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Essays on R&D Investments, Market Structure and Welfare

Doctoral Thesis
submitted to Justus-Liebeig-University Giessen,
Department of Economics and Business Studies

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خیام اگر ز باده مستی خوش باش   با ماه رخی اگرنشستی خوش باش
چون عاقبت کارجهان نیستی است   انگارکه نیستی چوهستی خوش باش

خیام

In life devote yourself to joy and love   Behold the beauty of the peaceful dove
Those who live, in the end must all perish   Live as if you are already in heavens above

Khayyam

To:
my parents
my brother

Contents

Chapter 1

Introduction

Introduction

Research and Development (R&D) is the driving force behind our wealth. The importance of R&D is well documented by the amount governments, universities and firms together spend in R&D: around 1.4 trillion US dollars a year.[1] Especially firms use R&D as one of the important instruments in order to increase their profits both in competitive and non-competitive environments. In general there are two types of R&D-investments: process R&D and product R&D.

Product R&D refers to investments and activities which are aiming at either producing new products or improving the quality of an existing product. The firms benefit from product R&D because consumers are willing to pay more for a product with higher quality, respectively the firms benefit from entering into new markets with their new products.

Process R&D means firms' investments in their productive efficiency and all activities aiming at cheaper production of known products. This type of R&D investment intends to decrease the firms' production costs and usually results in higher margins for the firms.

Both types of R&D are generally beneficial both for the firms – otherwise the firm would not make the investment in R&D – and for the consumers. The reason is that after the firms invest in R&D, their profit-maximizing-strategy aims at adjusting their new prices in a way that enables them to benefit both from a higher margin *and* higher demand.

Consumers normally benefit from product R&D because even if firms increase their prices parallel with the higher quality, they usually increase the prices to a lesser extent than the quality improvement. So in spite of higher prices, the demand for the improved good increases after the firms' R&D investments, which can be a sign of higher consumer benefit.

Similar to the case of product R&D, the profit maximizing strategy of the firms which invest in process R&D is also to profit from higher margins and higher demand. Therefore the firms usually have an incentive to partially pass through the cost reductions to the consumers, which again benefits the consumers. Thus – assuming that higher productive efficiency does *not* lead to lower product quality – consumers also profit from the firms' investments in process R&D.

In this thesis, I will concentrate on the latter case, namely on process R&D. However, both product and process R&D have a similar effect: they increase the gap between consumers' maximum willingness to pay and firms' marginal costs. Thus most of the results of this thesis – after examining and excluding possible sources of differences – are transferable to the results of product R&D.

1 The Economist, January 12th-18th 2013, Page 11

As it is mentioned above, R&D investments are an important instrument in any competitive environment for the firms to increase their profits. Joseph Schumpeter develops the concept of creative destruction in his books "The Theory of Economic Development" (1934), "*Business Cycles*" (1939) and especially in "*Capitalism, Socialism and Democracy*" (1942). In the latter, he writes "Capitalism [...] never can be stationary. The fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumers' goods, the new methods of production or transportation, the new markets, the new forms of industrial organization that capitalist enterprise creates. [...] The opening up of new markets, foreign or domestic, and the organizational development [...] illustrate the same process of industrial mutation [...] that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact about capitalism. It is what capitalism consists in and what every capitalist concern has got to live in.". The so called *Schumpeterians* stress the expectation of (at least temporary) monopoly profits as the main driving force of both product and process innovation.[2]

However, early empirical papers such as Scherer (1965) and (1967), show results which question Schumpeter's theory. Also in the theoretical front, the fundamental work of Arrow (1962) provides a different view to Schumpeter's thesis. He shows that for both drastic and non-drastic innovations a firm under perfect competition always invests more than a monopolist. Only few papers, such as Nickell (1996), can provide at least weak empirical evidence that competition increases firms' efficiency. The further discussion – derived from Cournot variant of Arrow's work – about the relationship between competition and R&D incentives leads to an inverted U-shaped relationship between the amount of R&D investments and the degree of competition.[3]

This Ph.D. thesis contributes to the discussion about investments in process R&D by presenting three papers. The paper "*R&D incentives in vertically related markets*" discusses how R&D incentives in a vertically related bilateral duopoly depend on different market circumstances. More precisely, the paper examines how the intensity of simultaneous interbrand and intrabrand competition influences the R&D investments in the downstream and upstream market. Among others, this paper shows a U-shaped relationship between R&D incentives and both interbrand and intrabrand competition. This contradicts the result of papers such as Aghion et al. (2005). Even though these two papers' approaches are too different to be comparable – as it will be further explained in the paper's introduction – it is worth understanding the roots of these differences.

2 By mentioning "new methods of production or transportation", Schumpeter is basically meaning process R&D and the "new consumers' goods" that was mentioned by Schumpeter, can be interpreted as product R&D.

3 See for example Aghion et al. (2005)

Beyond that, the model also considers how R&D investments of a firm influence the actions and profits of both the competitor in the same market *and* of the firms in a vertically related market. It shows that there are vertical spillovers of R&D, because asymmetries among firms in any market are dampened by vertically related firms. This finding is especially important if we take into account that some countries such as France legally forbid price discrimination in input markets. Forbidding price discrimination abolishes this dampening effect and can harm the less efficient retailer. In extreme cases, the absence of the dampening effect can lead to the elimination of the less efficient retailer.

The paper "*Profitable Entry into an Unprofitable Market*" shows how the entry into a per se unprofitable market can become a generally profitable investment for a firm. It shows that the market entry of a firm into a new market with a product which uses a similar production technology to an already existing product of the firm, has the positive side effect of committing the firm to higher investments in process R&D. This self-commitment of the firm intimidates its competitors in the old market from investing in R&D. The lower R&D investments of the competitors in the old market yield higher profits for the expanding firm in that market. In certain ranges of parameters, the higher profits in the old market can overcompensate the losses caused by the entry into the new market. This paper shows the typical parameter constellations such as market sizes, cost structures and competitive environment which enable that market entry into an unprofitable market to turn out to be profitable. This finding can be of interest to strategic decisions of firms concerning market entry.

The Paper "*Consumer-Welfare-Enhancing Merger to Monopoly*" considers two markets that are "connected" through at least one firm which is active with similar products in both markets. The paper examines through a simulation how changes in market concentration of one market harms or benefits consumers in another market due to changes in market competition *and* changes in R&D incentives. One important result of this paper is that a higher concentration in a market for example due to a merger of two firms can lead to higher consumer surplus in the other market and even to a higher *aggregated* consumer surplus. If the welfare loss of the consumers in the market where the merger takes place is less than the welfare gain of consumers in the other market, the merger or acquisition enhances aggregated consumer welfare. I show that this result can even hold in the extreme case when the merger causes a change in competition mode from duopoly into a monopoly. This finding can be helpful for the decision of competition authorities such as the FTC in the United States or the Bundeskartellamt in Germany. The outcome of this paper is also valid in the opposite direction, namely that the entry of a firm into a market can harm aggregated consumer surplus, even though consumers benefit in the market where the number of competitors increase. Furthermore, the paper examines the typical combination of parameter-ranges such as the degree of competition, sizes of the two markets, cost structures of the firms etc. for which monopolization can yield higher aggregated consumer surplus. The two latter papers show that whether R&D investments are higher under Monopoly, or under competition, or the relationship between R&D investments and competition is non-linear, depends on parameters and circumstances such as whether price discrimination is possible or not.

The remainder of this Ph.D. thesis is structured as follows: Chapter 2 contains the abstracts of the submitted papers. Chapters 3 to 5 present the papers. Chapter 6 contains the Curriculum Vitae and chapter 7 the affidavit.

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Chapter 2

Abstracts of the Submitted Papers

R&D Incentives in Vertically Related Markets

This paper focuses on R&D incentives in a bilateral duopoly setup. We consider how process R&D incentives of the firms in both upstream and downstream market depend on the intensity of simultaneous interbrand and intrabrand competition. Among the results: an increasing interbrand and/or intrabrand competition have both twofold effects on R&D incentives. Furthermore, the existence of a vertically related market with imperfect competition leads to underinvestment in process R&D for two reasons: competitive advantage through R&D investment decreases as the firms in vertically related market partly increase their margins after observing the R&D investment, and R&D's positive effects for them are not internalized by the investing firm. Moreover, We show how the impact of a firm's R&D investments in either market on consumer surplus and on the profits of all firms in the vertically related setup depends on the exogenous parameters.

Keywords: *research and development, interbrand and intrabrand competition, vertical relations, bilateral oligopoly, product differentiation, process innovation*

JEL Classification Codes: *L13, D43, O30*

Profitable Entry into an Unprofitable Market

This paper shows how market entry into a per se unprofitable market can be profitable for a firm. By investing irreversible sunk costs to enter into an unprofitable market, the firm increases its produced quantity and commits itself to more aggressive process R&D investments. This intimidates the competitor in the old market from investing in process R&D, which yields higher marginal costs of that competitor and higher profits for the expanding firm in the old market. If the profit gain of this feedback effect for the expanding firm exceeds the losses through market entry, then the (per se unprofitable) market entry is profitable for the firm. I also consider how the results change under Bertrand vs Cournot regime and how they change if third degree price discrimination is not possible. Moreover, I show how higher R&D costs or lower demand in a market can lead to lower profits of one firm, but higher profits of the other firm.

Keywords: *research and development, price discrimination, product differentiation, process innovation, interbrand competition, strategic commitment, separated markets, market entry*

JEL Classification Codes: *L13, D43, O30*

Consumer-Welfare-Enhancing Merger to Monopoly

This paper shows under which circumstances a merger or acquisition (M&A) can benefit consumers, even though there are no efficiency gains per se for the firms through the M&A. Analogously it can be shown that entry into a market can harm aggregated consumer surplus. We show which combinations of parameters – such as market size, cost structures etc. – typically lead to increasing (decreasing) aggregated consumer surplus in two markets, through monopolization (competition) in one of the markets. The model also considers how factors such as the possibility of third degree price discrimination among the two markets can influence the results.

Keywords: *merger and acquisition, research and development, consumer welfare, monopolization, inter-brand competition, price discrimination, product differentiation, process innovation, separated markets, Multinational Enterprises*

JEL Classification Codes: *L13, D43, O30*

Chapter 3

R&D Incentives in Vertically Related Markets

This paper was presented at the following refereed conferences:

09.2010 — 37th Annual Conference of the European Association for Research in Industrial Economics (EARIE), Sabanci University Istanbul

06.2010 — International Conference of the European Network on Industrial Policy; Universitat Rovira i Virgili

05.2010 — Third PhD Conference in Economics; University of Athens

05.2010 — Swiss IO Day; University of Bern

12.2009 — 4th Doctoral Workshop, Economic Behavior and Interaction Models (EBIM); University of Bielefeld

06.2009 — Second Dolomites Summer School on Antitrust for Networks, Focus on Vertical Restraints; University of Verona

R&D Incentives in Vertically Related Markets

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January 2013

Abstract

This paper focuses on R&D incentives in a bilateral duopoly setup. We consider how process R&D incentives of the firms in both upstream and downstream market depend on the intensity of simultaneous interbrand and intrabrand competition. Among the results: an increasing interbrand and/or intrabrand competition have both twofold effects on R&D incentives. Furthermore, the existence of a vertically related market with imperfect competition leads to underinvestment in process R&D for two reasons: competitive advantage through R&D investment decreases as the firms in vertically related market partly increase their margins after observing the R&D investment, and R&D's positive effects for them are not internalized by the investing firm. Moreover, We show how the impact of a firm's R&D investments in either market on consumer surplus and on the profits of all firms in the vertically related setup depends on the exogenous parameters.

Keywords: research and development, interbrand and intrabrand competition, vertical relations, bilateral oligopoly, product differentiation, process innovation

JEL Classification Codes: L13, D43, O30

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We would like to thank our colleagues in Giessen and the participants of the 37th Annual Conference of European Association for Research in Industrial Economics (EARIE) for their valuable comments on this paper.

1 Introduction

Every purchasing decision of any consumer usually involves these two questions: "Which product should I buy?" and "Where should I buy this product?". The order of the questions can be either way: for example some people decide first to buy a certain laptop model and then decide which retailer they want to buy it from; other consumers decide first to visit a certain retailer to see which laptop they would like to buy there. Some consumers visit several retailers, before they decide which laptop to buy in which store. No matter how the decision is made and which decision is made first, it is obvious that competition and product differentiation exist in two different but vertically related markets. Not only are both product and process innovation important for the competitors in the consumer goods industry, they also matter in the retailing sector. This paper models a vertically related bilateral duopoly with imperfect competition in both markets, and shows what influence the degree of competition in the upstream and downstream market has on prices, quantities, profits and on investments in research and development (R&D). Moreover, we also discuss under which circumstances consumers benefit more from R&D.

As we will discuss this more detailed later, most of the existing papers that deal with R&D in a vertically market structure, use the simplifying assumption of either monopoly or perfect competition in the upstream market or downstream market respectively. However, in many real world situations we can usually observe oligopoly competition both among manufacturers and retailers. The manufacturers are in interbrand competition with each other through the degree of substitution of their products which depends on product characteristics and product brand; and retailers' intrabrand competition is characterized by various different retailers' services, images or locations. This paper extends the existing literature by providing a framework, which gives an insight into a vertically related bilateral duopoly with simultaneous interbrand and intrabrand competition. Hereafter, we consider R&D incentives in the upstream and/or downstream market. We also examine how an investment of a retailer or a manufacturer in process R&D influences the profits of other firms in the same market *and* in the vertically related market depending on exogenous factors. Hereby, we assume that only one competitor from the upstream and/or downstream market invests in R&D – for example by buying a patent.

Our work is related to both fields of R&D and vertical relations. Much literature in the area of vertical relations usually considers the effects of (horizontal) mergers on input prices, especially focusing on the analysis of downstream horizontal mergers.[1] Other papers of vertical relations have

1 For example Dobson and Waterson (1997), Inderst and Wey (2003), and von Ungern-Sternberg (1996)

some common restrictions to simplify the analysis such as monopoly or perfect competition in the upstream or downstream market – e.g. Dobson and Waterson (1997) and Chen (2003) – or vertical price fixing like Retail Price Maintenance (RPM) – such as Dobson and Waterson (2007).[2] Also the link between vertical market structure and pricing in successive oligopoly is frequently discussed in the literature for example by Abriu et al. (1998), Chen (2001), Elberfeld (2001 and 2002), Gaudet and Long (1996), Jansen (2003) and Linnemer (2003) and Ordover et al. (1990).

Although these papers explain important aspects of retail sale behavior, they do not have the element of imperfect competition in both upstream and downstream market. In contrast to the extant literature, this paper allows imperfect competition among manufacturers as well as retailers for the wide range from monopoly to perfect competition, combined with asymmetric costs in both upstream and downstream stage.

Based on the pioneering works of Schumpeter (1934, 1939 and 1942) and Arrow (1962), the R&D literature explains underinvestment in R&D according to various reasons which include uncertainty, indivisibility, externality and other factors such as labor market policy.[3] Uncertainty can lead – for instance because of risk aversion of agents – to underinvestment in R&D. Indivisibility can cause underinvestment if there is an increasing return in R&D. Uncertainty and indivisibility are not relevant in our paper.[4] Literature concentrating on externalities, such as Spence (1984), usually explains underinvestment in R&D due to the presence of (horizontal) spillover effect in R&D. Horizontal spillover assumes that a firm's R&D investment also reduces the production costs of the rival firms. Spence (1984) concludes that because spillovers generate free-rider problems, a firm's incentive to undertake R&D activities is reduced. Other papers also consider vertical spillover effect of R&D in different setups of vertically related markets. For example, Ishii (2004) considers a bilateral duopoly model with Cournot competition and homogeneous products in both markets, and assumes a symmetric spillover between the firms in the vertically related markets. This assumption includes that knowledge spills over at the same rate from upstream firms to the downstream as it does in the opposite direction. In our model, even if there is *no* vertical and/or horizontal transfer/spillover of knowledge in any direction, *no*

2 Another paper that assumes homogeneous goods in a bilateral duopoly is Ishii (2004). In his paper, he compares different modes of R&D-cooperation and research joint ventures.

3 For example Haucap and Wey (2004) show that investment incentives are highest, if an industry union sets a uniform wage rate for all firms.

4 Another field of R&D research, which is connected to this paper in the broader sense, is about the connection between Innovation and patent protection, such as Jaffe and Lerner (2004), O'Donoghue and Zweimuller (2004) and Chu (2009) to mention a few of them.

uncertainty, *no* indivisibility or other factor that has been discussed in the R&D literature, we show that the existence of a vertically related market with imperfect competition yields a dampening effect of marginal cost differences.[5] This effect in turn lowers R&D incentives and that yields, for two reasons, to underinvestment in process R&D from the social planner's point of view:

1. Marginal cost reduction of a firm through its R&D investments yield lower price setting of that firm. This creates a positive externality effect on the firms in the vertically related market, which is not considered in the R&D decision of the investing firm.
2. As a firm invests in R&D, the firms in the vertically related market react to the R&D investments by increasing their own margins.[6] Since the investing firm anticipates this reaction of vertically related firms, it has diminishing incentives of R&D investments which leads to underinvestment in R&D. We show how the magnitude of the R&D-decline depends on the degree of competition in both stages of the market.

The latter finding extends a common result of DeGraba (1990) and Yoshida (2000). They both use a similar set up of a vertical market structure with a monopolist upstream firm and two downstream firms competing à la Cournot with homogeneous goods. Both papers find that when the upstream supplier is allowed to price discriminate, he charges the downstream firm with lower marginal costs a higher price, and subsides its less efficient competitor. In our model, we show that in an extended bilateral duopoly set up with imperfect competition in both markets, this effect exists in *both* directions – i.e. downstream firms also increase their margins for the good of the more efficient manufacturer. This effect might seem anti-intuitive since it implies that the larger downstream firm, that purchases more of the input, pays a higher price. As DeGraba (1990) mentions, "quantity discounts are used as a self-selection mechanism when the seller does not know the demand curves of the buyers". Since the upstream firms in our model know the demand curve for each buyer, quantity discounts are here unnecessary.

Our model shows that both interbrand and intrabrand competition have twofold impacts on firms' incentives to invest in R&D. There is a U-shaped relationship between the degree of competition among the firms in a market and the R&D incentives of the firms in the vertically related market. On the one hand, a more intensive competition in the vertically related market leads to lower double marginalization and therefore higher sales, which makes R&D investments more attractive to firms. On the other hand, higher differentiation of firms in the vertically related market

5 Inderst and Shaffer (2009) show that under other circumstances the opposite result can occur: if there is only a monopolist in the upstream market with observable two-part tariff contracts, the monopolist would set a *lower* wholesale-price for the more efficient firm.

6 In this paper we refer to absolute margins, that is, the difference between equilibrium prices and marginal costs.

serves a wider range of consumer tastes and yields ceteris paribus higher demand, which also increases R&D incentives.

The relationship between the degree of competition and R&D incentives in the same market are also U-shaped. On the one hand, an increasing degree of competition at a low or intermediate level lowers the R&D incentives for two reasons. Firstly, it yields ceteris paribus decreasing consumers' demand. Secondly, it leads to more aggressive price reaction of the competitor as a reaction to R&D investments of the innovative firm. On the other hand, if the goods are relatively homogeneous, then higher competition increases the R&D incentives of the investing firm as business stealing effect increases significantly. On the first glance, our U-shaped result contradicts the inverted-U relationship that was found by Aghion et al. (2005). They find that in their model "competition may increase the incremental profit from innovating, labeled the "escape-competition effect," but competition may also reduce innovation incentives for laggards, labeled the "Schumpeterian effect." The balance between these two effects changes between low and high levels of competition, generating an inverted-U relationship." Contrary to their model, it seems that in our bilateral duopoly model higher R&D incentives are rather when the competition environment among the firms allows favorable conditions either for the "escape-competition effect" or for the "Schumpeterian effect". This is the case when competition is in its extreme boundary areas, and generates a U-shaped relationship.

However, the results of Aghion et al. (2005) are for the following reasons not easily comparable with the results in our paper. They use their own predefined price cost margin of the firms to measure the competition within an industry. In our paper, we use the degree of product homogeneity as a competition measure. Furthermore, our result refers to the *entire* range from Monopoly to perfect competition, while they refer to the rather competitive area. Beyond that, Aghion et al. measure the innovation through the patenting activity. This can contain a significant time lag between the actual R&D investment and the patent itself. Within this time lag, the degree of competition might change significantly. In our paper we don't consider the patent activity, but the R&D investments. Moreover, we consider only the relationship between degree of competition and R&D investments in a theoretical model, while Aghion et al. consider empirical data, which can be influenced by many other unobservable factors. For example firms can be run by "satisficing" managers who do not value only profits per se. They also draw private benefits from maintaining the firm afloat, and thereby keeping their job. In this case, increasing competition may lead to "private incentives" of the manager to invest more in R&D in order to avoid bankruptcy.[7]

We also show that, if the firms in a market are asymmetric, the firm with lower marginal costs

7 For more information to this principal-agent model please refer to Hart (1983).

usually profits from R&D investments of a firm in the vertically related market, while the firm with higher costs does not always profit. The R&D investment of a firm in vertically related market is for the high-cost-firm only profitable, if the consumers' maximum willingness to pay is high enough and competition in vertically related market is tough enough. We also show that welfare gain of R&D in upstream market increases both with the degree of interbrand and in particular with the degree of intrabrand competition.

Another aspect of R&D is based indirectly on Singh and Vives (1984) and Vives (1985), who compare differentiated Bertrand vs. Cournout competition with differentiated goods and find out that prices are lower (and hence outputs and welfare are higher) under Bertrand competition than under Cournot régime. A number of papers such as Qiu (1997), Breton et al. (2004), as well as Hinloopen and Vandekerckhove (2007) consider the welfare effects of R&D and show that output and welfare effects of R&D are higher under Bertrand competition if interbrand competition is not very tough. This model can also support these findings.

The next section will introduce a vertical model with interbrand and intrabrand competition. In Section 3, we will introduce R&D investments in the upstream stage. In Section 4, we will consider welfare effects and draw conclusions for policy makers. Section 5 concludes.

2 The model

In this section, we will describe a basic vertically related market which is related to the common framework of several papers of Dobson and Waterson (1996, 1997, 2007). We modify their basic framework by changing two elements. We introduce asymmetries in both upstream and downstream market, and we assume that consumers' maximum willingness to pay is a.[8] After introducing the industry structure and demand side, we solve the equilibrium of the vertical structure recursively.

Industry Structure

There are two manufacturers, M_h and M_g , indexed by $\{h, g\} \in \{1,2\} \wedge h \neq g$. Each manufacturer produces and sells its own branded product to all retailers. Thereby, M_1 produces

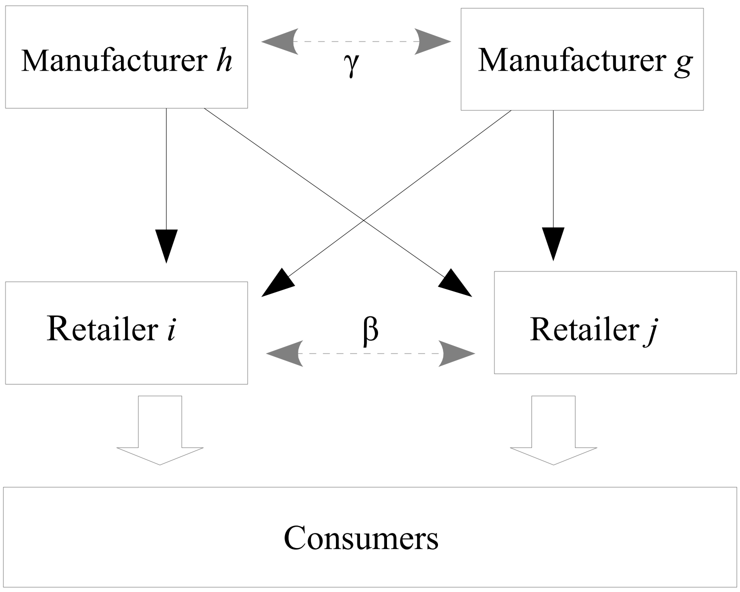
8 Dobson and Waterson set, without loss of generality, consumers' maximum willingness to pay per assumption equal to 1.

good 1 and M_2 produces good 2. The two retailers, R_i and R_j, indexed by $\{i, j\} \in \{1,2\} \wedge i \neq j$, both sell the products of all upstream firms to the consumers.

The manufacturers supply the products to the retailers at a constant unit price, where the wholesale price between retailer i and manufacturer h is w_{ih} for quantity q_{ih}, which is then sold to final consumers at the retail price p_{ih}. Manufacturers' goods are substitutes and the degree of interbrand competition is represented by γ which can vary between zero (independent goods) and one (perfect substitutes). Both goods 1 and 2 are distributed by both retailers 1 and 2. In this model manufacturers do *not* prefer any retailer, hence they are indifferent whether their products are sold by retailer 1 or 2.[9]

Retailers are also competing with each other through different retailer services associated with their location or characteristics, which can be interpreted in different ways.[10] The degree of intrabrand competition β measures how substitutable retailers' services are, and can also vary from zero (independent retailer services) to one (perfect substitutes).

Manufacturers and retailers compete à la Bertrand. The constellation of the frame model is illustrated in the graph below.



A very simple example is the electronic industry. Imagine two competing laptop manufacturers with comparable performance and equipment (no vertical differentiation). Their products are good substitutes for most consumers. If one of the manufacturers changes its product

9 Some papers about vertical relations, such as Kourandi and Vettas (2009), consider positioning of a manufacturer next to a retailer.

10 Tirole (1988, p. 177) mentions several examples of retailer's services such as free delivery, trading stamps, free alterations, credit, pre-sale information, elaborate premises, excess sales to keep waiting lines short.

and produces tablets, then the manufacturers' products are now more differentiated from consumers' point of view. The laptops of manufacturers 1 and 2 can be sold by two very similar retailers, located next to each other (such as Best Buy and Staples). The same laptops can be sold also in online shops such as Amazon or computer specialist shops as well. While the similar laptops sold by Best Buy and Staples in the same city are still good substitutes, the same laptop sold by Amazon attracts partly different consumer groups and is not such a good substitute any more. Therefore, differentiated retailers can also be an element of manufacturers' product differentiation.

Manufacturers have some constant marginal costs of production represented by c_h for manufacturer h and c_g for manufacturer g. Retailers' marginal costs consist of two blocks: wholesale price and the additional marginal cost to distribute the good, which we call hereafter the "operational marginal costs". The operational marginal costs are denoted by c_i respectively c_j and are constant as well. Retailers pay linear wholesale prices to the manufacturers, whereas retailer i pays the linear wholesale price w_{ih} for good h and so forth. The wholesale prices are assumed to be committed and cannot be renegotiated. The reason why we stay with linear wholesale pricing instead of two part tariffs is that two-part tariffs are contracts with a more complicated nature than linear wholesale prices and lead to more problems of imperfect contracts. Beside that linear wholesale prices help the feasibility of the model. Fixed production costs in both upstream and downstream market do not change the results. For this reason we assume fixed production costs to be zero for both manufacturers and retailers without loss of generality.

Demand Side

For simplicity, the demand is illustrated by a representative consumer who purchases all the goods q_{11}, q_{12}, q_{21} and q_{22}, whereas q_{12} is the amount retailer 1 purchases from good 2 and so forth. The representative consumer can be considered as the sum of the purchases of all the consumers from each good depending on its price. The representative consumer maximizes his linear quadratic utility function. The representative consumer's gross utility is: thereby:

$$U = a(q_{ih}+q_{ig}+q_{jh}+q_{jg}) - \frac{q_{ih}^2+q_{ig}^2+q_{jh}^2+q_{jg}^2}{2} - \beta(q_{ih}q_{jh}+q_{ig}q_{jg}) \\ -\gamma(q_{ih}q_{ig}+q_{jh}q_{jg}) - \delta(q_{ih}q_{jg}+q_{jh}q_{ig}) \quad (1)$$

For this term and – if applicable – for all other terms of this paper applies $\forall\{h,g\}\in\{1,2\}\wedge\{i,j\}\in\{1,2\}\wedge h\neq g\wedge i\neq j$. The demand effect of the rival brand sold at the rival retailer is represented by δ. In our model, where both retailers distribute products of both manufacturers, the inverse demand function for good *h* sold by retailer *i* can be easily derived by solving the four first order conditions with respect to quantities:

$$p_{ih}=a-q_{ih}-\beta q_{jh}-\gamma q_{ig}-\delta q_{jg}\text{, where}\{\beta,\gamma,\delta\}\in[0,1]$$
$$\text{where}\quad \{\beta,\gamma,\delta\}\in[0,1]. \tag{2}$$

Since parameter δ measures how substitutable different goods are, which are sold through different retailers, it contains both the degree of competition among retailers and among manufacturers. Therefore, it is reasonable to suppose that δ is a function of both the degree of interbrand competition γ, and the degree of intrabrand competition β. With (imperfect) interbrand and intrabrand competition it is clear that δ should be less than both β and γ. We weight both of these influences in equal proportions and assume hereinafter that $\delta = \beta\,\gamma$. This assumption, which has also been used by other papers such as Dobson and Waterson (1996), reduces the number of variables to just two key parameters β and γ. Beside feasibility, this allows us to present a graphical analysis. We would like to emphasize that there is no necessary correlation, positive or negative, at the definitional level between β (degree of intrabrand competition) and γ (degree of interbrand competition).

Inserting $\delta = \beta\,\gamma$, rearranging and solving the inverse demand functions, leads to the following demand function for good *h* sold by retailer *i*:

$$q_{ih}=\frac{a(1-\beta)(1-\gamma)-p_{ih}+p_{jh}\beta+p_{ig}\gamma-p_{jg}\beta\gamma}{(1-\beta^2)(1-\gamma^2)}\text{, where}\{\beta,\gamma\}\in[0,1[\tag{3}$$

The case of perfect competition in either upstream market or downstream market has been already discussed in the previous literature. Therefore, the result will be only briefly mentioned and not further discussed here: If a manufacturer (retailer) has lower marginal costs, it captures the entire market. Otherwise, we assume that each manufacturer (retailer) serves half of the market.

2.1 Equilibrium

Downstream Market

The model is solved recursively. First we have to solve the retailers' profit maximization problem for given wholesale prices. By setting the retail prices p_{ih} and p_{ig}, each retailer maximizes his profit function.

$$\pi_i=q_{ih}(p_{ih}-w_{ih}-c_i)+q_{ig}(p_{ig}-w_{ig}-c_i)\text{, where } i\in\{1,2\} \tag{4}$$

By inserting (3) into the profit function, we get:

$$\pi_i = \sum_{h=1}^{2} (p_{ih} - w_{ih} - c_i) \frac{a(1-\beta)(1-\gamma) - p_{ih} + p_{jh}\beta + p_{ig}\gamma - p_{jg}\beta\gamma}{(1-\beta^2)(1-\gamma^2)}, \text{ where } i \in \{1,2\} \tag{5}$$

The profit maximizing first order conditions of retailer *i* is:

$$\begin{aligned} \frac{\partial \pi_i}{\partial p_{ih}} = 0 \Leftrightarrow \frac{a}{1+\beta+\gamma+\beta\gamma} + \frac{c_i + w_{ih} - 2p_{ih} + p_{jh}\beta + (2p_{ig} - c_i - w_{ig} - p_{jg}\beta)\gamma}{(1-\beta^2)(1-\gamma^2)} = 0 \\ \frac{\partial \pi_i}{\partial p_{ig}} = 0 \Leftrightarrow \frac{a}{1+\beta+\gamma+\beta\gamma} + \frac{c_i + w_{ig} - 2p_{ig} + p_{jg}\beta + (2p_{ih} - c_i - w_{ih} - p_{jh}\beta)\gamma}{(1-\beta^2)(1-\gamma^2)} = 0 \end{aligned} \tag{6}$$

These first order conditions lead to the equilibrium retail price of each good $h \in \{1,2\}$ sold by retailer $i \in \{1,2\}$ depending on wholesale prices:

$$p_{ih} = \frac{a(2-\beta-\beta^2) + 2(w_{ih}+c_i) + \beta(w_{jh}+c_j)}{4-\beta^2} \tag{7}$$

The retail prices increase ceteris paribus, the higher firm *i*'s marginal costs and its competitor's marginal costs are, and the higher the wholesale price of good *h* for the retailer and for it's competitor is. Assuming that the total marginal costs of the competing retailer – which is w_{jh}+ c_j – is less than the consumers' maximum willingness to pay, a higher β yields decreasing retail prices. The retail prices do neither depend directly on degree of interbrand competition nor on the wholesale prices of the substitute good *g* paid by the retailer. Later we will show that the wholesale price of any good depends on degree of interbrand competition and the wholesale prices of the substitute good. Inserting $\beta = 0$ in (7) leads to the standard monopoly price $p_{ih} = (a + w_{ih} + c_i)/2$. On the other extreme, the better substitutes the goods become, the more does retail price p_{ih} approach $p_{ih} = (2(w_{ih}+c_i) + w_{jh} + c_j)/3$. As soon as interbrand competition exceeds a certain threshold (which we will analyze later), the retailer with higher operational marginal costs exits from the market and the remaining monopolist sets prices low enough to keep the competitor out of the market.

Substituting (7) in (3) yields the equilibrium outputs depending on wholesale prices:

$$q_{ih} = \frac{a(2-\beta-\beta^2)(1-\gamma) - (2-\beta^2)w_{ih} + (2+\beta^2)w_{ig}\gamma + \beta(w_{jh} + w_{jg}\gamma) + (1-\gamma)(c_i(2-\beta^2) - c_j\beta)}{(4-5\beta^2+\beta^4)(1-\gamma^2)} \tag{8}$$

The terms for q_{ig}, q_{jh} and q_{jg} are analogous.

Upstream Market

After solving the problem of firms in the downstream stage, we consider now the second step of the game and solve the profit maximizing problem of the upstream firms. The marginal costs of manufacturers *h* and *g* are denoted by c_h and c_g respectively. In this stage each manufacturer maximizes his profits by choosing wholesale prices taking into account how wholesale prices influence the retail prices and thus the sales.

The profit function of manufacturer *h* is:

$$\pi_h=(w_{ih}-c_h)q_{ih}+(w_{jh}-c_h)q_{jh}\forall h\in\{1,2\} \tag{9}$$

By inserting (8) in (9), building the profit maximizing first order conditions subject to w_{ih} and w_{jh}, and solving them we get the wholesale prices:

$$w_{ih}=\frac{a(2-\gamma-\gamma^2)+2(c_h-c_i)+\gamma(c_g+c_i(1+\gamma))}{4-\gamma^2} \tag{10}$$

If retailers have symmetric operational marginal costs ($c_i = c_j$), then manufacturers have no incentive to price discriminate among retailers. If the manufacturers' goods are independent ($\gamma = 0$), then manufacturer *h*'s wholesale price for retailer *i* is $(a+c_h - c_i)/2$. The higher interbrand competition γ, the stronger wholesale prices depend on marginal costs of the competitor, and the lower are equilibrium wholesale prices ceteris paribus. The wholesale prices do *not* depend on degree of intrabrand competition.

By inserting (10) in (7) and (8) we derive the retail prices and outputs in equilibrium depending only on exogenous parameters such as manufacturers' costs, consumers' maximum willingness to pay and the degree of interbrand and intrabrand competition:

$$p_{ih}=a-\frac{a}{(2-\beta)(2-\gamma)}+\frac{2c_h+c_g\gamma}{(2-\beta)(4-\gamma^2)}+\frac{2c_i+\beta c_j}{(4-\beta^2)(2-\gamma)} \tag{11}$$

$$q_{ih}=\frac{a}{(2+\beta-\beta^2)(2+\gamma-\gamma^2)}-\frac{c_h(2-\gamma^2)-c_g\gamma}{(2+\beta-\beta^2)(4-5\gamma^2+\gamma^4)}-\frac{c_i(2-\beta^2)-c_j\beta}{(2+\gamma-\gamma^2)(4-5\beta^2+\beta^4)} \tag{12}$$

If we assume that there is a monopoly in both stages ($\beta = \gamma = 0$), we get the standard solution $p_{ih}=\frac{a+c_h+c_i}{4}$ and $q_{ih}=\frac{a-c_h-c_i}{4}$ due to double marginalization in the vertical structure.[11] For

11 If we consider the case of symmetric manufacturers and symmetric retailers, then the wholesale price in equilibrium will be for all the goods and each retailer $w=a-\frac{a-c}{2-\gamma}$ and the corresponding equilibrium output for each of the goods sold by any retailer is $q_{ih}=\frac{a-c}{(2-\beta)(1+\beta)(2-\gamma)(1+\gamma)}$. The common retail price for all goods is $p=a-\frac{a-c}{(2-\beta)(2-\gamma)}$, the profits of both manufacturers are $\pi_i=\alpha(1-\gamma)$ and retailers' profits are $\pi_h=\alpha\frac{(1-\beta)}{(2-\beta)}$, where $\alpha=\frac{2(a-c)^2}{(2-\beta)(1+\beta)(2-\gamma)^2(1+\gamma)}$.
The profits of manufacturers decreases as β approaches to 0.5 or as γ increases. Retailers' profits decrease as β increases or as γ decreases.

the same reason, the retail price converges to $p_{ih} = \frac{2(c_h + c_i) + c_g + c_j}{3}$, the tougher interbrand and intrabrand competition become (β , γ → 1).[12]

By calculating the prices for Cournot competition in both markets we find that prices are lower and thus outputs and welfare are higher under Bertrand competition which confirms the results in the existing literature. The Cournot results can be found in appendix A.

Profits

In order to make the discussion of manufacturers' profits more feasible, we assume both firms in the downstream market have symmetric operational marginal costs c_d (c_u). Substituting (10) and (12) back into (9) leads – under the assumption $c_i = c_j = c_d$ – to the profit function of manufacturer *h* in equilibrium:

$$\pi_h = \frac{2(\gamma(c_g + c_d + \gamma(c_h + c_d)) - 2(c_h + c_d) + a(2 - \gamma - \gamma^2))^2}{(2 + \beta - \beta^2)(4 - \gamma^2)^2(1 - \gamma^2)} \tag{13}$$

Since β can only be found in the denominator of manufacturers' profit, the dependency of manufacturers' profits on intrabrand competition in the downstream market can be expressed as $1/(2 + \beta - \beta^2)$. Thus, the manufacturers' profits have a U-shaped relationship with the retailers' degree of substitution β: They increase as β gets closer to the borders 0 or 1 (either if retailers' services are totally independent or perfect substitutes) and they decrease as β gets closer to 0.5.

The reason for this U-shaped relationship is that if retailers are in perfect competition, there is no double marginalization. The elimination of double marginalization leads ceteris paribus to lower retail prices and hence, to an increase of demand for manufacturers' goods. On the one hand, higher differentiation of retailers' services lead to higher double marginalization effect. But on the other hand, if retailer services are more differentiated, more consumer tastes are served, and due to the assumed linear quadratic utility function, the demand is ceteris paribus higher. This countervailing effect leads to a second maximum level of upstream firms' profits with respect to the intrabrand competition by β = 0. Therefore, a change in degree of intrabrand competition has a U-shaped external effect on the profits of both manufacturers.

Inserting (10), (11) and (12) into (5) leads – under the assumption $c_h = c_g = c_u$ – to the profit function of retailer *i* in equilibrium:

12 As we mentioned above, if manufacturers (retailers) are asymmetric, the demand of the weaker competitor collapses, as soon as the difference among the marginal costs of manufacturers (retailers) exceeds a certain threshold. This threshold will be analyzed in proposition 1 in section 3.

$$\pi_i = \frac{2(2(c_i + c_u) - \beta(c_j + c_u + \beta(c_i + c_u)) + a(2 - \beta - \beta^2))^2}{(2-\gamma)^2(1+\gamma)(4-\beta^2)^2(1-\beta^2)} \tag{14}$$

The dependency of downstream firms' profits on competition in the vertically related market can be expressed as $\frac{1}{(2+\gamma-\gamma^2)(1+\gamma)}$. Thus, the profits of retailers increase with the degree of competition among manufacturers.

In opposite to the manufacturer's profits, retailers' profits strictly increase with the degree of competition in the vertically related market. The reason lies in the different effects that higher degree of competition has for the vertically related market. While higher competition in the upstream market yields lower wholesale prices for the retailers, higher Degree of competition in the downstream market lowers the double marginalization effect. Since the first effect is stronger than the latter effect, only the effect of lower double marginalization can be overcompensated through higher demand caused by higher differentiation among retailers. Higher product differentiation of manufacturers' products causes higher wholesale prices on the on hand, and ceterus paribus higher consumer demand on the other hand. Here, higher wholesale prices can not be compensated by the higher demand. Therefore, higher product differentiation yields lower profits for the retailers.

3 Research and Development

This chapter focuses on analyzing the incentives to invest in process R&D. We assume that only one firm in each level – in the upstream market, in the downstream market, or in both markets – can invest in process R&D and that the amount of marginal cost reductions is common knowledge. For example consider the case, where an inventor offers a patented innovation to the firms, so that only the highest bidding firm can use the innovation. Adding research and development to the basic model, which already contains some complex features, requires the simplifying tool of considering just the R&D incentives instead of endogenizing the R&D investment. Therefore, we consider the impact of the determinants on R&D incentives devoid of specifying the amount of R&D investment. In this paper, we consider the case where the firms in a market have equal marginal costs before the R&D stage. Thus, we assume implicitly that the firm which invests in R&D obtains a marginal-cost-advantage.[13]

13 It is also possible to consider other cases. Assume for example a case, where the investing firm has a location disadvantage and compensates this disadvantage through R&D. Slight modifications on this model allows the discussion of such cases. However, this paper focuses on the case where the competitors in the upstream or downstream market have equal pre R&D marginal costs.

We will first start in subsection 3.1 to consider R&D incentives of manufacturer i with symmetric downstream firms. Afterward, in 3.2 we consider the R&D incentives for retailer h with symmetric upstream firms. Subsection 3.3 discusses how R&D investment in a market depends on both the degree of competition in that market as well as in the vertically related market. Finally, we introduce asymmetries in both markets by allowing R&D for both manufacturer h and retailer i in subsection 3.4.

3.1 R&D investments in upstream market

We assume that manufacturer h reduces his marginal costs by amount d through some fixed investments F_U in process R&D. Before manufacturer h invests in R&D, both upstream firms h and g have symmetric marginal costs denoted by c_u. Downstream firms' operational marginal costs are assumed to be symmetric and are denoted by c_d. This assumption will be relaxed later.

The profits of retailers are:

$$\pi_i = q_{ih}(p_{ih} - w_{ih} - c_d) + q_{ig}(p_{ig} - w_{ig} - c_d) \qquad \forall\, i \in \{1,2\} \tag{15}$$

Manufacturer h's marginal costs reduce due to R&D to c_u - d and it sets its wholesale prices according to the reduced marginal costs. This yields the following wholesale price of manufacturer h:

$$w_{ih} = w_{jh} = \frac{(a - c_d)(1-\gamma) + c_u}{2-\gamma} - \frac{2d}{4-\gamma^2} \tag{16}$$

The better substitutes the goods are – i.e. the greater γ is – the “more aggressively” does manufacturer h reduce its wholesale prices in order to better use its marginal cost advantage due to R&D investment. The reason is the higher business stealing effect that comes along with a higher degree of substitution of products.

Due to the new wholesale prices of upstream firm h, manufacturer g reacts by decreasing his wholesale prices as well. But since manufacturer g has higher marginal costs than its competitor h, it does not decrease its wholesale prices as strongly as manufacturer h does. The new wholesale prices of manufacturer g are therefore:

$$w_{ig} = w_{jg} = \frac{(a - c_d)(1-\gamma) + c_u}{2-\gamma} - \frac{\gamma d}{4-\gamma^2} \tag{17}$$

The better substitutes the goods are, the stronger does manufacturer g reduces its price, because consumers react more sensitively to price differences. As long as both manufacturers are active in the market, their price-setting-behavior depends - among other factors – on operational marginal costs of retailers. From (16) and (17) follows that both manufacturers set higher wholesale prices the lower the operational marginal costs of retailers are. De Graba (1990) shows this effect for one price discriminating manufacturer and two retailers, who compete à la Cournot and face a linear demand for the final good. We show that this result also holds when there are two firms in the upstream market, downstream firms compete à la Bertrand, and the demand curve in the final goods market is non-linear. The reason for this effect in our model is, similar to De Graba, due to the more inelastic demand of the low cost firm.

We have to take into account that if costs are more different – or products are more substitutable – than a certain threshold, only one firm can remain in the market. If manufacturer *h*'s price reduction exceeds a certain threshold,[14] the demand of the weaker competitor collapses, because the difference among the marginal costs of manufacturers are too much.

Proposition 1: *Manufacturer g, who does not invest in R&D, produces it's product* q_g *only if its marginal cost disadvantage d is less than* $\frac{(a-c_u-c_d)(1-\gamma)(2+\gamma)}{\gamma}$.

Proof: See Appendix B. □

There are three different types of competition regimes that can be found among manufacturers.[15] As long as both manufacturers are in the market, there is a duopoly competition. As proposition 1 shows, if marginal cost differences due to firm *h*'s R&D investments are higher than a certain threshold, manufacturer *g*'s demand collapses and it exits the market. In this case, we have to distinguish between two other possible competition regimes, depending on whether firm *h*'s innovation is drastic or not. If it is drastic, i.e. the monopoly wholesale price of manufacturer *h* is below it's competitor's marginal cost, firm *h* simply sets its monopoly wholesale price. Otherwise, it is a contestable market and manufacturer *h*'s optimal duopoly wholesale price is the following limit price:

$$w_{ih}=w_{jh}=a-c_d-\frac{(a-c_d-c_u)}{\gamma} \tag{18}$$

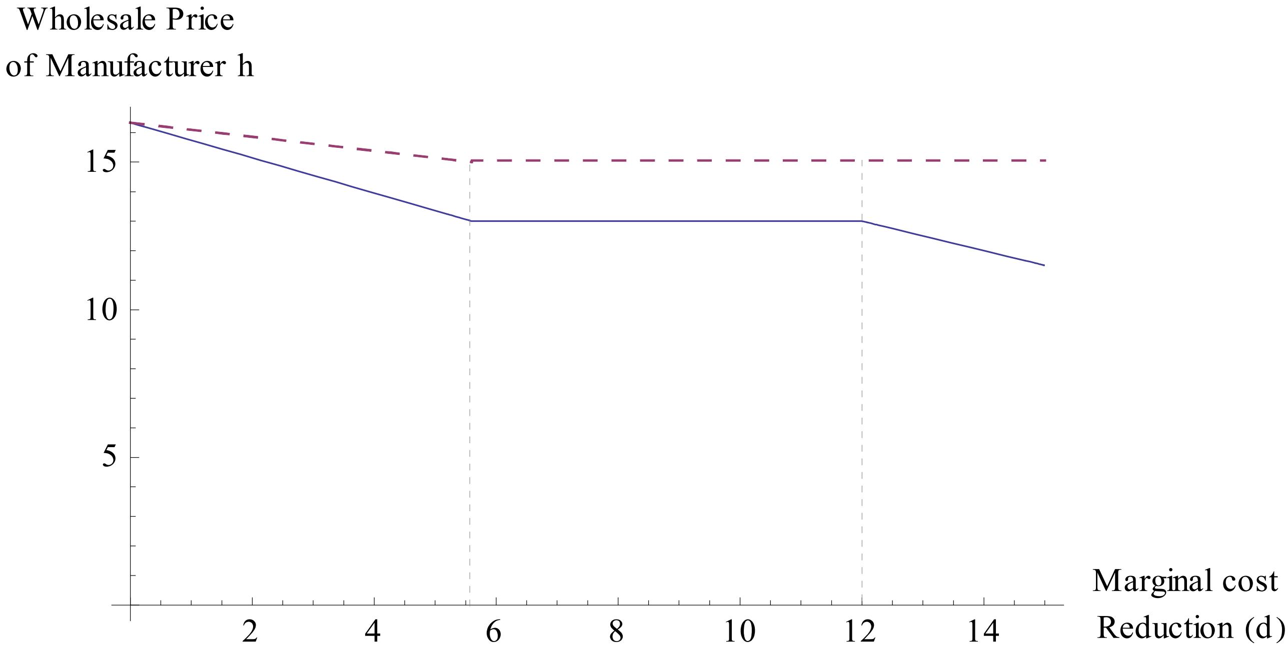
This price is just low enough to keep manufacturer *g* out of the market. Manufacturer *h* sets limit prices in (18) if price reduction *d* exceeds the threshold $\bar{d}=a-c_d-(a-c_d-c_u)/\gamma$ to keep the competitor out of the market, but is not high enough to be drastic. The better substitutes the

14 Analogously we can say: "if interbrand competition exceeds a certain threshold,...". The threshold for degree of interbrand competition is $\gamma=\frac{\sqrt{8(a-c_d-c_u)^2+(a-c_d-c_u+d)^2}-a+c_d+c_u-d}{2(a-c_d-c_u)}$.

15 These competition regimes can be found analogously for the retailers when they have different marginal costs.

goods are, the lower sets manufacturer *h* its limit price.

The innovation is drastic, if $d \geqslant 3c_u + c_d - a$. As mentioned above, manufacturer *h* sets its monopoly wholesale prices since they are now below the limit prices in (18). The price setting behavior of both manufacturers subject to manufacturer *h*'s marginal cost reduction *d* is demonstrated in the graph below.



Graph 1: Price setting behavior of manufacturer *h* (solid line), which invests in process R&D to reduce its marginal costs, and manufacturer *g* (dashed line). The parameter values of this graph are: a = 38, γ = 0.8, c_d = 15, c_u = 15.

The graph above illustrates the three different competition regimes. In this illustration there is a duopoly competition among the firms if *d* is below the threshold $\bar{d} = 5.6$. If *d* exceeds this threshold, manufacturer *g* drives out of the market. As long as *d* is within the range [5.6 , 12], the market is a contestable market with manufacturer *g* as potential entrant and manufacturer *h* sets limit prices. If d > 12, then the innovation is drastic and there is no threat of competition and manufacturer *h* sets the monopoly wholesale price. The different price setting phases are in this graph separated by threshold values of parameter *d*. However, as it was mentioned previously in a footnote, it is also possible to assume a fix value for *d*, and consider instead different threshold values of γ instead of *d*. The price setting phases we consider is analogous to the entire range of possibilities that can be found for values of γ in [0 , 1].

As both manufacturers reduce the wholesale prices due to process R&D, the retailers face lower marginal costs for both goods. From (16) and (17) follows that R&D investments of manufacturer *h* have therefore a positive externality effect on the retailers, which is $2d/4-\gamma^2$ for good *h* and $d\gamma/4-\gamma^2$ for good *g*. The positive externality effect of R&D is higher, the better substitutes the products are. The difference in the wholesale prices of manufacturers *g* and *h* is $d/(2+\gamma)$. Thus the difference in wholesale prices of manufacturers in this model represents only 1/2 to 1/3 of the difference in marginal costs.

Since retailers face lower costs, they will set lower final prices for the goods. The new retail prices of goods *h* and *g* are:

$$p_{ih}=p_{jh}=a-\frac{a-c_u-c_d}{(2-\beta)(2-\gamma)}-\frac{2d}{(2-\beta)(4-\gamma^2)} \quad \text{for good } h \text{ and}$$

$$p_{ig}=p_{jg}=a-\frac{a-c_u-c_d}{(2-\beta)(2-\gamma)}-\frac{d\gamma}{(2-\beta)(4-\gamma^2)} \quad \text{for good } g. \tag{19}$$

Unless the retailers' services are perfect substitutes, they do not pass through the total reduction of the wholesale prices to the final consumers. A price reduction of manufacturer *h* by the amount of $2d/4-\gamma^2$, leads to a final price reduction of good *g* by $d\gamma/((4-\gamma^2)(2-\beta))$. Thus, even customers who only buy product *g*, profit from R&D investments of firm *h* as well. Since manufacturer *g* lowers the wholesale prices to a lesser extent than manufacturer *h*, the retail price of product *g* is by $d/((2+\gamma)(2-\beta))$ higher than the retail price of product *h*. Not only the intensity of price reduction, but also the altitude of the difference in retail prices among the goods depends on the degree of both interbrand and intrabrand competition. If manufacturer's products are very similar, manufacturer *g* reacts stronger to the price reduction of his competitor; this leads ceteris paribus to a weaker difference in retail prices. Thus, in a vertical model with interbrand and intrabrand competition and asymmetric manufacturers, similar retail prices of the same good at different retailers can be either a sign of intense competition among manufacturers or a sign of low competitive pressure among retailers!

Lemma 1: *Retailer's pass through rate of the lower wholesale price is* $\frac{1}{(2-\beta)}$.

Proof: Equilibrium (19) shows that cost reduction of manufacturer *h* is partly passed through to the final price of good *h* with a total pass through rate $\frac{2d}{(4-\gamma^2)(2-\beta)}$. In addition to this, the final price of good *g* decreases by $\frac{\gamma d}{(4-\gamma^2)(2-\beta)}$. These total pass through rates consist of manufacturers' pass-through rates and retailers' pass-through rates.

From (16) and (17) we get manufacturers' wholesale price reductions to retailers which are $(2d)/4-\gamma^2$ for good *h* and $(\gamma d)/4-\gamma^2$ for good *g*. By dividing Manufacturers' wholesale price reductions through total pass through rates, we get Retailers' pass through rate, which is

$$\frac{1}{(2-\beta)} \ . \ \square$$

Lemma 1 shows that up to 50% of the cost differences among the manufacturers is dampened by retailers. Through lemma 1 we can show proposition 2.

Proposition 2: *R&D investments in the upstream market lead to stronger price reductions for final consumers the higher both degree of interbrand and intrabrand competition is. This is true for all non drastic innovations.*

Proof: See Appendix C. □

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3.2 R&D in the downstream market

Retailers' total marginal costs consists of two cost blocks: the wholesale prices and the operational marginal costs c_i for retailer i and c_j for retailer j to distribute a good. In this subsection we assume that both retailers have identical operational marginal costs c_d before investing in R&D. Analogous to the previous chapter, I assume that one retailer – hereafter denoted by retailer i – can invest the fixed costs F_D in process R&D to reduce its operational marginal costs by r.[16] Therefore we express the operational marginal costs of retailer j as c_d and the operational marginal costs of retailer i as $c_d - r$. In this subsection we assume that manufacturers are asymmetric, hence $c_h \neq c_g$.

The R&D investments of retailer i leads to a reduction of marginal costs of that retailer. Hence, the retailers' profits are:

$$\pi_i = \sum_{h=1}^{2} q_{ih}(p_{ih} - w_{ih} - c_d + r) - F_D$$
$$\pi_j = \sum_{h=1}^{2} q_{jh}(p_{jh} - w_{jh} - c_d) \qquad (20)$$

Since retail prices are functions of r, the profit maximizing prices of retailer i are:

$$p_{ih} = \frac{a(1-\beta)+c_d}{(2-\beta)} + \frac{2w_{ih} + w_{jh}\beta - 2r}{(4-\beta^2)}, \qquad (21)$$

And retailer j's retail prices are:

16 This could be motivated in different ways: The process R&D can be an investment in a new warehousing or in a new logistic system. Alternatively, one can also imagine that the downstream firms are just in another intermediate stage and need the output of upstream firms for their products, which is the input for the firms in the next stage. In this case, the process R&D can be an investment in a new technology, which reduces the marginal costs of producing the (intermediate-) good of the downstream firm.

$$p_{jh}=\frac{a(1-\beta)+c_d}{(2-\beta)}+\frac{2w_{jh}+w_{ih}\beta-\beta r}{(4-\beta^2)}, \tag{22}$$

Inserting the prices into the quantities of retailer *i* yield:

$$q_{ih}=\frac{a-c_d}{(2+\beta-\beta^2)(1+\gamma)}+\frac{w_{jh}\beta-w_{ih}(2-\beta^2)+\gamma(2w_{ig}-w_{jg}\beta-w_{ig}\beta^2)}{(4-5\beta^2+\beta^4)(1-\gamma^2)}+\frac{r(2-\beta^2)}{(4-5\beta^2+\beta^4)(1+\gamma)} \tag{23}$$

And retailer *j*'s output is:

$$q_{jh}=\frac{a-c_d}{(2+\beta-\beta^2)(1+\gamma)}+\frac{w_{ih}\beta-w_{jh}(2-\beta^2)+\gamma(2w_{jg}-w_{ig}\beta-w_{jg}\beta^2)}{(4-5\beta^2+\beta^4)(1-\gamma^2)}-\frac{r\beta}{(4-5\beta^2+\beta^4)(1+\gamma)} \tag{24}$$

Inserting (23) and (24) into (9) and maximizing subject to the wholesale prices and solving the four first order conditions and solving the equation system leads to the wholesale prices. Manufacturers' wholesale prices are

$$\begin{aligned} w_{ih}&=\frac{(a-c_d+r)(1-\gamma)}{2-\gamma}+\frac{2c_h+\gamma c_g}{4-\gamma^2}, \qquad \forall\ h\in\{1,2\} \\ w_{jh}&=\frac{(a-c_d)(1-\gamma)}{2-\gamma}+\frac{2c_h+\gamma c_g}{4-\gamma^2}, \qquad \forall\ h\in\{1,2\} \end{aligned} \tag{25}$$

From (25) it follows that – unless manufacturers' goods are perfect substitutes – upstream firms price discriminate among retailers with asymmetric marginal costs, which is caused by process R&D of retailer *i*. While manufacturers charge retailer *j* the same wholesale price as before, they increase the wholesale price of the innovative retailer *i* by:

$$w_{ih}(r)-w_{ih}(r=0)=r\frac{(1-\gamma)}{(2-\gamma)} \tag{26}$$

If manufacturers' are symmetric and their goods are perfect substitutes (γ=1), they simply set the wholesale prices equal to their marginal costs and therefore, they will not price discriminate among the asymmetric retailers. The more differentiated manufacturers' goods are, the more they will increase the wholesale price for retailer *i* as a fraction of *r*. If manufacturers are monopolists (γ=0), half of the retailer's marginal cost reduction is absorbed by higher wholesale prices of manufacturers.

An explanation of why the more efficient retailer faces a higher wholesale price, lies in the price elasticity of demand $\eta=\frac{\partial q}{\partial p}\frac{p}{q}$. In this case, the price elasticity of demand for the product *h* by retailer *i* is:[17]

17 We introduce for better analysis of price elasticity the assumption c_g = c_h = c_u. This assumption is only for the equations (27) and (28) in this subsection.

$$\eta_{ih} = \frac{p_{ih}}{a(1-\beta)(1-\gamma) - p_{ih} + p_{jh}\beta + p_{ig}\gamma - p_{jg}\beta\gamma} \tag{27}$$

The price elasticity increases with the retail price p_{ih}. Inserting p_{ih} from (19) in (27) (whereas $d = 0$) leads to the price elasticity depending on the external variables:

$$\eta_{ih} = \frac{c_d + c_u + a(3-\beta(2-\gamma)-2\gamma)}{(a-c_d-c_u)(1-\beta)(1-\gamma)} \tag{28}$$

The lower the operational marginal costs (c_d) of a distributing retailer is, the lower its price elasticity of demand is. Hence, the retailer who invests in process R&D and decreases its operational marginal costs, has a lower price elasticity of demand than its competitor. Therefore, the manufacturers increase wholesale prices for retailer i as it invests in R&D, while they do not change the wholesale prices for retailer j, which absorbs a part of the inequality of retailers.

After analyzing the impact of retailer i's process R&D on manufacturers' wholesale-price-setting, we analyze the effect on final prices. From substituting back (25) into(21) we get retailer i's prices depending on exogenous variables only:

$$p_{ih} = a - \frac{a-c_d}{(2-\beta)(2-\gamma)} + \frac{2c_h + \gamma c_g}{(2-\beta)(4-\gamma^2)} - \frac{2r}{(4-\beta^2)(2-\gamma)} \tag{29}$$

Inserting (25) into (22) shows retailer j's final prices in dependence of exogenous parameters only:

$$p_{jh} = a - \frac{a-c_d}{(2-\beta)(2-\gamma)} + \frac{2c_h + \gamma c_g}{(2-\beta)(4-\gamma^2)} - \frac{\beta r}{(4-\beta^2)(2-\gamma)} \tag{30}$$

Although retailer j's marginal costs remain constant, it reacts to the lower costs of retailer i and also sets lower retail prices.

Subtracting (29) from (30) shows that even though retailer j reacts to price reduction of its competitor, retailer j's final price is by $\frac{r}{(2+\beta)(2-\gamma)}$ higher than retailer i's final price.

Inserting (29) and (30) in (8) leads to the quantities depending only on external variables:

$$q_{ih} = \frac{a-c_d}{(2+\beta-\beta^2)(2+\gamma-\gamma^2)} + \frac{\gamma c_g - c_h(2-\gamma^2)}{(2+\beta-\beta^2)(2+\gamma-\gamma^2)} + \frac{r(2-\beta^2)}{(4-5\beta^2+\beta^4)(2+\gamma-\gamma^2)}\ , \tag{31}$$

The quantity sold by retailer j is:

$$q_{jh} = \frac{a-c_d}{(2+\beta-\beta^2)(2+\gamma-\gamma^2)} + \frac{\gamma c_g - c_h(2-\gamma^2)}{(2+\beta-\beta^2)(2+\gamma-\gamma^2)} - \frac{r\beta}{(4-5\beta^2+\beta^4)(2+\gamma-\gamma^2)} \tag{32}$$

Similar to the case of R&D in upstream market, retailer j will sell no goods any more if retailer i's cost reduction exceeds a certain threshold.

Proposition 3: *The retailer with higher marginal costs operates under Bertrand regime only if* $r \leqslant (2-\beta-\beta^2)(\frac{a}{\beta}+\gamma(c_d(1+\gamma)+c_g+\gamma c_h)-2(c_d+c_h))$, *where c_h represents the marginal costs of manufacturer with low marginal costs and c_g represents its competitor's marginal costs.*

Proof: The proof is equivalent to proof of proposition 1. □

Comparing (29) and (30) with (11) shows that retailer *i* reduces its price by $\frac{2r}{(4-\beta^2)(2-\gamma)}$ and the competitor reduces its price by $\frac{\beta r}{(4-\beta^2)(2-\gamma)}$. These price reductions consist of two parts:[18]

- Retail-price-setting of downstream firms depending on R&D effect
- Manufacturers' wholesale-price-setting.

How R&D investments of retailer *i* impact manufacturers' wholesale prices w_i and w_j is already shown in (26) and discussed above. Here we will briefly consider the impact of downstream firms' retail-price-setting behavior. In order to see the pure mechanism of this effect only, we consider the price setting behavior of retailers under the assumption that manufacturers set the same wholesale prices that they were setting before R&D investments of retailer *i*.

Hereby, retailer *i* decreases its price by $2r/(4-\beta^2)$ and retailer *j* by $\beta r/(4-\beta^2)$. A comparison of these terms with (29) and (30) shows that the dampening effect of manufacturers' price setting causes lower differences in retail prices.

3.3 Impacts of interbrand and intrabrand competition on results of R&D

As we have mentioned in the introduction, there are several papers, such as Qiu (1997) and Breton et al. (2004), that analyze R&D incentives depending on the degree of competition between the innovating firm and its competitors.[19] One of the contributions of this paper is to go beyond the dependence of R&D incentives on the degree of competition in the same market and to analyze how R&D incentives in a market depend on the degree of competition in the vertically related market. In order to analyze R&D incentives of manufacturer *h*, we compare how the profit increases if a fixed

18 These price reductions are analogous to the total pass through rate of manufacturer *h*'s R&D investment, hence it means what proportion of the marginal cost reduction is passed through to the retail prices.

19 Other papers such as Lin and Saggi go one step further and show that investments in process R&D increase with the degree of product differentiation, and they also discuss the relationship between process R&D and product R&D.

amount of R&D is invested depending on interbrand and intrabrand competition.

The profit of manufacturer *h* is:

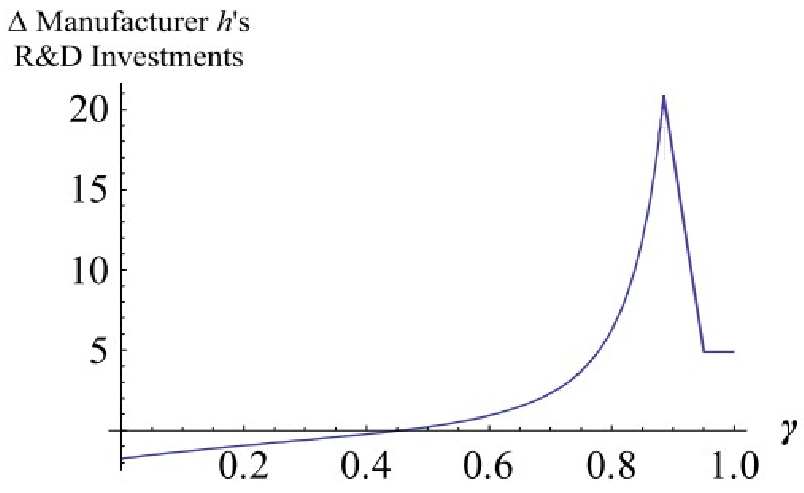
$$\pi_h = \frac{2[2(c_d+c_u-d)-\gamma(c_d+c_u+\gamma(c_d+c_u-d))-a(2-\gamma-\gamma^2)]^2}{(2-\beta)(1+\beta)(4-\gamma^2)^2(1-\gamma^2)} \tag{33}$$

The derivative of manufacturer's profit function with respect to *d* considers the profit gain of manufacturer *h* through higher process innovation, without taking the fixed costs into account. Therefore, it demonstrates the *incentives* of manufacturers to invest in R&D. The R&D incentives of manufacturer *h* is:

$$\frac{\partial \pi_h}{\partial d} = \frac{-4(2-\gamma^2)(2(c_d+c_u-d)+\gamma(c_d+c_u+(c_d+c_u-d)\gamma)-a(2-\gamma-\gamma^2))}{(2-\beta)(1+\beta)(4-\gamma^2)^2(1-\gamma^2)} \tag{34}$$

In order to analyze under which value of intrabrand competition manufacturer *h* has the highest/lowest incentives to invest in R&D, we differentiate (34) with respect to β. Setting the derivative equal to zero and solving for β leads to the only solution β= ½. Since the second derivative of manufacturer *h*'s R&D incentives is positive, the R&D incentives of the manufacturers are minimized if intrabrand competition is at β = ½. Since this is the only local extremum for $\beta \in [0,1]$, we conclude that the R&D incentive of manufacturer *i* consistently increases as the value of β approaches the extreme values zero and one. When β approaches 1, competition among retailers become tougher and retailers' pass through rate of wholesale price reduction, which is a consequence of manufacturers' R&D investments, increases. On the other hand, due to the assumed linear quadratic utility function, when β approaches 0, the higher differentiation of retailers' services yields ceteris paribus higher consumer demand. This in turn, yields higher R&D incentives of upstream firms.

The graph below depicts the derivative of manufacturer *h*'s profit with respect to γ. In other words, it shows how R&D incentives of manufacturer *h* change, depending on the degree of interbrand competition γ.



Graph 2: Changes in manufacturer *h*'s R&D incentive subject to degree of interbrand competition. The parameter values of the graph are: a = 24, c_d = 8, c_u = 8, d = 3, β = ½. The degree of interbrand competition γ is on the horizontal axes, and manufacturer *h*'s R&D incentives is on the vertical axis.

In the area where γ is below (above) the threshold value $\bar{\gamma} \approx .46$, tougher interbrand competition yields lower (higher) R&D incentives. The lower the costs of investment in process R&D are, the lower is the value of the threshold $\bar{\gamma}$.

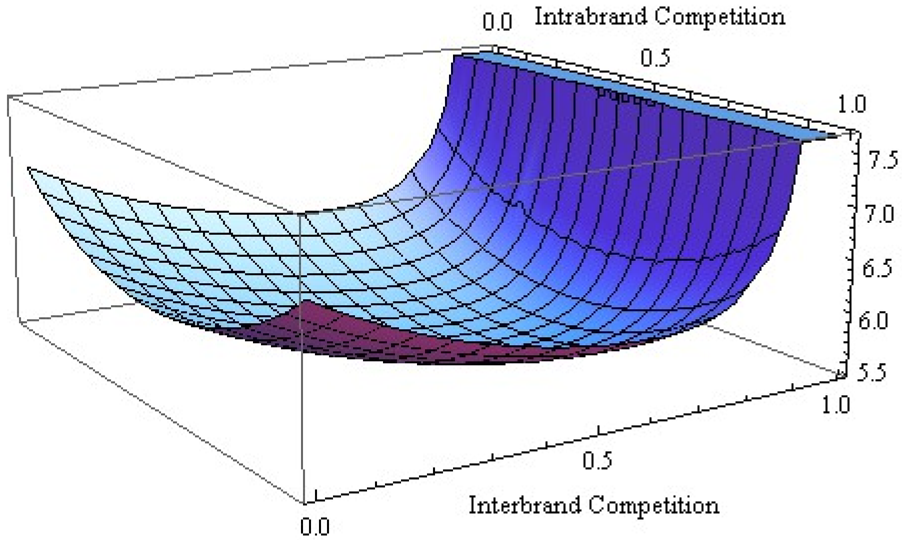
In the area where interbrand competition is relaxed, an increasing degree of interbrand competition γ causes lower R&D incentives of manufacturer *h*. The reason is that the competitor reacts more strongly to firm *h*'s R&D investments and decreases its wholesale prices more, when γ increases. This leads to lower profit-gain through R&D investment of manufacturer *h* and therefore, lower R&D incentives of that firm.

In the relatively high ranges of γ – hence when competition is tough, but not tough enough to force manufacturer *g* exit the market – then the profit gain due to R&D is increasing and convex for higher γ. Under these circumstances, the wholesale price is already close to the marginal costs *before* manufacturer *h* invests in R&D and hence, the margins of manufacturer *g* are low. The higher γ is, the lower are the margins of firm *g* and therefore, the less "elastic" – or in other words the weaker – is firm *g*'s price reduction as a reaction to firm *h*'s R&D investments. For this reason, R&D incentives of manufacturer *h* increases, the tougher interbrand competition is.

If the degree of interbrand competition is close enough to 1 so that the innovation is drastic, manufacturer *h* is enabled to set it's monopoly price in order to keep the competitor out of the market. Therefore, manufacturer *h* always invests the "monopoly-level" in R&D, and its R&D-incentives do not change due to a further rise of degree of interbrand competition.

If the combination of the degree of interbrand competition γ and the marginal-cost-reducing-innovation *d* is high enough to keep manufacturer *g* out of the market, but is not high enough to be drastic, manufacturer *h* applies limit pricing. In this range, an increasing γ yields lower R&D investments of firm 1.

The figure below visualizes the combined relationship between manufacturer *h*'s R&D-incentives, the degree of intrabrand competition β, and the degree of interbrand competition γ.



Graph 3: R&D incentives of manufacturer *h* subject to the degree of interbrand and intrabrand competition. The parameter values of the graph are the following: $a = 20$, $c_d = 4$, $c_u = 4$, $d = 2$.

The graph shows the R&D incentives of manufacturer *h*, which is mathematically expressed as $\frac{\partial \pi_h}{\partial d}$, subject to interbrand $\frac{\partial \pi_h}{\partial \gamma \partial d}$ and intrabrand $\frac{\partial \pi_h}{\partial \beta \partial d}$ competition.

It has been already discussed, manufacturer *h*'s R&D incentives are minimized if $\beta = ½$. Hereby, if $\beta \in [0.5; 1]$, higher β yields higher R&D incentives of manufacturer *h* and if th value of β is in the range $\beta \in [0; 0.5]$, the R&D incentives increases the *lower* β is.

A lower γ has, similar to the case of β, an increasing demand effect due to the assumed utility function. On the other hand, an increasing γ yields higher business stealing effect, which in turn yields more benefits of R&D investment for manufacturer *h*. If γ is higher than a certain threshold, manufacturer *g* can even be driven out of the market.

3.4 R&D in upstream and downstream market

In this subsection, we solve the model for simultaneous R&D investments of manufacturer *h* and retailer *i.* Because of the simultaneous R&D investments, we have asymmetries in both upstream and downstream market. In the earlier sections, we have shown that if the firms in a market are symmetric, they both profit from the R&D investment in the vertically related market. In this section we consider what happens with the profits of both asymmetric firms, if a firm in a vertically related market expands its investments in process R&D. First, we consider the market equilibrium. In the downstream stage the retailers' gross profits are:

$$\begin{gathered}\pi_i = q_{ih}(p_{ih} - w_{ih} - c_d + r) + q_{ig}(p_{ig} - w_{ig} - c_d + r) - F_D \\ \pi_j = q_{jh}(p_{jh} - w_{jh} - c_d) + q_{jg}(p_{jg} - w_{jg} - c_d)\end{gathered} \tag{35}$$

Solving the downstream stage leads to the following profit maximizing retail prices:

$$\begin{gathered}p_{ih} = \frac{a(1-\beta)+c_d}{2-\beta} + \frac{2w_{ih}+\beta w_{jh} - 2\mathrm{r}}{4-\beta^2}, \forall i \in \{1,2\} \\ p_{jh} = \frac{a(1-\beta)+c_d}{2-\beta} + \frac{2w_{ih}+\beta w_{jh} - \beta r}{4-\beta^2}, \forall i \in \{1,2\}\end{gathered} \tag{36}$$

The corresponding quantities are:

$$\begin{gathered}q_{ih} = \frac{a-c_d}{(2+\beta-\beta^2)(1+\gamma)} + \frac{w_{jh}\beta - w_{ih}(2-\beta^2) + \gamma(2w_{ig} - w_{jg}\beta - w_{ig}\beta^2)}{(4-5\beta^2+\beta^4)(1-\gamma^2)} + \frac{r(2-\beta^2)}{(4-5\beta^2+\beta^4)(1+\gamma)}, \\ \forall h \in \{1,2\} \\ q_{jh} = \frac{a-c_d}{(2+\beta-\beta^2)(1+\gamma)} + \frac{w_{ih}\beta - w_{jh}(2-\beta^2) + \gamma(2w_{jg} - w_{ig}\beta - w_{jg}\beta^2)}{(4-5\beta^2+\beta^4)(1-\gamma^2)} + \frac{r(2-\beta^2)}{(4-5\beta^2+\beta^4)(1+\gamma)} \\ \forall h \in \{1,2\}\end{gathered} \tag{37}$$

The profits of manufacturers are:

$$\begin{gathered}\pi_h = q_{ih}(w_{ih} - c_u + d) + q_{jh}(w_{jh} - c_u + d) - F_U \\ \pi_g = q_{ig}(w_{ig} - c_u) + q_{jg}(w_{jg} - c_u)\end{gathered} \tag{38}$$

Taking the profit maximizing first order conditions and solving the equation system leads to the following wholesale prices:

$$\begin{gathered}w_{ih} = \frac{(a-c_d+r)(1-\gamma)+c_u}{2-\gamma} - \frac{2d}{4-\gamma^2}, \qquad w_{jh} = \frac{(a-c_d)(1-\gamma)+c_u}{2-\gamma} - \frac{2d}{4-\gamma^2}, \\ w_{ig} = \frac{(a-c_d+r)(1-\gamma)+c_u}{2-\gamma} - \frac{\gamma d}{4-\gamma^2}, \qquad w_{jg} = \frac{(a-c_d)(1-\gamma)+c_u}{2-\gamma} - \frac{\gamma d}{4-\gamma^2}\end{gathered} \tag{39}$$

Next, we consider the effects of process R&D in one market stage on the profits of the firms in the vertically related market by building the derivative of the firms' profits with respect to the cost reduction in the vertically related market.

The derivative of manufacturer *h*'s profits w.r.t. R&D investments in downstream market is:

$$\begin{gathered}\frac{\partial \pi_h}{\partial r} = \frac{2(a-c_u-c_d)(1-\gamma)}{(2+\beta-\beta^2)(2-\gamma)^2(1+\gamma)} + \frac{2r(2-\beta^2)(1-\gamma)}{(4-5\beta^2+\beta^4)(2-\gamma)^2(1+\gamma)} \\ + \frac{2\mathrm{d}(2-\gamma^2)}{(2+\beta-\beta^2)(2-\gamma)^2(1+\gamma)(2+\gamma)}\end{gathered} \tag{40}$$

All three fractions are always positive, for all γ and β in the range [0, 1[, as well as for all

$a > c_u + c_d$ (which indicates that the maximum willingness to pay of consumers is higher than the aggregated costs of upstream and downstream stage). Therefore, a raise in process R&D investment of retailer *i* always increases manufacturer *h*'s profits.

Manufacturer *g*'s derivative is:

$$\frac{\partial \pi_g}{\partial r} = \frac{2(a-c_u-c_d)(1-\gamma)}{(2+\beta-\beta^2)(2-\gamma)^2(1+\gamma)} + \frac{2r(2-\beta^2)(1-\gamma)}{(4-5\beta^2+\beta^4)(2-\gamma)^2(1+\gamma)} - \frac{2d\gamma}{(2+\beta-\beta^2)(2-\gamma)^2(2+3\gamma+\gamma^2)} \tag{41}$$

Since the third fraction in (41) is negative, the entire term can become negative if the values of d and γ are high enough.[20] Thus higher process R&D investment of retailer *i* can decrease manufacturer *g*'s profits, especially when the values of d and γ are high.

Next, we examine whether retailers' profits react in a similar way to manufacturers' R&D investments. The derivatives of the profits of retailers *i* with respect to R&D investments in the upstream market is:

$$\frac{\partial \pi_i}{\partial d} = \frac{2(a-c_u-c_d)(1-\beta)}{(2-\beta)^2(1+\beta)(2-\gamma)^2(1+\gamma)} + \frac{2r(2-\beta^2)}{(2-\beta)^2(2+3\beta+\beta^2)(2-\gamma)^2(1+\gamma)} + \frac{2d(1-\beta)(4-3\gamma^2)}{(2-\beta)^2(1+\beta)(4-\gamma^2)^2(1-\gamma^2)} \tag{42}$$

All three fractions are always positive, for all γ and β in the range [0, 1[as well as for all $a > c_u + c_d$**.** Hence, a raise in process R&D investment of manufacturer *h* yields always higher profits for retailer *i*. Retailer *j*'s derivative is:

$$\frac{\partial \pi_j}{\partial d} = \frac{2(a-c_u-c_d)(1-\beta)}{(2-\beta)^2(1+\beta)(2-\gamma)^2(1+\gamma)} + \frac{2d(1-\beta)(4-3\gamma^2)}{(2-\beta)^2(1+\beta)(4-\gamma^2)^2(1-\gamma^2)} - \frac{2r\beta}{(2-\beta)^2(2+3\beta+\beta^2)(2-\gamma)^2(1+\gamma)} \tag{43}$$

Since the third fraction is always negative, retailer *j*'s profit can decrease if the values of r and/or β are sufficiently high. The terms (40) to (43) show very similar results, namely that only the more productive retailer always profits from higher R&D investments in the vertically related market, while the effect on the unproductive firm is twofold. As we see in the terms (41) and (43), higher R&D investment of retailer *i* (manufacturer *h*) yields lower profits of manufacturer *g* (retailer *j*) if:

20 A higher value of parameter d increases the value of the negative fraction in absolute terms. The term $1/(2-\gamma)^2$ is common in all three fractions. If we hypothetically take out this term from all fractions, we can see the effect of an increasing γ, namely lowering the relative value of the positive fractions and increasing the relative value of the negative fraction.

- manufacturer *g*'s (retailer *j*'s) marginal cost disadvantage is high
- degree of intrabrand (interbrand) competition is high

These findings are crucial both for authorities and for the stakeholders of the firms in both stages. Competition authorities might think about means to reduce R&D incentives in a stage, for example if higher R&D can yield market exit of weak competitors in the vertically related market. Also the stakeholders might use these effects. For example if the innovative firm wants to take over the weaker (Stronger) firm in the vertically related market, it might be better to do this after (before) their own R&D investments. In this case they might achieve a better purchase price since their own R&D investments ceteris paribus lowers (increases) the profits of the targeted firm. This can be discussed more detailed in a future work.

4. Consumer Surplus

In this chapter we analyze the determinants of consumer surplus before and after process R&D. By subtracting consumers' expenses for the goods from the gross utility of consumers in (1), we get the net consumer surplus from consuming the goods.

As a benchmark, we use the net consumer surplus *before* R&D investments with symmetric manufacturers and retailers (CS_0):

$$CS_0 = \frac{2(a-c_d-c_u)^2}{(2-\beta)^2(1+\beta)(2-\gamma)^2(1+\gamma)} \tag{44}$$

Higher competition among manufacturers and retailers leads on the one hand to lower prices, but on the other hand to lower variety for the consumers. The derivative of the consumer surplus with respect to β respectively γ shows that the effect of lower prices on consumer welfare exceeds the effect of lower product variety for the consumers:

$$\begin{aligned} \frac{\partial CS}{\partial \beta} &= \frac{6(a-c_d-c_u)\beta}{(2-\beta)^3(1+\beta)^2(2-\gamma)^2(1+\gamma)} > 0 \\ \frac{\partial CS}{\partial \gamma} &= \frac{6(a-c_d-c_u)\gamma}{(2-\gamma)^3(1+\gamma)^2(2-\beta)^2(1+\gamma)} > 0 \end{aligned} \tag{45}$$

Although there is a welfare increasing element of variety in the assumed demand function, it follows from (45) that higher competition in any market stage leads ceteris paribus to higher consumer surplus. If a manufacturer invests in process R&D, consumer welfare increases by:

$$\Delta CS=\frac{2d(a-c_d-c_u)}{(2-\beta)^2(1+\beta)(2-\gamma)^2(1+\gamma)}+\frac{d^2(4-3\gamma^2)}{(2-\beta)^2(1+\beta)(4-\gamma^2)^2(1-\gamma^2)} \quad (46)$$

It is straight forward that the higher R&D investments are, the more consumers profit from R&D. Equation (46) shows furthermore that consumers profit more from manufacturer's R&D investment, the lower the marginal cost levels of manufacturers (c_u) and of retailers (c_d) are, *before* the stage of R&D investment. Beyond that, we can show that higher interbrand and intrabrand competition as well as higher consumer's maximum willingness to pay also yield higher benefit of consumers from R&D investments.

Proposition 4: *Consumers profit even more from manufacturer's R&D investment, the higher their willingness to pay is and the higher interbrand and intrabrand competition among manufacturers and retailers are.*

Proof: The derivative of consumer surplus with respect to a, γ, and with respect to β is:

$$\frac{\partial \Delta CS}{\partial \gamma}=\frac{6d\gamma(a-c_d-c_u)}{(2-\beta)^2(1+\beta)(2-\gamma)^3(1+\gamma)^2}+\frac{6d^2\gamma(4-5\gamma^2+2\gamma^4)}{(2-\beta)^2(1+\beta)(4-\gamma^2)^3(1-\gamma^2)^2}>0$$

$$\frac{\partial \Delta CS}{\partial \beta}=\frac{6d\beta(a-c_d-c_u)}{(2-\beta)^3(1+\beta)^2(2-\gamma)^2(1+\gamma)}+\frac{3d^2\beta(4-3\gamma^2)}{(2-\beta)^3(1+\beta)^2(4-\gamma^2)^2(1-\gamma^2)}>0$$

$$\frac{\partial \Delta CS}{\partial a}=\frac{2d}{(2-\beta)^2(1+\beta)(2-\gamma)^2(1+\gamma)}>0$$

Since all derivatives are always positive for the assumed values of our model, the consumer surplus through process R&D of manufacturer h or retailer i increases, the tougher interbrand and intrabrand competition are and the higher consumers' maximum willingness to pay is. □

This point can be interesting for the authorities, e.g. in the cases where they have scarce means and have to decide which industry's R&D investments they want to subsidize. The higher consumer's maximum willingness to pay, the degree of competition among the firms within the industry, but also among the firms in the downstream market and the lower pre R&D marginal costs in both upstream and downstream market, the more would consumers profit ceteris paribus from higher R&D investments. Moreover, as it was mentioned in subsection 3.4, one should also keep in mind that under certain circumstances, R&D can yield market exit of a firm in the vertically related market.

5. Conclusion

Due to the assumed linear quadratic utility function, a change in degree of interbrand and/or intrabrand competition has a twofold effect on quantity. On the one hand, an increasing degree of competition in upstream and/or downstream market yields lower prices, which yields higher demand. On the other hand, the linear quadratic utility function yields ceteris paribus higher demand, the more differentiated manufacturers' products and retailers' services are. This is a reasonable assumption as because of higher differentiation in upstream or downstream market, a wider range of consumers can be served. As an example, when one manufacturer offers a car which is rather for the highway, while the competitor offers a city car, the total demand for cars are higher than the demand for two similar types of city cars. These effects cause the non-linear relationship, which was mentioned in the introduction, between the degree of competition among the firms in a market and the R&D incentives of the firms in the vertically related market.

We started a basic set up with two vertically related oligopoly markets, which contains both elements of interbrand and intrabrand competition as well as asymmetries in both upstream and downstream market. In Section 3, we introduced R&D investments and showed that asymmetries among firms in any market are dampened by vertically related firms. This finding shows an ambivalent effect of laws that forbid price discrimination in input markets in some countries such as France. Forbidding price discrimination abolishes the dampening effect found in this paper. This increases the R&D incentives because the firm's R&D efforts can not be “absorbed” any more by the firms in the vertically related market. Furthermore, it increases the allocative efficiency, since the wholesale price for the more efficient retailer sinks. However, the elimination of the dampening effect harms the less efficient retailer. In extreme cases, this can lead to market exit of the less efficient retailer, whereas the same retailer would be able to remain in the market if price discrimination would be possible.

Another interesting result of this paper for competition authorities is that in vertically related markets, similar prices not necessarily mean a high degree of product substitution and intense competition, but it can mean the exact opposite, namely a sign of highly differentiated products or services. Moreover, we showed that the R&D of a firm can harm under certain circumstances the less efficient firm in the vertically related market, if price discrimination in input market is allowed.

We also show that if a firm in a bilateral duopoly setup invests in R&D, the firms in the vertically related market increase their margins. Beside that, the innovating firm does not take the positive externality effects of its R&D investments into consideration. Therefore, the existence of a vertically related mareket with imperfect competition usually yields to R&D-underinvestments,

even without any direct vertical spillover of knowledge.

The model can be generalized in different ways. The assumption on agents' information (all manufacturers know the cost functions of both retailers and vice versa) is rather strong. Relaxing these assumptions can modify some results. This paper considers a bilateral duopoly. One can extend this model to a case which has more than two firms either in upstream, or in downstream, or in both markets. Furthermore, other factors such as the possibility of resale-price maintenance can also be considered in future works.

This model offers also the base for other research questions related to R&D in vertically related markets. For example the timing of a vertical integration can be crucial, as a firm's R&D investments have an effect on the vertically related firm's profits and therefore, on its market value. This is subject to future research.

Appendix

Appendix A

Prices and quantities under Cournot competition:

The prices in the vertical frame model are $p_{ih}=p_{jh}=a-\frac{a(1+\beta)}{(2+\beta)(2-\gamma)}+\frac{(1+\beta)(2c_h+c_g\gamma)}{(2+\beta)(4-\gamma^2)}$ for good h and $p_{ig}=p_{jg}=a-\frac{a(1+\beta)}{(2+\beta)(2-\gamma)}+\frac{(1+\beta)(2c_g+c_h\gamma)}{(2+\beta)(4-\gamma^2)}$ for good g. The corresponding equilibrium outputs are $q_{ih}=q_{jh}=\frac{a}{(2+\beta)(2-\gamma)(1+\gamma)}-\frac{c_h(2-\gamma^2)-c_g\gamma}{(2+\beta)(4-5\gamma^2+\gamma^4)}$ for good h and $q_{ig}=q_{jg}=\frac{a}{(2+\beta)(2-\gamma)(1+\gamma)}-\frac{c_g(2-\gamma^2)-c_h\gamma}{(2+\beta)(4-5\gamma^2+\gamma^4)}$ for good g.

Appendix B

Proof of Proposition 1: *Substituting (16) and (17) into (8) under the assumption $c_i = c_j = c_d$ yields* $q_{ig}=q_{jg}=\frac{(a-c_d-c_u)(2-\gamma)}{(2+\beta-\beta^2)(2+\gamma-\gamma^2)}-\frac{d\gamma}{(2+\beta-\beta^2)(4-5\gamma^2+\gamma^4)}$. *Setting the equation equal to zero and solving with respect to d leads to the threshold* $d=\frac{(a-c_u-c_d)(1-\gamma)(2+\gamma)}{\gamma}$. *Since $q_{ig} = q_{ig}$ sinks as d increases, d must be below this threshold in order that q_{ig} is positive.* □

Appendix C

Proof of Proposition 2: From (19) and lemma 1 it follows that the retail price of good *h* decreases by $\frac{2d}{(4-\gamma^2)(2-\beta)}$ and retail price of good *g* decreases by $\frac{d\gamma}{(4-\gamma^2)(2-\beta)}$ due to process R&D of manufacturer *h*. Since both terms increase with higher β and/or with higher γ, manufacturers and retailers pass through rates increase ceteris paribus the tougher they are in competition.

Both the retail prices of good h and of good *g* "react" stronger to process innovation of manufacturer *h*, the higher β and/or γ are, thus the higher the degree of interbrand and intrabrand competition are. □

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Chapter 4

Profitable Entry into an Unprofitable Market

This paper was presented at the following refereed conferences:

09.2012 39th Annual Conference of the European Association for Research in Industrial Economics (EARIE), Università degli Studi di Roma Tor Vergata and Libera Università Internazionale degli Studi Sociali Guido Carli di Roma

07.2010 Zvi Griliches Research Summer School in the Economics of Innovation; Universitat Autònoma de Barcelona

Profitable Entry into an Unprofitable Market

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February 2013

Abstract

This paper shows how market entry into a per se unprofitable market can be profitable for a firm. By investing irreversible sunk costs to enter into an unprofitable market, the firm increases its produced quantity and commits itself to more aggressive process R&D investments. This intimidates the competitor in the old market from investing in process R&D, which yields higher marginal costs of that competitor and higher profits for the expanding firm in the old market. If the profit gain of this feedback effect for the expanding firm exceeds the losses through market entry, then the (per se unprofitable) market entry is profitable for the firm. I also consider how the results change under Bertrand vs Cournot regime and how they change if third degree price discrimination is not possible. Moreover, I show how higher R&D costs or lower demand in a market can lead to lower profits of one firm, but higher profits of the other firm.

Keywords: *research and development, price discrimination, product differentiation, process innovation, interbrand competition, strategic commitment, separated markets, market entry*
JEL Classification Codes: L13, D43, O30

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I would like to thank Georg Götz, Silke Januszewski Forbes, my colleagues in Giessen, and the participants of the 39th Annual Conference of European Association for Research in Industrial Economics (EARIE) for their valuable comments on this paper.

1. Introduction

One of the instruments that firms use to grow and increase their sales and/or profits, is expanding into new markets. Expansion into a new market can have several benefits for a firm: it can benefit from economies of scale, product portfolio diversification, increased revenues, reduced risks and so forth.

However, any market entry usually needs some irreversible initial investments for advertising, building up a distribution channel etc, which might be higher than the benefits, and deter the firms from entering into new markets. Usually, firms' decisions about whether to enter into a new market or not, are based mainly on whether the profits through market entry cover the initial costs or not. Many market niches are served just because the costs for a firm to use an existing product and modify it for the new market are cheap enough to be less than the additional revenues from the new market. For example, if we consider a car producer, the costs of developing a platform is a substantial part of the fixed costs of developing a new car model. Thus, once a car producer has spent the costs of developing a platform for one specific model, it uses this platform for different models which target other consumers. A very well known example is Volkswagen (VW), with its so called "Modularer Querbaukasten" strategy (MQB), translating from German to "Modular Transversal Toolkit" platform. For example, the MQB it has recently launched will be shared by the firm's most selling model VW Golf, the more expensive Audi A3, the more modestly priced Skoda Octavia and even for cars of other sizes.[1] One reason VW uses the MQB strategy is to decrease the additional costs to develop a product for a market niche and therefore, it allows VW to offer a broader range of vehicles across its many brands and enter into new market niches.

The focus of this paper is on another, more subtle aspect of the MQB strategy, and of market entry in general: As a firm – hereafter called "firm 1" – penetrates into a new market, it has some irreversible initial investments on the one hand, and higher total sales volume on the other hand. Assuming firm 1's product in the new market is similar to its existing products in the old market – in our example, VW generates the similarity through the MQB strategy – the higher sales volume through market entry yields higher incentives for firm 1 to invest in marginal cost reducing process R&D (from now on simply called "R&D investments"). Thus, making *irreversible* initial investments for developing a product, advertising, distribution channel and so forth to penetrate into a new market, can be used as a credible self commitment to higher R&D investments, which is observed by the competitor in the old market – hereafter called "firm 2". If firm 1 and firm 2 have

1 The Economist, April 20th-26th 2013, Special Report Cars Section, page 4.

similar marginal costs *before* the firms invest in R&D, firm 2 has a weaker position in the "race" for investing in process R&D. In this case the optimal strategy for firm 2 can be to invest less in process R&D, set higher prices and focus on its loyal customers in a differentiated market. Hence, by expanding into a new market (hereafter called "market *N*"), firm 1 increases its profits in the *old* market (called "market *M*" from now on) through weakening its competitors and gaining a more dominant position in that market. To my knowledge, this strategic motive of market entry has gone unnoticed in this form in the previous literature. This effect delivers an explanation why some niches are served even though they are too small or too competitive to allow firms to cover the irreversible initial costs for entering into those markets.

The mechanism described above works only when price discrimination is possible.[2] However we demonstrate that even if price discrimination is not possible, market entry into a per se unprofitable market can increase profits of firm 1 through a different mechanism: since firm 1 has to set the same price in market *N* (where it is a monopolist) and market *M* (where it competes with firm 2), market entry of firm 1 yields higher incentives to increase its unit price in order not to harm its profits in the new monopoly market. Firm 2 – which is firm 1's competitor in market *M* – anticipates this, and sets in turn higher prices in market *M* as well. Thus market entry into market *N* softens the competitor's pricing behavior in market *M*, and leads therefore to higher profits in market *M*.

Furthermore, we consider in this paper the influence of different competition regimes on the results and show that both under Bertrand and Cournot regimes, even though a market entry is not profitable per se, it *can* be better for a firm to enter into that market. This is of course always the case when the profit gains in the old market are higher than the losses in the new market. Another point that will be considered in this paper is how results change if the firms are asymmetric, especially when firm 1 has higher marginal costs *before* the firms invest in R&D (hereafter called "pre-R&D" marginal costs).

The R&D literature is based on the pioneering works of Schumpeter (1942) and Arrow (1962). Some of the central questions are how a change in the competitive environment such as market structure, or the regime of competition influences the R&D incentives of the firms. Several papers compare differentiated Bertrand vs. differentiated Cournout competition and find out that prices are lower (and hence outputs and total welfare are higher) under differentiated Bertrand competition.[3] A number of papers such as Qiu (1997), Breton et al. (2004) and Hinloopen and Vandekerckhove (2007) show that outputs and welfare effect of R&D are higher under Bertrand

2 In the following, the term price discrimination is used exclusively to refer to third degree price discrimination.

3 See for example Singh and Vives (1984) and Vives (1985)

competition if interbrand competition is not very tough. There is also a number of papers considering the relation between degree of competition and intensity of R&D investments empirically. For example Bertschek (1995) shows that tougher competition (represented by higher imports) causes more investments in innovation.[4] We show that under certain circumstances, we can get some contrary results to the existing literature.

Other empirical papers such as Scherer (1965) and (1967), Link (1980), as well as Acs and Audretsch (1987) test the two essential Schumpeterian theorems – that innovation is stimulated through the existence of large firms and imperfect competition. Since the market entry of firm 1 causes an asymmetry in the old market, and therefore firm 1 becomes the dominant firm in that market, our model is also related in the broader sense to the literature which treats dominant firm and Schumpeterian theories. Acs and Audretsch (1987), for example, find that large firms tend to have a relative innovative advantage in industries which are capital-intensive, concentrated and produce a differentiated good. Our specific model structure, with two separated markets connected through a firm which is active in both markets, leads to a different result. The innovative advantage of firm 1 increases with the degree of business stealing effect which, in turn, is higher the *less* differentiated the goods are.

Brander and Spencer (1983) discuss in their model the strategic commitment effect of R&D investments in a symmetric two-stage Nash duopoly model. They show that, when R&D is used for strategic purposes, firms invest more in R&D than required to minimize the total cost of their output, thus total costs would *not* be minimized for the output produced. This contradicts the results of nonstrategic models, such as Dasgupta and Stiglitz (1980), where R&D is only used to minimize costs and cannot be used strategically, for example because R&D level and output are determined strategically. This extends the result of Dixit (1980) formally to the case of equal opportunity.

In this paper, the expansion of firm 1 into a new market has a commitment element for the R&D investments of that firm.[5] since in this game the firms invest in R&D *before* they sell their products, R&D investments are, similarly to the papers mentioned above, used strategically. The model relaxes some assumptions of the previous models by allowing multiple asymmetries to appear simultaneously. The intimation effect caused by the higher R&D-commitment of firm 1 on firm 2's R&D investments is similar to that in Buehler and Schmutzler (2008). They show in their model of a bilateral duopoly that vertical integration increases own investment and intimidates competitors from investing in process R&D. However, while in Buehler and Schmutzler the effect

4 Nickell (1996) can also provide (weak) empirical evidence that competition increases firms' efficiency.

5 An element of “commitment” or “credible threat” appear in several papers, such as Eaton and Lipsey (1981) and Spence (1979), as well.

is due to vertical integration, the intimidation effect in this model is due to market entry into a new market.

Since the market entry causes asymmetric R&D investments of the firms which yields different post-R&D marginal costs and different prices of firms, this paper is also related to dominant firm literature. Most of the dominant firm papers are usually based on Forchheimer's model of price leadership with one dominant firm and one or several fringe firm(s). The papers regarding dominant firm models are considering various aspects of competition. Ono (1982) considers a model where the dominant firm first sets the market price, the fringe firms set their outputs and the dominant firm serves the residual demand. Deneckere and Kovenock (1992) present a model where all firms use the price as strategic variable in a Bertrand-Edgeworth duopoly game.[6] Tasnádi (2000) extends the model of Bertrand-Edgeworth price setting game to a game with infinitely many firms. In a later model (2010) he also considers a quantity setting game based on Forchheimer.[7] Wied-Nebbeling (2007) considers degree of heterogeneity in a Bertrand setting. She assumes one dominant firm with constant marginal costs and two fringe firms with increasing marginal costs. In her model, she demonstrates that fringe firms are not necessarily better off in a heterogeneous market. Other works – such as Cherry (2000) and Gaskins (1971) – consider the dynamic limit price setting problem of the dominant firm and the short-term versus long-term price setting behavior of the dominant firm.[8]

In this paper, the difference between dominant and fringe firm is not necessarily caused by different pre-R&D cost functions, but by different amounts of investment in process R&D caused by the market entry of firm 1 into a new market. The market entry of firm 1 makes it a dominant firm in the old market and some of the mentioned results presented above are contradicted under the assumptions of our model. Moreover, the model considers how factors such as degree of product homogeneity, costs of R&D and the size of the markets influence the profits and R&D investments of both the dominant and the fringe firm. In addition to the attribution to the literature mentioned above, the model reinforces some elements in the literature such as:[9]

6 For an empirical paper on price leadership see Rassenti and Wilson (2004).

7 In an other paper Tasnádi (2004) shows that in a simple price-setting game with a large firm and many fringe firms the large firm does not accept the role of the price leader.

8 This subject is also discussed in some Industrial Organization books such as Martin (1994), Shepherd (1997) and Tirole (1988).

9 For example Athey and Schmutzler (2001) show these points in a dynamic oligopoly model with firms which are market leaders through low costs or high quality.

- Investments are strategic substitutes.
- The greater ceteris paribus the opponent's cost reduction is, the lower are the R&D incentives of a given firm.
- The lower a firm's post-R&D marginal costs, the greater are the incentives to invest.

The next section introduces into the model. Section 3 shows the results under Bertrand competition when price discrimination is possible and section 4 compares these outcomes in the case where price discrimination is not possible. In section 5, we will consider the results under Cournot regime and section 6 concludes.

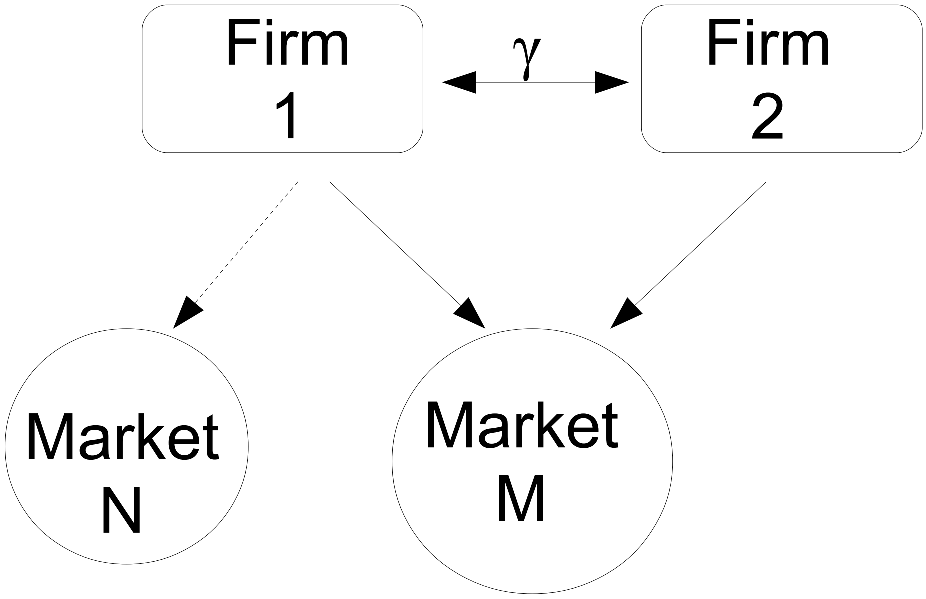
2. The model

I assume two separated markets, *M* and *N*, which differ in size. Both markets are represented by the same representative consumer, where the difference in market size arises from the different number of consumers in each market. There are *m* consumers in market *M*, and *n* consumers in market *N*, where $m > n$. To be more precise, I assume that market *N* is small enough to be per se unprofitable for a firm to enter, thus the fixed costs of entry cannot be covered.[10]

There exist two firms, 1 and 2, where firm 1 produces good 1 and firm 2 produces good 2. The products 1 and 2 are substitutes and the degree of substitution among them is represented by γ, where γ can vary among the wide range of independent goods ($\gamma = 0$) and perfect substitutes ($\gamma = 1$). Both firms are active in market *M* only. If any firm decides to enter into market *N*, its market entry involves some fixed investment *F*. I assume that one of the firms – hereafter per assumption firm 1 – enters into market *N* and is a monopolist there. Firm 2 decides to stay out of market *N*, because it would face competition against firm 1 if it would enter into that market. The market entry would *not* be profitable for firm 2, even if we consider the intimidation effect in the old market which was mentioned above.

The structure of the model is illustrated in the figure below:

10 However, I assume that market *N* is large enough to be profitable for the first firm that enters into that market and is a monopolist there, if one adds the profits that it makes in market *M* through the intimidation effect of serving market *N*.



The timing of the game is the following. In period t_0 the nature decides the degree of substitution among the goods of firms 1 and 2.[11] In period t_1 firm 1 decides whether it wants to enter into market *N* or not. In period t_2 both firm 1 and firm 2 decide whether they want to remain in market *M* or exit the market, knowing their own and competitor's original cost functions and degree of product substitution γ. In Period t_3 firms decide how much they want to invest in R&D and these R&D levels are made known to each other. In period t_4 they set their final prices/quantities depending on the chosen R&D levels under Bertrand/Cournot regime and sell their products.

In this model, I consider how the outcomes differ depending on whether price discrimination is possible for firm 1 or not, and I compare the results both under Cournot and Bertrand competition. I start with Bertrand competition whereby price discrimination is possible.

3. Bertrand Competition with price discrimination

In this section, I allow firm 1 to set different prices in markets *M* and *N*. I assume that firms compete à la Bertrand and the representative consumer in both markets have a linear quadratic utility function which has the form $U=a(q_1+q_2)-(q_1^2+q_2^2)/2-\gamma q_1 q_2$. As we see in the utility function, the consumers prefer ceteris paribus high product differentiation in this model. The utility function yields the following linear inverse demand function for each individual in market *M:*

11 I assume that γ is an exogenous parameter for the following reason: Even if firms influence the degree of product differentiation of their products by investing in marketing campaigns, product design etc, they still cannot fully control how substitutable the product at the end will be for consumers comparing to other products in the market.

$$p_{im}=a-q_{im}-\gamma q_{jm} \quad , \quad \forall i,j \in \{1,2\} \quad \text{where} \quad i \neq j \tag{1}$$

Hereby, a is the maximum willingness to pay of the representative consumer, q_{1m} is the quantity sold in market M by firm 1 and analogously q_{2m} is the quantity sold in market M by firm 2. If firm 1 enters into market N, the inverse demand function of each consumer for good 1 in market N is:

$$p_{1n}=a-q_{1n} \tag{2}$$

From (1) and (2) we can derive the quantities sold by firm 1 and firm 2 in market M (q_{1m} and q_{2m}) and the quantity sold by firm 1 in market N (q_{1n}).

$$q_{im}=\frac{a(1-\gamma)-p_{im}+p_{jm}\gamma}{1-\gamma^2}, \quad \forall i,j \in \{1,2\} \quad \text{where} \quad i \neq j$$

$$q_{1n}=a-p_{1n} \tag{3}$$

The profit functions of the firms have the following form:

$$\pi_1=m(p_{1m}-c_1+x_1)q_{1m}+n(p_{1n}-c_1+x_1)q_{1n}-v\frac{x_1^2}{2}-2F$$

$$\pi_2=m(p_{2m}-c_2+x_2)q_2-v\frac{x_2^2}{2}-F \tag{4}$$

The pre-R&D marginal costs of firms 1 and 2, thus their cost functions in periods t_0, t_1 and t_2, are represented by c_1 and c_2 respectively. The irreversible fixed cost of market entry – e.g. for advertising and building up a distribution channel – is denoted by F, and $\nu/2$ represents how costly firms' R&D investments in period t_3 are. The amount of cost reduction due to R&D investments of firm i is represented by x_i. Thus the total costs of R&D investments of firm i is $\nu\, x_i^2/2 \quad \forall i \in \{1,2\}$. The effectiveness of R&D investments is negatively correlated with the parameter v. The amount of marginal cost reduction is ordinally connected with the R&D investments of the firms. For this reason I use the investments in marginal cost reduction and R&D investments as synonyms in this paper in order to compare in which case R&D investments are higher or lower. The model is solved recursively, hence we start to solve the second stage by inserting (3) into (4):

$$\pi_1=m\frac{(p_{1m}-c_1+x_1)(a(1-\gamma)-p_{1m}+p_2\gamma)}{1-\gamma^2}+n(p_{1n}-c_1+x_1)(a-p_{1n})-v\frac{x_1^2}{2}-2F$$

$$\pi_2=m\frac{(p_2-c_2+x_2)(a(1-\gamma)-p_2+p_1\gamma)}{1-\gamma^2}-v\frac{x_2^2}{2}-F \tag{5}$$

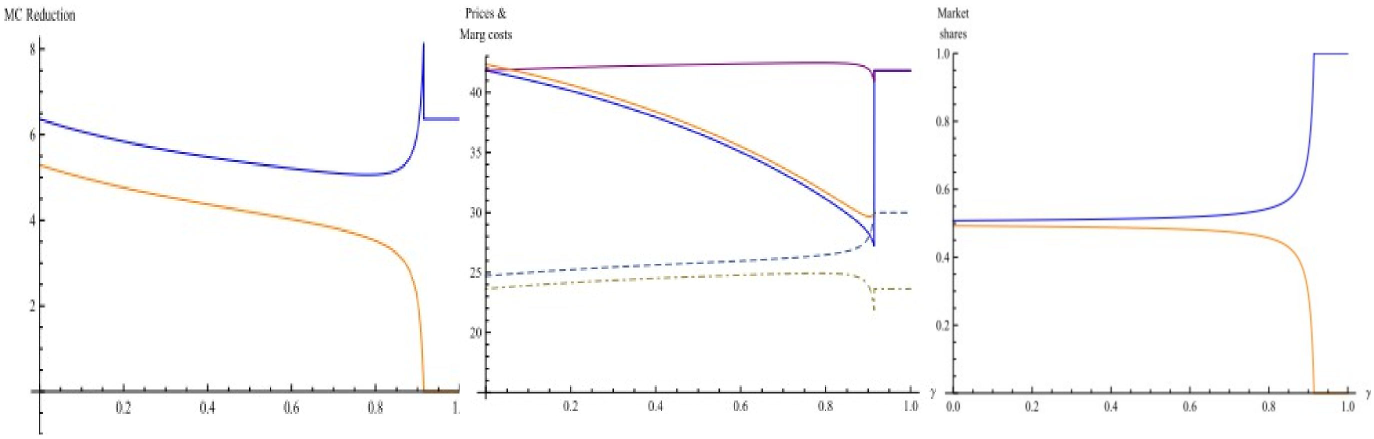
Building the first order conditions from the profit functions in (5) with respect to the prices and solving them yields:

$$p_{1m} = \frac{1}{2}\left(a + c_1 - x_1 - \frac{m(a - p_2)\gamma}{m + n(1-\gamma^2)}\right)$$
$$p_{2m} = \frac{1}{2}\left(a(1-\gamma) + c_2 - x_2 + p_1\gamma\right) \quad (6)$$
$$p_{1n} = \frac{a + c - x_1}{2}$$

Inserting the prices in (6) into each other lead to the prices depending on x_1 and x_2:

$$p_{im} = \frac{a(2-\gamma-\gamma^2) + 2(c_i - x_i) + \gamma(c_j - x_j)}{4-\gamma^2} \quad , \quad \forall\, i, j \in \{1,2\} \quad \text{where} \quad i \neq j$$
$$p_{1n} = \frac{a + c - x_1}{2} \quad (7)$$

After solving the last stage of the game, the optimal R&D investments of firms 1 and 2 (x_1 and x_2) can be determined by inserting (7) into (5). Maximizing these profit functions w.r.t. x_1 and x_2, and inserting them into each other leads to the optimal R&D investments. By inserting the optimal R&D investments into (7) we get the prices depending only on external variables. The marginal cost reductions, prices, marginal costs and market shares of firms 1 and 2 depending on the degree of competition γ are simulated in the graphs below. The terms of the optimal amount of marginal cost reduction can be found in appendix A.



Graph 1, Left graph: Marginal Cost reductions of firm 1 (blue) and firm 2 (orange) which are ordinally related to their R&D investments. Middle graph: post-R&D marginal costs of firm 1 (dot-dashed) and firm 2 (dashed) and prices p_{1M} (blue), p_{1N} (purple) and p_2 (orange). Right graph: market shares of firm 1 (blue) and firm 2 (orange) in market M. All graphs depend on degree of competition γ. The parameter values of the graph are: a = 60, m = 0.6, n = 0.1, v = 2, c_1 = 30, c_2 = 30.

In the simulation above, I assume $c_1 = c_2 = 30$, thus the firms have symmetric pre-R&D marginal costs. As we can see in the graphs, when degree of competition in market M is higher than a certain threshold, there is a breaking point in the development of marginal cost reductions, prices and marginal costs. The reason for this breaking point is that if γ is above this threshold, firm 2 decides to exit market *M* in period t_2 and therefore, firm 1 can set monopoly prices in period t_4, instead of limit pricing. Since firm 1 serves 2 markets, it has higher sales and thus R&D investments of firm 1 are always higher than firm 2. The higher degree of substitution γ among goods 1 and 2 is chosen by nature in period t_0, the stronger are the following two countervailing effects on R&D incentives of the firms:[12]

- "Lowered demand effect" due to the assumed utility function of consumers. Demand lowers ceteris paribus when γ increases and thus both firms have less incentives to invest in R&D.
- "Reinforced business stealing effect" due to the better degree of substitution γ among the goods. This yields lower prices in the competitive market and stronger incentives for the more productive firm to invest in R&D.

As graph 1 demonstrates, the combination of the two countervailing effects act as follows: in the areas of low γ, the first effect – namely lower demand of consumers due to a higher degree of substitution among goods 1 and 2 – dominates. Therefore, a higher degree of competition leads to lower R&D investments and thus higher marginal costs and higher price of firm 1 in its monopoly market *N*, but lower prices of both firms in market *M*. Even though a higher γ causes, in this case, sinking R&D investments of the firms – and thus higher post-R&D marginal costs, both firms set lower prices in market *M* due to tougher competition. This yields lower margins of both firms in market *M*. Since firm 1 invests more in R&D, it has lower post-R&D marginal costs than firm 2. Thus if products are more homogeneous than a certain threshold, firm 2 exits market *M* and thus does not invest in R&D any more. This is the breaking point of the graph (here $\gamma \approx 0.9143$).

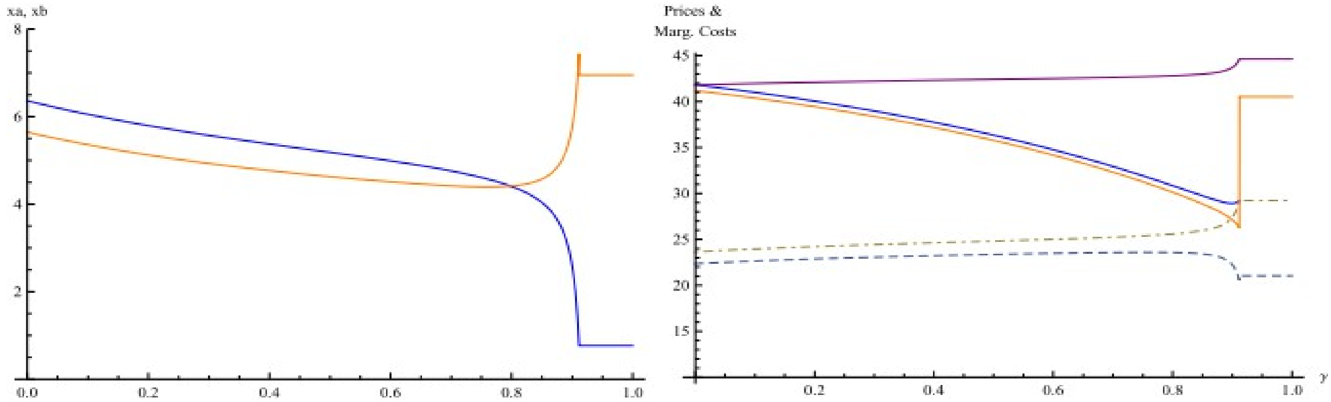
Only in the area where γ is below but close to the value of the breaking point, an increasing γ leads to higher R&D investments of firm 1. In all other areas where both firms are active in market *M*, a higher value of γ yields lower R&D investments of both firms.

In the area where γ is above this breaking point, firm 1 is a monopolist in both markets. Hence, firm 1 chooses the monopoly level of R&D investments and sets the monopoly price in both markets. In this model firm 1 does not need limit pricing when firm 2 is not active in market *M* due

12 Note that when I mention higher or lower γ, I usually consider external changes of γ. As a possible extension to this model, one can assume a situation where the life cycle of a firm's product ends and it wants to introduce a new generation of that product into the market, knowing how the competitor's product is positioned. By giving a different image to the new generation of that product (for example through a different design), a firm can influence the optimal level of R&D investments of itself and its competitor and – as I show later in this paper – the prices and profits.

to the timing of the model. As mentioned earlier, firms choose their amount of R&D investments, prices and marginal costs *after* knowing whether the other firm has exited market M in period t_2 or not.

The next graphs simulate R&D investments, prices and marginal costs in a different scenario, namely when firm 2 has a superior production technology, but faces financial constraints and cannot enter into market N. In this case firm 2 has significantly lower pre-R&D marginal costs than firm 1, so $c_2 < c_1$, but firm 1 commits itself to higher R&D investments through market entry.



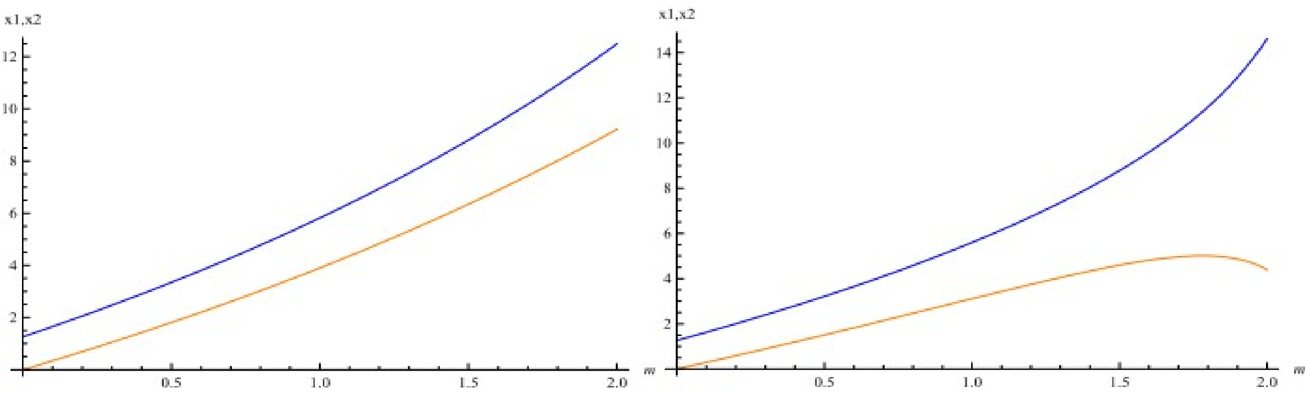
Graph 2: Left graph: marginal cost reductions of firm 1 (blue) and firm 2 (orange) which are ordinally related to their R&D investments. Right graph: post-R&D marginal costs of firm 1 (dot-dashed) and firm 2 (dashed) and prices p_{1M} (blue), p_{1N} (purple) and p_2 (orange) depending on degree of competition, whereby $c_2 < c_1$. The parameter values of the graphs are: $a = 60$, $m = 0.6$, $n = 0.1$, $v = 2.8$, $c_1 = 30$, $c_2 = 28$.

In graph 2 each firm has a different advantage: by entering into market N, firm 1 credibly commits itself to invest more aggressively in process R&D; firm 2 has lower pre-R&D marginal costs, thus its production technology is more efficient in the pre-R&D stage.[13] In this simulation, if the goods are rather independent, then firm 1 invests more in R&D and decreases its marginal costs stronger than its competitor. The more homogeneous nature chooses the goods in period t_0, the lower both firms' investments in R&D are (due to the "lower demand effect" in market M), and the lower the firms' prices are (due to the "Business stealing effect). However, as the goods become more homogeneous, firm 2's superior production technology gains a higher importance in the competition. If the products are homogeneous enough, and a relative small size of market N as well as a relative significant marginal cost advantage of firm 2 are given, then the "power constellation" changes. In this case firm 1 has less incentives to invest in R&D due to technological advantage of

13 Considering the case where firm 1 has lower pre-R&D marginal costs would simply reinforce the dominance of firm 1 and leads to similar results that we observed with equal pre-R&D marginal costs (c1 = c2). Therefore, we concentrate here on the more interesting case where firm 1 has financial constraints and therefore, it is firm 2 that enters into market N.

firm 2 and furthermore, firm 1 can even be driven out of market *M*. Analogously to the first graph, firm 2 sets monopoly price after the competitor is driven out of market *M*. Note that in contrast to the first graph, even though firm 1 is driven out of market *M*, it still invests in R&D. The reason is that firm 1 is still active in market *N*, where it is a monopolist.

The graphs below depict how the firms' R&D investments depend on *m*, the number of consumers in market *M*, which determines the size of market *M*.



Graph 3: marginal cost reductions of the firms depending on size of market *M* under Bertrand competition with price discrimination. The parameter values of this graph are: $a = 60$, $c_1 = 36$, $c_2 = 36$, $n = 0.3$, $v = 3$, $\gamma = 0.4$ (left graph) and $\gamma= 0.75$ (right graph).

If *m* is rather small, an increasing size of market *M* yields higher incentives of both firms to invest in R&D. However, a larger size of market *M* reinforces the firm's incentives to gain market share through lower prices, hence it has a similar effect like increasing business stealing effect. As we can see in the right graph above, if both γ and *m* are high, firm 1 invests aggressive enough in R&D to intimidate firm 2 from investing in R&D. In this case, a further growth of market *M* yields *less* R&D investments of firm 2 while firm 1 invests more in R&D.

Proposition 1

An increasing size of market M can lead to lower profits of firm 2. This is the case when both the R&D costs v and the size of market M are relatively high.

The proof is shown in Appendix B. □

As it has been shown in graph , both higher *m* and higher γ yield per se higher R&D incentives of the firms. However – since firm 1 created a self commitment to higher R&D investments – if the values of γ and *m* are high, a further increasing of *m* intimidates firm 2 from investing in R&D. Hence, firm 2 increases its R&D investments less aggressive than firm 1, or even decreases its R&D investments, if *m* increases. That in turn leads higher post-R&D marginal cost disadvantage of firm 2 in comparison to firm 1. Therefore, if the combination of γ and *m* is high enough, a further rise of the number of consumers in market *m* can yield lower profits of firm 2.

4. Bertrand competition without price discrimination

In this section, I change an assumption and allow arbitrage between the markets *M* and *N*. For simplicity, I assume that there are no transportation costs. Thus, firm 1 *cannot* set different prices in markets *M* and *N*, and therefore $p_{1m} = p_{1n} = p_1$. Inserting the demands from (3) into (4) and maximizing them w.r.t. the prices and solving them, results into the following optimal prices:

$$p_1=\frac{2(m+n)(a+c_1-x_1)-m(a-c_2+x_2)\gamma-(a(m+2n)+2n(c_1-x_1))\gamma^2}{4(m+n)-(m+4\text{n})\gamma^2}$$
$$p_2=\frac{(m+n(1-\gamma^2))(2c_2-2x_2+(c_1-x_1)\gamma)+a(1-\gamma)(m(2+\gamma)+n(2+\gamma-\gamma^2))}{4(m+n)-(m+4\text{n})\gamma^2} \tag{8}$$

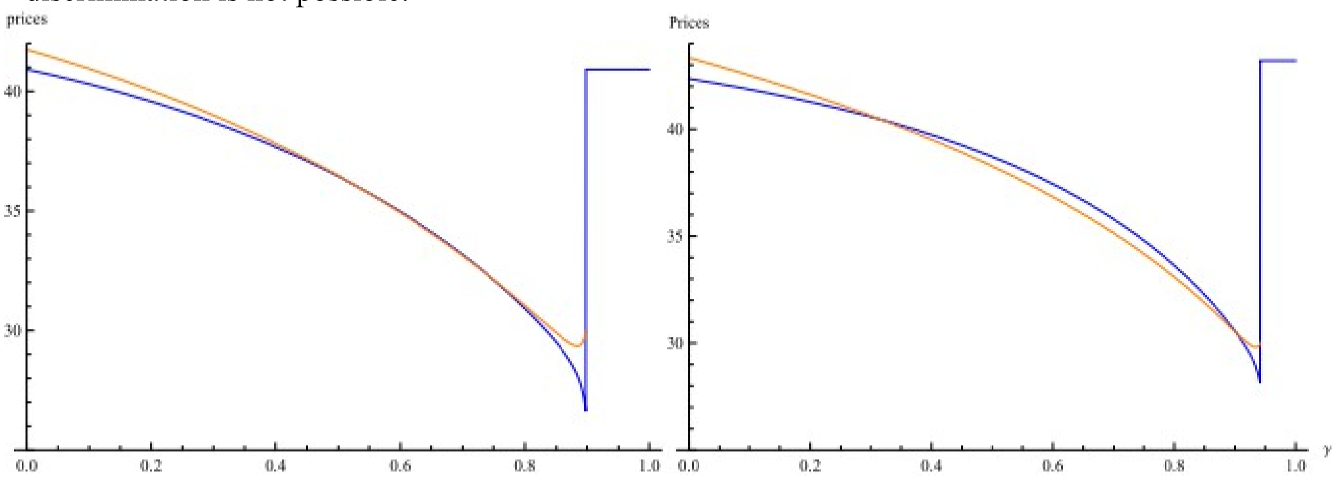
Inserting back (8) into (4) and maximizing the profits w.r.t. the R&D investments, and inserting them into each other yields the optimal R&D investments of the firms. The terms can be found in appendix C. The graph of simulation in this case (which has the same parameter values as graph 1 with equal pre-R&D marginal costs of firms 1 and 2) is very similar to that of the graph 1. However, in this graph, firm 2 is driven out of market *M* by γ = 0.9143 (vs γ = 0.8981 in the "price-discrimination-case"). The reason why firm 2 is driven here out of market *M* at a higher γ is that firm 1 has to set the same price in the market where it is a monopolist as in the market where it competes with firm 2. Hence firm 1 sets here ceteris paribus a higher price in market *M* (and sells less), but it sets a lower price in market *N* (and sells more), than in the price-discrimination-case. Hereby, firm 1's higher price in market *M* leads to a "higher" threshold of firm 2's market exit (γ = 0.9143 vs γ = 0.8981).

As in graph 1, investment decisions are strategic substitute in the non-price-discrimination case as well. Thus, a firm's incentive to invest in marginal-cost-reducing process R&D is lower when the competitor is investing more in process R&D.

Both firms know that firm 1 has higher R&D incentives than firm 2 due to its entry into market *N*. As the products become more similar, both firms' R&D incentives decrease because of the lowered demand effect, however, the business stealing effect becomes more significant as well.

As in the previous section, when business stealing effect is already significant (combination of values of γ and *m* is high), a further homogeneity of the products yields firm 1 using its strategic advantage and investing more in R&D, even though the demand in market *M* is ceteris paribus less. In this case, firm 2 invests less since R&D investments are strategic substitutes, and if competition is over a certain threshold, firm 2 can be driven out of market.

The graphs below simulates typical price setting behaviors of the firms when price discrimination is not possible:

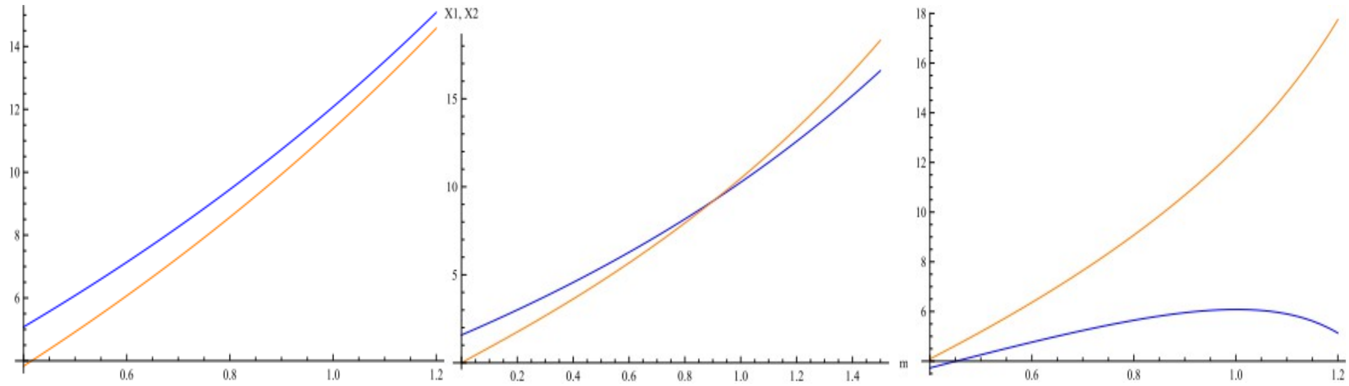


Graph 4: prices of firm 1 (blue) and firm 2 (orange) in Bertrand competition without price discrimination. The parameter values of the graph are: $a = 60$, $n = 0.2$, $v = 2.8$, $c_1 = 30$, $c_2 = 30$, $m = 1$ (left) and $m = 0.4$ (right).

The higher degree of homogeneity the nature chooses in stage t_0 for the goods 1 and 2, the more firm 1 faces two problems: the demand in market *M* is ceteris paribus lower, and firm 1's optimal prices in markets *M* and *N* diverge more from each other due to the tougher competition in market *M*. Thus, the unit price firm 1 chooses for both markets is more remote from the optimal prices firm 1 would have set in markets *M* and *N* if it could price discriminate. The lower demand in market *M* is, the stronger are ceteris paribus firm 1's incentives to keep its price high in order to benefit from high margins in market *N* where it is a monopolist. Hence firm 1's prices react “less elastically” than firm 2's prices on an increasing degree of competition in market *M*.

As we can see in the right graph above, if goods are relatively independent and the size of market *M* is not large, then firm 1 sets lower prices because of its lower post-R&D costs due to its higher R&D investments. If competition is in the middle ranges, firm 1 prefers to set higher prices in order to avoid too low prices in market *N*, where it is a monopolist. If the goods are comparatively homogeneous, the business stealing effect gains a higher weight. In this case, since the prices are already relatively low due to tough competition, firm 1 uses its advantage through higher R&D investment for an aggressive price setting to gain more customers from firm 2, and eventually even to force firm 2 to stay out of the market.[14]

The graphs below demonstrate how the amount of marginal cost reduction, and thus the amount of R&D investments, depend on the size of market *M*. Other than in graph 3, I assume here that firm 2 has a technological advantage in t_0 – t_2, before the firms invest in R&D.



Graph 5: Marginal cost reduction of firm 1 (blue) and firm 2 (orange) depending on the size of market *M*. The parameter values of the graphs are a= 60, c_1=30, c_2=24, v = 2, n= 0.2, γ = 0.1 (left graph), γ = 0.4 (middle graph) and γ = 0.75 (right graph).

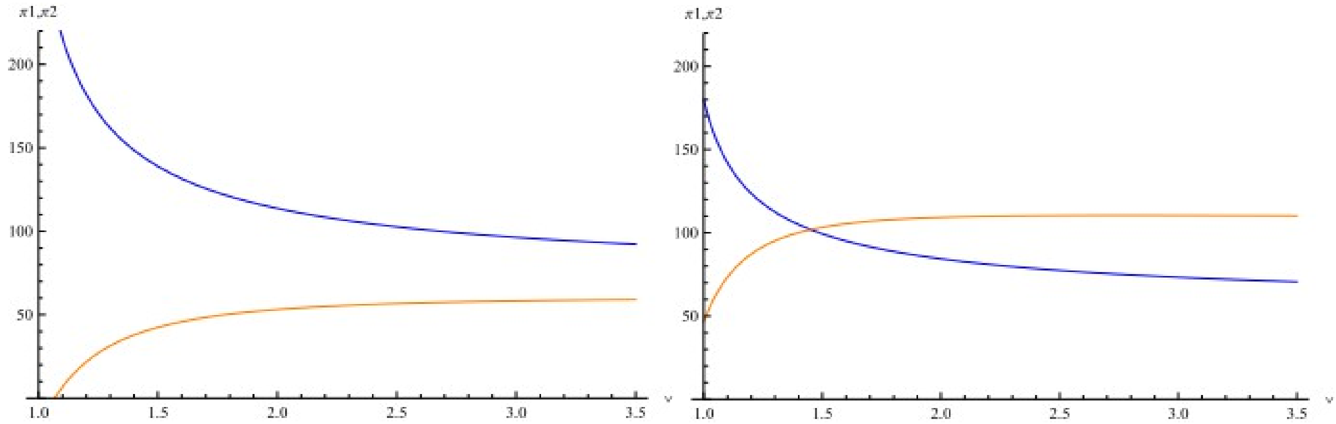
Intuitively, one would always expect from an increasing size of market *M* more aggressive marginal cost reduction and thus higher R&D investments of the firms. However in the constellation simulated in the graph above – with firm 1 serving two markets and firm 2 having significantly lower pre-R&D marginal costs, but financial constraints that does not allow it to enter into market *N* – this is not always the case. While a larger size of market *M* always leads to higher R&D investments of firm 2, it only yields higher R&D investments of firm 1 if the products of firms 1 and 2 are relatively differentiated. Firm 2's advantage of lower pre-R&D marginal costs gains higher significance, the more homogeneous the products are and this causes more aggressive R&D investments of firm 2.[15] In this case firm 1 prefers to invest less in R&D, sets a higher price and focuses rather on its monopoly market *N* and its loyal customers in market *M*. This yields higher "convergence" of firm 1's price to the monopoly price in market *N* and therefore lower R&D investments of firm 1. If degree of competition is high enough and market *M* is already comparatively large, a further rise of of firm *M*'s size can even yield lower R&D investments of firm 1.

As the graphs below shows, a rise of the R&D costs ν can lead to higher profits of firm 2. By

14 Due to the timing of the model, this is an equilibrium in pure strategy. Firms decide in period t_2 whether the stay in a market and produce, or exit the market.

15 This effect could be also observed already in graph 4, where firm 1 would even stay out of market *M* if the degree of product homogeneity was over a certain threshold.

inserting the optimal prices and R&D level into (5), we get the profit functions depending only on external variables. The graphs simulate two examples where higher R&D costs ν lead to higher profits of firm 2.



Graph 6: Profits of the firms when firm 1 enters into market *N* depending on costs of R&D investments ν under Bertrand competition without price discrimination. The parameter values of this graph are: a = 60, n = 0.3, m = 0.8, γ = 0.6 , F = 40, c_1 = 30, c_2 = 30 (left graph) and c_2 = 26 (right graph).

The dependency between firm 1's profit function and R&D costs ν is intuitive: the more costly R&D investments are, the less are the profits of firm 1. For firm 2, however, the relation is not intuitive at the first glance. As the graphs depict, the profit of firm 2 can rise as R&D costs ν increases.[16] Since higher R&D costs lead to lower R&D incentives of both firms, the advantage of firm 1 – which is higher R&D investments – becomes less significant. This, in turn, makes firm 2 relatively more competitive and thus increases its profits. It can even happen that, in case R&D is cheap enough, firm 1 becomes very aggressive in its R&D investments so that firm 2 can even be driven out of the market. The right graph depicts that higher R&D costs can yield higher profits of firm 2 even if firm 2 has lower pre-R&D marginal costs.

5. Cournot Competition

In this section, I will consider how the results change if we assume firms 1 and 2 compete à la Cournot. Since Cournot competition and product differentiation have comparable effects of weakening competition among firms, I assume homogeneous products under Cournot competition (so γ = 1) and concentrate on the effects of other variables. The model is solved recursively by

16 This is not the case if the goods are highly independent. In that case the profits of both firms decrease if costs of R&D increase.

inserting (1) and (2) into (4) to get the profit functions of the firms depending on quantities q_{m1}, q_{m2}, and q_2.

$$\pi_1 = m\, q_{m1}[(a - q_{m1} - q_{m2}\gamma - c_1 + x_1)] + n\, q_{n1}[(a - q_{n1} - c_1 + x_1)] - v\frac{x_1^2}{2} - 2F$$
$$\pi_2 = m\, q_2[(a - q_2 - q_{m1}\gamma - c_2 + x_2)] - v\frac{x_2^2}{2} - F \qquad (9)$$

Building the first order conditions from the profit functions in (9) w.r.t. the quantities and inserting the quantities into each other yield:[17]

$$q_{1\mathrm{m}} = \frac{a - 2c_1 + c_2 + 2x_1 - x_2}{3}$$
$$q_{1\mathrm{n}} = \frac{(a - c_1 + x_1)}{2} \qquad (10)$$
$$q_2 = \frac{a - 2c_2 + c_1 + 2x_2 - x_1}{3}$$

Hereby, the prices are:

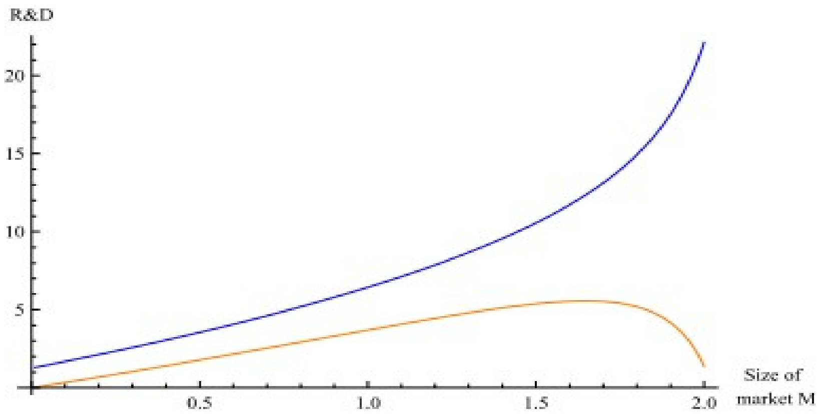
$$p_{1\mathrm{m}} = p_2 = \frac{a + c_1 + c_2 - x_1 - x_2}{3}$$
$$p_{1\mathrm{n}} = \frac{(a + c_1 - x_1)}{2} \qquad (11)$$

The optimal R&D investment of each firm can be determined by inserting (10) into (9) and maximizing both profit functions w.r.t. R&D investments. This leads to the following reaction functions:

$$x_1 = \frac{(a - c_1)(8m + 9n) + 8\mathrm{m}(c_2 - c_1) - 8\mathrm{m}\, x_2}{9(2\nu - n) - 16m}$$
$$x_2 = \frac{4m(a - c - x_1)}{9\nu - 8m} \qquad (12)$$

Inserting the reaction functions into each other leads to the optimal R&D investments. For a better visualization, I simulate the optimal R&D investments depending on the size of market *M*.

17 Under monopoly, the quantity sold in market *M* is $(q_{im} = (a - c) + x_i)/2$ and as competition mode changes to a duopoly Cournot competition, the quantity sold by each firms is: $(q_{im} = (a - c) + 2x_i - x_j)/3, \forall i, j \in \{1, 2\}$.



Graph 8: R&D investments of the firms under Cournot competition when price discrimination is possible. The parameter values of this graph are: a = 60, c_1 = 36, c_2 = 36, n = 0.3, v = 3.

Analogous to the case of Bertrand competition, if market *M* is not large, an increase in size of market *M* simply leads to higher R&D investments of both firms. If the size of market *M* exceeds a certain level, then a further increasing size of market *M* leads only to higher R&D investments of firm 1. Similar to the case of Bertrand competition with relatively homogeneous products, firm 2 invests less the larger market *M* becomes. The reason is the same as under Bertrand competition and is discussed in the previous section.

The quantities of the firms in equilibrium are:

$$q_{1m}=\frac{3\nu(3n(a-c_2)+6\nu(a-2c_1+c_2)+8m(c_1-a))}{32m^2+24m(n-4\nu)+27\nu(2\nu-n)}$$

$$q_{1n}=\frac{3\nu(8c_1m+4c_2m+9\nu(a-c_1)-12am)}{32m^2+24m(n-4\nu)+27\nu(2\nu-n)} \qquad (13)$$

$$q_2=\frac{6\nu(3\nu(a+c_1-2c_2)+(4m+3n)(c_2-a))}{32m^2+24m(n-4\nu)+27\nu(2\nu-n)}$$

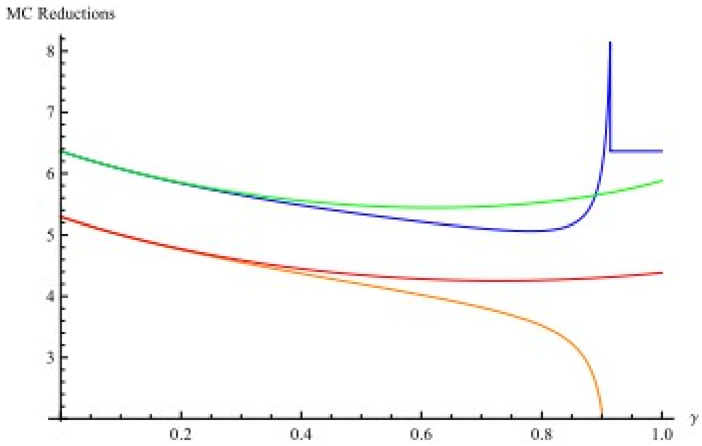
And the prices are:

$$p_{1m}=p_2=\frac{8am(4m+3n)-3\nu(8m(2a+c_1+c_2)+3n(2a+c_2))+18\nu^2(a+c_1+c_2)}{32m^2+24m(n-4\nu)+27\nu(2\nu-n)}$$

$$p_{1n}=\frac{a(8m-9\nu)(4m+3n-3\nu)+3\nu(9c_1\nu-4m(2c_1+c_2))}{32m^2+24m(n-4\nu)+27\nu(2\nu-n)} \qquad (14)$$

As we can conclude from (12) and (11), the quantities and prices of firm 2 depend also on the size of market *N*, even though firm 2 is not active there. Therefore, any change in size of market *N* influences price, quantity and R&D investment of firm 2.

In the following graph, I relax the assumption of perfect competition among the firms and let γ be again within the interval [0, 1]. This allows me to compare the R&D investments of both firms under Cournot and Bertrand regime depending on degree of competition.



Graph 9: Comparison of the R&D investments of both firms when firm 1 is active in both markets under Cournot competition vs. under Bertrand competition depending on γ. The green (red) line represents x_1 (x_2) under Cournot competition, the blue (orange) line represents x_1 (x_2) under Bertrand regime. The parameter values of this graph are: $a = 60$, $c_1 = 30$, $c_2 = 30$, $n = 0.1$, $m = 0.6$, $F = 30$, $v = 2$.

For a better comparability, I have used the same values in the graph above as in graph 1. It has already been shown that under Bertrand competition and for the assumed parameter values, firm 2 is driven out of market *M* if γ is over the threshold 0.9143. Under Cournot competition, firm 1 does not drive firm 2 out of market *M* for any value of γ.

If γ is above or around the threshold value 0.9143, firm 1 invests more and firm 2 invests less under Bertrand that under Cournot competition. For other values of γ both firms invest less under Bertrand competition than Cournot competition. This is contradicting with the standard results in the literature such as Qiu (1997), where both firms invest more under Bertrand competition. This standard result is only valid for high values of parameter γ when the constellation of our model is given.

5.1 An example for the (Un-)profitable market entry under Cournot competition

In order to prove that a market entry into an unprofitable market can be profitable, we need to know how much the profits of firm 1 are if it does *not* enter into market *N*. Then we compare the total profits of firm 1 with the case where it enters into market *N*. If firm 1 stays out of market *N* and $c_1 = c_2 = c$, then the firms are symmetric. In this case, their reaction functions are:

$$q_i = \frac{a - c - q_j + x_i}{2} \forall \{i, j\} \in \{1,2\} \tag{15}$$

Inserting the reaction functions into each other results into the quantities:

$$q_i = \frac{a - c + 2x_i - x_j}{3} \forall \{i, j\} \in \{1,2\} \tag{16}$$

Inserting back the quantities into the profit functions, and maximizing the profit functions with respect to the R&D investments yields the following optimal R&D investments:

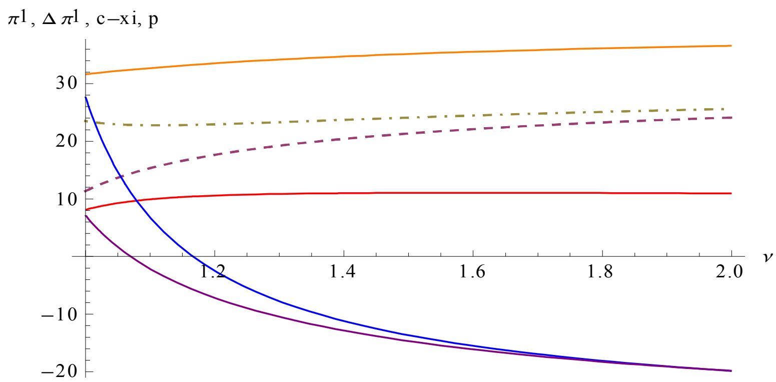
$$x_i = x_j = \frac{4m(a-c)}{9\nu - 4m} \forall \{i, j\} \in \{1,2\} \tag{17}$$

The profits of both firms are:

$$\pi_i = \pi_j = \frac{(a-c)^2 m(9\nu - 8m)\nu}{(4m - 9\nu)^2} - F \forall \{i, j\} \in \{1,2\} \tag{18}$$

Just as in the Bertrand case, firm 1 commits itself to higher R&D investments by penetrating into market *N* and paying the irreversible fixed costs *F* for brand advertising, building a distribution channel etc. This has an intimidation effect on firm 2's R&D investments and firm 1 faces a less efficient competitor in market *M*. Hence, the entry of firm 1 into market *N* yields higher profits in market *M*.

The graph below illustrates inter alia how profitable firm 1's entry into market *N* per se is and how it changes the total profits of firm 1 depending on the costs of R&D. The post-R&D cost functions, price and quantity of firm 2 are also simulated to make sure that firm 2 is not driven out of the market in the considered area.



Graph 10: Orange: price of firm 1 in market *M*. Dashed and dot dashed: post-R&D cost functions of firms 1 and 2 Red: quantities sold by firm 2. Purple: additional profit/loss that firm 1 makes through entering into market *N*. Blue: how much the total profits of firm 1 changes due to entry in market *N*. Horizontal Axis: *v* (parameter for cost of R&D/inverse productivity measure). The parameter values are: $a = 60$, $c = 30$, $n = 0.1$, $m = 0.6$, $F = 52$.

As we can see in the graph above, if ν is for example 1.1, firm 1 would make losses in market *N* if it enters into that market (purple line), however, the total profits of firm 1 increase (blue line). Inserting the parameter values and calculating the numerical results shows that market entry into market *N* creates losses of approximately 2.1334 in that market. However, the market entry increases total profits of firm 1 by nearly 6.7776. Thus, due to the intimidation effect in market *M*, the profits of firm 1 increases by approximately 8.9110 in that market, which is more than four times of firm 1's loss in market *N*, and yields profitable entry into an unprofitable market.

6. Conclusion

This paper shows how in some cases, entry into a new market can be profitable even though the irreversible ex ante fixed costs of market entry for advertisement, distribution channel and so forth *cannot* be covered. When firm 1 enters into market *N*, it commits itself to higher production volume, and thus higher R&D investments. Since the firms' R&D investments are strategic substitutes, firm 1's commitment to higher R&D investments yields lower investments of firm 2 in process R&D. Firm 1 faces therefore a weaker competitor in market *M* through its entry into market *N*. The R&D-advantage of firm 1 increases, the better the degree of product homogeneity and the larger the size of market *M* and/or market *N* is. This can even lead to market exit of firm 2, if the combination of firm 1's post-R&D marginal costs and degree of product substitution γ exceeds a certain level.

We also consider another case where firm 2 has a pre-R&D cost advantage, but financial constraints which hinder firm 2 from entering into new markets. Therefore, it is firm 1, and not firm 2, that enters into market *N* and creates the commitment to higher R&D. If firm 2's pre-R&D cost advantage is significant comparing to the higher R&D incentives of firm 1, a better degree of product homogeneity and a larger size of market *M* can emphasize the cost advantage of firm 2 and be disadvantageous for firm 1. If the products are homogeneous enough and the size of market *N* is relatively small, higher degree of product substitution can force firm 1 to exit from market *M* and concentrate on market *N* only.

Furthermore, the paper shows how changes in variables influence R&D investments and profits of the firms. Among others, the paper demonstrates that higher costs of process R&D can lead to lower profits of firm 1, but to higher profits of firm 2. In addition, the paper shows that for some values of γ, both firms invest less under Bertrand competition than Cournot competition in this model. This finding contradicts the standard results in the literature.

We have shown that for high γ and m, a further incremental of Market M's size results into lower profits of firm 2, even though all other parameters, such as number of competitors and degree of product substitution, remain the same and the firms simply operate in a larger market. We also have shown that – under Bertrand competition without price discrimination and significantly lower pre-R&D marginal costs of firm 2 – an increasing size of market M has two effects: it increases the incentives of both firms to invest in R&D and it increases the relative weight of firm 2's pre-R&D cost advantage. As m increases, both firms invest more in R&D. However, firm 2's increasing R&D investments grow faster than firm 1's R&D investments. This effect is stronger, the better substitutes the goods become.

This model can provide an additional explanation for the proliferation of firms into new market niches, which can be observed in some industries such as automobile production. Many manufacturers – such as VW, GM, or Renault-Nissan – try to use an existing platform with a different chassis, and enter with this new model into a new market niche – or even “create” a new market niche. Since the different models share the same platform and the development of a platform is a substantial part of developing a new model, the different car models are still technologically similar products and meet one of the important assumptions of this model. As mentioned in the introduction, VW group's MQB-strategy is a prominent example for this phenomena.

Not only can this paper explain a market entry, that yields an intimidation effect on R&D investments of competitors in the old market; it can help us to understand another type of unprofitable market entry as well. For example, the decision of Ferdinand Piëch, the former CEO of VW, to develop and produce the Phaeton, was not motivated by the self commitment effect to higher production. One of the main intentions of Mr. Piëch's decision about entry of VW into the luxury car segment, was to support the VW brand image.[18] A more prestigious image of the VW brand increases consumers' interest and their willingness to pay for other models of VW, which leads to higher profits for those VW-models and can (over-) compensate the loss through Phaeton. Since an increasing demand/consumers' willingness to pay and lowering production costs have similar effects on the model-mechanisms, this paper can help us to understand also this type of “profitable entry into an unprofitable market”.

18 See for example http://en.wikipedia.org/wiki/Volkswagen_Phaeton#Development (19.08.2013)

Appendix

NOTE: The terms in the appendix are copied from Wolfram Mathematica files. Therein, the terms used are slightly different than in the paper: "g" is γ, "ca" is c_1, "cb" is c_2, "am" is a_M and "an" is a_N.

Appendix A

Marginal cost reductions of the firms in Bertrand with price discrimination in the area of competition

$x_1 =$

$$\frac{(a-c)(v(-2+g)(-1+g)(2+g)^2(8-4g^2+a(-2+g)^2(1+g)(2+g))+2(-2+g^2)2(-4+a(-4+g^2)))}{2v^2(-4+g^2)3(-1+g^2)-2(-2+g^2)^2(-4+a(-4+g^2))-v(-4+g^2)(-8(-2+g^2)2+a(-4+g^2)2(-1+g^2))},$$

$x_2 =$

$$\frac{-(2(a-c)(-2+g^2)(2v(-2+g)(-1+g)(2+g)^2-(-2+g^2)(-4+a(-4+g^2))))}{(2v^2(-4+g^2)3(-1+g^2)-2(-2+g^2)^2(-4+a(-4+g^2))-v(-4+g^2)(-8(-2+g^2)^2+a(-4+g^2)^2(-1+g^2)))}$$

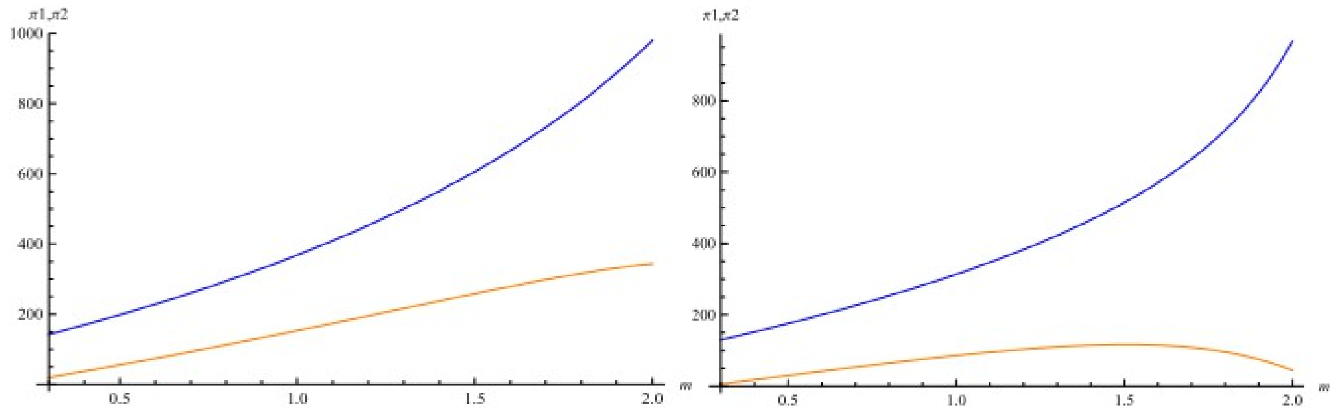
Marginal cost reductions of the firm 1 as a monopolist when firm 2 exits market *M*:

$$x_1^M = \frac{(a-c_a)(m+n)}{(2v-m-n)}$$

Appendix B

Proof of Proposition 1:

In order to show that an increasing size of market *M can* lead to lower profits of firm 2, I present the simulation of one example where this is the case. Inserting the prices – which are simulated in graph 1 – into the profit functions in (5) leads to the profit of the firms depending on external variables. The graph below shows the plot of the profit functions of the firms depending on the size of market *M*.



Graph: Profit of the firms depending on size of market *M*. The values of this graph are: a = 60, c_1 = 30, c_2 = 30, n = 0.5, ν = 2, F = 30, γ = 0.3 (left graph) and γ = 0.5 (right graph)

As we can see in the right graph, for high γ and m, it can happen that a rise of Market *M*'s size results into lower profits of firm 2. The combination of high γ and m yields a high business stealing effect through lower prices. As it has been shown in the paper, this yields very aggressive R&D investments of firm 1. As the left graph shows, this phenomena does *not* appear, when the values of m and γ are low. □

Appendix C

Optimal R&D investments of the firms under Bertrand competition when price discrimination is not possible

$$x_1 = \frac{-(cv(1+g)(-4+g^2)(4m(-2+g^2)+(-2+g)(-1+g)(2+g)(-ng+2v(2+g))))}{(8m^2(-2+g^2)2-2m(n-4v)(-4+g^2)(-2+g^2)^2-(n-2v)v(-4+g^2)^3(-1+g^2))} +$$

$$\frac{(a(-8m^2(-2+g^2)2+v(-4+g^2)2(-1+g^2)(n(-4+g+g^2)-2v(-2+g+g^2))+2m(8-6g^2+g^4)(n(-2+g^2)-2v(-3+g+2g^2))))}{(8m^2(-2+g^2)2-2m(n-4v)(-4+g^2)(-2+g^2)2-(n-2v)v(-4+g^2)^3(-1+g^2))}$$

$x_2 =$

$$\frac{a+c+((a-c)(8m^2(-2+g^2)2-nv(-4+g^2)^3(-1+g^2)-2m(8-6g^2+g^4)(n(-2+g^2)-2v(-2+g+g^2))))}{2(8m^2(-2+g^2)2-2m(n-4v)(-4+g^2)(-2+g^2)2-(n-2v)v(-4+g^2)^3(-1+g^2))}$$

Appendix D

Price setting of the firms in Bertrand with price discrimination

$$p_{am} = \frac{-(cv(1+g)(-4+g^2)(4m(-2+g^2)+(-2+g)(-1+g)(2+g)(-ng+2v(2+g))))}{(8m^2(-2+g^2)^2-2m(n-4v)(-4+g^2)(-2+g^2)^2-(n-2v)v(-4+g^2)^3(-1+g^2))} +$$

$$\frac{a(-8m^2(-2+g^2)^2+v(-4+g^2)^2(-1+g^2)(n(-4+g+g^2)-2v(-2+g+g^2))+2m(8-6g^2+g^4)(n(-2+g^2)-2v(-3+g+2g^2)))}{(8m^2(-2+g^2)^2-2m(n-4v)(-4+g^2)(-2+g^2)^2-(n-2v)v(-4+g^2)^3(-1+g^2))}$$

$p_{an}=$

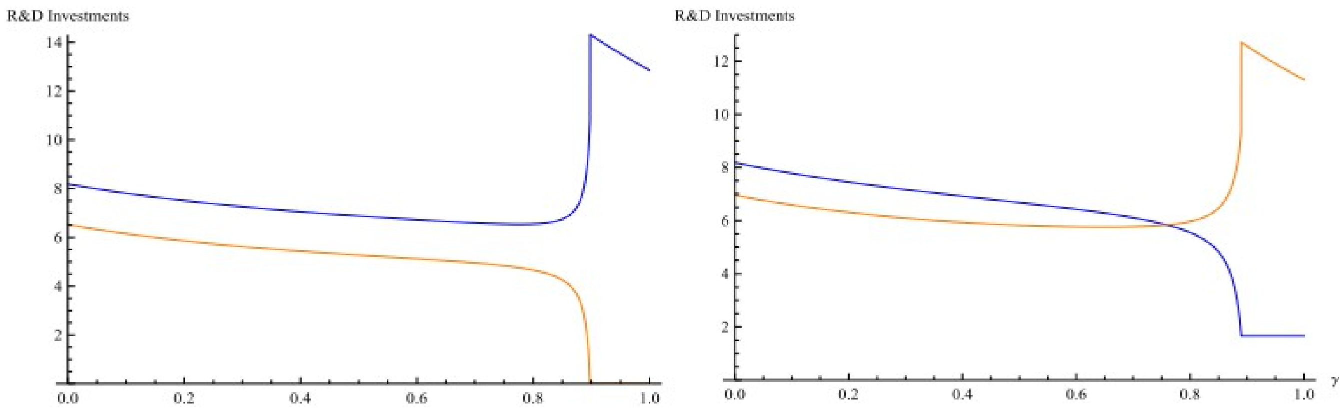
$$\frac{a+c+((a-c)(8m^2(-2+g^2)^2-nv(-4+g^2)^3(-1+g^2)-2m(8-6g^2+g^4)(n(-2+g^2)-2v(-2+g+g^2))))}{2(8m^2(-2+g^2)2-2m(n-4v)(-4+g^2)(-2+g^2)^2-(n-2v)v(-4+g^2)^3(-1+g^2))}$$

$$p_b=\frac{-(2cv(-2+g)(1+g)(2+g)(2m(-2+g^2)+(-2+g)(-1+g)(2+g)(-n+v(2+g))))}{(8m^2(-2+g^2)^2-2m(n-4v)(-4+g^2)(-2+g^2)^2-(n-2v)v(-4+g^2)^3(-1+g^2))}+$$

$$\frac{-a(2m(-2+g^2)+v(4-5g^2+g^4))(4m(-2+g^2)-(-4+g^2)(n(-2+g^2)-2v(-2+g+g^2)))}{(8m^2(-2+g^2)^2-2m(n-4v)(-4+g^2)(-2+g^2)^2-(n-2v)v(-4+g^2)^3(-1+g^2))}$$

Appendix E

The graph below demonstrates R&D investments depending on γ, the degree of competition in market *M*.



Graph: Optimal R&D investments of the firms depending on degree of competition γ. The blue lines are the R&D investments of firm 1 and the orange lines are the R&D investments of firm 2. The parameter values of the graph are: $a = 60$, $c = 30$, $n = 0.2$, $m = 1$, $v = 2.8$, $c_1 = 30$, $c_2 = 30$ (left graph) and $c_2 = 28$ (right graph). Changing the parameter values does not change the "shape" of the graph.

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Chapter 5

Consumer-Welfare-Enhancing Merger to Monopoly

This paper has been accepted at the following refereed conferences:

09.2013 (Forthcoming) 40th Annual Conference of the European Association for Research in Industrial Economics (EARIE), Universidade de Évora

This paper has been accepted for presentation at the following refereed conferences. A participation was unfortunately prevented by the need to economize given a relatively tight budget.

08.2013 Forum on Industrial Organization and Marketing, Frankfurt am Main, Germany

06.2013 Conference of International Journal of Arts and Sciences, Munich, Germany

Consumer-Welfare-Enhancing Merger to Monopoly

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(First and preliminary version, please do not cite)

March 2013

Abstract

This paper shows under which circumstances a merger or acquisition (M&A) can benefit consumers, even though there are no efficiency gains per se for the firms through the M&A. Analogously it can be shown that entry into a market can harm aggregated consumer surplus. We show which combinations of parameters – such as market size, cost structures etc. – typically lead to increasing (decreasing) aggregated consumer surplus in two markets through monopolization (competition) in one of the markets. The model also considers how factors such as the possibility of third degree price discrimination among the two markets can influence the results.

Keywords: *merger and acquisition, research and development, consumer welfare, monopolization, inter-brand competition, price discrimination, product differentiation, process innovation, separated markets, Multinational Enterprises*
JEL Classification Codes: L13, D43, O30

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1. Introduction

A central tenet in economics is that monopolization through market exit of a firm, or through merger and/or acquisition (M&A) of two or several firms, always yields lower consumer surplus unless there are efficiency gains through the M&A itself.[1] Analogously, there is a common belief that higher competition, for example, through market entry of new competitors, always increases consumer surplus. For this reason, many of M&A attempts have been blocked by the competition authorities.

The object of this paper is to show that exceptions of this belief may appear in a setup where one of the firms – hereafter called "firm 1" – is active in two separated markets. We show that M&A (competition) in one of the markets – hereafter called "Market *M*" – can benefit (damage) consumers in the other market where firm 1 is also active – hereafter called "market *N*". This benefit (damage) in consumer surplus of market *N* can be high enough to overcompensate the damage (benefit) from concentration (competition) for the consumers in market *M*. Hence competition (monopolization) in market *M* can lead to a loss (benefit) in aggregated consumer welfare in the overall markets. The magnitude of this effect depends on various factors such as number and wealthiness of consumers in the markets, firms' marginal cost structures *before* investing in R&D (hereafter also called firms' pre-R&D costs), degree of competition among the firms, whether price discrimination is possible or not, costs of marginal cost reduction when firms invest in process R&D, etc.[2] We show what combination of all the factors mentioned above aid and abet a situation where concentration (competition) in market *M* leads to higher (lower) aggregated consumer welfare.

An example of this phenomena could be observed over the past few years in the German cable market. There were two M&A-attempts – between Kabel Deutschland and Tele Colombus, as well as between Unity Media and Kabel BW – which have been blocked by the Bundekartellamt, the federal cartel authority of Germany. The latter M&A attempt has finally been accepted by the Bundeskartellamt. However, two other players in the market, Deutsche Telekom and Net Cologne, sued against this decision by the Oberlandesgericht Düsseldorf, which is the higher regional court. In its decision, the Oberlandesgericht Düsseldorf ordered to reverse the merger to separate the merged company again into the former separated firms.

One important point, that probably have not received the importance it deserves, is that the merged company can invest a significantly higher amount in the quality of broadband than the two

1 In this paper, the terms "merger" and "M&A" are synonyms and can be used interchangeably.

2 In this paper, the term price discrimination is used exclusively to refer to third degree price discrimination.

separate firms. This can enhance the consumer surplus, in spite of an eventual rise in the prices through the merger, if the improvement of broadband quality is significant.

Whether M&A leads to higher consumer surplus or competition harms consumers, they are the two sides of the same coin because they tell the reverse story. In one case, the number of competitors in market *M* decreases from two to one through a merger or acquisition. In the other case, the number of competitors in market *M* increases in the same model setup from one to two through market entry of a competitor. Since these two scenarios are analogous, we will concentrate in chapters 2, 3 and 4 on the case where monopolization can increase the aggregated consumer surplus. This scenario is especially crucial for Federal Trade Commission (FTC) and similar authorities in other countries such as the Bundeskartellamt in Germany. The situation discussed in the model can be found similarly in many industries (e.g. the automotive industry) where one firm is active with the same product – or a similar product – in a separated market. The terminology "separated market" can be understood here both as geographically separated, but also when simply the target-consumers are different within the same geographic area. In chapter 5, we briefly discuss the scenario of consumer harming competition by transforming the results of the paper into that scenario. Thereby, we also discuss how the timing of the game changes in that scenario.

There has already been a dialogue in the economic literature about whether, and if so, under which circumstances does increasing competition amongst firms contribute positively to total welfare. Based on the setup of Zanchettin (2006) with asymmetric firms,[3] Kao and Menezes (2010) show that under Cournot competition, the parameter range for total welfare increasing merger is wider the better substitutes the products are, while M&A is never welfare enhancing under Price competition. The reason is that the efficient firm always produces more under Bertrand than under Cournot competition and therefore the efficiency gains through merger are lower under Bertrand competition. Farrell and Shapiro (1990) show that higher total welfare through the merger is possible, if a merger creates synergies. In this model we show that even mergers which do not create static synergies can enhance aggregated consumer surplus.

Head and Ries (1997) model horizontal mergers between firms based in different nations, and specify the critical minimum consumption share of a nation to veto mergers that reduce world welfare. They argue that it is in national interest if the competition authority blocks most world welfare reducing mergers. Some papers use the Canada-United States Free Trade Agreement of 1989 as a natural experiment. For example, Breinlich (2008) shows thereby that trade liberalization

3 Zanchettin (2006) extends the model of Singh and Vives (1984), and shows that industry profit can be higher under Bertrand than under Cournot competition. This is the case if asymmetry among the firms are strong and /or the firms' products are weakly differentiated.

leads to a significant increase in M&A activity.

Lahiri and Ono (1988) show that under Cournot oligopoly, a marginal cost reduction in a firm with a sufficiently low share decreases national welfare and further more that national welfare even increases if a firm with a sufficiently low share is removed from the market. They argue that the elimination of minor firms improves the average industry efficiency, and that may exceed diseconomies of changes in market structure.

While some papers argue that in a monopolistically competitive market, free entry can result in too little entry compared to the social optimum, other papers such as Stiglitz (1981), Spence (1984) and Tandon (1984) have found that too much competition is not desirable for total welfare. A very common argument is that since an entrant causes incumbent firms to reduce output, entry is more desirable to the entrant than it is to the society. The reason is that as an individual firm enters into the market, it only considers whether market entry is profitable for that firm. So it does not take the business stealing effect toward other firms into account. Mankiw and Whinston (1986) show that a bias toward excessive entry exists in homogeneous product markets combined with the existence of imperfect competition and business-stealing effect, while product diversity can reverse that bias.

There are also papers in the "reciprocal dumping" literature which show that, if there are transportation costs, increasing competition amongst firms through trade may have adverse consequences on welfare under certain conditions. In particular, when there is two-way trade with almost homogenous goods ("reciprocal dumping") and important barriers to entry, the costs of transporting (nearly) identical goods in opposite directions can dominate the positive, pro-competitive effect of trade. This effect was first shown in Brander (1981), and further developed in Brander and Krugman (1983). Friberg and Ganslandt (2008) show that reciprocal dumping can result in lower total surplus rather than protectionism in a Cournot model for any degree of product differentiation, and in a Bertrand model when products are sufficiently close substitutes. Dei (1990) presents a model of reciprocal dumping with two markets and two firms which can decide to act as multinational companies rather than exporting their products to the other market. He demonstrates that global welfare increases through the introduction of multinational companies whereby the larger market tends to lose and the smaller market tends to gain.

Even though these papers have shown that excessive entry might be *socially* undesirable, market entry is usually considered profitable for the consumers unless there are transportation or trade costs. For example, Deltas et al. (2012) assume transport (or more generally trade) costs to show that collusive behavior among two firms can lead to higher aggregated consumer surplus. They use a model with two firms whose products are differentiated. They assume both firms have a home markets in two geographically separated markets and selling the product of a firm in a "foreign market" causes trade costs. To my knowledge, there are no papers in the literature that can show higher (lower) *consumer surplus* through less (more) competition where no costs such as transport or trade costs – e.g. Deltas et al. (2012) or reciprocal dumping literature – are involved.

Salent et al. (1983) show in a Cournot model, that some exogenous merger may reduce the joint profits of the colluding firms. As they argue, it is not an equilibrium any more for the merged firm to produce exactly as its components did in the premerger equilibrium; in the new equilibrium, given unchanged output of other players, the merged firm reduces its production. They also show that exogenous mergers can still cause losses for the joint profits of the merging firms, even when the merger creates efficiency gains through scale economics, that are large enough to be socially profitable. In their model, a merger to monopoly is always profitable for the firms.

One of the contributions of this paper is to show that M&A can not only increase social welfare, but also consumer surplus even if there are no transportation costs, trade costs and no efficiency gains through M&A. Moreover, we show that even a merger to monopoly can be consumer welfare enhancing. Furthermore, this paper shows that competition in market *M* can harm consumers in market *N* in both cases when the firms have the same or different pre-R&D cost structures.

The next section describes the model. In section 2.1 we consider the monopoly case which helps us as a benchmark to measure how aggregated consumer surplus changes due to M&A of firms 1 and 2. Section 3 considers the case where price discrimination is possible and thus firm 1 can set different prices in markets *M* and *N*. Section 4 shows how results change if price discrimination is not possible and Section 5 concludes the results.

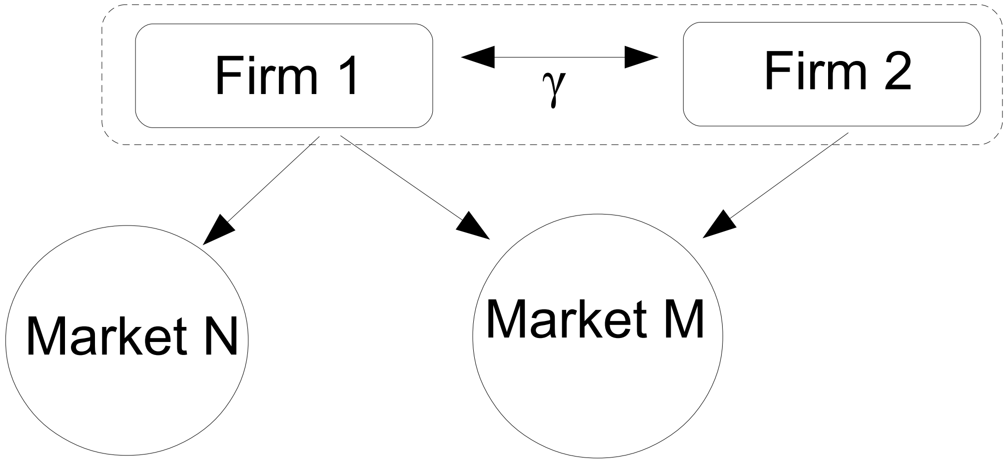
2. The Model

Consider two markets, *M* and *N*, which are separate from each other. There are *m* representative consumers in market *M*, and *n* representative consumers in market *N*. There is a firm, called "firm 1", which is active in both markets. Now assume that there is another firm, hereafter called "firm 2", which is only in market *M*. There can be different reasons why firm 2 is not active in market *N*. One possibility is that market *N* is too small to be profitable for a second firm to enter into that market.[4] Another possibility is that the government of country *N* protects the domestic

4 We assume here that market *N* is small enough, that even if we consider the effect which is explained in Saboori Memar (2013), market entry is still unprofitable. That paper shows how market entry into a per se unprofitable market can become profitable under certain circumstances, if we consider the profit increasing feedback effect of

firms against foreign competitors. Another possibility is that firm 2 faces capital restraints and therefore can not pay the fixed costs of market entry into market *N*.

This structure is similar to the situation in the previous paper of this dissertation, Saboori Memar (2013) “Profitable Entry into an unprofitable market”, when the firm has entered into market *N*. Hereby, firm 1 competes with firm 2 in market *M*, while it is a monopolist in market *N*. The basic structure of the model is illustrated in the following draft:



The parameter γ represents the degree of competition which can vary from independent goods (γ = 0) to perfect substitutes (γ = 1). We assume that firms can not control the taste of consumers concerning how close substitutes the goods are, thus the degree of substitution is an exogenous parameter. The representative consumer in each market has a standard linear quadratic utility function in the form of:

$$U_k = a_k(q_i + q_j) - \frac{q_i^2 + q_j^2}{2} - \gamma q_i q_j, \quad \text{where} \quad i, j = \{1,2\} \wedge i \neq j, k \in \{M, N\} \tag{1}$$

There are fixed costs of market entry *F*. The consumers' maximum willingness to pay in market *M* is denoted by a_M and in market *N* by a_N. Hence a difference in market size can arise both from the different number of consumers and from different willingness to pay of the representative consumers in each market. The time structure of the model is as follows: In t_0 nature decides how substitutable the products of firm 1 and firm 2 are. In stage t_1, each firm decides, for the given γ and under common knowledge about the own and competitor's cost structure, whether or not they want to acquire/merge with the other firm, and the authorities decide whether or not to allow the acquisition/merger. In stage t_2, each firm decides whether it wants to stay in the market or to exit the market, whereby market exit is free. In stage t_3, firms set the amount they want to invest in process

market entry into the old market.

R&D. In stage t_4, firms set their final prices/quantities depending on the mode of competition.[5]

The model is solved recursively. In stage 4 the firms maximize their profits with respect to the market prices. The firms' profit functions are:

$$\begin{aligned}\pi_1 &= m(p_1 - c_1 + x_1)q_{1M} + n(p_{1n} - c_1 + x_1)q_{1N} - v\frac{x_1^2}{2} \\ \pi_2 &= m(p_2 - c_2 + x_2)q_{2M} - v\frac{x_2^2}{2}\end{aligned} \tag{2}$$

The price of firm i in market k is denoted by p_{ik}, the marginal costs by c_i, and q_{ik} denotes the quantity that firm i sells in market k for all $i \in \{1,2\}, k \in \{M, N\}$. The amount of cost reduction due to R&D investments of firm i is represented by x_i and $v/2$ is an inverse measure for productivity of R&D, hence firm i's total costs of R&D is $vx_i^2/2 \quad \forall i \in \{1,2\}$. In order to show that consumer welfare increases through merger, we first consider the benchmark-case where firms 1 and 2 are merged to firm 12, and act as a monopolist in both markets.

2.1 Firm 1 as a monopolist in both markets

In this part we assume that there is an M&A between firm 1 and firm 2. The resulting monopolist is called hereafter firm 12. The results are used later as benchmark to show that consumer welfare increases due to M&A of the firms. Since the merged firm faces ceteris paribus a higher demand than a firm under competition, it invests more in process R&D and has a lower post-R&D cost structure than the firms under competition. The lower marginal costs yield lower prices of the merged firm. Hence, in circumstances where the benefits of competition are weak for the consumers – for example when the competing firms have highly asymmetric post-R&D marginal costs – M&A of the competitors can yield higher consumer surplus.

The merged firm has different possible strategies after the merger. It can continue with the status quo, which is offering both goods in market *M* and only product 1 in market *N* (hereafter called “status-quo strategy”). Alternatively, the merged firm can close one production plant and offer only the good with lower costs to the consumers in both markets (hereafter called “one-product strategy”).[6]

5 The timing of the game in stages t_1 and t_2 differs if we consider the scenario where an entry of firm 2 into market *N* leads to lower aggregated consumer welfare. In this scenario, firm 2 decides in stage t_1 whether to enter in market *M* or not. In stage t_2, firm 1 decides whether or not to exit market *M* as a reaction to firm 2's market entry. The timing of the two scenarios in stages t_0, t_3 and t_4 are identical.

6 The merged firm would not follow the strategy of offering both goods in both markets by introducing good 2 into market *N*. An assumption of this set up is that, when the two firms are *not* merged and firm 1 is active in

If firm 12 chooses the status-quo strategy, the consumers in market *M* face a higher variety of goods compared with the one-product strategy. Hence, due to the assumed consumers' utility function, their aggregated demand for both products is ceteris paribus higher under the status-quo strategy. However, offering a second product in market *M* yields lower demand from consumers for the first product. That, in turn, yields lower R&D investments of firm 12 in production of the first product and therefore higher post-R&D marginal costs of product 1. Moreover, the monopolist has higher fixed costs for advertising and distributing two products in market *M*.

This paper also aims to identify typical circumstances, where M&A yields higher consumer surplus. The merged firm usually chooses the one-product strategy over the status-quo strategy except in cases of extremely differentiated products. For this reason, we concentrate on the one-product strategy in this paper, however, we show in appendix A that M&A can also yield higher consumer surplus if firm 12 follows the status-quo strategy. There are mainly two reasons why we rather focus on one-product strategy case in this paper. Firstly, because we can show that even though there is a monopolization *and* a loss of product variety in market *M*, consumer welfare increases. Secondly, according to the utility function of the consumers, their utility is ceteris paribus lower, the less the number of offered products are.

As we consider the results throughout the paper both with and without the possibility of price discrimination, we consider these two cases for the monopolist as well. We calculate for both cases of price discrimination (PD) and non-price discrimination (NPD) what prices, quantities and level of R&D the monopolist chooses and how much the aggregated consumer welfare is.

We assume that the merged firm has the pre-R&D marginal costs c_{12}, sells the quantity q_{12M} in market *M* and q_{12N} in market *N,* and sets the price p_{12} (in the NPD case), respectively sets the prices p_{12M} in market *M* and p_{12N} in market *N* (if PD is possible). The profit function of the monopolist is:

$$\pi_M = m(p_{12} - c_{12} + x_{12})(q_{12\mathrm{M}}) + n(p_{12} - c_{12} + x_{12})(q_{12\mathrm{N}}) - v\frac{x_{12}^2}{2}, \quad \text{if PD is not possible}$$

$$\pi_M = m(p_{12\mathrm{M}} - c_{12} + x_{12})q_{12\mathrm{M}} + n(p_{12\mathrm{N}} - c_{12} + x_{12})q_{12\mathrm{N}} - v\frac{x_{12}^2}{2}, \quad \text{if PD is possible} \tag{3}$$

Analogous to the case where firms 1 and 2 compete, the amount of cost reduction due to R&D investments of firm 12 is represented by x_{12} and $v/2$ is the inverse productivity of R&D, hence firm

both markets, firm 2 would not enter into market *N*, because market *N* is too small to cover firm 2's costs of market entry. When the two firms are merged, the profit losses of firm 1 in market *N* due to entry of firm 2 into that market are internalized. Due to this “Cannibalization-effect”, a market entry causes even higher losses for firm 12 than market entry of firm 2. Hence, it is never profitable for the merged firm to introduce product 2 into market *N*.

12's total R&D-investments are ½ νx_{12}^2.

The monopolist faces the following demand function in each market:

$$q_{12K} = a_K - p_{12K}, \quad \forall K \in \{M, N\} \text{ , if PD is possible and}$$
$$q_{12K} = a_K - p_{12}, \quad \forall K \in \{M, N\}, \text{ if PD is } \textit{not} \text{ possible} \tag{4}$$

The model is solved recursively. By inserting (4) into (3) and deriving the first order condition therefrom with respect to either prices or quantities, we get the following monopoly prices depending on the monopolist's level of cost reduction x_{12}:

$$p_{12K} = (a_K + c_{12} - x_{12})/2, \quad \forall K \in \{M, N\}, \text{ if PD is possible and}$$
$$p_{12} = \frac{a_M m + a_N n + (m+n)(c_{12} - x_{12})}{2(m+n)}, \text{ if PD is } \textit{not} \text{ possible.} \tag{5}$$

Inserting (5) into (2) and maximizing with respect to x_{12} we get the optimal amount of marginal cost reductions x_{12} and thus the optimal amount of R&D investment (which is $\nu x_{12}^2/2$):

$$x_{12} = \frac{(a_M - c_{12})m + (a_N - c_{12})n}{2\nu - m - n}, \quad \text{both if PD is possible or not} \quad \forall m+n<2\nu \tag{6}$$

At the first glimpse it might not appear intuitively why x_{12} is the same for both cases of PD and NPD. However, inserting (5) into the quantities in (4), and comparing the quantities in the PD case with the quantities in the NPD case, shows that the aggregated quantities sold by the monopolist are equal. Therefore, the monopolist invests the same amount in process R&D independent of the possibility of price discrimination.[7]

Inserting now (6) into (5) and (4) leads to the prices and quantities depending only on external variables. By inserting the prices and quantities into the consumers' utility functions and subtracting consumers' costs, we can get the aggregated consumer surplus in both markets:

$$CS_{MN} = \frac{(a_M m - a_N m + 2\nu(a_N - c_{12}))^2}{8(m+n-2\nu)^2} + \frac{(a_M n - a_N n - 2\nu(a_M - c_{12}))^2}{8(m+n-2\nu)^2}, \text{ if PD is possible, and}$$

$$CS_{MN} = \frac{((a_M - a_N)m(m+n) - (a_M m + c_{12}(m+n) - a_N(2m+n))\nu)^2}{2(m+n)^2(m+n-2\nu)^2} + \frac{((a_M - a_N)n(m+n) + (a_N n + c_{12}(m+n) - a_M(m+2n))\nu)^2}{2(m+n)^2(m+n-2\nu)^2}, \text{ if PD is } \textit{not} \text{ possible.} \tag{7}$$

After solving the monopoly scenario, we can now consider the cases where firms 1 and 2 remain competitors and do *not* merge, and compare the results with this monopoly scenario.

7 This has been shown similarly in Pepall et al. (2008) and other sources as well.

3. Price discrimination is possible

In this section we will consider the case where firm 1 is a monopolist in market *N*, while it competes with firm 2 in market *M*, and can set different prices in markets *M* and *N*. In section 4, we compare how results change if firm 1 *cannot* price discriminate between markets *M* and *N*.

The derivative of the utility function of the representative consumer in (1) yields the following demand for products 1 and 2:

$$q_{iM}=a_M-p_{iM}-q_{jM}\gamma, \quad \forall i,j\in\{1,2\}, \text{ where } i\neq j \text{ in market } M\text{, and}$$
$$q_{1N}=a_N-p_{1N} \text{ in market } N. \tag{8}$$

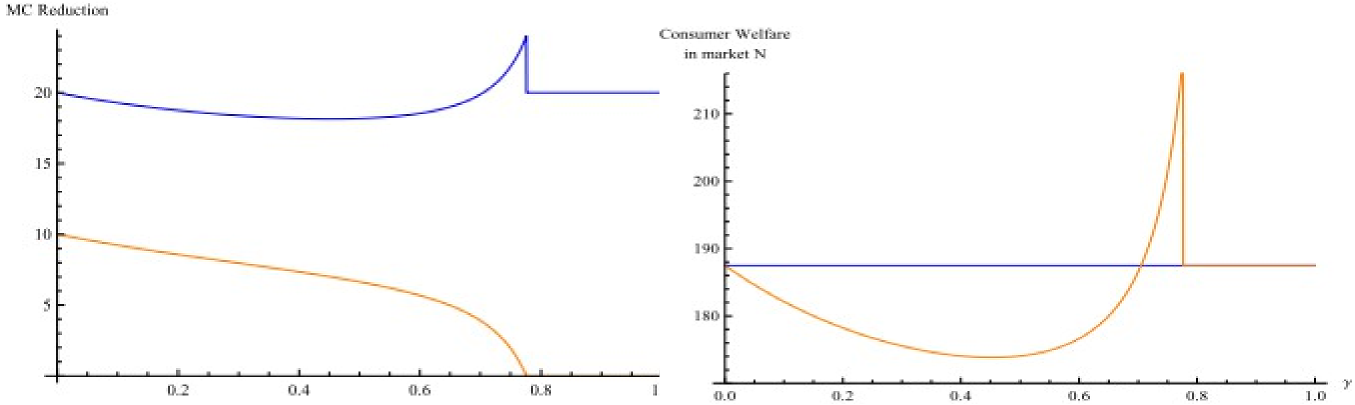
Inserting the demands into each other and solving with respect to q_1 and q_2 leads to:

$$q_{iM}=\frac{a_M(1-\gamma)-p_{iM}+p_{jM}\gamma}{1-\gamma^2}, \quad \forall i,j\in\{1,2\}, \text{ where } i\neq j \text{ in market } M\text{, and}$$
$$q_{1N}=a_N-p_{1N} \text{ in market } N. \tag{9}$$

We get the price reaction functions of the firms, by inserting (8) into the firms' profit functions in (2) and maximizing the results with respect to the prices. Solving the equation system with the price reaction functions yields the optimal prices depending on marginal cost reductions x_1 and x_2:

$$p_{iM}=\frac{a_M(2-\gamma-\gamma^2)+2(c_i-x_i)+\gamma(c_j-x_j)}{4-\gamma^2}, \forall i,j\in\{1,2\}, \quad \text{where } i\neq j \text{ in market } M\,,$$
$$\text{and } \quad p_{1N}=\frac{a_N+c_1-x_1}{2} \quad \text{in market } N. \tag{10}$$

Inserting (8) and (7) back into the profit functions in (2) and maximizing with respect to x_1 respectively x_2 yields the optimal amount of marginal cost reductions of the firms, which is directly related to the R&D investments. By Inserting the optimal x_1 and x_2 into the prices and quantities we get the equilibrium prices and quantities and we can also simulate the consumer welfare. The following graphs compare the marginal cost reductions of firms 1 and 2 (left graph), as well as consumer welfare in market *N* (right graph), before and after M&A in market *M*. The degree of product differentiation γ is represented on the horizontal axis. In order to exclude the effect of asymmetric consumers' maximum willingness to pay and asymmetric pre-R&D marginal costs, these parameters are set symmetric in these graphs. This allows us to concentrate on how other effects such as degree of competition can lead to higher CS under monopoly. Later in this section and in section 4, we also consider the effect of asymmetric maximum willingness to pay of consumers and asymmetric pre-R&D marginal costs.



Graph 2, Left: Marginal cost reduction of firm 1 (blue) and firm 2 (orange) when firms 1 and 2 compete in market *M*. For comparison: in the monopoly case, the marginal cost reduction of the monopolist is 20. Even though the graph simulates just x_1 and x_2, the graph also represents ordinal the R&D investments, since R&D investments are $\nu x_i^2/2 \, \forall x_i \in \{1,2\}$. Right: Comparison of consumer welfare in market *N*, when firm 1 is a monopolist in both markets (blue line), versus when the firms 1 and 2 compete in market *M* (orange line). The parameter values of the parameters in both graphs are: $a_M = a_N = 60$, $m = 1$, $n = 0.6$, $\nu = 2$, $c_1 = 30$, $c_2 = 30$.

As we can see in the left graph, if the pre-R&D marginal costs of firms 1 and 2 are similar, firm 1 always invests more aggressively in R&D than firm 2 since it serves both markets, while firm 2 serves market *M* only. For this reason, firm 1 has ceteris paribus lower post-R&D marginal costs than firm 2. If the two firms' products are more homogeneous than a certain threshold, firm 2 would make losses if it stays in market *M* and therefore it decides to exit that market in stage t_1.[8] In the area which is above this threshold, firm 2 exits market *M* in stage t_1 and firm 1 can simply act as a monopolist in stages t_2 to t_4. Hereby, the prices, quantities and marginal cost reductions of firm 1 is like the monopoly case, which has been already explained in section 2.1.

The right graph demonstrates what the main source of higher CS through monopolization is. Monopolization in market *M* leads to a higher demand of product 1 and thus higher investments of firm 1 in process R&D. If γ is in the low range, this yields lower post-R&D marginal costs and ceteris paribus lower price of firm 1 in market *N*. Hence, if products of firms 1 and 2 are not close substitutes, M&A in market *M* yields higher consumer surplus in market *N*.[9] However, a higher degree of substitution among the goods also means higher business stealing effect, which increases firm 1's incentives to use its post-R&D cost advantage to capture more of the competitor's consumers through lowering its prices. Therefore, if the value of γ is high enough to be below, but

8 The value of this threshold depends on other variables such as market sizes, firms' cost structures and how costly marginal cost reductions are. In this graph this threshold is by approximately 0.78.

9 Whether the value of γ is low/high depends also on other values such market sizes.

close to the threshold which leads to market exit of firm 2, M&A does not enhance aggregated consumer welfare.

For firm 2, an increasing degree of substitution causes the opposite effect: firm 2 is intimidated from investing in R&D, because it faces an aggressive competitor which has the advantage of self-commitment to higher R&D investments and lower post-R&D marginal costs. Hereby, firm 2 prefers to lower its sales volume and concentrate on its loyal customers. A further increasing γ can even yield market exit of firm 2 in stage t_1, since it becomes unprofitable for firm 2 to compete with firm 1.

3.1 Introducing asymmetries

In the previous graphs, the representative consumers in both markets have the same demand function for the goods. Hence a difference in the market sizes arises in the last graphs only by different number of representative consumers in the markets. After knowing what effect degree of product differentiation γ has, in this part, we add two more asymmetries to the model. The first asymmetry we introduce is different types of representative consumers in each market through different maximum willingness to pay (a_M for consumers in market M and a_N for consumers in market N). Thus, the market sizes do not differ any more only by number of consumers, but also by the "wealth" of the representative consumer in each market.

The other asymmetry introduced in this section's simulations regards the firms. In this section, we consider firms with different pre-R&D marginal costs, thus different cost structures *before* R&D investments. This way, we can analyze how firms with different production technologies can compete with each other. The assumption that firm 1 has lower pre-R&D marginal costs than firm 2, would simply reinforce firm 1's advantage and therefore leads to similar results as those we already observed in the previous chapters. For this reason, we focus here on the more interesting case where firm 2 has a pre-R&D cost advantage.[10] In This case each firm has an advantage in comparison to its competitor. Depending on the parameter values, the model can result into different scenarios: a dominant-firm-game with either firm as dominant player and the other one as fringe competitor, or, in rather rare cases, two firms with different technologies, but the same post-R&D marginal costs.

We assume that the merged firm 12 follows the one-product strategy, closes the plant with

10 As an example, one can consider a former state-owned monopolist, which now faces competition in some areas of its market. Since the competitors are entrants, they use a new technology, and have therefore a different technology with lower pre-R&D marginal costs.

higher production costs, and serves both markets through the production facility with lower pre-R&D marginal costs. By analyzing the simulation we try to show under which circumstances an M&A can possibly lead to higher consumer welfare, and therefore, a permission for the M&A from the competition authorities can rather be achieved.[11]

In order to understand why CS can be lower under competition than under monopoly, we need to analyze what effects does M&A have. The impact of M&A on consumer welfare in market *N* has already been explained above: firm 1 invests more in process R&D, its price in market *N* decreases and consumer welfare in that market increases. In market *M*, however, the M&A has several effects which impact consumer welfare in contrary directions. On the one hand, changing the mode of competition from duopoly to monopoly decreases consumer welfare in market *M* because of both monopoly pricing and the loss in product variety. On the other hand, the damage to consumers in market *M* through M&A is dampened, because the remaining monopolist has lower marginal costs since it uses the more efficient plant and also invests more in R&D than separate firms under competition. Thus the monopolist has lower post-R&D marginal costs than the former competitors. Obviously, if consumers in market *N* gain more from the M&A than consumers in market *M* lose, does M&A lead to higher aggregated CS.

The table below summarizes the results of the simulation and demonstrates what the *typical situations* are, whereat the aggregated consumer welfare increases through M&A in market *M*. We try to illustrate the complex relationships of different variables of the Mathematica-simulations in this table. The signs and legends are explained below the table, followed by an explanation of the results.

Note that low, medium or high ranges are mentioned for some parameters below. The value of no parameter can be negative, so zero is the lower boundary for most of the parameters. The lower boundaries for a_M and a_N are straight forward since their value can not be lower than the firms' post-R&D marginal costs. The lower and upper boundary for γ are rigid, since γ ranges per definition between zero (monopoly) and one (perfect competition). If $2v$ is less than $m+n$, the productivity of R&D is too high and the results are not defined. Therefore, the lower boundary for v is ½ $(m+n)$. The question whether v is high or low can only be answered when it is set in relationship with the combined number of consumers in the two markets *M* and *N*. Therefore, the values of v, m and n are "tied" together. For example, by low *relative* costs of R&D (respectively high relative productivity

11 The primary goal is more concentrated on ascertaining the typical conditions under which higher CS under monopoly is given, rather than where the highest difference between the aggregated CS under monopoly versus under competition is. In other words, we focus in this analysis rather on the "wideness" than on the "depth" of higher CS under monopoly in the cases where these two elements are contradicting each other.

of R&D), we mean when v is closed to but above its lower boundary ½ $m+n$. Analogously, the upper boundary of the combined market size $m+n$ is 2 v.

The typical cases of higher CS through monopolization differ depending on which firm has higher pre-R&D marginal costs. The simulations show that, if firm 1 has approximately equal or lower pre-R&D marginal costs than firm 2 (right column), monopolization leads in fewer cases to higher consumer surplus. But if firm 1 has higher pre-R&D marginal costs (left and middle column), the typical circumstances of higher CS through M&A depend on the relative number of representative consumers in market N. The reason lies in an immediate positive effect of R&D for the consumers in market N, which will be explained below in the specific explanation of marginal costs c_1 and c_2. Therefore, typical circumstances of higher CS through M&A change significantly depending on n. For this reason, we distinguish in this case between high and low n, which depends on m and v, subject to the restriction $m+n<2v$.

Comp. mode / Parameter	PD, low n $c_1 > c_2$	PD, high n $c_1 > c_2$	PD $c_1 < c_2$
γ	≠↑	≠↑	≠↑
ν	≠↑→n*	→ n(+m)*	↓→ $(n+m)/2$ **
a_M	↓ ***	↓ Necessary Condition	↑
a_N	○****	≈→a_M	○
m	≠ ~	↓	↑ Necessary Condition
n	∩	∪	↓, because high m is necessary condition and $v > (n+m)/2$

Table I: Which combinations of parameters lead to a situation of higher consumer welfare after M&A if price discrimination is possible and the merged firm follows the one-product strategy.

* The value of parameter v needs to be relatively similar to n in order to have higher consumer surplus under monopoly. This is not meant in absolute number, but in relative term. Thus if n is high, then a high value of v provides rather a favorable situation.

** ν should be as low as possible, however the condition $\nu > (n+m)/2$ should not be violated.

*** A high a_M can only be compensated by a significantly lower c_2 than c_1, extremely low v, or significantly lower m than n.

**** The value of a_N has little significance on the probability of CS-Enhancing merger

Explanations of the signs and legends in the tables:

↑ /↓/ ~ : The parameter should be in the high/low/middle ranges.

$a_N \approx\rightarrow a_M$: The parameter value should be close to another parameter (here: a_N should be close to a_M).

≠~/ ≠↑/ ≠↓: The parameter value should not be high/should not be low/should be either low or high.

○: Relatively irrelevant because even significant changes in the value brings only insignificant changes in the result

∪(∩): There is a U-shaped (adverse U-shaped) relationship between the parameter value, and the probability of consumer-welfare-Enhancing

Interpretation of the table and analysis of each single parameter

a) General explanation for parameters γ and ν *for all tables* in this paper:

Degree of product differentiation γ

The most straightforward relationship is regarding γ, the degree of competition among the firms under duopoly. In order to have higher CS under monopoly, the value of γ should be in the middle ranges or in the low ranges, depending on the other parameters. If the goods in market *M* are rather differentiated, then M&A in market *M* does not have a significantly negative effects for the consumers in that market. Thus, the positive effect of lower post-R&D marginal costs of the remaining monopolist outweighs the negative effects of eliminating competition, so M&A rather yields higher consumer surplus. This is true for all the cases that are presented in both tables I and II. Furthermore, when firms are under competition, γ should *not* be around or higher than the threshold where firm 2 would exit from market *M* in stage t_1.

Costs of Research and development *v*

In general we can say that higher *v* leads to a less favorable situation for higher CS through M&A. Since consumer-surplus-enhancing M&A is based on the effect of higher R&D incentives of the newly formed monopolist, higher costs of R&D weakens this effect. Thus, higher CS under monopoly only occurs if v is either in the low or medium ranges. This is true for all the cases in both tables.

b) Specific explanations for the parameters a_M, a_N, M and N in table I:

Marginal costs c_1 and c_2

If $c_1 > c_2$ the new monopolist takes over firm 2's cost structures after M&A. Since firm 2 is only active in market *M* before the M&A takes place, there is an "immediate" positive effect of M&A for consumers in market *N*, namely lower *pre-R&D* marginal costs of the monopolist (hereafter called the "direct positive effect" of R&D). Due to this effect, $c_1 > c_2$ yields rather a favorable condition of higher CS through M&A than $c_1 < c_2$.

If $c_1 < c_2$, the probability for higher CS under monopoly increases if either firm 2's pre-R&D marginal costs decrease or firm 1' pre-R&D marginal costs increase. Furthermore, the closer the pre-R&D marginal costs of the two firms are to the maximum willingness to pay of consumers – a_M and a_N – the less market power the monopolist has and therefore, the more likely a CS enhancing M&A is.

Size of market *N*: a_N and n

If $c_1 > c_2$, an increasing n causes higher CS through M&A, due to the direct positive effect in market *N* which has been explained above. However, the value of n cannot be in the high-end-range. Firstly, if n is "too high", it could violate the assumption that market *N* is not big enough to be profitable for firm 2 to enter into it. Secondly, a larger n has a second effect, namely firm 1's post-R&D marginal cost advantage is more significant under competition. This implies a higher asymmetry among the firms, which yields lower competitive pressure under competition. Thus, if n is too large,[12] the CS enhancing effect of M&A becomes weaker than the negative effect of monopolization through M&A. So, n should be in the middle ranges in order to have higher CS through M&A if $c_1 > c_2$.

If we consider $c_1 < c_2$ then firm 12 takes over the production plant of product 1, which was also sold in both markets before the M&A. Therefore, there is no direct positive effect of M&A. In

12 Whenever we compare the advantages of firm 1 (serving both markets) and firm 2 ($c_2 < c_1$), by a high (low) n we mean a value of n which yields to a significant overweight of firm 1's (2's) competitive advantage. Analogously, n is in the middle range, when the two firm's have similar post-R&D marginal costs. So whether the value of n is high or low, depends also on other factors such as the difference between c_1 and c_2.

that case changes in a_N do not significantly influence the results. Higher CS through monopolization is less common when $c_1 < c_2$, and it is only possible when M is large. A high M is a necessary condition for higher CS through monopolization (see below for explanation). Therefore, N must be low in order that the condition $m+n<2v$ holds. It should be emphasized that, no matter if $c_1 < c_2$ or $c_1 > c_2$, the assumption that "market N is small enough so that a market entry of firm 2 would be unprofitable" should hold. This should also be considered when we analyze the other parameters as well.

Size of market *M*: a_M and *m*

Assuming $c_1 > c_2$, if n is high, firm 1 invests already at a high level in process R&D and is the dominant firm in market M. In this case, a sinking m leads to significant reduction of firm 2's R&D investments, as market M is the only market it serves. A lower value of m weakens ceteris paribus the advantages of competition for consumers due to higher prices and higher asymmetry among the competing firms. Thus, if n is high, m should be low in order to have higher CS through M&A.

Consumers are hurt from M&A most when competition in market M is intense – for example when the *post-R&D* marginal costs of the competing firms are relatively equal. Assuming $c_1 > c_2$ and n is small, competition is intense when m is in a range where it roughly balances out firm 1's and firm 2's competitive advantages and yields similar post-R&D marginal costs of these firms. If m is below (above) this range, then firm 1's (2's) advantage has tendentiously a higher weight than firm 2 's (1's) advantage and thus firm 1 (2) faces a weak competitor in market M. In both cases where m is too small or too large, competition in market M does not significantly benefit consumers and thus M&A can lead to higher CS.

A lower a_M yields lower price settings of all firms both before and after M&A. Hereby, the merged firm 12 decreases its prices stronger than the firms under competition. The reason is that firm 12's market power depends more on a_M than the market power of the competing firms 1 and 2. Hence, it is likely to have higher consumer welfare under monopoly the lower a_M is.

In a nutshell, if $c_1 < c_2$, there is no direct positive effect for the consumers in market N and as I mentioned above, a CS enhancing merger is less likely. However, the competing firms in market M are asymmetric because firm 1 has in this case both competitive advantages: lower pre-R&D marginal costs as well as higher R&D incentives due to serving market N. Since a larger m yields more aggressive R&D investments of the dominant firm 1, it reinforces the asymmetry among the firms and leads to lower benefits of competition for consumers. Therefore, a high value of parameter m is a necessary condition for higher CS through M&A, and due to the restriction $m+n<2v$, the value of parameter *n* should be low.

4. Price discrimination is *not* possible

In this section, we assume that firm 1 can not price discriminate between markets *M* and *N*, thus $p_{1M} = p_{1N} = p_1$. This can be the case for instance when transportation costs are zero. There are also other examples where firm 1 can not price discriminate among the markets while its monopoly position in market *N* is ensured. Assume that market *N* represents country $\bar{N}$ and its government protects market *N* against foreign competition under the condition that the protected firm has to set the same price in domestic market and in foreign market. Through this law, the government of country $\bar{N}$ protects the domestic firms against foreign competition, but prevents consumers to be harmed due to monopoly price setting of the domestic firm in the own market.

The main difference between section 3 and section 4 is that in the latter case firm 1 has to find a balanced unit price for both the competitive and the monopoly market to generate its maximum total profits, while in section 3 firm 1 can simply set the optimal price in each market. A comparison of the price of firm 1 in this section (p_1) with the prices of firm 1 in section 3 (p_{1m} and p_{1n}) shows that p_1 is usually higher than p_{1M} in market *M,* where firm 1 faces competition, and lower than p_{1N} in market *N*, where firm 1 is a monopolist.

The derivations of prices, quantities, R&D investments and consumer welfare are analogous to section 2.3. Therefore, we do not explain them in this section again. However, the terms for prices, quantities and R&D investments can be found in appendix B.

4.1 Analyzing the non-price-discrimination-case

Even though price discrimination is, in contrast to section 3, *not* possible in this section, there are no significant changes about how the parameters γ, v, c_1 and c_2 should be compared to section 3, for a CS enhancing M&A. Since these parameters are already explained in section 3, they will not be repeated anymore in this section. The other parameters are briefly discussed here, before all parameters are summarized in table 2.

Size of market *M*: a_M and *m*

If $c_2 < c_1$, both lower *m* and lower a_M lead in this case to a more favorable situation for higher

CS through M&A.[13] A lower a_M means lower prices under monopoly and it implies that each representative consumer profits less from competition. The reason has already been explained in the previous section.

The smaller *m* is, the smaller is the number of consumers in market *M* who profit from competition. Furthermore, a smaller *m* weakens firm 2 as a competitor in market *M*, which creates an asymmetric competition there.

Assuming $c_1 < c_2$, the situation changes because firm 1 has now both competitive advantages. In this case, an increasing size of market *M* (enhancing a_M or *m*) yields more aggressive R&D investments of firm 1 and higher asymmetry among the competing firms, which yields rather CS enhancing M&A.

Size of market *N*: a_N and *n*

As explained above – under the assumption that $c_2 < c_1$ – generally more consumers in market *N* profit from the direct positive effect of M&A, the higher *n* and a_N are. However, if *n* is rather large, a further increasing *n* causes an asymmetry among the competing firms, and yields a dominant position of firm 1.[14] In this case, a further increasing *n* is rather disadvantageous for CS enhancing M&A and therefore, *n* should be large but not too large.

The "optimal value" of a_N for higher CS through M&A depends on a_M. If a_N is significantly lower than a_M, then consumers' maximum willingness to pay is low in the market where firm 1 is monopolist and high in the market where it faces competition. In this case, firm 1 tendentiously chooses a low unit price before M&A. Furthermore, in case of a merger, firm 12 faces no competition anymore in market *M*, which is the "wealthier market", and it would set a high unit price. Therefore, if $c_2 < c_1$, the values of a_N and a_M should not be too divergent in order to have a situation of higher CS through merger.

The table below sums up the results for the non-price-discrimination case, assuming firm 12 follows the one-product strategy after M&A. The table for status-quo strategy can be found in appendix C. The signs and legends are already explained in the table in section 3, so they are *not* mentioned here again. Contrary to the previous section, a high or low *n* does *not* cause significantly

13 We should keep in mind that it is also in the non-price-discrimination-case a necessary condition, that γ should not be too high, otherwise consumers have higher CS if the competition authority forbids the M&A.

14 Reminder: whenever we are talking about high/large *m* and/or *n*, it should be set in the context of the relationship of *m* and *n* with *v*, regarding the constraint $m + n < 2\,v$. Furthermore, we consider values of *n*, which are small enough to not break the assumption that market *N* is not profitable for firm 2 to enter into it.

different combination of parameters, which lead to a situation of CS enhancing M&A. Therefore, there is no need to distinguish between low and high number of consumers in market N.

Comp. Mode / Parameter	NPD, One-product strategy $c_1 > c_2$	NPD, One-product strategy $c_1 < c_2$
γ	≠ ↑	↓
ν	↓→ $\frac{n(+m)}{2}$ †	↓→ $\frac{n(+m)}{2}$ †
a_M	↓ (Necessary Condition)	↑
a_N	↓ , ≈→ a_M††	↓
m	↓	↑
n	∩	↑

Table II: What combinations of parameters lead to a consumer-welfare-enhancing M&A if price discrimination is *not* possible and the merged firm follows the one-product strategy.

For some parameters, we have very clear and robust results which are valid both in the PD case and in the NPD case. For example, γ and ν should be low in both cases independent of other parameters. The exact threshold value of γ and ν, which turns a merger into to a consumer-welfare-enhancing merger *does* depend on other parameters. However, independent of other parameters, the finding that γ and ν need to be low is a robust result.

The mechanisms of other parameters are of a more complicated nature. For instance, if $c_1 < c_2$, the relative values of a_M and m should be high for consumer welfare enhancing merger to monopoly. However, they are also cases where the parameters act different than the PD case. For example, if $c_1 > c_2$ the value of a_N should rather be low in the NPD case, while it is relatively insignificant in the PD case. Furthermore, when $c_1 < c_2$, the value of n should be rather low in the PD case, but it should be high in the NPD case. The reason is that, if c_2 is significantly lower than c_1, a smaller N yields a more dominant position of firm 2. On the other side, if $c_1 < c_2$, then a larger N further emphasizes the already dominant position of firm 1. As this example shows, the determination of parameter values, which enable a consumer-surplus-enhancing merger to

†† If n is rather high, a_N should be even lower than a_M and since a low value of a_M is a necessary condition for higher consumer welfare through M&A, a_N should also be low.

monopoly is rather very complex and many variables my change depending on other variables. The tables are an attempt to depict and simplify the highly complex relationship among the different variables as much as possible.

5. Conclusion

This paper demonstrates how M&A in a market influences the consumers' welfare both in that market *and* in other markets where at least one of the merging firms offers its products too. The effect of M&A on the consumers in different markets is in many cases opposite sided. For instance, if price discrimination is possible, M&A in market *M* causes lower consumer surplus in that market, but higher consumer surplus in market *N*. Clearly if consumers in market *N* gain more from the M&A than consumers in market *M* lose, the aggregated consumer welfare increases through the merger.

Traditionally mergers between firms whose products are not close substitutes are viewed more favorably by the competition authorities. This is based on the premise that the merged firm would have higher incentive to reduce outputs when the products are better substitutes. This model confirms this assumption. However, it shows that this assumption can not be considered solely and many other factors need to be taken into account as well.

Even though this paper concentrates mainly on higher consumer welfare through M&A, we can also reverse the action of the model. By reversing the action of the game, we can show that under the same circumstances where M&A yields higher consumer surplus, a change in the mode of competition in market *M* from duopoly to monopoly can harm consumers. For that case, we need to assume that firm 1 is a monopolist in both markets and firm 2 enters into market *M*. Thereby, consumers in market *M* benefit, while consumers in market *N* lose. Analogously to the scenario which was presented in this paper, firm 2's entry into market *M* can result in lower aggregated consumer welfare, if consumers in market *N* lose more than consumers in market *M* gain. As it has already been explained above in footnote 5, we need to assume a different timing of the game for this scenario.

Moreover, this paper examines what the typical combinations of the parameter values are, which yield higher consumer welfare through M&A, respectively lower consumer surplus through market entry of firm 2 into market *M*. It also specifies what role each parameter plays in this setting, and how these parameters interact with each other. Thereby, we try to consider as many parameters as possible. It results into a vast amount of possibilities and different parameters influencing the mechanisms in different direction and that yields very complex results. Possibly, we try in the future research to concentrate on few key parameters, such as γ and ν, which deliver clear and robust results both in the PD case and in the NPD case. This would contain less information than the current version of the model, however it allows to focus on the more general and tangible findings.

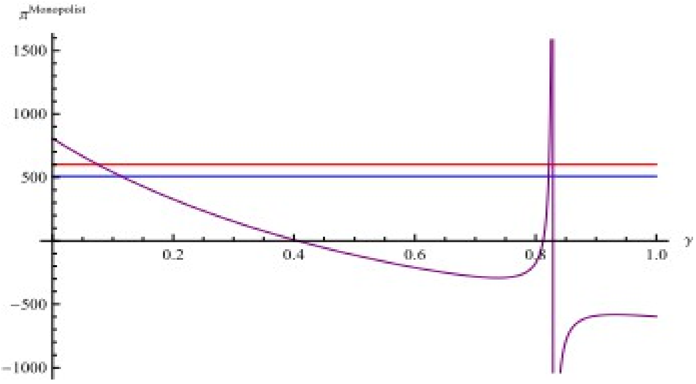
APPENDIX

NOTE: The terms in the appendix are copied from Wolfram Mathematica files. Therein, the terms used are slightly different than in the paper: “ca” is c_1, “cb” is c_2, “am” is a_M and “an” is a_N.

Appendix A:

Can M&A yield higher consumer surplus if firm 12 follows the status-quo strategy?

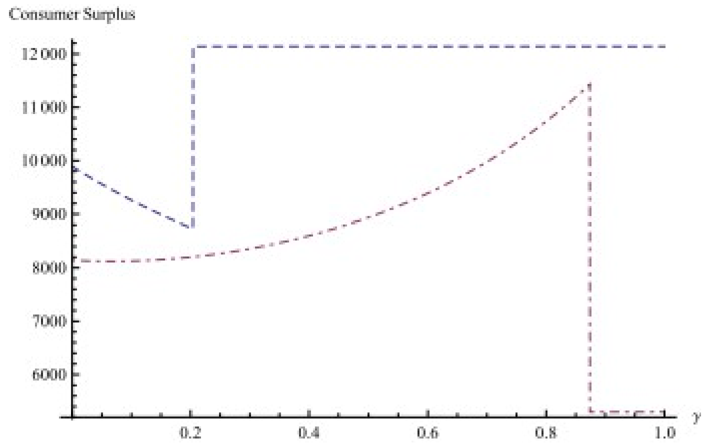
Graph: Profit of merged firm depending on the strategy it uses (PD).



The parameter values of the graph are c_1= 38 c_2=37 v=5 a_M=85 a_N=84 m=1.6 n=1.2

The graph shows the profits of the firm 12 when it chooses the status-quo strategy (purple line) versus the one-product strategy with product 1 (Blue), respectively with product 2 (Red). It chooses its profit maximizing strategy depending on degree of competition. In this case, firm 12 would chose the status-quo strategy only in the area where the products are extremely differentiated ($\gamma < 0.09$).

Graph: Consumer surplus under Duopoly (Dot-dashed) versus Monopoly (Dashed), if PD is possible.



The parameter values of the graph are: c_1 =40, c_2 =20, a_m =220, a_n = 200, v = 4, m = 0.5, n = 0.6

The graph shows the aggregated consumer surplus in the monopoly case (blue dashed) vs the competition case (purple dash-dotted). Thereby, firm 12 can choose between the one-product strategy with the more profitable product (In this case product 2), and the status-quo strategy. Firm 12 chooses its profit maximizing strategy depending on degree of competition. In this case, it would chose the status-quo strategy only in the area where the products are extremely differentiated (here when $\gamma < 0.22$). In this graph consumer surplus is always higher after M&A, independent of the profit maximizing strategy of the merged monopolist. The graph depicts that higher consumer surplus due to M&A is also possible when firm 12 follows the one-product strategy.

Appendix B

Prices, Quantities and Marginal Cost Reductions of firms 1 and 2 when price discrimination is not possible

Price of Firm 1:

$$
\begin{aligned}
-(&\mathrm{am}\, m \left(2\left(\gamma^2-2\right)m^2-\left(\gamma^4-5\gamma^2+4\right)m\,(2n-v)-4\left(\gamma^2-1\right)^2 n\,(n-v)\right) \\
&\quad \left(2\left(\gamma^2-2\right)m^2+(\gamma-1)\,m\left(4(\gamma+1)\,n+(\gamma-2)(\gamma+2)^2 v\right)+4(\gamma-1)^2(\gamma+1)(\gamma+2)\,n\,v\right)+ \\
&\quad 2\,\mathrm{an}\, n \left(2\left(\gamma^2-2\right)m^2-\left(\gamma^4-5\gamma^2+4\right)m\,(2n-v)-4\left(\gamma^2-1\right)^2 n\,(n-v)\right) \\
&\quad \left(\left(\gamma^2-2\right)m^2+\left(\gamma^2-1\right)m\left(2n+\left(\gamma^2-4\right)v\right)+4\left(\gamma^2-1\right)^2 n\,v\right)+ \\
&\quad v\left(\gamma^2(m+4n)-4(m+n)\right)\left(\gamma\,\mathrm{cb}\, m\left(-2\left(\gamma^2-2\right)m^2+\left(\gamma^4-5\gamma^2+4\right)m\,(2n-v)+4\left(\gamma^2-1\right)^2 n\,(n-v)\right)-\right. \\
&\qquad \left.2\,\mathrm{ca}\left(m+\gamma^2(-n)+n\right)\left(\left(\gamma^2-2\right)m^2+\left(\gamma^2-1\right)m\left(2n+\left(\gamma^2-4\right)v\right)+4\left(\gamma^2-1\right)^2 n\,v\right)\right)\Big)\Big/ \\
&\left(-4\left(\gamma^2-2\right)^2 m^5+4\left(\gamma^2-2\right)m^4\left(\left(\gamma^4-8\gamma^2+8\right)n-\left(\gamma^4-6\gamma^2+8\right)v\right)+\right. \\
&\quad \left(\gamma^2-1\right)m^3\left(4\left(5\gamma^4-24\gamma^2+24\right)n^2+2\left(\gamma^2-2\right)\left(\gamma^4-22\gamma^2+56\right)n\,v+\left(\gamma^2-4\right)^3\left(-v^2\right)\right)+ \\
&\quad 4\left(\gamma^2-1\right)^2 m^2 n\left(8\left(\gamma^2-2\right)n^2+4\left(\gamma^4-10\gamma^2+18\right)n\,v-3\left(\gamma^2-4\right)^2 v^2\right)+ \\
&\quad \left.8\left(\gamma^2-1\right)^3 m\,n^2\left(2n^2+5\left(\gamma^2-4\right)n\,v-6\left(\gamma^2-4\right)v^2\right)+32\left(\gamma^2-1\right)^4 n^3 v\,(n-2v)\right)
\end{aligned}
$$

Price of Firm 2:

$$
\begin{aligned}
-(&\mathrm{am}\left(2\left(\gamma^2-2\right)m^2+\left(\gamma^2-1\right)m\left(4n+\left(\gamma^2-4\right)v\right)+4\left(\gamma^2-1\right)^2 n\,v\right) \\
&\quad \left(2\left(\gamma^2-2\right)m^3-(\gamma-1)\,m^2\left(2(\gamma(\gamma(\gamma+2)-4)-6)\,n-(\gamma-2)(\gamma+2)^2 v\right)+\right. \\
&\qquad \left.2(\gamma-1)^2(\gamma+1)\,m\,n\,(((\gamma-2)\gamma-6)\,n-(\gamma-4)(\gamma+2)\,v)+4(\gamma-1)^3(\gamma+1)^2 n^2(n-2v)\right)+ \\
&\quad \gamma\left(2\left(\gamma^2-2\right)m^2+\left(\gamma^2-1\right)m\left(4n+\left(\gamma^2-4\right)v\right)+4\left(\gamma^2-1\right)^2 n\,v\right) \\
&\quad \left(\mathrm{an}\, n\left(2\left(\gamma^2-2\right)m^2-\left(\gamma^4-5\gamma^2+4\right)m\,(2n-v)-4\left(\gamma^2-1\right)^2 n\,(n-v)\right)-\right. \\
&\qquad \left.\mathrm{ca}\, v\left(m+\gamma^2(-n)+n\right)\left(\gamma^2(m+4n)-4(m+n)\right)\right)- \\
&\quad 2\,\mathrm{cb}\, v\left(\gamma^2(m+4n)-4(m+n)\right)\left(m+\gamma^2(-n)+n\right)\left(\left(\gamma^2-2\right)m^2-\left(\gamma^4-5\gamma^2+4\right)m\,(n-v)-2\left(\gamma^2-1\right)^2 n\,(n-2v)\right)\Big)\Big/ \\
&\left(-4\left(\gamma^2-2\right)^2 m^5+4\left(\gamma^2-2\right)m^4\left(\left(\gamma^4-8\gamma^2+8\right)n-\left(\gamma^4-6\gamma^2+8\right)v\right)+\right. \\
&\quad \left(\gamma^2-1\right)m^3\left(4\left(5\gamma^4-24\gamma^2+24\right)n^2+2\left(\gamma^2-2\right)\left(\gamma^4-22\gamma^2+56\right)n\,v+\left(\gamma^2-4\right)^3\left(-v^2\right)\right)+ \\
&\quad 4\left(\gamma^2-1\right)^2 m^2 n\left(8\left(\gamma^2-2\right)n^2+4\left(\gamma^4-10\gamma^2+18\right)n\,v-3\left(\gamma^2-4\right)^2 v^2\right)+ \\
&\quad \left.8\left(\gamma^2-1\right)^3 m\,n^2\left(2n^2+5\left(\gamma^2-4\right)n\,v-6\left(\gamma^2-4\right)v^2\right)+32\left(\gamma^2-1\right)^4 n^3 v\,(n-2v)\right)
\end{aligned}
$$

Quanity sold by firm 1 in market M (q_{1M})

$$
\begin{aligned}
&\Big(\text{am}\left(m^2\left(\gamma^2(v-2n)+4n-4v\right)+2\left(\gamma^2-1\right)mn\left(\gamma^2(n-v)-4n+6v\right)+4\left(\gamma^2-1\right)^2n^2(n-2v)\right)\\
&\quad\left(2\left(\gamma^2-2\right)m^2+(\gamma-1)m\left(4(\gamma+1)n+(\gamma-2)(\gamma+2)^2v\right)+4(\gamma-1)^2(\gamma+1)(\gamma+2)nv\right)+\\
&\quad \text{an}\,n\left(\gamma^4v(m+4n)+2\gamma^2(m+2n)(m-3v)-4(m+n)(m-2v)\right)\\
&\quad\left(2\left(\gamma^2-2\right)m^2-\left(\gamma^4-5\gamma^2+4\right)m(2n-v)-4\left(\gamma^2-1\right)^2n(n-v)\right)-\\
&\quad v\left(\gamma^2(m+4n)-4(m+n)\right)\left(\text{ca}\left(m+\gamma^2(-n)+n\right)\left(\gamma^4v(m+4n)+2\gamma^2(m+2n)(m-3v)-4(m+n)(m-2v)\right)+\right.\\
&\quad\quad\left.\gamma\,\text{cb}\left(m^2\left(\gamma^2(v-2n)+4n-4v\right)+2\left(\gamma^2-1\right)mn\left(\gamma^2(n-v)-4n+6v\right)+4\left(\gamma^2-1\right)^2n^2(n-2v)\right)\right)\Big)\Big/\\
&\Big(-4\left(\gamma^2-2\right)^2m^5+4\left(\gamma^2-2\right)m^4\left(\left(\gamma^4-8\gamma^2+8\right)n-\left(\gamma^4-6\gamma^2+8\right)v\right)+\\
&\quad\left(\gamma^2-1\right)m^3\left(4\left(5\gamma^4-24\gamma^2+24\right)n^2+2\left(\gamma^2-2\right)\left(\gamma^4-22\gamma^2+56\right)nv+\left(\gamma^2-4\right)^3\left(-v^2\right)\right)+\\
&\quad 4\left(\gamma^2-1\right)^2m^2n\left(8\left(\gamma^2-2\right)n^2+4\left(\gamma^4-10\gamma^2+18\right)nv-3\left(\gamma^2-4\right)^2v^2\right)+\\
&\quad 8\left(\gamma^2-1\right)^3mn^2\left(2n^2+5\left(\gamma^2-4\right)nv-6\left(\gamma^2-4\right)v^2\right)+32\left(\gamma^2-1\right)^4n^3v(n-2v)\Big)
\end{aligned}
$$

Quanity sold by firm 1 in market N (q_{1N})

$$
\begin{aligned}
&\Big(\text{am}\,m\left(2\left(\gamma^2-2\right)m^2-\left(\gamma^4-5\gamma^2+4\right)m(2n-v)-4\left(\gamma^2-1\right)^2n(n-v)\right)\\
&\quad\left(2\left(\gamma^2-2\right)m^2+(\gamma-1)m\left(4(\gamma+1)n+(\gamma-2)(\gamma+2)^2v\right)+4(\gamma-1)^2(\gamma+1)(\gamma+2)nv\right)+\\
&\quad 2\,\text{an}\,n\left(2\left(\gamma^2-2\right)m^2-\left(\gamma^4-5\gamma^2+4\right)m(2n-v)-4\left(\gamma^2-1\right)^2n(n-v)\right)\\
&\quad\left(\left(\gamma^2-2\right)m^2+\left(\gamma^2-1\right)m\left(2n+\left(\gamma^2-4\right)v\right)+4\left(\gamma^2-1\right)^2nv\right)+\\
&\quad v\left(\gamma^2(m+4n)-4(m+n)\right)\left(\gamma\,\text{cb}\,m\left(-2\left(\gamma^2-2\right)m^2+\left(\gamma^4-5\gamma^2+4\right)m(2n-v)+4\left(\gamma^2-1\right)^2n(n-v)\right)-\right.\\
&\quad\quad\left.2\,\text{ca}\left(m+\gamma^2(-n)+n\right)\left(\left(\gamma^2-2\right)m^2+\left(\gamma^2-1\right)m\left(2n+\left(\gamma^2-4\right)v\right)+4\left(\gamma^2-1\right)^2nv\right)\right)\Big)\Big/\\
&\Big(-4\left(\gamma^2-2\right)^2m^5+4\left(\gamma^2-2\right)m^4\left(\left(\gamma^4-8\gamma^2+8\right)n-\left(\gamma^4-6\gamma^2+8\right)v\right)+\\
&\quad\left(\gamma^2-1\right)m^3\left(4\left(5\gamma^4-24\gamma^2+24\right)n^2+2\left(\gamma^2-2\right)\left(\gamma^4-22\gamma^2+56\right)nv+\left(\gamma^2-4\right)^3\left(-v^2\right)\right)+\\
&\quad 4\left(\gamma^2-1\right)^2m^2n\left(8\left(\gamma^2-2\right)n^2+4\left(\gamma^4-10\gamma^2+18\right)nv-3\left(\gamma^2-4\right)^2v^2\right)+\\
&\quad 8\left(\gamma^2-1\right)^3mn^2\left(2n^2+5\left(\gamma^2-4\right)nv-6\left(\gamma^2-4\right)v^2\right)+32\left(\gamma^2-1\right)^4n^3v(n-2v)\Big)+\text{an}
\end{aligned}
$$

Quanity sold by firm 2 (q_2)

$$
\begin{aligned}
&\Big(v\left(\gamma^2(m+4n)-4(m+n)\right)\\
&\quad\Big(-\gamma^3\left(v\left(mn(-14\,\text{am}+5\,\text{an}+9\,\text{ca})+8n^2(-2\,\text{am}+\text{an}+\text{ca})+m^2(\text{ca}-\text{am})\right)+2n(\text{am}-\text{an})(m+n)(m+4n)\right)+\\
&\quad\quad\gamma^5n\left(2n(\text{am}-\text{an})(m+2n)-v(m+4n)(2\,\text{am}-\text{an}-\text{ca})\right)+\\
&\quad\quad 4\gamma(m+n)\left(v\left(-\text{am}(m+2n)+\text{an}\,n+\text{ca}(m+n)\right)+n(\text{am}-\text{an})(m+n)\right)+\\
&\quad\quad 2\gamma^2(\text{am}-\text{cb})(m+n)\left(m^2+m(5n-3v)+4n(n-2v)\right)-\\
&\quad\quad\gamma^4(\text{am}-\text{cb})(m+2n)\left(2n(m+n)-v(m+4n)\right)-4(\text{am}-\text{cb})(m+n)^2(m+n-2v)\Big)\Big)\Big/\\
&\Big(-4\left(\gamma^2-2\right)^2m^5+4\left(\gamma^2-2\right)m^4\left(\left(\gamma^4-8\gamma^2+8\right)n-\left(\gamma^4-6\gamma^2+8\right)v\right)+\\
&\quad\left(\gamma^2-1\right)m^3\left(4\left(5\gamma^4-24\gamma^2+24\right)n^2+2\left(\gamma^2-2\right)\left(\gamma^4-22\gamma^2+56\right)nv+\left(\gamma^2-4\right)^3\left(-v^2\right)\right)+\\
&\quad 4\left(\gamma^2-1\right)^2m^2n\left(8\left(\gamma^2-2\right)n^2+4\left(\gamma^4-10\gamma^2+18\right)nv-3\left(\gamma^2-4\right)^2v^2\right)+\\
&\quad 8\left(\gamma^2-1\right)^3mn^2\left(2n^2+5\left(\gamma^2-4\right)nv-6\left(\gamma^2-4\right)v^2\right)+32\left(\gamma^2-1\right)^4n^3v(n-2v)\Big)
\end{aligned}
$$

Optimal amount of cost reductions of firms 1 and 2:

x_1 if firm 1 competes with firm 2 in market M:

$$\begin{aligned}&\Big(-4\,\mathrm{am}\left(\gamma^2-2\right) m\left(2\left(\gamma^2-2\right) m+(\gamma-2)(\gamma-1)(\gamma+2)^2\, v\right)+\\&\quad\left(\gamma^2-4\right)\left(\mathrm{an}\, n\left(2\left(\gamma^2-2\right)^2 m+\left(\gamma^2-1\right)\left(\gamma^2-4\right)^2 v\right)+4\,\gamma\left(\gamma^2-2\right)\mathrm{cb}\, m\, v\right)+\\&\quad\mathrm{ca}\left(8\left(\gamma^2-2\right)^2 m^2-2\left(\gamma^2-2\right)^2\left(\gamma^2-4\right) m\,(n-2\,v)+\left(\gamma^2-1\right)\left(\gamma^2-4\right)^3(-n)\, v\right)\Big)\Big/\\&\left(8\left(\gamma^2-2\right)^2 m^2-2\left(\gamma^2-2\right)^2\left(\gamma^2-4\right) m\,(n-4\,v)+\left(\gamma^2-1\right)\left(\gamma^2-4\right)^3 v\,(-(n-2\,v))\right)\end{aligned}$$

x_1 when firm 2 exits market M in stage t_1 and firm 1 follows the status-quo strategy as a monopolist:

$$\frac{(-2\,a\,m+2\,cb\,m-a\,n\,\gamma+ca\,n\,\gamma)}{((n-2\,v)\,\gamma)}$$

x_2 in competitive area:

$$\begin{aligned}&-\Big(2\left(\gamma^2-2\right) m\left(\mathrm{am}\left(4\left(\gamma^2-2\right) m-(\gamma-2)(\gamma-1)(\gamma+2)^2(n-2\,v)\right)+\right.\\&\quad\left.\gamma\left(\gamma^2-4\right)(\mathrm{an}\, n-2\,\mathrm{ca}\, v)+\left(\gamma^2-2\right)\mathrm{cb}\left(\left(\gamma^2-4\right)(n-2\,v)-4\,m\right)\right)\Big)\Big/\\&\left(8\left(\gamma^2-2\right)^2 m^2-2\left(\gamma^2-2\right)^2\left(\gamma^2-4\right) m\,(n-4\,v)+\left(\gamma^2-1\right)\left(\gamma^2-4\right)^3 v\,(-(n-2\,v))\right)\end{aligned}$$

Appendix C

Status-quo strategy or one-product strategy?

The table below demonstrates under which circumstances firm 12 rather chooses status-quo strategy instead of the one-product strategy.

Comp. Mode / Parameter	Firm 12 chooses status-quo strategy over one-product strategy
γ	↑
ν	$\downarrow \rightarrow \frac{n(+m)}{2}$ †
a_M	↓
a_N	↑
c_1 - c_2	$c_1 < c_2$ not NC
m	↑
n	↑

†: ν should be as low as possible, however the condition $\nu > \frac{n(+m)}{2}$ should not be violated.

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Chapter 6

Curriculum Vitae

Der Lebenslauf wurde aus der elektronischen Version der Arbeit entfernt.

The curriculum vitae was removed from the electronic version of the paper.

Presentations in Conferences and Participations in PhD Courses

09.2013	(Forthcoming) 40th Annual Conference of the European Association for Research in Industrial Economics (EARIE), Universidade de Évora
09.2012	39th Annual Conference of the European Association for Research in Industrial Economics (EARIE), Università degli Studi di Roma Tor Vergata and Libera Università Internazionale degli Studi Sociali Guido Carli di Roma
09.2010	37th Annual Conference of the European Association for Research in Industrial Economics (EARIE), Sabanci University Istanbul
07.2010	Zvi Griliches Research Summer School in the Economics of Innovation; Universitat Autònoma de Barcelona
06.2010	International Conference of the European Network on Industrial Policy; Universitat Rovira i Virgili
05.2010	Competition and Innovation Summer School; ZEW Mannheim, K.U.Leuven and COST/STRIKE network
05.2010	Third PhD Conference in Economics; University of Athens
05.2010	Swiss IO Day; University of Bern
01.2010	Workshop "Lectures on Cartels"; University of Giessen Prof. Joseph Harrington (Johns Hopkins University in Baltimore, USA)
12.2009	4th Doctoral Workshop, Economic Behavior and Interaction Models (EBIM); University of Bielefeld
11.2009	PhD course "Topics in Industrial Organization"; University of Giessen
10.2009	PhD course "Game Theory"; University of Marburg
06.2009	Second Dolomites Summer School on Antitrust for Networks, Focus on Vertical Restraints; University of Verona
01.2009	PhD course "Empirical Industrial Organization"; University of Frankfurt
11.2008	PhD course "Industrial Economics"; University of Giessen
08.2008	MAGKS Seminar; Rauischholzhausen
05.2008	PhD course "Mathematica"; University of Giessen
03.2008	PhD course "Intellectual property rights"; University of Marburg

Working Papers

- “Research and Development in Vertically Related Markets”
- “Profitable Entry into an Unprofitable Market”
- “Consumer-Welfare-Enhancing Merger to Monopoly”

Publications

09/2012 „Has socialism failed in Cuba?“, Tejarat Farda, 2012/41 (in Persian)

Languages

German	Native
Farsi	Native
English	Fluent
French	Intermediate
Spanish	Intermediate
Portuguese	Basic knowledge

Bonn, August 2013

Chapter 7

Affidavit

Affidavit

Ich erkläre hiermit, dass ich die vorgelegten und nachfolgend aufgelisteten Aufsätze selbständig und nur mit den Hilfen angefertigt habe, die im jeweiligen Aufsatz angegeben oder zusätzlich in der nachfolgenden Liste angeführt sind. In der Zusammenarbeit mit den angeführten Koautoren war ich mindestens anteilig beteiligt. Bei den von mir durchgeführten und in den Aufsätzen erwähnten Untersuchungen habe ich die Grundsätze guter wissenschaftlicher Praxis, wie sie in der Satzung der Justus-Liebig-Universität Giessen zur Sicherung guter wissenschaftlicher Praxis niedergelegt sind, eingehalten.

Ahmad Reza Saboori Memar

Bonn,