SCHOOL OF ECONOMICS AND MANAGEMENT

In a Position of Competition

Pricing Behavior in an Online Marketplace

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Abstract

In times where commerce has shifted into e-commerce, the influence of price comparison websites has become unmistakable. In contrast to previous literature, studying the contemporary effects on demand for retailers in decreasing rankings, we have studied the event from a strategic perspective of pricing. With a unique dataset of more than 20 million observations from the Swedish price comparison site Prisjakt, we provide evidence that retailers are adjusting their prices to retain rank positions in cases where they just recently have experienced a decrease. The frequency of these price adjustments shows a significant decremental effect the further down the rankings we study, thus giving clear indications of a reduced utility of the rank positions. Even though the size of the company appears to be decisive in the magnitude of the price adjustments, it is not possible to distinguish retailers of the different size classes among the highest ranked companies, thus strengthening the belief of a declining marginal benefit of rankings.

1. Introduction

You only have time to read a limited number of theses. How did you choose to read this one? In a world where consumers are exposed to an information flow giving rise to a myriad of consumer choices to navigate in, it is difficult to distinguish what can be of interest and what is not. In the same way as there is an abundance of products to choose from, there is an equal abundance of information about them in marketplaces. Once consumers have found interest in a particular product, they are most likely to engage in time-consuming research of different retailers, determining from which you get the best offer in accordance with the preferences of the consumer. This hypercompetition creates a competitive landscape where retailers are constantly battling for the customer's attention to obtain a favorable position. It can all be seen as a game of competition.

Competition in online marketplaces has experienced an impressive development during the last decade. In 1999, The Economist expressed that "*[t]he explosive growth of the Internet promises a new age of perfectly competitive markets. With perfect information about prices and products at their fingertips, consumers can quickly and easily find the best deals*". The development of online marketplaces can also be witnessed in the Swedish market, where e-commerce has grown to a current level of 300 billion SEK in 2019 (Dibs, 2019). Furthermore, with 96 % of the Swedish population being internet users (Internetstiftelsen, 2020), price comparison sites play an essential role in distributing information and thus creating competitive markets.

Though physical costs of searches have been heavily reduced since the expansion of e-commerce, multiple studies still found significant price dispersions disproving the competitive markets stated in The Economist (see Smith & Brynjolfsson, 2001; Baye, Morgan & Scholten, 2004; Einav et al., 2015). One way of explaining the remaining costs of searching is the magnitude of competing retailers, whose prices often tend to be adjusted regularly and in combination with the different consumer preferences (Dinerstein, 2018). Thus, empirically, the remaining search costs often result in consumers evaluating only a limited number of retailers regardless of the total quantity of competitive retailers.

In establishing and developing e-commerce, transaction costs decrease significantly, as price comparison sites reduce friction and enable price comparisons at most retailers. With established price comparison sites such as Prisjakt, the leading price analysis tool in Sweden,

with over 8,8 million prices for 887,000 different products (Rudholm & Lindgren, 2019) and over 6 million visitors each month (Kantar Sifo, 2020), the rank position of retailers becomes crucial for a company's potential to attract customers. While using a unique dataset obtained from Prisjakt, this study adopts the assumption that a low product price is key but examines how key it is to have *the* low price.

The purpose of this study is to test whether retailers adjust their prices as a consequence of a decreased ranking on Prisjakt. The study's ambition is to deepen the understanding of the relationship of retailers' pricing behavior and the ordinal ranking on the price comparison website Prisjakt. To address the research purpose, I will examine the following hypotheses:

H1: Retailers adopt a pricing strategy that responds to the changes in ranking.
H2: A rank-dependent pricing behavior is more frequent for top-ranked retailers.
H3: There is no cost difference in retaining rank positions across Prisjakt's rankings.

The first and most important result of the study gives evidence that retailers are adjusting their prices as an effect of losing a ranking spot. The second main empirical result confirms a monotone decline in the frequency of price adjustments following a falling ranking, where retailers located in top-ranked positions are more likely to adjust their prices to remain in a favorable position. This has been concluded after conducting an empirical frequency distribution in which the three states of pricing – increasing, decreasing or remaining the same – can be generalized as a trinomial distribution. Thirdly, we illustrate a pricing behavior of a decremental magnitude of price adjustments further down the ranking list we study. The different frequencies and magnitudes of price changes dependent on the retailers' ranking position gives us reason to doubt the notion of a frictionless Swedish market. For the seven top-ranked retailers, we also display signs of uniform pricing behavior, whereas for retailers in successive positions, we encounter differences by the size of the retailer.

To the best of my knowledge, this is the first study of how retailers listed on Prisjakt adjust the price of their products based on changes in ranking. With web scraped data containing more than 20 million observations, this study makes a potentially significant contribution to the area of strategic pricing in online marketplaces. Compared to previous literature within the field of online marketplaces, the model focuses on retailers' pricing strategies rather than solely how retailers are affected by changes in rank. While focusing on prices, this opens up for the interest

of other stakeholders within the retail industry than just the competing retailers themselves. Therefore, the contribution of this study will be of equal interest to consumers since it captures explicit features for online marketplaces and price comparison websites. In that sense, it explains product pricing from a perspective embedded in internet shopping from a consumer's point of view, thus highlighting the breadth of actors involved.

The remainder of the thesis is organized as follows. In section 2, we will present literature confirming how the ordinal ranking of retailers on price comparison websites is influencing their attractiveness by consumers. The following section outlines the data and presents the shopping environment of the price comparison website Prisjakt. In section 4, we will present the model used to test the occurrence of rank-depending pricing. The result is lastly presented and analyzed in section 5. This section also highlights the following market effects concerning the occurrence of strategic pricing.

2. Theoretical framework

This study relates to a well-cited literature by Stigler (1961) on price competition and search friction. Stigler builds a theoretical framework assuming that a consumer can't consider or even know the range of different prices available on the market for a product. Since the prices of the seller's products *ex-ante* were uncertain for the consumers, they had to search until their preferences and expected price decrease no longer exceeded the associated search cost.

Though the search environment presented by Stigler has significantly changed, where the breakthrough of the Internet to society has had a tremendous impact, we still see similar behavior. Chen and He (2011) explain the phenomenon of price searching from a more modernly anchored perspective. They establish a theoretical consensus where the consumer will search among retailers until her preferences of price and reputation are met. As soon as these conditions are satisfied, the consumer will no longer consider other retailers. This search behavior is critical in how consumers will not pay attention to the retailer unless they are in a somewhat favorable ranking.

With a more granular focus on search frictions in online markets in the sense of the number of visited retailer sites, De los Santos (2012) found that as little as one third of U.S. consumers visited more than one seller's site when searching for a product. The appearance on price comparison sites for sellers is therefore substantially important. For this reason, it becomes crucial for retailers listed on price comparison sites to obtain a high ranking as consumers go through fewer alternatives before a purchasing decision is made.

In cohesion with the previously mentioned reasoning of search behavior, multiple studies have been conducted to support the top-down ordered search model, where the consumer is exposed to the sellers in order of lowest price. From the sequential search occurring by consumers, Arbatskaya (2007) presents a strong relationship between the ordinal ranking of sellers and consumers' choices. Therefore, the price itself is not what is essential for the choice of consumers, but instead, the ordinal ranking is a better predictor of sales than the listed prices (Ellison & Ellison, 2009). Following this logic, Arbatskaya (2007) provides evidence that retailers with the lowest price have incentives to increase their price to a slight extent without surpassing the retailer in the following place. Thus, instead of regarding price as the

determinant if consumers will find interest in the retailer or not, the price is reasoned to serve as a tool to enhance the utility of each position, given the ranking retailers are located in.

To gain an expanded understanding of the importance of the ranking, Ellison and Ellison (2009) have studied how demand, in the form of traffic or "clicks" from price comparison sites, is affected by the retailer's ranking. From their study of different categories of computer parts, Ellison and Ellison found that retailers lost 83 % of the traffic from the price comparison site Pricewatch when shifting from the first rank to seventh. From a qualitative measure, they also provide evidence showing that price setters check price comparison sites multiple times per day and change the prices if their rank has shifted too far from what is usually the case. For this reason, one can assume retailers have an appropriate awareness of their ranking.

In a similar study of clicks from online marketplaces, Baye, Gatti, Kattuman and Morgan (2009) examined the most prominent UK price comparison site, also operating in seven other European countries. The study found a result equivalent to what Ellison and Ellison (2009) found for the computer part search engine Pricewatch.com. More specifically, Baye et al. (2009) found that for each competitor listed above a specific retailer, their average loss in clicks was 17 %. With multiple studies on different markets and for different products finding similar effects on demand for lower ranked retailers, we may expect this outcome to occur in the Swedish marketplace as well. With this said, there is a wide range of literature addressing how retailers listed on online marketplaces are affected by their ranking. However, there is still a lack in the literature on the following market effects discontinuities in prices. More explicitly, how retailers counteract these losses in rank, and thus also losses in clicks, which connects to the motivation for how this particular study aims to contribute to the pricing behavior of online marketplaces.

To complement the studies made for demand, independently of price, Smith and Brynjolfsson (2000) studied the differences in pricing behavior for online and conventional retailers. In this study, they found that online retailer's price adjustments are up to 100 times smaller than for traditional retailers, in which the dominant factor for this was reasoned to be the differing costs of the actual price change. Therefore, for conventional retail stores, the price adjustment will only be motivated once it bears a more significant gain of value than the associated cost. On the other hand, for electronically managed stores, these costs are of less friction, thus opening up for greater possibilities of smaller price adjustments in response to the competitors.

To clarify the frequency of price adjustments, Mizuno, Nirei and Watanabe (2010) investigated the price-setting behavior of retailers on a major Japanese price comparison site. They found that sellers' pricing behavior is not characterized by time-dependent pricing but state-dependent. This means that the frequency of price adjustments is rising rapidly when the average product price decreases. Which after that is compared to a steady frequency of price adjustments only dependent on a declining value of the product over time. This empirical evidence gives reason to believe online marketplaces, after all, will shift towards a more frictionless market.

Developed from the Bertrand model of price competition, Brynjolfsson and Smith (2000) studied homogenous products for CDs and books. They proved that 49 % of consumers using price comparison sites make their decisions solely on price. The Bertrand model assumes that consumers want to buy from the company offering the lowest price. Following this demanding assumption, it also assumes products to be perfectly homogenous, no search or transport costs and all consumers are informed of all prices. The competition between retailers is therefore isolated from pricing alone, which given the first assumption would result in the fact that all retailers would set a price equal to the marginal cost. Though this would not be entirely realistic, even for price comparison sites like Prisjakt, which compiles information for consumers to compare for only a fraction of the original search cost, this should lead to a pricing environment the Bertrand model would resemble with a frictionless market.

Mizuno and Watanabe (2013) respond to the discussion of a frictionless market from another perspective. In contrast to Brynjolfsson and Smith (2000), they argue that the presence of price dispersions is apparent since consumers have a greater set of preferences than solely price, where quality and reassurance, which is inferred in consumer ratings, are also decisive. In section 4, we will further explain how the empirical model considers how consumers not only consider the price as the only aspect of interest during purchasing decisions but acknowledges a broader set of preferences.

When studying if sellers are changing their price when their ranking is altered due to a change in consumer rating, other things equal, a fundamental aspect is making sure manipulation of ratings does not occur. In fact, manipulation of ratings is feasible due to its beneficial effect on the position in price comparison rankings. However, this source of error can be considered

from three perspectives. First, following Dinerstein, Einav and Sundaresan (2018), we assume price is a flexible attribute chosen in the short run but quality, the determinant for ratings, is fixed in the short run. With this in mind, they show evidence that retailers only change their prices to enter the consumers' consideration sets. Secondly, Prisjakt implements an extensive process of detecting ratings submitted by retailers themselves or others with self-interest in the company (Prisjakt, 2021a). Lastly, given that it would be possible for sellers to manipulate their ratings to the greatest extent possible, one can also argue for the distribution of all ratings to shift upward since all retailers are better off manipulating their ratings. Self-promoting reviews will therefore not have an effect as significant as one can believe at first glance, since all retailers would manipulate their ratings, thus not leading to a relative change among the retailers.

3. Data

The data used for this study comes from Prisjakt.nu. Prisjakt is primarily known for comparing brand new products but also offers price comparison including used products. Ordered in a list ranked from lowest to highest price, the retailers for each product are comparable. In cases where a product has the same price for two or more retailers, the retailers are ranked based on the highest consumer rating followed by stock availability. After that, the consumer can click a button on Prisjakt's website, transferring them to the retailer's website before finalizing the product's potential purchase of the product.

The data consists of detailed information on 20,440,366 observations for 85,553 products in 932 different categories of 2,832 retailers from Prisjakt during the time period 3 December 2019 to 28 February 2020.

Figure 1 shows an exemplary return for the product Apple Watch Series 6 from Prisjakt, in which we see nine retailers in an order stated by their prices. On top of the price comparison, the consumer obtains a brief description of the product, stock availability, and information regarding consumer ratings and shipping. Figure 1 also shows evidence of the heterogeneity of retailers and the price variation between them for an otherwise homogeneous product.

To guarantee an adequate comparison, we have only taken products from Prisjakt that are identical in every aspect. Therefore, we only examine products that have the exact same product specification, color and other technical details. For this reason, Prisjakt's price comparison service on previously used products will not be present in the data since there may be deficiencies of different degrees. Furthermore, this measure allows us to disregard price variation that refers to differences in product characteristics. It is also noted that Prisjakt updates the information on the website daily (Prisjakt, 2021b), which further enables a study measuring how changes in rankings for retailers affect their tendency to change the price.

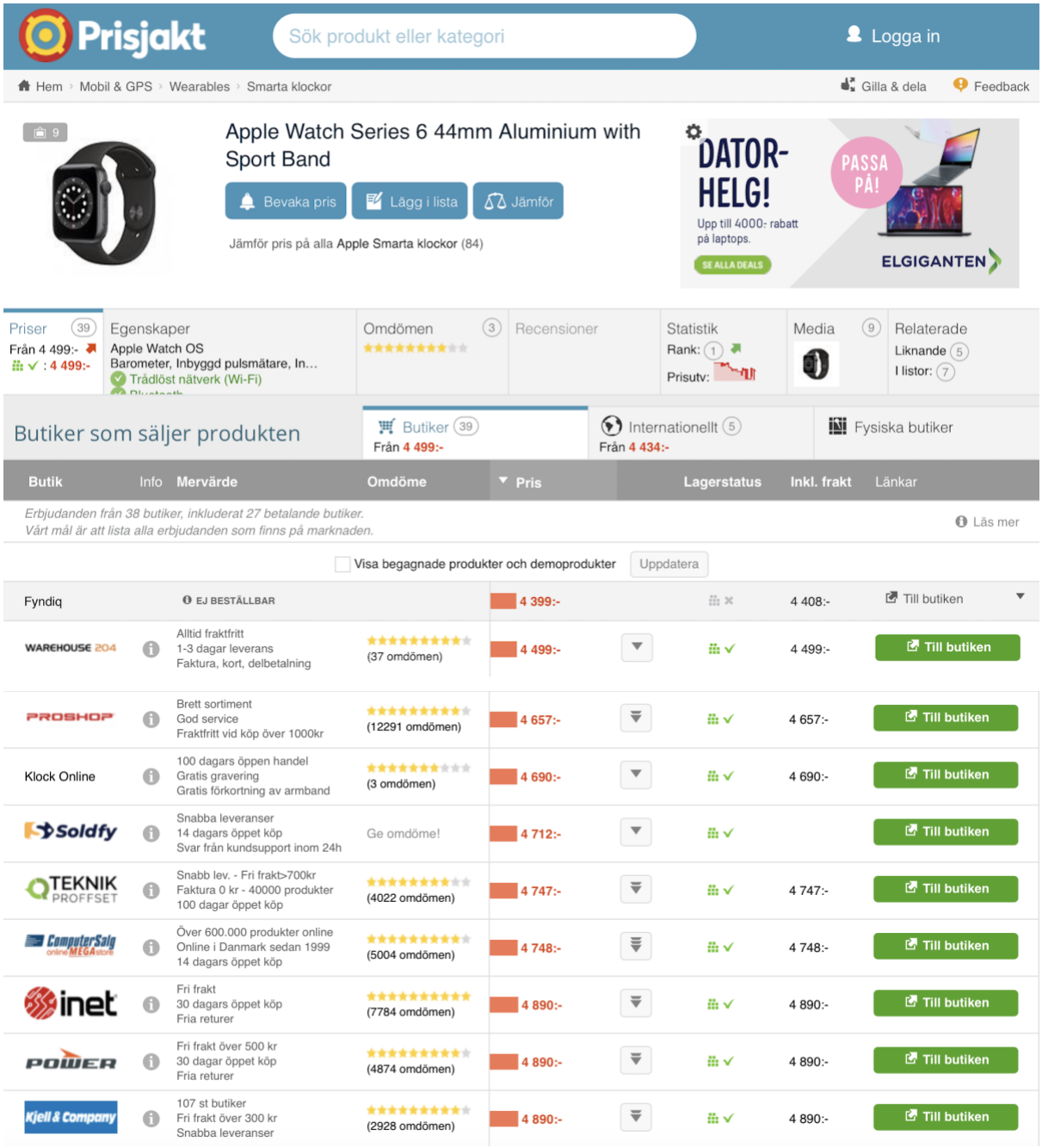

Figure 1: Screenshot of Prisjakt for the product Apple Watch Series 6 44 mm Aluminium with Sport Band

From the data accessed from product searches from Prisjakt, It was necessary to create additional variables to perform calculations on equivalent grounds. Therefore, to augment the data provided by Prisjakt, we have created variables such as time-lagged price, changes in ranking, size of the company and average consumer rating for each of the researched days. These will both serve as control variables when testing if retailers are adjusting their prices after losing their ranking spot and for analyzing potential patterns in pricing strategies. These variables will be further discussed in section 4.

For all the benefits of the data, it however still consists of a few shortcomings essential to highlight. Initially, the data lacks information on the number of clicks to the retailer's website for the different prices retailers apply. Nor does it provide information on the actual sales relating to the prices. Furthermore, though there are multiple elasticity studies concerning the relationship between rankings and clicks in an international setting (see Baye et al., 2009; Ellison & Ellison, 2009; Dinerstein, Einav, Levin & Sundaresan, 2018), these may still give an inaccurate understanding of the click behavior in Sweden. Therefore, the optimal conditions would be to address the importance of the ranking from within a Swedish context, and from this formulate retailers' motivation for being aware of their ranking. However, there are great reasons to believe that the online marketplace in Sweden is similar to the international, thus disproving the relevance of devoting effort into combining both of these research questions. For this reason, the additional benefit of also performing a similar analysis of the clicks for a Swedish online marketplace becomes insignificant in relation to the contribution of relying on previous literature. On that note, focusing on the pricing behavior to overcome the effects on clicks that the ranking suggests, therefore contributes more to the research field of today.

4. Model

In the following section, we will present the models used to test if retailers whose ranking has decreased will change their price to regain a more favorable ranking. In an attempt to isolate the causal pricing effects of changed rankings, thus avoiding an endogeneity problem, the design of the models will only take into account those changes in ranking that are occurring as an effect of other factors than price. That means we are looking at changes in ranking derived from shifts in relative consumer ratings, given that prices are the same. Formulated on the basis of this approach, the two models of the study follow an ordinary least square method presented below, followed by a table of definitions and summary statistics for the included variables.

$$Dummy\ Price\ Diff = \beta_0 + \beta_1 \cdot Dummy\ Rank\ Diff + \beta_2 \cdot Rating + \beta_3 \cdot Average\ Rating + \gamma_1 \cdot Retailer + \gamma_2 \cdot Product + \gamma_3 \cdot Time \quad (1)$$

$$Absolute\ Price\ Diff = \beta_0 + \beta_1 \cdot Dummy\ Rank\ Diff + \beta_2 \cdot Rating + \beta_3 \cdot Average\ Rating + \gamma_1 \cdot Retailer + \gamma_2 \cdot Product + \gamma_3 \cdot Time \quad (2)$$

Table 1: Definitions and summary statistics of variables included in the regression models

Variable	Definition	Mean	Std. dev	Min	Max
Dummy Price Diff	Dummy variable for price difference of listed products. Time delayed for 4 days.	0.1665	0.3725	0	1
Absolute Price Diff	Absolute value of logarithmic price difference for listed products. Time delayed for 4 days.	2.8262	2.6624	0	4.8647
Rank Diff	Decreases in rank due to change in relative rating, other things equal	0.0831	0.2339	0	1
Rating	Retailer's rating per day	5.5287	3.7442	-1	9.87
Average Rating	Average rating per day for other retailers	5.5086	2.2746	-1	9.87
Retailer	Retailer specific fixed effect	—	—	—	—
Product	Product specific fixed effect	—	—	—	—
Time	Time specific fixed effect	—	—	—	—

Though the study of Ellison and Ellison (2009) found that price setters often check price comparison sites each day and adjust their prices after that, we have chosen to add a more generous delay to price adjustments, defined in the dependent variables in the two equations. However, there is no clear and obvious choice of an appropriate lag for adjusting the prices. Therefore, a longer delay will ensure we won't exclude the retailers who are aware of their ranking and adjust their prices accordingly but may not check price comparison sites daily. However, a too long time lag will do a worse job of isolating the retailers who purposefully check sites like Prisjakt and price in conjunction with information from it. For this reason, a four-day delay is chosen since it is assumed to seize the retailers with interest in their position while not interfering with the outcome while including noise to an excessive degree.

Since the study intends to explain retailers' pricing behavior resulting from if their ranking has changed, we obtain identical main variable of both equation (1) and (2). *Rank Diff*, represents the occurrence where retailers whose ranking has changed only due to a change in their relative rating have adjusted their price. The effect of this main variable will, however, be studied from two perspectives.

The first of these two perspectives are shown on the left hand side of equation (1). The dependent variable, *Dummy Price Diff*, studies if retailers change their prices as a binary variable – yes or no. The magnitude of the price adjustment will be insignificant since we are only studying retailers with the same price but different consumer ratings. Therefore, the size of the price adjustment will not affect if the retailer will regain the recently lost position or not.

Though studying a binary change of price of the main variable is enough to understand whether we encounter price adjustments following a decrease in ranking, we will also study the absolute value of price adjustments, formulated as the dependent variable in equation (2). The variable *Absolute Price Diff* makes no difference in whether we encounter a price increase or decrease but considers the magnitude of the change. This model will be used to test hypothesis H3.

Since we are comparing products whose prices often are highly different, we will perform a monotone transformation on the dependent variable in equation (2). This transformation will only change the scale of measurement from changes in the currency SEK to the percentage of change without influencing it in any other way. The transformation will make it easier to compare the prices of different products.

To ensure the relationship between the main variable of the formulas and the dependent variable, *Price*, is not hindered by factors regarding retailers' ratings, we have also included control variables for the retailers' individual and average ratings for each day, defined as *Rating* and *Average Rating* respectively. These will ensure that there will not be any inflation in retailers' ratings, nor will allow changes in ratings will be part of the sought-after effect. Any significance for these variables will be of no relevance for the empirical results.

Considering previous studies' reasoning, the model considers that consumers are not necessarily rational in contrast to what was presented in the Bertrand model of price competition. Instead, consumers are considered to be heterogeneous regarding preferable retail attributes. Similarly, it has been established that product brands also affect consumers' sense of quality and willingness to buy (Dodds, Monroe & Grewal, 1991). For this reason, we will include fixed effects for both retailer and product to control for these unobserved characteristics. On that note, large, well-established retailers will not be compared with small newcomers. Likewise, fixed time effects will make sure events shifting over time will not be compared with each other.

The variables chosen in the model have been evaluated based on the intraclass correlation, the existence of linearity in the model and, lastly, parameter stability. The regression model is tested for multicollinearity by examining the correlation and Variance Inflation Factor (VIF) between the variables. The linearity of the model and parameter stability is tested with a Ramsey RESET test and Chow test, respectively, showing no signs of disturbance to the model.

Hereafter, the residuals of the model will be tested for homoscedasticity, statistical independence, and lastly if they are normally distributed. First, homoscedasticity is tested with a Breusch-Pagan test, where the null hypothesis of homoskedaticity could not be rejected. Another critical assumption to test is if the residuals are correlated. This is done with a Durbin Watson test, where we can see no form of autocorrelation. Lastly, we examine the distribution of the residuals, where we find a log-normal distribution.

Thereafter, hypothesis H2 will be tested and analyzed based on an empirical frequency distribution of the price adjustments. The three states of price adjustments are presented as $X = -1$, $X = 1$ and $X = 0$, representing a price decrease, increase and no adjustment at all, and will

be studied as a trinomial distribution. By virtue of a great quantity of data, we can generalize the frequency of the different price adjustments, thus enabling us to conduct a distribution of probabilities across the different rankings.

To extract and process the data from what was its original form, it was necessary to compute several nested loops in the software R. The sheer amount of data turned out to make this computation problematic since the requirements of a powerful processor in the computer increase multiplicatively rather than linearly for these loops. Though being provided with a computer from the Department of Statistics at Lund University, this problem sought to be solved from another method. To avoid this problem, the extraction of the original form of the data was performed in many increments before being merged into one where the statistical calculations were executed.

In conclusion, this section has presented and reviewed the design of the empirical model and its including parameters. The model will in the following section be tested to answer the study's underlying research question.

5. Results

This section has been divided into three parts, examining the hypotheses of the study. In the first part, we will present the analysis of the rank-dependent pricing, thus answering the first hypothesis of the study, H1. Then, for the following hypothesis, H2, we will provide an empirical frequency distribution of this rank-dependent price adjustment of which the different pricing states can be regarded as a trinomial distribution. Lastly, to examine hypothesis H3, we will conduct a cost function for companies to retain their previous ranking. For the utility of retaining a previous ranking, we will first divide the price adjustments into decreases and increases and after that study how the size of the retailers may cause differences in pricing behavior. Throughout this entire section, we will emphasize the distinction between statistical and economic significance, where the latter also entails the economic effect inherent from the data.

While examining over 88,500 different products from more than 2,800 retailers, we provide evidence that retailers are not only engaged in their ranking but also adjust their prices in accordance with the changes in ranking. Since the first model only considers the binary adjustment in price, we do not differentiate retailers adjusting their prices with the least possible margin with those changing their prices more abruptly. The result presented in table 2 shows evidence that retailers tend to adjust their prices following a decrease in ranking. Therefore, the position in the market can be concluded as essential when adopting a pricing strategy on online marketplaces. In hypothesis H2, we will analyze the economic significance further, breaking down the occurrences of price adjustments across different rankings. For the second model, we can also see how the price adjustments are significantly different from zero. However, the magnitude of change will be further portrayed and analyzed in hypothesis H3.

Table 2: Effect of Decrease in Ranking.

	Model	
	Dummy variable of price change	*Absolute value of price change*
Rank Diff	0.012624***	3.79E-06***
	(0.000158)	(2.04E-05)
Rating	-1.40E-05	-5.03E-06
	(8.40E-05)	(8.30E-06)
Average Rating	0.001557***	0.00153***
	(0.000105)	(0.000105)
Fixed effects	Yes	Yes

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

A natural follow-up to understand retailers' pricing strategies, formulated in hypothesis H2, is to study an empirical frequency distribution of the occurrence of changes in ratings, given retailers' rankings. Therefore, we will analyze how the retailers' ranking will be decisive if they choose to adjust their prices after losing a rank on Prisjakt. In accordance with Baye et al. (2009) and Ellison and Ellison (2009), proving how the ranking is crucial for the number of clicks the retailer will receive from the price comparison website, we also see how the frequency of price adjustments are highly reduced for lower rankings.

In Figure 2, we see the percentages of retailers adjusting their prices based on their ranking. To ensure the data is not biased because of a skewed distribution of retailers among the rank positions, we have adjusted the frequencies of price adjustments to show the relative percentage instead of absolute frequency. The higher the retailers are ranked, the more they tend to adjust their prices.

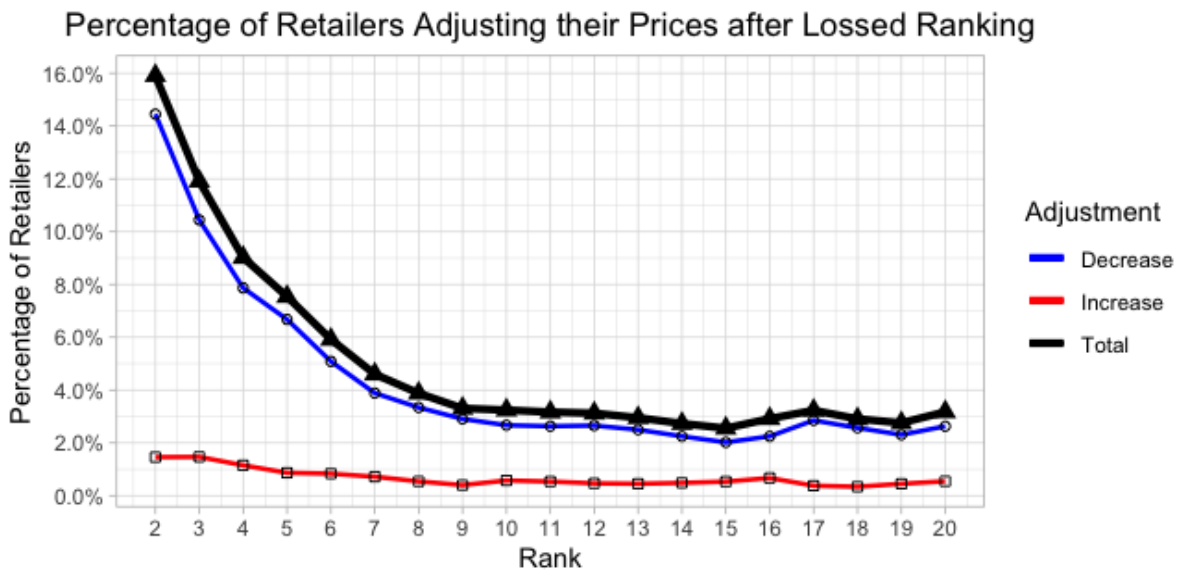

Figure 2: Percentage of retailers adjusting their prices following a decreased ranking of order 1.

An essential requirement to interpret the empirical frequency distribution as probabilities of random events is that the underlying data is sufficiently extensive to make it generalizable. Therefore, the quantity of the data is critical. With over 20 million observations for more than 85,000 products, these requirements are more than satisfied. Though, for a more granular break down of the probabilities, we should still examine the results with care.

For each of the rankings we obtain specific trinomial distributions, where the alternatives are presented by the geometric objects in Figure 2. This means we obtain empirical probability distributions with three states. For each rank we see the probability of retailers increasing, decreasing or not adjusting their prices at all. For example, retailers in the second ranking, meaning those who have just recently been downgraded from the first to second position on Prisjakt, can be expected to decrease their prices with a probability of 14.3 %, whereas the probabilities of a price increase or no adjustment at all will be 1.7 and 84 %, respectively. Mathematically, the probabilities of the trinomial distribution for the stochastic variable $X(Rank = 2)$ are as follows:

$$P(X = -1) = 0.143 \tag{3}$$

$$P(X = 1) = 0.017 \tag{4}$$

$$P(X = 0) = 0.84 \tag{5}$$

where $X = -1$ means retailers are decreasing their prices, $X = 1$ means retailers are increasing their prices and lastly $X = 0$ implies the retailers are not adjusting their prices in either direction. When we are studying these probability distributions across all of the 20 top ranked positions, Figure 2 can be seen as a family of trinomial distributions where each ranking is dependent on the previous ranking. If we move down the ranks and study the empirical probabilities of price adjustments for retailers downgraded to seventh position, we expect to see price decreases and increases in 3.9 and 0.9 % of the cases, respectively. This implies 95.2 % of the retailers will not be adjusting their prices at all, which indicate a rather quickly decreasing utility of retaining the rankings. Comparing the frequency of price adjustments from retailers in the second rank with those in seventh, we obtain a drop by 70 %, which can be compared with the 83 % decline in clicks if a retailer drops from first to seventh position in the study of Ellison and Ellison (2007).

Even though we retrieve up to 65 competing retailers for certain products, we have chosen only to visualize the first 20 rankings. This is determined from the reasoning of Baye et al. (2009) and Ellison and Ellison (2009), arguing for how the lower ranked retailers are only experiencing a fraction of the utility of what top-ranked retailers would obtain. Also, this delimitation has been conducted to make sure we obtain generalizable results across all rankings we are studying. Therefore, we only focus on the retailers whose marginal utility of receiving a better ranking by changing their prices is considered significant. Furthermore, as

seen in the figure, the total frequency of price adjustments has been split up into decreases and increases of prices to display a greater granularity of frequency of price adjustments.

Following Arbatskaya (2007), who argues that it is the ordinal ranking, rather than price, that determines consumers' buying behavior, a decrease in ranking is expected to result in two active responses from retailers to counteract decreasing revenues[1]. Either the firm lowers their prices to the degree where they retake their previous ranking, thus expecting to sell more products, other things equal. Otherwise, given that the retailers are not willing to lower their prices, they are better off adjusting the price upward until they only have a slight price advantage toward their subsequent competitor. This strategy would not imply a greater quantity of sold products, but a higher revenue per sold item. In combination with the action of not adjusting the prices at all, we therefore have justified the three states in the trinomial distribution evident in the empirical frequency distribution in Figure 2.

Assuming retailers are less price sensitive when defending a top-ranked position, we will return to hypothesis H3, in which we study if there is a cost difference in retaining rankings across the positions. To understand the importance of retaining a more beneficial ranking, we calculate a cost function from the average price adjustments of retailers in each rank position. When performing this cost function, we will both study the overall trend but also take into consideration that retailers may not possess the same financial muscles. For this reason, we adopt dummy variables separating the retailers into subgroups of small, medium and large retailers. The lower quartile conducted this separation as the threshold for small and medium-sized retailers and the upper quartile for separating medium and large retailers. This ensures we have a more significant medium segment, following a normal distribution of the retailers' sizes.

Starting with the average decrease in price after losing a ranking, Figure 3 shows evidence of a significant heterogeneity of price decreases among the different retailer subgroups from the sixth rank and following. These different strategies are also evident while studying the trendline and its standard deviation, visible as the shaded area. From this trend, we can identify a slight decrease in average price reduction for retailers positioned in worsened rank positions on Prisjakt's comparison lists. Though, while considering the standard deviation, we cannot

[1] Revenue is calculated as price per unit sold × number of units sold.

confirm this decrease. This means we cannot reject hypothesis H3, stating that it would not be any difference in retaining rankings across the positions.

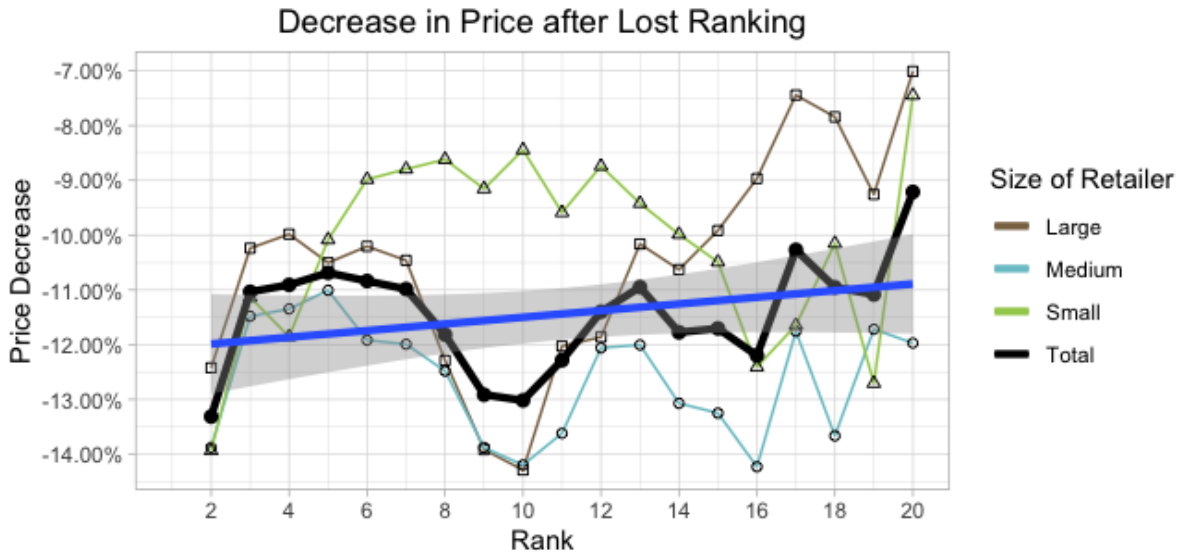

Figure 3: Decrease in price in order to retain lost ranking. Retailers have been separated by size. Dark blue line symbolizes the trend where the shadow area displays one standard deviation.

For the five top-ranked retailers, we can see a pricing behavior consistent across the subgroups. After that, the different subgroups are separated, where small retailers tend to adopt a different approach compared to the large and medium-sized retailers. When the latter subgroups keep decreasing their prices to a comparably large degree, the smaller retailers ease the extent they lower their prices. Therefore, one can assume that these retailers do not possess a financial strength equivalent to what is needed to keep pursuing price decreases similar to what takes place for medium and large retailers. For the lower ranked retailers, defined by their position in rank 15 to 20, we can contend that the marginal utility of the ranking is already limited compared to what it is for top-ranked retailers. In combination with the large variance of price decreases, it is difficult to argue for a particular pricing strategy being present.

This pricing behavior follows a reasoning where retailers are less price sensitive to defend their top-ranked positions. With support from Chen and He's (2011), there are reasons to believe that retailers are willing to implement larger price decreases, given that they are in positions on the price comparison website where they can expect to be examined by the consumer. The worse ranking, the more likely it is that they will not be considered by the consumers, thus reducing the incentives to carry out a similar price decrease.

Regardless of the average price adjustment, one should critically evaluate why we see different price adjustments contingent upon the rank position. With the foundation in Arbatskaya's (2007) reasoning, suggesting that it is only the ordinal ranking that is of importance, the sufficiency of a price decrease of as little as 1 SEK would be enough, given the conditions we have tested. However, with average price decreases fluctuating between 9 and 13 % for the 20 highest ranked retailers, we should problematize if Arbatskaya's reasoning is appropriate for the Swedish market.

Even though Figure 2 only presented how price increases were comparably infrequent, we should examine how these price increases evolve for the rankings. With a limited variation in the average total price increase for the different positions, we observe a steep downward facing trendline with a minimal standard deviation, presented in Figure 4. Since hypothesis H3 only studies if there is a cost difference in retaining rank positions across Prisjakt's rankings, a price increase following a decreasing ranking will not be addressed in the given hypothesis. Despite this, we can confidently argue for the occurrence of price increase depending on the ranking. Similar to the price decreases, we also identify how the most extensive degree of change occurs for the highest rankings, which after that is followed by a steeper reduction in price increases as we move down the rankings.

Figure 4: Increase in price as a consequence of lost ranking. Retailers have been separated by size. Dark blue line symbolizes the trend where the shadow area displays one standard deviation.

Comparing the two types of price adjustments previously presented in Figure 3 and now recently in Figure 4, we experience a lower magnitude of change. From previously fluctuating between 7 and 14 %, we now encounter average price adjustment between as little as 2 % up to 14. These minor adjustments show tendencies of the fact that retailers are more likely to increase their price to that degree where it still would mean additional rankings would not be lost. This entails retailers only increasing their prices to enhance their marginals while, given the reasoning of Arbatskaya (2007), not risking losing the attractiveness of consumers.

Similar to the price decrease strategies, we see how the behavior of the different segments follow each other while being positioned in higher ranked positions, and after that pursue separate responses to the loss of rankings. With support from the descriptive statistics of Figures 3 and 4, we can conclude that we have a consistent pricing behavior for the top-ranked retailers, similar to what Chen and He (2011) argued for. Therefore, the importance of being in highly ranked positions can be seen as equally important for retailers, regardless of their size.

Conclusion

The importance of price comparison sites' rankings has during the last decade grown into being a cornerstone of e-commerce. This has also been widely revealed from the number of studies regarding click elasticities across retailers in different rankings. In this study, however, we have studied the aftereffects of this drop in consumer demand from a strategic perspective. We recognized that retailers are adjusting their pricing to a greater extent when they recently have experienced a decrease in ranking. Our analysis also notes a striking trend of a highly decremental frequency of price adjustments for lower ranked retailers. The higher ranking for the retailer, the more likely we are to experience a price adjustment. Though we can see a heterogenous pricing behavior across retailer's size segments, they all seem to follow a similar pattern for the top-ranked positions. Therefore, we can conclude that the significance of being in top positions on the price comparison site Prisjakt surpasses the profit margin cutback it also implies.

Despite frequently changing prices as a consequence of changes in rankings proving the occurrence of pricing strategies across all segments of the retailers, it is still difficult to acknowledge a frictionless market as cited in The Economist (1999). Regardless the signs of an absent market emulating the prerequisites of the Bertrand model of price competition, we see few signs indicating price comparison sites will have a less outstanding role in the future. If commerce has not yet evolved into e-commerce totally, it is not long until that is the case. The playing field of today is price comparison websites, and for retailers, it is inevitable to escape from being in a position of competition.

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