Quantitative Studies on Pricing and Consumer Behavior

Hampus Poppius

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by Hampus Poppius

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Abstract

This thesis consists of three self-contained papers. The first paper studies how multimarket contact facilitates collusion in online retail. With data on the universe of consumer goods sold online in Sweden, I estimate that multimarket contact increases prices. To more closely investigate what drives the effect, I employ a machine-learning method to estimate effect heterogeneity. The main finding is that multimarket contact increases prices to a greater extent if fewer firms participate in the contact markets, which is one of the theoretical predictions. The effect is stronger than in previously studied settings.

The second paper explores the link between the vertical relationship and downstream price conformity. Following the descriptions of how manufacturers enforce resale price maintenance in the European Commission's sector inquiry, I estimate how retail price conformity depends on the intensity of the vertical relationship. I find a positive effect of the vertical relationship intensity on the retail price conformity. I estimate heterogeneous effects to show how the effect varies with product, brand, and retailer characteristics. The effect is higher when brands sell through common retailers, retailers have lower rating, categories include many products, and the brand has many products. These results concur with contexts in which resale price maintenance hurts consumers.

The third paper shows how the consumer's familiarity with contextual surroundings may influence consumption. In a randomized field experiment involving 16 fast-food restaurants over five months, we randomly varied the degree of familiarity of the background music. We find that playing familiar music reduces revenues and quantity sold by more than 4% relative to playing similar but unfamiliar music. We conduct a complementary survey that shows that familiar music attracts consumers attention more than unfamiliar music. We therefore argue that the key mechanism for familiar music to reduce consumption is distraction. The results have implications for the literature on attention and framing as well as for marketing policy.

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Abstract

This thesis consists of three self-contained papers in industrial organization and behavioral economics.

The first paper studies multimarket contact and collusion in online retail. When firms meet in multiple markets, they can leverage punishment ability in one market to sustain collusion in another. This is the first paper to test this theory for multi-product retailers that sell consumer goods online. With data on the universe of consumer goods sold online in Sweden, I estimate that multimarket contact increases prices. To investigate what drives the effect more closely, I employ a machine-learning method to estimate effect heterogeneity. The main finding is that multimarket contact increases prices to a greater extent if fewer firms participate in the contact markets, which is one of the theoretical predictions. Previous studies focus on geographical markets, where firms provide goods or services in different locations. I instead define markets as different product markets, where the type of goods defines each market. This is the first paper to study multimarket contact and collusion with this type of market definition. The effect is stronger than in previously studied settings.

The second paper explores the link between the vertical relationship and downstream price conformity. Following the descriptions of how manufacturers enforce resale price maintenance in the European Commission's sector inquiry, I estimate how retail price conformity depends on the intensity of the vertical relationship. I find a positive effect of the vertical relationship intensity on the retail price conformity. I use a machine-learning driven estimation of heterogeneous effects to show how the effect varies with product, brand, and retailer characteristics. The effect is higher when brands sell through common retailers, retailers have lower ratings, categories include many products, and the brand has many products. These results concur with contexts in which resale price maintenance hurts consumers.

This paper explores how the consumer's familiarity with contextual surroundings may influence consumption. In a randomized field experiment involving 16 fast-food restaurants over five months, we randomly varied the degree of familiarity of the background music. We find that playing familiar music reduces revenues and quantity sold by more than 4 percent relative to playing similar but unfamiliar music. We conduct a complementary survey that shows that familiar music attracts consumers attention more than unfamiliar music. We therefore argue that the key mechanism for familiar music to reduce consumption is distraction. The results have implications for the literature on attention and framing as well as for marketing policy.

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As a fundamentally optimistic and confident person, for me, starting the PhD programme was exciting. I was going to generate groundbreaking research and impress the world. After some time, reality caught up with me and showed me how hard that would be. However modest the benefits I have generated for the world may be, it has been a truly rewarding experience. For that, I want to sincerely thank everyone who has helped me along the way.

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Senoren, April 2020
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Introduction

Introduction

This thesis consists of three self-contained papers in industrial economics. The first two papers study pricing in online retail and have implications for competition policy. Well-functioning competition between firms is essential for consumer welfare as, for example, it leads to lower prices, higher product quality, and more innovation. Competition policy is the public policy that ensures that competition is not restricted in ways that are detrimental to consumers. Competition policy relies heavily on economic research because policy makers must understand the effects of firms' undertakings on consumers to intervene appropriately.

The first paper shows how relations between competing online retailers suppress competitive pressure. This result is important for merger control, the competition policy tool that prohibits mergers between firms that would decrease competition without counter-balancing benefits.

The second paper indicates how vertical price restraints (when manufacturers limit their retailers' pricing decisions) are widely used in the online retailing of consumer goods in Sweden. Such restraints are intensely debated within competition policy circles because whether they benefit or harm consumers depends on the specific characteristics of the goods and the industry structure. The results of the second paper indicate that firms mainly use vertical price restraints in contexts where such restraints harm consumers. Hence, competition authorities should be wary.

The third paper in this thesis studies consumers in fast-food restaurants and how background music influences consumer behavior. Understanding consumer behavior is important for a wide range of policy makers. While public policy makers need to understand consumer behavior to implement efficient policies, firms and marketers must understand consumer behavior to provide relevant offers and remain competitive. In this paper, we test a real business practice to give easily applied business policy advice and provide more general insights for behavioral research.

The common element of all three papers is the use of data and quantitative methods. My ambition throughout the thesis has been to exploit modern technological and methodological advancements with respect to data collection, analysis, and estimation techniques.

First, with technological progress and digitization, there is a huge availability of data. Governments, firms, and organizations collect vast amounts of data at an incredible pace, enabling economists to test economic theory and study behavior in a wide variety of settings. In this thesis, I use the data collection of firms in two different ways. In the first two papers, I use a price comparison website whose business model relies on collecting all prices for all products that are available online. For the third paper, my co-authors and I collaborated with a fast-food restaurant chain and a music provider. We use detailed sales data from multiple restaurants over time, combined with survey data collected at the restaurants, to understand their customers' behavior.

Second, modern applied microeconometrics have expanded the range of statistical tools for making credible claims about causal relationships, i.e., causal inference. This advancement of empirical economics is called "the credibility revolution" (Angrist and Pischke, 2010). An experiment with a random allocation of treatment, which has long been the gold standard in medical research, makes causal inference straightforward. However, in contrast with medical researchers or experimenters at tech companies, economists are often unable to conduct the ideal randomized experiments. Instead, econometricians of the credibility revolution have developed statistical tools that make stating and assessing the assumptions needed to make credible causal claims straightforward.

The first two papers in this thesis study how relations between firms affect pricing. Hence, the random allocation of treatment (relations between firms) is infeasible. Instead, I use statistical tools that isolate the relationship between the key variables from other factors. This technique vastly reduces the alternative interpretations of my results and enables me to clearly state the necessary assumptions for a causal interpretation.

In the third paper, we randomly allocate music selections to fast-food restaurants to estimate the effect of different music selections on consumer behavior. While we are able to allocate the treatment randomly, the setting is fairly small. Therefore, we exploit variation over time and use statistical techniques that are specifically designed for small settings.

The third technological and methodological advancement that I use is machine learning. Most (supervised) machine-learning algorithms are statistical tools that use data to predict behavior (or any outcome of interest). While good predictions may be useful in many practical applications, we often need to understand why we obtain a specific prediction. The complexity of most machine-learning algorithms typically makes it difficult to answer that. However, recent advances in statistical research modify machine-learning algorithms to solve problems that are very common in economic research.

The problem that I use machine learning to solve is the challenge of estimating treatment effect heterogeneity. When we estimate the effect of a treatment on an outcome, we usually focus on the average effect. That means answering how individuals (or firms) on average respond to the treatment. However, we know that different individuals respond differently to the same treatment. The difference between how different individuals respond to the treatment may, in some cases, be much more useful than the average response. To answer the question of effect heterogeneity, the researcher typically splits the sample into groups and estimates the average effect within each group. The problem is that there are often many potential groups to consider, and therefore some will yield significant results by pure chance. Thus, if we run multiple tests and then report the significant results, we potentially only report meaningless results that will mislead the reader. Even if we have good intentions and properly adjust for multiple testing, the reader cannot know how many tests we run but choose not to report.

Athey et al. (2019) take a conventional machine-learning algorithm called Random Forest and modify it to estimate heterogeneous effects without invalidating statistical inference. This algorithm eliminates the majority of the researcher's discretion in searching for heterogeneity and makes the search much more efficient. I use this algorithm in the first two papers to understand the firms' behavior in more depth. In addition, I generally find this algorithm very useful to enhance the credibility of the main estimate and the assumptions for causal inference. To further reduce my discretion and reliance on strong assumptions, I draw on the suggestions from Chernozhukov et al. (2018) and present the heterogeneity results as descriptively and as extensively as possible. The results from the heterogeneity analyses are in line with some key theoretical results in the literature. These results enhance the understanding of the firm behavior that I study and bolster the policy implications.

While the common elements throughout the thesis are mainly methodological, the policy implications are about the various settings of the papers. Therefore, the remainder of this introduction summarizes the settings and policy implications for each paper separately.

1 Paper I: Multimarket contact and collusion in online retail

Over the past two decades, online retail has moved from being almost non-existent to becoming a normal part of many people's lives in developed countries. With the internet and online retail, the competition between firms and the interplay with consumers are quite different from when consumers physically visited brick-and-mortar stores to know what they offered. Now, consumers can easily find all available offerings and prices in a very short time, and stores can set up shop and reach consumers across a large spectrum at very low costs.

One could expect that competitive forces would prevail in such an information-rich environment and result in low prices and zero profits. However, firms do not simply give up profits and sometimes go to great lengths to mitigate the internet features that intensify competition. For example, Ellison and Ellison (2009) show that online retailers deliberately obfuscate their offerings to make it more difficult for consumers to search for and compare competing offers. Paper I studies how competing retailers learn to avoid competition by leveraging multimarket contact and, thus, the ability to punish each other in multiple product markets.

To avoid competitive pressure on prices, competing firms can agree on high prices. Such an agreement is called a cartel and is illegal. Firms can, however, learn to mutually refrain from cutting prices without explicit communication. If a firm employs a dynamic strategy that punishes its competitor's price cuts by cutting its own prices and rewards its competitor's price increases by increasing its own prices, the competitor may learn that it is more profitable to keep prices high. Hence, in markets where firms meet repeatedly and expect to continue meeting, they may refrain from cutting prices out of fear of retaliatory price cuts from their competitors.

Such implicit cooperative pricing is called tacit collusion. Economists have long understood that various market characteristics can facilitate collusion. One such characteristic is that if firms compete in multiple markets, they can sustain collusion in one market by leveraging the risk of punishment in another. This idea was set out by Edwards (1955) and was formalized by Bernheim and Whinston (1990). Bernheim and Whinston (1990) show that firms may indeed leverage the ability to punish in other markets to sustain collusion in the reference market, where collusion would otherwise not be stable. It is not, however, enough to simply have contact in additional markets. A contact market can only facilitate collusion in the reference market if collusion is stable in the contact market.

The empirical literature shows that prices increase with multimarket contact in, for example, the airline industry (Evans and Kessides, 1994) and in the hospital industry (Schmitt, 2018). This is generally regarded as support for Bernheim and Whinston (1990). In all studied industries, however, multimarket contact means that firms meet in multiple geographically separated markets. For example, airlines may compete on multiple routes, and hospital systems may compete in multiple cities or regions. For online retailers, geographical markets are less distinct. A more relevant distinction is between product markets.

I study all retailers listed on the leading price comparison website in Sweden. The website's purpose is to list all products from all retailers that deliver to Swedish consumers. It lists prices and some additional information about the products and retailers. No transactions take place on the comparison website, consumers are just redirected to the retailers' own websites. The price comparison website merely collects and publishes information, while the retailers are the economic agents studied in this paper.

I use data from two points in time one year apart (September 2018 and 2019) and use a web scraper to collect all available data on the website at each point in time. For example, 4Sound, a music equipment retailer, has 4,815 different products listed on the price comparison website when I collected the data in 2019. Products that 4Sound offers include, for example, the Epiphone SG Special (electric guitar) and Sennheiser HD 25-III Plus (headphones). I collect the price and additional information for each product and repeat the process for every retailer on the website. There are roughly 3,200 retailers and roughly 750,000 different products. As

I collect the data at two points in time, I can track retailers and products over time to understand pricing behavior.

Most online retailers sell a wide range of different products. Therefore, I define markets as the product categories the price comparison website uses to sort products. There are almost a thousand such product categories. Some examples are shower doors, blenders, and smartwatches. Thus, if two retailers both sell blenders and smartwatches, they have contact in two markets. I measure the retailers' average multimarket contact with other retailers in that product market for each retailer in each product market. I then compare the changes in each retailer's average multimarket contact with the changes in prices over time.

The result is that prices increase with multimarket contact. Moreover, the effect I find is stronger than the effects reported in the literature. The average effect size implies that an increase in multimarket contact by one standard deviation leads to an increase in prices of approximately 7.5 percent. In almost all previous studies, the equivalent change in multimarket contact leads to a price increase of less than 5 percent.

When I explore how the effect differs across retailers and markets of various characteristics, I find strong support for the core mechanism outlined by Bernheim and Whinston (1990). They show that when the number of firms in a contact market is low, the contact is more likely to sustain collusion in the reference market than if the number of firms is high. The reason is that if the contact market is concentrated, i.e., few firms, it is more susceptible to collusive prices. Hence, if a price war in the reference market spreads to such a concentrated contact market, it would lead to a greater loss for the firms than if the contact market were highly competitive. Therefore, the effect of multimarket contact on prices should be larger when the contact markets contain fewer firms. That is precisely what I find.

Figure 1 illustrates how the effect of multimarket contact on prices depends on how many retailers there are in the contact markets relative to the reference market. Because I compare changes over time, we can consider both lost contacts (contact market in 2018 but not in 2019) on the vertical axis and gained contacts (vice versa) on the horizontal axis. For example, if the difference is 50, there are 50 retailers less in the contact market than there are in the reference market. Just as Bernheim and Whinston (1990) predicted, multimarket contact is more likely to facilitate collusion (darker color) when fewer firms are competing in the contact market.

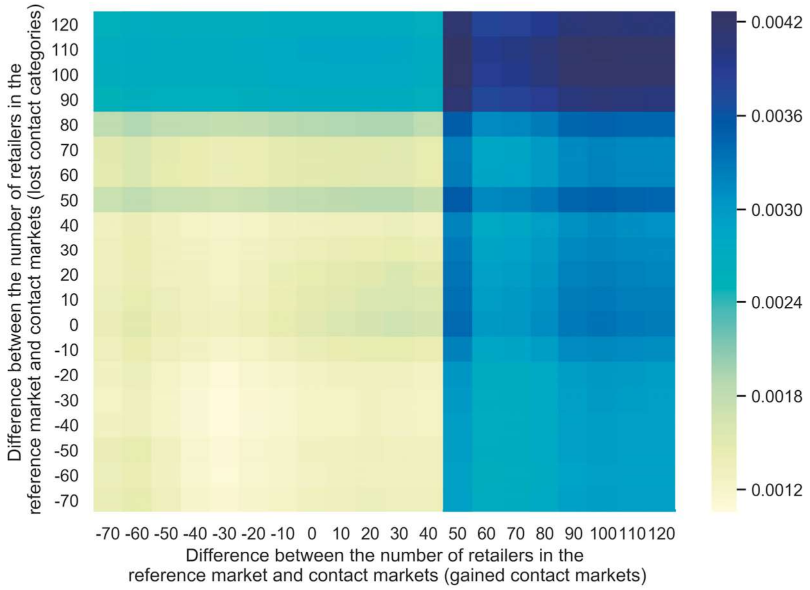

Figure 1: Effect of multimarket contact on log prices at different levels of market concentration in contact markets. Darker color implies a larger effect. The average effect size is .002.

This paper shows that online retailers can exploit multimarket contact to sustain high prices to an even greater extent than firms in previously studied industries. This has important implications for competition policy, especially merger control. When competition authorities evaluate whether to approve or block a merger between firms, they need to consider not only the market structure where the firms compete, but also how the merger affects the multiplicity of contacts with other firms. Suppose, for example, that two firms selling completely different products, e.g., home electronics and gardening tools, want to merge. Since they do not compete in any single product market, such a ”conglomerate” merger may seem harmless. However, if a third firm sells both home electronics and gardening tools, the merger will increase the merging firms’ multimarket contact with the third firm. This paper shows that a likely result from such a merger, especially if any of the product markets is highly concentrated, is higher prices for consumers.

2 Paper II: Vertical relations and retail price conformity

When firms are vertically related, i.e., operate at different stages of the supply chain, suppliers may want to restrain their retailers' prices. Such vertical price restraints are called resale price maintenance (RPM). In some circumstances, RPM benefits both the firms and the consumers. For example, Telser (1960) shows that when a monopoly supplier sells a good through multiple competing retailers and demand for the good increases with pre-sales services that the retailers must provide, there are clear benefits of RPM for the consumers. Without RPM, discount retailers can free ride on other retailers' provision of pre-sales services and thereby sell the goods at a lower price. With such free-riding, retailers have no incentive to provide the services that would benefit consumers and increase demand.

Other studies demonstrate that suppliers can employ RPM to sustain collusive prices (Jullien and Rey, 2007; Rey and Vergé, 2010; Gilo and Yehezkel, 2020) or block entry (Asker and Bar-Isaac, 2014). For example, Rey and Vergé (2010) show that when rival suppliers sell through the same competing retailers, they can use RPM to limit competition at both levels and sustain industry-wide monopoly prices. In addition, Hunold and Muthers (2017) show that under the same industry structure, rival suppliers selling through the same competing retailers, the demand for pre-sales services leads to a race to the bottom where retailers artificially suppress the level of services.

With these theories in mind, competition authorities generally prohibit RPM but may allow it under certain circumstances. Therefore, suppliers employ RPM implicitly by recommending resale prices and threatening retailers with retaliatory measures for undercutting the recommended price.

This paper studies RPM usage in the online retailing of consumer goods in Sweden. I use the same data and similar methods as in the first paper of this thesis. In this paper, however, the key variables are the brand's importance (the supplier) to the retailer and retail price conformity. I measure the brand's importance by the number of the retailer's products from that particular brand, divided by the total number of products that the retailer sells. I measure the price conformity for each product (sold by multiple retailers) by counting the number of retailers that set the most common price for this product (modal price) and dividing it by the number of retailers that sell the product. Hence, if many retailers set the same price, the price conformity is high. The logic behind the relationship between these two measures is that if the brand enforces a price recommendation by threatening to cut off deviating retailers, the retailers have stronger incentives to comply the more invested they are in the brand.

The main result is that when the brand's importance to the retailers' increases, price conformity increases. This is what we would expect if brands employ RPM and retailers comply when they value the relationship with the brand. However, we do not expect a uniform relationship because we do not expect all brands to employ RPM. I, therefore, perform a thorough analysis of heterogeneous effects using the algorithm mentioned above. The heterogeneity results show that for 48 percent of the products, there is a significant positive relationship between brand importance and price conformity. I also show that while most products have small or zero effects, the distribution of effects is highly skewed, as there is a set of products and brands that have very large effects. We expect this if only a few brands employ RPM meticulously, while most brands do not.

A key result pertains to the industry structure where the effect of brand importance on price conformity is large. A condition for RPM to hurt consumers in Rey and Vergé (2010) and Hunold and Muthers (2017) is that rival brands sell through the same retailers. Therefore, for each brand in each product category, I construct a measure that describes the extent to which the brand shares its retailers with rival brands in the same category. I then split the products into four equal groups based on this measure and compare the groups' effect sizes.

Figure 2 shows how the effect size increases with the extent to which the brand shares retailers with rival brands. The boxes show the distributions of effect size for each group of products by indicating the 90th, 75th, 50th, 25th, and 10th percentile from top to bottom. As the boxes generally move upwards as we go from left to right, the effects are larger when the brand's sharing of retailers is higher. All pairwise group comparisons of adjacent groups are statistically significant (rank-sum test). This is the prediction of both Rey and Vergé (2010) and Hunold and Muthers (2017), which suggest that brands employ RPM for reasons that hurt consumers.

The main policy implication is that competition authorities need to be wary of RPM usage in online retailing for consumer goods. While there have been indications in industry surveys and from some cases that brands use RPM, this paper provides statistical evidence of pricing patterns that we would expect if brands use RPM. The heterogeneity analysis shows that the pattern is more prevalent in settings where RPM increases prices and decreases service provision, all to the detriment of consumers.

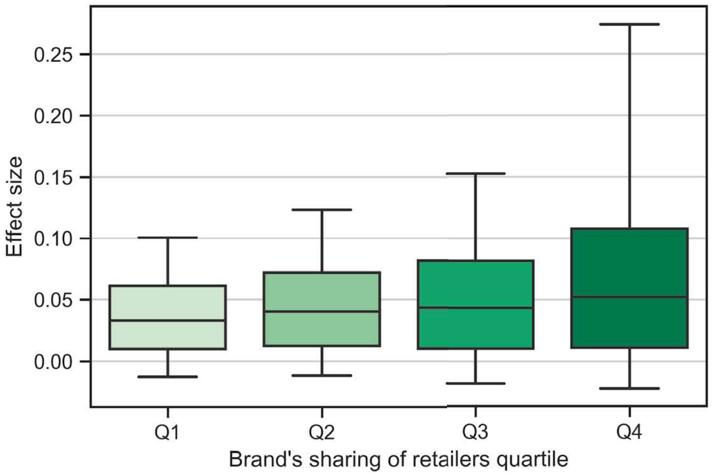

Figure 2: Distributions of product-specific effects of brand importance on price conformity. Groups are separated by quartiles of brand's sharing of retailers, i.e. percentiles 25, 50, and 75. All pairwise group comparisons of adjacent groups are statistically significant (rank-sum test).

3 Paper III: Familiar background music and consumer behavior: an experiment in fast-food restaurants

Retail stores, restaurants, and other commercial environments tend to play background music. It is not necessarily essential for the consumption per se, but it may make the experience more pleasant. As there are many different music types, scholars have argued that music affects consumer behavior in many different ways. This literature builds mainly on psychology theory and scholars typically state hypotheses and draw conclusions that are very specific to the context. While economists do not neglect psychology, we are typically interested in more general conclusions regarding decision making. There is, thus, a gap between the "music literature" and scholars in economic and related fields that study the cognitive processes underlying economic decision making. This paper narrows this gap by showing how the familiarity of the background music affects consumer behavior by distracting consumers. Hence, we do not only give easily applicable policy advise to marketers, but also propose a simple cognitive mechanism that bear relevance in a wide range of economic decision environments.

We collaborate with Soundtrack Your Brand (Spotify Business), who designs music playlists for commercial environments. We run a randomized field experiment in 16 fast-food restaurants that belong to a global market-leading fast-food chain. During 12 weeks, we randomly vary the background music in the restaurants to estimate the effect on the consumers. The different music playlists we vary mainly differ in terms of familiarity, based on the streaming activity of Swedish Spotify users. The music experts at Soundtrack Your Brand design the playlists so that they should not be too different on other dimensions than familiarity. In addition, we use metrics on music attributes to quantitatively test and make sure that the playlist do not differ significantly in other ways than familiarity.

We find that the playlist with highly familiar music decreases sales by 4 percent compared to the playlist with mainly unfamiliar music. We compare the effects on different sales metrics to find that the effect is driven by additional items with an average value of 20 SEK (2$), which is the typical price of coffees, ice-cream, and other dessert/side items. In addition, we use a customer survey to understand more closely how the customers react to music familiarity. When the music is familiar, more respondents notice it, recognize it, and like it.

While other mechanisms could be at play, our best explanation is that the familiar music distracts consumers, and thus reduces the consumers' attention to consumption possibilities. Therefore, they stick to their plan and do not add any additional items. It is simply the reduction of considered consumption possibilities that makes the consumer also reduce her consumption. This explanation may seem trivial, but we have not found any similar explanation in the literature. More research is required to replicate and bolster our explanation but we advise marketers to keep background cues, such as music, in the background.

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