On Product Differentiation and Shopping Hours — Five Essays in Industrial Organization

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Preface

This dissertation draws on research I undertook during the time in which I held a scholarship of the "Ruhr Graduate School in Economics " (RGS) at the Technische Universität Dortmund. The present thesis has strongly been influenced by and profited from discussions with professors and fellow students of the RGS, as well as presentations at various national and international conferences. I am very grateful to all who supported my work in that way. Financial support by the RGS and the Signal Iduna Insurance Company is gratefully acknowledged.

In particular, I would like to thank Wolfgang Leininger, who supervised my dissertation. I am also very thankful to my second supervisor Justus Haucap and my coauthor Yiquan Gu. Moreover, I would like to thank Julia Angerhausen, Leilanie Basilio, Tobias Guse, Burkhard Hehenkamp, Jan Heufer, Stefanie Neimann and Sina Risse, who all helped me to improve this thesis at various stages of its development.

Contents

Chapter 1

Introduction

This thesis deals with two topics in Industrial Organization: The first one is the issue of product differentiation, whereas the second one analyzes with the impact of deregulation of shopping hours in retail industries. These two subjects are treated in two separate parts.

Part I of the present thesis deals with product differentiation. Product differentiation is a prominent and important issue in economics as it is a feature of most markets: "It is evident that virtually all products are differentiated, at least slightly, and that, over a wide range of economic activity, differentiation is of considerable importance" (Chamberlin, 1933). The economic literature distinguishes between three main approaches in modeling product differentiation: the representative consumer approach, the discrete choice approach, and the address approach. The representative consumer approach assumes the existence of a single utility function that aggregates consumers preferences for diversity. Examples for this approach are the models by Dixit and Stiglitz (1977) and Spence (1976). The second type of model, the discrete choice or random utility approach, does not rely on a representative agent but models individual decision making. Agents are heterogenous with respect to their preference for differentiated products. However, these preferences are unobservable to firms who offer these products. Thus, from the firms' perspective, demand for their product is probabilistic and consumers' decisions can be treated as random variables. An overview of this stream of literature is given in Anderson, de Palma, and Thisse (1992). The address or spatial models assume that products can be described as points in a characteristics space, that is, products have an 'address' in this space. Consumers have preferences over the products in this space. Well-known elaborations of this approach are Hotelling (1929) and Salop (1979). This thesis follows the address approach of product differentiation. In this part, we develop three models that extend the existing literature on spatial product differentiation. A short summary of each of the three chapters in this part is provided below.

Chapter 2, entitled **'Product Differentiation and General Purpose Products'**, considers an extension to the classic Salop model. In the Salop model, all products are characterized by a location on the Salop circle. A product is a good match for a consumer who is closely located, but rather a bad match for a consumer located further away. In this chapter, these products are called tailored or targeted products as they are designed to serve a specific purpose. The extension of this chapter is to introduce a different type of product in the Salop model, namely a general purpose product. This product is suited for all purposes alike, and hence, has no location on the circle. We study a model where a general purpose product is in competition with tailored products. The main aim is to analyze entry behavior in such a market. With our model, we are able to answer questions like: When do we observe markets with a general purpose product, and when do we observe markets in which all products are tailored products? We find that high transportation costs and a low difference in the basic utility between targeted and general purpose product favor an outcome in which a general purpose product is in the market.

Chapter 3—coauthored with Yiquan Gu— contains **'A Note on the Excess Entry Theorem in Spatial Models with Elastic Demand'**. As in the preceding chapter, the analysis is based on the Salop model. One limitation of the standard Salop model is that each consumer buys a single unit of a product, that is, consumer demand is inelastic and does not depend on the price charged. In this chapter, we extend his model to price-dependent demand using a specific functional form for consumer demand, namely a demand function with a constant demand elasticity. Focus of the analysis lies on the so-called excess entry result in spatial models which states that the number of entrants in a free-entry equilibrium exceeds the number of entrants that maximizes total welfare. We show that the excess entry theorem need not hold when considering price-dependent demand. Indeed, the excess entry result does only hold when demand is sufficiently inelastic. However, when demand is sufficiently elastic, the opposite result emerges. The number of entrants in a free-entry equilibrium falls short of the number of entrants that should enter from a welfare point of view.

Chapter 4 is entitled **'Product Variety at the Top and at the Bottom'**. While the first two chapters use setups where products are differentiated along one single dimension, this chapter uses a framework where products can be differentiated along two dimensions, a horizontal as well as a vertical dimension. Starting from a duopoly industry that is from the outset vertically differentiated, we study the incentives to offer product variety. Hence, this chapter differs in two aspects from classic models of horizontal product differentiation. First, the analysis is embedded in a model with additional vertical differentiation and second, firms are allowed to offer more than a single product variant. In this setup, we study factors that determine the relative product variety level at the top of the market (high quality) relative to the bottom (low quality). For instance, we find that when the costs of producing a high quality product is a fixed cost only, we should expect at least the same level of product variety at the top as at the bottom.

Part II of the thesis deals with competition over shopping hours in retail industries. In the public and political debate, this topic is controversial. Though there has been a substantial trend towards deregulation in recent years, shopping hours are still regulated in many European countries. In Germany, shopping hours have been liberalized recently. However, the issue whether shopping hours should be further deregulated is still controversial. We treat this issue in two chapters, each chapter focusing on a different aspect of deregulation of shopping hours: The first chapter is concerned with competition over shopping hours when entry into the industry is endogenous. The second chapter of this part analyzes the unequal impact of a deregulation on retailers of different sizes, namely we study competition between a large retail chain and a small corner shop. However, we restrict our analysis on the industrial organization aspects of shopping hours: Retailers can use shopping hours as a strategic instrument in competition. By extending shopping hours, a retail firm can attract additional demand at the expense of rival retailers.

The second part of the present thesis relates to the first part by the use of the same methodology. The models used to analyze competition over shopping hours are also extensions of spatial models of product differentiation. The content of the two chapters is briefly summarized below.

Chapter 5 covers **'Liberalization of Opening Hours with Free Entry'**. It focuses on entry behavior when retailers compete over shopping hours. Building on a model in the spirit of Salop, retailers have two strategic instruments: price of goods and length of shopping hours. Assuming shopping hours are fully deregulated, we derive the number of retailers and shopping hours in a free-entry equilibrium. We find that shopping hours are too short from a total welfare perspective the reason being that market entry is excessive. Hence, restrictions on shopping hours do not help alleviating the market failure. Even worse, regulation of shopping hours works in the wrong direction. The model can also be used to assess the impact of liberalization. Here we find that deregulation of shopping hours leads to an increase in retail market concentration, that is, due to deregulation some retailers leave the market.

Chapter 6 is entitled **'Deregulation of Opening Hours: Corner Shops vs. Chain Stores'**. While the previous chapter analyzes competition over shopping hours among symmetric retailers, this chapter focuses on competition among asymmetric retailers, one retailer being a large chain and the other one being a smaller competitor. The aim of this chapter is to study the impact of a deregulation of shopping hours on these two types of competitors. This issue is especially controversial as small retailers fear that they cannot match shopping hours of large chains and therefore lose customers. This could lead to the exit of small retail firms. We model a retail chain as owning several stores, and the small firm by owning a single store. Then, we analyze competition with and without regulated shopping hours. We find that the impact of deregulation depends very much on whether the retail chain enjoys efficiency advantages over its smaller competitor. If these efficiency advantages are non-existent or negligible, deregulation leads to lower profits for the retail chain. The impact on the smaller firm is ambiguous. However, when the efficiency advantage is large, the opposite result emerges. The small retailer loses by deregulation, while the impact on the retail chain is ambiguous. In the end, whether deregulation favors large or small retailers remains an empirical question.

Part I

Product Differentiation

Chapter 2

Product Differentiation and General Purpose Products

2.1 Introduction

The purpose of this chapter is to offer a model of competition between products that are tailored to some segments of a market and general purpose products which appeal to a wide variety of different consumers. A targeted product has the advantage of providing high utility if the product exactly fits a consumer's needs but provides rather low utility if it misses the individual's requirements. If a tailored product is of a poor match, the consumer might then prefer a general purpose product.

There are many examples of markets where general purpose products and tailored products compete. Take, for instance, the sports shoe industry. There exist shoes which are produced for specific purposes, for instance, shoes for playing squash or football. On the other hand, there are shoes which can be used for generic purposes. Another example are car tires. There are tires which are designed to drive a car in special weather conditions. Snow tires are designed for driving on snow and summer tires are designed for dry weather. On the other hand, the all-weather tire is a general purpose product that can be used in any weather condition. More examples can be found in the papers by von Ungern-Sternberg (1988), Hendel and Neiva de Figueiredo (1997) and Weitzman (1994).

The present chapter investigates competition in such a dual industry and analyzes the incentives in entering the industry with a general purpose product or with a targeted product. To do this, we adopt the spatial competition model proposed by Salop (1979) and include a second type of product in the analysis. A firm can now choose to offer a general purpose product to consumers. This product offers all consumers the same level of utility independent of their locations on the circle. In contrast, the level of utility provided by a tailored product depends on the distance between the product and a consumer's location in the product space. The larger this distance, the less utility is provided. In the presence of a general purpose product competition among targeted products is no longer localized as in the standard Salop model. Now, each tailored product competes directly with the general purpose product, thus competition is global.

Competition is modeled in a two-stage framework. In the first stage, firms decide whether or not to enter the market and in the second stage, they compete in prices. It is found that when there are many tailored products available in the market, the general purpose product remains without demand. This result is quite intuitive: Why buy a general purpose product when a product that is targeted to a purpose at hand is available? Turning to the entry decision, the following findings are obtained: Whenever the fixed costs of entering the market with a tailored good are below a certain threshold, there is so much entry of tailored products such that entry with a general purpose product does not pay. On the contrary, when fixed costs for the tailored products are high but not too high for a general purpose product, a firm enters with a general purpose product.

The topic of general purpose products has received some attention in the literature. As the present chapter, von Ungern-Sternberg (1988) also uses a model of horizontal product differentiation a la Salop. He interprets the transportation cost parameter as a measure of the general purposeness of a product which can be influenced by producers. In a two-stage game, with entry in the first stage and simultaneous price and transportation cost choice in the second, he shows that the level of transportation costs are excessively low.[1] Hendel and Neiva de Figueiredo (1997) elaborate on the model by von Ungern-Sternberg (1988) and propose a different time structure. They

[1] In Weitzman (1994), a general equilibrium framework is developed, where specialization is a choice variable.

analyze a three-stage game with entry in the first stage, transportation cost choice in the second and price competition in the third. They show that when no additional costs are associated with the general purposeness of a product, then at most two firms will enter the market.
Doraszelski and Draganska (2006) criticize these two approaches in modeling general purpose products and propose to explicitly introduce two different types of products. They consider an environment with two firms where each firm can either produce a general purpose product, a tailored product (niche strategy) or several tailored products (full-line strategy). Hence, their focus is on market segmentation strategies by multi-product firms. Here, we follow their distinction between general purpose products and tailored products but our analysis is constrained to single product firms, that is, a firm can either produce a general purpose product or one tailored product. However, the analysis is not limited to the duopoly case and considers entry into the market. A different approach is followed by Alexandrov (2008). He proposes a model where products are not represented by points but rather by intervals. Thus, products are suited not for a single purpose but for all purposes alike inside the interval. This notion is similar to a general purpose product.[2]

On modeling structure, the paper by Bouckaert (2000) is closely related to this study but the context is different. Bouckaert (2000) analyzes competition between local retailers and a mail order business.[3] The main difference between the two models lies in the assumption regarding entry into the market. In the model by Bouckaert (2000), firms first decide whether to enter or not. In the second stage, after having observed the number of entrants, firms decide which type of product to offer. Contrary, in the present model, firms have to decide upon entry which type of product they want to offer. We think that our time structure is a more realistic description of firms' decision making. We would argue that a firm considering entry into a certain market will decide prior to entry what kind of product to offer, i.e. the decision general vs. targeted product in the present model and local retailer vs. mail order business in the model by Bouckaert.

[2] In our case, the general purpose product can be understood as a fat product with the interval encompassing the unit circle.

[3] Conceptually, this difference can be traced back to whether the Salop circle is interpreted in a horizontal or spatial way. A similar model to Bouckaert (2000) is laid out in Balasubramanian (1998).

This model developed here is also related, albeit more distantly, to studies that analyze the difference between local and global competition such as Anderson and de Palma (2000) and Legros and Stahl (2007). Anderson and de Palma (2000) develop a model integrating models of local competition (the Salop model) and global competition (CES representative consumer model) in one framework. Legros and Stahl (2007) propose a model where the impact of local and global competition are separated. In their setup, increased local competition decreases demand for neighboring firms whereas increased global competition decreases demand for all firms within a market.

The remainder of the chapter is organized as follows: Section 2.2 introduces the setup of the model. Section 2.3 derives the equilibrium prices. Section 2.4 considers entry decisions. Finally, section 2.5 concludes.

2.2 Model setup

We adopt the model in Salop (1979) and extend it by adding an additional type of product, that is, a general purpose product. All consumers value this product identically, independent of their locations on the circle.

2.2.1 Consumers

Consumers are located uniformly on a circle with circumference one. A consumer's location corresponds to his most preferred variety. The total mass of consumers is 1.

In contrast to the model in Salop (1979), consumers have the choice between two different types of products. A consumer can either buy a product that is tailored for a specific use (TP) or a general purpose product (GP). The tailored product is designed for one specific purpose. The value a consumer attaches to a product designed for a special purpose depends on his location. The less the product is suited for the purpose needed, the lower is a consumer's utility. The general purpose product is suited for all purposes and hence all consumers irrespective of their locations have identical willingness to pay for this product.

The indirect utility that a consumer, who is located at x, derives from buying a tailored product i is:

$$U_T^i = V - t|x - x_i| - P_T^i, \tag{2.1}$$

where V denotes the gross utility from consuming the product of the most preferred variety.[4] There is a loss of utility due to the mismatch between the preferred product and the offered one which is deducted from gross utility. These transportation costs are assumed to be linear in distance with t as the transportation cost parameter. The price, P_T^i, is also deducted.

The utility a consumer attaches to the general purpose product is given by:

$$U_G = V - \epsilon - P_G. \tag{2.2}$$

The parameter $\epsilon > 0$ represents the loss in gross utility of a general purpose product compared to a tailored product. It seems natural to assume that ϵ is strictly positive, meaning that a targeted product is better suited for the purpose it is designed for than a general product. P_G denotes the price charged by the GP firm.

2.2.2 Firms

There are two types of firms operating in the market. The first type of firm offers a tailored product. There are n firms of this type in the market. It is assumed that these firms are located equidistantly on the circle. Hence, the distance between two neighboring firms is $\frac{1}{n}$. This type of firm is also present in the model in Salop (1979). In contrast, there is a second type of firm present in the market. This type of firm offers the general purpose product. The analysis is restricted to the case of one single firm that offers this general purpose product.[5] Hence, in total there are $(n + 1)$ firms.

[4] Throughout this paper it is assumed that V is sufficiently high such that no consumer abstains from buying a product.

[5] If several GP firms were present in the market they would offer a homogenous product. Competition between them would force prices to equal marginal costs and lead to zero profits. Considering entry before price competition, as is done in section 2.4, no more than one firm offering the general purpose product would enter in the presence of fixed entry costs. Hence, the restriction to a single GP firm is indeed an equilibrium outcome.

2.2.3 Market structure

In a symmetric solution, where all tailored products have the same price, two different market structures can possibly arise in this model. One possibility is a structure where both types of firms have positive demand. A second possibility arises where only tailored products face positive demand and no consumer demands the general purpose product. These two possible market structures are pictured in Figure 2.1.[6]

The market structure where the general purpose product gets no demand arises if the general purpose product provides less utility for all consumers than competing tailored products. The consumer that is located midway between two tailored products, the distance of which is $\frac{1}{2n}$ to each TP product, has the lowest utility of consuming a TP product. If this consumer demands the TP product, then the GP firm is left without demand. Assuming that all TP firms charge P_T for their products, this arises if:[7]

$$V - \frac{t}{2n} - P_T \geq V - \epsilon - P_G \Leftrightarrow P_T \leq P_G + \epsilon - \frac{t}{2n}. \tag{2.3}$$

Hence, in an equilibrium with $P_T \leq P_G + \epsilon - \frac{t}{2n}$, the GP firm has zero market share. However, when $P_T > P_G + \epsilon - \frac{t}{2n}$, the GP product has a positive market share. Note that in a market structure where the GP firm gets zero demand competition is localized as each TP firm competes with its two neighboring firms. Contrary, in the presence of a GP firm, competition is global (or non-localized) in the sense, that each TP firm competes directly with the GP firm.

To derive demand, we consider the situation of a representative TP firm i which for convenience is designated the one located at $x = 0$. Suppose that this firm charges a price of P_T^i while all remaining TP firms charge P_T and the GP firm charges P_G. Then there are two marginal consumers. One marginal consumer is the one who is indifferent between buying from TP

[6] In equilibrium it is not possible that the complete market is covered by the general purpose product. As we assume that both types of firms face the same production costs and consumers face a disutility cost for buying the GP product it is not possible for the GP to attract the demand of consumers whose best preferred product coincides with TP's location.

[7] Assuming that when a consumer is indifferent between a TP product and a GP product, he opts for the TP product.

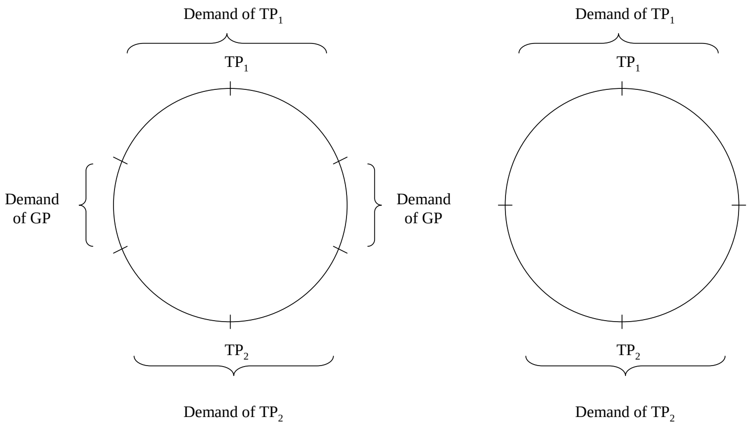

Figure 2.1: Market structures

firm i and the general purpose product. The second marginal consumer is indifferent between buying TP product i and the product $(i+1)$.

The consumer is indifferent between purchasing the general purpose product and the tailored product i if:

$$V - \epsilon - P_G = V - t\overline{x} - P_T^i, \tag{2.4}$$

$$\overline{x} = \frac{P_G - P_T^i + \epsilon}{t}. \tag{2.5}$$

The consumer is indifferent between purchasing tailored products i and $(i+1)$ if:

$$V - t\hat{x} - P_T^i = V - t\left(\frac{1}{n} - \hat{x}\right) - P_T, \tag{2.6}$$

$$\hat{x} = \frac{1}{2n} + \frac{P_T - P_T^i}{2t}. \tag{2.7}$$

Two different scenarios may arise here. When $\bar{x} < \hat{x}$, there are consumers who buy the general purpose product. However, when $\bar{x} \geq \hat{x}$, no consumer buys the general purpose product. These two situations are drawn in Figures 2.2 and 2.3. Using equations (2.5) and (2.7) the condition $\bar{x} \lesseqgtr \hat{x}$ translates into $P_T^i \gtreqless 2P_G - P_T + 2\epsilon - \frac{t}{n}$.

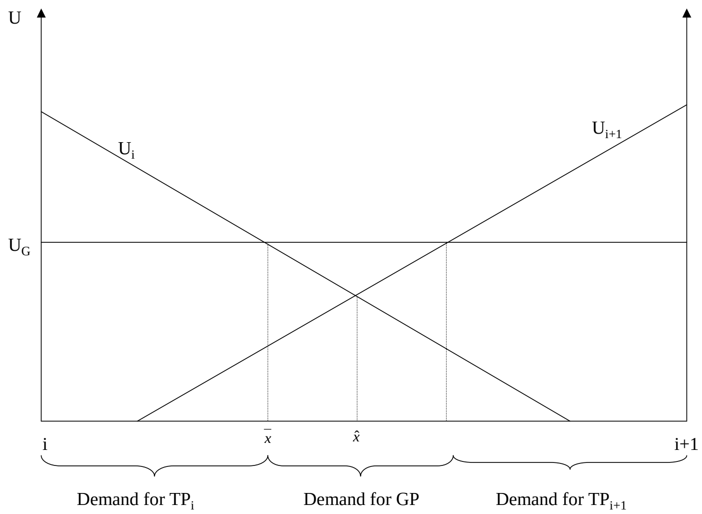

Figure 2.2: Marginal Consumer 1

The situation is symmetric with respect to the other adjacent TP firm $(i-1)$. Thus, a representative TP firm i faces the following demand when it charges P_T^i, the remaining TP firms charge P_T, and the GP firm charges P_G:

$$D_T^i = \begin{cases} 2\overline{x} & \text{if } P_T^i > 2P_G - P_T + 2\epsilon - \frac{t}{n} \\ 2\hat{x} & \text{if } P_T^i \leq 2P_G - P_T + 2\epsilon - \frac{t}{n}. \end{cases} \tag{2.8}$$

As we seek a symmetric equilibrium, demand for the general purpose product is stated when each TP firm charges the same price P_T. The condition $\bar{x} \lesseqgtr \hat{x}$ then reads $P_T \gtreqless P_G + \epsilon - \frac{t}{2n}$.

$$D_G = \begin{cases} 1 - 2n\overline{x} & \text{if } P_T > P_G + \epsilon - \frac{t}{2n} \\ 0 & \text{if } P_T \leq P_G + \epsilon - \frac{t}{2n}. \end{cases} \tag{2.9}$$

Abstracting from production costs by assuming zero marginal costs for both types of products, the profit functions are given by:

$$\Pi_T^i = \begin{cases} 2\left(\frac{P_G - P_T^i + \epsilon}{t}\right) P_T^i & \text{if } P_T^i > 2P_G - P_T + 2\epsilon - \frac{t}{n} \\ 2\left(\frac{1}{2n} + \frac{P_T - P_T^i}{2t}\right) P_T^i & \text{if } P_T^i \leq 2P_G - P_T + 2\epsilon - \frac{t}{n}, \end{cases} \tag{2.10}$$

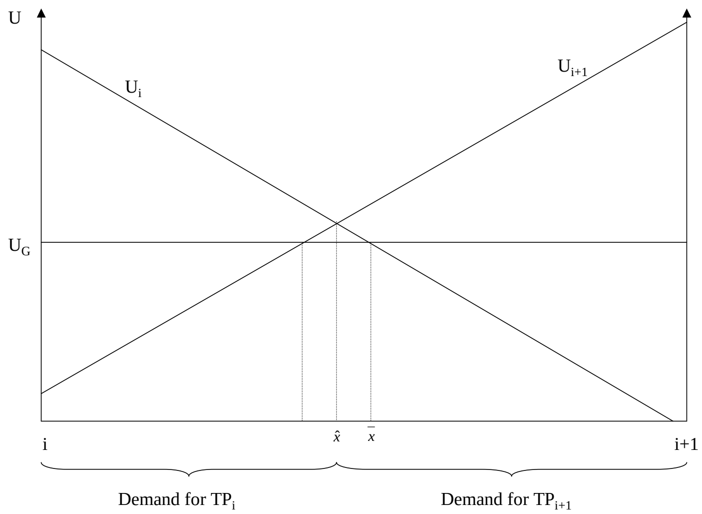

Figure 2.3: Marginal Consumer 2

$$\Pi_G = \begin{cases} \left(1 - 2n\frac{P_G - P_T + \epsilon}{t}\right) P_G & \text{if } P_T > P_G + \epsilon - \frac{t}{2n} \\ 0 & \text{if } P_T \leq P_G + \epsilon - \frac{t}{2n}. \end{cases} \tag{2.11}$$

2.3 Price equilibrium

The following prices constitute an equilibrium:

$$P_T^* = \begin{cases} \frac{t+2n\epsilon}{6n} & \text{if } n < \frac{t}{\epsilon} \\ \frac{2n\epsilon - t}{2n} & \text{if } \frac{t}{\epsilon} \leq n \leq \frac{3t}{2\epsilon} \\ \frac{t}{n} & \text{if } n > \frac{3t}{2\epsilon}, \end{cases} \tag{2.12}$$

$$P_G^* = \begin{cases} \frac{2t-2n\epsilon}{6n} & \text{if } n < \frac{t}{\epsilon} \\ 0 & \text{if } \frac{t}{\epsilon} \leq n \leq \frac{3t}{2\epsilon} \\ \geq \frac{3t-2n\epsilon}{2n} & \text{if } n > \frac{3t}{2\epsilon}. \end{cases} \tag{2.13}$$

Proof. See Appendix 2.6.

There are three different equilibrium price regions depending on the number of TP firms offering tailored products: for few TP firms ($n < \frac{t}{\epsilon}$), for an intermediate number of TP firms ($\frac{t}{\epsilon} \leq n \leq \frac{3t}{2\epsilon}$), and for a high number of TP products ($n > \frac{3t}{2\epsilon}$). For a low number of TP firms, equilibrium pricing is such that both types of firms get positive demand. For an intermediate number, the TP firms set a price such that the GP firm is excluded from getting demand. Finally, for a high number of TP firms, TP firms charge the standard Salop price. Then, the presence of a general purpose product does not affect pricing decisions. Comparative static properties of the three price regions are discussed below. The following result states the corresponding market structures that arise:

Result 2.1 *If $n < \frac{t}{\epsilon}$, the GP firm has positive market share. If $n \geq \frac{t}{\epsilon}$, the GP firm has no market share.*

This result accords with intuition. When there are many different varieties in the market, consumers have relatively good matches with those products, and hence consumers do not opt for the GP product. This is different when there are few varieties available such that the match for some consumers is poor. Whenever the number of TP products exceeds a certain threshold, the GP firm receives no demand. This depends positively on the transportation costs parameter t and negatively on the misfit parameter of the GP product, ϵ. The reasons are as follows. Higher transportation costs reduce consumer's utility if a TP product does not match consumer's tastes perfectly. Hence, higher transportation costs make the GP product relatively more attractive. Conversely, a higher value of the GP misfit parameter reduces the number of TP firms beyond which the general purpose product is left without demand as it worsens the competitive standing of the GP firm versus TP products by making the GP product less attractive.

2.3.1 The general purpose product has zero market share

For $n > \frac{3t}{2\epsilon}$, the price equilibrium is the standard Salop (1979) equilibrium. TP firms behave as if the GP firm is non-existent. All TP firms share the market evenly, thus market share is $\frac{1}{n}$. Profits of each TP firm are $\frac{t}{n^2}$. The impact of the number of firms and the magnitude of the transportation costs on equilibrium prices and profits are the standard results.

For $\frac{t}{\epsilon} \leq n \leq \frac{3t}{2\epsilon}$, the resulting market structure is the same. However, TP firms charge prices such that the GP firm is deterred from getting demand. The GP product attracts no consumers in equilibrium, however, equilibrium properties differ considerably. Transportation costs t and the number of TP firms n have an impact on the price charged opposite to those found in the regime above. Higher transportation costs lead to lower prices and a larger number of TP competitors to higher prices. The reason for these results lies in the fact that TP firms choose a price such that the GP is pushed out of the market. Higher transportation costs make a TP product less attractive compared to the GP product, so the TP price has to be reduced to deter the GP firm from getting demand. Conversely, with a higher number of TP products in the market, the maximal distance for consumers to the next TP product is reduced, and hence TP firms can raise the price.

It should be noted, however, that when considering entry before price competition, as is done in section 2.4, both subgames are never reached. In the presence of entry costs, the GP firm will refrain from entering.

2.3.2 The general purpose product has positive market share

When $n < \frac{t}{\epsilon}$, both types of products have positive demand in equilibrium. TP firms do not compete directly with each other but each of them competes with the GP product.

Comparing the prices for tailored product and the general purpose product, it turns out that the general purpose product is more expensive when there are few tailored products in the market ($n < \frac{t}{4\epsilon}$). When there are more TP products available to consumers, this relation reverses and tailored products are more expensive. The reason for this result lies in the fact that the GP firm has stronger market power when there are only few TP competitors as consumers have fewer opportunities to choose a TP product.

The equilibrium prices charged by the competitors lead to the following market shares

$$D_T^* = \frac{t + 2n\epsilon}{3nt}, \tag{2.14}$$

$$D_G^* = \frac{2t - 2n\epsilon}{3t}, \tag{2.15}$$

and profits

$$\Pi_T^* = \frac{(t + 2n\epsilon)^2}{18n^2 t}, \tag{2.16}$$

$$\Pi_G^* = \frac{(2t - 2n\epsilon)^2}{18nt}. \tag{2.17}$$

We find the following comparative statics results. Higher transportation costs lead to higher prices for both the GP product and the TP products. However, the price increase is stronger for the GP firm. GP profits increase with higher t, while the impact on TP profits is ambiguous. For $n < \frac{t}{2\epsilon}$, TP profits increase with t but for $n > \frac{t}{2\epsilon}$, TP profits decrease with t. This result is in contrast to the standard Salop model where higher transportation costs lead unambiguously to higher profits. The difference arises here due to the presence of the GP firm. With higher transportation costs, consumers' valuation for TP products decreases more rapidly and thereby make the GP product more attractive. An increase in ϵ makes the GP product less attractive. Consequently, the GP lowers its price and TP producers can raise the price of their products. The impact on profits is the same. Higher ϵ leads to higher profits for TP firms and lower profits for the GP firm. Additional TP firms increase competitive pressure and lead to lower prices for both types of products. Profits decrease as well.

2.4 Entry behavior

The analysis until now has treated the number of tailored products and the presence of the general purpose product in the market as exogenously given. This section considers firms' incentives to enter the market. The following time structure is assumed. In the first stage, firms decide simultaneously whether to enter or not. In the second stage, firms set prices. To enter the market a firm has to make an investment. Entry costs may differ for the GP and the TP firm. There is a fixed cost of $F_T > 0$ for TP firms and a cost of $F_G > 0$ for the GP firm.[8]

2.4.1 The general purpose firm does not enter

This part derives conditions for which an equilibrium exists wherein the general purpose firm does not enter. When the GP firm stays out, the situation reduces to the standard Salop (1979) model where prices charged by the TP firms are $\frac{t}{n_s}$ and they earn profits of $\frac{t}{n_s^2} - F_T$, where n_s denotes the number of entering TP firms. This number is determined via a zero profit condition:

$$\frac{t}{n_s^2} - F_T = 0 \Leftrightarrow n_s = \sqrt{\frac{t}{F_T}}. \tag{2.18}$$

The GP firm does not enter if this leads to negative profits. There are two cases when this arises. First, the GP firm is not able to attract any demand and hence has zero variable profits. Second, the GP firm is able to attract demand but earns variable profits that are too small to recover the entry costs.

The GP firm has zero demand when $n_s \geq \frac{t}{\epsilon}$. Combining this with equation (2.18) yields that the GP firm does not enter when

$$F_T \leq \frac{\epsilon^2}{t}. \tag{2.19}$$

The second possibility arises when the GP firm gains positive market share but is not able to compensate for the entry costs F_G. The GP firm can gain demand when $n_s < \frac{t}{\epsilon} \Leftrightarrow F_T > \frac{\epsilon^2}{t}$ and it makes negative profits when the entry costs F_G exceed a critical level:

$$F_{crit}^1 = \frac{2(t - n_s\epsilon)^2}{9n_s t} = \frac{2\left(t - \epsilon\sqrt{\frac{t}{F_T}}\right)^2}{9t\sqrt{\frac{t}{F_T}}}. \tag{2.20}$$

[8] Contrary, Bouckaert (2000) assumes that both types of firms face identical costs of entry.

Result 2.2 *There exists an equilibrium with the general purpose firm staying out of the market if i)* $F_T \leq \frac{\epsilon^2}{t}$*, or ii)* $F_T > \frac{\epsilon^2}{t}$ *and* $F_G \geq F^1_{crit}$*. The equilibrium number of TP firms is then* $\sqrt{\frac{t}{F_T}}$*.*

Figure 2.4 displays graphically the parameter region for which this equilibrium exists in a (F_T, F_G) - diagram. The diagram is drawn for given values of t and ϵ. The grey-shaded area represents parameter combinations without entry of a GP firm. Note that the F^1_{crit} is upward sloping. As F_T increases, less TP firms enter and the GP firm has higher variable profits. Thus for an equilibrium without the GP firm to exist entry costs F_G must also increase. The impact of t and ϵ can also be seen graphically. A higher value of ϵ shifts the F^1_{crit}-line down ($\frac{\partial F^1_{crit}}{\partial \epsilon} < 0$) and hence enlarges the zone for which there exists an equilibrium with the GP firm staying out. Contrary, an increase in the transportation costs leads to an upward shift of the line and hence reduces the zone ($\frac{\partial F^1_{crit}}{\partial t} > 0$).

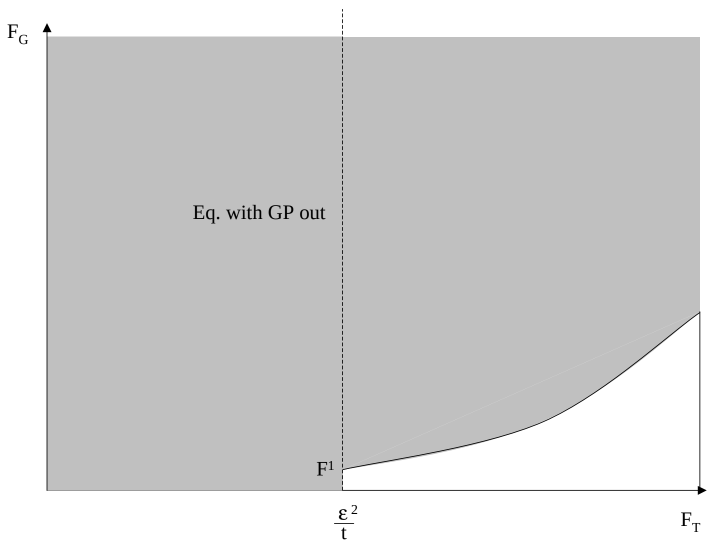

Figure 2.4: Equilibrium without GP entry

Summarizing, the following result states the comparative statics properties:

Result 2.3 *It is more likely that there exists an equilibrium in which the general purpose firm stays out of the market i) the higher the disutility of* *misfit (ϵ), ii) the lower the transportation costs (t), iii) the higher fixed costs for the GP firm F_G, and iv) the lower fixed costs for the TP firm F_T.*

2.4.2 The general purpose firm enters

We now turn to conditions for which an equilibrium exists wherein both types of firms enter. We denote the number of TP firms that enter by n_g. Using (2.16) this number is deduced via a zero-profit condition:

$$F_T = \frac{(t + 2n_g\epsilon)^2}{18n_g^2 t} \Leftrightarrow n_g = \frac{t(2\epsilon + 3\sqrt{2}\sqrt{tF_T})}{2(9tF_T - 2\epsilon^2)}. \tag{2.21}$$

The GP enters if it can make non-negative profits. The GP firm gets positive demand when $n_g < \frac{t}{\epsilon}$, or $F_T > \frac{\epsilon^2}{2t}$. Using (2.17) and (2.21), profits are non-negative if

$$F_G \leq F_{crit}^2 = \frac{2(t - n_g\epsilon)^2}{9n_g t} = \frac{(6tF_T - 2\epsilon^2 - \epsilon\sqrt{2tF_T})^2}{(2\epsilon + 3\sqrt{2tF_T})(9tF_T - 2\epsilon^2)}. \tag{2.22}$$

As $F_{crit}^2 > 0$ for $F_T > \frac{\epsilon^2}{2t}$, there exist some F_G with $F_G \leq F_{crit}^2$. Hence, there are parameter combinations for which an equilibrium exists with entry by the general purpose firm.

Result 2.4 *There exists an equilibrium with the general purpose firm entering if $F_T > \frac{\epsilon^2}{2t}$ and $F_G \leq F_{crit}^2$. The equilibrium number of TP firms is $n_g = \frac{t(2\epsilon+3\sqrt{2}\sqrt{tF_T})}{2(9tF_T-2\epsilon^2)}$.*

Figure 2.5 illustrates for which parameters this equilibrium exists, given by the grey-shaded area. The F_{crit}^2-line is upward sloping meaning that the GP firm can afford higher costs if entry costs for TP firms are higher (and hence the number of TP firms is lower). The comparative statics results are opposite to those without GP entry. As $\frac{\partial F_{crit}^2}{\partial \epsilon} < 0$ in the relevant range, a higher value of ϵ shifts the F_{crit}^2-line down and thus reduces the parameter space for which an equilibrium with GP exists. A higher value of t has the opposite effect on the F_{crit}^2-line and extends the parameter space for this equilibrium to exist.

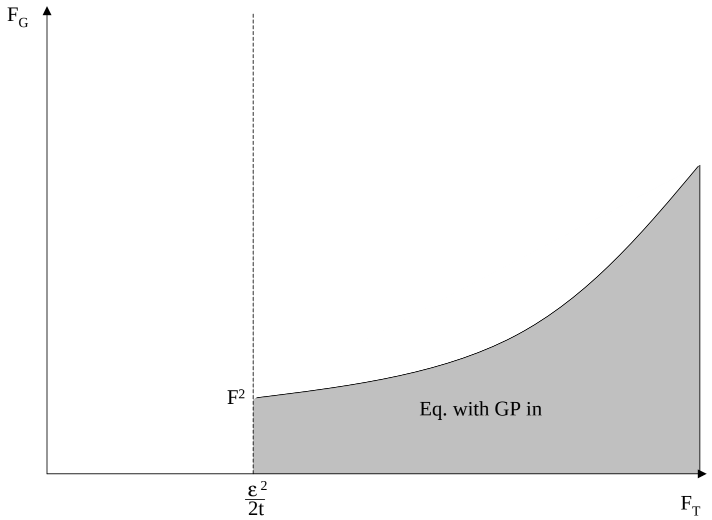

Figure 2.5: Equilibrium with GP entry

2.4.3 Equilibrium with free entry

This part combines the results of the two previous subsections. Aside from parameter combinations for which there exists a unique equilibrium outcome, two equilibria may simultaneously exist for certain parameter combinations—one in which the GP firm enters and one in which the GP stays out. Figure 2.6 shows the equilibrium outcomes of the entry stage. Note that $F^1_{crit} < F^2_{crit}$ as $n_s > n_g$.

Result 2.5 *Free-entry equilibrium. i) The general purpose firm staying out of the market is the unique equilibrium if* $F_T < \frac{\epsilon^2}{2t}$ *or* $F_T > \frac{\epsilon^2}{2t}$ *and* $F_G > F^2_{crit}$*. ii) The general purpose firm entering the market is the unique equilibrium if* $F_T > \frac{\epsilon^2}{t}$ *and* $F_G < F^1_{crit}$*. iii) Both equilibria exist if* $\frac{\epsilon^2}{2t} \leq F_T \leq \frac{\epsilon^2}{t}$ *and* $F_G \leq F^2_{crit}$*, or* $F_T \geq \frac{\epsilon^2}{t}$ *and* $F^2_{crit} \geq F_G \geq F^1_{crit}$*.*

2.5 Conclusion

The aim of this chapter is to model competition between general purpose products and targeted products in an environment with free entry into the

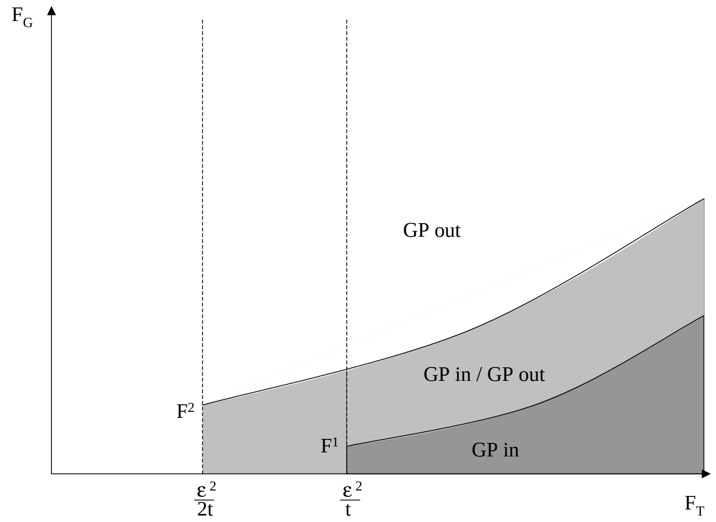

Figure 2.6: Equilibrium with entry

market. As a first step, pricing decisions are analyzed for a given market structure. The result here is that whenever the number of targeted products exceeds a certain threshold the general purpose product is priced out of the market and is not able to attract any consumer. As a second step, entry decisions are considered. The main goal here is to identify situations when one could expect the presence of general purpose products and when one could expect only targeted products to be in the market. The following factors are identified. Higher transportation costs and lower GP disutility costs are factors that improve the competitive situation of general purpose products, and hence make the presence of this product more likely. Low fixed costs of targeted products make the presence of a general purpose product less likely as low costs attract too many targeted products to enter the market. On the other hand, lower fixed costs for GP products tend to encourage entry by a GP firm.

2.6 Appendix

This appendix derives equilibrium prices as given in equations (2.12) and (2.13).

i) First, suppose $n < \frac{t}{\epsilon}$. The claim is then that both types of firms have positive market shares by charging prices as specified in equations (2.12) and (2.13). The profit functions when both types face positive demand are

$$\Pi_T = 2\left[\frac{P_G - P_T + \epsilon}{t}\right]P_T, \tag{2.23}$$

$$\Pi_G = \left[1 - 2n\frac{P_G - P_T + \epsilon}{t}\right]P_G. \tag{2.24}$$

Differentiation of (2.23) with respect to P_T and of (2.24) with respect to P_G and setting these first-order conditions equal to zero yields the equilibrium prices of $P_T^* = \frac{t+2n\epsilon}{6n}$ and $P_G^* \frac{2t-2n\epsilon}{6n}$. The GP firm does not deviate as long as it can charge a positive price. Equilibrium price is positive when $n < \frac{t}{\epsilon}$. It remains to be checked whether a TP firm has an incentive to undercut the GP firm and steal the whole demand of this firm. The undercutting price is $P_T^i = \frac{6n\epsilon-3t}{6n}$. The corresponding profit from undercutting is $\Pi^u = \frac{(5t-2n\epsilon)(2n\epsilon-t)}{6n^2t}$. It can be shown that the difference in profits $(\Pi_T^* - \Pi_T^u) = \frac{8(t^2-2nt\epsilon+n^2\epsilon^2)}{9n^2t}$ is positive when $n < \frac{t}{\epsilon}$. Hence, TP firms have no incentive to deviate.

ii) Next, suppose $\frac{t}{\epsilon} \leq n \leq \frac{3t}{2\epsilon}$. The claimed equilibrium prices are $P_T^* = \frac{2n\epsilon-t}{2n}$ and $P_G^* = 0$. At these prices, the GP firm faces no demand, hence it is clear that given the prices chosen by TP firms, the GP firm has no incentive to deviate as it would need to charge a negative price. It can also be shown that for $\frac{t}{\epsilon} \leq n \leq \frac{3t}{2\epsilon}$, no TP firm has an incentive to deviate. However, when $n < \frac{t}{\epsilon}$, a TP firm deviates by charging a higher price $(\frac{t}{\epsilon})$ to increase profits. When $n > \frac{3t}{2\epsilon}$, the TP firm can increase profits by charging a lower price of $\frac{t+2n\epsilon}{4n}$. Thus, for $\frac{t}{\epsilon} \leq n \leq \frac{3t}{2\epsilon}$, neither type of firm has an incentive to deviate.

iii) Finally, suppose $n > \frac{3t}{2\epsilon}$. The claim is that the equilibrium price charged by TP firms is then the standard Salop price $\frac{t}{n}$. The GP firm charges any price above $\frac{3t-2n\epsilon}{2n}$ and gets zero demand and zero profits. The presence of the GP firm is irrelevant for this parameter constellation. We check now that neither firm has an incentive to deviate from these prices. To get a positive demand, the GP firm would have to charge a price less than $\frac{3t-2n\epsilon}{2n}$. However, if $n > \frac{t}{\epsilon}$, this would mean charging a non-positive price. Hence, the GP firm has no incentive to deviate. As GP is priced out of the market we are back in the Salop model and hence, TP firms charge the standard Salop price.

Chapter 3

A Note on the Excess Entry Theorem in Spatial Models with Elastic Demand[1]

3.1 Introduction

Three main frameworks have been widely used to study product differentiation and monopolistic competition: representative consumer, discrete choice and spatial models. In representative consumer and discrete choice models, it is understood that equilibrium product variety could either be excessive or insufficient or optimal depending on the model configuration.[2] In spatial models such as Vickrey (1964) and Salop (1979), however, analysis shows that there is always excessive entry. This result became known as the excess entry theorem. Matsumura and Okamura (2006) extend this result for a large set of transportation costs and production technologies.[3]

One drawback of standard spatial models such as Hotelling (1929) and Salop (1979) is that consumer demand is completely inelastic. Each consumer

[1] This chapter is coauthored with Yiquan Gu. An earlier version of this chapter is Gu and Wenzel (2007).

[2] See, for example, Dixit and Stiglitz (1977), Pettengill (1979), Lancaster (1975), Sattinger (1984), Hart (1985) among many others.

[3] They do point out that there are also some situations in which entry can be insufficient.

demands a single unit of a differentiated product.[4] The present chapter lifts this restrictive assumption in the context of the Salop model and investigates the implications of price-dependent demand for the excess entry theorem.

To this aim, we incorporate a demand function with a constant elasticity into the Salop framework. We find that the number of entrants in a free-entry equilibrium is the lower the more elastic demand is. We also find that only when demand is sufficiently inelastic, there is excess entry. Otherwise, entry is insufficient. In the limiting case when the demand elasticity approaches unity, the market becomes a monopoly. Thus, the excess entry theorem is only valid for sufficiently inelastic demand and hence, the assumption of inelastic demand, typically employed, is not an innocuous one. This result is independent of whether we use a first-best or a second-best welfare benchmark. As a consequence of our welfare analysis we point out when and how a public policy can be desirable. In an extension, we broaden our result with a more general transportation cost function.

Our model setup is closely related to Anderson and de Palma (2000). The purpose of their paper is to develop a model that integrates features of spatial models where competition is localized and representative consumer models where competition between firms is global. Our formulation of the individual demand function is the same as in Anderson and de Palma (2000).[5] They also consider a constant elasticity demand function. However, the difference lies in the perspective of the papers. Their focus is on the interaction between local and global competition, while we focus on the implications of price-dependent demand on the excess entry result in spatial models.

Other approaches to introduce price-dependent demand into spatial models are Boeckem (1994), Rath and Zhao (2001) and Peitz (2002).[6] The first

[4] The assumption of inelastic demand can be a realistic one in the case of some durable goods, e.g. houses, etc. However, in case of nondurables, e.g. groceries, etc, the assumption seems to be less plausible.

[5] Our model is the special case of Anderson and de Palma (2000) when eliminating the taste component in their utility function. Thus, the present chapter considers a pure spatial model, while Anderson and de Palma (2000) analyze a model that has features of spatial and representative consumer models.

[6] A recent paper by Peng and Tabuchi (2007) combines a model of spatial competition with taste for variety in the spirit of Dixit and Stiglitz (1977). In their setup, the quantity demanded also depends on the price. However, their focus is a different one. They study the incentives of how much variety to offer and how many stores to establish. A paper by Hamilton, Klein, Sheshinski, and Slutsky (1994) analyzes elastic demand in a model with

two papers consider variants of the Hotelling framework. Boeckem (1994) introduces heterogenous consumers with respect to reservation prices. Depending on the price charged by firms some consumers choose not to buy a product. The paper by Rath and Zhao (2001) introduces elastic demand in the Hotelling framework by assuming that the quantity demanded by each consumer depends on the price charged. The authors propose a utility function that is quadratic in the quantity of the differentiated product leading to a linear demand function. In contrast to those two models, we build on the Salop model as we are interested in the relationship between price-dependent demand and entry into the market. Our approach is closer to Rath and Zhao (2001) as we also assume that each consumer has a downward sloping demand for the differentiated good. However, our demand function takes on a different functional form which has the advantage of yielding tractable results. Peitz (2002) features unit-elastic demand both in Hotelling and Salop settings but focuses on conditions for the existence of a Nash equilibrium in prices. He does not consider entry decisions.

This chapter is organized as follows. Section 3.2 sets up the model. Section 3.3 presents the analysis of the model. Section 3.4 analyzes the welfare outcome and policy implications. An extension with more general transportation cost functions is provided in section 3.5. Section 3.6 summarizes.

3.2 Model setup

There is a unit mass of consumers who are located on a circle with circumference one. The location of a consumer is denoted by x. In contrast to Salop (1979), consumers are not limited to buy a single unit of the differentiated good. The amount they purchase depends on the price. We propose the following utility function, U, which leads to a demand function with a constant elasticity of ϵ. We assume that this utility function is identical for all consumers:

quantity competition. In contrast to the present chapter the authors use transportation costs per unit of quantity purchased.

$$U = \begin{cases} \left(V - \frac{\epsilon}{1-\epsilon} q_d^{\frac{\epsilon-1}{\epsilon}} - t * dist\right) + q_h & \text{if consumes the differentiated product} \\ q_h & \text{otherwise.} \end{cases} \tag{3.1}$$

The utility derived by the consumption of the differentiated good consists of three parts. There is a gross utility for consuming this good (V). The second utility component depends on the quantity consumed (q_d). The parameter ϵ —which lies between (0,1)—will later turn out to be the demand elasticity. Finally, consumers have to incur transportation costs if the product's attributes do not match consumers' locations. We assume that transportation costs do not depend on the quantity consumed. Furthermore, we assume that transportation costs are linear in distance with transportation cost parameter t.[7] In section 3.5, we will lift this assumption and cover a broader class of transportation cost functions, namely power transportation costs. The variable q_h denotes the quantity of a homogenous good which serves as a numeraire good. The utility is linear in this commodity. Additionally, we make the assumption that the gross utility of the differentiated good (V) is large enough such that no consumers abstains from buying the differentiated product.

Each consumer has an exogenous income of Y which he can divide between the consumption of the differentiated good and the numeraire good. The price of the differentiated good is p_d, while the price of the numeraire is normalized to one. This leads to the following budget constraint:

$$Y = p_d * q_d + q_h. \tag{3.2}$$

Consumers maximize their utility (3.1) under their budget constraint (3.2). Then, demand for the differentiated product and the numeraire is:

$$\hat{q_d} = p_d^{-\epsilon}, \tag{3.3}$$

$$\hat{q_h} = Y - p_d^{1-\epsilon}. \tag{3.4}$$

[7]This allows a direct comparison to Salop (1979) model because the transportation costs are linear in that paper as well.

The demand for the differentiated good exhibits a constant demand elasticity of ϵ. A higher value of ϵ corresponds to more elastic demand. The limit case of $\epsilon \to 0$ corresponds to completely inelastic demand. Inserting these demand functions into equation (3.1) gives the indirect utility a consumer derives from consuming the differentiated product from a certain firm:

$$\hat{U} = V + Y - \frac{1}{1-\epsilon} p_d^{1-\epsilon} - t * dist. \tag{3.5}$$

There are $n \geq 2$ firms that offer the differentiated product. We assume that these firms are located equidistantly on the circle. Hence, the distance between two neighboring firms is $\frac{1}{n}$. Consumers choose to buy the differentiated product from the firm which offers them the highest utility. Given the symmetric structure of the model, we look for a symmetric equilibrium. Therefore we derive demand of a representative firm i. The marginal consumer is the consumer who is indifferent between choosing firm i and an adjacent firm. When firm i charges a price p_i while the remaining firms charge a price p, the marginal consumer is implicitly given by

$$V + Y - \frac{1}{1-\epsilon} p_i^{1-\epsilon} - t\bar{x} = V + Y - \frac{1}{1-\epsilon} p^{1-\epsilon} - t\left(\frac{1}{n} - \bar{x}\right), \tag{3.6}$$

or explicitly by

$$\bar{x} = \frac{1}{2n} + \frac{p^{1-\epsilon} - p_i^{1-\epsilon}}{2(1-\epsilon)t}. \tag{3.7}$$

As each firm faces two adjacent firms, the number of consumers choosing to buy from firm i is $2\bar{x}$. According to equation (3.3), each consumer buys an amount of $\hat{q}_i = p_i^{-\epsilon}$. Hence total demand for firm i is:

$$D_i = 2\bar{x} p_i^{-\epsilon}. \tag{3.8}$$

In contrast to the Salop model, total demand consists now of two parts: market share and quantity per consumer.

3.3 Equilibrium analysis

This section analyzes the equilibrium. We start by deriving equilibrium prices for a given number of firms in the market. In a second step, we determine the number of firms that enter.

3.3.1 Price equilibrium

We look for a symmetric equilibrium in which all firms charge the same price. Assuming zero production costs, the profit of a representative firm i when this firm charges a price p_i and all remaining firms charge a price p is given by:

$$\Pi_i = \left[\frac{1}{n} + \frac{p^{1-\epsilon} - p_i^{1-\epsilon}}{(1-\epsilon)t}\right] p_i^{-\epsilon} p_i. \tag{3.9}$$

Maximizing profits with respect to the price p_i and assuming symmetry among all firms leads to the following equilibrium price:[8]

$$p^* = \left[(1-\epsilon)\frac{t}{n}\right]^{\frac{1}{1-\epsilon}}. \tag{3.10}$$

The corresponding quantity purchased by each consumer then is

$$q^* = \left[(1-\epsilon)\frac{t}{n}\right]^{-\frac{\epsilon}{1-\epsilon}}. \tag{3.11}$$

As in the Salop model, the equilibrium price increases in transportation costs and decreases in the number of firms in the market. Conversely, the quantity purchased by each consumer rises with the number of firms and decreases with transportation costs. More interesting is the impact of the demand elasticity on the equilibrium price and quantity. Differentiation with respect to ϵ yields:

$$\frac{\partial p^*}{\partial \epsilon} \gtreqless 0 \Leftrightarrow \frac{(1-\epsilon)t}{n} \gtreqless e, \tag{3.12}$$

[8]For the proof of the existence of a symmetric price equilibrium, the reader is referred to Anderson and de Palma (2000).

$$\frac{\partial q^*}{\partial \epsilon} \lesseqgtr 0 \Leftrightarrow \frac{(1-\epsilon)t}{n} \gtreqless e^{\epsilon}, \tag{3.13}$$

where e denotes the Euler number. A higher demand elasticity has an ambiguous impact on equilibrium price and quantity. It can lead to a higher price as well as to a lower price. The intuition behind this result lies in the fact that firms can attract additional demand in two ways, via a larger market share and a larger quantity per consumer. Note, however, that the revenue per customer $p^* q^* = \frac{(1-\epsilon)t}{n}$ decreases in the price elasticity. In the limiting case of $\epsilon \to 1$, revenue per customer approaches zero.

In the equilibrium with a given number of firms in the market, each firm makes a profit of

$$\Pi^* = \frac{t(1-\epsilon)}{n^2}. \tag{3.14}$$

The impact of the demand elasticity on firms' profits is unambiguous. A larger demand elasticity reduces profits. This is due to the result that revenue per customer decreases with the demand elasticity and that the market share is constant at $\frac{1}{n}$ in equilibrium. Hence, product market competition is tougher as consumers react stronger to price changes. Higher transportation costs and a smaller number of active firms increase profits.

Result 3.1 *For a given number of firms, profits decrease with increasing demand elasticity.*

3.3.2 Entry behavior

Until now the analysis treated the number of firms which offer differentiated products as exogenously given. We now investigate the number of active firms when it is endogenously determined by the zero profit condition. We assume that to enter, a firm has to incur an entry cost or fixed cost of f. Additionally, we treat the number of entrants as a continuous variable. Setting equation (3.14) equal to f and solving for n yields the number of entrants:

$$n^c = \sqrt{\frac{t(1-\epsilon)}{f}}. \tag{3.15}$$

The comparative static results concerning transportation costs and fixed costs are as expected. Higher transportation costs lead to more entry while higher fixed costs lead to less entry. The interesting result concerns the impact of the demand elasticity:

Result 3.2 *The number of entrants decreases in the demand elasticity.*

A larger demand elasticity results in less entry into the market. The reason is that a higher elasticity yields lower profits for any given number of firms (see result 3.1).

Corresponding price and quantity in a free-entry equilibrium are:

$$p^c = \left[\sqrt{1-\epsilon}\sqrt{tf}\right]^{\frac{1}{1-\epsilon}}, \tag{3.16}$$

$$q^c = \left[\sqrt{1-\epsilon}\sqrt{tf}\right]^{-\frac{\epsilon}{1-\epsilon}}. \tag{3.17}$$

Higher transportation costs and higher fixed costs lead to higher prices and to lower quantities. As in the equilibrium for a given number of firms, the impact of the demand elasticity on price and quantity is ambiguous. More elastic demand may lead to higher or lower prices and quantities.

The model has interesting results in the limiting cases.

Result 3.3 *i) With $\epsilon \to 0$, our results reduce to the Salop results. ii) As $\epsilon \to 1$, the market is monopolized.*

When demand is completely inelastic, $\epsilon \to 0$, we can replicate the Salop results. Thus, our model encompasses his as a special case. As the demand elasticity approaches unity, a monopoly is the outcome. Competition in the market is so tough that as soon as more than one firm enters the market profits are driven to zero (see equation (3.14)).

3.4 Welfare analysis

This section considers the welfare and policy implications. We ask whether there is excess entry into the market as it is the case in models with inelastic demand.

In contrast to models with inelastic demand, we have to consider prices in our welfare analysis as they have an impact on the quantity purchased and hence on welfare. We define social welfare as the sum of consumer utility and industry profits. Consumer welfare can be calculated by integrating equation (3.5) over all consumers. According to equation (3.9) each firm earns revenues of $\frac{1}{n}pp^{-\epsilon} = \frac{1}{n}p^{1-\epsilon}$. Accounting for fixed costs industry profits are then $p^{1-\epsilon} - fn$. Adding up consumer welfare and industry profits yields:

$$W = \underbrace{V + Y - \frac{1}{1-\epsilon}p^{1-\epsilon} - 2n\int_0^{\frac{1}{2n}} tx\ dx}_{\text{Consumer welfare}} + \underbrace{p^{1-\epsilon} - fn}_{\text{Industry profits}}. \tag{3.18}$$

We consider two different welfare benchmarks, a first-best benchmark in which the social planner chooses both the level of entry and the price charged by firms, and a second-best benchmark in which the social planner can only control the level of entry, but not prices. Our result are qualitatively independent of the choice of the welfare benchmark.

3.4.1 First-best benchmark

In the first-best benchmark, the social planner can control prices and level of entry, that is, he maximizes total welfare with respect to p and n. From equation (3.18), we see that the optimal price set by the regulator is equal to marginal cost, in this case, $p = 0$. Inserting this into equation (3.18) yields

$$W = V + Y - 2n\int_0^{\frac{1}{2n}} tx\ dx - fn. \tag{3.19}$$

The problem for the social planner is then identical to the case with inelastic demand, hence reduced to a trade-off between transportation costs and fixed costs. The optimal number of entrants is

$$n^f = \sqrt{\frac{t}{4f}}. \tag{3.20}$$

Comparison with the free-entry level, n^c, leads to the following result:

Result 3.4 *Compared to the first-best benchmark, there is excess entry when $\epsilon < \frac{3}{4}$, insufficient entry when $\epsilon > \frac{3}{4}$, and optimal entry when $\epsilon = \frac{3}{4}$.*

It shows that the result of excess entry in the Salop model does not hold when demand is elastic. In the model with elastic demand whether there is too much entry or too little depends on the demand elasticity. Whenever demand is sufficiently inelastic, there is excess entry as is the case in the Salop model ($\epsilon \to 0$). However, if the demand elasticity exceeds $\frac{3}{4}$, there is insufficient entry into the market. Only when $\epsilon = \frac{3}{4}$, entry coincides with the socially optimal number. Thus, the excess entry theorem in spatial models depends crucially on the assumption of inelastic demand.

3.4.2 Second-best benchmark

Here we derive the welfare-maximizing number of firms given their pricing behavior after entry. Inserting equation (3.10) into (3.18) gives

$$W = V + Y - \frac{t}{n} - 2n \int_0^{\frac{1}{2n}} tx \; dx + \frac{t(1-\epsilon)}{n} - fn. \qquad (3.21)$$

Maximizing total welfare (3.21) with respect to n yields the optimal number of firms:

$$n^s = \sqrt{\frac{t(1+4\epsilon)}{4f}}. \qquad (3.22)$$

Comparing the optimal number of firms, n^s, with the outcome under free entry, n^c, the following result can be established:

Result 3.5 *Compared to the second-best benchmark, there is excess entry when $\epsilon < \frac{3}{8}$, insufficient entry when $\epsilon > \frac{3}{8}$, and optimal entry when $\epsilon = \frac{3}{8}$.*

Using the second-best benchmark, our result has the same structure as with the first-best benchmark. For sufficiently inelastic demand, we get excess entry and for sufficiently elastic demand, we get insufficient entry.

3.4.3 Policy implications

Here we derive some policy implications of our welfare analysis focusing on the case of the second-best welfare benchmark. Suppose that a government agency may either charge a fee against or grant a subsidy to each entry, e.g. license fee or start-up funds, respectively. Let s denote the value of such a transfer. When $s < 0$ we call it a subsidy, and when $s > 0$ we call it an entry fee.

Hence the number of firms under such an otherwise "Free Entry" policy now is:

$$n^{c'} = \sqrt{\frac{t(1-\epsilon)}{f+s}}. \tag{3.23}$$

This, of course, follows directly from equation (3.15) by adjusting the fixed cost term accordingly. By setting equation (3.23) equal to (3.22), we can determine the value of s that induces optimal entry into the market. This value is

$$s = f\frac{3-8\epsilon}{1+4\epsilon}. \tag{3.24}$$

The following corollary then immediately follows from result 3.5.

Corollary 3.1 *i) When $\epsilon < \frac{3}{8}$, a government agency should charge an entry fee to reduce excess entry; ii) when $\epsilon > \frac{3}{8}$, a government agency should subsidize entry.*

By such a transfer scheme, a government agency could effectively influence the number of active firms.

3.5 Power transportation costs

This section reconsiders the analysis assuming a more general transportation cost function. Instead of linear transportation costs, we now assume power transportation costs tx^{β} with $\beta \geq 1$. This functional form is also considered by Anderson, de Palma, and Thisse (1992) and Matsumura and Okamura (2006) which both show that the excess entry theorem always holds in the case of inelastic demand.[9] Our analysis will show that their result depends very much on the assumption of inelastic demand.

[9]Note that the existence of a price equilibrium is not ensured if β is too high. See Anderson, de Palma, and Thisse (1992, Ch. 6).

Following the same steps as in section 3.3, we can derive the number of entrants in a free-entry equilibrium and the socially optimal number. The derivation of these results is given in appendix 3.7.

The number of entrants in a free-entry equilibrium is

$$n^c = \left[\frac{(1-\epsilon)t\beta 2^{1-\beta}}{f}\right]^{\frac{1}{1+\beta}}, \tag{3.25}$$

and the optimal number of firms—using the second-best welfare benchmark—is

$$n^w = \left[\frac{t\beta 2^{-\beta}(2\beta\epsilon + \frac{1}{1+\beta})}{f}\right]^{\frac{1}{1+\beta}}. \tag{3.26}$$

We denote by $\bar{\epsilon} = \frac{1+2\beta}{2(1+\beta)^2}$ the demand elasticity such that optimal and competitive entry coincides. This leads to the following result:

Result 3.6 *Suppose that transportation costs are of the power function form tx^β. Then we have that i) there is excess entry if $\epsilon < \bar{\epsilon}(\beta)$ and insufficient entry if $\epsilon > \bar{\epsilon}(\beta)$, and ii) $\bar{\epsilon}(\beta)$ decreases in β.*

The first part of the result generalizes result 3.5 for the case of a more general transportation cost function. It states that as long as demand is sufficiently inelastic the excess entry theorem still holds. Otherwise, it does not hold. The second part of the result follows directly as $\frac{\partial \bar{\epsilon}}{\partial \beta} = -\frac{\beta}{(1+\beta)^3} < 0$. It says that the interval of demand elasticities for which the excess entry theorem holds shrinks with β.

3.6 Conclusion

The present chapter introduces elastic demand in the Salop (1979) model and investigates if the excess entry theorem still holds. We propose a utility function that leads to a demand function with constant elasticity. We find that a larger demand elasticity leads to less entry into the market. This is a hypothesis that can be tested empirically. Markets with higher demand elasticity should offer less product variety. In the limiting case of a unit demand elasticity the market outcome is a monopoly. Turning to the welfare analysis, we show that when demand is sufficiently inelastic there is excess entry. However, when demand is sufficiently elastic the number of entrants is lower than the socially optimal number. Further, we provide conditions on when and how a government intervention can be desirable. We also show that our results hold with more general transportation cost functions.

3.7 Appendix

Here we provide the derivation of the results for the model with power transportation costs. The derivation follows Anderson, de Palma, and Thisse (1992, Ch. 6), but is extended to price-dependent demand.

With power transportation costs, the marginal consumer is implicitly given by

$$-\frac{1}{1-\epsilon}p_i^{1-\epsilon} - t\bar{x}^\beta = -\frac{1}{1-\epsilon}p^{1-\epsilon} - t\left(\frac{1}{n} - \bar{x}\right)^\beta. \tag{3.27}$$

In contrast to the case of linear transportation costs, it is not possible to give a closed form solution for the marginal consumer. However, by total differentiation it is possible to calculate the impact of a price change on the marginal consumer, which is

$$\frac{d\bar{x}}{dp_i} = -\frac{p_i^{-\epsilon}}{t\beta(\bar{x}^{\beta-1} + (\frac{1}{n} - \bar{x})^{\beta-1})}. \tag{3.28}$$

As we are interested in a symmetric equilibrium we can evaluate this expression at the symmetric equilibrium, that is, at $\bar{x} = \frac{1}{2n}$. Then, we get

$$\frac{d\bar{x}}{dp_i}\Big|_{\bar{x}=\frac{1}{2n}} = -\frac{p_i^{-\epsilon}}{2t\beta(\frac{1}{2n})^{\beta-1}}. \tag{3.29}$$

Profits for the representative firm i is $\Pi_i = 2\bar{x}p_i^{1-\epsilon}$. The first-order condition for profit maximization and assuming symmetry gives the following equilibrium prices for a given number of firms in the market:

$$p = \left[(1-\epsilon)\frac{t\beta 2^{1-\beta}}{n^\beta}\right]^{\frac{1}{1-\epsilon}}. \tag{3.30}$$

For $\beta = 1$, this gives the results of our base model, and for $\epsilon = 0$, we get the results of Anderson, de Palma, and Thisse (1992, Ch. 6). Each firm earns a profit of

$$\frac{(1-\epsilon)t\beta 2^{1-\beta}}{n^{\beta+1}} - f. \tag{3.31}$$

The number of firms that enter in a free-entry equilibrium is determined via the zero-profit condition. This leads to the following number of entrants:

$$n^c = \left[\frac{(1-\epsilon)t\beta 2^{1-\beta}}{f}\right]^{\frac{1}{1+\beta}}. \tag{3.32}$$

With power transportation costs the second-best welfare benchmark can be expressed as:

$$W = V + Y - \frac{t\beta 2^{1-\beta}}{n^\beta} - \frac{t}{(1+\beta)n^\beta 2^\beta} + \frac{(1-\epsilon)t\beta 2^{1-\beta}}{n^\beta} - fn. \tag{3.33}$$

The number of firms that maximizes total welfare is then

$$n^w = \left[\frac{t\beta 2^{-\beta}(2\beta\epsilon + \frac{1}{1+\beta})}{f}\right]^{\frac{1}{1+\beta}}. \tag{3.34}$$

Comparison with the number of firms in a free-entry equilibrium shows that there is excess entry if $\epsilon < \frac{1+2\beta}{2(1+\beta)^2}$.

Chapter 4

Product Variety at the Top and at the Bottom

4.1 Introduction

The present chapter aims at considering the issues of product differentiation and multi-product firms from a joint perspective. In most models concerned with competition in differentiated product markets it is typically assumed that firms are constrained to offer a single product (see, for instance, the classic contributions by Hotelling (1929) or Shaked and Sutton (1982)). However, when turning to reality this assumption can easily be rejected. Most firms typically offer a lot of different variants of a product. That is, they are multi-product firms. The aim of the present chapter is to incorporate variety choice in a model of spatial product differentiation. Precisely, we study the incentives to offer product variety in a vertically-differentiated industry. Here we are interested in analyzing when to expect more variety in the high-quality segment (at the top) and when in the low-quality segment (at the bottom).

To this aim we construct a model of two-dimensional spatial product differentiation, one dimension being a horizontal one and the other one being a vertical dimension (quality). In such an industry, two firms are competing for customers. One firm offers a high-quality product, and the other one a product of lower quality. This aspect of vertical differentiation is exogenous in the present paper. We do not aim at explaining why these two firms offer products of different quality levels. Instead, we are interested in determining product variety. In our model, firms can decide about producing several variants of a differentiated product. We model the decision to offer product variety in a simple way by letting firms choose between two alternatives. A firm can either offer a single product variant or offer a product line, which comprises the continuum of all possible product variants. Of course, this setup simplifies considerably, but is sufficiently rich to analyze factors that determine equilibrium product variety choices. Competition between the two firms proceeds in two stages. In the first stage firms decide on product variety, and in the second stage firms set prices.

In this setup we show that a firm that enjoys an advantage at the pricing stage is more likely to offer a larger variety than its competitor. More precisely, the high-quality firm is more likely to offer more variety if the difference in marginal costs for producing high and low quality good is small for a given quality difference. Conversely, if the opposite holds, the low-quality firm is more likely to offer more variety. In the present model, in these situations one firm offers the product line and the other firm a single product variant. Beside these asymmetric outcomes, there can also be symmetric variety choices when costs for introducing additional product variety is either very large or very small. In the former case, both firms restrict their variety to a minimum, more variety is simply prohibitively expensive. In the latter case, the outcome is a symmetric choice with both firms offering the product line.

In the present chapter we show, that in the case of symmetric variety choices, profits—net of costs for additional variety—do not depend on the level of variety offered. Hence, firms may have an incentive to collude and restrict product variety. Analyzing a game where firms can collude on variety choice, but not on prices, we find that it is never optimal to offer the product line. Under some circumstances, asymmetric variety choice may lead to maximum industry profits.

The model of this chapter is related to two strands of literature. On the one hand, to the literature on multi-dimensional product differentiation and on the other hand, to the literature on multi-product competition.[1] Concerning multi-dimensional product differentiation the present paper builds on the

[1] An overview on these two topics is given in the survey by Manez and Waterson (2001).

model in Neven and Thisse (1990) who analyze location choice in a model of two-dimensional product differentiation. They find that in equilibrium firms differentiate along one dimension and imitate each other along the other dimension. Differentiation along both dimensions cannot be an equilibrium.[2] In Neven and Thisse (1990), firms are restricted to offer a single product variant. The present chapter extends their work by allowing firms to offer several product variants, however, by sacrificing location choice. On the other hand, this paper relates to the literature on multi-product competition. The seminal contribution here is Brander and Eaton (1984). In their duopoly model each firm produces two products. They ask whether firms produce two near substitutes (market interlacing) or two distant substitutes (market segmentation). Critical to their model is the assumption that firms are not free to choose the number of products.

Several other papers also aim at integrating the issues of product differentiation and multi-product firms. Closest to the present work are Gilbert and Matutes (1993) and Janssen, Karamychev, and van Reenen (2005). As the present paper, Gilbert and Matutes (1993) analyze the decision to offer several product varieties also in a model of two-dimensional product differentiation. Consumers have preferences over brand and variety. However, in contrast to the present paper, they consider an industry that is from the outset horizontally differentiated (by brands) while the model developed here considers a vertically differentiated industry. The structure of competition, however, is the same: In a first stage firms decide on which products to offer and in the second stage price competition arises. In the spirit of Gilbert and Matutes (1993), Janssen, Karamychev, and van Reenen (2005) develop a three-stage model with brand differentiation where the number of outlets, their locations, and the price are chosen. They find that firms' location decisions are independent from each other and that prices charged are independent of the number of locations when firms operate the same number of outlets. However, their model gives no specific results concerning the number of outlets a firm operates.

[2] Irmen and Thisse (1998) extend the model of Neven and Thisse (1990) to competition in n-dimensionally differentiated products. Their result is that "Hotelling (1929) was almost right" in the sense that firms tend to differentiate along one dimension and do not differentiate along the remaining (n-1) dimensions.

The chapter proceeds as follows. Section 4.2 describes the model setup. Section 4.3 analyzes the price game for given variety choices. Section 4.4 analyzes equilibrium product variety. In section 4.5 we compare equilibrium product variety with optimal variety. Section 4.6 studies semi-collusion where firms can coordinate their product variety decisions. Finally, section 4.7 concludes.

4.2 Model setup

This section describes the model used to analyze product variety decisions by firms. The general setup follows Neven and Thisse (1990), but we extend their model to answer the question how much product variety a firm chooses to offer.

4.2.1 Consumers

Consider an industry in which products can be differentiated along two dimensions. One dimension is a vertical attribute, quality (q); the other dimension is a horizontal attribute, variety (y). Consumers have preferences over these attributes. Each consumer has a most preferred variety (x). This most preferred variety lies within the interval [0,1]. Consumers are distributed uniformly along this dimension. All consumers prefer high quality to low quality, but the willingness to pay for quality (θ) differs across individuals. The valuation of quality lies within the interval [0,1]. Again, consumers are distributed uniformly on this interval. Hence, consumers can be characterized by (x, θ). The distribution along both dimensions is independent, thus consumers are uniformly distributed over the unit square. The mass of consumers is normalized to one. A consumer with preferences (x, θ) derives (indirect) utility by consuming the product offered by firm i:

$$U(y_i, q_i; x, \theta) = V + \theta q_i - |x - y_i| - p_i, \tag{4.1}$$

where q_i and y_i are the product's characteristics and p_i the price charged by firm i. The term (θq_i) describes the vertical aspect: The higher θ, the higher the willingness to pay for quality. The term $|x - y_i|$ represents the horizontal product characteristic. The further the product is away from the most preferred variety the greater the loss of utility. This 'transportation cost' is assumed to be linear. Furthermore, it is assumed that V, the gross utility from consuming a product, is high enough, such that in equilibrium each consumer buys one product.

4.2.2 Firms

In this industry, two firms—denoted by L and H—are operating. Firm L is a low-quality producer (quality level q_L) and firm H is a high-quality producer (quality level q_H) with $q_H > q_L$. The quality difference $(q_H - q_L)$ is exogenous and normalized to one. The aim of the present chapter is to study firms' decisions to offer product variety. Thus, firms have, unlike in Neven and Thisse (1990), the option to offer several variants of a product. We let the choice of variety be the following: A firm can either produce a single variant of the product or a product line. The product line includes all variants, $y_i \in [0, 1]$, given the firm's quality level. Thus, firms that opt for the product line produce a continuum of different variants.[3] This setup is sufficient to analyze qualitatively the incentive to provide product variety and to allow comparisons which of the two firms offers more variety. However, due to the limited choice of product variety, this approach does not allow to study the extent of the difference in variety.[4] Furthermore, it is assumed that a firm opting for a single product variant produces the 'central' variant, $y_i = \frac{1}{2}$.[5]

We assume the following cost structure. Production costs for high and low-quality products can possibly differ. There is a constant cost of c_L for

[3]From a technical point of view, a product line is equivalent to a general purpose product from chapter 2. Independent of location, consumers do not incur transportation costs. However, the interpretation is different. A product line from this chapter is a bundle of several products while the general purpose product is one single product.

[4]A different modeling structure, which leads to similar conclusions, would be to let firms choose between offering one or two varieties (or even more varieties). In Janssen, Karamychev, and van Reenen (2005) firms have the option to offer any number of varieties. The drawback of this more general choice set is, however, that it is not possible to say much about the choice of product variety.

[5]Indeed, to choose the central variant is an equilibrium outcome in an extended game where firms can choose locations as well—independent of the number of products offered by its competitor. This is also demonstrated in Janssen, Karamychev, and van Reenen (2005).

producing one unit of the low-quality good, and a unit cost of c_H for the high-quality good. Producing the higher quality can be more costly, that is, $c_H \geq c_L$. The cost c_L is normalized to zero so that $c_H = c \geq 0$ denotes the difference in production costs. Offering product variety is also costly. Firms face an additional fixed cost of f for offering the product line.

We impose the following assumption on our parameters:

Assumption 4.1

$$0 \leq c \leq 1.$$

This assumption ensures that in equilibrium for any given value of x there are some consumers who choose to buy from firm L and some from firm H.[6]

Competition between the duopolists is modeled as a two-stage game. In the first stage firms simultaneously decide whether to produce one single product variant or a product line. In the second stage—after having observed product choices—firms compete in prices. The solution concept is that of a subgame perfect Nash equilibrium.

4.2.3 Marginal consumer

We start our analysis by deriving the marginal consumer, that is, the consumer who is just indifferent between buying from firm H and firm L. Consumers buy the product that gives them the highest utility. Consumers with a higher taste for quality tend to buy from the high-quality firm and those with lower willingness to pay for quality tend to buy products from the low-quality producer. Given that each firm produces a single product variant the marginal consumer is implicitly characterized by:

$$U(y_L, q_L; x, \theta) = U(y_H, q_H; x, \theta).$$

Using equation (4.1) the marginal consumer can explicitly be expressed as:

$$\theta_m = (p_H - p_L) + |x - y_H| - |x - y_L|. \tag{4.2}$$

[6]A similar assumption is used by Janssen, Karamychev, and van Reenen (2005). They assume that brand differentiation between the two symmetric retail firms is sufficiently large.

All consumers with $\theta \leq \theta_m$ choose to buy the good from firm L and all consumers with a higher θ choose to buy the good from firm H. Besides the price difference, the location of the marginal consumer depends on the difference in transportation costs associated with each firm, that is, how good the product matches the consumers' tastes.

We can also derive the marginal consumer when a firm offers the product line, that is, the firm offers a continuum of variants. Here we assume that the firm charges the same price for all its variants. This assumption simplifies the analysis considerably.[7] We do not have to derive demand for each product variant separately, but it is sufficient to determine from which firm a consumer chooses to buy. We can adapt equation (4.2) to the case of the product line by noting that a consumer incurs no costs of mismatch as all possible varieties are covered by the product line. Thus, the only modification is to set the costs of mismatch associated with its products equal to zero when a firm offers the product line.

4.3 Price competition

The game is solved by backward induction. Hence, we start by analyzing the second stage of the game, that is, price competition for given product choices. When each firm has the choice between producing one product variant and the product line, a total of four constellations may arise. These are the following:

- both firms produce exactly one product (case 1),
- both firms produce the product line (case 2),

[7] This assumption is also used in related models, for instance by Janssen, Karamychev, and van Reenen (2005). However, it is clear that charging the same price is not fully optimal. For instance, in a situation where one firm offers more product variety than its competitor, charging the same price is not profit-maximizing. A firm should charge higher prices for product variants where there are less good substitutes and charge a lower one where close substitutes are available. However, in practice, it can often be observed that firms charge uniform prices within a product line. In the marketing literature, see for instance Xia, Monroe, and Cox (2004) or Dragangska and Jain (2006), it is argued that consumers perceive products within a line as similar and consider price differences as unfair.

- firm L produces the product line, whereas firm H produces one product (case 3),
- firm L produces one product, whereas firm H produces the product line (case 4).

This section characterizes prices and profits in each of these four subgames.

4.3.1 Case 1: Both firms produce one product variant

In this case, both firms produce the "central" variety, that is, $y_L = y_H = \frac{1}{2}$. The model then collapses to a standard model of vertical product differentiation. The marginal consumer in equation (4.2) condenses to:

$$\theta_m \quad = \quad (p_H - p_L) + |x - \frac{1}{2}| - |x - \frac{1}{2}| = p_H - p_L. \qquad (4.3)$$

As can be seen in Figure 4.1, the marginal consumer is independent of a consumer's most preferred varieties (x). Hence, graphically, the line of marginal consumers is a horizontal line. Demand for firm L is given by all consumers whose willingness to pay for quality is lower than θ_m:

$$D_L = \int_0^1 (p_H - p_L)\, dx = (p_H - p_L). \qquad (4.4)$$

Hence, demand for firm H is then given by:

$$D_H = 1 - D_L = 1 - (p_H - p_L). \qquad (4.5)$$

Both firms set prices simultaneously as to maximize their profits of $\Pi_L = D_L p_L$ and $\Pi_H = D_H(p_H - c)$, respectively. This leads to the following prices and profits in this subgame:

$$p_L^* = \frac{1+c}{3} \quad \text{and} \quad p_H^* = \frac{2+2c}{3}, \qquad (4.6)$$

and

$$\Pi_L^* = \left[\frac{1+c}{3}\right]^2 \quad \text{and} \quad \Pi_H^* = \left[\frac{2-c}{3}\right]^2. \qquad (4.7)$$

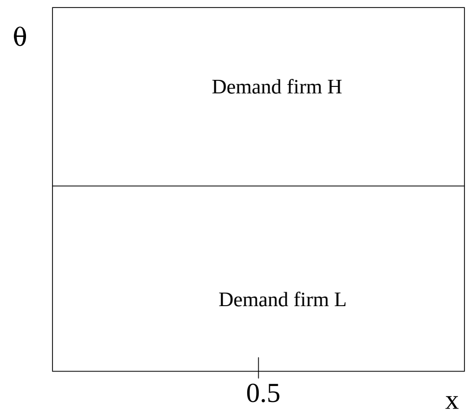

Figure 4.1: Market shares in case 1

Note that a larger marginal cost difference for producing high and low quality producing increase profits of firm L and reduces profits of firm H. The same qualitative comparative statics result emerges for the remaining product variety constellations.

4.3.2 Case 2: Both firms produce the product line

The case when both firms produce the product line is strategically equivalent to case 1. As costs for mismatch are zero for the products of both firms, the condition for the marginal consumer is the same as in case 1:

$$\theta_m = (p_H - p_L) \tag{4.8}$$

Hence, demand faced by the competitors is the same as in case 1 above. In consequence, prices charged by the firms are also the same. Equilibrium profits are reduced by an amount of f since now the costs for offering more product variety have to be paid. This result emerges also in the model by Janssen, Karamychev, and van Reenen (2005). Whenever firms offer the same number of varieties, prices do not depend on the number of varieties.[8] This makes clear that firms have an incentive to collude on product variety to save on fixed costs. We will address this issue in more detail in section 4.6.

4.3.3 Case 3: Firm L produces the product line, Firm H one product variant

In this subgame, the low-quality firm L offers the product line whereas the high-quality firm H offers the single variant. This means that consumers buying from firm L do not have to pay costs of mismatch, but those (except for $x = \frac{1}{2}$) buying from firm H have to. Modifying equation (4.2), the marginal consumer can be expressed as

$$\theta_m = (p_H - p_L) + |x - \frac{1}{2}|. \tag{4.9}$$

Figure 4.2 illustrates the situation. It can be seen that the line of marginal consumers exhibits a minimum at $x = \frac{1}{2}$ and increases towards the sides. This is due to the fact that firm L offers products that match customers' tastes better. Hence, firm L can attract additional customers in the region where firm H does not offer equivalent variants. Assumption 4.1 ensures that in equilibrium the marginal consumer line does not cross the horizontal axis, that is, $\theta_m \in [0, 1]$. The demand of firm L is the area below the line of marginal consumers, which is given by:

$$D_L = 2\int_0^{\frac{1}{2}} \theta_m dx = \left[p_H - p_L + \frac{1}{4}\right]. \tag{4.10}$$

Demand of firm H is then:

$$D_H = \left[\frac{3}{4} - (p_H - p_L)\right]. \tag{4.11}$$

Equilibrium prices in this subgame are:

$$p_L^* = \frac{5}{12} + \frac{c}{3} \quad \text{and} \quad p_H^* = \frac{7}{12} + \frac{2c}{3}. \tag{4.12}$$

[8] This result emerges also in the context of competition with respect to shopping hours in retailing. As shown by Shy and Stenbacka (2007) and also in chapter 6 as long as firms choose identical shopping hours, equilibrium prices do not depend on the length of shopping hours. Profits are reduced with longer shopping hours as this involves higher costs. Then, retailers have an incentive to collude on short shopping hours.

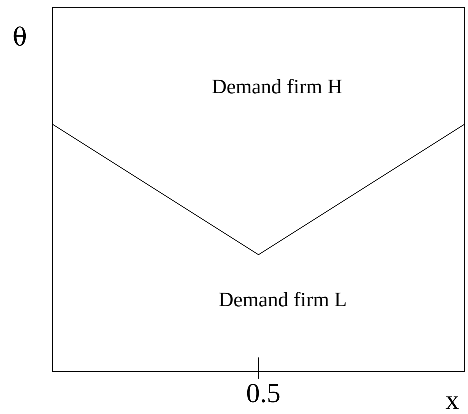

Figure 4.2: Market shares in case 3

Corresponding profits are:

$$\Pi_L^* = \left[\frac{5}{12} + \frac{c}{3}\right]^2 - f \quad \text{and} \quad \Pi_H^* = \left[\frac{7}{12} - \frac{c}{3}\right]^2. \tag{4.13}$$

Compared to the symmetric cases where both firms offer the same level of product variety, in this asymmetric case firm L—offering more product variety than its competitor—increases its price charged to customers by an amount of $\frac{1}{12}$. Firm H in turn decreases its price by the same amount. This result is quite intuitive. Since firm L offers product variants that are closer to consumers' tastes it enjoys a competitive advantage over its rival and therefore can profitably raise prices. Firm H, on the other hand, has to decrease its price in order to compensate customers for a less well suited product variant.[9]

[9] Similar results are again demonstrated in Janssen, Karamychev, and van Reenen (2005), Shy and Stenbacka (2007), and in chapter 6. Equilibrium prices reflect dominance in terms of outlets or length of shopping hours, or as in the present paper, in terms of product variety.

4.3.4 Case 4: Firm L produces one product variant, Firm H the product line

Now it is firm H that produces the product line and firm L that offers the single product variant. The marginal consumer is presented in Figure 4.3. The analysis is similar to case 3, so we present only prices charged and corresponding profits.[10]

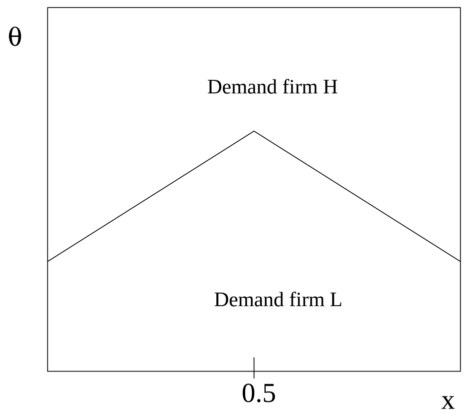

Figure 4.3: Market shares in case 4

Prices are

$$p_L^* = \frac{1}{4} + \frac{c}{3} \quad \text{and} \quad p_H^* = \frac{3}{4} + \frac{2c}{3}. \tag{4.14}$$

Corresponding profits are:

$$\Pi_L^* = \left[\frac{1}{4} + \frac{c}{3}\right]^2 \quad \text{and} \quad \Pi_H^* = \left[\frac{3}{4} - \frac{c}{3}\right]^2 - f. \tag{4.15}$$

Conversely to case 3, firm H now enjoys an advantage over its rival and can raise its price, while firm L has to reduce its price.

[10] Again, as in case 3, restrictions on the parameter ensure that the line of marginal consumers is always between 0 and 1 for all values of $x \in [0, 1]$.

4.4 Equilibrium product variety

This section analyzes the first stage of the game where firms decide on how much product variety to offer. When making this decision firms take into account the results from the subsequent price competition stage. Since firms' decision to offer product variety is restricted to be a discrete choice variable—either the product line or a single variant—the first stage of the game can be displayed in normal form as is done in Figure 4.4.

		Firm L: single product	Firm L: product line
Firm H	single	$[\frac{2-c}{3}]^2, [\frac{1+c}{3}]^2$	$[\frac{7}{12} - \frac{c}{3}]^2, [\frac{5}{12} + \frac{c}{3}]^2 - f$
	line	$[\frac{3}{4} - \frac{c}{3}]^2 - f, [\frac{1}{4} + \frac{c}{3}]^2$	$[\frac{2-c}{3}]^2 - f, [\frac{1+c}{3}]^2 - f$

Figure 4.4: Choice of product variety

The following result describes equilibrium product variety:[11]

Result 4.1

- *Low costs of providing quality ($c < \frac{3}{8}$): If the fixed costs for variety are low ($f \leq \frac{7+8c}{144}$), both firms offer the product line. For high values of f ($f \geq \frac{17-8c}{144}$) both firms produce a single variant. For intermediate values of fixed costs ($\frac{7+8c}{144} \leq f \leq \frac{17-8c}{144}$) the high-quality firm offers the product line while the low-quality producer offers a single variant.*

- *High costs of providing quality ($c > \frac{5}{8}$): If the fixed costs for variety are low ($f \leq \frac{15-8c}{144}$), both firms offer the product line. For high values of f ($f \geq \frac{9+8c}{144}$) both firms produce a single variant. For intermediate values of fixed costs ($\frac{15-8c}{144} \leq f \leq \frac{9+8c}{144}$) the low-quality firm offers the product line while the high-quality producer offers a single variant.*

- *Intermediate costs of providing quality ($\frac{3}{8} \leq c \leq \frac{5}{8}$): If the fixed costs for the product line are low both firms offer the product line. If these costs are high, both firms offer a single variant. If these costs are intermediate, the outcome is asymmetric with one firm offering the product line and the other one offering a single variant.*

The structure of equilibrium depends on the difference in marginal costs associated with higher quality. The parameter c denotes this difference. As

[11] The derivation of this result is relegated to the appendix of this chapter.

seen in section 4.3, a low c benefits the firm that offers high quality, and a large c benefits the low-quality firm, respectively. This advantage in the pricing stage translates into an advantage in offering more variety. When costs of providing quality are low, we have three different outcomes depending on the level of f. When f is high, both firms offer a single product variant. When f is low, both firms offer the product line. For intermediate levels the outcome is asymmetric with the high-quality firm offering the product line, and the low-quality firm restricting its product choice to the single variant. These results are reversed when providing quality is very costly. For high (low) fixed costs for variety both firms choose the single variant (the product line). For intermediate costs, the low-quality firm offers more variety than the high-quality firm. When the cost difference for providing quality is intermediate, that is, neither firm enjoys too large advantages in the pricing stage, we have symmetric variety equilibria for either large or small costs for introducing the product line. In an intermediate region, the equilibrium outcome is asymmetric with one firm offering more variety than its competitor. For some parameter combinations the equilibrium may not be unique.

The following corollaries emerge directly from result 4.1:

Corollary 4.1 *When there are no costs of providing product variety* ($f = 0$)*, both firms offer the product line.*

When offering more product variety is costless, in equilibrium both firms choose to offer the product line. This equilibrium is in dominant strategies. Independent of the product variety offered by the competitor, a firm can gain by choosing the product line.

Corollary 4.2 *When marginal costs of production are the same for both qualities* ($c = 0$)*, the high-quality firm offers at least the same amount of product variety as the low-quality firm.*

Some authors, for instance Shaked and Sutton (1982), argue that sometimes providing higher quality is not associated with higher marginal production costs, but with one-time fixed costs for investment in better production technologies. In this case, the corollary states that the high-quality firm provides at least the same amount of product variety as the low-quality firm.

Corollary 4.3 *i) When the costs of providing quality are relatively low, the high-quality firm offers at least the same amount of product variety as the low-quality firm. ii) When the costs of providing quality are relatively high, the low-quality firm offers at least the same amount of product variety as the high-quality firm. iii) When the costs of providing quality are intermediate, either firm may offer more variety.*

This last corollary states conditions about the relative product variety offered by the two vertically differentiated firms. The firm enjoying an advantage in the pricing stage is more likely to offer more variety than its competitor. Hence, if c is low (high) firm H (firm L) offers at least the same level of product variety as its competitor.

Now we turn to the comparative statics properties of equilibrium product variety:

Result 4.2 *i) An increase in f tends to reduce product variety in both segments. ii) An increase in c tends to increase product variety in low-quality segment at the expense of variety in high-quality segment.*

It is clear that higher costs for supplying variety (f) reduce the incentives to offer the product line for both firms. An increase of the marginal cost for producing quality improves the competitive situation of firm L relative to firm H. Thus, firm L—in contrast to H—has higher incentives to offer the product line. Hence, a higher c makes more variety at the bottom more likely.

4.5 Welfare analysis

This section derives optimal product variety from a welfare point of view. As our benchmark we use total welfare, that is, the sum of consumer utility and industry profits. As prices are mere transfers between consumers and firms they are irrelevant for welfare. Thus, social welfare comprises four parts: The transportation costs of consumers, the benefits of quality, production costs, and the costs for offering variety. Relegating the derivation to the appendix, welfare in our four different cases is:[12]

$$W_1 = V - \underbrace{\frac{1}{4}}_{\text{transportation costs}} + \underbrace{\frac{8-2c-c^2}{18}}_{\text{benefits of quality}} - \underbrace{\frac{2-c}{3}c}_{\text{production costs}} - \underbrace{0}_{\text{variety costs}} \tag{4.16}$$

$$W_2 = V - \underbrace{0}_{\text{transportation costs}} + \underbrace{\frac{8-2c-c^2}{18}}_{\text{benefits of quality}} - \underbrace{\frac{2-c}{3}c}_{\text{production costs}} - \underbrace{2f}_{\text{variety costs}} \tag{4.17}$$

$$W_3 = V - \underbrace{\frac{3-2c}{24}}_{\text{transportation costs}} + \underbrace{\frac{29-10c}{72} - \frac{c^2}{18}}_{\text{benefits of quality}} - \underbrace{\frac{7-4c}{12}c}_{\text{production costs}} - \underbrace{f}_{\text{variety costs}} \tag{4.18}$$

$$W_4 = V - \underbrace{\frac{1+2c}{24}}_{\text{transportation costs}} + \underbrace{\frac{11-2c}{24} - \frac{c^2}{18}}_{\text{benefits of quality}} - \underbrace{\frac{9-4c}{12}c}_{\text{production costs}} - \underbrace{f}_{\text{variety costs}} \tag{4.19}$$

Comparison of welfare yields:

Result 4.3

- *Low costs of providing quality ($c < \frac{1}{2}$): If the fixed costs for variety are low ($f \leq \frac{1+5c}{36}$), welfare is maximized when both firms offer the product line. For high values of f ($f \geq \frac{8-5c}{36}$) welfare is maximized when both firms produce a single variant. For intermediate values of fixed costs ($\frac{1+5c}{36} \leq f \leq \frac{8-5c}{36}$) welfare is maximized when the high-quality firm offers the product line and the low-quality producer offers a single variant.*

- *High costs of providing quality ($c \geq \frac{1}{2}$): If the fixed costs for variety are low ($f \leq \frac{6-5c}{36}$), welfare is maximized when both firms offer the product line. For high values of f ($f \geq \frac{3+5c}{36}$) welfare is maximized when both*

[12]Here we assume that q_L is normalized to zero, thus $q_h = 1$. Consequently, only consumers of firm H derive benefits from quality.

firms produce a single variant. For intermediate values of fixed costs ($\frac{6-5c}{36} \leq f \leq \frac{3+5c}{36}$) welfare is maximized when the low-quality firm offers the product line while the high-quality producer offers a single variant.

Comparing optimal and equilibrium variety, we find that equilibrium variety can differ in three ways from the optimal one. Firstly, there can be too few variety, secondly there can be too much variety, and thirdly, variety can be provided by the wrong firm. However, optimal and equilibrium variety can also coincide, that is, for some parameter regions, the equilibrium is efficient. In the appendix we provide parameter spaces for which these inefficient outcomes can result.

Result 4.4 *i) Compared to the welfare optimum, equilibrium variety can be too large or too low. ii) Variety can be provided by the wrong firm. iii) Equilibrium and optimal variety can coincide.*

4.6 Semi-collusion

We already mentioned that firms may have an incentive to collude on reducing product variety. In symmetric outcomes, firms prefer less product variety as this involves lower costs. Here we study collusion when determining product variety. However, we assume that collusion in the sphere of pricing is not possible. Thus, we study a case of semi-collusion where firms collude only partially.[13] Our original game modifies as follows: In the first stage firms choose product variety as to maximize joint industry profits. To allow collusion to be profitable for both firms, we implicitly assume that side transfers among firms are possible.[14] In the second stage, firms cannot collude and hence compete in prices. The first result that emerges is pretty clear.

[13] Similar types of semi-collusion among firms is studied, for instance, by Friedman and Thisse (1993) with respect to location choice in a model of horizontal product differentiation, by Haeckner (1994) in a model of vertical product differentiation, and by Ringbom and Shy (2007) on refunds.

[14] The need of side payments to sustain collusion is demonstrated in the appendix to this chapter.

Result 4.5 *When firms can collude on product variety, both firms offering the product line is no equilibrium.*

This result is quite obvious. Prices and variable profits are the same when both firms offer the same level of variety, and by restricting product variety firms can save on fixed costs f. Thus, under semi-collusion there is an incentive to reduce variety.

The following result establishes the product variety choice that leads to maximal industry profits:

Result 4.6 *When firms can collude in their decision to offer product variety, but not on prices, the following configurations maximize industry profits:*

- *when costs for providing variety are high ($f \geq max(\frac{8c-3}{72}, \frac{5-8c}{72})$) industry profits are maximized when both firms offer a single product variety;*
- *when costs for quality are low ($c \leq \frac{1}{2}$) and fixed costs for additional variety not too high ($f \leq \frac{5-8c}{72}$), industry profits are maximized when the high-quality firm offers the product line and the low-quality firm offers a single variety;*
- *when costs for quality are high ($c \geq \frac{1}{2}$) and fixed costs for additional variety not too high ($f \leq \frac{8c-3}{72}$), industry profits are maximized when the low-quality firm offers the product line and the high-quality firm offers a single variety.*

Proof. By comparing profits from section 4.3.

The above result states variety choices that maximize industry profits. For high fixed costs of offering variety (f), both firms restrict their product range to a single variant. Interestingly, in some situations industry profits are maximized by asymmetric levels of product variety. When costs for providing quality are relatively low, it is the high-quality firm who provides more variety, while with high costs for quality it is the low-quality firm. The intuition for these asymmetric outcomes is the following: For products that match their preferences consumers have a higher willingness to pay, thus when providing more variety this firm can charge a higher price. Against this benefit two costs have to be weighed: First, the fixed cost f has to be paid. And second, the firm with less variety can charge less and makes less profits. However, it should be noted that for asymmetric outcomes side payments among firms may be needed to allow for profitable collusion for both firms.

We can compare product variety under semi-collusion with socially optimal variety:

Result 4.7 *Product variety under semi-collusion is too small.*

This result is not surprising. Semi-collusion reduces variety below the variety level which would be implemented by a social planner.

4.7 Conclusion

The aim of this paper is to analyze choice of product variety in a vertically differentiated industry. Two firms compete in this market. A firm that offers a high-quality product and a firm that offers a low-quality product. In this setup, we analyze the incentives to provide product variety. We find that advantages in price competition translate into larger product variety. If producing a high quality product is associated with relatively small marginal costs compared to the low-quality product, we find that it is more likely to observe more product variety in the high-quality segment. The opposite result emerges when the difference between marginal production costs in the high and low-quality segment is large. Then, the firm in the low-quality sector has an advantage in the pricing stage, and is hence more likely to offer more product variety than its competitor. High costs to offer additional product variety reduce the incentives to offer variety in both segments. When firms can collude in selecting product variety, firms have an incentive to restrict product variety which can be detrimental to welfare.

4.8 Appendix

4.8.1 Equilibrium product variety

Incentives for firm H

Given that L offers a single variant, H chooses the product line when $\left[\frac{3}{4} - \frac{c}{3}\right]^2 - f \geq \left[\frac{2-c}{3}\right]^2 \Leftrightarrow f \leq \frac{17-8c}{144} = f_1$. Given that L offers the product line, H chooses the product line when $\left[\frac{2-c}{3}\right]^2 - f \geq \left[\frac{7}{12} - \frac{c}{3}\right]^2 \Leftrightarrow f \leq \frac{15-8c}{144} = f_2$.

Incentives for firm L

Given that H offers a single variant, L chooses the product line when $\left[\frac{5}{12} + \frac{c}{3}\right]^2 - f \geq \left[\frac{1+c}{3}\right]^2 \Leftrightarrow f \leq \frac{9+8c}{144} = f_3$. Given that H offers the product line, L chooses the product line when $\left[\frac{1+c}{3}\right]^2 - f \geq \left[\frac{1}{4} + \frac{c}{3}\right]^2 \Leftrightarrow f \leq \frac{7+8c}{144} = f_4$.

Equilibrium for low c

Suppose $c < \frac{3}{8}$. Then the following Nash equilibria exist: i) Both firms offering the product line is an equilibrium if $f \leq min(f_2, f_4)$. When $c < \frac{3}{8}$, $min(f_2, f_4) = f_4$. Thus, both firms choose to offer the product line when $f \leq f_4$. ii) Both firms choosing the single variant is an equilibrium if $f \geq max(f_1, f_3)$. When $c < \frac{3}{8}$, $max(f_1, f_3) = f_1$. Thus, both firms choose to offer the single variant when $f \geq f_1$. iii) There exists an equilibrium with H choosing the product line and L choosing the single variant if $f \leq f_1$ and $f \geq f_4$. Together, $f_1 \geq f \geq f_4$. This interval is nonempty if $c < \frac{3}{8}$. iv) There exists no equilibrium with H choosing the single variant and L choosing the product line. For such an equilibrium to exist $f_3 \geq f \geq f_2$ which is not possible for $c < \frac{3}{8}$.

Equilibrium for high c

Suppose $c > \frac{5}{8}$. Then the following Nash equilibria exist: i) Both firms offering the product line is an equilibrium if $f \leq min(f_2, f_4)$. When $c > \frac{5}{8}$, $min(f_2, f_4) = f_2$. Thus, both firms choose to offer the product line when $f \leq f_2$. ii) Both firms choosing the single variant is an equilibrium if $f \geq max(f_1, f_3)$. When $c > \frac{5}{8}$, $max(f_1, f_3) = f_3$. Thus, both firms choose to offer the single variant when $f \geq f_3$. iii) There exists an equilibrium with L choosing the product line and H choosing the single variant if $f \leq f_3$ and $f \geq f_2$. Together, $f_3 \geq f \geq f_2$. This interval is nonempty if $c > \frac{5}{8}$. iv) There exists no equilibrium with L choosing the single variant and H choosing the product line. For such an equilibrium to exist $f_1 \geq f \geq f_4$ which is not possible for $c > \frac{5}{8}$.

Equilibrium for intermediate c

Here, the analysis is divided into three parameter regions.

$\frac{3}{8} \leq c < \frac{1}{2}$

i) If $f < f_4$, both firms offering the product line is the unique equilibrium. ii) If $f_4 < f < f_2$, firm H chooses the product line and firm L chooses the single variant. iii) If $f_2 < f < f_3$, there are two asymmetric equilibria with one firm offering the product line and the other firm offering the single variant. iv) If $f_3 < f < f_1$, firm H chooses the product line and firm L chooses the single variant. v) If $f > f_1$, both firms choose the single variant.

$\frac{1}{2} < c \leq \frac{5}{8}$

i) If $f < f_2$, both firms offering the product line is the unique equilibrium. ii) If $f_2 < f < f_4$, firm L chooses the product line and firm H chooses the single variant. iii) If $f_4 < f < f_1$, there are two asymmetric equilibria with one firm offering the product line and the other firm offering the single variant. iv) If $f_1 < f < f_3$, firm L chooses the product line and firm H chooses the single variant. v) If $f > f_3$, both firms choose the single variant.

$c = \frac{1}{2}$

Then $f_1 = f_3$ and $f_2 = f_4$. i) If $f < f_4 = f_2$, both firms offering the product line is the unique equilibrium. ii) If $f_4 = f_2 < f < f_3 = f_1$, there are two asymmetric equilibria with one firm offering the product line and the other firm offering the single variant. iii) If $f > f_1 = f_3$, both firms choose the single variant.

4.8.2 Welfare analysis

Here we provide the derivation of welfare in case 1 and in case 3. The derivation of cases 2 and 4 are similar and therefore omitted.

Case 1

Both firms offer a single variant, that is, consumers of both firms have to incur transportation costs. They amount to

$$T = 2\int_0^{\frac{1}{2}} (x - \frac{1}{2})dx = \frac{1}{4}. \tag{4.20}$$

Firm H offers a product of quality $q_h = 1$, thus consumers of this firm gain utility from quality:

$$Q = \int_{\theta_m^*}^{1} \theta d\theta = \frac{4}{9} - \frac{c}{9} - \frac{c^2}{18}. \tag{4.21}$$

Production costs occur only for the high quality product. They are given by

$$C = D_H^* c = \frac{2-c}{3}c. \tag{4.22}$$

As both firms offer a single variant there are no fixed costs for providing variety. Hence, total welfare is given by:

$$W_1 = V - \underbrace{\frac{1}{4}}_{\text{transportation costs}} + \underbrace{\frac{8-2c-c^2}{18}}_{\text{benefits of quality}} - \underbrace{\frac{2-c}{3}c}_{\text{production costs}} - \underbrace{0}_{\text{variety costs}}. \tag{4.23}$$

Case 3

Firm L offers the product line and firm H a single variant. Hence, only consumers of firm H have to incur transportation costs. In light of Figure 4.2, we have to calculate transportation costs for two parts. First for consumers with $\theta \geq \theta_m^*(x=1)$ and second for consumers with $\theta < \theta_m^*(x=1)$:

$$\begin{aligned} T &= 2\int_{\theta_m^*(x=1)}^{1} \left[\int_{\frac{1}{2}}^{1} (x - \frac{1}{2})dx\right] d\theta & (4.24)\\ &+ 2\int_{\theta_m^*(x=\frac{1}{2})}^{\theta_m^*(x=1)} \left[\int_{\frac{1}{2}}^{x^*} (x - \frac{1}{2})dx\right] d\theta & (4.25)\\ &= 2\frac{1-c}{24} + 2\frac{1}{48} = \frac{3-2c}{24}. & (4.26) \end{aligned}$$

Benefits from quality are:

$$Q = 2\int_0^{\frac{1}{2}} \left[\int_{\theta_m^*}^1 \theta d\theta\right] dx = \frac{29}{72} - \frac{5c}{36} - \frac{c^2}{18}. \tag{4.27}$$

Production costs for the high quality product are:

$$C = D_H^* c = \frac{7-4c}{12}c. \tag{4.28}$$

Only firm L offers the product line, that is, fixed costs for variety are f. Summing up, total welfare in this case is:

$$W_3 = V - \underbrace{\frac{3-2c}{24}}_{\text{transportation costs}} + \underbrace{\frac{29-10c}{72} - \frac{c^2}{18}}_{\text{benefits of quality}} - \underbrace{\frac{7-4c}{12}c}_{\text{production costs}} - \underbrace{f}_{\text{variety costs}}. \tag{4.29}$$

4.8.3 Comparison optimal vs. equilibrium variety

Here, we provide examples for the market failures that can arise. We focus on two parameter regions to demonstrate the existence of the market failures summarized in result 4.4, namely $c < \frac{1}{4}$ and $\frac{3}{8} < c < \frac{1}{2}$.

First, suppose $c < \frac{1}{4}$. The outcome then depends on f. Compared to the welfare benchmark, too much or too low variety can be provided in equilibrium. i) $f > \frac{8-5c}{36}$: Equilibrium and optimal variety coincide. Both firms offer the single variant. ii) $\frac{17-8c}{144} < f < \frac{8-5c}{36}$: In equilibrium, both firms offer the single variant, optimal however, is that firm H offers the product line and firm L the single variant. Hence, variety is too low. iii) $\frac{7+8c}{144} < f < \frac{17-8c}{144}$: Equilibrium and optimal variety coincide. Firm H offers the product line and firm L the single variant. iv) $\frac{1+5c}{36} < f < \frac{7+8c}{144}$: In equilibrium, both firms offer the product line. Optimal, however, is that firm H offers the product line and firm L the single variant. Hence, too much variety is provided. v) $f < \frac{1+5c}{36}$: Equilibrium and optimal variety coincide. Both firms offer the product line.

Second, suppose $\frac{3}{8} < c < \frac{1}{2}$. For this parameter region, depending on f, optimal product variety can by symmetric (both firms offering the line / the single variant) or asymmetric with firm H offering the product line and firm L the single variant. From a welfare point of view an asymmetric outcome with firm L offering the product line and firm H a single variant is never optimal. However, this outcome may arise in equilibrium, such that variety is provided by the "wrong" firm.

4.8.4 Semi-collusion

Here, we demonstrate the need of side transfers to sustain collusion on variety. We focus on the case of $c < \frac{3}{8}$. Combining results 4.1 and 4.6, we can distinguish four parameter regions;

i) $f > \frac{17-8c}{144}$: The outcomes under competition and semi-collusion are identical. Both firms offer the single variant.

ii) $\frac{17-8c}{144} > f > \frac{10-16c}{144}$: Outcomes under competition and semi-collusion differ. Under semi-collusion, both firms should offer the single variant. Under market competition, however, firm H offers the product line and firm L the single variant. In this case, a side transfer is needed to sustain collusion. This payment must be made from firm L to firm H. Hence, this payment can be interpreted as a compensation not to offer the product line. The payment must be at least $\frac{17-8c}{144} - f$.

iii) $\frac{10-16c}{144} > f > \frac{7+8c}{144}$: The outcomes under competition and semi-collusion are identical. Firm H offers the product line and firm L offers the single variant.

iv) $\frac{7+8c}{144} > f$: Outcomes under competition and semi-collusion differ. Under semi-collusion, firm H should offer the product line and firm L the single variant. Under market competition, however, both firms offer the product line. Again, a side transfer is needed to sustain collusion. This payment must be made from firm H to firm L and can be interpreted as a compensation not to offer the product line. This payment must be at least $\frac{7+8c}{144} - f$.

Part II

Shopping Hours

Chapter 5

Liberalization of Opening Hours with Free Entry[1]

5.1 Introduction

This and the following chapter address the issue of opening hours in the retail industry and its liberalization. In the public and political debate, this topic is controversial. Though there has been a substantial trend towards deregulation in recent years, the debate is still ongoing. Restrictions on business hours differ a lot among European countries. For instance, in the UK and Sweden opening hours in the retail industry are much more liberalized than in France or Norway. In Germany, opening hours were highly regulated for the last decades but have been liberalized recently.

The focus of the present chapter is on the relationship between liberalization of opening hours and concentration in the retail sector. To this aim, a model of retail competition with free entry in the spirit of Salop (1979) is used. In contrast to his model, competition between retailers takes place in two dimensions. First, retailers compete in prices and second they compete in opening hours. The question is whether the competitive outcome is optimal or if restrictions on opening hours can improve total welfare. The model suggests that the competitive outcome without any restrictions on opening hours leads to a market failure with excessive entry into the market and under-provision of business hours. Hence, restrictions on opening hours

[1] An earlier version of this chapter is Wenzel (2007).

do not help to improve on the market outcome. Even worse, regulating opening hours works in the opposite direction. By restricting opening hours even further entry is induced. Thus, restrictions on business hours are not adequate to improve welfare but aggravate the market failure. Departing from the usual assumption of inelastic demand we find that the result of under-provision of business hours in a competitive market remains robust. However, the degree of the market failure rises the more elastic demand is. Analyzing the impact of a liberalization of opening hours, the model indicates that in the short run—where entry and exit in the market is not possible—prices remain constant. However, in the long run when the number of stores can adjust retail prices increase and the concentration in the retail sector increases. There may also be a positive effect on employment from liberalization as total industry opening hours increase.

Beyond the public debate, the issue of business hours (and its liberalization) has attracted considerable interest in the literature in recent years. Particularly, models are developed in which the choice of opening hours acts as a strategic variable in competition. Early contributions are de Meza (1984), Kay and Morris (1987) and Ferris (1990). Kay and Morris (1987) show under which conditions free competition may lead to excessive opening hours, however, they conclude from empirical evidence that this outcome is quite unlikely in reality. As the present paper, de Meza (1984) and Ferris (1990) use models based on Salop (1979). However, both papers relate shopping hours with transportation costs. Longer shopping hours tend to reduce transportation costs. Therefore, the impact of shopping hours depends very much on the location of a consumer. Assuming shopping hours to be linked to transportation costs has some appeal if the horizontal dimension in the Salop model is interpreted as physical location. However, this assumption seems less plausible if interpreted as a taste dimension.

Consequently, more recent models—also based on spatial models of product differentiation–make a clear distinction between the horizontal dimension and the impact of shopping hours on consumer utility. Inderst and Irmen (2005) consider a two-stage model with competition in prices and opening hours. In a model with two symmetric firms, firms can use shopping time strategically as an additional means to relax price competition by choosing asymmetric opening hours. Similarly, Shy and Stenbacka (2007) analyze a retail industry where competition takes place in opening hours and prices.

The focus of their study is on the impact of different shopping time flexibility assumptions. They study scenarios where consumers are bi-directional, that is, if a shop is closed at their preferred shopping time, consumers can postpone or advance their shopping. Furthermore, they explore situations where consumers are either forward- or backward-oriented, that is, they can either postpone or advance. The next chapter of this thesis also contributes to this literature by extending prior work to study competition over opening hours between large retail chains and smaller competitors. While the former contributions use models where consumers are distributed uniformly along the time dimension, Shy and Stenbacka (2006) analyze a setting where consumers' ideal shopping times are distributed non-uniformly. However, they treat prices as fixed.

The present chapter differs from the existing literature in several ways: Following more recent contributions, we make an explicit distinction between the taste dimension and the impact of shopping hours on consumer utility. In this setup we allow for free entry. Furthermore, opening hours are modeled as a vertical attribute as longer opening hours create more flexibility in shopping behavior in the eyes of consumers. Lastly, in Shy and Stenbacka (2007) and in Inderst and Irmen (2005) retailers are restricted to a discrete choice set of opening hours. In contrast, the present paper allows for a continuous choice of opening hours.

The remainder of the chapter is structured as follows: Section 5.2 introduces the model. Section 5.3 describes the equilibrium under liberalized opening hours. Section 5.4 compares the competitive outcome to the socially optimal one. Section 5.5 describes the equilibrium under regulated opening hours and analyzes the impact of deregulation. Section 5.6 extends the base model to price-dependent demand. Finally, section 5.7 concludes.

5.2 Model setup

We adopt the well-known Salop (1979) model with a modification to incorporate opening hours. Consumers in this market have preferences over a horizontal dimension and over opening hours.[2]

[2]From a technical point of view, the extension used here is similar to Economides (1993) who analyzes quality choice in the Salop model. Similar approaches are also used

5.2.1 Consumers

Consumers are uniformly distributed on a circle of circumference one, representing the spatial dimension. The location of a consumer, denoted by x, is interpreted as his most preferred variety (or alternatively as his preferred shopping location). There is a disutiliy cost if no store offers this variety. In contrast to the recent approaches by Inderst and Irmen (2005) and Shy and Stenbacka (2007, 2006), we model business hours as a vertical attribute, that is, all consumers have a preference for longer opening hours.[3] The idea is that longer opening hours increase consumers' flexibility of deciding when to go shopping. This may be relevant when consumers are ex-ante uncertain about when they want to shop. Then, "opening hours might incorporate a real options value by creating flexibility in the eyes of consumers" (Shy and Stenbacka, 2007, p. 32). Another reason to model business hours as a vertical attribute lies in an argument by Kosfeld (2002). He argues that consumers may be uncertain about the precise timing of opening hours of a store. Then, stores with long opening hours (or the reputation of it) might be preferred by consumers.

Consumers have the following utility, U, if buying from store i:

$$U = V - td_i + \theta h_i - p_i, \tag{5.1}$$

where d_i denotes the distance from the most preferred variety, and the parameter t is the associated measure of transportation costs. The variable h_i denotes the length of opening hours of the retailer's store while the parameter θ measures the benefit a consumer derives from an additional opening hour. Hence, this is the benefit consumers derive from increased opening hours due to more flexibility. The price, p_i, that the consumer is charged is deducted from utility. The gross utility from consuming the retail product, V, is assumed to be high enough such that each consumer buys. Further-

to study advertising in media markets, e.g. Anderson and Coate (2005) or Choi (2006). They introduce a variable reflecting nuisance of consumers due to advertising that affects consumers negatively and generates revenues, while we introduce a variable reflecting the length of opening hours that affects consumers positively, but entails a cost to the firm.

[3]In the models by Inderst and Irmen (2005), Shy and Stenbacka (2007, 2006) each consumer has an ideal shopping time. Consumers only care whether a store is open at that time or not. Thus, in their setup, consumers do not care about the length of shopping hours per se as is the case in the present model.

more, it is assumed that each consumer buys a single unit of the homogenous retail product. This assumption will be relaxed later in section 5.6. The total mass of consumers is normalized to one.

5.2.2 Retail stores

There are n retail stores, indexed by i, located equidistantly on the circle of circumference one. Without loss of generality store one is located at zero (one). The remaining stores are then located at $\frac{1}{n}, \frac{2}{n}, ... \frac{n-1}{n}$.

All retail stores face identical, constant marginal costs of production of the retail good. For simplicity, these costs are normalized to zero. Stores also face costs for their opening hours: These costs amount to $\frac{g}{2}h_i^2$. Hence, marginal costs of extending the opening time increase with the time already open. The economic rationale behind this assumption is that stores may have a higher wage bill when extending their business hours (e.g. overtime compensation, late night surcharges). Additionally, firms have to pay fixed costs of f for entering the market.

Competition between retail stores follows a two-stage game: In the first stage, potential entrants can simultaneously enter the market or stay out. In the second stage, those retailers who entered the market decide on price and opening hours. These two decisions are made simultaneously by all active retailers. The time structure imposed here reflects the fact that the entry decision is a long-term decision and that prices and opening hours can be changed relatively fastly.[4] Respecting the time structure, we look for a subgame-perfect equilibrium by applying backward induction.

To ensure that entry in the retail market is positive we make the following assumption:

Assumption 5.1

$$2tg - \theta^2 > 0.$$

[4]Alternatively, one could use a three stage game with entry in the first stage, choice of opening hours in the second stage and price competition in the last stage. However, this time structure does not change the qualitative results. Economides (1993) analyzes the differences that arise when the vertical variable (quality in his model) is chosen before price competition.

5.3 Equilibrium

This section derives the equilibrium.

5.3.1 Static equilibrium

In a first step we look for equilibrium prices and opening hours given a fixed number of stores in the retail market.

Given the symmetric structure of the model, we seek for an equilibrium in which all stores charge the same price and have identical opening hours.[5] We therefore consider the decision to be made by a representative store i. Take for instance the retail store located at zero. Competition in this model is local and takes place between store i and its two neighboring stores, $(i-1)$ and $(i+1)$. Starting with the store $(i+1)$, there is a consumer who is indifferent between buying from the shop located at zero and the shop located at $\frac{1}{n}$. This marginal consumer (x_m)—when firm i charges p_i and is open for h_i hours while the remaining $(n-1)$ retailers charge p and have opening hours of h—is implicitly given by

$$V - tx_m + \theta h_i - p_i = V - t\left(\frac{1}{n} - x_m\right) + \theta h - p, \tag{5.2}$$

or explicitly by

$$x_m = \frac{p - p_i + \theta(h_i - h) + \frac{t}{n}}{2t}. \tag{5.3}$$

Similarly, the retail shop faces a competitor located at $\frac{n-1}{n}$. The situation is symmetric, hence demand is given by $2x_m$. Demand depends positively on competitors' price and negatively on the own price. Longer own opening hours increase demand, and extended business hours at competitors' stores

[5] In the models by Inderst and Irmen (2005) and Shy and Stenbacka (2007) there are also asymmetric equilibria in which a priori symmetric stores choose asymmetric opening hours and prices. This result, however, is due to their assumption on the stores' choice of opening hours. In Shy and Stenbacka (2007), the opening hours variable is a discrete one: either a store opens full day or half day. In contrast, the present paper assumes that opening hours can be chosen continuously.

reduce demand. With the cost structure imposed, profits of the representative store are:

$$\Pi_i = \left[\frac{p - p_i + \theta(h_i - h) + \frac{t}{n}}{t} \right] p_i - \frac{g}{2} h_i^2 - f. \tag{5.4}$$

Retail stores decide simultaneously on prices and opening hours. The first-order conditions for the representative firm i are given by:

$$\frac{\partial \Pi_i}{\partial p_i} = 0 \Leftrightarrow 2p_i = p + \theta(h_i - h) + \frac{t}{n}, \tag{5.5}$$

$$\frac{\partial \Pi_i}{\partial h_i} = 0 \Leftrightarrow h_i = p_i \frac{\theta}{tg}. \tag{5.6}$$

The symmetric equilibrium values are then:

$$p^* = \frac{t}{n}, \tag{5.7}$$

$$h^* = \frac{\theta}{gn}. \tag{5.8}$$

Result 5.1 *i) The short-run equilibrium level of opening hours increases in θ and decreases in n and g. ii) The short-run equilibrium price increases in t and decreases in n.*

The equilibrium exhibits the expected properties of the equilibrium price. The price does not differ from the same model without opening hours (see Tirole (1988)). Price depends positively on the degree of product differentiation and negatively on the number of competitors in the market. The comparative static properties with respect to the equilibrium opening hours are more interesting. As might be expected opening hours depend positively on consumers valuation for increased shopping time flexibility and negatively on the costs for opening hours. Main result, however, is that opening hours depend negatively on the number of retail stores operating in the market. The reason for this result lies in the fact that a larger number of stores reduces the price and hence reduces the benefit of attracting customers via extended opening hours (see equation (5.6)).

5.3.2 Equilibrium with free-entry

The analysis above has derived opening hours and prices when the number of stores in the market is fixed exogenously. Now, we determine the number of stores that enter in a free-entry equilibrium. The number of these stores is denoted by n^c. Considering the prices and opening hours in the second stage (equation (5.7) and (5.8)), then n^c satisfies the zero profit condition:

$$\frac{t}{(n^c)^2} - \frac{g}{2}\left[\frac{\theta}{n^c g}\right]^2 - f = 0. \tag{5.9}$$

Solving for n^c explicitly gives the equilibrium number of retail stores in the market:[6]

$$n^c = \frac{\sqrt{2tg - \theta^2}}{\sqrt{2fg}}. \tag{5.10}$$

Assumption 5.1 ensures that there is a positive number of entrants into the market. The associated price and opening hours are then:

$$h^c = \frac{\theta}{gn^c} = \frac{\theta\sqrt{2fg}}{g\sqrt{2tg - \theta^2}}, \tag{5.11}$$

$$p^c = \frac{t}{n^c} = \frac{t\sqrt{2fg}}{\sqrt{2tg - \theta^2}}. \tag{5.12}$$

The equilibrium under free entry is hence characterized by equations (5.10), (5.11), (5.12).

Result 5.2 *i) With free entry the number of retail stores decreases with f and θ, and increases with t and g. ii) Opening hours increase with f and θ, and decrease with t and g. iii) The price increases with f and θ, and decreases with g. The impact of t on the price is ambiguous.*

Table 5.1 summarizes the comparative statics results. The impact of f and t on the number of stores is as expected. Higher fixed costs of entry reduce the number of firms and higher transportation costs as measured by t

[6] Literally, the number of retail stores has to be an integer. However, this integer problem is neglected here, and the number of stores is treated as continuous.

		Exogenous Variables			
		t	f	θ	g
Endogenous Variables	n^c	+	-	-	+
	p^c	?	+	+	-
	h^c	-	+	+	-

Table 5.1: Comparative statics results

increases the number of retailers that enter. More interesting are the comparative statics results on the number of retailers with respect to the costs and benefits of opening hours. Higher costs for extending opening hours g lead to more stores, and a higher valuation for shopping time flexibility decreases the number of stores. The reasoning behind these results is the following: As in equilibrium all stores have identical opening hours, no additional demand is attracted by longer opening hours. However, stores face the costs of opening. From the perspective in the first stage, these costs work like additional fixed costs on entry. Thus, factors that lead to longer (shorter) opening hours work like an increase (decrease) in costs of entry. Hence, a higher valuation for shopping time flexibility, leading to longer opening hours, leads to a smaller number of stores. The opposite holds for the costs of extending opening hours. This effect is an example of Sutton's endogenous sunk costs (Sutton, 1991).[7]

The comparative statics results concerning the length of opening hours are intuitive. Costs of entry and consumers' preferences for extended opening hours let shops expand their business hours as both tend to reduce the number of stores. The reverse holds for the transportation costs and the costs for extending business hours. Both factors induce more stores to enter and thus, have a negative impact on the length of opening hours chosen by the retailers.

The price increases with the fixed costs f and valuation for shopping time flexibility θ as these variables reduce the number of retail stores. Higher costs of extended business hours increase the number of stores and thus lead to a decrease in the price. The comparative statics property of the transportation cost parameter on the price is ambiguous. There are two

[7]Note that in Sutton's analysis the differentiation decision is made before the pricing decision. However, the different time structure has no impact on opening hours acting as an endogenous sunk cost.

effects at work, a direct one and an indirect one. The direct effect is that for a given number of retail stores a higher t leads to higher prices (see equation (5.7)). The indirect effect works via the number of stores. A higher t leads to more stores, and more stores lead to increased competition, and hence lower prices. Note that this indirect effect is stronger here than in the standard Salop model. The reason lies in the impact of the number of competitors on the choice of opening hours. A larger number of competitors reduces opening hours and so more retailers can survive in the market as costs are lower. When the influence of opening hours is strong ($\frac{\theta^2}{g} > t$), the indirect effect outweighs the direct one and larger transportation costs can lead to lower prices. However, when $\frac{\theta^2}{g} < t$, the direct effect is stronger and prices increase due to an increase in transportation costs.[8]

5.4 Welfare analysis

Does competition provide the socially optimal outcome? This section determines the socially optimal number of retail stores and their business hours. Social welfare is here defined as the sum of consumer utility (equation (5.1)) and profits of the retail industry (equation (5.4)). As prices are mere transfers between consumers and retailers they are irrelevant for welfare. Thus, social welfare, W, comprises four parts: The transportation costs of consumers, the benefit of extended opening hours, the costs due to opening hours, and the fixed costs of entry:

$$W = V - 2n \int_0^{\frac{1}{2n}} tx \; dx + \theta h - nf - n\frac{g}{2}h^2. \tag{5.13}$$

Welfare is maximized with respect to h and n. This gives the following first-order conditions:

$$h^s = \frac{\theta}{gn^s}, \tag{5.14}$$

$$\frac{t}{4(n^s)^2} = f + \frac{g}{2}(h^s)^2. \tag{5.15}$$

[8] In the standard Salop model the impact of transportation costs on prices in a free-entry equilibrium is unambiguous. Larger transportation costs lead to higher long-run prices.

These two equations describe the social optimum. Inspecting the first-order condition with respect to h it can be noticed that the opening hours chosen in the competitive market are optimal if the number of active firms is the optimal one (compare equation (5.14) with (5.8)). If the number of stores is too high (too low), opening hours are too short (long) in the market outcome compared to the social optimum.

Solving the two equations for n and h gives the optimal number of active firms and optimal opening hours explicitly:

$$n^s = \frac{\sqrt{\frac{tg}{2} - \theta^2}}{\sqrt{2fg}}, \tag{5.16}$$

and

$$h^s = \frac{\theta\sqrt{2fg}}{g\sqrt{\frac{tg}{2} - \theta^2}}. \tag{5.17}$$

Comparison with the free-entry equilibrium yields:

Result 5.3 *Compared to the social optimum, the market outcome leads to excessive entry behavior and opening hours that are too short.*

Proof. By comparing equation (5.10) with (5.16), and equation (5.11) with (5.17).

Result 5.3 presents the central result of the chapter. As in the original model by Salop (1979) entry is excessive. But in the present model the result of excessive entry has also an impact on the length of opening hours as it leads to under-provision of business hours. The present model argues that with free-entry opening hours are too short. Thus, further restrictions on opening hours are useless to correct for the market failure.

The literature delivers mixed welfare results. Ferris (1990) comes to the opposite conclusion than the present paper. He finds that shopping hours can be excessive and the number of stores that enter too low. As in his model extended opening hours reduce transportation costs, the marginal value for extending opening hours is larger the more distant a customer. This makes opening hours an effective instrument to attract customers located far away (the marginal consumer), but leads to excessive opening hours since for social welfare the average, and not the marginal, customer is relevant. This, in turn, leads to too few stores, as extended opening hours are costly. In Shy and Stenbacka (2006) a monopoly firm provides inefficiently short service hours. The reason lies in the fact that the firm does not internalize the costs of consumers who have to shift their business transactions to times when stores are open. The same reason leads in Shy and Stenbacka (2007) to the result that stores in a duopoly do not extend opening hours beyond the social optimum. However, in a setup with a partially served market, a monopolist may provide business hours that are too long from a welfare perspective. Along the same lines, in the model by Clemenz (1994) a monopolist extends opening hours beyond the social optimum. The reason in his model is that by extending opening hours a monopolist can attract more demand and hence raise prices.

5.5 Regulation of opening hours and liberalization

This section studies the impact of liberalization. Therefore, in a first step, we describe the outcome when opening hours are regulated. To analyze the impact of deregulation, the outcome under regulation is compared to the competitive outcome without any restrictions in section 5.3. Most of the results in this section follow directly from the welfare analysis.

5.5.1 Equilibrium under regulation

We start by characterizing the equilibrium under regulation. Consistent with the usual practice in many countries, there is an upper limit on the hours a retailer may stay open, $\overline{h}$. The analysis of regulated opening hours is then only interesting if the regulation is binding, i.e. retailers would like to open longer but are not allowed to. If firms would choose shorter opening hours the analysis would remain unchanged to the one in section 5.3. Thus we focus on the case with a binding regulation. This is ensured by

$$\overline{h} < h^c \Leftrightarrow \overline{h} < \sqrt{\frac{f\theta^2}{g(tg - \frac{\theta^2}{2})}} = h^{cr}. \tag{5.18}$$

Proceeding in an analogous way as in section 5.3 with opening hours being fixed to $\overline{h}$ the equilibrium with free entry under regulation is then characterized by:

$$\overline{n}^c = \frac{\sqrt{t}}{\sqrt{f + \frac{g}{2}\overline{h}^2}}, \tag{5.19}$$

$$\overline{p}^c = \frac{t}{\overline{n}^c} = \sqrt{t(f + \frac{g}{2}\overline{h}^2)}, \tag{5.20}$$

$$\overline{h}^c = \overline{h}. \tag{5.21}$$

Note that there is a positive relationship between the degree of regulation and the number of stores. The tighter regulation, that is, the lower $\overline{h}$, the more stores enter the market. That shows that regulations on opening hours worsen the competitive outcome. Instead of reducing entry—as is socially desirable—it induces even more entry.

So far, we have considered the impact of regulation on total welfare. Now we analyze the impact on consumer welfare. Regulation has two effects on consumer welfare, a direct and an indirect effect. The direct effect is that a binding regulation reduces the positive benefits of increased opening hours. The indirect effects works as a binding regulation increases the number of stores which in turn leads to lower prices and lower transportation costs for consumers. Consumer surplus (CS) comprises four parts: The gross utility of the retail good, the benefit of extended opening hours, transportation costs, and the price:

$$CS = V - \frac{t}{4n} + \theta h - p. \tag{5.22}$$

In the case of no regulation this modifies to:

$$CS^f = V - \frac{5t\sqrt{2fg}}{4\sqrt{2tg - \theta^2}} + \frac{\theta^2\sqrt{2fg}}{g\sqrt{2tg - theta^2}}. \tag{5.23}$$

In case opening hours are regulated consumer welfare is:

$$CS^r = V - \frac{5}{4}\sqrt{t(f + \frac{g\overline{h}^2}{2})} + \theta\overline{h}. \tag{5.24}$$

However, it turns out that the direct effect outweighs the indirect one, that is, $CS^f > CS^r$ if $\bar{h} < h^{cr}$:

Result 5.4 *Consumers do not benefit from regulated opening hours.*

Proof. To show: $CS^f > CS^r$ if $\overline{h} < h^{cr}$. We proceed in two steps. i) $CS^f = CS^r$ if $h = h^{cr}$. ii) $\frac{\partial CS^r}{\partial \overline{h}} > 0$ if $\overline{h} < h^{cr}$. Then, $CS^f > CS^r$ if $\overline{h} < h^{cr}$. ad i) by inserting h^{cr} into C^r. ad ii) $\frac{\partial CS^r}{\partial \overline{h}} = -\frac{5tg\overline{h}}{8\sqrt{t(f+\frac{g\overline{h}^2}{2})}} + \theta \Leftrightarrow \overline{h}^2 < \frac{64\theta^2 f}{g(25tg-32\theta^2)} = \hat{h}$. As $\hat{h} > h^{cr}$, it follows that $\frac{\partial CS^r}{\partial \overline{h}} > 0$ if $\overline{h} < h^{cr}$.

Together with result 5.3, result 5.4 is important for policy conclusions. By regulating opening hours, neither total welfare nor consumer welfare can be raised. Therefore, independent whether a policy maker favors a consumer or a total welfare standard, in this model restrictions of opening hours are not an adequate tool.

5.5.2 Impact of liberalization

The liberalization removes the limit $\overline{h}$. We study the impact in two steps. The short-run impact assumes that the number of retailers is still at its pre-liberalization level. The long-run impact takes the change in the number of retailers into account.

Result 5.5 *Impact of deregulation. i) In the short run after a liberalization prices remain unchanged and opening hours are longer. ii) In the long run the number of retailers decreases, the price increases, and opening hours increase compared to the pre-deregulation level and to the level immediately after deregulation. iii) Liberalization leads to higher total industry opening hours.*

Proof. i) follows from equation (5.7) and assumption of binding regulation. ii) $n^c < \overline{n}^c \Leftrightarrow \overline{h} < h^{cr}$, that holds under the assumption that regulation is binding. $p^c > \overline{p}^c \Leftrightarrow \frac{t}{n^c} > \frac{t}{\overline{n}^c}$. Since $n_c < \overline{n}^c$ this is true. To show $h^c > h^* > \overline{h}$. a) $h^c > h^* \Leftrightarrow \frac{\theta}{gn^c} > \frac{\theta}{g\overline{n}^c}$. Since $n_c < \overline{n}^c$ this is true. b) $h^* > \overline{h}$ if regulation is binding, $\overline{h} < h^{cr}$. Hence, $h^c > h^* > \overline{h}$. iii) $n^c h^c > \overline{n}^c \overline{h} \Leftrightarrow \overline{h} < h^{cr}$ which is true under the assumption of binding regulation.

As in the short-run after liberalization the number of stores remains constant, so does the price. This result is consistent with the impact of deregulation in models without entry as long as stores choose symmetric opening hours. Under asymmetric configurations—one store opens longer or stores open at different times—prices may change due to deregulation (Inderst and Irmen, 2005; Shy and Stenbacka, 2007). Opening hours increase as we assumed that regulation is binding.

In the long-run the number of retailers will decrease. This follows from the fact that opening hours are longer after the liberalization. As this results in higher costs without generating additional demand in equilibrium, the number of retailers that can survive in the market is lower. Therefore, a long-run consequence of liberalization is a higher concentration in the retail sector. This increase in concentration leads to higher prices for the retail good but also to a further increase in the length of opening hours. The result of higher prices due to liberalization is in contrast to de Meza (1984) and Clemenz (1990). De Meza (1984) finds that (for a fixed number of stores) prices are lower when shops are allowed to open Sundays than when they are not allowed, the reason being that the increased mobility of Sunday shoppers decreases firms' market power. In a model with consumer search Clemenz (1990) shows that liberalization of opening hours decreases prices as longer opening hours facilitate search activities.

Finally, total industry opening hours are higher after liberalization. If total industry opening hours can be interpreted as a measure of employment, liberalization of opening hours leads to more employment in the retail industry. This is consistent with empirical evidence. For example, Skuterud (2005) finds a positive employment effect due to deregulation of opening hours on Sundays in Canada. In his study, he estimates 8 to 12% more employment in the retail sector. Burda and Weil (2005) find evidence for the US that restrictions on opening hours reduce (mainly part-time) employment.

5.6 Price-dependent demand

In the base model it is assumed that each consumer buys a single unit of the retail good—independent of the price. In this section, we depart from this assumption and consider the case when the amount of the retail good bought by consumers depends on the price. However, we assume that the amount bought does not depend on the length of shopping hours. This assumption seems to be justified by empirical evidence (Skuterud, 2005). Following our approach from chapter 3 we assume the following utility function:[9]

$$U = \begin{cases} \left(V + \theta h_i - \frac{\epsilon}{1-\epsilon} q_i^{\frac{\epsilon-1}{\epsilon}} - t d_i\right) + q_h & \text{if a consumer buys the retail good } i \\ q_h & \text{otherwise.} \end{cases} \tag{5.25}$$

The utility function now includes a term to capture the impact of the quantity of the retail good ($\frac{\epsilon}{1-\epsilon} q_i^{\frac{\epsilon-1}{\epsilon}}$). The parameter $\epsilon \in (0, 1)$ denotes the demand elasticity. The variable q_h denotes the consumption of a numeraire good whose price is normalized to one. We skip further derivations and directly proceed with the main results:

Result 5.6 *Welfare analysis with price-dependent demand. i) Opening hours in a free-entry equilibrium are always too low. ii) The degree of under-provision rises with the demand elasticity. iii) Entry can be excessive or insufficient*

The main result of the paper, namely the under-provision of business hours in a competitive equilibrium, is robust to the introduction of price-dependent demand. However, the degree of under-provision may be understated in models with inelastic demand as the gap between shopping hours chosen in a free-entry equilibrium and the ones that maximize social welfare widens as the demand elasticity rises. In the limiting case of $\epsilon \to 1$ the gap is maximal as business hours approach zero. In the base model the under-provision of business hours was due to excess entry into the market. Here, another factor is of importance: The impact of the demand elasticity on the degree of competition. A higher demand elasticity makes competition harder and hence reduces retail prices. When prices are lower firms have less incentive to attract customers via costly business hours as the benefits are low. As a side result we find—as in chapter 3—that entry into the retail market can be excessive or insufficient.

[9]As we use our approach from chapter 3 we also employ the assumption that quantity demanded does not depend on transportation costs.

5.7 Conclusion

This chapter analyzes competition in business hours in an oligopoly model with free entry. It is shown that competitive markets lead to opening hours that are too short compared to the socially optimal level. The extent of under-provision of opening hours rises with increasing demand elasticity. Regulations on opening hours do not attenuate the market failure but worsen the outcome. Studying the impact of a liberalization of shopping hours we show that the impact in the longer run differs from the short-run effect. While in the short run prices remain constant, in the long run they increase. This is due to the fact that after liberalization retail market concentration rises. In accordance with empirical evidence the model predicts that employment in the retail industry should rise.

In this paper we argue that from a competition policy point of view there are no reasons to regulate opening hours. However, there may be reasons for having shop opening regulations which lie outside competition policy. For instance, as argued by Burda and Weil (2005), shop opening regulations can make sense if people enjoy spending leisure time together. Thum and Weichenrieder (1997) argue that consumers may be heterogenous with respect to the benefits of extended opening hours: Double-income families may prefer less regulated shopping hours than traditional single-income families. They explore the political economy of regulating shopping hours. The larger the share of double-income families the more likely there is no regulation.

Chapter 6

Deregulation of Opening Hours: Corner Shops vs. Chain Stores

6.1 Introduction

The model of the previous chapter is a completely symmetric one. All firms are alike and in equilibrium choose identical prices and opening hours. Thus, in this chapter we will turn to the issue when firms are not alike, but asymmetric. Specifically, we will consider competition between a large retail chain and a smaller competitor. The impact of deregulation of opening hours on competition between large and small retailers is particular controversial in the policy debate. Smaller competitors fear that they cannot match shopping hours of large retail chains, which may lead to fewer consumers shopping at small shops. In consequence, deregulation of shopping hours could lead to the exit of small shops. The present study develops a theoretical model to analyze the impact of deregulated shopping hours on competition between large and small retailers. Therefore, we aim to contribute to the policy debate by offering a framework in which to discuss the impact of deregulation on small firms.

For this purpose the following stylized situation is analyzed: There are two firms in a retail market. One firm is a 'retail chain' that operates multiple stores, the other firm is a 'corner shop' that operates a single store. Those two firms compete in a spatially differentiated industry. Competition is modeled in two stages. First, retailers can choose their business hours. Second, they compete in prices. We use this model to analyze the choice of shopping hours under deregulation, that is, shopping hours can be chosen without constraints and contrast this outcome with the one under regulated shopping hours.

We find that without regulation smaller retailers do not choose shorter business hours than large retail chains, but in some circumstances, they even choose longer opening hours. The impact of deregulation is also noteworthy. For non-trivial deregulations, a retail chain always loses by deregulation. In contrast, smaller stores may gain from deregulation in situations where deregulation leads to asymmetric business hours, but lose in situations when deregulation leads to symmetric business hours. These results are attained assuming that both types of stores are equally efficient, that is, both types of stores have the same cost structure. Re-analyzing the model with efficiency advantages for larger retail chains—be it due to more buyer power, more efficient organizational structures, or economies of scale—shows that our results are reversed for sufficiently large efficiency differences between the two types of retailers. Then, smaller retailers might lose in terms of customers and profits due to deregulation. In light of the present analysis, the fear of small retailers of losing in competition with large retail chains is only justified when chains are much more efficient. The problem for smaller retailers lies not in deregulation of shopping hours per se, but only in combination with lower efficiency.

Competition over business hours between large and small retailers is also studied by Morrison and Newman (1983), Tanguay, Vallee, and Lanoie (1995) and Inderst and Irmen (2005). Morrison and Newman (1983) associate small stores with high prices and low access costs, and large stores with low prices and high access costs. Longer opening hours decrease access costs. In their setup deregulation then leads to a redistribution of sales from small to large stores. However, their setup is highly parameterized. Neither prices, access costs (via location) nor opening hours are determined endogenously. Tanguay, Vallee, and Lanoie (1995) extend the model of Morrison and Newman (1983) by making the price choice endogenous. They find that following a deregulation prices at large stores increase while prices decrease at small stores, the reason being that longer opening hours increase demand at the large store at the expense of the small store. As in Morrison and Newman (1983), the choice of opening hours is not endogenous. In an extension to their symmetric base model, Inderst and Irmen (2005) consider competition between large and smaller retailers. The advantage of their approach is that the choice of opening hours is endogenous. However, they simply associate shop size with cost advantage. Their result is then that larger stores are more likely to have longer shopping hours. The present chapter complements their work on the impact of deregulation of business hours on different types of retailers. We construct a model where a retail chain is modeled explicitly by operating several stores, and a small shop just a single store. As in Inderst and Irmen (2005), price choice and choice of opening hours are endogenous.

The chapter proceeds as follows: Section 6.2 describes the model setup. Section 6.3 analyzes the price game. Section 6.4 considers the choice of shopping hours. Section 6.5 describes the impact of a deregulation. In section 6.6, we discuss two extensions of the base model. Section 6.7 concludes.

6.2 Model setup

The model setup draws on Inderst and Irmen (2005) and Shy and Stenbacka (2007), but extends their work to asymmetric firm types. Consider a spatially differentiated retail industry in the spirit of Salop (1979). Consumers in this market have preferences over the location of retail stores and over opening hours. There are two firms. One firm is a 'corner shop' and operates a single store. The second firm is a 'retail chain' operating several stores. These stores are located exogenously on a circle of circumference one. Similar extensions with one firm owning several stores on the Salop circle are, for example, Levy and Reitzes (1992) and Giraud-Heraud, Hammoudi, and Mokrane (2003).[1]

[1]Levy and Reitzes (1992) study the impact of mergers on the Salop circle. In Giraud-Heraud, Hammoudi, and Mokrane (2003), competition between one multi-store firm and several single-store firms is studied. In contrast to the present model, in both papers firms compete only in prices. Gal-Or and Dukes (2006) use a similar model variant to study the impact of mergers in media markets. In their setup, media firms compete in prices and advertising ratios.

6.2.1 Consumers

Consumers are uniformly distributed on a circle of circumference one, representing the spatial dimension ('spatial circle'). The location of a consumer, denoted by x, is interpreted as his most preferred shopping location. If there is no store at his preferred location, the consumer has to incur some costs to travel to the next store. Additionally, each consumer has a preferred shopping time (h). Time is here modeled as a unit circle ('time circle'). If a store is closed at the preferred shopping time, consumers can either postpone or advance their shopping. In the terminology of Shy and Stenbacka (2007), consumers are bi-directional. Again, consumers are assumed to be uniformly distributed on the 'time circle'. Hence, consumers can be characterized by the tuple (x, h). Both attributes are distributed independently, and the mass of consumers is normalized to one.

A consumer (x, h) derives the following utility, U, from buying at a store i. The utility depends on whether the store is open or closed at the consumer's preferred shopping time:

$$U = \begin{cases} V - p_i - td_i & \text{open at preferred time} \\ V - p_i - td_i - \tau \min |h - h_c, h_o - h| & \text{closed at preferred time,} \end{cases} \tag{6.1}$$

where V represents the gross valuation from buying the retail good. We assume that V is high enough such that no consumer abstains from buying. From gross utility, the price p_i and transportation costs are deducted. Transportation costs are linear with transportation cost parameter t, d_i denotes the distance from the preferred shopping location. If the store is closed at the consumer's preferred shopping time, additional inconvenience costs for shifting the shopping are deducted. Consumers can advance or postpone shopping. Optimally, this decision is done by minimizing $|h - h_c, h_o - h|$, where h_o (h_c) denotes the opening (closing) time of the store. The parameter τ in the utility function represents consumers' willingness to deviate from their preferred shopping time. The higher τ, the less people like to adjust their shopping time.

6.2.2 Retailers

Two firms operate in the retail market. The corner shop owns a single store. In the base model the retail chain owns two stores. In section 6.6, we will relax this assumption and study the case of an arbitrary number of stores owned by the retail chain. For now, there are only 3 stores in the market. Firms' stores are located equidistantly on the spatial circle. The corner shop is positioned at zero. The stores of the chain are then positioned at $\frac{1}{3}$ and $\frac{2}{3}$.

Firms can decide on the price of their product and on the length of opening hours. Following Inderst and Irmen (2005) and Shy and Stenbacka (2007), the choice of opening hours is a discrete one: a store can either be open part-time or full-time. The time period $h \in [0, \frac{1}{2}]$ represents day-time, and the period between $h \in [\frac{1}{2}, 1]$ represents the night-time. We assume that the opening time of each store is $h_o = 0$.[2] If a store is open part-time, the closing time is $h_c = \frac{1}{2}$, and if a store is open full-time, the closing time is $h_c = 1$. Thus, we interpret part-time as being open during day-time and full-time as being open day and night. We make the additional assumption that the retail chain is bound to choose uniform opening hours for all its stores.

Firms have the following cost structure: The retail good is produced without costs. For opening during day-time, firms have to pay a fixed cost of f_d which is normalized to zero. For opening full-time, an additional cost of $f_n = f > 0$ has to be paid for the night-time. Here, we assume that both types of firms have the same cost structure. In section 6.6, we will relax this assumption and assume that the retail chain has lower costs.

Competition between the retailers follows a two-stage game: In the first stage, firms have to decide on their opening hours. In the second stage of the game, firms decide on the prices they charge.[3] Thus, we look for a subgame-perfect equilibrium.

[2] In the appendix to this chapter, we analyze the case when retailers can choose differing opening times leading to non-intersecting shopping hours, that is, one retailer chooses to open during day-time, and the other during night-time. We show that this case is equivalent to symmetric opening hours, and hence, does not change our results.

[3] We do not allow firms to charge different prices during day and night-time. Thus, intertemporal price discrimination is not studied.

The following assumption is imposed on the parameter values:

Assumption 6.1
$$\frac{t}{\tau} > \frac{15}{16}.$$

This assumption ensures that differentiation along the spatial dimension is such that a retail store will not lose all consumers for any time preference h when it has shorter opening hours than the neighboring store. A similar assumption is made in Shy and Stenbacka (2007).

6.3 Price competition

We start our analysis with the second stage of the game, that is, retailers' price choice for given opening hours. As each retailer has two choices of opening hours, we have to consider four different cases, two symmetric ones and two asymmetric ones. These are the following:

- both retail firms are open full-time,
- both retail firms are open part-time,
- the retail chain is open full-time, the corner shop is open part-time,
- the corner shop is open full-time, the retail chain is open part-time.

6.3.1 Case 1: Symmetric opening hours

When retailers have symmetric opening hours, the analysis is identical whether stores are open full-time or part-time. To see this, we start by deriving the marginal consumer between the corner shop, located at zero, and the chain store located at $\frac{1}{3}$. From equation (6.1), this consumer is implicitly given by $V - p_s - tx_m = V - p_1 - t(\frac{1}{3} - x_m)$ when both stores are open at the consumer's preferred shopping time and by $V - p_s - tx_m - \tau \min|h - 0.5, 1 - h| = V - p_1 - t(\frac{1}{3} - x_m) - \tau \min|h - 0.5, 1 - h|$ when both stores are closed at the preferred shopping time. The prices charged by the retailers are p_s for the corner shop, and p_1 (p_2) for chain store 1 (2). Then, with symmetric shopping hours, the marginal consumer is independent of his preferred shopping time h and is given by:

$$x_m = \frac{1}{6} + \frac{p_1 - p_s}{2t}. \tag{6.2}$$

Similarly, one can derive the marginal consumer between the corner shop and chain store 2 located at $\frac{2}{3}$. Demand for the corner shop then is

$$D_s = \frac{1}{3} + \frac{p_1 + p_2 - 2p_s}{2t}. \tag{6.3}$$

Analogously, one can derive demand for the stores owned by the retail chain. The profit of the corner shop is:[4]

$$\Pi_s = p_s \left[\frac{1}{3} + \frac{p_1 + p_2 - 2p_s}{2t} \right]. \tag{6.4}$$

The profit of the chain is the sum of individual profits of the two stores:

$$\Pi_c = p_1 \left[\frac{1}{3} + \frac{p_s + p_2 - 2p_1}{2t} \right] + p_2 \left[\frac{1}{3} + \frac{p_s + p_1 - 2p_2}{2t} \right]. \tag{6.5}$$

Both firms choose prices so as to maximize their profits. Equilibrium prices are then

$$p_s^* = \frac{4}{9}t, \tag{6.6}$$

and

$$p_1^* = p_2^* = p_c^* = \frac{5}{9}t. \tag{6.7}$$

Comparing the prices charged by the retailers, one notes that the chain store charges a higher price than the corner shop. This result is intuitive. The retail chain internalizes the impact of a price increase on its neighboring stores, thus leading to higher prices charged by the retail chain. This is also shown in Giraud-Heraud, Hammoudi, and Mokrane (2003) and Levy and Reitzes (1992).

[4]We use the subscript s to denote the corner shop, and the subscript c to denote the retail chain.

In equilibrium, retailers earn the following profits:

$$\Pi_s^* = \left(\frac{4}{9}\right)^2 t, \tag{6.8}$$

$$\Pi_c^* = \left(\frac{5}{9}\right)^2 t. \tag{6.9}$$

In the case of both retail firms opening full-time, the costs for the extended opening hours have to be subtracted. These costs are f for the corner shop, and $2f$ for the retail chain.

6.3.2 Case 2: Retail chain is open full-time, corner shop is open part-time

We turn now to the first asymmetric case. Stores operated by the chain are open full-time and the corner shop is open part-time. Again, we determine the marginal consumer. For those consumers whose preferred shopping time is the day-time ($h \in [0, \frac{1}{2}]$), the situation is the same as before as both firms are open during the day. Only for those consumers whose preferred shopping time is during night-time ($h \in (\frac{1}{2}, 1)$), the decision may change. They can either buy at the chain store at their preferred time or postpone / advance their shopping and travel to the corner shop. The marginal consumer between the corner shop and chain store 1 is implicitly given by $V - p_s - tx_m - \tau * min[h - \frac{1}{2}, 1 - h] = V - p_1 - t(\frac{1}{3} - x_m)$. Optimally consumers with $h \in (\frac{1}{2}, \frac{3}{4})$ advance their shopping and those with $h \in (\frac{3}{4}, 1)$ postpone their shopping until the next day.

Summarizing, the marginal consumer—illustrated by Figure 6.1—depends on the preferred shopping time and is given by

$$x_m = \begin{cases} \frac{1}{6} + \frac{p_1 - p_s}{2t} & \text{for } h \in [0, \frac{1}{2}] \\ \frac{1}{6} + \frac{p_1 - p_s}{2t} - \frac{\tau}{2t}[h - \frac{1}{2}] & \text{for } h \in (\frac{1}{2}, \frac{3}{4}] \\ \frac{1}{6} + \frac{p_1 - p_s}{2t} - \frac{\tau}{2t}[1 - h] & \text{for } h \in (\frac{3}{4}, 1). \end{cases} \tag{6.10}$$

In light of Figure 6.1, Assumption 6.1 ensures that $x_m(h = \frac{3}{4}) > 0$.

The situation is symmetric with respect to the marginal consumer located between the corner shop and chain store 2. Demand for the corner shop is calculated by integrating over h:

$$D_s = \frac{1}{3} + \frac{p_1 + p_2 - 2p_s}{2t} - \frac{1}{16}\frac{\tau}{t}. \tag{6.11}$$

Figure 6.1: Case 2

Similarly, one can derive demand for the stores owned by the retail chain. Note, however, that the marginal consumer between these two stores is unchanged compared to scenario 1 as both chain stores have identical opening hours. Demand for stores 1 and 2 are then:

$$\begin{aligned} D_1 &= \frac{1}{3} + \frac{p_s + p_2 - 2p_1}{2t} + \frac{1}{32}\frac{\tau}{t}, \\ D_2 &= \frac{1}{3} + \frac{p_s + p_1 - 2p_2}{2t} + \frac{1}{32}\frac{\tau}{t}. \end{aligned} \tag{6.12}$$

The profits of the retailers are then:

$$\Pi_s = p_s \left[\frac{1}{3} + \frac{p_1 + p_2 - 2p_s}{2t} - \frac{1}{16}\frac{\tau}{t} \right], \tag{6.13}$$

$$\begin{aligned} \Pi_c = p_1 & \left[\frac{1}{3} + \frac{p_s + p_2 - 2p_1}{2t} + \frac{1}{32}\frac{\tau}{t} \right] \\ +p_2 & \left[\frac{1}{3} + \frac{p_s + p_1 - 2p_2}{2t} + \frac{1}{32}\frac{\tau}{t} \right] - 2f. \end{aligned} \tag{6.14}$$

In equilibrium, retailers set the following prices:

$$p_s^* = \frac{4}{9}t - \frac{\tau}{48}, \tag{6.15}$$

and

$$p_1^* = p_2^* = p_c^* = \frac{5}{9}t + \frac{\tau}{48}. \tag{6.16}$$

The difference in opening hours is reflected in prices. Compared to the symmetric case, the chain increases its prices by $\frac{\tau}{48}$ while the corner shop reduces its price by the same amount. The reason is that the chain store has a larger market power over consumers with a preferred shopping time during night-time and thus finds it profitable to increase prices. The price difference rises in τ, that is, in consumers' dislike to shift their shopping. It can also be shown that the market share of the retail chain is larger compared to symmetric opening hours.[5]

Profits are now:

$$\Pi_s^* = \frac{(\frac{4}{9}t - \frac{1}{48}\tau)^2}{t}, \tag{6.17}$$

and

$$\Pi_c^* = \frac{(\frac{5}{9}t + \frac{1}{48}\tau)^2}{t} - 2f. \tag{6.18}$$

6.3.3 Case 3: Corner shop is open full-time, retail chain is open part-time

In this case, the corner shop chooses full-time and the retail chain part-time. The marginal consumer is presented in Figure 6.2. As the analysis is similar to case 2, we only report equilibrium prices and profits:

$$p_s^* = \frac{4}{9}t + \frac{\tau}{48}, \tag{6.19}$$

and

$$p_1^* = p_2^* = p_c^* = \frac{5}{9}t - \frac{\tau}{48}. \tag{6.20}$$

[5] Shy and Stenbacka (2007) also show that the store with shorter shopping hours has a larger market share during day-time compared to symmetric shopping hours. This is due to the lower price charged by this store.

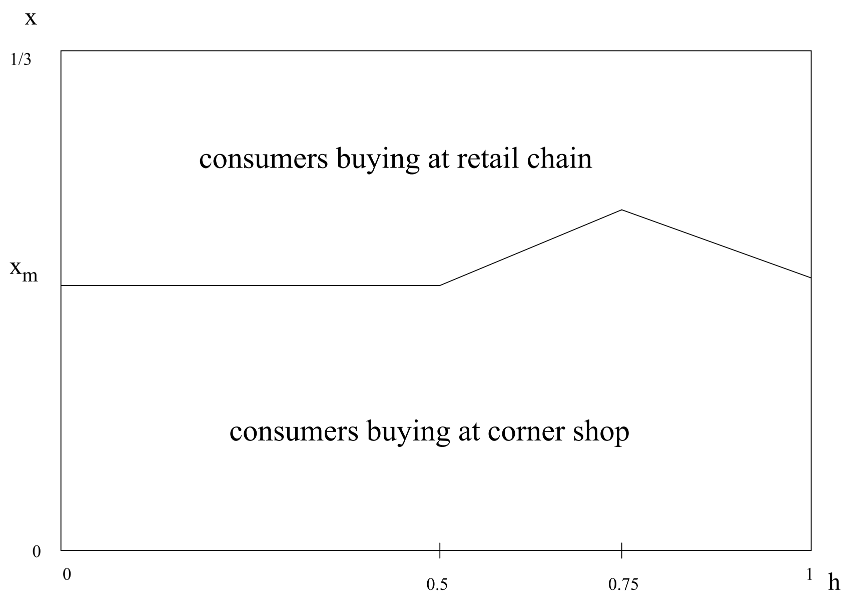

Figure 6.2: Case 3

Profits are now:

$$\Pi_s^* = \frac{(\frac{4}{9}t + \frac{1}{48}\tau)^2}{t} - f, \tag{6.21}$$

and

$$\Pi_c^* = \frac{(\frac{5}{9}t - \frac{1}{48}\tau)^2}{t}. \tag{6.22}$$

6.4 Shopping hours

Now, we are in the position to analyze firms' choice of shopping hours. Firms—being aware of the subsequent price competition—choose their shopping hours simultaneously. Figure 6.3 displays the reduced form of the game taking into account the outcomes of the price subgames.

We define the following critical levels of costs for extending shopping hours to full-time: $f_a = \frac{\tau}{48}(\frac{8}{9} + \frac{1}{48}\frac{\tau}{t})$ and $f_b = \frac{\tau}{48}(\frac{5}{9} - \frac{1}{96}\frac{\tau}{t})$, where $f_a > f_b$. The following result, which is derived in the appendix to this chapter, can then be established:[6]

[6] We assume that a firm indifferent between part-time and full-time chooses full-time.

		Corner Shop	
		full-time	part-time
Retail Chain	full-time	$\left(\frac{5}{9}\right)^2 t - 2f, \left(\frac{4}{9}\right)^2 t - f$	$\frac{(\frac{5}{9}t+\frac{1}{48}\tau)^2}{t} - 2f, \frac{(\frac{4}{9}t-\frac{1}{48}\tau)^2}{t}$
	part-time	$\frac{(\frac{5}{9}t-\frac{1}{48}\tau)^2}{t}, \frac{(\frac{4}{9}t+\frac{1}{48}\tau)^2}{t} - f$	$\left(\frac{5}{9}\right)^2 t, \left(\frac{4}{9}\right)^2 t$

Figure 6.3: Choice of shopping hours

Result 6.1 *Suppose the retail chain and the corner shop are equally efficient. Then, the corner shop chooses no shorter shopping hours than the retail chain.*

In more detail: If costs for extending shopping hours are high ($f > f_a$), both retailers choose part-time. For intermediate costs ($f_a \geq f > f_b$), the corner shop chooses full-time and the retail chain chooses part-time. Finally, when costs are low ($f \leq f_b$), both retailers choose full-time.

Assuming equally efficient retail firms, the corner shop chooses no shorter shopping hours than the retail chain, but potentially longer shopping hours. Depending on the additional costs for extending opening hours (f), three different equilibria can emerge–two symmetric equilibria and one asymmetric equilibrium. If the costs for extending business hours are either high or low, a symmetric outcome arises. For high costs, both firms are closed during night-time, and for low costs, both firms are open during night-time. The interesting result occurs for an intermediate level of costs. Then, the corner shop chooses longer opening hours than the retail chain.[7] In other words, the corner shop can afford higher costs than the retail chain, that is, the corner shop can gain more from extending opening hours than its competitor. By extending opening hours, the corner shop attracts customers from both neighboring stores—both owned by the retail chain. Conversely, the retail chain can only gain customers from one store, but has to pay the costs twice, that is, for each store once. In Inderst and Irmen (2005) the opposite result emerges. In their model, large retailers are associated with lower marginal costs of production which gives them an advantage in choosing longer opening hours. Hence, in their study large retailers are more likely to

[7]The structure of equilibrium shopping hours parallels the one in the symmetric model by Shy and Stenbacka (2007). For large and small costs for extending opening hours the resulting opening hours are symmetric. For intermediate values, the outcome is asymmetric with one store choosing longer opening hours than the competitor.

have longer opening hours. Our result here is not driven by cost differences, but by the assumption that the retail chain owns several stores which are also in competition with each other. In section 6.6.1, we will introduce cost differences between chain and corner shop. If these are large enough our equilibrium structure changes, and the result of Inderst and Irmen (2005) is re-established.

It is interesting to study the impact of τ, consumers' willingness to deviate from the preferred shopping time, and t, the transportation cost parameter, on an asymmetric choice of shopping hours:

Result 6.2 *i) An increase in τ increases the range of f for which an equilibrium with asymmetric shopping hours exists. ii) An increase in t decreases the range of f for which an equilibrium with asymmetric shopping hours exists.*

Proof. By noting that i) $\frac{\partial(f_a - f_b)}{\partial \tau} > 0$ and ii) $\frac{\partial(f_a - f_b)}{\partial t} < 0$.

When consumers have a stronger dislike to deviate from their preferred shopping time (larger τ), the outcome is more likely one in which the corner shop chooses longer shopping hours than the retail chain. An increase in τ raises the incentives to extend shopping hours for both firms, however, this effect is stronger for the corner shop. An increase in t has the opposite impact. A larger t, that is, price competition among retailers is softer, makes the asymmetric shopping hours less likely. The reason is that as transportation costs rise, it is less easy to attract customers via longer shopping hours. This effect is stronger for the corner shop as it tries to attract customers from two neighboring chain stores.

6.5 Impact of deregulation

This section studies the impact of a deregulation. As we are interested in the differential impact of deregulation on large and small retailers, we focus exclusively on the impact on firm profitability, and abstain from total welfare comparisons.

We say that under regulation stores are not allowed to open during night-time, but only during day-time. Hence, the outcome under regulation is described by case 1 with shops closed at night (section 6.3.1). When shopping hours are deregulated, retail firms are free to open at night as well. This outcome is given in section 6.4. Comparing profits in both situations, we can determine the impact of deregulation on firms' profits:

Result 6.3 *i) If costs for extending shopping hours are high ($f > f_a$), deregulation has no impact. ii) If costs are intermediate ($f_a \geq f > f_b$), the corner shop gains by deregulation and the retail chain loses. iii) If costs are low ($f \leq f_b$), both retailers lose by deregulation.*

It is clear that if costs for extending business hours are high, deregulation has no impact. Both firms decide not to open at night even if they are allowed to. For lower costs, deregulation is non-trivial. For intermediate costs, we have an asymmetric impact of deregulation. The corner shop gains, and the retail chain loses profits. From result 6.1 we know that in this case the corner shop is open full-time and the retail chain sticks to pre-deregulation opening hours. Compared to pre-deregulation, the corner shop can increase prices and market share, but has to bear the costs for additional business hours. The impact on profits, however, is positive. Contrary, the retail chain has to decrease prices and loses market share, and hence, profits decrease. For low costs, both retail firms lose from deregulation. The reason is that both stores extend their opening hours, hence prices and market shares remain unchanged, but operating costs are higher. Hence, profits decrease. This is an example of the classic prisoners' dilemma.[8]

Our results here differ from the existing literature. In Morrison and Newman (1983) and Tanguay, Vallee, and Lanoie (1995) large retailers benefit from deregulation at the expense of smaller competitors. The reason is that in their models deregulation leads to a shift of demand towards large retailers as the locational disadvantage is mitigated. However, in their models the choice of opening hours is not endogenous.

Summarizing, in this model the retail chain has nothing to gain from deregulation. Thus, we should expect large retail chains oppose further deregulation. Contrary, a corner shop may gain or lose from deregulation. In case of low costs, we expect the corner shop to oppose deregulation, but in case

[8]In Shy and Stenbacka (2007) a similar result emerges. They conclude that retailers have an incentive to collude on short shopping hours.

of intermediate costs be in favor of deregulation. Again, we should note that the analysis so far assumed that both types of retail stores are equally efficient. In extension 6.6.1, we show that the conclusions of this section may change when accounting for efficiency differences.

6.6 Extensions of the basic model

This section discusses two extensions of the base model. In the base model, we assume that corner shop and retail chain are equally efficient. In the first extension, we study the differences that arise when the retail chain has an efficiency advantage over its rival. The second extension relaxes the assumption that the chain store owns two stores, and generalizes our results for a larger number of stores.[9]

6.6.1 Efficiency advantage of the chain

It is sometimes argued that a retail chain has some efficiency advantages over smaller competitors. There may be many reasons for this, such as economies of scale, more efficient organizational structures or more buyer power. Here we come back to this idea and study the differences that may arise if the two types of retailers face different cost structures. In the present model, more efficiency can mean lower unit production costs or lower costs for extending business hours. We start by assuming that production costs for the retail good now differ for the corner shop and the retail chain. As before, the chain has zero production costs, but the corner shop now has a cost of c for each unit of the retail good. Thus, c denotes the efficiency advantage enjoyed by the retail chain. When re-analyzing the model with the new cost structure, we get the following result:[10]

Result 6.4 *i) For a small efficiency advantage ($c < \frac{3}{9}t - \frac{1}{32}\tau$), the corner shop chooses no shorter shopping hours than the retail chain. ii) For an intermediate efficiency advantage ($\frac{3}{9}t - \frac{1}{32}\tau \leq c \leq \frac{3}{9}t + \frac{1}{32}\tau$), either retailer*

[9]Other restrictive assumptions like, for instance, the density of customers during day and night-time, the length of day and night time, are discussed in Shy and Stenbacka (2007), however, only for the case of two symmetric retailers.

[10]The derivations are relegated to the appendix.

may choose longer shopping hours. iii) For a large efficiency advantage ($c > \frac{3}{9}t + \frac{1}{32}\tau$), the retail chain chooses no shorter shopping hours than the corner shop.

Not surprisingly, different productivity levels among the firms have an impact on our results. Only when the efficiency advantage for the retail chain is small enough, the results from our base model remain valid. Otherwise, different outcomes are possible. When the efficiency advantage for the chain is large, the result is reversed, and the retail chain has no shorter opening hours than a corner shop. In between, for an intermediate efficiency advantage, both outcomes are possible. Both types of stores may have longer business hours. In this case, equilibrium may not be unique.

Result 6.5 *If the efficiency advantage is large enough, the retail chain may gain from deregulation at the expense of the corner shop.*

Additionally, the impact of deregulation changes. It is no longer true that for non-trivial deregulation the retail chain loses profits unambiguously. If the efficiency advantage is high enough, the retail chain may increase profits due to deregulation. This is the case if deregulation leads to asymmetric business hours where the retail chain chooses full-time and the corner shop part-time. Then, we should expect retail chains to be in favor of deregulation.

Let us now consider a second efficiency advantage. A retail chain may face lower costs for extending shopping hours. Say, for instance, a corner shop has just one employee which works during day-time. In order to open at night, this shop has to hire an additional employee (or double working time). Larger stores have the additional option to redistribute labor along time by switching more labor from day-time to night-time, leaving the total amount of labor constant. Thus, a retail chain may have lower costs for extending shopping hours. From the previous analysis, it is clear that with different costs for extending business hours, the same outcomes are possible as with an efficiency advantage in marginal production costs.

6.6.2 Size of the retail chain

Until now we assumed that the retail chain owns two stores. To determine the impact of the size of the retail chain on equilibrium business hours, we extend our model by assuming that the retail chain now owns N stores. There is still only one corner shop present in the market. The main difference to our base model is that now some stores owned by the retail chain have only further chain stores as neighbors. Therefore, we allow the retail chain to price discriminate among its stores. We directly proceed with the main results relegating the derivations to the appendix.

Result 6.6 *The structure of equilibrium shopping hours is independent of the number of stores owned by the retail chain.*

Our first finding is that the structure of equilibrium business hours is unchanged to the case with $N = 2$. The corner shop chooses no shorter opening hours than the retail chain. But for some intermediate costs for extending opening hours, the corner shop chooses longer opening hours. Also, our results from the base model regarding the impact of deregulation apply here. The retail chain loses from deregulation, while the impact on the corner shop is ambiguous.

Result 6.7 *An increase in the number of stores owned by the retail chain i) decreases the range of f for which an equilibrium with both firms choosing full-time exists; ii) increases the range of f for which an equilibrium with both firms choosing part-time exists; iii) increases the range of f for which an equilibrium with asymmetric opening hours exists.*

Increasing chain size has two effects on competition. First, it increases the competitive pressure on the corner shop as the chain stores are closer. Thus, it reduces the incentives for the corner shop to extend opening hours as the number of customers served is smaller. Second, as we still stick to uniform opening hours by the chain, it increases the costs for the chain to extend opening hours. Hence, it also reduces the incentives for the chain to extend opening hours. Thus, the interval for which an equilibrium exists in which both firms choose full-time business hours shrinks for a larger number of stores owned by the chain. Conversely, the interval for which both firms choose part-time increases. The interval for which an asymmetric equilibrium exists in which the corner shop chooses longer opening hours than its competitor increases. The reason is that the negative impact of increasing chain size on the chain's incentives to extend business hours is larger than for the corner shop.

6.7 Conclusion

This chapter studies competition between a large retail chain and a small corner shop with respect to their choices of business hours. Building on Salop (1979), the retail chain is modeled as owning several stores while the corner shop owns a single store. Assuming that the corner shop and the retail chain are equally efficient we find that the corner shop chooses no shorter business hours than the retail chain. Additionally, we find that the impact of deregulation has asymmetric impacts on the retail firms. For a non-trivial deregulation, the retail chain loses, but the corner shop may gain if the costs for extending opening hours are not too large. This result is in contrast to the existing literature. We generalize our results by accounting for larger retail chains. However, our results rest on the assumption that both firms are equally efficient in providing the retail good or in extending their business hours. If the efficiency advantage by the retail chain is large enough, the results are reversed. Then, a retail chain may gain by deregulation and smaller competitors might lose. Thus, in light of the model, large retail chains do only oppose deregulation if their efficiency advantage is small.

6.8 Appendix

6.8.1 Non-intersecting shopping hours

In the chapter we assume that both retail firms choose identical opening times ($h_o = 0$). Here, we relax this assumption and allow for differing opening times, ($h_o = 0$) or ($h_o = \frac{1}{2}$). The only additional subgame that we have to analyze is the case where firms choose non-intersecting shopping hours, either the retail chain is open during day-time and the corner shop during night-time, or the retail chain is open during night-time and the corner shop during day-time. These two cases are equivalent.

Here, we show that the outcome when shopping hours do not intersect is identical to case 1 where both retailers choose symmetric shopping hours. Therefore, our simplifying assumption of identical opening times is innocuous.

We consider the situation when the retail chain is open during day-time $h \in [0, \frac{1}{2}]$ and the corner shop during night-time $h \in [\frac{1}{2}, 1]$. The marginal consumer—also illustrated in figure 6.4—depends on the preferred shopping time and is given by:

$$x_m = \begin{cases} \frac{1}{6} + \frac{p_1 - p_s}{2t} - \frac{\tau h}{2t} & \text{for } h \in (0, \frac{1}{4}] \\ \frac{1}{6} + \frac{p_1 - p_s}{2t} - \frac{\tau}{2t}[h - \frac{1}{2}] & \text{for } h \in (\frac{1}{4}, \frac{1}{2}] \\ \frac{1}{6} + \frac{p_1 - p_s}{2t} - \frac{\tau}{2t}[1 - h] & \text{for } h \in (\frac{1}{2}, \frac{3}{4}] \\ \frac{1}{6} + \frac{p_1 - p_s}{2t} - \frac{\tau}{2t}[1 - h] & \text{for } h \in (\frac{3}{4}, 1]. \end{cases} \tag{6.23}$$

Figure 6.4: Non-intersecting shopping hours

Integrating over h yields the demand for the corner shop:

$$D_s = \frac{1}{3} + \frac{p_1 + p_2 - 2p_2}{2t}.$$

Demand at the corner shop is identical to case 1 (see equation 6.3), and so is the demand at the two stores owned by the retail chain. Hence, prices and profits are also identical to case 1.

6.8.2 Derivations of result 6.1

Retail chain

Given that the corner shop chooses part-time, the retail chain chooses full-time if $f \leq f_1 = \frac{\tau}{48}(\frac{5}{9} + \frac{1}{96}\frac{\tau}{t})$. Given that the corner shop chooses full-time, the retail chain chooses full-time if $f \leq f_2 = \frac{\tau}{48}(\frac{5}{9} - \frac{1}{96}\frac{\tau}{t}) = f_b$. Note that $f_1 > f_2 = f_b$.

Corner shop

Given that the retail chain chooses part-time, the corner shop chooses full-time if $f \leq f_3 = \frac{\tau}{48}(\frac{8}{9} + \frac{1}{48}\frac{\tau}{t}) = f_a$. Given that the retail chain chooses full-time, the corner shop chooses full-time if $f \leq f_4 = \frac{\tau}{48}(\frac{8}{9} - \frac{1}{48}\frac{\tau}{t})$. Note that $f_3 = f_a > f_4$.

Equilibrium

Under assumption 6.1, we have $f_a = f_3 > f_4 > f_1 > f_2 = f_b$. Hence, for $f > f_3 = f_a$, both firms choose part-time. For $f_2 = f_b < f \leq f_3 = f_a$, the corner shop chooses full-time, and the retail chain chooses part-time. For $f \leq f_2 = f_b$, both firms choose full-time.

6.8.3 Derivations for extension 6.6.1

Here, we present the derivations for the case with different marginal costs of production. The demand functions in the different scenarios are unchanged to the base model. Only, profit functions do change. The corner shop has a now per-unit production costs of c, the retail chain has still zero production costs.

Price competition

a) Scenario 1

The profit function for the corner shop modifies to:

$$\Pi_s = (p_s - c)\left[\frac{1}{3} + \frac{p_1 + p_2 - 2p_s}{2t}\right].$$

The profit function for the retail remains unchanged. Nash prices in this subgame are then:

$$p_s^* = \frac{4}{9}t + \frac{2}{3}c; \qquad p_c^* = \frac{5}{9}t + \frac{1}{3}c,$$

leading to profits of

$$\Pi_s^* = \left[\frac{4}{9}t - \frac{1}{3}c\right]^2 \frac{1}{t}(-f); \qquad \Pi_c^* = \left[\frac{5}{9}t + \frac{1}{3}c\right]^2 \frac{1}{t}(-2f).$$

b) Scenario 2

Similarly, prices and profits in this subgame are:

$$p_s^* = \frac{4}{9}t + \frac{2}{3}c - \frac{\tau}{48}; \qquad p_c^* = \frac{5}{9}t + \frac{1}{3}c + \frac{\tau}{48},$$

$$\Pi_s^* = \left[\frac{4}{9}t - \frac{1}{3}c - \frac{1}{48}\tau\right]^2 \frac{1}{t}; \qquad \Pi_c^* = \left[\frac{5}{9}t + \frac{1}{3}c + \frac{1}{48}\tau\right]^2 \frac{1}{t} - 2f.$$

c) Scenario 3

$$p_s^* = \frac{4}{9}t + \frac{2}{3}c + \frac{\tau}{48}; \qquad p_c^* = \frac{5}{9}t + \frac{1}{3}c - \frac{\tau}{48},$$

$$\Pi_s^* = \left[\frac{4}{9}t - \frac{1}{3}c + \frac{1}{48}\tau\right]^2 \frac{1}{t} - f; \qquad \Pi_c^* = \left[\frac{5}{9}t + \frac{1}{3}c - \frac{1}{48}\tau\right]^2 \frac{1}{t}.$$

Choice of shopping hours

a) Retail chain

Given that the corner shop chooses part-time, the retail chain chooses full-time if $f \leq \bar{f}_1 = \frac{\tau}{48}(\frac{5}{9} + \frac{1}{96}\frac{\tau}{t} + \frac{1}{3}\frac{c}{t})$. Given that the corner shop chooses full-time, the retail chain chooses full-time if $f \leq \bar{f}_2 = \frac{\tau}{48}(\frac{5}{9} - \frac{1}{96}\frac{\tau}{t} + \frac{1}{3}\frac{c}{t})$. Note that $\bar{f}_1 > \bar{f}_2$.

b) Corner shop

Given that the retail chain chooses part-time, the corner shop chooses full-time if $f \leq \bar{f}_3 = \frac{\tau}{48}(\frac{8}{9} + \frac{1}{48}\frac{\tau}{t} - \frac{2}{3}\frac{c}{t})$. Given that the retail chain chooses full-time, the corner shop chooses full-time if $f \leq \bar{f}_4 = \frac{\tau}{48}(\frac{8}{9} - \frac{1}{48}\frac{\tau}{t} - \frac{2}{3}\frac{c}{t})$. Note that $\bar{f}_3 > \bar{f}_4$.

c) Equilibrium

When the efficiency advantage is small ($c < \frac{3}{9}t - \frac{1}{32}\tau$), we have $\bar{f}_3 > \bar{f}_4 > \bar{f}_1 > \bar{f}_2$, and hence the same equilibrium as in the base model.

When the efficiency advantage is large ($c > \frac{3}{9}t + \frac{1}{32}\tau$), we have $\bar{f}_1 > \bar{f}_2 > \bar{f}_3 > \bar{f}_4$. The situation is reversed compared to the base model. For large costs, both firms choose part-time. For intermediate costs, the retail chain chooses longer business hours than the corner shop. For small costs, both firms choose full-time.

When the efficiency advantage is intermediate ($\frac{3}{9}t - \frac{1}{32}\tau < c < \frac{3}{9}t + \frac{1}{32}\tau$), we have to distinguish between two cases: a) $\frac{3}{9}t - \frac{1}{32}\tau < c < \frac{3}{9}t - \frac{1}{96}\tau$ and b) $\frac{3}{9}t - \frac{1}{96}\tau < c < \frac{3}{9}t + \frac{1}{32}\tau$.

In case a), we have $\bar{f}_3 > \bar{f}_1 > \bar{f}_4 > \bar{f}_2$. For $f > \bar{f}_3$, both firms choose part-time. For $\bar{f}_1 < f \leq \bar{f}_3$, the corner shop chooses full-time and the retail chain part-time. For $\bar{f}_4 < f < \bar{f}_1$, there are two asymmetric equilibria with one store choosing full-time and the other part-time. For $\bar{f}_2 < f \leq \bar{f}_4$, the corner shop chooses full-time and the retail chain part-time. For $f \leq \bar{f}_2$, both stores are open full-time. Thus, either store can have longer opening hours, however, the parameter space is larger for which an equilibrium exists in which the corner shop has longer opening hours. In case b), we have $\bar{f}_1 > \bar{f}_3 > \bar{f}_2 > \bar{f}_4$. For $f > \bar{f}_1$, both firms are open part-time. For $\bar{f}_3 < f \leq \bar{f}_1$, the retail chain chooses full-time and the corner shop part-time. For $\bar{f}_2 < f < \bar{f}_3$, there are two asymmetric equilibria with one store choosing full-time and the other part-time. For $\bar{f}_4 < f \leq \bar{f}_2$, the retail chain is open full-time and the corner shop part-time. For $f \leq \bar{f}_4$, both stores are open full-time. Again, either store can have longer opening hours. The parameter region for which the retail chain chooses longer opening hours is larger.

Impact of deregulation

Deregulation leads to higher profits for the retail chain when it leads to asymmetric business hours with the retail chain choosing full-time and the corner shop choosing part-time. This can be the case for intermediate and large efficiency advantages, that is for $\frac{3}{9}t - \frac{1}{32}\tau \leq c \leq \frac{3}{9}t + \frac{1}{32}\tau$ and $c > \frac{3}{9}t + \frac{1}{32}\tau$. To be more precise, for intermediate efficiency advantages it is also possible that the corner shop can benefit from deregulation. This is not possible for large efficiency advantages.

6.8.4 Derivations for extension 6.6.2

Here we derive the result if the retail chain owns N stores. We assume that the chain can use price discrimination among its stores.

Price competition

a) Scenario 1

$$\Pi_s = p_s \left[\frac{1}{N+1} + \frac{p_1 + p_N - 2p_s}{2t} \right] (-f).$$

The profits of the chain is the sum of individual profits of the N stores:

$$\begin{aligned}
\Pi_c &= p_1 \left[\frac{1}{N+1} + \frac{p_s + p_2 - 2p_1}{t} \right] \\
&+ \sum_{i=2}^{N-1} p_i \left[\frac{1}{N+1} + \frac{p_{i-1} + p_{i+1} - 2p_i}{2t} \right] \\
&+ p_N \left[\frac{1}{N+1} + \frac{p_s + p_{N-1} - 2p_N}{2t} \right] - (Nf).
\end{aligned}$$

First-order condition for corner shop:

$$\frac{1}{N+1} + \frac{p_1 + p_n - 4p_s}{2t} = 0.$$

First-order conditions for chain-store:

$$\frac{1}{N+1} + \frac{p_2 + \frac{1}{2}p_s - 2p_1}{2t} = 0,$$
$$\frac{1}{N+1} + \frac{p_{i-1} + p_{i+1} - 2p_i}{t} = 0 \quad \forall i = 2, ..., (N-1),$$
$$\frac{1}{N+1} \frac{p_{N-1} + \frac{1}{2}p_s - 2p_N}{t} = 0.$$

The way to solve this system of (N+1) equations is to recognize that the first-order conditions for the retail chain constitute a difference equation with two initial conditions. We then get the following equilibrium prices:

$$p_s^* = \frac{2+N}{3(N+1)}t; \qquad p_i^* = \left[\frac{2+N}{6(N+1)} + \frac{i}{2} - \frac{i^2}{2(N+1)}\right] t.$$

The retail chain charges different prices at different stores. The further away a store is located from the competitor, the higher is the price (see also Giraud-Heraud, Hammoudi, and Mokrane (2003)). Profits are then

$$\pi_s^* = \left[\frac{2+N}{3(N+1)}\right]^2 t(-f); \qquad \pi_c^* = \frac{(2+N)(3N^2+17N+4)}{72(N+1)^2}t(-Nf).$$

b) Scenario 2

Similarly, one can derive equilibrium prices and profits for scenario 2.

$$p_s^* = \frac{2+N}{3(N+1)}t - \frac{\tau}{48}; \qquad p_i^* = \left[\frac{2+N}{6(N+1)} + \frac{i}{2} - \frac{i^2}{2(N+1)}\right] t + \frac{\tau}{48}.$$

Resulting profits are then:

$$\pi_s^* = \left[\frac{2+N}{3(N+1)}t - \frac{1}{48}\tau\right]^2 \frac{1}{t};$$

$$\pi_c^* = \frac{(2+N)(3N^2+17N+4)}{72(N+1)^2}t + \frac{2N+1}{72(N+1)}\tau + \frac{1}{2304t}\tau^2 - Nf.$$

c) Scenario 3

Prices:

$$p_s^* = \frac{2+N}{3(N+1)}t + \frac{\tau}{48}; \qquad p_i^* = \left[\frac{2+N}{6(N+1)} + \frac{i}{2} - \frac{i^2}{2(N+1)}\right] t - \frac{\tau}{48}.$$

Profits:

$$\pi_s^* = \left[\frac{2+N}{3(N+1)}t + \frac{1}{48}\tau\right]^2 \frac{1}{t} - f;$$

$$\pi_c^* = \frac{(2+N)(3N^2+17N+4)}{72(N+1)^2}t - \frac{2N+1}{72(N+1)}\tau + \frac{1}{2304t}\tau^2.$$

Choice of shopping hours

The structure of equilibrium is unaffected by the number of stores owned by the retail chain. Define $f_a = \frac{\tau}{48}(\frac{2(N+2)}{3(N+1)} + \frac{1}{48}\frac{\tau}{t})$ and $f_b = \frac{\tau}{48}\frac{1}{N}(\frac{2(2N+1)}{3(N+1)} - \frac{1}{48}\frac{\tau}{t})$, where $f_a > f_b$ for all N. Then for $f > f_a$, both firms choose part-time, for $f_a \geq f > f_b$, the corner shop chooses full-time and the retail chain part-time, and for $f \leq f_b$, both firms choose full-time. Result 6.7 then follows from i) $\frac{\partial f_b}{\partial N} < 0$; ii) $\frac{\partial f_a}{\partial N} < 0$; iii) $\frac{\partial (f_a - f_b)}{\partial N} > 0$.

Chapter 7

Conclusion and Further Research

We conclude the thesis by discussing further research directions.

Product differentiation and general purpose products

This chapter considers competition between targeted products and general purpose products. A shortcoming of the model is that there is at most one general purpose product offered in a free-entry equilibrium. The reason is that if a second general purpose product would be offered by another firm, both products would be homogenous and prices would be competed down to marginal costs. Thus, in the presence of positive entry costs, no more than one firm offers a general purpose product. Future research should try to generalize the present framework to multiple competing general purpose products. One possible solution would be to introduce brand preferences of consumers for general purpose products offered by different firms in the sprit of Gilbert and Matutes (1993) or Doraszelski and Draganska (2006). This would allow firms to obtain positive price-cost margins, and hence to cover the fixed costs for entry.

A second way for further research could be to follow a different interpretation of a general purpose product. In this thesis, a consumer demands a general purpose product if no tailored product is sufficiently close to a consumer's location on the Salop circle. A different setup would be the following: Each consumer wants to perform two (or even more) different tasks. Taking the example from the sports shoe industry, for instance, a consumer wants to play squash and football. This could be modeled by assuming that a consumer has more than one location in the characteristics space. Then, in the presence of a general purpose product a consumer has the choice between several targeted products and the general purpose product.

A note on the excess entry theorem in spatial models with elastic demand

The principal idea of this chapter is to introduce price-dependent demand in a model of spatial product differentiation and to analyze the impact on the excess entry result. In the present thesis, we use a specific functional form for consumer demand, namely a demand function with a constant elasticity, in the Salop framework. In such a framework, we show that the excess entry result does not always hold. When demand is sufficiently elastic, competition among firms is tougher, which leads to insufficient entry into the market. The use of a specific functional form for demand is a limiting factor of our results. Therefore, future research could consider more general demand functions for testing the robustness of our results.

The assumption of inelastic demand is commonly used in most spatial models. While we only consider the Salop model, it would also be interesting to introduce price-dependent demand in different models of spatial product differentiation. In the Hotelling setup, for instance, it could be analyzed whether price-dependent demand would change firms' location decisions. Rath and Zhao (2001) show this for a linear demand function. The question is whether this still holds for constant elastic demand as proposed in this thesis. Additionally, it would be interesting to introduce price-dependent demand in spatial models of non-localized competition such as the Spokes model (Chen and Riordan, 2007).

Spatial models of product differentiation are used extensively in applications. Among others, they have been applied to study advertising (Anderson and Coate, 2005), mergers (Levy and Reitzes, 1992), transparency of prices and available products (Schultz, 2004), or product proliferation (Martinez-Giralt and Neven, 1988). It could be useful to add price-dependent demand into these applications and study whether the assumption of inelastic demand is innocuous or whether it affects the results. In chapter 5, on shopping hours in a free-entry model, we analyze the changes that arise when accounting for price-dependent demand. In this application, the main result of under-provision of shopping hours proves to be robust, however, it could be shown that the degree of under-provision can be much more severe compared to the model with inelastic demand. Similar effects could turn out in the aforementioned applications.

Product variety at the top and at the bottom

The model in this chapter could be extended in several dimensions. A straightforward way would be to enrich the choice set of firms. In this thesis, each firm can either offer a single product variant or the product line encompassing all possible product variants. A more general model would allow firms to offer any number of product variants. This would provide for a comparison concerning the extent to which variety in the high-quality and the low-quality segment differs.

In this thesis, we also assume that quality levels are given exogenously. Future research could aim at endogenizing quality levels. The second restrictive assumption concerning quality levels used in this model is that all products offered by one firm are of the same quality, that is, firms cannot offer products of different qualities. Interesting questions would arise if firms can also produce commodities of different qualities. Would firms offer several variants of the same quality or would they supply products of different qualities (but the same horizontal variant)? In other words: Would firms differentiate along the vertical dimension or along the horizontal dimension? These questions could be pursued in future studies.

Deregulation of shopping hours

The models developed in chapters 5 and 6 derive a number of hypotheses that can be tested empirically. Chapter 5 derives hypotheses concerning the relationship between market structure and shopping hours as well as the impact of a deregulation of shopping hours. Concerning market structure the model predicts that a larger concentration in the retail sector leads to longer shopping hours. Furthermore, if shopping hours are regulated, stricter regulation leads to less concentration in the retail sector. Concerning a liberalization the model predicts the following long-run impacts: For non-trivial deregulations, concentration in the retail industry should rise which in turn leads to an increase in retail prices.

Chapter 6 implies also some testable hypotheses. The question here is whether larger stores choose longer shopping hours than smaller ones. If it turns out that larger stores choose longer shopping hours, in light of the model, this could be interpreted as evidence for relatively large cost differences between large and small stores. Contrary, if the opposite turns out, this can be interpreted as small differences in the cost structure. These hypotheses can be tested on empirical grounds. The recent deregulation in Germany might provide a useful example to study these questions.

In both models, consumers are similar in their preferences for extended shopping hours. In chapter 5, all consumers have the same valuation (θ) for extending opening hours. In chapter 6, all consumers have the same disutility—measured by the parameter τ—for deviating from their preferred shopping time. Of course, this is a simplifying assumption. In reality, consumers may very well be heterogenous in their preferences concerning shopping hours. Working people may have a much larger valuation for extending shopping hours than non-working people. It would be interesting to extend existing models to incorporate heterogenous preferences for shopping hours. Such models could then be useful to determine the impact of demographic change which could be modeled by an increase in non-working consumers with smaller valuations for extending opening hours.

A further interesting topic is the choice of shopping hours in different organizational forms, such as shopping malls or city centers (Gehrig, 1998; Smith and Hay, 2005). In shopping malls, decisions on opening hours, among other things, are made centrally for all stores within a mall. In contrast, stores located in city centers decide on an individual basis. The differences that arise in these two different organizational structures lie in the degree of internalization. Decision making within malls internalizes the external effects that arise due to an increase of shopping hours at one store on the profits of the remaining stores. These external effects are not internalized within city centers. An interesting extension of the existing literature would therefore be to determine optimal opening hours decisions in these different organizational forms.

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Ich versichere, dass ich diese Dissertation selbstständig verfasst habe. Bei der Erstellung der Arbeit habe ich mich ausschließlich der angegebenen Hilfsmittel bedient. Die Dissertation ist nicht bereits Gegenstand eines erfolgreich abgeschlossenen Promotions- oder sonstigen Prüfungsverfahrens gewesen.

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