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Essays on Economics of Advertising

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Azamat

Abstract

This dissertation studies two topics in the economics of advertising, in the framework of Industrial Organization. It considers the role of advertising in markets with network externalities in consumption, and advertising as a strategic response of incumbent to new entry.

The first chapter investigates the incentives for a monopolistic firm producing a good with network externalities to advertise when consumers face imperfect information and therefore must search to realize their actual willingness to pay for the good. A firm may disclose market information through advertising if it expects this to be beneficial. The results suggest that advertising is more likely in the case of a negative network effect and less likely with a positive network effect. When a monopolist faces a strong network externality, it chooses to support the maximum possible network and charge a price equal to the value of the externality. Finally, depending on the value of the search cost and type of network externality, a monopolist may use different advertising content: no information, price information only, product characteristics, or both price and product characteristics. Specifically, if all consumers have the same search cost, as the search cost grows the firm must include more information in the advertising content, while as the network externality changes from negative to positive, the firm reduces the content. In contrast, if the search costs of consumers differ, the firm tends to provide more information as the externality changes from negative to positive.

The second chapter considers an advertising game in a market with network externalities and consumers who cannot observe prices. Two oligopolists decide on their advertising strategies in the beginning of the game and then compete in prices. Upon observing the advertising decisions of firms, consumers search if needed. Negative consumption externality lowers the minimum threshold level of search costs and increases the profits of the advertising firm. Hence, at least one firm must advertise for a snob effect. Weak bandwagon effect and snob effect lead to equilibria with interior solutions in which both firms have positive market shares. When consumption externality exceeds a degree of product differentiation, the demand function of each firm becomes upward-slopping. The externality dominates any strategic and price effects and therefore a higher price is necessarily associated with a greater market share. Finally, the only equilibria with a strong bandwagon effect are those when only one firm supplies an entire market.

The third chapter is motivated by empirical studies on advertising outlays reporting that incumbent firms change their advertising strategies in response to a new entry. While some incumbents reduce their advertising expenditures, others increase them

in comparison to the pre-entry period. Existing literature on strategic advertising in entry games is mostly focused on entry deterrence, no theoretical foundation is found in this literature to explain what determines a change in the advertising strategies in the case of entry accommodation. The third chapter considers four types of advertising and builds a model that examines how accommodating incumbents decide on advertising. The paper also provides results on how advertising is related to the size of the entry. Particularly, informative advertising and advertising enhancing product differentiation allow greater entry, while complementary and business-stealing advertising result in fewer entries, since they reduce residual demand for potential entrants. Depending on whether post-entry competition variables are strategic substitutes or strategic complements, incumbent firms may increase or reduce their advertising outlays in response to new entries.

Abstrakt

V této dizertaci studujeme z pohledu industriální organizace dvě témata z oblasti ekonomie reklamy. Ve své práci uvažujeme roli reklamy na trzích se síťovou externalitou ve spotřebě, a dále analyzuji reklamu jako odpověď úřadující firmy na vstup nového konkurenta na trh.

První článek se zabývá pobídkou monopolistické firmy, která vyrábí produkt, jenž vykazuje charakteristiky síťové externality, inzerovat reklamu v situaci, kdy spotřebitelé nemají úplné informace, což vede k hledání jejich rezervační ceny. Pokud uzná za vhodné, může firma pomocí reklamy odhalit určité tržní informace. Výsledky naznačují, že reklama je pravděpodobnější v situaci negativní síťové externality a méně pravděpodobná v situaci pozitivní síťové externality. Pokud monopolista čelí silné síťové externalitě, pak podporuje maximální možnou síť a požaduje cenu, která odpovídá hodnotě této externality. Monopolista si může zvolit obsah své reklamy na základě typu síťové externality a nákladů spotřebitelů na hledání rezervační ceny. Obsah reklamy může obsahovat pouze informace o ceně produktu nebo pouze o vlastnostech produktu, nebo může obsahovat informace jak o ceně, tak o vlastnostech produktu. Firma si dále může zvolit takovou reklamu, která nebude poskytovat žádné výše zmíněné informace o produktu. Konkrétně pokud mají všichni spotřebitelé stejné náklady na hledání rezervační ceny pak s růstem těchto nákladů, musí firma do reklamy zahrnout více informací. Pokud dojde ke změně síťové externality z negativní na pozitivní, pak firma sníží množství poskytovaných informací v reklamě. Pokud mají ovšem spotřebitelé různé náklady na hledání rezervační ceny, pak, při změně externality z negativní na pozitivní, má firma sklon publikovat reklamu, jež obsahuje více informací.

Ve druhé kapitole se zaměřujeme na reklamní hru na trhu, v němž se vyskytuje síťová externalita a na němž spotřebitelé nemohou pozorovat ceny. Dva oligopolisté si na začátku této hry určí svou reklamní strategii a následně se dostávají do cenové konkurence. Poté co si obě firmy zvolí svou reklamní strategii, tak spotřebitelé mohou začít hledat dodatečné informace, pokud je potřebují. Negativní spotřební externalita vede ke snížení úrovně minimální hranice nákladů na hledání informací a zvyšuje zisky všem firmám inzerujícím reklamu. To znamená, že pro snobův efekt je zapotřebí, aby alespoň jedna firma inzerovala reklamu. Slabý bandwagon efekt a snobův efekt vedou

k rovnováze s vnitřním řešením, ve které mají obě firmy pozitivní tržní podíl. Když spotřební externalita překročí stupeň produktové diferenciace, pak se poptávková funkce změní v rostoucí funkci. V tomto případě externalita naprosto dominuje nad všemi strategiemi a cenami, což má za následek to, že vyšší ceny vedou k většímu tržnímu podílu. Pouze v situaci kdy celý trh zásobuje pouze jedna firma, je možné najít rovnováhy, ve kterých se objevuje silný bandwagon efekt.

Empirické studie zabývající se výdaji na reklamu ukazují, že firmy mění své reklamní strategie v závislosti na vstupu nové firmy do odvětví. Zatímco někteří incumbenti odpovídají na vstup nové firmy do odvětví snížením svých reklamních výdajů, jiní je naopak zvyšují. Stávající literatura zabývající se strategickou inzercí a reklamou v souvislosti se vstupem nové firmy do odvětví se většinou zaměřuje na znemožnění nového vstupu do odvětví. Ve stávajícím výzkumu ovšem doposud chybějí teoretické základy, které by pomohly vysvětlit, co ovlivňuje změnu reklamních strategií v situaci, kdy dojde k akomodaci nového vstupu. Ve své práci stavíme model, který zkoumá, jak se akomodující incumbenti rozhodují o reklamní strategii. Za tímto účelem uvažujeme čtyři typy reklamy. Ve svém článku také uvádíme, jak je reklamní strategie spojena s velikostí nově příchozích. Konkrétně říkáme, že informativní reklama a reklama zvýrazňující diferenciaci produktu umožňují větší počet vstupujících. Naproti tomu komplementární a business-stealing typy reklamy zmenšují zbylou poptávku pro potenciální nově vstupující, a tím vedou k menšímu počtu vstupů do odvětví. Incumbenti zvyšují, respektive snižují, reklamní výdaje v závislosti na tom, zda proměnné popisující konkurenci po vstupu jsou spíše strategické substituty nebo komplementy.

Introduction

The economics of advertising is a branch of economic theory that considers four main questions. Firstly, it studies the incentives for a firm to advertise. Clearly, most firms spend a significant share of their budget on advertising. There are economic reasons for firms to advertise. Secondly, economics of advertising investigates how firms decide what, how and how much to advertise. Specifically, firms choose what type/s of advertisements to use, what advertising content to include in the message and determine an optimal volume of advertising (e.g., number of leaflets sent, TV ads, etc.). Thirdly, it studies the effects of advertising on market performance. As economic research shows, advertising affects market power, competition and profitability in industries. Finally, it is also important to know how advertising influences the wellbeing of consumers and social welfare in general; whether advertising is socially excessive or inadequate.

The economics of advertising began with Marshal (1890, 1919), however a significant interest to advertising has arised in the beginning of the XX century only. There are three reasons advertising was not an important research question before that time. Firstly, until the end of the XIX century, the economic thought was primarily based on the neoclassical approach and the development of the theory of perfect competition. The latter does not suggest any reason for advertising at all, since under competition and neoclassical assumptions no firm can obtain a higher price through advertising, market information is complete and perfect, consumers are rational and possess fixed preferences. The second reason is that the beginning of the XX century was a time of industrial progress, transition to mass production and significant advances in transportation, communication and distribution. These economic conditions explain economies of scale and a need for expansion of demand through advertising. Moreover, this is exactly the time when the theory of imperfect competition became a central question in economic research. The third reason is an overall change in the society. Urbanization, income growth and more sophisticated consumer needs

gave room for marketing and promotion of goods and services. All these explained increased interest in advertising and the formation of advertising economics.

Recent research in the economics of advertising is closely related to industrial economics and studies the effects of advertising on market performance, market power, entry and competition. It also uses advances in information economics, like search models, signaling and disclosure games. Empirical analysis of advertising starts from the 1950s and mainly deals with the measurement of the effect of advertising on profit, sales, and market entry and concentration.

This dissertation considers two topics in economics of advertising. The first is the informative role of advertising in markets with network externalities in consumption. The second topic is how an accommodating incumbent reacts to a new market entry in terms of advertising.

The first part of the research describes markets where the consumer's decision to buy a good depends not only on actual physical characteristics but also how many people buy the same good. In these markets, clientele size determines the magnitudes of the network externality that may increase the valuation of the good if the network effect is positive, or decrease the valuation if the network effect is negative. When consumers face incomplete market information in such markets, they cannot correctly calculate their willingness to pay for the good and thus economic inefficiencies may arise. One way to resolve the information problem is to introduce a search, i.e. when consumers may incur some costs and thus gain access to the information they need. The second way is provision of market information by the firm in the form of advertising. This option may even be preferred by firms because the need to search usually lowers demand and can even lead to zero sales in extreme cases such as the Diamond paradox.

Chapter 1 considers the incentives of a monopolistic firm to advertise in a market with network externalities where consumers cannot freely observe price and product characteristics (the match of consumer tastes to a good). The firm can use four types of advertising content: no information, price only, product characteristics or both

price and product characteristics. The results show that, depending on the network externality, the firm chooses different advertising strategies. When all consumers have identical search costs, as network externality goes from positive to negative, the firm tends to include more information in its advertising. The reason is that the expected benefit of a search is decreasing in the network effect and thus consumers search less. The only way to expand demand is to provide market information in the form of advertising. However, if the search cost is low enough and the externality is positive, the firm may even choose to not advertise at all. When search costs are heterogeneous among consumers, the firm never remains silent, but must advertise at least its price or matches. Moreover, the firm increases its advertising content as the externality goes from negative to positive. The latter result differs from the case with homogeneous costs and crucially depends on the fact that the search decision is different for different consumers. Specifically, the expected benefit of a search is not only conditional on the network externality, but also whether a consumer's search cost is low enough. Since the consumer's willingness to pay is increasing in the network externality, the firm wants to support a larger clientele and thus it advertises more.

Chapter 2 continues the study of the market with network effects, but considers a strategic interaction between two oligopolists. In the first stage of the game the firms simultaneously decide whether or not to advertise their prices. In the second stage, they set prices. Consumers observe the advertising decisions of the firms and make their search and buying decisions based on the information they have. The full game is a disclosure game in which firms make their advertising and pricing choices. Three advertising outcomes are possible: both firms stay silent, only one firm advertises its price or both firms advertise. Depending on the nature and magnitudes of the network externality, different types of market equilibrium are possible. When the network effect is negative or weakly positive, both firms have positive market shares and at least one firm should advertise in the presence of the negative externality. When the market is characterized by a strong positive network effect, either both firms stay silent or both advertise. When the externality is positive and strong enough, the

expected benefit of a purchase is large enough to induce a search, so both firms may stay silent. However when the externality becomes larger, the equilibrium in which one firm captures a whole market dominates all other outcomes. In this case, the firm advertises a price that is equal to the net value of the externality.

There are two important concluding remarks on Chapters 1 and 2. Firstly, in contrast to the existing literature on network effects, the present research assumes that consumers cannot easily calculate their willingness to pay in markets with network externalities, since market information may be incomplete. Therefore, search and advertising are introduced to remedy the information problem. Secondly, advertising decisions of firms and their choice of advertising content depend not only on search costs, but also on the network externality. The results of Chapters 1 and 2 shed light on how firms choose advertising strategies in the presence of network effects.

Chapter 3 contains the second part of the research. It relates advertising to the theory of market entry. The entry deterrence effect of advertising is well studied in the literature. Advertising creates brand loyalty, enhances the valuation of the goods and product differentiation, increases penetration costs for new firms and thus can impede or even block new entries. Nevertheless, little has been done to explain the role of advertising when incumbent firms do not block, but rather accommodate new entry. Empirical works (e.g. Cubbin and Domberger, 1988) show that accommodating incumbents do not only significantly change their advertising outlays, but do it in a different manner: some firms reduce advertising, other firms increase advertising. Chapter 3 offers a theoretical model that explains different advertising strategies of an accommodating incumbent in the markets with differentiated products.

Recent advertising literature points out three different kinds of advertising: persuasive, informative and complementary. Persuasive advertising creates brand loyalty, enhances product differentiation and shifts the preferences of consumers towards the advertised good thereby increasing market power. Informative advertising transmits market information like prices, product characteristics, existence and locations of sellers. Complementary advertising is a good itself; it increases utility gain for the

advertised good, since consumers possess preferences for complementary advertising (advertising that enhances the image, brand or status of goods). Firms choose a particular type of advertising depending on the good they produce and market characteristics.

The results of the model in Chapter 3 show that, depending on the type of advertising chosen and whether post-entry competition variables are strategic substitutes or strategic complements, incumbent firms may increase or reduce their advertising outlays in response to new entries. Additionally, the model also considers how advertising is related to the size of entry, and concludes that informative advertising and advertising enhancing product differentiation allow greater entry, while complementary and business-stealing advertising result in fewer entries, since they reduce residual demand for potential entrants.

To sum up, this present dissertation contributes to the existing literature on the economics of advertising by studying the informative role of advertising in markets with network externalities and enriching prior conclusions on the entry aspects of advertising.

Chapter 1

Informative Advertising in a Monopoly with Network Externalities

1.1 Introduction

In some markets, the individual buying decision of a consumer may depend on the number of other consumers who own or buy the same good. In particular, the telecommunication, luxury products, books, gyms, swimming pools, software and fashion. Markets are characterized by strong network effects (also known as network externalities). These externalities may be positive or negative depending on how they affect consumers' willingness to pay. A network externality is positive when a consumer's utility increases with the number of consumers using the same good, i.e. consumers benefit from the greater clientele. One can observe this effect in, among others, the software, books, fashion, music markets. When the network effect is negative, a consumer's willingness to pay is decreasing in the number of consumers who buy the same good. No one likes overcrowded beaches or swimming pools, and some people who desire uniqueness and exclusivity enjoy goods with limited editions such as status and luxury goods.

Network effects are divided into two groups depending on the origin of the effect. The first group is technology side network effects, which are explained by the supply side of the market, specifically originating from technology, and include telecommunication, software, and hardware. They are characterized by a positive externality and the most important research questions are technology adoption and compatibility problems of competing brands. The second group is demand side effects (or network externalities in consumption), which usually originate from consumer preferences for

social-economic attributes of goods found in the markets of status goods, fashion, music, books, and subcultures. In the economic literature, a positive consumption effect is called conformity or bandwagon effect and a negative consumption externality is called vanity, snob effect or snobbism. The body of the literature on network externalities in consumption is small and mainly represented by signalling models and taxation of positional goods.

The research goal of this paper is to combine network externalities and a disclosure game to study the incentives of a monopoly to reveal any market information. In markets with network externalities, consumers make their buying decision before they realize the actual volumes of sales, and therefore they must form expectations based on the available market information. However, this information is not easy to obtain and therefore firms may disclose it themselves (at least partly) if needed. Surprisingly, related studies have not yet considered the problem of information frictions in these markets. While in many markets with network externalities, firms usually at least partly disclose some information. For example, producers of luxury products (cars, jewellery, watches, etc.) announce exact quantities of the good (as limited edition). Samsung and Apple advertise both prices and physical characteristics of their new products. Therefore, it is of a practical interest to study how sellers of products with network externalities decide whether to disclose any information and what content to include in the advertising message.

Literature on the effects of consumption network externalities on market functioning consists of several articles considering an oligopolistic setting where consumers rationally anticipate a market outcome with fulfilled expectations (Navon et al., 1995; Grilo et al , 2001; Griva and Vettas, 2001). Specifically, these studies assume that consumers are rational, perfectly informed, aware of market prices, and able to foresee the actual clientele size. Moreover, they do not consider any commitment problems related to prices. In reality, consumers face imperfect information, limited abilities to rationally foresee the market outcome and they may not also easily observe prices if firms have not advertised them. In this case consumers cannot correctly form their

expectations about clientele sizes and realize their actual willingness to pay for a good. For this reason, many producers of goods with network effects deliver some market information in the form of price advertising, announcement of total supply or product characteristics. This information is used by consumers to correctly foresee the market outcome. Additionally, advertising also works as a commitment device to ensure that firms adhere to their publicly announced prices or output.

Advertising is widely used in search models as a means of information disclosure. When consumers are *ex ante* poorly informed about charged prices or valuations for the good (product characteristics), they may search and learn necessary information by incurring some time or monetary costs. Otherwise, firms may disclose this information themselves in the form of advertising. In the latter case, all disclosed information becomes public knowledge, and as a result consumers are able to optimally make their buying decisions.

This chapter considers a model in which consumers are prone to consumption externalities but face a need to search because of incomplete information. Specifically, consumers are assumed to be *ex ante* unaware of prices and their actual valuation for the good. There are two ways to obtain necessary information: a costly search by consumers or advertising by firm. If consumers need to search, they compare their expected benefits of a purchase with the cost of the search that is assumed to be either homogeneous or heterogenous. If the monopolist advertises, it chooses how much information to disclose. The model considered in this paper serves to explain how consumers decide on a search, what price internalizes a consumption externality and what conditions influence the choice of the advertising content. In particular, the central research question is how the network externality affects the information disclosure decision of the firm.

The results suggest that when search cost is homogeneous, the firm needs to advertise for a negative network effect since the expected benefits of search decrease in the externality and thus consumers search less. As the network externality moves from negative to positive, the firm reduces the advertised content if search costs are

not large. When search cost is heterogenous, the firm advertises less information for a negative network effect and advertises more for a positive network effect. This occurs due to a more sensitive demand, since the probability of buying does not only depend on the consumer's match alone but also if her search cost is low enough. Moreover, for a negative network effect all consumers prefer a small clientele, and therefore providing little information reduces visits and thus restricts demand. Conversely, for a positive network effect all consumers benefit from a larger clientele, and thus providing more information increases visits and expands demand.

This chapter is organized as follows. Section 1.2 is a review of the related literature. Section 1.3 describes the search decision of consumers, price-settings of the firm and an advertising game. Section 1.4 presents results and concluding remarks.

1.2 Literature Review

There are three groups of literature closely related to this study. The first is a set of papers devoted to the social attributes of consumption. Network externalities in consumption was initially discussed by Veblen (1899) and then formalized by Leibenstein (1950) who coined the terms bandwagon effect, snob effect and Veblen effect[1]. These effects are the key terms used in studies associated with consumption externalities. Further literature on the topic is a set of signalling models[2] and a theory of conformity[3] explaining behavioral reasons as to why individuals are sensitive to a bandwagon or snobbism.

The second group of literature is related to network economics. A detailed review

[1] Veblen effect describes a situation in which demand positively reacts to a higher price of the good. Buying an expensive good (usually status goods or positional goods) shows a high social-economic status of the buyer. A higher price of a Veblen good serves as a signal of the status. It is important to distinguish between snob effect and Veblen effect. Snob effect is a demand-reducing effect associated with the total clientele size. With snob effect price is not importnat. Consumers only care how many other individuals own the same good. Snob effect can only decrease price elasticity but cannot contradict the law of demand. Veblen effect, in turn, changes the direction of the price effect from negative to positive.

[2] For instance, Bagwell & Bernheim (1996) and Corneo & Jeanne (1997) assume that buying a conspicuous good signals the social-economic status of consumers.

[3] Bernheim (1994) explains why people with heterogeneous preferences over behavioral patterns sometimes conform to a single conduct.

of network economics is found in Shy (2011), the author determines a network effect as a special kind of externality when consumer's utility or firm's profits are directly or indirectly affected by the number of adopters of the same buying decision or technology. Economides and Himmelberg (1995) analyze the equilibrium size of networks under different market structures and conclude that monopoly provides the smallest network, prefect competition results in the largest network, and oligopoly has a moderate network. Navon et al. (1995), Grilo et al. (2001), and Vettas and Griva (2011) study network externalities in oligopoly with product differentiation. These papers conclude that a negative network effect softens price competition, while a positive network effect leads to lower prices and stronger competition. Moreover, with a strong bandwagon effect a firm with a locational advantage may even capture a whole market. These studies shed light on how consumption externalities influence price competition in oligopoly. The core limitation of the studies is an assumption that consumers are able to perfectly foresee the market outcome, i.e. the authors consider equilibria with fulfilled expectations. This assumption has to be relaxed because in reality consumers face bounded rationality and incomplete information. Nevertheless, research in network economics has contributed to the building of bridges between the technological nature of networks and behavioral aspects of consumption.

The third group of related literature is devoted to search theory. This theory implies that with incomplete market information consumers need to incur some costs (e.g. time, effort, money) to obtain necessary information. In other words, they are engaged in a costly search. This market friction complicates a buying decision and reduces demand for firms. Anderson and Renault (2006) show that by advertising relevant information such as prices and valuations for the good, a firm can secure profits in the presence of search costs. Konishi and Sandfort (2002) consider an advertising game in monopoly and duopoly. In their paper, price advertising expands firms' demand and therefore firms may find it profitable to incur advertising costs in order to increase revenues. Depending on the values of advertising and search costs, firms choose between staying silent and advertising.

This chapter studies how the network externalities in consumption influence the advertising decision of a monopolist if consumers face a problem of incomplete information. Section 3 presents a model in which a monopolist decides whether to disclose any market information or make consumers search for this information themselves.

1.3 Model

This section presents a monopoly model of advertising in a market of a good with network effects when consumers are not able to correctly form their expectations about the potential clientele size, because they are poorly informed. Consumers may learn market information by searching or through the firm's advertising. If consumers search, they incur some search cost which is simply a cost of visiting the store. Otherwise, a monopolist may disclose some market information using advertising. Once consumers have learnt the information they are able to correctly anticipate future sales, form their willingness to pay and, make a buying decision. In this sense, the good is a search good[4].

A continuum of consumers is independently and uniformly distributed on a unit interval [0,1]. Each consumer has a valuation for the commodity θ which belongs to this interval. However, consumers have *ex ante* identical tastes, because in the beginning they are not informed about how much they value the product of the monopolist (e.g., they do not know product characteristics, their matches to the product). To learn both θ and a price, each consumer needs to visit the store and pay a search cost c. Search cost is public knowledge.

Every consumer has a utility function $U = \theta + \gamma d^e - p$, where p stands for the market price and d^e is the expected clientele size (future sales)[5]. The measure of the

[4]Nelson (1970, 1974) introduces two types of market goods: search goods and experience goods. A search good is a good with easily verified consumption characteristics, consumers are able to realize their willingness to pay (utility gain) after a search (a visit to the store) but before the purchase. With an experience good consumers can realize their actual utility gain only upon consumption, because product characteristics cannot be observed in advance.

[5]As discussed before, when consumers decide to buy a conspicuous good (or any good with a network effect), they base their decision on how many other consumers will own this good. Therefore, their willingness to pay is dependent on the clientele size (actual sales). If the price of this good is

network externality is reflected by γ. If $\gamma > 0$, there is a bandwagon effect (a positive network effect) and if $\gamma < 0$, there is a snob effect (a negative network effect). Without perfect information about market price and θ, the consumer is not able to correctly foresee d^e and consequently she cannot realize her actual benefits of the purchase.

A monopolistic firm produces a good at zero marginal cost, decides on the price and whether it wants to disclose any information with advertising. Advertising is costless. The model also assumes "truth-in-advertising law", whereby it is illegal to announce false information. A monopolist commits to its announcements with advertising. The game considered in this model has the following timing:

1. In the beginning of the game, the firm decides whether to advertise or not. Consumers do not know their valuations and the market price.

Case A: There is no advertising.

Case B: Only the price is advertised.

Case C: Only horizontal matches θ are advertised.

Case D: Both the price and θ are advertised. Consumers have no information problem but still need to pay c as a visiting cost.

2. Observing the advertising decision of the firm, consumers choose whether to search or not. If a consumer searches, she incurs a search cost c.

3. If there was no advertising, each consumer who decides to search realizes her match θ which is randomly drawn from the interval [0,1]

4. Once consumers have learnt both θ and the price, they make their buying decision.

In this section, two types of search costs are considered. The first case deals with a homogenous search cost, i.e. when all consumers have the same search cost c. In the second case, it is assumed that consumers are heterogenous in search costs and each consumer i has her own c_i. This search cost does not depend on θ_i.

public knowledge, everyone is able to correctly anticipate actual sales. However, in reality due to bounded rationality and imperfect market information, consumers are not able to perfectly foresee this and thus must spend some time, effort, and money to fix the problem. This situation can be, for instance, resolved with a search.

1.3.1 No advertising

Let us start with the problem of a representative consumer who observes no advertising from the firm. In this case she does not know her θ and the charged price, and thus she must search incurring some sunk visit cost c. A consumer i will buy the good if her surplus is not negative: $\theta_i + \gamma d^e - p \geqslant 0$, which means that the share of consumers with non-negative surplus is $(1 - \widehat{\theta})$, with $\widehat{\theta} = p - \gamma d^e$.

The firm cannot influence the search decision of consumers without advertising and thus takes the number of searching consumers as given[6]. Let us denote the share of searching consumers as s. In this case, the profit function of the monopolist is as follows:

$$\pi^n(p_n) = p_n \; s \; (1 - p_n + \gamma d^e)$$

Taking s and d^e as given, the FOC gives the monopoly price $p_n = \frac{1+\gamma d^e}{2}$. As expected, this price increases in γ. If there is a bandwagon effect, a greater clientele size increases the consumer's valuation for the product and thus increases the price. In contrast, with a snob effect, product valuation decreases with a larger volume of sales and thus it reduces the price.

Consumers anticipate this price and decide to search only if their benefits of the search exceed the search cost c. The expected benefit of a visit is the expected consumer surplus and therefore the search condition is as follows:

$$E(CS) = \int_{\widehat{\theta}}^{1} (\theta_i + \gamma d^e - p) \, d\theta \geqslant c$$

This search rule implies that a consumer decides to visit the store if the expected benefits of search $E(CS) \geqslant c$, and remains inactive otherwise[7].

[6] Since a firm cannot influence the number of consumers who search, it also cannot influence the expectations of consumers, i.e. d^e.

[7] When the expected benefits of a search are equal to the visiting cost, $E(CS) = c$, two types of equilibrium may exist: full participation in which all consumers decide to search, and partial participation in which consumers randomize between visiting and being inactive.

To avoid randomization, it is assumed that consumers prefer buying to having nothing and therefore they decide to search in any case. This assumption applies to the rest of the paper as well. An equilibrium with partial participation is considered in Appendix 1A.

When consumers visit the store, they learn all information and thus in equilibrium a market clearance condition must satisfy: $d^e = s(1-p+\gamma d^e)$. In other words, rational consumers must foresee that their expectations about actual sales d^e are exactly what is produced by the firm. In turn, this means that $d^e = \frac{s(1-p)}{1-\gamma s}$. If we solve this condition for the monopoly price $p_n = \frac{1+\gamma d^e}{2}$, then $d^e = \frac{s}{2-s\gamma}$ and $\widehat{\theta} = \frac{1-s\gamma}{2-s\gamma}$. The corresponding monopoly price is therefore $p_n = \frac{1}{2-s\gamma}$.

Therefore, the expected benefits of a search can be computed as follows:

$$E(CS) = \int\limits_{\frac{1-s\gamma}{2-s\gamma}}^{1} \left(\theta_i + \gamma\frac{s}{2-s\gamma} - \frac{1}{2-s\gamma}\right) d\theta = \frac{1}{2(2-s\gamma)^2}$$

Homogenous visiting costs

If a visiting cost is the same for everyone, then the search condition is identical for each consumer and the search decisions of all consumers coincide. This implies that a share of consumers who decide to visit, s, is either 1 or 0. If $s = 0$, no one is active and there is no market. If $s = 1$, then everyone searches and the corresponding equilibrium is defined by $p_n = \frac{1}{2-\gamma}$, $\widehat{\theta} = \frac{1-\gamma}{2-\gamma}$, $d^e = \frac{1}{2-\gamma}$ and $\pi^n = \frac{1}{(2-\gamma)^2}$.

It is important to note that two different equilibria are possible, depending on the value of γ. In particular, the equilibrium described above is only possible for $\gamma < 1$. However, with a strong bandwagon effect $\gamma \geqslant 1$, the equilibrium demand function $d^e = \frac{(1-p)}{1-\gamma}$ is upward slopping and thus the pricing rule changes. Let us start with the case in which $\gamma < 1$.

The corresponding search condition is described by the following inequality:

$$E(CS) = \frac{1}{2(2-\gamma)^2} \geqslant c$$

Let us denote the threshold cost where this condition holds as a strict equality as $\widetilde{c}$. If we investigate how this threshold cost changes with the measure of the externality γ, we will obtain the following result:

$$\frac{d\widetilde{c}}{d\gamma} = (2-\gamma)^{-3} > 0$$

This shows that as γ grows, the threshold search cost increases as depicted in Figure 1 and implies that the set of search costs for which consumers decide to search expands with γ. In other words, consumers are more likely to search for a positive γ and more likely to stay inactive for a negative γ. This conclusion is summarized in Lemma 1.

Lemma 1. *If a monopolist does not advertise prices and* $\gamma < 1$, *consumers tend to search more for a product with a bandwagon effect and tend to search less for a product with a snob effect. This implies that advertising is more effective in the case of a snob effect.*

With a bandwagon effect (i.e. a positive network effect) greater γ increases the expected consumer surplus, which in turn increases search intensity. With a snob effect (i.e. a negative network effect) greater expected sales reduce consumer surplus and thus the benefits of a search decrease.

The second option is that consumer preferences are characterized by a strong positive consumption externality, $\gamma \geqslant 1$. In this setting, the equilibrium demand function increases in price $d^e = \frac{(1-p)}{1-\gamma}$ and due to this functional form higher sales of the monopolist are always associated with a higher price. When there is a strong positive network effect, it can dominate the negative effect of price on demand[8] and thus the only way the firm may have a positive market share is to charge a higher price. The only equilibrium compatible in this setting is when everyone searches, everybody buys, and the monopolist charges the maximum possible price that supports this equilibrium. This price can be found from two conditions: $d^e = \frac{(1-p)}{1-\gamma}$ and $d^e = 1$. Thus, the only price that satisfies the conditions is $p = \gamma$. Consumers rationally anticipate this price and compute their expected surplus as:

[8] Appendix 1B presents a detailed explanation on how equilibrium demand with fulfilled expectations is formed for network goods. The appendix also provides an intuition why demand curve is upward slopping for a strong bandwagon effect.

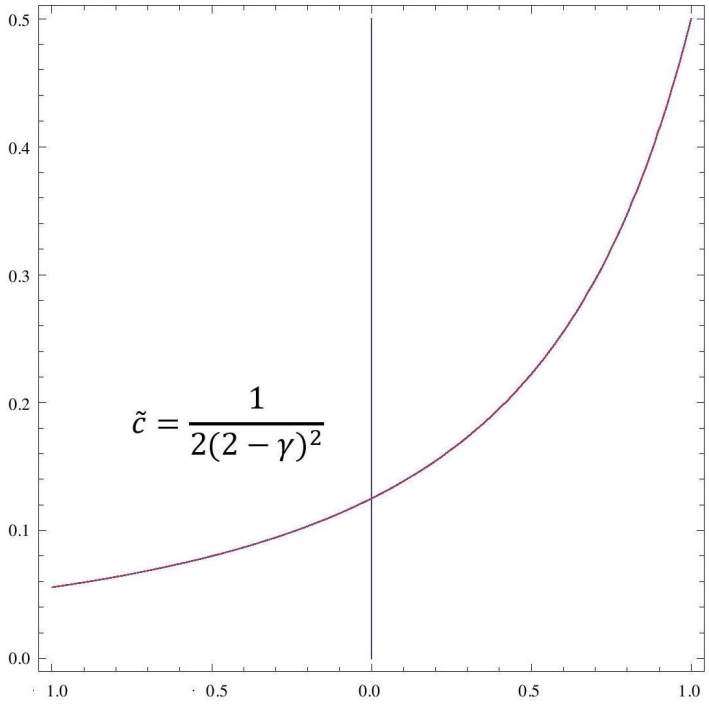

Figure 1: Threshold $\widetilde{c}$ under homogenous search cost

$$E(CS) = \int_0^1 (\theta_i + \gamma - \gamma)\, d\theta = \frac{1}{2}$$

Therefore, consumers search for $c < \frac{1}{2}$ and the resulting price is equal to γ. The corresponding profit is also γ

Lemma 2. *If a monopolist does not advertise and $\gamma \geqslant 1$, the only equilibrium is when everyone searches, the monopolist serves all consumers and charges a price equal to the value of the network externality γ.*

This result is intuitive: when the network effect is strong, the utility gain of consumers approaches its maximum at any price $p < \gamma$, since everyone is willing to buy the good. Thus, the monopolist charges the highest possible price that induces the full participation of consumers. In this case, both price and profit increase in the network effect: greater γ allows the monopolist to charge a higher price and obtain a higher profit.

To sum up, the firm can remain silent with a homogenous search cost in two cases:

when $\gamma < 1$ and $c \leqslant \frac{1}{2(2-\gamma)^2}$ it charges $p_n = \frac{1}{2-\gamma}$ serving $\frac{1}{2-\gamma}$ share of consumers; when $\gamma > 1$ and $c < \frac{1}{2}$ the firm charges $p_n = \gamma$ selling to everyone. Otherwise, there is no market because no one searches. Therefore, the only way to make consumers visit the store is to provide information in the form of advertising.

Heterogenous visiting costs

The case with heterogenous search costs means that the costs are different for every consumer. This difference may be explained by different abilities for a search, a different distance to the store, or a different value of time, etc. However, the key issue is that consumers do not have the same search costs. This implies that the share of visiting consumers s can take any value from 0 to 1.

Let us assume that each consumer i has a visit cost c_i which is uniformly distributed on [0,1] and is independent of θ. The problem of the firm is the same as before and the expected consumer surplus is as follows:

$$E(CS) = \int\limits_{\frac{1-s\gamma}{2-s\gamma}}^{1} \left(\theta_i + \gamma \frac{s}{2-s\gamma} - \frac{1}{2-s\gamma} \right) d\theta = \frac{1}{2(2-s\gamma)^2}$$

A consumer who decides to search must have a search cost no larger than $\frac{1}{2(2-s\gamma)^2}$, and given the uniform distribution of the visiting costs, $s = \frac{1}{2(2-s\gamma)^2}$ [9]. This condition can be transformed into an implicit function $F(s, y) = 0$ which indirectly expresses s via γ. It is of interest to see how the share of searching consumers depends on the network effect γ. This can be done using the implicit function theorem:

$$\frac{ds}{d\gamma} = -\frac{F'_\gamma}{F'_s} = \frac{(2-s\gamma)^3 - \gamma}{s}$$

Figure 2 shows that the share of searching consumers is higher for a bandwagon effect and lower for a snob effect even with heterogenous search costs. The same explanation as before is applicable to this result: a greater clientele size increases consumer surplus for a positive network effect and decreases the surplus for a negative

[9] Indeed, since c_i is uniformly distributed on [0,1], a share of consumers with $c_i < \frac{1}{2(2-s\gamma)^2}$ is a share of $\frac{1}{2(2-s\gamma)^2}$. These are the consumers who decide to search, i.e. s.

effect. This influences the search decision of consumers and, correspondingly, the advertising policy of the firm which is reflected in Lemma 1.

When the monopolist does not advertise and consumers have heterogenous search costs, the resulting equilibrium is described by $p_n = \frac{1}{2-s\gamma}$, $\widehat{\theta} = \frac{1-s\gamma}{2-s\gamma}$, $d^e = \frac{s}{2-s\gamma}$ and $\pi^n = \frac{s}{(2-s\gamma)^2}$. As one can see, heterogenous search costs bring lower price, sales, and profit in comparison with the homogenous costs case, because heterogenous costs reduce the share of potential buyers even more. Figure 3 shows the curves of equilibrium $s,\ d,\ p$ in the space of γ (horizontal axis). All three increase in the externality. Larger γ enhances the expected consumer surplus and thus stimulates a search and sales, and increases price.

As in the previous case, two options are possible: $s\gamma < 1$ and $s\gamma \geqslant 1$. By the same reasoning, if the network effect is high enough, there can be an equilibrium when a monopolist serves all consumers. This possibility occurs when the expected consumer surplus exceeds 1[10]:

$$E(CS) = \int_0^1 (\theta_i + \gamma - p)\, d\theta = \frac{1}{2} + \gamma - p \geqslant 1$$

This suggests a price $p = \gamma - \frac{1}{2}$ that supports an equilibrium with full participation. However, this equilibrium is only possible with a very large positive γ.

To summarize the results of the case when the monopolist does not advertise any information, let us state the proposition that follows:

Proposition 1. *When a monopoly provides no information about its price and consumers' matches, the likelihood of a visit increases in the bandwagon effect and decreases in the snob effect. Heterogeneous visiting cost has lower equilibrium sales and price compared to the case when the cost is homogeneous. A difference in the visiting costs of consumers reduces the search benefit even more and thus consumers tend to search less.*

[10] Note that since $c_i \in [0, 1]$, a consumer with the maximum search cost searches only if the expected surplus exceeds 1.

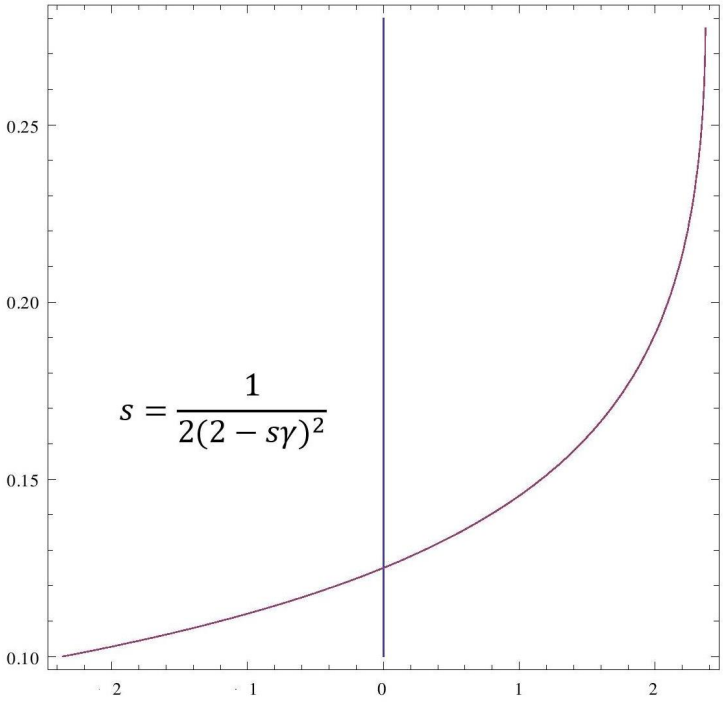

Figure 2: Share of searching consumers, s

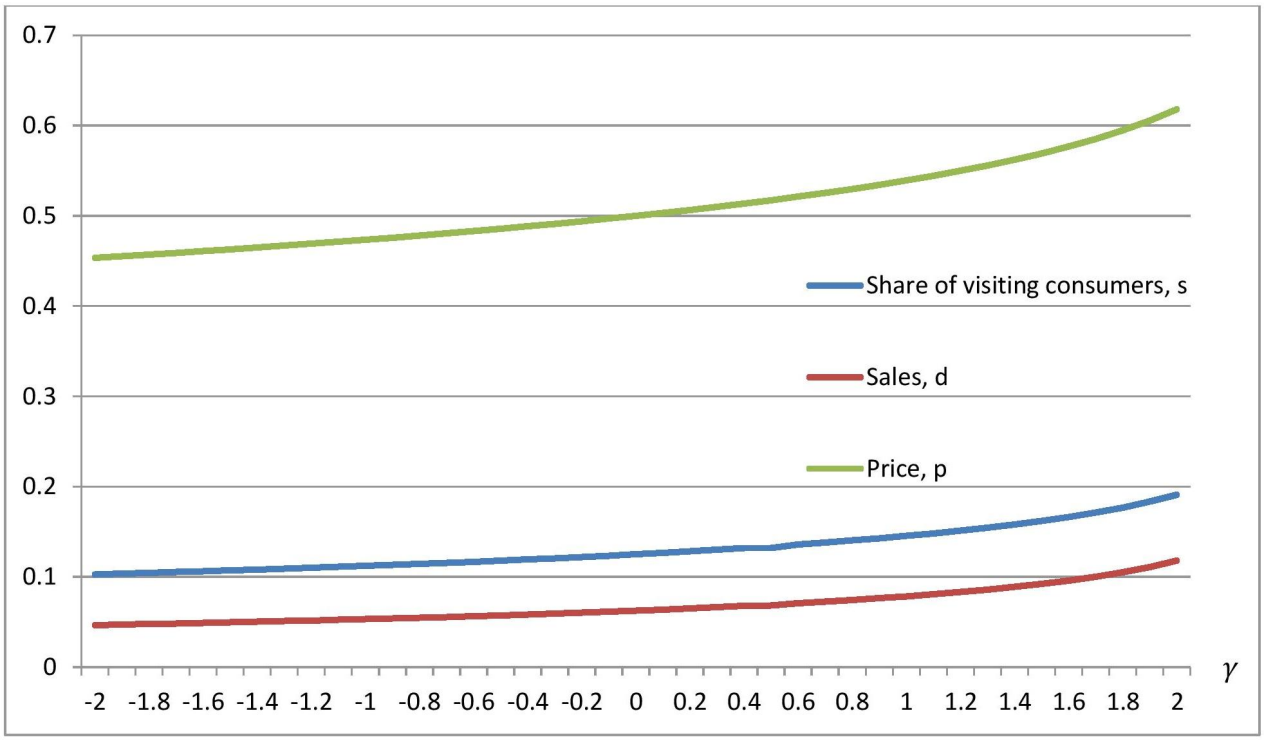

Figure 3: Equilibrium s, d, p when nothing is advertised

1.3.2 Price advertising only

Homogeneous visiting costs

Let us suppose that, at the first stage of the game, the monopolist decides to announce its price. This situation takes place when the search cost exceeds the threshold value $\widetilde{c}$ and thus there will be no market for the good without advertising. The firm must advertise at least its price to reassure consumers that visiting the store is worthwhile. By disclosing its price alone, the firm can internalize the consumption externality, but consumers still need to search because they do not know their horizontal matches, i.e. θ.

As in Anderson and Renault (2006), the firm advertises a price that renders expected an consumer surplus net of search cost zero. This means that, with homogeneous visiting costs, the advertised price is a critical price at which all consumers are indifferent between searching and being inactive. If the monopolist advertises some price p, a consumer will be indifferent between visiting the store and being inactive if:

$$E(CS) = \int_{p-\gamma d^e}^{1} (\theta_i + \gamma d^e - p)\, d\theta = \frac{(1 - p + \gamma d^e)^2}{2} = c$$

Given $d^e = \frac{1-p}{1-\gamma}$ if all consumers search, the monopolist advertises a price $p^* = 1 - \sqrt{2c}(1-\gamma) > 0$ and sells to $\sqrt{2c}$ consumers. If $\gamma < 1$, this equilibrium is possible only for $\sqrt{c} < \frac{1}{\sqrt{2}(1-\gamma)}$; if $\gamma \geqslant 1$, the equilibrium always exists. The resulting profit is $\pi^* = \sqrt{2c}\left(1 - \sqrt{2c}(1-\gamma)\right)$. It is interesting to note that actual sales do not depend on the network effect. When the firm advertises its price only, it chooses a target clientele size irrespective of the consumption externality and charges a price that captures the whole expected consumer surplus. When price is advertised alone, the firm can fully internalize the consumption externality with the announced price only. Since consumers still need to search to realize their matches, their visiting decision crucially depends on the value of c. Consequently, the equilibrium demand depends on the visit cost c only.

Lemma 3. *If a monopolist decides to advertise its price only, then the advertised price is* $p^* = 1-\sqrt{2c}(1-\gamma)$ *and the share of served consumers is* $\sqrt{2c}$*. This equilibrium exists only for* $\gamma > \frac{\sqrt{2c}-1}{\sqrt{2c}}$.

The equilibrium price decreases in the search cost for a snob effect and a weak bandwagon, $\gamma < 1$. This result is parallel to that in Anderson and Renault (2006) in which a larger search cost makes the firm advertise a lower price to attract consumers. However, when bandwagon is strong ($\gamma \geqslant 1$), the price increases in c. This can be explained by the unusual functional form of the demand function with a strong bandwagon effect. When $\gamma \geqslant 1$, demand function increases in price and thus a larger market share is always associated with a higher price. Actual sales of the monopolist equal $\sqrt{2c}$ and thus a higher search cost raises the equilibrium price for a strong positive network effect. In addition, if $c \geqslant \frac{1}{2}$, the monopolist needs to sell to the whole market, which implies that the advertised price is the price that induces full participation, $p = \gamma$. In contrast, in the previous case with no advertising, it was shown that an equilibrium with full participation of consumers is possible only if $c < \frac{1}{2}$. Therefore, price only advertising cannot have a fully covered market.

Heterogenous visiting costs

When visiting costs differ across consumers, the expected benefit of the purchase shows a fraction of consumers for whom visiting costs are lower than their expected consumer surplus. Therefore, a share of searching consumers, s, is equal to $E(CS) = \frac{(1-p+\gamma d^e)^2}{2}$.

When the firm advertises its price, it can influence the search decision of consumers with the announced price and thus its profit function is as follows:

$$\pi^p = p\ s\ (1-p+\gamma d^e) = p\frac{(1-p+\gamma d^e)^2}{2}(1-p+\gamma d^e) = p\frac{(1-p+\gamma d^e)^3}{2}$$

Both fulfilled expectations and market clearing conditions imply that consumers correctly anticipate what the firm will sell in the market: $d^e = \frac{(1-p+\gamma d^e)^3}{2}$. This condi-

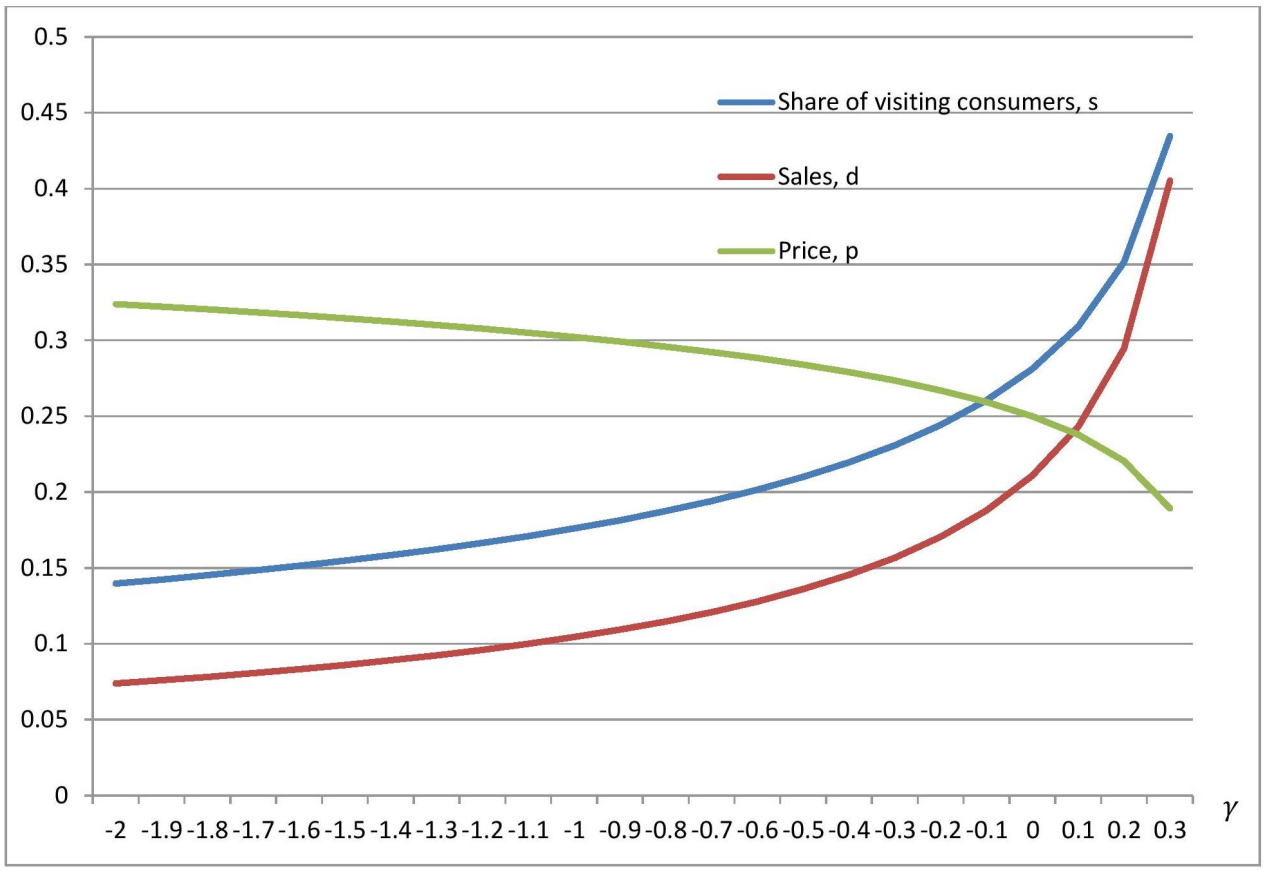

Figure 4: Equilibrium $s,\ d,\ p$ when price is advertised only

tion is an implicit equilibrium demand function.

The firm chooses to announce the price that maximizes its profit. FOC with respect to price is:

$$\pi_p^p = \frac{3(1-p+\gamma d^e)^2}{3\gamma(1-p+\gamma d^e)^2 - 2} p + \frac{(1-p+\gamma d^e)^3}{2} = 0$$

The corresponding equilibrium is defined by the system of three equations which implicitly express market price p, share of visiting consumers s, and equilibrium volume of sales d:

$$\begin{cases} s = \frac{(1-p+\gamma d)^2}{2} \\ d = s\sqrt{2s} \\ p = \frac{\sqrt{2s}(1-3s\gamma)}{3} \end{cases}$$

The corresponding curves of equilibrium $s,\ d,\ p$ are shown in Figure 4. The horizontal axis is a space of γ. Both sales and the share of visiting consumers increases in γ as expected, while price decreases in the externality. When the firm advertises its price, it can influence the expectations of consumers and thus it uses a price announcement to support a particular expectation about the clientele size. Specifically, if γ is negative, the firm must set a sufficiently high price to have a small clientele since a smaller clientele implies a higher valuation for the good. However, when γ approaches the bandwagon effect, the firm must charge a low price to attract more consumers since a higher clientele enhances consumers' willingness to pay. The firm can use this price advertising only for $\gamma < 0.36$ (a condition on positive values of $s,\ d$ and p).

Proposition 2. *If a monopolist advertises its price alone and does not provide any match information, then with a homogeneous visiting cost it chooses a fixed target volume of sales and internalizes the network externality with price only. This price increases in the network effect. In contrast, with a heterogeneous visiting cost both sales and the share of visiting consumers increase in the network effect while price positively reacts to the externality. The firm commits to its price with advertising and thus it can positively affect consumers' expectations with a higher price and negatively affect their expectations with a lower price.*

1.3.3 Match advertising only

Homogeneous visiting costs

Parameter θ indicates a valuation for the good. Specifically, it shows how much a consumer values product's functionality, practical characteristics and physical attributes (e.g. taste, color, shape, material, design, etc.). Consumers are heterogeneous in how they value these attributes. However, before consumers visit the shop, they don't know these characteristics. Consumers must visit the store and inspect the good to realize their "match": how well the product's characteristics suit the preferences

of a given consumer. Since consumers have different preferences over these attributes they may value the good differently.

Advertising of θ is thus a disclosure of product characteristics: materials used in production, taste, design, size, color, etc. This information helps consumers to form a more correct willingness to pay for a good with network externalities.

When the monopolist advertises only θ, consumers learn their matches (which differ across consumers). This type of advertising leads to a hold-up problem and consequently to the Diamond paradox where no one wants to visit the store. Thus, a monopolist never advertises θ only.

To explain why consumers never visit the store when they are informed only about their valuations for the good, let us consider the reasoning as follows. When consumers know their θ and no price is advertised, they rationally expect some realization of the price p charged by the firm and the associated sales d^e. If any consumer visits the firm, then this consumer has a willingness to pay that exceeds the sum of the price and the consumer's search cost: $\theta + \gamma d^e > p + c$. Although the firm takes it into account, it cannot influence the expectations of the consumer d^e with price (it simply cannot commit to price) and therefore tends to increase the price until the consumer's surplus is fully taken by the firm. This reasoning leads to the Diamond paradox, in which no price exists below the upper price limit and thus there will be no visits of consumers. This result is similar to that in Anderson and Renault (2006).

Heterogeneous visiting costs

The introduction of heterogeneous costs allows us to avoid the Diamond paradox. As discussed in Anderson and Renault (2006), with heterogenous search costs equilibrium prices may be less than the monopoly price and tend smoothly toward marginal cost as the search cost distribution puts more weight in the neighborhood of zero.

When the firm discloses horizontal matches to consumers, a particular consumer i expects some price p^* and visits the store if her $\theta_i > p^* + c_i - \gamma d^e$. Therefore, the

firm knows that for each c_i a share of visiting consumers is equal to $\int\limits_{p+c_i-\gamma d^e}^{1} d\theta = 1 - p - c_i + \gamma d^e$. An integration over all c_i gives a demand function as follows:

$$D = \int\limits_0^1 (1 - p - c + \gamma d^e)\, dc = \frac{1}{2} - p + \gamma d^e$$

Since the firm advertises matches only, it cannot influence the expectations of consumers with its price, hence d^e is taken by the firm as given. The corresponding profit function is $\pi^m = p\left(\frac{1}{2} - p + \gamma d^e\right)$ and FOC with respect to price gives $p = \frac{1+2\gamma d^e}{4}$. Consumers rationally anticipate this price and, given that consumers' expectations are fulfilled in equilibrium, the firm's sales are $d = \frac{1}{2(2-\gamma)}$. The corresponding equilibrium price is $p = \frac{1}{2(2-\gamma)}$ and $\pi^m = \frac{1}{4(2-\gamma)^2}$. Match advertising is only possible for $\gamma < 1.5$, since $d \in (0, 1)$.

Both price and sales increase in the consumption externality γ. Derivatives of both are positive: $d'_\gamma = p'_\gamma = \frac{1}{2(2-\gamma)^2} > 0$. Larger γ enhances consumers' valuation for the good and therefore increases both sales and the price.

Proposition 3. *A monopolist can use match advertising only if visiting costs are heterogeneous due to the Diamond paradox. Consumers learn their horizontal matches and thus different types of consumers have different searching rules: higher θ has a greater share of visits. Both demand and price increase in the network effect, since the externality positively affects the expected benefit of a purchase.*

1.3.4 Full disclosure

Homogeneous visiting costs

Let us suppose that the monopolist at the first stage of the game decides to reveal both θ and the price. By disclosing them, the firm can fully internalize the consumption externality and consumers can correctly form their expectations. With this advertising all information is public, so consumers do not search but still need to pay visiting costs. A consumer is willing to buy if her $\theta \geqslant p + c - \gamma d(p)$. In equilibrium

actual sales must be equal to the production of the firm: $d(p) = 1 + \gamma d(p) - p - c$. This gives a demand function $d(p) = \frac{1-p-c}{1-\gamma}$.

As before, two cases are possible: $\gamma < 1$ and $\gamma \geqslant 1$. In the latter case, the demand function increase in price and thus the pricing rule of the firm differs. Let us start with the case when $\gamma < 1$.

The monopolist's profit function is as follows:

$$\pi^a(p_a) = p_a \frac{1 - c - p_a}{1 - \gamma}$$

The profit maximization problem results in $p_a = \frac{1-c}{2}$, $d_a = \frac{1-c}{2(1-\gamma)}$ and $\pi^a = \frac{(1-c)^2}{4(1-\gamma)}$.

As one can see, the firm can charge the monopoly price $p_a = \frac{1-c}{2}$ to a greater share of the market[11]. This implies that with full disclosure the firm can internalize the consumption externality and charge the monopoly price. Specifically, this price is independent of γ, which in turn allows the firm to charge a high price even in the presence of the negative network effect[12]. This result supports Lemma 1, in which a monopolist would prefer to advertise in the case of negative γ. With full disclosure the firm can perfectly influence the expectations of consumers and consequently the search decision. Therefore, it can internalize the externality with the volume of equilibrium sales while charging a regular monopoly price.

It is important to note that the equilibrium described above is only possible for $\gamma \leqslant \frac{1+c}{2}$, because for any $\gamma \in \left(\frac{1+c}{2}; 1\right)$ the monopolist obtains all consumers at the price equal to $\frac{1-c}{2}$. In turn, this means that the firm can charge $p = \gamma - c$ and still sell to all consumers. Larger γ benefits the firm because it can charge a higher price and consequently receive greater profits.

When $\gamma \geqslant 1$, a positive consumption externality compensates the negative effect of price and thus the demand function positively reacts to the price increase: $d(p) =$

[11] A regular monopoly without the network effect would charge $p^m = \arg\max_p [p(1 - p - c)] = \frac{1-c}{2}$ and sell the good to $\frac{1-c}{2}$ share of the market.

[12] Without advertising, the price was $p_n = \frac{1}{2-\gamma}$; with advertising, it is $p_a = \frac{1-c}{2}$, which is larger for $\gamma < \frac{2c}{c-1} < 0$.

$\frac{1-p-c}{1-\gamma}$. As in the previous case, the only equilibrium that survives is the one where the firm sells to everyone and charges a price equal to the size of the network effect net of c: $p = \gamma - c$. Using the same reasoning as before, with a very strong bandwagon effect, the demand function positively depends on price and thus the firm is willing to sell to all consumers. The maximum possible price that supports full participation of consumers is found from: $d(p) = \frac{1-p-c}{1-\gamma} = 1$. It is equal to $p = \gamma - c$ and the corresponding profit is $\pi^a = \gamma - c$.

Lemma 4. *If a monopolist chooses to advertise both price and θ, then for a product with a snob effect or a weak bandwagon effect ($\gamma < \frac{1+c}{2}$), a regular monopoly price is charged $p^m = \frac{1-c}{2}$ that does not depend on γ. In the case of a strong bandwagon effect with $\gamma \geqslant \frac{1+c}{2}$, a monopolist sells to all consumers and charges a price equal to the size of the consumption externality net of c, $p = \gamma - c$.*

Heterogeneous visiting costs

When both price and matches are public information, each consumer i observes the advertised price p^* and visits the store if her $\theta_i > p^* + c_i - \gamma d^e$. Moreover, since the firm advertises its price it can perfectly influence the expectations of consumers, and consumers use the advertised price to calculate the actual sales. Therefore, the firm's demand function can be found from the equation as follows:

$$d = \int_0^1 \int_{p+c-\gamma d}^1 d\theta dc = \frac{1}{2} - p + \gamma d$$

Rearranging the terms brings $d = \frac{1-2p}{2(1-\gamma)}$ and the resulting profit function is $\pi^b = \frac{p(1-2p)}{2(1-\gamma)}$. FOC with respect to price gives $p = \frac{1}{4}$ and $d = \frac{1}{4(1-\gamma)}$. As in the case with homogeneous visiting costs, the equilibrium price does not depend on γ. Moreover, this price is a regular monopoly price (in the model with heterogenous visiting costs). Thus, the firm can charge a monopoly price to a greater share of the market while sales are adjusted to the consumption externality. This implies that when the firm advertises both matches and price, it internalizes the externality by means of sales

only. This equilibrium exists for $\frac{1}{4(1-\gamma)} \leqslant 1$ (or $\gamma \leqslant 0.75$).

When γ exceeds 1, the firm faces a strong bandwagon effect and the only equilibrium is where the firm sells to everyone. The lowest type consumer receives a surplus $CS = 0 - p + \gamma - 1$ and thus the price supporting the equilibrium with a corner solution is $p = \gamma - 1$.

Proposition 4. *When a monopoly fully discloses market information, it commits to its announced price and all consumers realize their matches. Therefore, the share of visiting consumers is equal to the actual volume of sales. The firm is able to set a monopoly price and fully internalizes the network externality with its output only. When the firm faces a strong bandwagon effect, it serves all consumers and charges a price equal to the value of the externality net of the maximum visiting cost.*

To sum up, we have considered four strategies of the firm. In the first scenario, the firm stays silent and does not advertise any information, and thus consumers must search to obtain necessary market information. In the second case, the firm advertises its price only. The third scenario is never used because the advertising of θ only leads to the Diamond paradox and zero sales if search costs are homogeneous. Finally, the firm may disclose full information and thus consumers make their buying decisions without any search frictions.

1.3.5 Advertising decision

Homogeneous visiting costs

Let us now consider the very beginning of the game when the monopolist chooses whether it is beneficial to advertise and which information to disclose. To know whether it is beneficial, the firm should compare its profits: π^n, π^* and π^a. If a monopolist does not advertise, only two equilibria exist: either when $\gamma < 1$ and $c \leqslant \frac{1}{2(2-\gamma)^2}$, the firm charges $p_n = \frac{1}{2-\gamma}$ serving $\frac{1}{2-\gamma}$ share of consumers; or when $\gamma \geqslant 1$ and $c < \frac{1}{2}$, the firm charges $p_n = \gamma$ selling to everyone. If a monopolist decides to advertise price only, the equilibrium price is $p^* = 1 - \sqrt{2c}(1-\gamma)$ and sales are $\sqrt{2c}$. This equilibrium exists for $c < \frac{1}{2}$ and $1 - \sqrt{2c}(1-\gamma) > 0$. Only θ advertising is never chosen because of the Diamond paradox. Finally, if a firm chooses to advertise both price and θ, then for $\gamma < \frac{1+c}{2}$, a regular monopoly price $p^m = \frac{1-c}{2}$ is charged to $\frac{1-c}{2(1-\gamma)}$ share of consumers, and for $\gamma \geqslant \frac{1+c}{2}$, the firm sells to all consumers and charges a price $p = \gamma - c$.

Depending on the values of γ and c the firm chooses under which conditions a particular advertising brings higher profits (or any positive profit if staying silent means no market). In particular, we are interested in finding the regions where the firm considers information disclosure a dominant strategy. In other words, the goal is to determine where π^*or π^a exceed π^n.

There are four threshold values of γ : $1 - \sqrt{\frac{1}{2c}}$, $2 - \sqrt{\frac{1}{2c}}$, $\frac{1+c}{2}$ and 1. First, only price advertising may exist only for $1 - \sqrt{2c}(1-\gamma) > 0$, which is identical to $\gamma > 1 - \sqrt{\frac{1}{2c}}$. Second, the firm can stay silent only if $c \leqslant \frac{1}{2(2-\gamma)^2}$ which implies that $\gamma \in [2 - \sqrt{\frac{1}{2c}}; 2 + \sqrt{\frac{1}{2c}}]$. Third, with advertising of both price and θ, the firm changes its pricing policy at $\gamma \geqslant \frac{1+c}{2}$. Fourth, without advertising the firm faces a strong network effect at $\gamma > 1$ and thus also changes its pricing policy[13]. At the same time, a threshold $\gamma = 2 - \sqrt{\frac{1}{2c}}$ may have three different locations: $2 - \sqrt{\frac{1}{2c}} < \frac{1+c}{2}$ for $c < \frac{(1-\sqrt{3})^2}{2}$; $\frac{1+c}{2} \leqslant 2 - \sqrt{\frac{1}{2c}} \leqslant 1$ for $c \in [\frac{(1-\sqrt{3})^2}{2}, \frac{1}{2}]$; $2 - \sqrt{\frac{1}{2c}} > 1$ for $c > \frac{1}{2}$. These

[13]Since $2 + \sqrt{\frac{1}{2c}} > 1$, a threshold value of $\gamma = 2 + \sqrt{\frac{1}{2c}}$ does not have any specific meaning in the analysis.

possible locations of threshold γ define three regions in the space of the search cost c: low search costs when $c < \frac{(1-\sqrt{3})^2}{2}$; moderate search costs with $c \in [\frac{(1-\sqrt{3})^2}{2}, \frac{1}{2}]$; high search costs with $c > \frac{1}{2}$. Let us investigate each case separately.

a) *Low search costs*

Consumers face low search costs if $c < \frac{(1-\sqrt{3})^2}{2}$. There are five regions in γ-space as it is depicted in Figure 5:

- when $\gamma < 1 - \sqrt{\frac{1}{2c}}$, the firm must advertise both price and θ because without this advertising a search cost exceeds the expected consumer surplus and consumers do not visit the store at all. The only way to make it work is to advertise a price $p^m = \frac{1-c}{2}$ and sell to $\frac{1-c}{2(1-\gamma)}$ share of consumers. Since $\frac{1}{2(1-\gamma)} < 1$, some consumers do not buy and the market is uncovered[14];

- when $\gamma \in [1-\sqrt{\frac{1}{2c}}; 2-\sqrt{\frac{1}{2c}}]$, the firm needs to advertise to make consumers visit the store. It may use only price advertising if $\pi^* > \pi^a$ or disclose full information if $\pi^a > \pi^*$;

- when $\gamma \in [2 - \sqrt{\frac{1}{2c}}; \frac{1+c}{2})$, the firm can choose between advertising or not. It compares $\pi^n,\ \pi^*,\ \pi^a$ and chooses a strategy that brings higher payoffs;

- when $\frac{1+c}{2} \leqslant \gamma < 1$, the firm also faces a choice whether to advertise or stay silent. However, only price advertising is always dominated by staying silent in this region, and thus it is never used. If the firm does not advertise, it obtains $\pi^n = \frac{1}{(2-\gamma)^2}$. If the firm advertises both price and θ, it faces a strong positive network effect, and thus it charges $p = \gamma - c$, sells to all consumers, and receives $\pi^a = \gamma - c$;

- when $\gamma \geqslant 1$, the firm faces a strong positive network effect. Since $\pi^* < \gamma - c < \gamma$, the firm chooses not to advertise at all. It charges a price equal to γ, consumers expect this price, and all choose to search since search costs are low[15].

b) *Moderate search costs*

Consumers face moderate search costs if $c \in [\frac{(1-\sqrt{3})^2}{2};\ \frac{1}{2}]$. There are five regions in

[14] If some consumers are not served in equilibrium, the market is uncovered. If all consumers participate and buy, the market is fully covered.

[15] Note that when $\gamma \geqslant 1$, without advertising consumers search if $c \leqslant \frac{1}{2}$.

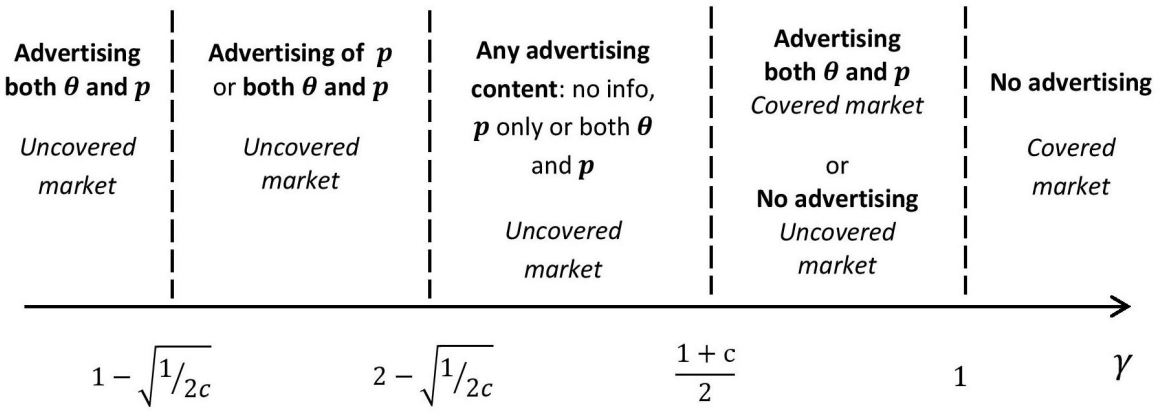

Figure 5: Low search cost, $c < \frac{(1-\sqrt{3})^2}{2}$

γ-space as depicted in Figure 6:

- when $\gamma < 1 - \sqrt{\frac{1}{2c}}$, the firm needs to advertise both price and θ. The advertised price is $p^m = \frac{1-c}{2}$ and sales are $\frac{1-c}{2(1-\gamma)}$. A search is not affordable;

- when $\gamma \in [1 - \sqrt{\frac{1}{2c}};\ \frac{1+c}{2})$, the firm also needs to advertise, but in this region only price advertising is also possible, and thus the firm compares advertising payoffs and chooses the best advertising option;

- when $\gamma \in [\frac{1+c}{2};\ 2 - \sqrt{\frac{1}{2c}})$, only price advertising brings higher profits than full information disclosure. Therefore, the firm advertises its price only;

- when $\gamma \in [2 - \sqrt{\frac{1}{2c}}; 1)$, the firm prefers to stay silent because search is possible and both types of advertising result in lower profits: $\pi^n > \pi^* > \gamma - c$. Since $\gamma < 1$ the market is uncovered;

- when $\gamma \geqslant 1$, the firm faces a strong positive network effect. Since search is possible and π^n exceeds both π^* and $\gamma - c$, the firm chooses not to advertise at all and charges $p = \gamma$. Consumers expect this price and choose to search because search costs are low enough. Since $\gamma \geqslant 1$, the market is fully covered.

Figures 5 and 6 demonstrate that a negative network effect makes the firm provide as much information as possible (advertising of both θ and price). Meanwhile, a strong positive externality brings higher profits when the firm is silent because the expected benefit of a search is positively related to the network externality. A negative network

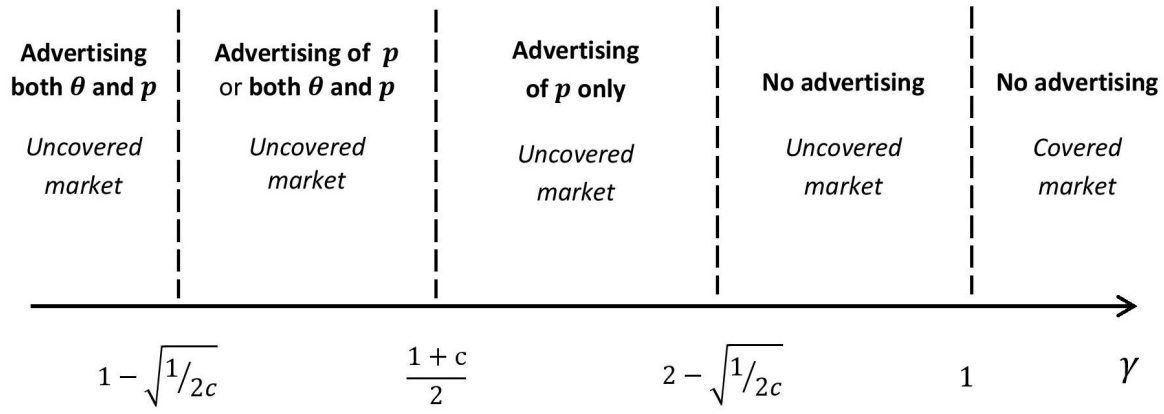

Figure 6: Moderate search cost, $\frac{(1-\sqrt{3})^2}{2} \leqslant c \leqslant \frac{1}{2}$

effect decreases the expected consumer surplus and thus consumers search less. The only way to make consumers visit the store is to provide necessary information in the form of advertising. As Anderson and Renault (2006) and Renault (2016) show, price is never advertised alone if the firm can reveal match information partially. However if match information must be fully informative, then the firm chooses to advertise price alone for intermediate visit costs.

c) *High search costs*

Consumers face high search costs if $c > \frac{1}{2}$. There are only two regions in γ-space as depicted in Figure 7:

- when $\gamma < \frac{1+c}{2}$, the firm needs to advertise both θ and a price $p^m = \frac{1-c}{2}$. A search is not affordable because the cost is high. Since sales are equal to $\frac{1-c}{2(1-\gamma)}$, the market is uncovered;

- when $\gamma \geqslant \frac{1+c}{2}$, the firm also needs to advertise both price and θ. However, in this region, it faces a strong positive network effect, and therefore it charges $p = \gamma - c$ and sells to all consumers. Moreover, the firm must advertise its price even for $\gamma \geqslant 1$, because with $c \geqslant \frac{1}{2}$ a search is not affordable. Thus, no consumer searches even for a strong bandwagon effect due to a high cost of a search. No market exists if there is no advertising.

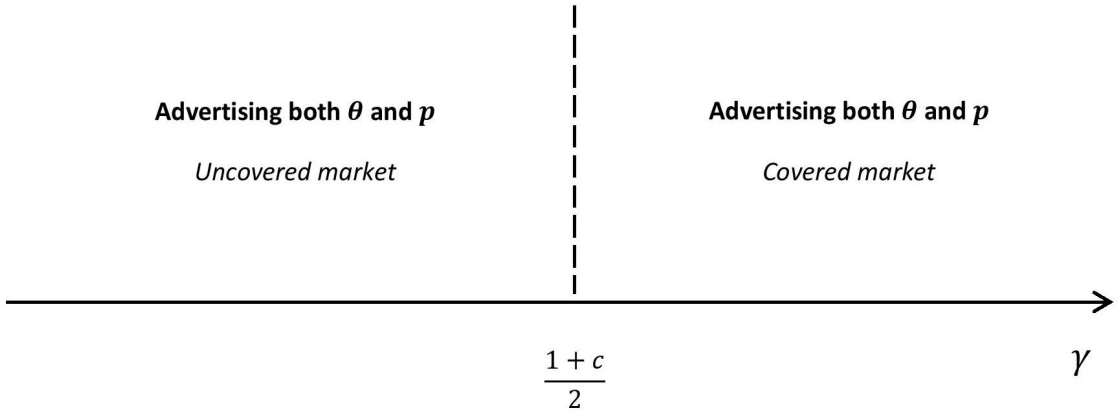

Figure 7: High search cost, $c > \frac{1}{2}$

Proposition 5. *When all consumers have identical visiting costs, the firm chooses its optimal advertising strategy depending on the network externality and the value of the visiting cost. The firm tends to disclose more information as the network externality moves from positive to negative when the cost of a visit is low or moderate, while a higher visiting cost always induces full disclosure.*

Unlike in the previous literature, an advertising decision of a monopolist does not only depend on c (as in Konishi and Sandfort, 2002; Anderson and Renault, 2006), but it also depends on the network effect γ. In particular, a relatively weak bandwagon effect and a regular snob effect require advertising if consumers are poorly informed. As Anderson and Renault (2006) and Renault (2016) show, as the visit cost grows, the optimal advertising strategy of the firm chomges from no advertising to full disclosure. In our case, the optimal advertising strategy changes from no advertising to full disclosure as γ decreases. Moreover, market coverage positively reacts to the increase in γ, reaching its maximum when the externality is strong.

Heterogeneous visiting costs

Considering the advertising decision of the firm when consumers are different in their visiting costs, this decision depends of the type of the consumption externality and its size. Since the firm prefers advertising content which gives the highest profit, it compares the profits under different advertising policies. When the firm provides

no information, it receives $\pi^n = \frac{s}{(2-s\gamma)^2}$, where $s = \frac{1}{2(2-s\gamma)^2}$. If the firm chooses to advertise its price alone, it obtains $\pi^p = \frac{2s^2(1-3s\gamma)}{3}$, where $s = \frac{(3+\sqrt{2s}(6s\gamma-1))^2}{18}$, but this advertising policy is possible only for $\gamma < 0.36$. Only match advertising takes place for $\gamma < 1.5$ and brings $\pi^m = \frac{1}{4(2-\gamma)^2}$. Finally, advertising of both price and match results in profits $\pi^b = \frac{1}{16(1-\gamma)}$ if $\gamma \leqslant 0.75$ and $\pi^b = \gamma - 1$ if $\gamma \geqslant 1$.

Since π^b is always greater than π^m for $\gamma \leqslant 0.75$, the firm prefers full disclosure to "match only" advertising. However, "both price and match" advertising is not achievable for $\gamma \in (0.75; 1)$, and therefore the firm uses match advertising in this region. Moreover, match advertising is also implemented for $\gamma \in [1; 1.5]$ because $\pi^m > \pi^b$ for these values. When $\gamma > 1.5$, the firm cannot use match advertising and thus it fully discloses both match information and price. Further analysis of the advertising policies and their comparison are shown in the figures that follow.

Figures 8 and 9 show profit curves for different advertising policies of the firm depending on the value of γ. The vertical axis is the value of profit and the horizontal axis is a space of γ. Figure 8 shows four profit curves for $\gamma < 0.36$, since equilibrium with "only price" advertising does not exist for $\gamma < 0.36$.

Clearly, "only price" advertising gives higher profits for $\gamma < -0.95$. After that point "both price and match" advertising dominates any other advertising decision. "Match only" and zero advertising is never chosen, since they result in lower profits. When the snob effect is strong, it is more profitable to influence the expectations of consumers with price only. If consumers benefit substantially from a small clientele, the firm advertises a high price to commit to a small sales in equilibrium. Indeed, since the snob effect makes demand less elastic, the equilibrium price with "price only" advertising decreases in γ as shown in Figure 4. With a strong snob effect the firm prefers to advertise a high price to support smaller sales, since demand is inelastic. Therefore, "price only" advertising brings the highest profits to the firm[16].

However, when $\gamma > -0.95$, full disclosure brings higher levels of profit. Demand

[16]When the firm announces both price and match, demand becomes perfectly elastic, since the firm charges a fixed monopoly price $p = \frac{1}{4}$.

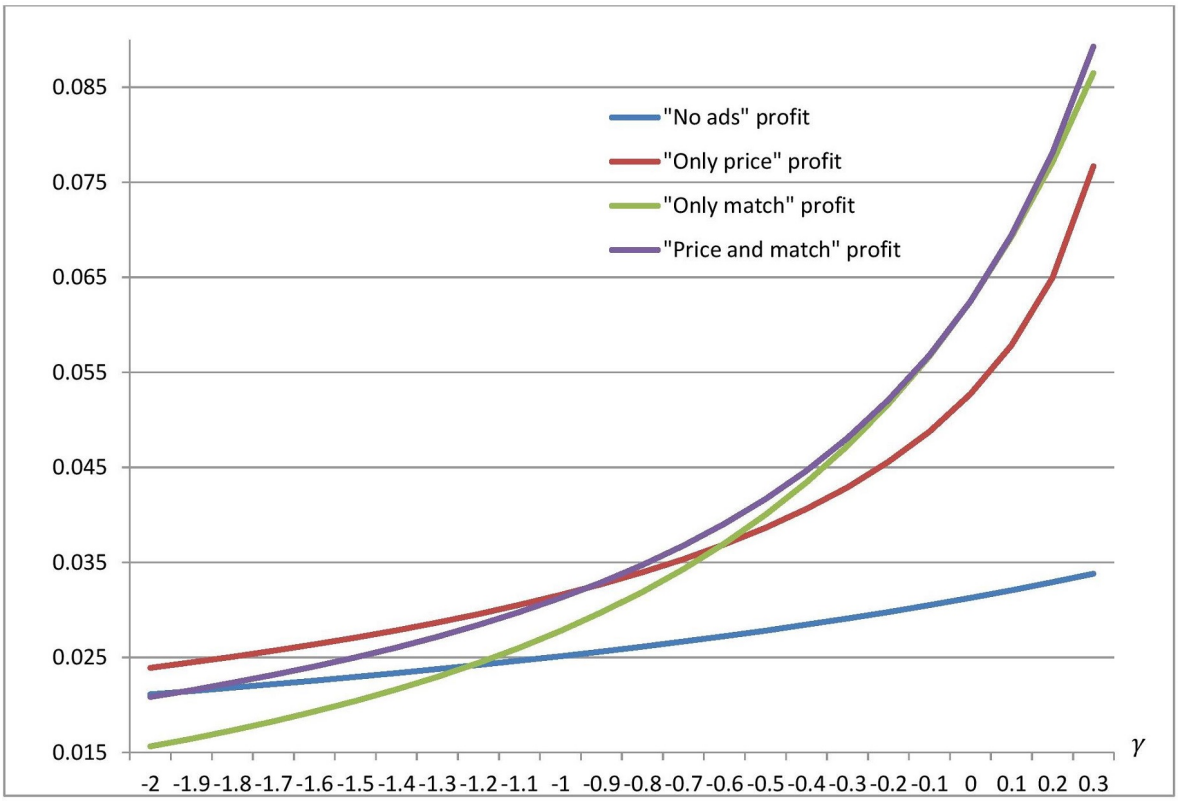

Figure 8: Profit curves under different advertising policies, $\gamma < 0.36$

becomes less inelastic and hence it is more profitable to have a higher clientele and lower price. Since the "both price and match" option gives the highest sales among all four possible advertising policies, the firm benefits from disclosing both θ and price.

Figure 9 shows profit curves for three advertising policies when $\gamma > 0.36$. "Both price and match" advertising dominates all other regimes for $\gamma \in (-0.95; 0.75)$ for the same reason as before: higher γ implies a more elastic demand and thus it is profitable to have larger clientele, advertising a lower price helps the firm commit to larger sales in equilibrium, and disclosing matches increases the probability of visits. Any other advertising policy results in lower equilibrium sales.

However, "both price and match" advertising cannot be used for $\gamma \in (0.75; 1)$. Therefore, "match only" advertising takes place for the given interval of γ. Moreover, for $\gamma > 1$ the firm serves the whole market and charges $p = \gamma - 1$ under full disclosure, which gives lower profits when $\gamma \in [1; 1.5]$. Therefore, the firm also uses "match only" advertising for $\gamma \in [1; 1.5]$. For $\gamma > 1.5$ the firm advertises both price and matches, and sells to all consumers at price $p = \gamma - 1$, which obviously increases in the externality, since larger γ implies greater benefits from the bandwagon effect.

To sum up, when consumers are different in their visiting costs, the optimal advertising policy depends on the consumption externality. Specifically, if $\gamma < -0.95$ the firm benefits more from "price only" advertising; if $\gamma \in (-0.95; 0.75)$ the firm advertises both price and matches, and has not fully covered market; if $\gamma \in [0.75; 1.5]$ the firm discloses horizontal matches only; if $\gamma > 1.5$ the firm announces both matches and price, and does not have a fully covered market.

Proposition 6. *When consumers have heterogenous visiting costs, a monopoly never remains silent and thus at least the price is advertised. As the network effect changes from negative to positive, the firm includes more information in its advertising content.*

The most important result is that with heterogeneous visiting costs, as γ changes from negative to positive values, the firm includes more information in its advertis-

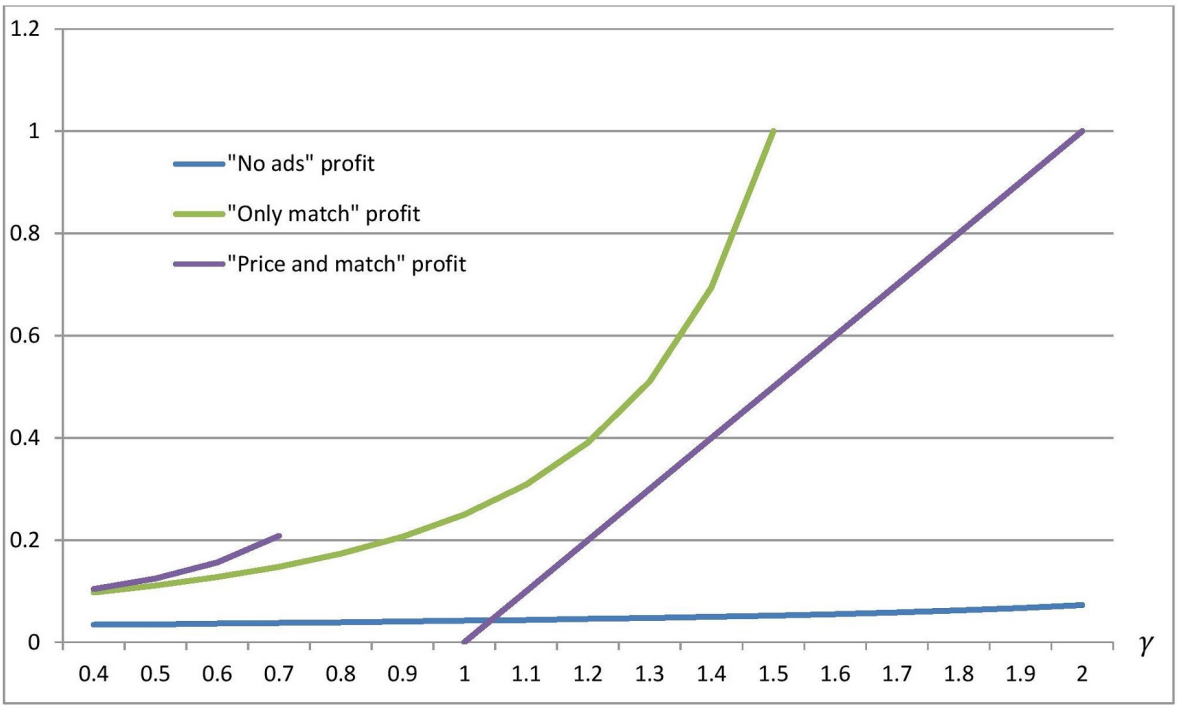

Figure 9: Profit curves under different advertising policies, $\gamma > 0.36$

ing. This result is opposite the case with homogeneous cost. This occurs due to a more sensitive demand, since the probability of buying does not only depend on the consumer's match alone, but also if her search cost is low enough. Moreover, for a negative network effect all consumers prefer a small clientele, because consumers' willingness to pay increases as clientele decreases. Therefore, providing little information reduces visits and thus restricts demand, while for a positive network effect all consumers benefit from a larger clientele, because consumers' willingness to pay increases as clientele increases. Hence,providing more information increases visits and expands demand. When the visit cost is the same for everyone, the firm only cares if the expected benefit of a search exceeds a given threshold, while the benefit decreases in γ.

1.4 Results and Concluding Remarks

The preceding section considers the incentives for a monopoly to disclose market information. In contrast to the previous literature, the model presented in this paper combines network externalities and an information disclosure game. Network effects in consumption are considered using a model of a market where the decision to buy a product depends on the total sales of the good. Disclosure game uses a framework of search and advertising. This implies that if the firm remains silent, consumers must search to obtain necessary market information; if the firm decides to reveal the information itself in the form of advertising, the information becomes public knowledge. This setting better describes the functioning of the markets with network goods, because the existing literature on the topic does not consider search frictions and price commitment problem as the main obstacles for consumers when they face network externalities. First, with network goods consumers make a buying decision based on their expectations about the actual sales (clientele size). This can be easily done if consumers are able to correctly foresee the market outcome. However, due to bounded rationality or a lack of necessary market information (e.g. price) forming the correct expectation is complicated. This explains why sellers of conspicuous goods usually reveal some information to help consumers to form correct expectations about possible clientele size. This information is usually transmitted via announcements of the total supply (or limited editions), product characteristics or price advertising. Second, the announcements and price advertising work as a commitment device, since any public announcement in the form of the official advertising obliges the firm to fulfil what it announced. Therefore, consumers are assured that the firm will not deviate and break promises.

Advertising as a disclosure method is widely used in search models to show that information disclosure may expand demand and secure higher profits in the presence of search costs (e.g. Anderson and Renault, 2006; Konishi and Sandfort, 2002). In network economics, consumers are assumed to rationally anticipate prices and actual

sales (e.g. Grilo et al., 2001; Griva and Vettas, 2011). However, this is only possible with no information problems. Thus, this assumption has to be relaxed because in real markets information is not perfect and therefore the formation of consumers' expectations is complicated. The model considered in this paper describes how consumers make their search and buying decisions, and what explains a firm's decision regarding what advertising content to use. This decision making process is a three-stage game.

In the beginning of the game a monopolist has an option to remain silent and keep consumers uninformed or to advertise and reveal either price only, match only or both price and consumers' matches which are *ex ante* unknown. When the firm chooses to stay silent consumers search if their search cost exceeds the expected consumer surplus. If the firm decides to advertise any information, consumers use this information to compute the expected clientele and decide on buying. The advertising strategy of the firm depends on two parameters: the size of the search cost and the measure of the network effect.

First, advertising is more likely for a negative network effect and less likely for a positive network effect. In other words, the benefits of search increase in the network effect, because a greater clientele size increases the expected consumer surplus. Search benefits are small in the case of a negative network effect and therefore the only way to secure profits is by advertising.

Second, a strong positive network effect can eliminate a negative price effect. With a strong positive externality the demand function increases in price because a greater clientele increases a consumer's willingness to pay more than a reduction due to price increase. Therefore, a monopolist prefers to sell to all consumers and charges a price equal to the value of the network externality.

Third, the previous two results hold for any type of search cost: both homogenous and heterogenous Homogenous search costs mean that all consumers face the same value of the cost. With heterogenous search costs, consumers differ in the costs due to their different value of time, different search abilities or locations..

Finally, when visiting costs are homogeneous, the advertising decision of the firm

also depends on the costs of a search. When search costs are low or moderate, the firm must advertise when the search costs exceed the expected benefit of the search or when price advertising gives higher profits. It is important to note that a monopolist needs to provide as much information as possible for a negative network effect, while a strong positive network effect brings higher profits when the firm remains silent. Depending on the value of the network externality, the market can be either partially served (uncovered market) or with the full participation of consumers (covered market). When search costs are high, the only way to sell is to provide consumers with full information about prices and product characteristics.

When visiting costs are heterogenous, zero advertising content is never chosen by the firm; at least price or matches should be disclosed. The firm advertises its price alone for a strong negative consumption externality, because the consumer's valuations for the good increase with a smaller clientele. Advertising a higher price and undisclosed matches reduce visits and consequently prevent large equilibrium sales. When demand becomes more elastic (increase in γ), it is more profitable to charge a lower price and facilitate visits. This can be done by disclosing as much information as possible. Thus, the firm prefers to advertise both price and matches whenever it is possible for a positive network externality.

Compared to the network literature, these results show that market frictions that complicate a consumer's ability to form correct expectations significantly affect the decision making process of consumers and therefore the market outcome. Moreover, the addition of network externalities to the advertising game in the search model enrich the conclusions of the search literature, because information disclosure decision becomes dependent not only on the costs of a search, but also on consumption externalities.

1.5 Appendix

1A Randomizing consumers

As shown in Janssen et al. (2005), when every search is costly, two types of equilibrium are possible. In particular, when the expected surplus of a purchase $E(CS)$ is equal to the visiting cost, either all consumers may decide to visit the store (this equilibrium is considered in the paper) or consumers may randomize between visiting the store and being inactive. The latter equilibrium implies that the probability of a visit is equal to the share of visiting consumers, s. In equilibrium where consumers randomize, s becomes endogenous and is determined in equilibrium.

Consumers may choose to randomize when $E(CS) = \frac{1}{2(2-s\gamma)^2} = c$. Therefore, the equilibrium share of visiting consumers or the probability of a visit, s^*, is a solution to the equation $\frac{1}{2(2-s\gamma)^2} - c = 0$. The corresponding price is $p = \frac{1}{2-\gamma s^*}$ and equilibrium sales are $d = \frac{s^*}{2-\gamma s^*}$. Let us investigate the properties of the equilibrium with partial participation. First, to have positive price and sales, the condition $(2 - \gamma s) > 0$ must hold. This gives the equilibrium $s^* = \frac{2\sqrt{c}-1}{\gamma\sqrt{c}}$. Hence, $p = \sqrt{2c}$ and $d = \frac{2\sqrt{2c}-1}{\gamma}$. Since $0 < d < 1$ and $0 < s < 1$, this equilibrium exists for $\left\{ \begin{array}{c} c > 0.125 \\ \gamma > 0 \\ \gamma > 2\sqrt{2c} - 1 \\ \sqrt{2c}(2-\gamma) < 1 \end{array} \right\}$ and $\left\{ \begin{array}{c} c < 0.125 \\ \gamma < 0 \\ \gamma < 2\sqrt{2c} - 1 \\ \sqrt{2c}(2-\gamma) > 1 \end{array} \right\}$.

Figure 10 presents the curves of $s = \frac{2\sqrt{c}-1}{\gamma\sqrt{c}}$ for different values of c. The vertical axis is s, the horizontal axis is γ. When γ is negative, the probability of a visit decreases in the snob effect and in the costs of search as expected because both negatively influence the consumer surplus. When $\gamma > 0$, the probability of a visit decreases in γ and increases in c. If γ grows and c is fixed, this would increase $E(CS)$, but to keep

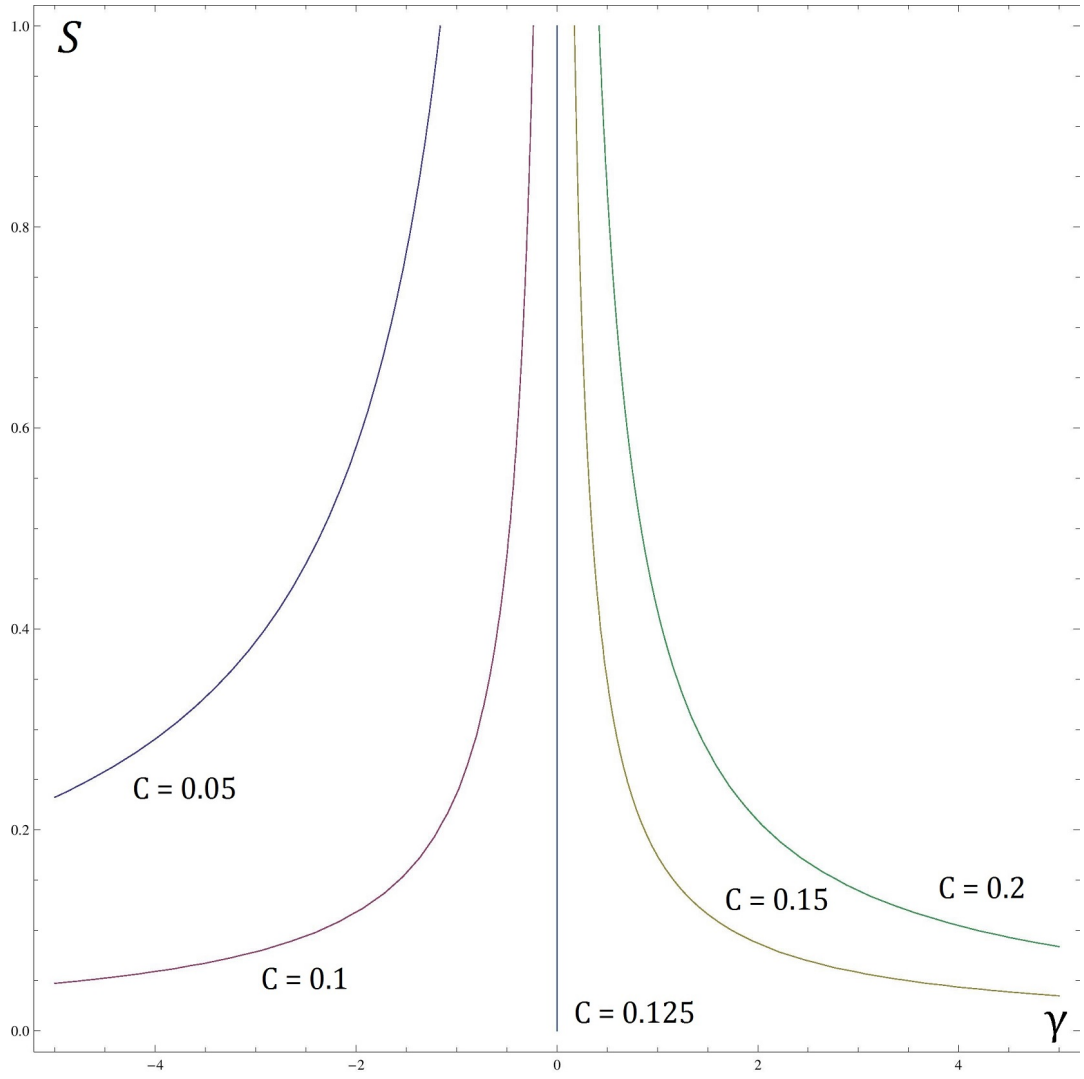

Figure 10: Locus of equilibrium s as a function of γ for different c

$E(CS) = \frac{1}{2(2-s\gamma)^2} = c$, the equilibrium s should decrease. If c grows and γ is fixed, the equilibrium s should decrease to keep the condition for randomization unchanged.

As shown, for a particular set of parameters γ and c an equilibrium with randomizing consumers may exist when $E(CS) = c$. However, in the main analysis it is assumed that all consumers prefer buying to being inactive.

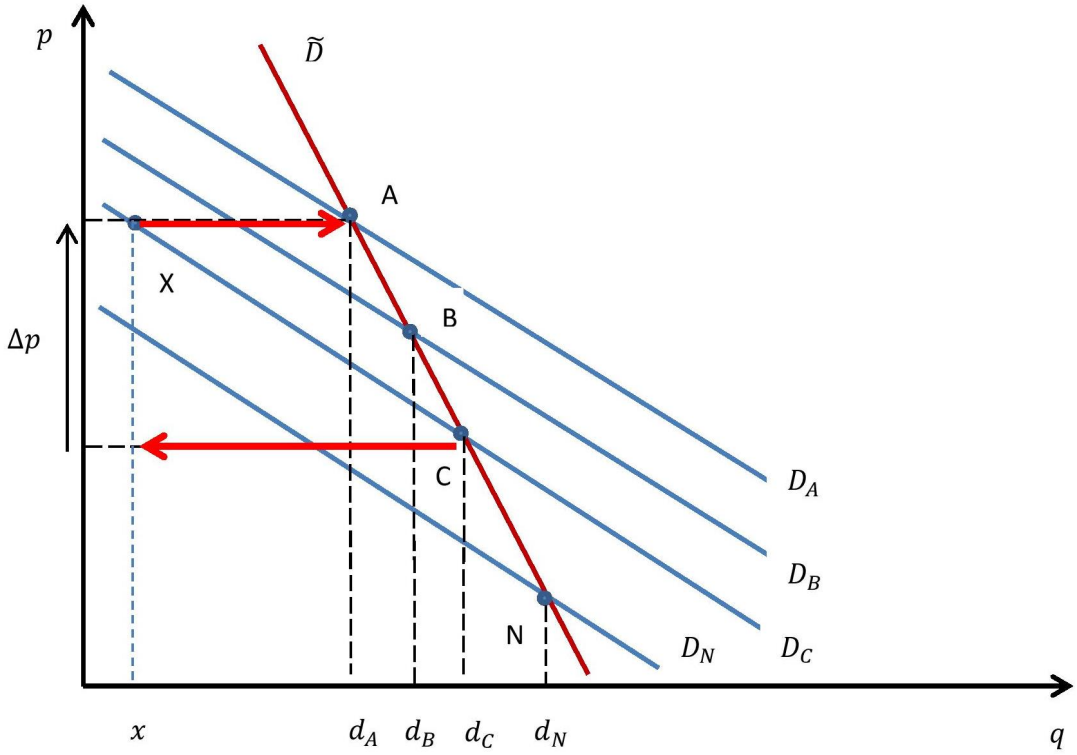

Figure 11: Snob Effect

1B Actual market demand with network externalities

Following the analysis in Leibenstein (1950), market demand is a function of consumers' expectations about the actual sales of the good with a network effect. It is therefore possible to treat expectations as a parameter and see how market demand changes with different expectations. Let the market demand D_j indicate the quantities demanded at alternate prices if all consumers expect that total sales are equal to d_j. Thus an increase in d_j shifts the demand curve D_j outwards. Considering a graphical analysis of snob and bandwagon effects, assume that alternative consumers' expectations of the sales are $d_A < d_B < d_C < ... < d_N$ and corresponding demand curves are $D_A,\ D_B,\ D_C, ..., D_N$ as shown in Figures 11, 12 and 13.

Snob Effect. Figure 11 demonstrates a snob effect. As shown, a higher expected clientele corresponds to lower levels of demand. If we assume that consumers are rational and they can correctly foresee the total sales at every market price, then

only one point on any of the curves $D_A,\ D_B,\ D_C, ..., D_N$ could be on the equilibrium demand curve. The points on each curve $D_A,\ D_B,\ D_C, ..., D_N$ represent the amounts that consumers expect to be the total sales. In these equilibrium points A, B, C, ..., N market demand at market price is equal to consumers' expectations. The locus of these points $\widetilde{D}$ is therefore the actual demand curve for the conspicuous commodity. $\widetilde{D}$ is less elastic compared to the demand curves $D_A,\ D_B,\ D_C, ..., D_N$ which treat consumers' expectations as parameters. The snob effect reduces the price sensitivity of demand.

Let us consider a price increase leading to a transition from equilibrium C to equilibrium A. Total decrease in the demanded quantities is $d_A d_C$, but only a part of this change is the price effect. To measure the price effect we go along the demand curve D_C to a new price level, which tells us the quantity that would be demanded at the new price if all consumers did not adjust their expectations. This transitional point is denoted as X. Therefore, the price effect is xd_C. The snob effect is $d_A x$, and shows that some consumers will enter the market due to the decreased expected clientele in new equilibrium A, because lower clientele increases a valuation for the good. Although price effect dominates the snob effect, market demand is now less elastic since the price effect and snob effect are of the opposite direction. Reduced demand elasticity allows the firm to charge a higher price.

Bandwagon Effect. Figure 12 demonstrates a bandwagon effect. As shown, a higher expected clientele corresponds to higher levels of demand. The rest of the analysis of the bandwagon effect is parallel to the snob effect. The locus $\widetilde{D}$ is the actual demand curve for the conspicuous commodity. $\widetilde{D}$ is more elastic compared to the demand curves $D_A,\ D_B,\ D_C, ..., D_N$ which treat consumers' expectations as parameters. This enhanced price sensitivity is explained by the bandwagon effect. Let us consider a price increase leading to a transition from equilibrium C to equilibrium A. Total decrease in the demanded quantities is $d_A d_C$, but only a part of this change is the price effect. To measure the price effect we go along the demand curve D_C to a new price level, which tells us the quantity that would be demanded at the new price

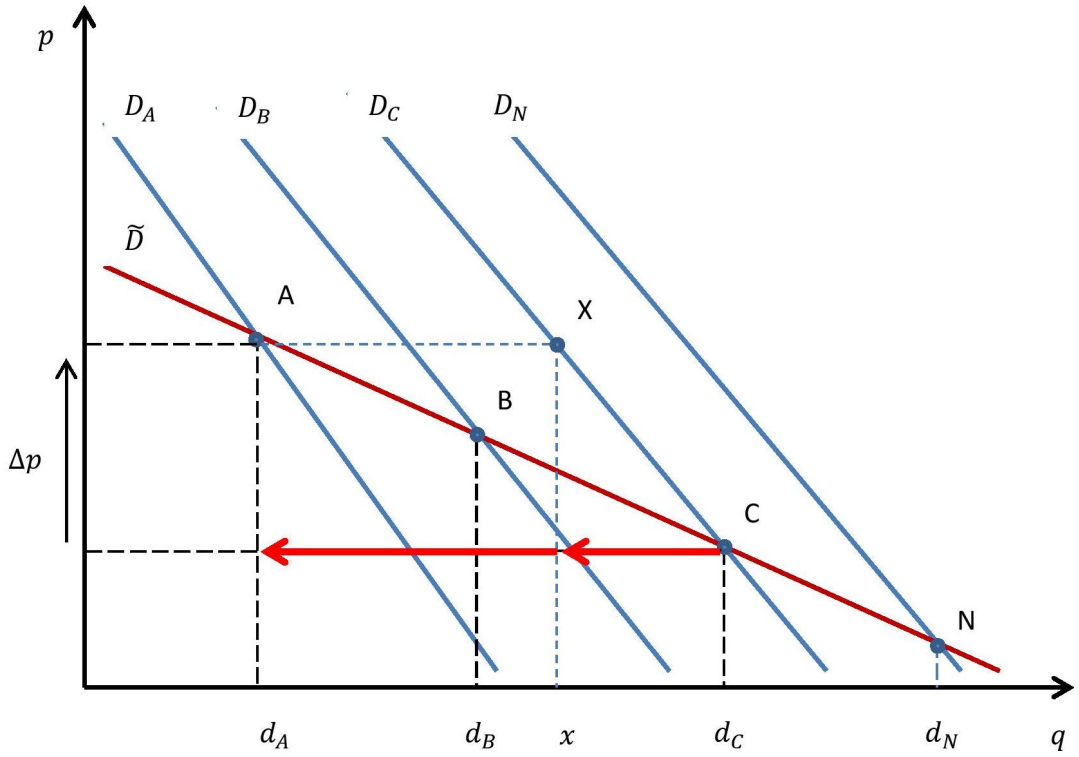

Figure 12: Bandwagon Effect

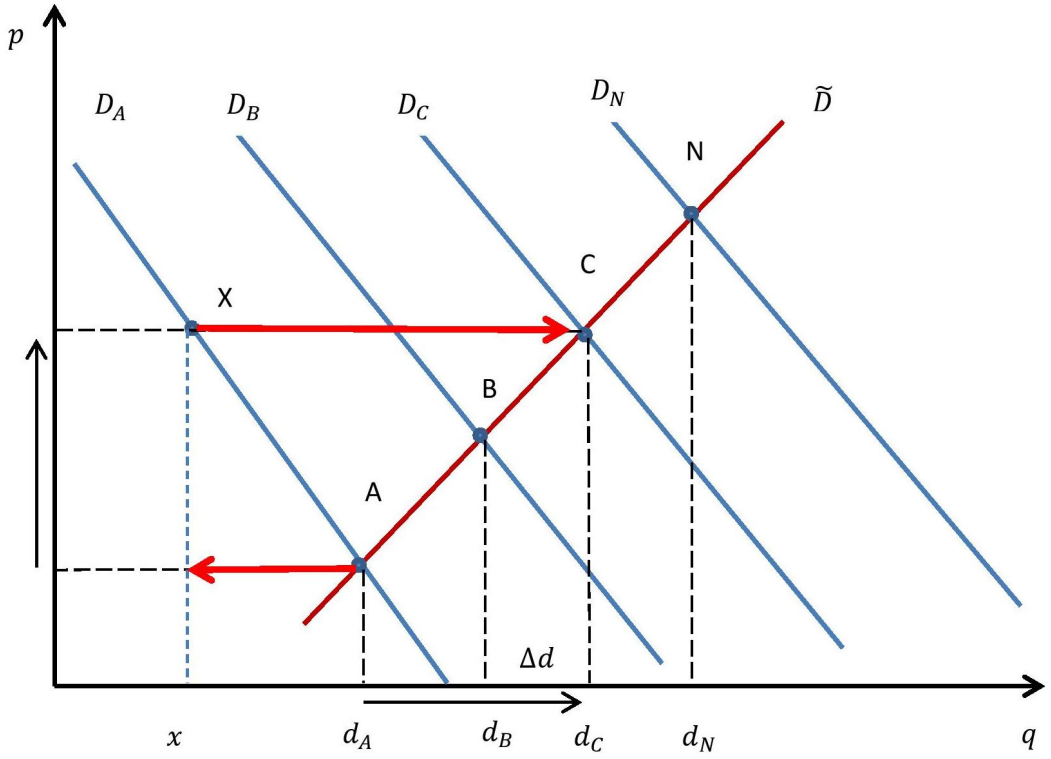

Figure 13: Strong Bandwagon Effect

if all consumers did not adjust their expectations. This transitional point is denoted as X. Therefore, the price effect is xd_C. The bandwagon effect is d_Ax, and represents an additional reduction in the number of consumers who left the market due to the decreased expected clientele in new equilibrium A. Therefore, the bandwagon effect enhances the price elasticity of market demand and thus it tends to lower prices. The price effect and bandwagon effect are of the same direction.

Strong Bandwagon Effect. A different analysis takes place with a strong bandwagon effect when a higher price is always associated with larger equilibrium sales. Actual market demand with fulfilled expectations is upward slopping now, as shown in Figure 13. Let us assume that the initial market state was at point A. There was a change in consumers' expectations about the actual sales from d_A to d_C and a new equilibrium with fulfilled expectations is at point C. Higher clientele enhances consumers' valuations for the network good and therefore there is a higher price in

equilibrium C. To decompose the total change in the demanded quantities Δd, let us measure both price and bandwagon effects as shown in Figure 13. We go along the demand curve D_A to the new price level, which tells us the quantity that would be demanded at the new price if all consumers keep their expectations fixed. The corresponding price effect is xd_A, which is negative. The bandwagon effect is $d_C x$, which is positive. In the case of a strong bandwagon, a negative price effect is dominated by a positive effect of the externality. Therefore, the total effect is positive and actual market demand is upward slopping. With a strong bandwagon effect, an enhanced consumers' valuation for the good dominates a loss in utility due to the increase in price. Hence, the actual demand with fulfilled expectations has a positive slope.

Strong bandwagon effect is not considered in Leibenstein (1950) and thus the case with a strong bandwagon effect is developed by the author of the thesis, while the analysis of regular bandwagon and snob effects is based on Leibenstein (1950).

Chapter 2

Price Advertising Game in a Duopoly with Network Externalities in Consumption

2.1 Introduction

In some markets, consumers' choice and benefits are dependent on the market behavior of other consumers. The decision to buy a product is not only conditional on the intrinsic utility of a good but also on how many other people buy the same good. Economics points out two possible reasons: conformity and vanity.

Conformity is the desire to belong to a particular social group whic is characterized by certain standards of behavior (also known as subcultures, fads, herding behavior, trends, etc.)[17]. Conformity is evident in watching TV programs, reading books, music and fashion trends, belonging to subcultures and so on. The second kind of network externality in consumption, vanity, is characterized by the desire to be different, exclusive and unique. Examples of vanity markets are status and luxury products: expensive cars, jewelry, perfumes, antiques and other goods that directly or indirectly signal social or income status. Both canformity and vanity are termed consumption externalities[18].

[17]People conform to these standards for different reasons. For example, Bernheim (1994) points out three possible reasons: 1) individuals tend to imitate behavior patterns of those who are believed to be better informed; 2) people act in the same way because it creates synergy effects as in networks; 3) social standards and patterns of behavior help to coordinate a selection of particular equilibrium if there is a case for multiple equilibria. Later Grilo et al. (2001) added one more reason: individuals imitate each other to avoid social ostracism.

[18]Consumption externality originates from consumers' preferences and thus directly enters the utility function. Moreover, it serves as a means of vertical product differentiation, i.e. the perceived quality of a product is determined by the size of the externality. For example, if there are two physically identical goods sold at the same price, consumers prefer a more popular good if there is conformism, or they prefer the scarce one if they are snobbish and thus the inherent quality of the good may be very different from the perceived one.

Recent economic literature relates consumption externalities to network effects. A network effect is a special kind of externality when a consumer's utility or firm's profits are directly or indirectly affected by the number of adopters of the same buying decision or production technology. Therefore, conformity is a positive network effect, and vanity is a negative network effect.

There are two interesting facts about markets with network externalities. First, since a real valuation of the good is not only determined by its physical qualities but also by its social attributes (or the size of the network effect), in order to correctly calculate a willingness to pay, consumers must foresee the actual clientele (the number of consumers buying the same good) prior to the purchase. Their ability to do this is usually limited by imperfect information or bounded rationality. It complicates the decision making process of consumers and creates additional frictions, such as costly search to access necessary market information. Second, in some markets with network externalities, firms disclose the information needed to make a correct consumption choice. For example, in a market of luxuries, firms usually send some information about the availability of their products. They may either directly announce the total number of items to be produced (Lamborghini and Jaguar announce the total number of cars to be produced when they release a new model), or indirectly signal partial information that helps people to anticipate the affordability of the good (like limited edition, individual production, expensive materials, etc.). It is also very common that firms simply announce their prices in advance. This also helps consumers to form expectations about how many people can afford to buy the good (for instance, Microsoft, Apple, Samsung make presentations of each new product and announce their prices in advance).

These facts raise two interesting research questions: 1) what explains the incentives of consumers to search when they face incomplete market information in a market with network effects; 2) what explains the incentives of firms producing a good with network externality to disclose information. Specifically, if prices are not observed by consumers, they must engage in a costly search to correctly foresee the market

outcome. Otherwise, firms may use price advertising to prevent consumers from searching.

This chapter considers an advertising game in which duopolists decide on advertising strategies in the beginning of the game and then compete in prices. Consumers observe advertising decisions of the firms and search if the expected benefits of search exceed a search cost. The results suggest that negative consumption externality lowers the minimum threshold level of search costs and increases the profits of the advertising firm. Hence, at least one firm must advertise for a snob effect. Weak bandwagon and snob effects lead to equilibria with interior solutions in which both firms have positive market shares. When consumption externality exceeds a degree of product differentiation, the demand function of each firm becomes upward-sloping. The externality dominates any strategic and price effects, and therefore a higher price is necessarily associated with a greater market share. Finally, the only equilibria with a strong bandwagon effect are those where only one firm supplies to an entire market.

A review of the related literature is given in section 2.2. Section 2.3 explains search decisions of consumers and pricing rules of firms in every sub-subgame and describes resulting equilibria in the advertising game. The conclusion and further discussion are given in section 2.4.

2.2 Literature Review

Initially, social aspects of consumption were introduced by Veblen (1899) in his famous work "The Theory of Leisure Class". 50 years later, Leibenstein (1950) formalized Veblen's theory and coined the notions of snobbism, bandwagon behavior and the Veblen effect. Snobbism describes a situation in which individual demand for a good is negatively affected by the quantity of the good sold in the market. It is closely related to a desire for exclusivity, when uniqueness or scarcity of the good delivers additional utility to buyers. Bandwagon is a case of conformity, fads, fashion or trends. It describes a situation in which individual demand is positively affected by the number of buyers of the good. Finally, the Veblen effect is related to market

of status goods in which a purchase signals wealth or a high position in a social hierarchy. These concepts by Leibenstein are widely used in economics, however, their microeconomic foundations and market implications are still unclear and need deeper investigation.

The present paper mostly addresses network economics which deal with network externalities. There is a wide body of literature on networks. The central point of this literature is the network effect. Shy (2011) describes this as a special kind of externality in which a consumer's utility or firm's profits are directly or indirectly affected by the number of adopters of the same buying decision or technology. Research in network economics has contributed to the building of bridges between the technological nature of networks and behavioral aspects of consumption.

In general, there are two kinds of network effects: positive and negative. Positive effects are found in telecommunication, software and hardware production, mobile connections and so on. In these industries, higher clientele size attracts more potential consumers. Negative network effect is usually represented by waiting costs in queues and congestion (a consumer suffers a negative effect only in case in which the clientele exceedes the capacity level). These examples belong to the supply side of network effects because they are associated with technology.

When the network externality originates from consumer preferences and utility formation, network effects belong to the demand side and are therefore called consumption externality. Using the notions of network economics, the bandwagon effect becomes a positive network effect, meaning the consumers are better off if the clientele size is large. The snob/exclusivity effect becomes a negative network effect, meaning that the consumer's willingness to pay is decreasing along with the size of the clientele.

Positive network effects and problems related to compatibility, technical standards and interconnection are well studied in the literature on telecommunication, software and IT applications. However, all these examples belong to the supply side, while network effects originating from the demand side are not well studied. Literature on negative effects is small and usually studies pricing and capacity level decisions.

In a series of papers, Navon et al. (1995) and Grilo et al. (2001) study conformity and vanity effects. They consider consumption externalities in the framework of spatial oligopoly models, particularly linear and circular cities. In their settings, the bandwagon effect is considered to be negative transportation costs and vanity is additional charges. Depending on the relationships between the values of the bandwagon effect and transportation costs, weak or strong conformity effects are possible. Weak conformity allows both firms to coexist and enhances price competition. Strong conformity gives market power to the firm with the initial clientele advantage and it may serve the whole market. Vanity relaxes price competition and results in higher prices. Under free entry, conformity reduces the number of firms and increases their shares, while vanity does the opposite. The results are intuitive and consistent with real world evidence. These papers, however, do not consider price commitment problems and the formation of consumer expectations. Indeed, a real valuation of a good is only realized after all consumers have made their purchases. In the models of Navon et al. (1995) and Grilo et al. (2001) consumers rationally anticipate future sales and their expectations are fulfilled in equilibrium. The issues of price commitment and expectation formation are taken into account by Economides and Himmelberg (1995), and Griva and Vettas (2011). The latter work is a complex model of both horizontal and vertical product differentiation in which consumer expectations may or may not be influenced by prices. The authors show that a formation of expectations plays an important role in the market outcome. However, these works consider the bandwagon effect only and thus their results may not be applicable in more general cases.

The most important limitation of the related papers is their assumption that consumers are able to perfectly foresee the size of the clientele and therefore their expectations are fulfilled in equilibrium. According to Katz and Shapiro (1985), the core feature of markets with networks is that consumers must make their buying decision before the actual network size in known. In the real world, market information is imperfect and the rationality of consumers may be bounded. For example, prices are not easily observed and thus consumers cannot always correctly foresee the fu-

ture. It takes time, effort and, in some cases, money to gather necessary information. When consumers face imperfect information they engage in a costly search to access necessary market information. Another way to resolve this problem is to allow firms to disclose necessary information themselves in the form of advertising. A paper by Konishi and Sandfort (2002) considers an advertising game in which firms may advertise their prices to expand their demand when consumers face a costly search. In their model, in the beginning of the game firms independently and simultaneously decide whether they want to advertise their prices. Then firms compete in prices, and consumers decide on search observing advertising decisions of the firms. The authors show that the advertising decision of the firms and resulting equilibria depend on the amount of advertising costs. Konishi and Sandfort (2002) consider a simple duopoly with homogeneous products and no consumption externality. However, their advertising game can be also used in the case of the network effects to study incentives to advertise when firms sell goods with network effects. Particularly, in Konishi and Sandfort (2002) advertising equilibrium depends on the amount of advertising cost. Meanwhile in case of network effects, the equilibrium depends on the nature and a magnitude of the externality.

Advertising is widely used in search models and models of asymmetric and incomplete information. For example, in Anderson and Renault (2006), through advertising relevant information like price or product characteristics, firms can secure profits in the presence of search costs. Once any piece of information is revealed, consumers can update their beliefs, which are used in calculation of the expected benefits of a search. If these benefits exceed the search cost, consumers participate in the market. In Anderson and Renault (2009), firms use comparative advertising which reveals horizontal match characteristics to consumers. The authors argue that in many cases consumers may not know their matches to alternative products and they must inspect the good. Comparative advertising may disclose product attributes and consumers can learn their valuations for the goods. So advertising is an important transmiter of market information which helps consumers to more correctly calculate their willingness to

pay.

The present paper studies firms' incentives to advertise prices in the presence of network effects and imperfect information. It considers the advertising game used in Konishi and Sandfort (2002) where firms compete in prices as in Grilo et al (2001), and Vettas and Griva (2011). The search behavior of consumers is close to the one in Anderson and Renault (2006).

2.3 Model

According to Miyao and Shapiro (1981), if a consumer faces a discrete choice (i.e. must choose to buy from only one seller) and her utility depends on the clientele of the seller, there is an uncertainty about the actual utility of each alternative. Therefore, a consumer's notional utility is a random variable. It is not certain what alternative will be chosen, however, the chosen one brings the highest perceived utility. Market demand for each alternative is thus proportional to the probability that a given alternative is chosen. In turn, this probability is a function of the number of consumers who choose the same alternative. These aspects of the discrete choice can be regarded within the framework of a random utility model with network effects.

There is a unit mass of consumers willing to buy at most one unit of the network good. Consumers differ in their taste for the goods (horizontal matches). If a consumer i chooses to purchase from a firm k, she receives utility U_{ik} :

$$U_{ik} = q + \gamma d_k - p_k + \mu\epsilon_{ik}$$

This utility consists of four elements: 1) a utility gain q from the good's physical functionality (or simply quality)[19]; 2) network externality γd_k, where d_k is the expected clientele of firm k and γ is a measure of the externality ($\gamma < 0$ corresponds to a negative network effect (snob effect), $\gamma > 0$ is a positive network effect (bandwagon

[19]It is assumed that q is rather high to ensure a full market coverage when both firms have positive market shares. Particularly, $q > \max\left\{2\mu b - \frac{\gamma}{2}; \frac{20\mu b - 15\gamma}{8}\right\}$. This condition is defined by non-negative consumer surplus in subsections 3.1 and 3.3.

effect)); p_k is a price charged by firm k; finally, $\mu\epsilon_{ik}$ is a match value of consumer i with a good of firm k. The match values are realizations of random variables which are identically and independently distributed[20]. The corresponding distribution function is uniform and symmetric in an interval $[-b, b]$. In the framework of the random utility approach, one can interpret $\mu > 0$ as a preference for diversity or a sensitivity to a randomness in utility. Parameter $b > 0$ shows a length of the interval $(2b)$ and also is a measure of the heterogeneity of the consumers tastes. Larger b implies greater differences in consumers' preferences for goods. Let us denote a product of μ and b as t which shows a sensitivity of consumers to the heterogeneity in tastes[21].

Both firms supply goods of the same physical quality q, however since different consumers receive different random increments ϵ_{ik} these goods are horizontally differentiated. In addition, network externality in consumption introduces a vertical differentiation into this model. In case of a positive network effect, a good with a larger clientele increases the valuation of the product for all consumers. In contrast, a negative externality decreases a valuation of the good with a larger clientele.

Consumers do not know their realizations of ϵ_{ik} unless they visit the stores and inspect the goods[22]. Moreover, they do not observe prices and thus cannot correctly foresee the clienteles of the firms. To know both prices and actual valuations of the goods, consumers must visit the stores. Visiting cost is $c > 0$. In this model, it is assumed that once a consumer decides to search (visit the store) and pays c, she receives all the necessary information[23]. Any consumer who decides to visit pays a

[20] That is, a consumer who visits the store, makes two stochastically independent draws from random variables ϵ_1 and ϵ_2 which determine her valuations for goods 1 and 2.

[21] Parameter $t = \mu b$ is also known as a degree of product differentiation, loyalty measure or a transportation cost in the address models of product differentiation.

[22] As discussed in Wernerfelt (1994) and Konishi and Sandfort (2002), when price advertising works as a commitment device, stores always choose to advertise its price (due to demand expansion and the hold-up problem). A desirable feature of the present paper is that a store may choose not to advertise depending on the network externality. This is because willingness to pay is assumed to be uncertain before a search.

This assumption also refers to cases when a consumer needs to inspect the good in reality, for example, try on clothes, have a test drive in a car, smell a fragrance, try a hardware or a software, etc.

[23] Assume that both stores are located at the same place, e.g., a shopping mall. Cost c is the cost of visiting this shopping mall (transportation cost, monetary value of time, effort, etc.). Once a consumer is in the shopping mall, she can freely inspect both goods and know the prices).

one-time sunk cost and discovers her valuations for both goods. A fully informed consumer buys a good with a greater utility gain.

Firms may use price advertising before consumers visit if they consider it profitable. This means that an advertising firm announces its price, consumers use this public knowledge, update their information set and correct their search behavior. Each firm maximizes its profits given the anticipated response of the rival and consumers' decision to visit. Each consumer maximizes her utility given the available information set.

The game considered in this model has a timing as follows:

1. In the beginning of the game, two firms independently and simultaneously decide whether to advertise or not[24]. Information disclosure is truthful and costless. Consumers do not know prices and cannot realize their horizontal matches until they visit the stores and inspect the goods.

2. In the second stage of the game, three cases are possible:

Case A: *Neither firm advertises.* In this case firms set their prices simultaneously, and these prices are not public information. Consumers must visit the stores to know the prices and to inspect the goods, incurring a visiting cost.

Case B: *Both firms advertise prices.* In this case prices are set simultaneously and are public knowledge, firms commit to these prices by advertising and consumers can use the prices when calculating the expected benefits of a purchase. Consumers still need to visit the stores to inspect the goods and realize their matches.

This assumption about collocated stores is common in the literature on search goods (Wolinsky, 1983; Stahl, 1982; Konishi and Sandfort, 2002). If commodities are search goods, firms have a strong incentive to collocate (same retail location). Since consumers' valuations are not known before a search, a consumer visiting a concentration of stores has an increased likelihood of finding the good for which her valuation is high. Consequently, collocated stores have higher probability of consumer searches and purchases.

[24] It is important to discuss why advertising decisions of firms and price setting are not simultaneous but sequential. Price advertising essentially works as a commitment device, therefore, if firms decide on advertising and price at the same time, the game becomes a simultaneous price commitment game.

As shown in Konishi and Sandfort (2002), if firms must decide on price commitment and price setting at the same node of the game, a concept of Perfect Bayesian Nash equilibrium is not enough to refine a set of equilibrium, because it weakens the predictive power of the standard equilibrium concept. This is why sequential advertising and the pricing decision making process is chosen to achieve a unique outcome.

Case C: *Only one firm advertises, the second one remains silent.* In this case, the advertising firm becomes a price leader and its silent competitor is a follower. The leader sets its price first and the follower sets its price accordingly Consumers observe the announced price, calculate the best response of the silent firm and use available information to form expectations about the market equilibrium. Consumers incur a visiting cost, visit the stores and realize their horizontal matches.

3. Observing the advertising decision of the firm, consumers choose whether to visit or not. If a consumer decides to visit, she incurs a visiting cost c. This cost is the same for all consumers.

4. Once consumers visited the stores, they choose a good with the highest utility gain.

Searching rule

Being in a given information set, a consumer decides to visit if the expected benefits (or the expected utility) of a purchase exceed the cost of visiting: $E(U_{ik}) \geqslant c$. Since prior to the visit all consumers are unaware of their horizontal matches, they have similar searching rules and thus their search behavior is identical. This means that the share of searching consumers s has only two values: 0 if no-one searches and 1 if everyone searches[25].

2.3.1 Neither firm advertises

When no firm advertises its price and consumers must visit the stores to inspect the goods and learn the prices, the firms cannot influence the search decision of consumers s with prices. Therefore, given consumers decide to visit the stores, demand for firm k is equal to the probability that $U_{ik} > U_{il}$: $D_k = \Pr(U_{ik} > U_{il}) = \Pr(\epsilon_{ik} - \epsilon_{il} > \frac{\gamma(d_l - d_k) - p_l + p_k}{\mu})$.

[25] To avoid randomization between searching and staying inactive, a case with $E(U) = c$ corresponds to an outcome with full participation, i.e. a consumer search with propability 1.

$$D_k = \begin{cases} 0, \text{ if } p_l + \mu b - \gamma \leqslant 0, \ p_k = d_k = 0 \\ \frac{p_l - p_k - \gamma(d_l - d_k) + \mu b}{2\mu b}, \text{ if } 0 < \frac{p_l - p_k - \gamma(d_l - d_k) + \mu b}{2\mu b} < 1 \\ 1, \text{ if } \ p_k + \mu b - \gamma \leqslant 0, \ p_l = d_l = 0 \end{cases}$$

Both firms maximizes their profits with prices:

$$\begin{aligned} \pi^1 &= s\ p_1 \left[\frac{t + \gamma\,(d_1 - d_2) - p_1 + p_2}{2t} \right] \\ \pi^2 &= s\ p_2 \left[1 - \frac{t + \gamma\,(d_1 - d_2) - p_1 + p_2}{2t} \right] \end{aligned}$$

First order condition with respect to prices gives reaction functions:

$$\begin{aligned} p_1(p_2) &= \frac{t + \gamma\,(d_1 - d_2) + p_2}{2} \\ p_2(p_1) &= \frac{t + \gamma\,(d_1 - d_2) + p_1}{2} \end{aligned}$$

These reaction functions result in the following equilibrium prices:

$$\begin{aligned} p_1 &= t + \frac{\gamma\,(d_1 - d_2)}{3} \\ p_2 &= t - \frac{\gamma\,(d_1 - d_2)}{3} \end{aligned}$$

The prices are increasing in t, because product differentiation softens price competition. Larger expected clientele increases prices with the bandwagon effect and reduces them for a snob effect. The market share of firm 1 is determined by:

$$D_1 = \frac{1}{2} + \frac{\gamma\,(d_1 - d_2)}{6t}$$

Equilibrium market shares and prices crucially depend on the consumers expectations. There are three possible equilibria: two corner solutions when either firm can capture the whole market and one interior solution. Therefore, the market share of

firm 1 can be expressed as follows:

$$D_1(d_1, d_2) = \begin{cases} 1, & \text{if } \gamma \geqslant 3t \text{ and } d_2 = p_2 = 0 \\ \frac{1}{2} + \frac{\gamma(d_1 - d_2)}{6t}, & \text{if } -3t < \gamma\,(d_a - d_b) < 3t \\ 0, & \text{if } \gamma \geqslant 3t \text{ and } d_1 = p_1 = 0 \end{cases}$$

When consumers believe that one firm will have a significantly larger market share than another one, a strong bandwagon ($\gamma \geqslant 3t$) may lead to an equilibrium in which one firm captures the entire market. When the difference in the expected clientele sizes is not that significant, both firms can have positive market shares. As one can see, a greater value of t makes it possible that both firms can operate with positive market shares. Greater heterogeneity in consumers tastes allows both firms to coexist, since consumers value diversity of products.

An equilibrium with rational expectation implies that consumers' expectations are fulfilled in equilibrium and thus $d_1 = sD_1$ and $d_2 = sD_2$ Another explanation is a market clearance condition: firms produce as much as consumers are willing to buy. Three cases are possible, depending on the value of the network externality γ.

When $\gamma < 3t$, i.e. there is a snob effect or a weak bandwagon effect, consumers expect that market shares will not be extreme since neither firm can attract a critical mass of consumers to ensure a corner solution. Indeed, a negative network effect can never induce a corner solution and a positive network effect with $\gamma < 3t$ is too weak to make consumers expect an extreme bandwagon. Therefore, both firms have positive market shares. Moreover, if consumers expect that both firms will equally share the market, their beliefs are fulfilled in equilibrium and thus the only equilibrium[26] that can be fulfilled is when $D_1^* = d_1^* = D_2^* = d_2^* = \frac{1}{2}$, $p_1^* = p_2^* = t = \mu b$, $\pi_1^* = \pi_2^* = \frac{t}{2}$.

[26] No other market sharing can be maintained as an equilibrium with fulfilled expectations, where actual sales must be equal to the expected clientele size that does not hold with unequal market shares: when $\frac{1}{2} < d_1 < 1$, price competition implies $D_1 > d_1$, when $0 < d_1 < \frac{1}{2}$, price competition implies $D_1 < d_1$.

Moreover, since q is large enough to ensure that consumers with the lowest consumer surplus are willing to buy, each firm has a half of the market.

The consumer with the lowest consumer surplus is indifferent between buying from 1 or 2 and $\epsilon = -b$. She receives $CS = q + \frac{\gamma}{2} - t - \mu b = q + \frac{\gamma}{2} - 2t$. Since $q > 2t - \frac{\gamma}{2}$, even the lowest type buys and thus the market is fully covered.

It is interesting to note that market price does not reflect the effect of γ. The reason is that, since firms do not advertise their prices, they cannot influence the search decision of consumers and therefore they are not able to internalize the consumption externality with their prices. This explains why silent firms set prices which do not depend on the network effect γ.

When $\gamma > 3t$, the network good exhibits a strong consumption externality. Three types of expectations can be fulfilled in equilibrium: firm 1 captures a whole market; firm 2 captures a whole market; both firms have equal shares with full coverage. If consumers expect that market shares will have significant differences, then a firm with a greater expected market share can capture a whole market. If consumers' expectations are not that extreme, both firms can enjoy equal clienteles. In a corner solution, an active firm charges a price $p = \gamma - t$ and obtains a profit equal to $\gamma - t$, since its market share is 1. Higher bandwagon effect allows the active firm to charge a higher price, since the consumer's valuation for the good is increasing in γ.

When $\gamma = 3t$, any expectation can be fulfilled in equilibrium and thus corresponding prices are $p_1 = 2d_1t$, $p_2 = 2(1-d_1)t$. This is the only case in which firms can have positive but not equal market shares.

As one can see, when $\gamma \geqslant 3t$, multiple equilibria arise. It is thus important to discuss how consumers can coordinate and choose one of the candidate equilibria. One of the most reasonable ways is to assume that all consumers prefer the equilibrium with the highest expected utility gain. Prior to the search decision, the expected utility from buying good k is the *ex ante* expected utility:

$$E(U_k) = \frac{1}{4b^2} \int_{-b}^{b} \int_{U_k-U_l}^{b} \left[q + \gamma d_k - p_k + \mu \epsilon_k \right] \, d\epsilon_k d\epsilon_l$$

When $\gamma > 3t$, interior solution with $D_k^* = \frac{1}{2}$ gives $E(U_k)^{int} = \frac{6q-4t+3\gamma}{12}$ and corner solution with $D_k^* = 1$ results in $E(U_k)^{cor} = q + t$. The latter is larger for $\gamma < \frac{16}{3}t + 2q$. This implies that consumers coordinate and all form expectations that correspond to the equilibrium where either firm can capture an entire market for $3t < \gamma < \frac{16}{3}t + 2q$.

When $\gamma = 3t$, the expected utilities are $E(U_k)^{int} = -\frac{t}{12} + td_k + qd_k$ and $E(U_k)^{cor} = q+t$. Since $\frac{dE(U_k)^{int}}{dd_k} > 0$, all consumers prefer to expect a greater market share of firm k in the equilibrium with fulfilled expectations. If d_k approaches 1, $E(U_k)^{int}$ tends to $q + t - \frac{t}{12}$ which is lower than $E(U_k)^{cor}$. This implies that with $\gamma = 3t$, all consumers would like to coordinate in their expectations to have an equilibrium in which either firm captures the market entirely.

Proposition 7: *When neither firm advertises their prices and consumers coordinate their beliefs such that they receive the highest expected consumer surplus, equilibrium with fulfilled expectations is as follows: 1) if* $\gamma < 3t$*, there is a unique equilibrium where firms equally share the market and charge prices equal to t; 2) if* $3t \leqslant \gamma < \frac{16}{3}t + 2q$*, either firm can capture an entire market charging a price equal to* $\gamma - t$*; if* $\gamma > \frac{16}{3}t + 2q$*, interior solution with equal shares prevail in equilibrium.*

The search decision of consumers crucially depends on the expected clientele sizes of the firms, since these parameters determine the benefits of buying. Consumers will visit only if the expected benefits of a purchase exceed visiting cost c.

When no firm advertises its price, consumers rationally anticipate firms to behave as stated in Proposition 7 and thus $E(U_k)^{int} = \frac{6q-4t+3\gamma}{12} = c_1$ and $E(U_k)^{cor} = q+t = c_2$. When $\gamma < 3t$, consumers decide to search and visit the stores if visiting cost $c \leqslant c_1$. When $\gamma \geqslant 3t$, consumers decide to visit if $c \leqslant c_2$. The search benefit is decreasing in t and increasing in γ. This means that stronger product differentiation tends to reduce the motivation of consumers to search, because higher t decreases price elasticity, softens price competition and consequently reduces consumer surplus. In contrast, positive network effect increases consumer surplus and thus encourages consumers to search. Meanwhile, negative network effect decreases the benefits of a search and thus consumers are expected to search less for negative γ.

Lemma 5. *If neither firm advertises, consumers are expected to search more when product differentiation is not strong and consumption effect is positive. In contrast, when product differentiation is rather strong and consumption externality is negative,*

consumers are expected to search less. In turn, this implies that price advertising is suitable for a higher product differentiation and strong snob effect.

To sum up, if firms do not reveal information about their prices, they are not able to influence the expectations of consumers and their search decisions. Therefore firms cannot internalize consumption externalities with prices and take both expectations and searching rules as given. When the network effect is a strong bandwagon behavior, multiple equilibria arise and thus consumers need to coordinate their expectations to achieve the most desirable outcome with the highest expected consumer surplus.

2.3.2 Both firms advertise

When both firms announce prices, consumers learn prices but still need to visit the stores to inspect the goods and choose the one with the best horizontal match. In this scenario, price advertising serves both as a source of information and as a credibility instrument because of truth-in-advertising laws. Consumers can use the announced prices to form their expectations, which are perfectly fulfilled in equilibrium.

It is worth mentioning that exactly this situation is studied by Navon et al. (1995), Grilo et al. (2001) and Griva and Vettas (2011). In all papers, the authors assume that prices are known to consumers and thus due to consumer rationality the expected clientele sizes are perfectly realized in equilibrium. Therefore, the analysis in this section is parallel to the logic of the above papers[27].

When prices are advertised, d_1 and d_2 can be correctly foreseen by consumers and thus both firms treat d_1 and d_2 as sD_1 and sD_2 respectively. Therefore, the demand function of firm 1 is $D_1 = \frac{p_2 - p_1 + t - \gamma}{2(t-\gamma)}$. Three situations are possible: if $t - \gamma > 0$, there is a snob effect or a weak bandwagon effect and thus we have a regular demand function; when $t - \gamma < 0$, there is a strong positive consumption externality which dominates the negative price effect and the demand function becomes increasing in price; when $\gamma = t$, the strength of the bandwagon effect is equal to the degree of

[27] A more detailed discussion of the case when prices are public information is given in Section 4 in Grilo et al. (2001).

product differentiation.

To start with, let us consider a case when $t > \gamma$. Since consumer expectations are perfectly influenced with advertised prices, firms' demand functions depend on advertised prices only. Three cases may happen: one interior solution and two corner solutions.

$$D_k(p_k, p_l) = \begin{cases} 1, & \text{if } p_k \leqslant \gamma - t \text{ and } p_l = d_l = 0 \\ \frac{1}{2} + \frac{p_k - p_l}{2(t-\gamma)}, & \text{if } \gamma - t < p_k - p_l < t - \gamma \\ 0, & \text{if } p_l \leqslant \gamma - t \text{ and } p_k = d_k = 0 \end{cases}$$

However, it is clear that only the interior solution exists, because corner solutions do not satisfy the condition that $t > \gamma$. If firm 1 captures a whole market, firm 2 is inactive and charges $p_2 = 0$. This implies that firm 1 should charge $p_1 \leqslant \gamma - t < 0$. This is not rational and thus the corner solution does not exist. The same logic applies to the case when firm 2 captures an entire market.

The interior solution is characterized by prices that maximize profits of firms:

$$\begin{aligned} \pi^1 &= p_a \left[\frac{t - \gamma - p_1 + p_2}{2(t-\gamma)} \right] \\ \pi^2 &= p_b \left[1 - \frac{t - \gamma - p_1 + p_2}{2(t-\gamma)} \right] \end{aligned}$$

First order conditions with respect to prices give two reaction functions:

$$\begin{aligned} p_1(p_2) &= \frac{t - \gamma + p_2}{2} \\ p_2(p_1) &= \frac{t - \gamma + p_1}{2} \end{aligned}$$

Corresponding equilibrium prices are $p^* = p_1^* = p_2^* = t - \gamma$. In comparison to the previous case where prices in which not advertised by firms, in this scenario, firms can internalize a consumption externality with advertised prices. Advertised prices account for the network effect and thus they depend on γ. This result supports the findings of Grilo et al. (2001) and Griva and Vettas (2011) that the bandwagon effect reduces market prices and the snob effect relaxes price competition. In particular, the snob effect increases prices and the bandwagon effect tends to decrease them. The

snob effect enhances perceived differences between products, strengthens the effect of tastes heterogeneity, i.e. reduces price elasticity and thus increases firms' market power. In contrast, bandwagon works to soften differences in tastes and can incentivize a consumer to buy a good with a worse horizontal match but with a larger network. In other words, it increases price elasticity and thus reduces prices.

Corresponding market shares are equal to $\frac{1}{2}$ and profits are $\frac{t-\gamma}{2}$ for each firm[28].

It is important to note that no firm has an incentive to deviate and capture a whole market. For example, if firm 1 wants to deviate from the equilibrium price where both firms share the market, it should charge a price such that $t - \gamma \geqslant p_1 + t - \gamma$, because when firm 2 charges $p_2 = t - \gamma$, the only possibility to capture the whole market is to charge a price $p_1 \leqslant p_2 - t + \gamma$. But this gives $p_1 = 0$, which is clearly dominated by the price which allows both firms to have positive market shares. The same logic applies to the deviation of firm 2.

Given this pricing behavior of two firms, consumers decide to visit if their visiting cost c does not exceed the expected utility of buying. In the case of the interior solution $E(U_k)^{int} = \frac{6q-4t+9\gamma}{12} = c_3$. It is clear that when prices are advertised, consumers take the prices into consideration and hence the expected utility of a consumer prior to the visit is more sensitive to γ. This means that firms can internalize the consumption externality through prices and influence consumer visiting decisions with prices.

When $t < \gamma$, the demand functions of both firms $D_k = \frac{p_l - p_k + t - \gamma}{2(t-\gamma)}$ become increasing in prices. Since the value of the consumption externality, γ, exceeds the degree of tastes heterogeneity t, the benefit of being in a greater network dominates the loss due to a purchase of a product with a worse match. The more intensive the network externality is, the greater the valuation for the good is, therefore a larger market share is always associated with a higher price. A demand function of firm k is given by:

[28]It is important to mention that t should not take extreme values, to gaurantee that consumer surplus is not negative under the full market coverage.

In this interior solution, a consumer with the lowest match receives $U(-b) = q - 2t + \frac{3\gamma}{2}$. This utility is always positive for our initial assumption that q is high enough to ensure full coverage: $q > \max\left\{2t - \frac{\gamma}{2}; \frac{20t-15\gamma}{8}\right\}$.

$$D_k(p_a, p_b) = \begin{cases} 1, & \text{if } p_k \leqslant \gamma - t \text{ and } p_l = d_l = 0 \\ \frac{1}{2} + \frac{p_l - p_k}{2(t-\gamma)}, & \text{if } t - \gamma < p_b - p_a < \gamma - t \\ 0, & \text{if } p_l \leqslant \gamma - t \text{ and } p_k = d_k = 0 \end{cases}$$

As in Grilo et al. (2001) and Griva and Vettas (2011), when the consumption externality is stronger than product differentiation $(\gamma > t)$, multiple equilibria exist. When price difference is $t-\gamma < p_b - p_a < \gamma - t$, any combination of prices can support this condition. Moreover, corner solutions in which one firm captures an entire market are also possible. This happens, because demand functions are now increasing in their prices, which means that a firm charging a higher price will also have the larger market share. A strong positive consumption externality dominates both strategic and price effects of competition. A more detailed discussion of the equilibria is in Appendix 2A.

When $\gamma = t$, the outcome looks like the Bertrand paradox. The firm with the lowest price can capture the market and therefore firms set prices at marginal costs, since with $\gamma = t$, the two goods are perfect substitutes. Consumers randomize between firms, but firms' profits are nil.

To restrict the set of possible equilibria it is important to discuss how out-of-equilibrium beliefs are formed. The refinement of equilibria in Grilo et al.(2001) and Griva and Vettas (2011) differs but leads to the same result. In both papers the authors come to the conclusion that, with a strong network effect, only the equilibrium, in which one firm captures a whole market, survives the refinement. Specifically, Grilo et al (2001) suggests using "invariance axiom" to show that at least one firm sets a price equal to zero while the other firm charges a price which does not exceed the limit price. When a firm charges a positive equilibrium price, it captures the entire market[29]. Another refinement method is used in Griva and Vettas (2011). The authors apply an assumption about the continuity of expectations: a small deviation from equilibrium prices leads to a small change in consumers expectations about market shares, i.e. consumers do not alter their expectation drastically when they observe

[29] This axiom and its proof are demonstrated in Section 4 in Grilo et al. (2001).

a deviation from the equilibrium prices[30]. In both papers, the authors suggest that after refinement, only corner solutions survive.

Another refinement leading to the same result is a conjecture about how consumers will react to a price change. Specifically, the probability that a consumer buys from firm k does not increase with the price of firm k. In other words, consumers still have a non-increasing demand function (higher price reduces a probability of buying) even when $\gamma > t$. With this refinement, there are no interior solutions where both firms have positive market shares. Indeed, when both firms charge positive prices, each firm would like to decrease its price and steal consumers from the rival. This leads us to the Bertrand paradox, in which both firms price at nil and consumers randomize between firms. However, there are two corner solutions. Assume that firm 1 charges $p_1 = 0$ and firm 2 charges $p_2 = \gamma - t$. If it is an equilibrium, then no firm has an incentive to deviate. It is not reasonable for firm 2 to decrease its price, because it already has all the consumers, so a price decrease would simply reduce profits. The firm will not consider it profitable to increase p_2 since $p_2 = \gamma - t$ is exactly the limiting price that allows firm 2 to serve all consumers. Firm 1 will never deviate to $p_1 < 0$, since this would lead to losses. Any price $p_1 > 0$ is not rational at all, since firm 2 has set a limiting price and owns all the consumers. Therefore, with a conjecture that price still negatively affects demand even with $\gamma > t$, only three price pairs (p_1, p_2) survive: $(0, \gamma - t)$, $(\gamma - t, 0)$, $(0, 0)$.

From a large set of possible equilibrium price pairs, three are left after the above refinement. However, two of them are Pareto superior to the third one. Specifically, equilibria with $(0, \gamma - t)$ and $(\gamma - t, 0)$ are payoff dominant, meaning that they both offer to each firm at least as much payoff as the Nash equilibrium with $(0, 0)$. Therefore, in the rest of the paper these two equilibria participate in further analysis.

Summing up, when the consumption externality is stronger than product differentiation $(\gamma > t)$, there are only two equilibria after the equilibrium selection where either firm supplies to an entire market, charging a price $p^* = \gamma - t$.

[30] Both the refinement and its proof are given in Section 5 in Griva & Vettas (2011).

Proposition 8. *When both firms announce their prices and $t > \gamma$, firms share the market equally and charge a price $p^* = t - \gamma$, no firm has an incentive to deviate and capture a whole market. In contrast, when $t < \gamma$ only one firm sells to the whole market under refinements and charges a price $p^* = \gamma - t$.*

Given this pricing behavior of two firms, consumers decide to visit if their visiting cost c does not exceed the expected utility of buying. In the case of the corner solution $E(U_k)^{cor} = q + t = c_2$.

2.3.3 One firm advertises and one stays silent

When only one firm decides to advertise its price, then the advertising firm becomes a price leader and charges its price first. The silent firm takes the advertised price as given[31] and chooses its price as a follower. As a result, this situation looks like a Stackelberg price competition, in which the silent firm becomes a follower in a sub-subgame and takes the price of the advertising firm as given. Consumers still need to visit the stores to inspect the goods (in order to choose the good with the most suitable horizontal match) and incur some visiting cost c.

Without loss of generality, assume that firm 1 advertises and 2 stays silent. The sequence of moves in this subgame thus begins with firm 1 announcing its price first. It is important to discuss how consumers form their expectations and treat d_1 and d_2. The advertising firm commits to its price, advertising p_1, consumers know that the price of firm 2 is its best response to the advertised price of firm 1. Consumers are able to calculate p_2 because the reaction function of firm 2 is common knowledge. This allows consumers to exactly foresee what price will be charged by firm 2 in response to any advertised price of firm 1, and to make their search decision accordingly in every subgame[32]. By this reasoning d_1 and d_2 can be also calculated by consumers

[31] If any firm decides to advertise its price, then its advertising functionss as a commitment instrument. By "truth-in-advertising" law, any public announcement obliges firms to fulfil what is advertised.

[32] The inference should be correct in each subgame. Each subgame starts by announcing p_1, and consumers make their search decision anticipating how firm 2 responses to p_1. Firm 2 does not know the consumer decision when it sets p_2.

when they observe advertised p_1 and know the best response of firm 2. In turn, the reaction function of firm 2 is the same as in section 2.3.2: $p_2(p_1) = \frac{t-\gamma+p_1}{2}$.

Firm 1 accounts for the price reaction of its follower and thus it chooses p_1 that maximizes its profit:

$$\pi^1 = s\ p_1 \left[\frac{t-\gamma-p_1+p_2(p_1)}{2(t-\gamma)}\right] = s\ p_1 \left[\frac{3(t-\gamma)-p_1}{4(t-\gamma)}\right]$$

This profit function is maximized at $p_1^* = \frac{3(t-\gamma)}{2}$. Corresponding market shares are $D_1^* = \frac{3}{8}$ and $D_2^* = \frac{5}{8}$, and $p_2^* = \frac{5(t-\gamma)}{4}$. Profits are $\pi^1 = \frac{9(t-\gamma)}{16}$, $\pi^2 = \frac{25(t-\gamma)}{32}$. Both prices are higher than in the case with full disclosure and $p_1^* > p_2^*$. When only one firm advertises, it can internalize the effect of consumption externality and thus both prices depend on γ. As one can see, the advertising firm receives lower profits in equilibrium than the silent one. This is in line with the results of Dowrick (1986): when two firms compete in prices and produce substitutes, the price-follower has a second-mover advantage and receives higher profits. Intuitively, the reason that a firm prefers to be a follower in the price setting game is that the leader has to reduce output to support the price, whereas the follower can take the price as fixed by the leader and produce as much as it wants; i.e., the follower can free-ride on the output restriction of the leader[33]. Meanwhile, the price leader's profit is greater than the profit in 2.3.2.

Consumers rationally anticipate these market outcomes and visit if the expected utility of the purchase exceeds the cost c.

$$E(U_k) = \frac{1}{4b^2} \int_{-bU_k}^{b} \int_{-U_l}^{b} \left[q + \gamma d_k - p_k + \mu\epsilon_k\right]\ d\epsilon_k d\epsilon_l$$

The expected utilities from buying goods 1 and 2 are $E(U_1) = \frac{120q-151t+225\gamma}{192}$ and $E(U_2) = \frac{120q-121t+225\gamma}{192}$ respectively. Prior to a visit, a consumer does not know what product she will buy when she visits the stores, however, she expects that in equi-

[33] In contrast, being a leader is always preferred to being a follower when firms compete in quantities, because of the first-mover advantage.

librium market shares are $\frac{3}{8}$ and $\frac{5}{8}$. So on average she will get $\frac{3}{8}\left(\frac{120q-151t+225\gamma}{192}\right) + \frac{5}{8}\left(\frac{120q-121t+225\gamma}{192}\right) = \frac{480q-529t+900\gamma}{768} = c_4$.

Thus, the visiting decision of consumers s equals 1 if $c \leqslant c_4$ and equals 0 if $c > c_4$. Since quality q is assumed to be high enough, there is full market coverage.[34]

Is there an equilibrium with a corner solution? Can firm 1 advertise a price that causes all consumers to only buy from it? A condition that supports this equilibrium is that $D_1 = \frac{1}{2} + \frac{p_2-p_1}{2(t-\gamma)} \geqslant 1$ or $p_2 - p_1 \geqslant t - \gamma$. In this equilibrium, $p_2^* = 0$ and $p_1^* = \gamma - t$. The latter condition states that this can happen only for a strong positive network effect, $\gamma > t$. Moreover, firm 1 strongly prefers to capture a whole market when the interior solution brings lower profits: $\frac{9(t-\gamma)}{16} < \gamma - t$. This happens only for $\gamma > t$.

Proposition 9. *When one firm advertises its price and another stays silent, the snob effect and the weak bandwagon effect ($\gamma < t$) allow both firms to have positive market shares. The advertising firm charges a higher price and receives a higher profit (compared to the case with no disclosure). This interior solution is only possible for $c \leqslant c_4$. When consumption externality is strong and positive ($\gamma > t$), advertising firm sets a price that allows it to capture a whole market. In this case consumers search if $c \leqslant c_2$.*

As shown above, when only one firm advertises, the other may not follow the same strategy. A non-advertising firm benefits from its rival's advertising which works as price commitment, suggesting free-riding by the non-advertising firm. Indeed, as one can see, silent firm earns more in the interior case.

2.3.4 Advertising game

In the previous sections, three subgames where firms choose their pricing were considered. The advertising game played in the first stage can be represented in the strategic forms as demonstrated in Figures 14, 15 and 16. These strategic forms

[34] Indeed, a consumer with the lowest match gets $U_1(-b) = \frac{8q+15\gamma-20t}{8}$ and $U_2(-b) = \frac{8q+15\gamma-18t}{8}$. As one can see, to have full coverage it must be that $8q + 15\gamma - 20t > 0$. However, this condition always holds for our initial assumption that q is high enough to ensure full coverage: $q > \max\left\{2t - \frac{\gamma}{2}; \frac{20t-15\gamma}{8}\right\}$.

contain firms profits and conditions under which a particular Nash equilibrium exists. Each firm has two disclosure strategies: price advertising (AD) and being silent (NA). There are four possible equilibria: both firms stay silent; firm 1 advertises only; firm 2 advertises only; both firms announce their prices. Depending on the strength of the network externality γ, three intervals are considered: $\gamma < t$ (negative network effect and weak bandwagon effect), $t \leqslant \gamma < 3t$ (strong bandwagon effect), $\gamma \geqslant 3t$ (extremely strong network effect). The analysis that follows is similar to that one in Konishi and Sandfort (2002)[35].

The snob effect and weak bandwagon effect

A case when $\gamma < t$ corresponds to a snob effect and weak bandwagon effect. A strategic form of the game is represented in Figure 14. The equilibrium strategy configuration changes depending on the values of the visiting cost c, degree of product differentiation t and consumption externality γ. Each equilibrium is described by the corresponding profits of the firms and the conditions under which this equilibrium exists.

There are four important observations:

1) At least one firm should advertise a price for a negative consumption externality. Indeed, given that a rival chooses NA strategy, advertising brings higher profits when $\gamma < \frac{t}{9}$. Moreover, advertising is always a dominant strategy (the only strategy) when the search cost exceeds the minimum threshold (c_1 or c_4). The expected benefit of a search decreases with negative γ and therefore advertising is the only way to avoid consumer inaction.

2) When only one firm advertises its price, both firms gain the highest profits. However, the leader receives a smaller profit than its follower. This is consistent with a general result of the Stackeberg price competition, that a price leader faces a first-movement disadvantage[36]. When $c \leqslant c_3$ and $\gamma < \frac{t}{9}$ this case becomes one

[35] In Konishi and Sandfort (2002) advertising equilibrium depends on the value of advertising. In our model, the equilibrium depends on γ and c.

[36] Price competition with sequential movements gives higher profits to both firms compared to semultaneous price setting. However, the leader earns a lower profit than the follower. Quantity

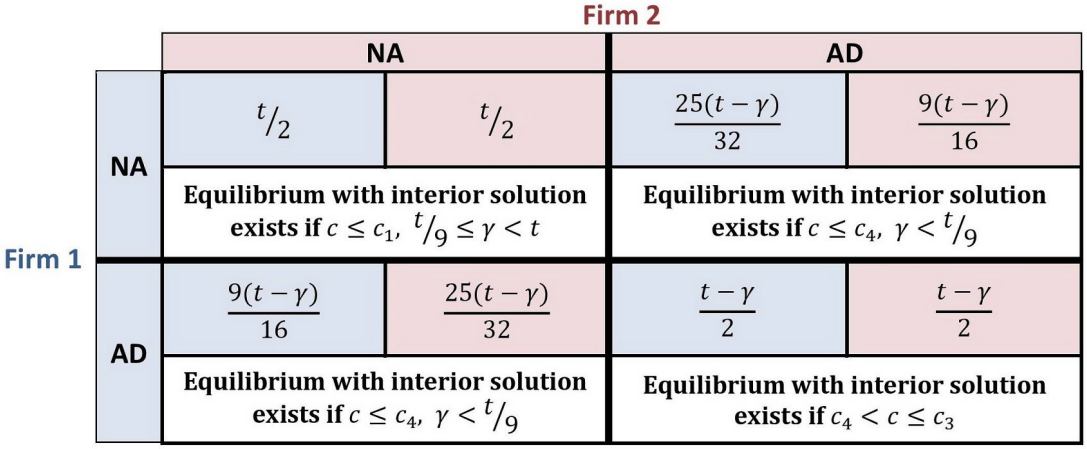

Figure 14: Snob effect and weak bandwagon effect, $\gamma < t$

of the "battle of sexes", thus, there are two pure strategy equilibria (NA, AD) and (AD, NA).

3) When the visiting cost is rather high (the cost exceeds a threshold value c_4), the only possible equilibria is one in which both firms advertise their prices, which takes place if $c \leqslant c_3$.

4) A weak bandwagon effect and snob effect lead to the equilibria with interior solutions where both firms have positive market shares.

Strong bandwagon effect

A case when $t \leqslant \gamma < 3t$ corresponds to a strong bandwagon effect. A strategic form of the game is represented in Figure 15. Given that the rival stays silent, the firm also stays silent if $\frac{t}{2} > \gamma - t$. It means that the equilibrium in which neither firm advertises occurs when $t \leqslant \gamma < \frac{3t}{2}$ and $c \leqslant c_1$. When $\frac{3t}{2} \leqslant \gamma < 3t$ and for $c \leqslant c_2$, advertising becomes a dominant strategy for each firm and thus only equilibria with two advertising firms are possible[37]. As shown in section 2.3.2, in these equilibria either firm can capture a whole market.

competition leads to a reverse result.

[37]When only one firms advertises and $\gamma > t$, a corner solution exists where the leader sells to the whole market. It implies that price advertising becomes a dominant strategy for both firms.

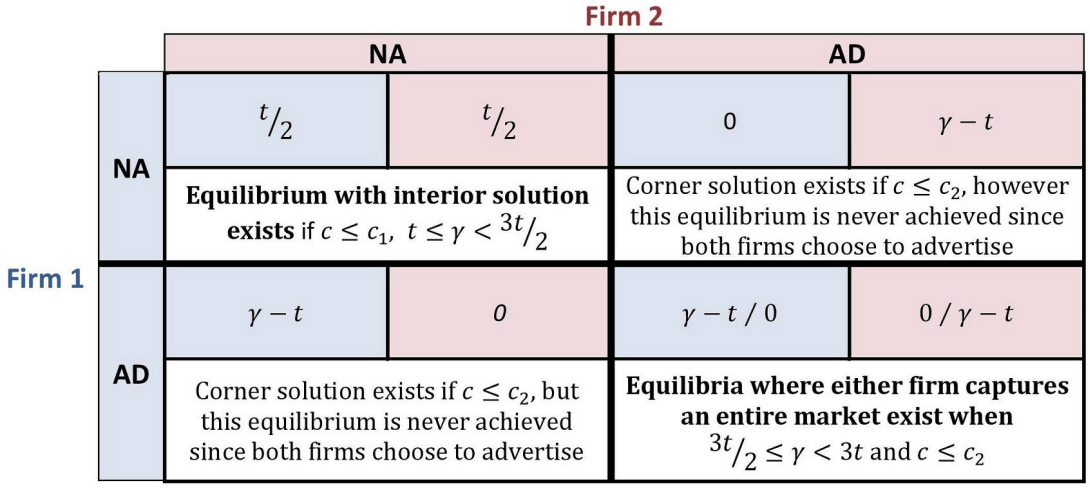

Figure 15: Strong bandwagon effect, $t < \gamma < 3t$

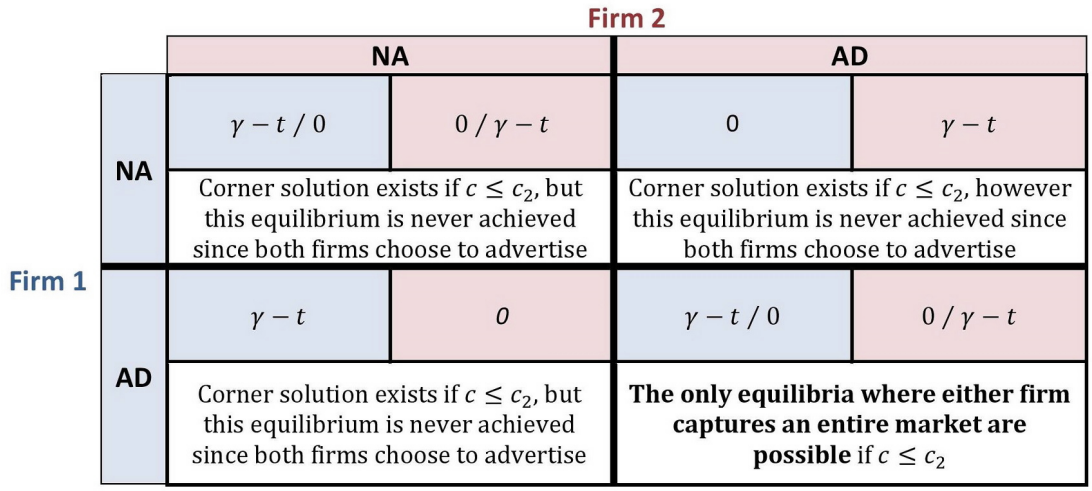

Figure 16: Extreme bandwagon effect, $\gamma \geqslant 3t$

Extreme bandwagon effect

This is a case in which $\gamma \geqslant 3t$ corresponds to an extremely strong positive externality. A strategic form of the game is represented in Figure 16. The only possible equilibria are those in which both firms choose price advertising independent of the values of the exogenous parameters. When the bandwagon effect is very strong, the AD strategy becomes dominant for both firms. This implies that the resulting equilibria have one firm supplying an entire market.

Let us summarize all results in Proposition 10.

Proposition 10. *In the first stage, when firms decide on their advertising strategies, price is advertised by at least one firm for a negative consumption externality. A weak bandwagon effect and snob effect ($\gamma < t$) always lead to the interior solution in which both firms have positive market shares. When the bandwagon effect is strong ($t \leqslant \gamma < 3t$), both firms may not advertise if the search cost is not high enough, otherwise the advertising strategy becomes dominant and thus corner solutions arise with either firm serving all consumers. When the bandwagon effect is extreme ($\gamma \geqslant 3t$), both firms choose to advertise but only one firm is active in the market.*

2.4 Concluding Remarks and Further Discussion

In some markets, the individual decision to buy a good depends on the number of other consumers who choose the same product. This phenomenon is mainly found in the markets with network effects, such as telecommunication, fashion, luxury and status goods, books, TV programs, music, etc. If the network effect originates from the consumer's preferences, it is called a demand side network effect or a network externality in consumption. If a consumer benefits from the larger product clientele, there is a case of a positive network effect (also known as the bandwagon effect and conformity). If the valuation of the good is decreasing with the size of the clientele, there is a case of a negative network effect (vanity, the snob effect).

Existing literature on network economics is extensive, but it is mostly focused on supply side effects and problems related to compatibility and imitations (like software, hardware and telecommunication). Demand side effects are only represented by a couple of papers considering consumption externalities in markets of differentiated products. Their main conclusions are that the snob effect softens price competition, a weak bandwagon effect tends to lead to lower prices and a strong bandwagon effect leads to greater market concentration.

Although related papers explain how the sellers of goods with network effects reach a particular equilibrium under consumption externalities in a price setting game, they make quite a strong assumption about consumer behavior. Specifically, it is assumed that consumers are fully informed and rational and prices are public information. This assumption limits the analysis, because in reality prices may not be easily observed and market information is imperfect. In the case of network goods, this condition becomes crucial, because in order to realize a correct valuation of the good, a consumer must perfectly foresee how many other consumers will choose the same good. With unobserved prices and incomplete information, this becomes complicated. One possibility to resolve this market friction is to introduce a search, when consumers costly gather necessary information. Another way is to allow firms to disclose this information themselves by means of advertising. Once search and advertising are possible, the problem of imperfect information is resolved and thus consumers may rationally foresee the market outcome.

This chapter studies the incentives of duopolists to advertise their prices and also considers how consumers decide to search when they face incomplete information in a market with network goods. To answer the first research question, the paper considers an advertising game in which, at the first stage, firms decide on advertising strategies, then they set prices and, at the last stage of the game, consumers decide on search and buying. Once the advertising decisions of firms are observed by consumers, they search if the expected search benefit exceeds their search costs.

When neither firm advertises, firms are not able to internalize the consumption ex-

ternality and their pricing does not reflect the real valuation of the product. Moreover, when prices are not advertised, firms are not able to influence the search decisions of consumers. When at least one firm decides to advertise its price, the consumption externality may be internalized and market prices account for the value of the network effects.

The expected benefits of a search are decreasing with the degree of product differentiation and the strength of the snob effect. Higher product differentiation reduces price elasticity of demand and thus allows firms to charge higher prices, which in turn lower consumer surplus. A stronger snob effect increases consumer utility losses and thus also reduces expected search benefits. In contrast, bandwagon effect increases the benefits of search because consumer utility grows as more consumers buy the same good.

The advertising game considered in section 2.3.4 demonstrates how firms decide on price advertising. There are four main results which explain what consitions influence the information disclosure by firms. Firstly, at least one firm must advertise for a negative network effect. A negative network effect lowers the minimum threshold level of search costs and increases the profits of the advertising firm compared to a case with no disclosure. Secondly, a weak bandwagon effect and snob effect lead to equilibria with interior solutions where both firms have positive market shares. This means that neither firm is able to capture a whole market. Thirdly, when consumption externality exceeds the degree of product differentiation, the demand function of each firm becomes upward-sloping. A strong positive network effect dominates any strategic and price effects and therefore a higher price is necessarily associated with a greater market share. Fourthly, applying the refinements considered in 2.3.2, the only equilibria with a strong bandwagon effect are those in which only one firm supplies the entire market.

Since the major goal is to study how network externalities affect the decisions of firms to advertise prices, the most important conclusion is that at least one firm must advertise for a negative network effect and an extreme bandwagon effect. This means

that the presence of network externalities forces firms to disclose market information and remedy search frictions.

Summing up, a market equilibrium with network effects depends not only on the type of consumption externality and degree of product differentiation (as shown in the previous literature), but also depends on the advertising decision of the firms and search conditions when consumers face market frictions such as imperfect information and bounded rationality.

Further research on the topic should incorporate the problem of asymmetry of firms. In the framework of the present model, three sources of asymmetry may arise. The first is locational advantage. This phenomenon is considered in Navon et al. (1995) and Grilo et al. (2001). Locational advantage means that a firm may not necessarily be located on the edges of the Hotelling line, but somewhere inside the interval. If any firm has a larger share of locked-in consumers, it will be able to have a greater clientele and can even more easily capture the whole market if the bandwagon effect is strong enough. The second source is vertical differentiation of competing products. When any firm has a higher quality good, a greater quality difference may result in higher prices and may also allow the firm to capture an entire market (as demonstrated in Griva and Vettas, 2011). The third source of asymmetry is the difference in the strength of consumption externality. A firm with a greater bandwagon effect will gain more from the larger clientele and therefore will be able to capture the whole market. In contrast, a firm with a stronger negative externality will gain more because demand for its good will become less elastic. It is also expected that a combination of these sources of asymmetry may also lead to interesting results. For example, a firm with a low quality good but a stronger bandwagon effect may have a larger market share and even higher price. This result is opposite to the vertical differentiation models in which a firm with a higher quality good receives a larger market share and charges a higher price.

All these possible extensions of the model may lead to richer inferences on price advertising and consumer searches in market with consumption externalities.

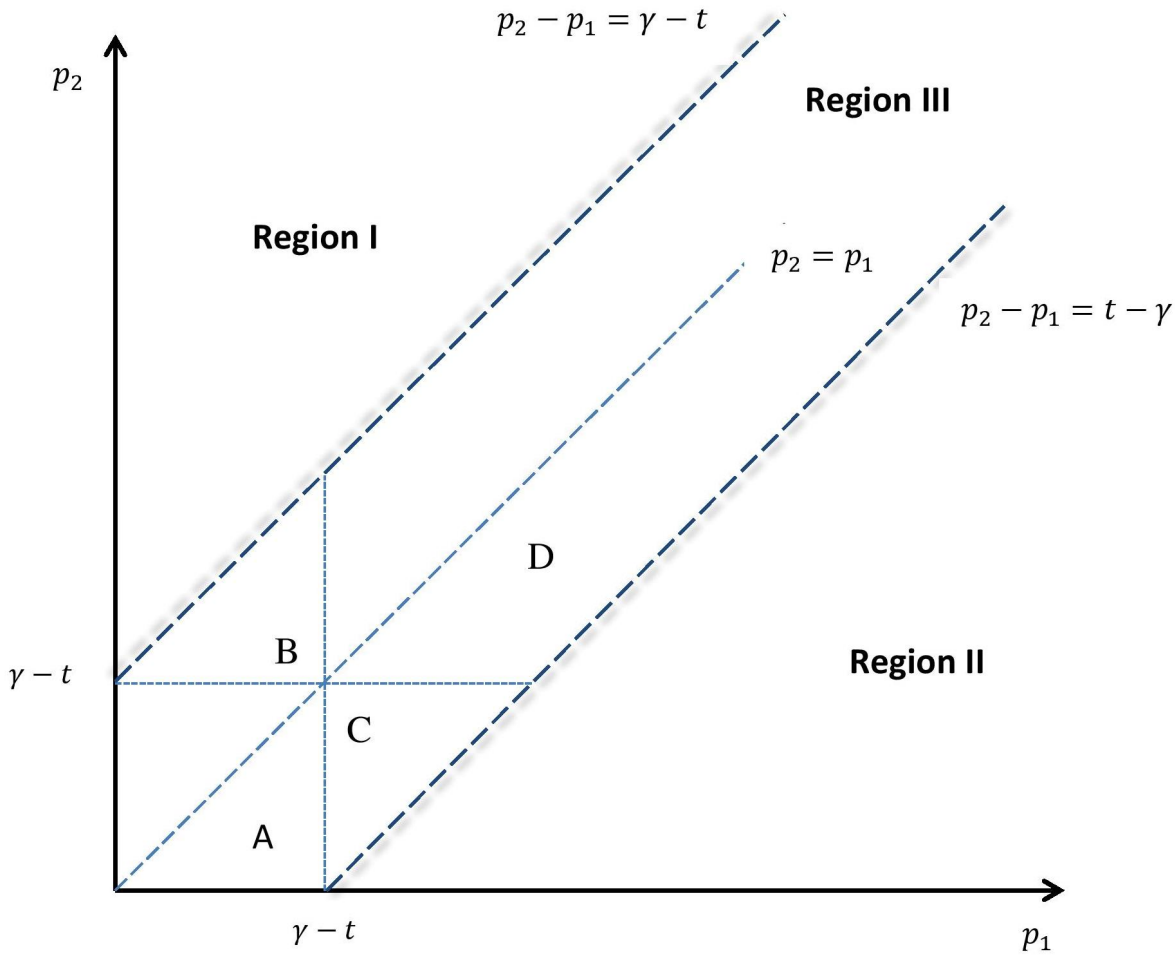

Figure 17: Multiple Equilibria when $\gamma > t$

2.5 Appendix: Analysis of equilibria 2A

Analysis of equilibria when $\gamma \geqslant t$

When the bandwagon effect exceeds a degree of product differentiation, multiple equilibria arise. Particularly, three types of market division may exist: firm 1 captures the market entirely; firm 2 captures the whole market; both firms have positive market shares. Firm 1 gets all consumers when $p_1 - p_2 \leqslant \gamma - t$ and firm 2 gets all consumers if $p_1 - p_2 \geqslant t - \gamma$. An interior solution takes place when the price difference is such that $t - \gamma < p_2 - p_1 < \gamma - t$. Figure 17 shows a division of the price space into three regions: I, II and III. Let us consider each of them in more details.

Region I is always associated with the case in which firm 1 has zero market share

because it lies above the line $p_1 - p_2 = t - \gamma$. No price pair in region I that can be an equilibrium, since firm 1 would like to deviate and decrease its price down to a level when $p_2 - p_1 \leqslant \gamma - t$. Therefore there is no equilibrium in Region I. The same reasoning is applicable to region II, where firm 2 will always find it profitable to decrease its price.

Region III is associated with three types of market division: two corner solutions and multiple interior solutions. Let us divide region III into four zones: square A, triangles B and C, and zone D.

In zone A, prices are rather low to allow firms to undercut each other. Neither firm 1 nor firm 2 can deviate and move to regions I or II. Therefore any price pairs can constitute an equilibrium with three possible outcomes: either corner or interior solutions.

In zone B, firm 1 can never capture the market, because firm 2 can always decrease its price and gain a positive market share. Therefore, either firm 2 captures the whole market or both firms have positive market shares. The latter is possible if firm 2 doesn't consider deviation to region I profitable, particularly if $p_2\left(\frac{p_1-p_2+t-\gamma}{2(t-\gamma)}\right) \geqslant p_1 - \gamma + t$. This condition is shown in Figure 18: price pairs which are above line (2) can support interior solutions. Zone B belongs to this set.

Zone C is a reverse zone B, so firm 2 is not able to serve all consumers and the only outcomes are those where firm 1 either captures the whole market or shares the market with firm 1. The latter is possible if deviation to region II is not profitable: $p_1\left(\frac{p_2-p_1+t-\gamma}{2(t-\gamma)}\right) \geqslant p_2 - \gamma + t$. All price pairs below line (1) support interior solutions. Zone C belongs to this set.

Finally, let us consider zone D. No equilibrium with corner solutions exists here, because any firm with zero sales can decrease its price and gain a positive share of the market up to full coverage. In contrast, equilibria in which both forms have a positive share can exist here. Any deviation from the equilibrium prices in zone D is not profitable[38]. The only profitable deviation is region I for firm 2 and region II

[38]For example, if consumers observe a price pair (p_k, p_l^*) in Region III, they assign $D_k = 0$.

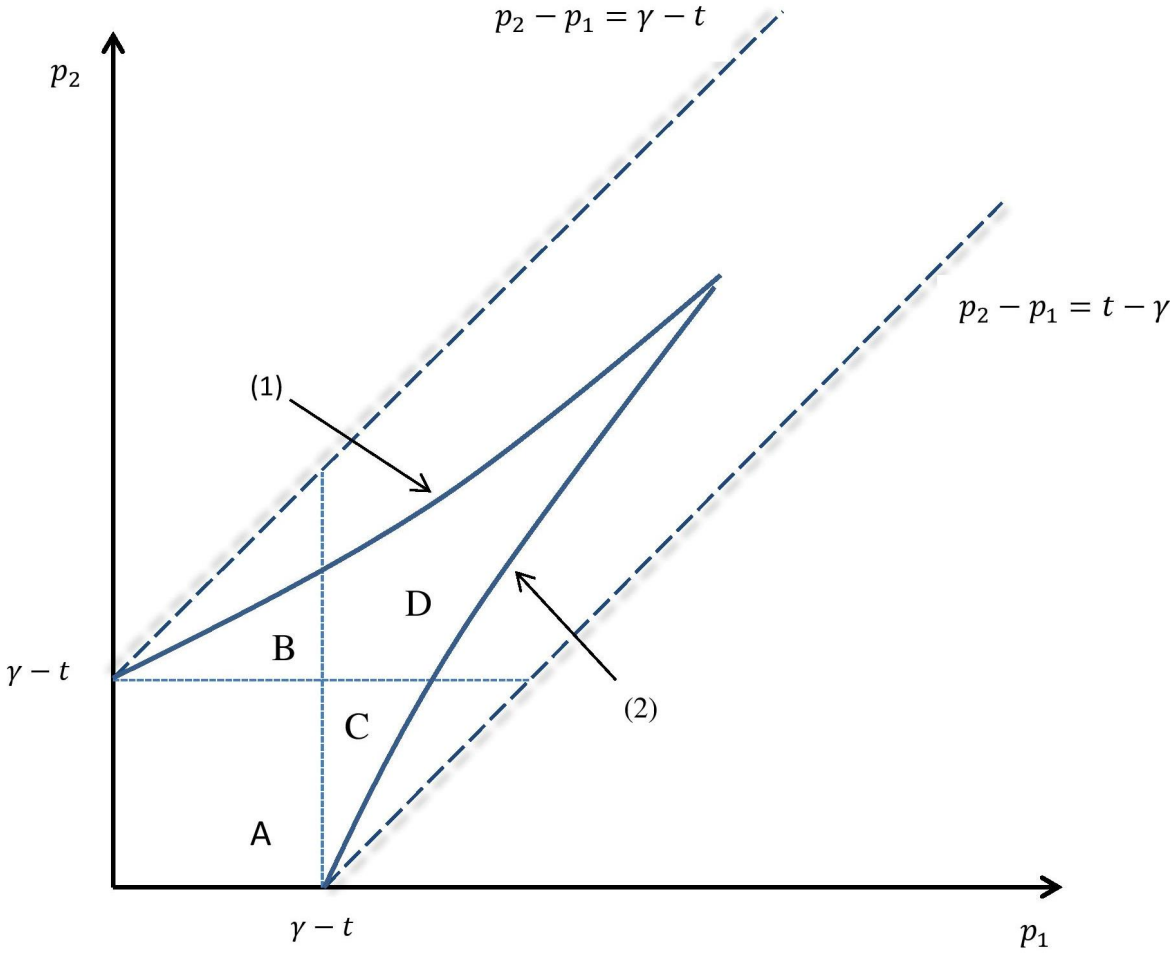

Figure 18: Equilibria Set in Region III

for firm 1. These deviations are not profitable for $p_1\left(\frac{p_2-p_1+t-\gamma}{2(t-\gamma)}\right) \geqslant p_2 - \gamma + t$ and $p_2\left(\frac{p_1-p_2+t-\gamma}{2(t-\gamma)}\right) \geqslant p_1 - \gamma + t$. This set lies between line (1) and (2) in Fig.5.

Summing up, when $\gamma > t$, multiple equilibria exist. In zone A, price pairs constitute equilibria with $D_1 = 0$, $D_1 = 1$ or $D_1 = \frac{p_2-p_1+t-\gamma}{2(t-\gamma)}$. In zone B, equilibrium market shares are either $D_1 = 0$ or $D_1 = \frac{p_2-p_1+t-\gamma}{2(t-\gamma)}$ (given $p_2\left(\frac{p_1-p_2+t-\gamma}{2(t-\gamma)}\right) \geqslant p_1 - \gamma + t$). In zone C, equilibrium market shares are either $D_1 = 1$ or $D_1 = \frac{p_2-p_1+t-\gamma}{2(t-\gamma)}$ (given $p_1\left(\frac{p_2-p_1+t-\gamma}{2(t-\gamma)}\right) \geqslant p_2 - \gamma + t$). Finally, in zone D, any combination of prices support equilibria with $D_1 = \frac{p_2-p_1+t-\gamma}{2(t-\gamma)}$.

Chapter 3

Advertising Response to New Entry

3.1 Introduction

Following a seminal paper by Bain (1956), advertising became an important and credible tool through which incumbent firms can limit, regulate or even deter entry. More recently, Sutton (1991) empirically supported this idea and added that advertising can also alter the market structure. Despite the obvious entry deterrence effect of advertising, little research has been done to explain the advertising behavior of incumbent firms when they do not block, but accommodate new entry. A set of papers devoted to entry accommodation mainly consists of empirical studies which measure advertising responses to new entry, or consider what market characteristics (e.g. concentration ratio) can explain a significant advertising response of incumbent to new entry (e.g. Cubbin and Domberger, 1988; Thomas, 1999). However, no theoretical foundation is provided to explain this response.

The present paper is motivated by the research of Cubbin and Domberger (1988), where the authors examine advertising responses to new entries of incumbent firms using data on 42 companies in 17 consumer good industries. Their empirical research suggests significant[39] changes in advertising intensity of 16 companies: five companies reduced their advertising intensity after entries and eleven companies increased their advertising expenditures. Cubbin and Domberger further show that a positive reaction (increase in advertising) to the entry is highly expected when the incumbent is a dominant firm in the industry and its market is either static or declining. In other

[39]The authors use a model of structural breaks to see how incumbent firms react to new entry. The breaks happen at the date of the new entry in a given industry. Corresponding dummy variables indicate a value of the reaction. Their estimates are statistically significant at 95% level in 16 cases.

words, a dominant firm fights for its market share more aggressively if the market is not growing.

The empirical research of Cubbin and Domberger (1988) offers an evidence that incumbent firms indeed react to new entries[40]. However, their paper does not provide a theoretical framework that could explain why different firms (even in the same industries) choose different advertising strategies: some of them reduce advertising and others increase their advertising intensities. Moreover, nothing is known about how the advertising response of an incumbent depends on the size of the entry: whether greater entry makes an incumbent firm more or less aggressive in advertising.

The present paper considers four different types of advertising: complementary advertising, informative advertising, persuasive advertising changing a distribution of consumer preferences (business-stealing) and persuasive advertising enhancing product differentiation. There are two research questions stated in the paper. The first one considers if different types of advertising lead to different reactions of an incumbent firm in the case of entry accommodation. In fact, as shown in Appendix 3A, incumbent firms react differently to new entries. The second question considers how advertising response is related to the size of the entry. Specifically, it is of great interest to know: if greater entry makes an incumbent firm more or less aggressive in advertising if entry is exogenous; and if more intensive advertising can limit new entry when the number of entering firms is endogenously determined.

The rest of the paper is organized as follows. Section 3.2 reviews related literature. Section 3.3 considers the models of duopoly and multiple entry. Sections 3.4 and 3.5 are results and conclusion respectively.

3.2 Literature Review

Economic analysis of advertising begins with Marshall (1890, 1919) and Chamberlin (1933). Prevailing at that time, the neoclassical school did not consider advertising

[40] A summary and an interpretation of the empirical results of Cubbin and Domberger (1988) are presented in Appendix 3A.

as a way to influence the functioning of the markets, since neoclassical principles assumed complete information, full rationality and fixed preferences. Moreover, under the assumption of competition, only market price determines supply and demand decisions and thus there is no purpose in advertising. However, Marshall (1890, 1919) argued that advertising has two economic roles: on the one hand, it can convey useful market information and thus it is constructive; on the other hand, it can really persuade consumers to switch between sellers and therefore it is combative. Later, Chamberlin (1933) integrated advertising in his model of product differentiation by arguing that advertising is a source and an attribute of product differentiation. Following his thought, advertising creates entry barriers, decreases demand elasticity and redistributes market shares, since it is able to change the tastes and preferences of consumers. These conclusions of Chamberlin (1933) and the development of the theory of imperfect competition motivated a more detailed study of the economics of advertising.

Modern economics points out three approaches to advertising: persuasive, informative and complementary. Persuasive advertising is the first view on advertising. It was introduced by Chamberlin (1933) and implies that advertising is a way that firms can change the tastes and preferences of consumers, create entry barriers and obtain market power. This theoretical approach was then empirically verified by Comanor and Wilson (1969, 1974). In their research, the authors show that market power measured as profit rates is strongly and significantly dependent on advertising intensity. Their conclusions imply that advertising may have a real entry-deterrence effect. This result is parallel to the one of Sutton (1974), who shows that advertising intensity reaches higher levels in oligopolies and moderately concentrated markets with differentiated products. The latter case is discussed in Fehr and Stevik (1998), where the authors considered three different ways that persuasive advertising is used in a duopoly. Their results suggest that when firms compete in persuasive advertising, changing consumers' tastes or reservation prices, they result in a wasteful advertising war and thus both would be better off if the firms could agree not to advertise. In

contrast, persuasive advertising enhancing product differentiation benefits both, since it makes market demand less elastic and softens price competition. In Bloch and Manceau (1999), the authors show how business-stealing persuasive advertising can shift the distribution of consumers' preferences towards the advertised product and thus it can steal consumers from rivals. Persuasive advertising is therefore socially overprovided and anticompetitive.

The second approach is related to the Chicago school and initiated by Stigler. In his study, Stigler (1961) considers an informative role of advertising. Particularly, he assumes that markets with full information are not real and therefore consumers lack necessary information on prices, product characteristics and the existence of sellers and products in general. Informative advertising can remedy information asymmetry and improve market performance. These ideas motivated research on informative advertising, for example, Butters (1977), Grossman and Shapiro (1984) and the interaction of advertising and search. In the latter case, when consumers face searching costs, advertising provides consumers with market information and stimulates search (e.g. Robert and Stahl,1993). It also allows firms to retain positive profits with high searching costs (e.g. Anderson and Renault, 2006) and finally it can expand demand (e.g. Konishi and Sandfort, 2002).

A complementary view on advertising is the third approach. It is firstly introduced in Becker and Stigler (1977) and then developed in Becker and Murphy (1993). This approach implies that advertising is a good in itself and thus it directly enters the utility function of consumers. Consequently, firms can directly influence consumers' willingness to pay through advertising. For example, complementary advertising can take the form of an image or brand-building advertising, or advertising developing the social-economic attributes of the advertised good. Therefore, advertising firms are able to increase a consumer's valuation for the good and reservation price respectively. Sutton (1991, 2012) uses brand advertising (which is purely complementary advertising) to study how the sunk costs of advertising influence the entry. He finds that the harder (more expensive) it is to develop a brand, the greater the number of

firms in the market. In contrast, the cheaper it is to advertise, the fewer firms will remain in the market. Sutton explains it with an endogenous sunk cost approach, a special type of sunk costs that limit the level of concentration in the industry. Recently, this approach was used by Etro (2014) and Senyuta and Zigic (2016) to investigate the entry effect of R&D outlays.

Different types of advertising (or view on advertising) predict different effects on market functioning. Persuasive and complementary advertising increase market power and thus are anticompetitive. On the contrary, informative advertising remedies information problems and thus promotes competition, since better informed consumers become more sensitive to price changes. Welfare effects therefore also vary depending on the nature of advertising.

One of the most interesting questions related to the economics of advertising is how incumbent firms use advertising when they expect a new entry. Comanor and Wilson (1974) have empirically shown that firms use advertising to secure market power. Advertising creates reputation, product differentiation, and high penetration costs to entrants. Thus advertising is able to deter entry if incumbent firms are not willing to allow a new entry.

When incumbent firms do not consider entry deterrence profitable, they may accommodate a new entry. In this case, however, incumbent firms may also change their advertising strategies if new entry occurs. This phenomenon is empirically shown in Cubbin and Domberger (1988). The authors investigate the advertising behavior of incumbent firms in 17 consumer goods industries and conclude that pre-entry advertising intensity significantly differs from post-entry advertising. Particularly, they find that a positive response is highly expected among dominant firms in declining or stagnant markets. In other words, larger firms have more to lose and thus they aggressively fight for their market share by the means of advertising. The authors also find that different firms demonstrate different responses: some of them increase their advertising intensity and others reduce their advertising. This result is interesting but the authors do not suggest any explanation why firms demonstrate different reactions.

Using different approaches to advertising, the present paper answers what explains the different advertising responses of incumbent firms in the case of entry accommodation. In addition, the paper considers multiple entry and studies how advertising response depends on the number of new firms when entry is exogenous and how the size of the endogenous entry depends on the advertising strategy of the incumbent firm.

3.3 Model

The model considers four types of advertising and studies whether an incumbent firm overinvests or underinvests in advertising when it accommodates an entrant. One has to understand underinvestment and overinvestment as accommodation strategies coined in Fudenberg and Tirole (1984). Following their theory, when an incumbent firm accommodates an entrant, it overinvests if it strategically increases its advertising to maximize profit[41]. In contrast, an incumbent underinvests when it strategically reduces its advertising to maximize profit when it allows entry. Depending on the nature of post-entry competition Fudenberg and Tirole (1984) classify overinvestment into *Fat Cat* and *Top Dog* business strategies, and underinvestment into *Puppy Dog* and *Lean and Hungry Look*.

This paper identifis what business strategy is chosen when an incumbent significantly reacts with a change in advertising intensity to the entrant. Four types of advertising are analyzed: complementary advertising, persuasive advertising changing the distribution of tastes and preferences, persuasive advertising enhancing product differentiation, informative advertising expanding demand.

[41] Both underinvestment and overinvestment are compared to the pre-entry level of (advertising) investment (or to the level of non-strategic investment). When a new entry occurs, an incumbent firm overinvests if it exceeds the pre-entry (non-strategic) level. The reverse holds for underinvestment.

3.3.1 Duopoly

The model uses a framework of horizontal product differentiation *a la* Hotelling. It considers a post-entry duopoly market where an incumbent and entrant are located at the edges of a unit line. The location of given consumer i is shown by x_i uniformly distributed on $[0, 1]$. When an incumbent accommodates, the firms compete in prices, although the incumbent reacts to the entry with a change in advertising, so post-entry competition is conditional on the strategic choice of the incumbent's advertising. It is assumed that the incumbent chooses advertising optimally and it is implemented effectively[42]. Advertising technique is explained by its corresponding effect on demand and is defined by a function of advertising expenditures $A(a)$, where a is an advertising intensity[43] of incumbent. This function is increasing and convex in a: $A'(a) > 0,\ A''(a) > 0,\ A(0) = 0$. Marginal costs are constant and normalized to zero. At the first stage the incumbent decides on strategic advertising. At the second stage entry occurs and firms choose their outputs and prices simultaneously.

Case 1. *Complementary advertising*

Following the idea of Stigler and Becker (1977) and Murphy and Becker (1993), complementary advertising implies that advertising directly enters the utility function of consumers because it complements an advertised good. This type of advertising increases a consumer's reservation price since the consumer possesses preferences for complementary advertising. Examples of this kind of advertising are image advertising or any advertising delivering social status when the advertised good is consumed. Additionally, complementary advertising is used to build a brand name or image associated with an advertised product.

If an incumbent decides to invest in complementary advertising, the advertising should influence the reservation price. So when consumer i buys from the incumbent,

[42] All advertising messages reach consumers and none are lost. Advertising is correctly understood by consumers.

[43] Advertsing intensity is a common notation for the amount of advertising produced by firms. It can be measured in units of advertising, the target fraction of consumers or a share of advertising expenditures in total revenue.

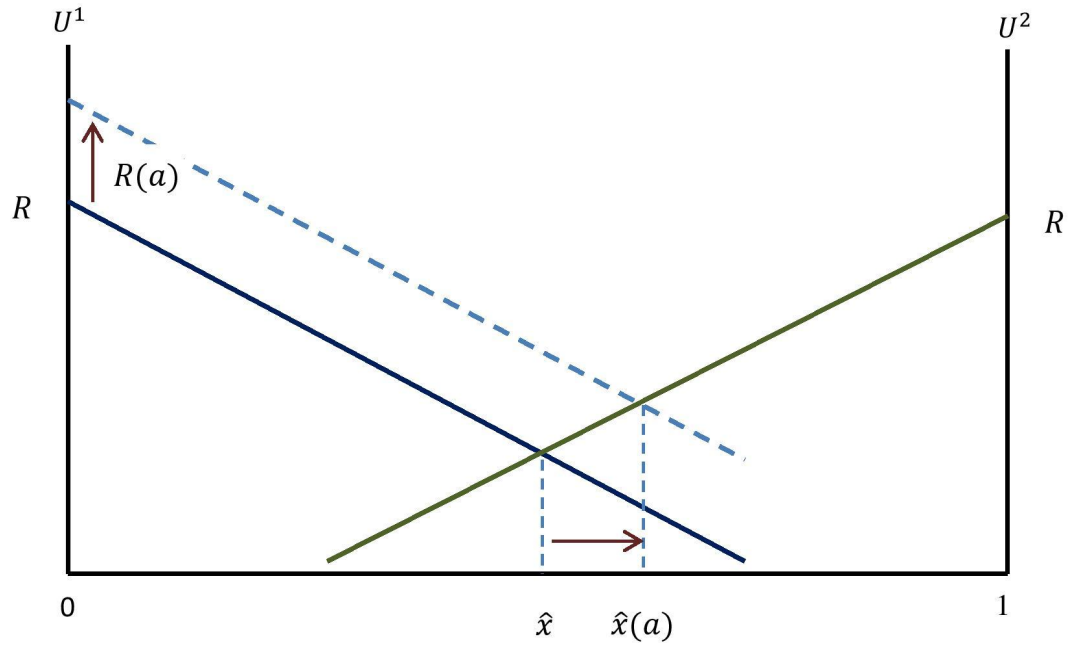

Figure 19: Complementary Advertising

her utility is $U^1(x_i) = R + R(a) - tx_i - p_1$ and if she buys from the entrant $U^2(x_i) = R - t(1 - x_i) - p_2$. The value of t is a measure of product differentiation. A function of $R(a)$ shows how complementary advertising influences the reservation price[44], while R stands for an objective valuation of the good (it is similar to both incumbent and entrant). Figure 19 demonstrates that advertising shifts up a graph of willingness-to-pay by $R(a)$ if consumers buy from the incumbent. In turn, this changes the location of indifferent consumer $\widehat{x}$ to $\widehat{x}(a)$.

As in any model *a la* Hotelling the location of the indifferent consumer is determined by condition $U^1(\widehat{x}) = U^2(\widehat{x})$ which is identical to the following equation:

$$\begin{aligned} R + R(a) - t\widehat{x} - p_1 &= R - t(1 - \widehat{x}) - p_2 \quad \text{or} \\ \widehat{x} &= \frac{R(a) + p_2 - p_1 + t}{2t} \end{aligned}$$

All consumers with x_i lower than $\widehat{x}$ buy from the incumbent and a share of $(1 - \widehat{x})$

[44]Since $R(a)$ shows the utility from complementary advertising, $R(a)$ has regular features of utility function: $R'(a) > 0,\ R''(a) < 0$.

buy from the entrant[45]. Profit functions are formed in a regular manner:

$$\begin{aligned}\pi^1(p_1,p_2,a) &= p_1\left[\frac{R(a)+p_2-p_1+t}{2t}\right]-A(a)\\ \pi^2(p_1,p_2,a) &= p_2\left[1-\frac{R(a)+p_2-p_1+t}{2t}\right]\end{aligned}$$

Joint first order conditions are determined by the partial derivatives of the profit functions with respect to corresponding prices:

$$\begin{aligned}\frac{\partial\pi^1}{\partial p_1} &= \frac{R(a)+p_2-2p_1+t}{2t}=0\\ \frac{\partial\pi^2}{\partial p_2} &= \frac{-R(a)-2p_2+p_1+t}{2t}=0\end{aligned}$$

The best response functions are given by $p_1(p_2,a)=\frac{R(a)+p_2+t}{2}$ and $p_2(p_1,a)=\frac{-R(a)+p_1+t}{2}$. So post-entry competition results in equilibrium prices $p_1(a)=\frac{R(a)+3t}{3}$ and $p_2(a)=\frac{-R(a)+3t}{3}$. As one can see, complementary advertising of an incumbent reduces the markup of an entrant which in turn indicates its aggressiveness.

The total effect of complementary advertising on an incumbent's profit is shown by:

$$\frac{d\pi^1}{da}=\left[-\frac{p_1}{2t}\frac{R'(a)}{3}\right]+\left[\frac{R'(a)p_1}{2t}-A'(a)\right]$$

The term in the first brackets is the strategic effect of complementary advertising and the term in the second brackets is the direct effect. Following the approach of Tirole and Fudenberg (1984), the direct effect is the effect of the strategic investment that directly influences the profit function. Strategic effect, in turn, influences the profit function through the choice of the strategic variable of the rival. Since $R'(a)>0$, strategic effect is negative, the incumbent underinvests in complementary advertising

[45]Since the paper is focused on accommodation only, interior solutions only are considered. Corner solutions are exactly the cases of the entry-deterrence and thus they are omitted. A condition on accommodation is in Appendix 3C.

and the corresponding business strategy is *Puppy Dog*. Enhancing the value of the advertised good for consumers, the incumbent is able to capture a bigger share of the market and increase its markup, while relatively lowering the valuation of the entrant's good[46]. A comparison of strategic and non-strategic[47] complementary advertising is shown in Appendix 3B.

Case 2. *Persuasive advertising changing the distribution of tastes and preferences*

Persuasive advertising changes consumers' tastes and preferences but does not directly enter the utility function of consumers[48]. Fehr and Stevik (1998) explain the role of persuasive advertising and conclude that it either shifts consumers' preferences towards the advertised product or increases product differentiation. In the first case, persuasive advertising changes the distribution of tastes and preferences, i.e. in terms of the present model it shifts the location of the indifferent consumer and thus captures a part of consumers located near the entrant. Figure 20 demonstrates that the distribution of consumers is shifted with persuasive advertising. Since consumers are distributed uniformly, this change in distribution is a horizontal shift of the willingness-to-pay curves to the right. A function of $x(a)$ shows a shift in the location of an indifferent consumer so that the incumbent steals $x(a)$ part of consumers located next to the entrant[49].

$$\widehat{x} = \frac{p_2 - p_1 + t}{2t} + x(a)$$

The incumbent sells to $\widehat{x}$ share of the market and the entrant obtains a residual share

[46] In this sense, complementary advertising is similar to vertical differentiation when an incumbent invests in higher quality.

[47] When incumbent firm does not take into account the strategic effect of advertising that it has on post-entry action of the entrant, the incumbent firm acts non-strategically. In other words, the incumbent chooses advertising intensity based on the direct effect of advertising only. While when it considers both strategic and direct effects of advertising together, it acts strategically. If non-strategic advertising is smaller (greater) than strategic, the incumbent overinvests (underinvests).

[48] Persuasive advertising does not enter the utility function directly as goods or complementary advertising do. Instead, it enters the utility function indirectly, changing the relation between the goods. In other words, it affects the mathematical form of the utility function.

[49] More intensive advertising shifts demand more and thus $x'(a) > 0$, although the marginal effectiveness of advertising decreases $x''(a) < 0$.

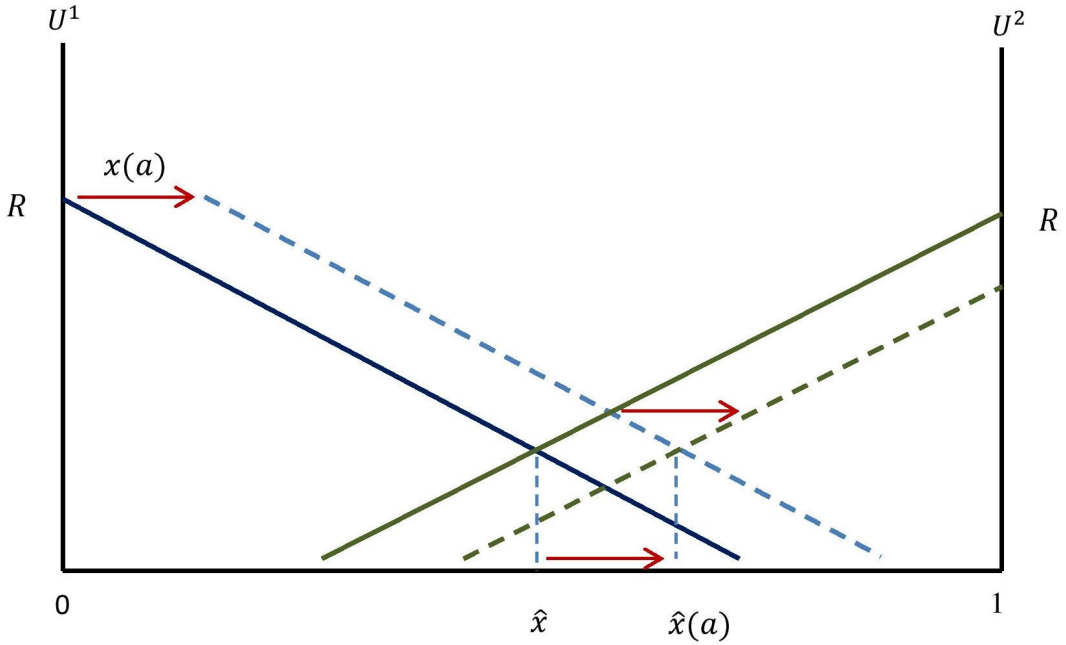

Figure 20: Persuasive Advertising Changing Distribution of Tastes and Preferences

of $(1-\widehat{x})$. The resulting profit functions are as follows:

$$\begin{aligned}\pi^1(p_1,p_2,a) &= p_1\left[\frac{p_2-p_1+t}{2t}+x(a)\right]-A(a)\\ \pi^2(p_1,p_2,a) &= p_2\left[1-\frac{p_2-p_1+t}{2t}-x(a)\right]\end{aligned}$$

Joint first order conditions are determined by the partial derivatives of the profit functions with respect to corresponding prices:

$$\begin{aligned}\frac{\partial\pi^1}{\partial p_1} &= \frac{p_2-2p_1+t}{2t}+x(a)=0\\ \frac{\partial\pi^2}{\partial p_2} &= \frac{-2p_2+p_1+t}{2t}-x(a)=0\end{aligned}$$

Reaction functions are defined by $p_1(p_2,a)=\frac{2tx(a)+p_2+t}{2}$, $p_2(p_1,a)=\frac{-2tx(a)+p_1+t}{2}$ and the corresponding prices are $p_1(a)=\frac{2tx(a)+3t}{3}$, $p_2(a)=\frac{-2tx(a)+3t}{3}$. Persuasive advertising reduces the entrant's markup and thus lowers the entrant's profitability. In turn, it shows that the incumbent is a tough competitor.

The total effect of persuasive advertising is defined by:

$$\frac{d\pi^1}{da} = \left[-p_1 \frac{x'(a)}{3}\right] + [p_1 x'(a) - A'(a)]$$

The term in the first brackets is a the strategic effect of persuasive advertising and the term in the second brackets is the direct effect. Since $x'(a) > 0$ strategic effect is negative, the incumbent underinvests in persuasive advertising that changes the distribution of tastes and preferences, thus the corresponding business strategy is *Puppy Dog*. A comparison of strategic and non-strategic persuasive advertising is in Appendix 3B.

Case 3. *Persuasive advertising enhancing product differentiation*

The second type of persuasive advertising enhances product differentiation or brand loyalty. In both cases persuasive advertising makes demand less elastic and thus increases market power. In the framework of the given model, advertising influences the value of t and hence changes the slope of the willingness-to-pay curves[50]. Figure 21 demonstrates that these graphs become steeper. To see how advertising affects post-entry competition, one has to look at the location of the indifferent consumer, profit functions and response functions. A point of the indifferent consumer is the same as in a traditional model of Hotelling. However, the degree of product differentiation is the function of advertising in the present setting: $\widehat{x} = \frac{p_2 - p_1 + t(a)}{2t(a)}$.

$$\begin{aligned} \pi^1(p_1, p_2, a) &= p_1 \left[\frac{p_2 - p_1 + t(a)}{2t(a)}\right] - A(a) \\ \pi^2(p_1, p_2, a) &= p_2 \left[1 - \frac{p_2 - p_1 + t(a)}{2t(a)}\right] \end{aligned}$$

Joint first order conditions are determined by the partial derivatives of the profit

[50] The function of $t(a)$ shows how persuasive advertising changes the degree of product differentiation. Higher advertising intensity results in greater perceived differences between products, $t'(a) > 0$.

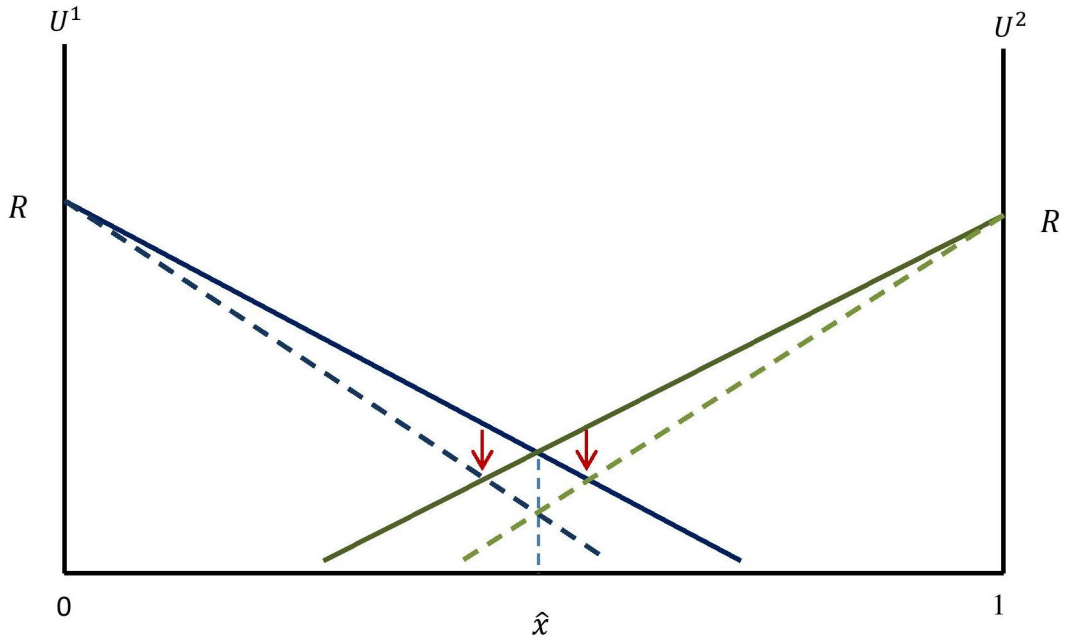

Figure 21: Persuasive Advertising Enhancing Product Differentiation

functions with respect to corresponding prices:

$$\begin{aligned}\frac{\partial \pi^1}{\partial p_1} &= \frac{p_2 - 2p_1 + t(a)}{2t(a)} = 0 \\ \frac{\partial \pi^2}{\partial p_2} &= \frac{-2p_2 + p_1 + t(a)}{2t(a)} = 0\end{aligned}$$

The best response functions are given by $p_1(p_2, a) = \frac{p_2+t(a)}{2}$, $p_2(p_1, a) = \frac{p_1+t(a)}{2}$ and thus prices are $p_1(a) = t(a)$, $p_2(a) = t(a)$. Persuasive advertising enhancing product differentiation benefits both incumbent and entrant, since it decreases demand elasticity and consequently brings market power to both. In fact, the entrant enjoys a positive externality from the incumbent's advertising because it softens price competition.

The total effect of persuasive advertising is determined by:

$$\frac{d\pi^1}{da} = \left[p_1 \frac{t'(a)}{2t(a)}\right] + \left[\frac{p_1(p_1 - p_2)t'(a)}{2t^2(a)} - A'(a)\right]$$

The term in the first brackets is the strategic effect of persuasive advertising and the term in the second brackets is the direct effect. Since $t'(a) > 0$ strategic effect

is positive, the incumbent overinvests in advertising and hence the corresponding business strategy is *Fat Cat*. A comparison of strategic and non-strategic persuasive advertising is in Appendix 3B.

Case 4. *Informative advertising*

Informative advertising provides consumers with market information like prices, product characteristics, usage instructions, availability, and existence of the advertised product. It thus increases demand elasticity. Literature on informative advertising usually considers advertising as a way to bring new customers to the market either by informing them about the existence of the advertised product or by reducing searching costs[51]. In the latter case consumers with high searching costs are motivated to participate in the market. In either case informative advertising expands the demand for the advertising firm. In the framework of the given model, informative advertising brings additional customers to the incumbent, which is shown by $\varphi(a)$[52]. Profit functions are as follows:

$$\begin{aligned} \pi^1(p_1, p_2, a) &= p_1 \left[\frac{p_2 - p_1 + t}{2t} + \varphi(a) \right] - A(a) \\ \pi^2(p_1, p_2, a) &= p_2 \left[1 - \frac{p_2 - p_1 + t}{2t} \right] \end{aligned}$$

Joint first order conditions are determined by the partial derivatives of the profit functions with respect to corresponding prices:

$$\begin{aligned} \frac{\partial \pi^1}{\partial p_1} &= \frac{p_2 - 2p_1 + t}{2t} + \varphi(a) = 0 \\ \frac{\partial \pi^2}{\partial p_2} &= \frac{-2p_2 + p_1 + t}{2t} = 0 \end{aligned}$$

The best response functions are $p_1(p_2, a) = \frac{2t\varphi(a) + p_2 + t}{2}$, $p_2(p_1, a) = \frac{p_1 + t}{2}$ and thus

[51] See for example Stigler (1961), Butters (1977), Grossman&Shapiro (1984), Konishi&Sandfort (2002).

[52] If the incumbent's advertising intensity is a, informative advertising attracts $\varphi(a)$ new customers: $\varphi'(a) > 0,\ \varphi''(a) < 0$.

prices are $p_1(a) = \frac{4t\varphi(a)+3t}{3}$, $p_2(a) = \frac{4t\varphi(a)+3t}{3}$. Informative advertising benefits both firms because the incumbent firm has shifted out its demand curve while not stealing customers from the entrant.

The total effect of informative advertising is defined by:

$$\frac{d\pi^1}{da} = \left[p_1 \frac{2\varphi'(a)}{3}\right] + [p_1\varphi'(a) - A'(a)]$$

The term in the first brackets is the strategic effect of informative advertising and the term in the second brackets is the direct effect. Since $\varphi'(a) > 0$ strategic effect is positive, the incumbent overinvests in advertising and hence the corresponding business strategy is *Fat Cat*. A comparison of strategic and non-strategic informative advertising is in Appendix 3B.

3.3.2 Multiple Entry

Let us now consider a multiple entry case where one incumbent accommodates several entrants. The incumbent anticipates this entry and invests in advertising which can be of four types, as in the previous chapter. Two different frameworks are going to be studied: exogenous entry (the number of entrants is fixed) and endogenous entry (free-entry condition). The firsts approach demonstrates how the advertising reaction of the incumbent depends on the competitive pressure (number of entries). The second one shows how the advertising response to entry influences the equilibrium number of entries.

Post-entry market is characterized by the following inverse demand functions[53] of incumbent i and N identical entrants e:

[53]These inverse demand functions are derived from quadratic utility function as done in Dixit (1979).

$$
\begin{aligned}
p_i &= d - b\left(x_i + \theta \sum_{e=1}^{N} x_e\right) \\
p_e &= d - b\left(x_e + \sum_{-e \neq e}^{N-1} x_{-e} + \theta x_i\right)
\end{aligned}
$$

where x_i and x_e are sales of the incumbent and one representative entrant; d, b, θ are demand parameters.

The incumbent can influence the parameters of the indirect demand functions by choosing what type of advertising is going to be used:

Complementary advertising increases the value of the incumbent's product for a consumer and thus changes the value of d in the inverse demand function of the incumbent. Therefore $d(a)$ is a function of advertising a, such that $d'(a) > 0,\ d''(a) < 0$.

Persuasive advertising enhancing product differentiation decreases the degree of product substitutability. Parameter θ indicates how close products of entrants are related to the incumbent's, if $\theta = 0$ products are not related in consumption, if $\theta = 1$ these goods are perfect substitutes. The incumbent can decrease the value of θ by means of advertising, such that $\theta'(a) < 0$.

Persuasive advertising changing the distribution of tastes and preferences steals consumers from potential entrants. It is also known as business-stealing advertising.

Informative advertising attracts new consumers and expands the market. It makes market demand more elastic since consumers become more sensitive to the change in prices. This can be captured by the reduction in parameter b, $b'(a) < 0$, that is responsible for the market capacity and demand function slope.

Advertising technology is described by an advertising expenditure function $A(a),\ A'(a) > 0,\ A''(a) > 0$. Variable production costs are normalized to zero, fixed cost is equal to F.

As in the previous chapter, the incumbent anticipates and accommodates entries. At the first stage of the game the incumbent invests in advertising and then at the sec-

ond stage competes with entrants in quantities, so x_i and x_e are strategic substitutes. Post-entry competition is simultaneous and non-cooperative.

Case 1. *Complementary Advertising*

In the second stage of the game, profit functions of the incumbent and of a representative entrant look as follows:

$$\begin{aligned}\pi_i &= x_i\left(d(a) - bx_i - b\theta\sum_{e=1}^{N} x_e\right) - A(a) - F \\ \pi_e &= x_e\left(d - bx_e - b\theta x_i - b\sum_{-e\neq e}^{N-1} x_{-e}\right) - F\end{aligned}$$

First order conditions of the profit optimization problems are as follows:

$$\begin{aligned}\frac{\partial\pi_i}{\partial x_i} &= d(a) - 2bx_i - b\theta\sum_{e=1}^{N} x_e = 0 \\ \frac{\partial\pi_e}{\partial x_e} &= d - 2bx_e - b\sum_{-e\neq e}^{N-1} x_{-e} - b\theta x_i = 0\end{aligned}$$

This brings the reaction function of the incumbent $x_i = \frac{d(a)-b\theta\sum_{e=1}^{N} x_e}{2b}$ and a reaction function of one representative entrant $x_e = \frac{d-b\sum_{-e\neq e}^{N-1} x_{-e}-b\theta x_i}{2b}$. There are N identical entrants so$\sum_{e=1}^{N} x_e = Nx_e$, that in turn results in usual best response functions:

$$\begin{aligned}x_i &= \frac{d(a) - b\theta N x_e}{2b} \\ x_e &= \frac{d - b\theta x_i}{b(N+1)}\end{aligned}$$

Equilibrium is described by $x_i^* = \frac{(N+1)d(a)-N\theta d}{b(N(2-\theta^2)+2)}$, $x_e^* = \frac{2d-\theta d(a)}{b(N(2-\theta^2)+2)}$, $p_i^* = \frac{(N+1)d(a)-Nd\theta}{(N(2-\theta^2)+2)}$, $p_e^* = \frac{2d-\theta d(a)}{(N(2-\theta^2)+2)}$.

Exogenous entry. The total effect of complementary advertising on the incumbent's profit is equal to $\frac{d\pi_i}{da} = \sum_{e=1}^{N} \frac{\partial\pi_i}{\partial x_e}\frac{dx_e}{da} + \frac{\partial\pi_i}{\partial a}$. The first part of the total effect is the strategic effect of advertising and the second part is the direct effect. In the case of

complementary advertising, strategic effect is equal to $\frac{N\theta^2 x_i \ d'(a)}{(N(2-\theta^2)+2)} > 0$, meaning that the incumbent overinvests in complementary advertising. The corresponding strategy is *Top Dog*.

The advertising rule is described by the FOC with respect to a: $\frac{d\pi_i(a)}{da} = 0$ This can be computed as the following condition:

$$d'(a)\left[\frac{2(N+1)^2 d(a) - 2N(N+1)\theta d}{b(N(2-\theta^2)+2)^2}\right] = A'(a)$$

To see how advertising changes with N, one has to check the sign of $\frac{da}{dN}$. This value can be found using the implicit function theorem $\frac{da}{dN} = -\frac{\pi_{aN}}{\pi_{aa}}$. By definition, the profit function is concave in advertising and thus $\pi_{aa} < 0$, which in turn means that $sign\left[\frac{da}{dN}\right] = sign\left[\pi_{aN}\right] = sign\left[\frac{d\pi_a}{dN}\right]$.

$$\frac{d\pi_a}{dN} = \frac{2\theta}{b}\left[\frac{2(N+1)(\theta d(a) - d) - \theta^2 dN}{(N(2-\theta^2)+2)^3}\right] d'(a) < 0$$

Since $\frac{d\pi_a}{dN} < 0$, the advertising response to the entry decreases with the number of entrants: $\frac{da}{dN} < 0$. It means that if the incumbent firm responds to the entry with complementary advertising, its advertising decreases with the number of entrants.

Vives (2008) proposes the decomposition of the total effect of demand parameter on strategic investment. In particular, the author computes how competitive pressure parameters (like the number of firms and market capacity) affect R&D through their effect on the firm's demand and market price. This approach of Vives (2008) is also applicable in the case of strategic advertising. By backward induction, at the first stage of the game the incumbent chooses how much to invest in complementary advertising. His profit function is thus $\pi_i(a, N) = x_i(a)\ p_i(x_i(a, N), x_e(a, N), N) - A(a) - F$ which is maximized at some $a = a^*$. Since $sign\left[\frac{da}{dN}\right] = sign\left[\frac{d\pi_a}{dN}\right]$, one can get more intuition about $\frac{da}{dN}$ by decomposing $\frac{d\pi_a}{dN}$.

$$\frac{d\pi_i(a,N)}{da} = \left[\frac{\partial p_i}{\partial x_i}\frac{\partial x_i}{\partial a} + \sum_{e=1}^{N}\frac{\partial p_i}{\partial x_e}\frac{\partial x_e}{\partial a} + \frac{\partial p_i}{\partial a}\right] x_i(a,N) + \frac{\partial x_i}{\partial a} p_i(x_i(a,N), x_e(a,N), N) -$$

$$-A'(a) = \frac{\partial x_i}{\partial a}\left[\frac{\partial p_i}{\partial x_i}x_i(a,N) + p_i(x_i(a,N), x_e(a,N), N)\right] + x_i(a,N)\left[\sum_{e=1}^{N}\frac{\partial p_i}{\partial x_e}\frac{\partial x_e}{\partial a} + \frac{\partial p_i}{\partial a}\right] -$$

$$-A'(a) = x_i(a,N)\left[\sum_{e=1}^{N}\frac{\partial p_i}{\partial x_e}\frac{\partial x_e}{\partial a} + \frac{\partial p_i}{\partial a}\right] - A'(a)$$

A term $\left[\frac{\partial p_i}{\partial x_i}x_i(a,N) + p_i(x_i(a,N), x_e(a,N), N)\right]$ is equal to zero because of the FOC with respect to x_i.

If $D(a,N) = x_i(a,N)$ and $P(a,N) = \sum_{e=1}^{N}\frac{\partial p_i}{\partial x_e}\frac{\partial x_e}{\partial a} + \frac{\partial p_i}{\partial a}$, then $d\pi_a = \frac{d\pi_i(a,N)}{da} = D(a,N)P(a,N) - A'(a)$ and $\frac{d\pi_a}{dN}$ can be computed as the following:

$$\frac{d\pi_a}{dN} = \frac{\partial D(a,N)}{\partial N}P(a,N) + \frac{\partial P(a,N)}{\partial N}D(a,N)$$

The first term $\frac{\partial D(a,N)}{\partial N}P(a,N)$ is the demand effect of N on advertising and the second term $\frac{\partial P(a,N)}{\partial N}D(a,N)$ is the price effect of N. This decomposition makes it possible to separate the two effects of N. The demand effect of the competitive pressure (number of firms N) shows how the size of the entry influences the advertising decision of the incumbent firm through the change in residual demand for the incumbent. Particularly, it indicates a change in marginal sales due to one additional entry. The price effect of competitive pressure shows how the size of entry affects advertising through its influence on the incumbent's price. Intuitively, it defines how the incumbent's marginal profitability of advertising changes with a new entry.

Since $P(a,N) = d'(a)\left[\frac{N\theta^2}{N(2-\theta^2)+2} + 1\right] > 0$ and $\frac{\partial D(a,N)}{\partial N} = \frac{-\theta(2d-\theta d(a))}{b\left(N(2-\theta^2)+2\right)^2} < 0$, demand effect of N is negative. It means that each additional entrant reduces marginal revenue of advertising, which in turn gives an incentive to reduce advertising. In contrast, price effect is positive, since $D(a,N) > 0$ and $\frac{\partial P(a,N)}{\partial N} = \frac{2d'(a)\theta^2}{b\left(N(2-\theta^2)+2\right)^2} > 0$. Complementary advertising is price-increasing by its nature, because it enhances the value of the product. As a result, it increases markup, which gives an incentive to stimulate advertising activity. The total effect $\frac{d\pi_a}{dN}$ is negative meaning that demand

effect exceeds the price effect and incumbent firm reduces its advertising as entry becomes greater.

Endogenous entry. Free entry implies that the equilibrium number of entrants is determined by the zero-profit condition: $\pi_e = x_e^* \, p_e^* - F = \frac{1}{b}\left[\frac{2d-\theta d(a)}{(N(2-\theta^2)+2)}\right]^2 - F = 0$.

To see how the size of entry depends on the advertising of the incumbent firm, one has to apply the implicit function theorem:

$$\frac{dN}{da} = -\frac{(\pi_e)'_a}{(\pi_e)'_N} = -\frac{\theta d'(a)(2+N(2-\theta^2))}{(2-\theta^2)(2d-\theta d(a))} < 0$$

This shows that when entry is endogenous, the equilibrium number of entrants is decreasing in complementary advertising. This result is explained by the fact that complementary advertising increases the value of the incumbent's good to consumers and thus captures greater market share and reduces the residual demand for potential entrants, because all consumers are willing to purchase from the incumbent. Free entry condition therefore results in fewer entries in the industry.

This result supports the conclusion of Sutton (1991, 2012) where the author studies complementary advertising as an endogenous sunk cost to build a brand (or increased perceived quality). Sutton concludes that the easier (cheaper) it is to advertise, the fewer firms remain in the market and vice versa. In the framework of the present model, cheaper advertising technology results in a decrease in $A(a)$ which leads to higher advertising outlays. And since for complementary advertising $\frac{dN}{da} < 0$, one can see that an increase in advertising leaves a smaller number of firms in the industry. In turn, it implies that cheaper advertising leads to fewer firms as it is in Sutton (1991, 2012)

Case 2. *Persuasive advertising enhancing product differentiation*

This kind of advertising lowers the value of θ, which reflects the degree of substitutability of competing products. At the second stage of the game, profit functions of the incumbent and of one representative entrant look as follows:

$$\begin{aligned}\pi_i &= x_i\left(d - bx_i - b\theta(a)\sum_{e=1}^{N} x_e\right) - A(a) - F\\ \pi_e &= x_e\left(d - bx_e - b\theta(a)\ x_i - b\sum_{-e\neq e}^{N-1} x_{-e}\right) - F\end{aligned}$$

First order conditions of the profit optimization problems are as follows:

$$\begin{aligned}\frac{\partial \pi_i}{\partial x_i} &= d - 2bx_i - b\theta(a)\sum_{e=1}^{N} x_e = 0\\ \frac{\partial \pi_e}{\partial x_e} &= d - 2bx_e - b\sum_{-e\neq e}^{N-1} x_{-e} - b\theta(a)x_i = 0\end{aligned}$$

This gives a reaction function of the incumbent $x_i = \frac{d-b\theta(a)\sum_{e=1}^{N} x_e}{2b}$ and a reaction function of one representative entrant $x_e = \frac{d-b\theta(a)\sum_{-e\neq e}^{N-1} x_{-e}-b\theta x_i}{2b}$. There are N identical entrants so$\sum_{e=1}^{N} x_e = Nx_e$, that in turn results in:

$$\begin{aligned}x_i &= \frac{d - b\theta(a)Nx_e}{2b}\\ x_e &= \frac{d - b\theta(a)x_i}{b(N+1)}\end{aligned}$$

Equilibrium is described by $x_i^* = \frac{d(1+N-N\theta(a))}{b(N(2-\theta^2(a))+2)}$, $x_e^* = \frac{d(2-\theta(a))}{b(N(2-\theta^2(a))+2)}$, $p_i^* = \frac{d(1+N-N\theta(a))}{(N(2-\theta^2(a))+2)}$, $p_e^* = \frac{d(2-\theta(a))}{(N(2-\theta^2(a))+2)}$.

Exogenous entry. Total effect of this kind of advertising on the incumbent's profit is equal to $\frac{d\pi_i}{da} = \sum_{e=1}^{N} \frac{\partial \pi_i}{\partial x_e}\frac{dx_e}{da} + \frac{\partial \pi_i}{\partial a}$. The first part of the total effect is the strategic effect of advertising and the second part is the direct effect. Strategic effect is equal to $\frac{d\ N\ \theta(a)\ x_i^*(2+N(2-4\theta(a)+\theta^2(a)))}{(N(2-\theta^2(a))+2)^2}\theta'(a)$. The sign of the strategic effect depends on the sign of $\left(2 + N(\theta^2(a) - 4\theta(a) + 2)\right)$. It is negative for $N \leq 2$ or $\theta(a) < 2 - \sqrt{2(1-\frac{1}{n})}$. In this case the incumbent underinvests and the corresponding business strategy is *Lean and Hungry Look*. When $N > 2$ and $\theta(a) > 2 - \sqrt{2(1-\frac{1}{n})}$, the incumbent overinvests and the corresponding business strategy is *Top Dog*. These results show that a more competitive environment (larger N and lower product differentiation)

makes the incumbent firm advertise more aggressively. The firm tries to differentiate itself from its rivals as much as possible if the initial θ is rather high. In contrast, if initial product differentiation is rather low, the incumbent underinvests. It is worth noting that as N approaches infinity, the threshold $\theta_1 = 2 - \sqrt{2(1-\frac{1}{n})}$ tends to 0.59. In turn, it means that for any N and any equilibrium $\theta^* \leq 0.59$, the incumbent firm underinvests. Since advertising enhancing product differentiation reduces the equilibrium value of $\theta^*(a)$, the situation with underinvestment becomes more probable.

By backward induction, at the first stage of the game the incumbent chooses how much to invest in advertising. Its profit function is thus $\pi_i(a) = x_i(a)\ p_i(a) - A(a) - F$ which is going to be maximized with respect to a :

$$\frac{2d^2N}{b}\left[\frac{(2\theta(a)(1+N-N\theta(a)) - (2+N(2-\theta^2(a))))(1+N-N\theta(a))}{(2+N(2-\theta^2(a)))^3}\right]\theta'(a) = A'(a)$$

To see how advertising changes with N, one has to check the sign of $\frac{d\pi_a}{dN}$. This value is positive for $N \leq 4$ or $\theta < \theta_2$ and negative for $\theta > \theta_2$ and $N > 4$[54]. Therefore the advertising response to the entry is decreasing in the number of entrants if competitive pressure is rather high (larger N and lower product differentiation). In contrast, if the environment is not much competitive, the incumbent firm increases its advertising, since advertising becomes more profitable and effective. As N approaches infinity, the threshold θ_2 tends to 0.71. It implies that for any N and any equilibrium $\theta^* < 0.71$ the incumbent firm increases its advertising in response to a larger entry. Since advertising enhancing product differentiation reduces the equilibrium value of $\theta^*(a)$, a situation with $\frac{d\pi_a}{dN} > 0$ becomes more probable.

Decomposition of the total effect into the demand effect and price effect is $\frac{d\pi_a}{dN} = \frac{\partial D(a,N)}{\partial N}P(a,N) + \frac{\partial P(a,N)}{\partial N}D(a,N)$. The first term $\frac{\partial D(a,N)}{\partial N}P(a,N)$ is the demand effect of N on advertising and the second term $\frac{\partial P(a,N)}{\partial N}D(a,N)$ is the price effect of N.

Since $P(a,N) = -d\theta'(a)N\left[\frac{2(1+N)+2\theta(a)(N-2)+N\theta^2(a)(3-N\theta(a))}{N(2-\theta^2(a))+2}\right] > 0$ and derivative

[54] θ_2 is a relevant solution to the equation $(2\theta_2(1+N-N\theta_2) - (2+N(2-\theta_2^2)))(1+N-N\theta_2) = 0$.

$\frac{\partial D(a,N)}{\partial N} = \frac{-d\theta(a)(2-\theta(a))}{b\left(N(2-\theta^2(a))+2\right)^2} < 0$, the demand effect of entry is negative. It means that each additional entrant reduces the marginal revenue of advertising, which in turn gives an incentive to reduce advertising. In contrast, the price effect is positive, since $D(a,N) > 0$ and $\frac{\partial P(a,N)}{\partial N} = \frac{-2d\theta'(a)(2-2\theta(a)+N(2+6\theta(a)-5\theta^2(a)+\theta^3(a)))}{(N(2-\theta^2(a))+2)^3} > 0$. Product differentiation advertising is price-increasing by its nature since it reduces price elasticity. It thus increases markup, which gives an incentive to stimulate advertising activity. If the total effect $\frac{d\pi_a}{dN}$ is positive, then the price effect exceeds the demand one and the incumbent firm advertises more as entry becomes greater. The reverse holds for $\frac{d\pi_a}{dN} < 0$.

Endogenous entry. Free entry implies that the equilibrium number of entrants is determined by zero-profit condition: $\pi_e = x_e^* \, p_e^* - F = \frac{1}{b}\left[\frac{d(2-\theta(a))}{(N(2-\theta^2(a))+2)}\right]^2 - F = 0$.

To see how the size of entry depends on the advertising of the incumbent firm, one has to apply the implicit function theorem:

$$\frac{dN}{da} = -\frac{(\pi_e)'_a}{(\pi_e)'_N} = -\theta'(a)\frac{2+N(2-4\theta(a)+\theta^2(a))}{(2-\theta(a))(2-\theta^2(a))}$$

As in the case with the sign of the strategic effect, the sign of $\frac{dN}{da}$ depends on the sign of $2 + N(2 - 4\theta(a) + \theta^2(a))$. It is positive equilibrium $N^* \leq 2$ or $\theta^* < \theta_1$. In contrast, it is negative for $N^* > 2$ and $\theta^* > \theta_1$. A limit of θ_1 equals 0.59 meaning that for any N and any equilibrium $\theta^* < 0.59$, a sign of $\frac{dN}{da}$ is always positive. Since advertising enhancing product differentiation reduces equilibrium θ^*, the situation with $\frac{dN}{da} > 0$ becomes more probable.

If $\frac{dN}{da}$ is positive then the incumbent's advertising increases the equilibrium number of entries. The incumbent increases the equilibrium degree of product differentiation (lowers θ^*). This result is logically expected since a higher degree of product differentiation expands residual demand for entrants and thus allows more entries. For example, these results are similar to Zigic (2012), where it is shown that when competing products are less alike, competition becomes softer and more firms enter in equilibrium.

Case 3. *Business-stealing advertising*

When an incumbent firm uses business-stealing advertising, it persuades consumers to buy its products by shifting their preferences towards the incumbent's product. In other words, the incumbent captures some portion of $s(a)$ consumers with advertising, $s'(a) > 0$. There are N identical entrants and thus every entrant loses $\frac{s(a)}{N}$ potential market share from the business-stealing advertising of the incumbent. Therefore profit functions for the incumbent and N identical entrants look as follows:

$$\begin{aligned}
\pi_i &= (x_i + s(a)) \left(d - bx_i - b\theta \sum_{e=1}^{N} x_e \right) - A(a) - F \\
\pi_e &= \left(x_e - \frac{s(a)}{N} \right) \left(d - bx_e - b\theta\ x_i - b \sum_{-e \neq e}^{N-1} x_{-e} \right) - F
\end{aligned}$$

First order conditions of the profit optimization problems are a system of two equations:

$$\begin{aligned}
\frac{\partial \pi_i}{\partial x_i} &= d - bx_i - b\theta \sum_{e=1}^{N} x_e - b(x_i + s(a)) = 0 \\
\frac{\partial \pi_e}{\partial x_e} &= d - bx_e - b \sum_{-e \neq e}^{N-1} x_{-e} - b\theta x_i - b \left(x_e - \frac{s(a)}{N} \right) = 0
\end{aligned}$$

Second stage competition results in the following reaction functions: $x_i = \frac{d - bs(a) - b\theta N x_e}{2b}$, $x_e = \frac{dN + bs(a) - b\theta N x_i}{bN(N+1)}$.

Equilibrium is described by outputs $x_i^* = \frac{d - bs(a) - bNs(a) + dN - b\theta s(a) - dN\theta}{b(2(N+1) - \theta^2 N)}$, $x_e^* = \frac{2bs(a) + 2dN + b\theta N s(a) - d\theta N}{bN(2(N+1) - \theta^2 N)}$ and prices $p_i^* = \frac{\left(d + Nd + bs(a) - Nd\theta - bs(a)\theta + Nbs(a) - Nbs(a)\theta^2 \right)}{(2(N+1) - \theta^2 N)}$, $p_e^* = \frac{\left(2d - d\theta - 2bs(a) + bs(a)\theta + bs(a)\theta^2 \right)}{(2(N+1) - \theta^2 N)}$.

Exogenous entry. Total effect of this kind of advertising on the incumbent's profit is equal to $\frac{d\pi_i}{da} = \sum_{e=1}^{N} \frac{\partial \pi_i}{\partial x_e} \frac{dx_e}{da} + \frac{\partial \pi_i}{\partial a}$. The first part of the total effect is the strategic effect of advertising and the second part is the direct effect. Strategic effect is equal to $\frac{-(x_i + s(a)) b\theta (2 + \theta N) s'(a)}{(2(N+1) - \theta^2 N)} < 0$ and implies that the incumbent firm underinvests in advertising if it wants to use business-stealing advertising. The corresponding business strategy is *Lean and Hungry Look*.

To see how advertising depends on the entry, one has to check the sign of $\frac{d\pi_a}{dN} =$

$\frac{-4(1-\theta)\theta(d(N-1)\theta+bs(a)(1+N+N\theta)(\theta^2+\theta-2))}{(2(N+1)-\theta^2N)^3}s'(a)$. It is positive, meaning that the incumbent firm advertises more intensively if entry is large and less intensively if entry is small.

Decomposition of the total effect into demand effect and price effect is $\frac{d\pi_a}{dN} = \frac{\partial D(a,N)}{\partial N}P(a,N) + \frac{\partial P(a,N)}{\partial N}D(a,N)$. The first term $\frac{\partial D(a,N)}{\partial N}P(a,N)$ is the demand effect of N on advertising and the second term $\frac{\partial P(a,N)}{\partial N}D(a,N)$ is the price effect of N.

Since $P(a,N) = -\theta bs'(a)\left[\frac{2+\theta}{N(2-\theta^2(a))+2}\right] < 0$ and $\frac{\partial D(a,N)}{\partial N} = \frac{\theta(d(\theta-2)-bs(a)(\theta^2+\theta-2))}{b\left(N(2-\theta^2(a))+2\right)^2} < 0$, the demand effect of N is positive. Because of the fact that larger entry reduces residual demand of the incumbent, the only way to compensate this loss is to steal consumers from the rivals with advertising. This stimulates advertising activity. The price effect is also positive, because $D(a,N) > 0$ and $\frac{\partial P(a,N)}{\partial N} = \frac{2\theta bs'(a)(2-\theta^2-\theta)}{b\left(N(2-\theta^2(a))+2\right)^2} > 0$. Every new entry makes competition tougher and reduces prices, the only way to compensate a loss in the markup is to capture more consumers with advertising. The total effect $\frac{d\pi_a}{dN}$ is positive and the incumbent firm advertises more as entry becomes greater.

Endogenous entry. Free entry implies that the equilibrium number of entrants is determined by the zero-profit condition $\pi_e = x_e^*\, p_e^* - F$ or:

$$\left[\frac{2bs(a)+2dN+b\theta Ns(a)-d\theta N}{bN(2(N+1)-\theta^2N)} - \frac{s(a)}{N}\right]\left[\frac{\left(2d-d\theta-2bs(a)+bs(a)\theta+bs(a)\theta^2\right)}{(2(N+1)-\theta^2N)}\right] - F = 0.$$

To see how the size of entry depends on the advertising of incumbent firm, one has to apply the implicit function theorem:

$$\frac{dN}{da} = -\frac{(\pi_e)'_a}{(\pi_e)'_N} = s'(a)\frac{b(\theta^2+\theta-2)(2+(2-\theta^2))}{(2-\theta^2)(d(2-\theta)+bs(a)(\theta^2+\theta-2))} < 0$$

The sign of $\frac{dN}{da}$ is negative, it means that as the incumbent invests more in advertising, entry becomes harder and fewer firms enter the market. As more consumers are persuaded to like the incumbent's product, a smaller market share is left to newcomers and thus fewer firms can enter. Indeed, if the incumbent firm can effectively shift the preferences of consumers towards its product, it would be hard for any entrant to profitably operate on shortened residual demand. And since business-stealing advertising reduces the available market share for all newcomers, entry is limited.

Case 4. *Informative advertising*

Informative advertising makes market demand more sensitive to the change in prices and attracts more consumers. These effects can be reflected by the decrease in $b(a),\ b'(a) < 0$. Profit functions look as follows:

$$\begin{aligned}\pi_i &= x_i\left(d - b(a)x_i - b(a)\theta\sum_{e=1}^{N} x_e\right) - A(a) - F\\ \pi_e &= x_e\left(d - b(a)x_e - b(a)\theta\ x_i - b(a)\sum_{-e\neq e}^{N-1} x_{-e}\right) - F\end{aligned}$$

First order conditions of the profit optimization problems are a system of two equations:

$$\begin{aligned}\frac{\partial\pi_i}{\partial x_i} &= d - 2b(a)x_i - b(a)\theta\sum_{e=1}^{N} x_e = 0\\ \frac{\partial\pi_e}{\partial x_e} &= d - 2b(a)x_e - b(a)\sum_{-e\neq e}^{N-1} x_{-e} - b(a)\theta x_i = 0\end{aligned}$$

This gives a reaction function of the incumbent $x_i = \frac{d-b(a)\theta\sum_{e=1}^{N} x_e}{2b(a)}$ and a reaction function of one representative entrant $x_e = \frac{d-b(a)\theta\sum_{-e\neq e}^{N-1} x_{-e} - b(a)\theta x_i}{2b(a)}$. There are N identical entrants so$\sum_{e=1}^{N} x_e = Nx_e$, that in turn bring usual best response functions:

$$\begin{aligned}x_i &= \frac{d - b(a)\theta N x_e}{2b(a)}\\ x_e &= \frac{d - b(a)\theta x_i}{(N+1)b(a)}\end{aligned}$$

Equilibrium is described by $x_i^* = \frac{(N+1-N\theta)d}{(N(2-\theta^2)+2)b(a)}$, $x_e^* = \frac{(2-\theta)d}{(N(2-\theta^2)+2)b(a)}$, $p_i^* = \frac{(N+1-N\theta)d}{(N(2-\theta^2)+2)}$, $p_e^* = \frac{(2-\theta)d}{(N(2-\theta^2)+2)}$.

Exogenous entry. The total effect of the advertising on incumbents profit is equal to $\frac{d\pi_i}{da} = \sum_{e=1}^{N}\frac{\partial\pi_i}{\partial x_e}\frac{dx_e}{da} + \frac{\partial\pi_i}{\partial a}$. The first part of the total effect is the strategic effect of advertising and the second part is the direct effect. In the case of informative advertising the strategic effect is equal to $\frac{N\theta x_i d(2-\theta)}{(N(2-\theta^2)+2)b(a)}b'(a) < 0$, meaning that the

incumbent underinvests in informative advertising. The corresponding strategy is *Lean and Hungry Look*.

Advertising rule is defined by FOC $\frac{d\pi_i(a)}{da} = 0$:

$$-b'(a)\left[\frac{d(1+N-N\theta)}{2(N+1)-n\theta^2}\right]^2 = A'(a)$$

To see how advertising changes with N, one has to check the sign of $\frac{da}{dN}$. Using the implicit function theorem $\frac{da}{dN} = -\frac{\pi_{aN}}{\pi_{aa}}$ and $\pi_{aa} < 0$, we have that $sign\left[\frac{da}{dN}\right] = sign\left[\frac{d\pi_a}{dN}\right]$:

$$\frac{d\pi_a}{dN} = \frac{2d^2\theta}{b^2}\left[\frac{(2-\theta)(1+N-N\theta)}{2(N+1)-n\theta^2}\right]b'(a) < 0$$

Since $\frac{d\pi_a}{dN} < 0$ the advertising response to the entry is decreasing in the number of entrants: $\frac{da}{dN} < 0$. It means that if the incumbent firm responds to the entry with informative advertising, its advertising decreases in the number of entrants. As more new firms enter the market, the less benefits the incumbent gets from informative advertising. Informative advertising may increase demand but it reduces prices because of the elasticity effect.

Decomposition of the total effect into demand effect and price effect is $\frac{d\pi_a}{dN} = \frac{\partial D(a,N)}{\partial N}P(a,N) + \frac{\partial P(a,N)}{\partial N}D(a,N)$. The first term $\frac{\partial D(a,N)}{\partial N}P(a,N)$ is the demand effect of N on advertising and the second term $\frac{\partial P(a,N)}{\partial N}D(a,N)$ is the price effect of N.

Since $P(a,N) = -b'(a)x_i > 0$ and $\frac{\partial D(a,N)}{\partial N} = \frac{-d\theta(2-\theta)}{b(a)\left(N(2-\theta^2(a))+2\right)^2} < 0$ the demand effect of N is negative. It means that each additional entrant reduces the marginal revenue of advertising which in turn gives an incentive to reduce advertising. The price effect is also negative, since $D(a,N) > 0$ and $\frac{\partial P(a,N)}{\partial N} = \frac{b'(a)d\theta(2-\theta)}{b(a)(N(2-\theta^2(a))+2)^3} < 0$. Informative advertising is procompetitive by its nature since it tends to reduce prices. Each additional entry reduces the markup of the incumbent firm and thus the incumbent decreases its advertising outlays. The total effect $\frac{d\pi_a}{dN}$ is negative, meaning that the incumbent firm advertises less as entry becomes greater.

Endogenous entry. Free entry implies that the equilibrium number of entrants is determined by the zero-profit condition: $\pi_e = x_e^*\, p_e^* - F = \frac{1}{b}\left[\frac{(2-\theta)d}{(N(2-\theta^2)+2)}\right]^2 - F = 0$.

To see how the size of entry depends on the advertising of incumbent firm, one has to apply the implicit function theorem:

$$\frac{dN}{da} = -\frac{(\pi_e)'_a}{(\pi_e)'_N} = -\frac{2 + 2N - N\theta^2}{2(2-\theta^2)b(a)}b'(a) > 0$$

This shows that when entry is endogenous, the equilibrium number of entrants is increasing in informative advertising. This result is very intuitive, because informative advertising is always procompetitive, it expands market capacity. The informative advertising of the incumbent delivers a positive externality to entrants by giving them greater residual demand. Free entry condition therefore results in greater entry in the industry.

3.4 Results

In the previous section, four types of advertising were considered. In the duopoly case, if the incumbent firm reacts to the entry with complementary advertising or persuasive advertising changing the distribution of consumer preferences, it underinvests. Or else, if the incumbent firm reacts with informative advertising or persuasive advertising enhancing product differentiation, it overinvests.

So now it is possible to match these conclusions with observations from the findings of Cubbin and Domberger (1988). To start with, it is important to identify which type of advertising suits a particular market the most. First of all, if a market is growing (especially the market of a new product), there is no need for combative behavior (stealing consumers from the rival with persuasive advertising) or demand shrinking (with an enhanced product differentiation). Therefore, a growing market mainly implies either informative or complementary advertising. Informative advertising attracts more consumers and expands demand by means of informing perspective consumers about the existence of the product, its useful characteristics, prices and so on. Complementary advertising is usually used to build the brand name associated with a product and it is necessary when a product is newly introduced into the market. So, if a market is growing and the incumbent firm overinvests, it is more likely to use informative advertising; if the incumbent underinvests in the growing market, it is likely to use complementary advertising. However, the incumbent may also use some persuasive advertising if the good is not new.

If a market is stagnant or declining, the product is well known to consumers and is in the mature stage of its life-cycle. In this situation, informative advertising cannot attract more consumers to the market, and complementary advertising cannot be used on the mature stages of the product since brand image is already established for mature products. Therefore, the only suitable types of advertising are those which imply either stealing consumers from the rival or increasing the loyalty of the clientele. Persuasive advertising changing the distribution of tastes and preferences steals

customers from the rival and thus is suitable for stagnant and declining markets. Persuasive advertising enhancing product differentiation is used to increase the loyalty of the clientele and make the perceived difference between differentiated products stronger. It increases market power and consequently markups of the incumbent. Summing up, when a market is stagnant or declining, the incumbent firm overinvests if it uses persuasive advertising, enhancing product differentiation, and the incumbent firm underinvests if it uses persuasive advertising, changing the distribution of tastes and preferences.

When the incumbent firm faces multiple entry, it reacts aggressively with advertising and the corresponding business strategies are either *Top Dog* or *Lean and Hungry Look*. However, only complementary and business-stealing advertising are anticompetitive, while informative advertising and advertising increasing product differentiation ease the entry of new firms. These results are explained by the fact that complementary and business-stealing advertising increase the market share of the incumbent firm by means of a reduction in residual demand of potential entrants, that in turn leaves a smaller market share to the rivals and thus fewer firms can enter the market. On the contrary, informative advertising of the incumbent expands the borders of the market and delivers a positive externality to the potential entrants. This increases the market shares of both the incumbent and entrants, and in turn allows more entries. As for advertising enhancing product differentiation, it reduces the substitutability of competing products and thus softens competition, making new entries profitable.

When entry is exogenous, business-stealing and product differentiation advertising increases in the amount of entering firms. In the first case, greater entry reduces market share for the incumbent firm and thus it uses more aggressive advertising to compensate this potential loss. In the second case, greater potential entry motivates the incumbent to differentiate its product more in order to soften potential competition. The other types of advertising decrease in the amount of potential entrants, since with exogenous entry the demand effect is negative and each additional entrant reduces the marginal revenue of advertising, which in turn leads to smaller advertising

Type of ads	Business Strategy	Effect of entry on Ads, da/dN Exogenous entry	Effect of Ads on the entry, dN/da Endogenous entry
Complementary	***Top Dog***	$\frac{da}{dN} < 0$	$\frac{dN}{da} < 0$
Business stealing	***Lean and Hungry Look***	$\frac{da}{dN} > 0$	$\frac{dN}{da} < 0$
Product differentiation	***Lean and Hungry Look*** if $N \leq 2$ or $\theta^* < \theta_1$ ***Top Dog*** if $N > 2$ and $\theta^* > \theta_1$	$\frac{da}{dN} > 0$ if $N \leq 4$ or $\theta^* < \theta_2$ $\frac{da}{dN} < 0$ if $N > 4$ and $\theta^* > \theta_2$	$\frac{dN}{da} > 0$ if $N^* \leq 2$ or $\theta^* < \theta_1$ $\frac{dN}{da} < 0$ if $N^* > 2$ and $\theta^* > \theta_1$
Informative	***Lean and Hungry Look***	$\frac{da}{dN} < 0$	$\frac{dN}{da} > 0$

Figure 22: Multiple Entry

outlays.

It is important to note that advertising enhancing product differentiation may have different outcomes depending on the value of the equilibrium product differentiation. Firstly, a more competitive environment (larger entry and higher substitutability of goods) reduces advertising due to the lower benefits of advertising. However, if the equilibrium degree of product differentiation does not exceed its threshold and therefore stays rather high, entry and advertising are positively correlated. Secondly, advertising enhancing product differentiation reduces product substitutability and thus equilibrium θ decreases, which implies that the incumbent's advertising and entry are more likely to be positively related.

All results are summarized in Figure 22.

3.5 Conclusion

Advertising is used by firms not only to create entry barriers and deter entry, but it can also be used as a response to new entry in the case of accommodation. Empirical evidence suggests significant changes in advertising patterns of incumbent firms when they face new firms on the market. Some of them reduce their advertising expenditures, others increase their advertising. Existing economic literature investigating this phenomenon does not provide any theoretical foundation why firms react differently to new entry and does not explain how advertising response is related to the size of the entry.

The present chapter considers four types of advertising and studies how the particular type of advertising chosen by the incumbent firm is related to the entry accommodation. Specifically, it investigates whether the incumbent firm overinvests or underinvests in a particular type of advertising and how the size of the entry is related to the advertising response.

In the case of a duopoly, when the post-entry market is organized *a la* Hotelling, the incumbent tends to overinvest (increase post-entry advertising levels) in informative advertising and persuasive advertising enhancing product differentiation. On the contrary, the incumbent underinvests (decreases post-entry advertising outlays) in complementary and business-stealing advertising.

In the case of multiple entry, when the demand structure is of Dixit (1979), the incumbent overinvests in complementary advertising and underinvests otherwise. If entry is exogenous, advertising that decreases substitutability of the competing products and business-stealing advertising is positively related to the size of entry, since, in the first case, greater potential competition motivates the incumbent firm to increase perceived differences between products and thus soften post-entry competition; and, in the second case, with larger entry, business-stealing advertising is the only way to secure a market share. When entry is endogenous, complementary and business-stealing advertising allow fewer firms to enter the market, since both reduce residual

demand to potential entrants. On the contrary, informative advertising and advertising increasing product differentiation are procompetitive and allow greater entry. Both of them are a positive externality that benefits potential entrants since both increase market shares of all firms operating in the market.

The theoretical model considered in the present paper serves to explain observations found in the empirical research of economists which investigate the advertising responses of incumbent firms to new entries. The model can be further extended to incorporate dynamics and to know how incumbents react to new entries treating advertising as an intangible asset.

3.6 Appendix

3A Results in Cubbin and Domberger (1988)

The empirical results of Cubbin and Domberger (1988) are summarized in Table 1. There are nine categories: company name; industry where the given company operates; year when new entry took place; market type; estimates of coefficients in the regression equations[55] (intercept, trend and dummy); dummy type; response ("over" means an increase in advertising above the pre-entry levels and "under" means a reduction in advertising under the pre-entry levels).

Some of the regressions are sketched in Figure 23. There are six examples of advertising responses based on the results from Table 1: Phillips, P&G (washing-up liquids) and Gillette demonstrate a significant increase in their advertising expenditures after entries; Colgate-Palmolive, P&G (shampoo) and Ellida-Gibbs show a reduction.

[55] The estimated equations with structural breaks are specified as follows: $A_{it} = \alpha_i + \beta_i t + \gamma_i^I \delta_i + e_i$ if there is a jump in intercept and $A_{it} = \alpha_i + \beta_i t + \gamma_i^S \delta_i t + e_i$ if there is a change in slope. A_{it} is advertising expenduture of the firm i in period t. δ_i is a dummy variable taking the value of 0 before entry and 1 afterwards. $t = 1, 2, ...n$ are quarterly time-periods.

Company	Industry	Year of Entry	Market Type	Intercept	Trend	Dummy	Dummy Type	Response
Philips	*Electric Shavers*	*1976*	*Growing*	656523	-19915	393779	intercept	**Over**
Colgate-Palmolive	*Toothpaste*	*1975*	*Growing*	300762	5534	-163986	intercept	**Under**
Huntley-Palmers	*Processed Nuts*	*1976*	*Stagnant*	5115	-583	24417	intercept	**Over**
Gillette	*Wet Shaving*	*1976*	*Declining*	356283	-9475	6598	slope	**Over**
Proctor & Gamble	*Washing-up Liquids*	*1979*	*Static*	372765	-7275	8533	slope	**Over**
Colgate-Palmolive	*Washing-up Liquids*	*1979*	*Static*	285911	-8275	2929	slope	**Over**
Nestles	*Instant Coffee*	*1973*	*Growing*	321797	17335	-15295	slope	**Under**
Proctor & Gamble	*Washing Powder*	*1977*	*Static*	1707782	-48490	24294	slope	**Over**
Lever Bros.	*Washing Powder*	*1977*	*Static*	1883686	-58631	24185	slope	**Over**
Swan	*Electric Kettles*	*1980*	*Static*	6820	1895	-1552	slope	**Under**
Colgate-Palmolive	*Disposable Nappies*	*1981*	*Growing*	75163	-3163	96394	intercept	**Over**
Robbinsons	*Disposable Nappies*	*1980-1981*	*Growing*	43686	-1755	124426	intercept	**Over**
Elida-Gibbs	*Shampoo*	*1973-1977*	*Static*	156762	2067	-2236	slope	**Under**
Proctor & Gamble	*Shampoo*	*1973-1977*	*Static*	6126	4850	-1629	slope	**Under**
Beechams	*Deodorants*	*1970-1975*	*Static*	128163	-5159	118323	intercept	**Over**
Rothmans	*Cigarettes*	*1978*	*Declining*	2547195	-26646	3235967	intercept	**Over**

Table 1. Summary of results based on Cubbin&Domberger (1988)

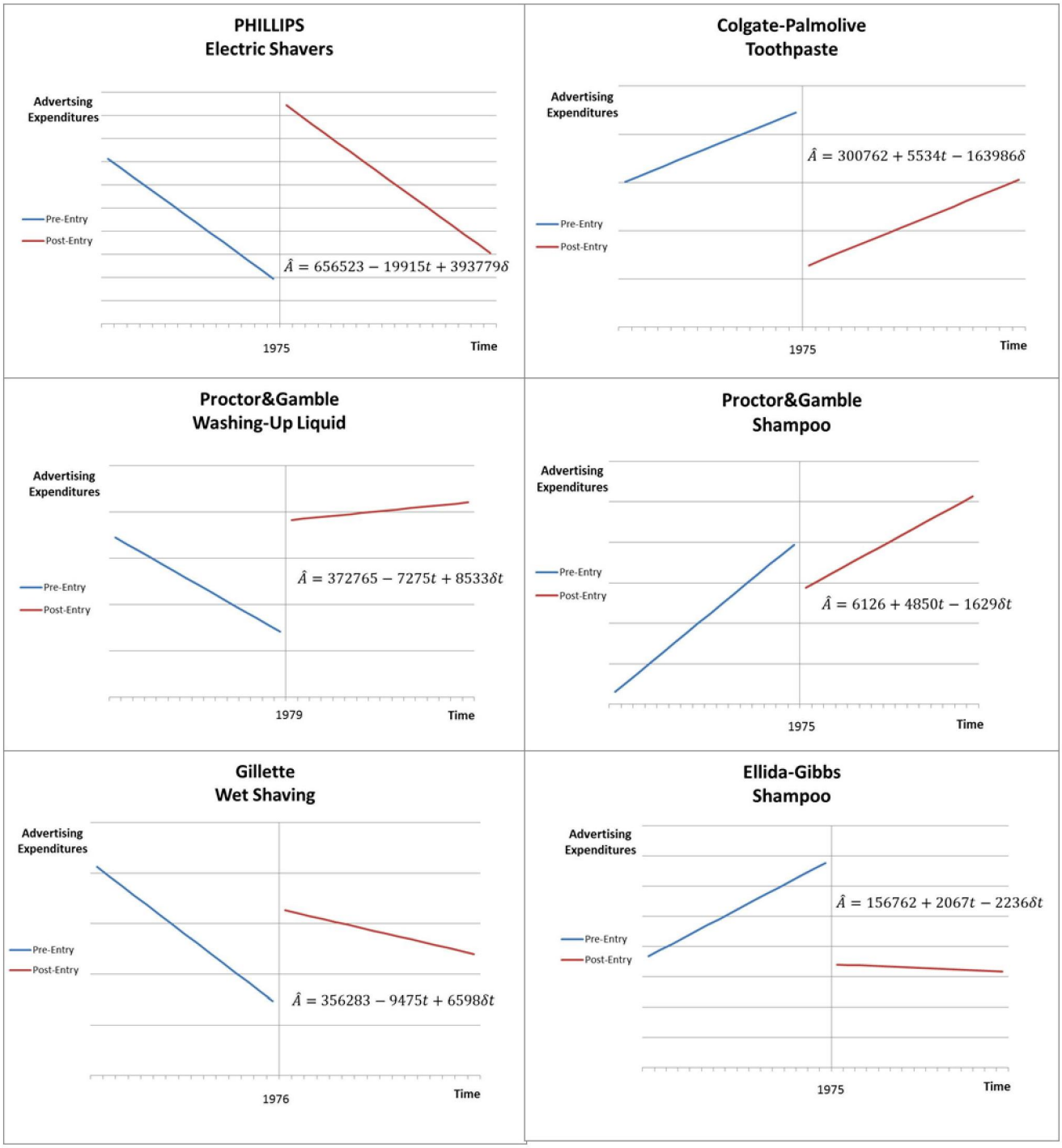

Figure 23: Examples of regression graphs from Table 1

3B Strategic and non-strategic advertising

Complementary advertising

When an incumbent firm decides on advertising non-strategically, it does not take into account the strategic effect it has on the entrant's post-entry action. In this case the incumbent's advertising rule is $\frac{p_1}{2t}R'(a) = A'(a)$ or $\frac{R(a)+3t}{6t}R'(a) = A'(a)$.

When an incumbent firm chooses advertising intensity strategically, it considers the total effect of advertising and thus the incumbent's advertising rule is $\left[-\frac{p_1}{2t}\frac{R'(a)}{3}\right] + \left[\frac{R'(a)p_1}{2t} - A'(a)\right] = 0$ or $\frac{R(a)+3t}{9t}R'(a) = A'(a)$. Since $\frac{R(a)+3t}{6t}R'(a) > \frac{R(a)+3t}{9t}R'(a)$, non-strategic advertising is greater than strategic, which means that the incumbent underinvests in complementary advertising when it accommodates an entrant.

Persuasive advertising changing the distribution of tastes and preferences

The non-strategic advertising rule is $p_1x'(a) = A'(a)$ or $\frac{(3t+2tx(a))}{3}x'(a) = A'(a)$.

The strategic advertising rule is $\left[-p_1\frac{x'(a)}{3}\right] + [p_1x'(a) - A'(a)] = 0$ or $\frac{2}{3}\frac{(3t+2tx(a))}{3}x'(a) = A'(a)$.

Since the non-strategic rule suggests higher levels of advertising, an incumbent underinvests in this kind of persuasive advertising.

Persuasive advertising enhancing product differentiation

The non-strategic advertising rule is $\left[\frac{p_1(p_1-p_2)t'(a)}{2t^2(a)} - A'(a)\right] = 0$ or $0 = A'(a)$ in a symmetric case. So a non-strategic incumbent would not advertise at all.

The strategic advertising rule is $\left[p_1\frac{t'(a)}{2t(a)}\right] + \left[\frac{p_1(p_1-p_2)t'(a)}{2t^2(a)} - A'(a)\right] = 0$ or $t'(a) = A'(a)$.

Since the strategic rule implies positive levels of advertising, an incumbent overinvests in persuasive advertising increasing t.

Informative advertising

The non-strategic advertising rule is $[p_1\varphi'(a) - A'(a)] = 0$ or $\frac{3t+4t\varphi(a)}{3}\varphi'(a) = A'(a)$.

The strategic advertising rule is $\left[p_1\frac{2\varphi'(a)}{3}\right]+[p_1\varphi'(a) - A'(a)] = 0$ or $\frac{5t+8t\varphi(a)}{3}\varphi'(a) = A'(a)$.

Since the strategic rule suggests higher levels of advertising, an incumbent overinvests in informative advertising.

3C Accommodation vs. entry deterrence

Condition on accommodation. There is a certain set of parameters $\theta,\ d,\ b,\ N,\ F$ when an incumbent prefers to accommodate instead of deter entry. In many models with product differentiation, entry deterrence is more profitable when competing products are close substitutes and accommodation is preferred when product differentiation is rather high (as discussed in Zigic, 2012). Since the present paper only considers cases when incumbent accommodates entries, there should be a condition that $\pi_i(block) < \pi_i(accom)$ or if F is normalized to 1 and $x_i(block) = \frac{d-\sqrt{b}(N+1)}{b\theta} > 0$:

$$\frac{\left[d - \sqrt{b}(N+1)\right]\left[\sqrt{b}(N+1) - d(1-\theta)\right]}{b\theta^2} < \frac{d^2(1+N-N\theta)^2}{b(2+N(2-\theta^2))^2}$$

In our model this condition always holds as a strict inequality.

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