Essays on Advertising and Innovation in Imperfectly Competitive Markets

by

Maria Alipranti

B.A., University of Crete (2006)
M.Sc. University of Crete (2008)

Submitted to the Department of Economics, University of Crete
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

at the

UNIVERSITY OF CRETE

JULY 2013

Signature of Author ....
Department of Economics, University of Crete
25/07/2013

Certified by ....
Andreas Panagopoulos
Assistant Professor, Department of Economics, University of Crete
Thesis Supervisor

Certified by ....
Paolo Giorgio Garella
Professor, Department of Economics Management and Quantitative Methods,
University of Milan
Thesis Supervisor

Accepted by ....
Emmanuel Petrakis
Chairperson, Professor, Department of Economics, University of Crete

Essays on Advertising and Innovation in Imperfectly Competitive Markets

by

Maria Alipranti

Submitted to the Department of Economics, University of Crete
on 25/07/2013, in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

Abstract

This thesis consists of four independent chapters that study alternative firms' long run strategies in imperfectly competitive markets.

The first chapter, "Comparative vs. Informative Advertising in Oligopolistic Markets", explores the firms' incentives to invest in informative and comparative advertising in oligopolistic markets with horizontally differentiated products. It is found that, in equilibrium the firms optimally mix over advertising strategies, combining both informative and comparative advertising. Further, it is shown that the optimal advertising mix always favors the aggressive form of comparative advertising. The chapter also compares equilibrium market outcomes and social welfare under the endogenous advertising portfolio with the respective ones under no advertising, mere informative advertising and mere comparative advertising, and shows that they crucially depend on the intensity of market competition and the efficiency of the advertising technology.

The second chapter, "Comparative Advertising in Markets with Network Externalities", investigates the firms' incentives to invest in comparative advertising in a spatially differentiated duopoly market characterized by network externalities. It is found that firms often have strong incentives to invest in comparative advertising, with their equilibrium investment levels to be positively related to transportation cost and negatively related to the intensity of network effects. More importantly, it is shown that the firms' location distance (or else, their products' differentiation) increases in the presence of network externalities and decreases in the presence of comparative advertising.

The third chapter, "The Speed of Technological Adoption under Price Competition: Two-tier vs. One-tier Industries", examines the firms' incentives to adopt a new cost reducing technology in vertically related markets, as well as, the effects of the vertical relations on the speed of the downstream firms' adoption of the new technology. It is found that, independently of the upstream market structure (i.e., upstream separate firms or upstream monopoly), downstream firms always have strong incentives to adopt the new technology. More importantly, it is shown that, independently of the upstream market structure, technology adoption may occur earlier in two-tier than in one-tier industries, depending on the intensity of the final market competition, the drasticity of the new technology on reducing the downstream firms' marginal cost of production and the bargaining power distribution in the market. Moreover, it is found that the first technology adoption takes place earlier under upstream monopoly than under upstream separated firms, when the new technology is sufficiently drastic and the final market

competition is fierce enough.

The forth chapter, "Cournot is more Competitive than Bertrand! Upstream Monopoly with Two-part Tariffs", compares the equilibrium outcomes and social welfare under Cournot and Bertrand downstream competition when the upstream sector is monopolized by a single input provider and the vertical trade is conducted via two-part tariffs contracts. It is found that, in such a setting, a Cournot downstream market turns out to be more competitive than a Bertrand one. In addition, contrary to the conventional wisdom that suggests that Bertrand competition leads to higher social welfare than Cournot competition, it is shown that in vertically related markets with upstream monopolistic market structure and two-part tariffs trading contracts, consumers' surplus and social welfare are higher under Cournot than under Bertrand competition.

Acknowledgements First and foremost, I would like to thank my supervisor Emmanuel Petrakis. I have benefited immensely from his encouragement and guidance.

In addition, I wish to thank my co-supervisors, Paolo Giorgio Garella and Andreas Panagopoulos, for their helpful comments and suggestions. I am extremely grateful to Nikolaos Georgantzis, Chrysovalantou Milliou, Evangelos Mitrokostas and Nikolaos Vettas, for their guidance and advices. For other scientific discussions and advice I would like to thank Simon Anderson, Martin Peitz, Konstantinos Serfes and Constantine Manasakis. I would like to extend my appreciation to all of the staff and students at the Laboratorio Economia Experimental (LEE) for welcoming me into their group and giving me friendship and encouragement throughout the course of this work. The financial support from the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) that is co-financed by the European Union (European Social Fund .ESF) and Greek national funds through - Research Funding Program: Thalis- Athens University of Economics and Business- "New Methods in the Analysis of Market Competition: Oligopoly, Networks and Regulation", as well as, the financial support from the Special Research Account (ELKE) of the University of Crete. Research Funding Program: "Firms' Long-run Strategies, Oligopolistic Competition and Welfare: Quality Enhancing R&D, Advertising and Corporate Social Responsibility" are gratefully acknowledged.

Thesis Supervisor: Andreas Panagopoulos
Title: Assistant Professor, Department of Economics, University of Crete

Thesis Supervisor: Paolo Giorgio Garella
Title: Professor, Department of Economics Management and Quantitative Methods, University of Milan

Contents

Chapter 1

Comparative vs. Informative Advertising in Oligopolistic Markets

1.1 Introduction

Comparative advertising, "the form of advertising that compares rivals brands on objectively measurable attributes or price, and identifies the rival brand by name, illustration or other distinctive information"[1], has lately received increased attention by business, academics and policy makers, since this aggressive form of advertising has emerged as a prevalent marketing practice in multiple industries. The advertising wars of Pepsi and Coke, Ducking Donuts and Starbucks, or the advertising campaign of Avis, "We try harder", are only few typical examples that highlight the daily consumers' exposure to comparative advertising messages. As Pechmann and Stewart (1990) show at the United States Market, 60 % of all the advertising campaigns contains indirect comparative claims, 20% contains direct comparative claims and only the remaining 20 % contains no comparative claims. Further, Muehling et al. (1990) suggest that almost 40% of all advertising content is comparative.[2] Clearly, the use of comparative advertising is extensive in the markets, despite the existed inconclusive empirical evidence re-

[1] Statement of policy regarding comparative advertising, Federal Trade Commission, Washington, D.C., August13, 1979.

[2] The distinction between direct and indirect comparative ads is based on whether or not the competitor is explicitly named or precisely identified by logos and images.

garding its effectiveness to increase the demand of the product that it promotes.[3] In particular, contrary to the self promoting informative advertising that firms use in order to convey product information to consumers (i.e., information about the product's characteristics, price, quality, etc.), comparative advertising is used in order to present each own firm's product as superior to the rival's one. Thus, comparative advertising has a push-me/pull-you effect, that means that, it increases the firm's demand by promoting the superiority of the "positively" advertised product and, at the same time, by denigrating the rival's product (Anderson et al., 2010 a,b).

The objective of this chapter is to investigate the firms' incentives to endogenously invest in comparative and informative advertising, when both types of advertising are available in the market, as well as, the effects of these investments in the market outcomes and the social welfare. In particular, we address the following four questions. First, what are the optimal firms' decisions over the type(s) of advertising that they are going to undertake in order to promote their products? Second, how do the intensity of the market competition and the effectiveness of the advertising technology affect the firms' investment levels in the two alternative types of advertising? Third, how do the firms' advertising investments affect their market performance? Forth, how do the firms' advertising decisions affect the social welfare?

We consider a duopoly market with horizontally differentiated products, where a-priori consumers do not possess all the relevant information about the products. Firms have on their set of marketing strategies both informative and comparative advertising. Informative advertising transmits all the relevant information to the mass of the consumers that are previously uninformed about the product's characteristics and helps them to identify the product that matches to their needs. Thus, informative advertising increases the consumers' valuation of the advertised product and shifts the firm's demand curve outwards. Comparative advertising presents the "positively" advertised product as superior to the rival's one. Therefore, it increases the consumers' valuation for the positively advertised product, while, at the same time, it decreases the consumers' valuation of the rival firm's product. The timing of the game is given as fol-

[3] The empirical evidence so far, suggest that comparative advertising may have either positive or negative effects on the consumers' demand. This is so, since comparative ads tend to be more effective than non comparative in inducing consumers' attention, message and brand awareness, favorable brand attitudes, and thus purchase intentions (Grewal et al., 1997; Jung and Sharon, 2002). On the contrary, apart from legal risks, they may enhance consumers' mistrust and lead to misidentifications of the sponsoring brands, (Wilkie and Farris, 1975; Prasad, 1976; Goodwin and Etgar, 1980; Barone and Miniard, 1999).

lows. In the first stage, the firms decide, independently and simultaneously, upon the type(s) of advertising, as well as, the investment level of each type of advertising that they are going to undertake in order to promote their products. In the second stage, the firms compete in the market by setting their quantities.

We show that in equilibrium firms optimally mix over advertising strategies, combining both informative and comparative advertising. This is so because, the mixed advertising strategy offers a competitive advantage in comparison to the single one-type advertising strategy, since it allows firms to launch the potential benefits of both types of advertising. In particular, the firms invest in informative advertising in order to directly increase their demand, while, at the same time, they invest in comparative advertising in order to increase their demand by the fall out of the rival's firm demand due to the denigration effect that comparative ads have. Further, we show that firms' investment levels in each type of advertising crucially depend on the intensity of the market competition, or else, on the degree of product differentiation. In more details, we demonstrate that the firms' expenditures on comparative advertising are positively related to the degree of the market competition, while the informative advertising expenditures are non monotonically -U shaped- related to the market competition degree. Intuitively, when the market competition is not fierce, or else, when the products are not close substitutes, the firms tend to decrease their investment levels in informative advertising, since the products are easily recognizable by the consumers. On the contrary, a fiercer market competition lead firms to invest more in both types of advertising as an attempt to enforce their market position and to obtain a competitive advantage over the rival. Interestingly enough, we show that, within the optimal advertising mix, the firms expenditures on comparative advertising always exceed the respective ones on informative advertising. That means that, in equilibrium firms always prefer an aggressive advertising mix.

Further, in order to unravel the impact of the firms' advertising decisions on the market outcomes and the social welfare, we compare the equilibrium results of our basic model, namely, the endogenous advertising configuration, with the benchmark case, where firms do not undertake any advertising activities, the mere informative advertising configuration, where firms have on their set of marketing strategies only informative advertising and the mere comparative advertising configuration, where firms have on their set of marketing strategies only comparative advertising. We demonstrate that the highest output production is obtained under the endogenous advertising configuration. Intuitively, the existence of the two types of advertising in the market, intensifies the firms' advertising competition and therefore, the output competition. In more details, we show that the existence of both types of advertising in a market, lead to higher firms' expenditures on both informative and comparative advertising compared to the respective firms' expenditures either on informative or comparative advertising, when in the market exists only a single type of advertising. Thus, given that the output is positively related to firms' investments in advertising, the higher firms' investment levels in both types of advertising under the endogenous advertising configuration, lead firms' to higher output production under the aforementioned configuration than under the benchmark, the mere informative and the mere comparative configurations.

As far as the firms' market performance in terms of profitability is being concerned, we show that the firms obtain the highest profits under the mere informative advertising configuration. This is because the self promoting informative advertising shifts the firms' demand curves outwards and thus, it increases the firms' profits. In addition, we indicate that equilibrium profits under the mere comparative and the endogenous advertising configuration are always lower than those of the benchmark case. Clearly, under the mere comparative advertising configuration the firms end up worse off comparing to the benchmark, since the beneficial effect that each own firm's investment in comparative advertising has over its profits is neutralized by the diminishing effect of the rival's comparative advertising expenditures. Moreover, under the endogenous advertising configuration, the positive effect on profits that the investments in informative advertising have, could not compensate the negative effects of the increased output competition and the cost of advertising. Therefore, the equilibrium profits under the endogenous advertising configuration are lower than those obtained under the benchmark case. The above results highlight that the use of comparative advertising lead firms to a prisoners' dilemma situation where they obtain lower profits than those obtained under the benchmark case without advertising activities. Last but not least, comparing the equilibrium profits in the endogenous advertising configuration with those of the mere comparative configuration, we show that the firms' profits are higher under the former case when the effectiveness of the advertising is sufficiently low, while the opposite holds when the effectiveness of advertising is sufficiently high. The intuition behind this result is based on two opposing effects. On the one hand, under the endogenous advertising configuration the firms' investments in informative advertising shift outwards the firms' demand curves and thus, tend to increase the firms' profits. On the other hand, the increased advertising competition under the endogenous advertising configuration lead firms to invest more in both types of advertising that in turn, leads to higher advertising costs that tend to decrease the firms' profitability. Obviously, a less effective advertising technology, discourage firms from engaging in unnecessary advertising warfare that acts beneficial to their profitability. Thus, when the effectiveness of the advertising is low, the beneficial effect of the firms' investments in informative advertising dominates the detrimental effect of the higher advertising costs that firms incur under the endogenous advertising configuration and thus, the firms' profits under the endogenous advertising configuration are higher than respective ones under the mere comparative configuration. The opposite holds when the effectiveness of advertising is sufficiently high, since the firms' warfare intensifies.

Regarding the welfare effects of the firms' advertising investments, we demonstrate that the consumers' surplus is the highest under the endogenous advertising configuration. This is so, since the consumers' surplus follows the same pattern with the firms' output production under the alternative advertising configurations. Further, we show that the social welfare is the highest under the mere informative advertising configuration, while it is the lowest under the mere comparative configuration. Yet, we argue that the welfare under the endogenous advertising configuration can be either higher or lower than that of the benchmark case depending on the degree of the market competition. In particular, the welfare in the endogenous advertising configuration is higher than that of the benchmark if the degree of market competition is low enough, while the opposite holds if the degree of market competition is high enough. Intuitively, when the market competition is relaxed, or in other words, when the degree of product substitutability is relatively low, the beneficial effect that the use of advertising has over the consumers' surplus, due to the higher firms' output production, compensates the detrimental effects of increased output and advertising competition on the firms' profits. The opposite stands when the degree of product substitutability is relatively high.

Our work contributes to the recent branch of the economic literature that examines the use of comparative advertising in imperfectly competitive markets. This literature has its origins in

Aluf and Shy (2001), where, using a Hotelling model with comparative advertising to increase the transportation cost to the rival's product, show that the use of comparative ads weakens price competition by enhancing the degree of product differentiation and leads to higher prices and profits. In a different vein, Barigozzi et al. (2009), examine comparative advertising as a means to signal quality, by considering a market where an entrant, whose quality is unknown, decides between the use of generic advertising, that is a standard money burning to signal quality, and the use comparative advertising, that implies a comparison over the qualities of the two firms, in order to face the incumbent whose quality is known.[4] They show that the entrant's incentives to use comparative advertising are closely related with the quality of its product and the penalty that the entrant is going to pay if the content of the advertising campaign is manipulative.[5] Similarly, Emons and Fluet (2012) examine the signaling role of comparative advertising in a duopolistic market where both firms use comparative advertising to highlight their quality differential and the cost of advertising increases as the firms move away from the truth. Further, Anderson and Renault (2009) considered comparative advertising as a mean through which firms can disclose information about the horizontal match characteristics of the products and thus, they reveal information about the rival's product attributes, that the latter might not wish to communicate. They show that when the products are of similar quality, firms have incentives to advertise only their own goods and therefore, comparative advertising plays no role, since full product information is provided regardless. On the other hand, when the products are of sufficiently different qualities, only the low quality firm has strong incentives to use comparative advertising (if it is legal) in order to reveal the horizontal attributes of both goods and thus, to survive in the market by the improving its consumers base. In addition, Anderson et al. (2010a,b) empirically investigating the advertising in the US over-the-counter analgetics market, show that almost the half of the advertising expenditures were comparative advertisements.

The present work contributes to the existing literature in four ways. Firstly, unlike to the bulk of the literature that approaches comparative advertising exogenously, we examine the

[4] The signaling role of advertising is based on the idea that high advertising spending works as a device designed to signal high quality (e.g. Nelson, 1974; Kihlstrom and Riordan, 1984; Milgrom and Roberts, 1986).

[5] They assumed that when the entrant uses comparative advertising, the incumbent has the opportunity to go to the court and to obtain gains if the court verdict is that the advertising content is manipulative and the entrant's true quality is low.

firms' incentives to invest in comparative and informative advertising endogenously by considering the investment levels in each type of advertising as strategic firms' decisions. Secondly, we provide results over the optimal advertising portfolio, or else, the optimal allocation of firms' advertising expenditures between comparative and informative advertising, when both types of advertising are available in the market. Thirdly, considering a duopolistic market with horizontally differentiated products, we provide results over the impact of the degree of the market competition on the firms' expenditures on each type of advertising. Lastly, comparing our results with alternative advertising configurations in the absence of one of the two types of advertising, we provide results over the effects that the firms' alternative marketing strategies could have on the market outcomes and the social welfare.

The rest of the chapter is organized as follows. In Section 2, we present our basic model. In the section 3, we adduce the equilibrium analysis, as well as, the welfare analysis of the endogenous advertising configuration. In addition, we adduce the comparisons with the benchmark case without advertising activities, the mere informative and the mere comparative configurations. In section 4, we examine the robustness of our results by extending our model in markets with price competition, advertising cost asymmetries and alternative demand functions. Finally, section 5 concludes. All proofs are demonstrated in the Appendix.

1.2 The Basic Model

We consider a market consisted by two firms denoted by $i, j = 1, 2$, $i \neq j$, each producing one brand of a differentiated good. Firms are profit maximizers and have on their set of marketing strategies both informative and comparative advertising. On the demand side, there is a unit mass of consumers composed by individuals with homogenous preferences regarding the two goods. The utility function of the representative consumer, following Häckner (2000), is given by,

$$U = (\alpha + \mu_i + \kappa_i - \kappa_j)q_i + (\alpha + \mu_j + \kappa_j - \kappa_i)q_j - [q_i^2 + q_j^2 + 2\gamma q_i q_j]/2 + m \qquad (1.1)$$

where q_i, is the quantity of good i bought by the representative consumer and m is the respective quantity of the "composite good". The parameter $\gamma \in [0, 1]$ denotes the degree of product substitutability, with $\gamma \to 0$ corresponding to the case of independent goods and $\gamma \to 1$ corresponding to the case of perfect substitute goods. Alternatively, γ can be interpreted as the intensity of the market competition, with higher γ corresponding to higher degree of competition between firms (Vives, 1985).

In line with Chakrabarti and Haller (2011), firm i's expenditures on informative advertising, denoted by μ_i, provide to the initially uninformed consumers the necessary information in order to identify the good that better covers their needs. Therefore, firm i's informative advertising expenditures increase the consumers' realized utility, or in other words, increase the consumers' valuation over the advertised product.[6] Further, as in Anderson et al. (2010 a,b), firm i's investments in comparative advertising, denoted by κ_i, increase the consumers' valuation of its own product, while, at the same time, they decrease the consumers' valuation of the rival's firm product.

Maximization of (1.1) with respect to q_i and q_j, gives the (inverse) demand function of the representative consumer,

$$p_i(q_i, q_j) = \alpha + \mu_i + \kappa_i - \kappa_j - q_i - \gamma q_j \tag{1.2}$$

where p_i denotes the price of good i, while the price of the "composite good" has been normalized to unit. Note here that the inverse demand function is positively related to the firm i's expenditures on advertising, while it is negatively related to the firm j's expenditures on comparative advertising. That means that, firm i's own investments in informative and comparative advertising shifts its demand curve outwards, while firm j's investments in comparative advertising shifts the firm i's demand curve inwards.

Firms are endowed with identical constant returns to scale production technologies, with their marginal production cost given by c, $0 \leq c < \alpha$. The cost of each type of advertising is quadratic and separable with diminishing returns of advertising expenditures and is given by $b(\mu_i^2 + \kappa_i^2)$. Parameter b denotes the effectiveness of the advertising technology on shifting the consumers' demand, with higher b corresponding to a less effective advertising technology and therefore, to higher required expenditures by firms, in order to obtain a given shift on consumers'

[6] More details on the definition of informative advertising in our model are provided on the extension section, Informative Advertising.

demand. As standard in the advertising literature, the convexity assumption, reflects that the cost of advertising is increasing in the number of consumers.[7] Regarding now the separability of costs, a recent strand of managerial literature, considers the fact that the vast advances in media technology have created the need for specialization in different advertising techniques applied by the corresponding agencies. According to Horsky (2006), firms would prefer to use different agencies to promote their product in different channels, based on their specialization.[8] In our case, given the different handling required for informative and comparative ads, due to the differential perception of consumers, we treat the two kinds of advertising as separate projects with different costs.

Furthermore, in order to guarantee that all the participants are active in the market under all the configurations considered, the following assumption should hold thought the chapter.[9]

Assumption 1. $b \geqslant b(\gamma) \equiv \frac{8+4\gamma+\gamma^2}{(\gamma^2-4)^2}$ with $b(1) = 1.444$

The firm i's profits are given by,

$$\Pi_i = (\alpha + \mu_i + \kappa_i - \kappa_j - q_i - \gamma q_j)q_i - cq_i - b(\mu_i^2 + \kappa_i^2) \tag{1.3}$$

Clearly, the advertising investments of firm i tend to increase its profitability, while the costs of its own advertising activities, as well as, the rival's comparative advertising expenditures, tend to diminish the firm i's profitability.

1.3 Equilibrium Analysis

1.3.1 The Benchmark case: No Advertising Configuration

We begin our analysis by briefly presenting our benchmark case, where firms do have on their set of strategies advertising, that is, $\mu_i = \mu_j = 0$ and $\kappa_i = \kappa_j = 0$. Thus, the market's outcomes corresponds to the standard Cournot game with horizontally differentiated goods, where firm

[7] See for instance, Butters (1977), Grossman Sharipo, (1984), Bester and Petrakis (1996), Hernandez-Garcia, (1997) and Hamilton (2009).

[8] Arzaghi et al.(2008) mention that advertising agencies in the US have moved from "full service provider" of advertising campaigns to providers of specialized services. Therefore, agency compensation has moved from a proportional commission based on final number targeted consumers to "fee for service" provided by each agency.

[9] The assumption corresponds with Peters (1984) and Bester and Petrakis (1995) who claim that in some cases firms are better off under advertising restrictions.

i chooses its output, q_i, taken as given the rival's decision over the output, q_j, in order to maximize its profits given by,

$$\pi_i = (a - q_i - q_j)q_i - cq_i \tag{1.4}$$

The first order conditions give rise to the firm i's reaction function,

$$R_i^N(q_j) = \frac{\alpha - \gamma q_j - c}{2} \tag{1.5}$$

Using standard backwards induction the equilibrium output, price and profits are given respectively by,

$$q^N = \frac{(a-c)}{2+\gamma}, \quad \Pi^N = \frac{(a-c)^2}{(2+\gamma)^2} \tag{1.6}$$

Further, the consumers' surplus and the social welfare are given respectively by,

$$CS^N = (1+\gamma)\frac{(a-c)^2}{(2+\gamma)^2}, \quad SW^N = (3+\gamma)\frac{(a-c)^2}{(2+\gamma)^2} \tag{1.7}$$

1.3.2 Endogenous Advertising Configuration

We proceed with the analysis of our basic model, where firms have on their set of marketing strategies both informative and comparative advertising. In the last stage of the game, firm i chooses its output, q_i, in order to maximize its profits, taking as given the rival's output, q_j, along with the expenses in advertising $(\mu_i, \mu_j, \kappa_i, \kappa_j)$, decided in the first stage of the game.

The first order conditions of (1.3), give rise to the firm i's reaction function,

$$R_i^E(q_j) = \frac{\alpha - \gamma q_j - c}{2} + \frac{\mu_i + \kappa_i - \kappa_j}{2} \tag{1.8}$$

Notice that, comparing $R_i^E(q_j)$ with the reaction function of the benchmark case, $R_i^C(q_j)$, in which only the first part of (1.8) appears, we observe that firm i's expenditures on informative and comparative advertising (μ_i, κ_i) tend to shift $R_i^E(q_j)$ outwards and thus, tend to increase firm i's equilibrium output production. On the contrary, the rival's firm investment in comparative advertising (κ_j) tends to shift $R_i^E(q_j)$ inwards and therefore, tend to decrease the firm i's equilibrium output.[10]

Solving the system of the reaction functions (1.8), firm i's output and profits in the second stage of the game are given respectively by,

$$q_i^E(\mu_i, \mu_j, \kappa_i, \kappa_j) = \frac{(2-\gamma)(\alpha - c) + 2(\mu_i + \kappa_i - \kappa_j) - \gamma(\mu_j + \kappa_j - \kappa_i)}{4 - \gamma^2} \tag{1.9}$$

$$\Pi_i^E(\mu_i, \mu_j, \kappa_i, \kappa_j) = [q_i^E(\mu_i, \mu_j, \kappa_i, \kappa_j)]^2 - b(\mu_i^2 + \kappa_i^2) \tag{1.10}$$

Observe here that, $\frac{\partial q_i^E}{\partial \mu_i} = \frac{2}{4-\gamma^2} > 0$, $\frac{\partial q_i^E}{\partial \kappa_i} = \frac{1}{2-\gamma} > 0$, and $\frac{\partial q_i^E}{\partial \kappa_j} = -\frac{1}{2-\gamma} < 0$, that means that, firm i's output is positively related to its own investments in advertising, while it is negatively connected to the rival's investments in comparative advertising. Notice also that firm i's output is decreasing in the degree of market competition γ (i.e., $\frac{\partial q_i^E}{\partial \gamma} < 0$), since by the equation (1.8), we have that $\frac{\partial R_i^E(q_j)}{\partial q_j} = -\frac{\gamma}{2}$, that implies that, as the market competition increases, the slope of the reaction function increases and therefore, the equilibrium output decreases.

In the first stage of the game, firm i chooses its investment levels in each type of advertising (μ_i, κ_i), taking as given the rival's firm decisions (μ_j, κ_j), in order to maximize its profits given in (1.10).

Applying first order conditions we obtain the best reply function for both informative and comparative advertising, that are given by,

$$\mu_i^E(\mu_j) = \frac{2[(2-\gamma)(\alpha - c) + (2+\gamma)(\kappa_i - \kappa_j) - \gamma\mu_j]}{b(4-\gamma^2)^2 - 4} \tag{1.11}$$

$$\kappa_i^E(\kappa_j) = \frac{(2-\gamma)(\alpha - c) - (2+\gamma)\kappa_j - \gamma\mu_j + 2\mu_i}{[b(2-\gamma)^2 - 1](\gamma + 2)} \tag{1.12}$$

Observe here that, $\frac{\partial \mu_i}{\partial \mu j} < 0$, $\frac{\partial \kappa_i}{\partial \kappa j} < 0$ and $\frac{\partial \mu_i}{\partial \kappa j} < 0$, that indicate strategic substitutability between the firm i's investments levels in informative and comparative advertising and the corresponding values of the rival's firm investments. Clearly, each firm is willing to increase its investments in both types of advertising in order to outweigh the impact of the rival's firm

[10] Note also that the slope of firm i's reaction curve is, $\frac{\partial R_i^E(q_j)}{\partial q_j} = -\frac{\gamma}{2}$, implying that is an outward and parallel shift of the respective curve in the benchmark case.

advertising expenditures and therefore, to remain competitive in the market. Further, $\frac{\partial \mu_i}{\partial \kappa_i} > 0$ and $\frac{\partial \kappa_i}{\partial \mu_i} > 0$, that means that, the firm's own investments in informative and comparative advertising are strategic complements. This is so, since the two alternative types of advertising are being perceived by the firms as separate marketing techniques.

Solving the system of the first order conditions, the equilibrium investment levels in informative and comparative advertising are given respectively by,

$$\mu^E = \frac{2(\alpha - c)}{b(2-\gamma)(2+\gamma)^2 - 2} > 0 \tag{1.13}$$

$$\kappa^E = \frac{(\alpha - c)(2+\gamma)}{b(2-\gamma)(2+\gamma)^2 - 2} > 0 \tag{1.14}$$

Obviously, in equilibrium firms optimally mix over advertising strategies, combining both informative and comparative advertising in order to extract the benefits of both types of advertising. The intuition behind this result is rather intuitive. Each firm through investing in advertising, is seeking for a competitive advantage over their rival via two effects: First, to increase the demand for its product and therefore its profitability. Second given the strategic substitutability between advertising investments of rival firms, to reduce the advertising expenditure, the demand and the profitability of the rival firm. Given also the strategic complementarity between the two types of advertising investment within each firm, firms will invest in both types of advertising. Hence, the following proposition derives,

Proposition 1 *In the equilibrium, firms invest in both informative and comparative advertising.*

Note also that, $\frac{\partial \kappa^E}{\partial \gamma} > 0$, that means that the firms' expenditures on comparative advertising are positively related to the degree of market competition. Clearly, as the market competition becomes fiercer, the advertising competition intensifies and leads firms to increase their investments in comparative advertising as an attempt to enlarge their market shares by obtaining, via the denigration of the rival's product, part of the rival's market share. Further we observe that, $\frac{\partial \mu^E}{\partial \gamma} < 0$ if $\gamma < \hat{\gamma} \equiv 0.666667$ and $\frac{\partial \mu}{\partial \gamma} > 0$ if $\gamma > \hat{\gamma}$. Thus, the firms' expenditures on informative advertising are non monotonically -U shaped- related to the degree of market competition. Intuitively, when the market competition is relaxed, or else, when the products are not close substitutes the firms tend to decrease their investment levels in informative advertising in order to reduce the advertising costs that they incur. On the contrary, as the market competition intensifies the advertising competition in the market increase, that in turn leads firms to increase their investment levels in informative advertising. Moreover, $\frac{\partial \mu^E}{\partial b} < 0$ and $\frac{\partial \kappa^E}{\partial b} < 0$ show that the more effective the advertising technology is (i.e., the lower the b is), the higher are the firms' investments in advertising, ceteris paribus. Last but not least, we observe that, $\frac{\mu_i^*}{\kappa_i^*} = \frac{2}{(\gamma+2)}$, $\gamma \neq 0$, with $\frac{\partial \mu_i^*/\kappa_i^*}{\partial \gamma} < 0$, that means that, the firms' investment levels in comparative advertising always exceed the respective ones in informative advertising. Thus, in equilibrium firms adopt aggressive advertising behavior, given that the optimal advertising mix favors the aggressive form of comparative advertising.

Lemma 1:

i) Equilibrium investments in informative advertising are non monotonically -U shaped-related to the degree of market competition, γ, while they are decreasing in the advertising effectiveness parameter, b.

ii) Equilibrium investments in comparative advertising are increasing in the degree of market competition, γ, while they are decreasing in the advertising effectiveness parameter, b.

Substituting equations (1.13) and (1.14) into (1.8) and (1.3), the equilibrium output and profits are given respectively by,

$$q^E = \frac{b(\alpha - c)(4 - \gamma^2)}{b(2 - \gamma)(\gamma + 2)^2 - 2} \tag{1.15}$$

$$\Pi^E = \frac{(\alpha - c)^2[b(4 - \gamma^2)^2 - \gamma^2 - 4\gamma - 8]}{[b(2 - \gamma)(\gamma + 2)^2 - 2]^2} \tag{1.16}$$

Observe here that the equilibrium output is negatively connected to both the degree of competition, γ, and the advertising effectiveness parameter b, (i.e., $\frac{\partial q^E}{\partial \gamma} < 0$ and $\frac{\partial q^E}{\partial b} < 0$). Intuitively, given the negative slope of the Cournot reply function (i.e., $\frac{\partial R_i^E(q_j)}{\partial q_j} = -\frac{\gamma}{2}$) as the market competition increases (i.e., higher values of γ) the slope of the reaction curve increase and the equilibrium output decrease. In addition, given Lemma 1 and the analysis after (1.9), we have that a less effective advertising technology leads to lower advertising investments and thus, to lower equilibrium output. Moreover, $\frac{\partial \Pi^E}{\partial \gamma} < 0$ and $\frac{\partial \Pi^E}{\partial b} > 0$, thus, the equilibrium profits are negatively connected to the degree of competition, γ, while they are positively connected to the advertising effectiveness. Clearly, the lower the effectiveness of advertising technology is (i.e., the higher the b is), the higher the firms' profitability is. The rationale behind the latter result lies on the fact that a less effective advertising technology, or, in other words, higher cost of advertising, discourage firms from engaging in unnecessary advertising warfare that acts beneficial to their profitability.

Lemma 2:

Equilibrium output and profits are decreasing in the degree of market competition, γ. Equilibrium output is decreasing, while the equilibrium profits are increasing, in the advertising effectiveness parameter, b.

1.3.3 Welfare Analysis

In this subsection we analyze the societal effects of the firms' mix advertising strategies.

Social welfare is defined as the sum of the consumers' and producers' surplus,

$$SW = CS + 2\Pi \tag{1.17}$$

with CS and 2Π corresponding to the consumers' surplus and the overall market profits, respectively. In particular, the consumers' surplus is given by,

$$CS^E = (\alpha + \mu_i + \kappa_i - \kappa_j)q_i + (\alpha + \mu_j + \kappa_j - \kappa_i)q_j - \frac{1}{2}(q_i^2 + q_j^2 + 2\gamma q_i q_j) - p_i q_i - p_j q_j \tag{1.18}$$

Imposing symmetry, $q_i^E = q_j^E = q^E$, $\mu_i^E = \mu_j^E = \mu^E$, $\kappa_i^E = \kappa_j^E = \kappa^E$, $p_i^E = p_j^E = p^E$, the consumers' surplus can be written as,

$$CS^E = (1+\gamma)[q^E]^2 \tag{1.19}$$

while, with respect to (1.18), (1.19),(1.15), the social welfare can be written as,

$$SW^E = \frac{(\alpha - c)^2 b[b(3+\gamma)(4-\gamma^2)^2 - 16 - 2\gamma(\gamma+4)]}{[b(2-\gamma)(\gamma+2)^2 - 2]^2} \tag{1.20}$$

Obviously, the consumers' surplus follows the same patterns as the equilibrium output and thus, it is negatively related to both the degree of market competition (i.e., $\frac{\partial CS^E}{\partial \gamma} < 0$) and the effectiveness of advertising technology (i.e., $\frac{\partial CS^E}{\partial b} < 0$). Further, we observe that the social welfare is negatively related to the degree of market competition (i.e. $\frac{\partial SW^E}{\partial \gamma} < 0$), while it is non monotonically -U-shaped- related to the effectiveness of advertising technology parameter, b (i.e., $\frac{\partial SW^E}{\partial b} < 0$ iff $\gamma < \breve{\gamma}(b)$ and $\frac{\partial SW^E}{\partial b} > 0$ iff $\gamma > \breve{\gamma}(b)$, with $\frac{\partial \breve{\gamma}}{\partial b} > 0$ and $\breve{\gamma}(1.444) = 0.366$). The intuition behind this result is driven by two opposing effects. First, given the analysis after (1.15), (1.16) and(1.19) the equilibrium output, profits and consumers' surplus are decreasing in the degree of market competition, γ, that acts diminishing to the welfare. Second, profits are increasing in the effectiveness of advertising, b, that is beneficial to the welfare. Results in equilibrium reveal that the second effect dominates the first for $\gamma < \breve{\gamma}(b)$, whilst the opposite holds for $\gamma > \breve{\gamma}(b)$.

Lemma 3:

i) Consumers' surplus is negatively related to both the degree of market competition, γ, and the advertising effectiveness parameter, b.

ii) Welfare is negatively related to the degree of market competition, γ, while it is non monotonically, U-shaped, related to the advertising effectiveness parameter, b.

1.3.4 Mere Informative Advertising Configuration

In this subsection we consider a market where firms have available only informative advertising, thus, $\kappa_i^I = \kappa_j^I = 0$.[11] Therefore, firm i's inverse demand function is given now by, $p_i^I = \alpha + \mu_i - q_i - \gamma q_j$, while the firm i 's profits function is given by $\Pi_i^I(.) = (\alpha + \mu_i - q_i - \gamma q_j)q_i - b\mu_i^2$.

Employing standard backward induction, the firms' equilibrium investments in informative

[11] This discussion has been motivated by two alternative facts. Firstly, even if the countries' legislation framework does not prohibit the use of comparative advertising, firms tend to avoid this aggressive marketing practice, because of the high risk to be accused for an attempt to mislead consumers and be prosecuted by the rival to the court (see for instance, Barigozzi and Peitz, 2006, and Barigozzi et al., 2006). In 2000 Papa John's was forced by the court to pay over 468.000$ in damages to Pizza Hut due to the advertising campaign "Better ingredients. Better pizza" that has been judged as misleading, since such claims can not be proved. Secondly, the fact that consumers may perceive a firm's comparative advertising campaign as manipulative and thus, as a non trustworthy source of information (Wilkie and Farris, 1975; Barone and Miniard, 1999)

advertising are given by,

$$\mu^I = \frac{\alpha - c}{b(2+\gamma)^2 - 1} \tag{1.21}$$

Comparing the equilibrium advertising investments in the mere informative advertising configuration, with the respective ones in the endogenous advertising configuration, the following Proposition derives,

Proposition 2 *Equilibrium investments in informative advertising under the endogenous advertising configuration always exceed those of the mere informative advertising configuration.*

Proof. See Appendix A1.1 ■

Intuitively, the absence of comparative advertising in the market, relaxes the advertising market competition and thus, leads firms to invest less in informative advertising under the current configuration than under the endogenous advertising one.

Furthermore, the equilibrium output, profits, consumers' surplus and social welfare are given respectively by,

$$q^I = \frac{b(a-c)(\gamma+2)}{b(2+\gamma)^2 - 1}, \quad \Pi^I = \frac{b(a-c)^2}{b(2+\gamma)^2 - 1} \tag{1.22}$$

$$CS^I = \frac{b^2(1+\gamma)(a-c)^2(\gamma+2)^2}{[b(2+\gamma)^2 - 1]^2}, \; SW^I = \frac{b[b(\gamma+2)^2(3+\gamma) - 2](a-c)^2}{[b(2+\gamma)^2 - 1]^2} \tag{1.23}$$

1.3.5 Mere Comparative Advertising Configuration

In this subsection we consider a market where firms have available only comparative advertising, thus, $\mu_i = \mu_j = 0$.[12] Therefore, firm i's inverse demand function is given now by $p_i^C = \alpha + \kappa_i - \kappa_j - q_i - \gamma q_j$ while, the firm i's profits function is given by $\Pi_i^C(.) = (\alpha + \kappa_i - \kappa_j - q_i - \gamma q_j)q_i - b\kappa_i^2$.

Employing standard backward induction, the firms' equilibrium investments in comparative advertising are given by,

$$\kappa_i^C = \frac{\alpha - c}{b(4-\gamma^2)} \tag{1.24}$$

Comparing the equilibrium advertising investments in the mere comparative advertising configuration with the respective ones in the endogenous advertising configuration, the following

[12] In this subsection we have excluded informative advertising from firms' set of marketing strategies, assuming that consumers are merely informed about the product characteristics, attributes e.t.c and comparative advertising provides full information in relevance to the rival good in the market.

Proposition derives,

Proposition 3 *Equilibrium investments in comparative advertising under the endogenous advertising configuration always exceed those of the mere comparative advertising configuration.*

Proof. See Appendix A1.2 ■

Let us now unravel the reasoning behind this result. Recall the pro-competitive nature of comparative advertising, through increasing own demand and decreasing the rival's demand. By considering (1.2), under the endogenous advertising configuration, firms could compensate from the losses in their demand due to the comparative advertising investments of the rival, by increasing their demand through investments in informative advertising. Yet, under the current configuration, due to the lack of such compensation mechanism, both firms have the opportunity to restrict the advertising warfare to their benefit, by decreasing their investments in comparative advertising.

The equilibrium results regarding output, profits, consumers' surplus and social welfare are given by,

$$q^C = \frac{a-c}{2+\gamma}, \quad \Pi^C = \frac{[b(\gamma-2)^2-1](a-c)^2}{b(\gamma^2-4)^2} \tag{1.25}$$

$$CS^C = (1+\gamma)\frac{(a-c)^2}{(2+\gamma)^2}, \; SW^C = \frac{(a-c)^2[(b(\gamma-2)^2(\gamma+3)-2)]}{b(\gamma^2-4)^2} \tag{1.26}$$

1.3.6 Comparative results

Let us now compare the equilibrium market outcomes of the alternative market configurations. By comparing the equilibrium output and profits in all configurations the following Proposition derives,

Proposition 4 *(i) Equilibrium output takes the highest value under the endogenous advertising configuration, the lowest under the mere comparative advertising configuration and the benchmark one, while it lies in between under the mere informative advertising configuration ($q^E > q^I > q^C = q^N$).*

(ii) Equilibrium profits under the mere informative advertising configuration, are always higher than under the benchmark. Equilibrium profits under the mere comparative and the endogenous advertising configuration are always lower than in the benchmark. Yet, equilibrium

profits under the mere comparative advertising configuration are lower than under the endogenous advertising one, if the effectiveness of advertising is sufficiently low, while the opposite holds if the effectiveness of advertising is sufficiently high ($\Pi^I > \Pi^N > \max[\Pi^C, \Pi^E]$*,* $\Pi^C < \Pi^E$ *iff* $b > \hat{b}(\gamma)$*, with* $\frac{\partial \hat{b}}{\partial \gamma} > 0$ *and* $\Pi^C > \Pi^E$ *iff* $b < \hat{b}(\gamma)$*).*

Proof. See Appendix A1.3 ■

Let us now unravel the intuitions that drive the above results. Regarding output, it is clear by the Proposition 2 and Proposition 3 that under the endogenous advertising configuration the firms' expenditures on advertising are higher than those of the other configurations. Thus, given that the output is positively related to the firms' advertising expenditures, the highest output production is obtained when both types of advertising are available in the market. Further, examining the mere comparative advertising configuration, the equilibrium output equals that of the benchmark, since the beneficial effect of each own firm's investments in comparative advertising on the output is being neutralized by the detrimental effect of the rival's comparative advertising. Lastly, under the mere informative advertising configuration, the firms' investment in advertising shifts the demand curves outwards and leads to higher output production than that obtained in the benchmark case without advertising activities.

Let us now explain the intuition behind the classification of profits. There are some opposing effects. On one hand, investments in any type of advertising shall lead to a positive effect on profitability, through increasing own demand in the case if informative advertising and decreasing the demand of the rival in the case of comparative advertising. Yet, investments in comparative advertising by the rival firm, increased advertising expenses and overproduction by both firms tend to decrease profits. In the mere informative advertising configuration, the beneficial effect of the higher firms' demand due to the fact that both firms invest only in informative advertising compensates for the detrimental effects of increased advertising costs and the fiercer output competition. Therefore, both firms end up being better off than in any alternative configuration. By considering the mere comparative advertising configuration, given that firms invest only in comparative advertising, any positive effect from each own firm's investments in comparative advertising investment is neutralized by the corresponding investments of the rival firm. Thus, the firms end up to a prisoners' dilemma situation, where they conclude worse off in terms of profitability.

Regarding the endogenous advertising configuration, the following observations hold. First, comparing to the benchmark case, it is clear that the enhancing effect on profits due to each own firm's investments in advertising could not compensate the diminishing effects of the rival's investments in comparative advertising, the fiercer advertising competition (i.e. overinvestment in both types of advertising) and the overproduction of both firms. Therefore, the firms' performance in terms of profitability is worst than in the benchmark. Second, comparing to the mere comparative configuration we have that $\Pi^C < \Pi^E$ iff $b > \hat{b}(\gamma) \equiv \frac{\gamma^2-12+\gamma^3+(\gamma-2)\sqrt{20+36\gamma+33\gamma^2+10\gamma^3+\gamma^4}}{2(16\gamma+8\gamma^2-8\gamma^3-\gamma^4+\gamma^5-16)}$ and $\Pi^C > \Pi^E$ iff $b < \hat{b}(\gamma)$. The intuition behind this result is as follows. On the one hand, under the endogenous advertising configuration the total advertising investments are higher than those under the mere comparative advertising configuration. Thus, under the endogenous configuration firms incur higher advertising costs that tend to decrease their profitability. On other hand, under the endogenous advertising configuration, the beneficial effect of informative advertising expenditures on the firms' demand tends to increase the firms' profitability. Obviously, a less effective advertising technology, discourage firms from engaging in unnecessary advertising warfare that acts beneficial to their profitability. Thus, when the effectiveness of the advertising is low, (i.e., $b > \hat{b}(\gamma)$), the beneficial effect of the firms' investments in informative advertising dominates the detrimental effect of the higher advertising costs that firms incur under the endogenous advertising configuration and thus, the firms' profits under the endogenous advertising configuration are higher than respective ones under the mere comparative configuration. The opposite holds when the effectiveness of advertising is sufficiently high, (i.e., $b < \hat{b}(\gamma)$), since the firms' warfare intensifies.

Let us now compare the equilibrium societal outcomes among the alternative configurations. The following Proposition summarizes,

Proposition 5 *(i) Equilibrium consumers' surplus takes the highest value under the endogenous advertising configuration, the lowest under the mere comparative advertising configuration that equals that of the benchmark, while it lies in between under the mere informative advertising configuration* ($CS^E > CS^I > CS^C = CS^N$).

(ii) Equilibrium social welfare takes the highest value under the mere informative advertising configuration and the lowest under the mere comparative advertising one. Social welfare is higher in the endogenous advertising configuration than in the benchmark if the degree of market

competition is relatively low. The inverse relation holds if the degree of market competition is relatively high ($SW^I > \max[SW^N, SW^E] > SW^C$, *while* $SW^E > SW^N$ *iff* $\gamma < \tilde{\gamma}(b)$, *with* $\frac{\partial \tilde{\gamma}}{\partial b} > 0$ *and* $\tilde{\gamma}(1.444) = 0.441068$ *and* $SW^E < SW^N$ *iff* $\gamma > \tilde{\gamma}(b)$.

Proof. See Appendix A1.4 ■

We turn now to discuss the main arguments that drive the above results. Advertising increases the consumers' surplus, since it increases the consumers' information about the firms' products. Further it intensifies market competition and leads to higher total output. Thus, given that the consumers' surplus follows the same patterns as the output, the rationale behind the former is based on the same arguments that lie behind the analysis after Proposition 4.

Regarding the welfare, it is obvious that the higher firms' profits along with the higher consumers' surplus in the mere informative advertising configuration result to higher welfare than in the benchmark. Further, comparing the welfare in the mere informative advertising configuration with that of the endogenous advertising configuration, we have that the effect of the higher firms' profits under the mere informative advertising configuration dominates over the effect of the higher consumers' surplus under the endogenous advertising configuration and thus, $SW^I > SW^E$. In addition, comparing the welfare in the mere comparative and the benchmark case, we have that the welfare is lower under the former case since, the firms' profits in the mere comparative case are lower than in the benchmark, while the consumers' surplus equals that of the benchmark. Yet, comparing the welfare in the mere comparative and the endogenous advertising configuration, we have that the welfare is lower under the latter configuration, since the lower consumers' surplus in the mere comparative advertising configuration dominates over the any positive effects of the higher firms' profits in the endogenous configuration when products are not close substitutes. From the above it is clear that the firms' investments in comparative advertising decrease both the firms' equilibrium profits and the welfare. This result offers important policy implications, leading to the conclusion that comparative advertising can be characterized as "wasteful advertising", since both firms and consumers can be better off, if this aggressive form of advertising has been prohibited.[13] Further, regarding the endogenous

[13] The term "wasteful advertising" was first introduced by Pigou (1924), in order to describe the prisoner's dilemma which arises when competing firms in a market invest equal efforts in advertising, in order to attract the favor of the public from the others. As Pigou first showed, this concludes in a prisoner's dilemma where none of the firms gains anything at all.

advertising configuration, from (1.17), Proposition 4 and the above analysis, there are two opposite effects on welfare comparing to the corresponding values in the benchmark: a positive effect due to the higher consumers' surplus and a negative effect due to lower profitability. Results in equilibrium reveal that, when the products are poor substitutes, the overruling effect is the first, the opposite holds when the products are close substitutes. Thus, $SW^E > SW^N$ iff $\gamma < \tilde{\gamma}(b)$ and $SW^E < SW^N$ iff $\gamma > \tilde{\gamma}(b)$.

1.4 Extensions-Discussion

In this section we examine a number of modifications of the basic model in order to briefly discuss the robustness of our results.[14]

1.4.1 Bertrand competition

We extend our analysis by investigating the robustness of our results under price market competition. That is, each firm i faces a standard linear demand given now by,

$$q_i = [a\,(1-\gamma) + \mu_i - \gamma\mu_j + (1+\gamma)(\kappa_i - \kappa_j) - p_i + \gamma p_j]/(1-\gamma^2)$$

Keeping all the other modeling specifications fixed, we reconfirm that our main results do not change qualitatively under price market competition. More specifically, we show that in equilibrium firms always invest in both informative and comparative advertising, while all the other outcomes (i.e., firms' profits, consumers' surplus, social welfare) follow the same pattern as in the Cournot market. Yet, we observe that the Assumption 1 over the advertising effectiveness parameter b, alters to $\bar{b} \geqslant -8 - \gamma(4 + \gamma(+2(\gamma-1)\gamma - 7)/(\gamma^2-4)^2(\gamma^2-1)$ with $\bar{b} > b(\gamma)$ under price competition. Clearly, the assumption over the effectiveness of advertising, $\bar{b}$ under price competition is stricter than that under quantity competition. Intuitively, we know from the seminal paper of Singh and Vives (1984) that competition is fiercer and profits are lower under price than under quantity competition. Thus, when firms compete in prices, will require lower effectiveness of advertising technology in order to engage efficiently in advertising investments,

[14] For each extension discussed below, the detailed analysis is available from the authors upon request.

than in output competition.

1.4.2 The $n-$firm case

In this section we extend our analysis to an industry with $n > 2$ firms that produce differentiated products. Each firm i, $i = 1, 2, .., n$, faces an inverse demand function given by, $p_i = \alpha + \mu_i + \kappa_i - K_{-i} - q_i - \gamma Q_{-i}$, where $K_{-i} = \sum_{j\neq i} \kappa_j$, $Q_{-i} = \sum_{j\neq i} q_j$ with all other parameters being defined as in the duopoly case.[15] The rest specifications of the model, as well as, the timing of the game, follows the same pattern as in our basic model given in Section 2.

Thus, the profit function of each firm i is now given by,

$$\Pi_i = (\alpha + \mu_i + \kappa_i - K_{-i} - q_i - \gamma Q_{-i})q_i - cq_i - b(\mu_i^2 + \kappa_i^2)$$

Solving the game backwards we obtain the firms' equilibrium levels in comparative and informative advertising given, respectively, by,

$$\mu^S = \frac{2(\alpha - c)[2 + \gamma(n-2)]}{b(2-\gamma)[(2+\gamma(n-1)]^2 - 2 - \gamma(n-2)}, \ \kappa^S = \frac{2(\alpha - c)[2 + \gamma(n-1)]}{b(2-\gamma)[(2+\gamma(n-1)]^2 - 2 - \gamma(n-2)} \tag{1.27}$$

Clearly, our basic result, given in the Proposition 1, holds independently of the market size. Notice here, that the firms' expenditures in advertising decrease as the number of the firms in the market increase. This is so, because, as the market size becomes larger, the relative weight of each firm in the market decrease and thus, any potential benefit from the advertising expenditures decrease. Furthermore, note that the optimal advertising mix $\frac{\mu^S}{\kappa^S} = \frac{2+\gamma(n-2)}{2+\gamma(n-1)}$, with $\frac{\partial \mu^S/\kappa^S}{\partial n} > 0$. That means that, as the market size increases, the firms substitute the informative advertising with the more aggressive comparative advertising. The intuition behind this result comes from the fact that, as the market size increases, the denigration effect that comparative advertising may have on the rival firms demand increases.

[15] The inverse demand functions are derived by aggregating individual demand functions of individuals who have homogenous preferences regarding the n products. In particular, following Häckner (2000), the utility function of the representative consumer is given by: (2.2): $U = (\alpha + \mu_i + \kappa_i - \kappa_j) \sum_{\substack{i=1 \\ j\neq i}}^{n} q_i - \frac{1}{2}(\sum_{i=1}^{n} q_i^2 + \gamma \sum_{i=1}^{n} \sum_{\substack{j=1 \\ j\neq i}}^{n} q_i q_j) + m$

Furthermore, the equilibrium output, profits, consumers' surplus and social welfare are given, respectively, by,

$$q^S = \frac{b(\alpha - c)(2-\gamma)[2+\gamma(n-1)]}{b(2-\gamma)[2+\gamma(n-1)]^2 - \gamma(n-2) - 2},\ \Pi^S = \frac{b(\alpha-c)^2[b(2+\gamma)^2(\gamma-2)^2 - (4+\gamma)\gamma - 8]}{(2-b(2-\gamma)(\gamma+2)^2)^2} \tag{1.28}$$

$$CS^S = \frac{1}{2}n[1+\gamma(n-1)][q^S]^2,\ SW^S = CS^S + n\Pi^S \tag{1.29}$$

As standard in the relevant literature, we observe that, $\frac{\partial q^s}{\partial n} < 0$, $\frac{\partial \Pi^s}{\partial n} < 0$, $\frac{\partial CS^s}{\partial n} > 0$, $\frac{\partial SW^s}{\partial n} > 0$. Thus, as the market size increases the equilibrium output and profits decrease, while the consumers' surplus and welfare increase.

1.4.3 Advertising cost asymmetries

In our basic model we have assumed that both informative and comparative advertising have equal marginal cost. However, in reality when firms invest in comparative advertising, with a non negligible profitability, they deal with the risk to be prosecuted to the court by the rival and be accused for misleading advertising. Thus, in this subsection we relax our assumption over the equality between the marginal cost of both types of advertising, and we consider the case where the marginal cost of comparative advertising (d) exceeds that of informative advertising (b). In this content each firm seeks to maximize its net profits given by $\Pi_i = (\alpha + \mu_i + \kappa_i - \kappa_j - q_i - \gamma q_j)q_i - cq_i - b\mu_i^2 - d\kappa_i^2$. Keeping all the other parameters unchanged, we reconfirm that firms always have strong incentives to invest in both types of advertising, even if comparative advertising is more expensive than informative advertising. All the other outcomes follow the same pattern as in our basic model.

1.4.4 Informative Advertising

In this subsection we analyze in more details the effect of informative advertising over the firms' demand. Consider a unit mass of consumers, $\phi < 1$ of which are well informed about the characteristics of both goods and have demand functions $p_i = a + \tau s - q_i - \gamma q_j$, with $\tau = 2$ and $s > 0$ an exogenous increase in the consumer's valuation of the goods. The rest $1 - \phi$ of consumers have imperfect information about these characteristics and believe that τ take values $(-2, -1, 1, 2)$ with equal probabilities. Hence, if they do not receive any advertising messages from the firms, their expected demand functions are: $p_i = a - q_i - \gamma q_j$. Let firm i launch informative and comparative advertising campaigns with respective intensities μ_i and κ_i, $i = 1, 2$. The latter represent the probability with which an uninformed consumer receives the respective advertising messages from firm i. If an uninformed consumer receives both messages from firm i and does not receive a comparative advertising message from firm j, then he believes that $\tau = 2$ for the firm i's product. If, however, he receives a comparative advertising message from firm j, then this message nullifies the respective comparative message received by firm i, and as result he believes that $\tau = 1$. If an uninformed consumer receives an informative or a comparative message from firm i and no message from firm j, then he believes again that $\tau = 1$ for the firm i's product. If, however, he also receives a comparative advertising message from firm j, then this message nullifies the one received from firm i and goes back to being uninformed about firm i' s good characteristics, i.e. $E\tau = 0$. Finally, if the uninformed consumer does not receive any message from firm i and receives a comparative advertising message from firm j, then he believes that $\tau = -1$ for the firm i's product. Otherwise, he has no additional information about firm i's product and thus $E\tau = 0$.

It turns out that the expected demand functions of uninformed consumers are: $p_i = a + (\mu_i + \kappa_i - \kappa_j)s - q_i - \gamma q_j$. Then firm i's demand function is given by:

$$p_i = a + 2\phi s + (1 - \phi)(\mu_i + \kappa_i - \kappa_j)s - q_i - \gamma q_j \tag{1.30}$$

Then, after setting $\widehat{a} = a + 2\phi s$ and $\widehat{s} = (1 - \phi)s$, (1.30) takes the form of the demand function assumed in the main model. Assuming that the costs of launching an informative and comparative advertising campaigns of intensity μ_i and κ_i are again separable and quadratic, i.e. $\widehat{b}(\mu_i^2 + \kappa_i^2)$, with $\widehat{b}$ sufficiently high to guarantee interior solutions, the problem basically reduces the one examined in Section 2.[16]

[16] In a similar way we can obtain the firms' demand functions in case of mere informative, mere comparative campaigns, which turn out to be of the form already seen in the previous sections.

1.5 Conclusions

In the present chapter we investigate the firms' incentives to invest in informative and comparative advertising in an oligopolistic market with horizontally differentiated products. We show that in equilibrium firms invest in mixed advertising strategies, that combine both informative and comparative advertising, in order to extract the beneficial effect that each type of advertising provides. In addition, we demonstrate that the firms' expenditures on each type of advertising crucially depends on the degree of market competition. In particular, the firms' expenditures on comparative advertising are positively related to degree of market competition, while the firms' expenditures on informative advertising are non monotonically -U- shaped- related to the degree of market competition. Clearly, a fiercer market competition, intensifies the firms' advertising competition and thus, firms invest more in both types of advertising as an attempt to enforce their position in the market and to obtain a comparative advantage over the rival.

Further, we compare our equilibrium outcomes obtained in the endogenous advertising configuration with alternative market configurations either in the absence of advertising or in the absence of one of the two types of advertising, in order to provide results over the impact that the different firms' marketing strategies have on the market outcomes and the social welfare. We demonstrate that the highest firms' output production is obtained under the endogenous advertising configuration, the lowest under the mere comparative advertising configuration that equals that of the benchmark, while it lies in between under the mere informative advertising configuration. These finding suggest that the existence of both types of advertising in the market, intensifies the market competition and leads to higher output production. Yet, regarding to the firms' market performance in terms of profitability, we show that firms obtain the highest profits under the mere informative advertising configuration, while they obtain the lowest profits under the endogenous advertising configuration (mere comparative advertising configuration, respectively) when the effectiveness of advertising is sufficiently low (sufficiently high, respectively). From the above it is clear that the use of comparative advertising leads firms to a prisoners' dilemma situation, where they end up worse off in terms of profitability.

Regarding the societal effects of advertising, we argue that the existence of both types of advertising in a market acts beneficially to consumers, since it leads to higher consumers' surplus due to the higher output and the improved information that the consumers possess. Further, we show that the social welfare is the highest under the mere informative advertising, while it is the lowest under the mere comparative configuration. In addition, we demonstrate that the welfare under the endogenous advertising configuration can be either higher or lower than that of the benchmark case, depending on the degree of the market competition. In particular, the welfare in the endogenous advertising configuration is higher than that of the benchmark if the intensity of the market competition is low enough, while the opposite holds if the market competition is fierce enough. These findings suggest that the firms' self promoting informative advertising should be encouraged by the policy makers, since it leads to higher welfare.

Our findings provide some guidelines for future experimental research on the firms' incentives to invest in both informative and comparative advertising, when subjects have on their set of strategies both types of advertising that could provide credible results over the firms' decision relatively to aggressive advertising marketing strategies and how these affect their market performance in oligopolistic industries. A number of testable hypotheses emerge relatively to our theoretical analysis. For instance, in the presence of both types of advertising in a market, the subjects have incentives to undertake aggressive advertising strategies that combine both informative and comparative advertising? and if yes, how does this affect the competition and therefore, the profitability in the industry. Another testable hypothesis could be that the probability of a firm employing comparative advertising is higher in industries where products are close substitutes.

Appendix A

A1.1 Proof of proposition 2:

Evaluating the difference between the equilibrium investment levels in informative advertising obtained in the endogenous advertising configuration and those of the mere informative advertising configuration we have,

$$\mu^E - \mu^I = \frac{(\alpha - c)2b\gamma(\gamma+2)^2}{[b(\gamma+2)^2 - 1][b(2-\gamma)(\gamma+2)^2 - 2]} > 0, \text{ for } \gamma > 0 \text{ and } b \geqslant b(\gamma)$$

Clearly, both the nominator and the denominator of the above expression exceed zero, for $\gamma > 0$ and $b \geqslant b(\gamma)$. Thus, $\mu^E - \mu^I > 0$ for $\gamma > 0$ and $\mu^E - \mu^I = 0$ for $\gamma = 0$.■

A1.2 Proof of proposition 3:

Evaluating the difference between the equilibrium investment levels in comparative advertising obtained in the endogenous advertising configuration and the those of the mere comparative advertising configuration we have,

$$\kappa^E - \kappa^C = \frac{2(\alpha - c)}{b(\gamma^2 - 4)[2 + b(\gamma - 2)(\gamma + 2)^2]} > 0, \text{ for } \gamma > 0 \text{ and } b \geqslant b(\gamma)$$

Clearly, both the nominator and the denominator of the above expression exceed zero, for $\gamma > 0$ and $b \geqslant b(\gamma)$. Thus, $\kappa^E - \kappa^I > 0$ for $\gamma > 0$ and $\kappa^E - \kappa^I = 0$ for $\gamma = 0$.■

A1.3 Proof of proposition 4:

Evaluating the difference between the equilibrium output under the endogenous advertising configuration and that of the benchmark case, we have that,

$$q^E - q^N = \frac{2(a - c)}{(\gamma + 2)[b(2 - \gamma)(\gamma + 2)^2 - 2]} > 0, \text{ for } \gamma \geqslant 0 \text{ and } b \geqslant b(\gamma)$$

Clearly, both the nominator and the denominator of the above expression exceed zero, for $\gamma \geqslant 0$ and all the given values of b, with $b \geqslant b(\gamma)$. Thus, $q^E - q^N > 0$ for any $\gamma \geqslant 0$ and $b \geqslant b(\gamma)$.■

Evaluating the difference between the equilibrium profits under the endogenous advertising configuration and those of the benchmark case, we have that,

$$\Pi^E - \Pi^N = \frac{-(\alpha - c)^2[b\gamma(\gamma + 2)^2(8 + \gamma) + 4]}{(\gamma + 2)^2[b(\gamma - 2)(\gamma + 2)^2 + 2]^2} < 0, \text{ for } \gamma \geqslant 0 \text{ and } b \geqslant b(\gamma)$$

Clearly, the nominator of the above expression is below zero, while the denominator exceed zero, for $\gamma \geqslant 0$ and all the given values of b, with $b \geqslant b(\gamma)$. Thus, $\Pi^E - \Pi^N > 0$ for any $\gamma \geqslant 0$ and $b \geqslant b(\gamma)$.■

Evaluating the difference between the equilibrium output under the endogenous advertising configuration and that of the mere informative advertising configuration, we have that,

$$q^E - q^I = \frac{(\alpha - c)b\gamma(2 + \gamma)}{[b(\gamma + 2)^2 - 1][b(2 - \gamma)(\gamma + 2)^2 - 2]} > 0, \text{ for } \gamma \geqslant 0 \text{ and } b \geqslant b(\gamma)$$

Clearly, both the nominator and the denominator of the above expression exceed zero, for $\gamma \geqslant 0$ and all the given values of b, with $b \geqslant b(\gamma)$. Thus, $q^E - q^I > 0$ for any $\gamma \geqslant 0$ and $b \geqslant b(\gamma)$.■

Evaluating the difference between the equilibrium profits under the endogenous advertising configuration and those of the mere informative advertising configuration, we have that,

$$\Pi^E - \Pi^I = \frac{-(\alpha - c)b[(2+\gamma)^2(2b(\gamma^2+2\gamma+2)-2)]}{[b(\gamma+2)^2-1][b(\gamma-2)(\gamma+2)^2+2]^2} < 0, \text{ for } \gamma \geqslant 0 \text{ and } b \geqslant b(\gamma)$$

Clearly, the nominator of the above expression is below zero, while the denominator exceed zero, for $\gamma \geqslant 0$ and all the given values of b, with $b \geqslant b(\gamma)$. Thus, $\Pi^E - \Pi^I > 0$ for any $\gamma \geqslant 0$ and $b \geqslant b(\gamma)$.■

Evaluating the difference between the equilibrium output under the endogenous advertising configuration and that of the mere comparative advertising configuration, we have that,

$$q^E - q^C = \frac{2(\alpha - c)}{(\gamma+2)[b(2-\gamma)(\gamma+2)^2-2]} > 0, \text{for } \gamma \geqslant 0 \text{ and } b \geqslant b(\gamma)$$

Clearly, both the nominator and the denominator of the above expression exceed zero, for $\gamma \geqslant 0$ and all the given values of b, with $b \geqslant b(\gamma)$. Thus, $q^E - q^C > 0$ for any $\gamma \geqslant 0$ and $b \geqslant b(\gamma)$.■

Evaluating the difference between the equilibrium profits under the endogenous advertising configuration and those of the mere comparative advertising configuration, we have that,

$$\begin{aligned} \Pi^E - \Pi^C &= \frac{-(\alpha - c)^2[4(-1 + b^2(\gamma-1)(\gamma^2-4)^2 - b(\gamma^3+\gamma^2-12)]}{b(\gamma^2-4)^2[2+b(\gamma-2)(\gamma+2)^2]^2} \\ \text{with } \Pi^C &< \Pi^E \text{ iff } b > \hat{b}(\gamma) \text{ and } \Pi^C > \Pi^E \text{ iff } b < \hat{b}(\hat{\gamma}) \end{aligned}$$

Setting, $\Pi^E - \Pi^C = 0$, and solving with respect to b, we find that $\Pi^E = \Pi^C$ for $\hat{b}(\gamma) = \frac{\gamma^2-12+\gamma^3+(\gamma-2)\sqrt{20+36\gamma+33\gamma^2+10\gamma^3+\gamma^4}}{2(16\gamma+8\gamma^2-8\gamma^3-\gamma^4+\gamma^5-16)}$ and $\gamma > 0$. Thus, $\Pi^C < \Pi^E$ if $b > \hat{b}(\gamma)$ and $\Pi^C > \Pi^E$ if $b < \hat{b}(\gamma)$.■

A1.4 Proof of proposition 5:

The consumers' surplus, under each configuration is given by, $CS^N = (1+\gamma)[q^N]^2$, $CS^E = (1+\gamma)[q^E]^2$, $CS^C = (1+\gamma)[q^C]^2$, $CS^I = (1+\gamma)[q^I]^2$. Thus, given that $q^E > q^I > q^C = q^N$, we obtain that, $CS^E > CS^I > CS^C = CS^N$, for all the given values of $\gamma \geqslant 0$ and $b \geqslant b(\gamma)$.■

Social Welfare: Evaluating the difference between the social welfare under the endogenous advertising configuration and that of the benchmark case, we have that,

$$SW^E - SW^N = -\frac{4(3+\gamma)+2b(\gamma+2)^2(3\gamma^2+6\gamma-4)}{(\gamma+2)^2[b(\gamma-2)(\gamma+2)^2+2]^2}$$

From the above equation it can be easily testified that $SW^E > SW^N$ holds for $\gamma < \tilde{\gamma}(b)$, while $SW^E < SW^N$, for $\gamma > \tilde{\gamma}(b)$.

Evaluating the difference between the social welfare in the endogenous advertising configuration and that of the mere informative advertising, we have that,

$$SW^E - SW^I = \frac{-(\alpha-c)b(2+\gamma)^2[2+b(-16-\gamma(12+(3+\gamma))+\Xi]}{[b(\gamma+2)^2-1]^2[b(\gamma-2)(\gamma+2)^2+2]^2} < 0, \text{ for } \gamma \geqslant 0 \text{ and } b \geqslant b(\gamma)$$

where, $\Xi \equiv 2b(2+\gamma^2)[(4+\gamma(\gamma^2+\gamma+2)]$

After some manipulations it can be checked by the above equation that the nominator of the fraction is always below zero, while the denominator always exceeds zero. Thus, $SW^E < SW^I$ holds for $\gamma \geqslant 0$ and $b \geqslant b(\gamma)$.■

Evaluating the difference between the social welfare in the endogenous advertising configuration and that of the mere comparative advertising, we have that,

$$SW^E - SW^C = \frac{(\alpha-c)^2 4[(2-b^2(\gamma^2-4)^2(\gamma^2+\gamma-4)+b(\gamma^2(\gamma+5)-28)]}{b(\gamma^2-4)^2[2+b(\gamma-2)(\gamma+2)^2]^2} > 0, \text{for } \gamma \geqslant 0 \text{ and } b \geqslant b(\gamma)$$

After some manipulations it can be checked that both the nominator and the denominator of the above equation exceed zero and thus, $SW^E > SW^C$ holds for $\gamma \geqslant 0$ and $b \geqslant b(\gamma)$.■

Bibliography

[1] Aluf, Y., Shy, O., 2001. Comparison advertising and competition. Mimeo, University of Haifa.

[2] Anderson, S.P., Renault R., 2009. Comparative Advertising: disclosing horizontal match information. The Rand Journal of Economics 40, 558-581.

[3] Anderson, S.P., Ciliberto F., Liaukonte J., 2010. Getting into Your Head(Ache): The Information Content of Advertising in the Over-the-Counter Analgesics Industry. Mimeo, University of Virginia.

[4] Anderson, S.P., Ciliberto F., Liaukonte J., and Renault R., 2010. Push-Me Pull-You: Comparative Advertising in the OTC Analgesics Industry. Mimeo, University of Virginia.

[5] Arzaghi, M., Berndt, E. R., Davis, J. C. , Silk, A. J., 2008. Economic factors underlying the unbundling of advertising agency services. WP 14345, NBER, Cambridge, MA.

[6] Bagwell, K., 2007.The Economic Analysis of Advertising", In Mark Armstrong and Rob Porter (eds.). The Handbook of Industrial Organization 3, 1701-1844.

[7] Barigozzi, F., Garella, P.G., Peitz, M., 2009. With a Little Help from my Enemy: Comparative Advertising as a Signal of Quality. Journal of Economics and Management Strategy 18, 1071-1094.

[8] Barigozzi, F., Peitz M., 2006. Comparative Advertising and Competition Policy. in, Choi, J.P.(ed.), Recent Trends in Antitrust: Theory and Evidence, MIT Press, Chapter 8, 215-263.

[9] Barone, M.J., Miniard, P.W., 1999. How and When Factual Ad Claims Mislead Consumers: Examining the Deceptive Consequences of Copy X Copy Interactions for Partial Comparative Advertisements. Journal of Marketing Research 36(1), 58-74.

[10] Bester, H., Petrakis, E., 1995. Price Competition and Advertising in Oligopoly. European Economic Review 39, 1075-88.

[11] Bester, H., Petrakis, E., 1996. Coupons and oligopolistic price discrimination. International Journal of Industrial Organization 14, 227-242.

[12] Butters, G., 1977. Equilibrium distribution of sales and advertising prices. Review of Economic Studies 44, 465-492.

[13] Chakrabarti S., Haller H., 2011. An Analysis of Advertising Wars. The Manchester School 79, 100-124.

[14] Emons W., Fluet C., 2012. Non-comparative versus Comparative Advertising as a Quality Signal. International Journal of Industrial Organization 30, 352-360.

[15] Goodwin, S., Etgar, M., 1980. An Experimental Investigation of Comparative Advertising: Impact of Massage Appeal, Information Load and Utility of Product Class. Journal of Marketing Research, 187-202.

[16] Grewal, D.S., Kavanoor, E,. Fern, C., Costley J., Barnes, 1997. Comparative Versus Noncomparative Advertising: A Meta- Analysis. Journal of Marketing 61(4), 517-32.

[17] Grossman, G.M., Sharipo, C., 1984. Informative Advertising with Differentiated Products. Review of Economics Studies 51, 63-81.

[18] Häkner, J., 2000. A note on price and quantity competition in differentiated oligopolies. Journal of Economic Theory 93, 233-239.

[19] Hamilton, S., 2009. Informative advertising in differentiated oligopoly markets. International Journal of Industrial Organization 27, 60 - 69.

[20] Hernandez-Garcia, J., 1997. Informative advertising, imperfect targeting and welfare. Economics Letters 55, 131-137.

[21] Horsky, S., 2006. The changing architecture of advertising agencies. Marketing science 25, 367-383.

[22] Jung O.K., Sharon E.B ., 2002. Comparative Advertising Effectiveness in Different National Countries. Journal of Business Research 55, 907-913.

[23] Kihlstrom R.E., Rionard M.H., 1984. Advertising as a signal. Journal of Political Economy 92 (3), 427-450.

[24] Milgrom P.R., Roberts J., 1984. Prices and Advertising Signals of Product Quality. Journal of Political Economy 94 (4), 796-821.

[25] Muehling D., Stoltman J., Grossbart S., 1990. The Impact of Comparative Advertising on Levels of Message Involvement. Journal of Advertising 19, 41-50.

[26] Nelson, P., 1974. Advertising as Information. Journal of Political Economy 82, 729-754.

[27] Pechmann, C., Steward D.W., 1990. The Effect of Comparative Advertising on Attention, Memory and Purchase Intention. Journal of Consumer Research 17, 180-191.

[28] Pechmann, C., Ratneshwar, S., 1991. The Use of Comparative Advertising for Brand Positioning: Association versus Differentiation. Journal of Consumer Research 18, 145-160.

[29] Peters, M., 1984. Restrictions on price advertising", Journal of Political Economy, Vol. 92, 472-485

[30] Pigou, A.C., 1924. The Economics of Welfare. London: Micmillan and Co., Limited. Second Edition.

[31] Prasad, V.K., 1976. Communications- Effectiveness of Comparative Advertising: a Laboratory Analysis. Journal of Marketing Research 13, 128-142.

[32] Singh, N., Vives X., 1984. Price and Quantity Competition in a Differentiated Duopoly. RAND Journal of Economics 15(4), 546-554.

[33] Wilkie, W.L., Farris, P.W., 1975. Comparative Advertising: Problems and Potential. Journal of Marketing 39, 7-15.

Chapter 2

Comparative Advertising in Markets with Network Externalities

2.1 Introduction

Comparative advertising is a marketing practise that promotes the superiority of one's own brand, while, at the same time, indicates the inferiority of the rival's brand via direct or indirect comparisons between the brands and their characteristics.[1] Thus, comparative advertising aims to increase the demand of the positively advertised brand, while it aims to decrease the demand of the targeted brand. However, it is well established that in many markets the utility that consumers derive by the consumption of a product and thus, the demanded quantity of the product, does not depend only on the product's physical characteristics but it depends also on the number of the agents that use the same product (Katz and Sharipo, 1985; Veblen, 1899). Therefore, in such markets the consumers' decisions to purchase a product depend not only on the products' differential but also on their expectations over the network size of each product. Under this setting a number of questions arise with regard to the firms' willingness to use the aggressive form of comparative advertising in markets that are characterized by network externalities and how this affects the firms' market performance.

In the present chapter we investigate the firms' incentives to invest in comparative advertis-

[1] Statement of policy regarding comparative advertising, Federal Trade Commission, Washington, D.C., August13, 1979.

ing in a spatially differentiated duopoly characterized by networks externalities. The idea that drives our research can be illustrated taking for example the Orange's comparative advertising campaign in 1994, "On average, Orange users save more than 20£ per month, compared to the Vodafone's and Cellnet's equivalent tariffs". Clearly, the aforementioned advertising campaign promotes the superiority of the Orange's tariffs against the Vodafone's and the Cellnet's tariffs. That means that, it targets to increase the consumers' valuation over the Orange's product, while, at the same time, it targets to decrease the consumers' valuation over both the Vodafone's and the Cellenet's products. However, when the products are characterized by consumption externalities, the consumers that are exposed to comparative advertising messages are going to evaluate apart from the advertising message and its' claims over the differences between the products, the expected network size of each product, since they are willing to participate in the most widely used network. Thus, a number of questions arise with regard to the firms' incentives to invest in comparative advertising in markets with network externalities. In particular, in the present chapter we aim to address the following three questions: First, are there any firms' incentives to invest in comparative advertising when the market is characterized by network effects? Second, how the use of comparative advertising and the intensity of the network externalities affect the firms' location decisions? Third, how the firms' location and comparative advertising decisions, in the presence of network externalities, affect the market outcomes?

We consider a spatially differentiated duopoly market characterized by network externalities where, firms strategically use comparative advertising in order to present their product as superior to the rival's one. More specifically, each firm's investment in comparative advertising has a dual effect, it increases the demand of its own product, while it decreases the demand of the rival's firm product. Clearly, "net effect" that comparative advertising has over the demand, crucially depends on products' differentiation, or else, on the location distance between the two firms. That means that, the closer the firms are located to each other, or, in other words, the closer substitutes the products are, the higher is the denigrating effect of the rival's firm comparative advertising. A four stage game is analyzed where the timing of the game is given as follows. In the first stage, the firms decide their location in the Hotelling line. In the second stage, the firms choose their investment levels in comparative advertising. In the third stage, the firms compete by setting their prices. In the final stage, the consumers after observing the firms' location, advertising and prices allocate themselves to one of the two networks.

We show that for sufficiently high transportation cost the firms have strong incentives to undertake comparative advertising activities, since each firm is willing by investing in comparative advertising to obtain a competitive advantage over the rival firm in the market via the denigrating effect that comparative advertising has over the rival's firm product. Further, we demonstrate that in equilibrium firms are symmetrically located within the edges of the linear city. In more details, a wide range of firms' location choices is available depending on the transportation cost, the consumers' valuation over the network externalities and the effectiveness of the comparative advertising. More importantly, we show that the location distance between the firms is negatively connected to the transportation cost, while it is positively connected to the intensity of the network externalities and the effectiveness of the advertising. Thus, we reconfirmed that, as standard in the literature, the higher the transportation cost is, the closer to each other the firms locate. On the contrary, the presence of network externalities in a market intensifies the market competition and thus, it leads firms to locate further apart. Moreover, we show that the firms' comparative advertising expenditures are positively connected to the transportation cost, while they are negatively connected to the intensity of the network effects. Intuitively, as the consumers' valuation over the network size increases, the firms will choose to locate further apart. The latter leads firms to decrease their expenditures on comparative advertising, since a comparison between unrelated products is less effective. The opposite holds, as the transportation cost increases.

Regarding the impact of comparative advertising on the market outcomes, we show that the firms' investments in comparative advertising intensify the market competition and lead to higher prices and profits than in the benchmark case without firms' advertising activities. Thus, comparative advertising can be characterized as "wasteful advertising", since it leads to a prisoners' dilemma situation where firms are worse off in terms of profitability.[2] Further, comparing the firms' location distance, advertising investments, prices and profits in markets with network externalities to the respective ones in the absence of networks externalities, we

[2] The term of wasteful advertising was first introduced by Pigou 1924, in order to describe the prisoners' dilemma that arize when the competing firms invest equal efforts in advertising in order to attract the favor of the public and none of the firms gains anything at all.

show that in equilibrium the firms' location distance and the advertising expenditures are higher in presence of network externalities, while prices and profits are lower. This is so, due to the fiercer competition that the presence of network externalities in a market generates.

Our work is related to the existing literature that examines the role of advertising in markets that are characterized by consumption externalities and has its origins in the seminal work of Pastine and Pastine (2002) that show that in such markets the firms' advertising, apart from its informative and persuasive role, could form as a device to coordinate the consumers' expectations over the purchasing decisions of other consumers. In the same vein, Clark and Hostmann (2005) extend the Pastine and Pastine (2002) work by investigating the coordination role of advertising when the firms' advertising levels are not fully observable to the consumers and show that firms can use advertising to coordinate the consumers purchases even if the advertising levels are unobservable. More recently, Pastine and Pastine (2011), examine whether advertising can serve as a coordination device for products of different quality. They show that, when the products are of sufficiently different quality, the low quality firm has incentives to advertise more and thus, in equilibrium the low quality product will be often the most popular. However, all of the aforementioned literature has focused on the coordination role of advertising in markets with consumption externalities, while it has ignored the effects of more aggressive forms of advertising on such markets. Closer to the present research, Kretschmer and Rosner (2010) investigate how the network externalities affect the firms' persuasive advertising expenditures and show that when the firms are symmetrically located, their advertising expenditures are not affected by the networks effects. In contrast, they suggest that if a firm has an initial location advantage its' advertising spending increase in the intensity of the network effects. However, Kretschmer and Rosner (2010), in order to study how the network externalities interact with the locational advantage, have assumed that firms' location are exogenously given. In the present chapter we relax this assumption and we investigate the firms incentives to invest in comparative advertising in markets with network externalities when the firms' locations, advertising expenditures and prices are determined endogenously.

Moreover, the present chapter is related to the emerging economic literature that examines the use of comparative advertising in imperfectly competitive markets. Aluf and Shy (2001) using a Hotelling model, where comparative advertising increases the transportation cost to the rival's product, show that the use of comparative ads weakens price competition by enhancing the degree of product differentiation and leads to higher prices and profits. In a different vein, Barigozzi et al. (2009) examine comparative advertising as a mean to signal quality. In particular, they consider a market where an incumbent whose quality is known faces an entrant whose quality is unknown. The entrant decides whether to use generic advertising, that is a standard money burning to signal quality, or comparative advertising that implies a comparison over the qualities of the two products. They conclude that the comparative advertising can be used to signal quality, while the entrant's incentives to use comparative advertising are determined by the quality of his product and the penalty that he is going to pay if the content of his advertising campaign is manipulative. In a similar vein, Emons and Fluet (2012) examine the signaling role of comparative advertising in a duopolistic market where both firms use comparative advertising to highlight their quality differential and the cost of advertising increases as the firms move away from the truth. Anderson and Renault (2009) investigate the informative comparative advertising in a quality disclosure game, where firms can use comparative advertising in order to reveal the products' horizontal match characteristics. They show that when the products are similar quality firms have incentives to advertise only their own goods. In contrast, when the products are of sufficiently different quality, only the low quality firm has incentives to use comparative advertising (if it is legal) in order to survive in the market. In addition, Anderson et al. (2010a,b) empirically investigating the advertising in the US over-the-counter analgetics market, show that almost the half of the advertising expenditures were comparative advertisements. More recently, Alipranti et al. (2013) examining firms' incentives to invest in comparative and informative advertising in oligopolistic markets with horizontal product differentiation, show that when the firms have on their set of marketing strategies both types of advertising, they invest in mixed advertising strategies that combine both informative and comparative advertising. Given the existed theoretical literature on the aspect of comparative advertising, the present work is novel in two dimensions. First, to the best of our knowledge, it is the first that explores the role of comparative advertising in the presence of networks externalities. Second, it is the first that provides results over the effects of strategic comparative advertising into the firms' endogenous locational decisions.

Finally, the present chapter is related to the literature on networks effects. This literature has its origins on the seminal paper of Veblen (1899) who has first introduce the idea of consumption externalities, by recognizing that the satisfaction obtained by the consumption of a particular good can be affected by the consumption choices of the other consumers. From then and on, an extensive literature on network externalities has been available. (see eg. Leibenstein, 1950; Katz and Sharipo, 1985; Economides, 1996; Grilo et al., 2001; Shy, 2001). Our work is closer related to the Grilo et al., (2001) who examine price competition in a spatial duopoly model with consumption externalities (classified as conformity or vanity). Similarly, Cintio (2007), investigates price competition in the presence of network effects using a spatial Hotelling model with linear transportation costs and endogenous firms' location decisions. Our work differs from the aforementioned papers, since it introduce into the model strategic comparative advertising. In particular, the present chapter provides results over the impact of the firms' comparative advertising expenditures on the firms' location choices and on the market outcomes.

The rest of the chapter is organized as follows. In Section 2, we present the basic model. In section 3, we adduce the equilibrium analysis of the benchmark case, where firms do not undertake any advertising activities, the case of comparative advertising in markets with network externalities, and the case of comparative advertising in markets without network externalities. Further, the comparison between the three cases is available in this section. Finally, section 4 concludes. All proofs are demonstrated in the Appendix.

2.2 The basic model

We consider a linear city with two firms, labelled $i = 1, 2$. The firms face a constant marginal cost of production, c, that for sake of simplicity has been normalized to zero (i.e, $c = 0$). The market is populated by a continuum of consumers with mass M, uniformly distributed over the unit-lenght interval. The firms' locations in the Hotelling line, are given respectively by, $y_1 \in [0, 1]$ and $y_2 \in [0, 1]$. Without loss of generality we assume that, $y_2 \geqslant y_1$, that means that, the good 1 is located left to the good 2. Each firm invests in comparative advertising in order to promote its own product and thus, to increase its demand. Following Anderson et al. (2010), comparative advertising has a push-me/pull-you effect, that is, it increases the consumers' valuation of the positively advertised product, while, at the same time, it decreases the consumers' valuation of the targeted product. The "net effect" of the firm i's investment in comparative advertising, X_i, is defined as follows,

$$X_i = x_i - (1 - y_2 + y_1)x_j, \; i, j = 1, 2, \; i \neq j. \tag{2.1}$$

where, x_i denotes firm i's expenditures on comparative advertising, while the coefficient $(1 - y_2 + y_1)x_j$ reflects the detrimental effect of the rival's firm expenditures on comparative advertising, x_j, and is proportional to the products' differentiation, or else, to the distance between the firms' locations. Notice here that, the detrimental effect of comparative advertising is at a minimum when the firms locate at the market endpoints (i.e., $y_2 = 1$, $y_1 = 0$), or else, when the products are independent. On the contrary, the detrimental effect of comparative advertising is at a maximum when firms share the same location (i.e., $y_2 = y_1$), or, else, when the products are perfect substitutes.

The market is characterized by network externalities, that means that, the consumers' utility increases as the number of the other individuals that consume the same product increase. As standard in the literature of spatial models, we assume that each consumer demands at most one unit of product and thus, he participates exclusively in one of the two incompatible networks that exist in the market. Each network is composed by each firm's clients, where, following Grilo et al. (2001), the excess utility that each consumer derives by his participation into the network, is given by, γn_i^e. The parameter γ, with $\gamma \geqslant 0$, measures the network effect while, n_i^e, denotes the number of the consumers that are expected to patronize the firm i's product. Thus, the utility that a consumer located at $\hat{s} \in [0, 1]$ derives is given by,

$$U_i = V + X_i - p_i - t(\hat{s} - y_i)^2 + \gamma n_i^e \tag{2.2}$$

where, V represents the gross intrinsic utility that a consumer derives by the consumption of one unit of product, and it is assumed to be large enough so that the market to be always covered. The parameter p_i is the price for good i, while $t > 0$ is the per unit transportation cost that a consumer incurs when purchases firm i's product. In line with D' Aspermont et al., (1979) in order to guarantee the equilibrium in the price stage, the transportation cost has been assumed to be quandratic. Further, as in Grilo et al. (2001), in order the consumers' expectations about the network size to be fulfilled in the equilibrium, the following condition must be satisfied,

Condition 1. $n_1 = n_1^e = \hat{s}M$ and $n_2 = n_2^e = (1-\hat{s})M$.

Throughout the chapter, we restrict our attention on markets where the network effects are not too strong compared to the product differentiation, that means that, the consumers evaluate more the products' features than the beneficial effect that their participation in the network generates. Thus, in order to exclude from our analysis upward sloping demands that lead to multiple subgame perfect equilibria the following assumption should holds, [3]

$$t(y_2 - y_1) - \gamma M > 0 \tag{2.3}$$

The cost of comparative advertising it is assumed to be quadratic, $C(x_i) = bx_i^2$, $i = 1, 2$, where, the parameter b reflects the effectiveness of the advertising technology. The higher the b is, the less effective is the advertising technology, or else, the higher is the cost of advertising.

We consider a four stage game with the following timing. In the first stage, firms decide their location. In the second stage, firms choose their investments in comparative advertising. In the third stage, firms compete by setting their prices. In the last stage, consumers after observing the firms' location, advertising and prices, allocate themselves to one of the two networks. We solve the game backwards by employing the Subgame Perfect Nash Equilibrium (SPNE) solution concept.

2.3 Equilibrium Analysis

2.3.1 The Benchmark Case

We begin our analysis by briefly presenting the benchmark case where in a market that is characterized by network externalities, firms do not have on their set of strategies advertising (i.e., $x_i = 0$, $i = 1, 2$ and, $X_i = 0$, $i = 1, 2$). Thus, firms compete in the market by choosing

[3] For an extended analysis of multiple subgame equilibria under conformity, see Grilo et al., 2001

their locations in the Hotelling line and then by setting their prices.[4]

Using, $U_0^n = U_1^n \Leftrightarrow V - p_1 - t(\hat{s}^n - y_1)^2 + \gamma n_1 = V - p_2 - t(\hat{s}^n - y_2)^2 + \gamma n_2$ and solving for $\hat{s}^n$, we obtain that the location of the indifferent consumer in the benchmark case is given by,

$$\hat{s}^n = \frac{(p_2 - p_1) + t(y_2^2 - y_1^2) - \gamma M}{2[t(y_2 - y_1) - \gamma M]} \tag{2.4}$$

Substituting (2.4) into the firms' profits, $\Pi_i = p_i n_i(p_1, p_2)$ and solving the game backwards, we have that in equilibrium the firms' locations, prices and profits are given, respectively, by,

$$y_1^n = -\frac{1}{4} , \, y_2^n = \frac{5}{4} \tag{2.5}$$

$$p_1^n = p_2^n = p^n = \frac{3t}{2} - \gamma M \tag{2.6}$$

$$\Pi_1^n = \Pi_2^n = \Pi^n = \frac{(3t - 2\gamma M)M}{4} \tag{2.7}$$

Observe here that, in line with Serfes and Zacharias (2011) in a market where two competing networks exist, the firms locate on the opposite sides of the market (i.e., maximum product differentiation). Intuitively, the existence of networks externalities in the market intensifies the market competition and leads firms to locate further apart, or else, to maximize the products' differentiation. Note also by the equations (2.6) and (2.7), that equilibrium prices and profits in markets with network externalities are lower than the standard d' Aspermont et al., (1979) equilibrium prices and profits. This is so, due to the fiercer market competition that the existence of network externalities generates. The following Lemma summarizes,

Lemma 4:

i) In a market with network externalities, there exists a subgame perfect Nash equilibrium where the firms' locations are given as in (2.5)

ii) The presence of networks externalities in a market increases the market competition and lead to lower prices and profits.

[4] This configuration reflects also the case where consumers perceive firm's comparative advertising campaing as manipulative and thus, as a non trustworthy source of information (see for details, Wilkie and Farris, 1975; Barone and Miniard, 1999). In this case, the results coinside with the ones obtain in this subsection.

2.3.2 Comparative Advertising in markets without networks externalities

We turn now to discuss the case where in a spatially differentiated duopoly market without network externalities the firms compete by choosing, their investment levels in comparative advertising, their locations, and their prices. Using $U_0^c = U_1^c$, we have that,

$$V + X_1 - p_1 - t(\hat{s}^c - y_1)^2 = V + X_2 - p_2 - t(\hat{s}^c - y_2)^2 \tag{2.8}$$

solving the above equation for $\hat{s}^c$, we obtain the location of the indifferent consumer,

$$\hat{s}^c = \frac{(p_2 - p_1) - (X_2 - X_1)}{2t(y_2 - y_1)} + \frac{y_2 + y_1}{2} \tag{2.9}$$

Clearly, the consumers that are located on the $[0, \hat{s}^c]$ interval buy good 1, while the opposite holds for the consumers that are located on the $[\hat{s}^c, 1]$. Further, as standard in the literature, one can easily observe that an increase in p_2 (respectively, p_1) shifts the position of the marginal consumer closer towards the right end (left, respectively) of the Hotelling line and thus, the demand for firm 2 (firm 1, respectively) increases.

In order to ensure that the location of the indifferent consumer $\hat{s}^c$ belongs in the $[0, 1]$ interval, the following inequality should holds,

$$t(y_2^2 - y_1^2) - (X_2 - X_1) < (p_2 - p_1) < (X_2 - X_1) + t(y_2 - y_1)(2 - y_2 - y_1) \tag{2.10}$$

The above inequality, specifies the all the possible pairs of prices, comparative advertising expenditures and locations for which the indifferent consumer belongs to the $[0, 1]$ interval and thus, the firms share the market as in (2.9). Outside of this area one of the two firms captures the entire market.

In the third stage of the game, the firms decide over their price, p_1 and p_2 in order to maximize their profits given respectively by,

$$\Pi_1 = p_1 n_1 - b x_1^2 \text{ with } n_1 = \hat{s}^c M \tag{2.11}$$

$$\Pi_2 = p_2 n_2 - b x_2^2 \text{ with } n_2 = (1 - \hat{s}^c) M \tag{2.12}$$

Solving the maximization problems, from the first order conditions, the prices on the third stage of the game are given respectively by,

$$p_1 = \frac{1}{3}[(x_1 - x_2)(2 + y_1 - y_2) + t(y_2 - y_1)(2 + y_1 + y_2)] \tag{2.13}$$

$$p_2 = \frac{1}{3}[(x_2 - x_1)(2 + y_1 - y_2) + t(y_2 - y_1)(4 - y_1 - y_2)] \tag{2.14}$$

Observe here that, the prices are increasing both in the transportation parameter, t, and in the products' differentiation. Further, the prices are increasing in the own firm's comparative advertising expenditures, while they are decreasing in the rival firm's investments in comparative advertising.

Substituting (2.13) and (2.14) into (2.11) and (2.12), respectively the profits in the third stage of the game are given by,

$$\Pi_1 = \frac{M[(x_1 - x_2)(2 + y_1 - y_2) + t(y_2 - y_1)(2 + y_1 + y_2)]^2}{18t(y_2 - y_1)} - bx_1^2 \tag{2.15}$$

$$\Pi_2 = \frac{M[(x_2 - x_1)(2 + y_1 - y_2) + t(y_2 - y_1)(4 - y_1 - y_2)]^2}{18t(y_2 - y_1)} - bx_2^2 \tag{2.16}$$

In the second stage of the game, firms, taking as given their locations decided in the first stage, choose, independently and simultaneously, their expenditures on comparative advertising in order to maximize their profits given in the (2.15) and (2.16).

Solving the maximization problems, from the first order conditions the following best reply functions arise,

$$x_1(x_2) = \frac{M(2 + y_1 - y_2)[x_2(2 + y_1 - y_2) - t(y_2 - y_1)(2 + y_1 + y_2)]}{M(2 + y_1 - y_2) - 18bt(y_2 - y_1)} \tag{2.17}$$

$$x_2(x_1) = \frac{M(2 + y_1 - y_2)[(x_2(2 + y_1 - y_2) + t(y_2 - y_1)(y_1 + y_2 - 4)]}{M(2 + y_1 - y_2) - 18bt(y_2 - y_1)} \tag{2.18}$$

Note here that in order the second order conditions be satisfied, the following condition should holds,

Condition 2. $t > \frac{M(2+y_1-y_2)^2}{18b(y_2-y_1)}$

Further, by the equations (2.17) and (2.18), we observe that $\frac{dx_1}{dx_2} = \frac{dx_2}{dx_1} = \frac{M(2+y_1-y_2)^2}{M(2+y_1-y_2)^2-18(y_2-y_1)} < 0$, that means that, the comparative advertising expenditures are being perceived by firms as strategic substitutes.

Solving the system of the best reply functions, the comparative advertising expenditures at the second stage are given by,

$$x_1 = \frac{M(2+y_1-y_2)[M(2+y_1-y_2)^2 - 3bt(y_2-y_1)(2+y_1+y_2)]}{6b[M(2+y_1-y_2)^2 - 9bt(y_2-y_1)]} \tag{2.19}$$

$$x_2 = \frac{M(2+y_1-y_2)[M(2+y_1-y_2)^2 + 3bt(y_2-y_1)(y_1+y_2-4)]}{6b[M(2+y_1-y_2)^2 - 9bt(y_2-y_1)]} \tag{2.20}$$

Observe here that the firms' expenditures on comparative advertising take the highest values, when the firms locate at the endpoints of the linear city (i.e., $y_1 = 0$, $y_2 = 1$), or in other words, when the products are independent, while they take the lowest values when firms share the same location (i.e., $y_1 = y_2$), or in other words, when the products are perfect substitutes. The rationale behind this result is based in the detrimental effect of comparative advertising on the rival's firm demand that is at a minimum when the products are independent, while it is at a maximum when the products are perfect substitutes. In more details, when the products are independent, the advertising message is being perceived by the consumers as mere self-promoting advertising. Thus, firms tend to invest more in advertising in order to increase the consumers' valuation over the product and therefore, to increase their demand. In contrast, a comparison between similar products generates strong denigrating effects and thus, firms tend to invest less in comparative advertising.

In the first stage of the game, firms compete by choosing their location in the Hotelling line, y_1 and y_2, with $y_1 + y_2 = 1$. Substituting (2.19) and (2.20) into (2.15) and (2.16) and solving the maximization problem, we obtain two sets of candidate equilibrium locations that are given as follows,

$$y_1^c = \frac{3\sqrt{bt(8M+9bt)} - 2M - 9bt}{4M} \tag{2.21}$$

$$y_2^c = \frac{6M + 9bt - 3\sqrt{bt(8M+9bt)}}{4M} \tag{2.22}$$

and

$$\hat{y}_1^c = -\frac{3\sqrt{bt(8M+9bt)}+2M+9bt}{4M} \tag{2.23}$$

$$\hat{y}_2^c = \frac{6M+9bt+3\sqrt{bt(8M+9bt)}}{4M} \tag{2.24}$$

Notice here that the second order conditions, are being satisfied only by the first set of the candidate equilibrium locations. Thus, in equilibrium the firms' locations are given as in the equations (2.21) and (2.22). Further, as standard in the literature, we observe that as the transportation cost increases firms tend to locate closer to each other. Notice also that, since an increase in the transportation cost leads firms to locate closer to each other, the detrimental effect of firm i's investments in comparative advertising on the firm j's demand increases.

Further, substituting (2.21), (2.22) into (2.19), (2.20), (2.13), (2.14), (2.15) and (2.16), the equilibrium comparative advertising expenditures, prices and profits are given respectively by,

$$x_1^c = x_2^c = x^c = \frac{\sqrt{bt(8M+9bt)}-3bt}{4b} \tag{2.25}$$

$$p_1^c = p_2^c = p^c = \frac{t[4M+9bt-3\sqrt{bt(8M+9bt)}]}{2M} \tag{2.26}$$

$$\Pi_1^c = \Pi_2^c = \Pi^c = \frac{t[4M+9bt-3\sqrt{bt(8M+9bt)}]}{8M} \tag{2.27}$$

Thus, from the condition 2, we have that for $t > \frac{M}{9b}$, there exist a subgame perfect Nash equilibrium where firms invest in comparative advertising. Further, we observe that in equilibrium firms' comparative advertising expenditures, prices and profits are positively related to the transportation cost parameter, t, while they are negatively connected to the advertising effectiveness parameter, b. The intuitions behind these results are given as follows. Clearly, the higher the transportation cost is, the closer to each other firms locate, or in other words, the lower is the products' differentiation that in turn, lead firms to invest more in comparative advertising in order to capture a competitive advantage over the rival, since the detrimental effect that comparative advertising has on the rival's firm demand increases. Further, with regard to the equilibrium profits two opposing effects stand. On the one hand, as the transportation cost increases, the price competition relaxes and thus, the profits tend to increase. On the other hand, as the transportation cost increases, the firms' investments in comparative advertising increase and thus, firms incur higher advertising costs that turns to decrease the profits. Clearly, in equilibrium the beneficial effect of the weaker price competition dominates the detrimental effect of the higher advertising costs and thus, the firms' profits increase as the transportation cost increase. The above analysis is summarized in the following Lemma,

Lemma 5:

i) For $t > \frac{M}{9b}$, there exists a perfect subgame Nash equilibrium where firms invest in comparative advertising.

ii) The equilibrium comparative advertising expenditures, prices and profits are decreasing in the advertising effectiveness parameter, b, while they are increasing in the transportation cost parameter, t.

2.3.3 Comparative advertising in markets with networks externalities

We proceed now with the analysis of our basic model where, in a market characterized by networks externalities, firms compete by choosing their location, comparative advertising investments and prices.

Using $U_1(\hat{s}) = U_2(\hat{s})$ we have that,

$$V + X_1 - p_1 - t(\hat{s} - y_1)^2 + \gamma n_1 = V + X_2 - p_2 - t(\hat{s} - y_2)^2 + \gamma n_2 \tag{2.28}$$

Solving the above equation for $\hat{s}$, we obtain the location of the indifferent consumer,

$$\hat{s} = \frac{(p_2 - p_1) - (X_2 - X_1) + t(y_2^2 - y_1^2) - \gamma M}{2[t(y_2 - y_1) - \gamma M]} \tag{2.29}$$

Clearly, the consumers that are located left in the $[0, \hat{s}]$ interval purchase the good 1, while the consumers that are located in the $[\hat{s}, 1]$ purchase the good 2.

In order to ensure that the location of the indifferent consumer, $\hat{s}$, belongs in the $[0, 1]$ interval, the following assumption should holds,

$$\gamma M - (X_2 - X_1) - t(y_2 - y_1)(2 - y_1 - y_2) < p_1 - p_2 < t(y_2^2 - y_1^2) - (X_2 - X_1) - \gamma M \tag{2.30}$$

Inequality (2.30) identifies all the possible price, comparative advertising expenditures and location combinations for which both firms exist in the market. Notice that when, $p_1 - p_2 \leqslant \gamma M - (X_2 - X_1) - t(y_2 - y_1)(2 - y_1 - y_2)$, firm 1 captures the entire market and thus, $n_1 = n$ and $n_2 = 0$, while the opposite holds when, $p_1 - p_2 \geqslant t(y_2^2 - y_1^2) - (X_2 - X_1) - \gamma M$.

In the third stage of the game, the firms choose their prices, $p_1$and p_2, such as to maximize their profits given by,

$$\underset{p_1}{Max}\ \Pi_1 = p_1 n_1 - bx_1^2 \text{ with } n_1 = \hat{s}M \tag{2.31}$$

$$\underset{p_2}{Max}\ \Pi_2 = p_2 n_2 - bx_2^2 \text{ with } n_2 = (1 - \hat{s})M \tag{2.32}$$

where, from the first order conditions, the prices in the third stage of the game are given as follows,

$$p_1 = \frac{1}{3}[(x_1 - x_2)(2 + y_1 - y_2) + t(y_2 - y_1)(2 + y_1 + y_2)] - \gamma M \tag{2.33}$$

$$p_2 = \frac{1}{3}[(x_2 - x_1)(2 + y_1 - y_2) + t(y_2 - y_1)(4 - y_1 - y_2)] - \gamma M \tag{2.34}$$

Notice here that the prices are decreasing in the network externality parameter, γ. That means that, as the intensity of the network effect becomes stronger the price competition in the market increases and thus, the prices decrease.

Substituting (2.33) and (2.34) into (2.31) and (2.32) the profits in the third stage of the game are given by,

$$\Pi_1 = \frac{M[3\gamma M + (x_1 - x_2)(2 + y_1 - y_2) + t(y_2 - y_1)(2 + y_1 + y_2)]^2}{18[t(y_2 - y_1) - \gamma M]} - bx_2^2 \tag{2.35}$$

$$\Pi_2 = \frac{M[3\gamma M + (x_2 - x_1)(2 + y_1 - y_2) + t(y_2 - y_1)(4 - y_1 - y_2)]^2}{18[t(y_2 - y_1) - \gamma M]} - bx_2^2 \tag{2.36}$$

In the second stage of the game, firms decide, independently and simultaneously, their investment levels in comparative advertising (x_1, x_2) in order to maximize their profits given respectively by, (2.35) and (2.36), Solving the maximization problems, from the first orders conditions the following reaction functions arise,

$$x_1(x_2) = \frac{M(2+y_1-y_2)[3\gamma M + x_2(2+y_1-y_2) - t(y_2-y_1)(2+y_1+y_2)]}{M[18b\gamma + (2+y_1-y_2)^2] - 18bt(y_2-y_1)} \tag{2.37}$$

$$x_2(x_1) = \frac{M(2+y_1-y_2)[3\gamma M + x_1(2+y_1-y_2) + t(y_2-y_1)(y_1+y_2-4)]}{M[18b\gamma + (2+y_1-y_2)^2] - 18bt(y_2-y_1)} \tag{2.38}$$

Note here that in order the second orders conditions to be satisfied the following condition should holds,

Condition 3. $t > \frac{M[18b\gamma+(2+y_1-y_2)^2]}{18b(y_2-y_1)}$

Further, by (2.37) and (2.38) we observe that $\frac{dx_1}{dx_2} = \frac{dx_2}{dx_1} = \frac{M(2+y_1-y_2)^2}{M[18b\gamma+(2+y_1-y_2)^2]-18bt(y_2-y_1)} < 0$, that means that, the comparative advertising expenditures are being perceived by firms as strategic substitutes.

Solving the system of the reaction functions, the comparative advertising expenditures in the second stage of the game are given by,

$$x_1 = \frac{M(2+y_1-y_2)[M(9b\gamma + (2+y_1-y_2)^2) - 3bt(y_2-y_1)(2+y_1+y_2)]}{6b[M(9b\gamma + (2+y_1-y_2)^2) - 9bt(y_2-y_1)]} \tag{2.39}$$

$$x_2 = \frac{M(2+y_1-y_2)[M(9b\gamma + (2+y_1-y_2)^2) + 3bt(y_2-y_1)(y_1+y_2-4)]}{6b[M(9b\gamma + (2+y_1-y_2)^2) - 9bt(y_2-y_1)]} \tag{2.40}$$

Comparing now the firms' investment levels in comparative advertising in markets that are characterized by network externalities with those obtained in the absence of network externalities given in (2.19) and (2.20) respectively, one can easily observe that the firms' investments in comparative advertising are higher in the presence of network externalities. Intuitively, the existence of network externalities intensifies the price market competition and thus, each firm tends to invest more in comparative advertising as an attempt to possess a competitive advantage over the rival and therefore, to increase its' market share.

In the first stage of the game, firms decide their locations in the Hotelling line, y_1 and y_2, with, $y_1+ y_2 = 1$. Substituting (2.39) and (2.40) into (2.35) and (2.36), and solving the maximization problems, we obtain two sets of candidate equilibrium locations given as follows,

$$y_1^* = \frac{3\sqrt{b(8Mt + 9bt^2 - 4\gamma M^2)} - 2M - 9bt}{4M} \tag{2.41}$$

$$y_2^* = \frac{6M + 9bt - 3\sqrt{b(8Mt + 9bt^2 - 4\gamma M^2)}}{4M} \tag{2.42}$$

and

$$\widehat{y}_1 = -\frac{3\sqrt{b(8Mt + 9bt^2 - 4\gamma M^2)} + 2M + 9bt}{4M} \tag{2.43}$$

$$\widehat{y}_2 = \frac{3[2M + 3bt + \sqrt{b(8Mt + 9bt^2 - 4\gamma M^2)}]}{4M} \tag{2.44}$$

Notice here that the condition 3 is being satisfied only by the first set of the candidate equilibrium locations. Thus, in equilibrium the location of firm 1 in the Hotelling line is given by the equation (2.41), while the location of firm 2 is given by the equation (2.42).

Further, we observe that, $\frac{\partial y_1^*}{\partial t} > 0$, $\frac{\partial y_2^*}{\partial t} < 0$, $\frac{\partial y_1^*}{\partial \gamma} < 0$, $\frac{\partial y_2^*}{\partial \gamma} > 0$, $\frac{\partial y_1^*}{\partial b} > 0$ and $\frac{\partial y_2^*}{\partial b} < 0$. Clearly, as standard in the literature, the higher the transportation cost is, the closer to each other the firms locate, or else, the lower the products' differentiation is.[5] On the contrary, the higher the network externalities parameter γ is, the further apart the firms locate, or else, the higher the products' differentiation is. This is so, since as the consumers' valuation over the network externalities increases, the price market competition becomes fiercer that leads firms to locate as far as possible in order to relax the fierce price market competition that the stronger network externalities generate in the market. In addition, one can easily check that the detrimental spillover effect that comparative advertising has on the rival's firm demand, i.e., $sp(y_1^*, y_2^*) = (1 - y_2^* + y_1^*) = \frac{3\sqrt{b(8Mt+9bt^2-4\gamma M^2} - 2M - 9bt}{2M}$, is decreasing both in the transportation cost coefficient, t, and the advertising effectiveness parameter, b, while it is increasing in the

[5] In particular, the comparative static effect of the transorpation cost parameter t into locational choices is given by:
$\frac{\partial y_1^*}{\partial t} = \frac{\frac{3b(8M+18bt)}{2\sqrt{b(8mt+9b-4\gamma M^2)}} - 9b}{4M} > 0$ $\qquad \frac{\partial y_2^*}{\partial t} = \frac{9b - \frac{3b(8M+18bt)}{2\sqrt{b(8mt+9b-4\gamma M^2)}}}{4M} < 0$ $\frac{\partial y_1^*}{\partial \gamma} = -\frac{3bM}{2\sqrt{b(8Mt+9bt^2-4\gamma M^2)}} < 0$, $\frac{\partial y_2^*}{\partial \gamma} = \frac{3bM}{2\sqrt{b(8Mt+9bt^2-4\gamma M^2)}} > 0$
and $\frac{\partial y_1^*}{\partial b} = \frac{\frac{3(8Mt+18bt^2-4\gamma M^2)}{2\sqrt{b(8Mt+9bt^2-4\gamma M^2)}} - 9t}{4M} > 0$, $\frac{\partial y_2^*}{\partial b} = \frac{9t - \frac{3(8Mt+18bt^2-4\gamma M^2)}{2\sqrt{b(8Mt+9bt^2-4\gamma M^2)}}}{4M} < 0$

network externalities parameter, γ, (i.e., $\frac{\partial sp^*}{\partial t} > 0, \frac{\partial sp^*}{\partial b} > 0, \frac{\partial sp^*}{\partial \gamma} < 0$).[6] Intuitively, as the transportation cost increases, the firms tend to locate closer to each other, or else, the product differentiation decreases. Therefore, the detrimental effect of the comparative advertising on the rival firm's demand increases, since the comparison between similar products becomes more effective. The opposite holds when the consumers' valuation over networks increases. The above discussion is summarized in the following Lemma,

Lemma 6:

i) The higher the transportation cost is, the lower the product differentiation will be and thus, the higher the detrimental effect of comparative advertising will be.

ii) The higher the valuation of consumers about networks is, the further apart firms will decide to locate and the lower the detrimental effect of comparative advertising will be.

iii) The less effective the comparative advertising is, the closer the firms will choose to locate.

Further, using (2.41) and (2.42), the equilibrium comparative advertising expenditures, prices and profits are given respectively by,

$$x_1^* = x_2^* = x^* = \frac{\sqrt{b(8Mt + 9bt^2 - 4\gamma M^2)} - 3bt}{4b} \tag{2.45}$$

$$p_1^* = p_2^* = p^* = \frac{t(4M + 9bt - 3\sqrt{b(8Mt + 9bt^2 - 4\gamma M^2)}) - 2\gamma M^2}{2M} \tag{2.46}$$

$$\Pi_1^* = \Pi_2^* = \Pi^* = \frac{1}{8}[t(4M + 9bt - 3\sqrt{b(8Mt + 9bt^2 - 4\gamma M^2)}) - 2\gamma M^2] \tag{2.47}$$

Thus, from the condition 3, in a market characterized by networks externalities, for $t > \frac{M}{9b} + \gamma M$, there exists a subgame perfect Nash equilibrium, where the firms invest positively in comparative advertising. Notice here that, given the condition 3, the extreme case of maximum product differentiation, $y_1 = 0$ and $y_2 = 1$, is not a Nash equilibrium, that means that, the firms will never choose to locate at the endpoints of the linear city.

[6] In particular, the comparative static effect of comparative advertising spillover is given by: $\frac{\partial sp^*}{\partial t} = \frac{\frac{3b(8M+18bt)}{2\sqrt{b(8mt+9bt^2-4\gamma M^2)}} - 9b}{2M} > 0$, $\frac{\partial sp^*}{\partial b} = \frac{\frac{3(8Mt+18bt^2-4\gamma M^2)}{2\sqrt{b(8mt+9bt^2-4\gamma M^2)}} - 9t}{2M} > 0$, $\frac{\partial sp^*}{\partial \gamma} = -\frac{3bM}{\sqrt{b(8Mt+9bt^2-4\gamma M^2)]}} < 0$.

Proposition 6 *For $t > \frac{M}{9b} + \gamma M$, there exists a (subgame-perfect) symmetric location equilibrium where, the firms' locations are given by (2.41) and (2.42), while the prices and the comparative advertising expenditures are given respectively by (2.46) and (2.45).*

Clearly, given symmetric locations, in equilibrium the firms will choose the same comparative advertising expenditures and prices. Thus, in line with existing literature (e.g., Tabuchi, 1994; Veendorp and Majeed, 1995; Irmen and Thisse, 1998; Piga and Theotoky, 2001), when firms compete in multi-characteristics space they maximize their differentiation in one dimension (in our case, location), while they minimize their differentiation in all the others (i.e., advertising, price). Further, by (2.45), (2.46) and (2.47), we observe that the equilibrium comparative advertising expenditures, prices and profits are positively related to the transportation parameter, t, while they are negatively related to the network externalities parameter, γ, and the advertising effectiveness parameter, b (i.e., $\frac{\partial x^*}{\partial \gamma} < 0$, $\frac{\partial x^*}{\partial b} < 0$, $\frac{\partial x^*}{\partial t} > 0$, $\frac{\partial p^*}{\partial \gamma} < 0$, $\frac{\partial p^*}{\partial b} < 0$, $\frac{\partial p^*}{\partial t} > 0$, $\frac{\partial \Pi^*}{\partial \gamma} < 0$, $\frac{\partial \Pi^*}{\partial b} < 0$ and $\frac{\partial \Pi^*}{\partial t} > 0$).[7] Interestingly, in contrast to Kretschmer and Rosner (2010) that suggest that when firms are located symmetrically in the Hotelling line their advertising expenditures are not affected by the networks externalities, we show that the firms' comparative advertising expenditures decrease as the consumers' valuation over the network size increases. Intuitively, as the intensity of networks externalities increases, the price market competition intensifies and leads firms to locate further apart, or in other words, leads to higher product differentiation. Thus, firms tend to decrease their expenditures on comparative advertising, since the denigration effect of a comparison between unrelated products is lower.

Proposition 7 *In a market that is characterized by network externalities, the equilibrium investments in comparative advertising, prices and profits are increasing in the transportation cost parameter, t, while they are decreasing in the network externalities parameter, γ, and the advertising effectiveness parameter, b.*

Proof. See Appendix B1.1 ■

[7] For the extended presentation see at the Appendix B1.1

2.3.4 Comparative Results

We turn now to compare the equilibrium outcomes obtained in a market with network externalities where firms undertake comparative advertising activities, with those obtained in a market without network externalities and those of the benchmark case.

Starting with the firms' location choices under the three cases, we show that, $y_1^n < y_1^* < y_1^c$ and $y_2^n > y_2^* > y_2^c$. [8] That means that, the fiercer market competition due to the presence of networks externalities in a market leads firms to locate further apart, while the use of comparative advertising leads firms to locate closer to each other in order to enlarge their market share by targeting the rival product. In more details, the comparison of the benchmark case without advertising activities with our basic model reveals the two alternative forces that drive our basic results. In particular, for a high enough transportation cost, the firms' investments in comparative advertising force firms to locate closer to each other. In contrast, the fiercer market competition due to the network externalities force firms to locate further apart. In equilibrium, we show that $y_1^n < y_1^*$ and $y_2^n > y_2^*$, that means that, the centripetal force of comparative advertising dominates the centrifugal force of networks externalities and leads firms to locate closer to the each other, or alternatively, leads to lower product differentiation.

Regarding the equilibrium prices and profits, comparing (2.46), (2.47) with (2.26), (2.27) and (2.6), (2.7), we have that $p^n > p^c > p^*$ and $\Pi^n > \Pi^c > \Pi^*$.[9] Obviously, the network externalities in the market along with the use of comparative advertising intensify the price market competition and thus, the prices and the profits in the market decrease. Given the above discussion one can easily observe that the use of comparative advertising leads firms to a prisoner's dilemma situation, where they end up worse off in terms of profitability. Further, we show that, $x_i^* > x_i^c$, that means that, the fiercer market competition due to the presence of network externalities in a market intensifies the firms' advertising competition and leads firms to invest more in comparative advertising.

[8] For proof see at the Appendix B1.2

[9] For proof see at the Appendix B1.2

Proposition 8 *i) The firms' location distance takes the highest value in the benchmark case without firms' advertising activities, the lowest in the comparative advertising without network externalities case, while it lies in between in the comparative advertising with network externalities case.*

ii) The equilibrium prices and profits when firms invest in comparative advertising in markets that are characterized by networks externalities are always lower than those obtained in markets without network externalities and those of the benchmark case without advertising activities.

Proof. See Appendix B1.2 ■

2.4 Conclusions

The present chapter investigates the firms' incentives to invest in comparative advertising in a spatially differentiated duopoly market characterized by network externalities, taking as basic premise that the detrimental effect of each firm's comparative advertising expenditures to the rival's firm demand is proportional to the location distance between firms, or else, to the products' differentiation.

We argue that for a sufficiently high transportation cost the firms have strong incentives to undertake comparative advertising activities. This is so, since each firm is willing by investing in comparative advertising to obtain a competitive advantage over the rival firm via the denigrating effect that this type of advertising has on the rival's firm product. Further, we show that in equilibrium firms are symmetrically located within the edges of the linear city, with the firms' location distance to be decreasing in the transportation cost, while increasing in the intensity of networks externalities and in the effectiveness of the advertising technology. Thus, we reconfirmed that, as standard in the literature, the higher the transportation cost is, the closer to each other the firms locate. In addition, we demonstrate that the presence of network externalities in the market, intensifies the market competition and thus, it leads firms to locate further apart. Regarding the effectiveness of the comparative advertising, our results reveal that the more effective the comparative advertising is, the further apart the firms will choose to locate. This is so, because the firms are willing by increasing the differentiation of the products to outweigh the detrimental effect that the rival's comparative advertising generates.

Moreover, we show that the firms' comparative advertising expenditures are positively connected to the transportation cost, while they are negatively connected to the intensity of network effects. Thus, contrary to Kretschmer and Rosner (2010) that suggest that, when the firms are symmetrically located, their advertising expenditures are not affected by the networks effects, we demonstrate that the firms' investments in comparative advertising decrease as the consumers' valuation over the network size increases. Clearly, as the consumers' valuation over the network size increases, the firms will choose to locate further apart that in turn, leads firms to decrease their expenditures in comparative advertising, since a comparison between unrelated products is less effective.

Yet, we demonstrate that the firms' investments in comparative advertising, intensify the market competition and lead to lower prices and profits than those obtained in the benchmark case, without firms' advertising activities. Thus, comparative advertising can be characterized as "wasteful advertising", since it leads to a prisoners' dilemma situation where the firms are worse off in terms of profitability. Lastly, we show that the equilibrium firms' investment levels in markets with network externalities always exceed those obtained in markets without network externalities. This is so, due to the fiercer market competition that the presence of network externalities generates.

Throughout the chapter we have restricted our attention in markets where the network effects are not too strong compared to the product differentiation. In other worlds, we have restricted our attention in markets where the consumers evaluate more the product's characteristics than the network size of the product. Thus, it would be interesting enough to extend our analysis in markets where the consumers evaluate more the product's network size than its' characteristics.

Further, our findings provide some guidelines for future empirical research on the effects of firms' investments in comparative advertising when the markets are characterized by network externalities, that is so far scare. Our analysis give rise to a number of testable hypothesis that should be empirically checked. A first testable hypothesis could be that the firms' investments in comparative advertising may increase competition in a market that is characterized by network effects and therefore decrease the prices and firms' profitability in a given industry. Another testable hypothesis could be that the probability of a firm to engage in comparative advertising is higher in industries with network externalities than the respective one in markets that are not characterized by network externalities.

Appendix B

Appendix B1.1 Extended presentations of the equations regarding Proposition 7

Taking into account how the equilibrium firms' investment levels alter with respect to the network externalities parameter, γ, the advertising effectiveness technology parameter, b and transportation cost parameter, t, we have that,

$$\frac{\partial x^*}{\partial \gamma} = -\frac{M^2}{2\sqrt{b(8Mt + 9bt^2 - 4\gamma M^2)}} < 0$$

$$\frac{\partial x^*}{\partial b} = -\frac{2Mt - \gamma M^2}{2b\sqrt{b(8Mt + 9bt^2 - 4\gamma M^2)}} < 0$$

$$\frac{\partial x^*}{\partial t} = \frac{\frac{b(8M+18bt)}{2\sqrt{b(8Mt+9bt^2-4\gamma M^2)}} - 3b}{4b} > 0$$

Taking into account how the equilibrium prices alter with respect to the network externalities parameter, γ, the advertising effectiveness technology parameter, b and transportation cost parameter, t, we have that,

$$\frac{\partial p^*}{\partial \gamma} = \frac{\frac{6btM^2}{\sqrt{b(8Mt+9bt^2-4\gamma M^2)}} - 2M^2}{2M} < 0$$

$$\frac{\partial p^*}{\partial b} = \frac{t[9t - \frac{3(t(4M+9bt)-2\gamma M^2)}{\sqrt{b(8Mt+9bt^2-4\gamma M^2)}} - 2M^2]}{2M} < 0$$

$$\frac{\partial p^*}{\partial t} = \frac{4M + 9bt - 3\sqrt{b(8Mt + 9bt^2 - 4\gamma M^2)} + t(9b - \frac{3b(4M+9bt)}{\sqrt{b[t(8M+9bt)-4\gamma M^2}})}{2M} > 0$$

Taking into account how the equilibrium firms' profits alter with respect to the network externalities parameter, γ, the advertising effectiveness technology parameter, b and transportation cost parameter, t, we have that,

$$\frac{\partial \Pi^*}{\partial \gamma} = \frac{6btM^2}{8\sqrt{b(8Mt+9bt^2-4\gamma M^2)}} - \frac{M^2}{4} < 0$$

$$\frac{\partial \Pi^*}{\partial b} = \frac{1}{8}t[9t - \frac{3(8Mt-4\gamma M^2+18bt^2)}{2\sqrt{b(8Mt+9bt^2-4\gamma M^2)}}] < 0$$

$$\frac{\partial \Pi^*}{\partial t} = \frac{4M+9bt-3\sqrt{b(8Mt+9bt^2-4\gamma M^2)}+t(9b-\frac{3b(4M+9bt)}{\sqrt{b[t(8M+9bt)-4\gamma M^2}})}{16M} > 0$$

Appendix B1.2: Proof of proposition 8

We calculate the firms' location difference between the case of a market characterized by network externalities, given in (2.41), and the case of a market that is not characterized by network externalities, given in (2.21),

$$y_1^* - y_1^c = \frac{3[\sqrt{b(8Mt+9bt^2-4\gamma M^2} - \sqrt{bt(8M+9bt)}]}{4M} < 0$$

$$y_2^* - y_2^c = \frac{3[\sqrt{bt(8M+9bt)} - \sqrt{b(8Mt+9bt^2-4\gamma M^2}]}{4M} > 0$$

From the above equations it can be easily checked that, under Assumption 1 and the Conditions 2 and 3, for all the given values of t, γ and b, $y_1^* - y_1^c < 0$ and thus, $y_1^* < y_1^c$ while, $y_2^* - y_2^c > 0$ and thus, $y_2^* > y_2^c$.

Further, the firms' location difference between the case where firms invest in comparative advertising and the market is not characterized by network externalities, given in (2.21), and the benchmark case, given in (2.5),

$$y_1^c - y_1^n = \frac{3\sqrt{bt(8M+9bt)}+6M+9bt}{4M} > 0$$

$$y_2^c - y_2^n = -\frac{3\sqrt{bt(8M+9bt)}-M-9bt}{4M} < 0$$

From the above equations it can be easily checked that under our Assumption 1 and the Conditions 2 and 3, for all the given values of t, γ and b, $y_1^c - y_1^n > 0$ and thus, $y_1^n < y_1^c$, while

$y_2^c - y_2^n < 0$ and thus, $y_2^n > y_2^c$. Thus, we have that in the equilibrium, $y_1^n < y_1^* < y_1^c$ and $y_2^n > y_2^* > y_2^c$.

We calculate the price differential between the case of a market characterized by network externalities, the case of a market the is not characterized by network externalities and the benchmark case and we have that,

$$p^* - p^n = \frac{Mt + 9bt^2 - 3t\sqrt{b(8Mt + 9bt^2 - 4\gamma M^2)}}{2M} < 0$$

$$p^* - p^c = \frac{3t\sqrt{bt(8M + 9bt)} - 3t\sqrt{b(8Mt + 9bt^2 - 4\gamma M^2)} - 2M^2 t}{2M} < 0$$

$$p^c - p^n = \frac{2\gamma M^2 + Mt + 9bt^2 - 3t\sqrt{bt(8M + 9bt)}}{2M} < 0$$

Thus, from the above equations, for all the given values of t, γ and b, $p^b > p^c > p^b$ holds.

Bibliography

[1] Alipranti, M., Mitrokostas, E., Petrakis, E., 2013. Comparative versus Informative Advertising in Oligopolistic Markets. Department of Economics, University of Crete, Working Paper Series, No: 2013-01.

[2] Aluf, Y., Shy, O., 2001. Comparison advertising and competition. Mimeo, University of Haifa.

[3] Anderson, S.P., Renault R., 2009. Comparative Advertising: disclosing horizontal match information. The Rand Journal of Economics 40, 558-581.

[4] Anderson, S.P., Ciliberto F., Liaukonte J., 2010. Getting into Your Head(Ache): The Information Content of Advertising in the Over-the-Counter Analgesics Industry. Mimeo, University of Virginia.

[5] Anderson, S.P., Ciliberto F., Liaukonte J., Renault R., 2010. Push-Me Pull-You: Comparative Advertising in the OTC Analgesics Industry. Mimeo, University of Virginia.

[6] Barigozzi, F., Garella, P.G., Peitz, M., 2009. With a Little Help from my Enemy: Comparative Advertising as a Signal of Quality. Journal of Economics and Management Strategy 18, 1071-1094.

[7] Barone, M.J., Miniard, P.W., 1999. How and When Factual Ad Claims Mislead Consumers: Examining the Deceptive Consequences of Copy X Copy Interactions for Partial Comparative Advertisements. Journal of Marketing Research 36(1), 58-74.

[8] Cintio, M., 2007. A note on the Hotelling principle of minimum differentiation: Imitation and crowd. Research in Economics 61, 122-129.

[9] Clark, C. R., Horstmann I. J., 2005. Advertising and Coordination in Markets with Consumption Scale Effects. Journal of Economics and Management Strategy 14 (2), 377-402.

[10] d'Aspermont, C., Gabszewicz, J.J., Thisse, J.F., 1979. On Hotelling's stability in competition. Econometrica 47, 1145-1150.

[11] Economides, N., 1996. The economics of networks. International Journal of Industrial Organization 14(4), 673-699.

[12] Emons W., Fluet C., 2012. Non-comparative versus Comparative Advertising as a Quality Signal. International Journal of Industrial Organization 30, 352-360.

[13] Grilo, I., Shy, O., Thisse, J.F., 2001. Price competition when consumer behavior is characterized by conformity or vanity. Journal of Public Economics 80, 385-408.

[14] Hotelling, H., 1929. Stability in competition. Economic Journal 39, 41-57.

[15] Irmen, A., Thisse, J.F., 1998. Competition in multi-characteristics spaces: hotelling was almost right. Journal of Economic Theory 78, 76-102.

[16] Katz, M., and Shapiro, C., 1985. Network externalities, competition and compatibility. American Economic Review 75(3), 424-439.

[17] Kretschmer, T., Rosner, M., 2010. Increasing Dominance - the Role of Advertising, Pricing and Product Design. Mimeo, University of Munich.

[18] Leibenstein, H., 1950. Bandwagon, snob and Veblen effects in the theory of consumers' demand. Quarterly Journal of Economics 64, 183-207.

[19] Pastine, I., Pastine T., 2002. Consumption Externalities, Coordination and Advertising. International Economic Review 43(3), 919-943.

[20] Pastine, I., Pastine T., 2011. Coordination In Markets With Consumption Externalities: Advertising And Product Quality. Manchester School 79(1), 45-62.

[21] Piga, C., Poyago-Theotoky, J., 2005. Endogenous R&D spillovers and locational choice. Regional Science and Urban Economics 35, 127- 139.

[22] Pigou, A.C., 1924. The Economics of Welfare. London: Micmillan and Co., Limited. Second Edition.

[23] Serfes, K., Zacharias, E., 2012. Location Decisions of Competing Networks. Journal of Economics & Management Strategy 21, 989-1005.

[24] Shy, O., 2001. The Economics of Network Industries. Cambridge University Press.

[25] Tabuchi, T., 1994. Two-stage two-dimensional spatial competition between two firms. Regional Science and Urban Economics 24, 207-227.

[26] Veblen, T., 1899. In: The Theory of the Leisure Class. An Economic Study of Institutions, Macmillan, London.

[27] Veendorp, E.C.H., Majeed, A., 1995. Differentiation in a two-dimensional market. Regional Science and Urban Economics 25, 75- 83.

[28] Wilkie, W.L., Farris, P.W., 1975. Comparative Advertising: Problems and Potential. Journal of Marketing 39, 7-15.

Chapter 3

The Speed of Technological Adoption under Price Competition: Two-tier vs. One-tier Industries

3.1 Introduction

It is well established that technological innovation, as well as, the speed of the adoption of a new technology are fundamental determinants of economic development and growth, since they crucially affect the markets' performance, productivity and efficiency (Krugman, 1994). However, theoretical and empirical studies suggest that the speed of the technology adoption differs significantly not only, across nations but also, across similar firms and industries, since the firms' incentives to adopt a new technology, as well as, the timing of the adoption crucially depend on the market features, such as the market structure, the intensity of the market competition, the market's power distribution, etc. (see e.g., Klette, 1996; Klenow and Rodriguez-Clare, 1997; Griliches, 1998; Sutton, 1998; Hall and Jones, 1999; Gotz, 1999; Caselli, 2005; Klette and Kortum, 2004; Milliou and Petrakis, 2011). According to empirical observations (see e.g., Lane, 1991; Charlsson and Jackobsson, 1994; Helper, 1995) the vertical relations in a market, such as the customers/suppliers relations, significantly affect the firms' decisions to adopt a new technology with closer relations and "relational contracting" to enhance the firms' incentives to adopt a new technology.

In this chapter, we investigate the firms' incentives to adopt a new cost reducing technology in vertically related markets under alternative upstream market structures (i.e., upstream separate firms market structure, upstream monopolistic market structure), as well as, the effects of the vertical relations on the firms' timing of the technology adoption. In particular, the present chapter aims to answer the following three questions. First, are there any downstream firms' incentives to adopt a new cost reducing technology in vertically related markets? Second, how does the timing of the technology adoption differs between alternative industry structures (i.e, one-tier vs. two-tier industries)? Third, how do the different upstream market structures (i.e., upstream monopoly vs. upstream separate firms market structure) affect the speed of the technology adoption?

To address the above questions, we consider a vertically related industry consisted either by two upstream and two downstream firms or by an upstream monopolist and two downstream firms. The trade relations between the upstream and downstream firms in the two by two scenario has been assumed to be exclusive, while trade is conducted via two-part tariffs contracts. Downstream firms are initially endowed with the same production technology when a new cost reducing technology appears in the market. If a downstream firm adopts the new technology first in the market, it achieves a competitive advantage over its rival due to the lower marginal cost of production that the adoption of the new technology implies. Instead, if a downstream firm adopts the new technology on a later date, it enjoys lower adoption costs either due to economies of learning or basic research adoption process innovation. The sequence of the moves are given as follows. At the initial date $t = 0$, downstream firms precommit to a specific technology adoption date at which the technological change will be fully implemented. At each date $t \geqslant 0$, there are two stages. In the first stage, upstream firm(s) negotiates, independently and simultaneously, with the downstream firm(s) over the trading contract terms. In the second stage, downstream firms compete by setting their prices.

We show that, in vertically related markets, independently of the upstream market structure, downstream firms always have strong incentives to adopt the new technology. Further, in line with the one-tier industries, we demonstrate that in equilibrium there exists technological diffusion, that means that, the speed of the technology adoption alters significantly between similar firms of the same industry. Moreover, we argue that the timing of the technology adoption in two-tier versus that of the one-tier industries alters significantly with regard to the intensity of the market competition, the drasticity of the new technology on reducing the downstream firms' marginal cost of production and the bargaining power distribution in the market. In particular, we show that independently of the upstream market structure, in vertically related markets technology adoption occurs earlier than in a one-tier industries, if and only if, the bargaining power of the upstream firm(s) is low enough, the final market competition is fierce enough and the new technology is not extremely drastic. The intuition behind this result is driven by two opposing effects that the vertical relations in a market generate, namely, the output effect and the subsidization effect. In more details, under vertically related markets the wholesale prices that the downstream firms pay to their respective upstream partner(s) lead to higher prices than those obtained under one-tier industries and therefore, given the negative price-output relationship, lead to lower firms' output production. Clearly, the lower firms' output production in the vertically related markets, or, in other words, the output effect of the vertical relations, tends to diminish the firms' speed of adoption of the new technology, since the cost reduction of the new technology will be applied to a lower volume of production. Further, the vertical relations in a market give rise to the subsidization effect, that captures the fact that when the upstream firm(s) possess low bargaining power in the market, the downstream firms are being subsidized by the upstream(s) via the fix fees. The latter along with the fact that the subsidies are higher when the downstream firms adopt the new technology, makes the adoption of the new technology under vertically related markets more attractive and thus, it tends to increase the downstream firms' speed of the adoption. Clearly, when the bargaining power of the upstream firm(s) is low enough, the final market competition is fierce enough and the new technology is not too drastic the subsidization effect dominates the output effect and thus, the downstream firms' adoption of the new technology takes place earlier in two-tier industries than in the one-tier ones.

As far as the effects of the alternative upstream market structures on the speed of the technology adoption are being considered, we show that independently of the upstream(s) bargaining power in the market, under upstream monopolistic market structure the first technology adoption takes place earlier than under upstream separated firms market structure, if and only if, the drasticity of the new technology is sufficiently high and the final market competition is fierce enough. Interestingly enough, this finding suggests that a more competitive upstream market sector, such as separated upstream firms does not always force the speed of the downstream firms adoption of the new technology.

There is an extensive theoretical literature that examines the firms' timing of technology adoption and the diffusion of a new technology in alternative markets (see for example, Reinganum, 1981a&b; 1983a&b; Fudenberg and Tirole, 1985; Hendricks, 1992; Riordan, 1992; Hoppe and Lehmann-Grube, 2001; Ruiz-Aliseda and Zemsky, 2006; Milliou and Petrakis 2011). In particular, Reinganum (1981a, 1983a&b) was the first to show that in a market with homogenous products and Cournot competition a new technology is diffused over the time when the firms precommit to specific dates of adoption. Similarly, Gotz (1999) demonstrates that in a market with differentiated products firms adopt the new technology at different dates, while increased competition promotes the diffusion. More recently, Milliou and Petrakis (2011), show that the timing of the adoption of a new technology could differ significantly not only, among similar firms but most importantly, among markets with alternative market features (i.e., mode of competition, the degree of product substitutability). In more details, they demonstrate that technology adoption can occur earlier in a market with Cournot competition than in a market with Betrand competition, while it can also occur earlier in markets where the products are not close substitutes. However, to the best of our knowledge, all of the existed theoretical research and analysis over the firms' timing of adoption and the diffusion of a new technology has been restricted in one-tier industries. Thus, the present chapter extends the existed literature by examining the firms' timing of adoption in vertically related markets, under alternative upstream market structures, in order to analyze how the vertical relations, as well as, the alternative upstream markets structures affect not only, the firms' incentives to adopt a new technology but also, the speed of the firms' adoption of the new technology comparing to that of the one-tier industries.

Further, this work is related to the limited empirical literature that examines the effects of the vertical relations and in particular, the effects of the customers/suppliers relationships over the firms' adoption of a new technology. Dore (1983, 1986) has provided some evidences that show that the increased security and trust between customers and suppliers in the Japanese market due to "relational contracting" lead to more technology investment and more rapid flow of the technology information. Lane (1991) has examined the adoption of Continuous Mining Machines (CMM) in the U.S. coal industry and found that the companies that are vertically integrated to their costumers are more likely to adopt the CMM technology. Carlsson and Jacobsson (1994) have analyzed the adoption of the Automazation Technological Systems (ATS) in the Swedish engineering industry and demonstrated that the adoption of ATS is higher when customers/suppliers relations are closer. Helper (1995) has examined the adoption of Computer Numerical Control technology (CNC) in the U.S. automotive industry and showed that the closer suppliers/customers relations enhance the adoption of CNC. Although the aforementioned literature focuses on the relationship between the technology adoption and the consumers/suppliers relations in a market, it provides some initial evidences that vertical relations crucially affect the firms' decision to adopt an new technology. Thus, the present chapter aims to contribute to that literature by providing a number of testable implications that could be tested empirically regarding to the role of the vertical relations (i.e., input suppliers/ manufactures relations) on the adoption of a new technology, as well as, on the speed of the adoption.

The remainder of the chapter is organized as follows. In Section 2, we present our main model. In section 3, we analyze and compare the firms' technology adoption patterns in one-tier industries and in vertically related markets with either upstream separated firms market structure or upstream monopolistic market structure. In Section 4 we examine the robustness of our results when the downstream market competition takes place in quantities. In Section 5, we conclude. All the proofs are relegated to the Appendix.

3.2 The basic model

We consider a two-tier industry consisting initially by two upstream and two downstream firms denoted by U_i and D_i, respectively, with $i = 1, 2$. Upstream firms are input providers with their marginal production cost being normalized to zero. Downstream firms are final good manufactures, where one unit of input is being transformed to one unit of final good. Trade relations between U_i and D_i are exclusive and trading is conducted via two part tariffs contracts

(w_i, F_i), where w_i denotes the wholesale price that D_i pays per-unit of input to U_i, while F_i is the fixed fee. Each D_i sells its' final good to the consumers facing the following demand function,

$$q_i = \frac{(\alpha - p_i) - \gamma(\alpha - p_j)}{1 - \gamma^2}, \quad i, j = 1, 2; \; i \neq j; \; 0 < \gamma \leqslant 1 \tag{3.1}$$

where q_i and p_i are respectively D_i's output and price. The parameter γ denotes the degree of the product substitutability. The higher is γ, the closer substitutes are the final products, or in other words, the fiercer is the final market competition (Vives, 1985).

We assume a continuous and infinite time horizon denoted by, $t \geqslant 0$. Initially, downstream firms are endowed with the same constant returns to scale production technology with their marginal production cost given by $c_i = c + w_i$, where c, $0 < c < \alpha$, denotes an exogenous constant marginal cost. At date $t = 0$, a new cost-reducing technology becomes available in the market. If D_i adopts the new technology, it decreases its marginal production cost by Δ, that is, $c_i = w_i + c - \Delta$ with, $0 < \Delta < c$. The cost that firm D_i incurs at date t for adopting the new technology, is given by $k(t)$. This cost combines both the present value of the cost of purchasing the new technology and the adjustment cost of bringing the new technology on line at date t, that is given by $k(t)e^{rt}$, where r, denotes the interest rate, $0 < r < 1$. In line with, Fudenberg and Tirole (1985) and Katz and Sharipo (1987), we assume that the cost of adopting the new technology is decreasing over the time with a decreasing rate (i.e., $(k(t)e^{rt})' > 0$ and $(k(t)e^{rt})'' > 0$). Further, we assume that immediate technology adoption is prohibited due to extremely high cost (i.e., $\lim_{t \to 0} k(t) = \infty$), while the technology adoption always occur at a finite time (i.e, $\lim_{t \to 0} k(t) = \infty$). Last, as standard in the relevant literature, we assume that no other technological improvements are available in the market.

We consider two alternative scenarios with regard to the upstream market structure named as, the upstream separate firms case (in terms of notation, ST) and the upstream monopoly case (in terms of notation, MT) where, in the latter case, the upstream market sector is being monopolized by a single firm that trades with both downstream firms separately and simultaneously. The sequence of the moves under both cases is given as follows. At date $t = 0$, each downstream firm D_i precommits on a specific adoption date, T_i, at which the technological change will be fully implemented. At each date $t \geqslant 0$, there are two distinct stages. In the first stage, the upstream firm(s) negotiates with their respective downstream partners over the trading contract terms (w_i, F_i). For sake of simplicity, we assume that the distribution of the bargaining power across the vertical chains is identical, with the bargaining power of the upstream firm(s) given by β and the bargaining power of the downstream firms given by $1-\beta$, with $0 \leqslant \beta \leqslant 1$. In the second stage, downstream firms compete by setting their prices. We solve the games backwards by employing Subgame Perfect Nash Equilibrium with stationary strategies.

In order to ensure that all the participants in the market are active under all the configurations considered the following assumption should hold throughout the chapter:

Assumption 1. $\gamma < \gamma(\delta)$, where $\gamma(\delta) = [-(1+\delta) + \sqrt{8+(1+\delta)^2}]$ with $\delta = \Delta/A$ and $A = a - c$.

where, the parameter A measures the relative size of the market, while the parameter δ denotes how drastic is the technological improvement, or, in other words, the effectiveness of the new technology on decreasing the firms' marginal production cost relatively to the market size. The higher is δ, the more effective is the technological improvement in decreasing D_i's marginal cost of production.

3.3 Equilibrium Analysis

3.3.1 The Benchmark Case: One-tier Industry

We begin our analysis by briefly presenting the benchmark case that corresponds to the case of one-tier industries where, in line with Milliou and Petrakis (2011), in a duopoly market the firms decide the date of the adoption of the new technology and then, they compete by setting their price. Thus, at date $t \geqslant 0$, each firm i chooses its price p_i, taking as given the decision over the price of the rival firm p_j, in order to maximize its per -period gross profits,

$$\underset{p_i}{Max}\ \pi_i^B(.) = (p_i - c_i)\frac{(a-p_i) - \gamma(a-p_j)}{1-\gamma^2} \tag{3.2}$$

The first order conditions give rise to the following reaction functions,

$$R_i^B(.) = \frac{(1-\gamma)\alpha + c_i + \gamma p_j}{2} \tag{3.3}$$

Thus, the per-period prices and the firm i's gross profits are given respectively by,

$$p_i^B(c_i, c_j) = \frac{(2+\gamma)(1-\gamma)a + 2c_i + \gamma c_j}{4-\gamma^2}, \quad \pi_i^B(.) = \frac{[p_i^B(c_i, c_j) - c_i]^2}{(1-\gamma^2)} \tag{3.4}$$

Observe here that when firm i adopts the new cost reducing technology (i.e., $c_i = c - \Delta$) both its' own price, p_i^B, and the rival's firm price, p_j^B, decrease.

At the date $t = 0$, firms precommit to their adoption time T_i^B, in order to maximize their discounted sum of profits, $\Pi_i^B(T_i^B, T_j^B)$. Without loss of generality, we assume throughout the chapter that when firms adopt the new technology sequentially, then firm 1 adopts it first. The discounted sum of profits are given by,

$$\underset{T_1^B}{Max}\ \Pi_1^B(.) = \int_0^{T_1^B} \pi_0^B e^{-rt}dt\ + \int_{T_1^B}^{T_2^B} \pi_l^B e^{-rt}dt\ + \int_{T_2^B}^{\infty} \pi_b^B e^{-rt}dt - k(T_1^B) \tag{3.5}$$

$$\underset{T_2^B}{Max}\ \Pi_2^B(.) = \int_0^{T_1} \pi_0^B e^{-rt}dt\ + \int_{T_1^B}^{T_2} \pi_f^B e^{-rt}dt\ + \int_{T_2^B}^{\infty} \pi_b^B e^{-rt}dt - k(T_2^B) \tag{3.6}$$

where, $\pi_0^B = \pi^B(c, c)$ are the pre-adoption gross profits of the firms, $\pi_b^B = \pi^B(c-\Delta, c-\Delta)$ are the per-period gross profits when both firms have adopted the new technology, $\pi_l^B = \pi^B(c-\Delta, c)$ and $\pi_f^B = \pi^B(c, c-\Delta)$ are respectively, the per-period gross profits of the firm that has already adopted the new technology -the leader- and those of the firm that has not yet adopted the new technology -the follower-.[1]

From the first order conditions of (3.5) and (3.6), we obtain,

$$I_1^B = -k'(T_1^B)e^{-rT_1^B} \text{ and } I_2^B = -k'(T_2^B)e^{-rT_2^B} \tag{3.7}$$

where, I_i^B denotes each firm's incremental benefits of the technology adoption (i.e., $I_1^B = \pi_l^B - \pi_0^B$ and $I_2^B = \pi_b^B - \pi_f^B$). Clearly, by the equation (3.7), the optimal adoption date, T_i^B, should equalize to the firm's incremental benefits from the technology adoption to the marginal cost of waiting. Thus, using the equation (3.4), the incremental benefits in the benchmark case

[1] For the detailed presentation of the expressions please see at the Appendix C1.1

are given by,

$$I_1^B = \frac{\delta(2-\gamma)A^2[2(1-\gamma)(2+\gamma)+\delta(2-\gamma^2)]}{(1-\gamma^2)(4-\gamma^2)^2} \tag{3.8}$$

$$I_2^B = \frac{\delta(2-\gamma)A^2[2(1-\gamma)(2+\gamma)+\delta(2-\gamma^2-2\gamma)]}{(1-\gamma^2)(4-\gamma^2)^2} \tag{3.9}$$

Notice here that, $I_i^B > 0$ always hold. That is, firms always have strong incentives to adopt the available cost reducing technology, with I_1^B (I_2^B) being U shaped (inversed U shaped, respectively) related to the degree of the final market competition, γ. Moreover, we observe that, $I_1^B > I_2^B$. That means that the first adoption is more beneficial than the second one and thus, given the assumptions over the cost of the technology adoption $k(t)$, the optimal adoption dates in the benchmark case are such that, $T_1^B < T_2^B$. Therefore, in the equilibrium there exists technological diffusion.

3.3.2 Vertically Related Markets

We proceed now with the analysis of our basic model where in the second stage of the repeated game at date $t \geqslant 0$, independently of the upstream market structure, each downstream firm D_i chooses its price p_i, taking as given the rival's downstream firm price p_j, in order to maximize its per period gross profits given by,

$$\underset{p_i}{Max}\ \pi_i(.) = (p_i - c_i - w_i)\frac{(\alpha-p_i)-\gamma(\alpha-p_j)}{1-\gamma^2} \tag{3.10}$$

The first order conditions give rise to the following reaction functions,

$$R_i^V(.) = \frac{(1-\gamma)\alpha + c_i + \gamma p_j}{2} + \frac{w_i}{2} \tag{3.11}$$

Comparing the reaction functions in the vertically related markets, R_i^V, with the respective ones in the benchmark case, R_i^E, in which only the right part of the eq. (3.11) appears, we observe that the wholesale price that the downstream firms pay to their upstream partner(s) under vertically related markets, shifts the reaction functions of the vertically related markets upwards, that in turn, given that the reaction functions when firms compete in prices are upward slopping, leads to higher prices and lower firms' output production than those obtained in the benchmark.

Solving the system of the reaction functions (3.11), the equilibrium price, output and downstream firms' profits in the second stage are given respectively by,

$$p_i^V(.) = \frac{(2+\gamma)(1-\gamma)\alpha + 2(c_i+w_i) + \gamma(c_j+w_j)}{4-\gamma^2} \quad (3.12)$$

$$q_i^V(.) = \frac{(2+\gamma)(1-\gamma)\alpha - (2-\gamma^2)(c_i+w_i) + \gamma(c_j+w_j)}{4-5\gamma^2+\gamma^4} \quad (3.13)$$

$$\pi_i^V(.) = \frac{[p_i - c_i - w_i]^2}{1-\gamma^2} \quad (3.14)$$

Note here that, an increase in the wholesale price, w_i, tends to increase $D_i^{,}$s price, while it tends to decrease its output production. The opposite holds when D_i adopts the new technology due to the lower marginal production cost that the new technology implies (i.e., $c_i = c - \Delta$).

In the first stage of the game at date $t \geqslant 0$, upstream(s) and downstream firms bargain over the trade contract terms. Given that the bargaining game alters significantly between the case of upstream separate firms and the case of upstream monopoly in what it follows we analyze the two cases separatively.

Upstream Separate Firms

In this subsection we consider the case where in the market exists two separate upstream input suppliers. In the first stage of the game at date $t \geqslant 0$, each U_i and D_i pair negotiates over the trading contract terms, (w_i, F_i), taking as given the outcome of the rival's pair simultaneously run negotiation (w_j^{ST}, F_j^{ST}), in order to maximize the generalized Nash product,

$$\underset{w_i,F_i}{Max}[\pi_{U_i} + F_i]^{\beta}[\pi_{D_i} - F_i]^{1-\beta} \quad (3.15)$$

where, $\pi_{U_i} = w_i q_i(w_i, w_j^{ST})$ and $\pi_{D_i} = [q_i(w_i, w_j^{ST})]^2$. Note here that, given the assumption of exclusive trade relations in the market, neither U_i nor D_i could achieve an agreement with an alternative trading partner and thus, the disagreement payoffs equal zero.

Maximizing (3.15) with respect to F_i, we obtain,

$$F_i = \beta\pi_{D_i} - (1-\beta)\pi_{U_i} \quad (3.16)$$

where, by substituting (3.16) into (3.15), we observe that the net profits of U_i and D_i are given as the shares of their joint surplus, $S = \pi_{U_i} + \pi_{D_i}$, that correspond to their respective bargaining powers $(\beta,\, 1-\beta)$. Thus, the generalized Nash product can be rewritten as function of each vertical chain's joint surplus, while the wholesale prices are chosen such to maximize this surplus,

$$\underset{w_i}{Max} S = [a - q_i(w_i, w_j^{ST}) - \gamma q_j(w_i, w_j^{ST})]q_i(w_i, w_j^{ST}) \tag{3.17}$$

From the first order conditions of (3.17), the equilibrium per period wholesale prices are given respectively by,

$$w^{ST}(c_i, c_j) = \frac{[a(1-\gamma)(4+2\gamma-\gamma^2) + c_j\gamma(2-\gamma^2) - c_i(4-3\gamma^2)]\gamma^2}{16-12\gamma^2+\gamma^4}, \quad \begin{array}{l} c_i = c \text{ or } c_i = c-\Delta \\ c_j = c \text{ or } c_j = c-\Delta \end{array} \tag{3.18}$$

where, using the eq.(3.18), the equilibrium wholesale prices in the pre adoption periods are given by, $w_0^{ST} = w^{ST}(c,c)$, the equilibrium wholesale prices in the post adoption periods are given by, $w_b^{ST} = w^{ST}(c-\Delta, c-\Delta)$, while $w_l^{ST} = w^{ST}(c-\Delta, c)$ and $w_f^{ST} = w^{ST}(c, c-\Delta)$ denote, respectively, the equilibrium wholesale price charged on the leader and the follower firm.[2]

Observe, by the eq.(3.18) that the equilibrium wholesale prices are independent of the bargaining power, since they are chosen in order to maximize the joint surplus of each vertical chain, while they are inversed U-shaped related to the product substitutability degree, γ. Clearly, the closer substitutes the products are, the fiercer is the final market competition that in turn, intensifies the upstream market competition and leads upstream firms to set lower wholesale prices in order to enforce their downstream partners position. In more details, a reduction in the wholesale price tends to shift the reaction function of D_i rightwards that, given the upward slope of the reaction functions, results in lower price and higher output production for the D_i firm and lower output production for the rival firm, D_j. Further, we observe, $w_l^{ST} > w_b^{ST} > w_0^{ST} > w_f^{ST}$. That means that, the upstream firms set higher wholesale prices to the downstream firms that have adopted the new technology. This is so, since the upstream firms use the wholesale prices

[2] For the detailed presentation of the expressions please see at the Appendix C1.2

as an instrument in order to extract part of the higher per period gross profits that their downstream partners obtain, due to the reduction of their marginal production cost that the adoption of the new technology implies. Yet, we observe that the wholesale price of the leader firm in adopting, w_l^{ST}, as well as, the wholesale price in the post-adoption periods, w_b^{ST}, are increasing in Δ. That means that, the more effective is the new technology on reducing the downstream firms' marginal cost of production, the higher are the wholesale prices that the upstream firms set on their respective technological advanced partners. On the contrary, the wholesale price of the follower firm, w_l^{ST}, is decreasing in Δ. That is so, because the upstream partner of the follower firm is willing by setting a lower wholesale price, or in other words, by decreasing the per-unit input price of the follower, to keep the latter active in the final market.

Lemma 7: *In vertically related market with upstream separate firms market structure,*

i) The equilibrium wholesale prices increase when the downstream firms adopt the new technology.

ii) The equilibrium wholesale prices are independent of the bargaining power β and they are inverse U-shaped in γ.

iii) The equilibrium wholesale prices of the leader firm in adopting, as well as, those when both firms have adopted the new technology are increasing in Δ, while the opposite holds for the wholesale price of the follower firm.

Using (3.18) and (3.12), it follows that the equilibrium per period prices and downstream firms' gross profits are given respectively by,

$$p_i^{ST}(c_i, c_j) = \frac{2a(4 - 2\gamma - 3\gamma^2 + \gamma^3) - (2 - \gamma^2)[c_i(\gamma^2 - 4) - 2c_j\gamma]}{16 - 12\gamma^2 + \gamma^4}, \quad \begin{array}{l} c_i = c \text{ or } c - \Delta \\ c_j = c \text{ or } c - \Delta \end{array} \tag{3.19}$$

$$\pi_{Di}^{ST}(c_i, c_j) = \frac{2(1 - \beta)(2 - \gamma^2)[a(4 - 2\gamma - 3\gamma^2 + \gamma^3) - (2 - \gamma^2)\gamma c_j - (4 - 3\gamma^2)c_i]^2}{(1 - \gamma)(\gamma^4 - 12\gamma^2 + 16)^2} \tag{3.20}$$

where, the equilibrium prices and gross profits in the pre adoption periods are given, respectively, by, $p_0^{ST} = p^{ST}(c, c)$ and $\pi_{D_0}^{ST} = \pi_D^{ST}(c, c)$. The equilibrium prices and gross profits in the post adoption periods are given respectively by, $p_b^{ST} = p^{ST}(c - \Delta, c - \Delta)$ and $\pi_{D_b}^{ST} = \pi_D^{ST}(c - \Delta, c - \Delta)$. The equilibrium price and gross profits of the leader firm are given respectively by, $p_l^{ST} = p^{ST}\ (c-\Delta, c)$ and $\pi_{D_l}^{ST} = \pi_D^{ST}(c-\Delta, c)$, while $p_f^{ST} = p^{ST}\ (c, c-\Delta)$ and $\pi_{Df}^{ST} = \pi_D^{ST}(c-, c-\Delta)$ are, respectively, the equilibrium price and gross profits of the follower firm.[3]

At the same time, the equilibrium per period upstream firms' profits and the fixed fees are given respectively by,

$$\pi_{Ui}^{ST}(c_i, c_j) = \frac{2\beta(2-\gamma^2)[a(4-2\gamma-3\gamma^2+\gamma^3)-(2-\gamma^2)\gamma c_j-(4-3\gamma^2)c_i]^2}{(1-\gamma)(\gamma^4-12\gamma^2+16)^2} \tag{3.21}$$

$$F_i^{ST}(c_i, c_j) = \frac{(2\beta-\gamma^2)(2-\gamma^2)[a(1-\gamma)(4+2\gamma-\gamma^2)+c_j(2\gamma-\gamma^3)-c_i(4-3\gamma^2)]^2}{(1-\gamma)(\gamma^4-12\gamma^2+16)^2} \tag{3.22}$$

In particular, using (3.21) and (3.22), the equilibrium upstream firms' profits and the fix fees in the pre-adoption periods are given respectively by, $\pi_{U_0}^{ST} = \pi_U^{ST}(c, c)$ and $F_0^{ST} = F^{ST}(c, c)$. The equilibrium upstream firms' profits and the fix fees in the post adoption periods given respectively by, $\pi_{U_b}^{ST} = \pi_U^{ST}(c-\Delta, c-\Delta)$ and $F_b^{ST} = F^{ST}(c-\Delta, c-\Delta)$. The equilibrium upstream firm's profits and the fix fees of the leader-follower periods are given respectively by, $\pi_{U_l}^{ST} = \pi_U^{ST}(c-\Delta, c)$ and $F_l^{ST} = F^{ST}\ (c-\Delta, c)$, $\pi_{Uf}^{ST} = \pi_U^{ST}(c, c-\Delta)$ and $F_f^{ST} = F^{ST}\ (c, c-\Delta)$.[4]

Observe, by the eq.(3.22) that, $F_i^{ST} < 0$ if, $\beta < \beta_c^{ST} = \frac{\gamma^2}{2}$ with, $\frac{\partial \beta_c^{ST}}{\partial \gamma} > 0$. That means that, when the upstream firms possess relatively low bargaining power in the market they subsidize their downstream partners by transferring part of their profits downstream via the fix fees. The intuition behind the latter is that, when the upstream firms' bargaining power is low, the power to extract the fix fee is instead reversed and thus, it is the downstream firms that are benefiting by extracting the fix rents. Further, it can be checked that $\left|F_l^{ST}\right| > \left|F_b^{ST}\right| > \left|F_0^{ST}\right| > \left|F_f^{ST}\right|$. Clearly, the fix fees (subsidy, if $\beta < \beta_c^{ST}$) when a downstream firm adopts the new technology always exceed the respective ones of the pre-adoption period. Intuitively, if $\beta > \beta_c^{ST}$, the upstream firms take advantage of their bargaining power in the market and set higher fix fees to the technological advanced downstream firms in order to extract part of the higher per period gross profits that the latter obtain. On the contrary, if $\beta < \beta_c^{ST}$, the technological advanced

[3] For the detailed presentation of the expressions please see at the Appendix C1.2
[4] For the detailed presentation of the expressions please see at the Appendix C1.2

downstream firms are extracting higher subsidies by their upstream partners, with the upstream firms' losses due to the higher subsidies to be more than compensated by the higher wholesale prices that they set to the firms that have adopted the new technology.

Further, after some manipulation we observe by the eq.(3.22) that, $\frac{\partial F_l^{ST}}{\partial \gamma} < 0$ (independently of γ and β), $\frac{\partial F_0^{ST}}{\partial \gamma} < 0, \frac{\partial F_b^{ST}}{\partial \gamma} < 0, \frac{\partial F_f^{ST}}{\partial \gamma} < 0$ (if γ is low enough, independently of β) and $\frac{\partial F_0^{ST}}{\partial \gamma} > 0, \frac{\partial F_b^{ST}}{\partial \gamma} > 0$,$\frac{\partial F_f^{ST}}{\partial \gamma} > 0$ (if γ is high enough and β low enough). It is noteworthy here, that when the final market competition is fierce and the upstream firms' bargaining power is low, F_0^{ST} , F_b^{ST}, F_f^{ST} are increasing in γ, or in other words, the subsidies are decreasing in γ. This is because, the upstream firms via a reduction in the subsidy are willing to outweigh the reduction in the wholesale prices that the fierce final market competition implies and its' negative effects on their profitability. Yet, $\frac{\partial F_l^{ST}}{\partial \Delta} > 0, \frac{\partial F_b^{ST}}{\partial \Delta} > 0, \frac{\partial F_f^{ST}}{\partial \Delta} < 0$ if $\beta > \beta_c^{ST}$, while the opposite holds if $\beta^{ST} < \beta_c^{ST}$. That means that, when the upstream firm(s) possess relatively high bargaining power in the market, the more effective is the new technology on reducing downstream firms' marginal production cost, the higher are the fix fees that the upstream firm(s) charge to their technological advanced downstream partners. This is so, since the upstream firms take advantage of their high bargaining power in the market and transfer upwards, via the fix fees, part of the higher downstream firms' per period gross profits. In contrast, when the upstream firms possess low bargaining power in the market, a more effective new technology leads upstream firms to increase the subsidy on their technological advanced partner(s). The losses of the higher subsidies are being more than compensated by the higher wholesale prices that upstream firms charge to their technological advanced partners. Note here that for the follower firm the inverse results hold. In particular, if $\beta > \beta_c^{ST}$, the fix fees charged on the follower firm decrease as the effectiveness of the new technology increase, while if $\beta < \beta_c^{ST}$, the subsidy that the follower firm obtain decreases. The intuition behind this result is driven by the lower profitability that the follower firm obtain when its rival has adopted the new technology.

Lemma 8: *In vertically related markets with upstream separate firms market structure, the equilibrium fix fees exceed zero if,* $\beta > \beta_c^{ST}$*, while the opposite holds if,* $\beta < \beta_c^{ST}$*.*

At date $t = 0$, the downstream firms choose their adoption date T_i^{ST}, in order to maximize their discounted sum of profits given as,

$$\underset{T_1^{ST}}{Max}\ \Pi_1^{ST}(.) = \int_0^{T_1^{ST}} \pi_{D_0}^{ST} e^{-rt}dt + \int_{T_1^{ST}}^{T_2^{ST}} \pi_{D_l}^{ST} e^{-rt}dt + \int_{T_2^{ST}}^{\infty} \pi_{D_b}^{ST} e^{-rt}dt - k(T_1^{ST}) \tag{3.23}$$

$$\underset{T_2^{ST}}{Max}\ \Pi_2^{ST}(.) = \int_0^{T_1^{ST}} \pi_{D_0}^{ST} e^{-rt}dt\ + \int_{T_1^{ST}}^{T_2^{ST}} \pi_{D_l}^{ST} e^{-rt}dt\ + \int_{T_2^{ST}}^{\infty} \pi_{D_b}^{ST} e^{-rt}dt - k(T_2^{ST}) \tag{3.24}$$

From the first order conditions of (3.23) and (3.24), we have that,

$$I_1^{ST} = -k(T_1^{ST})e^{-rT_1^{ST}} \quad \text{and} \quad I_2^{ST} = -k(T_2^{ST})e^{-rT_2^{ST}} \tag{3.25}$$

Therefore, given that each downstream firm chooses the date of adoption, T_i^{ST}, such that the incremental benefits from the adoption to equalize to the marginal cost of waiting (i.e, $I_1^{ST} = \pi_l^{ST} - \pi_0^{ST}$ and $I_2^{ST} = \pi_b^{ST} - \pi_f^{ST}$), the incremental benefits in the upstream separate firms case are given by,

$$I_1^{ST} = \frac{2(1-\beta)\delta A^2(3\gamma^4 - 10\gamma^2 + 8)[2(1-\gamma)(4 + (2-\gamma)\gamma) + \delta(4 - 3\gamma^2)]}{(1-\gamma^2)(\gamma^4 - 12\gamma^2 + 16)^2} \tag{3.26}$$

$$I_2^{ST} = \frac{2(1-\beta)\delta A^2(2-\gamma^2)(4-3\gamma^2)[2(1-\gamma)(4 + (2-\gamma)\gamma) + \delta(2-\gamma)(2 - 2\gamma^2 - \gamma)]}{(1-\gamma^2)(\gamma^4 - 12\gamma^2 + 16)^2} \tag{3.27}$$

In line with the benchmark case, $I_i^{ST} > 0$ always hold. That means that in vertically related markets with separated upstream market structure the downstream firms always have strong incentives to adopt the available cost reducing technology. Moreover, the first adoption is more beneficial than the second one (i.e., $I_1^{ST} > I_2^{ST}$) and thus, the equilibrium is characterized by technological diffusion, (i.e., $T_1^{ST} < T_2^{ST}$). Further, comparing the firms' incremental benefits in the vertically related market with upstream separated firms market structure with the respective ones in the benchmark case, we observe that they can be higher or lower than those of the benchmark, depending on the bargaining power, β, the degree of the final market competition, γ, and the drasticity of the new technology, δ.

Insert Figures 1a, 1b

In particular, comparing the firms' incremental benefits in the vertically related market with separate upstream firms, given in (3.26) and (3.27), with the respective ones of the benchmark case, given in (3.8) and (3.9), we observe that, regarding the first technology adoption, in the equilibrium there exists $\hat{\beta}_1^{ST} \equiv \frac{\gamma^3[128-8(2+\delta)(\gamma^5+4\gamma-4\gamma^3)+(2+\delta)\gamma^7+\gamma^2(88\gamma^2-192-10\gamma^4)]}{2(\gamma^2-4)^2(3\gamma^2-4)[2(3\gamma^2+2\gamma-\gamma^3-4)+\delta(3\gamma^2-4)]}$, with $\hat{\beta}_1^{ST} < \beta_c^{ST}$, such that if $\beta < \hat{\beta}_1^{ST}$ then, $I_1^{ST} > I_1^B$ and thus, $T_1^{ST} < T_1^B$ while, the opposite holds if $\beta^{ST} > \hat{\beta}_1^{ST}$. Further, regarding the second adoption, we demonstrate that in the equilibrium there exists $\hat{\beta}_2^{ST} \equiv \frac{\gamma^3[8(2+\delta)(\gamma^5+4\gamma-4\gamma^3)-(2+\delta)\gamma^7+(1+\delta)(10\gamma^6+192\gamma^2-128-88\gamma^4)]}{2(\gamma^2-4)^2(3\gamma^2-4)[(2+\delta)(4-3\gamma^2)+2(1+\delta)(\gamma^3-2\gamma)}$, with $\hat{\beta}_2^{ST} < \beta_c^{ST}$, such that if $\beta < \hat{\beta}_2^{ST}$ then, $I_2^{ST} > I_2^B$ and thus, $T_2^{ST} < T_2^B$ while, the opposite holds if $\beta > \hat{\beta}_2^{ST}$. Notice here that if $\beta < \hat{\beta}_1^{ST}$ both $I_1^{ST} > I_1^B$ and $I_2^{ST} > I_2^B$ hold and thus, $T_1^{ST} < T_1^B$ and $T_2^{ST} < T_2^B$. Put it in other words, we show that under vertically related markets with separate upstream market structure the first and second technology adoption take place earlier than under one-tier industries, when the upstream firms possess sufficiently low bargaining power in the market, the final market competition is fierce enough and the new cost reducing technology is not too drastic. The intuition behind this result is based on the two opposing effects that the vertical relations generate in the market, named as the output effect and the subsidization effect. In more details, according to the discussion over the reaction functions in the vertically related markets and the benchmark case, we have that under two-tier industries the wholesale prices that upstream firms set to their downstream partners lead to higher prices and lower output production than the respective ones obtained under the one-tier industries. That in turn, tends to postpone the adoption of the new technology by the downstream firms, since the cost reduction of the new technology is applied to a lower volume of production. On the other hand, according to Lemma 2, when the upstream firms possess low bargaining power in the market, they subsidize their downstream partners via the fix fees, with the subsidy to increase when the downstream firms adopt the new technology. The latter reinforces the downstream firms' incentives to adopt the new technology and tends to enhance the speed of the adoption. Clearly, when the final market competition is fierce enough and the new technology is not too drastic, the output effect becomes less stronger, given that according to Lemma 1, the wholesale prices that downstream firms pay when they adopt the new technology are decreasing in γ, while, they are increasing in Δ (or else, in δ). Thus, when the upstream firms possess relatively low bargaining power in the market, the final market competition is fierce enough and the new technology is not too drastic, the subsidization effect dominates the output effect and therefore, downstream firms adopt earlier the available cost reducing technology in the vertically related market with separate upstream firms than in one-tier industries.

Proposition 9 *Vertically related markets with upstream separate firms market structure lead to earlier first and second technological adoption than one-tier industries, if and only if, the final market competition is fierce enough, the upstream firms' bargaining power is low enough and the new technology is not too drastic.*

Proof. See Appendix C2.1 ■

Upstream Monopoly

In this subsection we extend our analysis considering the case of vertically related markets with monopolistic upstream market structure. In the first stage of the game, at date $t \geqslant 0$, the upstream monopolist U negotiates with each downstream firm D_i over the contract terms (w_i, F_i) taking as given the outcome of the simultaneous run negotiation with D_j (w_j^{MT}, F_j^{MT}), in order to maximize the generalized Nash product,

$$\underset{w_i,F_i}{Max}[\pi_U + F_i + F_i^{MT} - d(w_j^{MT}, F_j^{MT})]^{\beta}[\pi_{D_i} - F_i]^{1-\beta} \tag{3.28}$$

Note here that, the profits of the upstream monopolist are now given by the sum of its sales on both downstream firms, that is, $\pi_U = w_i q_i(w_i, w_j^{MT}) + w_j^{MT} q_j(w_i, w_j^{MT})$, while each downstream firm's profits are given by, $\pi_{D_i} = [q_i(w_i, w_j^{MT})]^2$. Note also that, in contrast to the upstream separate firms case, under monopolistic upstream market structure the disagreement payoff is no longer null, since the upstream monopolist has an "outside option" if an agreement between a (U, D_i) pair is not reached. Thus, the upstream monopolist faces a disagreement payoff given by,

$$d(w_j^{MT}, F_i^{MT}) = w_j^{MT} q_j^{MON} + F_j^{MT} \tag{3.29}$$

where, $q_j^{MON} = \frac{a-c-w_j^{MT}}{2}$ is the output produced by the monopolistic downstream firm D_j in case of disagreement between the (U, D_i) pair. In more details, if an agreement between U and D_i can not be reached, the upstream monopolist is expected to obtain the revenues by the input sales on the remaining downstream firm D_j (i.e, $w_j^{MT} q_j^{MON}$) plus the fixed fee, F_j^{MT}.

That means that, a breakdown in the (U, D_i) pair, does not give rise to new negotiations over the contract terms of the remaining (U, D_j) pair.

Maximizing (3.28) with respect to F_i, we have that,

$$F_i = \beta\pi_{D_i} - (1-\beta)[\pi_U - w_j^{MT} q_j^{MON}] \tag{3.30}$$

Substituting (3.30) into (3.28), we obtain that the net profits of the upstream monopolist, above its disagreement payoff, and the net profits of each downstream firm, D_i, are proportional to their joint surplus, $S^M = \pi_U + \pi_{D_i} - w_j^{MT} q_j^{MON}$, with the coefficients of proportionality to be given by their bargaining powers β and $1-\beta$, respectively. Thus, the wholesale prices w_i are chosen in order to maximize this surplus,

$$\underset{w_i}{Max} S^M = [a - q_i(w_i, w_j^{MT}) - \gamma q_j(w_i, w_j^{MT})] q_i(w_i, w_j^{MT}) + w_j^{MT}[q_j(w_i, w_j^{MT}) - q_j^{MON}] \tag{3.31}$$

From the first order conditions of (3.31), the equilibrium per period wholesale prices are given respectively by,

$$w^{MT}(c_i) = \frac{(a-c_i)\gamma^2}{4},\ c_i = c \text{ or } c_i = c - \Delta \tag{3.32}$$

where, using (3.32), the equilibrium wholesale prices in the pre adoption periods, as well as, the equilibrium wholesale price of the follower firm are given by, $w_0^{MT} = w_f^{MT} = w^{MT}(c)$, while the equilibrium wholesale prices in the post adoption periods and the equilibrium wholesale price of the leader firm are given by, $w_b^{MT} = w_l^{MT} = w^{MT}(c-\Delta)$.

Further, by the eq. (3.32), we observe that the equilibrium per period wholesale prices are independent of the bargaining power, β, while they are increasing in the product substitutability degree, γ. Clearly, contrary to the separate upstream firms case where the wholesale prices are inverse U shaped related to the degree of final market competition, in the upstream monopolist case the wholesale prices are always increasing in γ due to the lack of upstream market competition. In addition, one can easily check that $w_l^{MT} = w_b^{MT} > w_0^{MT} = w_f^{MT}$. This is so, since the upstream monopolist, by setting a higher wholesale price to the downstream firms that have adopted the new technology, is willing to extract part of the higher per period gross profits that the downstream technological advanced firms obtain due to the reduction of their marginal production cost. Yet, it is easily observable that the equilibrium wholesale price charged on the leader firm in adopting, w_l^{MT}, as well as, those in the post-adoption periods, w_b^{MT}, are increasing in Δ, while the wholesale price of the follower, w_f^{MT}, is independent of Δ. Intuitively, in line with the upstream separate firms case, the more effective is the new technology on reducing the downstream firms' marginal cost of production, the higher are the wholesale prices that the upstream monopolist sets on the downstream technological advanced firms in order to extract part of the higher downstream firms' profits that a more effective technology adoption implies. Note also that, in contrast to the separate upstream firms case where the wholesale price of the follower firm is decreasing in Δ, in the upstream monopolist case the wholesale price of the follower firm is independent of Δ since, the upstream sells to both downstream firms and thus, do not have incentives to decrease the wholesale price of the follower firm in order to enforce the latter's position in the final market. Last but not least, comparing the per period equilibrium wholesale prices charged under the upstream monopolist case with the respective ones of the upstream separate firms case, we have that $w^{MT} > w^{ST}$ always hold. That means that, the lack of upstream market competition in the upstream monopolistic case leads to higher per unit of input prices.

Lemma 9: *In vertically related market with upstream monopolistic market structure,*

i) The equilibrium wholesale prices are independent of β and increasing in γ.

ii)The equilibrium wholesale price of the leader firm in adopting, as well as, those when both downstream firms have adopted the new technology, are increasing in Δ, while the respective one of the follower is independent of Δ.

iii)The equilibrium wholesale prices in the upstream monopolist case always exceed those of the upstream separate firms case.

Using (3.32) and (3.12), it follows that the equilibrium per-period prices and downstream firms' gross profits are given respectively,

$$p^{MT}(c_i,c_j) = \frac{a(2-\gamma)+2c_i+\gamma c_j}{4}, \quad \begin{array}{l} c_i = c \text{ or } c_i = c-\Delta \\ c_j = c \text{ or } c_j = c-\Delta \end{array} \tag{3.33}$$

$$\pi_{Di}^{MT}(c_i,c_j) = \frac{(1-\beta)[8(a-c_i)((a-c_i)-(a-c_j)\gamma)+(3\gamma^4-\gamma^6)(a-c_j)^2-J(.)]}{32(1-\gamma)} \tag{3.34}$$

where $J(.) = 2\gamma^2[(a-c_i)^2-(2a-1)c_i+(2a-c_j)c_j]$.

In particular, the equilibrium prices and downstream firms' gross profits in the pre adoption periods are given respectively by, $p_0^{MT} = p^{MT}(c,c)$ and $\pi_{D_0}^{MT} = \pi_D^{MT}(c,c)$. The equilibrium prices and downstream firms' gross profits in the post adoption periods are given respectively by, $p_b^{MT} = p^{MT}(c-\Delta, c-\Delta)$ and $\pi_{D_b}^{MT} = \pi_D^{MT}(c-\Delta, c-\Delta)$. The equilibrium price and gross profits of the leader firm are given, respectively, $p_l^{MT} = p^{MT}\ (c-\Delta, c)$ and $\pi_{D_l}^{MT} = \pi_D^{MT}(c-\Delta, c)$, while $p_f^{MT} = p^{MT}\ (c, c-\Delta)$ and $\pi_{Df}^{MT} = \pi_D^{MT}(c, c-\Delta)$ are, respectively, the equilibrium price and gross profits of the follower firm.[5]

At the same time, the equilibrium per period fix fees and the upstream monopolist's profits are given respectively by,

$$F^{MT}(c_i,c_j) = \frac{(1-\beta)\gamma^2[4(a-c_i)[(a-c_j)\gamma-(a-c_i)]+2\beta[\Theta+\Phi]}{32(1-\gamma)^2} \tag{3.35}$$

$$\pi_U^{MT}(c_i,c_j) = \frac{[2\beta(4-\gamma^2)-(1-\beta)(3\gamma^4-\gamma^6)][2a^2+c_i^2+c_j^2-2a(c_i+c_j)]+\Xi}{32(1-\gamma^2)} \tag{3.36}$$

where, $\Theta = a(2-\gamma-\gamma^2)+\gamma c_j+(\gamma^2-2)c_i$ and $\Phi = (\gamma^4-\gamma^2)(a-c_j)^2+2c_i(2a-c_i)\gamma^2+2c_j(2a-c_j)\gamma^2$ and $\Xi = 4\gamma(\gamma^2-4\beta)(a-c_i)(a-c_j)$

Note that, the equilibrium fix fees and the upstream monopolist's profits in the pre-adoption periods are given respectively by, $F_0^{MT} = F^{MT}(c,c)$ and $\pi_{U_0}^{MT} = \pi_U^{MT}(c,c)$. The equilibrium fix fees and the upstream monopolist's profits in the post adoption periods given respectively by, $F_b^{MT} = F^{MT}(c-\Delta, c-\Delta)$ and $\pi_{U_b}^{MT} = \pi_U^{MT}(c-\Delta, c-\Delta)$. The equilibrium upstream

[5]For the detailed presentation of the expressions please see at the Appendix C1.3

monopolist's profits in the leader-follower periods are given by, $\pi_U^{MT} = \pi_U^{MT}(c-\Delta, c)$, while the equilibrium fix fees of the leader and the follower firm are given respectively by, $F_l^{MT} = F^{MT}$ $(c-\Delta, c)$ and $F_f^{MT} = F^{MT}$ $(c, c-\Delta)$.[6]

Further, by the eq. (3.35), we observe that $F_i^{MT} < 0$ if $\beta < \beta_c^{MT}$ where, $\beta_c^{MT} \equiv \frac{\gamma^2[4a-c+\Delta((a-c)\gamma-1)+(a-c)(\gamma^4-\gamma^2)-2\Delta\gamma^2(2(a-c)+2\Delta)}{8(a-c+\Delta)[(a-c)\gamma-(a-c+\Delta)]+(a-c)^2\gamma^2[2-3\gamma^2-\gamma^4]+4\Delta\gamma^2[2(a-c)+\Delta]}$. Clearly, in line with the upstream separate firms case, when the upstream bargaining power in the market is low enough, the fix fees turn to be negative. That means that the upstream monopolist subsidizes its downstream partners via the fix fees, with the losses of the subsidization to be covered by its input sells. In addition, using the eq. (3.35), we observe that, $\left|F_l^{MT}\right| > \left|F_b^{MT}\right| > \left|F_f^{MT}\right| > \left|F_0^{MT}\right|$, that implies that the fix fees (subsidies, respectively) are higher when a downstream firm adopts the new technology. Intuitively, when the upstream bargaining power is high enough (i.e, $\beta > \beta_c^{MT}$), the upstream sets higher fix fees to the downstream firms that have adopted the new technology in order to extract part of their higher per period gross profits. In contrast, when the upstream bargaining power is low (i.e, $\beta < \beta_c^{MT}$), the downstream firms that have adopted the new technology are being benefiting by the higher subsidies, given that if $\beta < \beta_c^{MT}$ the power to extract the fix fees is on the downstream firms. Note also here that the losses of the higher subsidies are being more than outweighed by the higher wholesale prices that the upstream monopolist sets on the technological advanced downstream partners.

Moreover, using the eq. (3.35), we observe that the equilibrium per period fix fees are negatively related to the degree of the final market competition, γ, (i.e., $\frac{\partial F_l^{MT}}{\partial \gamma} < 0$,$\frac{\partial F_0^{MT}}{\partial \gamma} < 0$, $\frac{\partial F_b^{MT}}{\partial \gamma} < 0$, $\frac{\partial F_f^{MT}}{\partial \gamma} < 0$). Note here, that for $\beta < \beta_c^{MT}$, the latter result means that a fiercer final market competition forces the upstream monopolist to offer higher subsidies to its downstream partners. Yet, using the eq. (3.35) and after some manipulations we obtain that,$\frac{\partial F_b^{MT}}{\partial \Delta} > 0$ if $\beta > \beta_{bc}^{MT} \equiv \frac{\gamma^2(2-\gamma+\gamma^2)}{4-2\gamma-\gamma^3+\gamma^4}$ ($\frac{\partial F_b^{MT}}{\partial \Delta} < 0$ if $\beta < \beta_{bc}^{MT}$, respectively), $\frac{\partial F_l^{MT}}{\partial \Delta} > 0$ if $\beta > \beta_c^{MT}$ ($\frac{\partial F_l^{MT}}{\partial \Delta} < 0$ if $\beta < \beta_c^{MT}$, respectively) and $\frac{\partial F_f^{MT}}{\partial \Delta} < 0$ if $\beta > \beta_{fc}^{MT} \equiv \frac{\gamma^2[2(a-c)-\gamma(a-c+\Delta)(3-\gamma^2)]}{4(a-c)-\gamma(a-c+\Delta)(\gamma^4-2-3\gamma^2)}$($\frac{\partial F_f^{MT}}{\partial \Delta} > 0$, $\beta < \beta_{fc}^{MT}$, respectively). In other words, when the upstream monopolist's bargaining power is high, the more effective the new technology is, the higher are the fix fees that the upstream sets to the downstream firms that have adopt the new technology, while the opposite holds when its bargaining power is low. The result is reversed for the follower firm, since the upstream is

[6] For the detailed presentation of the expressions please see at the Appendix C1.3

willing to keep the follower active in the market. Last but not least, comparing the fix fees under the upstream separate firms case and the upstream monopolist case, we obtain that the fix fees are higher under the former case (i.e., $F^{MT} < F^{ST}$). Notice here, that when the upstream(s) bargaining power in the market is low, the fix fees turn to be negative and thus, the above result is reversed, or in other words, the subsidies under the upstream monopolist case are higher than the respective ones under upstream separate firms case.

Lemma 10: *In vertically related markets with upstream monopolistic market structure,*

i) The equilibrium fix fees exceed zero if, $\beta > \beta_c^{MT}$ while, the opposite holds if, $\beta < \beta_c^{MT}$.

ii) The equilibrium fix fees (subsidies, respectively) under the upstream monopolistic market structure are lower (higher, respectively) than those under the upstream separate firms market structure.

At date $t = 0$, the downstream firms decide their adoption date T_i^{MT}, in order to maximize their discounted sum of profits given by,

$$\underset{T_1^{MT}}{Max}\ \Pi_1^{MT}(.) = \int_0^{T_1^{MT}} \pi_{D_0}^{MT} e^{-rt} dt \ + \int_{T_1^{MT}}^{T_2^{MT}} \pi_{D_l}^{MT} e^{-rt} dt \ + \int_{T_2^{MT}}^{\infty} \pi_{D_b}^{MT} e^{-rt} dt - k(T_1^{MT}) \quad (3.37)$$

$$\underset{T_2^{MT}}{Max}\ \Pi_2^{MT}(.) = \int_0^{T_1^{MT}} \pi_{D_0}^{MT} e^{-rt} dt \ + \int_{T_1^{MT}}^{T_2^{MT}} \pi_{D_l}^{MT} e^{-rt} dt \ + \int_{T_2^{MT}}^{\infty} \pi_{D_b}^{MT} e^{-rt} dt - k(T_2^{MT}) \quad (3.38)$$

Taking the first order conditions of (3.37) and (3.38) we have that,

$$I_1^{MT} = -k(T_1^{MT}) e^{-rT_1^{MT}} \quad \text{and} \quad I_2^{MT} = -k(T_2^{MT}) e^{-rT_2^{MT}} \quad (3.39)$$

where, given that each downstream firm chooses the date of adoption T_i^{MT}, such that the incremental benefits from the adoption to equalize to the marginal cost of waiting (i.e, $I_1^{MT} = \pi_{D_l}^{MT} - \pi_{D_0}^{MT}$ and $I_2^{MT} = \pi_{D_b}^{MT} - \pi_{Df}^{MT}$), the incremental benefits in the upstream monopolist case are given by,

$$I_1^{MT} = \frac{(1-\beta)\delta A^2[\delta(2-\gamma^2) + 2(2-\gamma-\gamma^2)]}{8(1-\gamma^2)} \quad (3.40)$$

$$I_2^{MT} = \frac{(1-\beta)\delta A^2[\delta(2-2\gamma-\gamma^2) + 2(2-\gamma-\gamma^2)]}{8(1-\gamma^2)} \quad (3.41)$$

In line with the upstream separate firms case and the benchmark case, we observe that in vertically related markets with upstream monopolistic market structure, the downstream firms always have strong incentives to adopt the new cost reducing technology (i.e., $I_i^{MT} > 0$). Further, in equilibrium there is technological diffusion, since the first adoption is more beneficial than the second one, that is, $I_1^{MT} > I_2^{MT}$ and thus, $T_1^{MT} < T_2^{MT}$.

Comparing now the incremental benefits in the upstream monopolist case, given in (3.40) and (3.41), with the respective ones in the benchmark case, given in (3.8) and (3.9), we obtain that in the equilibrium there exist, $\hat{\beta}^{MT} \equiv \frac{\gamma^4}{(\gamma^2-4)^2}$ with $\hat{\beta}^{MT} < \beta_c^{MT}$such that if, $\beta < \hat{\beta}^{MT}$ then, both $I_1^{MT} > I_1^B$ and $I_2^{MT} > I_2^B$ and thus, $T_1^{MT} < T_1^B$ and $T_2^{MT} < T_2^B$, while the inverse relation holds if, $\beta > \hat{\beta}^{MT}$. Thus, taking into account the limitations that the Assumption 1 implies over the degree of the final market competition, γ, and the drasticity of the new technology, δ, we observe that the vertically related markets with monopolistic upstream market structure lead to earlier first and second technological adoption than the one-tier industries, when the bargaining power of the upstream monopolist is low enough, the final market competition is fierce enough and the new technology is not extremely drastic. Intuitively, in line with the upstream separate firms case, when the upstream monopolist possesses low bargaining power in the market, the subsidization effect dominates the output effect and thus, the downstream firms' in the vertically related market adopt earlier the new cost reducing technology than in the one-tier industries technology.

Insert Figure 3

Proposition 10 *Vertically related markets with upstream monopolistic market structure lead to earlier first and second technological adoption than one-tier industries, if and only if, the bargaining power of the upstream monopolist is low enough, the final market competition is fierce enough and the new technology is not too drastic.*

Proof. See Appendix C2.2 ■

Further, comparing the downstream firms' incremental benefits under the upstream monopolist case with the respective ones under the upstream separate firms case, we obtain that, independently of the upstream firms' bargaining power, the first technology adoption takes place earlier under the former case, if and only if, the new technology is sufficiently drastic and the final market competition is fierce enough. In particular, we show that in the equilibrium there exists $\delta^c(\gamma) \equiv \frac{2[64(1-\gamma)+80(\gamma^3-\gamma^2)+24\gamma^4-26\gamma^5+\gamma^6+\gamma^7]}{\gamma(64-80\gamma^2+26\gamma^4+\gamma^6)}$ with $\frac{\partial\delta^c}{\partial\gamma} < 0$, such that if $\delta > \delta^c(\gamma)$ then, $I_1^{ST} < I_1^{MT}$ and thus, $T_1^{ST} > T_1^{MT}$ while, the opposite holds if $\delta < \delta^c(\gamma)$. In addition, we observe that the second technology adoption always takes place latter under the upstream monopolistic market structure than under the upstream separated market structure since, $I_2^{MT} < I_2^{ST}$ and thus, $T_2^{MT} > T_2^{ST}$. The intuition behind these result is driven by the relevant dominance of the output effect and the effect of the fix fees (subsidies, for low upstream (s) bargaining power, respectively). In more details, according to Lemma 3, the wholesale prices that downstream firms pay under the upstream monopolist case always exceed those of the upstream separate firms case. Therefore, the higher per unit input price that downstream firms face under the former case lead to lower downstream firms' output production. The latter tends to deforce the downstream firms' speed of technology adoption under the upstream monopolist case, since the new technology will be applied to a lower volume of production. On the contrary, according to Lemma 4, the fix fees under the upstream monopolist case (subsidies, if the upstream(s) bargaining power is low) are lower (higher, respectively) than those of the upstream separate firms case, that tends to enforce the speed of the technology adoption under the upstream monopolist case. Clearly, regarding the first adoption, the effect of the fix fees dominates the output effect and leads the downstream firms to adopt earlier the new technology under upstream monopolist market structure. In contrast, regarding the second technology adoption, we have that the reduction in the output production of the follower firm due to the higher per unit of input price that the follower firm pays when the market is monopolized by a single upstream firm, can not be compensated by the lower fix fees (higher subsidization, respectively) that he obtains under the upstream monopolistic market structure and thus, the second technology adoption always takes place earlier under upstream separate firms market structure.

Proposition 11 *i) In vertically related markets with upstream monopolistic market structure the first technology adoption takes place earlier than under upstream separate firms market structure, if and only if, the final market competition is fierce enough and the new technology is drastic enough.*

ii) In vertically related markets with upstream monopolistic market structure the second technology adoption takes place latter than under upstream separate firms market structure.

Proof. See Appendix C2.3 ■

3.4 Extensions-Discussion

3.4.1 Downstream quantities competition

In our basic model, we have assumed that the downstream firms in the final market compete in prices. Here, we briefly discuss how the main results of our model would change if the downstream firms compete by setting their quantities, where using (3.1) the inverse demand function for the final good that each D_i firm faces is given by,[7]

$$p_i = a - q_i - \gamma q_j, \quad i, j = 1, 2; \; i \neq j; \; 0 < \gamma \leqslant 1 \tag{3.42}$$

Using the above inverse demand function and keeping all the other modeling specifications fixed, we reconfirmed that in vertically related markets with upstream separated market structure the downstream firms' technology adoption takes place earlier than in one -tier industries, when the upstream firms' bargaining power in the market is low enough, the final market competition is fierce enough and the new technology is not extremely drastic. We should note here that under Cournot final market competition, independently of the upstream market structure, in equilibrium the wholesale prices are always lower than the marginal cost of production of the upstream firm(s) (i.e., $w^C < 0$), while the per period fix fees always exceed zero (i.e., $F^C > 0$). That means that, under Cournot final market competition, independently of the bargaining power distribution in the market, the upstream firm(s) subsidize their downstream partners via the wholesale prices. The intuition behind this result is as follows. In vertically related markets with upstream separate market structure where the downstream firms compete in quantities, each upstream firm is willing to make its downstream partner more aggressive in the final market competition by diminishing the per-unit of input price. Clearly, the upstream partner via a lower wholesale price shifts its downstream partner's reaction function outwards and thus, given that the reaction functions under Cournot competition are downward slopping, the own downstream partner's output and gross profits increase, while the rival's downstream firm output

[7] For the detailed analysis please see at the Appendix C3.

decreases. Further, in vertically related markets with upstream monopolistic market structure where the downstream firms compete in quantities, the upstream monopolist subsidize its downstream partners via the wholesale prices, since the monopolist faces a "commitment problem". In more details, when the contracts negotiations are not fully observable, the "commitment problem" arise, since the upstream monopolist could not commit to the downstream firms that it is not going to behave opportunistically and to secretly offer a lower wholesale price to the rival downstream firm. Thus, none of the downstream firms is going to agree to a wholesale price higher than the upstream monopolist cost of production (for detailed analysis of the commitment problem see among, McAfee and Schwartz, 1995; Rey and Vergi, 2004; de Fontenay and Gans, 2005). Notice here that, under both cases, the losses of the upstream firm(s) subsidization via the wholesale prices are being more than compensated via the fix fees, since part of the increased downstream firms' gross profits due to the lower wholesale prices are being transferred upstream via the fixed fees. We should also mention here that, when downstream firms compete in quantities, the upstream firms' subsidization via the wholesale prices (i.e., $w^C < 0$), lead to higher final output production in the vertically related markets than that in the one-tier industry. The latter, named as the output effect, tends to enforce the speed of the firms' technology adoption under vertically related markets, since the new cost reducing technology will be applied in a higher production volume. On the contrary, we observe that in two-tier industries with Cournot final market competition there exists a profits sharing effect, since part of the per period profits of the downstream firms' are transferred via the fix fees to the upstream partner(s). That in turn, tends to postpone the speed of the downstream firms' technological adoption, since part of their increased per period gross profits due to the technology adoption will be transferred upwards via the fix fees. Clearly, in vertically related markets with upstream separated market structure and Cournot final market competition, when the upstream firms bargaining power is low enough, the final market competition is fierce enough and the new technology is not too drastic the output effect dominates the profits sharing effect and thus, firms' technology adoption takes place earlier than under one-tier industries. In addition, we show that in vertically related markets with upstream monopolistic market structure and Cournot final market competition the firms' adoption of the new technology always takes place latter than in one-tier industries. This is so, since when the upstream power is low in the market, that is a necessary condition in order the technology adoption to take place earlier in vertically related markets than in one-tier industries, the upstream monopolist could not cover the losses of the subsidization via the fix fees.

3.5 Conclusions

In the present chapter we examine the downstream firms' incentives to adopt a new cost reducing technology under both upstream separated firms market structure and upstream monopolistic market structure, as well as, the effects of the vertical relations on the firms' speed of the adoption of the new technology.

We show that in vertically related markets, both under upstream separated firms and upstream monopoly market structure, downstream firms always have strong incentives to adopt the new cost reducing technology, while in equilibrium there is technology diffusion that comes from the diminishing incremental benefits of the adoption and the decreasing adoption cost. Further, we obtain that independently of the upstream market structure, the speed of the firms' technology adoption in vertically related markets compared to that of one-tier industries alters significantly with regard to the allocation of the bargaining power in the market, the drasticity of the new technology and the intensity of the final market competition. In particular, we demonstrate that in vertically related markets the firms adopt earlier the new cost reducing technology than in one-tier industries, if and only if, the upstream bargaining power is low, the final market competition is fierce and the new technology is not too drastic. This is so, since in vertically related markets where the upstream(s) bargaining power is low enough, the downstream firms are being subsidized by their upstream partner(s) via the fix fees that in turn, given that the fix fees (subsidies, respectively) increase when the downstreams adopt the new technology, leads downstream firms to increase their speed of the technology adoption in order to get the benefit of the higher subsidies. Interestingly enough, we further show that under upstream monopolistic market structure the first adoption takes place earlier than under upstream separated firms market structure, when the new technology is sufficiently drastic and the final market competition is fierce enough. That means that, a less competitive upstream market structure, captured in the upstream monopolistic market case, can encourage, under certain circumstances, the firms' speed of adoption of the new technology. The above results highlight that, the market structure (i.e.,two-tier vs. one-tier industries, upstream separated firms market structure vs. upstream monopoly market structure), as well as, the differences in the market features (i.e., the competition intensity, the allocation of the bargaining power) could alter significantly the speed of the firms' adoption of a new cost reducing technology.

To the best of our knowledge the present work is the first that provides some findings on how the vertical relations in a market affect the firms' incentives to adopt a new technology, as well as, the speed of the firms' technology adoption and thus, more work should be done in this area. In particular, throughout the chapter we have restricted our attention to the cases where firms precommit at the starting date of the game to the specific time that the technological adoption will be fully implemented. It would be interestingly enough to extend our analysis and examine how the results could alter when firms can not credibly commit to a specific time of technological adoption (i.e., preemption game). Further, it would be interesting enough to explore the firms' incentives to merge and how this can affect the speed of the adoption of a new technology. Both of these extensions are part of our future research.

Appendix C

Appendix C1

C.1.1 The equilibrium per period downstream profits in the benchmark case are given respectively by,

$$\pi_0^B = \pi^B(c,c) = \frac{(a-c)^2(1-\gamma)}{(\gamma-2)^2(1+\gamma)}$$

$$\pi_b^B = \pi^B(c-\Delta,c-\Delta) = \frac{(a-c-\Delta)^2(1-\gamma)}{(\gamma-2)^2(1+\gamma)}$$

$$\pi_l^B = \pi^B(c-\Delta,c) = \frac{[(a-c)(\gamma^2+\gamma-2)+\Delta(\gamma^2-2)]^2}{(\gamma^2-4)^2(1-\gamma^2)}$$

$$\pi_f^B = \pi^B(c,c-\Delta) = \frac{[(a-c)(\gamma^2+\gamma-2)+\gamma\Delta]^2}{(\gamma^2-4)^2(1-\gamma^2)}$$

C.1.2 Upstream Separate firms: The per-period equilibrium wholesale prices, prices, downstream firms' profits, fix fees and upstream firms' profits are given respectively by,

$$w_0^{ST} = \frac{(a-c)(1-\gamma)\gamma^2}{4-(2+\gamma)\gamma}$$

$$w_l^{ST} = \frac{[a(1-\gamma)(4+2\gamma-\gamma^2)+c\gamma(2-\gamma^2)-(c-\Delta)(4-3\gamma^2)]\gamma^2}{16-12\gamma^2+\gamma^4}$$

$$w_f^{ST} = \frac{[(a-c)(4-3\gamma^2)+(a-c+\Delta)(\gamma^3-2\gamma)]\gamma^2}{16-12\gamma^2+\gamma^4}$$

$$w_b^{ST} = \frac{(a-c+\Delta)(1-\gamma)\gamma^2}{4-(2+\gamma)\gamma}$$

$$p_0^{ST}(.) = \frac{2a(1-\gamma)+c(2-\gamma^2)}{4-2\gamma-\gamma^2}$$

$$p_l^{ST}(.) = \frac{2a(4-2\gamma-3\gamma^2+\gamma^3)-(2-\gamma^2)[(c-\Delta)(\gamma^2-4)-2c\gamma]}{16-12\gamma^2+\gamma^4}$$

$$p_f^{ST}(.) = \frac{2a(4-2\gamma-3\gamma^2+\gamma^3)-(2-\gamma^2)[2\Delta\gamma-c(4+2\gamma-\gamma^2)]}{16-12\gamma^2+\gamma^4}$$

$$p_b^{ST}(.) = \frac{2a(1-\gamma)+(c-\Delta)(2-\gamma^2)}{4-2\gamma-\gamma^2}$$

$$\pi_{D_0}^{ST}(.) = \frac{2(a-c)^2(1-\beta)(1-\gamma)(2-\gamma^2)}{(1+\gamma)[(2+\gamma)\gamma-4]^2}$$

$$\pi_{D_l}^{ST}(.) = \frac{2(1-\beta)(2-\gamma^2)[(4-3\gamma^2)(a-c+\Delta)-\gamma(a-c)(2-\gamma^2)]^2}{(1-\gamma)(\gamma^4-12\gamma^2+16)^2}$$

$$\pi_{D_f}^{ST}(.) = \frac{2(1-\beta)(2-\gamma^2)[(a-c)(4-3\gamma^2)+(a-c+\Delta)\gamma(\gamma^2-2)]^2}{(1-\gamma)(\gamma^4-12\gamma^2+16)^2}$$

$$\pi_{D_b}^{ST}(.) = \frac{2(a-c+\Delta)^2(1-\beta)(1-\gamma)(2-\gamma^2)}{(1-\gamma)(\gamma^4-12\gamma^2+16)^2}$$

$$F_0^{ST}(.) = \frac{(a-c)^2(1-\gamma)(2-\gamma^2)(2\beta-\gamma^2)}{(1+\gamma)[(2+\gamma)\gamma-4]^2}$$

$$F_l^{ST}(.) = \frac{(2\beta-\gamma^2)(2-\gamma^2)[a(1-\gamma)(4+2\gamma-\gamma^2)+c(2\gamma-\gamma^3)-(c-\Delta)(4-3\gamma^2)]^2}{(1-\gamma)(\gamma^4-12\gamma^2+16)^2}$$

$$F_f^{ST}(.) = \frac{(2\beta-\gamma^2)(2-\gamma^2)[a(1-\gamma)(4+2\gamma-\gamma^2)+(c-\Delta)(2\gamma-\gamma^3)-c(4-3\gamma^2)]^2}{(1-\gamma)(\gamma^4-12\gamma^2+16)^2}$$

$$F_b^{ST}(.) = \frac{(a-c+\Delta)^2(1-\gamma)(2-\gamma^2)(2\beta-\gamma^2)}{(1+\gamma)[(2+\gamma)\gamma-4]^2}$$

$$\pi_{U_0}^{ST}(.) = \frac{2\beta(a-c)^2(1-\gamma)(2-\gamma^2)}{(1+\gamma)(\gamma^2+2\gamma-4)^2}$$

$$\pi_{U_l}^{ST}(.) = \frac{2\beta(2-\gamma^2)[c\gamma(2-\gamma^2)-(c-\Delta)(4-3\gamma^2)+\alpha(4-2\gamma-3\gamma^2+\gamma^3)]^2}{(1-\gamma^2)(16-12\gamma^2+\gamma^4)^2}$$

$$\pi_{U_f}^{ST}(.) = \frac{2\beta(2-\gamma^2)[(c-\Delta)\gamma(2-\gamma^2)-c(4-3\gamma^2)+\alpha(4-2\gamma-3\gamma^2+\gamma^3)]^2}{(1-\gamma^2)(16-12\gamma^2+\gamma^4)^2}$$

$$\pi_{U_b}^{ST}(.) = \frac{2\beta(a-c+\Delta)^2(1-\gamma)(2-\gamma^2)}{(1+\gamma)(\gamma^2+2\gamma-4)^2}$$

C.1.3 Upstream Monopoly:

The per-period equilibrium wholesale prices, downstream firms' prices and profits, fix fees and upstream monopolist's profits are given respectively by,

$$w_0^{MT} = w_f^{MT} = \frac{(a-c)\gamma^2}{4}$$

$$w_b^{MT} = w_l^{MT} = \frac{(a-c+\Delta)\gamma^2}{4}$$

$$p_0^{MT}(.) = \frac{2(a+c)-\gamma(a-c)}{4}$$

$$p_l^{MT}(.) = \frac{2(a+c-\Delta)-\gamma(a-c)}{4}$$

$$p_f^{MT}(.) = \frac{2(a+c)\text{-}\gamma(a-c+\Delta)}{4}$$

$$p_b^{MT}(.) = \frac{2(a+c-\Delta)-\gamma(a-c+\Delta)}{4}$$

$$\pi_{D_0}^{MT}(.) = \frac{(a-c)^2(1-\beta)[8-(2\gamma^2+\gamma^4)(1+\gamma)]}{32(1+\gamma)}$$

$$\pi_{D_l}^{MT}(.) = \frac{(1-\beta)[\Sigma-(a-c)\gamma)-2\gamma^2((a-c)^2+2\Delta(2(a-c)+\Delta))+\gamma^4(a-c)^2(3-\gamma^2)]}{32(1+\gamma)}$$

where, $\Sigma = 8(a-c+\Delta)(a-c+\Delta)$

$$\pi^{MT}_{Df}(.)=\frac{(1-\beta)[V-2\gamma^2((a-c)^2-2\Delta((a-c)-\Delta))+\gamma^4(a-c+\Delta)^2(3-\gamma^2)]}{32(1+\gamma)}$$

where, $V = 8(a-c)[(a-c)-(a-c+\Delta)\gamma]$

$$\pi^{MT}_{D_b}(.)=\frac{(a-c+\Delta)^2(1-\beta)[8-(2\gamma^2+\gamma^4)(1+\gamma)]}{32(1+\gamma)}$$

$$F^{MT}_0(.)=\frac{(a-c)^2(2+\gamma)[\beta(4+\gamma^4-\gamma^3-2\gamma)-\gamma^2(2-\gamma+\gamma^2)]}{32(1+\gamma)}$$

$$F^{MT}_l(.)=\frac{(1-\beta)\gamma^2[Z-\gamma^2((a-c)(\gamma^2-\gamma^4)-2\Delta(2(a-c)-\Delta)]+S]^2}{32(1+\gamma)}$$

where, $Z = 4(a-c+\Delta)[\gamma(a-c)-(a-c+\Delta)]$ and $S = 2\beta[(a-c)(2-\gamma-\gamma^2)+\Delta(2-\gamma^2)]$

$$F^{MT}_f(.)=\frac{(1-\beta)\gamma^2[N-\gamma^2(a-c)((a-c)+6\Delta))+3\gamma^2\Delta^2+(a-c+\Delta)\gamma^4]^2}{32(1+\gamma)}$$

where, $N = 4(a-c)[\gamma(a-c+\Delta)-(a-c)]$ and $\Omega = 2\beta[(a-c)(2-\gamma-\gamma^2)-\Delta\gamma]$

$$F^{MT}_b(.)=\frac{(a-c+\Delta)^2(2+\gamma)[\beta(4+\gamma^4-\gamma^3-2\gamma)-\gamma^2(2-\gamma+\gamma^2)]}{32(1+\gamma)}$$

$$\pi^{MT}_{U_0}(.)=\frac{(2+\gamma)(a-c)^2[(1-\gamma)\gamma^3+\beta(4-2\gamma-\gamma^3+\gamma^4)}{16(1+\gamma)}$$

$$\pi^{MT}_{U_{l,f}}(.)=\frac{\Lambda[2\beta(4-\gamma^2)+3(1-\beta)(\gamma^6-\gamma^4)]+4(a-c)(a-c+\Delta)(\gamma^3-4\beta\gamma)}{32(1-\gamma^2)}$$

where, $\Lambda = 2(a-c)^2+2(a-c)\Delta+\Delta^2$

$$\pi^{MT}_{U_b}(.)=\frac{(2+\gamma)(a-c+\Delta)^2[(1-\gamma)\gamma^3+\beta(4-2\gamma-\gamma^3+\gamma^4)}{(1+\gamma)(\gamma^2+2\gamma-4)^2}$$

Appendix C2

C2.1 Proof of proposition 8

We calculate the difference of the firms 1's incremental benefits in the case of the upstream separated firms, given in (3.26), with the respective ones of the benchmark case, given in (3.8): $G_1^{STB}(A,\gamma,\beta,\delta) \equiv I_1^{ST} - I_1^{B}$. Setting $G_1^{STB}(A,\gamma,\beta,\delta) = 0$ and solving for β, we find $\hat{\beta}_1^{ST} \equiv \frac{\gamma^3[128-8(2+\delta)(\gamma^5+4\gamma-4\gamma^3)+(2+\delta)\gamma^7+\gamma^2(88\gamma^2-192-10\gamma^4)]}{2(\gamma^2-4)^2(3\gamma^2-4)[2(3\gamma^2+2\gamma-\gamma^3-4)+\delta(3\gamma^2-4)]}$ with $\hat{\beta}_1^{ST} < \beta_c^{ST}$. It can be checked that for all γ, δ that satisfy our Assumption 1 and $\beta < \hat{\beta}_1^{ST}$, $G_1^{STB}(A,\gamma,\beta,\delta) > 0$, that is $I_1^{ST} > I_1^{B}$ and thus, $T_1^{ST} < T_1^{B}$ while, $G_1^{STB}(A,\gamma,\beta,\delta) < 0$, if $\beta > \hat{\beta}_1^{ST}$. Further, we calculate the difference of the firms 2's incremental benefits in the case of the upstream separated firms, given in (3.27), with the respective ones of the benchmark case, given in (3.9): $G_2^{STB}(A,\gamma,\beta,\delta) \equiv I_2^{ST} - I_2^{B}$. Setting $G_2^{STB}(A,\gamma,\beta,\delta) = 0$ and solving for β, we find $\hat{\beta}_2^{ST} \equiv \frac{\gamma^3[8(2+\delta)(\gamma^5+4\gamma-4\gamma^3)-(2+\delta)\gamma^7+(1+\delta)(10\gamma^6+192\gamma^2-128-88\gamma^4)]}{2(\gamma^2-4)^2(3\gamma^2-4)[(2+\delta)(4-3\gamma^2)+2(1+\delta)(\gamma^3-2\gamma)}$, with $\hat{\beta}_2^{ST} < \beta_c^{ST}$. It can be checked that for all γ, δ that satisfy our Assumption 1 and $\beta < \hat{\beta}_2^{ST}$, $G_2^{STB}(A,\gamma,\beta,\delta) > 0$, that is $I_2^{ST} > I_2^{B}$ and thus, $T_1^{ST} < T_1^{B}$ while, $G_2^{STB}(A,\gamma,\beta,\delta) < 0$, if $\beta > \hat{\beta}_2^{ST}$. ■

C2.2 Proof of proposition 9

We calculate the difference of the firms 1's incremental benefits in the case of the upstream monopoly, given in (3.40), with the respective ones of the benchmark case, given in (3.8): $G_1^{MTB}(A,\gamma,\beta,\delta) \equiv I_1^{MT} - I_1^{B}$. Setting $G_1^{MTB}(A,\gamma,\beta,\delta) = 0$ and solving for β, we find $\hat{\beta}^{MT} \equiv \frac{\gamma^4}{(\gamma^2-4)^2}$ with $\hat{\beta}^{MT} < \beta_c^{MT}$. It can be checked that for all γ, δ that satisfy our Assumption 1 and $\beta < \hat{\beta}^{MT}$, $G_1^{MTB}(A,\gamma,\beta,\delta) > 0$, that is $I_1^{MT} > I_1^{B}$ and thus, $T_1^{MT} < T_1^{B}$ while, $G_1^{MTB}(A,\gamma,\beta,\delta) < 0$, if $\beta > \hat{\beta}_1^{MT}$. Further, we calculate the difference of the firms 2's incremental benefits in the case of the upstream monopoly, given in (3.41), with the respective ones of the benchmark case, given in (3.9): $G_2^{MTB}(A,\gamma,\beta,\delta) \equiv I_2^{MT} - I_2^{B}$. Setting $G_2^{MTB}(A,\gamma,\beta,\delta) = 0$ and solving for β, we find $\hat{\beta}^{MT} \equiv \frac{\gamma^4}{(\gamma^2-4)^2}$, with $\hat{\beta}^{MT} < \beta_c^{MT}$. It can be checked that for all γ, δ that satisfy our Assumption 1 and $\beta < \hat{\beta}^{MT}$, $G_2^{MTB}(A,\gamma,\beta,\delta) > 0$, that is $I_2^{MT} > I_2^{B}$ and thus, $T_1^{MT} < T_1^{B}$ while, $G_2^{MTB}(A,\gamma,\beta,\delta) < 0$, if $\beta > \hat{\beta}^{MT}$. ■

C2.3 Proof of proposition 10

We calculate the difference of the downstream firms 1's incremental benefits in the case of the upstream monopoly, given in (3.40), with the respective ones of the upstream separate firms case, given in (3.26): $G_1^{MS}(A,\gamma,\beta,\delta) \equiv I_1^{MT}-I_1^{ST}$. Setting $G_1^{MS}(A,\gamma,\beta,\delta) = 0$ and solving for δ, we find $\delta^c(\gamma) \equiv \frac{2[64(1-\gamma)+80(\gamma^3-\gamma^2)+24\gamma^4-26\gamma^5+\gamma^6+\gamma^7]}{\gamma(64-80\gamma^2+26\gamma^4+\gamma^6)}$ with $\frac{\partial\delta}{\partial\gamma} < 0$. It can be checked that for all γ that satisfy our Assumption 1 and $\delta > \delta^c(\gamma)$, $G_1^{MS}(A,\gamma,\beta,\delta) > 0$, that is $I_1^{MT} > I_1^{ST}$ and thus, $T_1^{MT} < T_1^{ST}$ while, $G_1^{MS}(A,\gamma,\beta,\delta) < 0$, $\delta < \delta^c(\gamma)$. Further, we calculate the difference of the firms 2's incremental benefits in the case of the upstream monopoly, given in (3.41), with the respective ones of the upstream separate firms case, given in (3.27): $G_2^{MS}(A,\gamma,\beta,\delta) \equiv I_2^{MT}-I_2^{ST}$ and after some manipulation, we show that for all γ, δ,β, $G_2^{MS}(A,\gamma,\beta,\delta) < 0$, that is $I_2^{MT} < I_2^{ST}$ and thus, $T_1^{MT} > T_1^{ST}$. ■

Appendix C3 Cournot Final Market Competition

Using, (3.1), we have that when the downstream firms compete by setting their quantities, the inverse demand function that each D_i faces is given by,

$$p_i = a - q_i - \gamma q_j, \quad i,j = 1,2;\ i \neq j;\ 0 < \gamma \leqslant 1$$

Benchmark Case

In the benchmark case of a one-tier industry, there exists two firms in the market that compete by choosing: First, the optimal dates of the adoption of the new technology and then, by setting their outputs. Solving the game backwards, at the second stage of the game each firm i decides its output q_i, taking as given the decision over the output of the rival firm q_j, in order to maximize its per -period gross profits:

$$\underset{q_i}{Max}\,\pi_i^{CB}(.) = (\alpha - q_i - \gamma q_j)q_i - c_i q_i$$

thus, each firm's per-period output and gross profits are given respectively by,

$$q_i^{CB}(.) = \frac{2(a-c_i) - \gamma(a-c_j)}{4-\gamma^2}$$

$$\pi_i^{CB}(.) = [\frac{2(a-c_i)-\gamma(a-c_j)}{(4-\gamma^2)}]^2$$

Observe here that, the downstream firm's adoption of the new technology that implies a lower marginal cost of production $(c-\Delta)$, tends to increase the own output production, q_i, while, it tends to decrease the rival's output production, q_j.

Further, at date $t=0$, by maximizing the discounted firms' profits given as in (3.5) and (3.6), where now the per period gross profits are given respectively as follows, $\pi_0^{CB} = \pi^{CB}(c,c)$, the gross profits in the pre-adoption periods, $\pi_b^{CB} = \pi^{CB}(c-\Delta, c-\Delta)$, the per period gross profits when both firms are technologically advanced and, $\pi_l^{CB} = \pi^{CB}(c-\Delta, c)$ and $\pi_f^{CB} = \pi^{CB}(c, c-\Delta)$, the per-period gross profits of the firm that has already adopted the new technology -the leader- and those of the firm that has not yet adopted the technological change -the follower- respectively, we find that the incremental benefits of the benchmark case under Cournot market competition are given by,

$$I_1^{CB} = \frac{4\delta A^2[(2-\gamma)+\delta]}{(4-\gamma^2)^2}$$

$$I_2^{CB} = \frac{4\delta A^2[(2-\gamma)+\delta(1-\gamma)]}{(4-\gamma^2)^2}$$

Note that, $I_i^{CB} > 0$, that means that under Cournot final market competition firms always have strong incentives to adopt the available cost reducing technology. Further, $I_1^{CB} > I_2^{CB}$, and thus, $T_1^{CB} < T_2^{CB}$ that means that in the equilibrium the market is characterized by technological diffusion.

Vertically Related Markets

In the vertically related markets where downstream firms compete in the final market by setting their outputs, at date $t \geqslant 0$, at the second stage of the game, independently of the upstream market structure, each downstream firm D_i maximizes its' per period gross profits,

$$\underset{q_i}{Max}\pi_{D_i}(.) = (a - q_i - \gamma q_j)q_i - (c_i + w_i)q_i$$

where solving the maximization problem, we obtain that the equilibrium per periods quantities and profits in the last stage are given by,

$$q_i(c_i, c_j) = \frac{2(a-c_i) - \gamma(a-c_j) - 2w_i + \gamma w_j}{4-\gamma^2}, \quad \begin{array}{l} c_i = c \text{ or } c_i = c - \Delta \\ c_j = c \text{ or } c_j = c - \Delta \end{array}$$

$$\pi_{D_i}(.) = \frac{[2(a-c_i) - \gamma(a-c_j) - 2w_i + \gamma w_j]^2}{[4-\gamma^2]^2}$$

Further, in order to ensure that all of the participants are active in the market under all the cases considered along with our basic model Assumption 1, the following assumption should also holds,

Assumption 2. $\beta \geqslant \tilde{\beta}(\gamma) = \gamma^3/(4 - 2\gamma(1+\gamma) + \gamma^3$

The above assumption is a necessary and sufficient condition in order to ensure the existence of pure strategy pairwise proof equilibria under the case of the upstream monopolist. Non-existence of pure strategy equilibria may occur because pairwise proofness leads to negative profits for the upstream monopolist. This is so since, if for given γ, the upstream monopolist power is low enough, the upstream is being subject to opportunism and is unable to cover its losses from the input subsidization via the fixed-fees.

Upstream Separate Firms

Letting $(w_j^{SC},\ F_j^{SC})$ denote the equilibrium outcome of the $(U_j,\ D_j)$ pair's negotiations, the $w_i$and F_i, when the downstream market competition takes place in quantities, are chosen such to maximize the generalized Nash product,

$$\underset{w_i, F_i}{Max} = [\pi_{U_i} + F_i]^{\beta} [\pi_{D_i} - F_i]^{1-\beta}$$

where, $\pi_{U_i} = w_i q_i(w_i, w_j^{SC})$ and $\pi_{D_i} = [q_i(w_i, w_j^{SC})]^2$.

Maximizing the generalized Nash product with respect to F_i, we have that,

$$F_i = \beta \pi_{D_i} - (1-\beta)\pi_{U_i}$$

Substituting the above equation into the generalized Nash product, we observe that the net profits of the U_i and D_i are given by the shares of their joint surplus, $S = \pi_{U_i} + \pi_{D_i}$, that corresponds to their respective bargaining power $(\beta, 1-\beta)$ Thus, the generalized Nash product can be rewritten as function of the vertical chain's joint surplus, while the wholesale prices, w_i, are chosen in order to maximize that surplus,

$$\underset{w_i}{Max} S = [a - q_i(w_i, w_j^{SC}) - \gamma q_j(w_i, w_j^{SC})]q_i(w_i, w_j^{SC})$$

Taking the first order conditions of the above expression, the per period equilibrium wholesale prices under Cournot final market competition are given by,

$$w^{SC}(c_i, c_j) = -\frac{\gamma^2[a(4-\gamma(2+\gamma)) - (4-\gamma^2)c_i + 2c_j]}{16 - 12\gamma^2 + \gamma^4} \quad \begin{array}{l} c_i = c \text{ or } c_i = c - \Delta \\ c_j = c \text{ or } c_j = c - \Delta \end{array}$$

In particular, the equilibrium wholesale prices in the pre adoption periods are given by, $w_0^{SC} = w^{SC}(c, c)$, the equilibrium wholesale prices in the post adoption periods are given by, $w_b^{SC} = w^{SC}(c - \Delta, c - \Delta)$ while, $w_l^{SC} = w^{SC}(c - \Delta, c)$ and $w_f^{SC} = w^{SC}(c, c - \Delta)$ denote the equilibrium wholesale price charged on the leader and the follower firm, respectively.

Observe here that under Cournot final market competition the per period equilibrium wholesale prices are always lower than the upstream firms' marginal cost of production. That means that, when the downstream firms compete in the final market by setting their quantities, the upstream firms subsidize their downstream partners via the wholesale prices. This is so, since each upstream firm by setting a lower wholesale price to its downstream partner is willing to make the latter more aggressive in the final market. In more details, a lower wholesale price shifts out the reaction function of the downstream firm and thus, given that the reaction functions under Cournot competition are downward slopping, the output of the rival downstream firm decrease, while the output and the per period gross profits of the own downstream firm increase. Part of these increased downstream firm's per period gross profits are transferred via the fixed fees upstream and thus, the upstream firm more than cover the losses of the downstream's subsidization. Note also, that the equilibrium wholesale prices decrease when the downstream firms adopt the new technology.

Further, the downstream firms' equilibrium per period output and gross profits under

Cournot final market competition are given respectively by,

$$q_i^{SC}(c_i, c_j) = \frac{2a(4-2\gamma-\gamma^2)+4\gamma c_j - 2c_i(4-\gamma^2)}{16-12\gamma^2+\gamma^4}, \quad \begin{matrix} c_i = c \text{ or } c-\Delta \\ c_j = c \text{ or } c-\Delta \end{matrix}$$

$$\pi_{D_i}^{SC}(c_i, c_j) = \frac{2(1-\beta)(2-\gamma^2)[a(4-2\gamma-\gamma^2)+2\gamma c_j-(4-\gamma^2)c_i]^2}{(16-12\gamma^2+\gamma^4)^2}$$

where, the equilibrium output and gross profits in the pre adoption periods are given by, $q_0^{SC} = q^{SC}(c, c)$ and $\pi_{D_0}^{SC} = \pi_D^{SC}(c, c)$, respectively. The equilibrium output and gross profits in the post adoption periods are given respectively by, $q_b^{SC} = q^{SC}(c-\Delta, c-\Delta)$ and $\pi_{D_b}^{SC} = \pi_D^{SC}(c-\Delta, c-\Delta)$. The equilibrium output and gross profits of the leader firm are given, respectively, $q_l^{SC} = q^{SC}$ $(c-\Delta, c)$ and $\pi_{D_l}^{SC} = \pi_D^{SC}(c-\Delta, c)$ while $q_f^{SC} = q^{SC}$ $(c, c-\Delta)$ and $\pi_{Df}^{SC} = \pi_D^{SC}(c, c-\Delta)$ are respectively, the equilibrium output and gross profits of the follower firm.

At the same time, the equilibrium per period upstream firms' profits and the fixed fees are given respectively by,

$$\pi_{U_i}^{SC}(c_i, c_j) = \frac{2\beta(2-\gamma^2)[a(4-2\gamma-\gamma^2)+2\gamma c_j-(4-\gamma^2)c_i]^2}{(16-12\gamma^2+\gamma^4)^2}$$

$$F_i^{SC}(c_i, c_j) = \frac{2[2\beta+(1-\beta)\gamma^2][a(2\gamma+\gamma^2-4)-2\gamma c_j+(4-\gamma^2)c_i]^2}{(16-12\gamma^2+\gamma^4)^2}$$

In particular, the equilibrium upstream firms' profits and the fix fees in the pre-adoption periods are given respectively by, $\pi_{U_0}^{SC} = \pi_U^{SC}(c, c)$ and $F_0^{SC} = F^{SC}(c, c)$. The equilibrium upstream firms' profits and the fix fees in the post adoption periods given respectively by, $\pi_{U_b}^{SC} = \pi_U^{SC}(c-\Delta, c-\Delta)$ and $F_b^{SC} = F^{SC}(c-\Delta, c-\Delta)$. The equilibrium upstream firm's profits and fix fees of the leader-follower periods are given respectively by, $\pi_{U_l}^{SC} = \pi_U^{SC}(c-\Delta, c)$ and $F_l^{SC} = F^{SC}$ $(c-\Delta, c)$, $\pi_{Uf}^{SC} = \pi_U^{SC}(c, c-\Delta)$ and $F_f^{SC} = F^{SC}$ $(c, c-\Delta)$. Observe here that, in contrast to the case of Betrand final market, when the final market competition takes place in quantities the fix fees that the upstream firms set always exceed zero, independently of the bargaining power that upstream firms possess in the market.

Further, at date $t = 0$, by maximizing with respect to T_i the discounted downstream firms profits given as in the equations (3.23) and (3.24) where the per period profits are given now by, $\pi_{D_0}^{SC}$, $\pi_{D_b}^{SC}$, $\pi_{D_l}^{SC}$ and π_{Df}^{SC}, we obtain that the incremental benefits in the upstream separate firms case when the downstream firms compete by setting their quantities are given by,

$$I_1^{SC}=\frac{2(1-\beta)\delta A^2(\gamma^4-6\gamma^2+8)[2(4-\gamma(\gamma+2)+\delta(4-\gamma^2)]}{(\gamma^4-12\gamma^2+16)^2}$$

$$I_2^{SC}=\frac{2(1-\beta)\delta A^2(\gamma^4-6\gamma^2+8)[2(4-\gamma(\gamma+2)+\delta(4-\gamma(\gamma+4))]}{(\gamma^4-12\gamma^2+16)^2}$$

Observe here that, under vertically related markets with upstream separate firms market structure and Cournot final market competition, the downstream firms always have strong incentives to adopt the new technology, since $I_i^{SC}>0$, while, at the same time, in the equilibrium there exists technological diffusion, since $I_1^{SC}>I_2^{SC}$, and thus, $T_1^{SC}<T_2^{SC}$.

Further, comparing the firms' incremental benefits under the upstream separate firms market structure with the respective ones of the benchmark case, when downstream firms compete in quantities, we show that in the equilibrium there exists $\hat{\beta}_1^{SC}\equiv\frac{\gamma^3[128-(2+\delta)(96\gamma+80\gamma^3-16\gamma^5+\gamma^7)-4(2\gamma^4+\gamma^6)]}{(\gamma^2-4)^3(2-\gamma^2)[(2+\delta)(4-\gamma^2)-4\gamma)]}$, such that if $\beta<\hat{\beta}_1^{SC}$ then, $I_1^{SC}>I_1^{CB}$ and thus, $T_1^{SC}<T_1^{CB}$, while the opposite holds if, $\beta>\hat{\beta}_1^{SC}$. Further, regarding the second technology adoption, we demonstrate that in the equilibrium there exists $\hat{\beta}_2^{SC}\equiv\frac{\gamma^3[2(2-\gamma)(4-2\gamma-\gamma^2)][8-(4+\gamma(8-\gamma-\gamma^2)]+\delta[128-\gamma(96+(\gamma^2-2)\gamma(\gamma+4)(4-2\gamma-\gamma^2)]}{(\gamma^2-4)^3(2-\gamma^2)[(2+\delta)(4-\gamma-\gamma^2)]}$, such that if $\beta<\hat{\beta}_2^{SC}$ then, $I_2^{SC}>I_2^{CB}$ and thus, $T_2^{SC}<T_2^{CB}$, while the opposite holds if, $\beta>\hat{\beta}_2^{SC}$. Thus, given the above results and our Assumption 2, it is clear that, two-tier industries with upstream separate firms market structure and Cournot final market competition, lead to earlier first and second adoption than one-tier industries, if and only if, the upstream firms' bargaining power is low enough, the final market competition is fierce enough and the new technology is not too drastic. The intuition behind this result, is based on the two opposing effects that vertical relations generate in the market, named as the output effect and the profits sharing effect. In more details, as we have already mentioned, in vertically related markets with upstream separate firms and Cournot final market competition the wholesale prices that upstream firms set are always below their marginal production cost while, they decrease when the downstream firms adopt the new technology. Thus, given the subsidization of the downstream firms production via the lower wholesale prices, we have that the final output production under vertically related markets with Cournot final market competition is higher than under one tier industries.

The latter, named as the output effect, tends to enforce the downstream firms' speed of technology adoption in the vertically related markets with upstream separate firms markets structure and Cournot final market competition, since the new technology will be applied to a higher volume of production. On the contrary, we observe that in two-tier industries with Cournot final market competition there exists a profits sharing effect, since part of the per period profits of the downstream firms' are transferred via the fix fees to the upstream firms. That in turn, tends to postpone the speed of the downstream firms' technological adoption, since part of their increased per period gross profits due to the technology adoption will be transferred upwards via the fix fees. Clearly, when the final market competition is fierce enough, the upstream firms possess low bargaining power and the new technology is not extremely drastic the output effect dominates the profits sharing effect and thus, the first and second technology adoption take place earlier in two-tier industries than in the one-tier ones.

Upstream Monopoly

Letting (w_j^{MC}, F_j^{MC}) denote the equilibrium outcome of the (U, D_j) pair's negotiations, the $w_i$and F_i, when the downstream market competition takes place in quantities, are chosen such to maximize the generalized Nash product,

$$\underset{w_i,F_i}{Max} = [\pi_U{+}F_i{+}F_i^{MC}{-}d(w_j^{MC},F_j^{MC})]^{\beta}[\pi_{D_i}{-}F_i]^{1-\beta}$$

where, $\pi_U = w_i q_i(w_i, w_j^{MC}) + w_j^{MC} q_j(w_i, w_j^{MC})$ and $\pi_{D_i} = [q_i(w_i, w_j^{MC})]^2$, while the outside option is given by, $d(w_j^{MC}, F_i^{MC}) = w_j^{MC} q_j^{MON} + F_j^{MC}$ with $q_j^{MON} = \frac{a-c-w_j^{MC}}{2}$.

Maximizing the generalized Nash product with respect to F_i, we have that,

$$F_i{=}\ \beta\pi_{D_i}{-}(1-\beta)[\pi_U{-}w_j^{MC}q_j^{MON}]$$

Substituting the above equation into the generalized Nash product, we obtain that the net profits of the upstream monopolist, above its disagreement payoff, and the net profits of D_i, are proportional to their joint surplus, $S^{MC} = \pi_U + \pi_{D_i} - w_j^{MC} q_j^{MON}$, with the coefficients of proportionality to be given by their bargaining powers β and $1-\beta$, respectively. Thus, the wholesale prices w_i are chosen in order to maximize this surplus:

$$\underset{w_i}{Max} S^{MC} = [a - q_i(w_i, w_j^{MC}) - \gamma q_j(w_i, w_j^{MC})] q_i(w_i, w_j^{MC}) + w_j^{MC}[q_j(w_i, w_j^{MC}) - q_j^{MON}]$$

From the first order conditions of the above equation, we obtain that the equilibrium per period wholesale prices in the vertically related markets with upstream monopolist market structure when the final market competition takes place in quantities, are given respectively by,

$$w^{MC}(c_i) = -\frac{(a - c_i)\gamma^2}{2(2 - \gamma^2)}, c_i = c \text{ or } c_i = c - \Delta$$

In particular, the equilibrium wholesale prices in the pre adoption periods, as well as, the equilibrium wholesale price of the follower firm are given by, $w_0^{MC} = w_f^{MC} = w^{MC}(c)$, the equilibrium wholesale prices in the post adoption periods, as well as, the equilibrium wholesale price of the leader firm in adopting are given by, $w_l^{MC} = w_b^{MC} = w^{MC}(c - \Delta)$.

Observe here that, the upstream monopolist's per period equilibrium wholesale prices are always lower than the upstream's marginal cost of production. That means that, the upstream monopolist subsidizes its downstream partners via the wholesale prices. This is so, due to the so called "commitment problem" that arises when the contracts negotiations are not fully observable, since the upstream monopolist could not commit to the downstream firms that it is not going to behave opportunistically and to secretly offer a lower wholesale price to the rival downstream firm in order to make the latter more competitive in the final market. The upstream monopolist has incentives to offer a lower wholesale price, since he will extract the benefit of the higher gross profits that the favored downstream partner will obtain by transferring part of these higher profits upstream via the fix fees. Thus, given that the downstream firms are aware of the upstream monopolist's incentives to behave opportunistically, none of the them is going to agree to a wholesale price higher than the upstream monopolist cost of production (for detailed analysis of the commitment problem see among, McAfee and Schwartz, 1995; Rey and Vergi, 2004; de Fontenay and Gans, 2005). Note also, that the equilibrium wholesale prices decrease when the downstream firms adopt the new cost reducing technology.

Further, the downstream firms' equilibrium per period output and gross profits under

Cournot final market competition are given respectively by,

$$q_i^{MC}(c_i, c_j) = \frac{2(a - c_i) - (a - c_j)\gamma}{4 - \gamma^2}, \quad \begin{matrix} c_i = c \text{ or } c - \Delta \\ c_j = c \text{ or } c - \Delta \end{matrix}$$

$$\pi_{D_i}^{MC}(c_i, c_j) = \frac{(1 - \beta)[2c_i - \gamma c_j - a(2 - \gamma)]^2}{8(2 - \gamma^2)^2}$$

where, the equilibrium output and gross profits in the pre adoption periods are given by, $q_0^{MC} = q^{MT}(c, c)$ and $\pi_{D_0}^{MC} = \pi_D^{MC}(c, c)$, respectively. The equilibrium output and gross profits in the post adoption periods are given respectively by, $q_b^{MC} = q^{MC}(c - \Delta, c - \Delta)$ and $\pi_{D_b}^{MC} = \pi_D^{MC}(c - \Delta, c - \Delta)$. The equilibrium output and gross profits of the leader firm are given, respectively by, $q_l^{MC} = q^{MC}\ (c - \Delta, c)$ and $\pi_{D_l}^{MC} = \pi_D^{MC}(c - \Delta, c)$, while $q_f^{MC} = q^{MC}\ (c, c - \Delta)$ and $\pi_{Df}^{MC} = \pi_D^{MC}(c, c - \Delta)$ are respectively, the equilibrium output and gross profits of the follower firm.

At the same time, the equilibrium per period upstream monopolist's profits and the fixed fees are given respectively by,

$$\pi_{U_i}^{MC}(c_i, c_j) = \frac{2\beta(2 - \gamma^2)[a(4 - 2\gamma - \gamma^2) + 2\gamma c_j - (4 - \gamma^2)c_i]^2}{(16 - 12\gamma^2 + \gamma^4)^2}$$

$$F_i^{MC}(c_i, c_j) = \frac{2[2\beta + (1 - \beta)\gamma^2][2c_i - \gamma c_j - a(2 - \gamma)]^2}{8(\gamma^2 - 2)^2}$$

In particular, the equilibrium upstream monopolist's profits and the fix fees in the pre-adoption periods are given respectively by, $\pi_{U_0}^{MC} = \pi_U^{MC}(c, c)$ and $F_0^{MC} = F^{MC}(c, c)$. The equilibrium upstream monopolist's profits and the fix fees in the post adoption periods given respectively by, $\pi_{U_b}^{MC} = \pi_U^{MC}(c - \Delta, c - \Delta)$ and $F_b^{MC} = F^{MC}(c - \Delta, c - \Delta)$. The equilibrium fix fees of the leader-follower periods are given respectively by, $F_l^{MC} = F^{MC}\ (c - \Delta, c)$, and $F_f^{MC} = F^{MC}\ (c, c - \Delta)$ and the equilibrium upstream monopolist's profits in the leader-follower periods are given by $\pi_U^{MC} = \pi_U^{MC}(c - \Delta, c)$. Observe here that, in contrast to the Betrand final market competition case, when the final market competition takes place in quantities the fix fees that the upstream monopolist sets always exceed zero, independently of its bargaining power in the market.

Further, at date $t = 0$, by maximizing with respect to T_i the discounted downstream firms profits given as in the equations (3.37) and (3.38), where the per period profits are given now by, $\pi_{D_0}^{MC}$, $\pi_{D_b}^{MC}$, $\pi_{D_l}^{MC}$ and π_{Df}^{MC}, we obtain that the incremental benefits in the upstream monopolist case when the downstream firms compete by setting their quantities are given by,

$$I_1^{MC} = \frac{(1-\beta)\delta A^2[(2-\gamma)+\delta]}{2(2-\gamma^2)}$$

$$I_2^{MC} = \frac{(1-\beta)\delta A^2[(2-\gamma)+\delta(1-\gamma)]}{2(2-\gamma^2)}$$

Observe here that, in line with our basic model's results, in vertically related markets with upstream monopolistic market structure and Cournot final market competition the downstream firms always have strong incentives to adopt the new technology, since $I_i^{MC} > 0$, while, at the same time, in equilibrium there exists technological diffusion, since $I_1^{MC} > I_2^{MC}$, and thus, $T_1^{MC} < T_2^{MC}$.

Comparing now the firms' incremental benefits under the upstream monopolistic market structure with the respective ones of the benchmark case, when the final market competition takes place in quantities, we show that in equilibrium the firms' incremental benefits in the benchmark case always exceed those of upstream monopolist case, that is, $I_1^{MC} < I_1^{CB}$ and thus, $T_1^{MC} > T_1^{CB}$ and $I_2^{MC} < I_2^{CB}$ and thus, $T_2^{MC} > T_2^{CB}$. In other words, we demonstrate that in two-tier industries, under upstream monopolistic market structure and Cournot final market competition, the technology adoption always takes place latter than in one-tier industries. This is so, since as we have see by our analysis in order the technology adoption to take place earlier under vertically related market, the upstream's sector bargaining power in the market should be low enough. However, given our Assumption 2, in the upstream monopolistic case where downstream firms compete in quantities a low enough upstream monopolist's bargaining power in the market leads to negative profits for the upstream. In other words, when the upstream's power in the market is low enough, the upstream monopolist is unable to cover its losses from the input subsidization via the fixed-fees.

Figures

In the following figures (i.e., Figs. 1a &1b), ΔI_i, ($i = 1, 2$,respectively) denotes the geometrical locus, as function of the product substitutability degree (γ) and the drasticity of the new cost reducing technology (δ), where the firm i's incremental benefits in the separated vertically related market equal those of the benchmark case of the one tier industry (i.e, $I_i^{ST} = I_i^B$ and thus, $T_i^{ST} = T_i^B$). On the right of ΔI_i (area A) the firm i's incremental benefits in the separated vertically related market exceed those of the benchmark case (i.e, $I_i^{ST} > I_i^B$ and thus, $T_i^{ST} < T_i^B$) while, the opposite hold on the left of ΔI_i (area B) (i.e, $I_i^{ST} < I_i^B$ and thus, $T_i^{ST} > T_i^B$). Last but not least, the area on the right of As.1 (area Γ) has been excluded from our analysis since it does not satisfy the basic assumption of our model.

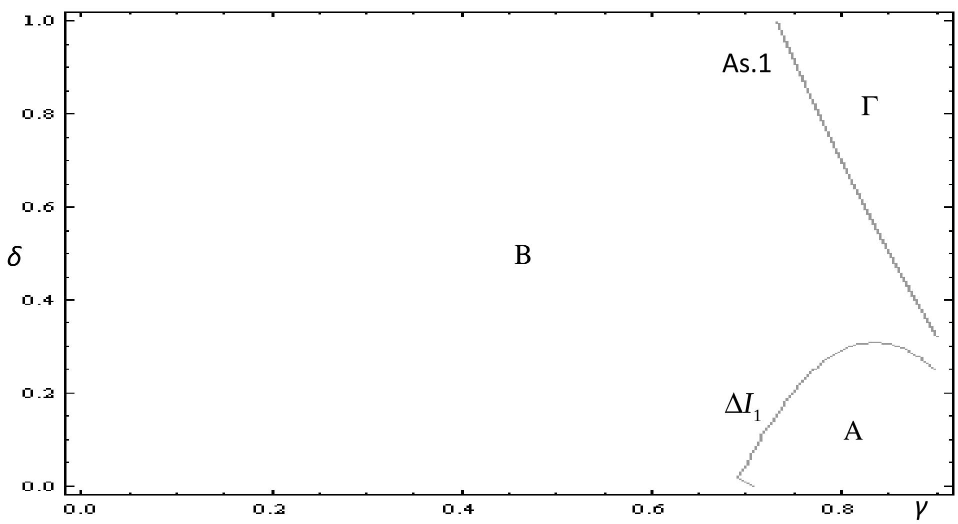

Fig.1a. The geometrical locus, ΔI_1 , where firm 1's incremental benefits obtained in the upstream separate firms case equal those of the benchmark case as function of γ and δ and with respect to basic assumption of the model, As.1. (β=0.05)

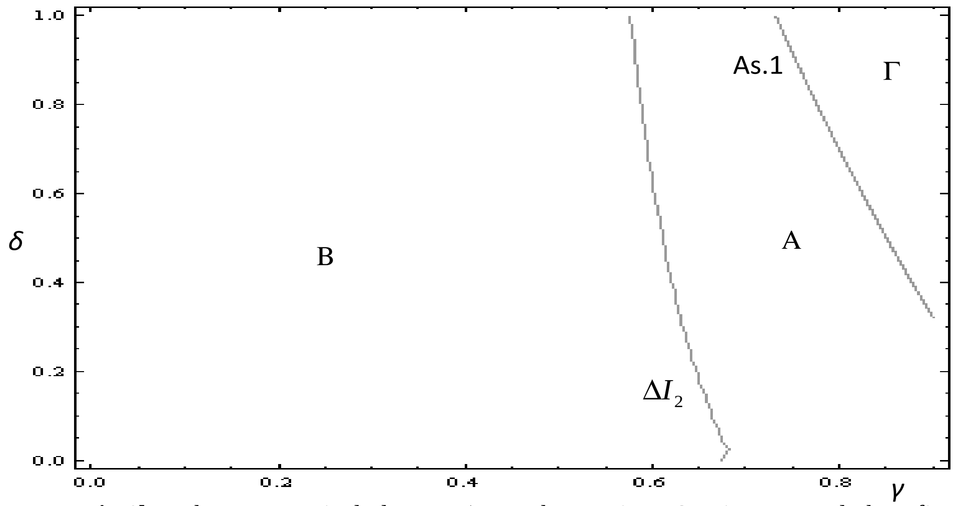

Fig.1b. The geometrical locus, ΔI_2, where Firm 2's incremental benefits obtained in the upstream separate firms case equal those of the benchmark case as function of γ and δ and with respect to basic assumption of the model, As.1.(β=0.05)

In the following figure (i.e., Fig. 3), ΔI_i, ($i = 1, 2$,respectively) denotes the geometrical locus, as function of the product substitutability degree (γ) and the drasticity of the new cost reducing technology (δ), where the firm i's incremental benefits in the monopolistic vertically related market equal those of the benchmark case of the one tier industry (i.e, $I_i^{MT} = I_i^B$ and thus, $T_i^{MT} = T_i^B$). On the right of ΔI_i (area A) the firm i's incremental benefits in the monopolistic vertically related market exceed those of the benchmark case (i.e, $I_i^{MT} > I_i^B$ and thus, $T_i^{MT} < T_i^B$) while, the opposite hold on the left of ΔI_i (area B) (i.e, $I_i^{MT} < I_i^B$and thus, $T_i^{MT} > T_i^B$). Last but not least, the area on the right of As.1 (area Γ) has been excluded from our analysis since it does not satisfy the basic assumption of our model.

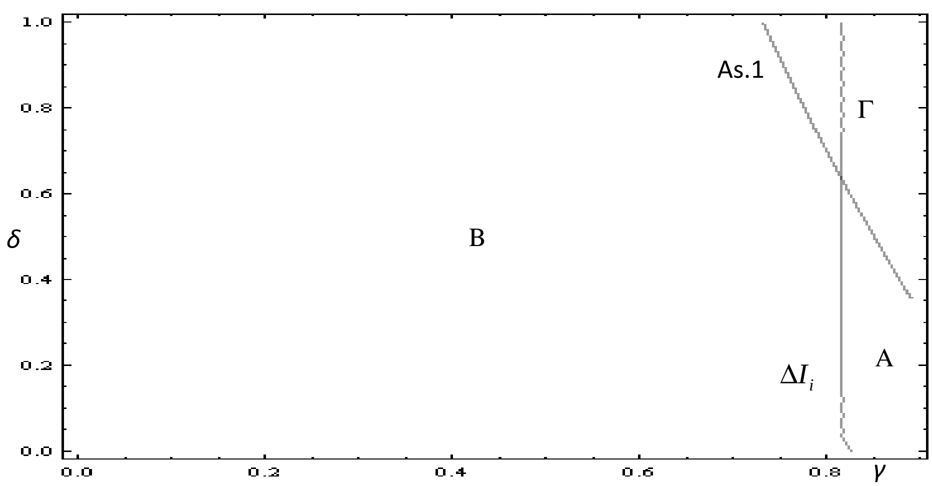

Fig.3. The geometrical locus, ΔI_i, where Firm i's incremental benefits obtained in the upstream monopolist case equal those of the benchmark case as function of γ and δ and with respect to basic assumption of the model, As.1. (β=0.04)

Bibliography

[1] Caselli, F., 2005. Accounting for Cross-Country Income Differences. Handbook of Economic Growth, 679-741.

[2] Carlsson B., Jacobsson S., 1994. Technological Systems and Economic Policy: The Diffusion of Factory Automation in Sweden. Research Policy 23, 235-248.

[3] de Fontenay, C.C., Gans J.S., 2005. Vertical Integration in the Presence of Upstream Competition. Rand Journal of Economics 36, 544-572.

[4] Fudenberg, D., Tirole, J., 1985. Preemption and rent equalization in the adoption of new technology. Review of Economic Studies 52, 383-401.

[5] Gotz, G., 1999. Monopolistic Competition and the Diffusion of New Technology. Rand Journal of Economics 30, 679-693.

[6] Griliches, Z., 1998. R&D and Productivity: The Econometric Evidence. NBER Monograph series, Chicago: University of Chicago Press.

[7] Hall, R.E, Charles I.J, 1999. Why Do Some Countries Produce So Much More Output per Worker Than Others. Quarterly Journal of Economics 114, 83–116.

[8] Helper, S., 1995. Supplier Relations and Adoption of New Technology: Results of Survey Research in the U.S. Auto Industry. NBER Working Paper #5278.

[9] Hendricks, K., 1992. Reputation in the adoption of a new technology. International Journal of Industrial Organization 10, 663-677.

[10] Hoppe, H., 2002. The timing of new technology adoption: theoretical models and empirical evidence. The Manchester School 70, 56-76.

[11] Katz, M., Shapiro, C., 1987. R&D Rivalry with Licensing or Imitation. American Economic Review 77, 402-420.

[12] Klenow, P.J., Rodriguez-Clare, A., 1997. The Neoclassical Revival in Growth Economics: Has It Gone Too Far. NBER Macroeconomics Annual 1997, Cambridge, MA: MIT Press, 73-103.

[13] Klette, T.J., 1996. R&D, Scope Economies, and Plant Performance, RAND Journal of Economics 27, 502-22.

[14] Krugman, P., 1994. Peddling Prosperity, New York, Norton.

[15] Lane, S., 1991. The Determinants of Investment in New Technology. American Economic Review 81, 262-65.

[16] McAfee, P., Schwartz, M., 1995. The non-existence of pairwise-proof equilibrium. Economics Letters 49, 251–259.

[17] Milliou, C., Petrakis E., 2011. Timing of technology adoption and product market competition. International Journal of Industrial Organization 29, 513-523.

[18] Milliou, C., Petrakis E., 2007. Upstream Horizontal Mergers, Vertical Contracts, and Bargaining. International Journal of Industrial Organization 25, 963-987.

[19] Riordan, M., 1992. Regulation and preemptive technology adoption. Rand Journal of Economics 23, 334-349

[20] Rey, P., Verge T., 2004. Bilateral Control with Vertical Contracts. Rand Journal of Economics 35, 728-746.

[21] Reinganum, J., 1981a. On the diffusion of new technology: a game theoretic approach. Review of Economic Studies 48, 395-405.

[22] Reinganum, J., 1981b. Market structure and the diffusion of new technology. The Bell Journal of Economics 12, 618-624.

[23] Reinganum, J., 1983a. Technology adoption under imperfect information. The Bell Journal of Economics 14, 57-69.

[24] Reinganum, J., 1983b. Uncertain innovation and the persistence of monopoly. American Economic Review 73, 741-748.

[25] Ruiz-Aliseda, F., Zemsky, P., 2006. Adoption is not Development: First Mover Advantages in the Diffusion of New Technology. Insead Working Paper, 2007/03/ST.

[26] Schumpeter, J., 1934. The Theory of Economic Development. Cambridge, Mass: Harvard University Press.

[27] Sutton, J., 1998. Technology and Market Structure: Theory and History. Cambridge, MA: MIT Press.

[28] Vives, X., 1985. On the Efficiency of Bertrand and Cournot Equilibria with Product Differentiation. Journal of Economic Theory 36, 166-175.

Chapter 4

Cournot is more Competitive than Bertrand! Upstream Monopoly with Two-part Tariffs

4.1 Introduction

It is well established in oligopoly theory that the mode of the market competition crucially affects the market outcomes and the social welfare. Singh and Vives (1984) were the first to show that the equilibrium market outcomes and the social welfare differ significantly under alternative modes of market competition, namely Cournot (quantity) and Bertrand (price) competition, with the equilibrium prices and profits (quantities, respectively) being higher (lower, respectively) under Cournot competition than under Bertrand, while the Bertrand competition being more efficient in terms of social welfare than the Cournot. Thus, given the significant market and policy implications that the mode of the market competition has, a substantial economic literature has been developed that examines the robustness of these traditional results under alternative market frameworks (see among, Cheng, 1985; Vives, 1985; Okuguchi, 1987; Dastidar, 1997; Häckner, 2000). Cheng (1985) provides the geometrical proof of the Singh and Vives (1984) results, while Okuguchi (1987) provides the general conditions for the comparison of the Cournot and Bertrand equilibrium prices under nonlinear cost and demand functions. Further, Vives (1985), examining the Cournot-Bertrand differences in a n-firms oligopoly market with general demand functions, shows that the price-cost margin under Cournot competition is higher than under Bertrand. Dastidar (1997) points out the sensitivity of the Singh and Vives (1984) results on the market shares rules and demonstrates that they may not be valid under equal sharing and cost asymmetries. More recently, Häckner (2000) investigates the robustness of the Singh and Vives (1984) results under a n-firm oligopoly market structure with vertical product differentiation and shows that the results can not be generalized to the n-firm case when the products are of sufficiently different quality (i.e., a high quality firm may obtain higher profits under Bertrand competition than under Cournot competition).

Further, the robustness of these cornerstone results when firms undertake R&D and Innovation activities has been extensively investigated in the economic literature (see among, Delbono and Denicolo, 1990; Qiu, 1997; Symeonidis, 2003; Mukherjee, 2011; Chang and Peng, 2012). In particular, Delbono and Denicolo (1990) show that, under a symmetric and homogenous product duopoly, the Singh and Vives (1984) results over the welfare can be reversed when firms invest in process R&D. In the same vein, Qiu (1997) demonstrates that when firms invest in cost-reducing R&D the Bertrand competition is more efficient in terms of welfare than the Cournot one, if either R&D productivity is low, or spillovers are weak, or products are sufficiently differentiated, while the opposite holds when R&D productivity is high, spillovers are strong and the products are close substitutes. More recently, Symeonidis (2003) comparing the Bertrand and Cournot equilibria in a differentiated duopoly with substitute goods and product R&D, shows that prices and profits are always higher under quantity competition than under price competition, while, the output, the consumers' surplus and the social welfare are higher under Bertrand than under Cournot competition when the R&D spillovers are weak or when the products are sufficiently differentiated. The opposite holds when the R&D spillovers are strong and the products are less differentiated. In a different vein, Mukherjee (2011) and Chang and Peng (2012) introduce technology licensing into the Bertrand and Cournot markets and show that a Cournot market is more profitable than a Bertrand market when the technology innovation levels are high enough.

However, all of the aforementioned literature examines the differences between Cournot and Betrand competition under the classic one-tier market structure, while the relevant research under more complex market structures, such as the vertically related markets is still limited. Correa-Lopez and Naylon (2004) were the first to extend the Cournot-Bertrand debate, taking into account the effects of vertical relations. In particular, comparing the Cournot and Bertrand profits under a unionized duopoly market with differentiated products, they show that the profits of the downstream firms are higher under Bertrand competition when the products are imperfect substitutes and the unions are sufficiently powerful. Moreover, Lopez (2007) shows that if the upstream firms are profit maximizers and the products are close substitutes, then the downstream firms' profits are higher under Cournot competition. Furthermore, Fanti and Meccheri (2011), investigating the Cournot-Bertrand profits differential in a differentiated duopoly market with unions and decreasing labour returns, demonstrate that the traditional result that the profits are higher under Cournot competition, holds when the labour has decreasing returns and the wages are unilaterally fixed by a total wage bill maximizing union. More recently, Mukherjee et al. (2012), examining the Cournot-Betrand profits' differential in a vertically related market with homogenous final goods, where the upstream monopolist sets the input price for the downstream firm and the downstream firms differ in terms of production technologies, show that under uniform upstream monopolist's pricing strategy and downstream firms' sufficiently asymmetric production technologies the downstream firms' profits are higher under Bertrand than under Cournot competition, while the opposite holds under price discrimination of the upstream monopolist. However, all of the aforementioned works share a common feature, they examine how Cournot and Bertrand downstream competition affect the equilibrium market outcomes and the social welfare in vertically related markets where, the upstream firms/unions negotiate with the downstream firms over the per unit input price/wages, while they ignore alternative vertical trade forms, such as two-part tariffs trading contracts. Thus, given that the two-part tariffs trade contracts are widely practiced in vertically related industries, the objective of the present chapter is to extend the existing literature over the Cournot-Bertrand debate by investigating the robustness of the standard results on the ranking of Cournot and Bertrand equilibrium outcomes under vertically related markets, where trade between the upstream and the downstream firms is conducted via two-part tariffs contracts.

To do so, we consider a two-tier industry with differentiated final goods, consisted by an upstream monopolistic firm and two downstream firms. The upstream monopolist provides to the downstream firms the necessary input for the final good's production, while the downstream firms transform the input into a final good and then sells it to the final consumers. The trade between the upstream monopolist and the downstream firms is conducted via two-part tariffs contracts, that means that the upstream and the downstream firms bargain over the per -unit of input price, or else the wholesale price, and the fix fees. The timing of the game is given as follows. In the first stage of the game the upstream monopolist bargains, simultaneously and separately, with each of the downstream firms over the contract terms (i.e., the wholesale price and the fix fees), while, in the second stage, the downstream firms compete by setting their prices or their quantities.

We show that in vertically related markets with upstream monopolistic market structure where the trade between the firms is conducted via two-part tariffs contracts, the equilibrium quantities under Cournot downstream competition are higher than those obtained under Bertrand downstream competition. Thus, a Cournot downstream market turns to be more competitive than a Bertrand one. This is so, since under Cournot downstream market competition the wholesale prices that the downstream firms pay to the upstream monopolist are lower than those under Bertrand downstream market competition. In more details, contrary to the Cournot downstream market where the upstream monopolist subsidize the downstream production by setting wholesale prices lower than its' marginal production cost, under Bertrand downstream competition the upstream monopolist does not subsidize the downstream production via the wholesale prices since, given that the prices are strategic complements, the upstream monopolist does not wish its downstream partners to behave aggressively in the final market. Put it in other words, under Bertrand downstream competition, the upstream monopolist faces a less severe "commitment problem" and thus, it sets higher per unit of input prices than under Cournot downstream competition.[1] Therefore, the downstream firms' marginal cost of production under

[1] As standard in the literature, we shown that the upstream monopolist, when the trade is conducted via two-part tariffs contracts and the final market competition takes place in quantities, can not fully excerpt its market power and thus, instead of charging the wholesale price that allows him to obtain the monopoly profits, it sets wholesale prices lower than its marginal production cost. This is so, due to the so called "commitment problem" that arises when the contracts negotiations are not fully observable, since the upstream monopolist could not commit to the downstream firms that it is not going to behave opportunistically and to secretly offer a lower wholesale price to the rival downstream firm. Thus, none of the downstream firms is going to agree to a wholesale price higher than the upstream monopolist cost of production (for detailed analysis of the commitment problem see among, McAfee and Schwartz, 1995; Rey and Vergi, 2004; de Fontenay and Gans, 2005). However, in vertically related markets with Bertrand final market competition, the wholesale prices that the upstream

Bertrand downstream competition is higher than under Cournot downstream competition that leads to lower output production under Bertrand than under Cournot downstream competition.

Further, we show that the downstream firms' profits are higher under Cournot downstream competition than under Bertrand downstream competition. Clearly, the lower wholesale prices that the downstream firms pay to the upstream monopolist under Cournot downstream competition along with their higher output production, increase the downstream firms' profitability and thus, the downstream firms' profits under Cournot competition always exceed the respective ones obtained under Bertrand competition. On the contrary, we demonstrate that the upstream monopolist's profits under Bertrand downstream competition are higher than under Cournot downstream competition. The intuition behind the latter comes from the fact that the wholesale prices that the upstream monopolist sets under Bertrand downstream competition are always higher than those under Cournot downstream competition, since, under the former mode of downstream competition, the "commitment problem" that the upstream monopolist faces is less severe.

Interestingly enough, we also show that contrary to the conventional wisdom that suggests that the consumers' surplus and the social welfare are higher under Bertrand than under Cournot competition, in vertically related markets with upstream monopolistic market structure and two-part tariffs trading contracts both the consumers' surplus and the social welfare are higher under Cournot competition than under Bertrand competition. This finding has significant policy implications, since it reveals that in vertically related markets where the trade is conducted via two-part tariffs contracts and the upstream sector is monopolized by a single input provider the Cournot competition is more socially desirable than the Bertrand one.

The rest of the chapter is organized as follows. In Section 2, we present our model. In Section 3, we present the equilibrium analysis of our model under both Cournot and Bertrand final market competition and we compare the equilibrium results under the two cases. In Section 4, we examine the robustness of our results in vertically related markets with upstream separate firms market structure. In Section 5, we conclude.

---

monopolist sets are always higher than its marginal production cost, which means that the upstream does not subsidize the downstream production via the wholesale prices. This is so because under Bertrand final market competition the upstream monopolist faces a less severe commitment problem, since the prices, contrary to quantities, are strategic complements, and thus the upstream does not wish its downstream partners to behave aggressively in the final market competition.

4.2 The Basic Model

We consider a two-tier industry consisting of an upstream monopolist and two downstream firms denoted by U and D_i, respectively, with $i = 1, 2$. The upstream monopolist is an input provider with a constant marginal production cost normalized, for sake of simplicity, to zero. The downstream firms are final good manufactures, with one unit of input being transformed into one unit of final good. Following, Singh and Vives (1984), we assume that the utility function of the representative consumer in the market is given by, $V_i(q_i, q_j) = a(q_i+q_j)-(q_i^2+q_j^2+\gamma q_i q_j)/2$. Thus, maximizing the consumer's utility function, we have that each downstream firm D_i sells its product to the final market facing the following demand and inverse demand functions,

$$q_i = \frac{(\alpha - p_i) - \gamma(\alpha - p_j)}{1-\gamma^2}, \quad i, j = 1, 2;\ i \neq j;\ 0 < \gamma \leqslant 1 \tag{4.1}$$

$$p_i = a - q_i - \gamma q_j, \quad i, j = 1, 2;\ i \neq j;\ 0 < \gamma \leqslant 1 \tag{4.2}$$

where q_i, p_i denote, respectively, the D_i's output and price. The parameter γ denotes the degree of product substitutability. The higher the γ, the closer substitutes the final products are, or in other words, the fiercer the final market competition is (Vives, 1985).

We assume that the trade between the upstream monopolist and the downstream firms is conducted via two part tariffs contracts (w_i, F_i), where w_i, denotes the per-unit of input price, or else, the wholesale price that each downstream firm pays to the upstream monopolist and F_i denotes the fixed fees. Downstreams are endowed with the same constant returns to scale production technology with their marginal production cost given by $c_i = c + w_i$, where c, $0 < c < \alpha$, is an exogenous constant marginal cost. A two stage game has been considered, where the sequence of the moves are given as follows. In the first stage of the game, the upstream monopolist bargains, simultaneously and separatively, with each downstream firm over the trading contract terms (w_i, F_i), where the bargaining power of the upstream firm in the market is given by β, while $1-\beta$ corresponds to the bargaining power of the downstream firms. In the second stage, the downstream firms compete by setting either their outputs (Cournot final market competition) or their prices (Bertrand final market competition).We solve the above game backwards by employing the Subgame Perfect Nash Equilibrium (SPNE) solution concept.

Further, in order to ensure that all the participants in the market are active under all the configurations considered, the following assumption should hold throughout the chapter:

Assumption 1. $\beta \geqslant \beta(\gamma)$, where $\beta(\gamma) = \gamma^3/4 - 2\gamma - 2\gamma^2 + \gamma^3$

Assumption 1 is a necessary and sufficient condition in order to ensure the existence of pure strategy pairwise proof equilibria under the case of the upstream monopolist. Non-existence of pure strategy equilibria may occur because pairwise proofness leads to negative profits for the upstream monopolist. This is so, since if for given γ the upstream monopolist power is low enough in the market, the upstream is being subject to opportunism and is unable to cover its losses from the input subsidization via the fixed-fees.

4.3 Equilibrium Outcomes and Mode of Competition

4.3.1 Cournot Competition

Starting with the case where the downstream firms compete in the final market by setting their outputs, we have that in the second stage of the game, each downstream firm D_i chooses its output q_i, taking as given the decision over the output of the rival downstream firm q_j, in order to maximize its (gross) profits,

$$\underset{q_i}{Max}\pi_i^C(.) = (a - q_i - \gamma q_j)q_i - (c + w_i)q_i \tag{4.3}$$

The first order conditions give rise to the following reaction functions,

$$q_i(q_j) = \frac{a - c - w_i - \gamma q_j}{2} \tag{4.4}$$

Observe here that, as $\gamma > 0$, the reaction functions are downward sloping, that means that, as standard in the literature, under Cournot final market competition, the quantities are strategic substitutes. Also notice, that a reduction in the wholesale price that D_i pays to the upstream monopolist, shifts out its reaction function and leads to higher own output's production and to lower rival's output production, or in other words, makes the D_i more aggressive in the final market competition.

Solving the system of the reaction functions, given in equation (4.4), the quantities in the second stage of the game are given by,

$$q_i^C(w_i, w_j) = \frac{(a-c)(2-\gamma) - 2w_i + \gamma w_j}{4-\gamma^2} \tag{4.5}$$

Consequently, the prices and D_i's gross profits in the second stage under Cournot final market competition are given respectively by,

$$p_i^C(w_i, w_j) = \frac{[a + c(1+\gamma)](2-\gamma) + (2-\gamma^2)w_i + \gamma w_j}{4-\gamma^2} \tag{4.6}$$

$$\pi_{Di}^C(w_i, w_j) = \frac{[(a-c)(2-\gamma) - 2w_i + \gamma w_j]^2}{[4-\gamma^2]^2} \tag{4.7}$$

In the first stage of the game, the upstream monopolist U and each of the downstream firms D_i negotiate over the contract terms (w_i, F_i), taking as given the contract terms of the rival pair (w_j^{MC}, F_j^{MC}). Thus, each U and D_i pair chooses the trading contract terms, w_i and F_i in order to maximize the generalized Nash product,

$$\underset{w_i, F_i}{Max}[\pi_U^C(w_i, w_j^{MC}) + F_i + F_i^{MC} - d(w_j^{MC}, F_j^{MC})]^{\beta}[\pi_{D_i}^C(w_i, w_j^{MC}) - F_i]^{1-\beta}. \tag{4.8}$$

where, $\pi_U^C(w_i, w_j^{MC})$ denotes the profits of the upstream monopolist that are given by the sum of its' sales to both downstream firms, that is, $\pi_U^C(w_i, w_j^{MC}) = w_i q_i^C(w_i, w_j^{MC}) + w_j^{MC} q_j^C(w_i, w_j^{MC})$, while $d(w_j^{MC}, F_j^{MC}) = w_j^{MC} q_j^{MON} + F_j^{MC}$ is the disagreement payoff that the upstream monopolist faces, if an agreement between a (U, D_i) pair is not reached. In more details, if an agreement between a (U, D_i) pair can not be reached, the upstream monopolist is expected to obtain the revenues by its input sales on the remaining downstream firm, D_j, that is, $\pi_U^C(w_j^{MC}) = w_j^{MC} q_j^{MON}$, where $q_j^{MON} = \frac{a-c-w_j^{MC}}{2}$ is the output produced by the remaining downstream firm, that monopolizes the final market, plus the fixed fees, F_j^{MC}. Notice that a disagreement between the U and D_i, does not give rise to new negotiations over the contract terms of the remaining (U, D_j) pair.

Maximizing (4.8) with respect to the fix fees, F_i, we have that,

$$F_i = \beta \pi_{D_i}^C(w_i, w_j^{MC}) - (1-\beta)[\pi_U^C(w_i, w_j^{MC}) - w_j^{MC} q_j^{MON}] \tag{4.9}$$

Substituting (4.9) into (4.8), we obtain that the net profits of the upstream monopolist, above its disagreement payoff, and the net profits of each downstream firm, D_i, are proportional to their joint surplus, $S^C = \pi_U^C(w_i, w_j^{MC}) + \pi_{D_i}^C(w_i, w_j^{MC}) - w_j^{MC} q_j^{MON}$, with the coefficients of the proportionality to be given by the bargaining powers, β and $1-\beta$, respectively. Thus, the wholesale prices, w_i, are chosen in order to maximize this surplus,

$$\underset{w_i}{Max} S^C = [a - q_i^C(w_i, w_j^{MC}) - \gamma q_j^C(w_i, w_j^{MC})] q_i^C(w_i, w_j^{MC}) + w_j^{MC}[q_j^C(w_i, w_j^{MC}) - q_j^{MON}] \quad (4.10)$$

From the first order conditions of (4.10), we obtain that the equilibrium wholesale prices under Cournot downstream competition are given by,

$$w_i^C = w_j^C = w^C = -\frac{(a-c)\gamma^2}{2(2-\gamma)} \quad (4.11)$$

Observe here, that in vertically related markets with upstream monopolistic market structure and Cournot downstream competition, the equilibrium wholesale prices are always lower than the upstream monopolist's marginal production cost (i.e., $w^C < 0$). That means that the upstream monopolist, when trade is conducted via two-part tariffs contracts and the final market competition takes place in quantities, can not fully excerpt its market power and thus, instead of charging the wholesale price that it allows him to obtain the monopoly profits, it subsidizes via the wholesale prices the downstream production. This is so, due to the so called "commitment problem" that arises when the contracts negotiations are not fully observable. In more details, as standard in the relevant literature (see e.g, McAfee and Schwartz, 1995; Rey and Vergi, 2004; de Fontenay and Gans, 2005), when the contracts negotiations are not fully observable, the upstream monopolist could not commit to the D_i firm that he is not going to behave opportunistically and to secretly offer a lower wholesale price to the rival downstream firm, D_j in order to make the later more aggressive in the final market. Put it in other words, when the negotiations are not observable, the downstream firms are aware of the upstream monopolist's incentives to behave opportunistically and to secretly offer a lower wholesale price to the rival downstream firm, in order to make the latter more aggressive in the final market and to be benefited by the higher gross profits that the favored downstream partner will obtain (the upstream monopolist extracts the benefit of the higher downstream firm's profits by transferring part of these higher profits upstream via the fix fees). Therefore, none of the downstream firms will agree to a wholesale price higher than the upstream monopolist's cost of production.

Further, observe that the wholesale prices do not depend on the bargaining power distribution in the market, β, since they are chosen such to maximize the joint surplus of each (U, D_i) pair, while they are decreasing in the degree of the final market competition, γ. Clearly, the closer substitutes the products, the fiercer the final market competition is, that in turn, leads the upstream monopolist to decrease the wholesale prices in order to make the downstream firms more aggressive in the final market.

Lemma 12: *In a vertically related market with monopolistic upstream structure and Cournot downstream competition the equilibrium wholesale prices are always lower than the upstream monopolist's marginal production cost, while they are independent of the bargaining power distribution, β, and decreasing in the degree of the final market competition, γ.*

Using (4.11), (4.5) and (4.9) it follows that the equilibrium output and the fix fees when the final market competition takes place in quantities, are given respectively by,

$$q^C(.) = \frac{(a-c)(2-\gamma)}{2(2-\gamma^2)} \tag{4.12}$$

$$F^C(.) = \frac{(a-c)^2(\gamma-2)^2[2\beta+(1-\beta)\gamma^2]}{8(\gamma^2-2)^2} \tag{4.13}$$

Observe here that the equilibrium fix fees depend on the bargaining power distribution, β, while they always exceed the upstream monopolist's marginal production cost.

Moreover, the equilibrium downstream firms' profits and the upstream monopolist's profits under Cournot final market competition are given respectively by,

$$\pi^C_{Di}(.) = \frac{(1-\beta)(a-c)^2(\gamma-2)^2}{8(2-\gamma^2)} \tag{4.14}$$

$$\pi^C_U(.) = \frac{(a-c)^2(2-\gamma)[\beta(2-\gamma)(2-\gamma^2)-\gamma^3]}{4(\gamma^2-2)^2} \tag{4.15}$$

4.3.2 Bertrand Competition

We turn now to discuss the case where the downstream firms compete by setting their prices (i.e., Bertrand downstream competition). In the second stage of the game, each downstream firm D_i, chooses its price p_i, taking as given the decision over the price of the rival downstream firm p_j, in order to maximize its (gross) profits,

$$\underset{p_i}{Max}\ \pi_i^B(.) = (p_i - c - w_i)\frac{(\alpha - p_i) - \gamma(\alpha - p_j)}{1-\gamma^2} \tag{4.16}$$

The first order conditions give rise to the following reaction functions,

$$p_i(p_j) = \frac{(1-\gamma)\alpha + c + \gamma p_j + w_i}{2} \tag{4.17}$$

Observe here that for $\gamma > 0$, the reaction functions are upward sloping and thus, prices under the Bertrand downstream competition are strategic complements.

Solving the system of the reaction functions given in (4.17), the prices in the second stage of the game when the final market competition takes place in prices, are given by,

$$p_i^B(w_i, w_j) = \frac{(2+\gamma)[(1-\gamma)\alpha + c] + 2(w_i + w_j)}{4-\gamma^2} \tag{4.18}$$

Consequently, the output and D_i's gross profits in the second stage under Bertrand downstream competition are given respectively by,

$$q_i^B(w_i, w_j) = \frac{(\alpha - c)(2+\gamma)(1-\gamma) - (2-\gamma^2)w_i + \gamma w_j}{4 - 5\gamma^2 + \gamma^4} \tag{4.19}$$

$$\pi_{D_i}^B(w_i, w_j) = \frac{[(a-c)(\gamma^2 + \gamma - 2) + (2-\gamma^2)w_i + \gamma w_j]^2}{(1-\gamma)(\gamma^2-4)^2} \tag{4.20}$$

In the first stage of the game, the upstream monopolist U and the downstream firm D_i bargain over the contract terms (w_i, F_i), taking as given the contract terms of the rival pair (w_j^{MB}, F_j^{MB}). Thus, each U and D_i pair chooses the trading contract terms, w_i and F_i in order to maximize the generalized Nash product,

$$\underset{w_i,F_i}{Max}[\pi_U^B(w_i, w_j^{MB}) + F_i + F_i^{MB} - d(w_j^{MB}, F_j^{MB})]^{\beta}[\pi_{D_i}^B(w_i, w_j^{MB}) - F_i]^{1-\beta} \tag{4.21}$$

where $\pi_U^B(w_i, w_j^{MB})$ denotes the upstream monopolist's profits that are given by the sum of the upstream's sales to both downstream firms, that is, $\pi_U^B(w_i, w_j^{MB}) = w_i q_i^B(w_i, w_j^{MB}) + w_j^{MB} q_j^B(w_i, w_j^{MB})$, while $d(w_j^{MB}, F_j^{MB}) = w_j^{MB} q_j^{MON} + F_j^{MB}$ is the disagreement payoff that the upstream monopolist will face, if an agreement between a (U, D_i) pair is not reached.

Maximizing (4.21) with respect to the fix fees, F_i, we have that,

$$F_i = \beta\pi_{D_i}^B(w_i, w_j^{MB}) - (1-\beta)[\pi_U^B(w_i, w_j^{MB}) - w_j^{MB} q_j^{MON}] \tag{4.22}$$

Substituting (4.22) into (4.21), we have that the net upstream monopolist's profits above its disagreement payoff, and the net profits of the downstream firm, D_i, are proportional to their joint surplus, $S^B = \pi_U^B(w_i, w_j^{MB}) + \pi_{D_i}^B(w_i, w_j^{MB}) - w_j^{MB} q_j^{MON}$, with the coefficients of proportionality to be given by the bargaining powers, β and $1-\beta$, respectively. Hence, the wholesale prices, w_i, are chosen in order to maximize this surplus,

$$\underset{w_i}{Max} S^B = [a - q_i^B(w_i, w_j^{MB}) - \gamma q_j^B(w_i, w_j^{MB})] q_i^B(w_i, w_j^{MB}) + w_j^{MB}[q_j^B(w_i, w_j^{MB}) - q_j^{MON}] \tag{4.23}$$

From the first order conditions of (4.23), we have that the equilibrium wholesale prices under Bertrand downstream competition are given by,

$$w_i^B = w_j^B = w^B = \frac{(a-c)\gamma^2}{4} \tag{4.24}$$

Observe here, that in contrast to the vertically related markets with Cournot downstream competition, under vertically related markets with upstream monopolistic market structure and Bertrand downstream competition, the equilibrium wholesale prices are always higher than the upstream monopolist's marginal production cost (i.e., $w^B > 0$). That means that, in vertically related markets with Bertrand downstream competition, the upstream monopolist does not subsidize the downstream production via the wholesale prices. Intuitively, under

Bertrand market competition the upstream monopolist faces a less severe commitment problem, since the prices, contrary to quantities, are strategic complements. Thus, the upstream does not subsidize the downstream partners via the wholesale prices, since he does not wish its downstream partners to behave aggressively in the final market competition. Also note that, in line with the Cournot downstream market, the equilibrium wholesale prices under the Bertrand downstream competition are independent of the bargaining power distribution in the market, β, since they are chosen in order to maximize the joint surplus of each vertical chain in the market. Yet, contrary to the Cournot downstream market, under Bertrand downstream competition the equilibrium wholesale prices are increasing in the degree of the market competition, γ. This is so, since, prices are strategic complements and thus, as the final market competition becomes fiercer, the upstream monopolist is willing by setting a higher wholesale price, to force its downstream partners to behave less aggressively.

Lemma 13: *In a vertically related market with monopolistic upstream structure and Bertrand downstream competition, the equilibrium wholesale prices always exceed the upstream monopolist's marginal production cost, while they are independent of the bargaining power distribution, β, and increasing in the degree of the final market competition, γ.*

Using (4.24), (4.19) and (4.22), it follows that the equilibrium output and the fix fees when the final market competition takes place in prices, are given respectively by,

$$q^B(.) = \frac{(a-c)(2+\gamma)}{4(1+\gamma)} \tag{4.25}$$

$$F^B(.) = \frac{(a-c)^2(2+\gamma)[\beta(4-2\gamma-\gamma^3+\gamma^4)-(2-\gamma+\gamma^2)\gamma^2]}{32(1+\gamma)} \tag{4.26}$$

while the equilibrium downstream firms' profits and the upstream monopolist's profits, under Bertrand downstream competition, are given respectively by,

$$\pi^B_{D_i}(.) = \frac{(1-\beta)(a-c)^2(2+\gamma)[4-2\gamma-\gamma^3+\gamma^4]}{32(1+\gamma)} \tag{4.27}$$

$$\pi^B_U(.) = \frac{(a-c)^2(2+\gamma)[2\beta(2-\gamma)-(1-\beta)(\gamma^4-\gamma^3)]}{16(1+\gamma)} \tag{4.28}$$

Note by the eq. (4.26), that the equilibrium fix fees turn to be negative when the upstream monopolist's bargaining power in the market is low enough, that is, $F^B < 0$ if $\beta < \beta_c \equiv \frac{\gamma^2(2-\gamma+\gamma^2)}{4-2\gamma-\gamma^3+\gamma^4}$. That means that, in contrast to the Cournot market where the upstream monopolist subsidizes its downstream partners via the wholesale prices, under Bertrand downstream competition the upstream monopolist's subsidizes its downstream partners via the fix fees if its bargaining power in the market is relatively low. This is so, since when the upstream bargaining power in the market is low enough, the power to extract the fix fees is instead reversed and thus, it is the downstream firms that obtain the benefit of the fix rents.

4.3.3 Welfare Analysis

In this subsection, we present the social welfare implications of Cournot and Bertrand market competition. In vertically related markets with upstream monopolistic market sector, the social welfare is defined as the sum of the consumers' surplus plus the profits of the upstream monopolist and the downstream firms,

$$SW = CS + \Pi_U + \Pi_{Di} + \Pi_{D_j} \tag{4.29}$$

where the consumers surplus is given by,

$$CS(.) = a(q_i + q_j) - \frac{(q_i^2 + q_j^2 + \gamma q_i q_j)}{2} - p_i q_i - p_j q_j \tag{4.30}$$

In equilibrium, imposing symmetry we have that, $q_i = q_j = q$, $p_i = p_j = p$, and thus, the social welfare can be written as,

$$CS = (1+\gamma)[q]^2 \tag{4.31}$$

Substituting (4.12) into (4.31) we have that the consumers' surplus in vertically related markets with upstream monopolistic market structure, where the final market competition takes place in quantities, is given by,

$$CS^C = \frac{(1+\gamma)(a-c)^2(2-\gamma)^2}{4(2-\gamma^2)^2} \tag{4.32}$$

while, substituting (4.32), (4.14) and (4.15) into (4.29), we have that the social welfare under Cournot downstream competition is given by,

$$SW^C = \frac{(a-c)^2(2-\gamma)(6-\gamma-3\gamma^2)}{4(2-\gamma^2)^2} \tag{4.33}$$

Correspondingly, substituting (4.25) into (4.31) we have that the consumers' surplus under Bertrand downstream competition is given by,

$$CS^B = \frac{(a-c)^2(2+\gamma)^2}{16(1+\gamma)} \tag{4.34}$$

while, substituting (4.34), (4.27) and (4.28) into (4.29), we have that the social welfare under Bertrand downstream competition is given by,

$$SW^B = \frac{(a-c)^2(2+\gamma)(6-\gamma)}{16(1+\gamma)} \tag{4.35}$$

4.3.4 *Comparative Results*

We turn now to compare the equilibrium outcomes and the social welfare obtained under Cournot and Bertrand final market competition, in order to examine how the alternative modes of the final market competition affect the output production, the upstream monopolist's and the downstream firms' profits and the social welfare.

Starting with the comparison over the output production under the alternative modes of competition, using the equations (4.12) and (4.25), we have that the Cournot-Bertrand output differential is given by,

$$\Delta q = q^C - q^B = \frac{(a-c)\gamma^3}{4(2+2\gamma-\gamma^2-\gamma^3)} > 0 \tag{4.36}$$

from which the following result derives,

Proposition 12 *The equilibrium output production under Cournot downstream competition is always higher than under Bertrand downstream competition.*

Interestingly enough, the above result reveals that the product market competition is more intense under Cournot downstream competition than under Bertrand downstream competition, since the equilibrium quantity in the Cournot downstream market is always higher than that in the Bertrand downstream market. The intuition behind this result is based on the lower marginal production cost that the downstream firms face under Cournot downstream competition, since the wholesale prices (or else, the per unit of input prices) under Cournot downstream competition are always lower than under Bertrand downstream competition. In other words, according to our discussion over Lemma 1 and Lemma 2, we show that, contrary to the Bertrand downstream market, when the final market competition takes place in quantities, the upstream monopolist subsidizes the downstream production by setting wholesale prices lower than its marginal production cost. This means that the downstream firms under Cournot downstream competition behave more aggressively and thus, the final market competition is more intense under Cournot competition than under Bertrand competition.

Furthermore, using the equations (4.14) and (4.27), we have that Cournot-Bertrand downstream firms' profits differential is given by,

$$\Delta\pi_D = \pi^C_{D_i} - \pi^B_{D_i} = \frac{(1-\beta)(a-c)\gamma^3\Xi}{32(1+\gamma)(2-\gamma^2)} > 0 \tag{4.37}$$

where, $\Xi = 8 - (2-\gamma)(2+\gamma)\gamma(1+\gamma)$. From the above equation the following proposition derives,

Proposition 13 *The equilibrium downstream firms' profits under Cournot downstream competition are always higher than under Bertrand downstream competition.*

Clearly, the lower wholesale prices that the upstream monopolist sets under Cournot downstream competition along with the higher downstream firms' output production, increase the downstream firms' profitability in the Cournot downstream market and thus, the downstream firms' profits in the Cournot downstream market always exceed those of the Bertrand downstream market.

Further, using the equations (4.15) and (4.28), we have that Cournot-Bertrand upstream monopolist's profits differential is given by,

$$\Delta\pi_U = \pi^C_U - \pi^B_U = -\frac{(a-c)^2\gamma^3[16 - \beta(1-\gamma^2)\Xi - \gamma^2(16 - 4\gamma - 6\gamma^2 + \gamma^3 + \gamma^4)}{16(1+\gamma)(\gamma^2-2)^2} < 0 \tag{4.38}$$

from which the following proposition derives,

Proposition 14 *The equilibrium upstream monopolist's profits under Bertrand downstream competition are always higher than under Cournot downstream competition.*

The intuition behind this result comes from the fact that the wholesale prices in the Bertrand market always exceed those of the Cournot market. This is so, since the "commitment problem" that the upstream monopolist faces when the contract negotiations are not fully observable is less severe under Betrand downstream competition than under Cournot downstream competition.

We turn now to compare the consumers' surplus and the social welfare under the Cournot and Bertrand markets. As far as the consumers' surplus is being concerned, it is straightforward that, since $CS = (1+\gamma)q^2$ and $q^C > q^B$ always holds, then $CS^C > CS^B$. Clearly, the consumers' surplus is higher under Cournot downstream competition, that means that the consumers are better off when the downstream firms compete by setting their quantities. This is so, since according to our discussion over the Proposition 1, the Cournot downstream market is more competitive than the Bertrand one and thus, the consumers' are being benefited by the higher output production that Cournot downstream competition implies.

Further, using the equations (4.33) and (4.35) we have that the social welfare differential is given by,

$$\Delta TW = TW^C - TW^B = \frac{(a-c)^2\gamma^3[8-\gamma(4+(4-\gamma)\gamma)]}{16(1+\gamma)(\gamma-2)^2} > 0 \tag{4.39}$$

Thus, contrary to the standard Singh and Vives (1984) result that suggests that the social welfare is higher under Bertrand than under Cournot competition, we show that the social welfare in vertically related markets with upstream monopolistic market structure, two-part tariffs contracts and Cournot downstream competition is higher than that obtained under Bertrand downstream competition. Obviously, under Cournot downstream competition, the beneficial effects of the higher consumers' surplus and the higher upstream monopolist's profits on the social welfare dominate the diminishing effect of the lower downstream firms' profits and thus, Cournot final market competition is more socially desirable than Bertrand competition.

4.4 Extensions-Discussion

4.4.1 Upstream Separate Firms Market Structure

In our basic model we have assumed that the upstream market sector is being monopolized by a single firm. Here we relax this assumption and we briefly discuss the Cournot-Betrand comparison results in vertically related markets with upstream separate firms market structure. In particular, we extend our analysis considering a vertically related market consisted by two upstream and two downstream firms where the trade relations between each upstream and each downstream firm are exclusive while, the trade between the firms is conducted via two-part tariffs contracts. Note here, that given the assumption of exclusive trade relations between the upstream and the downstream firms, none of the upstream and the downstream firms could achieve an agreement with an alternative trading partner and thus, the disagreement payoffs under this configuration is null. Keeping all the other modeling specifications fixed, we show that the upstream firms' profits and the downstream firms' profits are always higher under Cournot downstream competition than under Betrand downstream competition, while the equilibrium output, the consumers' surplus and the social welfare are higher under Betrand downstream competition. This is so, since in vertically related markets with upstream separate firms market structure, the effect of the lower wholesale prices that the upstream firms set under Cournot downstream competition can not compensate the fact that the Cournot competition is by its nature more "monopolistic" than the Betrand competition.

4.5 Conclusions

In the present chapter we investigate how the alternative modes of downstream market competition, namely Cournot and Bertrand competition affect the equilibrium outcomes and the social welfare in vertically related markets with monopolistic upstream market structure, where the trade is conducted via two part tariffs contracts.

Interestingly, in such a setting, we show that a Cournot downstream market turns out to be more competitive than a Bertrand one. In more details, we show that the downstream firms' output production in the Cournot downstream market is higher than in the Bertrand one. Intuitively, the lower wholesale prices that the upstream monopolist sets under Cournot final market competition, make the downstream firms to behave more aggressively in the Cournot downstream market than in the Bertrand one. Furthermore, in line with the standard Singh and Vives (1984) result, that claims that profits are higher under Cournot competition than under Bertrand, we demonstrate that the profits in the downstream market under Cournot competition always exceed those obtained under Bertrand competition. On the contrary, we show that the upstream monopolist obtains higher profits when the downstream market competition takes place in prices.

Moreover, regarding the societal effects of the different modes of downstream market competition, we argue that the consumers' surplus is higher under Cournot downstream competition than under Bertrand downstream competition, since the consumers are benefiting by the higher output production of the former mode of final market competition. Last but not least, contrary to the conventional wisdom that suggests that Bertrand competition leads to higher social welfare than Cournot competition, it is shown that in vertically related markets with upstream monopolistic market structure and two-part tariffs trade contracts, the social welfare is higher under Cournot than under Bertrand competition. That means that Cournot competition in such markets is more socially desirable than the Betrand one.

Bibliography

[1] Brollo U., Mukherjee, A., Mukherjee, S., 2012. Bertrand versus Cournot Competition in a Vertical Structure: A Note. The Manchester School 80, 545-559.

[2] Chang, R., Peng C., 2012. Comparing Bertrand and Cournot Competition in a Differentiated Duopoly with Technology Licensing. Mimeo, Fu Jen Catholic University, Taiwan.

[3] Cheng, L., 1985. Comparing Bertrand and Cournot equilibria: A geometric approach. Rand Journal of Economics 16, 146-152.

[4] Correa-Lopez, M., Naylor, R.A., 2004. The Cournot-Bertrand profit differential: a reversal result in a differentiated duopoly with wage bargaining. European Economic Review 48, 681-696.

[5] Dastidar, K.G., 1997. Comparing Cournot and Bertrand in a homogenous product market. Journal of Economic Theory 75, 205-212.

[6] de Fontenay, C.C., Gans J.S., 2005. Vertical Integration in the Presence of Upstream Competition. Rand Journal of Economics 36, 544-572.

[7] Delbono, F., Denicolo, V., 1990. R&D investment in a symmetric and homogeneous oligopoly. International Journal of Industrial Organization 8, 297-313.

[8] Fanti, L., Meccheri N., 2011. The Cournot-Bertrand profit differential in a differentiated duopoly with unions and labour decreasing returns. Economics Bulletin 31, 233-244.

[9] Häckner, J., 2000. A note on price and quantity competition in differentiated oligopolies. Journal of Economic Theory 93, 233-239.

[10] Lopez, M.C., 2007. Price and Quantity Competition in a Differentiated Duopoly with Upstream Suppliers. Journal of Economics and Management Strategy 16, 469-505.

[11] McAfee, P., Schwartz, M., 1995. The non-existence of pairwise-proof equilibrium. Economics Letters 49, 251-259.

[12] Milliou, C., Petrakis E., 2007. Upstream Horizontal Mergers, Vertical Contracts, and Bargaining. International Journal of Industrial Organization 25, 963-987.

[13] Mukherjee, A., 2011. Competition, Innovation and Welfare. The Manchester School 19, 1045-1057.

[14] Okuguchi, K., 1987. Equilibrium prices in the Bertrand and Cournot oligopolies. Journal of Economic Theory 42, 128-139.

[15] Qiu, L.D., 1997. On the dynamic efficiency of Bertrand and Cournot equilibria. Journal of Economic Theory 75, 213-229.

[16] Rey, P., Verge T., 2004. Bilateral Control with Vertical Contracts. Rand Journal of Economics 35, 728-746.

[17] Singh, N., Vives, X., 1984. Price and quantity competition in a differentiated duopoly. Rand Journal of Economics, 15, 546-554.

[18] Symeonidis, G., 2003. Comparing Cournot and Bertrand Equilibria in a Differentiated Duopoly with Product R&D. International Journal of Industrial Organization 21, 39-55.

[19] Vives, X., 1985. On the efficiency of Bertrand and Cournot equilibria with product differentiation. Journal of Economic Theory 36, 166-175.

Περίληψη

Η παρούσα διδακτορική διατριβή με τίτλο, "Essays on Advertising and Innovation in Imperfectly Competitive Markets" εξετάζει ζητήματα βέλτιστων στρατηγικών ανταγωνισμού των επιχειρήσεων σε ατελώς ανταγωνιστικές και καθετοποιημένες αγορές. Ειδικότερα, αναλύονται και διερευνώνται: α) Οι βέλτιστες αποφάσεις των επιχειρήσεων για την επένδυση σε διαφήμιση (συγκριτική ή πληροφοριακή διαφήμιση) σε ολιγοπωλιακές αγορές με οριζοντίως διαφοροποιημένα προϊόντα β) Οι βέλτιστες αποφάσεις των επιχειρήσεων για την επένδυση σε συγκριτική διαφήμιση σε ατελώς ανταγωνιστικές αγορές που χαρακτηρίζονται από εξωτερικότερες δικτύων (network externalities) γ) Οι βέλτιστες αποφάσεις των επιχειρήσεων σε ότι αφορά την υιοθέτηση μιας νέας τεχνολογίας μείωσης κόστους παραγωγής σε καθετοποιημένες αγορές, την χρονική στιγμή υιοθέτησης αυτής της τεχνολογίας και το πως αυτές οι αποφάσεις διαφοροποιούνται σε σχέση με τις αποφάσεις που λαμβάνουν οι επιχειρήσεις σε μη καθετοποιημένες αγορές. Τέλος, εξετάζονται οι επιπτώσεις των εναλλακτικών μορφών ανταγωνισμού (Ανταγωνισμός σε ποσότητες, Ανταγωνισμός σε τιμές) στις κάθετες αγορές με μονοπωλιακή ανοδική δομή αγοράς (monopolistic upstream market structure) στα αποτελέσματα των αγορών και στην κοινωνική ευημερία.

Τα προαναφερθέντα προβλήματα διατυπώνονται και τυποποιούνται με τη χρήση της θεωρίας παιγνίων. Κάθε πρόβλημα τυποποιείται ως ένα δυναμικό πολλαπλών σταδίων παίγνιο μη-μηδενικού αθροίσματος (non-zero sum game) στο οποίο υπάρχει αλληλουχία μεταξύ των διαδοχικών στρατηγικών αποφάσεων. Η λήψη της βέλτιστης απόφασης κάθε οικονομικού δρώντα στην αγορά βασίζεται τόσο στις αποφάσεις που λαμβάνονται στα προηγούμενα σταδία των παιγνίων όσο και στο τι στρατηγική προσδοκά να ακολουθήσουν οι αντίπαλοι του σε κάθε στάδιο του παιγνίου. Κάθε δυναμικό παίγνιο επιλύεται με τη μέθοδο της οπισθογενούς επαγωγής (backwards induction) προκειμένου να οριστεί η τέλεια ισορροπία υπο-παιγνίων κατά Nash (Subgame Perfect Nash Equilibrium).

Αναλυτικότερα, στο πρώτο κεφάλαιο της παρούσας διδακτορικής διατριβής με τίτλο "Comparative advertising vs. Informative Advertising in Oligopolistic Markets"

εξετάζονται οι βέλτιστες στρατηγικές αποφάσεις των επιχειρήσεων να επενδύσουν σε πληροφοριακή και συγκριτική διαφήμιση σε μια δυοπωλιακή αγορά με οριζοντίως διαφοροποιημένα προϊόντα καθώς και οι συνέπειες αυτών των αποφάσεων τόσο στα αποτελέσματα της αγοράς (το επίπεδο παραγωγής των επιχειρήσεων, η κερδοφορία των επιχειρήσεων κτλ) όσο και στην κοινωνική ευημερία.

Σύμφωνα με την κλασσική οικονομική προσέγγιση η επένδυση σε διαφήμιση εξυπηρετεί: πρώτον, την παροχή πληροφόρησης (πληροφοριακή διαφήμιση) και δεύτερον, τη διαφοροποίηση των προϊόντων στα ματιά των καταναλωτών (διαφήμιση της πειθούς), (Bagwell, 2007). Πέραν όμως των κλασσικών μορφών επένδυσης σε διαφήμιση, τελευταία παρατηρείται η υιοθέτηση από τις επιχειρήσεις νέων πρακτικών διαφήμισης, όπως, η συγκριτική διαφήμιση, που ορίζεται από την Ομοσπονδιακή Επιτροπή Ανταγωνισμού (FTC) ως «Ο τύπος διαφήμισης που επιτρέπει την έμμεση ή άμεση (κατονομάζοντας ρητά τον αντίπαλο μέσω της επωνυμίας ή/και χαρακτηριστικού του γνωρίσματος) σύγκριση των ανταγωνιστικών προϊόντων με βάση τα χαρακτηριστικά τους, τις τιμές και την ποιότητα τους»[1].

Βεβαία, παρά την ευρέως διαδομένη χρήση της συγκριτικής διαφήμισης, η εμπειρική και θεωρητική ερευνά αναφορικά με τα κίνητρα επένδυσης, την αποτελεσματικότητα και τις συνέπειές της στον ανταγωνισμό, έναντι των παραδοσιακών μορφών διαφήμισης, βρίσκεται σε πρώιμο στάδιο.[2] Συμφώνα τις υπάρχουσες εμπειρικές μελέτες τα συμπεράσματα αναφορικά με την αποτελεσματικότητα της συγκριτικής διαφήμισης είναι αντικρουόμενα. Όπως οι Goodwin and Etgar (1980) και Wilkie and Farris (1975) υποστηρίζουν, η χρήση της συγκριτικής διαφήμισης κάθε άλλο παρά αποτελεσματική είναι διότι αυξάνει την δυσπιστία των καταναλωτών και εκλαμβάνεται από αυτούς σαν μια προσπάθεια χειραγώγησής τους. Αντιθέτως οι Grewal et al. (1997) και Jung and Sharon (2002) υποστηρίζουν, ότι η συγκριτική διαφήμιση αποδεικνύεται αποτελεσματικότερη έναντι των παραδοσιακών μορφών διαφήμισης διότι εγείρει την προσοχή των καταναλωτών και αυξάνει την πρόθεση αγοράς του διαφημιζόμενου έναντι του ανταγωνιστικού προϊόντος.

[1] Statement of policy regarding comparative advertising, Federal Trade Commission, Washington, D.C., August13, 1979.

[2] Συμφώνα με τους Pechmann and Stewart (1990) το 60% του συνόλου των διαφημιστικών καμπανιών εμπεριέχουν στοιχειά έμμεσης σύγκρισης, το 20% στοιχειά άμεσης σύγκρισης και μόνον το υπόλοιπο 20% δεν εμπεριέχει κανένα στοιχειό σύγκρισης.

Πέραν της εμπειρικής προσέγγισης, ελάχιστη είναι και η θεωρητική ερευνά στο πεδίο της συγκριτικής διαφήμισης. Σε μια πρώτη προσπάθεια έρευνας, οι Aluf και Shy (2001) προσεγγίζουν την συγκριτική διαφήμιση σαν μια προέκταση της διαφήμισης της πειθούς και υποστηρίζουν ότι η χρήση της αυξάνει την διαφοροποίηση των προϊόντων στα ματιά των καταναλωτών και οδηγεί σε αύξηση της συγκέντρωσης του κλάδου, των τιμών και της κερδοφορίας των επιχειρήσεων. Είναι προφανές όμως ότι αυτή η θεώρηση αδυνατεί να ενσωματώσει τον πληροφοριακό χαρακτήρα της συγκριτικής διαφήμισης και αποτελεί κατά κύριο λόγο μια προσπάθεια μοντελοποίησης της «αρνητικής» διαφήμισης της πειθούς Υπό διαφορετικό πρίσμα, οι Barigozzi et al. (2009) και Emons και Fluet (2012) εξετάζουν την συγκριτική διαφήμιση ως ένα μέσο σηματοδότησης (signaling role) της ποιότητας του διαφημιζόμενου προϊόντος και καταλήγουν στο ότι αυτή αποδεικνύεται αποτελεσματικότερη έναντι της μη συγκριτικής. Οι Anderson and Renault (2009) εξετάζοντας, αρχικά τα κίνητρα των επιχειρήσεων να διαφημίσουν ή μη τα προϊόντα τους, και δευτερευόντως, ως εξωγενώς καθορισμένη μεταβλητή, την μορφή διαφήμισης που θα χρησιμοποιήσουν (συγκριτική ή συμβατική μη συγκριτική διαφήμιση), καταλήγουν στο ότι ισχυρό κίνητρο χρήσης συγκριτικής διαφήμισης (όταν αυτή θεωρείται νόμιμη) παρουσιάζουν μονό οι επιχειρήσεις με χαμηλής ποιότητας προϊόντα ούτος ώστε να πείσουν το αγοραστικό κοινό και να διασφαλίσουν την επιβίωσή τους στην αγορά.

Η παραπάνω βιβλιογραφική επισκόπηση καταδεικνύει ότι η υφιστάμενη βιβλιογραφία περιορίζεται στην μελέτη της συγκριτικής διαφήμισης ως εξωγενώς καθορισμένης μεταβλητής και όχι ως ενδογενή στρατηγική μεταβλητή απόφασης των επιχειρήσεων. Στο πρώτο κεφάλαιο της παρούσας διδακτορικής διατριβής ερευνάμε τα κίνητρα των επιχειρήσεων να επενδύσουν σε συγκριτική και πληροφοριακή διαφήμιση (παίρνοντας ως ενδογενείς μεταβλητές απόφασης τις επενδύσεις σε διαφήμιση) καθώς και τα αποτελέσματα αυτών των επενδύσεων στα αποτελέσματα της αγοράς και την κοινωνική ευημερία. Πιο συγκεκριμένα απαντώνται οι παρακάτω ερωτήσεις: Ποιες είναι οι βέλτιστες αποφάσεις των επιχειρήσεων σχετικά με τον τύπο/τύπους διαφήμισης που θα χρησιμοποιήσουν για την προώθηση του προϊόντος τους? Πως τα χαρακτηριστικά της αγοράς όπως, ο βαθμός υποκατάστασης των προϊόντων και η αποτελεσματικότητα της διαφήμισης, επηρεάζουν τα επίπεδα επένδυσης των επιχειρήσεων τόσο στην συγκριτική όσο και στην πληροφοριακή διαφήμιση? Ποιες οι συνέπειες των αποφάσεων των επιχειρήσεων για επένδυση σε διαφήμιση στην κερδοφορία τους και στην κοινωνική ευημερία?

Υποθέτουμε μια δυοπωλιακή αγορά με οριζοντίως διαφοροποιημένα προϊόντα οπού οι καταναλωτές a-priori δεν έχουν πλήρη πληροφόρηση σχετικά με τα προϊόντα. Οι επιχειρήσεις έχουν στην διάθεση τους δυο τύπους διαφήμισης, πληροφοριακή διαφήμιση και συγκριτική διαφήμιση. Η χρήση της πληροφοριακής διαφήμισης από τις επιχειρήσεις έχει ως στόχο την πληροφόρηση των καταναλωτών σχετικά με τα προϊόντα και τα χαρακτηριστικά τους, ώστε να τους βοηθήσει να αναγνωρίσουν το προϊόν που καλύπτει επαρκώς τις ανάγκες τους. Κατά συνέπεια η πληροφοριακή διαφήμιση αυξάνει την εκτίμηση των καταναλωτών για το διαφημιζόμενο προϊόν και ως εκ τούτου την ζήτηση του διαφημιζόμενου προϊόντος (η καμπύλη ζήτησης του διαφημιζόμενου προϊόντος μετατοπίζεται παράλληλα προς τα πάνω). Από την άλλη πλευρά η συγκριτική διαφήμιση χρησιμοποιείται από μια επιχείρηση για να παρουσιάσει το προϊόν της ως ανώτερο από αυτό του αντίπαλου της στην αγορά. Κατά συνέπεια η ζήτηση των καταναλωτών για το "θετικά" διαφημιζόμενο προϊόν αυξάνεται ενώ ταυτόχρονος, μειώνεται η ζήτηση για το "αρνητικά" διαφημιζόμενο προϊόν.

Το παραπάνω πρόβλημα τυποποιείται σε ένα παίγνιο δυο σταδίων με την ακολουθία των αποφάσεων των επιχειρήσεων να δίνεται ως εξής. Στο πρώτο στάδιο, οι επιχειρήσεις αποφασίζουν, ταυτόχρονα και ανεξάρτητα, τον τύπο/τύπους της διαφήμισης που θα επενδύσουν καθώς και τα επίπεδα επένδυσης σε κάθε τύπο διαφήμισης, ώστε να προωθήσουν το προϊόν τους στην αγορά. Στο δεύτερο στάδιο, οι επιχειρήσεις ανταγωνίζονται στην αγορά θέτοντας τις τιμές τους. Λύνοντας το παίγνιο οπισθογενώς στην ισορροπία προκύπτουν τα ακόλουθα αποτελέσματα:

Η βέλτιστη στρατηγική των επιχειρήσεων είναι να επενδύσουν σε μια μικτή στρατηγική διαφήμισης, η όποια συνδυάζει επενδύσεις τόσο στην συγκριτική όσο και την πληροφοριακή διαφήμιση, ούτος ώστε να επωφεληθούν από τα θετικά χαρακτηριστικά κάθε τύπου διαφήμισης. Επιπλέον, τα αποτελέσματα στην ισορροπία δείχνουν ότι οι διαφημιστικές δαπάνες των επιχειρήσεων σε κάθε είδος διαφήμισης εξαρτώνται σημαντικά από το βαθμό υποκαταστασιμότητας των προϊόντων στην αγορά. Πιο συγκεκριμένα, οι δαπάνες σε συγκριτική διαφήμιση βαίνουν αυξανόμενες όσο αυξάνεται ο βαθμός υποκατάστασης μεταξύ των προϊόντων. Αντίθετα οι δαπάνες σε πληροφοριακή διαφήμιση βαίνουν μειούμενες για σχετικά μικρό βαθμό υποκατάστασης μεταξύ των προϊόντων ενώ αυξαίνονται όταν τα προϊόντα τείνουν να γίνουν τέλεια υποκατάστατα.

Συγκρίνοντας τα αποτελέσματα μας όταν οι επιχειρήσεις επιλέγουν ενδογενώς τον τύπο και τα επίπεδα διαφήμισης που θα χρησιμοποιήσουν με τρεις εναλλακτικές μορφές αγορών, την κλασσική δυοπωλιακή αγορά με οριζοντίως διαφοροποιημένα προϊόντα, την δυοπωλιακή αγορά όπου οι επιχειρήσεις μπορούν να επενδύσουν μονό σε πληροφορική διαφήμιση και την αγορά όπου οι επιχειρήσεις μπορούν να επενδύσουν μονό σε συγκριτική διαφήμιση, δείξαμε ότι οι επιχειρήσεις επενδύουν τα μέγιστα σε διαφήμιση όταν στην αγορά έχουν την δυνατότητα να επενδύσουν τόσο σε συγκριτική όσο και σε πληροφοριακή διαφήμιση. Το αποτέλεσμα αυτό υποδεικνύει ότι η ύπαρξη και των δύο τύπων της διαφήμισης στην αγορά, εντείνει τον ανταγωνισμό και οδηγεί σε αύξηση των επίπεδων επένδυσης των επιχειρήσεων και στους δυο τύπους διαφήμισης. Σε ότι αφορά την κερδοφορία των επιχειρήσεων, το εξαχθέν αποτέλεσμα είναι ότι οι επιχειρήσεις λαμβάνουν τα υψηλοτέρα κέρδη όταν στην αγορά είναι δυνατή η επένδυση μονό σε πληροφοριακή διαφήμιση, ενώ, για χαμηλό βαθμό υποκαταστασημότητας των προϊόντων, οι επιχειρήσεις λαμβάνουν τα χαμηλότερα κέρδη όταν στην αγορά είναι δυνατή η επένδυση μονό σε συγκριτική διαφήμιση και για υψηλό βαθμό υποκαταστασιμότητας των προϊόντων, όταν συνυπάρχουν και οι δυο μορφές διαφήμισης. Γίνεται εμφανές λοιπόν από τα παραπάνω αποτελέσματα ότι η χρήση της συγκριτικής διαφήμισης οδηγεί τις επιχείρησης στο δίλημμα του φυλακισμένου, όπου καταλήγουν να έχουν μικρότερη κερδοφορία από αυτήν που θα μπορούσαν να έχουν αν δεν επένδυαν σε συγκριτική διαφήμιση.

Αναφορικά με τις επιπτώσεις που έχουν οι επενδύσεις των επιχειρήσεων σε διαφήμιση στο πλεόνασμα των καταναλωτών και στην κοινωνική ευημερία, δείξαμε ότι η ύπαρξη και των δυο μορφών διαφήμισης στην αγορά λειτούργει ευεργετικά για τους καταναλωτές καθώς το πλεόνασμα των καταναλωτών είναι υψηλότερο όταν στην αγορά συνυπάρχουν και οι δυο μορφές διαφήμισης. Επιπλέον, η συνολική κοινωνική ευημερία μεγιστοποιείται όταν στην αγορά οι επιχειρήσεις μπορούν να επενδύσουν μονό σε πληροφοριακή διαφήμιση ενώ ελαχιστοποιείται όταν στην αγορά οι επιχειρήσεις μπορούν να επενδύσουν μονό σε συγκριτική διαφήμιση. Τα παραπάνω αποτελέσματα καταδεικνύουν ότι τα μέτρα πολίτικης ανταγωνισμού θα πρέπει να προωθούν την χρήση πληροφοριακής διαφήμισης έναντι της συγκριτικής καθώς η χρήση πληροφοριακής διαφήμισης αυξάνει την κοινωνική ευημερία. Τέλος, τα παραπάνω αποτελέσματα παραμένουν σε ισχύ όταν οι επιχειρήσεις ανταγωνίζονται με στρατηγική μεταβλητή ανταγωνισμού τις τιμές.

Στο δεύτερο κεφάλαιο της παρούσας διδακτορικής διατριβής με τίτλο: "Comparative advertising in Markets with Network Externalities" μελετώνται οι αποφάσεις των επιχειρήσεων για επένδυση σε συγκριτική διαφήμιση σε αγορές που χαρακτηρίζονται από θετικές εξωτερικότητες δικτύων (network externalities).

Η διαφήμιση και οι επιπτώσεις της στις αγορές που χαρακτηρίζονται από εξωτερικότητες δικτύων έχει πρόσφατα προσελκύσει το ενδιαφέρον της ακαδημαϊκής κοινότητας, δεδομένου ότι, σε μια τέτοια αγορά, η απόφαση των καταναλωτών για την αγορά ενός προϊόντος δεν εξαρτάται μόνο από τα φυσικά χαρακτηριστικά του προϊόντος, αλλά εξαρτάται επίσης από τον αριθμό των άλλων καταναλωτών που χρησιμοποιούν το ίδιο προϊόν (Katz και Sharipo, 1985; Veblen, 1899). Και αυτό γιατί, σε αγορές που χαρακτηρίζονται από θετικές εξωτερικότητες δικτύων, η χρησιμότητα που λαμβάνουν οι καταναλωτές αυξάνεται όσο αυξάνεται ο αριθμός των καταναλωτών που χρησιμοποιούν το ίδιο προϊόν με αυτούς. Ως εκ τούτου η διαφήμιση περά από τον πληροφοριακό της χαρακτήρα, σε αγορές με εξωτερικότητες δικτύων μπορεί να χρησιμοποιηθεί από τις επιχειρήσεις ως ένα μέσω συντονισμού των καταναλωτικών αγορών σε ένα δίκτυο, ή με αλλά λόγια, ως τρόπος για να επηρεάσει η κάθε επιχείρηση τις προσδοκίες των καταναλωτών σχετικά με το μέγεθος του δικτύου του προϊόντος της στην αγορά (Pastine και Pastine, 2002; Clark και Horstmann, 2005; Pastine και Pastine, 2011).

Αν και η υπάρχουσα βιβλιογραφία έχει αναλύσει εκτενώς το "συντονιστικό" ρόλο που η διαφήμιση μπορεί να έχει στις εν λόγω αγορές, έχει αγνοήσει μέχρι τώρα τις επιπτώσεις που εγείρει η χρήση πιο επιθετικών μορφών διαφήμισης, όπως, η συγκριτική διαφήμιση σε αγορές που χαρακτηρίζονται από εξωτερικότητες δικτύων.

Στο δεύτερο κεφάλαιο της παρούσας διδακτορικής διατριβής, εξετάζονται τα κίνητρα των επιχειρήσεων να επενδύσουν σε συγκριτική διαφήμιση σε μια δυοπωλιακή αγορά με χωρικά διαφοροποιημένα προϊόντα η όποια χαρακτηρίζεται από εξωτερικότητες δικτύων. Πιο συγκριμένα απαντώνται οι παρακάτω ερωτήσεις: Υπάρχουν ισχυρά κίνητρα για τις επιχειρήσεις να επενδύσουν σε συγκριτική διαφήμιση σε αγορές που χαρακτηρίζονται από εξωτερικότητες δικτύων? Πως οι επενδύσεις των επιχειρήσεων σε συγκριτική διαφήμιση και η εξωτερικότητες του δικτύου επηρεάζουν τις αποφάσεις των επιχειρήσεων σχετικά με την τοποθέτηση τους στην γραμμική πόλη? Πως οι επιλογές των επιχειρήσεων σχετικά με την τοποθέτηση τους στην γραμμική πόλη, οι επενδύσεις σε συγκριτική διαφήμιση και οι εξωτερικότητες της αγοράς επηρεάζουν τα αποτελέσματα της αγοράς στην ισορροπία?

Υποθέσαμε μια δυοπωλιακή αγορά όπου οι επιχειρήσεις ανταγωνίζονται έχοντας ως στρατηγικές μεταβλητές την τοποθεσία τους στην γραμμική πόλη, τα επίπεδα επένδυσης τους σε στρατηγική διαφήμιση και τις τιμές τους. Η χρήση της συγκριτικής διαφήμισης από τις επιχειρήσεις έχει διττό ρολό, αυξάνει την αποτίμηση για το θετικά διαφημιζόμενο προϊόν, ενώ, ταυτόχρονα, μειώνει την αποτίμηση των καταναλωτών για το προϊόν του αντιπάλου. Η «καθαρή επίδραση» (net effect) που έχει η συγκριτική διαφήμιση στη ζήτηση των καταναλωτών, εξαρτάται από την διαφοροποίηση των προϊόντων, ή με αλλά λόγια, την απόσταση μεταξύ των δύο επιχειρήσεων στην γραμμική πόλη. Πιο συγκεκριμένα, όσο μικρότερη η χωρική απόσταση των δυο επιχειρήσεων, ή διαφορετικά, όσο πιο στενά υποκατάστατα είναι τα προϊόντα, τόσο μεγαλύτερη είναι το δυσφημιστικό αποτέλεσμα της συγκριτικής διαφήμισης μιας επιχείρησης στο αντίπαλο προϊόν.

Το πρόβλημα τυποποιείται σε ένα παίγνιο τεσσάρων σταδίων όπου οι ακολουθία των αποφάσεων των επιχειρήσεων έχεις ως εξής: Στο πρώτο στάδιο, οι επιχειρήσεις αποφασίσουν θέση τους στο γραμμική πόλη. Στο δεύτερο στάδιο, οι επιχειρήσεις επιλέγουν το επίπεδο επένδυσης τους σε συγκριτική διαφήμιση. Στο τρίτο στάδιο, οι επιχειρήσεις ανταγωνίζονται θέτοντας τις τιμές τους. Στο τέταρτο στάδιο, οι καταναλωτές μετά την παρατήρηση των θέσεων των επιχειρήσεων, της διαφήμισης και των τιμών επιλέγουν ένα από τα δύο δίκτυα.

Δείξαμε ότι, για ένα αρκετά υψηλό κόστος μετακίνησης (transportation cost), οι επιχειρήσεις έχουν ισχυρά κίνητρα να επενδύσουν σε συγκριτική διαφήμιση. Επιπλέον, δείξαμε στην ισορροπία οι επιχειρήσεις τοποθετούνται συμμετρικά όντος των ορίων της γραμμικής πόλης καθώς και ότι η απόσταση μεταξύ των επιχειρήσεων μειώνεται καθώς αυξάνεται το κόστος μετακίνησης, ενώ αυξάνεται όσο η αποτίμηση των καταναλωτών για την εξωτερικότητα των δικτύων και η αποτελεσματικότητα της διαφήμισης αυξάνονται.

Επιπλέον, δείξαμε ότι δαπάνες των επιχειρήσεων σε συγκριτική διαφήμιση αυξάνονται όσο αυξάνεται το κόστος μετακίνησης, ενώ μειώνονται όσο η αποτίμηση των καταναλωτών για την εξωτερικότητα των δικτύων αυξάνεται. Το αποτέλεσμα αυτό έρχεται σε αντίθεση με Kretschmer και Rosner (2010) οι οποίοι δείχνουν ότι, όταν οι επιχειρήσεις τοποθετούνται συμμετρικά εντός των ορίων της γραμμικής πόλης, τα επίπεδα επένδυσης τους σε διαφήμιση δεν επηρεάζονται από τις εξωτερικότητες του δικτύου.

Ακόμα, συγκρίνοντας τα αποτελέσματα ισορροπίας μας με δυο εναλλακτικές μορφές αγορών, της αγοράς όπου δεν υπάρχουν εξωτερικότητες δικτύου και αυτής όπου οι επιχειρήσεις δεν επενδύουν σε διαφήμιση, δείξαμε ότι οι επενδύσεις των επιχειρήσεων σε συγκριτική διαφήμιση, εντείνει τον ανταγωνισμό στην αγορά, και οδηγεί σε χαμηλότερες τιμές και κέρδη από αυτά που προκύπτουν στις προαναφερθέντες μορφές αγοράς. Κατά συνέπεια, η συγκριτική διαφήμιση μπορεί να χαρακτηριστεί ως "wasteful advertising" δεδομένου ότι οδηγεί τις επιχειρήσεις στο δίλημμα του φυλακισμένου, όπου καταλήγουν να έχουν μικρότερη κερδοφορία από αυτήν που θα μπορούσαν να έχουν αν δεν επένδυαν σε συγκριτική διαφήμιση.

Τέλος, δείξαμε ότι τα επίπεδα των επενδύσεων των επιχειρήσεων σε διαφήμιση σε αγορές που χαρακτηρίζονται από εξωτερικότητες δικτύου είναι πάντα μεγαλύτερα από αυτά των αγορών χωρίς εξωτερικότητες δικτύου. Το παραπάνω αποτέλεσμα βασίζεται στο γεγονός ότι η ύπαρξη εξωτερικοτήτων δικτύων στην αγορά εντείνει των ανταγωνισμό μεταξύ των επιχειρήσεων και κατά συνέπεια οδηγεί τις επιχειρήσεις στο να επενδύουν περισσότερο σε διαφήμιση.

Στο τρίτο κεφάλαιο της παρούσας διδακτορικής διατριβής με τίτλο " The speed of technological adoption under price competition: two-tier vs. one-tier industries" εξετάζουμε τα κίνητρα των επιχειρήσεων να υιοθετήσουν μια νέα τεχνολογία μείωσης κόστους σε καθετοποιημένες αγορές (vertically related markets) καθώς τις επιπτώσεις που έχουν οι κάθετες σχέσεις στην αγορά αλλά και οι εναλλακτικές δομές της ανοδικής αγοράς (μονοπωλιακή ανοδική αγορά, δυοπωλιακή ανοδική αγορά) στην ταχύτητα υιοθέτησης της νέας τεχνολογίας σε σύγκριση με τις μη καθετοποιημένες αγορές (one-tier industries).

Συμφώνα με την υφιστάμενη βιβλιογραφία η ταχύτητα υιοθέτησης μιας νέας τεχνολογίας από τις επιχειρήσεις στην αγορά εξαρτάται σε μεγάλο βαθμό από τα χαρακτηριστικά της αγοράς, όπως η μορφή του ανταγωνισμού (ανταγωνισμός σε ποσότητες ή σε τιμές), η δομή της αγοράς και ο βαθμός υποκαταστασιμότητας των προϊόντων. (see e.g., Gotz, 1999; Milliou and Petrakis, 2011). Παράλληλα, σύμφωνα με εμπειρικές παρατηρήσεις (Lane, 1991; Charlsson και Jackobsson, 1994; Helper 1995) οι κάθετες σχέσεις σε μια αγορά όπως, οι σχέσεις μεταξύ των καταναλωτών και των επιχειρήσεων, επηρεάζουν σημαντικά τις αποφάσεις των επιχειρήσεων να υιοθετήσουν μια νέα τεχνολογία. Πιο συγκεκριμένα, όσο πιο στενή η σχέση μεταξύ των δυο συμβαλλόμενων μερών της αγοράς αλλά και η ύπαρξη συμβολαίου μεταξύ των μερών (rational contracting) της αγοράς, τόσο ισχυρότερα είναι τα κίνητρα των επιχειρήσεων να υιοθετήσουν μια νέα τεχνολογία.

Με βάση αυτά τα συμπεράσματα, στο τρίτο κεφάλαιο διερευνώνται τα κίνητρα των επιχειρήσεων να υιοθετήσουν μια νέα τεχνολογία μείωσης παραγωγικού κόστους σε καθετοποιημένες αγορές αλλά και οι επιπτώσεις που έχει η ύπαρξη καθέτων σχέσεων στην αγορά στην ταχύτητα υιοθέτησης της νέας αυτής τεχνολογίας από τις επιχειρήσεις σε σχέση με την ταχύτητα υιοθέτησης μιας νέας τεχνολογίας σε αγορές χωρίς κάθετες σχέσεις. Επιπλέον μελετώνται οι επιπτώσεις της δομής της ανοδικής αγοράς (upstream market structure) στην ταχύτητα υιοθέτησης μιας νέας καινοτόμας τεχνολογίας μείωσης κόστους παράγωγης από τις επιχειρήσεις. Πιο συγκεκριμένα στο τρίτο κεφάλαιο απαντώνται οι παρακάτω ερωτήσεις: Υπάρχουν ισχυρά κίνητρα στις καθετοποιημένες αγορές ώστε οι παραγωγοί του τελικού προϊόντος (downstream firms) να υιοθετήσουν μια νέα τεχνολογία μείωσης παραγωγικού κόστους? Πως η ύπαρξη κάθετων σχέσεων στην αγορά επηρεάζει την ταχύτητα υιοθέτησης μιας νέας τεχνολογίας από τις επιχειρήσεις σε σχέση με αυτή των μη καθετοποιημένων αγορών? Πως η ταχύτητα υιοθέτησης της νέας τεχνολογίας διαφέρει κάτω από διαφορετικές μορφές της ανοδικής αγοράς (μονοπωλιακή ανοδική αγορά και δυοπωλιακή ανοδική αγορά)?

Υποθέτουμε δυο εναλλακτικά σενάρια καθετοποιημένων αγορών. Στο πρώτο "upstream separate firms market structure" δυο καθοδικές επιχειρήσεις παράγουν και πωλούν το τελικό προϊόν στους καταναλωτές, για την παράγωγη του τελικού προϊόντος οι καθοδικές επιχειρήσεις χρησιμοποιούν μια πρώτη υλη η όποια διατίθεται από δυο ανοδικές επιχειρήσεις. Κάθε ανοδική επιχείρηση συνεργάζεται αποκλειστικά, με μια καθοδική επιχείρηση ενώ η συνδιαλλαγή μεταξύ τους γίνεται με "two-part tariffs contracts. Αρχικά, οι καθοδικές επιχειρήσεις έχουν την ιδία τεχνολογία παράγωγης, όταν στην αγορά γίνεται διαθέσιμη μια νέα τεχνολογία μείωσης του κόστους παράγωγης. Υποθέτουμε ότι, η καθοδική επιχείρηση που θα υιοθετήσει πρώτη την νέα τεχνολογία αποκτά συγκριτικό πλεονέκτημα έναντι της αντιπάλου της στην αγορά λόγο του μειωμένου κόστους παράγωγης. Αντιθέτως, αν η καθοδική επιχείρηση υιοθετήσει την νέα τεχνολογία κάποια στιγμή μέσα στο χρόνο θα επωφεληθεί από χαμηλότερο κόστος υιοθέτησης της νέας τεχνολογίας. Αναλύουμε ένα δυναμικό παίγνιο πολλαπλών σταδίων όπου, στον χρόνο $t=0$ οι καθοδικές επιχειρήσεις καθορίζουν την ημερομηνία υιοθέτησης της νέας τεχνολογίας. Στον χρόνο $t \geq 0$ το παίγνιο είναι δυο σταδίων. Στο πρώτο στάδιο κάθε ζευγάρι ανοδικής και καθοδικής επιχειρήσεων διαπραγματεύεται και αποφασίζει τους όρους του συμβολαίου που θα γίνει η συνδιαλλαγή τους. Στο δεύτερο στάδιο, οι καθοδικές επιχειρήσεις ανταγωνίζονται θέτοντας τις τιμές τους.

Δείξαμε ότι στις καθετοποιημένες αγορές, ανεξαρτήτως της δομής της ανοδικής αγοράς (upstream separate firms market structure, upstream monopolistic market structure), οι καθοδικές επιχειρήσεις έχουν ισχυρά κίνητρα να υιοθετήσουν μια νέα τεχνολογία μείωσης του κόστους παράγωγης, ενώ στην ισορροπία παρατηρείται διάχυση της τεχνολογίας (η ταχύτητα υιοθέτησης της νέας τεχνολογίας από όμοιες επιχειρήσεις στην αγορά διαφέρει σημαντικά). Επιπλέον, δείξαμε ότι οι καθοδικές επιχειρήσεις υιοθετούν την νέα τεχνολογία γρηγορότερα στην περίπτωση των κάθετων αγορών από ότι στις μη καθετοποιημένες αγορές, εάν και μονό εάν, οι ανοδικές επιχειρήσεις έχουν μικρή διαπραγματευτική ισχύ στην αγορά, ο ανταγωνισμός στην αγορά είναι έντονος και η νέα τεχνολογία δεν είναι πολύ δραστική σε ότι αφορά την μείωση κόστους των επιχειρήσεων. Το ανάποδο συμβαίνει σε κάθε άλλη περίπτωση.

Ακόμα δείξαμε ότι η δομή της ανοδικής αγοράς επηρεάζει την ταχύτητα της υιοθέτησης της νέας τεχνολογίας. Πιο συγκεκριμένα, η επιχείρηση που υιοθέτει πρώτη την νέα τεχνολογία (first adoption) την υιοθέτει ταχύτερα όταν η ανοδική αγορά έχει μονοπωλιακή δομή από ότι όταν έχει δυοπωλιακή δομή, εάν και μονό έναν, η τεχνολογία είναι επαρκώς δραστική σε ότι αφορά την μείωση του κόστους παράγωγης. Αντίθετα, η ταχύτητα της δεύτερης υιοθέτησης στην αγορά είναι πάντα μεγαλύτερη όταν η ανοδική αγορά έχει δυοπωλιακή δομή.

Στο τέταρτο κεφάλαιο της παρούσας διατριβής με τίτλο, "Cournot is more competitive than Bertrand! Upstream Monopoly with Two-part Tariffs", συγκρίνουμε τα αποτελέσματα της ισορροπίας και την κοινωνική ευημερία της καθετοποιημένης αγοράς, όπου οι συναλλαγές ανάμεσα στις καθοδικές και στις ανοδικές επιχειρήσεις γίνονται με two-part tariffs contracts και οι καθοδικές επιχειρήσεις ανταγωνίζονται με στρατηγικές μεταβλητές τις ποσότητες (Cournot competition), με τα αντίστοιχα αποτελέσματα της αγοράς όταν οι καθοδικές επιχειρήσεις ανταγωνίζονται με στρατηγικές μεταβλητές τις τιμές (Bertrand competition).

Ένα κλασσικό αποτέλεσμα στα οικονομικά είναι ότι όταν οι επιχειρήσεις ανταγωνίζονται θέτοντας τις τιμές τους, η παραγόμενη ποσότητα στην αγορά καθώς και η κοινωνική ευημερία είναι υψηλότερες από εκείνες όταν ανταγωνίζονται θέτοντας τις ποσότητες τους. Το ανάποδο αποτέλεσμα ισχύει για τα κέρδη των επιχειρήσεων. (Singh και Vives, 1984). Στο τέταρτο κεφάλαιο της διδακτορικής διατριβής εξετάζουμε την ισχύ αυτού του αποτελέσματος σε καθετοποιημένες αγορές με μονοπωλιακή ανοδική δομή (monopolistic upstream market structure) όταν οι επιχειρήσεις δεσμεύονται με two-part tariffs contracts.

Υποθέτουμε μια καθετοποιημένη αγορά αποτελούμενη από μια ανοδική επιχείρηση και δυο καθοδικές επιχειρήσεις όπου η ανοδική επιχείρηση διαθέτει στις καθοδικές επιχειρήσεις την απαραίτητη πρώτη υλη για την παράγωγη του τελικού προϊόντος, ενώ, οι καθοδικές επιχειρήσεις μεταποιούν την πρώτη υλη σε τελικό προϊόν και το πουλούν στους καταναλωτές. Η συνδιαλλαγές μεταξύ της ανοδικής και των καθοδικών επιχειρήσεων γίνονται με two-part tariffs contracts, το οποίο σημαίνει ότι οι επιχειρήσεις διαπραγματεύονται για τον καθορισμό της τιμής, ανά μονάδας προϊόντος πρώτης ύλης (wholesale price) και του σταθερού ποσού συνδιαλλαγής (fix fee). Αναλύουμε ένα παίγνιο δυο σταδίων όπου στο πρώτο στάδιο η ανοδική μονοπωλιακή επιχείρηση διαπραγματεύεται τους ορούς του συμβολαίου (the wholesale price and the fix fee), ανεξάρτητα και ταυτόχρονος, με κάθε μια από τις καθοδικές επιχειρήσεις. Στο δεύτερο στάδιο οι καθοδικές επιχειρήσεις ανταγωνίζονται στην αγορά θέτοντας τις τιμές ή τις ποσότητες τους (Bertrand or Cournot competition).

Δείξαμε ότι σε αντίθεση με τα κλασσικά αποτελέσματα των Sighn και Vives (1984) σε μια καθετοποιημένη αγορά με μια μονοπωλιακή ανοδική επιχείρηση όπου οι καθοδικές και οι ανοδικές επιχειρήσεις συναλλάσσονται με two-part tariffs contracts, η παραγόμενη ποσότητα προϊόντος από τις επιχειρήσεις όταν αυτές ανταγωνίζονται θέτοντας τις ποσότητες τους (Cournot competition) είναι μεγαλύτερη από όταν οι επιχειρήσεις ανταγωνίζονται θέτοντας τις τιμές τους (Bertrand competition). Επιπλέον δείξαμε ότι τα κέρδη των καθοδικών επιχειρήσεων, όταν αυτές ανταγωνίζονται με στρατηγική μεταβλητή ανταγωνισμού τις ποσότητες, είναι πάντα μεγαλύτερα από όταν ανταγωνίζονται με στρατηγική μεταβλητή ανταγωνισμού τις τιμές. Το ανάποδο ισχύει για τα κέρδη της ανοδικής μονοπωλιακής επιχείρησης.

Αναφορικά με την κοινωνική ευημερία και το πλεόνασμα των καταναλωτών, δείξαμε ότι τόσο το πλεόνασμα των καταναλωτών όσο και η συνολική κοινωνική ευημερία είναι μεγαλύτερα όταν οι επιχειρήσεις ανταγωνίζονται με στρατηγική μεταβλητή απόφασης τις τιμές τους.

Βιβλιογραφία

1. Aluf, Y., Shy, O., 2001. Comparison advertising and competition. Mimeo, University of Haifa.

2. Anderson, S.P., Renault R., 2009. Comparative Advertising: disclosing horizontal match information. The Rand Journal of Economics 40, 558-581.

3. Bagwell, K., 2007.The Economic Analysis of Advertising", In Mark Armstrong and Rob Porter (eds.). The Handbook of Industrial Organization 3, 1701-1844.

4. Barigozzi, F., Garella, P.G., Peitz, M., 2009. With a Little Help from my Enemy: Comparative Advertising as a Signal of Quality. Journal of Economics and Management Strategy 18, 1071-1094.

5. Carlsson B., Jacobsson S., 1994. Technological Systems and Economic Policy: The Diffusion of Factory Automation in Sweden. Research Policy 23, 235-248.

6. Clark, C. R., Horstmann I. J., 2005. Advertising and Coordination in Markets with Consumption Scale Effects. Journal of Economics and Management Strategy 14 (2), 377-402.

7. Emons W., Fluet C., 2012. Non-comparative versus Comparative Advertising as a Quality Signal. International Journal of Industrial Organization 30, 352-360.

8. Goodwin, S., Etgar, M., 1980. An Experimental Investigation of Comparative Advertising: Impact of Massage Appeal, Information Load and Utility of Product Class. Journal of Marketing Research, 187-202.

9. Gotz, G., 1999. Monopolistic Competition and the Diffusion of New Technology. Rand Journal of Economics 30, 679-693.

10. Grewal, D.S., Kavanoor, E,. Fern, C., Costley J., Barnes, 1997. Comparative Versus Non-comparative Advertising: A Meta- Analysis. Journal of Marketing 61(4), 517-32.

11. Helper, S., 1995. Supplier Relations and Adoption of New Technology: Results of Survey Research in the U.S. Auto Industry. NBER Working Paper #5278.

12. Jung O.K., Sharon E.B ., 2002. Comparative Advertising Effectiveness in Different National Countries. Journal of Business Research 55, 907-913.

13. Katz, M., and Shapiro, C., 1985. Network externalities, competition and compatibility. American Economic Review 75(3), 424-439.

14. Kretschmer, T., Rosner, M., 2010. Increasing Dominance - the Role of Advertising, Pricing and Product Design. Mimeo, University of Munich.

15. Lane, S., 1991. The Determinants of Investment in New Technology. American Economic Review 81, 262-65.

16. Milliou, C., Petrakis E., 2011. Timing of technology adoption and product market competition. International Journal of Industrial Organization 29, 513-523.

17. Pastine, I., Pastine T., 2011. Coordination In Markets With Consumption Externalities: Advertising And Product Quality. Manchester School 79(1), 45-62.

18. Pastine, I., Pastine T., 2002. Consumption Externalities, Coordination and Advertising. International Economic Review 43(3), 919-943.

19. Singh, N., Vives, X., 1984. Price and quantity competition in a differentiated duopoly. Rand Journal ofEconomics, 15, 546-554.

20. Veblen, T., 1899. In: The Theory of the Leisure Class. An Economic Study of Institutions, Macmillan, London.

21. Wilkie, W.L., Farris, P.W., 1975. Comparative Advertising: Problems and Potential. Journal of Marketing 39, 7-15.