ABSTRACT

Title of Dissertation: ESSAYS ON ADVERTISING AND PRICE COLLUSION

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Chapter I: Persuasive advertising alters consumers' tastes and creates brand loyalty. The established view in the economics literature is that such advertising is anti-competitive and results in higher prices. This paper demonstrates that this is not necessarily true. This is shown in a model of a duopoly with horizontal product differentiation, where firms interact repeatedly over an infinite horizon. Firms in such a market try to increase their profits by avoiding price competition. They do this by colluding on price while making independent decisions on advertising. This practice is called price semicollusion. However, collusion on price leads to intensified advertising, which may lower firm profits to below the competitive level when advertising is market-stealing (rather than market-expanding). In such a case the collusion on price would break down and firms would revert to price competition. Thus, persuasive advertising can induce price competition. Moreover, the paper shows that the equilibrium price in a market with persuasive advertising can be lower than the price without it. This contradicts the prevalent view on the effect of persuasive advertising.

Chapter II: This paper examines the effect of advertising on price collusion using data on price fixing across manufacturing industries in the United States. I construct an original dataset from summaries of price fixing cases initiated by the Department of Justice between 1960 and 2003. In determining if advertising hinders or facilitates price collusion, the paper makes a distinction between market-expanding and market-stealing advertising. The need for the distinction between the two kinds of advertising is driven by the theoretical model outlined in the paper. The model shows that price collusion results in intensified advertising. This could undermine the gains from collusion if advertising is market-stealing rather than market-expanding. The paper identifies two types of industries where advertising is more market-stealing: (1) Industries with low market growth and (2) Industries with high product differentiation. The econometric results from a probit model provide evidence that supports the theory. The incidence of collusion is found to be lower in low-growth industries with high advertising. Collusion is also found to be less likely in product differentiated industries with high advertising.

ESSAYS ON ADVERTISING AND PRICE COLLUSION

By

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Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
2005

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DEDICATION

This dissertation is dedicated to my parents.

ACKNOWLEDGEMENTS

I owe a big debt of gratitude to my advisor Prof. Deborah Minehart, who has been a true academic role-model. Her advice and guidance were invaluable.
I would like to thank my committee members Prof. Roger Betancourt, Prof. Ginger Jin and Prof. Dan Vincent for all their help and encouragement. I would also like to thank Devesh Roy for all the helpful discussions I had with him.
Last but not the least, my wife Aparna Mathur has been a constant source of support and patience and has helped make everything possible.

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Chapter 1

Introduction

Advertising is an increasingly important means of competition between firms. According to TNS Media Intelligence, total advertising expenditures for all media in the U.S. in 2004 was $141.1 billion. Whether advertising is used to announce the release of a new product in the market, to provide information on prices or attributes of existing products or used as a means to enhance the image of the product in the eyes of the consumer, its effect seems to be pervasive.

The first chapter of this dissertation deals with advertising that is aimed at enhancing the perceived value that a consumer attaches to a product. Such advertising, called persuasive advertising, is generally believed to be anti-competitive as it tends to make the demand for an advertised product more inelastic. Thus, it is argued that consumers would be better off in the absence of such advertising as they would face lower prices. However, as is shown in the chapter, advertising can have an important bearing on firms' pricing conduct in a market. In particular, when a firm's advertising has the effect of diverting demand away from other firms in the market, in which case advertising is classified as market-stealing, advertising can break down an attempt at price collusion between firms by reducing the benefit of price collusion relative to the alternative of price competition. If firms in a market were prohibited from engaging in such advertising, successful price collusion would be possible between them., Thus, under certain conditions the equilibrium price in a market would be lower, and consumer welfare higher, with persuasive advertising than without.

Chapter 2 examines the incidence of price collusion across U.S. manufacturing to determine whether advertising facilitates or hinders price collusion. If the theoretical prediction reached in chapter 2 is accurate, advertising should hinder price collusion when it is market-stealing and when this effect is significant. On the other hand a facilitating role for advertising cannot be ruled out, particularly when it serves as a barrier to entry for new firms.

The study of the incidence of price collusion involves the construction of an original data set on pricing conduct across the manufacturing sector in the U.S.. This data set is constructed from summaries of price-fixing cases initiated by the Antitrust Division of the Department of Justice between 1960 and 2003. Information from these cases is used to assign manufacturing industries into one of two groups: collusive and non-collusive. These two groups of industries are then systematically compared with regards to various industry characteristics that oligopoly theory suggests affect the likelihood of price collusion including advertising.

Two empirical strategies are followed to identify industries where advertising might have a significant market-stealing effect. These are identified as industries that are characterized by both low market growth and high advertising as part of the first strategy. The second empirical strategy identifies consumer goods industries with high advertising as industries with a significant market-stealing advertising.

The results from the estimation of a probit model suggest the following. The incidence of price collusion is lower amongst industries that are characterized by low growth and high advertising. The incidence of collusion is also found to be lower amongst consumer goods industries with high advertising. Taken together, these results imply that the incidence of price collusion is lower in industries characterized by a significant market-stealing effect of advertising. This lends support to the main hypothesis that advertising can break down price collusion when it is market-stealing.

The estimation results also provide evidence that higher market growth and higher capital intensity are both associated with a higher likelihood of collusion. This effect of these industry characteristics on the incidence of collusion have been documented before using U.K. data from the 1950s and that on export cartel formation in the U.S. in the 1920s and 1930s.

Chapter 2

Persuasive Advertising and Price Semicollusion

2.1 Introduction

Advertising that directly affects a consumer's preferences to increase the consumer's valuation of the advertised product is called persuasive advertising. Such advertising makes demand more inelastic. The result of such advertising, according to the existing literature, is a softening of price competition between oligopolistic firms resulting in higher prices in equilibrium. Persuasive advertising is thus viewed as being anti-competitive.

This paper presents a theoretical model that incorporates all the essential features of persuasive advertising. However, contrary to the existing view, the paper shows that persuasive advertising is not necessarily anti-competitive. It can weaken the incentives for tacit price collusion and thus *help in fostering competition.* Furthermore, consumers may face a lower price with such advertising than without. This is shown in a dynamic game with repeated interaction between oligopolistic firms who choose price and advertising every period.

2.2 Literature Review

According to Tirole (1988), persuasive advertising is viewed as altering consumers' tastes, creating product differentiation that is not real ("spurious" product differentiation) and brand loyalty. Such advertising is believed, at best, to persuade consumers and at worst, to fool them (Galbraith (1967), Solow (1967)). As a consequence of advertising, the demand for an advertised product becomes more inelastic, resulting in higher prices. It is also thought that such advertising by established firms may give rise to barriers to entry. If advertising has an effect of inducing brand loyalty amongst consumers and tying them in, established firms can gain a captive set of consumers with the help of advertising over a sustained period of time. A potential entrant needs to contend with the required level of advertising expenditure go wean consumers away from the established firms in addition to any other investments. Thus the established view on persuasive advertising suggests it may have strong anti-competitive effects as it has no "real" value to consumers. Bagwell (2003) states that Joan Robinson was amongst the first advocates of this view. According to Robinson (1933), "the customer will be influenced by advertisements , which play upon his mind with studied skill and makes him prefer the goods of one producer over another because they are brought to his notice in a more pleasing and forceful manner." On the other hand, Braithwate (1928) regarded advertising as a "selling cost". As per him, firms engage in advertising in order to change consumers' valuations so that they value the advertised product more. Advertising thus, shifts out a consumer's demand for the advertised product thereby distorting the consumers decisions compared to those that are represented by his "true" preferences (captured by the pre-advertising demand). The economic resources that are used in advertising activities thus may be wasted, since advertising's effect is to induce consumers to buy the "wrong" quantities of goods that are not well suited to their true needs at prices that are swollen from the cost of advertising.

Advertising for consumer goods (usually non-durable) for which consumers are not likely to indulge in costly search before purchase, is believed by many to be of the persuasive type. Network television is usually the medium of such advertising. The medium has a very wide reach but often conveys very little information. Nicholls' (1951) study of the cigarette industry shows that from the 1920s on, cigarette manufacturers primarily competed through advertising and brand proliferation instead of competing on price or quality.

Dixit and Norman (1978) show that persuasive advertising in an oligopolistic industry softens price competition between firms resulting in higher prices in equilibrium. As a result, consumer welfare is lower with advertising than without. This is in contrast with the case where advertising is informative, where consumer welfare is higher with advertising than without (Stigler and Becker (1977)).

As I show, the equilibrium price in an oligopolistic industry can be lower with persuasive advertising than without. Welfare comparisons should take this possibility into account.

2.3 The Model

The theoretical model draws from Singh and Vives (1984) and has an oligopolistic industry with two firms, each one producing a horizontally differentiated good, and a competitive numeraire good producing industry. There is a continuum of identical consumers, each with a utility function separable and linear in the numeraire good, thus eliminating any income effects on the goods produced in the oligopolistic industry. The mass of consumers is normalized to one without loss of generality.

The setup of Singh and Vives is modified to incorporate persuasive advertising. I model persuasive advertising by firms as affecting the preferences of the consumers in two possible ways. First, it may enhance the value of the advertised product in the eye of the consumer. I shall term this type of advertising Type A advertising. Type A advertising in turn may work in two ways. It may be generic, in the sense that advertising by firm 1 not only increases the value attached by the consumer to the product of firm 1 but also the value attached to the product of firm 2. This is especially likely if the two products are seemingly identical and satisfy similar wants. On the other hand, type one advertising may be purely selective. This is the case when advertising by firm 1 only increases the value attached by the consumer to the product of firm 1.

Second, advertising by a firm may seek to align the preferences of the consumer more in line with the characteristics of the advertised product. I call this Type B advertising. Such advertising would increase the value of the advertised product as well as lower the value of the other product. Type B advertising is thus like a tug of war.[1].

[1] This is consistent with how the literature on advertising views persuasive advertising affecting consumers' preferences. For instance see von der Fehr and Stevik (1998).

I denote the prices charged by firm 1 and firm 2 as p_1 and p_2 respectively and Φ_1 and Φ_2 as the respective levels of advertising undertaken by them. The quantities of the two products consumed by the representative consumer are denoted by q_1 and q_2 respectively. Since the utility function is separable and linear in the numeraire good, the consumer's problem can be expressed as the maximization of the (sub) utility function corresponding to the oligopolistic industry. The consumer selects a pair (q_1, q_2) to solve:

$$\max\ u\left(q_1, q_2\right) - \sum_{i=1}^{2} p_i q_i$$

where

$$u\left(q_1, q_2\right) = \sum_{i=1}^{2} \left[\sigma + \left(\varepsilon + \tau\right)\Phi_i - \left(\psi - \tau\right)\Phi_{j \neq i}\right] q_i - \frac{1}{2}\left(\omega q_1^2 + 2\chi q_1 q_2 + \omega q_2^2\right)$$

The goods are substitutes, independent or complementary depending on whether $\chi > 0$, $\chi = 0$ or $\chi < 0$. I shall restrict attention to the case where the goods produced by the two firms are imperfect substitutes (thus it is assumed that $\omega > \chi$).

The effect of advertising on the consumer's utility is captured by the parameters ε, τ and ψ. The effect of the selective component of Type A advertising is captured by ε, whereas that of the generic component is captured by τ. The effect of Type B advertising is captured by ψ.

The above utility function gives rise to the following demand functions for firm 1 and firm 2 respectively[2]

$$D_1\left(p_1, p_2, \Phi_1, \Phi_2\right) = \alpha - \beta p_1 + \delta p_2 + \gamma \Phi_1 - \lambda \Phi_2 \tag{2.1}$$

[2]The derivation of the demand functions is shown in the appendix. The parameters β and δ are respectively the own-price effect and the cross-price effect where $\beta = \frac{\omega}{\omega^2 - \chi^2}$ and $\delta = \frac{\chi}{\omega^2 - \chi^2}$.

and

$$D_2\left(p_1, p_2, \Phi_1, \Phi_2\right) = \alpha - \beta p_2 + \delta p_1 + \gamma \Phi_2 - \lambda \Phi_1 \tag{2.2}$$

where the parameters γ and λ capture the effects of advertising and are defined as follows.

Definition 1 *Define γ as the own-effect of advertising such that $\gamma = \frac{\varepsilon+\tau}{\omega+\chi}$.*

Definition 2 *Define λ as the magnitude of cross-effect of advertising such that $\lambda = \left|\frac{\tau-\psi}{\omega+\chi}\right|$*[3]*.*

The demand functions above are for the case where the effect of Type B advertising dominates the generic effect of Type A advertising. Advertising by a firm reduces the demand of the other firm in the industry. In such a case, advertising in the industry is said to be market-stealing. If the generic component of Type A advertising were to dominate instead, advertising in the industry would be market-expanding. Advertising by a firm would then increase the demand for the other firm in the industry as well. This would be represented by λ entering the demand functions with a positive sign as follows

$$D_1\left(p_1, p_2, \Phi_1, \Phi_2\right) = \alpha - \beta p_1 + \delta p_2 + \gamma \Phi_1 - \lambda \Phi_2 \tag{2.3}$$

and

$$D_2\left(p_1, p_2, \Phi_1, \Phi_2\right) = \alpha - \beta p_2 + \delta p_1 + \gamma \Phi_2 - \lambda \Phi_1 \tag{2.4}$$

Note that the elasticity of demand for, say, firm 1 at $p_1 = p_2 = p$ and $\Phi_1 = \Phi_2 = \Phi$ is

$$\epsilon_1 = -\frac{\partial D_1}{\partial p_1}\frac{p_1}{D_1} = \frac{(\beta-\delta)\,p}{\alpha-(\beta-\delta)\,p+(\gamma-\lambda)\,\Phi}$$

[3]Thus, $\lambda = \frac{\psi-\tau}{\omega+\chi}$ if $\psi > \tau$ and $\lambda = \frac{\tau-\psi}{\omega+\chi}$ if $\psi > \tau$.

At any positive level of demand, the elasticity of demand is a decreasing function of advertising. This is consistent with the view on persuasive advertising.

Firms have access to the same advertising and production technologies. The cost of advertising is $a\frac{\Phi^2}{2}$. The marginal cost of production is constant and is set equal to zero.

There are infinite periods over which firms face each other in the market. In each period the demand facing each firm is as given in eq.(2.1) and eq. (2.2). In each of these periods, firms choose their respective prices and advertising levels.

2.3.1 Competition

Under competition, firms compete on both price and advertising. The equilibrium of the repeated game is for each firm to choose the Nash equilibrium price and advertising of the one-shot simultaneous move stage game. In this case firm 1's behavior is described by

$$max\left\{\pi_1 = p_1\left(\alpha - \beta p_1 + \delta p_2 + \gamma\Phi_1 - \lambda\Phi_2\right) - a\frac{\Phi_1^2}{2}\right\}$$

with respect to $\{p_1, \Phi_1\}$

and firm 2 's behavior is similarly described. The first order conditions[4] give the two best response functions for firm 1

$$p_1 = \frac{1}{2\beta}\left[\alpha + \delta p_2\right] + \frac{1}{2\beta}\left[\gamma\Phi_1 - \lambda\Phi_2\right] \tag{2.5}$$

and

$$\Phi_1 = \frac{\gamma}{a}p_1 \tag{2.6}$$

[4]The strict concavity of the demand functions in guarantee the staisfaction of the second order conditions.

The first term on the right-hand side of eq.(2.5) is simply the price best response function without advertising where firm 1's optimal price is increasing in the price charged by firm 2. The second term is an extra markup associated with the presence of advertising and reflects the fact that the elasticity of demand is lower with advertising.

Eq.(2.6) states that the optimal level of advertising for a firm is such that at that level, the marginal cost of an additional unit of advertising is exactly offset by the marginal benefit from advertising (which is equal to the profit margin times the increase in demand brought about by that extra unit of advertising).[5]

Solving for the Nash equilibrium ($p_1^n = p_2^n = p^n$ and $\Phi_1^n = \Phi_2^n = \Phi^n$) I get

$$\begin{aligned} p^n &= \frac{1}{(2\beta - \delta)} \left[\alpha + (\gamma - \lambda)\, \Phi^n\right] \\ p^n &= \frac{a\alpha}{a\,(2\beta - \delta) - \gamma\,(\gamma - \lambda)} \end{aligned} \tag{2.7}$$

$$\Phi^n = \frac{\alpha\gamma}{a\,(2\beta - \delta) - \gamma\,(\gamma - \lambda)} \tag{2.8}$$

The equilibrium price p^n in eq.2.7 exceeds the Nash equilibrium price *without* advertising $\frac{\alpha}{(2\beta-\delta)}$ This is due to the lower elasticity of demand in the presence of advertising . Advertising may give each firm a set of captive or loyal customers. The firms would not compete as intensively for these customers. Advertising thus, lowers the intensity of price competition, thereby increasing the equilibrium price.

Interestingly, the equilibrium price is decreasing in the cost of advertising (a). The reason for this is that advertising lowers the price elasticity of demand, thereby increasing the price that a firm can charge. Higher advertising cost, by lowering the equilibrium level of

[5]Note that firm 2's advertising level Φ_2 does not directly enter firm1's advertising best response function. However, firm 1's optimal choice of advertising does depend on firm 2's advertising through the latter's influence on firm1's optimal price (as shown in firm1's price best response function in eq.2.5) which does enter its advertising best response function.

advertising, lowers the equilibrium price as well. As the cost of advertising rises, firms rely less on advertising as a means of competition and are forced to compete more intensively on price, thus driving down the price charged in equilibrium. Consider the case where the cost of advertising is such that it makes advertising prohibitive such that firms choose not to advertise at all in equilibrium (when $\alpha \to \infty$). In such a case the equilibrium price would be given by $p^n = \frac{\alpha}{(2\beta-\delta)}$. This is equal to the equilibrium price without advertising and lower than the equilibrium price with positive advertising in this model.

Under competition, each firm sets its price equal to p^n and advertising equal to Φ^n in each period. The profit earned by each firm in every period is denoted by π^n.

2.3.2 Semicollusion

Firms can try to collectively reign in price competition while setting advertising levels independently in an effort to raise their profits. This practice where firms collude on price but compete on advertising is called price semicollusion. Many authors such as Scherer (1980), Brander (1984) and Davidson and Deneckere (1990) have argued that frequently, firms in oligopolistic markets have tended to compete with respect to non-price variables such as advertising, capacity or R&D and collude on price. Symeonidis (2003) surveys price-fixing agreements in the 1950s in the United Kingdom and finds the such agreements did not include agreements or restrictions on such activities as advertising and R&D[6].

[6]Firms may realize that aggressive price competition of the type described above is extremely detrimental to all firms, where the adverse impact on all the firms of this form of competition is immediate. Firms may then tacitly and collectively reign themselves in from engaging in this form of competition while competing with each other through other non-price means of competition like advertising. This is especially true if the means of non-price-competition like advertising is perceived to produce gains for the firm that are not easily replicated by its rivals. Another reason behind such a practice is that cooperation on price or quantity may be more feasible than cooperation on other variables (advertising or R&D) because the former are more easily observed and may be easier to adjust.

A classic example, as cited by Nicholls (1952) and Scherer (1980) is of the cigarette industry in the 1920s and 1930s. The Big Three (American, Ligget & Myers and Reynolds) controlled between 70% and 90% of the market during this period and there is evidence that they colluded on price. However they competed intensively on advertising. More recently, Slade (2000) and Ramrattan (1999) find empirical evidence in support of firms colluding on price and competing on advertising in the market for saltine crackers and automobiles respectively. Nevo (1998) provides evidence that refutes the results of earlier empirical work by Schmalensee (1978) and Scherer (1982) that had found evidence of firms colluding on price and competing through advertising in the ready-to-eat cereal industry.

Even though previous research has studied semicollusion, it has done so with regard to cartels colluding on price or quantity and competing through investment in capacity or through R&D. To the best of my knowledge, the case of firms colluding on price and competing on advertising has not been studied at a theoretical level before. Since advertising has very different effects and implications than other means of non-price competition like R&D[7], the case of price semicollusion and advertising competition warrants a separate analysis in itself. Equally important, studying price semicollusion helps in analyzing important implications of persuasive advertising in an industry that have not been considered previously.

The following analysis of price semicollusion and advertising competition shows that what determines whether semicollusion results in higher or lower profits than competition are the effects of advertising. In particular, only when advertising in an industry is

[7]In the literature, R&D has been modeled in a way that investment in it leads to lower production costs. R&D thus operates on the production side. Advertising on the other hand enters the demand side.

market-stealing can firm profits be lower under semicollusion than under competition.

Price semicollusion is analyzed as follows. First, I characterize firm behavior under price semicollusion. This identifies the price and advertising level chosen by the firms in each period. Next, I identify the conditions under which such behavior on the part of firms is subgame-perfect. This involves comparing the benefits from semicollusion to the firms' incentive of deviating from it.

Firm Price and Advertising under Semicollusion

Under price semicollusion, in each period the two firms set their prices to maximize the sum of their individual profits with the knowledge that each firm will be independently determined by each firm to maximize its individual profit. Thus, p_1 and p_2 will be determined by the maximization of the joint profits over them for given advertising levels of the two firms as follows

$$max \left\{ \begin{array}{c} \pi_1 + \pi_2 = p_1 \left[\alpha - \beta p_1 + \delta p_2 + \gamma\Phi_1 - \lambda\Phi_2\right] - a\frac{\Phi_1^2}{2} \\ +p_2 \left[\alpha - \beta p_2 + \delta p_1 + \gamma\Phi_2 - \lambda\Phi_1\right] - a\frac{\Phi_2^2}{2} \end{array} \right\}$$

with respect to p_1 and p_2. The first order condition for firm 1's price for a given level of advertising undertaken by it is given by (the superscript pc denotes price collusion)

$$p^{pc} = \frac{1}{2(\beta - \delta)} \left[\alpha + (\gamma - \lambda)\Phi\right] \tag{2.9}$$

The advertising level of firm i, on the other hand, will be determined by the maximization of π_i *alone* over Φ_i for given prices of firm 1 and firm 2. For firm 1 the problem is represented as

$$max\left\{\pi_1 = p_1\left[\alpha - \beta p_1 + \delta p_2 + \gamma\Phi_1 - \lambda\Phi_2\right] - a\frac{\Phi_1^2}{2}\right\}$$

with respect to Φ_1.Firm 2's behavior would be similarly described. The first order condition for firm 1's advertising level for a given price level chosen by firm 1 is still given by eq.(2.6) above.

Solving the two first order conditions given by eq.(2.9) and eq.(2.6) yield the following symmetric solution

$$p^{pc} = \frac{a\alpha}{2a\left(\beta - \delta\right) - \gamma\left(\gamma - \lambda\right)} \tag{2.10}$$

$$\Phi^{pc} = \frac{\alpha\gamma}{2a\left(\beta - \delta\right) - \gamma\left(\gamma - \lambda\right)} \tag{2.11}$$

Proposition 1 *The price under price semicollusion, exceeds the price that prevails under competition.*

Proof. See appendix. ■

When firms set prices collusively, the incentive to undercut the rival's price is eliminated and the collusive price is therefore, higher than the Nash equilibrium price.

Proposition 2 *The level of advertising that prevails under price semicollusion exceeds the level of advertising under competition.*

Proof. Given that $\beta > \delta$, $(2\beta - \delta) > 2\left(\beta - \delta\right)$.Comparing the Nash equilibrium advertising level Φ^n in eq.(2.8) with the equilibrium advertising level Φ^{pc} in eq.(2.11) one can see that the latter exceeds the former . ■

Since the level of advertising is set competitively even when firms collude on price, the optimal level of advertising for each firm is still given by the advertising best response function in eq.(2.6). This is increasing in the price charged by the firm since the marginal benefit of an additional unit of advertising is higher when the profit margin is higher. Since the price under semicollusion is higher (from proposition 2) so is the level of advertising. This result is independent of whether advertising is market-stealing or market-expanding.

Price Semicollusion as Subgame-Perfect Outcome

Under price semicollusion, each firm would set its price equal to p^{pc} and advertising equal to Φ^{pc} in each period. The profit earned by each firm in every period is denoted by π^{pc}. Assuming that firms support semicollusion through Nash reversion grim-trigger strategies[8][9], firms would have an incentive to engage in price semicollusion *only* if the profits of each firm are higher than those under competition[10]. The grim-trigger strategies would constitute a subgame-perfect equilibrium of the repeated game (with price semicollusion as the subgame-perfect outcome) if the loss of future gains from semicollusion exceed the one-time benefit of deviating.

Let π_d^{pc} denote a firm's profit from optimally deviating in any period when the other firm chooses the semicollusion price and advertising. Furthermore, let d denote each firm's discount factor. For price semicollusion to be a subgame-perfect outcome of the repeated game the following condition needs to be satisfied

[8]The grim-trigger strategy for firm i is given as:
(1) At t=1 choose semicollusion price and advertising level.
(2) At any t >1, choose semicollusion price and advertising level if both firms had chosen these in all previous periods; otherwise revert forever to the Nash equilibrium price and advertising level.

[9]The use of these punishments is common in the literature. It is argued that features of antitrust laws imply that this is the correct benchmark to punishment to use as a response to a breakdown of collusion. For e.g. see Deneckere (1982), Chang (1991) and Ross (1992).

[10]Given that collusion is illegal and carries the risk of prosecution, firms would enage in such collusion if it yeilds benefit in terms of higher profits than the alternative– competition.

$$\frac{\pi^{pc}}{1-d} \geq \pi_d^{pc} + \pi^n \frac{d}{1-d} \tag{2.12}$$

For the above to be true, a necessary condition is for the semicollusion profit to exceed the competitive profit

$$\pi^{pc} \geq \pi^n \tag{2.13}$$

The following two sections show that the distinction between market-expanding and market-stealing advertising is critical in determining whether the above necessary condition is satisfied. While the condition is always satisfied when advertising is market-stealing, it is not always satisfied when advertising is market-stealing. Thus, as is shown below, price semicollusion is not always subgame-perfect when advertising is market-stealing.

Price Semicollusion with Market-Expanding Advertising

When advertising is market-expanding one firm's advertising increases the other firm's demand. The demand functions of the two firms in such a case are

$$D_1(p_1, p_2, \Phi_1, \Phi_2) = \alpha - \beta p_1 + \delta p_2 + \gamma \Phi_1 + \lambda \Phi_2$$

and

$$D_2(p_1, p_2, \Phi_1, \Phi_2) = \alpha - \beta p_2 + \delta p_1 + \gamma \Phi_2 + \lambda \Phi_1$$

For given values of the parameters a, α, β and δ, the difference between the profit of each firm under price semicollusion and that under competition $(\pi^{pc} - \pi^n)$ can be expressed as a function of γ and λ. I denote this function by $G(\gamma, \lambda)$ [11].

[11]This function is defined over the range of parameter values over which both π^{pc} and π^n are positive.The consition $2a\delta - \gamma(\gamma + \lambda) \geq 0$ guarantees that both π^{pc} and π^n are positive.

Definition 3 $G(\gamma, \lambda) = \pi^{pc}(\gamma, \lambda) - \pi^{n}(\gamma, \lambda)$.

Lemma 1 $G(\gamma, \lambda) > 0$.

Proof. See appendix. ■

Proposition 3 *Price semicollusion is subgame-perfect when advertising is market-expanding if firms value the future sufficiently.*

Proof. From lemma 1 and condition given by eq.(2.12). ■

When advertising is market-expanding, a firm benefits from the advertising of another firm in the industry. Under price semicollusion, firms benefit both from the higher price that results directly from the collusion and the higher advertising by each firm that follows because of the higher price. Thus, the profits of firms under price semicollusion are always higher than those under competition[12]. This is independent of the magnitude of market-expanding effect of advertising. Thus, price semicollusion can be subgame-perfect if the discount factor d satisfies the condition given by eq. (2.12).

This result is in contrast to that of Brod and Shivkumar, who study the case of price semicollusion and R&D competition. As stated before, they find that the R&D investment of one firm should have "significant" positive spillovers on the other's profits for price semicollusion to generate higher profits than competition.

[12]This result extends to the case where $\lambda = 0$, i.e. when advertising has no cross effect.

Price Semicollusion with Market-Stealing Advertising

When advertising is market-stealing, a firm's advertising adversely affects the other's demand and profit. The firms' demand functions are given by

$$D_1(p_1, p_2, \Phi_1, \Phi_2) = \alpha - \beta p_1 + \delta p_2 + \gamma \Phi_1 - \lambda \Phi_2$$

and

$$D_2(p_1, p_2, \Phi_1, \Phi_2) = \alpha - \beta p_2 + \delta p_1 + \gamma \Phi_2 - \lambda \Phi_1$$

Again, for given values of the parameters a, α, β and δ, the difference between the profit of each firm under price semicollusion and that under competition $(\pi^{pc} - \pi^{n})$ can be expressed as a function of γ and λ. I denote this function by $F(\gamma, \lambda)$[13].

Definition 4 $F(\gamma, \lambda) = \pi^{pc}(\gamma, \lambda) - \pi^{n}(\gamma, \lambda)$.

As shown above, a necessary condition for price semicollusion to be subgame-perfect is for semicollusion profits (π^{pc}) to exceed the competitive profits (π^{n}). In other words, price semicollusion cannot be subgame-perfect if $F(\gamma, \lambda) < 0$.

When $F(\gamma, \lambda) = 0$, profits under price semicollusion are equal to those under competition. Using the implicit function theorem, $F(\gamma, \lambda) = 0$ defines the implicit function $\lambda = f(\gamma)$. For a given value of γ, $f(\gamma)$ gives the critical value of λ such that the profit of each firm is equal under price semicollusion and competition.

Lemma 2 *The function $\lambda = f(\gamma)$ has a negative slope, i.e.* $\frac{d\lambda}{d\gamma} < 0$.

[13]This function is defined over the range of parameter values over which both π^{pc} and π^{n} are positive.The consition $2a\delta - \gamma^2 > 0$ guarantees that both π^{pc} and π^{n} are positive.

Proof. See appendix. ■

In figure 1 I plot the implicit function $\lambda = f(\gamma)$ defined by $F(\gamma, \lambda) = 0$. It represents those values of γ and λ such that each firm's profit is equal under semicollusion and competition. The negative slope of the function implies that the critical value of λ, such that $\pi^{pc} = \pi^{n}$, is decreasing in γ.

Definition 5 *The market-stealing effect of advertising is said to be dominant if* $\lambda > f(\gamma)$*.*

The $f(\gamma)$ curve thus partitions the parameter space into two regions. In the region above the curve, the market-stealing effect of advertising is dominant.

Lemma 3 *Firm profits are lower under price semicollusion than under competition when the market-stealing effect of advertising is dominant.*

Proof. See appendix. ■

For a given value of γ, $f(\gamma)$ gives the critical value of λ such that $F(\gamma, \lambda) = 0$. As stated in lemma 2 above, for values of λ higher than this critical value, $F(\gamma, \lambda) < 0$ i.e. the profit of each firm under price semicollusion is lower than that under competition.

On the other hand, for values of λ lower than this critical value, $F(\gamma, \lambda) > 0$ i.e. the profit of each firm under price semicollusion is higher than that under competition. Thus, for a given value of γ, $f(\gamma)$, gives the threshold value of λ, such that only for values of λ below this threshold level will price semicollusion be "profitable". For values of λ higher than this threshold level, firms will not find semicollusion "profitable". This allows us to state the following proposition the proof of which follows from lemma 3 and the necessary condition given by eq.(2.13).

Proposition 4 *Firms will not engage in price semicollusion when the market-stealing effect of advertising is dominant.*

Proof. Follows from lemma 3 and necessary condition for price semicollusion to be subgame-perfect given in eq. (2.13). ■

When advertising is market-stealing, price semicollusion affects firms in two different ways. On the one hand, firms benefit from the higher price that is the direct result of the price collusion (proposition 1). However, firms advertise more as a result of the higher price under semicollusion (proposition2). Since advertising is market-stealing, higher advertising by both firms under semicollusion adversely effects firm profits much more than under competition. When the market-stealing effect is large, this effect of higher advertising is strong enough to negate all the gains of price collusion. In such a case each firm's profit is lower under semicollusion than under competition. Price semicollusion is not consistent with subgame-perfect behavior.

Note that for semicollusion to be "profitable", the higher is the own-effect of advertising (γ) lower should be the market-stealing effect of advertising (λ). keeping the own-effect of advertising fixed, a high value of the market-stealing effect of advertising serves to reduce the benefits from price collusion due to the reasons stated above. Furthermore, keeping the market-stealing effect of advertising fixed, a high value of the own-effect of advertising also reduces the benefits of price collusion. The own-effect captures the private benefit from advertising that accrues to a firm from its advertising. The higher this is the more each firm will advertise. But, the greater the level of advertising undertaken by each firm the greater is the "damage" inflicted by each firm on the other for *any given level* *of the market-stealing effect of advertising.* Thus, in general, very high values of either effect of advertising would be inconsistent with semicollusion being subgame-perfect when advertising is market-stealing.

When the market-stealing effect of advertising is not dominant, intensified advertising competition does not negate all the gains from price collusion. Firm profits under price semicollusion are higher than under competition. Thus, price semicollusion can be subgame-perfect if the discount factor d satisfies the condition given by eq. (2.12).

When the market-stealing effect of advertising is dominant, firms gain nothing from price semicollusion and any attempt at it would break down with firms reverting to competition. This is independent of the magnitude of the discount factor of each firm. In such a case, if firms were prevented from advertising they could collude on price since their profits in each period would unambiguously be higher. In such a case advertising would not be present as a choice variable to "restrict" the firms' ability to collude on price. The relevant equilibrium price to consider in the absence of advertising would then be the collusive price (given a high enough discount factor).

2.3.3 Advertising Cost and Product Substitutability

Previous research on semicollusion studies cartel formation when firms jointly determine output but make independent decisions on R&D expenditure or investment capacity. Fershtman and Gandal (1994) find that what determines whether semicollusion leads to higher or lower profits for the firms constituting the cartel, is the cost of R&D (capacity). If the cost of investing in R&D (installing capacity) is sufficiently high, semicollusion would generate higher profits for the firms than competition. If not then semicollusion would lead to lower profits for the firms constituting the cartel than if they were to compete on both price and R&D (capacity). Brod and Shivkumar (1999), build on Fershtman and Gandal's analysis, to allow for the possibility of positive spillovers in R&D and the possibility of the firms' products being imperfect substitutes. They find that, for a *given* cost of R&D, the determinants of whether semicollusion leads to higher profits than competition, are the degree of substitutability between the products of the firms and the extent of positive spillovers between the R&D of one firm and the profit of another. In their analysis, semicollusion leads to higher profits than competition, if the positive spillovers are sufficiently high and /or the degree of substitutability is sufficiently low.

In the analysis in the preceding two sections the focus has been on the nature of advertising and how this affects the gains from semicollusion to firms. I show that when advertising is market-expanding, i.e. when advertising by one firm exerts a positive externality on the other firm, price semicollusion *always* leads to higher profits for firms than competition, irrespective of the magnitude of this positive externality. In fact, unless advertising by a firm exerts a negative externality on the other firm, i.e. unless advertising is market-stealing, price semicollusion can not lead to lower profits than competition. Furthermore, even in the latter case, semicollusion may yet generate higher profits for firms than competition.

In this section I analyze the relationship between advertising cost and the gains from semicollusion vis a vis competition when advertising is market-stealing. Next, I look at the relationship between the degree of substitutability between products and the gains from collusion. The magnitude of the cross-price effect captures the degree of substitutability between products, with a higher cross-price effect being associated with a greater degree of substitutability between products[14].

As shown before, for given values of all parameters in the model, including the cost of advertising (a) and the cross-price effect (δ), the gains from price collusion are negated by intensified advertising competition when the market-stealing effect of advertising is dominant. This is the case when $\lambda > f(\gamma)$ and price semicollusion is not subgame-perfect. For $\lambda < f(\gamma)$, semicollusion gives each firm a higher profit every period than competition. The function $\lambda = f(\gamma)$, divides the advertising parameter space into two regions. For combinations of the advertising parameters λ and γ that lie in the region above the function, semicollusion is not subgame-perfect whereas in the region below the curve semicollusion can be subgame-perfect. Any change that increases the latter region, i.e. increases the subset of advertising parameter space for which semicollusion can be subgame-perfect is akin to one that makes semicollusion easier to sustain.

The effect of the advertising cost parameter (a) and the cross price effect (δ) on the relation between firm profits under price semicollusion and those under competition, can be assessed by their impact on the function $\lambda = f(\gamma)$.

Lemma 4 *If $\lambda = f^1(\gamma)$ gives the locus of values of γ and λ such that $\pi^{pc} = \pi^n$ when $a = a_1$ and $\lambda = f^2(\gamma)$ denotes the same when $a = a_2$ such that $a_2 > a_1$ then $f^2(\gamma)$ lies above $f^1(\gamma)$ everywhere.*

Proof. See appendix. ■

[14]Recall that χ captures the degree of product substitutability in the utility function. The cross price effect is captured by δ which equals $\frac{\chi}{\omega^2-\chi^2}$ which is increasing in χ.

Lemma 5 *If* $\lambda = f^1(\gamma)$ *gives the locus of values of* γ *and* λ *such that* $\pi^{pc} = \pi^n$ *when* $a = a_1$ *and* $\lambda = f^2(\gamma)$ *denotes the same when* $a = a_2$ *such that* $a_2 < a_1$ *then* $f^2(\gamma)$ *lies below* $f^1(\gamma)$ *everywhere.*

Proof. Analogous to proof of Lemma 4. ■

Thus, a higher value of the advertising cost parameter (a) implies that for a given value of the own-effect of advertising (γ), the market-stealing effect (λ) needs to be *higher* for intensified advertising competition to exactly offset the gains from price collusion. This means that a higher advertising cost implies a larger subset of the advertising parameter space for which semicollusion can be subgame-perfect. Lemmas 4 and 5 now allow us to state the following proposition.

Proposition 5 *The higher is the advertising cost, the easier it is to sustain price semicollusion when advertising is market-stealing.*

Proof. Follows from lemmas 4 and 5. ■

A higher value of the advertising cost parameter (a) leads to a lower level of advertising by firms under competition *as well as under semicollusion.* The lower level of advertising under semicollusion means that it may not be enough to outweigh the gains of price collusion even for relatively high values of the market-stealing effect of advertising. In effect, higher advertising cost makes semicollusion more attractive to firms by reducing the intensity of advertising competition that takes place under it thereby not allowing the market-stealing effect of advertising to come in play as much as it would if the advertising competition were more intense with lower advertising cost.

A higher degree of product substitutability increases the attractiveness of price semicollusion. The gains from reigning in price competition relative to setting prices aggressively and independently are far higher when the goods are close substitutes of each other than when the goods are relatively independent. High gains from price collusion mean that these may not be completely negated by intensified advertising competition even when the market-stealing effect of advertising is relatively strong. Thus, a greater degree of substitutability between the firms' products allows price semicollusion to be subgame-perfect over a larger range of values of the market-stealing effect of advertising and thus over a larger subset of the advertising parameter space. This is stated in Proposition 6 that follows from Lemmas 6 and 7.

Lemma 6 *If $\lambda = f^1(\gamma)$ gives the locus of values of γ and λ such that $\pi^{pc} = \pi^n$ when $\delta = \delta_1$ and $\lambda = f^2(\gamma)$ denotes the same when $\delta = \delta_2$ such that $\delta_2 > \delta_1$ then $f^2(\gamma)$ lies above $f^1(\gamma)$ everywhere.*

Proof. See appendix. ■

Lemma 7 *If $\lambda = f^1(\gamma)$ gives the locus of values of γ and λ such that $\pi^{pc} = \pi^n$ when $\delta = \delta_1$ and $\lambda = f^2(\gamma)$ denotes the same when $\delta = \delta_2$ such that $\delta_2 < \delta_1$ then $f^2(\gamma)$ lies below $f^1(\gamma)$ everywhere.*

Proof. Analogous to proof of lemma 6 ■

Thus, a greater degree of product substitutability as captured by the cross-price effect (δ) implies that for a given value of the own-effect of advertising (γ), the market-stealing effect (λ) needs to be *higher* for intensified advertising competition to exactly offset the gains from price collusion. This means that a greater degree of product substitutability implies a larger subset of the advertising parameter space for which semicollusion can be subgame-perfect. Lemmas 6 and 7 now allow us to state the following proposition.

Proposition 6 *The higher is the degree of product substitutability, the easier it is to sustain price semicollusion when advertising is market-stealing.*

Proof. Follows from Lemmas 6 and 7. ■

Figure 2.5 shows the $\lambda = f^2(\gamma)$ curve corresponding to $a = a_2(\delta_2)$ above the $\lambda = f^1(\gamma)$ curve corresponding to $a = a_1(\delta_1)$ where $a_2 > a_1$ $(\delta_2 > \delta_1)$. Both, higher advertising cost and a greater degree of product substitutability make semicollusion more attractive relative to competition for firms.

2.4 Price Comparison Across Regimes

Benham (1972), Cady (1976), Maurizi and Kelly (1978), Feldman and Begun (1978, 1980) and Kwoka (1984) all find empirical evidence that regulatory restriction on advertising is associated with higher prices when *advertising is informative.* In this section I show that restrictions on advertising can be associated with higher prices *even when advertising is persuasive*, albeit due to completely different reasons. This goes against the established view in the literature on advertising.

In section 2.3.2 I showed that when advertising is market-stealing, competition in advertising may prevent firms from benefitting from price semicollusion such that the profit of each firm is lower under price semicollusion than under competition $(\pi^{pc} < \pi^n)$. In such a case price semicollusion can not constitute a subgame-perfect outcome of a repeated game between firms.

What determines whether firms find it mutually beneficial to engage in price semicollusion are the magnitudes of the two effects of advertising: the magnitude of the own effect (γ) and the magnitude of the cross effect (λ) when advertising is market-stealing. For a given value of γ, the market-stealing effect of advertising is said to be dominant when $\lambda > f(\gamma)$. Thus, the presence of advertising as a means of non-price competition prevents firms from engaging in price semicollusion when advertising is market-stealing and this effect is dominant.

This effect of advertising should be taken into consideration in assessing the impact of any regulation on advertising such as an outright ban. Consumers may face a higher price without advertising than in the presence of advertising. This is because under the conditions of advertising outlined above, advertising prevents price semicollusion by firms. If firms are prohibited from advertising,due to a ban on advertising in the said market, firms would no longer be curtailed in their ability to collude on price. Thus in the presence of advertising, consumers would be faced with prices that might be inflated due to the effect of (persuasive) advertising but shielded from the possibility of price collusion. Without advertising, prices would no longer be inflated by the effect of (persuasive) advertising. However, since nothing would restrain the firms from colluding on price, prices faced by the consumer may yet be higher through this channel.

I now compare the price charged in equilibrium by the two firms in the market in two regimes: one where firms are free to advertise and the other where firms are prohibited from engaging in any kind of advertising. In the following analysis I restrict attention to the case where the market-stealing effect of advertising is dominant such that firms do not engage in price semicollusion when they are allowed to advertise (proposition 4). The subgame-perfect equilibrium of the repeated game, in the regime where firms are allowed to engage in advertising, is for firms to charge the competitive price p_a^n and set advertising levels at the competitive level Φ_a^n in every period. As such, p_a^n in (2.7) and Φ_a^n in (2.8) are given by

$$p_a^n = \frac{a\alpha}{a\left(2\beta - \delta\right) - \gamma\left(\gamma - \lambda\right)} \tag{2.14}$$

and

$$\Phi_a^n = \frac{\alpha\gamma}{a\left(2\beta - \delta\right) - \gamma\left(\gamma - \lambda\right)} \tag{2.15}$$

The subscript is added to indicate that the competitive price and advertising level above are for the regime in which firms are allowed to engage in advertising.

In the regime where firms are prohibited from engaging in any advertising, under the assumptions made in this section, the demand curve facing firm 1 and firm 2 respectively are given by

$$D_1\left(p_1, p_2\right) = \alpha - \beta p_1 + \delta p_2$$

and

$$D_2\left(p_1, p_2\right) = \alpha - \beta p_2 + \delta p_1$$

As shown in the appendix, firms will always earn higher per period profits if they collude on price than when they compete on price. The price charged by each firm when they collude on price is given by

$$p_{na}^{c} = \frac{\alpha}{2(\beta - \delta)} \tag{2.16}$$

The superscript and the subscript denote that this is the collusive price (c for collusion) in the regime where firms are not permitted to advertise (na for no advertising).

I restrict attention to the case where the discount factor by which firms discount future profits is sufficiently large such that colluding on price, where each firm charges a price equal to p_{na}^{c} in eq.(2.15) above, is subgame-perfect[15]

Thus, consumers face an equilibrium price given by p_{a}^{n} when firms are allowed to engage in advertising, whereas they face an equilibrium price given by p_{na}^{c} when firms are not allowed to engage in any advertising. As shown in the appendix, p_{na}^{c} is higher than p_{a}^{n} when the following inequality holds

$$a\delta > \gamma(\gamma - \lambda) \tag{2.17}$$

The collusive price in the no-advertising regime (p_{na}^{c}) is more likely to exceed the competitive price in the advertising regime (p_{a}^{n}) for high values of the advertising cost parameter a, the cross price effect δ and the net cross effect of advertising λ and for low values of the net own effect of advertising γ. Higher advertising cost implies low advertising by firms and thus a lower inflationary impact of persuasive advertising on the price charged by firms when firms are allowed to advertise. Higher values of the cross-price effect mean

[15]The condition on the discount factor d is given by:
$d \geq \frac{\pi_d^c - \pi^c}{\pi_d^c - \pi^n}$
where the subscript na is omitted for simplicity.

that the goods produced by the two firms are close substitutes. Competition would drive prices down. Collusion would avoid this downward pressure on prices.

The inequality in 2.17 can also be written as

$$\lambda > \gamma - \frac{a\delta}{\gamma} \tag{2.18}$$

Taking the values of a and δ as given, the inequality in 2.18 can be expressed solely in terms of the magnitude of the net cross effect of advertising (λ) and the net own effect of advertising (γ) as follows

$$\lambda > h(\gamma) \tag{2.19}$$

where $h(\gamma) = \gamma - \frac{a\delta}{\gamma}$.

Proposition 7 *The difference between the competitive price with advertising and the collusive price without advertising is increasing in the market-stealing effect of advertising.*

Proof. Follows from the inequality in eq.(2.18) ■

For any given value of γ, $h(\gamma)$ gives the critical value of λ such that the equilibrium price without advertising (p_{na}^c) is equal to the equilibrium price with advertising(p_a^n). For values of λ higher than this threshold level, the equilibrium price without advertising (p_{na}^c) would be higher than the equilibrium price with advertising (p_a^n). This critical value of λ given by $h(\gamma)$ increases with γ and is closer to γ the higher γ is. As shown in the appendix, $h(\gamma)$ is increasing and concave.

The collusive price in the no-advertising regime is independent of the effects of advertising. However, the price in the advertising regime is affected by these. A high own effect of advertising translates into higher advertising by each firm and thus a higher inflationary impact of such advertising on price, other things equal. However, if the market-stealing effect of advertising is also high, each firm's advertising works to cancel the effect of the other's advertising. The inflationary impact of advertising on price is reduced. Thus, if the advertising is sufficiently market-stealing, the collusive price without advertising would be higher than the competitive price with advertising.

Figure 3 shows $h(\gamma)$ where it divides the parameter space into two regions. In the region where $\lambda > h(\gamma)$, the equilibrium price without advertising (p_{na}^{c}) is higher than the equilibrium price with advertising (p_{a}^{n}) whereas, in the where $\lambda < h(\gamma)$, the opposite is true.

Figure 4 has $h(\gamma)$ from figure 3 superimposed onto $f(\gamma)$ from figure 2. Recall that $f(\gamma)$ divides the parameter space into two regions such that the region where $\lambda > f(\gamma)$, price semicollusion is not subgame-perfect.

The region above both curves in figure 4 depicts those combinations of λ and γ such that (1) Firms would compete on both price and advertising in the advertising regime as price semicollusion would not be subgame-perfect and (2) The collusive price in the no-advertising regime would be higher than the price in the advertising regime. Thus, the higher the market-stealing effect of advertising (λ) the greater the likelihood of persuasive advertising "preventing" price semicollusion and resulting in a lower price.

2.5 Conclusion

The economics literature has traditionally taken an adverse view of persuasive advertising. It is thought to be anti-competitive and unlike informative advertising believed to provide no real benefit to consumers. Prices in markets are believed to be higher than with persuasive advertising than without.

This paper makes a departure from such a view. It makes a distinction between two effects of persuasive advertising. These are a market-stealing effect and a market-expanding effect. Persuasive advertising can induce competition by breaking down collusion on price between firms when it is market-stealing. In markets without such advertising, firms would face no impediment in their ability to collude on price. Furthermore, the price that would prevail in such markets without advertising would be higher than the non-collusive price with advertising if advertising has a sufficiently large market-stealing effect. Thus, persuasive advertising is not necessarily anti-competitive and does not result in a higher equilibrium price than the one that would prevail without it.

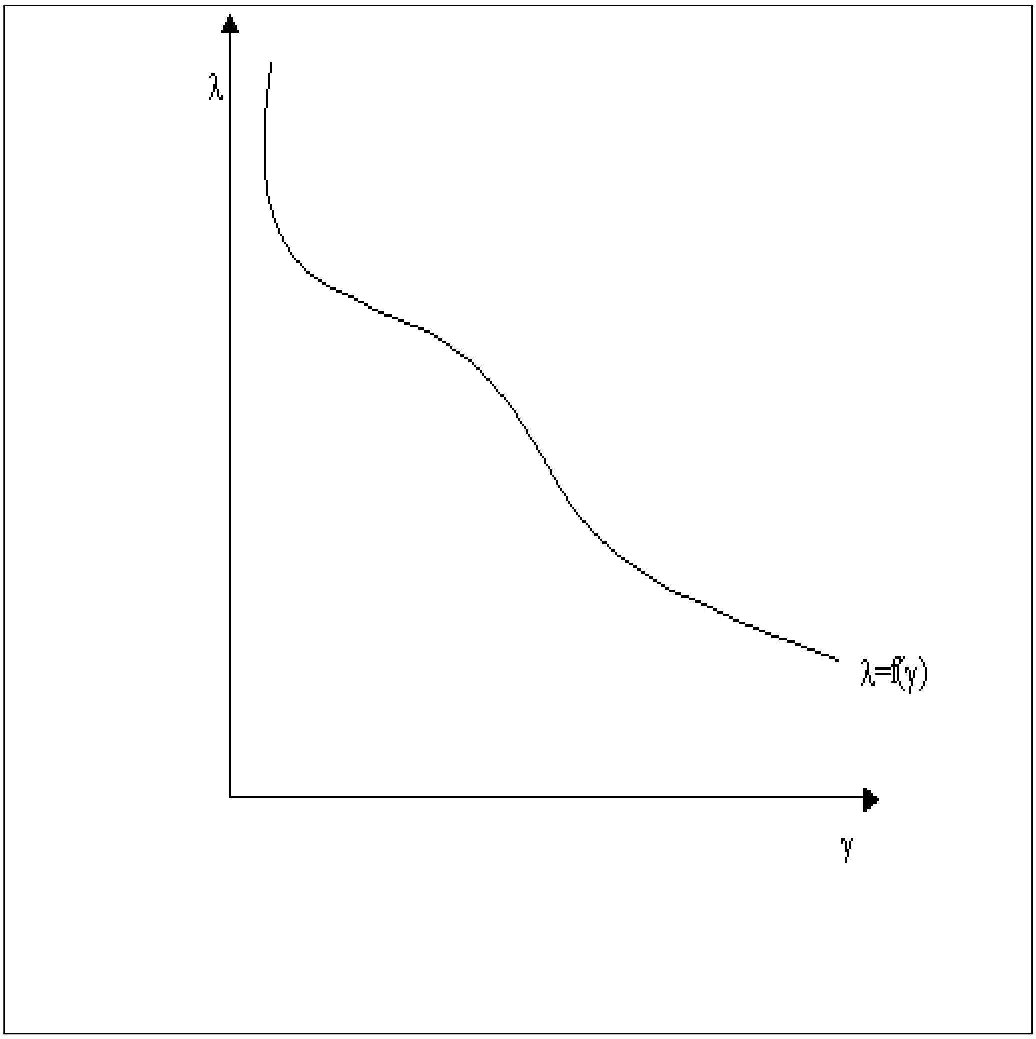

Figure 2.1: $\lambda = f\left(\gamma\right)$

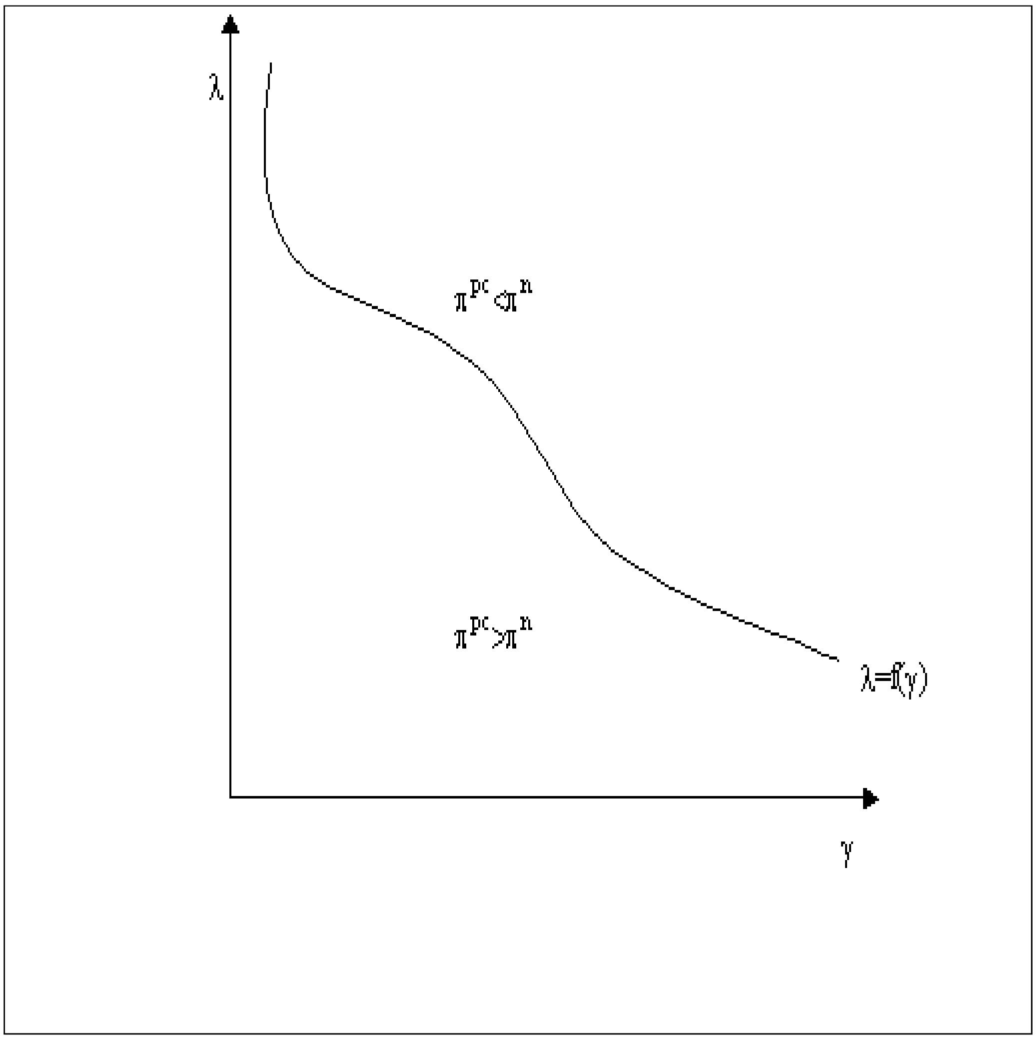

Figure 2.2: $\lambda = f\left(\gamma\right)$

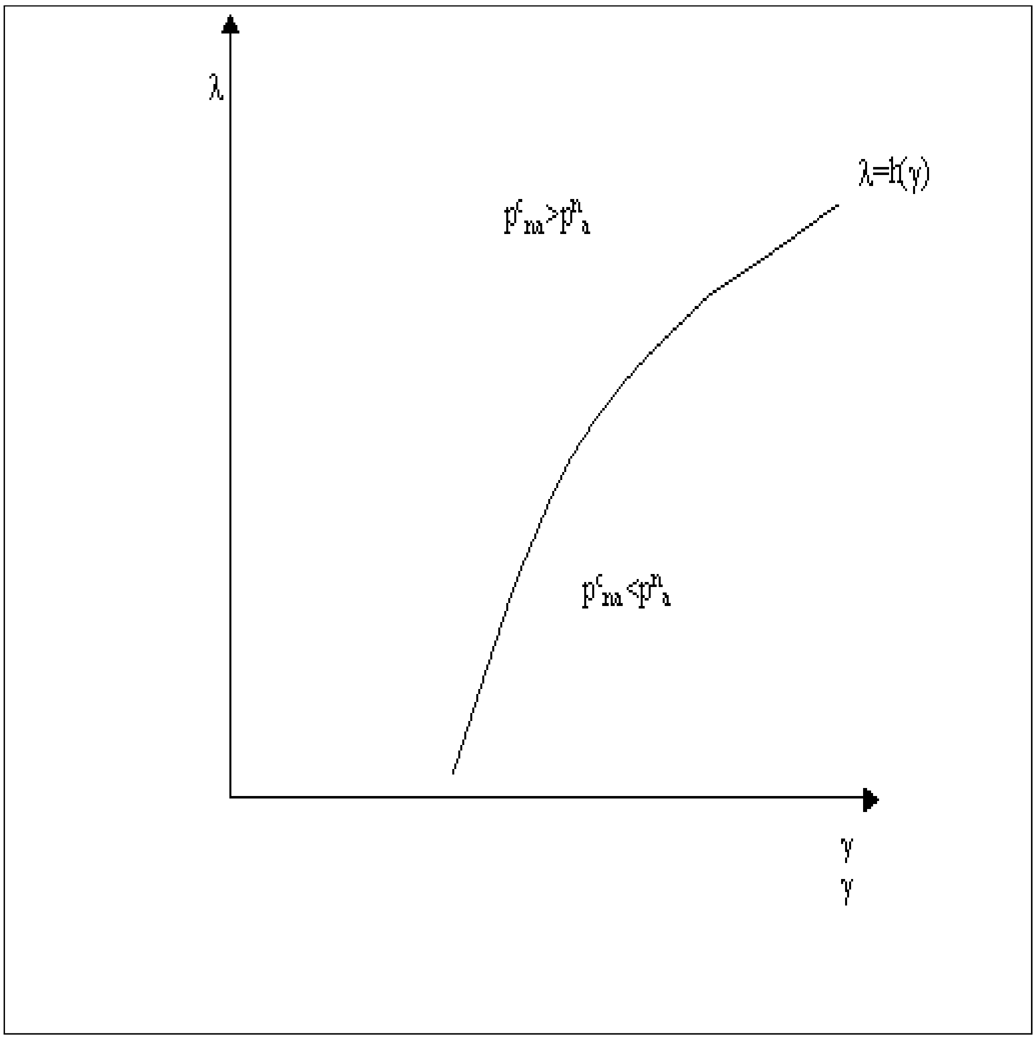

Figure 2.3: $\lambda = h\,(\gamma)$

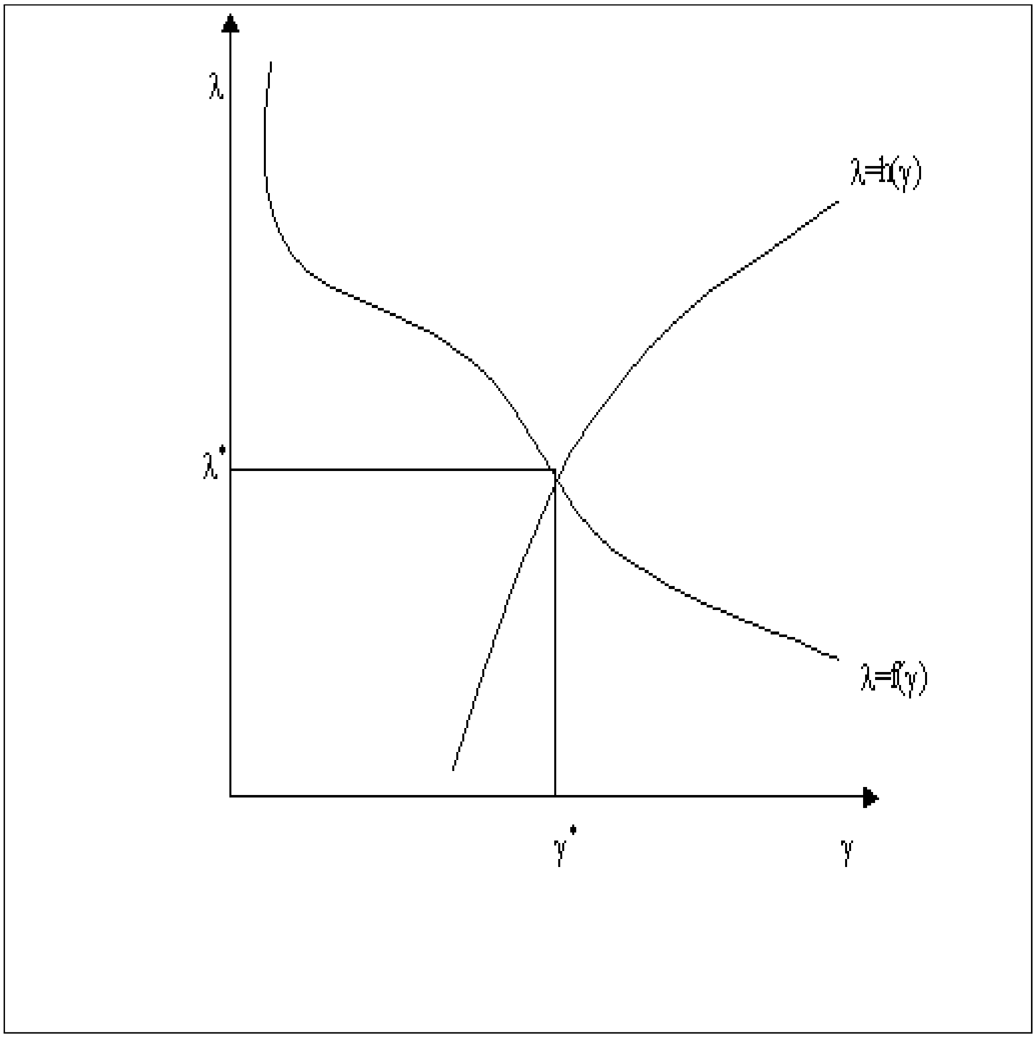

Figure 2.4: $\lambda = f(\gamma)$ and $\lambda = h(\lambda)$

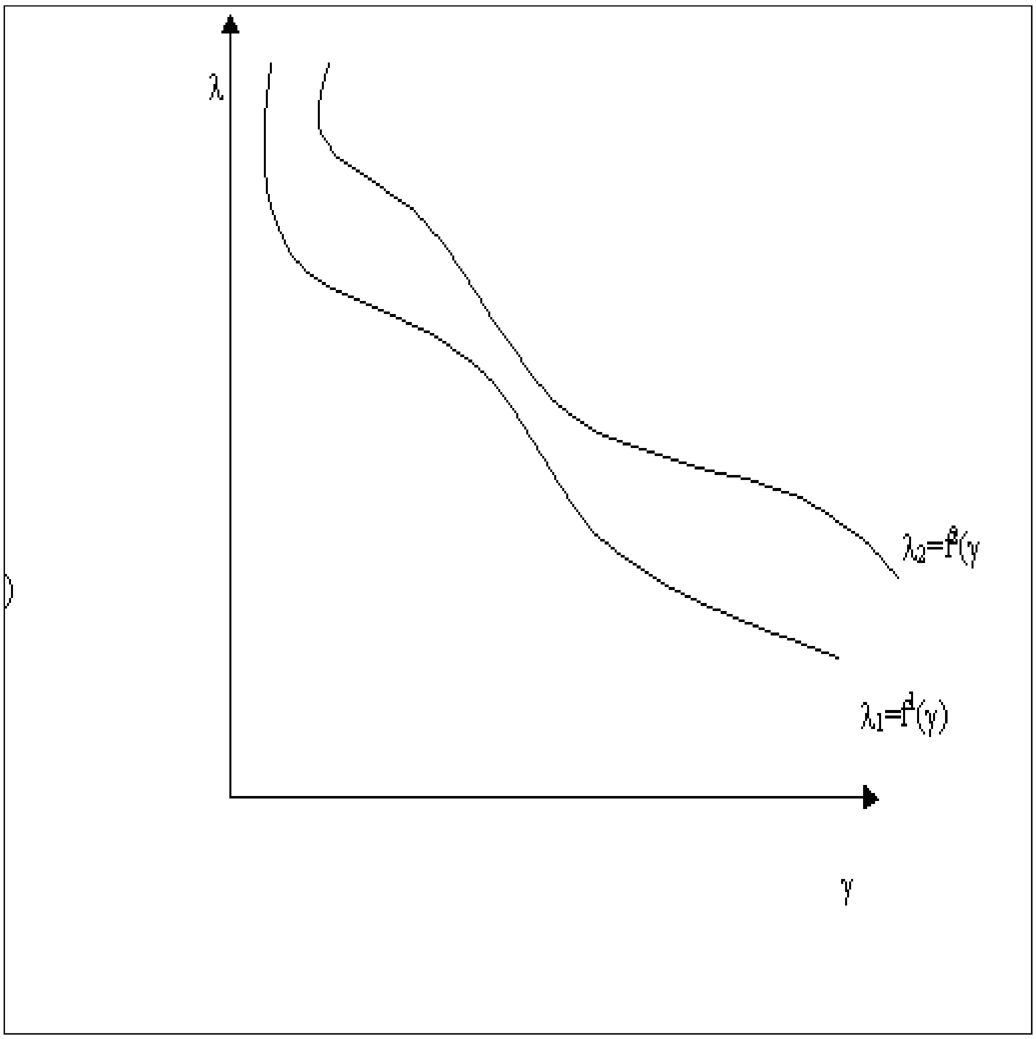

Figure 2.5: $\lambda = f^1(\gamma)$ when $a = a_1$ $(\delta = \delta_1)$ $\lambda = f^2(\gamma)$ when $a = a_2$ $(\delta = \delta_2)$

Chapter 3

The Effect of Advertising on Price Collusion: Evidence from U.S. Manufacturing

3.1 Introduction

Oligopoly theory sheds light on various factors that may facilitate or hinder price collusion in a market. Among these, advertising is viewed as one that could make collusion more difficult to sustain. However, the literature does not provide clear answers as to exactly how advertising may break down collusion and whether this effect is more likely in certain industries as opposed to others. The question has received even less attention in the empirical literature.

According to Lande and Marvel (2000), "antitrust law has long held collusion to be paramount among the offenses that it is charged with prohibiting." Section 1 of the Sherman Act declares every "conspiracy in the restraint of trade" illegal. In these, price fixing conspiracies are amongst the most important. Within the European Union, article 85 of the Roman Treaty makes any cartel that affects trade between member states illegal. Furthermore, member states have their own competition law that makes cartels affecting trade within these countries illegal. Given the importance attached to detecting and successfully prosecuting price fixing conspiracies, identifying industries whose structure might encourage and sustain such conspiracies should be an area for research to focus on. Advertising is an important structural characteristic, whose effectiveness and thus, intensity varies from one industry to another. Its effect on the feasibility and sustainability of collusion needs to be adequately studied.

The objective of this paper is to provide a clearer understanding of the effect of advertising on price collusion. It seeks to determine whether advertising in general can reduce the propensity to collude in an industry. Or, in studying this effect of advertising, is it important to make any distinction between advertising that is market-stealing and advertising that is primarily market-expanding. This is first paper to study this distinction. The motivation for the need to distinguish between the two effects of advertising comes from the main results in chapter 2 which shows that advertising may prevent collusion when it is market-stealing but not when it is market-expanding.

The paper also seeks to determine the effect of several other structural industrial characteristics on the propensity to collude in an industry. To address these questions I carry out a comparison of industries where firms have been found guilty of price fixing with industries without such firms. I construct an original data set from case summaries of formal legal actions of the Antitrust Division of the U.S. Department of Justice (DOJ) against illegal (explicit) price fixing arrangements from the 1960's to the present.

The econometric results in the paper suggest the following. Collusion is less likely in industries with slow growth and high advertising. Also, collusion is less likely in consumer goods industries with high advertising. These results are consistent with the theoretical predictions in chapter 2. In addition, the paper also provides evidence that confirms previous findings that collusion is more likely in industries with a high degree of capital intensity and with high market growth.

The paper is organized as follows. The next section discusses previous research that is related to the issue at hand. Section 3.3 outlines the theoretical underpinnings from chapter 2 that form the main focus of this paper, i.e. the effect of advertising on price collusion. This is followed by a detailed description of an original data set that is constructed by combining information from antitrust cases of price fixing with Economic Census data from the Census Bureau. Section 3.5 presents the empirical methodology adopted in the paper and discusses some relevant concerns that arise due to the nature of this data set. Section 3.6 presents the empirical findings.

3.2 Literature Review

The study that is most closely related to this paper is Symeonidis (2003). Symeonidis (2003) examines the impact of industry variables on pricing conduct using a data set on the incidence of collusion across British manufacturing industries in the 1950s. The study classifies an industry as cartelized if it had an agreement registered under the 1956 Restrictive Trade Practices Act. Others are classified as non-cartelized. The econometric results suggest that collusion is more likely the higher are capital intensity and market growth. Symeonidis (2003) also finds collusion to be less likely in advertising intensive industries than in low advertising industries. As I argue below, this conclusion may be misleading and may result from two possible drawbacks in the paper. The first is the failure to distinguish between the two kinds of advertising mentioned above: market-stealing and market-expanding. The second, which in turn can be partly blamed for the first, is the lack of suitable data on advertising due to the time period in which the industries are studied. This paper provides a richer treatment of the effects of advertising on the likelihood of collusion using U.S. data that is also more recent.

Dick (1996) examines the factors that explain the formation of cartels and their longevity with the help of a data set of legal, privately enforced export industry cartels that formed under the Webb-Pomerene Export Trade Act of 1918. The Webb-Pomerene Export Trade Act authorized U.S. exporters to enter into joint selling agreements for oversees markets. The paper finds that cartels formed more frequently in industries with significant potential market power and high barriers to entry. However, Dick (1996) does not include advertising as an industry characteristic affecting cartel formation. Furthermore, his analysis is specific to export cartels, which cover a very small fraction of economic activity and this limits the applicability of his findings.

There are also a few studies that rely on review of case studies of price fixing agreements and some summary statistics to infer the economic conditions supporting collusion.

Such studies yield mixed results. For instance, Hay and Kelley (1974) suggest that product differentiation hinders collusion (a finding that's contradicts that of Dick (1996)). Collusion is more likely in concentrated industries according to Hay and Kelley (1974) and Fraas and Greer (1977) but not according to Asch and Seneca (1976). Hay and Kelley (1974) find no link between capital intensity and the incidence of collusion as opposed to Dick (1996) who finds a positive link between the two.

3.3 Theoretical Model

In this section I briefly outline the main results of the theoretical model presented in chapter 2. The model draws on Singh and Vives (1984)and has an oligopolistic industry with two firms. Each firm produces a horizontally differentiated good. There is also a competitive numeraire good producing industry. There is a continuum of identical consumers, each with a utility function separable and linear in the numeraire good. The mass of consumers is normalized to one without loss of generality. The theoretical model with the results is discussed in detail in chapter 2, section 2.3. I present a brief description of the model here for the convenience.

3.3.1 Advertising and Consumer Preferences

The setup of Singh and Vives (1984)is modified to incorporate the presence of advertising as a choice variable of each firm. Advertising is modeled as affecting the preferences of the consumers in two possible ways. First, it may enhance the value of the advertised product in the eye of the consumer. I call this kind of advertising Type A advertising.

Type A advertising in turn may work in two ways. It may be generic, in the sense that advertising by firm 1 not only increases the value attached by the consumer to the product of firm 1 but also the value attached to the product of firm 2. This is especially likely if the two products are seemingly identical and satisfy similar wants. On the other hand, Type A advertising may be purely selective. This is the case when advertising by firm 1 only increases the value attached by the consumer to the product of firm 1.

Second, advertising by a firm may seek to align the preferences of the consumer more in line with the characteristics of the advertised product. I call this Type B advertising. Such advertising would increase the value of the advertised product *as well as lower* the value of the other product. Type B advertising is thus like a tug of war.[1].

The prices charged by firm 1 and firm 2 are denoted by p_1 and p_2 respectively and Φ_1 and Φ_2 are the respective levels of advertising undertaken by them. The quantities of the two products consumed by the representative consumer are denoted by q_1 and q_2 respectively. Since the utility function is separable and linear in the numeraire good, consumer's problem can be described as the maximization of the (sub) utility function corresponding to the oligopolistic industry. The consumer selects a pair (q_1, q_2) to solve:

$$\max \; u\left(q_1, q_2\right) - \sum_{i=1}^{2} p_i q_i$$

where

$$u\left(q_1, q_2\right) = \sum_{i=1}^{2} \left[\sigma + \left(\varepsilon + \tau\right)\Phi_i - \left(\psi - \tau\right)\Phi_{j \neq i}\right] q_i - \frac{1}{2}\left(\omega q_1^2 + 2\chi q_1 q_2 + \omega q_2^2\right)$$

[1] This is consistent with how the literature on advertising views persuasive advertising affecting consumers' preferences. For instance see von der Fehr and Stevik (1998).

The goods are substitutes, independent or complementary depending on whether $\chi > 0$, $\chi = 0$ or $\chi < 0$. I consider the case where the goods produced by the two firms are substitutes and assume that $\omega > \chi$, i.e. the goods are not perfect substitutes. Note that χ captures the degree of product differentiation with high values denoting a high degree of substitutability and thus a low level of product differentiation between the two products.

The effect of advertising on the consumer's utility is captured by the parameters ε, τ and ψ. The effect of the selective component of Type A advertising is captured by ε, whereas that of the generic component is captured by τ. The effect of Type B advertising is captured by ψ.

3.3.2 Demand Functions

The above utility function gives rise to the following demand functions for firm 1 and firm 2 respectively

$$D_1(p_1, p_2, \Phi_1, \Phi_2) = \alpha - \beta p_1 + \delta p_2 + \gamma \Phi_1 - \lambda \Phi_2 \tag{3.1}$$

and

$$D_2(p_1, p_2, \Phi_1, \Phi_2) = \alpha - \beta p_2 + \delta p_1 + \gamma \Phi_2 - \lambda \Phi_1 \tag{3.2}$$

where

$$\begin{aligned} \alpha &= \frac{\sigma}{\omega + \chi} \\ \beta &= \frac{\omega}{\omega^2 - \chi^2} \\ \delta &= \frac{\chi}{\omega^2 - \chi^2} \end{aligned}$$

and where γ is defined as the net own effect of advertising such that $\gamma = \frac{\varepsilon + \tau}{\omega + \chi}$. Furthermore,

λ is defined as the magnitude of the cross price effect such that $\lambda = |\frac{\tau-\psi}{\omega+\chi}|^2$. Note that the demand functions written above are for the case where $\psi > \tau$. Advertising in such a scenario is termed as market-stealing. This is because advertising by a firm not only increases it own demand, but also reduces that of its rival. On the other hand, if $\tau > \psi$, λ would enter each demand function with a positive sign. Advertising in such a scenario is called market-expanding. Advertising by a firm increases its own demand as well as that of its rival. In such a case the demand functions for the two firms would be

$$D_1(p_1, p_2, \Phi_1, \Phi_2) = \alpha - \beta p_1 + \delta p_2 + \gamma\Phi_1 + \lambda\Phi_2 \tag{3.3}$$

and

$$D_2(p_1, p_2, \Phi_1, \Phi_2) = \alpha - \beta p_2 + \delta p_1 + \gamma\Phi_2 + \lambda\Phi_1 \tag{3.4}$$

A high degree of product differentiation can be seen as affecting the cross-effect of advertising in two ways. One, it increases the likelihood of advertising being market-stealing rather than market-expanding. A higher degree of product differentiation increases the efficacy of Type B advertising as captured by the parameter ψ. Advertising that seeks to align the preferences of the consumer more in line with the characteristics of the advertised product is more effective when it has greater differences (real or perceived) between the products to exploit[3]. A higher degree of product differentiation would also reduce the effect of the generic component of Type A advertising as captured by τ. The more dissimilar the two products, the smaller is the positive spillover of one firm's advertising on the other's demand[4].A higher degree of product differentiation also translates into a greater magnitude

[2]Thus, $\lambda = \frac{\tau-\psi}{\omega+\chi}$ if $\tau > \psi$ and $\lambda = \frac{\psi-\tau}{\omega+\chi}$ if $\psi > \tau$.

[3]Formally, this would be represented by ψ as a function of χ, $\psi(\chi)$ where $\psi'(\chi) < 0$. Note that higher χ implies a lower level of product differentiation.

[4]Formally this would be represented by τ as a function of χ, $\tau(\chi)$ where $\tau'(\chi) > 0$. Note that higher χ

of the cross effect of advertising. Recall that higher product differentiation is represented by low values of χ, which in turn implies a high value of λ. Thus in product differentiated industries advertising is more likely to be market-stealing *and* this effect is likely to be large in magnitude.

Note that the distinction that is of paramount importance for the subject of this paper is between market-stealing and market-expanding advertising as represented by the two sets of demand functions above. Unlike chapter 2, the empirical analysis and results of the paper are not restricted to the case of persuasive advertising but can be applied to the case where advertising has an informative role. What is of primary importance are the two sets of demand functions representing the alternative effect of advertising. The assumption of persuasive advertising in the utility function is purely illustrative in this chapter and is made in order to show how such demand functions can be derived from the utility maximizing behavior of consumers. The results apply to the case of informative advertising as well in as much as such advertising is consistent with demand functions where advertising can have a market-stealing effect. The appendix presents an example of such a case of informative advertising that yields the identical set of demand functions as those in eq.(3.1) and eq.(3.2).

3.3.3 Firm Behavior

Firm interaction is considered in the framework of an infinitely repeated game, such that in each period firms choose their price and advertising levels. Two possibilities of firm-behavior are considered. First, firms may compete with each other on both price and

implies a lower level of product differentiation.

advertising and earn the Nash equilibrium (competitive) profits in each period denoted by π^n. Or, firms may choose to set prices collusively and advertising levels independently in each period. In such a case each firm will earn the collusive profit in each period denoted by π^c. Considering only grim-trigger strategies for the firms, collusion can emerge as a sub-game-perfect outcome of the game only when $\pi^c - \pi^n > 0$.

For given values of the parameters a, α, β and δ, the each firm's profit under collusion (π^c) as well as that under competition (π^n),can be expressed purely in terms of the net own effect of advertising (γ) and the magnitude of the net cross effect (λ). Thus, the difference between the profit of each firm under collusion and that under competition ($\pi^c - \pi^n$) can be expressed as a function of γ and λ. This function is denoted by $F(\gamma, \lambda)$

3.3.4 Price Collusion under Market-Expanding Advertising

The function $F(\gamma, \lambda) > 0$ when advertising is market-expanding. Under collusion not only is the price higher but so is the (independently set) level of advertising of each firm. The former is an obvious consequence of the elimination of the motive to undercut one's rival's price. The latter follows from the higher price that each firm now earns due to collusion. With a higher price on each unit of output, the incentive to expand demand through advertising is stronger. When the net cross effect of advertising is positive, a firm benefits from the advertising of another firm in the industry. Under collusion, firms benefit both from the higher price that results directly from the collusion and the higher advertising by each firm that follows as a consequence. Thus, the profits of firms under price collusion are always higher than those under competition when advertising is market-expanding[5].

[5]This result extends to the case where $\lambda = 0$, i.e. when advertising has no cross effect.

This is independent of the magnitude of the market-expanding effect. For a high enough discount factor, price collusion in each period can be a sub-game perfect outcome.

3.3.5 Price Collusion under Market-Stealing Advertising

The case where advertising is market-stealing is different. On the one hand, firms benefit from the higher price that is the direct consequence of collusion. However, firms advertise more as a result of the higher price under collusion. Owing to combativeness of advertising, higher advertising by both firms adversely affects their profits much more than under competition. The latter effect may be strong enough to negate all the gains from price collusion, such that each firm's profit under collusion is lower than under competition, i.e., $F(\gamma, \lambda) < 0$. In such a case, price collusion can not be a sub-game perfect outcome of the infinitely repeated game. Figure 1 depicts the implicit function $\lambda = f(\gamma)$ that is defined by $F(\gamma, \lambda) = 0$. As such, it represents those combinations of values of γ and λ such that each firm's profit is equal under collusion and competition. For values of γ and λ above (below) the curve, $F(\gamma, \lambda) < 0$ $(F(\gamma, \lambda) < 0)$. Using the terminology adopted in chapter 2, the market-stealing effect of advertising is said to be dominant when $\lambda > f(\gamma)$. In such a case, the intensified advertising that necessarily accompanies price collusion, negates all the gains of that collusion. In such a case collusion will not be sub-game perfect. On the other hand, when $\lambda < f(\gamma)$, the market-stealing effect is not dominant and advertising competition does not outweigh the gains from collusion for the firms. Collusion can be sub-game perfect as long as each firm values the future sufficiently.

Thus when advertising is market-expanding or when the market-stealing effect is not dominant, it poses no impediment in the ability of firms to successfully collude on price.

This is not the case when the market-stealing effect is dominant $(\lambda > f(\gamma))$. Firms do not benefit from price collusion in such a case as price collusion and the resulting higher price leads to intensified competition on advertising. Since advertising is highly market-stealing, the result of this intensified competition on advertising is lower profits for each firm and the breakdown of collusion.

Furthermore, as discussed above, not only is advertising likely to be market-stealing in industries with greater product differentiation but the magnitude of this effect is also likely to be higher in such industries. Section 3.5.3 discusses the empirical strategies used in identifying industries where the market-stealing effect of advertising is likely to be dominant.

3.4 Data Set

The construction of the data set involves the collection of a group of collusive industries which is then compared with a non-collusive group. The comparison is done in terms of several industry characteristics which are described below and data on which, for the most part, are available in the Economic Census that is carried out by the Census Bureau every five years.

3.4.1 Collusive Industries

The most comprehensive and readily accessible source of historical records for antitrust cases filed by the DOJ is the Trade Regulation Reporter (TRR) published by Commerce Clearing House. The TRR reports a case summary of a DOJ indictment that contains the list of defendants, which includes individuals, corporations and trade associations (where applicable), the nature of the conspiracy that the defendants allegedly participated in, the duration of the conspiracy, the products involved in the conspiracy, the geographical scope of the alleged conspiracy, the regional division and the official heading the investigation and lastly the ultimate settlement of the case. Often there is supplementary information as well, including the market share accounted for by the firms involved in the conspiracy and the total sales of the product in the relevant period. Some cases summaries also include details about how the conspiracy was actually carried out such as the time and location of meetings of alleged coconspirators.

The first step in constructing a sample of collusive industries was the selection of cases of price fixing that were initiated between 1960 and 2003. There were three criteria that were used in the selection of this preliminary sample: first, the corporations, individuals or trade associations had to be charged with explicit (horizontal) price fixing. Second, only cases from the manufacturing sector were included. Third, for a case to be included in the sample, the ultimate settlement of the case had to be adverse to the defendants. For this, consent settlements and *nolo contondre*[6] pleas were included along with adverse trial decisions while acquittals, dismissals and withdrawals were not included. Using these criteria a preliminary sample of 156 cases was collected.

To construct the preliminary sample of collusive industries each product listed in the price fixing cases selected thus far, was mapped into a four-digit Standard Industrial Classification (SIC) code that identifies an industry. Each product was first mapped into

[6]A nolo contondre plea is one where the defendent does not contest the charge and is usually seen as a victory for the prosecuting authorities. It seems plausible to assume that such pleas would occur in cases where the trial decision is fairly certain.

a six-digit North American Industrial Classification System (NAICS) code with the help of the NAICS search function on the Economic Census Website or with the help of Websters online business dictionary. The NAICS code was then mapped into the SIC code with the help of the bridge between NAICS and SIC on the Census Bureau website. [7]. A collusive industry was thus uniquely identified by its four-digit SIC code. Each collusive industry in the preliminary sample was then paired with a *single* census year depending on the time period of the price fixing conspiracy as given in the case summary of the DOJ indictment in the TRR. Often, the duration of the conspiracy was such that it could be paired with more than one census year. In such cases the *earliest* census year was chosen. The reason for doing this is discussed in detail in section 3.5.6 on potential endogeneity.

The above process year yielded 226 unique industry-year pairs in which one or more of the constituent products of an industry was subject to a price fixing conspiracy[8]. In this there are industries where collusion has been detected more than once. Accounting for such industries so that they are counted only once I get a total of 138 unique industries that are classified as collusive.

It is worth noting that under this classification, when an industry is classified as collusive it does not imply that all products in the industry in the given year were subject to price-fixing conspiracies. An industry is classified as collusive even *if a single product* that falls within that industry was subject to a price-fixing conspiracy.

[7]The SIC was used for censuses prior to the one in 1997 and was replaced by the NAICS in 1997. Only for about forty percent of the industries is the mapping between SIC and NAICS one-to-one. For others the mapping was done with the knowledge of the constituent collusive product (i.e common to both).

[8]The reason for the number of cases being different from the industry-year pairs is that often the product that is the subject of a price-fixing conspiracy maps into more than one industry. For instance the product chain-link fence maps into the two SIC codes 3496 and 3315. Sometimes two or more products map into the same industry, for eg. artificial abrasive grain and industrial diamonds both map into the SIC code 3291.

The above sample was modified by eliminating all price fixing conspiracies that were not national in scope. Such agreements were restricted to the sale of the relevant product in a limited local or regional market by firms that typically operated only in those markets[9]. The rationale for excluding local and regional cases of price fixing is the use of census data for industry variables. These variables are measured at the national level and using them to derive any inferences about price fixing that only covers local or regional markets would lead one to draw incorrect conclusions.

Over the years the Census Bureau has added a number of industry variables to the list of those that it gathers data on and reports in the Economic Census. As a consequence, while the recent censuses have most of the industry variables that are required for this study the same is not true for earlier censuses. For this reason only data from three census years, namely 1987, 1992 and 1997 are used in this paper. Thus, in the final sample of collusive industries only those are included that have been paired with one of the above three census years. This yields a final sample of 65 collusive industries each paired with only one of the three census years listed above.

A question that can reasonably be asked with regards to the pairing of collusive industries with corresponding census years is why an industry with a price-fixing conspiracy long enough for it to be paired with more than one census year is paired with a single (and earliest possible) census year. As an example, consider an industry with a price-fixing conspiracy that lasted between 1987 and 1992. Given that only data from the three census years, 1987, 1992 and 1997 is used in this paper, one possibility is to construct a panel

[9] An exception was made regarding agreements that covered a large proportion of the national market and involved firms that operated on a national scale and were typically national market leaders

of industries with three data points for each industry corresponding to the three census years. In such a panel the classification of the industry (as collusive or noncollusive) could be determined by the presence and duration of a price fixing conspiracy in that industry. For instance, the above industry could be classified as collusive in the years 1987 and 1992 but noncollusive in 1997.

The fundamental problem in this approach lies in the uncertain status of the hypothetical industry in the year 1997. Specifically one cannot be sure if the industry should be classified as noncollusive in that year. The reason being that the absence of collusion in the industry could be due to unfavorable industry conditions that make collusion difficult to sustain, which indeed constitutes the subject of this chapter. Or, and herein lies the problem, the absence of collusion could be due to the fact that the firms in the industry were caught and charged with colluding in the past and are under scrutiny by the DOJ. In such a scenario even though the industry characteristics may be such that they give rise to a high propensity to collude this would not result in actual collusion by firms.

The objective of this paper is to study the impact of several industry characteristics on the propensity to collude in an industry. Since the latter is unobservable, observed collusive conduct in an industry is taken as an indicator of a high propensity to collude in that industry. However, if firms in an industry have been found guilty of collusion in the past, and the industry is under scrutiny by antitrust authorities on that account, a high propensity to collude is less likely to lead to actual price collusion, such that the latter no longer remains a good indicator of the former. It is for this reason that the use of a panel is avoided and instead each industry is paired with only one census year[10].

[10]As is explained below, if an industry is classified as collusive in any given year (even if that year is not

However, the construction and use of a panel of industries would be extremely useful in empirically testing the another prediction of the theoretical model described in chapter 2. This is the proposition that the equilibrium advertising in an industry will be higher when pricing conduct in the industry is collusive rather than competitive. The panel would enable the use of industries that underwent a change in pricing conduct (from collusive to noncollusive) as a treatment group and other industries that underwent no change in pricing conduct as a control group. If advertising is found to exhibit a significant decline in the former group but not in the latter, this would constitute as evidence in support of the theoretical prediction. However, this is the subject of a future study.

3.4.2 Price Collusion and Advertising Competition

The theoretical model outlined in Section 3.3 and studied in detail in chapter 2, describes the behavior of firms under collusion as jointly setting prices but setting advertising levels independently. It is thus a model of price collusion and advertising competition. It needs to be asked how accurate such a characterization of firm behavior is and how it measures up to actual cases of price fixing that are used in constructing the sample of collusive industries in Section 3.4.1.

Typically, the price fixing cases in the sample have the defendants being charged with setting minimum or fixed prices and standard conditions of sale. However, there were no cases where firms were accused of either restricting or otherwise collectively deciding on advertising in addition to fixing prices. The reason for this could not be a lack of interest on the part of antitrust authorities in such agreements. This is borne out by several instances

included in the final sample years) the industry is never classified as noncollusive.

where firms have entered into agreements to restrict advertising (independent of any price fixing) that have been investigated by the DOJ. An example of firms being prosecuted for colluding on advertising by the DOJ is that of five Iowa hospitals[11]. These hospitals were charged by the DOJ with “agreeing to limit the dollar amount spent on advertising”. The hospitals agreed not to make “claims that would be considered image building or self-aggrandizement”. There was no accompanying charge of price-fixing. The decree passed prohibited the defendants from “entering into any future agreements about the amount of advertising they use”. Thus, the lack of accompanying charges of advertising collusion *in all* the price fixing cases used to construct the sample of collusive industries, given that such an offense has been investigated and prosecuted by the DOJ separately from price fixing allows one to make the reasonable conclusion that firms colluding on price do not necessarily collude on advertising. This conclusion is further reinforced from a survey of the price-fixing agreements that constitute the sample studied in Symeonidis (2003). After studying the price fixing agreements that were registered in 1956 in the U.K., Symeonidis (2003) finds that “there were in general no restrictions regarding capital investment, media advertising or R&D expenditure”.

However, the observation that firms colluding on price do not attempt to reduce the intensity of non-price competition such as in advertising poses the question why firms actually engage in such behavior. Why don’t firms colluding on price attempt to collude in other dimensions of their interaction like advertising? I believe that at least part of the answer to this question lies in particular industry characteristics and industry norms that may facilitate price collusion but not other forms of collusion.

[11]For details on the case see Commerce Clearing House Trade Regulation Report 1992.

An example of an industry characteristic that lends itself to facilitating price fixing is the presence of a trade association. Indeed, in a number of price fixing cases surveyed in this study trade associations figure prominently as defendants along with the firms participating in the conspiracy. Trade associations can work to make the price of firms public in an environment where they may not be, such as in the case where sales are made privately to large customers. This makes a collusive agreement easier to monitor and sustain. Equally important, trade associations may act as a mechanism for coordinating on a collusive price and adjusting it in response to a change in the external environment. One possible way that firms may do this is to announce a future price increase through a trade association. The firm would follow up on the announced price increase if it has been met with similar announcements by other firms but would retract it if other firms do not respond appropriately. Firms could iterate back and forth until they reach a mutually agreeable price. Furthermore such a practice can be justified by firms (to antitrust authorities) on the grounds of "sound business practices" that benefits consumers can get information on prices of all firms at one location and who are informed of price increases in advance and can adjust their behavior accordingly. Trade associations can not be used to facilitate collusion on advertising in the same way partly because firms cannot make the case that sharing information on advertising through trade associations is of any benefit to consumers. An industry-wide practice of issuing press notices on future price increases serves a similar purpose and is similarly justified by firms. Such behavior corresponds to actual cases of price fixing such as the one involving manufacturers of an antiknock compound for gasoline in 1984[12] and the 1993 case against eight major airlines where instead of a trade association, the Airline Tariff and

[12] See Hay (1999)

Publishing Company was used as a coordinating mechanism[13].

The industry-wide norm of offering "most favored customer" clauses in an industry is another feature that helps in sustaining price collusion but not advertising collusion. A "most-favored customer" clause lowers the incentive from deviating from a collusive price by offering a lower price to gain a customer, particularly when sales are made privately to large customers. By committing to offer same discounts to all customers, a firm effectively reduces the benefit of offering a discount to a new customer. "Most favored customer clauses" not only create a disincentive for cheating, they also reduce the uncertainty about a rival's pricing policy in general and male collusion easier. Again, such a policy can be explained away by firms as a "sound business practice".

Thus, there are arrangements in industries that can facilitate price collusion and can by justified as ostensibly serving competitive purposes but cannot be used to facilitate advertising collusion. Firms may also feel less of a need for advertising collusion as opposed to price collusion. Price competition is the most direct form of competition that produces gains that are short lived and easily replicated as opposed to advertising that may generate brand loyalty. Thus firms' incentives to curtail price competition may be the strongest[14].

3.4.3 Non Collusive Industries

An industry is classified as non-collusive if there has never been any price-fixing case by the DOJ in that industry for the period for which the antitrust case summaries are used in this paper (including regional and local cases). This eliminates 138 industries that

[13]See Borenstein (1999).

[14]Deltas and Serfes (2002) provide a theoretical model where firms may find it more beneficial to engage in semicollusion as opposed to full collusion in the presence of demand uncertainty.

comprise the preliminary sample of collusive industries from the set of all possible four-digit SIC industries. Each non-collusive industry thus classified in this sample is then randomly paired with one of the three census years being considered. After dropping industries with missing data, there are 272 industries that comprise the group of non-collusive industries. In the empirical analysis,the group of 65 collusive industries is compared to the group of 272 non-collusive industries.

3.4.4 Sample Selection

Before one embarks on the use of the constructed data set for empirical estimation, acknowledgment of possible weaknesses in that data set is in order. The data set is constructed by including industries where the Antitrust Division of the DOJ successfully prosecuted cases of price fixing and this very fact leaves it prone to selection issues. For instance, it can be asked whether this constructed sample represents industries that are collusive or those that have some characteristics that make for easier prosecution by the DOJ. In the latter case, comparing industry characteristics of this group with those of a non-collusive group may pick up differences between the two that make for successful antitrust legislation rather than the determinants of price collusion which is the subject of this paper.

The constructed sample of collusive industries does not include all collusive industries but simply those that get caught and are then tried successfully by the DOJ. As such it can be argued, that such cases of collusion would be the weakest. The argument could take the line that since the known cases of price fixing by definition involve firms that get caught, there may be something inherent in those agreements that made them predestined to fail. One possibility being that such industries did not have characteristics conducive for successful price collusion. Therefore, by studying characteristics of such industries one would not draw inferences about what makes collusion more likely, but instead what makes collusion easier to detect and therefore more likely to fail.

Dick (1996) criticizes the use of antitrust data in the early studies that reviewed case histories of prosecuted price-fixing agreements to infer the economic conditions supporting collusion. He points out that by selecting cases based on their prosecution status, these studies failed to separate cleanly the determinants of cartel formation from those guiding successful antitrust enforcement. The result, according to him, was biased sampling that led to misleading interpretation of the evidence. Since this paper also relies on data from antitrust cases, its important to effectively justify the use of this data by dealing with the principal concern about the data that is raised by Dick (1996). Dick argues that because low industry concentration and high cartel membership increases the cartel's visibility to antitrust enforcement agencies, cartels with these features will appear more numerous in these studies leading them to make misleading conclusions regarding the correlation between industry concentration (and the number of firms) and the incidence of price fixing in an industry.

I disagree with such arguments on two counts. The first owes to the inherent randomness in the process by which typical cases of price fixing are detected. According to Posner (1970) the Department of Justice's price-fixing cases are frequently based on tips and testimony of defecting conspirators or disgruntled employees. The larger the number of conspirators the higher the likelihood of such evidence turning up and leading to prosecution by the DOJ. If tips and testimony by sources related to the number of conspirators were the only sources of information leading to detection and prosecution of price-fixing cases, then the use of data from such cases will certainly lead to incorrect inferences about the effect of industry concentration on price-fixing. However, this is clearly not the case. As Posner (1970) himself points out, buyers are an extremely important source of information.

A survey of the price-fixing conspiracies used in this paper throws up some interesting facts about how these agreements get detected by the DOJ. Frequently, DOJ investigation into possible price-fixing are triggered by completely unrelated events. For example the DOJ may level a charge against a firm or an employee that is unrelated to price-fixing but a detailed investigation into the firm's accounts and operations may throw up evidence of other wrongdoing including price-fixing. This then triggers a specific investigation into price-fixing. Hay and Kelley (1974) have presented information on the means of detection for those cases within their sample for which such information is available. They find that detection through sources which might be related to the number of conspirators occurred in only 15 cases (30%). In other cases, detection was effected through processes independent of the number of conspirators. This evidence would suggests that it is not significantly easier to detect a price-fixing conspiracy involving a large number of conspirators than one involving only a few parties. On the basis of the above discussion it seems reasonable to conclude that the possibility of any bias arising from a systematic relationship between the number of conspirators and the likelihood of detection is low.

Second, it can be argued, equally persuasively, that the cases of price fixing that are actually caught and brought to trial successfully are not the weakest but in some sense the most blatant and thus the strongest (amongst explicit price-fixing arrangements). Given the risks attached to being caught (and given that the DOJ's stand on such issues has never been in doubt), one participates in such a conspiracy only if the rewards are sufficiently high. Thus the industries in which price fixing cases have been detected and the defendants successfully tried would have characteristics that make for the strongest incentives for collusion. Fraas and Greer (1977) argue that as structural conditions vary from most favorable to least favorable for the emergence of collusive behavior, and as legal sanctions apply, conduct of firms ranges from tacit collusion to explicit price collusion to independent action. Their reasoning for this is that since the purpose of all collusion is maximization of joint profits, the incidence of specific types of collusion will depend of firms fulfilling this purpose while minimizing legal risk. Thus, explicit collusion will occur when it is both *possible* and *necessary* for joint maximization of profits.

Data on industry variables is discussed in the next section on the empirical methodology adopted in the paper.

3.5 Empirical Methodology

3.5.1 Industry Variables

Oligopoly theory and previous empirical research, most notably, Symeonidis (2003), provide an extensive list of industry variables that may affect the likelihood of collusion in a given industry and are thus included in this paper. Following is a definition of industry variables used in the empirical estimation and a brief discussion of how each is expected to impact the likelihood of collusion on the basis of the theoretical literature and previous empirical research.

A higher rate of growth in industry sales is believed to increase the likelihood of collusion in an industry, other things being equal. Higher market growth increases the weight firms attach to future profits relative to current profits. This reduces the incentive of a firm to deviate from a collusive agreement in the present. The market growth for an industry is calculated as the ratio of the value of shipments between the current census and the preceding census minus the inflation rate[15] for the relevant period. This is the variable $GROWTH$ which is used to construct the variables $INVGROWTH$ and GD used in alternate specifications. The variable $INVGROWTH$ is simply calculated as $\frac{1}{GROWTH}$. Thus, low values of this variable are expected to be associated with a higher likelihood of collusion on the basis of the above discussion. The dummy variable GD classifies an industry as a *low-growth industry* and takes the value 1 for industries with lower than median market growth in the sample.

The ease with which entry can occur in an industry constrains a price-fixing cartel's profitability. Barriers to entry increase the likelihood of collusion. By making entry more difficult,the gains from collusion are more difficult to eliminate. Economies of scale and large sunk costs in an industry act as entry barriers. Collusion monitoring costs are also lower when firms must sink specific investments to enter the industry. If a cheating firm is punished by forfeiting the future collusive return on its sunk assets, its incentive to deviate by undercutting the collusive price is weakened. The measure of economies of scale used for each industry is capital intensity. Two alternative measures of capital intensity are used. The first, $LNCAPINT1$ is the natural logarithm of the total value of assets in

[15] The inflation rate for the relevant period is calculated using the inflation calculator on the BLS website.

the industry divided by the number of establishments. The second, $LNCAPINT2$, is the natural logarithm of the total capital expenditure in the industry divided by the value of shipments.

Industry concentration could strengthen the incentive for firms to collude on price. First, with fewer members in a price-fixing cartel, the share of each in the cartel profit is higher. Secondly, with fewer firms, monitoring of the collusive agreement becomes easier and the incentive to cheat consequently lower. However, the data in this study is on explicit collusion. With high industry concentration the need for explicit price-fixing agreements as opposed to tacit collusion may be obviated for the very reasons that make collusion easier to sustain as stated above. Thus, explicit collusion would be unnecessary at very high levels of industry concentration and unfeasible at very low levels of concentration. For this reason industry concentration as measured by the four-firm concentration ratio[16] enters the estimation equation, both as a level term $CONC$ and a squared term $CONC^2$.

The effect of product differentiation on the incidence of collusion is not certain. Differentiation may raise the cost of enforcing collusion as product quality and style differences must be identified and monitored to deter cheating along non-price lines. However, if buyers' markets for goods are relatively atomistic (due to high product differentiation), price cuts to individual buyers would be relatively unprofitable and the incentive to deviate from a collusive agreement weaker. The paper only considers horizontal product differentiation. The measure relies on the distinction between consumer-goods industries and others. It is constructed by using the end-use classification of industries to divide industries into

[16] Alternate specifications not reported in the paper use the eight-firm concentration ratio and the herschman-herfindahl index which yield similar results.

consumer goods industries and non-consumer goods industries[17]. This is a commonly used measure of product differentiation and is used by Dick (1996) to study the determinants of export cartel formation. The underlying belief is that consumer goods industries are associated with a higher degree of (horizontal) product differentiation than other industries (capital goods, producer goods, primary goods, intermediate goods etc.). Thus the measure of product differentiation used in the estimation equation, PD, is a dummy variable that takes the value 1 if the industry in question is a consumer goods industry and 0 otherwise.

An alternative measure of product differentiation considered in the paper is the trade overlap index of an industry. The trade overlap index for industry i, TOI_i, is calculated as follows

$$TOI_i = \frac{Min(X_{ik}, M_{ik})}{Max(X_{ik}, M_{ik})}$$

where X_{ik} are country i's exports in industry k while, M_{ik} denotes country i's imports in industry k. The trade overlap index measures the extent of overlap between imports and exports in international trade of a country for a given industry. Industry trade is classified as two-way for large values of the trade overlap index (close to one). Product differentiation is cited as the reason for intra-industry trade in the International Trade literature[18]. This underlies the rational for capturing product differentiation using a measure of intra-industry trade.

A dummy variable is constructed, $TOID$, that takes the value 1 for industries

[17] End-use classification is an alternative classification of industries. These were mapped into NAICS which in turn were mapped into SIC. Each SIC code was then classified as consumer-goods or nonconsumer-goods on the basis of the corresponding end-use classification code(s).

[18] Another reason along with product differentiation that is given to explain intra-industry trade is the presence of economies of scale in the industry. This is explicitly controlled for by the capital intensity variable.

that have a trade overlap index higher than the median and 0 for industries with lower than the median trade overlap index in the sample. Thus, this variables classifies an industry as product differentiated if it has a high trade overlap index. This follows the methodology adopted by Chiarlone (2000) and Freudenberg and Muller (1992) who use a similar binary variable constructed from the trade overlap index to classify industries as product differentiated or homogeneous. Data on imports and exports at the industry level are obtained from the United States International Trade Commission website. The trade overlap index was calculated for the years 1987-1996. The dummy variable $TOID$ was constructed using the average of the TOI over all the years.

3.5.2 Advertising

The focus of this paper is the effect of advertising on the likelihood of collusion in an industry. The prevalent view in the literature is that higher advertising intensity (measured as the ratio of advertising expenditure and sales) should reduce the attractiveness of price collusion for firms. One possible reason given for this is that advertising may induce vertical differentiation or "perceived quality" differences and these make coordination on a collusive price more difficult. Some authors also identify industries with high advertising intensity as industries with high product differentiation. For instance, Symeonidis (2003) explains the negative association between advertising intensity and the likelihood of collusion in the U.K. on these lines. However, this paper makes a departure from such studies by separately accounting for product differentiation (discussed below). More importantly, as shown in the theoretical model outlined earlier, the effect of advertising may differ depending on whether it is market-stealing or market-expanding. Only when advertising is market-stealing and this effect is dominant, does advertising present an impediment in sustaining a successful price-fixing agreement. The reason for this is that only under such a scenario, intensified competition in advertising, which inevitably follows price collusion, can outweigh the gains of that price collusion.

Advertising intensity at the industry level is measured as the ratio of purchased advertising services to the value of product shipments, both of which are reported in the Economic Census. This variable is denoted by $ADINT$ in the estimation equation.

Alternatively, an industry is classified as a high-advertising industry if the advertising intensity in that industry is higher than the median advertising intensity in the sample. This is captured by the dummy variable AD that takes the value 1 for high-advertising industries and 0 otherwise.

The availability of such data from a common source is one of the improvements over previous research that have relied on relatively imprecise data from various different sources to construct measures for advertising intensity that have been subject to a fair degree of measurement error.

3.5.3 Market-Stealing Advertising

The primary purpose of this chapter is to empirically determine if advertising competition can affect the likelihood of price collusion in a manner consistent with the theoretical model presented in detail in chapter 2. The model yields two predictions. First, the equilibrium level of advertising in an industry is higher when pricing conduct in the industry is collusive rather than competitive. This is because the prospect of earning a higher price through collusion gives each firm a stronger incentive to expand its demand through advertising, thus leading to higher overall advertising in the industry. Second, the intensified advertising competition that results from an attempt at price collusion can undermine that very attempt. Advertising competition can possibly negate all the gains from price collusion leading to a break down in the collusion. This is the case in industries where advertising is market-stealing and where the market-stealing effect is dominant.

In terms of the parameters of the theoretical model, an industry with dominant market-stealing advertising is one where $\lambda > f(\gamma)$. Recall that γ is the own-effect of advertising and measures the private benefit a firm derives from one of unit of advertising. This benefit is the increase in the firm's demand due to advertising. The own-effect of advertising thus determines how much advertising a firm will engage in, with a higher value of γ implying a higher level of advertising by each firm and thus a higher level of equilibrium industry advertising as well. On the other hand, λ captures the magnitude of the market-stealing effect. This is the adverse effect of one firm's advertising on the other's demand. If one could observe these parameter values for each industry, industries with dominant market-stealing advertising could be identified. Observation of a lower likelihood of collusion in such industries as opposed to others would constitute evidence in support of the theoretical model. However, one obviously cannot observe underlying industry characteristics represented by the parameters γ and λ. The approach taken in this paper is to rely on *observed* industry characteristics and utilize these in drawing inferences about the associated underlying parameters.

Figure 2.2 depicts the parameter space where the market-stealing effect is dominant and advertising competition breaks down an attempt at price collusion. This is the region lying above the $\lambda = f(\gamma)$ curve. Note that a high magnitude of the market-stealing effect is neither necessary not sufficient in order for the market-stealing effect to be dominant. A high value for the magnitude is insufficient to negate the gains of price collusion by itself when the corresponding own-effect of advertising, γ, is small in magnitude. A low magnitude of the own-effect implies a low level of equilibrium advertising for the industry. In such a scenario even if the market-stealing effect of advertising were large, advertising competition would not negate all the gains from price collusion. This is because firms in the industry do not engage in an adequate level of advertising for the market-stealing effect to have a significant impact. Advertising in such industries is largely inconsequential. Thus, what makes the market-stealing effect of advertising dominant in an industry is a combination of two factors: a large magnitude of the market-stealing effect (high value of λ) and and a large magnitude of the own-effect of advertising (a high value of γ).

The paper adopts two approaches to empirically identify industries with dominant market-stealing advertising. The first approach identifies an industry with dominant market-stealing advertising as one that is characterized by low market-growth *and* high advertising. As part of this approach, first industries with low market growth are identified as those where advertising is market-stealing and where this market-stealing effect is significant in magnitude. In the absence of market expansion (growth), high advertising by a firm could only be raising demand for the advertising firm by diverting (or tending to divert) demand from other firms. The observation of negligible or low market growth in an industry would lead to the reasonable conclusion that any benefit to an advertising firm in terms of increased demand is unlikely to spill over to other firms and in fact would most likely come at the cost of reduced demand for other firms in the industry. Thus, as part of the first empirical strategy, the observation of low market growth in an industry is taken as an indicator of a high magnitude of the market-stealing effect (λ).

However, this is not sufficient in identifying dominant market-stealing advertising industries as a high magnitude of the market-stealing effect does not by itself guarantee dominant market-stealing advertising. For this the accompanying own-effect of advertising is also required to be sufficiently large. High observed advertising in an industry is taken as an indicator of a high magnitude of the own-effect (γ) in that industry. The reasoning behind this is straightforward. Since the own-effect captures the private benefit that accrues to a firm from one unit of advertising, the level of advertising undertaken by each firm and consequently the aggregate level of advertising in the industry is directly affected by the own-effect.

Thus, the first approach uses observed market growth in an industry to derive information on the underlying magnitude of the market-stealing effect of advertising (λ) in that industry. While low market growth is taken as an indicator of significant market-stealing effect of advertising, the observation of high market growth does not imply that advertising is market-expanding as the market expansion may be independent of advertising. Furthermore, this approach uses observed industry advertising to draw an inference on the magnitude of the own-effect of advertising (γ), with the observation of high advertising taken as reflecting a high magnitude of the own-effect.

Two versions of this empirical strategy are implemented in the paper. The first uses a dummy variable, $MSAD_1$, to classify an industry as one with dominant market-stealing advertising. The variable takes the value 1 for for an industry, if the industry is characterized by *both* higher advertising intensity than the median advertising intensity in the sample *and* lower market growth than the median growth rate in the sample[19]. In an alternative specification I construct a continuous variable MSA_1 as the product of the advertising growth in an industry and the *inverse* of the market growth. Thus, high values of MSA_1 reflect high advertising in conjunction with low market growth, precisely the scenario where the market-stealing effect of advertising is likely to be dominant as per the rationale underlining the first identification strategy.

It deserves mention that advertising need not necessarily be persuasive in order for the empirical strategy to accurately identify industries with dominant market-stealing advertising. The validity of using low market growth to identify industries with market-stealing advertising is unaffected by whether advertising is informative or persuasive. Similarly the link between a high magnitude of the own-effect of advertising in an industry and high level of observed industry advertising would hold irrespective of whether advertising is informative or persuasive.

The second approach adopted in this paper to empirically identify industries with dominant market-stealing advertising utilizes differences in the extent of product differentiation between industries. There are two reasons why advertising can be expected to be more market-stealing in industries with a greater degree of product differentiation as opposed to relatively homogenous product industries. First, advertising that highlights some product attributes of the advertised product exerts no positive spillover on other products

[19]The dummy variable $MSAD_1$ is thus an interaction of high advertising dummy AD and a low-growth dummy GD as described above.

and thus cannot be market-expanding if these attributes are not shared by all products in the industry[20]. Thus, the potential for market-expanding advertising is limited in industries with a greater degree of product differentiation.

Second, given the existence of product differences, a firm may choose to engage in advertising that highlights these differences and makes the consumers value these differences more. Such advertising would result in higher demand for the advertised product as well as lower demand for the other (different) products in the industry. In other words, the potential for market-stealing advertising is higher in industries with a greater degree of product differentiation. Analogous reasoning that applies to the case of informative advertising is presented in the appendix to this chapter.

The measure of product differentiation used in this paper is a consumer goods industry dummy variable (as explained above). Given the rationale underlying the second strategy, this variable can also help identify industries where advertising is likely to have a significant market-stealing effect (λ). Once again, high observed industry advertising is taken as an indicator of a high magnitude of the own-effect of advertising (γ). Taken together, the second strategy identifies product differentiated industries with high advertising as those with dominant market-stealing advertising. This is represented by the dummy variable $MSAD_2$ that takes the value one for an industry if it is a high advertising consumer goods industry[21]

[20]Again, the reasoning applies to the case of both informative and persuasive advertising. Informative advertising that informs consumers about the benefits of a product arising out of some specific attributes will only affect the demand of the advertised product if the attributes are unique to that product. Similarly, persuasive advertising that seeks to raise the demand for a product by making consumers value some attributes of the advertised product will not affect the demand for other products in the industry if the attributes are not shared amongst the different products.

[21]Thus, $MSAD_2$ is an interaction of the thet wo dummy variables PD and AD.

The different indices of dominant market-stealing advertising are used in alternate specifications.

3.5.4 Data Description

Table 3.1 summarizes the distribution of collusive and non-collusive industries across manufacturing industry-groups in the sample. Fourteen industry-groups have been identified and are represented by 3-digit SIC codes or when appropriate, by a collection of 3-digit SIC codes. Chemicals, petroleum and coal products and Metal and metal products are two industry-groups that stand out for the high incidence of collusion in them. Leather products and instruments are industry-groups with no collusive industries. Descriptive statistics for the entire sample and separately for collusive and non-collusive industries are given in Table 3.2.

3.5.5 Empirical Model

The empirical model used in the paper to examine the effect of the industry variables described above on the incidence of explicit price-fixing across the U.S. manufacturing sector, is a probit model with the following basic specification

$$\begin{aligned} COLL_i^* &= \alpha_i + \beta_1 GD_i + \beta_3 LNCAPINT_i + \beta_4 PD_i \\ &\quad + \beta_5 AD_i + \beta_6 CAD_i + \beta_7 CONC_i + \beta_8 CONC_i^2 + u_i \end{aligned} \tag{3.5}$$

where instead of the "propensity to collude" $COLL^*$ an unobserved latent variable, we observe the dichotomous variable $COLL$ which takes the value 0 for non-collusive industries and 1 for collusive industries.

3.5.6 Potential Endogeneity

One possible problem with the above specification is that some variables on the right hand side may be endogenous. In particular, a two-way link between market growth and collusion; and advertising intensity and collusion cannot, in principle, be ruled out. With firms colluding on a higher price, industry growth can be expected to be lower than under a regime of price competition. Also, under price collusion, with collusion resulting in higher prices than those that would prevail under competition, each firm's incentive to advertise would be higher. Thus advertising intensity is likely to be higher under price collusion than under price competition.

The problem of possible endogeneity of the market growth variable is taken care of by using lagged values. For instance, market growth for the census year 1987 is measured as the growth in value of shipments between 1982 and 1987 minus the rate of inflation in the same period.

The potential endogeneity of advertising cannot be solved by using lagged values since data for advertising is not available for the earlier census years (which is the reason that the sample is restricted to the three census years in the first place). This problem is of particular concern as the criterion used to identify industries with dominant market-stealing advertising rely on observed industry advertising. If the latter were indeed endogenous then the veracity of any empirical results would be called into question.

To test whether advertising is in fact endogenous to the model I adopt a simple test of exogeneity for limited dependent variable models suggested by Smith and Blundell

(1986). The test involves specifying that the exogeneity of one or more explanatory variables is under suspicion. This test is related to the Davidson-MacKinnon auxiliary regression test for exogeneity in a regression context, which in turn is a convenient alternative to the commonly employed Hausman test. Under the null hypothesis, all explanatory variables are exogenous in the following empirical model which is essentially similar to the one in Symeonidis (2003) and serves as a baseline model here

$$\begin{aligned} COLL_i^* &= \alpha_i + \beta_1 GROWTH_i + \beta_2 LNCAPINT_i \\ &\quad + \beta_3 ADINT_i + \beta_4 CONC_i + \beta_5 CONC_i^2 + u_i \end{aligned} \tag{3.6}$$

Under the alternative hypothesis, the suspected endogenous variable, advertising intensity as measured by $ADINT$ is expressed as a linear projection of a set of instruments in the following first stage regression model[22].

$$ADINT_i = \alpha_i + \beta_1 GROWTH_i + \beta_2 LAM_i + \beta_3 PD_i + \beta_4 CONC_i + e_i \tag{3.7}$$

where LAM_i is the lagged value of the average mark-up[23] in industry i.

The results of the Smith-Blundell test along with the estimation results of the baseline model in eq.(3.6) are given in Table 3.3. Given the p-values for the Smith-Blundell exogeneity test *null of exogeneity of advertising cannot be rejected*.In all cases the p-values are far from conventional significance levels.

[22]The first stage regression model is similar to the one in Strickland and Weiss (1976).

[23]The average mark-up in industry i is calculated as the ratio of value added minus the sum of capital and wage expenditure in the industry to that of total value of sales.

For the test to be valid, the instruments for advertising intensity in eq. (3.7) have to be exogenous to the model in eq.(3.6). It is for this reason that the average mark-up is included with a lag[24].

The fundamental premise of this paper is that observed industry characteristics that contain information on underlying industry parameters affect the (latent) propensity to collude in an industry. The objective is to assess the impact of these variables on the propensity to collude. It is important to note that the industry characteristics in turn, *are not* affected by the propensity to collude. For instance, while high market growth is believed to facilitate collusion and thus should increase the propensity to collude in an industry, a high propensity to collude will not affect the market growth in the industry. It is *only* when a high propensity to collude translates into *actual collusion practiced by firms* that market growth in the industry will be affected. This means that industry characteristics measured at a point in time *before* collusion was actually practiced by firms, will be free from the effect of that collusion. This is despite the fact that the industry characteristics from the earlier time period may cause the *propensity to collude* in the industry to be high. Thus, the likelihood of lagged values of the industry characteristics being endogenous is low.

The records of the DOJ as summarized in the cases listed in the Trade Regulation Reporter, contain information on the duration of the alleged price-fixing conspiracy with a beginning and an end date (this information is in terms of the year and in some cases the month as well). For many cases the end date of the conspiracy precedes the date when the DOJ investigation was initiated while for others the two dates coincide. Recall from

[24]Note also that the way the market growth is calculated for an industry means that lagged values of the growth rate are being used in all estimation equations.

section 3.4.1 on data set construction, that an industry classified as collusive was paired with the *earliest* census year possible given the time period of the associated price-fixing conspiracy. For example, the four-digit SIC industry *Medicinals and Botanicals* had two constituents products, vitamins B3 and B4 (niacin and niacinamide) that were the subject of a price-fixing conspiracy between 1992 and 1998. Information on this case was first filed in September 1998 in the federal district court of Dallas. The *Medicinal and Botanicals* industry (SIC code 2833) is thus classified as collusive and enters the sample paired with the earliest possible census year, 1992. The lagged value of the average mark-up used in eq.(3.7) for this industry is from the previous census year i.e. 1987. Even allowing for some inaccuracy in the records of the DOJ regarding the price-fixing conspiracy actually having started in 1992, using the lagged value of the average mark-up (from 1987) minimizes the chances of this being endogenous.

Now, since each of the variables on the right hand side of eq.(3.7) can be taken as exogenous to the model in eq.(3.6), each of them is uncorrelated with u in eq.(3.6). Thus, $ADINT$ will be uncorrelated with u as well if and only if e is uncorrelated with u. The Smith-Blundell test of exogeneity, thus involves including the residuals from the first stage estimation of eq.(3.7) as an additional regressor in the second stage estimation of eq.(3.6). Under the null hypothesis of exogeneity, the first-stage residuals have no power at the second stage. As mentioned above, given the results of the test the null of exogeneity of advertising cannot be rejected.

A possible reason behind the Smith-Blundell test result is as follows. Recall again from Section 3.4.1 that an industry is classified as collusive, if even one of the many products constituting that industry has been subject to a price-fixing conspiracy. In the majority of the industries thus classified, there is a single such product which has been subject to a price-fixing conspiracy. Collusion in effect, is determined and measured at the *product level*. Evidence of price fixing at the product level is used to classify the associated industry as collusive. Typically the weight of such products, in terms of the fraction of total industry sales is around 10%. On the other hand, all the variables used in the estimation equation, including market growth and advertising intensity, are measured at the *industry level* and are thus determined by *all* products constituting that industry, not just the collusive product[25]. Any link between variables measured at the industry level and collusion at the product level, is likely to run from the former to the latter. As Symeonidis (2003) argues advertising intensity in an industry is determined primarily by exogenous industry characteristics. These may be inherent industry characteristics that determine advertising effectiveness or others such as government regulations[26].

3.6 Results and Interpretation

The marginal effects from the estimation of different specifications of the basic probit model in eq.(3.5) are reported in Tables 3.5 through **??**. The specifications differ from each other in the use of different measures of market-stealing advertising that are

[25]Admittedly, this is less than perfect for measuring the impact of factors like market growth and advertising intensity on the incidence of collusion. Detailed data on these variables at the product level would be much better suited for the purpose at hand. However, data is available only at the more aggregated level of industries rather than products.

[26]For instance, until recently, the Food and Drug Administration required drug manufacturerers to announce all possible side-effects in any television advertisement for any drug so advertised. This made television advertising in the pharmaceutical industry prohibitively expensive. However, a change in the stipulation now allows the manufacturers to list all these side-effects briefly at the end of the advertisement. The change in regulation has thus made television a viable medium for advertisement in the pharmaceutical industry and can be thought of as increasing the effectiveness of advertising in that industry.

defined above, and in the inclusion of controls for industry-group specific effects. The industry-groups used for this are those that are identified in Section 3.5.4. Controlling for the industry-group helps in alleviating misspecification concerns that may arise due to omitted variables or due to industry specific effects[27].

3.6.1 Advertising

The results strongly suggest that collusion is less likely in industries with low growth and high advertising. This is borne out by the negative and significant marginal effect of the market-staling advertising dummy $MSAD1$ as reported in Table 3.4. Moreover, this result is robust to the inclusion of industry-group fixed effects. The variable $MSAD1$ takes the value 1 for industries with lower than median growth and higher than median advertising intensity, i.e. for those industries where market-stealing advertising is likely to be dominant. An industry thus classified as having dominant market-stealing advertising, has a probability of collusion that is *lower* by 10-15% points (as calculated at the sample means).

The above effect is reaffirmed in the alternate specification that uses a continuous measure of dominant market-stealing advertising MSA_1 whose results are reported in Table 3.5. Recall that MSA_1 is the interaction of advertising intensity and the inverse of the market growth in an industry. Higher values of MSA_1 imply high advertising coupled with lower growth, i.e. precisely the scenario when market-stealing advertising is more likely to be dominant. The marginal effect of MSA_1 is negative and significant for all specifications

[27]The coefficients for the industry-group dummies are usually jointly significant at the 5% or the 10% level.

including fixed effects probit as shown in Table 3.5. A unit increase in dominant market-stealing advertising, as measured by MSA_1, *reduces* the probability of collusion by 50-63% points (at the sample means).

Collusion also seems less likely in consumer goods industries with high advertising as the negative and significant marginal effect of $MSAD_2$ reported in Table 3.6 shows. Once again, this result is robust to the inclusion of industry-group fixed effects. The variable $MSAD_2$ takes the value 1 for those industries that are consumer-goods industries (for whom $PD = 1$) with advertising intensity higher than the median. Consumer-goods industries are believed to have a higher level of product differentiation and advertising is more likely to be market-stealing in product differentiated industries than relatively homogeneous product industries. When advertising is high in such industries, the market-stealing effect is likely to be dominant. Thus, the above industries are likely to be those with dominant market-stealing advertising. An industry thus classified as having market-stealing advertising, has a probability of collusion that is *lower* by 9-11% points (calculated at the sample means).

There is little clear evidence regarding the effect of advertising in general (i.e. when advertising is market-expanding or the market-stealing effect is not dominant) on the likelihood of collusion. The marginal effect of the high advertising dummy AD is usually insignificant. The exception is in the specification with $MSAD_2$, where the marginal effect of AD is negative and significant. However, this result is not robust to the inclusion of industry-fixed effects as can be seen in Table 3.6. On the other hand, the marginal effect of advertising intensity $ADINT$ is positive and always significant.

These results taken together provide strong evidence in support of the theoretical result obtained earlier that advertising can break down price collusion only when it is market-stealing and the market-stealing effect is dominant. Advertising that is not market-stealing should prove no hindrance in price collusion. The reason for this result is as follows. Under price collusion, the resulting higher price increases each firm's incentive to advertise as each firm's private marginal return from a unit of advertising is higher. Thus, under price collusion advertising competition is intensified. If advertising in the particular industry is market-expanding, higher advertising by each firm exerts a positive externality on the other firm and each firm's profits are higher not only due to the higher collusive price but also from the resulting higher advertising. However, when advertising in the industry is market-stealing the intensified competition in advertising has an adverse impact on each firm's demand and thus profit. With dominant market-stealing advertising, the intensified advertising competition may offset all the gains from price collusion and thus break down collusion.

This effect of advertising on the likelihood of collusion has not been documented in the empirical literature before. Previous empirical research in the area, has focused on the effect of advertising effectiveness, as measured by advertising intensity, on the incidence of collusion across industries. For instance, Symeonidis (2003) incorporates advertising in the regression as a dummy variable that takes the value 1 when advertising intensity is greater than one percent. He finds that the incidence of price collusion is lower in advertising-intensive industries and interprets this finding as high advertising effectiveness reducing the likelihood of collusion. However,as the theoretical model outlined in this paper shows, high advertising effectiveness (in terms of a high private benefit to advertising) is not sufficient to break down collusion. It is advertising *combativeness* not *effectiveness* that can break down collusion and the estimation results reported in the paper lend strong support to this hypothesis.

However, it is not difficult to reconcile the result in Symeonidis (2003) with those obtained in this paper. First, the possibility of the results for advertising intensity in Symeonidis (2003) being affected by measurement error cannot be ruled out[28]. As is outlined in his paper, Symeonidis (2003) has collected data on advertising from various different sources at levels of aggregation different from the four-digit industry level used in the empirical estimation[29]. Second, it is possible, especially in light of the possibility of measurement error highlighted above, that the industries that are classified as advertising-intensive are also industries with market-stealing advertising. The source of advertising data used by Symeonidis (2003) is *Statistical Review of Press and TV Advertising* which reports data on advertising primarily for consumer-goods industries. Other industries for which data is not available have been classified as low-advertising industries by Symeonidis (2003). Thus, the effect that Symeonidis (2003) is capturing is that of *high advertising in consumer-goods industries on the likelihood of price collusion* which he finds to be negative and ascribes to advertising in general. But this is precisely the result that is obtained in this paper as borne out by the negative and significant marginal effect of $MSAD_2$. To the extent that consumer-goods industries are also product-differentiated industries and advertising is more

[28]The possibility of measurement error is common in other studies that use advertising data. For eg. Asch and Seneca use advertising data at the minor industry group level as reported by the Income Tax Source Book published by the IRS and use it draw inferences on the incidence of collusion at the industry level. Minor industry groups usually comprise 5-10 industries.

[29]This is the reason Symeonidis uses a dummy variable to classify advertising intensive industries. He argues that industries (primarily non consumer-goods industries) for which data on advertising is not available are low-advertising industries.

market-stealing in product-differentiated industries, the market-stealing effect is likely to be dominant in consumer-goods industries with high advertising. Thus the finding in Symeonidis (2003) that the incidence of collusion is lower in advertising-intensive industries can actually be interpreted as the incidence of collusion being *lower in industries with dominant market-stealing advertising.*

To further test the validity of the results obtained in this paper, I divide the entire sample of industries into two sub-samples: high-growth and low-growth industries. The first sub-sample includes industries with growth rates higher than the median of the entire sample while the opposite is true of the second sub-sample. I estimate a probit model which differs with the original specification in the exclusion of the dominant market-stealing advertising term. If advertising is indeed more market-stealing in slow growth industries than in high growth industries, and market-stealing advertising reduces the likelihood of collusion (when advertising is high such that the market-stealing effect becomes dominant) then this would result in a negative and significant marginal effect of advertising intensity ($ADINT$) for the low-growth sub-sample but not for the high-growth one. In fact this is exactly the case as is shown in Table 3.7 and Table **??**. The marginal effect of $ADINT$ is negative and significant for low-growth industries but not for high-growth industries. In low growth industries advertising is more market-stealing and high advertising in such industries makes the market-stealing effect dominant. Thus in these industries, high advertising intensity reduces the likelihood of collusion.

Dividing the entire sample into low-growth and high-growth industries also allows to test for the possibility of an entry-barrier effect of advertising. Firms can try to use advertising to create brand loyalty to tie in consumers. This increases the cost of entering a market for prospective entrants and thus acts as an entry barrier. By reducing the likelihood of future entry of new firms advertising can increase the likelihood of price collusion. The lower prospects of future entry mean that the collusive profits are shared amongst fewer firms and these are less likely to be eroded in the future through new entrants. This reduces the incentive for a firm in a collusive agreement to deviate from that agreement. Second, by reducing entry, advertising keeps the number of firms in the market down and known which makes collusion easier to monitor.

However, if advertising acts as a barrier to entry it should have a positive effect on the likelihood of collusion *especially amongst high-growth industries*. This is because the threat of entry is higher in faster growing industries and firms are more likely to use advertising as an entry barrier precisely in such industries. As the results in Table 3.7 and Table **??** show this is clearly not the case. Advertising has an insignificant marginal effect on the likelihood of collusion in the high-growth industries.

3.6.2 Other Industry Variables

The estimation results suggest a positive relation between market growth and the likelihood of collusion, with low market growth being associated with a lower probability of collusion. This is borne out by the negative and significant marginal effect of the low growth dummy GD as reported in Table 3.4 and Table 3.6. According to these results an industry with low market growth has a probability of collusion that is lower by 13-21% points (at the sample means). This positive link is reaffirmed by the negative and significant marginal effect of the inverse of market growth $INVGROWTH$ as reported in Table 3.6. Lower market growth makes it more difficult for firms to sustain collusion. With lower market growth, firms value future profits from collusion less which increases the attractiveness of deviating from collusion in the present.

The regression results strongly suggest that incidence of collusion is higher in industries with high capital intensity. The marginal effect of both measures of capital intensity $LNCAPINT1$ and $LNCAPINT2$ are always positive and significant[30]. Two reasons, one relating to barriers to entry and the other to the monitoring of collusion help in explaining this result. The importance of sunk costs, that are implied by high capital intensity, reduce the extent of entry in an industry. Lower entry implies that the gains from collusion for firms are unlikely to be eliminated in the future due to increased competitive pressure from new firms. This strengthens the incentive for collusion.

There is no clear evidence, either way, of any link between industry concentration and the incidence of collusion. The marginal effect of $CONC$ is negative but not significant. High concentration may have two opposing effects on the likelihood of collusion. On the one hand, high concentration increases each firm's share of collusive profits and makes monitoring easier. On the other hand, high industry concentration may be associated with the presence of dominant firms and significant firm asymmetries. This may make collusion more unlikely in any given industry. High industry concentration could eliminate the need for explicit price collusion as tacit collusion becomes easy to enforce when the number of firms is small.

There is no evidence on the effect of product differentiation on collusion either.

[30] Capital intensity as a level term (instead of in logs) was also tried in other specifications, the results of which are not reported here. The results were similar.

The coefficient on PD is always insignificant. Martin (2001) presents theoretical models of cartel stability under horizontal product differentiation that yield ambiguous results. Under product differentiation markets are relatively more atomistic. If buyers' markets for goods are relatively atomistic price cuts to individual buyers would be relatively unprofitable, the incentive to deviate from a collusive agreement for a firm would be weaker and thus, the prospects for collusion would be enhanced.

The estimation results for the alternative measure of product differentiation $TOID$ that is constructed from the trade overlap index, and the associated index of market-stealing advertising are not reported as they are not found to be significant. A possible reason for this is that the for the trade overlap index to be used as a proxy for product differentiation it should ideally be calculated at the product level. Calculating the trade overlap index at the industry level may add too much noise for it to be an accurate measure of the level of product differentiation in an industry thereby leading to statistically insignificant results. However, future studies should consider the trade overlap index as an alternative measure of product differentiation when using data at the product level.

3.7 Conclusion

The paper examines the effect of advertising on price collusion using an original data set constructed from summaries of price-fixing cases across the manufacturing sector in the United States. The theoretical model outlined in the paper shows that this effect of advertising on collusion depends on whether advertising in an industry is market-stealing or market-expanding. Advertising could hinder price collusion when it is market-stealing (and this effect is dominant) but not when it is market-expanding.

Two types of industries are identified where the market-stealing effect of advertising is likely to be dominant. In industries with low market growth, advertising is more likely to be market-stealing than market-expanding. In addition, advertising in industries with a higher level of product-differentiation is more likely to be market-stealing. Furthermore, when the above industries also have high advertising, the market-stealing effect is likely to be dominant.

The econometric results presented in the paper support the predictions of the theory. Collusion is found to be less likely in industries with low market growth and high advertising. Furthermore, the incidence of collusion is also found to be lower in product-differentiated industries with high advertising. This is the first paper to document these effects of advertising on price collusion.

The paper also finds a positive relationship between market growth and price collusion. In addition, collusion is found to be more likely in industries with a higher capital intensity. These results have been previously documented for the United Kingdom in the 1950s. However, this is the first paper to use U.S. antitrust data to systematically study the factors that affect collusion across manufacturing industries.

Table 3.1: Distribution of Manufacturing Industries

Industry Group	Number of Four Digit Industries Collusive	Noncollusive
Food, drink and tobacco	4	35
Textiles and apparel	3	45
Lumber, furniture, etc	4	18
Paper, printing and publishing	3	7
Chemicals, petroleum and coal products	13	14
Rubber and plastic products	3	5
Leather products	0	11
Stone, clay and glass	8	17
Metal and metal products	15	22
Industrial machinery	4	36
Electric and electronic products	6	19
Transportation equipment	1	13
Instruments	0	16
Miscellaneous	1	14

Table 3.2: Descriptive Statistics

		Collusive N=65	Noncollusive N=272	All N=337
GROWTH	Mean	1.18	1.02	1.06
	Std. Deviation	0.24	0.26	0.27
CAPINT1	Mean	12214.27	7950.65	8721.18
	Std. Deviation	22310.46	20434.59	20815.94
CAPINT2	Mean	4.41	3.05	3.31
	Std. Deviation	2.62	1.85	2.08
ADINT	Mean	0.31	0.42	0.40
	Std. Deviation	0.45	0.57	0.55
F4	Mean	33.07	41.26	39.65
	Std. Deviation	18.65	21.29	21.01
F8	Mean	46.53	54.11	52.61
	Std. Deviation	21.66	23.09	22.97
HHI	Mean	581.45	741.64	709.70
	Std. Deviation	575.88	670.03	654.52

Table 3.3: Smith Blundell Test Of Exogeneity
Dependent Variable COLLUSION=1 for collusive industries, 0 for noncollusive
337 Observations

	(1)	(2)
Growth Rate (GROWTH)	0.29***	0.27***
	(0.08)	(0.07)
Advertising Intensity (ADINT)	-0.07*	-0.05
	(0.04)	(0.04)
Log of Capital Intensity 1 (LNCAPINT1= Log of Total Assets-Log of Number of Establishments)	0.06***	0.03**
	(0.01)	(0.01)
Four Firm Concentration Ratio (CONC)	-0.001	-0.0001
	(0.003)	(0.003)
Four Firm Concentration Ratio^2 (CONC^2)	-0.0002	-0.0004
	(0.0004)	(0.0004)
Industry Group Dummies in First Stage Equation	Yes	Yes
Industry Group Dummies in Second Stage Equation	No	Yes
Smith-Blundell Test Statistic (Probability>χ^2)	0.005	0.41
	(0.94)	(0.52)

Note: *** significant at 1%
** significant at 5%
* significant at 10%
Standard errors in parenthesis

Table 3.4:Probit Estimation Marginal Effects

Dependent Variable COLLUSION=1 for collusive industries, 0 for noncollusive

337 Observations

	(1)	(2)	(3)	(4)
Low Growth Dummy (GD)	-0.12**	-0.13***	-0.11**	-0.13***
	(0.05)	(0.05)	(0.05)	(0.05)
High Advertising Dummy (AD)	-0.05	-0.03	-0.05	-0.04
	(0.04)	(0.04)	(0.04)	(0.04)
Dominant Market-Stealing Advertising Dummy 1 (MSAD1=High Advertising Dummy*Low Growth Dummy)	-0.14***	-0.10***	-0.13***	-0.10***
	(0.04)	(0.04)	(0.05)	(0.04)
Log of Capital Intensity 1 (LNCAPINT1= Log of Total Assets-Log of Number of Establishments)	0.05***	0.02*		
	(0.02)	(0.01)	-	-
Log of Capital Intensity 2 (LNCAPINT2= Log of Total Capital Expenditure-Log of Total Sales)			0.15***	0.10**
	-	-	(0.04)	(0.03)
Four Firm Concentration Ratio (CONC)	-0.002	-0.0002	-0.001	-0.001
	(0.003)	(0.003)	(0.003)	(0.003)
Four Firm Concentration Ratio^2 ($CONC^2$)	-0.00002	-0.00003	-0.00003	-0.00003
	(0.00004)	(0.00003)	(0.00004)	(0.00003)
Industry Group Dummies	No	Yes	No	Yes
Year Dummies	No	Yes	No	Yes
Pseudo R^2	0.1879	0.3154	0.2226	0.3319

Note: *** significant at 1%
** significant at 5%
* significant at 10%
Standard errors in parenthesis

Table 3.5: Probit Estimation Marginal Effects
Dependent Variable COLLUSION=1 for collusive industries, 0 for noncollusive
337 Observations

	(1)	(2)	(3)	(4)
Inverse Growth (INVGRTH)	-0.18*	-0.19**	-0.18	-0.18*
	(0.11)	(0.10)	(0.11)	(0.10)
Advertising Intensity (ADINT)	0.46**	0.39**	0.41**	0.36*
	(0.20)	(0.18)	(0.21)	(0.18)
Dominant Market-Stealing Advertising (MSA1=Advertising Intensity* Inverse Growth)	-0.63***	-0.52**	-0.58**	-0.50**
	(0.23)	(0.21)	(0.25)	(0.22)
Log of Capital Intensity 1 (LNCAPINT1= Log of Total Assets-Log of Number of Establishments)	0.04***	0.02*		
	(0.01)	(0.01)	-	-
Log of Capital Intensity 2 (LNCAPINT2= Log of Total Capital Expenditure-Log of Total Sales)			0.14***	0.09**
	-	-	(0.04)	(0.04)
Four Firm Concentration Ratio (CONC)	-0.001	-0.0001	-0.0003	-0.0005
	(0.003)	(0.003)	(0.003)	(0.003)
Four Firm Concentration Ratio^2 ($CONC^2$)	-0.00002	-0.00002	-0.00004	-0.00002
	(0.00004)	(0.00003)	(0.00004)	(0.00004)
Industry Group Dummies	No	Yes	No	Yes
Year Dummies	No	Yes	No	Yes
Pseudo R^2	0.1615	0.2790	0.1936	0.2961

Note: *** significant at 1%
** significant at 5%
* significant at 10%
Standard errors in parenthesis

Table 3.6: Probit Estimation Marginal Effects

Dependent Variable COLLUSION=1 for collusive industries, 0 for noncollusive

337 Observations

	(1)	(2)	(3)	(4)
Low Growth Dummy (GD)	-0.19***	-0.19***	-0.18***	-0.18***
	(0.04)	(0.04)	(0.04)	(0.04)
High Advertising Dummy (AD)	-0.08*	-0.05	-0.08*	-0.05
	(0.04)	(0.03)	(0.04)	(0.04)
Consumer Goods Dummy (PD)	-0.05	-0.03	-0.01	0.03
	(0.09)	(0.07)	(0.07)	(0.07)
Dominant Market-Stealing Advertising Dummy 2 (MSAD2=High Advertising Dummy*Consumer Goods Dummy)	-0.11**	-0.09***	-0.10*	-0.10***
	(0.05)	(0.03)	(0.05)	(0.03)
Log of Capital Intensity 1 (LNCAPINT1= Log of Total Assets-Log of Number of Establishments)	0.05***	0.03*		
	(0.01)	(0.01)	-	-
Log of Capital Intensity 2 (LNCAPINT2= Log of Total Capital Expenditure-Log of Total Sales)			0.16***	0.09***
	-	-	(0.04)	(0.04)
Four Firm Concentration Ratio (CONC)	-0.001	-0.0003	-0.0005	-0.0005
	(0.004)	(0.003)	(0.004)	(0.003)
Four Firm Concentration Ratio^2 ($CONC^2$)	-0.00004	-0.00004	-0.00004	-0.00003
	(0.00004)	(0.00003)	(0.00004)	(0.00004)
Industry Group Dummies	No	Yes	No	Yes
Year Dummies	No	Yes	No	Yes
Pseudo R^2	0.1788	0.3164	0.2198	0.3361

Note: *** significant at 1%

** significant at 5%

* significant at 10%

Standard errors in parenthesis

Table 3.7: Probit Estimation Marginal Effects

Dependent variable COLL =1 for collusive industries, 0 for noncollusive

	All Industries:337	Low Growth Industries: 169	High Growth Industries: 168
Growth Rate (GROWTH)	0.30***	0.11	0.003
	(0.08)	(0.11)	(0.18)
Advertising Intensity (ADINT)	-0.07*	-0.13***	-0.05
	(0.04)	(0.05)	(0.08)
Log of Capital Intensity 1 (LNCAPINT1= Log of Total Assets-Log of Number of Establishments)	0.06***	0.01	0.09***
	(0.01)	(0.01)	(0.03)
Four Firm Concentration Ratio (CONC)	-0.001	-0.001	-0.004
	(0.004)	(0.003)	(0.007)
Four Firm Concentration Ratio^2 ($CONC^2$)	-0.00004	-0.00002	-0.00004
	(0.00004)	(0.00003)	(0.00008)
Pseudo R^2	0.1295	0.1573	0.0792

Note: *** significant at 1%
** significant at 5%
* significant at 10%
Standard errors in parenthesis

Table 3.8: Probit Estimation Marginal Effects

Dependent variable COLL =1 for collusive industries, 0 for noncollusive

	All Industries:337	Low Growth Industries: 169	High Growth Industries: 168
Growth Rate (GROWTH)	0.25***	0.11	0.004
	(0.08)	(0.11)	(0.18)
Advertising Intensity (ADINT)	-0.07*	-0.13***	-0.05
	(0.04)	(0.05)	(0.07)
Log of Capital Intensity 2 (LNCAPINT2=Log of Total Capital Expenditure-Log of Sales)	0.18***	0.03	0.33***
	(0.04)	(0.03)	(0.08)
Four Firm Concentration Ratio (CONC)	-0.0001	0.001	-0.002
	(0.004)	(0.003)	(0.007)
Four Firm Concentration Ratio^2 (CONC^2)	-0.00004	-0.00002	-0.00005
	(0.00005)	(0.00003)	(0.00009)
Pseudo R^2	0.1667	0.1576	0.1298

Note: *** significant at 1%
** significant at 5%
* significant at 10%
Standard errors in parenthesis

Appendix A

Appendix to Chapter 1

A.1 Derivation of demand functions

The representative consumer maximizes

$$u\left(q_1, q_2\right) - \sum_{i=1}^{2} p_i q_i \tag{A.1}$$

where

$$u\left(q_1, q_2\right) = \sum_{i=1}^{2} \left[\sigma + \left(\varepsilon + \tau\right)\Phi_i - \left(\psi - \tau\right)\Phi_{j \neq i}\right] q_i - \frac{1}{2}\left(\omega q_1^2 + 2\chi q_1 q_2 + \omega q_2^2\right)$$

Maximizing the expression in A.1 with respect to q_1 and q_2 gives the following two first order conditions

$$\sigma + \left(\varepsilon + \tau\right)\Phi_1 - \left(\psi - \tau\right)\Phi_2 - \omega q_1 - \chi q_2 - p_1 = 0 \tag{A.2}$$

and

$$\sigma + (\varepsilon + \tau)\,\Phi_2 - (\psi - \tau)\,\Phi_1 - \omega q_2 - \chi q_1 - p_1 = 0 \tag{A.3}$$

Solving the two simultaneous equations for q_1 and q_2 I get the demand functions of the two firms

$$D_1\,(p_1, p_2, \Phi_1, \Phi_2) = \alpha - \beta p_1 + \delta p_2 + \gamma \Phi_1 - \lambda \Phi_2$$

and

$$D_2\,(p_1, p_2, \Phi_1, \Phi_2) = \alpha - \beta p_2 + \delta p_1 + \gamma \Phi_2 - \lambda \Phi_1$$

where,

$$\begin{aligned}
\alpha &= \frac{\sigma}{\omega + \chi} \\
\beta &= \frac{\omega}{\omega^2 - \chi^2} \\
\delta &= \frac{\chi}{\omega^2 - \chi^2} \\
\gamma &= \frac{\varepsilon + \tau}{\omega + \chi} \\
\lambda &= \frac{\psi - \tau}{\omega + \chi}
\end{aligned}$$

Since I assume $\omega > \chi$, it follows that $\beta > \delta$.

A.2 Proofs

A.2.1 Proposition 1

The competitive equilibrium price in eq.2.7 can be written as

$$\frac{1}{(2\beta-\delta)}\left[\alpha+\frac{\alpha\gamma\left(\gamma-\lambda\right)}{a\left(2\beta-\delta\right)-\gamma\left(\gamma-\lambda\right)}\right]$$

and that under price semicollusion in eq.2.9 as

$$\frac{1}{2\left(\beta-\delta\right)}\left[\alpha+\frac{\alpha\gamma\left(\gamma-\lambda\right)}{2a\left(\beta-\delta\right)-\gamma\left(\gamma-\lambda\right)}\right]$$

Since $\beta > \delta$, it has to be true that $(2\beta-\delta) > 2\left(\beta-\delta\right)$ and therefore, $a\left(2\beta-\delta\right) > 2a\beta-\delta)$. Also since $(2\beta-\delta) > 2\left(\beta-\delta\right)$, $\frac{1}{(2\beta-\delta)} < \frac{1}{2(\beta-\delta)}$ and therefore,

$$A > B$$

Where,

$$A \equiv \frac{1}{2\left(\beta-\delta\right)}\left[\alpha+\frac{\alpha\gamma\left(\gamma-\lambda\right)}{2a\left(\beta-\delta\right)-\gamma\left(\gamma-\lambda\right)}\right]$$

$$B \equiv \frac{1}{(2\beta-\delta)}\left[\alpha+\frac{\alpha\gamma\left(\gamma-\lambda\right)}{a\left(2\beta-\delta\right)-\gamma\left(\gamma-\lambda\right)}\right]$$

A.2.2 Lemma 1

The expressions for the profit of each firm under competition (π^n) and that under price semicollusion (π^{pc}) are:

$$\pi^n = \frac{a\alpha^2\left(2a\beta-\gamma^2\right)}{2\left[a\left(2\beta-\delta\right)-\gamma\left(\gamma+\lambda\right)\right]^2} \tag{A.4}$$

and

$$\pi^{pc} = \frac{a\alpha^2\left[2a\left(\beta-\delta\right)-\gamma^2\right]}{2\left[2a\left(\beta-\delta\right)-\gamma\left(\gamma+\lambda\right)\right]^2} \tag{A.5}$$

Once again, I restrict attention to the case where the profit of each firm under price semicollusion is positive. I therefore make the following assumption that guarantees positive profits for firms under price semicollusion:

- Assumption 1: $2a\left(\beta-\delta\right)-\gamma\left(\gamma+\lambda\right)>0$.[1]

For given values of the parameters a, α, β and δ, and using the above expressions for π^n and π^{pc} in eq.A.7 and A.8 definition 3 I get the expression of $G\left(\gamma,\lambda\right)$:

$$G\left(\gamma,\lambda\right) = \frac{a^2\alpha^2\delta}{2}\left[\frac{a\delta\left[2a\left(\beta-\delta\right)-\gamma^2\right]+2\gamma\lambda\left[2a\left(\beta-\delta\right)-\gamma\left(\gamma+\lambda\right)\right]}{\left[2a\left(\beta-\delta\right)-\gamma\left(\gamma+\lambda\right)\right]^2\left[a\left(2\beta-\delta\right)-\gamma\left(\gamma+\lambda\right)\right]^2}\right] \tag{A.6}$$

Using assumption 1 that guarantees positive profits for firms under price semicollusion it is clear that $G\left(\gamma,\lambda\right)>0$ which gives the result stated in the text..

A.2.3 Lemma 2

The expressions for the profit of each firm under competition (π^n) and that under price semicollusion (π^{pc}) are:

$$\pi^n = \frac{a\alpha^2\left(2a\beta-\gamma^2\right)}{2\left[a\left(2\beta-\delta\right)-\gamma\left(\gamma-\lambda\right)\right]^2} \tag{A.7}$$

and

[1]This assumption is also sufficient (though not necessary) for the profit of each firm under the competitive equilibrium (π^n) to be positive.

$$\pi^{pc} = \frac{a\alpha^2\left[2a\left(\beta-\delta\right)-\gamma^2\right]}{2\left[2a\left(\beta-\delta\right)-\gamma\left(\gamma-\lambda\right)\right]^2} \tag{A.8}$$

I restrict attention to the case where the profit of each firm under price semicollusion is positive. I therefore make the following assumption that guarantees positive profits for firms under price semicollusion:

- Assumption 2: $2a\left(\beta-\delta\right)-\gamma^2 > 0$.[2]

For given values of the parameters a, α, β and δ, and using the above expressions for π^n and π^{pc} in eq.A.7 and A.8 definition 4 I get the expression of $F\left(\gamma,\lambda\right)$:

$$F\left(\gamma,\lambda\right) = \frac{a^2\alpha^2\delta}{2}\left[\frac{a\delta\left[2a\left(\beta-\delta\right)-\gamma^2\right]-2\gamma\lambda\left[2a\left(\beta-\delta\right)-\gamma\left(\gamma-\lambda\right)\right]}{\left[2a\left(\beta-\delta\right)-\gamma\left(\gamma-\lambda\right)\right]^2\left[a\left(2\beta-\delta\right)-\gamma\left(\gamma-\lambda\right)\right]^2}\right] \tag{A.9}$$

As stated in the text using the implicit function theorem $F\left(\gamma,\lambda\right)=0$ defines an implicit function $\lambda = f\left(\gamma\right)$. The equation $F\left(\gamma,\lambda\right)=0$ has the status of an identity in the neighborhood in which it is defined, therefore,

$$dF\left(\gamma,\lambda\right) = d0$$

$\Rightarrow$

$$F_\gamma d\gamma + F_\lambda d\lambda = 0$$

$\Rightarrow$

[2]This assumption is also sufficient (though not necessary) for the profit of each firm under the competitive equilibrium $\left(\pi^n\right)$ to be positive.

$$\frac{d\lambda}{d\gamma} = -\frac{F_\gamma}{F_\lambda} \tag{A.10}$$

Since $\lambda = f(\gamma)$ is defined by $F(\gamma, \lambda) = 0$, $\frac{d\lambda}{d\gamma}$ in eq.A.10 gives the slope of this function.

Now, using eq. A.9 the implicit function $\lambda = f(\gamma)$ is given by

$$a\delta\left[2a(\beta-\delta)-\gamma^2\right] - 2\gamma\lambda\left[2a(\beta-\delta)-\gamma(\gamma-\lambda)\right] = 0 \tag{A.11}$$

Taking the total derivative of eq.A.11 and simplifying I get

$$\frac{d\lambda}{d\gamma} = -\frac{2\lambda\left[2a(\beta-\delta)-\gamma^2\right]+2\gamma\left[a\delta-2\gamma\lambda\right]+4\gamma\lambda^2}{2\gamma\left[2a(\beta-\delta)-\gamma^2\right]+4\gamma^2\lambda} \tag{A.12}$$

Since I'm considering the case where the profit of each firm price semicollusion (π^{pc}) is positive, its has to be true that $2a(\beta-\delta)-\gamma^2 > 0$ (from assumption 2) and therefore the denominator of the term on the R.H.S. of eq.A.12 is positive.

$$2\gamma\left[2a(\beta-\delta)-\gamma^2\right]+4\gamma^2\lambda > 0 \tag{A.13}$$

From eq.A.11:

$$\frac{a\delta}{2\gamma\lambda} = \frac{2a(\beta-\delta)-\gamma(\gamma-\lambda)}{2a(\beta-\delta)-\gamma^2}$$

$\Rightarrow$

$$\frac{a\delta}{2\gamma\lambda} = \frac{2a(\beta-\delta)-\gamma^2+\gamma\lambda}{2a(\beta-\delta)-\gamma^2}$$

$\Rightarrow$

$$\frac{a\delta}{2\gamma\lambda} > 1 \tag{A.14}$$

Once again using assumption 1 along with eq.A.14, the numerator of the term on the R.H.S. of eq.A.12 has to be positive, i.e.

$$2\lambda\left[2a\left(\beta-\delta\right)-\gamma^2\right]+2\gamma\left(a\delta-2\gamma\lambda\right)+4\gamma\lambda^2 > 0 \tag{A.15}$$

Combining eq.A.15 and eq.A.13 I get the result $\frac{d\lambda}{d\gamma} < 0$.

A.2.4 Lemma 3

Since $\lambda = f\left(\gamma\right)$ is the implicit function defined by $F\left(\gamma, \lambda\right) = 0$ and $\lambda^* = f\left(\gamma^*\right)$ it follows that $F\left(\gamma^*, \lambda^*\right) = 0$. Thus, from eq.A.9:

$$\frac{a^2\alpha^2\delta}{2}\left[\frac{a\delta\left[2a\left(\beta-\delta\right)-\gamma^{*2}\right]-2\gamma^*\lambda^*\left[2a\left(\beta-\delta\right)-\gamma^*\left(\gamma^*-\lambda^*\right)\right]}{\left[2a\left(\beta-\delta\right)-\gamma^*\left(\gamma^*-\lambda^*\right)\right]^2\left[a\left(2\beta-\delta\right)-\gamma^*\left(\gamma^*-\lambda^*\right)\right]^2}\right]=0 \tag{A.16}$$

Since I assume $2a\left(\beta-\delta\right)-\gamma^2 > 0$ to guarantee that the profits under price semicollusion are positive, the denominator of the term on the left hand side of eq.A.16 is always strictly positive. Therefore eq.A.16 implies:

$$a\delta\left[2a\left(\beta-\delta\right)-\gamma^{*2}\right]-2\gamma^*\lambda^*\left[2a\left(\beta-\delta\right)-\gamma^*\left(\gamma^*-\lambda^*\right)\right]=0$$

$\Rightarrow$

$$\frac{a\delta}{2\gamma^*\lambda^*}=\frac{2a\left(\beta-\delta\right)-\gamma^*(\gamma^*-\lambda^*)}{2a\left(\beta-\delta\right)-\gamma^{*2}}$$

$\Rightarrow$

$$\frac{a\delta}{2\gamma^{*}\lambda^{*}}=\frac{2a\left(\beta-\delta\right)-\gamma^{*2}+\gamma^{*}\lambda^{*}}{2a\left(\beta-\delta\right)-\gamma^{*2}} \tag{A.17}$$

Now consider $\lambda' < \lambda^{*}$, the following has to be true

$$\frac{a\delta}{2\gamma^{*}\lambda'}>\frac{a\delta}{2\gamma^{*}\lambda^{*}} \tag{A.18}$$

Next, I take the partial derivative of $\frac{2a(\beta-\delta)-\gamma^{2}+\gamma\lambda}{2a(\beta-\delta)-\gamma^{2}}$ with respect to λ.

$$\frac{\partial}{\partial\lambda}\left[\frac{2a\left(\beta-\delta\right)-\gamma^{2}+\gamma\lambda}{2a\left(\beta-\delta\right)-\gamma^{2}}\right]=\frac{\gamma}{\left[2a\left(\beta-\delta\right)-\gamma^{2}\right]^{2}}>0$$

Thus, $\frac{2a\delta-\gamma^{2}+\gamma\lambda}{2a\delta-\gamma^{2}}$ is increasing in λ. Since $\lambda' < \lambda^{*}$ and $\frac{2a(\beta-\delta)-\gamma^{2}+\gamma\lambda}{2a(\beta-\delta)-\gamma^{2}}$ is increasing in λ

$$\frac{2a\left(\beta-\delta\right)-\gamma^{*2}+\gamma^{*}\lambda^{*}}{2a\left(\beta-\delta\right)-\gamma^{*2}}>\frac{2a\left(\beta-\delta\right)-\gamma^{*2}+\gamma^{*}\lambda'}{2a\left(\beta-\delta\right)-\gamma^{*2}} \tag{A.19}$$

Using eq.A.17, eq.A.18 and eq.A.19 I get

$$\frac{a\delta}{2\gamma^{*}\lambda'}>\frac{2a\left(\beta-\delta\right)-\gamma^{*2}+\gamma^{*}\lambda'}{2a\left(\beta-\delta\right)-\gamma^{*2}}$$

$\Rightarrow$

$$a\delta\left[2a\left(\beta-\delta\right)-\gamma^{*2}\right]-2\gamma^{*}\lambda'\left[2a\left(\beta-\delta\right)-\gamma^{*}\left(\gamma^{*}-\lambda'\right)\right]>0 \tag{A.20}$$

Once again, since I assume $2a\left(\beta-\delta\right)-\gamma^{2}>0$ for all values of γ, to guarantee positive profits under price semicollusion

$$\left[2a\left(\beta-\delta\right)-\gamma^{*}\left(\gamma^{*}-\lambda'\right)\right]^{2}\left[a\left(2\beta-\delta\right)-\gamma^{*}\left(\gamma^{*}-\lambda'\right)\right]^{2}>0 \tag{A.21}$$

Dividing eq.A.20 by eq.A.21 and multiplying by $\frac{a^2\alpha^2\delta}{2}$ I get

$$\frac{a^{2}\alpha^{2}\delta}{2}\left[\frac{a\delta\left[2a\left(\beta-\delta\right)-\gamma^{*2}\right]-2\gamma^{*}\lambda'\left[2a\left(\beta-\delta\right)-\gamma^{*}\left(\gamma^{*}-\lambda'\right)\right]}{\left[2a\left(\beta-\delta\right)-\gamma^{*}\left(\gamma^{*}-\lambda'\right)\right]^{2}\left[a\left(2\beta-\delta\right)-\gamma^{*}\left(\gamma^{*}-\lambda'\right)\right]^{2}}\right]>0$$

$\Rightarrow$

$$F\left(\gamma^{*},\lambda'\right)>0$$

for any $\lambda' < \lambda^*$, where $\lambda^* = f(\gamma^*)$. By analogous reasoning I can show that

$$F\left(\gamma^{*},\lambda'\right)<0$$

for any $\lambda' > \lambda^*$, where $\lambda^* = f(\gamma^*)$.

A.2.5 Lemma 4 and Lemma 5

Since $\lambda = f(\gamma)$ is defined by $F(\gamma,\lambda) = 0$, where $F(\gamma,\lambda)$ is given by eq.A.11, $\lambda = f(\gamma)$ is given by

$$a\delta\left[2a\left(\beta-\delta\right)-\gamma^{2}\right]-2\gamma\lambda\left[2a\left(\beta-\delta\right)-\gamma\left(\gamma-\lambda\right)\right]=0$$

For any given value of γ and δ define $\lambda_1 = f^1(\gamma)$ such that $\lambda_1 = f^1(\gamma)$ is given by

$$a_{1}\delta\left[2a_{1}\left(\beta-\delta\right)-\gamma^{2}\right]-2\gamma\lambda_{1}\left[2a_{1}\left(\beta-\delta\right)-\gamma\left(\gamma-\lambda_{1}\right)\right]=0 \tag{A.22}$$

and define $\lambda_2 = f^2(\gamma)$ such that $\lambda_2 = f^2(\gamma)$ is given by

$$a_2\delta\left[2a_2(\beta-\delta)-\gamma^2\right]-2\gamma\lambda_2\left[2a_2(\beta-\delta)-\gamma(\gamma-\lambda_2)\right]=0 \tag{A.23}$$

where $a_2 > a_1$.

Rearranging the terms in eq.sA.22 and A.23 respectively, I get

$$\frac{a_1\delta}{2\gamma\lambda_1}=\frac{2a_1(\beta-\delta)-\gamma^2+\gamma\lambda_1}{2a_1(\beta-\delta)-\gamma^2} \tag{A.24}$$

and

$$\frac{a_2\delta}{2\gamma\lambda_2}=\frac{2a_2(\beta-\delta)-\gamma^2+\gamma\lambda_2}{2a_2(\beta-\delta)-\gamma^2} \tag{A.25}$$

Since $a_2 > a_1$,

$$\frac{a_2\delta}{2\gamma\lambda_1}>\frac{a_1\delta}{2\gamma\lambda_1} \tag{A.26}$$

Now, $\frac{2a(\beta-\delta)-\gamma^2+\gamma\lambda}{2a(\beta-\delta)-\gamma^2}$ is decreasing in a and $a_2 > a_1$, hence

$$\frac{2a_1(\beta-\delta)-\gamma^2+\gamma\lambda_1}{2a_1(\beta-\delta)-\gamma^2}>\frac{2a_2(\beta-\delta)-\gamma^2+\gamma\lambda_1}{2a_2(\beta-\delta)-\gamma^2} \tag{A.27}$$

Using eq.A.24, A.26 and A.27 I get

$$\frac{a_2\delta}{2\gamma\lambda_1}>\frac{2a_2(\beta-\delta)-\gamma^2+\gamma\lambda_1}{2a_2(\beta-\delta)-\gamma^2} \tag{A.28}$$

Now let us assume that $\lambda_2 < \lambda_1$. Since $\frac{2a(\beta-\delta)-\gamma^2+\gamma\lambda}{2a(\beta-\delta)-\gamma^2}$ is increasing in λ it follows

that

$$\frac{2a_2(\beta-\delta)-\gamma^2+\gamma\lambda_1}{2a_2\delta-\gamma^2} > \frac{2a_2(\beta-\delta)-\gamma^2+\gamma\lambda_2}{2a_2\delta-\gamma^2} \tag{A.29}$$

Using A.25, A.28 and A.29 I get

$$\frac{a_2\delta}{2\gamma\lambda_1} > \frac{a_2\delta}{2\gamma\lambda_2}$$

$\Rightarrow$

$$\lambda_2 > \lambda_1$$

which is a contradiction, since I assumed $\lambda_2 < \lambda_1$. Hence it has to be true that $\lambda_2 > \lambda_1$ where λ_1 and λ_2 are as defined by eq.s A.22 and A.23 $a_2 > a_1$. The proof of Lemma 5 is analogous

A.2.6 Lemma 6 and Lemma 7

Since $\lambda = f(\gamma)$ is defined by $F(\gamma,\lambda) = 0$, where $F(\gamma,\lambda)$ is given by eq.A.11, $\lambda = f(\gamma)$ is given by

$$a\delta\left[2a(\beta-\delta)-\gamma^2\right] - 2\gamma\lambda\left[2a(\beta-\delta)-\gamma(\gamma-\lambda)\right] = 0$$

For any given value of γ and a define $\lambda_1 = f^1(\gamma)$ such that $\lambda_1 = f^1(\gamma)$ is given by

$$a\delta_1\left[2a(\beta-\delta_1)-\gamma^2\right] - 2\gamma\lambda_1\left[2a(\beta-\delta_1)-\gamma(\gamma-\lambda_1)\right] = 0 \tag{A.30}$$

and define $\lambda_2 = f^2(\gamma)$ such that $\lambda_2 = f^2(\gamma)$ is given by

$$a\delta_2\left[2a\left(\beta-\delta_2\right)-\gamma^2\right]-2\gamma\lambda_2\left[2a\left(\beta-\delta_2\right)-\gamma\left(\gamma-\lambda_2\right)\right]=0 \tag{A.31}$$

where $\delta_2 > \delta_1$.

Rearranging the terms in eq.sA.30 and A.31 respectively, I get

$$\frac{a\delta_1}{2\gamma\lambda_1}=\frac{2a\left(\beta-\delta_1\right)-\gamma^2+\gamma\lambda_1}{2a\left(\beta-\delta_1\right)-\gamma^2} \tag{A.32}$$

and

$$\frac{a\delta_2}{2\gamma\lambda_2}=\frac{2a\left(\beta-\delta_2\right)-\gamma^2+\gamma\lambda_2}{2a\left(\beta-\delta_2\right)-\gamma^2} \tag{A.33}$$

Since $\delta_2 > \delta_1$,

$$\frac{a\delta_2}{2\gamma\lambda_1} > \frac{a\delta_2}{2\gamma\lambda_1} \tag{A.34}$$

Now, $\frac{2a(\beta-\delta)-\gamma^2+\gamma\lambda}{2a(\beta-\delta)-\gamma^2}$ is decreasing in δ and $\delta_2 > \delta_1$, hence

$$\frac{2a\left(\beta-\delta_1\right)-\gamma^2+\gamma\lambda_1}{2a\left(\beta-\delta_1\right)-\gamma^2} > \frac{2a\left(\beta-\delta_2\right)-\gamma^2+\gamma\lambda_1}{2a\left(\beta-\delta_2\right)-\gamma^2} \tag{A.35}$$

Using eq.A.32, A.34 and A.35 I get

$$\frac{a\delta_2}{2\gamma\lambda_1} > \frac{2a\left(\beta-\delta_2\right)-\gamma^2+\gamma\lambda_1}{2a\left(\beta-\delta_2\right)-\gamma^2} \tag{A.36}$$

Now let us assume that $\lambda_2 < \lambda_1$. Since $\frac{2a(\beta-\delta)-\gamma^2+\gamma\lambda}{2a(\beta-\delta)-\gamma^2}$ is increasing in λ it follows that

$$\frac{2a\left(\beta-\delta_2\right)-\gamma^2+\gamma\lambda_1}{2a\delta_2-\gamma^2}>\frac{2a\left(\beta-\delta_2\right)-\gamma^2+\gamma\lambda_2}{2a\delta_2-\gamma^2} \tag{A.37}$$

Using A.33, A.36 and A.37 I get

$$\frac{a\delta_2}{2\gamma\lambda_1}>\frac{a\delta_2}{2\gamma\lambda_2}$$

$\Rightarrow$

$$\lambda_2>\lambda_1$$

which is a contradiction, since I assumed $\lambda_2<\lambda_1$. Hence it has to be true that $\lambda_2>\lambda_1$ where λ_1 and λ_2 are as defined by eq.s A.22 and A.23 $\delta_2>\delta_1$. The proof of Lemma 7 is analogous.

A.2.7 Price Comparison Across Regimes

In the regime where firms are not allowed to engage in advertising, the demand curves facing firm 1 and firm 2 respectively, are given by

$$D_1\left(p_1,p_2\right)=\alpha-\beta p_1+\delta p_2$$

and

$$D_2\left(p_1,p_2\right)=\alpha-\beta p_2+\delta p_1$$

When the firms compete on price, firm 1's behavior and firm 2's behavior respectively are described as

$$max\left\{p_1\left(\alpha-\beta p_1+\delta p_2\right)\right\}$$

with respect to p_1 and.

$$max\left\{p_2\left(\alpha - \beta p_2 + \delta p_1\right)\right\}$$

with respect to p_2.

The first order conditions yield the following best response function for firm 1 and firm 2 respectively

$$p_1 = \frac{1}{2\beta}\left(\alpha + \delta p_2\right) \tag{A.38}$$

and

$$p_2 = \frac{1}{2\beta}\left(\alpha + \delta p_1\right) \tag{A.39}$$

Solving eq.A.38 and eq.A.39 simultaneously yields the following

$$p^n_{na} = \frac{\alpha}{2\beta - \delta} \tag{A.40}$$

where the superscript and the subscript denote that this is the competitive price (n for non-collusive) under the regime where advertising by firms is prohibited (na for no advertising). The profit of each firm when both firms compete on price in the regime without advertising is given by

$$\pi^n_{na} = \frac{\beta\alpha^2}{\left(2\beta - \delta\right)^2} \tag{A.41}$$

When firms collude on price, I impose the symmetry condition $p_1 = p_2 = p^c_{na}$ in each firm's profit function. Each firm's behavior is described as

$$max\left\{p\left[\alpha-(\beta-\delta)\,p\right]\right\}$$

with respect to p. This leads to the following solution for p^c_{na}, the price under collusion in the regime without advertising

$$p^c_{na}=\frac{\alpha}{2\,(\beta-\delta)}$$

The profit of each firm when they collude on price in the regime without advertising is thus, given by

$$\pi^c_{na}=\frac{\alpha^2}{4\,(\beta-\delta)} \tag{A.42}$$

Thus if the discount factor d is sufficiently large, price collusion will constitute a subgame perfect equilibrium of the game with repeated firm interaction, in the regime where advertising by firms is prohibited. In such a case, consumers would face the non collusive price p^n_a in the regime with advertising and may/ are likely to face the collusive price p^c_{na} in the regime without advertising. Using (2.14) and (2.16) from the text, one can see that the latter will exceed the former when

$$\frac{\alpha}{2\,(\beta-\delta)}>\frac{a\alpha}{a\,(2\beta-\delta)-\gamma\,(\gamma-\lambda)}$$

$\Rightarrow$

$$\frac{a\delta-\gamma\,(\gamma-\lambda)>0}{2\,(\beta-\delta)\left[a\,(2\beta-\delta)-\gamma\,(\gamma-\lambda)\right]}>0 \tag{A.43}$$

Recall that I assume $2a\,(\beta-\delta)-\gamma^2>0$, thus the denominator of the term on the left hand side of the inequality above, $a\left(2\beta-\delta\right)-\gamma\left(\gamma-\lambda\right)>0$. Therefore (A.43) gives us inequality(2.17) in the text

$$a\delta-\gamma\left(\gamma-\lambda\right)>0$$

Appendix B

Appendix to Chapter 2

B.1 Informative Advertising

According to Tirole (1988), informative advertising is used by firms to convey information to consumers. This information could be about the existence, price, quality or attributes of the firm's product.

B.1.1 Model

In this appendix I present a model of informative advertising. The purpose of this is to show that the demand functions given by eq.(3.1) and eq.(3.2) do not necessarily imply a persuasive role for advertising and are consistent with the possibility of advertising being informative. Furthermore, the rationale that advertising in industries with a higher degree of product differentiation is more likely to be market-stealing than in industries with relatively homogeneous products can be applied to the case where advertising is informative. The purpose behind presenting this model is purely illustrative.

The basic setup of the model is similar to that in the chapter in that there is an oligopolistic industry with two firms, each one producing a differentiated good, and a competitive numeraire good producing industry. There is a continuum of identical consumers, each with a utility function separable and linear in the numeraire good. The mass of consumers is normalized to one without loss of generality.

Let p_1 and p_2 denote the prices charged by firm 1 and firm 2 respectively. The quantities of the two products consumed by the representative consumer are denoted by q_1 and q_2 respectively. Since the utility function is separable and linear in the numeraire good, the consumer's problem can be expressed as the maximization of the (sub) utility function corresponding to the oligopolistic industry. The consumer selects a pair (q_1, q_2) to solve:

$$\max \; u(q_1, q_2) - \sum_{i=1}^{2} p_i q_i$$

where

$$u(q_1, q_2) = \sigma q_1 + \sigma q_2 - \frac{1}{2}\left(\omega q_1^2 + 2\chi q_1 q_2 + \omega q_2^2\right) \tag{B.1}$$

Once again, it is assumed that the goods produced by the two firms are imperfect substitutes (thus it is assumed that $\omega > \chi > 0$).

The role that is played by advertising is that of informing consumers about the benefits of the advertised product as well as those of the rival product (comparison advertising). This conforms to the definition of informative advertising given above. The nature of the advertising is such that it is believable and verifiable. An example of such a case is when a firm advertises that the long term health benefits of its product exceed previously held expectations, while that of its rival fall below previously held expectations *and* backs up such a claim by citing research conducted by an independent and reputed entity. Furthermore, the benefits are such that they are realized in the long term so that without such advertising, consumers would not be aware of them.

Consider the case where both firm 1 and 2 engage in such informative advertising. Firm 1 makes (and backs up) the claim that its product is better than was previously believed in one dimension (e.g. reducing the level of cholesterol in the long term) while the product of firm 2 is worse. Similarly, firm 2 makes (and backs up) the claim that its product is better than was previously believed in another dimension (e.g. it is better for the heart in the long term) while that of firm 1 is worse.

The advertising level of a firm in such a case is represented by the *proportion* of consumers that receive the firm's message with its claim. Let Φ_1 and Φ_2 represent the respective levels of advertising undertaken by firm 1 and firm 2, i.e. the proportion of consumers that the respective firm targets with its message. This is consistent with the modeling of informative advertising (for e.g. see Grossman and Shapiro (1984)[1])

The effect of firm 1's message on a consumer who receives it is a revaluation of the marginal benefit of firm 1's product (upwards) as well as that of firm 2's product (downwards). Let this be captured by the parameters ε_1 and ψ_1 denoting that upon receiving the (believable and verifiable) message of firm 1, the consumer believes the product of firm 1 to be better in one dimension and that of firm 2 to be worse in that dimension. The effect of this is for the consumer's (sub) utility function upon receiving firm 1's advertising message

[1]The difference is that in Grossman and Shapiro (1984) the informative advertising message is only used to inform the consumers about the existence of the product.

to be represented by

$$u(q_1, q_2) = (\sigma + \varepsilon_1) q_1 + (\sigma - \psi_1) q_2 - \frac{1}{2}\left(\omega q_1^2 + 2\chi q_1 q_2 + \omega q_2^2\right) \tag{B.2}$$

The extent of product differentiation in the industry will have a bearing on the magnitude of ψ_1, with the magnitude of this parameter decreasing in the extent of product substitutability (χ). The reason being that if the products are extremely similar to each other, then it is unlikely that the product of firm 1 is found to be much better in a certain dimension and firm 2's product is simultaneously found to be a lot worse in the same dimension. Thus, the magnitude of $\psi_1$would be decreasing (increasing) in the level of product substitutability (differentiation).

It is important to note that the firms' advertising *does not* enter the consumer's utility function at all. Thus, it can not be characterized as persuasive advertising. The proportion of consumers that receive firm 1's message but not firm 2's and for whom the (sub) utility function is given by eq.(B.2)is given by $\Phi_1 (1 - \Phi_2)$.

Similarly, the effect of firm 2's message is a revaluation, on the part of the consumer, of the marginal benefit of firm 2's product (upwards) as well as that of firm 1's product (downwards). Let this be captured by the parameters ε_2 and ψ_2 denoting that upon receiving the (believable and verifiable) message of firm 2, the consumer believes the product of firm 2 to be better in the second dimension and that of firm 1 to be worse in that dimension. The effect of this is for the consumer's (sub) utility function upon receiving firm 2's advertising message to be represented by

$$u(q_1, q_2) = (\sigma - \psi_2) q_1 + (\sigma + \varepsilon_2) q_2 - \frac{1}{2}\left(\omega q_1^2 + 2\chi q_1 q_2 + \omega q_2^2\right) \tag{B.3}$$

where the proportion of such consumers is given by $\Phi_2 (1 - \Phi_1)$.

The proportion of consumers that receive both firms' messages is $\Phi_1\Phi_2$. For these consumers the (sub) utility function is given by

$$u(q_1, q_2) = (\sigma + \varepsilon_1 - \psi_2) q_1 + (\sigma + \varepsilon_2 - \psi_1) q_2 - \frac{1}{2} \left(\omega q_1^2 + 2\chi q_1 q_2 + \omega q_2^2\right) \tag{B.4}$$

Lastly, the proportion of consumers who do not receive either firm's message is given by $(1 - \Phi_1)(1 - \Phi_2)$ and the (sub) utility function for these consumers is given by eq.(B.1).

Assuming $\varepsilon_1 = \varepsilon_2 = \varepsilon$ and $\psi_1 = \psi_2 = \psi$ for simplicity, utility maximization by the four classes of consumers above yields the individual demand functions for the product of firm 1 and firm 2 respectively for each class of consumers. For those consumers that receive neither firm's message (whose proportion is $(1 - \Phi_1)(1 - \Phi_2)$) and whose utility function is represented by eq.(B.1) the demand functions for the product of firm 1 and firm 2 respectively are given by

$$d_1(p_1, p_2, \Phi_1, \Phi_2) = \alpha - \beta p_1 + \delta p_2$$

and

$$d_2(p_1, p_2, \Phi_1, \Phi_2) = \alpha - \beta p_2 + \delta p_1$$

For those consumers that receive only firm 1's message (whose proportion is $\Phi_1 (1 - \Phi_2)$) and whose utility function is represented by eq.(B.2) the demand functions for the product of firm 1 and firm 2 respectively are given by

$$d_1(p_1, p_2, \Phi_1, \Phi_2) = \alpha + \gamma - \beta p_1 + \delta p_2$$

and

$$d_2\left(p_1, p_2, \Phi_1, \Phi_2\right) = \alpha - \lambda \beta p_2 + \delta p_1$$

For those consumers that receive only firm 2's message (whose proportion is $\Phi_2\left(1-\Phi_1\right)$) and whose utility function is represented by eq.(B.3) the demand functions for the product of firm 1 and firm 2 respectively are given by

$$d_1\left(p_1, p_2, \Phi_1, \Phi_2\right) = \alpha - \lambda - \beta p_1 + \delta p_2$$

and

$$d_2\left(p_1, p_2, \Phi_1, \Phi_2\right) = \alpha + \gamma - \beta p_2 + \delta p_1$$

And lastly, for those consumers that receive both firm's message (whose proportion is $\left(1-\Phi_1\right)\left(1-\Phi_2\right)$) and whose utility function is represented by eq.(B.4) the demand functions for the product of firm 1 and firm 2 respectively are given by

$$d_1\left(p_1, p_2, \Phi_1, \Phi_2\right) = \alpha + \gamma - \lambda - \beta p_1 + \delta p_2$$

and

$$d_2\left(p_1, p_2, \Phi_1, \Phi_2\right) = \alpha + \gamma - \lambda - \beta p_2 + \delta p_1$$

where,

$$\begin{aligned}
\alpha &= \frac{\sigma}{\omega+\chi}\\
\beta &= \frac{\omega}{\omega^2-\chi^2}\\
\delta &= \frac{\chi}{\omega^2-\chi^2}\\
\gamma &= \frac{\varepsilon}{\omega+\chi}\\
\lambda &= \frac{\psi}{\omega+\chi}
\end{aligned}$$

Weighting each of these individual demand functions with the corresponding proportion of such consumers one can arrive at the following aggregate demand functions for firm 1 and firm 2 respectively which are identical to those given by eq.(3.1) and eq(3.2) in the chapter

$$D_1(p_1, p_2, \Phi_1, \Phi_2) = \alpha - \beta p_1 + \delta p_2 + \gamma\Phi_1 - \lambda\Phi_2 \tag{B.5}$$

and

$$D_2(p_1, p_2, \Phi_1, \Phi_2) = \alpha - \beta p_2 + \delta p_1 + \gamma\Phi_2 - \lambda\Phi_1 \tag{B.6}$$

B.1.2 Product Differentiation and the Market-Stealing Effect of Advertising

The potential market-stealing effect of (informative) advertising (λ) in the demand functions above is expected to be increasing in the level of product differentiation. The magnitude of the negative effect of firm 1's advertising on the demand for firm 2's product is determined by the extent to which the product of firm 2 is found to be inferior in a particular dimension than was previously believed (ψ), on the basis of new information provided by firm 1's message. This is bounded by how *similar* the two products are. If the two product are very similar then ψ cannot be high in magnitude (for e.g. research that finds product 1 to be beneficial in a particular dimension is unlikely to find product 2 inferior in that dimension if the two products are almost similar)and correspondingly λ cannot be high in magnitude either. Thus it is possible even when advertising is informative that the market-stealing effect of advertising is stronger in differentiated product industries as opposed to relatively homogeneous product industries.

Appendix C

Data Appendix

C.1 Collusive Products and Four-digit SICS Collusive Industries

SICS Industry Code	Collusive Product	Census Year
2041	Bakery Flour	1957
2045	Bakery Flour	1957
2048	Feed and Feed Additives- Citric Acid	1997
2048	Lysine	1997
2051	Bread/Bakery Products	1967
2061	Industrial Cane Sugar	1972
2061	Refined and Raw Cane Sugar	1972
2061	Sugar Refining	1972
2062	Industrial Cane Sugar	1972
2062	Refined and Raw Cane Sugar	1972
2062	Sugar Refining	1972
2063	Sugar Refining	1972
2075	Salad Oil and Shortening	1957
2076	Crude Coconut Oil	1977
2079	Salad Oil and Shortening	1957
2086	Soft Drink Bottlers	1987
2091	Whole and Processed Fish/Seafood	1992
2092	Catfish Products	1987
2092	Whole and Processed Fish/Seafood	1987
2096	Snack Foods	1962
2221	Glass Fiber Industrial Fabrics	1957

2221	Packaged Fiberglass Yarn	1992
2253	Women s Blouses	1947
2273	Carpet	1987
2298	Cordage	1987
2331	Women s Blouses	1947
2361	Women s Blouses	1947
2392	Linen Supplies	1962
2431	Flush Doors	1962
2431	Residential Flush Doors	1992
2449	Wirebound Wooden Boxes	1987
2499	Toilet Seats	1967
2522	Metal Office Furniture	1962
2621	Glassine and Greaseproof Paper	1977
2621	Thermal Fax Paper	1987
2652	Folding Cartons	1962
2656	Folding Cartons	1962
2657	Folding Cartons	1962
2672	Paper Labels	1967
2672	Tape Products for Shoe Industry (Pressure Sensitive Tape Products)	1967
2672	Thermal Fax Paper	1987
2673	Consumer Bags	1952
2674	Consumer Bags	1952
2675	Paper Labels	1967
2679	Thermal Fax Paper	1992
2752	Paper Labels	1967
2754	Paper Labels	1967
2759	Paper Labels	1967
2816	Dyes	1972
2816	Magnetic Iron Oxide	1992
2819	Aluminum Phosphide	1992
2819	Artificial Abrasive Grain	1992
2819	Chemicals for Plastics: Persulfates	1972
2821	Coatings Resins	1972
2821	Industrial Nitrocellulose	1987
2823	Industrial Nitrocellulose	1977
2824	Polyester Staple	1997
2833	Antibiotics	1962
2833	Quinine and Quinidine	1957
2833	Vitamins (B3 and B4)	1992

2834	Antibiotics	1962
2834	Genric Drugs	1992
2835	Methyl Glucamine	1992
2861	Dyes	1972
2865	Dyes	1972
2869	Bromine Products (TBBA, DECA and Methyl Bromide)	1992
2869	Dry Cleaning Fluid: Perchloroethylene	1972
2869	Feed and Feed Additives- Citric Acid	1992
2869	Monochloroacetic Acid	1997
2869	Organic Peroxides	1997
2869	Rubber Chemicals	1997
2879	Aluminum Phosphide	1992
2892	Commercial Explosives	1992
2899	Rubber Chemicals	1992
2911	Gasoline	1967
2911	Gasoline	1962
2951	Liquid Bituminous Materials	1987
3052	Hydraulic Hose and Hydraulic Hose Assemblies	1962
3061	Hydraulic Hose and Hydraulic Hose Assemblies	1962
3083	High Pressure Laminates	1997
3084	Plastic Pipe	1957
3084	Plumbing Supplies (Plastic Pipe Fittings)	1967
3086	Metal Building Insulation	1992
3086	Plastic Dinnerware (Disposable)	1992
3088	Plumbing Fixtures	1962
3089	New Steel Drums	1992
3089	Plastic Dinnerware (Disposable)	1992
3089	Toilet Seats	1967
3211	Architectural Flat Glass	1997
3229	Glass Fiber Industrial Fabrics	1957
3229	Packaged Fiberglass Yarn	1992
3231	Architectural Flat Glass	1997
3231	Packaged Fiberglass Yarn	1997
3261	Plumbing Fixtures	1962
3272	Asbestos-Cement Pipe and Couplings	1962
3272	Ready-Mix Concrete	1987
3272	Ready-Mix Concrete	1967
3272	Ready-Mix Concrete	1977
3272	Steel or Concrete Pressure Pipe	1962

3273	Ready-Mix Concrete	1977
3273	Ready-Mix Concrete	1987
3273	Ready-Mix Concrete	1967
3291	Artificial Abrasive Grain	1987
3291	Industrial Diamonds	1987
3291	Steel Wool Scouring Pads	1992
3295	Commodity Ferrosilicon Products	1997
3296	Packaged Fiberglass Yarn	1997
3312	Electric Weld Steel Tubing	1962
3312	Passenger Automobile and Light Truck Replacement Wheels	1982
3312	Reinforcing Steel Bars	1972
3312	Steel and Alloy Pipe	1982
3312	Steel Castings	1962
3312	Steel or Concrete Pressure Pipe	1967
3313	Commodity Ferrosilicon Products	1992
3315	Chain Link Fence	1992
3315	Gabions	1977
3315	Shopping Carts	1967
3315	Welded Wire Fabric	1992
3316	Cable Stayed Bridge Materials	1997
3316	Electric Weld Steel Tubing	1962
3316	Reinforcing Steel Bars	1987
3317	Electric Weld Steel Tubing	1962
3317	Steel and Alloy Pipe	1983
3321	Steel and Alloy Pipe	1977
3325	Steel Castings	1957
3339	Brazing Alloys	1957
3339	Silver Mill Products	1947
3339	Titanium Mill Products	1972
3341	Brazing Alloys	1957
3341	Silver Mill Products	1947
3353	Aluminum Roll Jacketing	1972
3354	Gas Vent Pipe	1962
3356	Silver Mill Products	1947
3356	Titanium Mill Products	1972
3357	Aluminum Conductor Cable	1957
3364	Titanium Mill Products	1972
3369	Titanium Mill Products	1972
3399	Bronze and Copper Flakes	1987

3411	Steel Pails	1992
3412	New Steel Drums	1992
3412	Steel Pails	1992
3429	Architectural Hinges	1987
3431	Plumbing Fixtures	1962
3444	Gas Vent Pipe	1962
3444	Painted Aluminum Products	1997
3444	Steel or Concrete Pressure Pipe	1962
3449	Reinforcing Steel Bars	1972
3452	Internal Wrenchng Bolts (for Aircraft and Missiles)	1957
3452	Screws	1987
3452	Self Locking Nuts	1962
3462	Open Die Steel Forgings	1962
3463	Titanium Mill Products	1972
3491	Industrial Valves/ Filter	1992
3492	Hydraulic Hose and Hydraulic Hose Assemblies	1962
3494	Carbon Steel Pipe Flanges	1987
3495	Bed Springs	1957
3496	Chain Link Fence	1987
3496	Gabions	1987
3497	Aluminum Roll Jacketing	1972
3498	Gas Vent Pipe	1962
3498	Steel and Alloy Pipe	1983
3498	Steel or Concrete Pressure Pipe	1962
3499	Stamped Metal Parts for Lamps and Lighting Fixtures	1987
3533	Tricone Drill Bits	1992
3537	Gabions	1987
3537	Shopping Carts	1967
3559	Industrial Valves/ Filter	1992
3561	Oil-Well Pumps	1962
3568	Drill Jig Bushings	1962
3569	Electric Weld Steel Tubing	1962
3589	Industrial Valves/ Filter	1997
3589	Water Heaters	1962
3599	Electric Weld Steel Tubing	1962
3624	Electrical Carbon Products (Current Collectors and Carbon Brushes)	1997
3624	Graphite Elecrodes	1997
3624	Isostatic Graphite	1997
3639	Water Heaters	1962

3644	Electric Fuse Products	1967
3644	Pole/Transmission Line Hardware	1962
3645	Stamped Metal Parts for Lamps and Lighting Fixtures	1987
3676	Electrical Equipment Parts (Soft Ferrite Cores, Carbon Resistors, Metal Film Resistors)	1957
3678	Electrical Equipment Parts (Soft Ferrite Cores, Carbon Resistors, Metal Film Resistors)	1957
3679	Electric Wiring Devices	1962
3711	Fleet Market for Automobiles	1972
3714	Passenger Automobile and Light Truck Replacement Wheels	1987
3721	Light Airplanes	1962
3851	Eyeglass (Opthalmic Lenses)	1962
3952	Educational Art Materials	1987
3965	Zipper Sliders	1967
3999	Resale Book Matches	1952

C.2 Sample of Industries used in Estimation

Note: NC: Industry classified as non-collusive
C: Industry classified as collusive

SICS Industry Code	Industry Name	Census Year	Pricing Conduct
2011	FRESH AND FROZEN MEAT FROM ANIMALS	1987	NC
2013	SAUSAGE AND OTHER PREPARED MEATS	1987	NC
2015	POULTRY AND EGG PROCESSING	1987	NC
2021	CREAMERY BUTTER	1987	NC
2022	CHEESE, NATURAL AND PROCESSED	1987	NC
2023	DRY, CONDENSED, AND EVAPORATED MILK PRODUCTS	1992	NC
2024	ICE CREAM AND FROZEN DESSERTS	1997	NC
2026	FLUID MILK	1997	NC
2032	CANNED SPECIALTIES	1987	NC
2033	CANNED FRUITS AND VEGETABLES	1992	NC
2034	DRIED AND DEHYDRATED FRUITS, VEGETABLES, AND SOUPS	1987	NC
2035	PICKLES, SAUCES, AND SALAD DRESSINGS	1992	NC

2037	FROZEN FRUITS AND VEGETABLES	1992	NC
2038	FROZEN SPECIALTIES, N.E.C.	1987	NC
2043	CEREAL BREAKFAST FOODS	1987	NC
2044	RICE MILLING	1987	NC
2046	WET CORN MILLING	1987	NC
2047	DOG AND CAT FOOD	1997	NC
2048	PREPARED FEEDS, N.E.C.	1997	C
2052	COOKIES AND CRACKERS	1987	NC
2053	FROZEN BAKERY PRODUCTS	1997	NC
2066	CHOCOLATE AND COCOA PRODUCTS	1992	NC
2068	NUTS AND SEEDS	1992	NC
2074	COTTONSEED OIL MILLS	1987	NC
2077	ANIMAL AND MARINE FATS AND OILS	1992	NC
2082	MALT BEVERAGES	1987	NC
2083	MALT	1997	NC
2084	WINES, BRANDY, AND BRANDY SPIRITS	1997	NC
2085	DISTILLED AND BLENDED LIQUORS	1992	NC
2086	BOTTLED AND CANNED SOFT DRINKS	1987	C
2087	FLAVORING EXTRACTS AND SYRUPS, N.E.C.	1987	NC
2091	CANNED AND CURED FISH AND OTHER SEAFOODS	1992	C
2092	FRESH OR FROZEN PREPARED FISH AND OTHER SEAFOOD	1987	C
2095	ROASTED COFFEE	1992	NC
2097	MANUFACTURED ICE	1997	NC
2131	CHEWING AND SMOKING TOBACCO	1987	NC
2141	TOBACCO STEMMING AND REDRYING	1992	NC
2211	BROADWOVEN FABRIC MILLS, COTTON	1987	NC
2221	BROADWOVEN FABRIC MILLS, MANMADE FIBER AND SILK	1992	C
2231	BROADWOVEN FABRIC MILLS, WOOL	1987	NC
2241	NARROW FABRIC MILLS	1987	NC
2251	WOMEN S HOSIERY, EXCEPT SOCKS	1992	NC
2252	HOSIERY, N.E.C.	1992	NC
2254	KNIT UNDERWEAR MILLS	1987	NC
2257	WEFT KNIT FABRIC MILLS	1992	NC
2258	WARP KNIT FABRIC MILLS AND LACE GOODS	1992	NC
2259	KNITTING MILLS, N.E.C.	1987	NC
2261	FINISHING PLANTS, COTTON	1987	NC
2262	FINISHING PLANTS, MANMADE FIBER AND SILK	1992	NC
2269	FINISHING PLANTS, N.E.C.	1987	NC
2273	CARPETS AND RUGS	1987	C
2281	YARN SPINNING MILLS	1987	NC
2282	YARN THROWING AND WINDING MILLS	1992	NC
2284	THREAD MILLS	1992	NC

2295	COATED FABRICS, NOT RUBBERIZED	1992	NC
2296	TIRE CORD AND TIRE CORD FABRICS	1992	NC
2297	NONWOVEN FABRICS	1992	NC
2298	CORDAGE AND TWINE	1987	C
2299	TEXTILE GOODS, N.E.C.	1992	NC
2311	MEN S AND BOYS SUITS AND COATS	1987	NC
2321	MEN S AND BOYS SHIRTS	1987	NC
2322	MEN S AND BOYS UNDERWEAR AND NIGHTWEAR	1987	NC
2323	MEN S AND BOYS NECKWEAR	1997	NC
2325	MEN S AND BOYS TROUSERS AND SLACKS	1987	NC
2326	MEN S AND BOYS WORK CLOTHING	1987	NC
2329	MEN S AND BOYS CLOTHING, N.E.C.	1987	NC
2335	WOMEN S, MISSES , AND JUNIORS DRESSES	1987	NC
2339	WOMEN S, MISSES , AND JUNIORS OUTERWEAR, N.E.C.	1987	NC
2341	WOMEN S, CHILDREN S, AND INFANTS UW & NW	1992	NC
2342	BRASSIERES, GIRDLES, AND ALLIED GARMENTS	1987	NC
2353	HATS, CAPS, AND MILLINERY	1987	NC
2369	GIRLS , CHILDREN S, AND INFANTS OTHER OUTERWEAR	1992	NC
2371	FUR GOODS	1987	NC
2381	DRESS AND WORK GLOVES AND MITTENS	1992	NC
2384	ROBES AND DRESSING GOWNS	1992	NC
2385	WATERPROOF OUTERWEAR	1987	NC
2386	LEATHER AND SHEEP-LINED CLOTHING	1992	NC
2393	TEXTILE BAGS	1987	NC
2394	CANVAS AND RELATED PRODUCTS	1997	NC
2395	PLEATING AND STITCHING	1987	NC
2396	AUTOMOTIVE TRIMMINGS ETC.	1992	NC
2397	SCHIFFLI MACHINE EMBROIDERIES	1992	NC
2399	FABRICATED TEXTILE PRODUCTS, N.E.C.	1987	NC
2411	LOGGING	1987	NC
2421	SAWMILLS AND PLANING MILLS, GENERAL	1987	NC
2426	HARDWOOD DIMENSION AND FLOORING MILLS	1992	NC
2431	MILLWORK	1992	C
2434	WOOD KITCHEN CABINETS	1992	NC
2435	HARDWOOD VENEER AND PLYWOOD	1992	NC
2436	SOFTWOOD VENEER AND PLYWOOD	1997	NC
2439	STRUCTURAL WOOD MEMBERS, N.E.C.	1992	NC
2441	NAILED WOOD BOXES AND SHOOK	1987	NC
2449	WOOD CONTAINERS, N.E.C.	1987	C
2451	MOBILE HOMES	1992	NC
2452	PREFABRICATED WOOD BUILDINGS	1987	C
2491	WOOD PRESERVING	1987	NC

2493	RECONSTITUTED WOOD PRODUCTS	1992	C
2512	UPHOLSTERED HOUSEHOLD FURNITURE	1992	NC
2514	METAL HOUSEHOLD FURNITURE	1987	NC
2519	HOUSEHOLD FURNITURE, N.E.C.	1992	NC
2521	WOOD OFFICE FURNITURE	1992	NC
2531	PUBLIC BUILDING AND RELATED FURNITURE	1987	NC
2541	WOOD PARTITIONS AND FIXTURES	1992	NC
2542	PARTITIONS AND FIXTURES, EXCEPT WOOD	1992	NC
2591	DRAPERY HARDWARE AND BLINDS AND SHADES	1997	NC
2611	PULP MILLS	1992	NC
2621	PAPER MILLS	1987	C
2631	PAPERBOARD MILLS	1992	NC
2672	PAPER COATING AND LAMINATING, N.E.C.	1987	C
2679	CONVERTED PAPER PRODUCTS, N.E.C.	1992	C
2761	MANIFOLD BUSINESS FORMS	1987	NC
2771	GREETING CARDS	1992	NC
2782	BLANKBOOKS AND LOOSELEAF BINDERS	1992	NC
2791	TYPESETTING	1987	NC
2796	PLATEMAKING SERVICES	1987	NC
2812	ALKALIES AND CHLORINE	1992	NC
2813	INDUSTRIAL GASES	1992	NC
2816	INORGANIC PIGMENTS	1992	C
2819	INDUSTRIAL INORGANIC CHEMICALS, N.E.C.	1992	C
2824	MANMADE ORGANIC FIBERS, NONCELLULOSIC	1997	C
2833	MEDICINALS AND BOTANICALS	1992	C
2834	PHARMACEUTICAL PREPARATIONS	1992	C
2835	DIAGNOSTIC SUBSTANCES	1992	C
2836	BIOLOGICAL PRODUCTS, EXCEPT DIAGNOSTIC	1997	NC
2841	SOAP AND OTHER DETERGENTS	1992	NC
2842	POLISHES AND SANITATION GOODS	1992	NC
2843	SURFACTANTS, FINISHING AGENTS, AND ASSISTANTS	1987	NC
2844	TOILET PREPARATIONS	1987	NC
2851	PAINTS AND ALLIED PRODUCTS	1992	NC
2869	INDUSTRIAL ORGANIC CHEMICALS, N.E.C.	1992	C
2873	NITROGENOUS FERTILIZERS	1992	C
2874	PHOSPHATIC FERTILIZERS	1997	NC
2875	FERTILIZERS, MIXING ONLY	1987	NC
2879	AGRICULTURAL CHEMICALS, N.E.C.	1992	C
2892	EXPLOSIVES	1992	C
2895	CARBON BLACK	1987	NC
2899	CHEMICAL PREPARATIONS, N.E.C.	1992	C
2951	ASPHALT PAVING MIXTURES AND BLOCKS	1987	C

2952	ASPHALT FELTS AND COATINGS	1992	NC
2992	LUBRICATING OILS AND GREASES	1987	NC
3011	TIRES AND INNER TUBES	1992	NC
3021	RUBBER AND PLASTICS FOOTWEAR	1987	NC
3081	UNSUPPORTED PLASTICS FILM AND SHEET	1992	NC
3082	UNSUPPORTED PLASTICS PROFILE SHAPES	1997	NC
3083	LAMINATED PLASTICS PLATE AND SHEET	1997	C
3086	PLASTICS FOAM PRODUCTS	1992	C
3087	CUSTOM COMPOUND PURCHASED RESINS	1992	NC
3089	PLASTICS PRODUCTS, N.E.C.	1992	C
3111	LEATHER TANNING AND FINISHING	1987	NC
3131	BOOT AND SHOE CUT STOCK AND FINDINGS	1987	NC
3142	HOUSE SLIPPERS	1992	NC
3143	MEN S FOOTWEAR, EXCEPT ATHLETIC	1992	NC
3144	WOMEN S FOOTWEAR, EXCEPT ATHLETIC	1992	NC
3149	FOOTWEAR, EXCEPT RUBBER, N.E.C.	1987	NC
3151	LEATHER GLOVES AND MITTENS	1992	NC
3161	LUGGAGE	1997	NC
3171	WOMEN S AND CHILDREN S HANDBAGS AND PURSES	1987	NC
3172	PERSONAL LEATHER GOODS, N.E.C.	1997	NC
3199	LEATHER GOODS, N.E.C.	1987	NC
3211	FLAT GLASS	1997	C
3221	GLASS CONTAINERS	1997	NC
3241	CEMENT, HYDRAULIC	1992	NC
3251	BRICK AND STRUCTURAL CLAY TILE	1992	NC
3253	CERAMIC WALL AND FLOOR TILE	1997	NC
3255	CLAY REFRACTORIES	1987	NC
3259	STRUCTURAL CLAY PRODUCTS, N.E.C.	1987	NC
3262	VITREOUS CHINA TABLE AND KITCHENWARE	1992	NC
3263	SEMIVITREOUS TABLE AND KITCHENWARE	1987	NC
3264	PORCELAIN ELECTRICAL SUPPLIES	1992	NC
3269	POTTERY PRODUCTS, N.E.C.	1992	NC
3271	CONCRETE BLOCK AND BRICK	1987	NC
3272	CONCRETE PRODUCTS, N.E.C.	1987	C
3273	READY-MIXED CONCRETE	1987	C
3274	LIME	1992	NC
3275	GYPSUM PRODUCTS	1987	NC
3281	CUT STONE AND STONE PRODUCTS	1992	NC
3291	ABRASIVE PRODUCTS	1987	C
3292	ASBESTOS PRODUCTS	1992	NC
3295	MINERALS, GROUND OR TREATED	1997	C
3296	MINERAL WOOL	1997	C

3297	NONCLAY REFRACTORIES	1997	NC
3299	NONMETALLIC MINERAL PRODUCTS, N.E.C.	1987	NC
3312	BLAST FURNACES AND STEEL MILLS	1997	C
3313	ELECTROMETALLURGICAL PRODUCTS	1992	C
3315	STEEL WIRE AND RELATED PRODUCTS	1992	C
3316	COLD-FINISHING OF STEEL SHAPES	1987	C
3322	MALLEABLE IRON FOUNDRIES	1987	NC
3324	STEEL INVESTMENT FOUNDRIES	1992	NC
3331	PRIMARY COPPER	1992	NC
3334	PRIMARY ALUMINUM	1992	NC
3351	COPPER ROLLING AND DRAWING	1987	NC
3355	ALUMINUM ROLLING AND DRAWING, N.E.C.	1987	NC
3366	COPPER FOUNDRIES	1997	NC
3399	PRIMARY METAL PRODUCTS, N.E.C.	1987	C
3411	METAL CANS	1992	C
3412	METAL BARRELS, DRUMS, AND PAILS	1992	C
3421	CUTLERY	1987	NC
3423	HAND AND EDGE TOOLS, N.E.C.	1992	NC
3425	SAW BLADES AND HANDSAWS	1997	NC
3429	HARDWARE, N.E.C.	1987	C
3433	HEATING EQUIPMENT, EXCEPT ELECTRIC	1987	NC
3441	FABRICATED STRUCTURAL METAL	1997	C
3442	METAL DOORS, SASH, AND TRIM	1992	NC
3446	ARCHITECTURAL METAL WORK	1987	NC
3448	PREFABRICATED METAL BUILDINGS	1997	NC
3452	BOLTS, NUTS, RIVETS, AND WASHERS	1987	C
3465	AUTOMOTIVE STAMPINGS	1987	NC
3466	CROWNS AND CLOSURES	1987	NC
3469	METAL STAMPINGS, N.E.C.	1992	NC
3479	METAL COATING AND ALLIED SERVICES	1987	NC
3483	AMMUNITION, EXCEPT FOR SMALL ARMS, N.E.C.	1997	NC
3484	SMALL ARMS	1992	NC
3489	ORDNANCE AND ACCESSORIES, N.E.C.	1997	NC
3491	INDUSTRIAL VALVES	1992	C
3494	VALVES AND PIPE FITTINGS, N.E.C.	1987	C
3496	MISCELLANEOUS FABRICATED WIRE PRODUCTS	1987	C
3499	FABRICATED METAL PRODUCTS, N.E.C.	1987	C
3519	INTERNAL COMBUSTION ENGINES, N.E.C.	1987	NC
3523	FARM MACHINERY AND EQUIPMENT	1992	NC
3524	LAWN AND GARDEN EQUIPMENT	1992	NC
3531	CONSTRUCTION MACHINERY	1992	NC
3533	OIL AND GAS FIELD MACHINERY	1992	C

3534	ELEVATORS AND MOVING STAIRWAYS	1992	NC
3535	CONVEYORS AND CONVEYING EQUIPMENT	1992	NC
3536	HOISTS, CRANES, AND MONORAILS	1992	NC
3537	INDUSTRIAL TRUCKS AND TRACTORS	1987	C
3541	MACHINE TOOLS, METAL CUTTING TYPES	1992	NC
3542	MACHINE TOOLS, METAL FORMING TYPES	1992	NC
3543	INDUSTRIAL PATTERNS	1987	NC
3544	SPECIAL DIES, TOOLS, JIGS, AND FIXTURES	1992	NC
3546	POWER-DRIVEN HANDTOOLS	1997	NC
3547	ROLLING MILL MACHINERY	1987	NC
3548	WELDING APPARATUS	1992	NC
3549	METALWORKING MACHINERY, N.E.C.	1997	NC
3552	TEXTILE MACHINERY	1992	NC
3553	WOODWORKING MACHINERY	1997	NC
3554	PAPER INDUSTRIES MACHINERY	1992	NC
3555	PRINTING TRADES MACHINERY	1992	NC
3559	SPECIAL INDUSTRY MACHINERY, N.E.C.	1992	C
3562	BALL AND ROLLER BEARINGS	1992	NC
3563	AIR AND GAS COMPRESSORS	1992	NC
3564	BLOWERS AND FANS	1992	NC
3565	PACKAGING MACHINERY	1997	NC
3566	SPEED CHANGERS, DRIVES, AND GEARS	1987	NC
3567	INDUSTRIAL FURNACES AND OVENS	1997	NC
3577	COMPUTER PERIPHERAL EQUIPMENT, N.E.C.	1987	NC
3578	CALCULATING AND ACCOUNTING EQUIPMENT	1992	NC
3579	OFFICE MACHINES, N.E.C.	1992	NC
3581	AUTOMATIC MERCHANDISING MACHINES	1987	NC
3582	COMMERCIAL LAUNDRY EQUIPMENT	1987	NC
3585	REFRIGERATION AND HEATING EQUIPMENT	1992	NC
3586	MEASURING AND DISPENSING PUMPS	1992	NC
3589	SERVICE INDUSTRY MACHINERY, N.E.C.	1997	C
3592	CARBURETORS, PISTONS, RINGS, AND VALVES	1992	NC
3593	FLUID POWER CYLINDERS AND ACTUATORS	1992	NC
3594	HYDROSTATIC TRANSMISSION COMPONENTS	1987	NC
3612	TRANSFORMERS, EXCEPT ELECTRONIC	1987	NC
3621	MOTORS AND GENERATORS	1987	NC
3624	CARBON AND GRAPHITE PRODUCTS	1997	C
3625	RELAYS AND INDUSTRIAL CONTROLS	1997	NC
3629	ELECTRICAL INDUSTRIAL APPARATUS, N.E.C.	1987	NC
3631	HOUSEHOLD COOKING EQUIPMENT	1997	NC
3632	HOUSEHOLD REFRIGERATORS AND FREEZERS	1987	NC
3633	HOUSEHOLD LAUNDRY EQUIPMENT	1992	NC

3634	ELECTRIC HOUSEWARES AND FANS	1992	NC
3635	HOUSEHOLD VACUUM CLEANERS	1992	NC
3643	CURRENT-CARRYING WIRING DEVICES	1987	C
3644	NONCURRENT-CARRYING WIRING DEVICES	1987	C
3645	RESIDENTIAL LIGHTING FIXTURES	1987	C
3646	ELECTRIC LIGHTING FIXTURES	1987	C
3651	RADIO RECEIVERS, TELEVISION SETS, PHONOGRAPHS	1997	NC
3652	PRERECORDED RECORDS AND TAPES	1987	NC
3663	RADIO AND TV COMMUNICATIONS EQUIPMENT	1992	NC
3669	COMMUNICATIONS EQUIPMENT, N.E.C.	1997	NC
3672	PRINTED CIRCUIT BOARDS	1987	NC
3674	SEMICONDUCTORS AND RELATED DEVICES	1997	C
3677	COILS, TRANSFORMERS, REACTORS,CHOKES FOR ELEC. CIRC.	1992	NC
3691	STORAGE BATTERIES	1987	NC
3692	PRIMARY BATTERIES, DRY AND WET	1987	NC
3694	ENGINE ELECTRICAL EQUIPMENT	1992	NC
3699	ELECTRICAL MACHINERY, EQUIPMENT, AND SUPPLIES, N.E.C.	1987	NC
3713	TRUCK AND BUS BODIES	1987	NC
3714	MOTOR VEHICLE PARTS AND ACCESSORIES	1987	C
3715	TRUCK TRAILERS	1992	NC
3724	AIRCRAFT ENGINES AND ENGINE PARTS	1987	NC
3728	AIRCRAFT PARTS AND AUXILIARY EQUIPMENT, N.E.C.	1992	NC
3732	BOAT BUILDING AND REPAIRING	1987	NC
3761	GUIDED MISSILES AND SPACE VEHICLES	1987	NC
3764	SPACE PROPULSION UNITS AND PARTS	1997	NC
3769	SPACE VEHICLE EQUIPMENT, N.E.C.	1987	NC
3792	TRAVEL TRAILERS AND CAMPERS	1987	NC
3795	TANKS AND TANK COMPONENTS	1987	NC
3799	TRANSPORTATION EQUIPMENT, N.E.C.	1987	NC
3812	AERONAUTICAL AND NAUTICAL SYSTEMS AND EQUIPMENT	1992	NC
3821	LABORATORY APPARATUS AND FURNITURE	1997	NC
3822	ENVIRONMENTAL CONTROLS	1987	NC
3823	PROCESS CONTROL INSTRUMENTS	1987	NC
3824	FLUID METERS AND COUNTING DEVICES	1992	NC
3825	INSTRUMENTS TO MEASURE ELECTRICITY	1992	NC
3826	ANALYTICAL INSTRUMENTS	1987	NC
3827	OPTICAL INSTRUMENTS AND LENSES	1987	NC
3829	MEASURING AND CONTROLLING DEVICES, N.E.C.	1992	NC
3841	SURGICAL AND MEDICAL INSTRUMENTS	1987	NC

3842	SURGICAL APPLIANCES AND SUPPLIES	1992	NC
3843	DENTAL EQUIPMENT AND SUPPLIES	1992	NC
3844	X-RAY APPARATUS AND TUBES	1992	NC
3845	ELECTROMEDICAL EQUIPMENT	1992	NC
3861	PHOTOGRAPHIC EQUIPMENT AND SUPPLIES	1992	NC
3873	WATCHES, CLOCKS, WATCHCASES, AND PARTS	1987	NC
3911	JEWELRY, PRECIOUS METAL	1987	NC
3914	SILVERWARE AND PLATED WARE	1987	NC
3915	JEWELERS MATERIALS AND LAPIDARY WORK	1992	NC
3931	MUSICAL INSTRUMENTS	1987	NC
3942	DOLLS AND STUFFED TOYS	1987	NC
3944	GAMES, TOYS, AND CHILDREN S VEHICLES	1992	NC
3949	SPORTING AND ATHLETIC GOODS, N.E.C.	1992	NC
3951	PENS AND MECHANICAL PENCILS	1987	NC
3952	LEAD PENCILS AND ART GOODS	1987	C
3955	CARBON PAPER AND INKED RIBBONS	1992	NC
3961	COSTUME JEWELRY	1992	NC
3991	BROOMS AND BRUSHES	1992	NC
3993	SIGNS AND ADVERTISING SPECIALTIES	1992	NC
3996	HARD SURFACE FLOOR COVERINGS, N.E.C.	1992	NC

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