Essays on Industrial Organization and Networks: Retail Bundling, Exclusive Dealing, and Network Disruption

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To my loved ones.

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Contents

Chapter 1

Introduction

This thesis examines market structures from the perspective of industrial organization and network theory. With regard to the former perspective in this thesis, we[1] focus on vertical channels, where the manufacturing industry produces goods and sells them to the retail industry, which in turn sells them to the final customer. We are particularly interested in *how* the channel structure comes about; thus, how the goods are distributed from the producers to the retailers and finally to the customer (Choi, 1996). With regard to the network perspective in this thesis, we deal with equilibrium market structures as well, but do not consider a particular distribution system. We rather study the underlying network structure that enables the players in the network to distribute goods along their network connections. Overall, this thesis deals with the question: *What determines the distribution structure or the network structure in a market?* Under the industrial organization point of view, it further deals with the question: *Which welfare implications do the resulting channel structures have?* By means of this thesis, we gain a richer understanding of why certain channel structures occur and of the agents' incentives to choose particular distributions. The decisions about the channel structures might be taken decentrally by the channel participants themselves, or centrally by an outsider. Market structures have been studied for decades. Nevertheless, we identify several unanswered questions, which we will point out in the respective chapters.

The thesis proceeds as follows: In chapters 2 and 3, we focus on the distribution decisions on the downstream side of the market. In chapter 4, we concentrate on the distribution decisions on the upstream side of the market that determine the downstream sides' distribution options. Finally, in chapter 5, we study the network structures that an outsider of the market chooses for all network players.

After introducing some fundamental concepts that are applied in this thesis, we explain the main contributions of each chapter.

A common way to model competition between agents is with the Bertrand model (Bertrand, 1883) or the Cournot model (Cournot, 1838), in which the agents compete either in prices or in quantities with each other. The literature has established that price competition is more competitive than quantity competition (Amir and Jin, 2001) due to a more elastic demand under price competition (Singh and Vives, 1984). In chapters 2 to 4 of this thesis, we assume that our

[1] For the sake of consistency, I use 'we' throughout this thesis, even though 'I' might apply.

downstream firms compete in prices and identify that the resulting intense degree of competition affects the equilibrium distributions. In these chapters, we model the (representative) customer's demand by a utility function introduced by Dixit (1979) and Singh and Vives (1984), which is quadratic in the consumption goods and quasi-linear in the numeraire good. Strict concavity of the utility function is necessary and sufficient for its first order conditions to provide a well-defined demand system (Amir et al., 2017). Considering differentiated products, the assumption of strict concavity restricts the valid range of parameters for complements to $\left(-\frac{1}{n-1}, 0\right)$, with n being the number of products in the market. The valid parameter range for substitutes remains unrestricted from the number of goods in the market and is provided by $(0, 1)$ (Häckner, 2000). Once strict concavity and thus linear demand is secured, the stated utility function proves to be a neat function to study oligopolistic competition with. In chapters 2 to 4 of this thesis, we are further confronted with an inefficiency caused by the vertical market structure, the so-called *double marginalization*.[2] Vertical externalities arise when the upstream firms set a margin on their price and the downstream firms apply their own margin on the upstream firms' margin. Because of that, final prices are higher in a vertically related channel than in an integrated channel, which harms customers and firms (Belleflamme and Peitz, 2015). In the remainder of this introduction, we outline the respective chapters of this thesis.

In chapters 2 and 3, we focus on retail bundling as downstream distribution strategy and study the welfare implications of bundling. Product bundling – selling several goods for one price – is a common strategy for a firm that wants to introduce a non-linear pricing scheme.[3] Examples of bundled goods are sporting season tickets (Adams and Yellen, 1976) or television channels (Belleflamme and Peitz, 2015). Bundling can be implemented via *pure bundling*, where a firm only sells the goods bundled, or via *mixed bundling*, in which a firm offers the goods separately as well as in packages. We focus on pure bundling in this thesis. The literature has already identified several motives to use bundling as selling practice, e.g., cost-effectiveness, demand-side incentives, as entry-deterrence or price discrimination device, or to strategically reduce the degree of competition in the market (Belleflamme and Peitz, 2015). We will shed further light on the latter motive and on how the goods' characteristics impact bundling as a selling choice.

In both chapters, a multi-product downstream firm has the option to sell its goods bundled or on a standalone basis to the final customer. The literature about retail bundling in a decentralized channel is hitherto only sparsely addressed. To the best of our knowledge, Heinzel (2019) is the only study that assesses the retail bundling incentives in a decentralized market considering a certain competitive structure (called *leverage structure*)[4] in the downstream market. He considers goods that are independent in demand and have the same quality. However, the literature has also

[2] See Spengler (1950) for more details.

[3] See the seminal paper by Adams and Yellen (1976) for an introduction of bundling.

[4] The leverage structure in the downstream market is characterized by a multi-product firm with a monopoly position in one market that faces competition in the market for another good.

shown that the goods' characteristics impact the downstream selling choice (see e.g. Honhon and Pan, 2017; Venkatesh and Kamakura, 2003). Given that, we encounter a lack of insights about the interplay between the goods' characteristics and the incentives to (retail) bundle, as well as a research gap about the welfare effects of bundling in a set-up such as proposed by Heinzel (2019). Chapter 2 closes this gap for goods with different qualities. It carries the title **"The Impact of Product Qualities on Downstream Bundling in a Distribution Channel"** and is co-authored with Joachim Heinzel. The market set-up is based on Heinzel (2019) and the market consists of a supply chain with two price-setting manufacturers that each produce one good. One manufacturer sells its good non-exclusively to both retailers and the other manufacturer sells its good exclusively to one retailer. The multi-product downstream firm has the option to sell its goods bundled or separately to the final representative customer. The retailers compete in prices. We investigate the following:

Research Question 1. *How do different product qualities affect the two-product retailer's incentive to sell the goods as a bundle? What are the welfare effects of retail bundling?*

For retail bundling to occur in equilibrium, the quality of the good sold in the downstream duopoly *(good 2)* has to sufficiently exceed the quality of the exclusively sold good *(good 1)*. The intuition is that the two-product downstream firm can exploit those customers who have a high willingness to pay for the high quality good 2 under bundling. Besides, under bundling, the firm can extend its market power from the market of the monopolistically sold good 1 into the competitive downstream market for good 2. Both effects reduce the degree of competition in the market and allow the bundling retailer to raise bundling prices, which increases its bundling incentives. Aside from that, the aggravated double marginalization by bundling negatively affects its profits and thus its bundling incentives. Only when the quality of good 2 is sufficiently larger than the quality of good 1 can the positive effect of the reduction of competition predominate and yield bundling to be an equilibrium strategy.

Concerning welfare, we identify that profitable bundling reduces the consumer surplus due to the raise in retail prices under bundling. It further lowers the producer surplus, which is caused by the strong loss in profits of the upstream firm that sells the homogeneous good 2. Thus, from a social welfare perspective, retail bundling is not desirable in our set-up.

By varying the channel structure, we further assess that the vertical externalities combined with the horizontal externalities upstream weaken the incentive for retail bundling in our decentralized channel. In a robustness setting we confirm that the existence of a bundling equilibrium does not depend on the assumption that the bundle has the same total quality as the added-up qualities of its component goods. Instead, bundling also occurs in equilibrium when the goods' qualities have a *lower* added-up value or a *higher* added-up value than the added-up values of the standalone goods.

In chapter 3, we study the same market set-up as in chapter 2. However, we now assume that the traded goods are differentiated and have the same quality. Thereby, we close the research gap

with regard to the interplay between the degree of product differentiation and the retail bundling incentives as well as the research gap about the welfare effects of retail bundling in a set-up as proposed by Heinzel (2019). Chapter 3 is titled **"The Impact of Product Differentiation on Retail Bundling in a Vertical Market"** and represents joint work with Burkhard Hehenkamp and Joachim Heinzel. We approach the following questions:

Research Question 2. *How does product differentiation between the traded goods affects the two-product retailer's incentive to sell the goods as a bundle? What are the welfare effects of retail bundling?*

The main finding is that a bundling equilibrium only occurs if the goods are close substitutes. Then, bundling serves as an effective competition mitigation devise for the intense degree of competition in the market caused by the low degree of product differentiation. It reduces competition by lessening the intraproduct competition between goods within the *same* product market and by softening the interproduct competition between goods *across* both product markets. Again, we identify an aggravation of double marginalization by bundling that reduces the bundling incentives. Only when the positive effect of the reduction in competition on profit outweighs the negative effect of double marginalization on profit does a bundling equilibrium arise.

Regarding welfare, we ascertain that the consumer surplus is lower in the bundling equilibrium due to higher retail prices under bundling. Producer surplus, however, is higher since *all* firms gain from the retailer's bundling decision. Social welfare is only higher under bundling for a sufficiently low degree of product differentiation between the goods. Consequently, from a social planner's perspective, bundling should be encouraged when the goods are very close substitutes despite its harm on consumers.

Furthermore, by means of a robustness check we confirm that our market structure indeed occurs in equilibrium for close substitutes when the manufacturers make their distribution choice endogenously. We further conclude from the robustness check that the occurrence of a bundling equilibrium is robust to endogenizing the market structure.

We summarize from chapters 2 and 3 that bundling represents an equilibrium strategy if a certain relationship between the goods induces such a high degree of competition in the downstream market that the positive effect of mitigating competition outweighs the negative effect from the aggravation of the double marginalization problem. Consequently, the goods' characteristics greatly impact the channel structure in the downstream market and thus social welfare.

Having gained these insights about the equilibrium channel structures downstream, we now focus on the upstream industry's distribution choices for differentiated goods, which determine the scope for distribution in the downstream industry. Contrary to as in chapters 2 and 3, the downstream industry has no choice as how to sell to the final customer. We analyze the motives for the upstream firms to sell their goods exclusively or non-exclusively to the retail industry

and the resulting impact on welfare. Selling exclusively is especially common in industries such as the pharmaceutical industry or the car industry (Bako, 2016). Motives for the manufacturers' distribution choice might be to foreclose the market (see Chang, 1992) or to strategically impact the degree of competition in the market (see Moner-Colonques et al., 2004). This thesis takes a special interest in the latter motive and investigates how the degree of product differentiation affects the upstream firms' distribution decision.

Hitherto, the literature about equilibrium distribution systems for differentiated goods mainly evaluates markets with at most two retailers and two manufacturers. Exclusive dealing contracts are often structured such that *both* the retailer and the manufacturer are exclusively bound to each other (see e.g. Besanko and Perry, 1993). Both conditions restrict the possible channel structures. Besides, this literature rarely investigates the welfare effects that arise from channel structures in which differentiated goods are sold.

In chapter 4, we contribute to this literature by analyzing the impact of product differentiation on the manufacturers' distribution choice in an asymmetric market with two price competing retailers and *three* manufacturers. In addition, we study the welfare implications of the resulting distribution systems. We furthermore loosen the restriction on exclusive dealing agreements such that retailers are no longer bound to any exclusive restriction downstream, even if they purchase the goods exclusively upstream. This implies that, independently of the upstream distribution choice, there is in-store competition for (at least) two goods at (at least) one retailer, which already induces a certain competitive pressure in the market. Chapter 4 is titled **"The Impact of Product Differentiation on the Channel Structure in a Manufacturer-Driven Supply Chain"**. We analyze the following questions:

Research Question 3. *Which channel structures arise endogenously in a manufacturer-driven supply chain with product differentiation? Is the equilibrium channel structure efficient in terms of providing the highest social welfare level?*

Our main contribution is that the non-exclusive selling structure represents a Nash equilibrium for all degrees of product differentiation. When the goods are complements, the necessity to buy all three complementary goods fosters their demand, which in turn boosts all other products' demand and ultimately positively affects manufacturers' profits. This positive effect is dampened by the negative effect that the increase in competition from selling non-exclusively has on the manufacturers' profits. When the goods are close substitutes, the intense degree of competition in the downstream market induced by the low product differentiation indeed could be mitigated by selling exclusively. However, the manufacturers behave as in a prisoner's dilemma, which prevents them to switch to a more profitable exclusive selling distribution for this range of product differentiation. Furthermore, all firms would achieve a Pareto improvement if the manufacturers jointly agree on an exclusive distribution system for close substitutes.

Moreover, we ascertain that the non-exclusive equilibrium channel structure provides the highest social welfare and consumer welfare for all degrees of product differentiation. This is

induced by the low retail and wholesale prices in this distribution. Producer surplus is highest in the equilibrium distribution for complements and weak substitutes. Hence, the allocation of market power to one side of the market does not raise concerns from a social welfare or a consumer surplus perspective.

By means of a robustness check, we confirm that the non-exclusive distribution yields an equilibrium for all degrees of product differentiation also in a market with *four* manufacturers and two retailers. In contrast, in a market with *two* manufacturers and two retailers, the non-exclusive distribution yields equilibrium only for complements and weak substitutes.

Recapitulating, we observe in chapters 2 to 4 that a distribution decision is strategically used to impact the degree of competition in the market. In chapters 2 and 3 the *retailer* uses bundling to *reduce* competition and benefits from the resulting increase in retail prices. In chapter 4, the *manufacturers* use non-exclusive selling as a strategy to *intensify* competition in the market and profit from the associated output expansion.

Until now, we have analyzed the distribution structures that the downstream or upstream industry would choose for *themselves*. In chapter 5, we take a network perspective and investigate which kind of network structures an outsider of the network would build *for* the players. Thereby, we investigate a centralized approach in which a central network designer decides about the network structure. A network consists of nodes and links. The nodes depict the players in the network but, contrary to before, the players do not necessarily have certain roles such as a manufacturer or a retailer. The links between the nodes can be any kind of relationship. A network can depict trading or family relationships or business alliances, for example (Jackson, 2005).

The literature about networks has extensively studied how networks are formed.[5] More recently, the impact of a threat of network disruption on the network formation process has been taken into account as well. Network disruption implies that attacks target the nodes or links of the network to harm or destroy it. Most studies about network formation (under the threat of disruption) consider *decentralized* network formation, where the nodes decide themselves on the network structure. The only theoretical paper that studies *centralized* network formation, where a central designer decides about the network structure (under the threat of disruption) is by Dziubiński and Goyal (2013). Moreover, the motives for a centralized designer to form a network in any specific way are barely touched in the literature.

We contribute to this literature by experimentally assessing the impact of the threat of network disruption on the network formation process by a *centralized* designer. In chapter 5, we test the theoretical predictions made by Dziubiński and Goyal (2013) in a laboratory experiment. We furthermore assess the impact of the designer's cognitive abilities on the network formation process. Chapter 5 is titled **"Network Formation and Disruption – An Experiment: Are equilibrium networks too complex?"**, is coauthored by Behnud Mir Djawadi, Britta Hoyer,

[5] See Kosfeld (2004) for an overview.

and Sonja Recker and has been published in the *Journal of Economic Behavior & Organization* (Djawadi et al., 2019). We experimentally study network formation by a centralized designer under the threat of network disruption by an adversary. Notice that the designer and the adversary do not directly compete with each other unlike in the previous chapters.

The theoretical model by Dziubiński and Goyal (2013) studies cost-efficient network formation and defense in view of an upcoming attack. The model predicts a densely connected network without any protected nodes for high costs of node protection relative to linking, a center-protected star for low costs of defense relative to linking, and the empty network without any protection for very high costs of linking and defense. A network only has a value if it is connected, that is only if there is a path between every pair of nodes.

In our laboratory experiment, first, each participant acts in the role of the network designer.[6] In four starting networks with pre-determined links, he builds costly node protections and costly links knowing that an adversary will attack the nodes afterward. The designer's goal is to build networks for minimal costs that withstand those attacks. Second, another participant in the role of the adversary has the goal to disconnect the four networks by costly attacking the nodes. We use two different treatments varying the costs of node defense in order to generate the predictions in the model by Dziubiński and Goyal (2013). We omit to test their prediction of the empty network equilibrium for reasons of plausibility. Furthermore, we investigate whether the designer's cognitive abilities, such as his farsightedness and his risk behavior, impact the network formation process. We aim to answer the following question:

Research Question 4. *Is a central designer able to build a stable network for least cost that can endure (a certain amount of) attacks aimed at disrupting the network?*

We find that the designers are indeed able to build predominantly safe networks that cannot be disconnected by the adversary's attacks. However, participants build the center-protected star networks significantly more often in *both* treatments, even though it constitutes the predicted least cost solution only in the low defense treatment. Further, risk attitude has no significant impact on the designer's ability to build safe networks and his level of farsightedness (as measured in our experiment) does not concur with his ability to build least cost networks.

A robustness check with a reduced number of attacks confirms that the complexity of the task was not the reason that the designers build center-protected star networks significantly more often. Another robustness check substantiates that the pre-determined links in our starting networks did not bias the designer to build a certain network structure.

We conclude that our experiment confirms the theoretical predictions by Dziubiński and Goyal (2013) only partly. It seems as if the center-protected star is the most intuitive network to form independent of its cost-efficiency, while other equilibrium structures may rather be too complex to be obtained. The complexity of the task seems to constitute a limitation of the theoretical predictions, which apply to networks with unrestricted size.

[6] From now on, we refer to designer and adversary as male, independent of the participants' gender.

With this last chapter, we conclude our analysis, having derived several insights about the agents' distribution decisions and (partly) their consequences on welfare. This thesis leaves room for further research. An extension of chapters 2 to 4 would be to study a set-up in which the upstream as well as the downstream industry make their distribution choices endogenously. Additionally, it might be insightful to assess the impact of different goods' qualities *and* differentiation between goods or stores on the market structure in our settings. With regard to chapter 5, several theoretical and experimental studies might follow that evaluate the impact of the complexity of network formation or the designer's characteristics on the resulting networks.

Before proceeding with the chapters, it should be noted that all chapters have been written as independent research papers. Thus, there may be some overlaps between them, especially in the introduction, literature overview, and modeling part. Furthermore, the notation and terminology across chapters might vary slightly.

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