
# Advertising in Markets with Consumption Externalities

by

Adele Whelan

A thesis submitted in fulfilment of the requirements for the degree of Ph.D.

In the Department of Economics, Finance and Accounting,
National University of Ireland, Maynooth, Co. Kildare, Ireland.

May 2014

Head of Department: Professor Rowena Pecchenino

Thesis Supervisors: Professor Rowena Pecchenino (Lead Supervisor), Dr. Gerda Dewit and Dr. Tuvana Pastine

**Table of Contents**

**List of Tables** ..... **4**

**List of Figures** ..... **4**

**Summary** ..... **5**

**List of Presentations and Publications** ..... **6**

**Acknowledgements** ..... **8**

**1. Entry Deterrence, Coordinating Advertising and Pricing in Markets with Consumption Externalities** ..... **9**

1.1 Introduction ..... 10

1.2 Model ..... 18

1.2.1 Consumers ..... 18

1.2.2 Advertising ..... 20

1.3 Equilibrium ..... 21

1.3.1 Pricing Decisions ..... 21

1.3.2 Advertising Decisions ..... 29

1.3.2.1 Simultaneous Move Benchmark Case ..... 29

1.3.2.2 Sequential Move Advertising Case ..... 32

1.4 Discussion ..... 37

1.5 Conclusions ..... 39

1.6 References ..... 40

**2. Variation of Advertising to Sales Ratios and Entry Deterrence Behaviour: Evidence from UK Survey Data** ..... **44**

2.1 Introduction ..... 45

2.2 Literature Review ..... 48

2.3 The Data ..... 51

2.3.1 Advertising-Sales Ratio ..... 52

2.3.2 Entry Deterrence Strategy ..... 53

2.3.3 Sectors ..... 54

2.3.4 Turnover ..... 54

2.3.5 Number of Competing Firms ..... 55

2.3.6 Size of the Market ..... 55

2.4 Results ..... 56
2.5 Conclusions ..... 65
2.6 References ..... 66
2.7 Appendix ..... 69

**3. System Wars: The Power of Network Externalities ..... 70**
3.1 Introduction ..... 71
3.2 Model ..... 76
3.3 Equilibrium ..... 78
3.3.1 Stage 2: Prices ..... 78
3.3.2 Stage 1: Advertising ..... 82
3.4 Discussion ..... 85
3.5 Conclusions ..... 89
3.6 References ..... 90
3.7 Appendix ..... 92

## List of Tables

Table 2.1: OLS estimates of advertising expenditure as a percentage of sales ..... 57

Table 2.2: OLS estimates of advertising expenditure as a percentage of sales (Outliers adjusted)..... 61

Table 2.3: Tobit estimates of advertising expenditure as a percentage of sales (Outliers adjusted)..... 63

Table 2.4: Variable definitions and descriptive statistics ..... 69

Table 3.1: Case study statistics relating to the console system war ..... 86

## List of Figures

Figure 1.1: Firm *j* coordinates the demand for j, k $\in$ {Incumbent, Challenger} ..... 22

Figure 1.2: Demand for Firm *j* and *k* with monopoly prices and quantities ..... 26

Figure 1.3: Demand for firm *j* and *k* showing $\overline{P}_k$ and $\underline{P}_k$ on same isoprofit curve..... 27

Figure 1.4: Advertising reaction functions ..... 31

Figure 3.1: Price reaction functions..... 80

Figure 3.2: Advertising reaction functions ..... 83

**Summary**

This thesis consists of three papers analysing advertising in markets with consumption externalities. These markets, where the value of the product to the consumer increases as the number of other consumers purchasing the product increases, are growing due to network effects, connectivity and the improved ease of social interaction. Strategic advertising and pricing play important roles in such markets. These observations serve as a starting point for this thesis.

"Entry Deterrence, Coordinating Advertising and Pricing in Markets with Consumption Externalities" explores an incumbent's ability to use coordination advertising in a market with consumption externalities to deter future entry from a challenger with an equal quality product. I show that strategic entry deterrence is possible and involves strategic pre-commitment to over-investment. The findings suggest that an incumbent's ability to deter entry is sensitive to the size of the fixed cost of entry that the challenger must incur and the consumption externality parameter.

"Variation of Advertising to Sales Ratios and Entry Deterrence Behaviour: Evidence from UK Survey Data" uses Advertising and Industry Survey (AIS) data from over 800 UK firms to investigate the relationship between the firms' advertising to sales ratios and entry deterrence behaviour. Due to the construction of this dataset, it was not possible to focus on firms producing products with consumption externalities only. The behaviour of all firms are considered. Depending on what type of oligopoly is used, theoretical results either suggest over- or under-investment in advertising to deter entry. I find that if a firm perceives advertising expenditure as an important strategy to deter entry it will increase, rather than decrease, its advertising expenditure.

"System Wars: The Power of Network Externalities" introduces network externalities and persuasive advertising into a Hotelling framework to investigate two firms, producing different varieties of a good, competing in a market with asymmetric network intensities. In spite of different network intensities, I show that both firms can exist simultaneously in the market. The firm with the stronger network externality dominates. This provides a new example of a "Matthew Effect" where the initial advantage is self-amplifying. In equilibrium, this dominant firm, when compared to the firm with the lower network intensity, will have higher advertising expenditure, price, market share and profits.

## List of Presentations and Publications

### Presentations:

"System Wars: The Power of Network Externalities", The Irish Economic Association Conference, Limerick, May 2014

"System Wars: The Power of Network Externalities", 3rd Business PhD in France PhD Camp, ESCP Europe, Paris, April 2014

"System Wars: The Power of Network Externalities", The Irish Society of New Economists Annual Conference, National University of Maynooth, September 2013

"System Wars: The Power of Network Externalities", Department of Economics, Finance and Accounting Seminar, National University of Maynooth, February 2013

"Variation of Advertising to Sales Ratios and Entry Deterrence Behaviour: Evidence from UK Survey Data", The Irish Society of New Economists Annual Conference, University College Cork, August 2012

"Variation of Advertising to Sales Ratios and Entry Deterrence Behaviour: Evidence from UK Survey Data", Department of Economics, Finance and Accounting Seminar, National University of Maynooth, June 2012

"Variation of Advertising to Sales Ratios and Entry Deterrence Behaviour: Evidence from UK Survey Data", The Irish Economic Association Conference, Institute of Bankers Dublin, April 2012

"Variation of Advertising to Sales Ratios and Entry Deterrence Behaviour: Evidence from UK Survey Data", Department of Economics, Finance and Accounting Seminar, National University of Maynooth, November 2011

"Entry Deterrence, Coordinating Advertising and Pricing in Markets with Consumption Externalities", The Irish Society of New Economists Annual Conference, University College Dublin, August 2011

"Entry Deterrence, Coordinating Advertising and Pricing in Markets with Consumption Externalities", The Irish Economic Association Conference, Limerick, April 2011

"Entry Deterrence, Coordinating Advertising and Pricing in Markets with Consumption Externalities", Graduate Student Research Seminar, National University of Maynooth, November 2010

"Entry Deterrence, Coordinating Advertising and Pricing in Markets with Consumption Externalities", The Irish Society of New Economists Annual Conference, Trinity College Dublin, October 2010

"Entry Deterrence, Coordinating Advertising and Pricing in Markets with Consumption Externalities", Department of Economics, Finance and Accounting Seminar, National University of Maynooth, September 2010

"Entry Deterrence, Coordinating Advertising and Pricing in Markets with Consumption Externalities", Graduate Student Research Seminar, National University of Maynooth, February 2010

"Entry Deterrence and Coordinating Advertising in Markets with Consumption Externalities", The Irish Society of New Economists Annual Conference, University of Limerick, October 2009

"Entry Deterrence and Coordinating Advertising in Markets with Consumption Externalities", Department of Economics, Finance and Accounting Seminar, National University of Maynooth, June 2009

"Entry Deterrence and Coordinating Advertising in Markets with Consumption Externalities", The Irish Economic Association Conference, Blarney Co. Cork, April 2009

"Entry Deterrence and Coordinating Advertising in Markets with Consumption Externalities", Graduate Student Research Seminar, National University of Maynooth, March 2009

**Acknowledgments**

Completing this thesis would not have been possible without the help and support of many people who I wish to thank.

First and foremost, my greatest appreciation and gratitude goes to my supervisor, Professor Rowena Pecchenino, for her guidance, patience, insight and commitment over the course of my doctoral studies.

I am especially grateful to Dr. Gerda Dewit and Dr. Tuvana Pastine, who not only served on my committee, but also introduced me to Industrial Economics and shared their time, experience and vast knowledge with me.

I am indebted to all staff at the Department of Economics, Finance and Accounting, NUI Maynooth and extend my gratitude to those who have played a major role in my learning by providing me with endless opportunities to progress. I have had the pleasure of discussing this research with Professor Donal O' Neill, Dr. Dermot Leahy and the late Professor Denis Conniffe. I am grateful for their constructive comments and advice. Sincere thanks to my fellow students in the Department and my new colleagues at the ESRI for their support and suggestions.

Finally, I would like to express my deepest gratitude to my family and friends for all their love and encouragement. For my parents and grandparents who have supported me in all my pursuits. For Ronan Lawlor whose kindness, endless patience and faithful support during the final stages of this dissertation are much appreciated.

I dedicate this thesis to the memory of my beloved grandfather, Seamus Mackey who passed away as this final version of my thesis was nearing completion.

Adele Whelan
*National University of Ireland Maynooth*
November 2013

# 1. Entry Deterrence, Coordinating Advertising and Pricing in Markets with Consumption Externalities


**Abstract**

This paper extends the entry deterrence literature by examining coordinating advertising in markets with consumption externalities using a stochastic success function. Optimal advertising and pricing strategies are analysed when an incumbent firm faces a challenger with a product of equal quality. I show that strategic entry deterrence using advertising is possible and optimal entry deterrence involves strategic pre-commitment to over-investment relative to the non-strategic simultaneous advertising benchmark. I show that when entry deterrence is not possible the incumbent does not possess a first mover advantage and optimal entry accommodation involves strategic investment in advertising followed by aggressive price competition congruent with the non-strategic simultaneous advertising benchmark. The findings suggest that an incumbent's ability to deter entry through coordinating advertising in a market with products of equal quality is sensitive to the size of the fixed cost of entry that the challenger must incur and the consumption externality parameter.



**Keywords**

Limit Advertising, Coordinating Advertising, Consumption Externality, Entry Deterrence

## 1.1 INTRODUCTION

The incumbent firm can have a significant advantage over an aspiring entrant to the market through a first mover advantage and the opportunity to erect barriers to entry. Entry deterrence with advertising has been extensively studied since Spence (1980). Spence examined the persuasive role of advertising where advertising changes individual's preferences leading to a demand shift in favour of the good being advertised.[1] However, like many of the first examinations of barriers to entry in the early limit-pricing literature, he employs the game-theoretically unsound assumption that the incumbent must maintain output and advertising levels at the pre-entry levels. In this view of advertising, a large advertising expenditure can imply an aggressive setting for a potential entrant and may deter entry.

Schmalensee (1983), Fudenberg and Tirole (1984), Ishigaki (2000), Krahmer (2006), and Doraszelski and Marovich (2007) examine the role of advertising in entry deterrence where advertising builds goodwill, making it harder for an entrant to attract the attention of the consumer.[2]

Schmalensee (1983) was the first to examine entry deterrence using advertising expenditure in a subgame perfect equilibrium. He considers entry deterrence in a market for homogenous products served by an incumbent faced by a potential entrant. This is a three-stage model where the incumbent advertises in the first stage, in the second stage the challenger observes the incumbent's advertising and chooses whether to enter. If the challenger decides to enter the market, he incurs a sunk cost

[1] The persuasive view can be traced back to Braithwaite (1928), Kaldor (1950), Galbraith (1958, 1967), Bain (1956), Comanor and Wilson (1967, 1974), Solow (1967), Dixit and Norman (1978) and Becker and Murphy (1993).

[2] See Ozga (1960) and Stigler (1961). See also Telser (1964), Nelson (1970, 1974), Butters (1977), Schmalensee (1978), Grossman and Shapiro (1984), Kihlstrom and Riordan (1984), Milgrom and Roberts (1986), Stegeman (1991), Meurer and Stahl (1994), Robert and Stahl (1993), Stahl (1994) and Bagwell and Ramey (1994) for the informative view.

and makes his advertising investment. The advertising technology used is as Butters (1977) proposed, where consumers receive an advert from the incumbent which informs them of the company's existence and price of the product at zero cost. This message is durable and consumers remember the incumbent in the second stage of the game.[3] In the final stage, the firms simultaneously decide on quantities. Schmalensee (1983) finds that entry deterrence is possible and involves investing less in advertising than when there was no threat of entry. The reasoning is that if the incumbent were to launch a large advertising campaign it would have a large potential consumer base. In this case, a low output combined with a high price would be appealing to them. A rational entrant would prefer to enter the market under these circumstances. Therefore, the incumbent reduces its advertising expenditure so that it may respond to entry aggressively.

Sutton (1991) examines an oligopoly market structure model to show that an increase in the market size does not lead to a fragmented market structure when firms endogenously incur sunk costs through advertising expenditure. Therefore, increases in the density of consumers does not induce entry or exit to the market but additional profits are absorbed by higher advertising expenditure by firms. Sutton (1991) assumes that advertising expenditures by incumbents creates a barrier to entry, whereas, Schmalensee (1983) assumes that brand awareness creates the barrier to entry.

Ishigaki (2000) extends Schmalensee (1983) to examine entry deterrence in a market for homogenous products where post-entry competition is in prices. He finds that the incumbent is unable to deter entry by strategically committing to advertising

[3] This type of advertising technology is characteristic of the goodwill role of advertising.

investment. The simultaneous-move price-setting game in the post-advertising stage is solved as a unique mixed-strategy Bertrand-Nash equilibrium where the firm with the higher advertising tends to set high prices more often and earns higher profits than the firm with lower advertising expenditure. The research of Schmalensee (1983) and Ishigaki (2000) suggest that the goodwill effect of advertising in the homogenous-product market is sensitive to whether firms compete in prices and quantities after making their advertising decisions. However, neither paper suggests that an incumbent can deter entry in a market with homogenous products by increasing their advertising expenditure above the non-strategic simultaneous advertising benchmark.

Fudenberg and Tirole's (1984) seminal paper considers a two-stage model where the incumbent and the potential entrant compete with differentiated products. Similar to the advertising technology in Butters (1977), the incumbent chooses the proportion of consumers to inform of its existence and prices in the first stage, while charging the monopoly price. In the second stage, the incumbent and entrant make advertising and pricing decisions. The goodwill effect is intensified with the assumption that the consumers who receive an advert in the first stage remain consumers of the incumbent only for the duration of the game as they do not read any advert they receive in the second stage. Firms are assumed to advertise to cover the remaining market. Their findings include conditions where the incumbent over-invests to accommodate the entrant, referred to as becoming a "fat cat". However, when it is optimal to deter entry, the incumbent under-invests, referred to as the "lean-and-hungry look". It is most advantageous for the firm to create a small group of consumers for its product and constrain itself to a low price given the threat of entry.

Krahmer (2006) also extends Schmalensee (1983) to examine advertising and conspicuous consumption where brand recognition is of importance and consumers care about their image. This paper shows that an incumbent may strategically over-invest in advertising to deter entry. Doraszelski and Marovich (2007) propose a dynamic model with goodwill advertising in a market for differentiated goods. They solve numerically for the symmetric Markov-perfect equilibrium and find that an incumbent can deter entry with over-investment in advertising and generally accommodates entry by under-investment in advertising, although the optimal accommodation strategy varies with market features.

Entry deterrence has also been examined when it plays an informative role through signalling the incumbent's private information through its pre-entry behaviour. Bagwell and Ramey (1988) followed by Bagwell (2007) extend Milgrom and Roberts (1982) to show that price and advertising may be used to signal cost to the potential entrant. The results of this paper state that an incumbent can over-invest in advertising to deter entry and limit pricing can be expected to occur even when firms have the option to use advertising to signal costs. Linnemer (1998) has price and advertising jointly signalling costs and quality. This paper also shows that positive dissipative advertising, a large advertising campaign that does not directly affect demand, may be used along with a distorted price to signal type.

In this paper, I assume that consumers and firms are fully informed of the product's existence, characteristics, prices and production costs but a role for advertising still exists as a tool for entry deterrence due to positive consumption externalities in the market. Positive consumption externalities arise in markets where the utility that a consumer derives from the consumption of a product increases with the number of

other consumers purchasing the same product either due to network or social interaction effects. For example, the decision about which computer software to purchase involves expectations about which package will be more heavily purchased in addition to the relative prices and qualities of the rival firms' packages. Decisions about which phone company to connect with, smartphone or internet gaming console to purchase, movie to watch, book to read, credit card to use, internet share network to join, are all likely to involve expectations about how many people will be using the same brand or network.

Chwe (2001), Clark and Horstmann (2005), Pastine and Pastine (2002, 2011), and Sahuguet (2011) show that in markets with consumption externalities firms may engage in advertising competition in order to coordinate consumer expectations on their own brand.[4] In a market with positive consumption externalities a consumer faced with two competing brands makes his purchase decision based on his expectations about which brand will be the popular one. Firms have an incentive to present consumers with a coordinating device to coordinate the consumers' expectations on their own product, even at a high cost to the firm. All else equal, due to the consumption externality, the consumer wishes to purchase the brand that is purchased by a greater proportion of the market. On viewing a large advertising campaign a consumer can rationalise that the firm would not have spent such a large amount on advertising if it did not expect the advertising to increase sales of its product. In this framework, this rationalization leads the consumer to purchase the

[4] Sahuguet (2011) shows coordinating advertising holds in a repeat advertising framework. Pastine and Pastine (2011) show that in vertically differentiated product markets advertising may be used as a coordinating device by firms. Clark and Horstmann (2005) show that the coordination role of advertising also survives in markets with horizontally differentiated products when advertising levels are imperfectly observable.

more heavily advertised brand, therefore, justifying the firm's expenditure on advertising.

This paper extends previous studies on coordinating advertising to analyse optimal advertising strategies in an entry deterrence framework where the monopolist incumbent has the first move and faces a challenger with a product of equal quality. This paper formalises the intuition that an incumbent monopolist firm may make it difficult for a would-be entrant by making a significant investment in advertising to coordinate consumers' expectations on its product. If the potential entrant has to incur similar costs it may be deterred from entering the market. This is the first examination of entry deterrence when advertising is used as a coordination device. Furthermore, previous studies on coordinating advertising to date have abstracted from the interaction between advertising and retail price competition, therefore, assuming that the prices of firms were exogenous. This paper addresses the coordinating role of advertising in markets with consumption externalities by investigating optimal advertising and pricing strategies.

The model extends existing coordination models of advertising in one other significant way. In Pastine and Pastine (2011) coordinating advertising takes the form of an all-pay auction and consumers purchase from the firm with the largest advertising expenditure. Therefore, in this set-up, if one firm advertises €1 more, consumers coordinate on its product. In this paper, a probabilistic outcome has been introduced using a stochastic success function based on a lottery type all pay-auction as devised by Tullock (1980). Each firm's probability of capturing the coordinated demand is proportional to the firm's share of the total expenditure on advertising. As a result, the more money spent on advertising the greater the probability of managing

to coordinate the consumers on its product. This aspect makes the model more realistic and could capture an aspect of an advertising campaign such as the chosen music or celebrity used leading to a particularly successful or unsuccessful campaign.

Paton (2008) provides empirical support for the hypothesis that firms do in fact use advertising to deter entry. Nearly one-quarter of 843 medium-sized and large UK-based firms surveyed about their advertising practices cite entry deterrence as an aim of their advertising. Furthermore, one in five managers of firms that advertise stated that they would increase advertising expenditure if a new rival company appeared in their market. Paton (2008, p.78) suggests "[s]pecifically, firms in services, producer manufacturing and those operating in highly monopolised markets appear to be much more likely to respond aggressively than others". These findings support the case that an incumbent monopoly firm is likely to respond to potential entry by aggressively increasing its advertising.

This paper shows that the size of the fixed set up cost is a key determinant of the industry structure. When advertising has a coordinating role and the fixed cost of set-up is high the incumbent can deter the challenger from entering with his advertising expenditure. A monopolist that does not face a potential entrant in my model would not advertise. Faced with a potential entrant, I show that the monopolist is induced to advertise for a range of values of the non-recoverable set-up cost ($\Omega$), either to accommodate or deter entry. Entry deterrence involves strategic pre-commitment to over-investment relative to the non-strategic simultaneous advertising benchmark. Therefore, the strategic entry deterrence is accomplished through over-investing in advertising. This is in contrast to the findings of Schmalensee (1983), Fudenberg and Tirole (1984), and Ishigaki (2000) where the threat of entry induces the incumbent

monopolist to advertise less than he would if entry were not possible. However, the model bears some resemblance to the more recent findings of Krahmer (2006), Bagwell (2007), and Doraszelski and Marovich (2007) that point to some cases where the incumbent monopolist may over-invest in advertising.

Furthermore, I show that when entry deterrence is not possible the incumbent does not possess a first mover advantage. Optimal entry accommodation involves a strategic investment in advertising followed by aggressive price competition congruent with the non-strategic simultaneous advertising benchmark. Such a result has not been seen in the literature before and stems from the introduction of the stochastic success function allowing a probabilistic outcome from the advertising expenditure.

The result of this paper can be interpreted as the advertising expenditure by the incumbent increasing the cost of entry and therefore leading to entry deterrence. In this view, the model bears some resemblance to the role of investment in entry deterrence (Spence (1977), Dixit (1980)). Similarly to Dixit (1980) and Fudenberg and Tirole (1984) this paper finds that in some cases, the incumbent would have to advertise on such a large scale in order to deter entry that it may not be profitable, in which case it is more profitable to accommodate entry. The main results are driven by the coordinating role of advertising, the consumption externality and how it affects firms' advertising incentives. The coordination device does not rely on commercial signaling or providing any information about the product itself; all that is necessary is for a person to know that other people are seeing the advertisements also. An illustrative anecdote is Windows95 introduction to the market. The competing similar operating system was OS2. Microsoft succeeded to coordinate consumers' expectations on Windows95. Its advertising campaign spending alone cost US$300

million and Microsoft chose to clearly state its expenditure on advertising on billboards during its advertising campaign. Microsoft told each viewer that many others also knew about Windows95. This paper tries to move from anecdote and evidence to theory.

The rest of the paper is organised as follows. In Section 1.2, I develop the model framework. The equilibrium is developed in Section 1.3 where I discuss pricing and advertising decisions. Section 1.4 concludes.

## 1.2 MODEL

The incumbent firm is challenged by a new entrant in a market with products of equal quality. The challenger must incur a sunk cost $(\Omega)$ in order to enter the market. Each profit maximizing firm has the same constant marginal production costs, normalised to zero. I consider a sequential game where the incumbent makes its irreversible advertising decision $(A_I)$ in the first stage. In the second stage, the potential entrant observes the incumbent's advertising and chooses whether to enter the market. If the challenger chooses to enter the market it determines its advertising level $(A_c)$. In the third stage, firms compete in prices. Consumers make their purchasing decisions simultaneously after observing the firms' advertising and pricing decisions. Communication between consumers is not considered in this model.

### 1.2.1 Consumers

Consumer preferences exhibit positive consumption externalities. The utility the consumer gets from the product is a function of the quality of the product $(V)$ and it is increasing in the number of people $(q)$ who purchase the same brand. Consumers want, at most, one unit from each brand. Following Pastine and Pastine (2011), there

is a continuum of consumers who differ in their taste $(\alpha)$ for the product where $\alpha$ is uniformly distributed between 0 and $\bar{\alpha}$. This represents a mass of consumers who are differentiated by their taste for this product where 0 is the consumer with lowest taste and $\bar{\alpha}$ is the consumer with the highest taste for the product, $\alpha \sim U[0,\ \bar{\alpha}]$.

Consumer *i*'s indirect utility is given by:

$$U_i = \begin{cases} 0 & \text{if he makes no purchase} \\ (\alpha_i V_j + \beta q_j - P_j) & \text{if he buys only product j} \\ (\alpha_i V_j + \beta q_j - P_j) + (\omega \alpha_i V_k + \beta q_k - P_k) & \text{if he buys product j and then product k} \end{cases} \quad (1)$$

for $j,\ k \in \{\text{Incumbent},\ \text{Challenger}\}$ and $j \neq k,\ \beta > 0,\ \omega \in (0, 1)$. $\beta$ is the consumption externality parameter and it is multiplied by the proportion of people $(q)$ who purchase the same brand. The intrinsic value $(V)$ is assumed to be symmetric across the two brands. Since $0 \leq \omega \leq 1$, $\omega$ reflects the fact that the utility function exhibits diminishing marginal utility. This utility function implies that consumers have at most a unit demand for each product. Depending on the prices and qualities of the products consumers with a high enough taste for the product may purchase both of the products. However no individual purchases two of the same item. For example, we can understand this to be true for products with consumption externalities such as computer software, smartphones, phone service provider, online gaming consoles, etc.

Due to the consumption externality, all else equal, consumers wish to purchase the brand that is purchased by a greater proportion of the market. In this framework, the rationalization that a firm would not have spent such a large amount on advertising if it did not expect the advertising to increase sales of its product leads the consumer to

use advertising as a coordination device and purchase the more heavily advertised brand.

### 1.2.2 Advertising

Firms can engage in advertising with multiple objectives, such as signalling an aggressive stance to the rival, providing information of the existence and price of the product, and persuading consumers that the product is desirable. In order to focus solely on the coordinating role of advertising, I abstract from all other roles of advertising. I assume that consumers are rational and that their preferences are constant, and that consumers and firms are fully informed of the product's existence, characteristics and production costs. Therefore, the role of advertising does not rely on commercial signalling or informing anything about the product itself, the firms use advertising expenditure to convince consumers that their product will be the product that will be purchased by the larger number of consumers.

## 1.3 EQUILIBRIUM

In this section, I show that strategic entry deterrence is possible, and optimal entry deterrence by the monopolist involves strategic pre-commitment to over-investment relative to the non-strategic simultaneous advertising benchmark. I show that when entry deterrence is not possible, the incumbent does not possess a first mover advantage. Optimal entry accommodation involves a strategic investment in advertising followed by aggressive price competition congruent with the non-strategic simultaneous advertising benchmark.

Using backward induction, I begin by examining the firm's optimal pricing decisions. Subsequently, I analyse the benchmark case where firms advertise simultaneously. This is followed by an analysis of the Stackelberg leadership model by examining the advertising reaction function of the challenger, and finally the optimal advertising strategy of the incumbent.

### 1.3.1 Pricing Decisions

In order to show firms optimal pricing decisions, first let me examine the consumer demand for both products. Consider the case where consumers, due to the relative advertising expenditures of firm *j* and *k* in the first stages, believe a higher proportion of people will purchase *j*'s product. All else equal, consumers will have a preference to buy firm *j*'s product as they expect to derive higher consumption externalities from this product as $q_j > q_k$ and therefore $(\alpha_i V + \beta q_j - P_j) > (\alpha_i V + \beta q_k - P_k)$ for $P_j = P_k$.

Firm demands are derived by looking for the indifferent consumers showing similarities to Hotelling's (1929) model. Notice from figure 1.1 below that consumers

who purchase product *k* are the individuals who purchase both products. I define $\alpha'$ such that if $\alpha_i$ is low ($\alpha_i < \alpha'$); consumers buy neither of the products. Define $\alpha''$ such that if $\alpha_i$ is high ($\alpha_i > \alpha''$); consumers buy both products. The critical values of $\alpha'$and $\alpha''$are derived below. If $\alpha_i$ takes a value, $\alpha' < \alpha_i < \alpha''$, these consumers buy one product and they choose the product which has captured the coordinated demand.

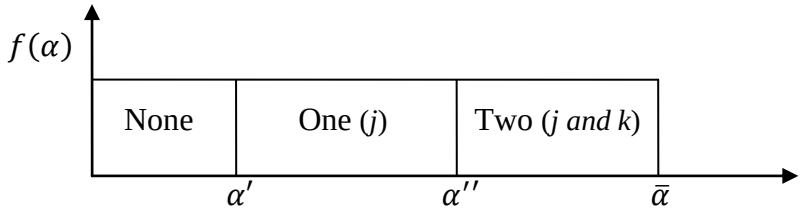


**Fig 1.1:** Firm *j* coordinates the demand for j, k ∈ {Incumbent, Challenger}

Following Pastine and Pastine (2011) consumers whose marginal benefit from the first purchase is higher than price buy *j* if,

$$\alpha' V + \beta q_j \geq P_j \tag{2}$$

which implies,

$$\alpha' \geq \frac{P_j - \beta q_j}{V}. \tag{3}$$

Individuals with taste $\alpha_i \geq \alpha'$ buy product *j*. Using equation (3) I can solve for the proportion of people who buy *j* as:

$$q_j = \left(1 - \frac{P_j - \beta q_j}{\bar{\alpha} V}\right). \tag{4}$$

Solving equation (4) for $q_j$ yields the demand for $q_j$ when consumers expect firm *j* to coordinate demand as:

$$q_j = \frac{\bar{\alpha} V - P_j}{\bar{\alpha} V - \beta} \tag{5}$$

Firm *j*'s profit when it coordinates demand is $\overline{\pi}$; given by $(q_j)$ from (5), times the price $(P_j)$:

$$\overline{\pi} = \frac{P_j(\bar{\alpha}V - P_j)}{\bar{\alpha}V - \beta} \tag{6}$$

Note that the demand for $q_j$ from equation (5) is a function of the price of product *j* but not a function of the price of product *k*. The quantity as stated in equation (5) is equal to the quantity that the monopoly firm would have enjoyed as the point $\alpha'$ remains unchanged.

A consumer purchases the second item *k*, along with the first item *j*, if the additional benefit from *k* is higher than the price,

$$(\alpha''\omega V + \beta q_k) \geq P_k \tag{7}$$

which implies,

$$\alpha'' \geq \frac{P_k - \beta q_k}{\omega V}. \tag{8}$$

Individuals with taste $\alpha_i \geq \alpha''$ buy product *k*. Using equation (8) I can solve for the proportion of people who buy *k* as:

$$q_k = \left(1 - \frac{P_k - \beta q_k}{\bar{\alpha}\omega V}\right) \tag{9}$$

Solving equation (9) for $q_k$ yields the demand for $q_k$ when consumers expect firm *j* to coordinate demand as:

$$q_k = \frac{\bar{\alpha}\omega V - P_k}{\bar{\alpha}\omega V - \beta} \tag{10}$$

Firm $k$'s profit with no coordinated demand is $\underline{\pi}$; given by $q_k$ from (10), times the price $(P_k)$:

$$\underline{\pi} = \frac{P_k(\bar{\alpha}\omega V - P_k)}{\bar{\alpha}\omega V - \beta} \tag{11}$$

The firm which manages to coordinate the demand will be assumed to have a greater demand $q_j > q_k$. If $j$ = Incumbent and $k$ = Challenger, the incumbent firm has managed to coordinate the consumer demand on its product. Alternatively, if $j$ = Challenger and $k$ = Incumbent, the challenger has managed to coordinate the consumer demand on its product.

On entering the pricing subgame, it is possible that the firms may have different levels of advertising. There exists an equilibrium where consumers coordinate on product *j* and an alternate equilibrium where consumers coordinate on product *k.* Firms have a preference over these equilibria and may try to distinguish themselves using advertising. Consumers believe that the firm with the higher level of advertising expenditure will have increased sales and be successful in coordinating the demand on its product.

There are three possible positions on entering the pricing subgame: (1) consumers believe the incumbent will coordinate demand, (2) consumers believe the challenger will coordinate demand, and (3) consumers believe that the incumbent and challenger will share the market equally. Consumers will expect to gain higher utility from the good with higher expected sales which is the product from the firm who has managed to coordinate the demand. In case (3), if the consumers believe that both firms have the same level of advertising, all else equal, they believe that $q_j = q_k$ as neither firm will manage to coordinate the demand and consumers who purchase one product will

split equally between the two products. Therefore, no firm manages to coordinate using advertising expenditure, consumers between the critical values of $\alpha'$ and $\alpha''$ are assumed to divide equally between product $j$ and k, consumer $\alpha_i > \alpha''$ buy both products and $q_j = q_k$.

Assuming that consumers expect firm $j$ to coordinate, notice that the coordinated demand $q_j$ in equation (5) only depends on the price of product $j$. Using equation (6) the coordinated profit of firm $j$ can be differentiated with respect to $P_j$ and set equal to zero yielding the optimal monopoly price for firm $j$ as:

$$\bar{P}_j = \frac{\overline{\alpha}V}{2} \tag{12}$$

Solving equation (5) for $q_j$ when firm $j$ is charging the monopoly price $\left(\overline{P_j}\right)$ yields the optimal monopoly quantity as:

$$\bar{q}_j = \frac{\overline{\alpha}V}{2(\overline{\alpha}V-\beta)} \tag{13}$$

Assuming that consumers expect firm $j$ to coordinate, notice that the uncoordinated demand $q_k$ in equation (9) also only depends on the price of product $k$. Using equation (11) the uncoordinated profit of firm $k$ can be differentiated with respect to $P_k$ and set equal to zero yielding the optimal monopoly price for firm $k$ as:

$$\bar{P}_k = \frac{\overline{\alpha}\omega V}{2} \tag{14}$$

Solving equation (10) for $q_k$ when firm $k$ is charging the monopoly price $\left(\overline{P_k}\right)$ yields the optimal monopoly quantity as:

$$\bar{q}_k = \frac{\overline{\alpha}\omega V}{2(\overline{\alpha}\omega V-\beta)} \tag{15}$$

Equations (12) and (14) show that the monopoly price of *j* is greater than the price of *k*, since $\omega \in (0,1)$. Notice that the monopoly prices are not a function of $\beta$, as a high value of the consumption externality parameter ($\beta$) would mean that the quantity demanded is high. This would make the firm want to increase the price of its product. However, if $\beta$ has a high value and the firm increases its price, the quantity demanded will decrease significantly. These two forces cancel each other out.

In figure 1.2, the demand curves are used to illustrate monopoly prices and quantities. With further examination of monopoly quantity equations (13) and (15) and figure 1.2, the monopoly pair of prices can be seen to be inconsistent with rational expectations that $q_j > q_k$, since $\omega \in (0,1)$. If $\omega < 1$ and the monopoly prices are charged, firm *k* will have higher sales for its product due to the price of its product being significantly lower than firm *j*'s product.

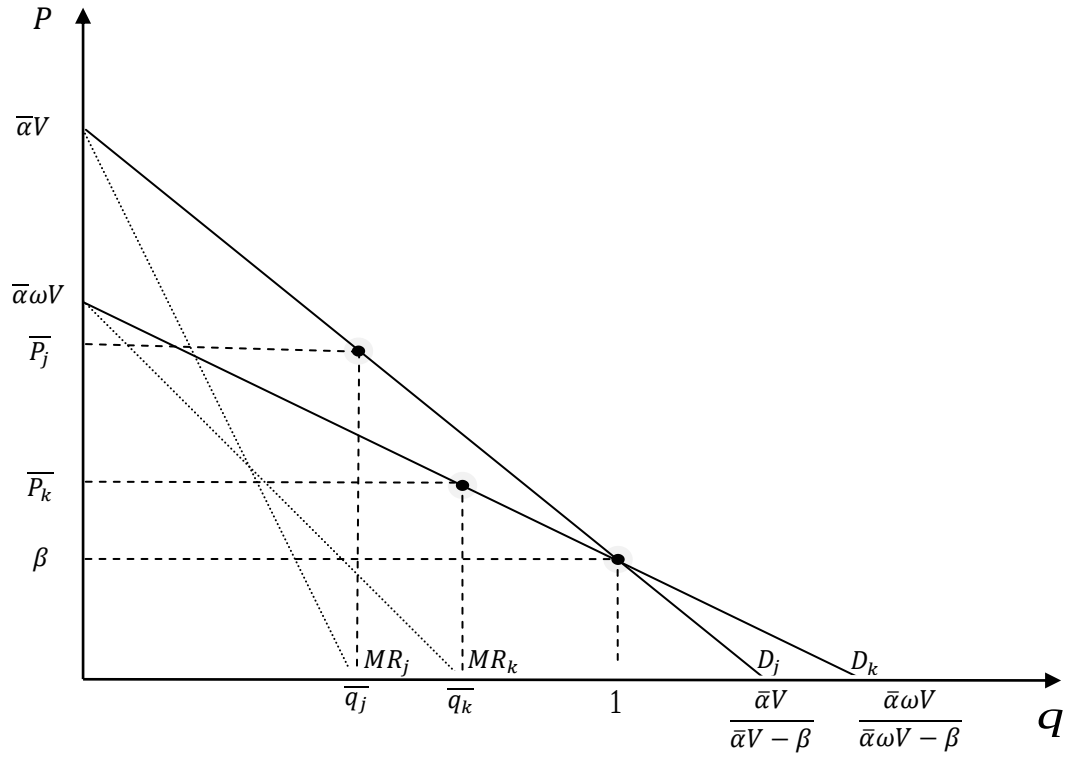


**Fig 1.2**: Demand for Firm *j* and *k* with monopoly prices and quantities

Notice that if firm $k$ would be willing to charge $\underline{P_k}$ in order to break the initial expectations, it would no longer be optimal for firm $j$ to charge $\bar{P}_k$. Firm $j$ would prefer to charge a lower price, $P_j < \bar{P}_j$, offering a higher consumer surplus, coordinating consumers on its product, while still charging higher than $\underline{P_k}$ . If firm $j$ decides that in the pricing stage it must fight for its popular position, the highest price it could charge as a function of $P_k$ is solved, using $q_j > q_k$, as:

$$\widetilde{P}_j < \frac{\overline{\alpha}V(\omega-1)\beta}{\overline{\alpha}\omega V-\beta} + \frac{(\overline{\alpha}V-\beta)P_k}{\overline{\alpha}\omega V-\beta} \tag{17}$$

Let $\tilde{P}_j^*$ denote the maximum price that firm $j$ can charge where firm $k$ is indifferent between breaking the initial expectation with $\underline{P_k^*}$ and choosing to accept the unpopular demand and charging the monopoly price, $\bar{P}_k$. Therefore, $\bar{\pi}_k\left(\underline{P_k^*}\left(\tilde{P}_j^*\right)\right) = \underline{\pi}_k(\bar{P}_k)$.

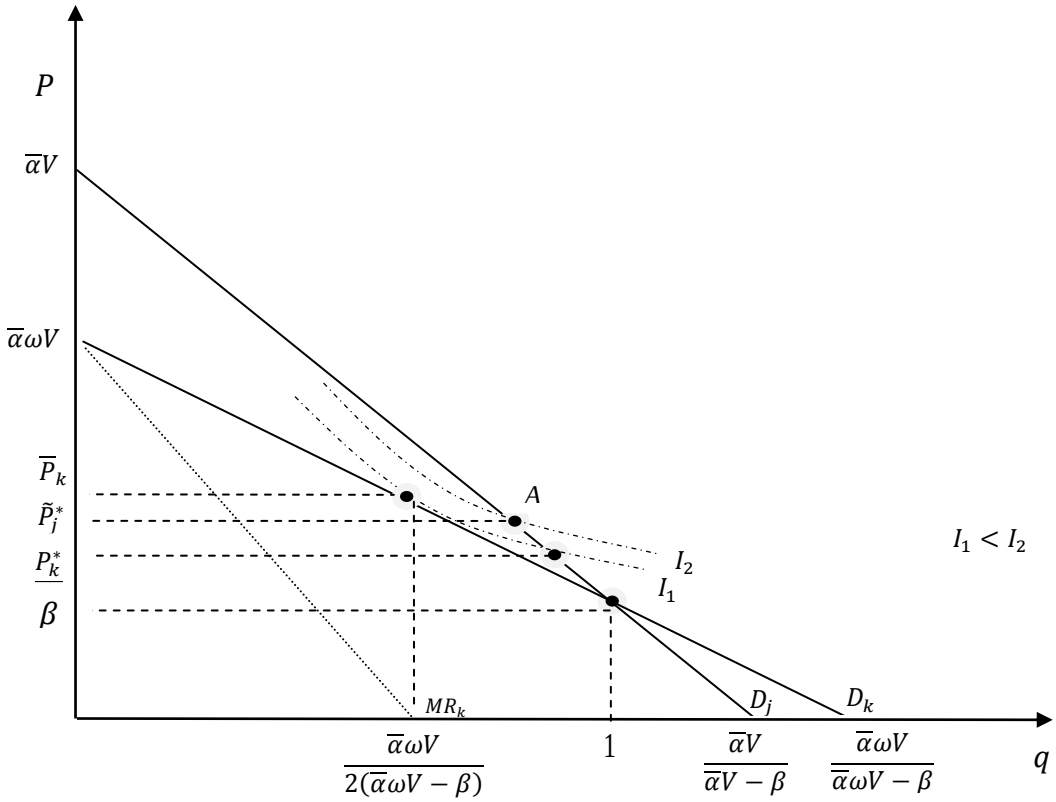


**Fig 1.3**: Demand for firm $j$ and $k$ showing $\overline{P}_k$and $\underline{P}_k$ on same isoprofit curve, $I_1$.

In figure 1.3, an example of the intersection of $\tilde{P}_j^*$ with the demand curve for product *j* can be seen at point *A*. $\tilde{P}_j^*$ may be greater or less than $\overline{P}_k$ depending on market conditions, but it will always be greater than $\underline{P_k^*}$. Notice also from figure 1.3 that $\overline{P}_k$ and $\underline{P_k^*}$ are positioned on the same isoprofit curve, $I_1$. Firm *k* will be indifferent between breaking the expectations and accepting the unpopular demand. $\tilde{P}_j^*$ is a higher price than $\underline{P_k^*}$ and offers a greater profit to the firm who consumers expect to coordinate demand before the pricing stage. Once firm *j* charges a price slightly below $\tilde{P}_j^*$ such as $\tilde{P}_j^* - \varepsilon$ , the optimal choice of firm *k* will be to accept the unpopular demand and charge $\overline{P}_k$.

In the final pricing stage, firms will compete in prices but it will not be necessary to undercut each other until the price equals marginal costs. Due to the consumption externality, both firms can earn positive profits. In equilibrium the firm who consumers expect to coordinate the demand after the advertising stage coordinates the demand by charging $\tilde{P}_j^* - \varepsilon$ and receives the highest profit denoted by $\bar{\pi}$, while the firm who consumers expected to fail to coordinate the demand after the advertising stage captures the uncoordinated demand, charges the monopoly price for this demand $\overline{P}_k$ and receives the lower uncoordinated profit, denoted by $\underline{\pi}$. The Nash equilibrium in prices $\left(\tilde{P}_j^*, \bar{P}_k^*\right) = \left(\frac{\overline{\alpha}V(\omega-1)\beta}{\overline{\alpha}\omega V-\beta} + \frac{(\overline{\alpha}V-\beta)P_k}{\overline{\alpha}\omega V-\beta}, \frac{\overline{\alpha}\omega V}{2}\right)$ are best responses to each other as it is optimal for the firm who consumers expect to coordinate the demand to defend its position through price competition in this stage.

### 1.3.2 Advertising Decisions

The advertising technology in this model has a probabilistic outcome based on a lottery type all pay-auction as devised by Tullock (1980) with a scale parameter of 1. The firm's probability of capturing the coordinated demand with the higher profit $Prob_i$ is proportional to the firm's share of the total expenditures on advertising.[5]

$$Prob_j(A_j, A_k) = \frac{A_j}{A_j + A_k} \tag{18}$$

Firm $j$ wins the higher coordinated profit $\bar{\pi}$ with probability $Prob_j(A_j, A_k)$ and gets the lower uncoordinated profit of $\underline{\pi}$ with the probability $1 - Prob_j(A_j, A_k)$. Therefore, the expected profit of firm $j$ is denoted by $\pi_j$, for j, k ∈ {Incumbent, Challenger}.

$$E(\pi_j) = \frac{A_j}{A_j + A_k}(\bar{\pi} - A_j) + \left(1 - \frac{A_j}{A_j + A_k}\right)(\underline{\pi} - A_j) \tag{19}$$

Let $j$ = Incumbent and $k$ = Challenger, then the expected profit to the incumbent firm is $E(\pi_j)$ as in equation (19). Let $j$ = Challenger and $k$ = Incumbent, then the expected profit to the challenging firm is $E(\pi_j)$ as in equation (19) but the challenger must also consider the fixed cost of set-up $(\Omega)$ on entering the market which enters negatively.

#### 1.3.2.1 Simultaneous Move Benchmark Case

First examine the reaction functions of both firms to set-up a non-strategic benchmark case. Lemma 1 summarizes the main properties of the reaction functions:

[5] Henceforth, j, k ∈ {Incumbent, Challenger}. For ease often only the incumbent's result will be shown. The challenger's result is given by changing the subscripts and taking into account the fixed set up cost.

**Lemma 1:** *The reaction function $R_j(A_k)$ is strictly concave for $0 \leq A_k \leq \overline{\pi} - \underline{\pi}$. The challenger has the following reaction function $R_j(A_k)$* for j, k ∈ {Incumbent, Challenger} and $j \neq k$:

$$R_j(A_k) = \begin{cases} \left[A_k\left(\overline{\pi} - \underline{\pi}\right)\right]^{\frac{1}{2}} - A_k & if \quad 0 \leq A_k \leq \overline{\pi} - \underline{\pi} \\ 0 & if \quad A_k \geq \overline{\pi} - \underline{\pi} \end{cases}$$

**Proof.**

The $E(\pi_j)$ is given by the following equation:

$$E(\pi_j) = \frac{A_j}{A_j + A_k}\left(\overline{\pi} - A_j\right) + \left(1 - \frac{A_j}{A_j + A_k}\right)\left(\underline{\pi} - A_j\right) - \Omega \tag{20}$$

The first derivative of $E(\pi_j)$ with respect to $A_j$ yields

$$\frac{\partial \pi_j(A_j, A_k)}{A_j} = A_k\left(\overline{\pi} - \underline{\pi}\right) - \left(A_j + A_k\right)^2 \tag{21}$$

Therefore, the reaction function of the challenger, $R_j(A_k)$ is:

$$R_j(A_k) = \left[A_k\left(\overline{\pi} - \underline{\pi}\right)\right]^{\frac{1}{2}} - A_k \tag{22}$$

The first derivative of $R_j(A_k)$ with respect to $A_k$ for $0 \leq A_k \leq \overline{\pi} - \underline{\pi}$ yields

$$\frac{\partial R_j(A_k)}{\partial A_k} = \frac{1}{2}\left(A_k^{-\frac{1}{2}}\left(\overline{\pi} - \underline{\pi}\right)^{\frac{1}{2}}\right) - 1 \tag{23}$$

Therefore,

$$\frac{\partial R_j(A_k)}{\partial A_k} = \begin{cases} > 0 & if \quad 0 \leq A_k \leq \frac{\overline{\pi}-\underline{\pi}}{4} \\ = 0 & if \quad A_k = \frac{\overline{\pi}-\underline{\pi}}{4} \\ < 0 & if \quad \overline{\pi} - \underline{\pi} \geq A_k \geq \frac{\overline{\pi}-\underline{\pi}}{4} \end{cases} \tag{24}$$

The second derivative of the reaction function for $0 \leq A_k \leq \overline{\pi} - \underline{\pi}$ yields,

$$\frac{\partial^2 R_j(A_k)}{\partial A_k^2} = -2\left(\overline{\pi} - \underline{\pi}\right)^{\frac{1}{2}} A_k^{-\frac{3}{2}} < 0. \tag{25}$$

Thus, the reaction function $R_j(A_k)$ is strictly concave for $0 \leq A_k \leq \overline{\pi} - \underline{\pi}$ and crosses the 45° line as well as achieving its maximum at the point $\left(A_j, A_k\right) = \left(\frac{\overline{\pi}-\underline{\pi}}{4}, \frac{\overline{\pi}-\underline{\pi}}{4}\right)$. See point *A* on Figure 1.4.

□

The reaction functions of both firms and the isoprofit curves of the incumbent are graphed below in Figure 1.4:

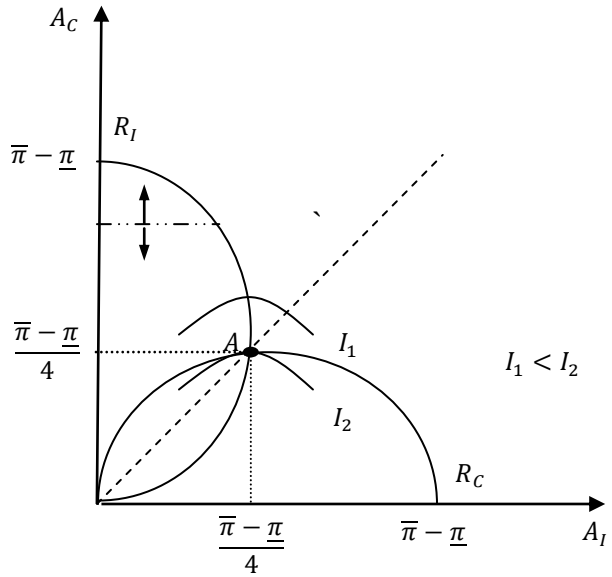


**Fig 1.4**: Advertising Reaction Functions

This benchmark non-strategic case shows that in equilibrium both firms would have the following equal advertising rates:

$$(A_I^*, A_C^*) = \left(\frac{\overline{\pi}-\underline{\pi}}{4}, \frac{\overline{\pi}-\underline{\pi}}{4}\right) \quad (26)$$

#### 1.3.2.2 Sequential Move Advertising Case

Using the reaction function of the challenger from equation (22), I now derive the equilibrium entry strategy of challenger. First, consider the case where the fixed cost is large enough to make it impossible for the challenger to enter and make a profit. If the fixed cost of set-up is greater than the expected profit for the challenger, $\Omega > E(\pi_C)$, the challenger will never enter the market. In this case, only the monopolist will be observed in the market, choosing not to advertise. Alternatively, if the fixed cost of set-up is less than the expected profit for the challenger, $\Omega < E(\pi_C)$, the challenger will always enter the market.

The incumbent is the first mover in this game and can choose to either advertise a positive amount or not advertise at all. The challenger can either choose not to enter allowing the incumbent to earn the profit from capturing the coordinated demand ($\overline{\pi}$), or the challenger can choose to enter and advertise. If the incumbent had chosen not to advertise, an advertisement level of a small positive amount would allow the challenger to capture the coordinated demand, leaving the incumbent the profit from capturing the uncoordinated demand $(\underline{\pi})$. If the incumbent had chosen to advertise, the challenger would also choose to advertise in accordance with his reaction function from Lemma 1. By comparing the payoffs to the challenger, zero in the case of no entry and $E(\pi_C) - \Omega$ in the case of entry, we can see that, if the expected profit to the

challenger is less than the fixed cost of entering, the challenger will always choose to stay out of the market.

If the expected profit to the challenger is greater than the fixed cost of entering, $(\pi_C) > \Omega$, the challenger will enter and the two firms will be observed in the market. Note that the expected profits when both firms are advertising in the market is $E(\pi_C) = \frac{1}{4}\overline{\pi} + \frac{3}{4}\underline{\pi}$ and this term is always greater than $\underline{\pi}$, since $\overline{\pi} > \underline{\pi}$ . Therefore, we will never observe a new entrant in the market with zero advertising.

Given the reaction function and the equilibrium entry strategy of the challenger, we can now solve the equilibrium strategy of the incumbent and the outcome of the game. If the challenger chooses to enter the market it determines its advertising level $(A_C)$.

**Proposition 1:** *The equilibrium advertising strategy* $(A_i^*)$ *for firm i is described for all cases below:*

$$A_I^* = \begin{cases} 0 & if \quad \Omega > \overline{\pi} & Blockaded\ Entry \\ \left[\left(\overline{\pi} - \underline{\pi}\right)^{\frac{1}{2}} - \left(\Omega - \underline{\pi}\right)^{\frac{1}{2}}\right]^2 & if \quad \overline{\pi} > \Omega > \frac{1}{4}\overline{\pi} + \frac{3}{4}\underline{\pi} & Entry\ Deterrence \\ \frac{\overline{\pi} - \underline{\pi}}{4} & if \quad \Omega < \frac{1}{4}\overline{\pi} + \frac{3}{4}\underline{\pi} & Entry\ Accomodation \end{cases}$$

$$A_C^* = \begin{cases} 0 & if \quad \Omega > \frac{1}{4}\overline{\pi} + \frac{3}{4}\underline{\pi} & No\ Entry \\ \frac{\overline{\pi} - \underline{\pi}}{4} & if \quad \Omega < \frac{1}{4}\overline{\pi} + \frac{3}{4}\underline{\pi} & Entry \end{cases}$$

**Proof.**

To find the level of advertising necessary to deter the challenger from entering, the case when $E(\pi_i) - \Omega = 0$ needs to be evaluated further:

$$E(\pi_i) - \Omega = \frac{A_C}{A_I + A_C}(\overline{\pi} - A_C) + \left(1 - \frac{A_C}{A_I + A_C}\right)(\underline{\pi} - A_C) - \Omega = 0 \qquad (27)$$

Using the challenger's reaction function $A_C = \left[A_I(\overline{\pi} - \underline{\pi})\right]^{\frac{1}{2}} - A_I$, the problem simplifies to:

$$(\overline{\pi} - \underline{\pi}) - 2\left[(A_I)(\overline{\pi} - \underline{\pi})\right]^{\frac{1}{2}} + A_I = \Omega - \underline{\pi} \qquad (28)$$

The deterrence level of advertising is therefore:

$$A_I^{DETER} \geq \left[(\overline{\pi} - \underline{\pi})^{\frac{1}{2}} - (\Omega - \underline{\pi})^{\frac{1}{2}}\right]^2 \qquad (29)$$

Using this level of advertising the incumbent can deter the challenger from entering because with this level of advertising the challenger's expected profit from entering the market and competing in advertising are equal to zero. From Lemma 1 the reaction function of the challenger is:

$$R_C(A_I) = \left[A_I(\overline{\pi} - \underline{\pi})\right]^{\frac{1}{2}} - A_I \qquad (30)$$

Knowing the reaction function of the challenger, the incumbent's problem can now be solved. Fitting $R_C(A_I)$ back into the incumbent's profit function yields

$$E(\pi_I) = \left[A_I(\overline{\pi} - \underline{\pi})^{\frac{1}{2}} + \underline{\pi} - A_I\right] \qquad (31)$$

The first derivative of $E(\pi_I)$ with respect to $A_I$ yields

$$\frac{\partial \pi_I(A_I)}{\partial A_I} = \frac{1}{2}\left(\overline{\pi} - \underline{\pi}\right)^{\frac{1}{2}} A_I^{-\frac{1}{2}} - 1 \tag{32}$$

The optimal level of advertising for the incumbent, $A_I^*$, in this case is:

$$A_I^* = \frac{\overline{\pi}-\underline{\pi}}{4} \tag{33}$$

Given the incumbent's advertising level of $A_I^*$, the challenger's optimal response is:

$$A_C^* = \frac{\overline{\pi}-\underline{\pi}}{4} \tag{34}$$

Therefore, $(A_I^*, A_C^*) = \left(\frac{\overline{\pi}-\underline{\pi}}{4}, \frac{\overline{\pi}-\underline{\pi}}{4}\right)$. See point *A* on Figure 4.

□

**Result 1:** *The incumbent will choose an advertising level to deter entry if the fixed cost of entry is greater than the challenger's expected operating profit and less than the profit from the coordinated demand* $\overline{\pi} > \Omega > \frac{1}{4}\overline{\pi} + \frac{3}{4}\underline{\pi}$. *In this case, the incumbent firm will advertise a positive amount* $A_I^{DETER} = \left[\left(\overline{\pi} - \underline{\pi}\right)^{\frac{1}{2}} - \left(\Omega - \underline{\pi}\right)^{\frac{1}{2}}\right]^2$, *charge the monopoly price* $\overline{P}_I = \frac{\overline{\alpha}V}{2}$, *coordinate the demand and the challenger will not enter the market. Moreover, if the fixed cost of entry is greater than the expected operating profit, entry is blocked, the incumbent firm will not advertise and the challenger will not enter the market.*

Result 1 shows that if $\overline{\pi} > \Omega > \frac{1}{4}\overline{\pi} + \frac{3}{4}\underline{\pi}$ (a) the incumbent advertises more than when new entry is blocked (b) there is first mover advantage and (c) the incumbent earns less than when it is an unthreatened monopolist. The entry deterring incumbent receives the same amount of revenue as the unthreatened monopolist, as the same price and quantity demanded hold, but the increased advertising expenditure $A_I^{DETER} > 0$ reduces its overall profit. When the fixed cost of set-up is greater than the expected profit for the challenger, the strategic advertising expenditure by the

incumbent firm makes it unprofitable for the challenger to enter. The challenger will choose to stay out of the market and there will be no price competition.

**Result 2:** *The incumbent will choose an advertising level to accommodate entry if the fixed cost of entry is less than the challenger's expected operating profit when both firms are in the market,* $\Omega < \frac{1}{4}\overline{\pi} + \frac{3}{4}\underline{\pi}$. *In this case, both firms will advertise a positive amount* $A_i^* = \left(\frac{\overline{\pi}-\underline{\pi}}{4}\right)$ *for* $i = \{I, C\}$ *and because this case is symmetric they will both have a fifty per cent chance of coordinating the demand. Therefore, in this case the* $E(\pi_i^*) = \frac{1}{4}\overline{\pi} - \frac{3}{4}\underline{\pi}$ *and* $E(p_i^*) = \frac{A_C}{A_I+A_C}\left(\tilde{P}_j^*\right) + \left(1 - \frac{A_C}{A_I+A_C}\right)\left(\underline{P}_k\right) - \Omega = 0$ *for* $i = \{I, C\}$.

Result 2 shows that if $\Omega < \frac{1}{4}\overline{\pi} + \frac{3}{4}\underline{\pi}$ (a) the incumbent advertises more than when $\Omega > \overline{\pi}$ and new entry is blocked but it has the same advertising expenditure as the entrant, (b) there is **no** first mover advantage and (c) the incumbent earns less than when it is a monopolist. This proposition characterises the advertising equilibrium where the leader-follower framework results prove to be the same as the simultaneous benchmark case. This can be seen by comparing equation (26) with equations (33) and (34). When the fixed cost of set-up is less than the expected profit for the challenger, entry deterrence is not possible, the incumbent does not possess a first mover advantage and optimal entry accommodation involves a strategic investment in advertising congruent with the non-strategic simultaneous advertising benchmark followed by aggressive price competition. This result differs from related work by Dixit (1980) and Fudenberg and Tirole (1984). The challenger will enter and both firms will compete in advertising and price with an equal probability of coordinating demand.

**Result 3:** *The incumbent's advertising is higher under deterrence,* $A_I^{DETER} = \left[\left(\overline{\pi} - \underline{\pi}\right)^{\frac{1}{2}} - \left(\Omega - \underline{\pi}\right)^{\frac{1}{2}}\right]^2$, *than accommodation,* $A_I^{ACC} = \frac{\overline{\pi}-\underline{\pi}}{4}$ .

**Proof.**

To evaluate the advertising expenditure of the incumbent across deterrence and accommodating strategies, let $A_I^{DETER} > A_I^{ACC}$:

$$\left[\left(\overline{\pi} - \underline{\pi}\right)^{\frac{1}{2}} - \left(\Omega - \underline{\pi}\right)^{\frac{1}{2}}\right]^2 > \frac{\overline{\pi}-\underline{\pi}}{4}, \tag{35}$$

which simplifies to,

$$\left[\frac{(3\overline{\pi}-7\underline{\pi}+4\Omega)^2}{64\left(\overline{\pi}-2\underline{\pi}+\Omega\right)}\right] > 0. \tag{36}$$

When $\Omega > \frac{1}{4}\overline{\pi} + \frac{3}{4}\underline{\pi}$, the above inequality is strictly positive as $\overline{\pi} > \underline{\pi}$.

□

Therefore, result 3 shows that the incumbent advertises more when advertising as a monopolist to deter entry than when accommodating and competing in a duopoly.

## 1.4 DISCUSSION

If the fixed cost of set-up outweighs the post-entry coordinated profit, entry is blockaded in the terminology of Bain (1956) and the challenger will not enter the market. This occurs when the fixed cost of entry is so high that the incumbent can act as an unthreatened monopolist. Thus, when $\Omega > \overline{\pi}$, only the incumbent is observed in the market with zero expenditure on advertising. When $\overline{\pi} > \Omega > \frac{1}{4}\overline{\pi} + \frac{3}{4}\underline{\pi}$, the challengers entry is deterred.

In Bain's classification, entry deterrence refers to cases where strategic behaviour by the monopolist deters entry. The incumbent actively raises a barrier to entry to prevent the potential competitor from entering the market. Notice that if the challenger enters the market and given that entry decision optimally sets its advertising level, $E(\overline{\pi}) - \Omega$

is non-positive. Thus, the incumbent sets $A_I^{DETER}$and the challenger will not enter the market. If $\Omega < \frac{1}{4}\overline{\pi} + \frac{3}{4}\underline{\pi}$, entry is easy in Bain's (1956) terminology. In this case, the incumbent would have to advertise on such a large scale in order to deter entry that it would not be profitable, in which case it is more profitable to accommodate entry. Thus, the challenger enters the market, both firms choose $A_i^* = \left(\frac{\overline{\pi}-\underline{\pi}}{4}\right)$ with the same expected price. There is no first mover advantage for the incumbent and optimal entry accommodation involves a strategic investment in advertising congruent with the non-strategic simultaneous advertising benchmark followed by aggressive price competition. It should also be noted that the difference between $\overline{\pi}$ and $\underline{\pi}$ is heavily based on the relative prices of the products and their sensitivity to the strength of the consumption externality.

The above examination suggests that Doraszelski and Markovich (2007) are correct in suggesting that entry deterrence is best studied by comparing the incumbent's advertising strategy in two scenarios: (a) when the set up cost is moderate so that entry is possible but not certain, and (b) when the set up cost is large enough to render entry impossible. I have shown that entry deterrence can occur if entry is possible but not certain, that is, entry takes place in some states but not in others.

## 1.5 CONCLUSIONS

This paper extends the literature by examining entry deterrence via coordinating advertising in a market with consumption externalities. Optimal advertising strategies and pricing are analysed in an entry deterrence framework where the monopolist incumbent has the first move and faces a challenger with a product of equal quality. A probabilistic outcome has been introduced using a stochastic success function based on a lottery type all pay-auction as devised by Tullock (1980). I show that in a market with consumption externalities, even when availability, quality and production costs are common knowledge and the consumer preferences are constant in the face of advertising, firms may still advertise in order to coordinate consumer expectations on their own brand and to deter entry.

Faced with a potential entrant, I show that the monopolist is induced to advertise for a range of values of the non-recoverable set-up cost ($\Omega$), either to accommodate or deter entry. Entry deterrence involves strategic pre-commitment to over-investment relative to the non-strategic simultaneous advertising benchmark. Therefore, the strategic entry deterrence is accomplished through over-investing in advertising. Furthermore, I show that when entry deterrence is not possible the incumbent does not possess a first mover advantage and optimal entry accommodation involves a strategic investment in advertising congruent with the non-strategic simultaneous advertising benchmark, followed by aggressive price competition. The findings suggest that an incumbent's ability to deter entry through coordinating advertising is sensitive to the size of the fixed cost of set-up and the consumption externality parameter.

## 1.6 REFERENCES


Bagwell, K. And G. Ramey (1988). "Advertising and Limit Pricing", *RAND Journal of Economics*, Vol 9, No. 1, pp. 59-71.

Bagwell, K. And G. Ramey (1994). "Coordination Economies, Advertising, and Search Behavior in Retail Markets", *American Economic Review*, Vol. 84, No. 3, pp. 289-294.

Bagwell, K. (2003). "The Economic Analysis of Advertising", *mimeo.*

Bagwell, K. (2007). "Signalling and Entry Deterrence: A Multidimensional Analysis", *RAND Journal of Economics*, Vol. 38, No. 3, pp. 670-697.

Bain, J. S. (1956). *Barriers to New Competition: Their Character and Consequences in Manufacturing Industries, American Economic Review*, Harvard UP, Cambridge.

Becker, G. And K. Murphy (1993). "A Simple Theory of Advertising as a Good or Bad", *Quarterly Journal of Economics*, Vol. 108, No. 4, pp. 941-964.

Braithwaite, D. (1928). "The Economic Effects of Advertisement", *Economic Journal*, Vol. 38, No. 149, pp. 16-37.

Butters, G. (1977). "Equilibrium Distribution of Prices and Advertising", *Review of Economic Studies*, Vol. 44, No. 3, pp. 465-492.

Chwe, M. (2001). Rational Ritual: Culture, Coordination, and Common Knowledge, Princeton, N.J.: Princeton University Press.

Clark, C. R. And I. J. Horstmann (2005). "Advertising and Coordination in Markets with Consumption Scale Effects", *Journal of Economics and Management Strategy*, Vol. 14, No. 2, Pp. 377-402.

Comanor, W. S. And T. A. Wilson (1967). "Advertising, Market Structure and Performance", *The Review of Economics and Statistics*, Vol. 49, No. 4, pp. 423-440.

Comanor, W. S. And T. A. Wilson (1974). *Advertising and Market Power*, Cambridge, Harvard University Press.

Dixit, A. (1980). "The Role of Investment in Entry-Deterrence", *The Economic Journal*, Vol. 90, No. 357, pp. 95-106.

Dixit, A. And V. Norman (1978). "Advertising and Coordination in Markets with Consumption Scale Effects", *Journal of Economics and Management Strategy*, Vol. 14, No. 2, pp. 377-402.

Doraszelski, U. And S. Markovich (2007). "Advertising Dynamics and Competitive Advantage", *The RAND Journal of Economics*, Vol. 38, No. 3, pp. 557-592.

Fudenberg, D. And J. Tirole (1984). "The Fat-Cat Effect, the Puppy-Dog Ploy, and the Lean and Hungry Look", *American Economic Review, Papers and Proceedings*, Vol. 74, No. 2, pp. 361-366.

Geroski, P.A. (1995). "What do we know about Entry?", *International Journal of Industrial Organization*, Vol. 13, No. ?, pp. 421-440.

Gilbraith, J. K. (1958). *The Affluent Society*, Boston, Houghton Mifflin.

Gilbraith, J. K. (1967). *The New Industrial State*, Boston, Houghton Mifflin.

Grossman, G. And C. Shapiro (1984). "Informative Advertising with Differentiated products", *Review of Economic Studies*, Vol. 51, No. 1, pp. 63-82.

Hotelling, H. (1929). "Stability in Competition", *Economic Journal*, Vol. 39, pp. 41-57.

Ishigaki, H. (2000). "Informative Advertising and Entry Deterrence: A Bertrand Model," *Economic Letters*, Vol 67, No. 3, pp. 337-343.

Kaldor, N. (1950). "The Economic Aspects of Advertising", *Review of Economic Studies*, Vol. 18, No. 1, pp. 1-27.

Kihlstrom, R. And M. Riordan (1984). "Advertising as a Signal", *Journal of Political Economy*, Vol. 92, No. 3, pp. 427-450.

Krahmer, D. (2006). "Advertising and Conspicuous Consumption", *Journal of Institutional and Theoretical Economics*, Vol. 162, No. 4, pp. 661-682.

Linnemer, L. (1998), "Entry Deterrence, Product Quality: Price and Advertising as Signals," *Journal of Economics and Management Strategy*, Vol. 7, No. 4, pp. 615-645.

Meurer, M. And D. Stahl (1994). "Informative Advertising and Product Match", *International Journal of Industrial Organization*, Vol. 12, No. 1, pp. 1-19.

Milgrom, P. And J. Roberts (1982). "Limit Pricing and Entry Under Incomplete Information: An Equilibrium Analysis", *Econometrica,* Vol. 50, No. 2, pp. 443-460.

Nelson, P. (1970). "Information and Consumer Behavior", *Journal of Political Economy,* Vol. 78, No.2, pp. 311-329.

Nelson, P. (1974). "Advertising as Information", *Journal of Political Economy,* Vol. 82, No. 4, pp. 729-754.

Ozga, S. A. (1960). "Imperfect Markets Through Lack of Knowledge", *Quarterly Journal of Economics,*Vol. 74, No. 1, pp. 29-52.

Pastine, I. And T. Pastine (2002). "Consumption Externalities, Coordination and Advertising", *International Economic Review,* Vol. 42, No. 3, pp. 919-943.

Pastine, I. And T. Pastine (2011). "Coordination in Markets with Consumption Externalities: Advertising and Product Quality", *The Manchester School,* Vol. 79, No. 1, pp. 24-62.

Paton, D. (2008). "Advertising as an Entry Deterrent: Evidence from UK firms", *International Journal of the Economics of Business,* Vol. 15, No. 1, pp. 63-83.

Reinsten, D. A. And C. M. Snyder (2005). "The influence of Expert Review on Consumer Demand for experience Goods: A Case of Movie Critics", *Journal of Industrial Economics,* Vol. 53, No. 1, pp. 27-51.

Robert, J. And D. Stahl (1993). "Informative Price Advertising in a Sequential Search Model", *Econometrica,* Vol. 61, No. 3, pp. 657-686.

Sahuguet, N. (2011). "A Model of Repeat Advertising", *Economic Letters,* Vol. 111, No. 1, pp. 20-22.

Schmalensee, R. (1978). "A Model of Advertising and Product Quality", *Journal of Political Economy,*Vol. 86, No. 3, pp. 485-503.

Schmalensee, R. (1983), "Advertising and Entry Deterrence: An Exploratory Model," *Journal of Political Economy,* Vol. 91, No. 4, pp. 636-653.

Solow, R. (1967). "The New Industrial State or Son of Affluence", *Public Interest,* Vol. 9, pp. 100-108.

Spence, M. (1977). "Entry, Capacity, Investment and Oligopolistic Pricing,"

*The Bell Journal of Economics,* Vol. 8, No. 2, pp. 534-544.

Spence, M. (1980). "Notes on Advertising, Economies of Scale, and Entry Barriers," *Quarterly Journal of Economics,* Vol. 95, No. 3, pp. 493-507.

Stahl, D. (1994). "Oligopolistic Pricing and Advertising", *Journal of Economic Theory,* Vol. 64, No. 1, pp. 162-177.

Stegeman, M. (1991). "Advertising in Competitive Markets", *American Economic Review,* Vol. 81, No. 1, pp. 162-177.

Stigler, G. L. (1961). "The Economics of Information", *Journal of Political Economy,* Vol. 69, No. 3, pp. 213-225.

Telser, L. G. (1964). "Advertising and Competition", *Journal of Political Economy,* Vol. 72, No. 6, pp.537-562.

Sutton, J. (1991). *Sunk Costs and Market Structure: Price Competition, Advertising and the Evolution of Concentration.* Cambridge: The MIT Press.

Tullock, G. (1980). "Efficient Rent Seeking," in J. Buchanan, R. Tollison, and G. Tullock, eds., *Towards a Theory of the Rent-Seeking Society.* College Station: Texas A&M University Press.

# 2. Variation of Advertising to Sales Ratios and Entry Deterrence Behaviour: Evidence from UK Survey Data

**Abstract**

The theoretical literature on advertising to deter entry either suggests over- or under-investment in advertising, relative to the non-strategic benchmark, depending on what type of oligopoly is used. I analyse survey data from over 800 UK firms to examine the relationship between the advertising to sales ratio and entry deterrence behaviour. The results show that if a firm perceives expenditure on advertising as an important strategy to deter entry into the market it will increase, rather than decrease, its advertising intensity. This result is consistent with the hypothesis that firms strategically over-invest in advertising to deter entry.

**Keywords**

Advertising, Entry Deterrence

## 2.1 INTRODUCTION

Strategic entry deterrence refers to a decision made by an incumbent which affects a potential entrant's expectations of the profitability of entry to the extent that it chooses to stay out of the market. Incumbent firms can have a significant advantage over potential entrants by using their position as first mover to erect barriers to entry and thereby benefit from a lower degree of competition. Such strategic decisions are important due to their anti-competitive nature and possible effects on welfare. Entry deterrence behaviour by an incumbent using strategic advertising decisions influences behaviour of a potential entrant without obvious signs of preventing entry. In fact, such strategic decisions will make entry unprofitable and makes antitrust investigation very difficult.

Questionnaire studies offer insights into the importance of advertising in entry deterrence. Cubbin and Domberger (1988) used UK MEAL data to investigate actual responses of firms to prospective entry in their study of 42 advertising-intensive UK industries and find that 40 percent of their sample noticed a change in advertising behaviour of incumbents on entry. Smiley (1988) and Bunch and Smiley (1992) find that advertising is one of the most frequently used entry deterrence strategies with Smiley (1988) reporting that 32 percent of firms in his survey indicated that they used advertising to defend new markets. Their findings show that limit pricing and capacity expansion are less popular strategies to deter entry. Thirty four percent of the Singh et al. (1998) survey respondents gave a high priority to slowing down or dissuading the entry of new products into their markets and achieved this end by advertising. These figures highlight that advertising is an important strategic variable and firm managers use it to deter entry. The Advertising and Industry Survey (AIS) data used in this

paper show a slightly lower proportion compared to the above literature with 23 percent of advertising managers attributing importance to entry deterrence as an aim of their advertising.

The theoretical literature has extensively considered the differing roles of advertising and investigated the relationship between advertising and entry deterrence behaviour. However, the results are inconclusive as to whether a firm will strategically over- or under-invest in advertising, relative to the non-strategic benchmark, in order to deter entry. If it is optimal for a firm to strategically decrease (increase) its advertising expenditure below (above) its non-strategic level in order to deter entry into the market this is referred to as under-advertising (over-advertising). Therefore, facing the threat of entry, is it optimal for a firm to increase its advertising expenditure to establish a large potential consumer base when its preference in the absence of such a threat would be to maintain a low level of output combined with a high price, or alternatively, decrease its advertising expenditure to establish a small group of loyal consumers for its product and constrain itself to a low price?

The strategic action of competing firms in post-entry competition must also be considered and the literature yields a number of general propositions. Quantity and price competition are usually referred to as strategic substitutes and strategic complements respectively. In the case of a symmetric firm competing with respect to quantities, if one firm were to increase its quantity of output, then the profit-maximising response of the other firm would be to decrease its output. In this case, the quantity decisions are referred to as strategic substitutes. In contrast, the optimal responses of firms with post-entry price competition differ. If one firm changes its price the optimal response of the competing firm is to alter its price in the same

direction (up or down). The pricing decisions are referred to as strategic complements. Fudenberg and Tirole (1984) establish that the optimal advertising investment level is determined by two factors: whether post-entry competition is in strategic substitutes or strategic complements and whether the investment increases or decreases the incumbent's marginal profitability. They conclude that if the investment in advertising increases the incumbent's marginal profitability then the incumbent has an incentive to over-advertise (under-advertise) with strategic substitutes (strategic complements). On the other hand, if an investment in advertising decreases the incumbent's marginal profitability, the incumbent has an incentive to under-advertise (over-advertise) with strategic substitutes (strategic complements).

The lack of good quality advertising data and information on entry deterrence behaviour has restricted empirical research in this area. However, this unique Advertising and Industry Survey (AIS) dataset includes interesting variables in relation to firms' advertising practices and advertising managers' motivations for advertising. In this paper I analyse AIS survey data of more than 800 UK firms to examine the relationship between the advertising and entry deterrence behaviour. The main result of this paper shows that if a firm perceives expenditure on advertising as an important strategy to deter entry into the market it will increase its advertising intensity when threatened by a potential entrant. This result is in contrast to the theoretical findings of Schmalensee (1983), Fudenberg and Tirole (1984), and Ishigaki (2000) where the threat of entry induces the incumbent monopolist to advertise less than it would if entry were not possible. However, the results support the theoretical findings of Krahmer (2006), Bagwell (2007), Doraszelski and Marovich (2007), and Whelan (2011) that point to entry deterrence cases where the incumbent monopolist over-invests in advertising. This result also supports Paton's

(2008) empirical study which explores the determinants of the importance of entry deterrence to advertising managers and finds a strong correlation between the perceived importance of advertising as an entry deterrence tool and the intensity of advertising spending.

The rest of the paper is organised as follows. Section 2.2 gives a review the literature and section 2.3 outlines the data used. The results are shown in section 2.4 and section 2.5 concludes.

## 2.2 LITERATURE REVIEW

The use of advertising to deter entry has been extensively studied since Spence (1980). Spence examined the persuasive role of advertising where advertising changes individuals' preferences leading to a demand shift in favour of the good being advertised. Schmalensee (1983), Fudenberg and Tirole (1984), Ishigaki (2000), Krahmer (2006), and Doraszelski and Marovich (2007) examine the role of advertising in entry deterrence where advertising builds goodwill, making it harder for an entrant to attract the attention of the consumer.

Schmalensee (1983) finds that entry deterrence is possible and involves under-advertising, investing less in advertising compared to the non-strategic benchmark case. In this model, suppose the incumbent were to launch a large advertising campaign. This would generate a large potential consumer base. In this scenario, the incumbent firm would produce little and charge a high price. However, a rational entrant would choose to enter the market under these circumstances. Advertising would induce rather than deter entry. Therefore, the incumbent reduces its advertising expenditure so that it may respond to entry aggressively via its pricing policy.

Ishigaki (2000) extends Schmalensee (1983) to examine entry deterrence in a market for homogenous products where post-entry competition is in prices. He finds that the incumbent is unable to deter entry by strategically committing to advertising investment. Fudenberg and Tirole's (1984) seminal paper considers a two-stage model where the incumbent and potential entrant compete with differentiated products. Their findings include conditions where the incumbent over-invests to accommodate the entrant, referred to as becoming a "fat cat". However, when it is optimal to deter entry, the incumbent under-invests, referred to as the "lean-and-hungry look". In this set-up, it is most advantageous for the firm to create a small group of loyal consumers for its product and constrain itself to a low price in the threat of entry. Therefore, neither the research of Schmalensee (1983), Fudenberg and Tirole (1984) nor Ishigaki (2000) suggests that an incumbent can deter entry by over-advertising.

Krahmer (2006) also extends Schmalensee (1983) to examine advertising and conspicuous consumption where brand recognition is of importance and consumers care about their image. This paper shows that an incumbent may strategically over-invest in advertising to deter entry. Doraszelski and Marovich (2007) propose a dynamic model with goodwill advertising in a market for differentiated goods. They solve numerically for the symmetric Markov-perfect equilibrium and find that an incumbent can deter entry with over-investment in advertising and generally accommodates entry by under-investment in advertising, although the optimal accommodation strategy varies with market features.

Entry deterrence has also been examined when it plays an informative role through signalling the incumbent's private information through its pre-entry behaviour.

Bagwell and Ramey (1988) followed by Bagwell (2007) extend Milgrom and Roberts (1982) to show that price and advertising may be used to signal cost to the potential entrant. The results of this paper state that an incumbent will over-invest in advertising to deter entry. Linnemer (1998) has price and advertising jointly signalling cost of production and quality. This paper also shows that positive dissipative advertising, i.e. a large advertising campaign that does not directly affect demand, may be used to signal type.

Chwe (2001), Clark and Horstmann (2005), Pastine and Pastine (2002, 2011), and Sahuguet (2011) show that in markets with consumption externalities firms may engage in advertising competition in order to coordinate consumer expectations on their own brand. Positive consumption externalities arise in markets where the utility that a consumer derives from the consumption of a product increases with the number of other consumers purchasing the same product either due to network or social interaction effects. The theoretical model in Whelan (2011) establishes that even when consumers and firms are fully informed of a product's existence, characteristics, price and production cost a role for advertising still exists as a tool for entry deterrence in the presence of positive consumption externalities. Strategic entry deterrence is accomplished through over-investing in advertising relative to the non-strategic benchmark. Whelan (2011) formalises the intuition that an incumbent firm may make it difficult for a would-be entrant by making a significant investment in advertising to coordinate consumers' expectations on its product. If the potential entrant has to incur similar costs it may be deterred from entering the market. The main result is driven by the coordinating role of advertising, the consumption externality and how it affects firms' advertising incentives.

Due to the lack of good quality data on firms' advertising practices and entry deterrence behaviour, testing the above theories has proven difficult. Empirical work has attempted to link the observed levels of advertising or the regulatory structure to measures of market concentration and entry. Rosenbaum and Lamort (1992) suggest that US manufacturing industries with high advertising to sales ratios have lower entry rates; therefore, providing support that advertising could be a factor inhibiting entry. Sass and Saurman (1995) come to an opposing conclusion from their industry analysis of the malt beverage market. They report evidence that larger national brewers gain market share in states where retail price advertising is restricted. Comanor and Wilson (1979) and Hilke and Nelson (1984) argue that advertising can be used strategically by an incumbent to deter entry while Paton (2008) points to a strong correlation between the perceived importance of advertising as an entry deterring tool and the intensity of advertising spending.

This paper investigates the relationship between advertising and entry deterrence behaviour to determine which strand of the theoretical literature best characterizes firm behaviour.

## 2.3 THE DATA

The 1999 Advertising and Industry Survey (AIS), obtained from the Economic and Social Research Council (ESRC), is a unique dataset containing information on the advertising practices of 843 UK firms. For this survey, firms were selected from the Financial Analysis Made Easy (FAME) database. Questionnaires designed to obtain background information about the company, its advertising decisions and competitive environment were sent to firms' advertising managers. The surveys were completed anonymously and ideally are reflective of advertising managers' thoughts on their

strategic advertising behaviour. Full details of the survey process are documented in Conant and Paton (2001). They establish, via numerous tests for sample bias, that the respondents are a fair representation of the population of 5,234 firms sampled.

A brief description of the variables used will be given below and summary statistics are provided Appendix Table 2.4.

### 3.3.1 Advertising-Sales Ratio

This paper attempts to examine the relationship between advertising intensity and strategic entry deterrence behaviour. Eighty-six percent of firms report that they engage in advertising and completed a question on their advertising to sales ratio. The advertising to sales ratio is one of the most commonly used measures of advertising intensity. It adjusts for sales volume to ensure that the scale factor does not dominate and intensity is properly measured. Also, budgeting advertising as a percentage of sales is a planning approach used by many firms. In the survey, firms are asked "During this financial year, how much will you spend on advertising as a percentage of your sales". Managers were also given a second option to answer this same question in part (b) of the same question, "If you do not know the percentage, within which range does it lie? 0-0.5%, 0.5-1%, 1-2%, 2-3%, 3-4%, 4-5%, 5-6%, 6-8%, 8-10%, 10+%".

Information from this question is used as the dependent variable in three different ways. First, I use the data from the first part of this question where firms directly stated the figure to define the advertising as a percentage of sales, namely, the variable ADP. The mean advertising to sales ratio of the ADP variable is reported as 2.7 percent. Second, I construct a variable, CADP, combining the data from part (a) of the question and using the midpoint for the firms who only categorical data was

available from part (b) of the question. The construction of this variable almost doubles the sample size available for analysis and the mean advertising to sales ratio is reduced to 2.4 percent. Third, as 13 percent of firms stated that they did not advertise at all in an early question and were not asked to complete the question about advertising as a percentage of their sales, I construct a variable, NCADP, which is composed of values of zero percent for firms who stated they did not advertise plus the CADP variable. As expected, the mean advertising to sales ratio is further reduced, to a value of 1.9 percent, and the overall sample size is increased to its highest level.

### 3.3.2 Entry Deterrence Strategy

An ordinal measure for the importance of entry deterrence as an aim of firms' advertising expenditures is provided in the data. The question "to what extent is the aim of your advertising to make it difficult for other companies to enter the market" provides me with a good indicator of firms which use advertising to deter entry. The proportion of advertising managers responding to each category are as follows: 35 percent 'Not at all'; 16 percent 'Quite unimportant'; 26 percent 'Neither important or unimportant'; 14 percent 'quite important'; and 9 percent 'very important'.

Advertising managers that responded 'Not at all', 'Quite unimportant' or 'Neither important or unimportant' were taken to not use advertising as an entry deterrence strategy and the 23 percent of all firms who answered 'quite important' or 'very important' were taken to use advertising to impose a barrier to entry. A dummy variable, AIMENT, is given a value of zero if the advertising manager responded in any of the first three categories, and a value of one if they responded in the other two categories indicating entry deterrence behaviour.

### 3.3.3 Sectors

Advertising to sales ratios vary across sectors. In the survey, firms classified themselves into seven categories: 12 percent of firms manufacture consumer goods (CMSEC), 22 percent manufacture producer goods (PMSEC), 10 percent are distribution firms (DISTSEC), 8 percent are in the retail sector (RETSEC), 28 percent service firms (SERSEC), and 20 percent are classified as other (OSEC). Categorical dummy variables are constructed to allow for differences across sectors. The distribution sector is chosen as the excluded category. This specification allows some evaluation of sectors where consumption externalities are more likely (e.g. manufacturing (consumer goods) and retail) compared to other sectors where consumption externalities are less likely.

### 3.3.4 Turnover

Turnover is included as a control for market share. A greater turnover is associated with a larger market share. In the survey, firms provided data on company turnover in the last financial year. Annual turnover is recorded in Millions GBP and the sample mean is £287.5025 million. In Farris and Albion's (1981) review a larger market share is associated with a relatively lower advertising intensity. Jones (1990) findings show that in the packaged goods market, brands with lower market shares spend relatively more on advertising compared to those with higher shares. At the firm level, Farris and Buzzell (1979) and Rundfelt (1973) also find a negative relationship between market share and advertising to sales ratios. Intuitively, firms with large market shares should be familiar to consumers and therefore require a lower advertising to sales ratio. The log value of turnover (LNTURN) is used as, on

inspection of the data, it appears that the relationship is non-linear and this specification provides a better fit to the data.

### 3.3.5 Number of Competing Firms

In the absence of a measure of the set-up cost of entry which is found to be an important determinant of advertising expenditure in Whelan (2011), the best proxy, given the data, is the number of firms competing in the market for the firm's main product line/service. It is assumed that the fewer firms competing in the market, that is, the more concentrated the market, the higher the fixed cost of entry. Dummy variables are constructed to identify firms with 0-1, 2-5, 6-10, and 10 or more firms competing in the market for their main product line/service. Two percent of firms fall into the 0-1 category, 21 percent with 2-5, 21 percent with 6-10 and 56 percent with 10 or more competitors. The excluded category is firms with the lowest level of competition, i.e. 0-1 competitors for their main product line/service.

### 3.3.6 Size of the Market

The size of the overall market to the firm can be expected to affect the chosen advertising intensity. A dummy variable is included with a value of one if a firm indicates that its only market is regional as opposed to the larger market sizes of the UK, EU or International. Twelve percent of firms indicated that their only market is regional. If the coefficient is negative on this variable it would indicate that when a firm's market is regional (small) it has a lower advertising to sales ratio.

Missing data reduces the final useable sample. Only 327 firms answered the specific advertising to sales question (ADP) so this is the smallest sample. When combined with the categorical data on firms' advertising to sales ratios the sample is increased

to 664 observations (CADP). The greatest sample size is 776 observations when the firms who report no advertising expenditure (NCADP) are included. Other variables suffer from missing data to a lesser extent; in these cases the missing data problem is homogenous across variables and less problematic.

In examining the relationship between firm's entry deterrence behaviour and advertising expenditure it may be suggested that higher advertising expenditure may drive higher entry deterrence behaviour; therefore, a possible issue of endogeneity arises. Alternatively, an unobserved variable may jointly determine both high levels of advertising and entry deterrence behaviour. I attempt to control for other factors that may influence advertising behaviour and establish correlations between the two variables to indicate the direction of the relationship. This allows me to test the idea of over- or under-advertising that already exists in the theoretical literature.

## 2.4 RESULTS

Table 2.1 presents OLS estimates of the impact of entry deterrence behaviour on advertising intensity. The dependent variable is the advertising to sales ratio for the firm reported by the advertising manager. The ADP variable refers to only the firms who gave their advertising to sales ratio in percentage terms and the CADP variable refers to the constructed variable which includes the data from ADP, plus data from the firms who answered which category their advertising to sales ratio was in, for which I used the midpoint of the range.

**TABLE 2.1: OLS estimates of advertising expenditure as a percentage of sales**

| Dependent Variable: | Model (1) ADP | Model (2) CADP | Model (3) ADP | Model (4) CADP |
|---|---|---|---|---|
| Independent Variables | | | | |
| AIMENT | 2.17** | 1.18** | 2.53*** | 1.36** |
| | (0.91) | (0.50) | (0.94) | (0.57) |
| CMSEC | | | 2.70** | 1.67*** |
| | | | (1.24) | (0.56) |
| PMSEC | | | 0.88 | 0.40 |
| | | | (1.14) | (0.48) |
| RETSEC | | | 2.38 | 2.18*** |
| | | | (1.48) | (0.80) |
| SETSEC | | | 1.61 | 0.77 |
| | | | (1.49) | (0.56) |
| OSEC | | | 1.39 | 0.92* |
| | | | (1.17) | (0.50) |
| LN(TURN) | | | -0.22 | -0.18** |
| | | | (0.14) | (0.08) |
| NFMS | | | | |
| 2-5 | | | -8.89 | -4.22 |
| | | | (8.77) | (4.59) |
| 6-10 | | | -8.22 | -3.68 |
| | | | (8.53) | (4.52) |
| 10+ | | | -8.62 | -4.03 |
| | | | (8.71) | (4.55) |
| REGM | | | -0.64 | -0.77 |
| | | | (0.94) | (0.57) |
| _cons | 2.33*** | 2.08*** | 9.99 | 5.73 |
| | (0.21) | (0.14) | (7.75) | (4.34) |
| $R^2$ | 0.04 | 0.02 | 0.12 | 0.07 |
| N | 317 | 636 | 283 | 540 |

Notes:

i. M1 and M3: The dependant variable is advertising as a percentage of sales as reported by firms.
ii. M2 and M4: The dependant variable is advertising as a percentage of sales as reported by firms and as reported in categories where the midpoint is used.
iii. * p<.1; ** p<.05; *** p<.01
iv. Standard errors are reported in brackets for M1 and M2.
v. Robust standard errors are reported in brackets for M3 and M4.
vi. $R^2$ can only be compared across models with the same dependent variables.

The first specification in the table (Model 1 and Model 2), contains no additional regressors (other than a constant term) and compares the dependent variables ADP and CADP. In Model 1, the coefficient on the entry deterrence dummy (AIMENT), which identifies a firm aiming to deter entry with its advertising, implies that the average increase in advertising to sales ratio associated with entry deterrence behaviour is around 2.2 percent and this is highly significant. This marginal effect indicates that a firm with entry deterrence as an aim of its advertising is estimated to have a 93 percent increase in its advertising intensity compared to a firm who does not use advertising to deter entry, i.e. an advertising to sales ratio of 4.5 percent compared to 2.33 percent.

The coefficient on the entry deterrence dummy in Model 2 implies that the average increase in advertising to sales ratio associated with entry deterrence behaviour is lower than in Model 1 at an increase of around 1.2 percent (approximately a 57 percent increase for firms who indicate that entry deterrence is an aim of their advertising) and this result is also highly significant.

Models 3 and 4 in the table include controls that determine advertising to sales ratios as discussed in the data section earlier. Specifically, some firm characteristics are controlled for, such as, sector, number of competing firms, turnover, and market size. These variables are included in an attempt to assess to what extent differences in firm characteristics affect advertising intensity.

In Model 3, the coefficient on the entry deterrence dummy is around 2.5 implying that the advertising to sales ratio associated with entry deterrence behaviour is around 2.5 percent greater and this is highly significant. Again Model 4 produces a lower coefficient indicating an increase of 1.36 percent. Across all four models, all

coefficients for the entry deterrence dummy are positive and significant at (at least) the 5 percent level. Inclusion of the control variables increases the coefficient on the entry deterrence dummy marginally in both Models 3 and 4 while remaining significant. Thus, there is no evidence that the advertising effect is the result of these industry specific factors.

The results of Model 4 indicate that turnover is negatively associated with advertising intensity and the coefficients here can be interpreted as elasticities where a one percent increase in turnover (Millions GBP) results in a 0.18 percent reduction in advertising intensity. This negative relationship supports the findings of Rundfelt (1973), Farris and Buzzell (1979), and Jones (1990).

The dummy variables controlling for sector differences indicate that consumer manufacturing products are positively associated with advertising intensity in models 3 and 4, compared to the excluded distribution sector category. Again Model 4, using the combined advertising to sales ratio (CADP), produces a lower coefficient indicating an increase of around 1.7 percent, compared to the 2.7 percent produced in Model 3. The retail sector (RETSEC) becomes significant in Model 4 with a positive coefficient of 2.18 percent. None of the effects relating to the number of firms or size of the market are statistically significantly different from zero, indicating no relationship between the fixed cost of entry or overall size of the market with firm's advertising intensity.

OLS estimation is sensitive to violations of standard assumptions regarding the error term. Diagnostic tests suggest that the null hypothesis of homoskedastic errors (Breusch-Pagan / Cook-Weisberg test) should be rejected. The existence of different variances is often encountered when using cross-sectional firm data. Confidence

intervals and the validity of hypothesis tests that use the standard errors usually computed for the OLS estimator may be misleading. Therefore, standard errors robust to heteroscedasticity are reported in Table 2.1 and Table 2.2 for Models 3 and 4.

On inspection there appeared to be some outliers in relation to the advertising to sales ratios (ADP) and turnover variables (TURN). In relation to the advertising to sales ratio, three large outliers were identified as values more than three standard deviations away from the mean. In relation to turnover, seven outliers were identified with values more than three standard deviations away from the mean. In the analysis reported below in Table 2.2, as a robustness check, outliers are reassigned the value of three standard deviations away from the mean, to help to retain the cases but to reduce the impact of the extreme values on the regression results.

With adjustment of the outliers, across all four models, all coefficients for the entry deterrence dummy remain positive and highly significant, but as expected they are lower relative to those reported without adjustments. The marginal effects on the coefficient on the entry deterrence dummy (AIMENT) in Table 2.3 is around 1.5 percent in model 1 (67 percent increase in advertising intensity) and 0.8 percent in model 2 (40 percent increase in advertising intensity). When controls are included, in model 3 the coefficient is around 1.9 percent and again model 4 produces a lower coefficient indicating an increase of 0.9 percent. As a final robustness check, the analysis was re-estimated excluding the outliers which confirmed that the results are not driven by the outliers.

**TABLE 2.2: OLS estimates of advertising expenditure as a percentage of sales (Outliers adjusted)**

| Dependent Variable: | Model (1) ADP | Model (2) CADP | Model (3) ADP | Model (4) CADP |
|---|---|---|---|---|
| Independent Variables | | | | |
| AIMENT | 1.53*** | 0.80*** | 1.86*** | 0.89** |
| | (0.45) | (0.28) | (0.64) | (0.36) |
| CMSEC | | | 1.94** | 1.41*** |
| | | | (0.85) | (0.49) |
| PMSEC | | | 0.22 | 0.15 |
| | | | (0.74) | (0.39) |
| RETSEC | | | 1.59 | 1.87*** |
| | | | (1.12) | (0.69) |
| SERSEC | | | 0.49 | 0.42 |
| | | | (0.79) | (0.38) |
| OSEC | | | 0.53 | 0.74* |
| | | | (0.76) | (0.42) |
| LN(TURN) | | | -0.31*** | -0.19*** |
| | | | (0.11) | (0.07) |
| NFMS | | | | |
| 2-5 | | | -1.83 | -0.62 |
| | | | (2.79) | (1.21) |
| 6-10 | | | -1.62 | -0.24 |
| | | | (2.71) | (1.20) |
| 10+ | | | -1.68 | -0.50 |
| | | | (2.75) | (1.18) |
| REGM | | | -0.97 | -0.91** |
| | | | (0.61) | (0.36) |
| _cons | 2.27*** | 2.04*** | 4.26* | 2.53** |
| | (0.21) | (0.13) | (2.46) | (1.17) |
| N | 317 | 636 | 283 | 540 |
| $R^2$ | 0.04 | 0.02 | 0.10 | 0.06 |
| Prob > F | 0.00 | 0.01 | 0.03 | 0.00 |

Notes:

i. M1 and M3: The dependant variable is advertising as a percentage of sales as reported by firms.
ii. M2 and M4: The dependant variable is advertising as a percentage of sales as reported by firms and as reported in categories where the midpoint is used.
iii. * p<.1; ** p<.05; *** p<.01
iv. Standard errors are reported in brackets for M1 and M2.
v. Robust standard errors are reported in brackets for M3 and M4.
vi. $R^2$ can only be compared across models with the same dependent variables.

Tobit analysis was also used to include the 13 percent of firms who indicated that they did not advertise at all. The advertising ratios included for these firms were zero and the importance of entry deterrence as an aim of their advertising was included as unimportant i.e. a value of zero entered for the entry deterrence dummy (AIMENT). Results are reported in Table 2.3 below where the estimates for the entry deterrence variable can be seen as positive and highly significant in all models. In fact, all estimates are greater than the estimates using the OLS estimation technique. This suggests that by only considering the firms who are advertising underestimates the relationship between advertising intensity and entry deterrence behaviour.

**TABLE 2.3: Tobit estimates of advertising expenditure as a percentage of sales (Outliers adjusted)**

| Dependent Variable: | Model (1) NADP | Model (2) NCADP | Model (3) NADP | Model (4) NCADP |
|---|---|---|---|---|
| Independent Variables | | | | |
| NAIMENT | 3.16*** | 1.60*** | 3.12*** | 1.50*** |
| | (0.49) | (0.30) | (0.53) | (0.32) |
| CMSEC | | | 2.28** | 1.42*** |
| | | | (0.90) | (0.54) |
| PMSEC | | | 0.16 | 0.07 |
| | | | (0.80) | (0.47) |
| RETSEC | | | 2.08 | 1.91*** |
| | | | (0.98) | (0.60) |
| SETSEC | | | 1.06 | 0.56 |
| | | | (0.80) | (0.46) |
| OSEC | | | 0.93 | 0.84* |
| | | | (0.85) | (0.49) |
| LN(TURN) | | | -0.20* | -0.13** |
| | | | (0.10) | (0.06) |
| NFMS | | | | |
| 2-5 | | | -1.82 | -0.53 |
| | | | (1.53) | (0.94) |
| 6-10 | | | -0.92 | 0.11 |
| | | | (1.52) | (0.93) |
| 10+ | | | -1.21 | -0.28 |
| | | | (1.49) | (0.91) |
| REGM | | | -0.31 | -0.54 |
| | | | (0.65) | (0.41) |
| _cons | 0.65*** | 1.26*** | 1.91 | 1.43 |
| | (0.21) | (0.13) | (1.55) | (0.99) |
| sigma | 3.76 | 3.15 | 3.63 | 3.02 |
| | (0.15) | (0.09) | (0.16) | (0.09) |
| N | 432 | 748 | 355 | 610 |
| Log Likelihood | -953.70372 | -1724.2203 | -819.33236 | -1421.0043 |
| Prob > chi² | 0.00 | 0.00 | 0.00 | 0.00 |
| Pseudo R² | 0.02 | 0.01 | 0.03 | 0.02 |
| Proportion Advertising | 0.63 | 0.82 | 0.74 | 0.87 |

Notes:

i. M1 and M3: The dependant variable is advertising as a percentage of sales as reported by firms (includes firms who reported no advertising as zero percent).

ii. M2 and M4: The dependant variable is advertising as a percentage of sales as reported by firms and as reported in categories where the midpoint is used (includes firms who reported no advertising as zero percent).

iii. * p<.1; ** p<.05; *** p<.01

iv. Standard errors are reported in brackets

## 2.5 CONCLUSION

Incumbent firms can have a significant advantage over potential entrants by erecting barriers to entry, thereby benefiting from a lower degree of competition. In this paper I investigate the relationship between the advertising and entry deterrence behaviour by analysing survey data from over 800 UK firms from the AIS Dataset. The results indicate that if a firm perceives expenditure on advertising as an important tool to deter entry into the market it will increase its advertising intensity. This is important because strategic investments in advertising are anti-competitive and may adversely affect welfare. The behaviour of a potential entrant is influenced by making entry unprofitable without obvious signs of preventing entry. This is a policy predicament making antitrust investigation very difficult.

The theoretical literature on advertising to deter entry either suggests over- or under-investment in advertising, relative to the non-strategic benchmark, depending on what type of oligopoly is used. Some papers determine that it is optimal for the firm to decrease its advertising expenditure to establish a small group of consumers for their product and constrain itself to a low price in the threat of entry. Others determine that it is optimal for a firm to increase its advertising expenditure, establish a large potential consumer base, and combine a low output with a high price.

This paper provides empirical support for the theoretical findings of Krahmer (2006), Bagwell (2007), Doraszelski and Marovich (2007), and Whelan (2011) and that point to entry deterrence cases where the incumbent monopolist over-invests in advertising. This paper also supports Paton's (2008) empirical study which explores the determinants of the importance of entry deterrence to advertising managers and finds

a strong correlation between the perceived importance of advertising as an entry deterrence tool and the intensity of advertising spending.

However, the result of this paper is in contrast to the theoretical findings of Schmalensee (1983), Fudenberg and Tirole (1984), and Ishigaki (2000) where the threat of entry induces the incumbent monopolist to advertise less than it would if entry were not possible. The results of this empirical analysis show that firms which indicate that strategic entry deterrence is an aim of their advertising are significantly more likely to have a greater advertising to sales ratio. Furthermore, a firm which indicated that entry deterrence is an aim of its advertising is associated with an increased advertising intensity of above 57%.

## 2.6 REFERENCES


Bagwell, K. And G. Ramey (1988). "Advertising and Limit Pricing", *RAND Journal of Economics,* Vol 9, No. 1, pp. 59-71.

Bagwell, K. (2007). "Signalling and Entry Deterrence: A Multidimensional Analysis", *RAND Journal of Economics,* Vol. 38, No. 3, pp. 670-697.

Bunch, D.S. and Siley, R. (1992). "Who Deters Entry? Evidence on the Use of Strategic Entry Deterrents", *Review of Economics and Statistics,* Vol. 74, No. 3, pp. 509-521.

Chwe, M. (2001). Rational Ritual: Culture, Coordination, and Common Knowledge, Princeton, N.J.: Princeton University Press.

Clark, C. R. and I. J. Horstmann (2005). "Advertising and Coordination in Markets with Consumption Scale Effects", *Journal of Economics and Management Strategy,* Vol. 14, No. 2, Pp. 377-402.

Comanor, W. S. and T. A. Wilson (1979). "The Effects of Advertising on Competition: A Survey", *Journal of Economics Literature,* Vol. 17, Pp. 453-476.

Conant, N. and D. Paton (2001), 'An Introduction to the 1999 Advertising and Industry Survey', *The Journal of Industrial Economics,* Notes and Comments Page.

Cubbin, J. and S. Domberger (1988). "Advertising and Post Entry Oligopoly Behaviour", *Journal of Industrial Economics,* Vol. 37, No. 2, Pp. 123-140.

Doraszelski, U. and S. Markovich (2007). "Advertising Dynamics and Competitive Advantage", *The RAND Journal of Economics,* Vol. 38, No. 3, pp. 557-592.

Farris, P. W. and Albion, M.S. (1981), "Determinants of the advertising-to-sales ratio", *Journal of Advertising Research,* Vol. 21, No. 1, pp. 19-27.

Farris, P. W. and Buzzell, R.D. (1979), "Why advertising and promotion costs vary: some cross sectional analyses", *Journal of Marketing,* Vol. 443, No. 4, pp. 112-122.

Fudenberg, D. and J. Tirole (1984). "The Fat-Cat Effect, the Puppy-Dog Ploy, and the Lean and Hungry Look", *American Economic Review, Papers and Proceedings,* Vol. 74, No. 2, pp. 361-366.

Hilke, J. C. and P.B. Nelson (1984). "Noisy Advertising and the Predation Rule in Antitrust Analysis", *American Economic Review, Papers and Proceedings,* Vol. 74, pp.367-371

Ishigaki, H. (2000). "Informative Advertising and Entry Deterrence: A Bertrand Model," *Economic Letters,* Vol 67, No. 3, pp. 337-343.

Jones, J. P. (1990), "Ad spending: maintaining market share", *Harvard Business Review,* Vol. 68, No. 1, pp. 38-42.

Krahmer, D. (2006). "Advertising and Conspicuous Consumption", *Journal of Institutional and Theoretical Economics,* Vol. 162, No. 4, pp. 661-682.

Linnemer, L. (1998), "Entry Deterrence, Product Quality: Price and Advertising as Signals," *Journal of Economics and Management Strategy,* Vol. 7, No. 4, pp. 615-645.

Milgrom, P. and J. Roberts (1982). "Limit Pricing and Entry Under Incomplete Information: An Equilibrium Analysis", *Econometrica,* Vol. 50, No. 2, pp. 443-460.

Pastine, I. and T. Pastine (2002). "Consumption Externalities, Coordination and Advertising", *International Economic Review,* Vol. 42, No. 3, pp. 919-943.

Pastine, I. and T. Pastine (2011). "Coordination in Markets with Consumption Externalities: Advertising and Product Quality", *The Manchester School,* Vol. 79, No. 1, pp. 24-62.

Paton, D. (2008). "Advertising as an Entry Deterrent: Evidence from UK Firms", *International Journal of the Economics of Business,* Vol. 15, No. 1, pp. 63-83.

Rosenbaum, D. I. and F. Lamort (1992). "Entry Barriers, Exit and Sunk Costs: An Analysis", *Applied Economics,* Vol. 24, pp. 297-304.

Rundfelt, R. (1973), *Advertising Costs in Sweden: Structure and Determinants,* Almqvist och Wiksell, Stockholm.

Sahuguet, N. (2011). "A Model of Repeat Advertising", *Economic Letters,* Vol. 111, No. 1, pp. 20-22.

Sass, T. R. and D. Saurman (1995). "Advertising Restrictions and Concentration: The Case of Malt Beverages", *The Review of Economics and Statistics,* Vol. 77, No. 1, pp. 66-81.

Schmalensee, R. (1978). "A Model of Advertising and Product Quality", *Journal of Political Economy,* Vol. 86, No. 3, pp. 485-503.

Schmalensee, R. (1983), "Advertising and Entry Deterrence: An Exploratory Model," *Journal of Political Economy,* Vol. 91, No. 4, pp. 636-653.

Singh, S., M. Utton and M. Waterson (1991). "Entry Deterring Strategies by Established Firms," *Internationa*l *Journal of Industrial Organization,* Vol. 16, No. 2, pp. 229-251.

Smiley, R. (1988). "Empirical Evidence on Strategic Entry Deterrence," *International Journal of Industrial Organisation,* Vol. 6, No. 2, pp. 167-180.

Spence, M. (1980). "Notes on Advertising, Economies of Scale, and Entry Barriers," *Quarterly Journal of Economics,* Vol. 95, No. 3, pp. 493-507.

Whelan, A. (2011). "Entry Deterrence, Coordinating Advertising and Pricing in Markets with Consumption Externalities" Working Paper.

## 2.7 APPENDIX

**Table 2.4: Variable definitions and descriptive statistics**

| Names | Definition | Mean | SD |
|---|---|---|---|
| **Dependent variables:** | | | |
| ADP | Proportion of total advertising to sales as reported by the manager for this year (1999) (327 observations) | 2.744 | 4.626 |
| ADP (outliers adj.) | As above with three large outliers adjusted to the value three standard deviations from the mean | 2.552 | 3.384 |
| NADP | As above with zero percent added for firms who reported not advertising (442 observations) | 1.888 | 3.118 |
| CADP | Proportion of total advertising to sales as reported by the manager for this year (1999), combined with categorical data using the midpoint of categories (664 observations) | 2.285 | 3.770 |
| CADP (outliers adj.) | As above with three large outliers adjusted to the value three standard deviations from the mean | 2.165 | 2.926 |
| NCADP | As above with zero percent added for firms who reported not advertising (776 observations) | 1.851 | 2.812 |
| **Independent variables:** | | | |
| AIMENT | Dummy variable equalling 1 if importance of entry deterrence was ranked as quite important or very important by the manager | 0.224 | 0.417 |
| NAIMENT | As above with zero included for firms who reported not advertising | 0.192 | 0.394 |
| CMSEC | Dummy variable equalling 1 if the manager states the company's main product/service is in manufacturing (consumer goods) | 0.120 | 0.325 |
| PMSEC | Dummy variable equalling 1 if the manager states the company's main product/service is in manufacturing (producer goods) | 0.216 | 0.411 |
| DISTSEC | Dummy variable equalling 1 if the manager states the company's main product/service is in distribution | 0.103 | 0.304 |
| RETSEC | Dummy variable equalling 1 if the manager states the company's main product/service is in retail | 0.082 | 0.275 |
| SERSEC | Dummy variable equalling 1 if the manager states the company's main product/service is in services | 0.282 | 0.450 |
| OSEC | Dummy variable equalling 1 if the manager states the company's main product/service is in 'other' | 0.196 | 0.400 |
| REGM | Dummy variable equalling 1 if the manger indicates that the market for its main product/services is regional | 0.114 | 0.318 |
| TURN | Company's annual turnover in the last financial year (1998) in Millions GBP as reported by the manager | 287.50 | 1645.875 |
| LNTURN | Natural log of the above variable: ln(TURN) | 3.216 | 2.085 |
| LNTURN(outliersadj.) | As above with seven outliers adjusted to the value three standard deviations from the mean | 3.225 | 2.042 |

# 3. System Wars: The Power of Network Externalities


## Abstract

In a market with network externalities the relative network intensity across products is likely to have consequences for advertising expenditures, prices and the market equilibrium. I introduce network externalities and persuasive advertising into a Hotelling framework to investigate two firms producing different varieties of a good in a market with network externalities. Firms' optimal advertising and pricing strategies are shown to depend on the strength of the network externality for their product. In spite of differences in network intensities, the findings show that both firms can exist simultaneously in the market. The firm with the stronger network externality dominates. This result highlights a "Matthew Effect", where the initial advantage is self-amplifying. In equilibrium, this dominant firm, when compared to the firm with the lower network intensity, will have higher advertising expenditure, price, market share and profits.



## Keywords

Network Externalities, Persuasive Advertising, Product Differentiation, Spatial Competition, Network Effects, Interdependent Preferences.

## 3.1 INTRODUCTION

In the midst of a system war, a consumer is faced with two or more products, and, all else equal, they wish to purchase the brand or system that is more heavily purchased. For example, due to online gaming, the decision about which gaming console to purchase involves expectations about which console will be more heavily purchased in addition to the relative prices and qualities of the rival firms' products. Microsoft and Sony launched a console war with their products, Xbox 360 and Playstation 3, respectively, in 2005. Other examples of such wars are: Microsoft 95 versus IBM OS/2 in the computer software market, HD-DVD versus Blu-Ray in the DVD player market, and Apple versus Samsung in the smartphone market.

In such markets, the utility that a consumer derives from the product increases with the expected number of other consumers purchasing the same brand due to network effects. Some other modern examples include: mobile networks, tablet computers, computer operating systems and/or applications, social networking sites, websites (Ebay, Google, Wiki, etc), credit cards, electric cars, pharmaceutical drugs, music players, and video recorders.

In this paper I introduce persuasive advertising and network externalities into a Hotelling framework to investigate two firms producing different varieties of a good competing in a market with network externalities. This work draws on two strands of industrial organisation literature: persuasive advertising and network externalities. Persuasive advertising affects demand by changing tastes and creating brand loyalty.[6] The advertised brand faces a lower elasticity of demand; consumers are less price sensitive.[7] By examining U.S. manufacturing industries, Bain (1956) and Comanor and Wilson (1967) offer the earliest empirical support

[6] Bagwell (2007) provides a complete survey of the economics of advertising.

[7] Braithwaite (1928) was the first to develop persuasive advertising. Robinson (1933) and Spence (1980) find that persuasive advertising creates brand loyalty.

for persuasive advertising and evidence is presented that advertising intensity exerts a significantly positive influence on the explanation of profits.[8] In this paper, I analyse persuasive advertising in the spirit of Khatibi and Vergote (2011).[9] Their paper analyses pricing, non-price instuments (e.g. advertising) and trade policy barriers. My approach differs by analysing optimal pricing and advertising decisions for a duopoly in a market with network externalities.

Persuasive advertising is particularly important in markets with network externalities. Network externalities arise in markets where the utility a consumer derives from the consumption of a product increases with the number of other consumers purchasing the same product either due to network or social interaction effects.[10] Two sources of economic value are significant for the consumer: the inherent value (a consumer derives value from their own use of the product) and the network value (a consumer derives value from other consumers' use of the product). A network externality by nature is a positive consumption externality.[11] Katz and Shapiro (1985) state two ways in which network externalities can occur. Direct network externalities exist when an increase in the size of a network increases the number of

[8] This is consistent with the hypothesis that advertising creates brand loyalty.

[9] Khatibi and Vergote (2011) analyse pricing, non-price instruments and trade policy barriers to show that whether a tariff is placed on the non-price instrument or on the good itself, the foreign firm prefers to increase its use of its pricing tool and give up some of its use of the non-price instrument. Furthermore, in the presence of a non-price instrument, tariffs do not always lead both firms to increase their price: it can lead the foreign firm to decrease its price.

[10] Farrell and Klemperer (2007) provide a complete survey of the economics of network effects. Rohlfs (1974) originally applied the insight of network externalities to analyse the origins and development of communication networks. Early research focused on examples such as telephones and fax machines. Except for applications to communications, the analysis of markets with network externalities lay largely dormant until the 1980s. At that point, economic historians such as David (1985) as well as economic theorists such as Farrell and Saloner (1985) and Katz and Shapiro (1985) began to explore these issues.

[11] Chwe (2001), Clark and Horstmann (2005), Pastine and Pastine (2002, 2011), and Sahuguet (2011) show that in markets with positive consumption externalities firms may engage in advertising competition in order to coordinate consumer expectations on their own brand. Whelan (2011) establishes that even when consumers and firms are fully informed of a product's existence, characteristics, price and production costs a role for coordination advertising still exists as a tool for entry deterrence in the presence of positive consumption externalities.

others with whom one can interact directly. Indirect network externalities exist when an increase in the size of a consumer base expands the range of complementary products available. Economic agents are not always purely self-interested; they have interdependent preferences where their utility function will depend on the decisions of other consumers.

In this paper, two firms play a two-stage game. In the first stage, firms simultaneously choose their investment level of advertising, and in the second stage, they compete in prices. Consumers observe firms' advertising and pricing decisions then simultaneously make their purchasing decisions. I first construct a benchmark case where firms' marginal network externalities are symmetric across brands. Second, I introduce an exogenous difference in firms' network externalities and analyse firms' advertising expenditures, pricing, profits and market shares in comparison to the benchmark case.

As in Hotelling (1929) product differences are modelled by their location at extreme ends of a distinct product space. Heterogeneous consumer preferences are modelled by their location along the same space. Firms invest in advertising in order to change the product or brand's image. Advertising in this model can also be considered as an investment to improve the product's design, increase technology, promotion of the product using a celebrity endorsement or anything else that will change its perceived 'quality' or 'location' for consumers.

In this paper, I analyse outcomes when the market is shared by two products. There are many examples of products competing in markets with network externalities where more than one firm exists. I wish to examine the optimal pricing and advertising decisions for firms in this situation. In order for this outcome to occur, the demand by some users for the intrinsic characteristics of the good on a less popular network must be especially strong. Firms are competing for consumers. They can increase their chances of gaining extra consumers by

spending more money on product enhancements, advertising, or price reductions. In this paper, I address the question of optimal advertising investment and pricing decisions for each firm, knowing that its competitor is facing similar decisions.

In the benchmark case with symmetric network externalities, prices are shown to be strategic complements whereas advertising expenditures are strategic substitutes. I show that the presence of network externalities intensifies competition between the two firms, leading to increased price competition. I find that as the network effect becomes more significant in consumers' preferences, equilibrium prices are reduced. With symmetric network externalities, when both firms are observed in the market they gain equal market share and profits with symmetric advertising expenditure and prices. The game is a prisoner's dilemma as higher profits could be attained if they reduced their spending on advertising. However, in a one shot game, they cannot trust that their rival will not advertise.

Subsequently, I introduce an exogenous difference in network externalities across products and show that, despite this difference, in equilibrium both firms will simultaneously exist in the market. Furthermore, optimal pricing and advertising strategies are found to differ across firms. The main result associated with relative differences in network externalities highlights a "Matthew Effect": "to those who have, more shall be given".[12] In this paper, I show that the firm with the stronger network externality dominates the market. This dominant firm, in equilibrium, when compared to the firm with the lower network intensity, will have higher advertising expenditure, price, market share and profits.

[12] The term "Matthew Effect": was coined by the sociologist Robert K. Merton (1968) to refer to his theory of cumulative advantage in science. The phenomenon was named after a verse in the Gospel of Matthew (13:12) which states that "for whosoever hath, to him shall be given, and he shall have more abundance: but whosoever hath not, from him shall be taken away even that he hath". Mrázová and Neary (2013) also refer to the "Matthew Effect" when examining selection effects with heterogenous firms.

The type of products in markets with network externalities are ever increasing due to the growth of network effects, increased connectivity and ease of social interaction. When competing in a market with network externalities, the relative value of a network externality across products is likely to have consequences for advertising expenditures, prices and the market equilibrium. The theory of network effects, or consumption externalities, has fundamental importance for competition policy, regulation, business strategy, intellectual property, and technical change in a wide range of industries. Developments in these growing industries cannot be fully understood without understanding the power of network externalities.

The rest of the paper is organised as follows. In section 3.2, I develop the model framework. The equilibrium is developed in Section 3.3 where I discuss outcomes with symmetric and asymmetric network externalities. Section 3.4 provides a further discussion of the market for online gaming consoles and section 3.5 concludes.

### 3.2 MODEL

Two firms, 1 and 2, compete over two stages. In the first stage, firms simultaneously choose their investment level of advertising, and in the second stage, they compete in prices. Consumers observe firms' advertising and pricing decisions then simultaneously make their purchasing decisions. This is a rational expectations model where consumers' expectations are consistent with equilibrium outcomes. Communication between consumers is not considered. There are no fixed costs in the model.

Marginal production costs are assumed to be constant and equal to zero. The level of investment in advertising is denoted by $\mathrm{a}_i$, $i = \{1,2\}$. Let $C(\mathrm{a}_1)$ and $C(\mathrm{a}_2)$ denote the associated cost of advertising, given by:[13]

$$C(\mathrm{a}_i) = \frac{c}{2}\mathrm{a}_\mathrm{i}^2 \qquad (1)$$

where c is a positive parameter. If c were to increase it is more costly for the firms to invest in advertising.

There is a continuum of consumers, uniformly distributed along a line. The population size is normalised to one. Firms have a fixed location and are located at opposite ends of this line: Firm 1 is located at point zero and firm 2 at point one. Consumers are differentiated by their location on the unit line, $x \in [0,1]$. A consumer's location $x$ represents the location of his ideal brand and characterises his relative tastes for the two available products. A consumer located $x$ units of distance from firm 1 pays a "transportation" cost of $tx$ when purchasing from firm 1 and $t(1-x)$ when purchasing from firm 2. The "transportation" cost $t > 0$ measures the per unit of distance transport cost. This "transportation" cost is interpreted as a

[13] I assume a quadratic functional form, common to the advertising literature. Khatibi and Vergote (2011), Hernández-García, J. M. (1997), Bester and Petrakis (1996), Levy and Gerlowsky (1991), and Economides (1989) use a similar quadratic functional form. The curvature of the quadratic functional form makes solving the problem more straight forward.

"mismatch cost" representing the consumer's disutility associated with buying a brand different to their ideal brand. Consumers face a discrete choice in this model: they purchase 1 unit from either firm 1 or firm 2 but not both.

The utility of the consumer located at $x$, $x \in [0,1]$, buying from firm 1 or firm 2, is respectively given by:

$$U_x^1 = n_1 q_1 + v_1 + a_1 - p_1 - tx; \quad (2)$$

$$U_x^2 = z\, n_1 q_2 + v_2 + a_2 - p_2 - t(1-x). \quad (3)$$

where $q_i$ denotes the proportion of consumers buying from firm $i$. The network effect ($n_i$) is multiplied by the proportion of consumers who choose to purchase the same brand. For convenience of notation, firm 2's network externality is expressed in terms of firm 1's, $n_2 = zn_1$, where $z \geq 1$. Due to network externalities, all else equal, consumers wish to purchase the brand that is purchased by a greater proportion of the market. The intrinsic value (v) is assumed to be symmetric across the two brands. If neither firm chooses to use advertising ($a_1 = a_2 = 0$) and there is no difference in network externalities across products ($z = 1$), consumers buy from the firm with the best price-location combination. I consider two cases: first, the benchmark case, where the value of the network externality is symmetric across products ($z = 1$), and second, where firm 2's product has a higher network externality than firm 1's, ($z > 1$).

In order to guarantee interior solutions, thus focusing on the case in which both firms are in the market, I assume that consumer's disutility associated with a product different from his ideal brand is strong enough to ensure that some consumers continue to purchase each of the products in equilibrium, even in the presence of network externalities: $t > \frac{2}{9c} + \frac{(1+z)n_1}{2}$. [14]

[14] See appendix A(ii) for the proof of this stability condition.

## 3.3 EQUILIBRIUM

In this section, I solve the model by backward induction. I begin by solving the second-stage optimal pricing decisions for firms. Subsequently, I determine the firms' optimal advertising decisions. For expositional clarity, I will give all the derivations for the general case ($z \geq 1$) and discuss the outcomes for the symmetric benchmark ($z = 1$) and the asymmetric case ($z > 1$) separately in each stage.

### 3.3.1 Stage 2: Prices

Firm demands are derived by determining the consumer who is indifferent between purchasing from firm 1 or firm 2, denoted by $\hat{x}$**.** By definition, the utility obtained by this consumer is the same for either brand, that is:

$$n_1 q_1 + v + a_1 - p_1 - t\hat{x} = z\, n_1 q_2 + v + a_2 - p_2 - t(1 - \hat{x}) \qquad (4)$$

The demand functions are derived, by letting $q_1 = \hat{x}$ and $q_2 = (1 - \hat{x})$, as:

$$q_1 = \frac{(a_1 - a_2) + (p_2 - p_1) + (t - z n_1)}{2t - (1+z) n_1}; \qquad (5)$$

$$q_2 = \frac{(a_2 - a_2) + (p_1 - p_2) + (t - n_1)}{2t - (1+z) n_1}. \qquad (6)$$

Equations (5) and (6) are market shares for firm 1 and firm 2, respectively. If firms choose not to advertise, then consumers will make their purchasing decisions based on the relative prices and their location. At this stage, all else equal, a firm would need to advertise more than the rival firm or charge a lower price to increase its demand.

In the benchmark case, when the network externalities across firms are equal, ($z = 1$), for equal pricing and advertising expenditure, the demand functions in equations (5) and (6) are symmetric. In the asymmetric case, where firm 2's product has a greater marginal network externality, $z > 1$, for equal pricing and advertising expenditure, Firm 1 (with the lower network externality) can be seen to have a lower market share than Firm 2 as $z > 1$.

In the second stage, firms compete in prices. The optimization problems for firms 1 and 2 are, respectively, given by:

$$max_{p_1}\, \pi_1 = p_1 \frac{(a_1 - a_2) + (p_2 - p_1) + (t - zn_1)}{2t - (1+z)n_1} - \frac{c}{2} a_1{}^2, \tag{7}$$

$$max_{p_2}\, \pi_2 = p_2 \frac{(a_2 - a_1) + (p_1 - p_2) + (t - n_1)}{2t - (1+z)n_1} - \frac{c}{2} a_2{}^2. \tag{8}$$

From the first-order conditions,

$$\frac{\partial \pi_1}{\partial p_1} = \frac{(a_1 - a_2) + (p_2 - 2p_1) + (t - zn_1)}{2t - (1+z)n_1} = 0, \tag{9}$$

$$\frac{\partial \pi_2}{\partial p_2} = \frac{(a_2 - a_1) + (p_1 - 2p_2) + (t - n_1)}{2t - (1+z)n_1} = 0, \tag{10}$$

And, the second-order conditions require,

$$\frac{\partial^2 \pi_1}{\partial p_1^2} = \frac{\partial^2 \pi_2}{\partial p_2^2} = \frac{-2}{2t - (1+z)n_1} < 0, \tag{11}$$

I derive the pricing reaction functions[15]:

$$p_1 = \frac{1}{2}(a_1 - a_2 + p_2 + t - zn_1), \tag{12}$$

$$p_2 = \frac{1}{2}(a_2 - a_1 + p_1 + t - n_1). \tag{13}$$

[15] Please refer to Appendices A(i) for stability condition proofs.

The reaction functions show that prices are strategic complements. Figure 1 depicts the pricing reaction functions when network externalities are symmetric, $z = 1$. The reaction function for firm 1 shifts to the left with asymmetric network externalities, $z > 1$.

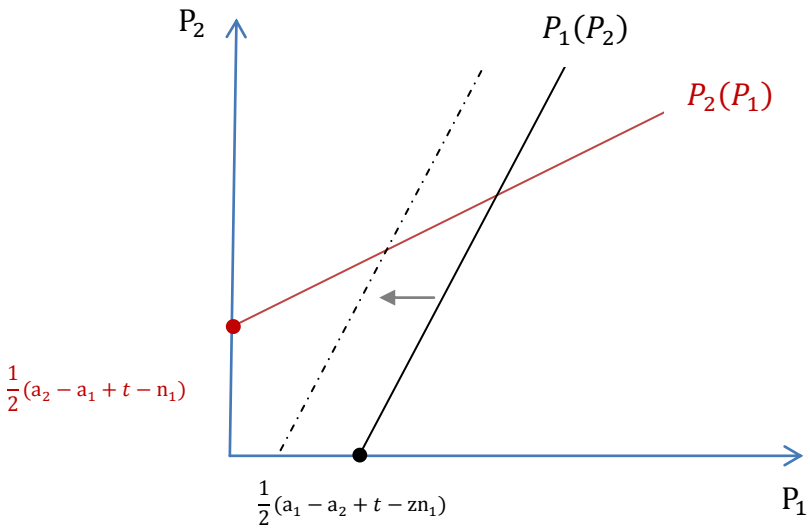


Figure 3.1: Price Reaction Functions

From the first-order conditions, (9) and (10), the second-stage equilibrium prices are:

$$p_1 = \frac{1}{3}(a_1 - a_2 - n_1(1 + 2z) + 3t); \quad (14)$$

$$p_2 = \frac{1}{3}(a_2 - a_1 - n_1(2 + z) + 3t). \quad (15)$$

And, equilibrium quantities are:

$$q_1 = \frac{a_1 - a_2 + 3t - (1+2z)n_1}{3(2t - (1+z)n_1)}; \quad (16)$$

$$q_2 = \frac{a_2 - a_1 + 3t - (2+z)n_1}{3(2t - (1+z)n_1)}. \quad (17)$$

Hence, firm's profits are equal to:

$$\pi_1 = \frac{(a_1 - a_2 + 3t - (1+2z)n_1)^2}{9(2t - (1+z)n_1)}; \quad (18)$$

$$\pi_2 = \frac{(a_2 - a_1 + 3t - (2+z)n_1)^2}{9(2t - (1+z)n_1)}. \quad (19)$$

In the benchmark case, given that I assume firms to be symmetric, without loss of generality, I will adopt the perspective of firm 1. Under symmetry when the network externalities across firms are equal, $(z = 1)$, equilibrium price, quantity and profits simplify to: $p_1 = \frac{1}{3}\left(a_1 - a_2 + 3(t - n_1)\right);\ q_1 = \frac{a_1 - a_2 + 3(t - n_1)}{6(t - n_1)};\ \pi_1 = \frac{(a_1 - a_2 + 3(t - n_1))^2}{18(t - n_1)}$. Thus, prices, market share and profits depend positively on own advertising expenditure and negatively on the advertising expenditure of the rival.

The term $(t - n_1)$ denotes the consumer's disutility or distaste associated with buying a brand different to their ideal brand less the benefit to the consumer from the network externality. This "transportation" cost $(t)$ is interpreted as a "mismatch cost" and the greater this cost the less likely consumers with a location preference for firm *i* are to consume the rival brand. Therefore, $t$ enters positively in the price equations. Firms will charge higher prices as consumer's disutility or distaste associated with purchasing a brand that differs from their ideal brand increases. Conversely, the value of the network externality enters negatively into the price equations. The presence of positive network externalities increases competition between firms and results in lower prices. Due to the positive network externality, a reduction in the price of firm *i*'s product increases the demand for firm *i*, and due to this increase in demand the product becomes even more attractive to other consumers, increasing the demand for firm $i$ further.

In the asymmetric case, where firm 2's product has a greater marginal network externality, $z > 1$, the results show that, similar to the benchmark case, equilibrium prices for firm *i* will depend positively on the advertising expenditure of firm *i* and negatively on the advertising expenditure of the rival firm. Holding advertising expenditures equal, firm 1's price, market share and profits are lower than firm 2's $(z > 1)$. Firm 1 has a lower network externality than firm 2 and must compensate for this fact by charging a lower price to entice consumers onto

its brand and remain in the market. As before, the higher the "transport" cost per unit the higher the prices of both products and the value of the network externality enters negatively into the price equations.

**Result 1.** *Given the levels of advertising, in the presence of positive network externalities, prices fall as the consumer's transport cost (disutility associated with purchasing away from their ideal brand) decreases and as network externalities become more significant in consumers' preferences (n increases).*

### 3.3.2 Stage 1: Advertising

In the first stage, the optimization problems for firm 1 and 2 are given by:

$$\max_{a_1} \pi_1 = p_1 \frac{(a_1 - a_2) + (p_2 - p_1) + (t - z n_1)}{2t - (1+z) n_1} - \frac{c}{2} {a_1}^2, \tag{20}$$

$$\max_{a_2} \pi_2 = p_2 \frac{(a_2 - a_1) + (p_1 - p_2) + (t - n_1)}{2t - (1+z) n_1} - \frac{c}{2} {a_2}^2. \tag{21}$$

The first-order conditions are given by:

$$\frac{\partial \Pi_1}{\partial a_1} = \frac{2(3t - a_2 - (1-2z) n_1) - a_1 (9c(2t - (1+z) n_1) - 2)}{9(2t - (1+z) n_1)} = 0, \tag{22}$$

$$\frac{\partial \Pi_2}{\partial a_2} = \frac{2(3t - a_1 - (2+z) n_1) - a_2 (9c(2t - (1+z) n_1) - 2)}{9(2t - (1+z) n_1)} = 0. \tag{23}$$

And, the second-order conditions require,

$$\frac{\partial^2 \pi_1}{\partial a_1^2} = \frac{\partial^2 \pi_2}{\partial a_2^2} = \frac{-(9c(2t - (1+z) n_1) - 2)}{9(2t - (1+z) n_1)} < 0. \tag{24}$$

In the symmetric case, I will, again, adopt the perspective of firm 1. Under symmetry when the network externalities across firms are equal, $(z = 1)$, the advertising reaction function of firm 1 simplifies to $a_1 = \frac{3(t - n_1) - a_2}{9c(t - n_1) - 1}$.

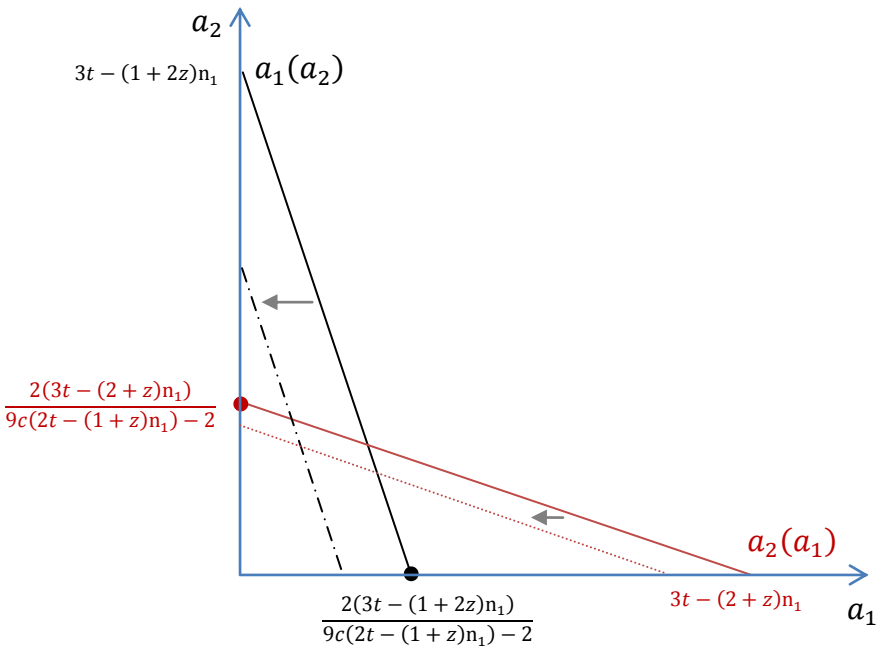


Figure 3.2: Advertising Reaction Functions

The reaction functions show that advertising expenditures are strategic substitutes. Figure 2 depicts the advertising reaction functions when network externalities are symmetric, $z = 1$. The reaction functions for both firms shifts to the left with asymmetric network externalities, $z > 1$. Firm 1's reaction function shifts further to the left than Firm 2's for any given z>1.

In the symmetric case, the subgame perfect equilibrium advertising, quantity and profits simplify to: $a_1 = a_2 = \frac{1}{3c}, p_1 = p_2 = t - n_1, q_1 = q_2 = \frac{1}{2}$ and $\pi_1 = \pi_2 = \frac{9c(t-n_1)-1}{18c}$.

**Result 2.** *In the benchmark case with symmetric network externalities, when* $t > \frac{2}{9c} + n$, *there is a stable equilibrium where advertising, pricing, demands and profits for firms 1 and 2 are equal.*

The result here shows that in the benchmark case where network externalities are the same across firms, firms will share the market equally in equilibrium with identical prices and expenditure on advertising. Market shares are equal in comparison to the Hotelling model without advertising or network externalities. However, the prices are affected negatively by

the network externality and positively by the transport cost, as seen in the analysis of the pricing stage.

In the case of an interior equilibrium in the second stage, the second order conditions of both firms are satisfied when $t > \frac{1}{9c} + \frac{(1+z)n_1}{2}$. Furthermore, I consider the condition for reaction function stability which states that own effects of advertising on marginal profits dominate cross effects. The equilibrium is locally unstable with transport costs such that $\frac{1}{9c} + \frac{(1+z)n_1}{2} < t \leq \frac{2}{9c} + \frac{(1+z)n_1}{2}$ . I focus my attention on locally (and globally) stable equilibria; $t > \frac{2}{9c} + \frac{(1+z)n_1}{2}$ .[16] From the first-order conditions (22) and (23), I derive the advertising reaction functions:

$$a_1 = \frac{2(3t - a_2 - (1+2z)n_1)}{9c(2t - (1+z)n_1) - 2}; \tag{25}$$

$$a_2 = \frac{2(3t - a_1 - (2+z)n_1)}{9c(2t - (1+z)n_1) - 2}. \tag{26}$$

**Result 3.** *In the presence of asymmetric positive network externalities both firms will exist in the market, when* $t > \frac{2}{9c} + \frac{(1+z)n_1}{2}$. *The firm with the greater network externality will dominate with higher advertising expenditure, price, market share and profits compared to the firm with the lower network intensity.*

The result above provides a new example of a "Matthew Effect" in markets with relative differences in network externalities where an initial advantage begets further advantage. A firm entering the market with a relatively higher network externality than his rival is found to dominate the market in equilibrium. However, due to product differentiation (branding) and heterogeneous consumers, both firms can exist in the market. The dominant firm with the greater network externality will charge a higher price and spend more on advertising.

[16] Please refer to Appendices A (ii) for stability condition proofs.

## 3.4 DISCUSSION

The gaming industry was reported to be worth almost $80 billion in 2012, according to a recent report in *The Economist* (2013). This figure combines the revenue from devices, software and gaming revenue. Microsoft and Sony are now in the midst of another console war with their respective products, Xbox One and Playstation 4, both due for release in the run up to the holiday season this year. Network externalities are important for the gaming industry as gamers interact with each other through online gaming networks. The gaming consoles are launched simultaneously and the majority of gamers decide on one game console to purchase. Strategic advertising and price competition are fierce during the launch of these products.

In the introduction, I mentioned the console war launched between Microsoft and Sony in 2005. In this section, I will apply product information and statistics from their respective products, Xbox 360 and Playstation 3, to analyse this system war further. I have chosen to examine this industry because most of the information and statistics of importance are available in some form. However, these products are available worldwide, competing in many different markets which have evolved considerably over the period from 2005 to the present day. My focus is on the sales of their hardware, i.e. console devices, but inevitably firms in this industry are also concerned with the complementary market of gaming software.

The decision for gamers about which gaming console to purchase involves expectations about which console will be more heavily purchased in addition to the relative prices and qualities of the rival firms' products. These expectations are due to the fact that a higher number of purchases of a given console translate directly into an increase in the number of competitors on the online network, social interaction, troubleshooting knowledge base, availability of games, and complementary products, for the gamer.

There is little difference between the qualities of the hardware of these consoles. Games exclusive to one console are available and some games are available across both consoles. What is important for the application of this model is that in order for network users to play each other using an online network, even with a game available to both, they must own the same console. The Xbox 360 console and its online multiplayer gaming and digital media service Xbox Live operated by Microsoft boosted the largest, most active online community of friends, family and rivals worldwide after its launch in 2007.[17] It is still reported to have the largest online community which presents a more "hardcore" experience for online gamers.[18] These benefits offer each Xbox 360 console buyer an increased marginal benefit from joining this network over the alternative provided by Playstation, namely, Playstation Network.

| | Sony Playstation 3 | Microsoft Xbox 360 |
|---|---|---|
| **Advertising** | $150 million | $945 million |
| **Price** | $249 + free online service | $299 + $60 yearly online subscription |
| **Market Share** | 73.8 million units | 74.9 million units |
| **Profits** | -4.951 billion | -2.996 billion |

Table 3.1: Case study statistics relating to the console system war

When examining the advertising revenue of the rival companies during the launch of these products it is clear that Microsoft's advertising budget was much greater than Sony's. Ad age reports that Jeff Bell, Microsoft's Xbox Marketing head, had an advertising budget of $945 million during this period.[19] Meanwhile Sony was reported to be spending $150 million on their ad campaign during the launch of the Playstation 3.[20] This large difference can be observed as a trend over time. In 2010, when Microsoft launched the Xbox Kinect, a gaming

[17] http://live.vgcore.com/news/2174.html
[18] http://games.ninemsn.com.au/news/ps3-vs-xbox-360-who-wins
[19] http://www.joystiq.com/2006/11/12/jeff-bell-has-945mm-to-spend-marketing-the-xbox-and-zune
[20] http://money.cnn.com/magazines/fortune/fortune_archive/2006/11/13/8393083/

system that combines a hands free controller with the Xbox 360 console, they launched a $500 million marketing campaign. [21] In a similar product launch in 2009, Sony is reported to have spent £82 million ($132 million) on a marketing campaign during the release of the PS3 slim gaming console.[22] In viewing their relative advertising expenditure during 2012, a period where both firms were winding down their current products, Microsoft spent $62.2 million and Sony spent $53.6 million on media advertising.[23] Furthermore, to highlight this difference in spending on advertising, Sony in 2010 admitted that it will never be able, or perhaps want, to spend the same amount on promoting the Playstation as Microsoft does on the Xbox.[24]

Sony originally launched with a higher price but quickly dropped its price. Its approach to the pricing of the next generation PS4, due to launch this year, is also reported to be lower than the Xbox One, $400 compared to $500.[25] Considering the yearly subscription of $59.99 per year to access Xbox Live, Microsoft's console users have a higher price to pay. The Playstation Network has no associated charge for players. At the end of 2012, the market shares were very close with global sales of Xbox 360 reaching 74.9 million units and Playstation 3 reaching 73.8 million units. [26] These figures show that Microsoft has continued to hold the lead with a greater market share over the seven-year period from 2006 to 2013. However, both firms are significant players in the gaming market and the market share is very close with Playstation gaining significant ground.

The consoles are sold at a loss due to the profits made from the sales of the complementary games software. Despite sales of over 70 million consoles each, Ben Cousins, a former EA and Sony employee, reports that the consoles have cost the companies collectively over $8

[21] http://www.informationweek.com/smb/mobile/xbox-kinect-to-appear-on-oprah-ellen/227900162?cid=RSSfeed_IWK_All
[22] http://www.itproportal.com/2009/08/25/sony-spend-82m-ps3-european-campaign/
[23] http://adage.com/article/digital/xbox-playstation-prep-bruising-ad-spending-battle/242141/
[24] http://www.computerandvideogames.com/263948/sony-we-cant-compete-with-xboxs-spending/
[25] http://fansided.com/2013/08/06/which-company-will-win-the-next-gen-console-wars-xbox-one-vs-ps4/
[26] http://www.vgchartz.com/yearly/2012/Global/

billion in losses.[27] Citing financial reports of the companies, Cousins' report states that Microsoft has spent close to $3 billion on Xbox 360 while Sony has fared worse, spending close to $5 billion on Playstation 3. Therefore, when considering their relative profits relating to the consoles Microsoft's profit is greater.

The outcome of my model predicts that the dominant firm with the greater network externality will optimally spend more on advertising, charge a higher price, gain a greater market share and ultimately have higher profits in equilibrium. This analysis, using evidence from the market for gaming consoles, highlights the role of network externalities and a 'Matthew effect' in equilibrium outcomes. I expect that an examination of products in the area of computer software, mobile networks, smartphones, tablet computers, computer operating systems and/or applications, social networking sites, websites (Ebay, Google, Wiki, etc), credit cards, electric cars, pharmaceutical drugs, music players, and video recorders, may show further evidence of the role of differences across network externalities. Moreover, the type of products in markets with network externalities are ever increasing due to the growth of network effects and the increased ease of social interaction

[27] http://www.gamefront.com/the-ps3-and-xbox-360-have-made-huge-losses-up-to-8-billion/

## 3.5 CONCLUSION

In this paper, I presented a Hotelling model investigating two firms, producing different varieties of a good, competing in a market with persuasive advertising and network externalities. Strategic interactions in advertising and pricing were analysed. A benchmark case where firms' network externalities are symmetric provided a case for comparison. This model is a first attempt to focus on how firms' relative network externalities affect price and advertising competition in a duopoly setting.

First, I found that given symmetry and advertising expenditures, network externalities intensify price competition with equilibrium prices falling as network effects become more significant. Second, with asymmetric network externalities, if the consumer's disutility or distaste associated with purchasing a brand different from his ideal brand (travel costs) are not 'too' low, both firms will exist in the market. The findings provide support for a "Matthew Effect" where the firm's initial advantage due to its higher network externality accumulates further advantage through the advertising and pricing stages. The firm with the greater network externality is found to dominate the market. This dominant firm will be observed with a higher advertising expenditure, price, profits and market share relative to the rival firm.

The approach remains partial in many respects. The model is linear in transportation costs, differences in network externalities are exogenous and the market size is fixed. Further research to endogenise network externalities and investigate the results in a more general model would test the robustness of my results.

## 3.6 REFERENCES


Bagwell, K. (2007). "The Economic Analysis of Advertising", *Handbook of Industrial Organization,* Vol. 3, pp. 1701-1844.

Bain, J. S. (1956). *Barriers to New Competition: Their Character and Consequences in Manufacturing Industries, American Economic Review,* Harvard UP, Cambridge.

Bester, H. And E. Petrakis (1996). "Coupons and Oligopolistic Price Discrimination", *International Journal of Industrial Organisation,* Vol. 14, No. 2, Pp. 227-242.

Braithwaite, D. (1928). "The Economic Effects of Advertisement", *Economic Journal,* Vol. 38, No. 149, pp. 16-37.

Chwe, M. (2001). Rational Ritual: Culture, Coordination, and Common Knowledge, Princeton, N.J.: Princeton University Press.

Clark, C. R. And I. J. Horstmann (2005). "Advertising and Coordination in Markets with Consumption Scale Effects", *Journal of Economics and Management Strategy,* Vol. 14, No. 2, Pp. 377-402.

Comanor, W. S. And T. A. Wilson (1967). "Advertising, Market Structure and Performance", *The Review of Economics and Statistics,* Vol. 49, No. 4, pp. 423-440.

David, P. A. (1985). "Clio and the Economics of QWERTY", *American Economic Review,* Vol. 75, No. 2, pp. 332-337.

Dixit, A. And V. Norman (1978). "Advertising and Coordination in Markets with Consumption Scale Effects", *Journal of Economics and Management Strategy,* Vol. 14, No. 2, pp. 377-402.

Economides, N. (1989). "Quality Variations and Maximal Product Differentiation", *Regional Science and Urban Economics,*Vol. 19, pp. 21-29.

Economist (2013). "Battle of the boxes", *The Economist,* [online] 25 May. Available at: <http://www.economist.com/news/business/21578427-microsofts-newest-games-console-has-entire-living-room-its-sights-battle-boxes> [accessed 20 August 2013]

Farrell, J. And Klemperer, P. (2007). "Coordination and Lock-In: Competition with Switching Costs and Network Effects", *Handbook of Industrial Organization,* Elsevier.

Farrell, J. And Saloner, G. (1985). "Standardization, Compatibility, and Innovation", *Rand Journal of Economics,* Vol. 16, No. 1, pp. 17-83.

Hernández-García, J. M. (1997). "Informative Advertising, Imperfect Targeting and Welfare", *Economic Letters,* Vol. 55, No. 1, pp. 131-137.

Hotelling, H. (1929). "Stability in Competition", *Economic Journal,* Vol. 39, pp. 41-57.

Katz, M. L. And Shapiro, C. (1985). "Network Externalities, Competition, and Compatibility", *American Economic Review,* Vol. 75, No. 3, pp. 424-440.

Khatibi, A. And Vergote, W. (2011). "Trade Policy in the Face of Price and Non-Price Strategies", *Portugese Economic Journal,* Vol. 10, No. 1, pp. 3-21.

Krahmer, D. (2006). "Advertising and Conspicuous Consumption", *Journal of Institutional and Theoretical Economics,* Vol. 162, No. 4, pp. 661-682.

Levy, D. T. And D. A. Gerlowsky (1991). "Competition, Advertising and Meeting Competition Clauses", *Economic Letters,* Vol. 37, No. 3, Pp. 217-221.

Merton, R. K. (1968). "The Matthew Effect in Science", *Science,* Vol. 159, No. 3810, pp. 56-63.

Mrázová, M. And P. Neary (2013). "Selection Effects with Heterogeneous Firms", CEPR Discussion Paper No. DP9288. Available at SSRN: http://ssrn.com/abstract=2210258

Pastine, I. And T. Pastine (2002). "Consumption Externalities, Coordination and Advertising", *International Economic Review,* Vol. 42, No. 3, pp. 919-943.

Pastine, I. And T. Pastine (2011). "Coordination in Markets with Consumption Externalities: Advertising and Product Quality", *The Manchester School,* Vol. 79, No. 1, pp. 24-62.

Robinson, J. (1933). Economics of Imperfect Competition, London: Macmillan and Co..

Rohlfs, J. (1974). "A Theory of Interdependent Demand for a Communications Service", *Bell Journal of Economics and Management Science,* Vol. 5, No. 1, pp. 16-37.

Sahuguet, N. (2011). "A Model of Repeat Advertising", *Economic Letters,* Vol. 111, No. 1, pp. 20-22.

Spence, M. (1980). "Notes on Advertising, Economies of Scale, and Entry Barriers," *Quarterly Journal of Economics,* Vol. 95, No. 3, pp. 493-507.

Whelan, A. (2011). "Entry Deterrence, Coordinating Advertising and Pricing in Markets with Consumption Externalities" Working Paper.

## 3.7 APPENDIX

### A. The Stability of the Equilibrium

#### i. Pricing

This proof shows that the Nash pricing equilibrium presented in the symmetric case is stable. The corollary used is taken from Vives (2001): Consider a two-player game with one-dimensional strategy spaces. If set of strategies $(\mathrm{p}_1, \mathrm{p}_2)$ is a regular Nash equilibrium, then it is locally stable if at $(\mathrm{p}_1, \mathrm{p}_2)$:

$$\left| \frac{\partial^2 \Pi_1}{\partial p_1^2} \quad \frac{\partial^2 \Pi_2}{\partial p_2^2} \right| > \left| \frac{\partial^2 \Pi_1}{\partial p_1 \partial p_2} \quad \frac{\partial^2 \Pi_2}{\partial p_1 \partial p_2} \right| \tag{27}$$

The profit maximisation functions are given in equation (7) and (8). Using equation (27), computing second order conditions and cross derivatives, the following result is obtained:

$$\left| \left(\frac{-2}{2(t-n_1)}\right)\left(\frac{-2}{2(t-n_1)}\right) \right| > \left| \left(\frac{1}{2(t-n_1)}\right)\left(\frac{1}{2(t-n_1)}\right) \right| \tag{28}$$

$$\left| \frac{4}{(2(t-n_1))^2} \right| > \left| \frac{1}{(2(t-n_1))^2} \right| \tag{29}$$

The inequality is strictly satisfied.

□

#### ii. Advertising

This proof shows that the Nash advertising equilibrium presented is (locally) stable if and only if $\mathrm{t} > \frac{2}{9c} + \frac{(1+z)\mathrm{n}_1}{2}$ . The profit maximisation functions are given in equation (7) and (8). Using equation (27), computing second order conditions and cross derivatives, the following result is obtained:

$$\left| \left(\frac{-(9c(2t-(1+z)\mathrm{n}_1)-2)}{(9c(2t-(1+z)\mathrm{n}_1)}\right)^2 \right| > \left| \left(\frac{-2}{(9c(2t-(1+z)\mathrm{n}_1)}\right)^2 \right| \tag{30}$$

$$|9c(2t-(1+z)\mathrm{n}_1) - 2| > |2| \tag{31}$$

The inequality is satisfied if and only if $\mathrm{t} > \frac{2}{9c} + \frac{(1+z)\mathrm{n}_1}{2}$.

□