms can be written as:

\[
E(\pi_i) = n_r - n_r(p) + \prod_{j \neq i} (1 - F_j(p)) p_s \quad \forall i
\]

(3)

Next proposition discovers and presents the uniqueness of some positions firms hold in this game with many opponents and enable us to solve the set of equations we presented.

**Proposition 3:** Only firms in the SL cluster will have positive support in the interval \( [p_{SL}^{\min}, r] \) or any other interval.

**Proof:** We start our analysis in the interval with the lowest prices. Since in \( [0, p_{SL}^{\min}] \) no firm can realize a profit higher than its minmax profit, it is the next interval \( [p_{SL}^{\min}, p_{e+}^{\min}] \) that the firms in SL cluster can price in. In this notation, we refer to the minimum of \( (p_{SS}^{\min}, p_{LL}^{\min}) \) as \( p_{e+}^{\min} \). We denote the number of firms in SL cluster as \( e \) and also refer to the firms in either SS or LL cluster with the next lowest minimum price as Firms \( e+ \). Note that in the interval \( [p_{SL}^{\min}, p_{e+}^{\min}] \) all firms in SL cluster will have lower prices than the rest of the firms with probability 1, and hence can capture the switcher segment if they can price lower than the
other firms in the SL cluster. The competition in this interval can be thought to be very similar to that in [24] with two exceptions. First the number of firms is determined exogenously, and second, there are in fact other firms competing in the market, but just not in this interval. Thus, the firms in the SL cluster will randomize their prices in this interval so that the expected profit will be equal to the reservation profits. We can write the equilibrium conditions for this interval as:

\[ \pi_{e+}^{\text{min}} = \alpha - \beta + \gamma \]  

where \( e \) represents the number of firms in the SL cluster. Note that in this equation, the interactions with only the other firms in the SL cluster are included in the formulation because all other firms have minimum feasible prices above the upper limit of this interval. The solution to this equilibrium condition is:

\[ F(p) = 1 - \left( \frac{(r-p)L}{pL} \right)^{1/e} \]  

Note that with this solution \( F(p_{e+}^{\text{min}}) = 0 \) as expected and the cumulative probabilities of firms in the SL cluster pricing below \( p_{e+}^{\text{min}} \) is given by:

\[ F(p) = 1 - \left( \frac{(r-p_{e+}^{\text{min}})L}{p_{e+}^{\text{min}} L} \right)^{1/e} \]  

We will use this distribution function for our analysis in the next interval. Note that, this cumulative function represents the mass of prices already lower than the prices of the remaining firms. Hence, depending on the detrimental sizes of the functions reach for the intervals in which \( e+ \) firms can ever price, firms will decide if they price at all.

After showing that the \( e \) firms in the SL cluster price in the interval \([p_{SL}^{\text{min}}, p_{e+}^{\text{min}}] \), we proceed to show that, it is not possible for any other firm to have support in the interval \([p_{e+}^{\text{min}}, r] \). Note that the lowest price that Firms \( e+ \) will ever quote is \( p_{e+}^{\text{min}} \), and at this price the expected profit they will realize is given by:

\[ \pi_{e+}(p_{e+}^{\text{min}}) = n_{e+}p_{e+}^{\text{min}} + [1 - F(p_{e+}^{\text{min}})]e p_{e+}^{\text{min}} \]  

Yet, Firms \( e+ \) will never price at \( p_{e+}^{\text{min}} \) if \( \pi_{e+}(p_{e+}^{\text{min}}) \) is less than their minmax profit of \( n_{e+}r \). Inserting values from Equation (6) into Equation (7) we see that \( \pi_{e+}(p_{e+}^{\text{min}}) < n_{e+}r \) always holds, which means that Firms \( e+ \) will never price at \( p_{e+}^{\text{min}} \) given the SL firms are already competing for the switcher segment below this price. Also note that, since only the SL firms can compete at \( p_{e+}^{\text{min}} \) and possibly above as we have just shown, the cumulative distribution functions presented by Equation (5) will also remain valid above \( p_{e+}^{\text{min}} \). In fact, we can solve for the lowest price point above \( p_{e+}^{\text{min}} \) that Firms \( e+ \) will ever reduce its price to by solving the equation:

\[ n_{e+}r = n_{e+}p + [1 - F(p)]e ps \]  

The only solution of this equation that is above \( p_{e+}^{\text{min}} \) is \( r \). Hence, given the firms in the SL cluster are already competing for the switcher segment below \( p_{e+}^{\text{min}} \), Firms \( e+ \) will never price in the interval \([p_{e+}^{\text{min}}, r] \) but only at \( r \). Moreover, since the firms in other clusters, including those in LS are no different than Firms \( e+ \) in responding to the price competition between the \( e \) firms in SL cluster, they will also not compete in any interval but price strictly at \( r \). That is, all the firms in the group with relatively larger loyal segments will only price at their reservation prices. Hence, in any given interval, only the \( e \) firms in the SL cluster will have support because they are the only firms that can offer the deepest discounts to capture the switcher segment.

This is a critical result. The frequency and depth of discounts the \( e \) firms offer in order to steal the switcher segment from one and other are so significant that, it does not pay off for any other firm to even attempt to serve the switcher segment. That is, only the firms that have the least to lose offering the deepest discounts will offer discounts forcing the other firms price at the reservation price. Hence, most firms delegate the price competition to the \( e \) firms that can profitably compete with each other in this equilibrium. Solving Equation 3 accordingly, we derive the probability distribution functions representing the equilibrium strategies of the firms.

\[ f_i(p) = \begin{cases} 0 & p < r \\ 1 & p = r \\ 0 & p > r \end{cases} \quad i \in LL, LS, SS \]
Equations (9) and (10) demonstrate the two distinct promotional strategies that firms adopt in a market with many asymmetrically positioned retailers. Firms with large loyal segment sizes never promote in this market. Figure 1 depicts the cumulative distribution functions that represent the mixed strategies firms adopt.

\[
f_i(p) = \begin{cases} 
0 & p < p_{SL}^{min} \\
\frac{(r-p)S^{(1/\epsilon)-1}}{rS - \frac{pL}{p^2Le}} & p_{SL}^{min} \leq p < r \\
1 & p \geq r 
\end{cases}
\]

\[i \in SL\]

\[\text{(10)}\]

**Empirical Validation:**

In this section, we use data from three markets with many asymmetrically positioned retailers to test our model predictions. We choose the online markets for books, printers and cameras for this purpose.

**Description of the Data Set**

Our model yields predictions on the promotional behavior of the firms based on the size of their relative loyal customer segments, given there is also a switcher segment that is aware of the prices quoted by at least some of these retailers. While, one could list all the retailers that are selling the homogenous good to incorporate in such a study, it is also crucial that, the switcher segment be aware of available prices from most of these retailers included in the list. Otherwise, the competitive forces that we model in our research would fail to be operational. To find such a market, in which not only the majority of the retailers selling the homogenous good are identifiable, but also all are included in the comparison shopping set of the switcher segment, we turned to the online markets for cameras, printers and books. These markets have many favorable properties. In addition to enabling the daily collection of price information on many items with the least error, the on-line market for cameras, printers and books are also served by price comparison engines, which are tools that the price comparing customers use in order to observe all the retailers and their prices for a particular product. While hundreds of on-line retailers exist, we compiled the list of retailers that we included in this study for each category as the list of all the retailers that a search for most items within that category returned at the most utilized price comparison engine. The price comparison site with the biggest market share that we used for the compilation of the retailer list was MySimon.com. During the course of the data collection period, MySimon was the leading price comparison engine with 80% of the market share in price comparison site visits with an estimated 14 M unique visitors in a market with a potential size of 35 M ([15]).

[1] research the reliability of data collected through “price aggregators” such as MySimon and other price comparison sites, collecting data on 459 different books from eight price aggregators daily for four months. They conclude that MySimon covers the market best in terms of cross-sectional consistency as well as longitudinal consistency and report that if a single price aggregator were to be used, that ought to be MySimon. Since our research requires the coverage of a switcher segment that is informed about the retailer offerings homogenously across the switchers, we were required to work with a single price aggregator, and this study by [1] confirm our choice of MySimon among the set of available price comparison sites.

We collected data on a randomly compiled list of 1388 books from 15 retailers, 112 printers from 20 retailers and 95 cameras from 53 retailers. The prices were collected over a course of one month, June 2002, as a typical user of the price comparison site would have observed them. Overall, this attempt results in more than 800,000 data points in our data set.
Testing the Model Predictions

Our model yields the pricing behavior of firms given asymmetrical loyal segment sizes. The pricing strategy of a retailer is represented by the probability measure of quotable prices, and hence we attempt to observe if such data could follow from the predicted behavior of the firms in testing our model predictions. According to our model results, we can hypothesize that there will be two groups of retailers with significantly separate pricing behavior. Moreover, the retailers with smaller average prices will also have higher promotional activity, while the retailers with greater average prices will have less promotional behavior. We define promotional activity as price cuts from the ongoing price, or in more general terms as frequency and depth of changes in the prices in the course of the month as they are captured by the standard deviation in price. In the analysis that follows, we utilize the average standard deviation across products as an indicator of promotional activity while the average prices across time and products serve as the average price. To calculate the average standard deviation across products, we calculate the standard deviation of prices for every product across time and take the average of those across products within a category.

To empirically validate our model predictions we run K-means cluster analysis for the book, camera and printer categories. Based on the cluster memberships, we also run independent samples t-test to see if clusters are formed such that we have lower priced higher promotional activity firms as well as higher priced lower promotional activity firms. The results of the K-means cluster analysis and t-test results are presented in Table 1.

As Table 1 shows, we see significant clusters for each of the categories that we’ve considered. We’ve named the first cluster in any market such that that cluster also has the higher average price. As is evident from Table 1, Cluster 1 for each category, on top of having the higher price, also has the lower level of promotional activity. The price differences between clusters within any category are significant at the 0.000 levels. Although, significance levels vary, the level of promotional activity is also higher for the clusters with lower average prices for all categories. These results support the prediction of our model that the lower priced group of retailers compete with more randomized prices to capture the switcher segments while the higher priced group of retailers prefer charging the higher reservation price with less randomization to maximize their profits from their loyal segments. We also present the groups of retailers with their average prices and average promotions in Figure 1.

<table>
<thead>
<tr>
<th>Cameras</th>
<th>N</th>
<th>Average Price</th>
<th>Average Promotion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster 1</td>
<td>16</td>
<td>0.81</td>
<td>0.0041</td>
</tr>
<tr>
<td>Cluster 2</td>
<td>37</td>
<td>0.66</td>
<td>0.0086</td>
</tr>
<tr>
<td>t-test</td>
<td></td>
<td>9.637</td>
<td>-1.980</td>
</tr>
<tr>
<td>Significance</td>
<td></td>
<td>0.000</td>
<td>0.553</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Books</th>
<th>N</th>
<th>Average Price</th>
<th>Average Promotion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster 1</td>
<td>8</td>
<td>0.88</td>
<td>0.0023</td>
</tr>
<tr>
<td>Cluster 2</td>
<td>6</td>
<td>0.73</td>
<td>0.0042</td>
</tr>
<tr>
<td>t-test</td>
<td></td>
<td>7.376</td>
<td>-0.955</td>
</tr>
<tr>
<td>Significance</td>
<td></td>
<td>0.000</td>
<td>0.359</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Printers</th>
<th>N</th>
<th>Average Price</th>
<th>Average Promotion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster 1</td>
<td>9</td>
<td>0.79</td>
<td>0.009</td>
</tr>
<tr>
<td>Cluster 2</td>
<td>11</td>
<td>0.73</td>
<td>0.013</td>
</tr>
<tr>
<td>t-test</td>
<td></td>
<td>8.23</td>
<td>-1.674</td>
</tr>
<tr>
<td>Significance</td>
<td></td>
<td>0.000</td>
<td>0.111</td>
</tr>
</tbody>
</table>

Table 1: Clusters with Average Prices and Promotions.

In addition to the cluster analysis, we can also test to see if a negative correlation exists between price and promotional behavior, on a firm-by-firm basis. In a regression analyses of all the retailers in each category, using average price as the dependent variable and average standard deviation across products as the independent variable, the standardized coefficient of the independent variable along with its significance are by definition identical to the Pearson correlation coefficient and its significance. We report these correlations in Table 2. We observe from Table 2 that the average standard deviation across products as an indicator of promotional activity is a significant predictor of the degree of average price levels for the firms. The negative and significant signs point to the fact that higher priced firms engage in less promotional price cuts, supporting our finding that the firms that go after price comparison shoppers with price cuts will have lower prices while others will prefer to price at the higher reservation prices with no discounts.

<table>
<thead>
<tr>
<th>Average price for a firm in product category</th>
<th>Cameras</th>
<th>Books</th>
<th>Printers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promotion</td>
<td>-0.042</td>
<td>-0.022</td>
<td>-0.109</td>
</tr>
</tbody>
</table>

*p<.10, **p<.05, ***p<.01

Table 2: Correlations of Promotional activity and Retailer Prices
Figure 1: Scatter Graphs of retailers in the three categories.

**Discussion:**

One theoretical finding that we would like to discuss further relates to the delegation of price promotion by the firms with larger loyal segments. As our model demonstrates, all but the firms in the SL cluster delegate competition to the firms with the least to lose from the deepest price promotions. However, we can not test this finding directly since the loyal segment sizes of each firm are private information that no firm would reveal. Whereas it may be possible to identify the firms with larger loyal segment sizes from industry resources, it is especially unattainable to have information on the loyal segment sizes of smaller firms. Furthermore, given that the number of firms competing in any online markets is possibly in the hundreds, there will be many smaller firms on which accurate information is unattainable. For example, even in our sample of 20 printer retailers, there exist many small players on which even other firms do not have detailed information. Therefore, whereas it is empirically not possible to identify the firms in the SL cluster, since they are just some small firms along with other firms in the SS and SL clusters, their ability to categorize themselves as SL members is sufficient for them to develop the strategic reactions that they develop.

Therefore, the capability to generally classify itself and the other firms with respect to their loyal segment sizes is enough for any firm to behave strategically in this competitive environment. Moreover, this type of a classification not only helps the firms to decide how to price competitively, but essentially categorizes each firm in either of two groups; those that compete for price comparison shoppers and those for which loyal customers are more profitable to serve with higher prices. Hence, while we recognize that not having a measure of loyal segment sizes is a limitation of our empirical work, we also acknowledge that this information in detail is neither available nor necessary for firms to form their strategic reactions. The information to classify firms in broad cluster memberships is all that is required for firms to choose their price promotion behavior.

**Conclusion:**

Our objective in building and testing a model of price competition in an oligopolistic market with asymmetrically positioned firms was to provide theoretical and empirical insight to markets in which price comparison shopping was possible. From a theoretical point of view, our model demonstrates the existence of at least two distinct pricing strategies, indicating the trade offs different firms make in order to balance the desire to serve the price comparing switcher segment and the desire to maximize the profit from their loyal segments. Moreover, the two distinct strategies also provide a theoretical explanation to the observed price dispersions in the homogenous goods markets.

---

Our central model finding demonstrates that only the firms that have the least to lose offering the deepest discounts will offer discounts forcing the other firms price at the reservation price. We empirically validate our model predictions using data from the on-line book, camera and printer markets. The data generally supports our model predictions and provide explanation to the diverse pricing strategies as well as the observed prices and price dispersions that we observe in many markets today.

Our theoretical and empirical findings demonstrate the weakness of firms that rely on traffic generation thru price comparison shopping while simultaneously signifying the accuracy of established loyalty as an indicator of sustainable profitability.

A natural next step for future research would be introducing heterogeneity to the positioning of firms. This heterogeneity could capture the quality tiers that firms belong to, and could reveal itself in the form of heterogeneous reservation prices compared to the homogenous reservation prices that we assume in this study.

References: