Three Essays in Applied Industrial Organization

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To my parents and siblings,
for 27 years of loving atmosphere, patience and support.

To Michela and Sarah,
for everything that makes life meaningful.

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Preface

"*Understanding the details of demand and knowing how they fit into the system are very important.*"

[Prof. Ariel Pakes, Harvard, in *The Harvard University Gazette* (January 27th, 2000)]

This thesis consists of three essays in industrial organization. Reading the titles of these essays one is tempted to conclude that this sentence already exhausts the similarities between them. Indeed it is difficult to see an integrative topic behind three completely different subjects such as the regulation of the hospital market, non-informative advertising and smoking bans in bars. In terms of content, I confess, this is true. There is, however, another more subliminal concept of economics standing behind these three papers, a philosophy that the quote by Ariel Pakes hints at: When we, as economists, want to make recommendations for real world problems, we have to study the details of the respective industry, because these details can matter a lot. In particular, a general economic concept may work in theory and it may even work in a number of industries, but in some other industries it may fail. An example of this can be found in Chapter 1 of this dissertation. Yardstick competition may be a good concept in the electricity industry, but it is not such a good idea in the hospital market. Therefore, the ultimate step in economic theorizing must be the study of specific market environments. This is what I do in this thesis. I use industrial economics to analyze three very specific questions that are currently controversially debated in Germany: First, the reform of hospital regulation. Second, the question whether the legislation should enact a general smoking ban. Third, whether advertising may induce our society to consume excessively.

Chapter 1 of this thesis is concerned with the regulation of the hospital sector. It is obvious that hospitals are extremely important for the well-being of the population. What is less known is that this sector is also of great economic significance. In Germany, there are 3.634 hospitals and Reha-Centers containing 749.473 beds and employing 1.2 million people. The expenditures for hospital care amount to 85 billion Euros.[1] It is obviously of fundamental importance for a nation and its economy that its hospitals provide high quality of care, but also work efficiently.

This, however, is not so easy to achieve, because the hospital sector is very different from other sectors. In most industries the market has proven to be the most efficient form of organization. Supply and demand are matched via a price that fluctuates freely and contains all (or at least most of) the relevant information. In the hospital industry, however, market mechanisms are widely absent. While there are a number of reasons for this, the most important one is that a price mechanism is very difficult to implement. "Consumers" of hospital care don't pay prices to hospitals. Due to the big risks involved in health care, they rather pay fees to insurances and can then choose freely among hospitals. For hospital services a market in which the price matches supply and demand is therefore absent. What is more, the third-party payer principle implies a moral hazard problem on the demand side. Since a patient does not bear directly the costs of treatment he is tempted to demand the highest quality and quantity of service convenient to him. As pointed out in the medical arm's race literature (see e.g. Robinson and Luft (1985)), it is therefore quality that is the salient competitive factor, and the market is prone to excess demand and supply.

These imperfections of the market call for governmental intervention, and, indeed, the hospital sector is one of the most extensively regulated sectors in an economy. It deals with market entry (both by hospitals and by physicians), product offering (not every hospital and doctor can offer all services) and pricing. Of special interest in this dissertation is the last point, the pricing.

As mentioned above, hospitals are typically not paid by their patients directly, but by insurance companies. The way these payments are made is regulated by the government. Until the year 2000, German insurances and

[1] Data for the year 2000. Source: Bundesministerium für Gesundheit (2000).

regulators had used a cost-of-service regulation (CoSR) to finance the hospitals. Practically, this meant that hospitals simply got reimbursed all their (reasonable) costs. The advantages of this system were that the regulator did not need much information other than cost reports and a rough assessment whether those reports were correct. Furthermore, quality of care was quite high, because doctors had no financial loss from providing high quality. The disadvantage of such a system was, though, that it lacked incentives for the hospitals to minimize costs.

In response to tightening budget constraints in the 1990s, German politicians and insurers were therefore eager to do something about the costs. In 2000, the Bundestag passed a set of laws to reform the health care system. This reform included a change of the hospital regulation. In essence, this change consisted of a switch from the cost-of-service regulation to a prospective payment system (PPS). In a PPS, a patient is assigned according to his diagnosis into a certain group (diagnosis related group = DRG). The hospital then receives a predetermined amount of money ("price" as we will say henceforth) for the treatment of this patient. The advantage of this regulatory scheme is that it sets incentives to minimize costs, because it makes the hospital the residual claimant of profits. Whether this theoretic prediction holds what it promises and whether quality of care does not suffer, is, however, an open question. The experiences are mixed.

Prospective payment systems as part of hospital regulation were first introduced in the U.S. in the early 1980s. Since then, there has been a lot of effort to assess the effectiveness of PPS. Empirical research, however, faces significant problems in the field of hospital care, mostly because data on the key parameters (cost reduction efforts and quality of care) are typically not available. Consequently, econometricians have to improvise a lot and use very crude indirect measures such as length of stay for cost reduction effort and mortality rates for quality.[2] Unsurprisingly, the results are therefore mixed. Some estimates indicate increases in efficiency and/or quality, others the opposite. Unfortunately, research for other countries is scarce and faces even more serious data problems. Especially in Germany reliable databases on quality

[2] For a more detailed description of the obstacles in emprical research on hospitals and the means to overcome them see e.g. Chalkley and Malcomson (2000) and Romano and Mutter (2004).

in hospitals are scarce. But anecdotal evidence about decline in quality in hospitals is abundant. Since the introduction of the reform, the German news agenda is full of nation-wide strikes of hospital employees, decreased care intensity, rejection of patients and bankruptcies of rural area hospitals. While patients experience treatment by overworked doctors and nurses, the graduates from medical schools wonder whether they should really start a career in which they have to work 70 hours per week plus some nights and the weekend on on-call duty for less than 2000 Euros per month. They can earn twice the amount in e.g. Great Britain for less work or leave the profession for a lucrative job in the pharmaceutical industry. Consequently, thousands of vacancies at hospitals cannot be filled. Overall, the experiences with PPS in the real world are mixed, at best, and certainly justify a closer look at the theory. Is PPS a suitable alternative for the regulation of hospitals, at all? Or does practical regulation only deviate too much from theoretic suggestions?

Since the early 1980s there has been an ongoing discussion among health economists whether a PPS performs better than CoSR or not or whether a mixed system is superior. A basic problem of PPS in the hospital sector is that prices cannot be made contingent on quality of service, because quality is typically unverifiable by regulators. The reason lies in the complexity of the "product", i.e. the way health outcomes are produced. Consequently, it did not take long until Ellis and McGuire (1986) pointed out that quality of care could suffer under a PPS, because PPS makes profits independent of quality. If quality is only costly but does not yield any benefits, a profit oriented hospital will set quality to zero. This argument was critized by Pope (1989) who pointed out that hospital demand (and therewith also profits) depends at least to some extent on quality. Although quality may not be directly verifiable by the regulator, word of mouth recommendations will always drive patients away from hospitals with low quality. Competition will therefore force a hospital to provide high quality. This optimistic view of PPS was advanced by Ma (1994) who used a multitask agent model to show that PPS can in principle even induce first best provision of quality and cost reduction effort.

Here is where my dissertation picks up. In Ma's model the price a hospital receives is crucial. To compute the right price, a regulator needs to have a lot of information on the hospital, in particular its cost function. But in the real world this is typically not the case. Regulators have little knowledge about hospital cost functions. Consequently, they typically prove inapt to determine the optimal price and have to rely on other methods for price-setting. The tool that is recommended by the literature and that regulators usually use is called "yardstick competition". The logic of yardstick competition is best and most prominently described by Shleifer (1985). If the regulator has no knowledge about a firm's cost function, but can observe only its cost level, he can use other, comparable firms' cost levels as reference points for pricing that respective firm. Shleifer demonstrates that corresponding marginal cost pricing yields first best outcomes and correctly adapted average cost pricing at least second best production.

It is very important to note, however, that the rather general setting Shleifer uses is incapable of capturing the many ways in which the hospital sector differs from other sectors, as described at the beginning of this preface. In particular, in Shleifer's model demand depends on price and quality does not play any role. In line with Ariel Pakes' citation above, these details may, however, matter a lot. *It is the purpose of the first chapter of my dissertation to fill this gap in the literature.* Hence, Chapter 1 analyses what happens if yardstick competition a la Shleifer (1985) is applied in the specific environment of the hospital sector as described by Ma (1994). I show that Shleifer's results do not persist. Hospitals will respond to this sort of pricing by decreasing quality of care to zero. In this sense, my dissertation predicts that properly applied yardstick competition regulation of hospitals results in serious distortions in the supply of hospital care.

The scientific contribution that Chapter 1 of my dissertation makes is to link two strands of literature, namely the health economics literature on prospective payment systems together with the regulation literature on yardstick competition. Chapter 1 advances the understanding of what prospective payment systems can realistically achieve in the regulation of the hospital sector.

The policy recommendation of Chapter 1 is to reconsider the use of prospective payment systems as the main tool for financing hospitals. If we use PPS, we need to think extensively about how we set the prices and about how we monitor the quality of service.

Chapter 2 addresses another controversially debated regulation issue. In Germany there are around 240.000 restaurants, cafés, bars, etc. In only about 800 of them smoking is prohibited.[3] This makes a ratio of 0.3%. In contrast to this, 76% of Germans (or 54 million) are non-smokers.[4] Furthermore, according to a survey by the Allensbach Institute, 47% of Germans support a general smoking ban in taverns, while only 41% are against it.[5] Although there are various ways these numbers can be interpreted, they strongly suggest that there is some sort of market failure. If so, governmental intervention in the form of a general smoking ban in taverns is desirable, just as it has been (partially) introduced in numerous other countries like the U.S., Italy, Ireland, Spain, etc.

Despite these numbers, the strongest argument put forward by opponents of smoking bans is that the free market solves the question itself. If it were in the interest of consumers, they say, tavern owners would prohibit smoking in their domain and benefit from the increased demand.

It is the aim of Chapter 2 to analyze whether this argument is valid. Is it true that profit maximizing tavern owners have an interest to act in their consumers' interest? Do profit maximization and welfare maximization always lead to identical results with respect to smoking bans?

In the economic literature this question has received little attention, although a general smoking ban (and its omission alike) affects the lives of millions of people every day and has enormous health as well as economic consequences. Only a very small number of papers (mostly funded by the Philip Morris Management Corporation) analyzes the question whether or not smoking bans in taverns are beneficial or not. All of these papers are either empirical (e.g. Dunham and Marlow (2000, 2003 and 2004) or purely verbal (e.g. Lee (1991) and Tollison and Wagner (1992)). Section 2.2 gives an exhaustive and detailed literature overview. Here it suffices to understand the basic hypothesis that all of the cited papers share.

It is widely acknowledged that smoking produces negative externalities.

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[3] These numbers are taken from the article "Freiwillige Verpflichtungen wirken nicht" (*Frankfurter Allgemeine Sonntagszeitung*, August 20th, 2006) by Michael Krzyanowski, unit head of the German office of the World Health Organization.

[4] People who smoke daily in percentage of people 15 years or older. Source: Organisation for Economic Co-operation and Development (2005).

[5] Source: Institut für Demoskopie Allensbach Gesellschaft zum Studium der öffentlichen Meinung mbH, IfD Umfrage 7091, July 2006.

When a smoker smokes, people around him suffer from bad air and adverse health effects.[6] On the other side, smokers obviously have some utility from smoking. In principle, this is therefore a classic social cost problem a la Coase (1960). Unfortunately, the Coase Theorem does not apply, at least not directly, because transaction costs are prohibitively high. The authors cited above, however, claim that the Coase Theorem applies somewhat indirectly. The reason is that the theorem requires only two conditions, both of which are fulfilled in the gastronomic market, they say. First, property rights must be clearly assigned. This is the case, because the owner of a bar also owns the air space in his bar. He can do with it what he wants. Second, transaction costs must be zero. This requirement is also met, the authors argue, because the owner of the bar acts as an intermediary between his guests. He internalizes the negative externalities caused by the smokers and allocates air space accordingly. If it is in his consumers' interest to prohibit smoking, he would do so. None of the cited papers is, however, able to verify this hypothesis in a convincing manner.

To the best of my knowledge there exists no stringent mircoeconomic model to clarify that the above hypothesis is correct. *It is the aim of Chapter 2 of this dissertation to fill this gap.* I do so by setting up a model of two bars, one seated at one end of a Hotelling line, the other seated at the other end. They compete via prices for two kinds of consumers, both uniformly distributed in the space between the two bars. The first sort of consumers is of the non-smoker type and is of mass N_{ns}. The other is of the smoker type and is of mass N_s. While the first group suffers negative externalities from smoke and the second group enjoys utility from being allowed to smoke, both appreciate the presence of other customers in the form of positive network externalities. It is important to note that also the negative externalities have a network character. The reason is that the smoke one smoker produces spreads evenly in the air space and causes negative externalities for every non-smoker in the bar.

I then calculate three cases. First, both pubs allow smoking. Second, both pubs ban smoking (either voluntarily or forced by law). Third, one pub pro-

[6] For a study on the danger of passive smoking see e.g. Deutsches Krebsforschungszentrum, Heidelberg (2005).

hibits smoking unilaterally. I then compare the profits realized by the non-smoker pub in the third case with the profits it would make had it not prohibited smoking, i.e. the profits in the first case. The resulting inequality is compared to the condition that determines that welfare in the second case (general ban of smoking) is larger than in the first (no ban). I show that they do not exclude each other. I conclude from this that it is possible that bars do not ban smoking in their domain, even though it is in the public's interest. The reason for this result lies in the network character of the negative externalities caused by smoking. Negative network externalities soften competition. This is why it is in the interest of pubs to allow smoking in their domain. We see again the validity of Pakes' quote confirmed here. The details of demand matter and can generate counter-intuitive outcomes.

The scientific contribution of this chapter is to provide the first microeconomic model to answer the question whether general smoking bans in taverns are a legitimate governmental intervention in the market or not.

The policy recommendation that follows from this chapter is that a general smoking ban may very well be welfare increasing. The German government should support further research in this field to assess whether market failure is indeed present or not.

Chapter 3 is concerned with microeconomic modelling of advertising, its effect on consumer's behavior and on welfare. This is an interesting topic, because, on the one side, the seductive character of advertising raises a lot of scepticism about its welfare effect. On the other side, advertising is so omnipresent and such a big economic factor that it is hard to ignore. We encounter advertisements everywhere in our lives. In the morning, when we listen to the radio, the flyers we find in our mailbox when we get the newspaper, the ads in the newspaper itself. On the way to work we pass advertising pillars, huge screens and posters installed on house facades and roofs, posters at the buss stop or in the underground trains. At work, we receive spam mail when we open our email accounts and have to click away pop-up advertising when we open websites. In the evening we are confronted with commercial spots in TV or in the cinema. Advertising spending in U.S., only, amounts to $143.3

billion.[7]

Some of this advertising contains useful information like prices and locations of vendors. It thereby reduces frictions in the economy and is, thus, beneficial for the consumer and the economy as whole. Chamberlin (1933) acknowledged this early on and Ozga (1960), Stigler (1961) and Telser (1964) formalized his verbal argumentation into a formal theory of informative advertising.

The bulk of advertising, however, does not contain this sort of explicit information. The prime example for this kind of advertising are probably TV commercial spots. In them we usually see some person consuming some good. We do not receive any information that goes beyond the pure existence of the good, some information on its basic characteristics (at the level of "This is a car. It can drive.") and the suggestion that its consumption yields pleasure. While the informative view of advertising can also be applied on this sort of advertising, it does not seem to capture the whole story, not all effects that this *non-informative* advertising can have. Consequently, researchers have developed other explanations of the cognitive and psychological processes associated with non-informative advertising.

Some of these economists express the suspicion that advertising can have a persuasive character and alter the consumer's tastes and wants. Also this is acknowledged by Chamberlin (1933). He captures this effect by assuming that advertising shifts the demand curve outward. Subsequent research by e.g. Robinson (1933), Kaldor (1950), Galbraith (1958) Commanor and Wilson (1967) elaborates on this. Unfortunately, however, these studies typically lack microeconomic modelling of consumer's behavior. The reason for this - and at the same time the main criticism - is that this theory implies a change of the consumer's preference ordering. This, however, is a violation of the basic microeconomic assumption of rationality. Furthermore, without a stringent theory on how advertising affects people's consumption decision, welfare analysis is impossible, or at least incomplete. Thus, although the "persuasive view" yields some key insights, it is insufficient in explaining how people react to non-informative advertising.

Nelson (1970, 1974) offers another theory. He claims that only those firms

[7]Number for 2005, according to TNS Media Intelligence (2006).

advertise who produce high quality. His argument is the following. Most goods are experience goods, the real quality of which can only be judged by consuming them. Additionally, most goods are substituted by a new version after a while (due to e.g. decay of quality and functionality). Thus, people will get to a situation in which they have to repurchase a good and then they will buy from the same brand only if they were content with the old version. Hence, a seller of high quality products gains more from selling to a person than a producer of low quality. Consequently, he can more easily afford to push sales by advertisement. Unfortunately, Nelson does not provide a formal analysis of his reasoning. Subsequent researchers, as for example Schmalensee (1978), do so and raise doubts on the validity of Nelson's line of argument. A producer of low quality, for instance, is likely to have low costs and will therefore also gain considerably from demand expansion.

Yet another view is taken by Becker and Murphy (1993). They assume that a good and its advertisement are complements. Consequently, as advertisement increases, so does the marginal utility of the good itself and therewith also the demand for it. The authors advertise their model as one allowing for normative welfare analysis and for being able to explain demand increasing effects of advertising without violating the rationality assumption. On the other side, their approach exhibits some awkward features. First, their explanation for why advertising shall be a complement is somewhat blurry. It seems intuitive to assume that advertising raises the social prestige associated with the respective good. But this matters only, if peers watch the advertising. One's own consumption of this publicity seems rather irrelevant. Second, complementarity also works the other way around. That is, the more I consume a good, the more I enjoy consuming the commercial for it - which appears counter-intuitive as the authors admit themselves.

I conclude from this little overview of the literature that the theory on advertising is still somewhat incomplete and leaves open a number of questions. *Chapter 3 of my dissertation addresses these issues and offers another (in parts complementary) theory of non-informative advertising.* It consists of two elements. First, I assume that people usually make their consumption decisions in a social environment. I model this feature with an adjusted version of the theory of inequity aversion. Second, I argue that advertising can be seen as a tool to change people's reference groups. The model fulfills all the requirements desired from a theory of advertising: It explains why advertising can increase demand; allows for the analysis of welfare as well as competition issues; and can capture utility increasing as well as utility decreasing effects. In particular, it is explained why and when what sort of advertising increases demand by which people and for which good. It is shown that the welfare effect can be positive as well as negative and gives conditions for when either is the case. The same is done for the impact on utility, which can also be positive or negative.

In essence, my theory of non-informative advertising is the mathematical, microeconomic formulation of a suspicion that has already been expressed verbally by other authors. In his 2004 article Samuelson gives an evolutionary explanation for why most people's preferences exhibit relative consumption effects. In the conclusion of his paper he contends that "The development of modern advertising and mass communications may accentuate the visibility of high consumption effects." (p. 110), which is exactly what I mean by the second element of my theory. Similarly, also Becker and Murphy (1993) themselves admit that "To be sure, consumers may respond to the social and psychological pressures generated by advertisements." (p. 942).

Frank (1999) wrote a whole book on issues like conspicuous consumption, social preferences and alike. In his chapter on advertising related issues he states that "[...] most of us are surprised to discover how strongly our choices and evaluations are influenced by information that we happen to have readily at hand." (p. 176) He then refers to Kahnemann, Slovic and Tversky's (1982) famous experience. Kahnemann et al. asked test persons to spin a wheel on which numbers from 1 to 100 were written. After the wheel stopped and one number was displayed, they asked the individuals to estimate the percentage of African states that were member of the U.N. The result was that people's answers were significantly correlated with the number displayed on the wheel. This example demonstrates that subconsciously people can be influenced by obviously irrelevant information. With respect to advertising this implies: "Because the things we see most often are most readily available in memory, they tend to have disproportionate influence on our spending decisions." (Frank, p. 177).

In this sense, the scientific contribution of Chapter 3 is twofold. First, I provide a model of advertising that can explain how advertising can increase demand and why it can be utility decreasing or increasing as well as allows for standard welfare analysis and the study of competitive effects. Second, the model constitutes the microeconomic formulation of the suspicion that advertising spurs consumption by pushing social comparisons and envy effects. In this context, a somewhat surprising result of my paper is that this very negative view of advertising does not necessarily imply welfare losses. The reasons are that, on the one hand, due to price being larger than costs, consumption may be too low in the outset, and, on the other hand, that in this consumption game also producers of lower quality goods advertise, thereby keeping the system in balance.

Chapter 1

Yardstick Competition when Quality is Endogenous

1.1 Introduction

Until recently, hospitals in most countries have been financed by a cost-of-service regulation (CoSR[1]) scheme, i.e. they were simply reimbursed all their costs. The problem with this type of regulatory policy is that it lacks incentives to control expenditures. In reaction to rising health care costs an increasing number of countries therefore changes the regulation of their hospital markets. The main component of this change is typically a switch from CoSR to a prospective payment system (PPS). In a PPS illnesses are categorized according to their diagnosis into about 500 different groups (diagnosis related group = DRG). A hospital gets the same pre-determined price per patient in a specific group. The basic logic of this system is simple: Giving it a fixed price for a patient, it is then the hospital who bears the costs of treatment. This will motivate the hospital to minimize costs.

Experience in practice, however, renders the view of PPS less positive than had been hoped. In Germany, for example, already the partial introduction of PPS has had a number of undesirable or at least questionable effects. The most prominent of those are overworked doctors and nurses, nation wide strikes, emigration of qualified personal to other European countries, decreased care intensity, rejection of patients, and bankruptcies of rural area hospitals.[2]

This emphasizes that costs are only one dimension of a hospital's activity. The second dimension is quality of care. As a matter of fact, there is hardly any other product in which quality is so important for the customer as in health care. Consequently, there has been a lot of concern whether a PPS may not also have negative effects on the quality provision. Ever since a PPS was first introduced in the U.S. in the early eighties, this issue has received considerable attention in the literature. Ellis and McGuire (1986) were the first to point out the basic problem of a PPS: If quality is costly, a fixed price gives incentives to reduce quality. The major counterargument is brought up by

[1] We use the abbreviation CoSR instead of the commonly used FFS (fee for service), because we experienced some confusion in discussions when using FFS. The reason seems to be that "fee" sounds more like a pricing mechanism than like cost reimbursement.

[2] Especially the last two points cause increasing grief, because they imply that patients have to travel longer distances for treatment. Since these transport costs do not only consist of fuel and time consumption but also of risk of accidents and worsening of health condition due to delayed treatment, they are estimated to have a significant negative effect on a patient's utility. See e.g. Ho (2005) for details.

Pope (1989). He argues that since patients do not pay for treatment directly, hospital demand depends mostly on quality. Consequently, hospitals have an interest in retaining high reputation in order to attract patients. This could set incentives strong enough to provide high quality. As a matter of fact, Ma (1994) demonstrates in a multitask agent model that PPS may even achieve the first best allocation in cost as well as in quality effort - if prices are set correctly.

This last "if" is, however, crucial. None of the relevant papers discusses the regulator's ability to set prices correctly. In particular, Ma states conditions that prices must fulfill, but implicitly assumes the regulator to have perfect information on each hospital and its market environment. Most critically, he needs to know the hospital's cost function.

This, however, is far from reality and causes serious problems for regulators in practice. They usually do not know hospitals' cost functions. Consequently they are unable to determine first best inducing prices. Instead, they have to rely on other price mechanisms. Unfortunately, the literature of health economics is of little use in this quest and points to regulatory economics, namely Shleifer's (1985) yardstick competition. This is a method for regulating firms whose costs functions are unknown to the regulator, but whose cost levels are observable. The main goal of this regulation is to make it impossible for the regulated firm to influence its own price. This is done by reimbursing the regulated firm with a price that reflects the costs of an identical twin of this firm. Thereby the regulator can induce an indirect competition between the regulated company and it's yardstick. The Nash equilibrium can result in first best outcomes.

In the light of the discussion on hospital regulation, Shleifer's (1985) paper has some important shortcomings, though, because it neglects some key features of the hospital market. First, Shleifer does not incorporate endogenous quality of care. Second, unlike the customers in Shleifer's model, patients do not pay prices for medical treatment.

This is where my paper picks up. I link together the two strands of literature, the health economics side and the regulatory economics side, by merging the two decisive papers in the respective fields, namely Ma's (1994) multitask agent model and Shleifer's (1985) yardstick competition. Specifically, I take

Ma's multitask agent model, specify the regulator's information set the way this is typically done in the discussion among practitioners, and then apply the yardstick competition regulation rule. The aim is to see whether yardstick competition is really applicable in the specific hospital sector.

I find that Shleifer's results do not persist in this environment. In particular, hospitals will set quality equal to zero in response to pricing a la Shleifer. The intuition for this result is the following. Since the demand response to quality is the only incentive for hospitals to provide high quality, hospitals need to receive positive mark-ups per patient. In the Nash equilibrium of the indirect competition induced by a yardstick regulation, the mark-ups are, however, zero. It turns out that a simpler version of yardstick competition performs better, though not perfectly.[3]

The chapter is organized as follows. Section 1.2 summarizes the related literature other than Ma (1994) and Shleifer (1985). Section 1.3 introduces the model's basics. Section 1.4 briefly summarizes Ma's model, but draws a different conclusion than Ma, namely that under the restrictions of the regulator's information set it is a very difficult task to determine optimal prices. Section 1.5 reviews Shleifer's model in its original form. Section 1.6 is the main part of this paper. It introduces quality into yardstick competition. In response to the results, section 1.7 proposes a simpler and more favorable pricing rule. The paper then concludes with section 1.8.

1.2 Related Literature

1.2.1 Theoretic Literature

In the health economics literature most papers ignore the restrictions of the regulator's information set and his difficulties to determine prices. Instead, authors concentrate more on the question whether a fixed price per patient

[3] To the best of my knowledge there exists only one other paper, Tangeras (2002), that discusses yardstick competiton when quality matters. This sentence, however, already exhausts the similiarties to my paper. The reason is that Tangeras defines yardstick competition in a much broader sense and asks a more general question, namely whether it is useful to use other firms' reports on cost functions to evaluate whether the cost function that the regulated firm i reports is reasonable. Since this is also done under CoSR, Tangeras' results do not help in answering the more specific question we are dealing with in this paper.

generally leads to too low quality provision within a DRG. In addition to Ma and Shleifer, the following authors have contributed especially valuable insights to the discussion on PPS:

The quality issue was first considered by Ellis and McGuire (1986). They argue that as prices in the PPS are fix, it is profitable for hospitals to reduce quality of treatment if quality is costly. This result is formally derived in a model where each patient is locked-in to his physician. They suggest that a mixed reimbursement system (fixed price component and a cost based variable component) is superior to pure PPS. Ellis and McGuire assume efficient production as well as patient homogeneity, and do not model competition, or hospital heterogeneity.

In contrast to this, Pope (1989) offers a model of competition under a PPS, where identical hospitals choose quality and degree of managerial slack. In the symmetric Cournot equilibrium, competition (in quantity, by setting quality) does not only reduce managerial slack (i.e. increase efficiency), but also increases quality. The intuition is that expanding quantity by increasing quality is profitable. Pope concludes that a mixed reimbursement system may be better in situations where there is little competition. When competition is very strong, quality may be excessive. This can, however, be mitigated by reducing the price. His equilibrium concept requires complete symmetry of the firms. He does not analyze the price setting.

Dranove (1987) is the first to distinguish severity of cases within a DRG. He points out that there may be efficiency effects due to specialization. These effects may be positive as well as negative. He considers two types of hospitals in a given DRG - an efficient type and an inefficient type. Furthermore, he assumes that patients within a DRG vary in the costs they cause. At given price, inefficient hospitals may stop treating patients, while efficient ones continue to treat - an efficiency enhancing specialization. If hospitals can forecast the costs a specific patient will cause, they may engage in dumping (treat the relatively cheap patients and turn down the costly ones) - an efficiency decreasing specialization. Dranove does not take into account quality of treatment and competition among hospitals.

Ellis (1998) points out that the degree of competition for patients within one DRG may be ambiguous when travel costs are present (horizontal differentiation) and patients' severity of illness varies (vertical differentiation). In this case, low severity patients are those who are (relatively) unwilling to travel great distances. Each hospital is then a local monopolist for low severity patients. Since under PPS hospitals receive a fixed price for this DRG and since low severity patients offer a greater margin, hospitals will generally oversupply services (creaming) in order to extend demand. High severity patients on the other side are willing to travel great distances. Hospitals are therefore automatically competitors for those. Since high severity patients are, however, less profitable, hospitals will try to not treat ("dump") or at least underprovide services for them ("skimp"). Since no reimbursement system is able to take travel costs and differences in severity of illness for each single patient into account (due too informational and complexity problems), no regulation scheme can hope to achieve neither first nor second best outcomes. Ellis argues that a mixed reimbursement system may nevertheless be superior to both, a pure cost-of-service system and a pure PPS, for the same reasons as stated in Ellis and McGuire (1986). Ellis assumes efficient production and complete symmetry of hospitals.

1.2.2 Empirical Literature

The empirical literature is vast, has to fight with serious structural problems, and delivers mixed results. The biggest obstacle for empirical researchers is that the key variables (cost reduction efforts, quality of care and hospital cost functions) in hospital markets are unobservable. The lack of observations and the corresponding reliance on imperfect proxies of the important factors make econometric research in this field a very difficult task and vulnerable to an infinity of objections. The incomplete list of contributions reported here is mainly drawn from Chalkley and Malcomson (2000).

Among the pioneers in assessing the cost saving effects of a switch from CoSR to PPS are Freiman et al. (1989), Frank and Lave (1989), Newhouse and Byrne (1988) and Ellis and McGuire (1996). They report that the length of stay in hospitals (the most commonly used proxy for resource usage) declines in response to a change to PPS. Among the many criticisms of this proxy, the most severe one is that length of stay is influenced by large number of factors. This is demonstrated by e.g. DesHarnais et al. (1987) and Miller and Sulvetta

(1995), the latter attributing 69 % of costs to exogenous factors.

The quality effects of a switch in regulation has recently received increasing attention, but suffers a lot from the lack of reliable, objective quality measurements. The most frequently used variable are mortality rates. This is a very crude and relatively inelastic measure of quality, because only a small number of patients is so severely ill that a low quality of care will cause them to die. Even among those patients the results are mixed, though. DesHarnais et al. (1987, 1990) find no change in mortality rates in reaction to a change to PPS. Cutler (1995), on the other side, observes no change in the overall rate, but in the timing of mortality. An alternative measure for quality are treatment numbers. The results by Hodgkin and McGuire (1994) indicate a decline in treatment numbers. This could be due to dumping of costly patients, transfer of patients to non-PPS institutions or reduced quality. Another study by Ellis and McGuire (1996) provides evidence that 40% of reduction in length of stay is due to reduced care intensity, while 60% is due to other aspects of quality or effort.

1.3 The Model Primitives

To simplify matters, I will consider hospitals that produce only one DRG (one-product firm). Furthermore, I assume patients to be homogenous.

1.3.1 Costs

Since the regulator is interested in a long-term regulation scheme, I will proceed in my analysis by considering the long-run cost curves of hospitals. In the long-run, all treatment costs are variable costs that depend on the quality of treatment q and on cost reducing efforts e. Additionally, there will be some costs of quality-increasing and cost-reducing efforts, $E(e,q)$. The interpretation of the variables is the following: The quality of treatment q consists of intensity of care, qualification of the doctors and nurses, available technical equipment, effectiveness of medication, etc. Cost reducing effort e is mainly organizational effort that incorporates effort to optimize the length of a patient's stay in hospital, setting incentives to use the cheapest medication for given quality, design of efficient wages for employees, monitoring of employees, organization of work flows, etc. Marginal costs $c(q, e)$ are all observable long-run marginal costs of running a hospital, i.e. mainly wages, expenditures for technical equipment, maintenance costs of buildings, payments for electricity and water, etc. $E(e, q)$ are those costs of the residual claimant of profits (chief doctor, administration, local municipality, management, shareholders of private hospital) that he bears for e.g. designing incentive compatible wage contracts for the employees, monitoring the employees, organization (duration of stay of patients, ...), optimizing the work flow in the hospital, etc. We will make the following assumptions on the cost function of hospital i:

$$C^i(q^i, e^i) = c(q^i, e^i)D^i(q^i) + E(q^i, e^i) \tag{1.1}$$

where:

1. Structural Assumptions:
   - The functional forms of $c(\bullet)$ and $E(\bullet)$ are the same for all hospitals $i = 1, ..., n$. This is a simplification which is based upon the hypothesis that in the long run all hospitals have access to the same production technology.
   - The demand function $D^i(q^i)$ is different for each hospital and increasing with quality. This assumption captures the heterogeneity of hospitals, as for example the differences in market environments and sizes between metropolitan and rural area hospitals. See next section for a detailed discussion.
   - $c_{q^i}(\cdot) > 0$, $c_{q^iq^i}(\cdot) > 0$, $c_{e^i}(\cdot) < 0$, $c_{e^ie^i} > 0$, $c_{q^ie^i} \geq 0$
   - For all markets i, $D^i_{q^i}(q^i) > 0$ and $D^i_{q^iq^i}(q^i) < 0$ is assumed.
   - $c(q^i, e^i)D^i(q^i)$ is assumed to be a convex function
   - $E_{q^i}(\cdot) > 0$, $E_{q^iq^i}(\cdot) > 0$, $E_{e^i}(\cdot) > 0$, $E_{e^ie^i}(\cdot) > 0$, $E_{q^ie^i}(\cdot) \geq 0$
2. Informational Assumptions:
   - e^i is unobservable[4]

[4] For a discussion of the empirical observability of e and q see e.g. Chalkley and Malcomson (2000).

- q^i is unverifiable for the regulator, but observable by local doctors such that it influences demand (see next section for a detailed discussion)
- The total levels $c(q^i, e^i)$, $E(q^i, e^i)$ and $D^i(q^i)$ are verifiable by the regulator.
- The functional forms of $D^i(q^i)$ are known to the regulator, but not the ones of $c(q^i, e^i)$ or $E(q^i, e^i)$.[5]

1.3.2 Demand

Due to the insurance principle in health care, patients do not bear any direct costs of treatment. This creates a moral hazard problem on the demand side: Patients will seek the best treatment quality and intensity possible, without taking into account the costs they cause.[6] Therefore, demand depends mostly on quality of care.

Typically, ordinary people are, however, unable to judge quality of treatment, because medical care is a highly sophisticated product. In order to decide what hospital to visit, prospective patients have to rely upon sources of information and advice other than their own judgement.

It is therefore a reasonable working hypothesis to assume that a patient chooses the hospital for treatment that is recommended to him by his physician ("Hausarzt").[7] What does a physician base his recommendation upon? Considering him a reasonably good agent of his patient, he suggests the hospital that he thinks will deliver the best care. In how far is a physician able to judge the quality of care in a given hospital? Like the regulator, a physician will have significant difficulties to evaluate the quality of care in all hospitals in Germany. It seems sensible, though, to assume that he has superior (to

[5] Estimating hospital cost functions is a very difficult task. Some of the most evident problems are unobservable case mix variations, output measurement in aggregates, uncertainty of demand, difficulties in modelling hospital competition, etc. For a discussion of these matters see e.g. Gaynor and Vogt (2000).

[6] The use of the term "moral hazard" in this context may be irritating for some reader. It is, however, the typical expression for the observed behavior of fully insured patients, who do not take the costs they cause into account. For a more detailed discussion see e.g. Newhouse (2002), pp. 80-81.

[7] Quoting a German chief doctor: "Our customers are, in fact, not the patients, but their physicians."

the regulator) knowledge about local hospitals with which he has been dealing for quite a while. Therefore, as long as a patient chooses among local hospitals, only, he is able to assess a hospital's quality fairly well and select the one that yields him the highest utility[8] For this reason it is a fair assumption that demand of hospital i depends roughly on the quality of treatment in this hospital, i.e. $D^i = D^i(q^i)$.

Own quality of care, however, is not the only determinant of own demand. Usually, there is at least some degree of competition among hospitals - weakened by transport costs, d, and individual preferences (which may be independent of quality of care, such as e.g. design of the rooms, relatives working or having been treated there, etc.). Hence, a more elaborate model of competition would be desirable, specifying the individual hospital's competitive environment and demand: $D^i = D(q^i, q^j, d)$. The methodological problem with such a model is, however, that it implies the solution of reaction functions, which is generally impossible without specifying functional forms of cost functions - something that we want to avoid, since the nescience of the cost functions is the origin of our quest.

For this reason, I base my analysis on a model of monopolistic competition in which $D^i = D^i(q^i)$, $\frac{dD^i(q^i)}{dq^i} > 0$, but varying in its functional forms over the different hospitals $i = 1, ..., n$. Wherever necessary, I additionally provide a model of competition to show that the results carry over.

1.4 Achievability of First Best

This section shows that a PPS can in principle achieve the first best allocation of quality and cost reduction efforts. In essence, it is simply a summary of the key results of Albert Ma's seminal (1994) paper. Going beyond Ma, however, we want to analyze here what the regulator can achieve under the restrictions we impose on his information set in the previous section. It turns out that under these assumptions the authorities are incapable of determining the first best inducing prices.

[8] A number of econometric studies have established the close relationship between distance and patient's hospital choice. In a recent study by Ho (2005) the author estimates that if a hospital moves one additional mile away from a patient's home this reduces the probability that the patient chooses it by 21%.

1.4.1 Benchmark First Best

The regulator seeks to maximize social welfare which is defined as

$$SW = W(q^i) - c(q^i, e^i)D^i(q^i) - E(q^i, e^i) \tag{1.2}$$

where $W(q^i)$ is some function that measures consumer benefits from quality, $W_{q^i}(q^i) > 0$. The first order conditions are then given by:

$$q^{i,SO} \quad : \quad W_{q^i}(q^i) - c_{q^i}(q^i, e^i)D^i(q^i) - c(q^i, e^i)D^i_{q^i}(q^i) = E_{q^i}(q^i, e^i) \tag{1.3}$$

$$e^{i,SO} \quad : \quad - c_{e^i}(q^i, e^i)D^i(q^i) = E_{e^i}(q^i, e^i) \tag{1.4}$$

These equations are the benchmark for the performance of PPS.

1.4.2 Prospective Payment System

Under the prospective payment system a fixed price, p^i, is paid per patient, that is independent of the hospital's own costs. Profits are therefore:

$$\pi^i(q^i, e^i) = p^i D^i(q^i) - c(q^i, e^i)D^i(q^i) - E(q^i, e^i) \tag{1.5}$$

and the first order conditions for the private optimum:

$$q^{i,*} \quad : \quad p^i D^i_{q^i}(q_i) - c_{q^i}(q^i, e^i)D^i(q^i) - c(q^i, e^i)D^i_{q^i}(q^i) = E_{q^i}(q^i, e^i) \tag{1.6}$$

$$e^{i,*} \quad : \quad - c_{e^i}(q^i, e^i)D^i(q^i) = E_{e^i}(q^i, e^i) \tag{1.7}$$

Clearly the hospital exerts some cost-reducing effort. What is more, this is even the first best effort level, if $q^{i,*} = q^{i,SO}$. The quality provision depends, among other things, on the price the hospital receives. Proposition 1.1 summarizes the results.

Proposition 1.1 *Under a prospective payment system the first best effort level is induced if* $q^{i,*} = q^{i,SO}$. *The quality level depends on the functions* $c(q^i, e^i)$, $c_{q^i}(\cdot)$, $E_{q^i}(\cdot)$, $D^i_{q^i}(q^i)$ *and price* p^i. *The first best level is induced if* $p^i = \left.\frac{W_{q^i}(q^i)}{D^i_{q^i}(q^i)}\right|_{q^i = q^{i,SO}}$.

Thus, in principle, PPS can achieve the first best allocation. That is Ma's (1994) conclusion. This is, however, an incomplete reading of proposition 1.1, because it says that the first best allocation is achieved **only if** $p^i = \left.\frac{W_{q^i}(q^i)}{D^i_{q^i}(q^i)}\right|_{q^i=q^{i,SO}}$. This is an important detail, because $q^{i,SO}$ depends on the functions $c(q^i, e^i)$ and $E(q^i, e^i)$, which are unknown to the regulator. He will therefore be unable to evaluate the first best inducing prices.[9] If he sets the wrong price, distortions may be great, even greater than under CoSR.

If a regulator wants to change to a PPS, he therefore has to find a method to compute welfare maximizing prices that does not require knowledge of the hospitals' production function. Regulatory practice as well as the theoretic literature relies upon Shleifer's (1985) yardstick competition for a solution to this problem. Unfortunately, Shleifer's paper does not consider quality issues. The next section reviews Shleifer's original model. The section thereafter analyzes the consequences of applying Shleifer's yardstick competition in Ma's environment, i.e. when quality is endogenous and unverifiable.

1.5 Yardstick Competition a la Shleifer

For those readers who are not familiar with yardstick competition this section offers a brief summary of Shleifer's (1985) model in his original form. The next section will then apply yardstick competition in the previously described environment of Ma (1994).

1.5.1 Overview

In a general framework of local monopolists, Shleifer (1985) suggests to use the costs of a (or several) comparable firm, a yardstick, to set the price for the regulated firm. The three properties of his approach that make it appealing for the regulation of hospitals are: (i) It does not matter whether the market environments (especially the demand functions) of the regulated firms are different. (ii) Marginal cost pricing, where simply $p_i = c_j$ is set and losses are covered by a lump-sum transfer, achieves first best production. (iii) Adjusted

[9] Not to mention the problems that the regulator usually has in computing $D^i(\cdot)$ and $W(q^i)$.

average cost pricing, where the regulated firm is reimbursed as if it had the same marginal and fix costs as the yardstick, leads to second best production.

1.5.2 Marginal Cost Pricing

In our notation Shleifer's argument works as follows. Profits are given by

$$\pi^i = (p^i - c(e^i))D^i(p^i) - E(e^i) \tag{1.8}$$

Suppose now that there is a set of identical firms $j = 1, ..., n-1$. Then the regulator can induce i to produce efficiently by setting the firms j as i's yardstick against which i has to compete. He does so by setting

$$p^i = \overline{c}^i := \frac{1}{n-1}\sum_{j\neq i}^{n} c(e^j)$$

and an extra transfer of

$$T^i = \frac{1}{n-1}\sum_{j\neq i}^{n} E(e^j)$$

Profit maximization then yields:

$$\begin{aligned} &\max_{e^i}(\overline{c}^i - c(e^i))D^i(c(e^j)) - E(e^i) + T^i \\ \Rightarrow\quad &-c_{e^i}(e^i))D^i(c(e^j)) = E_{e^i}(e^i) \end{aligned}$$

Obviously, one interior symmetric Nash equilibrium is that both firms choose the socially optimal $e^{i,SO}$. It turns out that this is also unique.[10]

1.5.3 Adjusted Average Cost Pricing

In case that the regulator is unable to use lump-sum transfers, he can still achieve second best outcomes by applying the following adjusted average pricing scheme. Under $T^i = 0$ the optimal allocation is characterized by the

[10]For the formal proof see pp. 322/323 in Shleifer (1985).

following two equations:

$$-c_{e^i}(e^i)D^i(p^i) \quad = \quad E_{e^i}(e^i) \tag{1.9}$$

$$\left(p^i - c(e^i)\right) D^i(p^i) - E(e^i) \quad = \quad 0 \tag{1.10}$$

The first one equates marginal gain from cost reduction effort to marginal cost. The second one is the breakeven condition. The regulator can now implement second best allocation by replacing $c(e^i)$ by $c(e^j)$ and $E(e^i)$ by $E(e^j)$ in 1.10 and solve for p^i. Under this price, firm i's cost minimization leads to the second best optimum.

1.6 Yardstick Competition in Presence of Competition in Quality

Shleifer's model does not capture some important characteristics of the hospital market. First, patients do not pay prices for treatment. This implies that they go where quality is highest. At the same time, quality cannot be verified by the regulator. This means that he can steer it only via the prices he pays to the hospitals.

It is the aim of this section to analyze to what extent these issues matter. It turns out that they cause serious problems for yardstick competition. To see this, consider Shleifer's model under the assumptions made in section 1.3. The hospital's profit function is then

$$\pi^i(q^i, e^i) = p^i D^i(q^i) - c(q^i, e^i)D^i(q^i) - E(q^i, e^i)$$

1.6.1 Marginal Cost Pricing

Under the marginal cost pricing rule of yardstick competition, hospitals are reimbursed according to the following rule:

$$p^i = \frac{1}{n-1}\sum_{j \neq i}^{n} c(q^j, e^j) \text{ and } T^i = \frac{1}{n-1}\sum_{j \neq i}^{n} E(q^j, e^j) \tag{1.11}$$

Profits are then

$$\Rightarrow \pi^i(q^i, e^i) = \left(\frac{1}{n-1}\sum_{j\neq i}^{n} c(q^j, e^j) - c(q^i, e^i)\right) D^i(q^i) + \sum_{j\neq i}^{n} \frac{1}{n-1} E(q^j, e^j) - E(q^i, e^i) \tag{1.12}$$

which leads to the first order conditions

$$q^{i,*} : \frac{1}{n-1}\sum_{j\neq i}^{n} c(q^j, e^j) D^i_{q^i}(q^i) - c_{q^i}(q^i, e^i) D^i(q^i) - c(q^i, e^i) D^i_{q^i}(q^i) = E_{q^i}(q^i, e^i) \tag{1.13}$$

$$e^{i,*} : \; - c_{e^i}(q^i, e^i) D^i(q^i) = E_{e^i}(q^i, e^i) \tag{1.14}$$

The difference to the first best FOCs 1.3 and 1.4 is that here we have $\frac{1}{n-1}\sum_{j\neq i}^{n} c(q^j, e^j) D^i_{q^i}(q^i)$ instead of $W_{q^i}(q^i)$. How big this distortion is, cannot be said without some more structure. The next sections show that the distortions are tremendous.

Symmetric Hospitals

Suppose there are n hospitals. All have access to the same cost functions and face identical demand functions. For the moment we neglect competition, i.e. $D^i = D^i(q^i)$ instead of $D^i = D^i(q^i, q^j)$. This facilitates the analysis considerably and allows us to study general demand and cost functions. Later we will also specify a more elaborate model of competition. Section 1.6.1 shows that the following result also translates to more asymmetric environments.

Proposition 1.2 *In the case of complete symmetry, marginal cost pricing that follows yardstick competition leads to zero quality:* $q^{i,*} = 0$. *If furthermore* $D^i(q^i = 0) = 0$, *then also* $e^{i,*} = 0$.

Proof. If all hospitals are identical, all hospitals will get the same price $p^i = p^j = p$. If all hospitals get the same price, the optimization problem is the same for all hospitals, yielding the same set of first order conditions

$$q^{i,*}(p) \;:\; pD^i_{q^i}(q^i) - c_{q_i}(q^i,e^i)D^i(q^i) - c(q^i,e^i)D^i_{q^i}(q^i) = E_{q_i}(q^i,e^i) \quad (1.15)$$
$$e^{i,*}(p) \;:\; -c_{e^i}(q^i,e^i)D^i(q^i) = E_{e^i}(q^i,e^i) \quad (1.16)$$

It follows that all hospitals choose the same quality and effort levels $q^{i,*}(p) = q^{j,*}(p)$ and $e^{i,*}(p) = e^{j,*}(p)$. This implies that all of them will have the same marginal cost levels $c(q^{i,*}(p), e^{i,*}(p)) = c(q^{j,*}(p), e^{j,*}(p))$. According to the pricing rule $p^i = \frac{1}{n-1}\sum_{j\neq i}^{n} c(q^j, e^j)$ this implies $p^i = p = c(q^{i,*}, e^{i,*})$. Inserting this into 1.15 yields $-c_{q^i}(q^{i,*}, e^{i,*})D^i(q^{i,*}) - E_{q_i}(q^*_i, e^*_i) = 0$ which yields the corner solution $q^{i,*} = 0$. Substituting this into 1.16 results in $e^{i,*} = 0$, if $D_i(q_i = 0) = 0$. ■

The intuition for this result is that, in equilibrium, hospitals earn a zero profit margin per patient. Then, however, no hospital has an interest in sustaining high reputation. Consequently, it provides zero quality. A more detailed interpretation and discussion is given further below.

Symmetric Hospitals in Competition on a Salop Circle

The result of zero cost reduction effort depends on the assumption $D^i(q^i = 0) = 0$. This may seem unrealistic, because patients may still prefer low (or even zero) quality treatment in a hospital than no treatment at all. To see how this changes the results, consider a model of quality competition among hospitals on a Salop circle. On a Salop circle, which may as usual be thought of as a city, there are n identical hospitals active, each facing marginal costs $c^i(q^i, e^i) = q^i - e^i$ and effort costs $E(q^i, e^i) = (q^i)^2 + (e^i)^2$. Consumers derive utility $u(q^i)$ from being treated at hospital i. When yielding care from a hospital, a patient does not have to pay prices, but incurs transportation costs of $d * distance$. We assume $u_{q^i}(q^i) > 0$, $u_{q^iq^i}(q^i) < 0$ and $u(q = 0) > d$ to assure that market is always covered, independent of the number of hospitals. Marginal consumers $\widetilde{x}$ are then characterized by

$$u(q^i) - d\widetilde{x} = u(q^j) - d(\frac{1}{n} - \widetilde{x}) \quad (1.17)$$
$$\Leftrightarrow \widetilde{x} = \frac{u(q^i) - u(q^j) + \frac{d}{n}}{2d} \quad (1.18)$$

which implies demand for hospital i of

$$D^i(q^i, q^j) = \frac{u(q^i) - u(q^j) + \frac{d}{n}}{d} \tag{1.19}$$

Under PPS his results in the optimization problem

$$\max_{e^i,q^i} \pi^i = (p^i - q^i + e^i)\frac{u(q^i) - u(q^j) + \frac{d}{n}}{d} - \left(q^i\right)^2 - \left(e^i\right)^2 + T^i \tag{1.20}$$

with the first order conditions

$$q^{i,*} \quad : \quad -\frac{u(q^i) - u(q^j) + \frac{d}{n}}{d} + (p^i - q^i + e^i)\frac{u_{q^i}(q^i)}{d} - 2q^i = 0 \tag{1.21}$$

$$e^{i,*} \quad : \quad \frac{u(q^i) - u(q^j) + \frac{d}{n}}{d} - 2e^i = 0 \tag{1.22}$$

which implies $e^{i,*} = \frac{u(q^i)-u(q^j)+\frac{d}{n}}{2d}$. Substituting this into 1.21 yields

$$-\frac{u(q^i) - u(q^j) + \frac{d}{n}}{d} + \left(p^i - q^i + \frac{u(q^i) - u(q^j) + \frac{d}{n}}{2d}\right)\frac{u_{q^i}(q^i)}{d} - 2q^i = 0 \tag{1.23}$$

Due to the symmetry, we have $p^i = p^j = p$ and $q^i = q^j$, from which follows

$$q^{i,*} \quad : \quad -\frac{1}{n} + \left(p - q^i + \frac{1}{2n}\right)\frac{u_{q^i}(q^i)}{d} - 2q^i = 0 \tag{1.24}$$

$$e^{i,*} \quad : \quad e^{i,*} = \frac{1}{2n} \tag{1.25}$$

The pricing rule $p^i = \frac{1}{n-1}\sum_{j\neq i}^{n} c(q^j, e^j)$ implies also here $p = c(q^{i,*}, e^{i,*}) = q^{i,*} - \frac{1}{2n}$. This leads to the corner solution $q^{i,*} = q^* = 0$.

How does this compare to the social optimum? Welfare is given by

$$W = u(q) - q + e - q^2n - ne^2 - \frac{d}{4n} \tag{1.26}$$

The first order conditions are then:

$$q^{SO} \quad : \quad u_q(q) - 1 - 2qn = 0 \tag{1.27}$$

$$e^{SO} \quad : \quad 1 - 2ne = 0 \tag{1.28}$$

In the social optimum we have therefore $e^{SO} = \frac{1}{2n}$ and $q^{SO} > 0$ **for given n**. The comparison is summarized in the following proposition

Proposition 1.3 *Let the number of hospitals be exogenously fixed. If $D^i(q^i = 0) > 0$, the marginal cost pricing rule of yardstick competition potentially achieves first best cost reduction effort, but leads to too low, namely zero, quality.*

The intuition for this result is the following: As before, the hospital has no incentive to increase its reputation and therefore chooses zero quality. But it has an incentive to save on costs, because in equilibrium it gets an amount of transfers that it cannot influence (due to symmetric positive equilibrium demand) - the typical yardstick competition effect.

Remark 1.1 *Recall that in this Salop example we had to make explicit assumptions on the cost functions. In particular, the restrictions $c_{qe} = 0$ and $E_{qe}(\cdot) = 0$ are important. It may seem more reasonable to assume $c_{qe}(\cdot) > 0$ and $E_{qe}(\cdot) > 0$. This leaves the result of zero quality provision unaffected, but implies that then the cost reduction effort level is distorted upwards, i.e. too much weight is put on reducing costs - a typical result of multitask agent models.*

Asymmetric Hospitals

When hospitals differ from each other in market environments, then the question is what firm(s) $j \in \{1, ..., n\}$, $j \neq i$ does the regulator take as a yardstick for firm i? The only candidates are all those firms that have the same market environments, because if other firms are taken, it is not guaranteed anymore that the regulated firm yields nonnegative profits. Then, however we are back at equations 1.15 and 1.16. which results in the same conclusion as stated in propositions 1.2 and 1.3.

What do these results mean? Let us summarize what we have done up to now to recall the context for these results. In the introduction we described that the former regulation scheme of hospitals, simple reimbursement of cost of service, does not give any incentives to save costs. As reaction, a regulatory authority may want to switch to prospective payment systems to finance the hospitals. This scheme can in principle induce hospitals to produce first best efforts in quality as well as in cost control. This is possible if prices are set correctly. In reality, however, the regulator has problems to determine these optimal prices, because he does not know the hospitals' cost functions. It is commonly said that the way to bypass this problem is to use yardstick competition a la Shleifer, in particular the marginal cost pricing version discussed in this section. Unfortunately, Shleifer's mechanism does not take into account some particularities of the hospital market. In this section of the paper we do this, and propositions 1.2 and 1.3 show that if a regulator uses Shleifer's marginal cost pricing rule, hospitals will provide zero quality. The reason is that they earn a zero profit margin per patient and therefore have no incentive to compete for patients by setting high quality.

Is this realistic? Will this happen? Not quite, probably, because, most of all, doctors may have motives other than profit maximization. In particular, they may be driven by altruism or fear of law suits. It is therefore more likely that quality will be driven down to some minimum level. The basic logic, however, remains the same. We conclude, therefore, that a prospective payment system, where the marginal cost pricing rule of yardstick competition is used, generally leads to too low, in the extreme, zero, quality of service and to a cost reduction effort level of $e^* \lesseqgtr e^{SO}$ (depending on $D^i(q^i = 0)$ and $c_{qe}(\cdot)$ as well as $E_{qe}(\cdot)$).

Since the reason for this result lies in the marginal cost pricing, it is a natural question to ask whether the average cost pricing scheme of yardstick competition can do any better. This is subject of the next section.

1.6.2 Adjusted Average Cost Pricing

The average cost pricing version of yardstick competition demands the regulator to take for each hospital i at least one twin j and set p^i such that the following condition is fulfilled:

$$\pi^i(q^i, e^i) = p^i D^i(q^i) - \frac{1}{n-1}\sum_{j\neq i}^{n} c(q^j, e^j) D^i(q^i) - \frac{1}{n-1}\sum_{j\neq i}^{n} E(q^j, e^j) = 0$$

$$\Leftrightarrow p^i = \frac{\frac{1}{n-1}\sum_{j\neq i}^{n} c(q^j, e^j)D^i(q^i) + \frac{1}{n-1}\sum_{j\neq i}^{n} E(q^j, e^j)}{D^i(q^i)} \tag{1.29}$$

We observe that price is larger than marginal costs. This suggests that the problems we have with marginal costs, as described in section 1.6.1, are not present here. But there is another one: Here p_i depends on the own choice of q^i, namely decreasingly in q^i. This is detrimental to the idea of yardstick competition:

Proposition 1.4 *In presence of Cournot competition via quality, the average cost pricing scheme of yardstick competition does not make own price independent of own decisions, anymore:* $p^i = p^i(q^i)$.

This results in significant distortions as we shall demonstrate now.

The first order conditions of the hospital's maximization problem are:

$$q^{i,*} : p^i_{q^i}(q^i)D(q^i) + p^i D^i_{q^i}(q^i) - c_{q^i}(q^i, e^i)D^i(q^i) \tag{1.30}$$

$$-c(q^i, e^i)D^i_{q^i}(q^i) = E_{q^i}(q^i, e^i) \tag{1.31}$$

$$e^{i,*} : -c_{e^i}(q^i, e^i)D^i(q^i) = E_{e^i}(q^i, e^i)$$

Average cost pricing a la Shleifer implies two opposing price effects. One, $p^i D^i_{q^i}(q^i)$, works quality increasing and is the desired effect of any prospective payment system. The other one, $p^i_{q^i}(q^i)D(q^i)$, stems from the adjustment of j's costs to i's demand environment. As described in proposition 1.4, this effect is negative. Inserting 1.29 for p^i yields:

$$q^{i,*} : -\frac{\frac{1}{n-1}\sum_{j\neq i}^{n} E(q^j, e^j)}{D^i(q^i)} D^i_{q^i}(q^i)$$

$$+\frac{\frac{1}{n-1}\sum_{j\neq i}^{n} c(q^j, e^j)D^i(q^i) + \frac{1}{n-1}\sum_{j\neq i}^{n} E(q^j, e^j)}{D^i(q^i)} D^i_{q^i}(q^i)$$

$$-c_{q^i}(q^i, e^i)D^i(q^i) - c(q^i, e^i)D^i_{q^i}(q^i) = E_{q^i}(q^i, e^i) \tag{1.32}$$

$$e^{i,*} : -c_{e^i}(q^i, e^i)D^i(q^i) = E_{e^i}(q^i, e^i)$$

Analogously to the proof of proposition 1.2, under symmetry we have $c(q^{i,*}(p), e^{i,*}(p)) = c(q^{j,*}(p), e^{j,*}(p))$. It follows:

$$q^{i,*} \quad : \quad -c_{q^i}(q^{i,*}, e^{i,*})D^i(q^{i,*}) - E_{q^i}(q^{i,*}, e^{i,*}) = 0 \tag{1.33}$$

$$e^{i,*} \quad : \quad -c_{e^i}(q^i, e^i)D^i(q^i) = E_{e^i}(q^i, e^i) \tag{1.34}$$

The result is completely analogous to the preceding section on marginal cost pricing and is summarized in proposition 1.5.

Proposition 1.5 *In the case of complete symmetry, average cost pricing a la Shleifer (1985) leads to zero quality:* $q^{i,*} = 0$*. If furthermore* $D^i(q^i = 0) = 0$*, then also* $e^{i,*} = 0$*.*

The reason for this zero quality result is that the two effects of an increase in quality, namely increase in demand and decrease in price, exactly outweigh each other.

The next section shows that the zero quality result also holds in a strategic competitive environment, but that cost reduction effort may be optimal.

Symmetric Hospitals in Competition on a Salop Circle

We will use the same Salop model as in the section on marginal cost pricing. The only difference is that now the pricing scheme is different. Here, however, the hospital can affect its own price:

$$\max_{e^i, q^i} \pi^i = (p^i(q^i) - q^i + e^i)\frac{u(q^i) - u(q^j) + \frac{d}{n}}{d} - \left(q^i\right)^2 - \left(e^i\right)^2$$

$$q^{i,*} : (p^i_{q^i}(q^i) - 1)\frac{u(q^i) - u(q^j) + \frac{d}{n}}{d} + (p^i(q^i) - q^i + e^i)\frac{u_{q^i}(q^i)}{d} \tag{1.35}$$

$$-2q^i = 0 \tag{1.36}$$

$$e^{i,*} : \frac{u(q^i) - u(q^j) + \frac{d}{n}}{d} - 2e^i = 0$$

Following Shleifer's pricing rule we have $p^i(q^i) = \frac{(q^j - e^j) D_i(q_i) + \left(q^i\right)^2 + \left(e^i\right)^2}{D^i(q^i)}$ and $p^i_{q^i}(q_i) = \frac{-(\left(q^i\right)^2 + \left(e^i\right)^2) D_i'(q_i)}{(D^i(q^i))^2}$. Additionally, $D^i(q^i) = \frac{u(q^i) - u(q^j) + \frac{d}{n}}{d}$. Inserting this yields:

$$q^{i,*} : \frac{-((q^i)^2 + (e^i)^2)\frac{u_{q^i}(q^i)}{d}}{\frac{u(q^i)-u(q^j)+\frac{d}{n}}{d}} - \frac{u(q^i) - u(q^j) + \frac{d}{n}}{d}$$
$$+ \left(\frac{(q^j - e^j)\frac{u(q^i)-u(q^j)+\frac{d}{n}}{d} + (q^i)^2 + (e^i)^2}{\frac{u(q^i)-u(q^j)+\frac{d}{n}}{d}} - q^i + e^i \right) \frac{u_{q^i}(q^i)}{d} - 2q^i = 0$$

$$e^{i,*} : \frac{u(q^i) - u(q^j) + \frac{d}{n}}{d} - 2e^i = 0$$

This simplifies to:

$$q^{i,*} \quad : \quad -\frac{u(q^i) - u(q^j) + \frac{d}{n}}{d} + (q^j - e^j)\frac{u^i_{q^i}(q^i)}{d}\left(-q^i + e^i\right)\frac{u_{q^i}(q^i)}{d} - 2q^i = 0$$
$$e^{i,*} \quad : \quad \frac{u(q^i) - u(q^j) + \frac{d}{n}}{d} - 2e^i = 0$$

Due to the symmetry we have $p^i = p^j = p$, $e^i = e^j$ and $q^i = q^j$, from which follows

$$q^{i,*} \quad : \quad -\frac{1}{n} - 2q^i = 0 \Rightarrow q^{i,*} = 0$$
$$e^{i,*} \quad : \quad \frac{1}{n} - 2e^i = 0 \Leftrightarrow e^{i,*} = \frac{1}{2n}$$

Recall that the social optimum is determined by

$$q^{SO} \quad : \quad u_q(q) - 1 - 2qn = 0 \tag{1.37}$$
$$e^{SO} \quad : \quad e^{SO} = \frac{1}{2n} \tag{1.38}$$

Obviously, cost reduction effort is provided in the socially optimal amount, but quality is zero and therewith suboptimal:

Proposition 1.6 *If $D(q^i = 0) > 0$ and additionally $c_{qe}(\cdot) = 0$ and $E_{qe}(\cdot) = 0$, then the average cost pricing rule of yardstick competition achieves first best* *cost reduction effort, but leads to too low, namely zero, quality.*

1.6.3 Summary

In this section we have analyzed what happens if yardstick competition a la Shleifer (1985) is applied in the specific market environment of the hospital sector. We have shown that it always leads to zero quality provision. If additionally $D(q^i = 0) = 0$, $c_{qe}(\cdot) \neq 0$ or $E_{qe}(\cdot) \neq 0$, then also cost reduction efforts are at an inefficient level. For the practice of regulation this means that a regulator, who changes to a prospective payment system and uses yardstick competition as his method to compute prices, introduces significant distortions into the system. He cannot be sure that he improves the health care system at all. Instead he may even worsen it.

1.7 A Simple Refinement of Yardstick Competition

We have seen that yardstick competition à la Shleifer leads to zero quality provision. The question is whether yardstick competition can be refined and improved in some way. Indeed this is the case, but only to a certain extend. Recall that a regulator has to choose completely identical hospitals as yardsticks to ensure nonnegative profits. Then, however, he can use simple average cost pricing $p^i = AC^j$ instead of the adjusted average cost pricing rule that Shleifer proposes. The advantage is that then price is independent of own action and larger than marginal costs. This results in strictly positive quality provision:

$$q^{i,*} \quad : \quad p^i D^i_{q^i}(q^i) - c_{q^i}(q^i, e^i) D^i(q^i) - c(q^i, e^i) D^i_{q^i}(q^i) = E_{q^i}(q^i, e^i) \quad (1.39)$$

$$e^{i,*} \quad : \quad -c_{e^i}(q^i, e^i) D^i(q^i) = E_{e^i}(q^i, e^i) \quad (1.40)$$

Inserting $p^i = AC^j$ and using the symmetry argument, i.e. $c(q^{i,*}(p), e^{i,*}(p)) = c(q^{j,*}(p), e^{j,*}(p))$, yields:

$$
\begin{aligned}
q^{i,*} &: \frac{E(q^j, e^j)}{D^j(q^j)} D^i_{q^i}(q^i) - c_{q^i}(q^i, e^i) D^i(q^i) = E_{q^i}(q^i, e^i) \\
e^{i,*} &: -c_{e^i}(q^i, e^i) D^i(q^i) = E_{e^i}(q^i, e^i)
\end{aligned}
$$

which has, in principle, an interior solution.

Proposition 1.7 *Simple average cost pricing, $p^i = AC^j$, where hospital j is an identical twin to hospital i, leads to positive quality provision.*

We can, however, not say much more about the level of quality provided. It can be everything: just right, too low, or even too high. If furthermore, the cross-derivatives of $c(q^i, e^i)$ or $E(q^i, e^i)$ are non-zero, also cost reduction effort is distorted. Summing up, even under this refined version of yardstick competition, a prospective payment system may harm a health system more than it helps.

1.8 Conclusion

The dominating opinion in the literature is that, as regulatory scheme for the hospital market, a prospective payment system is superior to cost of service regulation. The arguments put forward are that, first, PPS gives higher incentives for cost savings. Second, reputation effects will force the hospitals to provide high levels of quality.

This chapter argues that this judgement is incomplete, because it ignores informational limitations of the regulator. The level of quality provided depends crucially on the prices set. In practice, however, the regulator proves unable to determine optimal prices. Therefore, unless a suitable second best pricing mechanism is found, PPS may even worsen the performance of the health care sector.

The pricing mechanism suggested in the literature is Shleifer's yardstick competition. Shleifer does not consider quality, though. It was the aim of this chapter to understand, whether yardstick competition really is applicable to the hospital market. The analysis yields the following objections:

First, yardstick competition in this environment requires the regulator to use only firms as yardsticks that are identical to the regulated firm even in demand. Second, it is shown that even if all necessary information can be inferred and an identical twin can be found for each firm, yardstick competition à la Shleifer will lead to zero quality provision. Third, a simpler version of yardstick competition average cost pricing can lead to positive quality and cost reduction effort. Even then, however, quality can be too low or even excessive depending on the individual market environments. Furthermore, if cost functions exhibit non-negative cross derivatives, the distortions in quality will also lead to too low or too strong cost reduction effort.

Chapter 2

Smoking Ban in Taverns: Increase in Welfare or Illegitimate Market Intervention?

"To the best of my knowledge we live in a so called free market economy. If it is in the interest of a bartender to prohibit smoking in his establishment, then there is nothing you could object. But this should not be imposed from above."

"I believe that every bartender shall be allowed to run his bar as he likes. If the public - and not only some grumblers - had an interest in non-smoker bars, those would spring up like mushrooms."

[Translations of stated opinions in a forum on "General Ban of Smoking in Bars and Restaurants" by Die Zeit Online in Fall 2005]

"If a smoking ban were good for taverns, competition alone would already lead to the first smoke-free pubs."

[Translation of a quote of Klaus Uwe Benneter, former general secretary of the German Social Democratic Party, Spiegel Online, June 20^{th} 2006.]

2.1 Introduction

The U.S., Ireland, England, Scotland, Sweden, Spain, Italy and India are examples of countries that have strict smoking laws, including smoking bans in restaurants, bars, and discotheques.[1] In other countries, e.g. Germany, smoking bans are not present, but controversially discussed. Unsurprisingly, this debate is typically a very emotional one, because the motives are very strong: Non-smokers suffer from the bad air and see their health threatened. Smokers, on the other side, see their freedom of choice in danger. Both parties have sound economic arguments on their sides. Non-smokers clearly suffer from a negative externality in a pub when other customers smoke. They believe to have a right of clean air and demand protection by the government. Smokers, on the contrary, claim the right to air pollution for themselves and emphasize their right of pursuit of happiness. They point out that non-smokers do not need to enter a pub. If they do nevertheless, they should tolerate the smoke. After all, they say, if it were in the interest of the gross of customers, bars would prohibit smoking themselves.

[1] In this paper no differences are made between restaurants, bars, pubs, discotheques, etc. Therefore we can use these terms interchangeably.

Who is right in this dispute? Does the free market achieve the best solution or is there a case for governmental intervention? This is the key question that any legislation needs to answer before deciding in favor or against a general ban of smoking - a decision with far-reaching economic, health, legal and emotional consequences for millions of people every day.

Where to start? In essence, the question we are dealing with here is a classic social cost problem a la Coase (1960). The hitch is that the transaction costs are so high that the Coase Theorem does not apply. Or, as Phelps (1992, p. 430) states it: "Trying to use agreements [...] between people in a restaurant to determine whether smoking would take place would be the height of absurdity, and nobody would think seriously of a full "property rights" approach to such a problem. The transaction costs of reaching agreements would overwhelm the problem."

Nevertheless a lot of people, as the introductory citations show, argue directly or indirectly with Coase to justify their claim that the free market yields the best outcome. This line of argumentation is put into economic terms by Tollison and Wagner (1992), Lee (1991), Boyes and Marlow (1996), Dunham and Marlow (2000, 2003, 2004) and proceeds the following way. For the Coase Theorem to work, two conditions need to hold. First, property rights must be clearly assigned. This condition is fulfilled, because the air space in a private pub or restaurant belongs to the owner of the establishment. Second, transaction costs must be zero. Also this condition is fulfilled, the above authors argue, because the establishment owner acts as intermediary between smokers and non-smokers. He internalizes the externalities by allocating the air space to smokers and non-smokers according to profit maximization. In other words: If it is in the interest of the customers, bar owners would prohibit smoking. Governmental intervention is therefore unnecessary.

While this argumentation sounds reasonable, it seems, however, to be at odds with reality. In Germany there are about 240.000 pubs, cafés and restaurants. Only 800 of them are non-smoker locations.[2] In contrast to this, 76 % of Germans are smokers.[3] In this light, it is difficult to believe that the market

[2] These numbers are taken from the article "Freiwillige Verpflichtungen wirken nicht" (*Frankfurter Allgemeine Sonntagszeitung*, August 20th, 2006) by Michael Krzyanowski, unit head of the German office of the World Health Organization.

[3] People who smoke daily in percentage of people 15 years or older. Source: Organisation

internalizes all externalities and works efficiently. Unfortunately, none of the authors, who claim that profit maximization internalizes the externalities from smoking, provides a formal model that could help to solve this apparent contradiction. To the best of my knowledge there does not exist one single model in the literature that deals with this problem. It is the aim of this paper to fill this gap and provide the discussion, politics and econometricians with a stringent model for further progress.

In what follows, a model of competition between pubs (or restaurants, cafés, discotheques, etc.) is built. Consumers go to pubs for consumption of beverages as well as for social reasons. It is shown that pub owners do internalize externalities from smoking, but in a way that is not always beneficial to consumers. Specifically, negative externalities from smoking allow firms to charge higher prices. Consequently, choosing to allow smoking can be used as a collusive device. As a result, profit maximization and welfare maximization can lead to completely different results. There are reasonable parameter values for which pubs choose to allow smoking, although it is in the public interest to prohibit it. The arguments against smoking bans stated above are therefore false. Market failure may very well be present and governmental intervention may be justified. The final answer to the question whether to ban smoking or not is an empirical one.

2.2 Related Literature

While there is a lot of literature on smoking in general, its health effects and tobacco taxation, there are only a few papers on the question whether smoking should be banned in restaurants, bars, etc. Furthermore, many of those works are purely verbal. To the best of my knowledge there exists no paper that offers a formal theoretic model. There are, however, a few empirical studies.

Dunham and Marlow (2000) analyze the data from a 1996 U.S. nationwide telephone survey, which consists of owners/managers of randomly selected 650 restaurants and 650 bars. They are asked for their estimation of revenue changes due to stricter smoking laws. The key results are that 39% of the restaurant owners expect a decrease in profits and 51% expect no changes.

for Economic Co-operation and Development (2005).

Dunham and Marlow (2003) use a survey conducted in 2001 in Wisconsin. The survey consists of 550 owners of restaurants and 428 owners of bars. The restaurants are differentiated according to whether they are already subject to governmental smoking restrictions or not. The owners were asked whether they expect or experienced profit decreases in response to stricter smoking laws. 38% of restaurant owners experienced a decrease in profits, and 50% reported no change. 81% of bar owners expected/experienced a decrease in profits, 13% responded with "no change". Furthermore, the survey contains information on changes in other parameters (prices, promotions, entertainment, opening hours and benefits to workers). 20 % of restaurant owners already subject to smoking restrictions reported that restrictions caused them to raise prices, while 22% introduced promotions. In the other two categories 30-35% reported price increases and the same percentage replied with "introduce promotions". The authors leave unclear, however, what exactly is meant by promotions. Since promotions typically include offering discounts and free trials, promotions can imply lowering prices. The overall price effect seems, therefore, to remain ambiguous.

Dunham and Marlow (2004) use the same data as in their 2003 paper to explore whether restaurant owners adapt to the needs of their customers. Running an OLS-regression for restaurants not subject to governmental restriction (smoking bans or minimum non-smoker seating requirement), the following variables have a significantly positive influence on the share of non-smoking seating: Share of customers with white collar jobs, share of customers with children, being part of a chain and number of seats. The factors that have a significantly negative effect are share of customers being smokers, having a general liquor license and age of establishment. Dunham and Marlow conclude from this that without any governmental restrictions restaurant owners adapt to the interests of their customers. Running the same regression for restaurants subject to governmental restrictions, there remains only one variable with a significant influence, namely the share of smokers among customers. From this drop in significance levels the authors infer that governmental restrictions overturns all other factors of seating allocation and prevents diversity in the market. This result is neither surprising nor relevant from a welfare perspective, though. If the government prohibits smoking in bars, individual differences in treating smokers and non-smokers are leveled by definition. It is also clear that welfare optimality implies product differentiation among pubs, and that therewith a general smoking ban cannot be welfare optimal. The real question is, however, whether a stricter regulation improves welfare in comparison to the free market outcome or not.

2.3 A Model of the Market

It seems obvious that the driving force of a pub's demand is of social nature. People usually go to a pub to enjoy the specific atmosphere, which consists to a high degree of the other visitors. This feature of tavern demand is best captured as network effects. A customer of a bar benefits from the presence of other customers.[4]

Furthermore, we have to distinguish two groups of customers: smokers and non-smokers. Customers from each side benefit from the presence of all other customers at a given pub, independently of what side they stem from. Non-smokers, however, suffer also negative externalities from smokers' tobacco consumption. The model setting that I use to capture these effects resembles the two-sided market framework a la Armstrong (2004). The market, however, is not two-sided, in the sense that the bar owners cannot price differentiate between the two groups. Let us discuss these issues in more detail.

2.3.1 Consumers

Suppose that the two groups of customers, smokers and non-smokers, are each distributed on a Hotelling line. Non-smokers are all identical and uniformly distributed on the unit interval with mass N_{ns}. Also smokers are all identical and uniformly distributed on the unit interval, but are of mass N_s.

[4]Not everybody may agree with this view. I am sure that also the reader of this note has experienced an evening in a restaurant or a bar during which she was so annoyed by the neighbouring table that she regreted her choice of bar. In general, however, I believe that most of us in most instances enjoy the social atmosphere in a pub. After all, who would go to an empty pub? One may just as well stay home and have a beer there.

2.3.2 Bars

There are two pubs competing for customers. Pub A is situated at the beginning of the unit interval (x=0) and pub B at the end (x=1). The differentiation parameter t (the same for both groups) can therefore be interpreted as a taste parameter, as a distance parameter or some combination of the two. Firms are profit maximizers that set prices and can choose whether they allow smoking or prohibit it. Firms can, however, not price discriminate between the two market sides. Consequently, the price firm i sets is the same for both consumer groups. Both firms incur the same constant marginal costs c per unit provision of consumption goods.

2.3.3 Utility

Each consumer (no matter whether he is smoker or non-smoker) has unit demand for consumption.[5] Suppose that if he consumes this unit in a bar instead of at home, this yields extra utility u_{ns} if he is a non-smoker and u_s if he is a smoker.[6] Additionally, each consumer derives utility α from the company of every other customer in the same pub.[7]

Moreover, each smoker smokes (if he is allowed to at the place where he consumes) some amount of tobacco which produces a unit amount of smoke, but also yields him some extra net utility of s (net the production costs incurred by the tobacco company[8]). For simplicity, let us assume that a smoker smokes in a smoker pub only.[9] If he goes to a non-smoker bar or stays at home, I assume, he does not smoke.[10]

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[5] This may be thought of as a bundle of foods and drinks which is assumed to be the same for all customers.

[6] I use different utility indices to allow for potential positive correlations between being a smoker and enjoying evening entertainment - a claim that some readers may want to make.

[7] Some readers may object that a pub visitor derives his main social benefit from the friends whom together with he goes out. The model can incorporate this by interpreting each potential consumer as a group instead of a single customers, whose outside option (staying at home) is normalized to zero.

[8] We use utility from smoking net the production costs, because this allows us to ignore tobacco companies in the welfare analysis. See the next subsection for details.

[9] This allows us to normalize the outside option to zero, but has no effect on the results.

[10] A different interpretation is that at those places he has to go outside to smoke - something most smokers do also at home. In this sense s can be interpreted as the utility of not having to leave the bar.

One may just as well assume that smokers smoke also inside their appartments. This does

Each non-smoker, however, suffers from each unit of smoke a utility loss of e (negative externality of smoking).[11] Note that this translates into a reduction of the positive network effects that a non-smoker has from smokers in a pub in which smoking is allowed.

Suppose that each consumer can choose whether he goes to pub A or to pub B or stays home. Additionally, each smoker will smoke if he is allowed to. Gross utilities are therefore given by

- for a non-smoker:

$$U_{ns} = \begin{cases} u_{ns} + \alpha(n_{ns}^i N_{ns} + n_s^i N_s) - p^i & \text{if he goes to a non-smoker bar} \\ u_{ns} + \alpha n_{ns}^i N_{ns} + (\alpha - e) n_s^i N_s - p^i & \text{if he goes to a smoker bar} \\ 0 & \text{if he stays home} \end{cases} \tag{2.1}$$

- for a smoker:

$$U_s = \begin{cases} u_s + \alpha(n_{ns}^i N_{ns} + n_s^i N_s) - p^i & \text{if he goes to a non-smoker bar} \\ u_s + s + \alpha(n_{ns}^i N_{ns} + n_s^i N_s) - p^i & \text{if he goes to a smoker bar} \\ 0 & \text{if he stays home} \end{cases} \tag{2.2}$$

where n_l^i is the fraction of market side $l \in \{ns, s\}$ that firm $i \in \{A, B\}$ captures and p^i the price at pub i for the unit amount of consumption the price that each consumer has to pay for the same unit bundle when he stays at home.[12] Note that the value of the outside option is normalized to zero.

2.3.4 Tobacco Companies

To simplify the model, tobacco companies are neglected throughout this paper. This is motivated by the following assumptions. First, the tobacco companies

not affect the analysis in a significant way and leaves the general results unchanged. It only raises the outside option for the smokers and therefore makes their participation constraint more restrictive.

[11] Due to the laws of diffusion and the Brownian Motion tobacco smoke spreads evenly in the air space surrounding the source of smoke. It therefore takes by nature the form of negative network externalities.

[12] I define gross utility as utility excluding "transportation costs" and net utility as utility including them.

cannot directly influence the market for pubs and therefore act unstrategically.[13] Second, the utility from smoking s is net the production costs that the tobacco companies incur by producing this unit of consumed tobacco. Third, prices paid by the consumers are directly transferred to the tobacco companies. Since the tobacco companies also enter the welfare function, the welfare effect of smoking or not smoking is reduced to the net utility s per consumer.

2.3.5 Timing of the Game and Structure of the Chapter

The structure of the game is the following:

1. **stage:** The legislation decides whether to allow smoking or to impose a general smoking ban in bars, restaurants, etc.

2. **stage:** If smoking is allowed, firms decide whether to allow or prohibit smoking in their establishment. Both firms observe the respective other firm's decision. If at the first stage a smoking ban is imposed, the second stage does not apply.

3. **stage:** Both establishments simultaneously choose their prices.

4. **stage:** Consumers observe the prices and decide to which pub they go.

5. **stage:** Payoffs are realized.

As usual, the game will be solved by backwards induction. Five subgames have therefore to be distinguished. Two pairs of them are completely symmetric and can thus be treated as one. First, smoking is allowed by both pubs (section 2.4). Second, smoking is prohibited by law or by both pubs voluntarily (section 2.5). Third, pub i allows smoking and pub j prohibits smoking (section 2.7). Comparison of the welfare of cases 1 and 2 yields a condition under which a smoking ban is desirable (section 2.6). Comparison of profits in case 1 and case 3 yields a condition under which it is not profitable for an establishment to prohibit smoking voluntarily (section 2.8). Solving these

[13] This is actually not quite right. As a former promoter of a cigarette producer told me, pubs get significant amounts of money by tobacco firms for placing ash-trays with the respective logo on the tables and counters. Since this would only strengthen the point we are going to make in this paper, we neglect it here for simplicity.

two conditions simultaneously shows that there are reasonable combinations of parameter ranges for which prohibition of smoking in both pubs is desirable, but will not be provided voluntarily. Consequently, for these combinations of parameter ranges, a general smoking ban is welfare increasing. Section 2.9 discusses the role of separate seating instead of complete bans. The paper concludes in section 2.10.

2.3.6 Assumptions

Assumptions 1 and 2 guarantee concavity of profits in prices in all relevant cases:

Assumption 1: $t > \frac{N_{ns}N_s}{N_{ns}+N_s}e$

Assumption 2: $t > \alpha(N_s + N_{ns})$

Assumption 3-9 are straightforward restrictions of the parameter values to the space of positive real numbers:

Assumption 3-9: $\alpha, e, s, N_{ns}, N_s, u_s, u_{ns} > 0$

Assumption 10 ensures that markets are always covered in equilibrium:

Assumption 10: u_{ns} and u_s are sufficiently large to ensure that markets are always covered.[14]

2.4 Status Quo - A and B as Smoker Pubs

I call the case in which both pubs allow smoking "status quo", because this is what is observed in Germany at present.

Demand fractions n_l^i can be found by determining the marginal consumer, who is situated at point x and is indifferent between going to pub A or B:

$$U_l^A - tx_l = U_l^B - t(1 - x_l) \tag{2.3}$$

$$\Leftrightarrow x_l = \frac{1}{2} + \frac{U_l^A - U_l^B}{2t} \tag{2.4}$$

Market shares are therefore

[14] The precise thresholds are tedious to calculate, because of the asymmetric case. Since the precise thresholds are also irrelevant for the (theoretic) result of this paper, we can content ourselves with assuming that the utility from going to a pub is so large that markets are always covered. Stating the precise condition does not add any useful information.

$$\Rightarrow n_l^i = \frac{1}{2} + \frac{U_l^i - U_l^j}{2t} \tag{2.5}$$

Substituting the utilities from equations 2.1 and 2.2 into 2.5, taking into account that $n_l^i = 1 - n_l^j$, and solving for n_l^i yields the demand reaction functions $n_l^i(n_m^i)$. Solving these simultaneously for the demand fractions yields:

$$n_{ns}^i = \frac{1}{2} + \frac{(p^j - p^i)(t - eN_s)}{2(t^2 - t\alpha(N_{ns} + N_s) + \alpha e N_{ns} N_s)} \tag{2.6}$$

$$n_s^i = \frac{1}{2} + \frac{(p^j - p^i)t}{2(t^2 - t\alpha(N_{ns} + N_s) + \alpha e N_{ns} N_s)} \tag{2.7}$$

Assumption 2 guarantees that the denominator of n_l^i is non-zero.

Note that $n_{ns}^i \neq n_s^i$ if $p^j \neq p^i$. Suppose for example that $p^j > p^i$ and $t > eN_s$, then firm i catches more than half of the smoker market. Then, however, non-smokers suffer more negative externalities there than in the high-pricing pub. This drives some of them away. Consequently, the low-pricing pub has fewer non-smokers than smokers. If e is very large, it is possible that the market share on the non-smoker side even drops below 1/2. However, if firms are symmetric - as we assume here - the outcome will be $p^j = p^i$ and therefore $n_{ns}^i = n_s^i = n_{ns}^j = n_s^j = \frac{1}{2}$.

Remembering that demand is demand fractions multiplied by the total numbers of respective customers, profits are given by

$$\pi^i = (p^i - c)n_{ns}^i N_{ns} + (p^i - c)n_s^i N_s \tag{2.8}$$

Substituting 2.6 and 2.7 into this equation, we can rewrite profits as:

$$\begin{aligned}\pi^i = (p^i - c)&\left(\frac{1}{2} + \frac{(p^j - p^i)(t - eN_s)}{2(t^2 - t\alpha(N_{ns} + N_s) + \alpha e N_{ns} N_s)}\right) N_{ns} \\ + (p^i - c)&\left(\frac{1}{2} + \frac{(p^j - p^i)t}{2(t^2 - t\alpha(N_{ns} + N_s) + \alpha e N_{ns} N_s)}\right) N_s\end{aligned} \tag{2.9}$$

which is quadratic in the price and concave under Assumption 1. We can therefore differentiate w.r.t. p^i, set this equal to zero, solve for p^i to get the reaction functions. We solve these simultaneously and rearrange to get equilibrium prices

$$p^i = \underbrace{c}_{\text{costs}} \underbrace{-(N_{ns} + N_s)\alpha}_{\text{network externalities}} \underbrace{+t}_{\text{market power}} \underbrace{+\frac{N_{ns}N_s et}{(N_{ns} + N_s)t - N_{ns}N_s e}}_{\text{negative externalities}} \tag{2.10}$$

Interpretation:

1. The **first term** are the costs.

2. The **second term** captures the effect of network externalities. Network externalities stiffen the competition, because each additional customer does not only yield extra profits, but also adds to the value of the network for all other existing and potential new members. Hence, this term reduces the price.

3. The **third term** represents the effect of market power due to differentiation.

4. The **fourth term** can be interpreted as the effect of the negative externalities: These externalities weaken the network externalities on the non-smoker market side. Assumption 1 ensures that the term is positive.

Because of the symmetry, $p^A = p^B$. Therefore each of the two pubs gets half of both market sides and profits are:

$$\pi^i_{ss} = \frac{1}{2}\left[t - (N_{ns} + N_s)\alpha + \frac{N_{ns}N_s et}{(N_{ns} + N_s)t - N_{ns}N_s e}\right](N_{ns} + N_s) \tag{2.11}$$

where the index ss denotes the case we are in (both pubs allow smoking). Note that assumption 2 guarantees that profits are positive.

Welfare Let us define welfare in this paper as the sum of consumer and producer surplus. Note that the prices paid become thereby irrelevant for the total welfare - as long as markets are covered.

Consumer surplus is then

$$
\begin{aligned}
CS^{SQ} &= C_{ns}^{SQ} + C_{s}^{SQ} \\
&= N_{ns}\left(u_{ns} + \frac{\alpha}{2}(N_{ns}+N_s) - \frac{1}{4}t - \frac{e}{2}N_s - p_i\right) \\
&\quad + N_s\left(u_s + \frac{\alpha}{2}(N_{ns}+N_s) - \frac{1}{4}t + s - p_i\right)
\end{aligned}
$$

Producer surplus is given by

$$PS^{SQ} = 2\pi^i = (p_i - c)(N_{ns} + N_s)$$

Consequently, total welfare sums up to

$$W^{SQ} = \underbrace{\left(\alpha\frac{(N_{ns}+N_s)}{2} - \frac{1}{4}t - c\right)(N_{ns}+N_s)}_{1} \underbrace{+N_{ns}u_{ns}}_{2} \underbrace{+N_s u_s}_{3} \underbrace{+sN_s}_{4} \underbrace{-\frac{e}{2}N_s N_{ns}}_{5} \tag{2.12}$$

Interpretation

1. The first term is the sum of the benefits that every consumer has from enjoying other bar visitors' company minus the total of transportation and production costs.
2. The second and third term measure the sum of the value added of visiting a bar instead of staying at home for the different consumer types.
3. The fourth term captures the pleasure smokers enjoy from smoking.
4. The fifth term is sum of negative externalities that non-smokers suffer from the smoke.

2.5 Prohibition of Smoking - A and B as Non-Smoker Pubs

This section is concerned with the two cases in which either the government imposes a general smoking ban or in which both pubs prohibit smoking voluntarily.

We find the pubs' demand in the same way as in the preceding section. Now, however, the gross utilities are:

$$U^i_{ns} = u_{ns} + \alpha(n^i_{ns}N_{ns} + n^i_s N_s) - p^i$$

for a non-smoker who visits pub i. Equivalently,

$$U^i_s = u_s + \alpha(n^i_{ns}N_{ns} + n^i_s N_s) - p^i$$

for a smoker who visits pub i.

The resulting demand reaction functions $n^i_l(n^i_m)$ solve simultaneously for the following demand fractions:

$$n^i_{ns} = \frac{1}{2} + \frac{p^j - p^i}{t - \alpha(N_{ns} + N_s)}$$

$$n^i_s = \frac{1}{2} + \frac{p^j - p^i}{t - \alpha(N_{ns} + N_s)}$$

Assumption 2 does not only guarantee that the denominator of n^i_l is non-zero, but also that the maximization problem is concave in price as well as non-negativity of profits in the pricing equilibrium.

Profits are generally given by

$$\pi^i = (p^i - c)(n^i_{ns}N_{ns} + n^i_s N_s)$$

Substituting for the demand fractions we can rewrite profits as

$$\pi^i = (p^i - c)\left(N_{ns} + N_s\right)\left(\frac{1}{2} + \frac{p^j - p^i}{t - \alpha(N_{ns} + N_s)}\right)$$

Differentiation w.r.t. p^i, setting this equal to zero, solving for p^i yields the reaction functions. We solve these simultaneously and rearrange to get equilibrium prices

$$p^i = \underbrace{c}_{\text{costs}} \underbrace{-(N_{ns} + N_s)\alpha}_{\text{network externalities}} \underbrace{+t}_{\text{market power}} \tag{2.13}$$

which is strictly smaller than the price in the status quo case. The reason is that the negative externalities of tobacco consumption by smokers effectively transform into a unilateral decrease of network effects. This softens the price competition in the status quo case. Consequently, this implies that the opposite, namely a prohibition of smoking in all pubs, increases network effects and thereby intensifies competition.

Proposition 2.1 *Under assumptions 1,2, 10 and symmetry an inner solution is guaranteed. Then prohibition of smoking (by law or by both pubs voluntarily) increases competition among pubs and therewith result in lower prices.*

Because of the symmetry, the two pubs share markets equally. Profits are therefore:

$$\pi^i_{nsns} = \frac{1}{2}t\,(N_{ns} + N_s) - \frac{1}{2}\alpha(N_{ns} + N_s)^2$$

Proposition 2.2 is straightforward:

Proposition 2.2 *The profits associated with Proposition 1 are strictly lower than if both pubs allow smoking.*

This result is in line with existing empirical studies. Recall, for example, Dunham and Marlow's (2000) numbers from section 2. They report that 39% of restaurant owners in the U.S. and 83% of bar owners expect or already experienced decline in profits as a result of stricter smoking regulation, while only 6% and 2% respectively predict revenue increases.

Welfare We proceed for this case analogously to the section on the status quo.

Consumer surplus is given by

$$\begin{aligned} CS^{Ban} &= C^{Ban}_{ns} + C^{Ban}_{s} \\ &= N_{ns}\left(u_{ns} + \frac{\alpha}{2}(N_{ns} + N_s) - \frac{1}{4}t - p_i\right) \\ &\quad + N_s\left(u_s + \frac{\alpha}{2}(N_{ns} + N_s) - \frac{1}{4}t - p_i\right) \end{aligned}$$

Producer surplus is given by

$$PS^{Ban} = 2\pi^i = (p_i - c)(N_{ns} + N_s)$$

Consequently, total welfare sums up to

$$W^{Ban} = \left(\frac{\alpha}{2}(N_{ns} + N_s) - \frac{1}{4}t - c\right)(N_{ns} + N_s) + N_{ns}u_{ns} + N_s u_s \qquad (2.14)$$

The interpretation of this equation is the same as for the welfare in the previous case except that here terms four and five are missing due to the smoking ban.

2.6 When is a General Prohibition of Smoking in Pubs Welfare Improving?

A prohibition of smoking in pubs increases welfare if

$$\begin{aligned} W^{Ban} &> W^{SQ} \\ &\Rightarrow \left(\frac{\alpha}{2}(N_{ns} + N_s) - \frac{1}{4}t - c\right)(N_{ns} + N_s) + N_{ns}u_{ns} + N_s u_s \\ &> \left(\frac{\alpha}{2}(N_{ns} + N_s) - \frac{1}{4}t - c\right)(N_{ns} + N_s) + N_{ns}u_{ns} + N_s u_s + sN_s \\ &\quad -\frac{e}{2}N_s N_{ns} + sN_s \qquad (2.15) \\ \Leftrightarrow \frac{e}{2}N_{ns} &> s \qquad (2.16) \end{aligned}$$

The interpretation of this inequality is straightforward. The positive net utility that a smoker gets from smoking is smaller than the negative externality that he causes for the non-smokers who visit the same pub.

Proposition 2.3 *Banning smoking is desirable iff* $\frac{e}{2}N_{ns} > s$.

We now have to check whether this inequality contradicts the set of conditions under which it is rational for a pub not to prohibit smoking by itself. If there is no contradiction, then the legislator should check whether there is indeed room for a welfare improving ban of smoking in pubs, restaurants, etc.

2.7 One Smoker Pub and One Non-Smoker Pub

In order to understand why there are so few - if any - non-smoker pubs we need to calculate profits for a pub that decides to prohibit smoking unilaterally. Let us here take A as the pub that prohibits smoking.

As in the previous sections market fractions are given by

$$n_l^i = \frac{1}{2} + \frac{U_l^i - U_l^j}{2t} \tag{2.17}$$

Proceeding in the same way as before, we find the explicit expression for n_l^i with the difference being that there is no symmetry between the pubs anymore:

For the non-smoker side:

$$\begin{aligned} n_{ns}^A &= \overbrace{\frac{1}{2}}^{1.} + \frac{\overbrace{(p^B - p^A)t}^{2.}}{2(t^2 - t\alpha(N_{ns} + N_s)) + \alpha N_{ns} N_s e} \\ &+ \frac{\overbrace{-(p^B - p^A)N_s e}^{3.} \overbrace{+ eN_s(s - \alpha N_s + t)}^{4.} \overbrace{-2\alpha N_s s}^{5.}}{2(2(t^2 - t\alpha(N_{ns} + N_s)) + \alpha N_{ns} N_s e)} \end{aligned} \tag{2.18}$$

$$\begin{aligned} n_{ns}^B &= 1 - n_{ns}^A = \frac{1}{2} + \frac{(p^A - p^B)t}{2(t^2 - t\alpha(N_{ns} + N_s)) + \alpha N_{ns} N_s e} \\ &+ \frac{-(p^A - p^B)N_s e - eN_s(s - \alpha N_s + t) + 2\alpha N_s s}{2(2(t^2 - t\alpha(N_{ns} + N_s)) + \alpha N_{ns} N_s e)} \end{aligned} \tag{2.19}$$

Interpretation: For illustrative reasons let us analyze n_{ns}^A. For n_{ns}^B an analogous interpretation holds, except that some signs are reverted.

1. Each pub gets half the market.
2. Pub A gets an additional share if its price is lower than that of pub B.
3. The negative externalities that non-smokers suffer from smoking soften the price effects. This is best understood in comparative statics terms.

Consider some status quo demand n_{ns}^A. Suppose now that pub B raises its price. We would expect n_{ns}^A to increase. This, however, is not unambiguously the case, because as p^B increases, also smokers leave pub B (on the margin exactly N_s). Therewith, the amount of smoke is reduced (by precisely eN_s on the margin) and thus more non-smokers are attracted to pub B and thereby less to pub A.

4. The fourth component captures the positive demand effect of the negative externalities: The marginal group of smokers at pub B produces N_s units of smoke, i.e. $N_s e$ units of smoking externalities. This will drive non-smokers out of pub B into pub A. (The term in brackets is larger than zero by assumption 2.)

5. The fifth factor represents the comparative advantage that utility from smoking gives the smoker pub B: Smokers have more utility (net transportation costs) from pub B than from pub A. Thus, c.p. they prefer this pub. This increases the network size in B, which again attracts also non-smokers.

For the smoker side:

$$n_s^A = \frac{1}{2} + \frac{\overbrace{(p^B - p^A)t}^{1} \overbrace{- s(t - \alpha N_{ns})}^{2} \overbrace{+ \frac{1}{2}\alpha e N_{ns} N_s}^{3}}{2(t^2 - t\alpha(N_{ns} + N_s)) + \alpha N_{ns} N_s e} \tag{2.20}$$

$$n_s^B = 1 - n_s^A = \frac{1}{2} + \frac{(p^A - p^B)t + s(t - \alpha N_{ns}) - \frac{1}{2}\alpha e N_{ns} N_s}{2(t^2 - t\alpha(N_{ns} + N_s)) + \alpha N_{ns} N_s e} \tag{2.21}$$

Interpretation:

Each pub gets half the market plus a factor whose numerator consists of three parts:

1. Market power due to product differentiation softens the competition.

2. This component measures the value added of allowing smoking. Due to assumption 2 it is always negative for the non-smoker pub and positive for the smoker pub.

3. The third part measures the interaction between the negative externality of smoking, network effects and groups sizes. It adds demand to the non-smoker pub and decreases the demand for the smoker pub for the following reason: non-smokers dislike smoke and will therefore prefer the non-smoker pub A. This increases A's network and thereby also attracts more smokers.

Profits are given by

$$\pi^i = (p^i - c)(n^i_{ns} N_{ns} + n^i_s N_s) \tag{2.22}$$

both of which are quadratic in own price. Furthermore, both are concave under assumptions 1 and 2. To find the equilibrium prices we differentiate w.r.t. p^i, set this equal to zero, solve for p^i to get the reaction functions. We solve these simultaneously and rearrange to get equilibrium prices

$$\begin{aligned} p^A \;=\; & \underbrace{c}_{\text{costs}} \underbrace{-(N_{ns}+N_s)\alpha}_{\text{network externalities}} \underbrace{+t}_{\text{market power}} + \underbrace{\frac{4N_{ns}N_s e t}{6t(N_{ns}+N_s) - 3N_{ns}N_s e}}_{\text{negative externalities}} \\ & \underbrace{-sN_s \frac{2t - N_{ns}}{6t(N_{ns}+N_s) - 3N_{ns}N_s e}}_{\text{comparative } \textbf{disadvantage}} \end{aligned} \tag{2.23}$$

$$\begin{aligned} p^B \;=\; & \underbrace{c}_{\text{costs}} \underbrace{-(N_{ns}+N_s)\alpha}_{\text{network externalities}} \underbrace{+t}_{\text{market power}} + \underbrace{\frac{2N_{ns}N_s e t}{6t(N_{ns}+N_s) - 3N_{ns}N_s e}}_{\text{negative externalities}} \\ & \underbrace{+sN_s \frac{2t - N_{ns}}{6t(N_{ns}+N_s) - 3N_{ns}N_s e}}_{\text{comparative } \textbf{advantage}} \end{aligned} \tag{2.24}$$

Interpretation: Note that the first three terms of each price are identical to those of equation 2.4, i.e. for the price pair in the section, where both pubs were of the smoker type.

1. The **first term** are the costs.

2. The **second term** captures the effect of network externalities.

3. The **third term** represents the effect of market power due to the price differentiation.

4. The **fourth term** is positive by our concavity assumption, and it can be interpreted as the effect of the negative externalities. Note, however, that now pub A is a non-smoker pub. For the smoker pub (B) the interpretation from the previous section still holds: The negative externalities weaken the network externalities on the non-smoker market side, thereby giving the differentiation parameter a stronger weight. This effect is therefore still larger than zero but

   - smaller in comparison with equation 2.4 and
   - smaller in comparison with the price the non-smoker pub can demand (p^A)

   because non-smokers are deterred from the smoker pub and attracted by the non-smoker pub. For the non-smoker pub (A) the interpretation changes: People do not smoke here. Therefore, the network externalities are not weakened on the non-smoker side. They rather increase non-smokers' willingness to pay.

5. As long as $N_{ns} < 2t$, i.e. the number of non-smokers is sufficiently small, the **fifth term** is negative for pub A and positive for pub B. The reason is that it captures the value that being allowed to smoke adds to pub B's guests, i.e. pub B's comparative advantage.

Note that we do not make any assumptions that guarantee positive profits here. The reason is that we want to find out why π^A is smaller than π^i of the previous section, because this should be the case. Otherwise we would observe non-smoker bars. This, however, explicitly includes the possibility that $\pi^A < 0$.

The profits can be found by substituting equilibrium prices into the profit functions. Simplification yields

$$\pi^A_{nss} = \frac{(2N_s t(-3t + 3\alpha N_s + 6N_{ns}\alpha + s) + 6N_{ns}t(\alpha N_{ns} - t)}{18(-N_{ns}N_s e + 2N_s t + 2tN_{ns})} \frac{-N_{ns}N_s e(3N_s\alpha + s + t + 3\alpha N_{ns}))^2}{(\alpha N_{ns}N_s e + 2t^2 - 2\alpha N_s t - 2t\alpha N_{ns})} \quad (2.25)$$

$$\pi^B_{nss} = \frac{(2N_s t(3t - 3\alpha N_s - 6N_{ns}\alpha + s) - 6N_{ns}t(\alpha N_{ns} - t)}{18(-N_{ns}N_s e + 2N_s t + 2tN_{ns})} \frac{+N_{ns}N_s e(3N_s\alpha - s - t + 3\alpha N_{ns}))^2}{(\alpha N_{ns}N_s e + 2t^2 - 2\alpha N_s t - 2t\alpha N_{ns})} \quad (2.26)$$

2.8 Is there a Case for Governmental Intervention?

Up to now we have solved the problem on stages 3-5. Now we are at stage 2. Suppose that $\frac{e}{2}N_{ns} > s$ holds, but that the legislation does not issue a general ban of smoking in the hope that the free market solves the externality problem by itself. How do pubs react? Is it possible that both pubs allow smoking, nevertheless? The following payoff matrix illustrates the situation:

		Pub B	
		smoking	non-smoking
Pub A	smoking	$\pi^A_{ss} = \pi^B_{ss}$	π^A_{sns} π^B_{sns}
	non-smoking	π^A_{nss} π^B_{nsns}	$\pi^A_{nsns} = \pi^B_{nsns}$

Indeed, smoking/smoking can be a Nash equilibrium, despite the fact that $\frac{e}{2}N_{ns} > s$, as is shown in the proof of proposition 2.4. Then, however, the legislation should enact a general ban of smoking, because the market yields a welfare inferior outcome.

Proposition 2.4 *Under assumptions 1-10, a general ban of smoking by law is necessary and welfare improving if* $\frac{e}{2}N_{ns} > s$ *and* $\pi^A_{nss} < \pi^A_{ss}$ *(and equivalently*

$\pi^B_{sns} < \pi^B_{ss}$). *There exists a range of parameter constellations, for which this is the case.*

Proof. The task is to prove that there exists a solution to a certain set of inequalities. The inequalities are:

First, a pub must get higher profits from allowing smoking (equation 2.11) than from prohibiting it unilaterally (equation 2.25):

$$\begin{aligned} & \frac{1}{2}\left[t-(N_{ns}+N_s)\alpha+\frac{N_{ns}N_s et}{(N_{ns}+N_s)t-N_{ns}N_s e}\right](N_{ns}+N_s) \\ & -\frac{1}{18}\frac{(-6N_s t^2-6N_{ns}t^2+6\alpha N_s^2 t-N_{ns}N_s et+12N_{ns}\alpha N_s t+2N_s st+6t\alpha N_{ns}^2}{(-N_{ns}N_s e+2N_s t+2tN_{ns})} \\ & \frac{-3N_{ns}N_s^2 e\alpha-N_{ns}N_s es-3\alpha N_{ns}^2 N_s e)^2}{(\alpha N_{ns}N_s e+2t^2-2\alpha N_s t-2t\alpha N_{ns})} \\ \geq & \ 0 \end{aligned} \tag{2.27}$$

Second, prohibiting smoking in all pubs must be welfare superior to not prohibiting it, i.e. $\frac{e}{2}N_{ns} > s$ must hold. This can be translated into $s = \frac{e}{2}N_{ns} - \varepsilon$ with $\varepsilon > 0$. Substituting for s in 2.27 yields

$$\begin{aligned} & \frac{1}{2}\left[t-(N_{ns}+N_s)\alpha+\frac{N_{ns}N_s et}{(N_{ns}+N_s)t-N_{ns}N_s e}\right](N_{ns}+N_s) \\ & -\frac{1}{18}\frac{(-6N_s t^2-6N_{ns}t^2+6\alpha N_s^2 t-N_{ns}N_s et+12N_{ns}\alpha N_s t}{(-N_{ns}N_s e+2N_s t+2tN_{ns})} \\ & \frac{+(2tN_s-N_{ns}e)(\frac{e}{2}N_{ns}-\varepsilon)+6t\alpha N_{ns}^2-3N_{ns}N_s^2 e\alpha-3\alpha N_{ns}^2 N_s e)^2}{(\alpha N_{ns}N_s e+2t^2-2\alpha N_s t-2t\alpha N_{ns})} \\ \geq & \ 0 \end{aligned} \tag{2.28}$$

Additionally the assumptions 1-10 and $\varepsilon > 0$ must hold.

The proof used here is a proof by construction: We construct an interval of solutions in $\mathbb{R}$.

Assume the following valid parameter values (assumptions 1, 3-10 and $\varepsilon > 0$ are fulfilled): $N_{ns} = N_s = 300, e = 0.01, t = 20, \varepsilon = 0.001, u_s = u_{ns} = 14$. Inserting these values in 2.28 yields

$$\frac{5565617.700\alpha - 192744.2130}{23100\alpha - 800} \geq 0 \tag{2.29}$$

Note that by assumption 2 α is now restricted to the interval $[0, 1/30]$. Therefore we can solve inequation 2.29 for α:

$$\alpha \leq 0,03463123473248980072777905676130 1$$

It follows that one solution to the set of twelve inequalities is given by:

$$N_{ns} = N_s = 300, e = 0.01, t = 20, \varepsilon = 0.001, u_s = u_{ns} = 14, \alpha \epsilon \left] 0, \frac{1}{30} \right[$$

■

The easiest way to get an intuition for this result is to ignore the social network parameter, i.e. set $\alpha = 0$ for illustration. Then the result from proposition 2.4 is driven only by the negative externality from smoking. At the outset one may think that in absence of complicating social network effects pub A should always gain from prohibiting smoking, because the prohibition will give it a competitive advantage. On the margin this is indeed the case. But there is an additional effect. Prohibiting smoking works as a softening of negative network effects or, in other words, as an increase of (positive) network externalities. Thus, it increases competition. If pub A prohibits smoking and $\frac{e}{2}N_{ns} > s$ holds, then pub B loses more customers on the non-smoker side than it wins on the smoker side. This may force the owner of pub B to lower it's price. Pub A will react by decreasing it's own price and may end up with lower profits than if it had not banned smoking in its domain.

What role does the social network parameter α play? It turns out that the overall effect is ambiguous and hinges on the relation to the other parameters. This can best be seen by concentrating on the thickness of the two market sides. If, for instance, N_s is relatively large, then α spurs two countervailing effects. On the one hand, the social network effect makes the comparative advantage from being a non-smoker pub smaller on the margin. It thereby makes it less likely that the pub gains by prohibiting smoking. On the other hand, together with the comparative advantage also the competitive pressure decreases, i.e. the other, the smoker pub will - if at all - lower its price less strongly. Thus, the overall effect of α is ambiguous and dependent on the other parameters.

2.9 Extension: Separate Seating for Smokers and Non-Smokers

Typically, the literature as well as opponents of smoking bans concentrate in their argumentation on separate seating and not so much on complete bans. They do not claim that pubs would prohibit smoking completely if it were in the interest of the customers. Rather they say that owners would offer separate seatings for smokers and non-smokers. In the optimum, seating will be allocated according to the people's preferences.

In our model such a decision can be interpreted as a decrease in externality each smoker produces in a smoking pub. If separation can be done perfectly, e may be set to zero. What is the effect? Do pubs have an interest in doing so?

If one pub decides to do so, we are in case 3. The only difference to our analysis above is that now pub A does not lose any customers on the smoker side. This also means, however, that pub B is even more under pressure to lower its price. The resulting price may make pub A even worse off.

Some people may rightfully object that pub B could also react by offering separate seating itself. The relevant case for this situation is the one in which both pubs allow smoking, i.e. section 2.4. How does a decrease in the externality in both pubs affect profits here? Recall equation 2.11.

$$\pi^A = \pi^B = \pi^i = \frac{1}{2}\left[t - (N_{ns} + N_s)\alpha + \frac{N_{ns}N_s et}{(N_{ns} + N_s)t - N_{ns}N_s e}\right](N_{ns} + N_s)$$

Under assumption 2 profits are increasing with the externality. Therefore, while it may be in the unilateral interest of a pub to offer separate seating for non-smokers, it is certainly not in the whole industries' interest. This helps to explain the intensity with which the German gastronomy lobby groups fight against smoking bans.

2.10 Conclusion

In Germany it is controversially discussed whether the legislation should enact a general ban of smoking in restaurants, bars and alike establishments. The main argument in favor of such a regulatory measure is that smokers produce a negative externality from which non-smokers need to be protected. Opponents of such an intervention claim that the free market solves this problem itself. If it were in the interest of consumers to have non-smoker bars, owners would follow customers' demand and prohibit smoking. The fact that this is not done, shows that consumers prefer smoker bars. Therefore, no general ban is needed.

This paper investigates the arguments used in this debate. It is shown that the free market does not necessarily act in the public's interest. There are reasonable ranges of parameter constellations for which pubs do not prohibit smoking in their domain, although this would increase welfare. The reason for this is the following: When a customer consumes tobacco, the resulting smoke spreads in the whole room, disturbing all non-smokers present. Therefore smoking externalities take the form of negative network externalities. Negative network externalities, however, soften competition. In this sense, choosing to allow smoking can work as a collusive device for bars.

A typical drawback of the Hotelling model used in this paper is that market coverage has to be assumed to capture competitive effects. I concede that it would be more realistic to have a deeper market to allow for consumers who do not go to a pub. A starting point for such a model is described by Bockem (1994). It turns out, however, that such a model with network externalities and asymmetric firms, as needed for our purpose, is very tedious to track. I conjecture, furthermore, that it also does not make any difference for the key results of this paper for the following reasons. First, in all three cases firms would demand lower prices, but smoking regulation will nevertheless strengthen competition and lead to even lower prices. Second, from the welfare perspective lower prices are good and make smoking regulation even more desirable.

I conclude that the free market does not necessarily yield the welfare optimal outcome. There may very well be a case for governmental intervention in the form of a general smoking ban. In the end this is, however, an empirical question. The value of this paper lies in structuring the question, identifying the crucial effects and building the foundation for empirical work.

Chapter 3

The Puzzle of Non-Informative Advertising: A Behavioral Approach

3.1 Introduction

Advertising is a phenomenon that economists usually feel ambiguous about. On the one side, some advertising (like yellow pages) reveals information about product attributes, quality and price. Since this reduces information, search and transaction costs as well as increases price competition, this sort of advertising is clearly welfare increasing.[1] On the other side, there is non-informative advertising (like TV commercials). As an example, take a handsome middle-aged model driving a BMW sports vehicle down a scenic coastline. What does this tell a consumer? Not much. Still, there must be some reaction in consumer behavior. Otherwise, firms would be wasting billions of dollars (in 2003 the TV advertising expenditures in the U.S. alone rose over $50 billion).[2] So, how does non-informative advertising work? Does it influence demand? Always? When? What are the welfare implications? Is Marshall (1919) right by describing advertising as a *social waste*?

The explanation that comes to mind first is that advertising could have an influence on people's preferences. This persuasive view was developed by Chamberlin (1933), Kaldor (1950) and others.[3] Typically, however, these works lack microeconomic modelling of consumer behavior. Rather, it is simply assumed that advertising shifts the demand curve outwards. Thus, these models are not applicable in answering our question, because, first, it is left open why exactly demand is increased. Second, by assuming that advertising somehow changes preferences, fundamental assumptions on rational behavior are violated. Third, stringent welfare analysis is not possible - simply because there is no stringent micro foundation.

This failure has inspired some researchers (especially Nelson (1970, 1974)) to alter the informative view by postulating that "non-informative" advertising may convey information indirectly. They claim that there are goods the quality of which can only be experienced. Non-informative advertising can then convey indirect information by working as some sort of signal of the good's

[1] This 'informative view' of advertising was first developed by Ozga (1960), Stigler (1961), and Telser (1964). For a good overview on the advertsing literature in general see Bagwell (2003).

[2] Source: TNS Media Intelligence/CMR (2006).

[3] see also Braithwaite (1928), Robinson (1933), Galbraith (1958, 1967), Packard (1957, 1969), Dixit and Norman (1978).

quality. While this idea has its appeal, it, too, faces limitations. First, the distinction between experience and normal (pure search goods) is somewhat arbitrary. Second, Nelson does not provide a formal model of his predictions. Subsequent researchers, especially Schmalensee (1978), provide such a model and show that it is not necessarily true that (only) high quality firms advertise.[4] For example, a producer of low quality typically also has lower marginal costs. He will therefore gain differentially from demand expansion and consequently advertise more. Additionally, producers of high quality find it more profitable to signal quality through prices. These objections are supported by the empirical literature.[5]

The third prominent approach to advertising is the complementary view developed by Stigler and Becker (1977) and extended by Becker and Murphy (1993). They claim that advertising is a complement to the good advertised. Then, as advertising increases, the marginal utility of the good also increases and so does demand. Modelling advertising this way allows for standard welfare analysis. Still, in the application of this theory a number of problems arise. First, it is unclear why and in what way advertising increases the marginal utility of the advertised good. An intuitive justification would be that advertising raises the prestige of the good consumed. However, prestige is usually considered as some sort of admiration that other people have for the good. In other words, the consumer's marginal utility is increased only if peer mates regard the good as more valuable. Then, however, one's own consumption of advertising becomes irrelevant.[6] Second, it is questionable whether people consume advertisement on a voluntary basis. Third, modelling advertisement and the advertised good as complements also implies that the more I consume the more I enjoy watching advertisement for the good, which seems a bit awkward.

In this paper a new theory of non-informative advertising is offered that is based upon new developments in behavioral economics. The theory has two elements. First, it is claimed that consumer decisions are embedded in social environments. To incorporate this into the formal analysis the theory of inequity aversion is transformed into a standard consumer optimization

[4] See also Horstmann and MacDonald (1994) and Bagwell (2003).

[5] See e.g. Caves and Greene (1996) and Bagwell (2003) for an overview.

[6] Engström (2004) picks up this criticism and shows how the Becker and Murphy model can be generalized.

problem. Second, it is argued that advertising may work as a mean to change people's reference group rather than their preferences.

3.2 A Behavioral Model of Advertising

3.2.1 Reference Points and Utility

Consider the simplest possible consumption decision of an individual who derives utility from consuming a consumption good of quantity or quality x and money m. Specifically, assume that his utility function is of the quasi-linear form.[7] Also, let the consumer face a standard budget constraint as well as the usual non-negativity constraints:

$$U_i(x_i, m_i) = u_i(x_i) + m_i \tag{3.1}$$

$$\text{s.t. } px_i + m_i \leq M_i \tag{3.2}$$

$$x_i \geq 0 \tag{3.3}$$

$$m_i \geq 0 \tag{3.4}$$

where p is the market price for the consumer good and $M_i > 0$ the consumer's budget, both of which are exogenously given. Assume the individual is completely informed about all the parameters and the good's characteristics.

Next, I claim that people's utility is not independent from the consumption of others. Admittedly, this is a debatable assumption. Whether or not utility depends on what other people have and consume is to a large extent related to what goods one talks about. One could, for example, distinguish necessity goods (like oxygen, water and food), whose effect on utility is quite irrelevant of other people's consumption, versus luxury (in a very broad sense) goods such as cars, perfume, diamonds, alcohol, cigarettes, clothes, sweets, etc. Indeed, advertising for necessity goods (bread, fruits, etc.) is rather scarce.[8] The

[7] In most cases it is more intuitive to think of x_i in terms of quality - an example of which would be cars (a lower value of x_i is associated with a middle class type of car and higher one with a more luxurious one). Note that in this setting p would have to be interpreted as the price per unit of quality.

[8] Note that this distinction is quite arbitrary. For example, we see advertising for different kinds of mineral water. Clearly, water is a necessity good. But tap water would usually do it, too. One can easily formalize these observations into the quality setting, described

detailed discussion of this distinction is not of interest here, though. All we need is that consumers compare themselves to other people - a peer group - and that this influences their utility in a specific way: it changes at least in some range of x_i their marginal utility. The basic idea is that *individual (consumption) decisions are usually made in a social context.*[9]

There has been considerable effort in research to explore in what way people's utility is dependent on other people's consumption, starting from simple altruism models, followed by the relative income hypothesis, and most recently, very sophisticated theoretic and experimental studies on envy, reciprocity, fairness, inequity aversion, etc.[10]. Of special interest here are the more recent developments. Specifically, let us use a slightly adjusted version of the *theory of inequity aversion* developed by Fehr and Schmidt (1999) and assume that our individual's utility from consumption of x takes the form

$$u_i(x_i, x_j) = \begin{cases} \phi_i(x_i) - \alpha_i \frac{1}{n-1} \sum_{j \neq i}^{n} max\{\phi_i(x_j) - \phi_i(x_i), 0\} & \text{for } n \geq 2 \\ \phi_i(x_i) & \text{for } n = 1 \end{cases} \tag{3.5}$$

where $\phi_i(x_i)$ denotes the direct utility the individual derives from consuming x_i, on which we impose the usual conditions $\phi_i(0) = 0$, $\frac{d\phi_i(x_i)}{dx_i} > 0$, $\frac{d^2\phi_i(x_i)}{dx_i^2} < 0$, and $\left.\frac{d\phi_i(x_i)}{dx_i}\right|_{x_i=0} = \infty$. Further, $\alpha_i \geq 0$ measures the degree of the individual's discomfort with inequity that is to his disadvantage, n is the number of people in i's reference (peer) group, x_j denotes the consumption of reference peer j, and $\phi_i(x_j)$ is the utility level that i assigns to j's consumption.[11]

above by saying that only from some threshold $\overline{x}_i$ onwards the utility is dependent on other people's consumption of x. For a more detailed sociologic discussion see e.g. Lichtenberg (1996).

[9] Samuelson (2004) provides a nice evolutionary explanation for why people may have developed utility functions that exhibit relative consumption effects. He shows that social preferences can help individuals to survive in a fluctuating environment, because it induces them to make use of information that is conveyed by compatriots' actions.

[10] For a survey of the related literature see e.g Fehr and Schmidt (2001).

[11] Note three distinct changes to the original Fehr-Schmidt utility function:

1. I use direct utility instead of income. This is a neglectable change if one thinks of ϕ_i as money-measured utility.

2. I assume individual i to compare himself to the utility that *he* assigns to x_j rather than what j assigns to it. This way the utility function is more similar to the Fehr-Schmidt one, where measurable pay-offs are compared. In principle, one could of

This utility function differs from standard utility theory by the second term, which measures the utility loss from disadvantageous inequity. Individual i suffers if people of his reference group consume more of x than he does. The more peers consume more than him, the more he suffers. What is more, he only cares about his own relative position within the group (*self-centered inequity*) rather than about overall equity within the group. Note that the inequity aversion term is normalized by division by $n-1$ to make the relative effect of inequity aversion on i's total payoff independent of the number of players.

I use the Fehr-Schmidt utility function, because it is simple, intuitive, and achieves very good results in most economic set-ups that can be tested in experiments, specifically in the ultimatum game, public good games with and without punishment, the gift exchange game, and market games. One could also use alternative utility functions such as developed in Bolton (1991), Bolton and Ockenfels (2000), or Charness and Rabin (1999). The principal mechanics for our purpose remain the same as long as at least in some environments the addition of one player j with x_j changes the marginal utility of x_i. The driving force of this is usually some sort of envy or inequity aversion. I discuss the implications of using this utility function instead of others as we go along.

Let us now turn to the consumption decision.

3.2.2 Consumer Behavior in Absence of Advertising

The consumer faces the following optimization problem

course also use ϕ_j instead, which could be argued to be more realistic, because people already get jealous when they see how much other people enjoy some amount x_j that they themselves would not enjoy that much. I believe, though, that it is more sensible to use ϕ_i because i usually *does not know* j's utility function.

3. This model is one of envy, only. Including dislike of positive deviation from average consumption does not change the results qualitatively.

$$\begin{aligned}
\max_{x_i,m_i} U_i(x_i,m_i) &= \phi_i(x_i) \\
&\quad -\alpha_i \frac{1}{n-1}\sum_{j\neq i}^{n} \max\{\phi_i(x_j)-\phi_i(x_i),0\} + m_i && (3.6) \\
\text{s.t. } px_i + m_i &\leq M_i && (3.7) \\
x_i &\geq 0 && (3.8) \\
m_i &\geq 0 && (3.9)
\end{aligned}$$

which is a bit inconvenient, because the utility function exhibits kinks at every $x_i = x_j$. It is thus not continuously differentiable. It is, however, still concave, continuous and piecewise twice continuously differentiable for all $x_i \neq x_j$. For illustrative reasons let us therefore assume that the parameters are such that in the outset the optimal consumption bundle x_i^* is an interior solution (i.e. $x_i^* < \frac{M_i}{p}$) and that $x_i^* \neq x_j$.[12] It is characterized by

$$\begin{aligned}
x_i^* &: \quad \phi_i'(x_i^*) = \frac{p}{1+\alpha_i \frac{1}{n-1} n^H} \\
m_i^* &= \quad M_i - px_i^*
\end{aligned}$$

where $n^H(x_i^*)$ is defined as the number of peers j who consume more than i in equilibrium, i.e. all peers j with $x_j > x_i^*$.

3.2.3 Consumer Behavior in Presence of Advertising

How does advertising affect the consumer's optimization problem? The persuasive view claims that advertising changes the basic utility function of the individual and thereby creates wants. I, on the contrary, claim that advertising only changes the individual's *reference group*. In other words, it does not create wants, but rather the *feeling of consuming too little*. In proceeding this way violations of the basic assumptions that underlie consumer theory can be avoided: The basic utility function given by (5) stays the same, advertising only changes the peer group.

What precisely do I mean? Take the pre-advertising set-up described in

[12] See appendix 3.A.1 for the formal analysis.

the last section. Suppose that now the consumer is exposed to repeated advertisement in which some model $j = m$ consumes x_m. Suppose that for whatever reasons this model enters the reference group of our individual i.[13] Then his optimization problem becomes:

$$\max_{x_i,m_i} U_i(x_i, m_i) = \phi_i(x_i) - \alpha_i \frac{1}{n}\sum_{j\neq i}^{n} max\{\phi_i(x_j) - \phi_i(x_i), 0\} \quad (3.10)$$

$$-\alpha_i \frac{1}{n} max\{\phi_i(x_m) - \phi_i(x_i), 0\} + m_i \quad (3.11)$$

$$\text{s.t. } px_i + m_i \leq M_i \quad (3.12)$$

$$x_i \geq 0 \quad (3.13)$$

$$m_i \geq 0 \quad (3.14)$$

Naturally, some questions arise in reaction to proceeding this way. Let us anticipate them:

1. Do consumers really compare themselves to ideal models in advertising?

   - In many circumstances, yes. As an example think of teenage girls who watch a model putting skin cream on her face.[14]
   - In other cases this may not be true. Then, however, advertising can work as a reminder of people *like* the models. As an example take a standard middle-aged male model driving a BMW sports cabriolet down the Californian coast line. Middle-aged middle class males that watch this commercial may not compare themselves to the model itself, but very well to people like the model whom they half-know or see on the street.

[13] One could also argue that the model has always been in the individuum's reference group (like e.g. sport stars), but the individuum had no knowledge about x_j. Advertising can then be interpreted as a signal of x_j. The prinicpal mechanics stay the same, but the qualitative outcomes for $x_m < x_i^*$ change.

[14] In this example the girls envy the model's look, of course, which presumably has very little to do with the cream. This can, however, easily be incorporated into our analysis. Suppose the utility of consuming x also depends on some factor (or good) a that is not purchaseable (like e.g. genetic predisposition), where $\partial\Phi(x,a)/\partial a > 0$. Analogously, consider now some x_m, x_i^*, a_i, a_m with $a_m > a_i$. The mechanics of our approach remain the same, with slightly different results.

2. Concerning the first point, why do these girls not compare themselves to these models in absence of advertising?

    - They are models or ideals. They do not exist the way they are presented in advertising.

3. Concerning the second point of item number one, why are not these "real" people part of the consumer's peer group to start with?

    - People like this may be so rare that one does not meet them regularly enough.
    - People like this could be in a different social class that the consumer does not interact with on a basis regular enough so to make him incorporate them into his reference group. As an example, ordinary New Yorkers are unlikely to include movie stars they see once in a while on the street in their daily life peer group.
    - Even if one encounters model-like people regularly enough, they do not talk to you, smile at you, etc. The quality of interaction is insufficient to make them a peer.

4. If that is so, how can advertising make the models (or the people like them) members of the consumer's reference group?

    - Advertising strategists make consumers *familiar* with the models and products by *often repeating* commercials over a longer period of time.
    - The models behave in a much more direct way to the consumer. They are put into a specific, possibly ordinary, environment (not just the street), smile, talk to the consumer, etc.

Accepting this argumentation, how does advertising change consumption behavior? To get an intuition, let us look at figure 1, in which $u(x_i)$ before (blue) and after advertising (red) is depicted. How does the addition of a reference point, say $x_2 < x_m < x_3$, affect consumption?

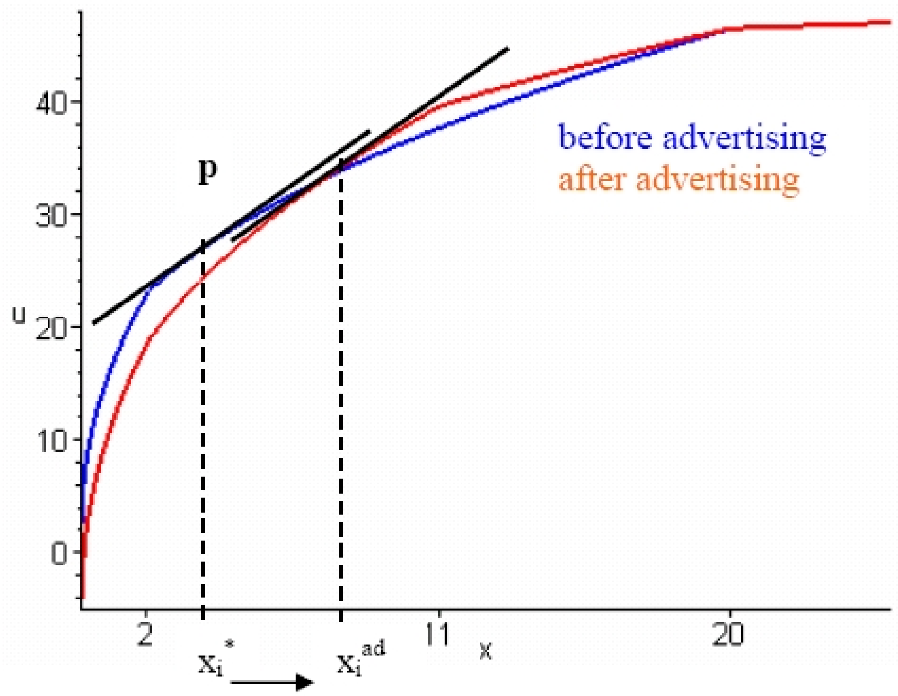

Figure 1: Before advertising (blue) with peers $x_2 = 2$ and $x_3 = 20$. After advertising (red) with peers at $x_2 = 2$ and $x_3 = 20$ and $x_m = 11$.

Proposition 3.1 *For every $x_i \neq x_j$ and $x_i \in [0, x_m[$ **marginal utility** $u_i'(x_i)$ increases. For every $x_i \neq x_j$ and $x_i \in]x_m, \max\{x_m, x_j^{\max}\}[$ marginal utility decreases. For every $x_i > \max\{x_m, x_j^{\max}\}$ marginal utility remains unchanged.*

Proof. See appendix 3.A.2. ■

Since marginal utility determines the consumption level, such advertising changes consumption behavior. Specifically:

Proposition 3.2 *If consumer i consumes $x_i^* \neq x_j$ and $x_i^* \in [0, x_m[$ in the pre-advertising situation, then advertising induces him to increase consumption. For every $x_i^* \neq x_j$ and $x_i^* \in]x_m, \max\{x_m, x_j^{\max}\}[$ consumption decreases. For every $x_i^* > \max\{x_m, x_j^{\max}\}$ consumption is unaffected. In the case of $x_i^* = x_j$ it is possible that consumption is affected by advertising, but need not. If $x_i^* = \frac{M_i}{p}$, then consumption can only be affected if $x_m < \frac{M_i}{p} < x_j^{\max}$. In this case it can be decreased, but need not.*

Proof. See appendix 3.A.3. ■

What is the intuition behind the increase of consumption for $x_i^* \in [0, x_m[$? Consumer i feels that he is consuming too little in comparison to his peer group.[15] He therefore adjusts consumption. As an example, think of a teenager who is afraid of deviating too much from his peer group and is permanently confronted with the good/accessory that his peers (will) consume.

Analogously, a consumer who consumes "too much" will adjust his consumption downwards, because he feels that he is over-spending in comparison with his peers.[16]

Note that the necessary condition for the advertising to be successful is that it changes the consumer's reference group. The sufficient condition is that it changes consumer's marginal utility at the point of his consumption. The necessary condition may in reality not always be fulfilled for all advertising and for all consumers. This will depend on the underlying structure of each individual's reference group and of the design of advertising. For example, the number of reference points in a person's reference group is certainly limited, i.e. $n \in \{1, 2, ..., \overline{n}\}$ (due to limited capacities of brain, memory, and psychology). In this sense our analysis has interesting implications also for the design of advertising. This can, however, not be analyzed in more detail without a stringent theory of reference groups and their changes - a promising field for future research.[17]

Remark 3.1 *It may seem implausible (though not necessarily wrong) that advertising can also decrease consumption. Four arguments need to be taken notice of here. First, goods advertised are usually new products - i.e. consumer i actually compares the depreciated value of his consumption good to the new good. Second, it is plausible that not all advertising changes people's*

[15] Another interpretation is that he interprets advertising as a signal of what peers (will) consume.

[16] This effect, captured by the decrease of the α-term due to an increase of n, will be amplified for those individuals who detest consuming more than their peers (the β-term in Fehr and Schmidt (1999).

[17] The influence of the social environment on people's behavior has long been a research topic for a number of disciplines, especially sociology and psychology. Reference group theory was initiated by Stouffer et al. (1949) and was a hot topic among sociologists throughout the 1940s, 1950s, and 1960s. A classic overview is given by Merton (1968). In this context, also the modern literature on the formation of (social) networks (e.g. Jin, Girvan and Newman (2001) and Albert-László Barabási, 2003) may be helpful.

reference groups (see above). Third, firms have incentives to set x_m high. It is therefore unlikely that consumers will be faced by some $x_m < x_i^*$, if it is not in the firms' interests. Fourth, for producers of lower quality it may be profitable to decrease the quality that the consumers consume. See the discussion of perfect substitutes below.

3.3 Welfare

The standard welfare concept defines welfare as the sum of producer and consumer surplus. The welfare associated with the situations pre- and post-advertising is therefore:

$$W^* = \phi_i(x_i^*) - \alpha_i \frac{1}{n-1} \sum_{j \neq i}^{n} max\{\phi_i(x_j) - \phi_i(x_i^*), 0\} + M_i - cx_i^*$$

$$\begin{aligned} W^{ad} &= \phi_i(x_i^{ad}) \\ &\quad -\alpha_i \frac{1}{n-1} \left(\sum_{j \neq i}^{n} max\{\phi_i(x_j) - \phi_i(x_i^{ad}), 0\} + max\{\phi_i(x_m) - \phi_i(x_i^{ad}), 0\} \right) \\ &\quad +M_i - cx_i^{ad} - A \end{aligned}$$

where A is some fixed cost of advertising. The difference is then

$$\begin{aligned} \Delta W &= W^{ad} - W^* = \phi_i(x_i^{ad}) - \phi_i(x_i^*) \\ &\quad -\alpha_i \frac{1}{n} \left(\sum_{j \neq i}^{n} max\{\phi_i(x_j) - \phi_i(x_i^{ad}), 0\} + max\{\phi_i(x_m) - \phi_i(x_i^{ad}), 0\} \right) \\ &\quad +\alpha_i \frac{1}{n-1} \sum_{j \neq i}^{n} max\{\phi_i(x_j) - \phi_i(x_i^*), 0\} + c(x_i^* - x_i^{ad}) - A \end{aligned}$$

Proposition 3.3 *The welfare effect is ambiguous for all $x_i^* < x_m$. Also for all $x_i^* \in]x_m, \max\{x_m, x_j^{\max}\}[$ it is ambiguous. It is negative for all $x_i^* > \max\{x_m, x_j^{\max}\}$.*

Proof. See appendix 3.A.4. ■

While it is clear that for all $x_i^* > \max\{x_m, x_j^{\max}\}$ welfare is decreased (no change in utility, consumption, producer surplus, but loss from spending on advertising), this is not so obvious for the other two cases.

The ambiguity in the range of $x_i^* < x_m$ stems from the increase in consumption and peer effects. Since consumption increases so does direct utility $\phi_i(x_i^{ad})$. This alone can outweigh the welfare losses of advertising and production costs. The reason is that due to $p \geq c$ the welfare optimal amount of consumption is larger than the realized one, $x_i^* \leq x_i^{so}$. Additionally, there is a second effect, the peer effect. Clearly, the addition of the peer $x_m > x_i^*$ can deprive the consumer, i.e. decrease his utility. But it need not. Advertising may make him also better off. As an example recall figure 1, in which utility increases in response to advertising in a range $[\overline{x_i}, x_m]$ with $\overline{x_i} < x_m$. Mathematically spoken the reason for this is that i's average difference in consumption from its peers is reduced. The intuitive interpretation of this is that i feels assured of consuming quite rightly in relation to his peers.

The ambiguity for the case of $x_i^* \in]x_m, \max\{x_m, x_j^{\max}\}$ is a bit more difficult to understand, because in this range indirect utility is increased by the advertising[18]. At the same time, however, producer surplus is decreased, because consumption falls. Since the payments px_i^{ad} net out, we are left with the comparison of the social gain from lower production and the social loss from utility, which can be negative.

Summing up, we can record that the welfare effect of successful non-informative advertising is ambiguous. This is somewhat surprising, because the way we look at non-informative advertising in this paper is a very negative one. We postulate that non-informative advertising plays a role in manipulating the social environment of consumers in a way that is profitable for firms, but in some cases depriving for consumers. Nevertheless this may be beneficial for social welfare, because from a bird-eyes perspective it is desirable that the consumer buys higher quantity (or quality), as long as $p > c$.

[18]It is easy to see that in this range utility at x_i^* is increased by advertising: $U(x_i^*) \geq U^{ad}(x_i^*)$
$\iff \phi_i(x_i^*) - \alpha_i \frac{1}{n} \sum_{j \neq i}^{n} max\{\phi_i(x_j) - \phi_i(x_i^*), 0\} + M_i - px_i^*$
$\geq \phi_i(x_i^*) - \alpha_i \frac{1}{n-1} \sum_{j \neq i}^{n} max\{\phi_i(x_j) - \phi_i(x_i^*), 0\} + M_i - px_i^*$
By optimality we then also have $U^{ad}(x_i^{ad}) \geq U^{ad}(x_i^*)$, i.e. indirect utility is increased by advertising.

Remark 3.2 *It is important to note that here welfare is defined as the sum of the rents of producer and* ***one*** *consumer. A complete welfare analysis would have to include the effects on other producers (not only rivals, but every producer of whom the consumer is a customer, because all of them are affected by the consumer's change in behavior), all individuals i that are affected by the advertising, as well as all people of whose peer group consumer i is a member. A general analysis of this sort is not very promising, though, because it would consist of a very large number of case differentiations at the end of which the ambiguity result will again prevail.*

3.4 Perfect Substitutes

One possible objection against the model is that a larger product variety could per se be utility decreasing - which would indeed be an implausible implication of the model. My belief is that this is not true for two reasons. First, it is sensible to interpret product variety in terms of perfect substitutes. Second, product variety is usually advantageous only at the specific point in time when one *buys* something. How do these characteristics of product variety enter into the model?

Perfect substitutes (say x and y) should be incorporated into the model in the following way:

$$U_i(x_i, y_i, m_i) = u_i(x_i, y_i) + m_i$$

$$\text{where } u_i(x_i, y_i) = \phi_i(a_i x_i + b_i y_i)$$

$$-\alpha_i \frac{1}{n-1} \sum_{j \neq i}^{n} max\{\phi_i(a_i x_j + b_i y_j) - \phi_i(a_i x_i + b_i y_i), 0\} \text{ for } n \geq 2 \qquad (3.15)$$

If product variety is increased, this would change the utility function only by adding more terms into $\phi_i(a_i x_i + b_i y_i)$, which per se does not change the utility level.

Remark 3.3 *Note that the introduction of new products may lead to an increase of the amount of advertising one consumes. This may change the ref-*

erence group and thereby decrease utility. This is, however, a different argumentation, namely: An increased number of non-informative advertising spots decreases utility.

As a matter of fact, the addition of a product can increase i's utility if i decides to make a new buy, because of the fiercer price competition and the increased variety. To illustrate the first argument, suppose i prefers x over y. The introduction of y may now force the producer of x to decrease p_x, which c.p. increases i's utility. For the second argument it is sufficient to imagine that i simply prefers y over x, i.e. $b_i > a_i$.

One more way in which the introduction of y can increase utility is that some of i's peers switch to y, whereas i prefers x.

Remark 3.4 *One straightforward implication of this analysis is that non-informative advertising has no influence on the competition between producers of perfect substitutes (as long as he produces the whole range of quality). That is non-informative advertising will not convince people to change brands. Even more, advertising for y will not only not decrease i's consumption of x, but may well increase it. Thus, a commercial for BMW may not only increase demand for BMW, but also for Mercedes. This is, however, not at all unrealistic. One may call this the "cooperative effect of non-cooperative advertising".*

Remark 3.5 *It is, however, still possible that BMW is threatened by advertising of a producer like Porsche or Seat who offers quality that BMW does not offer. Mathematically spoken, suppose producer A (e.g. BMW) produces good x where $x \in [\underline{x}, \overline{x}]$ and producer B (e.g. Seat) produces good y where $y \in [\underline{y}, \overline{y}]$. Let x and y be perfect substitutes, such that consumer's utility is given by (3.15). For simplicity assume $a_i = b_i = 1$ and suppose that c.p. $\phi_i(\overline{y}) < \phi_i(\underline{x})$, i.e. A produces higher quality than B. Also suppose that in the outset i is consuming good x, i.e. some $x_i^* \in [\underline{x}, \overline{x}]$. Producer B has now an incentive to advertise his product in such a way that i is willing to lower the quality of consumption until $x_i^{ad} < \underline{x}$. Because then i will switch to producer B. (In other words, BMW loses market shares to Seat.)*

3.5 Conclusion

Among economists it is still an open debate how non-informative advertising works and whether it is socially beneficial or a social waste. This paper offers a new approach to this topic. The theory has two elements. **First**, it is argued that consumer decisions are embedded in social environments. To incorporate this into the formal analysis it is assumed that people's utility functions are not independent of other people's consumption decisions. More precisely, a slightly adjusted version of a specific functional form, developed by Fehr and Schmidt (1999), is used, which is known to be able to explain the experimental results of most standard economic games. In principal, however, other functional forms would work just as well - as long as at least in some environments a change in the reference group also changes the marginal utility. **Second**, it is argued that watching often repeated advertising makes viewers gradually compare themselves to the advertisement models (or people like them). In other words, *advertising may work as a mean to change people's reference group* rather than their utility function (as proposed by early theorizing).

The advantage of this framework is that it is able to explain how non-informative advertising can affect consumer decision without violating basic assumptions that underlie microeconomic theory, such as rationality and stable preferences. Additionally, welfare analysis is applicable. Specifically, it is shown that although effective advertising can cause relative deprivation for the consumer, its welfare effect is ambiguous. The exact welfare effect depends on the structure of reference groups, preferences, consumers' income, good characteristics, advertising design, and price mark-ups.

The model gives interesting starting points for further research on reference group theory, design of advertising, empirical evaluation of advertising and government intervention.

3.A Appendix

3.A.1 Kuhn-Tucker Optimization in Absence of Advertising

First, note that in the optimum the budget constraint must be binding, i.e. $m_i = M_i - px_i$.

Furthermore, we cannot simply apply Kuhn-Tucker, because the utility function is not continuously differentiable. Rather we have to check first whether any of the kinks in the function is a candidate for a relative extremum. Since the function is concave, continuous and continuously differentiable in the environment of every such point x_j, we can evaluate the left-hand and the right-hand derivatives of $U_i(x_i) = u(x_i) + M_i - px_i$ at every $x_i = x_j < \frac{M_i}{p}$ for all $j = 2, ..., n$. If $U_i'(x_i)$ changes signs (from positive to negative) at some $x_i = x_j$, then $U_i(x_i)$ has its maximum there. If there is no x_i for which this is the case, then we have to check for extrema in the parts in which $U_i(x_i)$ is continuously differentiable. We do so by applying Kuhn-Tucker. The corresponding Langrangian is

$$\begin{aligned}\mathcal{L}(x_i, \lambda_1, \lambda_2) &= \phi_i(x_i) \\ &\quad -\alpha_i \frac{1}{n-1} \sum_{j \neq i}^{n} max\{\phi_i(x_j) - \phi_i(x_i), 0\} + M_i - px_i \\ &\quad +\lambda_1 x_i + \lambda_2 (M_i - px_i)\end{aligned}$$

the first order conditions for which are

$$\begin{aligned}
\frac{\partial \mathcal{L}}{\partial x_i} &= \phi_i'(x_i) + \alpha_i \frac{1}{n-1} n^H(x_i)\phi_i'(x_i) - p + \lambda_1 - \lambda_2 p \leq 0 \\
x_i \frac{\partial \mathcal{L}}{\partial x_i} &= x_i \left(\phi_i'(x_i) + \alpha_i \frac{1}{n-1} n^H(x_i)\phi_i'(x_i) - p + \lambda_1 - \lambda_2 p \right) = 0 \\
\frac{\partial \mathcal{L}}{\partial \lambda_1} &= x_i \geq 0 \\
\lambda_1 \frac{\partial \mathcal{L}}{\partial \lambda_1} &= \lambda_1 x_i = 0 \\
\frac{\partial \mathcal{L}}{\partial \lambda_2} &= M_i - p x_i \geq 0 \\
\lambda_2 \frac{\partial \mathcal{L}}{\partial \lambda 2} &= \lambda_2 (M_i - p x_i) = 0
\end{aligned}$$

where n^H is defined as the number of peers j who consume more than i at given x_i, i.e. all peers j with $x_j > x_i$. These Kuhn-Tucker conditions describe two possible sorts of equilibria:

1. The corner solution of $x_i^* = \frac{M_i}{p}$ In this case $\lambda_1 = 0$, $\lambda_2 > 0$ and $\phi_i'(x_i^*) = \frac{1+\lambda_2}{1+\alpha_i \frac{1}{n-1} n^H(x_i^*)} p$

2. The inner solution $0 < x_i^* < \frac{M_i}{p}$ and $x_i^* \neq x_j$. In this case $\lambda_1 = 0$, $\lambda_2 = 0$ and $\phi_i'(x_i^*) = \frac{1}{1+\alpha_i \frac{1}{n-1} n^H(x_i^*)} p$

3.A.2 Proof of Proposition 3.1

Proof. $u_i(x_i) = \phi_i'(x_i) + \alpha_i \frac{1}{n-1} n^H(x_i)\phi_i'(x_i)$ where n^H is defined as the number of peers j who consume more than i at given x_i, i.e. all peers j with $x_j > x_i$. Since marginal utility is decreasing in x_i, the first statement is true if $MU_{pre-advertising}|_{x_i < x_m} \leq MU_{after-advertising}|_{x_i \neq x_j \text{ and} x_i < x_m}$

$\Rightarrow \phi_i'(x_i) + \alpha_i \frac{1}{n-1} n^H \phi_i'(x_i) \leq \phi_i'(x_i) + \alpha_i \frac{1}{n-1+1}(n^H + 1)\phi_i'(x_i) \Leftrightarrow n^H \leq n - 1$ which is true by definition.

The second statement is true if $MU_{pre-advertising}|_{x_i \neq x_j \text{ and } x_i \in]x_m, \max\{x_m, x_j^{\max}\}[}$ $\geq MU_{after-advertising}|_{x_i \neq x_j \text{ and } x_i \in]x_m, \max\{x_m, x_j^{\max}\}[}$. Since for any $x_i \neq x_j$ and $x_i \in]x_m, \max\{x_m, x_j^{\max}\}[$ we have $n^H_{pre-advertising} = n^H_{after-advertising}$ it follows that $\phi_i'(x_i) + \alpha_i \frac{1}{n-1} n^H \phi_i'(x_i) \leq \phi_i'(x_i) + \alpha_i \frac{1}{n-1+1}(n^H)\phi_i'(x_i) \Leftrightarrow 1 \geq 0$. The third statement is true, because here $n^H_{pre-advertising} = n^H_{after-advertising} = 0$ and therefore $\phi_i'(x_i) = \phi_i'(x_i)$. ■

3.A.3 Proof of Proposition 3.2

Proof. To find the optimum we proceed in the same way as in 3.A.1. The results are identical except that here we have n^H_{ad} instead of n^H and $n_{ad} = n+1$. The corresponding Kuhn-Tucker conditions again describe two possible sorts of equilibria:

1. The corner solution of $x_i^{ad} = \frac{M_i}{p}$ In this case $\lambda_1 = 0$, $\lambda_2 > 0$ and $\phi_i'(x_i^{ad}) = \frac{1+\lambda_2}{1+\alpha_i \frac{1}{n} n^H_{ad}(x_i^{ad})} p$
2. The inner solution $0 < x_i^{ad} < \frac{M_i}{p}$ and $x_i^{ad} \neq x_j$. In this case $\lambda_1 = 0$, $\lambda_2 = 0$ and $\phi_i'(x_i^{ad}) = \frac{1}{1+\alpha_i \frac{1}{n} n^H_{ad}(x_i^{ad})} p$

Let us first consider the **inner solution**. For every $x_i^{ad} < x_m$ we have $n^H_{ad} > n^H$. Then the first order conditions imply $\phi_i'(x_i^{ad}) < \phi_i'(x_i^*)$, if $x_i \neq x_j$. Since $\phi_i(x_i)$ is concave, this in turn means that $x_i^{ad} > x_i^*$. For all other $x_i \neq x_j$ the proof is analogously.

Second, suppose before advertising we had optimal consumption at a **kink**, i.e. $x_i^* = x_j$. This implies that $\lim_{x_i \nearrow x_j^-} u_i'(x_i^*) > p$ and $\lim_{x_i \searrow x_j^+} u_i'(x_i^*) < p$. Advertising changes these limits of $u_i'(x_i)$. But it is possible that the changes are not strong enough, so that $x_i^{ad} = x_i^*$. If they are strong enough, however, the same analysis applies as for the inner solution.

Third, suppose that in the pre-advertising situation i consumed at a **corner solution**, i.e. $x_i^* = \frac{M_i}{p}$. Obviously, advertising does not change this consumption, if $x_m > x_i^*$ (because consumption already exhausts $i's$ budget), nor if $x_i^* > \max\{x_m, x_j^{\max}\}$ (because the derivative is left unchanged). If, however, $x_m < \frac{M_i}{p} < x_j^{\max}$, then consumption can be decreased if the associated fall in marginal utility is substantial enough. Otherwise it is left unchanged. ■

3.A.4 Proof of Proposition 3.3

Proof. The welfare difference is given by:

$$\begin{aligned}\Delta W &= W^{ad} - W^{*} = \phi_i(x_i^{ad}) - \phi_i(x_i^{*}) \\ &\quad -\alpha_i \frac{1}{n}\left(\sum_{j\neq i}^{n} max\{\phi_i(x_j) - \phi_i(x_i^{ad}), 0\} + max\{\phi_i(x_m) - \phi_i(x_i^{ad}), 0\}\right) \\ &\quad +\alpha_i \frac{1}{n-1}\sum_{j\neq i}^{n} max\{\phi_i(x_j) - \phi_i(x_i^{*}), 0\} + c(x_i^{*} - x_i^{ad}) - A\end{aligned}$$

We will now prove the three statements of proposition 3.3 consecutively:

1. Since in this range we have $x^{ad} > x_i^{*}$, the welfare effect is given by:

$$\begin{aligned}\Delta W &= W^{ad} - W^{*} = \overbrace{\phi_i(x_i^{ad}) - \phi_i(x_i^{*})}^{>0}\overbrace{+c(x_i^{*} - x_i^{ad})}^{<0}\overbrace{-A}^{<0} \\ &\underbrace{\begin{aligned}&+\alpha_i \tfrac{1}{n-1}\textstyle\sum_{j\neq i}^{n} max\{\phi_i(x_j) - \phi_i(x_i^{*}), 0\} \\ &-\alpha_i \tfrac{1}{n}\left(\textstyle\sum_{j\neq i}^{n} max\{\phi_i(x_j) - \phi_i(x_i^{ad}), 0\} + max\{\phi_i(x_m) - \phi_i(x_i^{ad}), 0\}\right)\end{aligned}}_{\lesseqgtr 0 \text{ (because the addition of the peer at } x_m \text{ can decrease the } \textbf{average deviation} \text{ from peers)}}\end{aligned}$$

   which is ambiguous.

2. For any $x_i^{*} \in]x_m, \max\{x_m, x_j^{\max}\}[$ we know that also x_i^{ad} cannot be smaller than x_m, because below x_m the derivative is even larger than in the pre-advertising situation. The welfare effect is therefore described by

$$\begin{aligned}\Delta W &= W^{ad} - W^{*} = \overbrace{\phi_i(x_i^{ad}) - \phi_i(x_i^{*})}^{<0}\overbrace{+c(x_i^{*} - x_i^{ad})}^{>0}\overbrace{-A}^{<0} \\ &\underbrace{\begin{aligned}&+\alpha_i \tfrac{1}{n-1}\textstyle\sum_{j\neq i}^{n} max\{\phi_i(x_j) - \phi_i(x_i^{*}), 0\} \\ &-\alpha_i \tfrac{1}{n}\left(\textstyle\sum_{j\neq i}^{n} max\{\phi_i(x_j) - \phi_i(x_i^{ad}), 0\}\right)\end{aligned}}_{\lesseqgtr 0 \text{ (because of a possible increase in peers with } x_j > x_i^{Ad} \text{ in reaction to decreasing demand)}}\end{aligned}$$

   which is ambiguous.

3. To prove that $\Delta W = 0$ for all $x_i^{*} > \max\{x_m, x_j^{\max}\}$, note first that in this range $x_i^{ad} = x_i^{*}$. Since also $n_{ad}^{H} = n^{H} = 0$, we have $\Delta W = -A$.

■

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Ich versichere hiermit eidesstattlich, dass ich die vorliegende Arbeit selbständig und ohne fremde Hilfe verfasst habe. Die aus fremden Quellen direkt oder indirekt übernommenen Gedanken sowie mir gegebenen Anregungen sind als solche kenntlich gemacht. Die Arbeit wurde bisher keiner anderen Prüfungsbehörde vorgelegt und auch noch nicht veröffentlicht.

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