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STRATEGIC CONSIDERATIONS IN
VERTICAL RELATIONSHIPS

by

PHILIPPE CYRENNE

A thesis submitted to
the Faculty of Graduate Studies and Research
in partial fulfilment of
the requirements for the degree of

(Doctor of Philosophy)

Department of Economics

Carleton University
Ottawa, Ontario
August
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submitted by

Phillippe Cyrenne, B.A., M.A.

in partial fulfilment of the requirements
for the degree of Doctor of Philosophy

.....
Chairman, Department of Economics

.....
Thesis Supervisor

.....
External Examiner

Carleton University

July 10, 1991

Abstract

This thesis examines a number of strategic considerations in the vertical relationship between manufacturers and retailers. The approach taken has three key elements, exclusive dealing, product differentiation and a perfect equilibrium solution concept.

The second chapter examines the incentives for less intense retail price competition in a perfect equilibrium model. An important result is that when goods are close substitutes Cournot competition is preferred to Bertrand competition since this acts as a break to the destructive price competition at the manufacturing level. However, when products are differentiated, Bertrand competition at the retail level is preferred to Cournot competition.

The third chapter examines the role of price leadership at the retail level and resale price maintenance in a perfect equilibrium framework. It demonstrates that the manufacturer selling to a retailer who is a price leader earns more profits than the two-stage Vertical Separation equilibrium if goods are relatively close substitutes. Resale price maintenance can substitute for collusion on manufacturing prices, under certain information assumptions, while the unilateral imposition of RPM by a manufacturer is not a Nash equilibrium in a two stage game.

In the fourth chapter, a perfect equilibrium model of the Vertical Separation-Vertical Integration decision on the part of manufacturers is developed. I show that when the products are highly differentiated, the only Nash equilibrium is vertical integration by both manufacturers. As the products become closer substitutes, an additional Nash equilibrium appears, both firms vertically separated. The vertically separated equilibrium always Pareto dominates the vertical integration equilibrium when both equilibria exist. An alternative to vertical integration, consignment selling is considered, and it is shown that it can replicate the vertical integration result.

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Chapter 1: Introduction

1.1 An Overview of the Thesis

This thesis involves an examination of strategic considerations in vertical control. Vertical control involves the use by manufacturers of a number of instruments in their relationship with retailers to enhance their control. These control instruments, or vertical restraints, include resale price maintenance, consignment selling, exclusive dealing, exclusive territories and licencing. Resale price maintenance involves restrictions imposed by manufacturers on prices set by retailers; exclusive dealing involves a restriction by manufacturers that retailers, or distributors, handle their good exclusively; consignment selling, a practice where manufacturers retain ownership of the product and control the selling price in return for a fixed commission paid to retailers; exclusive territories assign a particular market area to a retailer; while licencing involves a manufacturer assigning the right to a retailer to be an "authorized" distributor of its product.

A number of these restraints are considered in a formal model which has two principal features. The first is the emphasis on the strategic nature of the restraints. In particular, how the precise form of the restraint alters the strategic interaction between manufacturers and retailers. The second is product differentiation; which refers to the fact that goods serving the same uses may not be identical from a consumer's point of view. An important implication is that a higher price charged by one firm in the industry may not lead to a loss of all sales by the firm. In this thesis, it is shown that the strategic nature of the restraints must be appreciated and understood before their welfare merits are discussed.

This chapter is designed to provide a background to the subsequent chapters in the

thesis. It involves a brief literature review, an overview of the thesis and a discussion of the major assumptions of the model.¹ The literature review will involve a selective survey of a number of important papers in the area of vertical restraints. Since the chapters deal with a number of instruments of vertical control, the choice of papers included in the review are those of particular relevance to the models used in the thesis. It is not meant to be a definitive survey of the literature but instead an examination of important articles and those relevant to the present analysis. Particular emphasis will be given to papers modelling vertical restraints in the context of differentiated products.

The remaining chapters in this thesis are organized as follows. Chapter 2 involves an examination of the incentives for price floors in a two stage perfect equilibrium model. The analysis is limited to two manufacturers and two retailers in an exclusive dealing arrangement. I show that manufacturers and retailers prefer competition in quantities (Cournot) to competition in prices (Bertrand) at the retail level, when manufacturers are Bertrand-Nash competitors and the goods are perfect substitutes. The higher equilibrium retail prices which occur under Cournot competition result in a more desirable noncooperative equilibrium for manufacturers. The reason is that Cournot competition acts as a break to excessive retail competition, effectively preventing manufacturers from being drawn into a price war. Simulations show that manufacturers and retailers prefer Cournot competition to Bertrand competition primarily when the goods are close substitutes; for poor substitutes, the converse is true. In contrast, if the demands for the goods are independent, noncooperative manufacturers are indifferent between Bertrand and Cournot competition. If manufacturers are colluding, manufacturers prefer more intense price competition at the retail level, while

¹. For a good synthesis of the vertical control literature, see Tirole (1989), p. 169-201; for a broader survey, see Katz (1989). For a survey of the vertical integration literature, see Perry (1989), p. 183-255.

retailers prefer less.

Chapter 3 involves an examination of the role of retail price leadership and resale price maintenance in the above model. I solve for the equilibrium manufacturing prices, retail prices, quantities and profits for the retail price leadership equilibrium. Simulations show that manufacturers and retailers are both better off if one retailer engages in price leadership. This is contrasted with the case of resale price maintenance, where manufacturers impose price restraints on retailers. A number of results are obtained. First, I show that if resale price maintenance is part of a collusive agreement it can be an effective substitute for collusion on manufacturing prices. Reasons why RPM might be preferable are given. Second, I show that a unilateral imposition of resale price maintenance is not profitable, since this provides a strong incentive for price cutting by the other manufacturer.

Chapter 4 examines the decision by manufacturers to integrate as an alternative to the price war equilibrium. I show that the Nash equilibrium to the integrate versus non-integrate decision depends on the degree of substitutability between the products. If goods are close substitutes, the Nash equilibrium is for both firms to remain separated. However, if the goods are relatively poor substitutes, the Nash equilibrium results in both firms integrating.

Contrasted with this result is a case where the manufacturer selects the retail price, and determines a margin, or commission to the retailer. For our purposes, this will be termed consignment selling. I show that the same result as vertical integration can be achieved, if the margin is set at zero. However, a number of cases discussed indicate that more complex consignment arrangements have been used, which would alter the strategic nature of the game between manufacturers.

1.2 The Economics of Vertical Control.

(A) Telser (1960)

It may be argued that the modern literature regarding resale price maintenance began with the seminal article by Telser (1960). In that paper, Telser put forth two distinct explanations for the existence of resale price maintenance, a policy whereby manufacturers prevent retailers from selling their product below a price set by the manufacturer.

The first was the "Special Services" argument. Telser argued that resale price maintenance may be desired by a manufacturer in the following circumstance. Suppose a complex product is sold through retailers who must incur costs to inform consumers. Preventing sales below a pre-sale inclusive price would prevent discount retailers from "free riding" on the information provided by full service retailers. That is, without resale price maintenance, consumers could obtain the information at full service outlets and purchase the good at the discount store. Faced with this situation, full service retailers would reduce pre-sale service until few, if any, full service retailers remained reducing the sales and profits of manufacturers. This would not occur if price floors were imposed on all retailers because cut rate retailers would be prevented from reducing price below some "efficient" price which maximizes the profits of manufacturers.

Telser's second explanation of why resale price maintenance might be in a manufacturer's interest is the "Manufacturer Cartel Theory." Suppose a group of manufacturers attempt to maintain a cartel at the manufacturing level despite the individual incentives which exist for secret price cutting. A policy of price floors at the retail level may stabilize a cartel at the manufacturing level according to the following reasoning. Suppose one manufacturer contemplates cheating on the manufacturing cartel price. A price cut at

the manufacturing level would only be profitable if its associated retailer also cut its price, otherwise, the lower manufacturing price would only increase the profits of the retailer. A policy of resale price maintenance would eliminate the incentives of manufacturers to cheat on the cartel by reducing their price to retailers.

These two explanations can be classified into efficiency and anti-competitive theories. Of the two explanations, the special services argument has spawned a larger number of papers. Two important papers, dealing with the services argument, are Marvel and McCafferty (1984) and Mathewson and Winter (1984). Other papers, such as Gould and Preston (1965) and Gallini and Winter (1983) deal with the more general relationship between vertical restraints and the optimal number of retail firms from the manufacturer's perspective. A number of recent papers deal explicitly with the relationship between resale price maintenance, exclusive dealing, and product differentiation. These papers are outlined in turn.

(B) Gould and Preston (1965)

Gould and Preston emphasize the effect that the number of retailers or outlets has on the demand for a manufacturer's product. They consider resale price maintenance as a device used by a monopolist manufacturer to alter the number and size of retail outlets for the purpose of providing more exposure for his product. Specifically, they show that if retail average costs are U-shaped, resale price maintenance will reduce the output of each retailer below the long run equilibrium level, allowing total output to be served by more firms. Resale price maintenance prevents retailers from expanding output to the optimal level and hence reducing the number of firms in equilibrium.

Gould and Preston's model yields the following testable implications. Resale price

maintenance is more likely to be adopted by a monopolist manufacturer when; (i) the quantity demanded by consumers is strongly responsive to the number of outlets, and (ii) the economies of scale at the retail level are not too great. Also their model predicts that resale price maintenance should result in smaller and more numerous retailers. They also show that resale price maintenance does not necessarily imply higher retail prices; a profit maximizing monopolist might find it profitable to lower wholesale prices resulting in lower retail prices. Gould and Preston maintain that a model of the "Services Hypothesis" would have a very similar structure to theirs, with services replacing outlets in the explanation.

(C) Gallini and Winter (1983)

Gallini and Winter have generalized the outlets hypothesis of Gould and Preston by considering the case of monopolistic competition rather than perfect competition at the downstream market. Their focus is on the role of resale price maintenance in a monopolistically competitive environment; where monopolistically competitive means fixed costs on the supply side, product diversity on the demand side, and zero equilibrium profits in the retail industry.

Gallini and Winter examine the role of vertical restraints in the context of two types of externalities which arise in a monopolistically competitive model: (i) a horizontal pecuniary externality operating through the retail price, and (ii) a vertical externality, that is, retail outlets do not set the profit maximizing price from the perspective of the manufacturer. A horizontal pecuniary externality occurs when a retailer fails to take into account the positive effect that its price increases have on other retail firms. The vertical pecuniary externality refers to the under investment by retailers in attracting demand because they only appropriate a fraction of the increased profits. Gallini and Winter argue that depending on the relative

strength of these two effects, a manufacturer may impose a price floor or price ceiling.

They show that resale price maintenance, that is, a price floor, can be profitable if the positive impact of the increased number of firms overwhelms the negative effect of the higher maintained price. The higher price involves a smaller output, similar to Gould and Preston's model; however, Gallini and Winter's result applies to a symmetric, monopolistically competitive equilibrium. Gould and Preston's result is an extreme case where each retailer perceives the elasticity of demand at the retail level to be infinite. A price ceiling will be imposed in the case of no horizontal externality, that is when each outlet perceives its change in price will be reflected in a change in the market demand.

Using the traditional measures of welfare, the maximization of producer and consumer surplus, and a specific parameterization of the model, Gallini and Winter show that whenever a price floor or ceiling is privately profitable, it is welfare improving at the margin.

(D) Mathewson and Winter (1983a)

Mathewson and Winter consider the role that imperfect information has on the desirability of a number of vertical restraints used by manufacturers. They contrast administered pricing, the fixing of the retail price, with resale price maintenance, a retail price floor. They examine a situation where retail firms must inform customers who require product and price information before purchasing a good which, in the absence of manufacturer restraints, can be the subject of free riding.

In this framework, Mathewson and Winter consider the following simplified search strategy on the part of consumers: if a consumer decides to search, the store offering the lowest price is chosen at some specified cost. Under administered prices and a zero profit condition at the retail level, the manufacturer can determine the optimal number of informing

stores by setting the wholesale or manufacturing price. Under resale price maintenance, the manufacturer may profit if retailers have an incentive only to lower price.

The logic of the argument is as follows. Mathewson and Winter assume that in the unrestrained equilibrium there are two types of stores, informing and uninforming. The informing stores charge a monopoly price and retain a fraction of the potential customers they inform, the non-informing stores charge a lower price and retain the rest of the customers. Mathewson and Winter argue that a price floor between these two prices can be profitable for the manufacturer. A slightly lower price than the monopoly price would enable the informing stores to retain all their customers rather than the fraction they had before. For the uninforming stores, a higher retail price than the lower price previously charged would also be beneficial.

They argue that an increase in the number of informing stores is a necessary condition for RPM to be Pareto improving and a sufficient condition for RPM to be a perfect substitute for administered pricing.

(E) Marvel and McCafferty (1984)

Marvel and McCafferty attempt to broaden the applicability of Telser's services argument by addressing what has been perceived as a major limitation of his analysis. This limitation is that Telser's argument seems to be appropriate only for goods where the consumer requires substantial pre-sale service. Most cases involving resale price maintenance involve goods where it is difficult to interpret the goods as complex in any narrow sense. For example, resale price maintenance has been imposed on gasoline products, skis, electric

shavers, as well as cameras.² While the latter product might be considered complex, the other goods can hardly be called technologically sophisticated products.

Faced with this problem, Marvel and McCafferty developed a "generalized special services" argument. They maintain that it is not the nature of the product that is important in Telser's argument, but the distinction between high quality and low quality retailers. They argue that price floors, at the retail level, ensure that high quality retailers stock the product, and if consumer demand responds favourably to this result, manufacturers profits can increase. The higher retail price ensures that the fixed costs of the higher quality stores are covered.

(F) Mathewson and Winter (1984)

Mathewson and Winter (1984) have developed a general explanation of vertical restraints which involves an analysis of the determinants of restrictions imposed by manufacturers on retailers. The restraints are on prices, locations, and sales, of retail firms. They examine the "minimally sufficient" set of constraints which are imposed by manufacturers to internalize potential externalities.

Mathewson and Winter adopt a spatial framework, with two types of conjectures regarding firm behaviour at the retail level; Loschian and Nash (Hotelling-Smithies). Under Loschian conjectures, each retailer assumes that its market area is fixed, independent of its own price, since it is assumed that neighbouring firms will change their prices to perfectly offset the price change. Under Nash conjectures, each retailer assumes that its neighbour's price is invariant to its price change. The results, outlined below, are sensitive to the type

². For Canadian cases, see Mathewson and Winter (1985), for U.S. cases, see Overstreet (1983).

of conjectures assumed.

In the model, each retailer chooses a level of expenditure on advertising (A_i), and a retail price, to maximize profits where the demand for the good is a function of price, radius and advertising level, $q(P_i, R_i, A_i)$. Among the main assumptions are; (i) information on the existence of the product is provided only by retail firms, (ii) information disseminated by firms takes the form of advertising messages or sales effort, (iii) a certain proportion of these expenditures (grouped under the heading advertising, A_i) spill over into other retail market areas, (iv) once consumers are informed of the product's existence, the consumers become perfectly informed, at zero cost, of the prices and locations of all retail firms. This specification is a formal, spatial approach, to the services type argument of Telser where prior to sale retailers provide some "service" which is valuable to consumers and helps manufacturers but is subject to free riding. They show that setting the wholesale price alone is insufficient to ensure that the externalities, or spillovers, are internalized. They define the minimally efficient set of constraints as the instruments in addition to the wholesale price which are capable of replicating the vertically integrated result. That is, the constraints which maximize the profit of the manufacturer. Mathewson and Winter show that when conjectures are non-Loschian and there are informational spillovers, the case most in the spirit of Telser (1960) that either; (i) franchise fees and resale price maintenance, or (ii) quantity forcing and resale price maintenance, constitute minimally sufficient sets of restraints (Proposition 6). Franchise fees are defined as two part pricing, lump sum fee and per unit pricing, and quantity forcing is defined as the requirement that the retailer sell a minimum quantity of the product. In the case where there are no informational spillovers and conjectures are non-Loschian, resale price maintenance is unnecessary, the wholesale price and franchise fee are sufficient instruments (Proposition 2). Other restraints are optimal depending on the

particular combination of spillovers and conjectures assumed.

(G) Perry and Groff (1985)

Perry and Groff (1985) examine the role of resale price maintenance in a model of product differentiation, specifically as it relates to benefits from vertical integration. They use a CES formulation in their model and consider a manufacturer's choice between resale price maintenance and forward integration into the downstream industry.

They contrast their formulation with results derived by Dixit (1983) and Mathewson and Winter (1983b) using Salop's (1979) spatial model where it was found that vertical integration by a monopolist into a monopolistically competitive downstream industry improves welfare. Perry and Groff report the following results. First, forward integration by an upstream monopolist or by upstream oligopolists reduces welfare. Through integration, prices fall, but the lower prices imply losses and reduced product diversity. Second, with their CES formulation, they show that by using the following vertical restraints; franchise fee, resale price maintenance, quantity forcing, and licensing of downstream franchises, the upstream monopolist can replicate the integrated outcome. In particular they find that any of the above controls, except licensing, is sufficient for the upstream monopolist to obtain the integrated profits. Hence, resale price maintenance would also result in a reduction in welfare.

(H) Rey and Tirole (1986)

Rey and Tirole (1986) look at vertical restraints from an information viewpoint, considering the impact uncertainty regarding demand and cost conditions plays in the control by manufacturers' of their respective retailers. They argue that previous work - Dixit (1983),

Gallini and Winter (1983), and Mathewson and Winter (1983a, 1984) - while looking at the delegation question, has neglected to focus on the source of the problem. The problem is the combination of uncertainty, coupled with risk aversion, which produces divergent incentives which must be resolved through the use of either resale price maintenance (RPM), exclusive territories, or some combination of the two.

Their definition of resale price maintenance involves a two part tariff, a franchise fee coupled with a wholesale price where the manufacturer sets the retail price. Exclusive territories are captured by the use of a spatial model with transportation costs, specifically, a local spatial monopoly by retailers.

Rey and Tirole consider a risk neutral manufacturer dealing with first an extreme risk averse retailer, and then risk neutral retailer, under conditions of demand and/or cost uncertainty. Their results are as follows. Using the most general assumption regarding retailer risk aversion they find: i) that the manufacturer always prefers competition among retailers to RPM when retailers are undifferentiated and there is market uncertainty, ii) that the manufacturer prefers competition (exclusive territories) if the retailers are very risk averse (risk neutral), iii) that aggregate welfare is always higher with competition than under resale price maintenance or exclusive territories.

(I) Klein and Murphy (1988)

While most attention has been confined to developing the special services argument, criticism has been directed towards the entire logic of the explanation. Klein and Murphy argue there is no logical connection between higher retail prices, associated with resale price maintenance, and the provision of services by retailers which benefit manufacturers. The fact that a higher return is provided to retailers does not ensure these services are provided. The

retailers can merely pocket the return and provide services which benefit themselves and not manufacturers. Klein and Murphy develop a general model of contract enforcement whereby manufacturers ensure that a quasi-rent stream is provided as an incentive for retailers to provide pre-sale service. If the retailers renege on their implicit agreement, then the quasi-rent stream is forfeited. Klein and Murphy also argue that the free rider explanations of Telser (1960) and Mathewson and Winter (1984) have neglected to consider the role of other expenditures which may be undertaken by retailers. These explanations only hold if the only kind of non-price competition is of the "special services" type. In contrast, Klein and Murphy explicitly incorporate the possibility of other expenditures taking place which may benefit retailers but not manufacturers.

In the context of their model, Klein and Murphy show that resale price maintenance serves a dual purpose for manufacturers: it provides a private enforcement mechanism to ensure that retail services are provided as well as a limitation on the short-run profits which exist for non-performing dealers.

(J) Bolton and Bonanno (1988)

Bolton and Bonanno (1988) consider vertical restraints in a model where retailers provide service with sales (cum) or post-sales or both. They argue that in this case the free riding problems outlined by Telser (1960) disappear. Bolton and Bonanno's model is one of vertical differentiation, an approach to product differentiation where retailers offer goods of different qualities and if two goods are offered at the same price, consumers buy the higher quality good. Following Shaked and Sutton (1982) they look at vertical restraints, (eg. resale price maintenance and franchise fees) in circumstances where retail firms will attempt to relax price competition through product differentiation. Specifically, firms contemplating entry are

aware that if they enter with the same quality as incumbent firms, price competition will ensue. To avoid this result, firms must provide goods of different qualities and the number of firms existing in equilibrium depends on the diversity of consumer tastes and the sunk cost of production.³

Bolton and Bonanno show that these simple restraints dominate linear price contracts from the perspective of manufacturers but do not result in vertical efficiency. However, they do emphasize that their model deals with the relationship of a single monopolist to two retailers and state that a more general model would involve more firms at the manufacturing and retail level.

(K) Porter and Perry (1989)

Perry and Porter have also addressed the question of the role of vertical restraints in a model of monopolistic competition. They recognize the logic of the "special services" hypothesis but maintain, along with Klein and Murphy, that the result is dependent on the implicit assumption that retail service is the only dimension of non-price competition. Their model is an attempt to generalize the Telser argument to allow for product differentiation which is achieved through the combination of the manufacturer's product and the bundle of services provided by retailers. They model the externality explicitly, introducing a parameter which captures the degree of service externality.

They compare the welfare properties of the following equilibria: i) the social optimum, ii) vertical integration by the manufacturer, iii) no vertical controls, iv) resale price maintenance (RPM), v) exclusive territories and vi) RPM and exclusive territories.

Their results are as follows. The optimal choices of quantity (x^*), service (s^*) and the

³. For a good discussion of vertical differentiation, see Eaton and Lipsey (1989).

number of firms (m^*) for the social optimum are independent of the service externality. However, since there are fixed retail costs, the social optimum cannot be sustained as a competitive outcome.

The vertical integration equilibrium results in an internalization of the service externality ($s=s^*$), the same quantity ($x=x^*$), but a number of firms ($m < m^*$) less than the social optima. All profits accrue to the manufacturer which are achieved by setting $p > mc$, and reducing the number of firms below the efficient level. The no vertical controls case results in higher retail prices, sub-optimal service level, reduced quantity and more retailers than under vertical integration but less than the social optimum. Under RPM, a situation where the manufacturer sets the wholesale and retail price, the retail margin is lower with RPM than with no vertical controls. Porter and Perry find that when a service externality exists, the monopolist does not use its control over the retail margin to induce retailers to increase service above the no vertical control case. Rather, RPM is used to solve the successive monopoly problem and the entry externality. The entry externality results from new retailers ignoring the reduction in profits to existing retailers brought about by their entry decision.

Under exclusive territories, the optimal number of firms from the manufacturer's perspective, Porter and Perry show that the retail margin is smaller than with no vertical controls, the service is higher than under RPM or exclusive territories, profits are greater than with no vertical controls and may or may not be greater than RPM. Finally, with RPM and exclusive dealing, the manufacturer can replicate the vertical integration case if a franchise fee is used. In addition, the retail price is now a price floor and the retailers would like to cheat on the retail margin.

Porter and Perry compare the welfare levels of the preceding equilibria and find that

RPM alone is never optimal, it is dominated by other combinations of vertical control.

II. Exclusive Dealing

(L) Comanor and Frech (1985)

Comanor and Frech (1985) are interested in examining the market conditions under which exclusive dealing restricts entry. Specifically, they consider its effect on the cost conditions of rival firms. They examine the implications of product differentiation advantages on the decision by a dominant manufacturer to select exclusive dealing. They identify two groups of consumers, Class A who consider the dominant firm's product to be superior to any rival brand, and Class B consumers who view the products of all sellers as identical. Comanor and Frech assume that consumers obtain the product through independent distributors, who have some degree of market power and set distribution margins above marginal operating costs.

A number of cases which include distribution without exclusive dealing and distribution with exclusive dealing are considered. In the first case, Comanor and Frech maintain that the dominant manufacturer has two possible pricing strategies; a low price strategy, setting price equal to marginal cost, and a high price, limit entry strategy that captures the sales of the Class A consumers foregoing sales to Class B.

With the second case, distribution with exclusive dealing, the entrant must distribute his product through alternative channels. Comanor and Frech argue that the original manufacturer will gain a competitive advantage, since by using the original distributor, gains through economies of scope can be achieved. Once again, two price strategies, high and low

are possible. Under the low price strategy, selling to both classes, the original manufacturer can now raise his price to the level of the entrant's costs which are higher because of higher distribution costs. Class B customers are worse off, while Class A customers will be worse off if the higher distribution cost is greater than the sum of the product differentiation advantage and the lower distribution cost. Under the high price strategy, the original manufacturer adds his product differentiation advantage to the costs of the entrant, which include its marginal cost and the higher distribution costs.

Comanor and Frech conclude that with exclusive dealing both classes pay higher prices because of the higher distribution cost: the Class A customers buy from the original manufacturer, and the Class B individuals purchase the entrant's product through alternate channels of distribution.

Comanor and Frech investigate, in the context of their model, whether this result can be offset by actions taken by distributors. They conclude that exclusive dealing is more likely where brand preferences are strong and low price strategies are followed. Comanor and Frech also consider the relationship of exclusive dealing to entry deterrence and maintain that it increases the credibility of the threat by manufacturers to exclude rivals.

(M) Mathewson and Winter (1987)

Mathewson and Winter argue that Comanor and Frech use the wrong criteria in their analysis of the merits of exclusive dealing. While Comanor and Frech have argued that exclusive dealing raises rivals' entry costs and therefore is anti-competitive, Mathewson and Winter feel that the traditional criteria, the maximization of efficiency or welfare, is more appropriate.

Mathewson and Winter argue that while exclusive dealing does eliminate a rival from

the market, competition between manufacturers for the right to supply the retail monopolist results in lower manufacturing prices and possibly lower retail prices. That is, potential competition rather than actual competition is the disciplining force in the market.

They use a simple model of differentiated products in which the retail sector has monopoly power but no monopsony power. They argue that it is possible to have one without the other. With many small retailers, the organization of a buyer cartel becomes difficult and the purchases of each retailer are a small share of the wholesale market which means that they essentially take contracts as given.

Mathewson and Winter also make a number of additional assumptions. They assume that neither manufacturer incurs any sunk cost in offering a contract, a condition necessary for the contestability of the retail markets. Furthermore, the decisions on exclusive dealing are made based on the expected prices and with perfect foresight as to the equilibrium of the exclusive dealing pricing game. Also, the existence of both products is assumed.

Using this model, Mathewson and Winter find that potential competition between manufacturers for exclusive dealing arrangements with retailers may result in a lower retail prices, and hence welfare increases. They also predict that exclusive dealing arrangements are more likely where there is an asymmetry in demand for the products.

(N) Schwartz (1987)

Marius Schwartz (1987) reaches conclusions opposite to those arrived at by Comanor and Frech. He claims that exclusive dealing is more likely to occur when product differentiation is relatively weak. Also relative to non-exclusive dealing, price does not rise to both groups but rises for one and falls for another.

Schwartz focuses his attention on the response by the dealers to the proposed

exclusive dealing arrangement. In particular, he emphasizes that Comanor and Frech require the dominant manufacturer to make an all-or-none offer to the low cost dealers. He shows that under weak brand preference, the dominant manufacturer cannot achieve an exclusive dealing arrangement unless it lowers its wholesale price below its non-exclusive dealing level. However, under strong brand preference, it is possible for the manufacturer to achieve both, exclusivity and a wholesale price higher than under non-exclusive dealing.

Schwartz argues that Comanor and Frech have not incorporated dealer rationality in their model. He carefully outlines the exclusive dealing decision in terms of participation constraints. Unless it is profitable for the dealers, they will not participate in the exclusive dealing arrangement. This constraint places a restriction on the manufacturer's wholesale price.

(O) Besanko and Perry (1989)

Besanko and Perry examine the competitive effects of exclusive dealing in two stage model of product differentiation. Using a logit model to capture brand differentiation, they model the case of two manufacturers producing differentiated brands which are sold to consumers by independent, spatially differentiated retailers. Exclusive dealing involves each retailer handling only one brand. Free entry into retailing is assumed.

According to Besanko and Perry, exclusive dealing results in competition between manufacturers being entangled with competition between retailers. That is, it results in all dimensions of differentiation entering the demand functions of retailers and manufacturers.

In the absence of neighbouring retailers, the intensity of consumer preferences for nearby brands may induce higher transportation costs with a corresponding reduction in consumer and social surplus. However, this loss may be offset if free entry into retailing increases the

density of retailers sufficiently.

In contrast, without exclusive dealing, each stage of distribution competes with respect to its own dimension of differentiation. They conclude that exclusive dealing results in higher retail prices and reduces the social surplus if there are no reductions in the total fixed costs of retailing.

III. Intensity of Retail Price Competition

(P) Fershtman and Judd (1987)

Fershtman and Judd examine the incentives given to managers by owners and their effects on retail competition. They derive equilibrium weights between profit and sales maximization given to managers under Cournot and Bertrand competition. The weights are the respective rewards given to managers which emphasize some linear combination of profits and sales. They show that for Cournot competition, the equilibrium weight induces managers to act aggressively, increasing output; while under price competition, the equilibrium weight induces a less aggressive response, resulting in a price higher than dictated by profit maximization. Similar responses by other oligopolists result in higher profits to owners under price competition.

(Q) Bonanno and Vickers (1988)

Bonanno and Vickers using a simple duopoly model show that it may be more profitable for a manufacturer to sell through a retailer when differentiated product Bertrand competition exists at the retail level. That is "vertical separation", if accompanied by a

franchise fee levied on the retailer, results in higher profits than the integrated solution. Furthermore, they show that both manufacturers will be better off if they both vertically separate when products are strategic complements since this results in each rival firm responding by raising price with accompanying benefits.

(R) Winter (1989)

Ralph Winter argues that manufacturers impose vertical restraints on retailers in cases where there "is a bias in intra-brand (retailer) rivalry between price competition and non-price competition relative to inter-brand competition". Winter argues that the bias towards price competition is a result of heterogeneity in the opportunity costs of time. If complete contracting were possible, manufacturers would set price and non-price instruments to accommodate the tastes of the average consumer, those on the margin between buying and not buying the product. However, he argues that in markets characterized by costly search, consumers with low opportunity costs of time are "over-represented" on the inter-retailer margin relative to the product margin. The product margin refers to the purchase decision, whether to buy, while the inter-retailer margin relates to the location of the purchase, that is, the particular retailer.

Winter argues that the role of retailer services is to reduce the opportunity costs of purchasing goods, and this interacts with the variation in consumer tastes to produce a bias towards inter-retailer or price competition. Vertical restraints in his model are likely to arise in circumstances where the variation in consumer tastes and search costs are high.

(S) E. Gal-Or (1990)

Esther Gal-Or considers the role that delegation to agents plays in the relationship

between manufacturers and consumers. She shows that producers may prefer to be represented by agents, rather than selling directly to consumers, if this results in a less aggressive price reaction function. In Bertrand competition, prices are strategic complements and in Gal-Or's model precommitment to sell through an agent serves to induce competitors to set higher prices as well.

Gal-Or's model consists of three stages: in the first, producers decide whether to sell directly to consumers or use agents; in the second, the firms deciding to use agents in the preceding stage determine the terms of trade with their agents; in the third, the agents and producers not using agents choose prices and sell the quantities demanded at those prices.

Gal-Or shows that the nature of the equilibrium depends on the size of the contracting costs and the number of firms. For low contracting costs, the benefits to using an agent increases with the number of firms, resulting in equilibrium where all producers are represented by agents. For high contracting costs, all firms sell directly to consumers, without using agents.

A brief overview of the model used in the thesis is given in the next section.

1.3 Assumptions of the Model

The model used in this thesis has three important features; (i) product differentiation, (ii) strategic behaviour, and (iii) exclusive dealing. These are discussed in turn.

(i) Product Differentiation

An important element of the approach is the idea that product differentiation is an important aspect of vertical restraints. A great deal of research has been devoted to developing models that allow for product heterogeneity, the idea that products in the same market are not identical.

Papers in the vertical restraints literature in which a product differentiation approach is used are Mathewson and Winter (1984), Perry and Groff (1985), Gallini and Winter (1983), Bonanno and Vickers (1988) and Porter and Perry (1989). These papers can be further subdivided into spatial and non-spatial approaches.⁴ For example, within the spatial approach is Mathewson and Winter (1984) in which products are differentiated in terms of location. Gallini and Winter, Bonanno and Vickers, Perry and Groff and Porter and Perry use the nonspatial approach, where competition is between all differentiated products, that is, competition is not localized. This is the approach taken in this thesis, where the firms are Bertrand competitors and compete over the entire market area. That is, the model is from what Archibald, Eaton and Lipsey (1986) call the non-address branch. The preferences of consumers are assumed to be represented by a quadratic utility function, with zero income effects. This allows for partial equilibrium analysis as well as for linear demand curves. It has been used by Singh and Vives (1984) which is similar to that used by Levitan and Shubik (1980). Singh and Vives argue that the model can represent a continuum of individuals of the same type; Levitan and Shubik maintain that it represents the preferences of consumers considered in the aggregate.⁵ Either interpretation is obviously amenable to criticisms that

⁴. Archibald, Eaton and Lipsey include spatial models in what they call "address" models. Models where preferences are defined over a finite or countably infinite set of goods have been termed "non-address" models. The model used in this thesis would be included in the non-address branch.

⁵. See Levitan and Shubik (1980:68-69).

problems involved in going from individual to group preferences have been ignored.⁶ However, for the purposes set out in this thesis, the model has the advantage of analytical tractability as well as straightforward interpretations of the results.

(ii) Strategic Behaviour

A second important element of the model used in this thesis is an emphasis on strategic behaviour. The model makes use of a number of concepts from modern game theory. The elements are fairly standard in the industrial organization literature, namely Bertrand price competition, and the subgame perfect equilibrium solution concept. The second assumption is less familiar. This concept applies to games of perfect and complete information. That is, all previous moves taken by players are common knowledge, and all elements of the game are known. Since the perfection assumption allows for equilibrium points supported by incredible threats, Selten (1975) proposed a refinement. To rule out incredible threats, Selten proposed a condition called subgame perfection which required the strategies of players to be best replies in any subgame of the game tree.⁷

The model in the thesis features a two stage game. In the first stage, the manufacturers take into account the reaction of retailers in setting their manufacturing price. This means they are Stackelberg leaders with respect to retailers. Both a cooperative and a noncooperative solution are considered at the manufacturing stage. The noncooperative solution involves Bertrand competition between manufacturers. Manufacturers choose their prices simultaneously, taking into account the reactions of retailers. Furthermore, we assume

⁶. For a good discussion of the differences between address (spatial) models and non-address models, see Archibald, Eaton and Lipsey (1986).

⁷. A good reference for the definitions of subgames and subgame perfection is Friedman (1986: 80-81).

that manufacturers have correct conjectures regarding the nature of the equilibrium at the retail level.

A specific assumption, implicit in the two stage formulation, is that manufacturers choose prices for their products noncooperatively, taking into account the subsequent stage game, and sell them to retailers who have market power. The two stage formulation implies that retailers do not have any monopsony power. That is, retailers and manufacturers are not in a bargaining arrangement. This assumption has been used in the model of exclusive dealing by Mathewson and Winter (1987), which has already been discussed.

(iii) Exclusive Dealing Assumption

An important element of the model is the exclusive dealing assumption. In fact, there might also be termed exclusive territories, in that the model does not allow for inter-brand competition. The model could be generalized quite easily to incorporate competition between many retailers selling the same good without changing the qualitative nature of the results. An extension to allow retailers to handle products of both firms would undoubtedly affect the results. This is the subject of further work although some preliminary conjectures might be made. First, it would seem important that there be some additional differentiation between retailers. In our formulation, it is relatively unimportant whether differentiation takes place at the retail or manufacturing level. However, with retailers holding both goods, it would be necessary to introduce additional differentiation at the retail level to make the problem interesting. For example, one might consider brand differentiation at the manufacturing level and spatial differentiation by retailers as in Besanko and Perry (1989).⁸ Secondly, the nature of the equilibrium and hence welfare implications would undoubtedly depend on the relative

⁸. Besanko and Perry (1989) also assume there is free entry into retailing.

strengths of the two types of differentiation. These conjectures are the subject of future research.

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Chapter 2

Incentives for Vertical Restraints in a Two Stage Model of Perfect Information

2.1 Introduction

The search for a rationale for vertical restraints, particularly resale price maintenance, has spawned a large and still growing literature.¹ The seminal paper in this area is Telser (1960) who offered two explanations for why manufacturers might impose price floors on retailers. The first is the now famous "Special Services" argument in which a monopolist manufacturer protects retail margins through the imposition of a price floor in return for the provision of retail services. The increased retail services increases both the sales and profits of the manufacturer. The second explanation views the imposition of price floors by members of a manufacturing cartel as an effective way of eliminating their incentives for noncooperative behaviour. Price floors at the retail level remove the incentive for manufacturers to shave their prices in the hopes of servicing an increased share of the market.

¹. Excellent summaries of the literature can be found in Mathewson and Winter (1985a) and Overstreet (1983). For a useful synthesis of the issues, see Tirole (1989).

These explanations have spawned a number of papers in which extensions and generalizations can be found. Gallini and Winter (1983) show that vertical restraints can be profitable for a manufacturer in a model of monopolistic competition where more firms increase the availability and hence the demand for the manufacturer's product. More firms are sustainable if prices are higher than prices at the unconstrained level. Marvel and McCafferty (1985) generalize Telser's argument and show that manufacturers can gain if the higher retail price enables higher quality retail firms to stock and thereby "certify" the product. Mathewson and Winter (1984) model Telser's argument in a spatial framework and find efficiency explanations for resale price maintenance. Recently, criticisms of these explanations have emerged in a number of papers. Klein and Murphy (1988) question the logic of Telser's Services argument. They argue there is no direct link between the higher maintained resale prices and the provision of special services. They subsequently develop a link between the two in a model of contract enforcement. Perry and Porter (1990) take issue with Marvel and McCafferty's model, particularly the assumption that retailers expand service to the point of zero profits. They argue that the result is unlikely to occur if retailers are choosing service levels. Unlike Mathewson and Winter, Perry and Porter show that the use of vertical restraints, resale price maintenance and franchise fees, will not necessarily increase welfare.

Perhaps a more common criticism of special services type models is their apparent limited applicability. Scherer (1980) while agreeing with the logic of the special services argument thought that it was of little empirical significance.² Overstreet (1983) in his examination of the empirical evidence found RPM has been used on products for which the

². Scherer (1980:593) was sympathetic towards an anti-competitive argument for RPM.

services argument appears strained.³ Furthermore a quick glance at the Canadian competition policy record reveals that RPM has been used for a wide variety of products ranging from greeting cards to stereo equipment, implying there may be more to the practice than simply service provision.⁴

Whatever the empirical significance of the services argument, a feature common to these papers is their preoccupation with the relation of a single monopolist to many retailers, ignoring the nature of the competition at the manufacturing stage. Furthermore, they are all variations on Telser's "Special Service" argument in that price restrictions provide an indirect benefit to manufacturers, either services, availability or quality certification, which overcomes the direct harm resulting from the price increase.⁵ Arguments appealing to anti-competitive elements, either manufacturing or retailing cartels, have received much less attention. Apart from Telser's manufacturing cartel argument and some informal analyses of retailer cartels, the precise conditions under which either cartel can be maintained remain relatively unexplored.⁶

This chapter attempts to address this deficiency in the literature by modelling the interaction between manufacturers and retailers in a simple model of differentiated products. The motivation is to discover whether vertical price restrictions would ever be profitable for manufacturers in a model without special services. Specifically, I show that in a two stage

³. Overstreet (1983:162,163) did suggest that it was unlikely that one single explanation would be found.

⁴. A good summary is contained in the appendix to Mathewson and Winter (1985a:105-116). Further information, for the U.S., can be found in Overstreet (1983:177-196).

⁵. Mathewson and Winter (1985a:15-27) provide an excellent synthesis of this literature.

⁶. See Mathewson and Winter (1985a) and Overstreet (1983) for an informal discussion of cartel theories.

perfect equilibrium model, it may be more profitable for manufacturers and retailers if a higher retail price associated with Cournot competition obtains rather than a lower retail price resulting from Bertrand competition. The key assumption is that it *may* be impossible for manufacturers to commit themselves to a fixed manufacturing price in the face of Bertrand competition at the retail level. The important result is that less intense price competition may result in a preferable *noncooperative* equilibrium for manufacturers. Price restraints at the retail level prevent manufacturers from being drawn into a price war or, in other words, a less desirable noncooperative equilibrium.

This paper is organized as follows. Section 2 outlines the retail stage of the two stage game. The solutions for Bertrand competition, Cournot competition and the Collusive outcome will be summarized. These results are important when the preceding stage game is formulated. Section 3 discusses the manufacturing stage of the game as well as the perfect equilibrium solution concept. Section 4 investigates the relationship between the retail equilibria and the profits from collusion at the manufacturing level. Section 5 derives noncooperative equilibria for manufacturers for the various retail games. The last section relates the analysis contained here with other work in the area.

2.2 The Retail Stage

For simplicity, the retail stage is modelled as a symmetric duopoly. Each retail firm purchases a unit of the good at prices, m_i , $i=1,2$ from its manufacturer under an exclusive dealing arrangement. The retailers incur a per unit cost of sales equal to s_i , $i=1,2$, which are assumed to be a necessary input on the part of the retailer. Since these retail expenditures do not affect the evaluation of the good by consumers, the model is not dealing with the

special services or quality certification argument. Furthermore, it is assumed that there are no fixed costs of production.

Following Singh and Vives (1984), a two sector model is assumed, one competitive, which acts as a numeraire, the other monopolistic, comprised of two firms. Demand is represented as a continuum of consumers of the same type with a separable utility function which is linear in the numeraire good.⁷

The representative consumer maximizes $W = U(q_1, q_2) - \sum p_i q_i$, where q_i is the amount of good i and p_i its price. U is assumed to be quadratic and strictly concave of the following form:⁸

$$U(q_1, q_2) = \alpha_1 q_1 + \alpha_2 q_2 - (\beta_1 q_1^2 + 2\tau q_1 q_2 + \beta_2 q_2^2)/2 \quad (1)$$

where α_i and β_i are positive, $i=1,2$, assuming $\sigma = \beta_1 \beta_2 - \tau^2 > 0$, for stability⁹ and $a_i = \alpha_i \beta_j - \alpha_j \tau > 0$ for $i \neq j$, $i=1,2$. This utility function produces demand curves which are linear. In inverse form they are,

$$p_1 = \alpha_1 - \beta_1 q_1 - \tau q_2 \quad (2)$$

$$\text{and} \quad p_2 = \alpha_2 - \tau q_1 - \beta_2 q_2 \quad (3)$$

⁷. This specification allows for partial equilibrium analysis, since there are no income effects on the monopolistic sector.

⁸. This model is used by Dixit (1979) and developed further by Singh and Vives (1984)

⁹. If $\beta_1 = \beta_2 = \beta = \tau$, then $\sigma = 0$ and the utility function is not strictly concave. As σ approaches 0, the slope of the demand curves approach infinity.

in the region of quantity space where prices are positive. Denoting $c=\tau/\sigma$, $b_1=\beta_2/\sigma$, $b_2=\beta_1/\sigma$ and using the definitions σ , a_1, a_2 (where $a_i, b_i, i=1,2$ are positive, by assumption), the direct demand functions can be written as

$$q_1 = a_1 - b_1 p_1 + c p_2 \quad (4)$$

$$q_2 = a_2 - b_2 p_2 + c p_1 \quad (5)$$

provided that quantities are positive. The algebra is simplified considerably if (4) and (5) are rewritten in terms of parameters of the utility function. Substituting for the definitions of a_1 , a_2 , b_1 , b_2 and c and collecting terms yields (4') and (5').

$$q_1 = [\beta_2(\alpha_1 - p_1) + \tau(p_2 - \alpha_2)]/\sigma \quad (4')$$

$$q_2 = [\beta_1(\alpha_2 - p_2) + \tau(p_1 - \alpha_1)]/\sigma \quad (5')$$

For the rest of the paper, the analysis will be conducted using these expressions. The sign of the parameter τ , which enters directly and through σ , determines whether the goods are substitutes, complements or independent goods, depending on whether τ is greater than, less than, or equal to 0. When $\alpha_1 = \alpha_2$, $\theta = \tau^2/(\beta_1 \beta_2)$ expresses the degree of product differentiation, $\theta=0$ representing independent goods, $\theta=1$ when the goods are perfect substitutes.¹⁰

¹⁰. This approach is in contrast to the spatial differentiation in Mathewson and Winter (1984).

Each retail firm is assumed to maximize the following: $\pi_i = [(p_i - (m_i + s_i))] q_i$, $i=1,2$. The solution to this stage of the game depends on the strategic variable used, prices or quantities, and the assumed conjectures. The results are presented in the following section.

2.21 Retail Market Equilibrium

In this section, I examine three solution concepts: Bertrand-Nash, Collusion or Cournot-Nash. In Bertrand competition, firms choose prices simultaneously and equilibrium obtains when the conjectures about the other firms' prices are correct.

The reaction functions for the two retailers are the following:¹¹

$$p_1 = (\alpha_1 + m_1 + s_1)/2 - \alpha_2 \tau / 2\beta_2 + \tau p_2 / 2\beta_2$$

$$p_2 = (\alpha_2 + m_2 + s_2)/2 - \alpha_1 \tau / 2\beta_1 + \tau p_1 / 2\beta_1.$$

This equilibrium is depicted in figures 1(a) and 1(b), for the case of high and low differentiated goods. The slopes and intercepts of the reaction functions depend on the degree of product differentiation. For independent goods, the reaction functions are perpendicular, at the monopoly price.¹² As the goods approach perfect substitutes, the intercepts approach $(m_i + s_i)/2$, for $i,j=1,2$ and $i \neq j$, and the slopes approach $1/2$. In general,

¹¹. The existence of a unique Nash equilibrium requires that these reaction functions, or best reply mappings, be contractions. For the reaction functions specified, this requires that $\tau/2\beta_1$ and $\tau/2\beta_2$ be less than 1. For a detailed discussion of this point, see Friedman (1986) p. 42-45.

¹². Set $\tau=0$ in the two reaction functions which results in equilibrium prices, $p_1^* = (\alpha_1 + m_1 + s_1)/2$ and $p_2^* = (\alpha_2 + m_2 + s_2)/2$.

the slope of their reaction functions, dp_i/dp_j increase as the goods become closer substitutes. In contrast, the intercepts defined as $I_i = (\alpha_i + m_i + s_i)/2 - \alpha_j \tau / 2\beta_j$ decrease as the goods become closer substitutes for $i, j = 1, 2$ and $i \neq j$.¹³

The intercept of firm 1's reaction function, I_1 , is depicted in figures 1(a) and 1(b). In general, the intercepts are functions of demand parameters, selling costs, and manufacturing prices. It is clear that manufacturers could alter the payoffs in the retail stage if they so desired. The determination of these optimal manufacturing prices is the subject of the latter part of the paper.

Solving these reaction functions simultaneously yields the following equilibrium prices, for the symmetric case where $\alpha_1 = \alpha_2 = \alpha$, $\beta_1 = \beta_2 = \beta$, $s_1 = s_2 = s$.

$$P_1^{*B-N} = [(\alpha + m_1 + s)2\beta^2 + \tau\beta(m_2 + s - \alpha) - \alpha\tau^2] / \Phi \quad (6)$$

$$P_2^{*B-N} = [(\alpha + m_2 + s)2\beta^2 + \tau\beta(m_1 + s - \alpha) - \alpha\tau^2] / \Phi \quad (6')$$

where $\Phi = 4\beta^2 - \tau^2$

If in addition, $m_1 = m_2 = m$, then (6) and (6') simplify to $P^{*B-N} = [(\alpha + m + s)\beta - \alpha\tau] / (2\beta - \tau)$ which when substituted into the symmetric version of (4') and (5') yields the Bertrand-Nash quantity, $q^{*B-N} = [\beta(\alpha - m - s)] / [(\beta + \tau)(2\beta - \tau)]$. In general, the Nash prices and quantities are functions of all parameters of the utility function, as well as all costs of production, m_i and s . As is well known, for an equilibrium to exist for Bertrand competition, the capacity of

¹³. Differentiate the expression with respect to τ to verify the result. Equivalently, the reaction functions can be rewritten in terms of θ , the measure of product differentiation, by substituting for τ the expression $\theta = \tau^2 / \beta_1 \beta_2$. These expressions would then be differentiated with respect to θ .

retailers is assumed to be sufficient to meet demand.¹⁴ It is straightforward to show that if the goods are independent $\theta=0$, then $P_1^{*B-N} = (\alpha + m_1 + s)/2$; and if the goods are perfect substitutes, $P_1^{*B-N} = (m_1 + s)$.¹⁵

In contrast to this noncooperative equilibrium, it is interesting to outline the collusive outcome, that is, where joint profits at the retail level are maximized. The equilibrium prices are as follows, in terms of parameters of the utility function.

$$P_1^{*C} = (\alpha + m_1 + s)/2 \quad (7)$$

$$P_2^{*C} = (\alpha + m_2 + s)/2 \quad (7')$$

As can be seen, the collusive prices are solely functions of the manufacturing prices, selling costs and α , the willingness to pay parameter.¹⁶ Furthermore, if $m_1 = m_2 = m$, then the collusive output is $q^{C*} = (\alpha - m - s)/2(\beta + \tau)$.

This result is shown in figure 2. Since this is a model of differentiated goods, drawing the demand curve for one good requires an assumption regarding output and/or the nature of the other good.¹⁷ Imposing symmetry, $\alpha_1 = \alpha_2 = \alpha$, $\beta_1 = \beta_2 = \beta$ and $s_1 = s_2 = s$ on the demand

¹⁴. This avoids the famous Edgeworth cycle, see Levitan and Shubik (1980) for a discussion of this point.

¹⁵. Substitute for $\tau^2 = \theta\beta_1\beta_2$ and for $\tau = (\theta\beta_1\beta_2)^{1/2}$ in (6) and (7) evaluate at $\theta=0$ and $\theta=1$, for the latter case, impose symmetry, $m_1 = m_2 = m$, $s_1 = s_2 = s$, $\alpha_1 = \alpha_2 = \alpha$ and $\beta_1 = \beta_2 = \beta$.

¹⁶. The collusive prices for the nonsymmetric case are $P_i^{*C} = (\alpha_i + m_i + s_i)/2$, for $i=1,2$.

¹⁷. In general, a contingent demand curve should be drawn, see Shubik and Levitan (1980) for details. For simplicity, I impose symmetry.

functions (2) and (3) yields, $(p_1=p_2=p, q_1=q_2=q)$, $p=\alpha - (\beta+\tau)q$. Marginal revenue for this curve is $MR= \alpha-2(\beta+\tau)q$ which when set equal marginal cost $(m+s)$, yields $q^*=(\alpha-m-s)/(2\beta+\tau)$. Substituting this quantity into the demand curve, yields $p^*=(\alpha+m+s)/2$, which corresponds to expressions (7) and (7').

Another important noncooperative solution concept is the Cournot-Nash equilibrium. As is well known, in Cournot competition, firms choose quantities simultaneously and equilibrium obtains when the conjectures about the other firms' quantities are correct. An important difference here is that the Cournot competition is between differentiated products. The reaction functions for the two firms are as follows:

$$q_1 = [\alpha_1-(m_1+s_1)-\tau q_2]/2\beta_1$$

$$q_2 = [\alpha_2-(m_2+s_2)-\tau q_1]/2\beta_2.$$

The equilibrium quantities, for Cournot competition at the retail level are listed below, for the symmetric case.

$$q_1^{*C-N} = [2\beta(\alpha-m_1-s)+\tau(s+m_2-\alpha)]/\Phi \quad (8)$$

$$q_2^{*C-N} = [2\beta(\alpha-m_2-s)+\tau(s+m_1-\alpha)]/\Phi \quad (8')$$

where $\Phi=4\beta^2-\tau^2$

If in addition, $m_1=m_2=m$, then expressions (8) and (8') simplify to $q^{*C-N} = (\alpha-m-s)/(2\beta+\tau)$. For perfect substitutes, $\theta=1$, the Cournot quantities equal

$(\alpha - m - s)/3\beta$.¹⁸ The equilibrium prices, obtained by substituting (8) and (8') into (2) are as follows.

$$P_1^{*C-N} = [2\beta^2(\alpha + m_1 + s) + \tau\beta(m_2 + s - \alpha) - \tau^2(m_1 + s)]/\Phi \quad (9)$$

$$P_2^{*C-N} = [2\beta^2(\alpha + m_2 + s) + \tau\beta(m_1 + s - \alpha) - \tau^2(m_2 + s)]/\Phi \quad (9')$$

Similarly, if $m_1 = m_2 = m$, then the Cournot prices equal

$p^{*C-N} = [\beta(\alpha + m + s) + \tau(m + s)]/(2\beta + \tau)$. Singh and Vives (1984) using a variant of this model, show that Cournot prices are higher than Bertrand prices, if the goods are substitutes. It is easy to show that in our formulation $P^{*C-N} > P^{*B-N}$, if the goods are substitutes, since $\tau > 0$, $\Phi > 0$ and $(\alpha - m - s) > 0$, that is, the willingness to pay for the good is greater than the total unit costs, which include manufacturing prices and selling costs. Since these prices depend on the manufacturing prices, as well as the other parameters in the model, for a full solution the nature of the competition at the preceding stage must be addressed.

2.3 The Manufacturing Stage

As was seen in figure 1, the Nash equilibrium at the retail level is dependent, among other things, on the manufacturing prices chosen in the preceding stage. The task in this section is to determine the equilibrium manufacturing prices m_1^* and m_2^* given the nature

¹⁸. Refer to footnote 14 for details on evaluating the expressions for perfect substitutes.

of the competition at the retail stage.¹⁹ An important question to be addressed is whether the equilibrium manufacturing prices are dependent on the nature of the competition at the retail stage.

In this model, it will be assumed that vertical integration is unprofitable, that is, it is uneconomic for manufacturers to sell directly to consumers.²⁰ Manufacturers want to maximize $\pi_i = (m_i - k_i)q_i$, $i=1,2$, where m_i is the manufacturing price set by firm i , and k_i is the average and marginal cost of production of manufacturing firm i , which has been set at zero with no loss in generality.²¹ The solution to this two stage game depends once again on the strategic variable used, whether prices or quantities, and the assumed conjectures.

The two stage game is solved using the perfect equilibrium solution concept of Selten (1975). This technique is applicable to cases of perfect and complete information and assumes that decisions are taken sequentially. In the context of the model, manufacturers are assumed to be first movers. They choose their manufacturing prices taking into account the reaction of retailers, both their own and their competitors, under the assumptions of complete and perfect information.

¹⁹. In this chapter, manufacturers choose prices anticipating the nature of the retail equilibrium. It is possible that the timing is reversed; that is, retailers choose retail prices knowing how manufacturers are going to respond. Manufacturers would determine the quantity they would wish to supply. This problem, which is interesting and non-trivial, will not be pursued at this time.

²⁰. This question is addressed in Chapter 4 of this thesis.

²¹. Restricting the contracts to linear pricing schemes is a strong assumption which requires justification. For the case of one manufacturer and one retailer, a non-linear pricing scheme, a franchise fee plus a wholesale price set at the marginal cost of the manufacturer, would yield the first best outcome for the manufacturer. However, there are problems which accompany the use of a franchise fee. First, the retailer has to be concerned about moral hazard on the part of the manufacturer if efficiency requires the manufacturer provide advertising or other inputs. Second, there may be a financial constraint associated with the payment of an up-front fee by retailers to manufacturers. These problems are well known from the franchise literature, for example, Mathewson and Winter (1985b).

The possible combinations of strategies and payoffs can be represented in Table 1. The table outlines the implication of cooperative versus noncooperative behaviour for the manufacturers, assuming that the strategic variable is price for the noncooperative case.²²

		<i>Manufacturers</i>	
<i>Retailers</i>		Collude (m_i^{*C})	Non-Cooperative (m_i^{*NC})
Collude	(P _i ^{*C})	$\pi_i^M = \pi_{M1}$	$\pi_i^M = \pi_{M2}$
		$\pi_i^R = \pi_{R1}$	$\pi_i^R = \pi_{R2}$
Cournot	(P _i ^{*C-N})	$\pi_i^M = \pi_{M3}$	$\pi_i^M = \pi_{M4}$
		$\pi_i^R = \pi_{R3}$	$\pi_i^R = \pi_{R4}$
B-N	(P _i ^{*B-N})	$\pi_i^M = \pi_{M5}$	$\pi_i^M = \pi_{M6}$
		$\pi_i^R = \pi_{R5}$	$\pi_i^R = \pi_{R6}$

Table 1

The table includes an additional solution concept for retailers, Cournot-Nash. That is, there is a cooperative solution concept as well as two noncooperative solution concepts, one with respect to prices the other with respect to quantities.²³

The problem at the manufacturing level is to solve for m_i^{*C} and m_i^{*B-N} , the optimal collusive and Bertrand-Nash manufacturing prices taking into account the game at the retail level. Once these are determined they are substituted into the respective prices depending

²². It is possible to have manufacturers play a Cournot-game but this possibility is not considered at this time.

²³. It is important to note that this is not a normal, or strategic form, depiction of the two stage game, but merely a listing of the outcomes considered in this paper.

on the nature of the downstream competition. The question to be addressed involves a comparison of the profit levels for manufacturers and retailers in each cell. The important point will be to determine if manufacturers would prefer an equilibrium which results in higher prices at the retail level: that is, is there an incentive for manufacturers to support higher retail prices?

The solution to the game at the manufacturing level is derived in the next section. The case of cooperation at the manufacturing level will be presented first, followed by the noncooperative equilibrium, for the various retail equilibria already discussed. To illustrate the solution method for the complete game, the first case, collusion at the manufacturing level and collusion at the retail level, will be outlined in detail.

2.4 Collusion at the Manufacturing Level

The manufacturing firms choose m_1 and m_2 to maximize, $\pi = m_1q_1 + m_2q_2$. The first order conditions for this problem are

$$\partial\pi/\partial m_1 = m_1 \partial q_1/\partial m_1 + q_1 + m_2 \partial q_2/\partial m_1 = 0 \quad (10)$$

$$\partial\pi/\partial m_2 = m_1 \partial q_1/\partial m_2 + m_2 \partial q_2/\partial m_2 + q_2 = 0 \quad (11)$$

Equations (10) and (11) reveal the externalities present in the two stage game, and vertical relationships in general. For manufacturer 1, the horizontal externality imposed on manufacturer 2 is the term $m_2 \partial q_2/\partial m_1$. This is the effect on manufacturer two's profits from an increase in the manufacturing price of firm 1. Under collusion, this externality is

internalized. The vertical externality comes through the term $\partial q_2/\partial m_1 = \partial q_2/\partial p_2 \partial p_2/\partial m_1 + \partial q_2/\partial p_1 \partial p_1/\partial m_1$, (using the demand functions (4') and (5')). This externality involves the effect the retail pricing decision has on the sales and hence profits of the manufacturer.

If colluding manufacturers believe that retailers will also collude, the optimal manufacturing prices are determined as follows. To solve equations (10) and (11) for the optimal manufacturing prices, the derivatives $\partial q_1/\partial m_1$, $\partial q_2/\partial m_1$, $\partial q_1/\partial m_2$, $\partial q_2/\partial m_2$, and the values of q_1 and q_2 are required. However, from (4') and (5') the above derivatives and values of q_1 and q_2 actually depend on the prices p_1 and p_2 . The solution, therefore, depends on the prices used to determine the derivatives and outputs.

Here use is made of the perfect equilibrium solution concept. Manufacturers are assumed to hold correct conjectures regarding the nature of the game at the retail level. In this case, manufacturers know that retailers will collude. Therefore, the prices from the collusive outcome at the retail level equation (8) are substituted into the expressions (4') and (5') to obtain, setting $\beta_1=\beta_2=\beta$ and $s_1=s_2=s$:

$$q_1^{*C} = [\beta(\alpha - m_1 - s) + \tau(m_2 + s - \alpha)]/2\sigma \quad (4'')$$

$$q_2^{*C} = [\beta(\alpha - m_2 - s) + \tau(m_1 + s - \alpha)]/2\sigma \quad (5'')$$

Next, the derivatives, $\partial q_1/\partial m_1$, $\partial q_1/\partial m_2$, $\partial q_2/\partial m_1$, and $\partial q_2/\partial m_2$ are taken. Taking the derivatives of (4'') and (5'') and substituting (4'') and (5'') into the first order conditions (14) and (15) and solving simultaneously, yields the solution to the case of collusion at both the manufacturing and retail level, m_C^C (where the superscript refers to the nature of the competition at the manufacturing level, and the subscript refers to the nature of the competition at the retail level). This is presented below.

$$m_C^* = (\alpha - s)/2 \quad (12)$$

The optimal collusive manufacturing prices when collusion exists at the retail level depend on α , the willingness to pay parameter from the utility function, and s , the retail selling cost. Other cases, Cournot-Nash and Bertrand-Nash at the retail level, are obtained in the same manner, evaluating the quantities and derivatives using the Cournot or Bertrand-Nash prices depending on the case considered.

The optimal collusive manufacturing price, m_C^* , can be obtained in a more direct manner. That is, the solution $(\alpha - s)/2$ can be determined by examining the problem of successive market power.²⁴ The first step is to determine the marginal revenue for the retail monopolist. Given the symmetric demand curve $p = \alpha - (\beta + \tau)q$, the marginal revenue curve is defined as $MR_R = \alpha - 2(\beta + \tau)q$. Setting this equal to the retailer's marginal cost, $m + s$, and solving yields, $q_R^* = (\alpha - m - s)/2(\beta + \tau)$. Substituting this quantity into the demand curve yields the retail price, $p^* = (\alpha + m + s)/2$. This corresponds to expressions (7) and (7').

To determine the input price of a monopolist at the manufacturing level, observe that the first order condition for the retailer can be written as $MR_R - m - s = 0$, or $m = MR_R - s$. Substituting for MR_R , and multiplying by q yields the total revenue for a monopolist at the manufacturing level. Taking the derivative with respect to q , yields marginal revenue for the monopolist, $MR_M = \alpha - 4(\beta + \tau)q$. Setting this equal to the sum of the retail selling cost and the manufacturer's cost of production which is assumed to be zero for simplicity, and solving yields $q_M^* = (\alpha - s)/4(\beta + \tau)$. Substituting q_M^* into MR_R and subtracting s and using the condition $m = MR_R - s$ from the first order condition of the retail monopolist, yields,

²⁴. For a good reference on this point, see Waterson (1984:83-87)

$m^*=(\alpha-s)/2$, which corresponds to expression (12). Finally, substituting m^* into the expression for the monopoly retail price $p^*=(\alpha+m^*+s)/2$, yields the double mark-up retail price, $p^*=(3\alpha+s)/4$ with the corresponding equilibrium quantity $q^*=(\alpha-s)/4(\beta+\tau)$. This equilibrium is represented as point A in figure 2.

It is useful to relate this manufacturing price to the retail price set by an integrated monopolist.²⁵ Setting the marginal revenue of the integrated firm, $\alpha-2(\beta+\tau)q$ equal to integrated marginal cost, s , yields the integrated quantity $q^{*1}=(\alpha-s)/2(\beta+\tau)$. Substituting this into the demand curve yields the integrated price $P^{*1}=(\alpha+s)/2$, which is given by point B in figure 2. If the retail selling cost is subtracted, this equals the price set by a monopolist at the manufacturing level, $m^*=(\alpha-s)/2$. As intuition would suggest, colluding monopolists at the manufacturing level subtract the selling costs of retailers from the integrated monopoly prices to obtain their manufacturing prices. The perfect equilibrium solution concept has confirmed this intuition.

The equilibrium manufacturing prices would appear to depend on the nature of the competition at the retail stage. The case of collusion at the retail level has been derived: the question is whether the optimal prices change when either Cournot-Nash or Bertrand-Nash competition prevails at the retail level. The answer is no, as shown in the following proposition.

Proposition 1. In a perfect equilibrium, collusive manufacturers choose the same manufacturing prices, whether retailers collude, engage in Cournot competition or Bertrand-Nash competition.

Proof: see Appendix I.

²⁵. This result is derived in the Appendix to this chapter.

This proposition argues that the collusive manufacturing prices are invariant to the nature of the retail competition, even if they know whether retailers are colluding, engaging in Cournot competition or Bertrand-Nash competition. This result is particular to the assumptions of the model because for all three cases the linear derived demand curve for the monopolist manufacturer rotates around a common intercept.²⁶

Once the manufacturing prices are chosen, the retail price is determined depending on the nature of the competition at the retail level. If the manufacturers are able to commit to a fixed set of manufacturing prices, the price given by (16) remains optimal regardless of the nature of the downstream competition. However, if they *cannot* then manufacturers will choose their prices noncooperatively.

This result allows us to present a simple proof, within our framework, of Telser's observation that price floors appear to work against the interests of manufacturers. That is, without any other motivation, it appears that manufacturers should prefer *more* rather than less competition at the retail level. Manufacturers should prefer smaller markups at the retail level, since that would result in increased sales. The support by manufacturers of Fair Trade laws, which prevented lower retail prices, was the paradox addressed by Telser.²⁷ The assertion that manufacturers would prefer lower retail prices is proved in the following set of propositions.

²⁶. This point can be illustrated for a general demand curve. Suppose we have a demand curve given by $p=a-bq$. Marginal revenue is given therefore as $MR=a-2bq$ which when set equal to $MC=c$, yields $q^*=(a-c)/2b$ which when substituted into the demand curve yields $p^*=(a+c)/2$. As can be seen, as long as the intercept remains unchanged the monopoly price is independent of the slope of the demand curve.

²⁷. For a discussion of the Fair Trade Movement, see Overstreet (1983).

The following results apply to the case of collusion at the manufacturing level, for the various retail equilibria. The proofs for the following propositions make use of the results in tables 2 and 3.

Proposition 2. For a set of cooperative prices at the manufacturing level, the ranking of retail prices, from highest to lowest is Collusion, Cournot-Nash, Bertrand-Nash.

Proof: see Appendix I.

The proposition states that $P_i^{*C} > P_i^{*C-N} > P_i^{*B-N}$ for $i=1,2$. The result accords with intuition. When the two goods are substitutes, colluding retailers internalize the positive externality, the positive effect on the other retail firm from increasing one's price, which is neglected by non-cooperative retailers. For the differentiated products case, Cournot competition between retailers results in higher prices than Bertrand-Nash competition.

It is useful to determine the cases in the first column of Table 1 in order to summarize the case of collusion at the manufacturing level for the various retail equilibria.

Proposition 3. For a set of cooperative prices at the manufacturing level, the ranking of manufacturers' profits for the given retail competition, is Bertrand-Nash, Cournot, then Collusion, while for retailers the rankings are reversed.

Proof: see Appendix I.

This proposition addresses Telser's fundamental question: Why would manufacturers want Fair Trade? That is, it is clear from proposition 3 that manufacturers profit from unconstrained competition at the retail level, over any price maintained above the Bertrand-

Nash price vector, P^{B-N} . The propositions remain the same if manufacturers are perfect competitors: the propositions hold for any fixed set of manufacturing prices. An explanation for manufacturer support of Fair Trade Laws then must be sought elsewhere as suggested by Telser. Our approach is to investigate the role of noncooperative behaviour at the manufacturing level as a possible explanation.

2.5 Non-cooperation at the Manufacturing Level

Suppose manufacturers are unable to maintain the collusive price. One reason for a lack of commitment may be that prices at the manufacturing level are often negotiable for large quantities. Another might be that it is relatively easier for competition law authorities to monitor the pricing practices of a small number of manufacturers. Without collusion, the result will be a noncooperative equilibrium at the manufacturing level.

In this paper, it is assumed that the noncooperative solution concept will be in terms of prices, that is, Bertrand-Nash competition. Each manufacturer chooses its price simultaneously and equilibrium obtains when the conjectures about the other firm's price is correct. The first order conditions are outlined below.

$$\partial\pi/\partial m_1 = m_1 \partial q_1/\partial m_1 + q_1 = 0 \quad (13)$$

$$\partial\pi/\partial m_2 = m_1 \partial q_1/\partial m_2 + q_2 = 0 \quad (14)$$

Once again, the solution requires a specification of the appropriate quantities which depend on the nature of the competition assumed at the retail level. An important question

is whether noncooperative manufacturers prefer a certain type of competition at the retail level given that the competition can be perfectly anticipated. The three types of equilibria, at the retail level, are considered: (i) collusion, (ii) Cournot-Nash and (iii) Bertrand-Nash. It is important to note that manufacturers are behaving noncooperatively at the first stage and are assumed to have correct conjectures regarding the nature of the game at the retail level. The various equilibria are listed below in the following table (where in m^{*B-N}_C the superscript refers to the nature of the competition at the manufacturing level, and the subscript refers to the nature of the competition at the retail level).

$$m^{*B-N}_C = [(\alpha-s)(\beta-\tau)]/(2\beta-\tau) \quad (15)$$

$$m^{*B-N}_{C-N} = [(\alpha-s)(2\beta-\tau)]/(4\beta-\tau) \quad (16)$$

$$m^{*B-N}_{B-N} = [(\alpha-s)(2\beta^2-\tau^2-\tau\beta)]/(4\beta^2-2\tau^2-\tau\beta) \quad (17)$$

This chapter is interested, fundamentally, in how these prices compare, and more importantly, how the profits of manufacturers and retailers are affected by the nature of the competition at the retail level. The following propositions determine the precise relationship.

Proposition 4. When goods are substitutes, and for intermediate ranges of product differentiation $0 < \theta < 1$, the perfect noncooperative equilibrium at the manufacturing level results in higher *manufacturing* prices and *retail* prices for Cournot competition at the retail level than for Bertrand-Nash competition at the retail level.

Proof: see Appendix I.

The first part of the proposition states that $m_i^{*B-N}_{C-N} > m_i^{*B-N}_{B-N}$, where the superscript refers to the nature of the competition at the manufacturing level, and the subscript refers to the nature of the competition at the retail level. That is, the optimal manufacturing price, chosen noncooperatively, is higher for Cournot competition at the retail level than for Bertrand-Nash.²⁸ The noncooperative equilibria at the manufacturing level for the respective retail competition are summarized in Table 5.

In addition, the higher manufacturing prices translate into higher retail prices. This proof differs from that presented in Singh and Vives (1984). In that model they show that Cournot prices are higher than Bertrand prices for a single stage game if the goods are substitutes. Proposition 4 refers to a perfect equilibrium two stage game where the retail prices in the second stage are dependent on the manufacturing prices chosen noncooperatively in the first stage. The important concern for manufacturers and retailers is the relationship of these prices to profits. The following proposition makes use of the information in table 6. Included in the table are the expressions for the profits of both manufacturers and retailers, for Bertrand-Nash competition at the manufacturing level and for Collusion, Cournot-Nash or Bertrand-Nash at the retail level. In table 7, these expressions are written in terms of the product differentiation parameter.

Proposition 5. For a perfect noncooperative equilibrium at the manufacturing level, the profits of *manufacturers* and *retailers* are higher if retailers play Cournot rather than Bertrand-Nash when the goods are perfect substitutes. They are identical if the demands for the two goods are independent.

Proof: see Appendix I.

²⁸. These prices are both less than the manufacturing price for the case of collusion at the retail level, see Appendix for proof.

Figures 3 and 4 reveal the implications of proposition 5. Proposition 5 shows that the profits are identical for Bertrand-Nash and Cournot-Nash when the demands are independent, $\theta=0$, while for perfect substitutes, $\theta=1$, profits are higher for both retailers and manufacturers for Cournot-Nash competition rather than Bertrand-Nash at the retail level. For manufacturers the condition is given by the ratio of the two profit functions listed in table 7.

$$\pi_{CN}^M/\pi_{BN}^M = \frac{[2(2-\theta^{1/2})^2(4-2\theta-\theta^{1/2})^2(1+\theta^{1/2})]}{[(2+\theta^{1/2})^2(4-\theta^{1/2})^2(1-\theta^{1/2})(2-\theta)]}$$

If $\theta=0$, the ratio is 1, if $\theta=1$, perfect substitutes, the ratio is greater than 1. For intermediate ranges of product differentiation, $0 \leq \theta \leq 1$, whether Cournot-Nash competition dominates Bertrand-Nash depends on the value of θ . The critical value is $\theta^*=.7865$, this is where the ratio is again unity. For $\theta < \theta^*$, Bertrand-Nash competition dominates Cournot-Nash competition downstream, for $\theta^* < \theta$, the opposite is true. This is depicted in figure 3. As the goods become closer substitutes, manufacturers prefer the less intensive Cournot competition to Bertrand-Nash. An interesting feature of the ratio is that it is solely a function of $\theta = \tau^2/\beta^2$, the product differentiation parameter, and independent of the magnitudes α, β, τ .

For retailers, the ratio of profits, π_{CN}^R/π_{BN}^R is greater than 1 for the range $0 < \theta \leq 1$. That is, the ratio obtained from table 7,

$$\pi_{CN}^R/\pi_{BN}^R = \frac{[4(2-\theta^{1/2})^2(1+\theta^{1/2})(4-2\theta-\theta^{1/2})^2]}{[(1-\theta^{1/2})(2+\theta^{1/2})^2(4-\theta^{1/2})^2(2-\theta)^2]}$$

is always greater than one except when the goods are independent $\theta=0$. This result is dependent only on θ , that is, only the ratio τ^2/β^2 , being important, not the magnitudes.

The intuition behind these results is quite straightforward. Both manufacturers and retailers gain from the higher retail price associated with Cournot competition rather than the price associated with Bertrand competition when the products are good substitutes. Manufacturers and retailers are better off if they avoid the worst case scenario, Bertrand-Nash at both levels, or in other words, the "price war" equilibrium. Profits are higher for retailers if they collude, resulting in the "double markup" equilibrium. For a wide range of differentiated products, an intermediate solution is preferable to the price war or double markup equilibrium. This equilibrium features higher retail prices than the price war equilibrium. Similarly, manufacturing prices are lower than the double markup equilibrium but higher than the price war equilibrium. Therefore, manufacturers will support resale price restraints as a way of forestalling the double markup equilibrium or the worst case, price war equilibrium.

2.6 Relevance of the Analysis

This model does not approach the vertical restraint problem from the perspective of the "services" or efficiency approach. It has more in common with Telser's cartel hypothesis. In that paper, Telser (1960) argued that price floors at the retail level may aid cartel stability at the *manufacturing* level. However, this paper differs from Telser's in a number of important ways. First, the equilibrium properties required for a full analysis are emphasized. A problem common to cartel theories of vertical restraints is that price restrictions are often *imposed* on the other stage of distribution. That is, retailer cartel theories impose price restraints on manufacturers; manufacturer cartel theories, such as Telser's, impose price restraints on retailers. Second, it is shown that the desire to support prices at the retail level does not depend on the maintenance of a cartel at the manufacturing level. Noncooperative manufacturers may still prefer higher *retail* prices if that results in a noncooperative equilibrium that is more profitable to the manufacturer.

As far as actual cases in the competition law, the analysis contained here is perhaps most applicable to markets where retailers have some degree of market power and where the special services provided are insignificant. For example, the numerous cases involving resale price maintenance in gasoline markets,²⁹ or any other cases where there are a small number of manufacturers, who recognize their interdependence, and where retailers have market power, can be analyzed using this framework.

²⁹. See Mathewson and Winter (1985) for a list of products subject to resale price maintenance.

2.7 Conclusion

This chapter has modelled the manufacturer-retailer interaction in a two stage perfect equilibrium framework. It has been shown that manufacturers as a group and retailers as a group are better off if the higher retail prices associated with Cournot competition occur rather than the lower prices under Bertrand competition. With Cournot competition at the retail level, manufacturer and retail profits are both higher than under Bertrand competition.

It is important to emphasize, as well, what the chapter has not done. The model used is a very specific type of product differentiation. A spatial approach to the problem would provide an interesting contrast. For example, if one considers firms as distributed along a line, a range of product differentiation can also be obtained, depending on whether firms are "maximally" or "minimally" differentiated.³⁰ While the existence of equilibrium is a problem in the linear-cost model, this can be overcome if a quadratic cost model is used instead.³¹ In the quadratic cost case, a term similar to the degree of product differentiation used in this paper, appears. However, this spatial model assumes the demand for goods by consumers is zero-one which implies there is frequently no deadweight loss from monopoly pricing. Hence, the welfare implications are sensitive to the type of product differentiation used. Often the results obtained in oligopoly models depend on the specific nature of the differentiation.

³⁰. This model was introduced by Hotelling (1929). An alternative approach is to consider a circular city with a uniform distribution of consumers. This latter model was developed by Salop (1979).

³¹. See Tirole (1989:279-282) for a good exposition of the linear city model.

Limiting the analysis to two retailers and two manufacturers, as well as the exclusive dealing assumption are important restrictions. Shubik and Levitan (1980) show how more firms can be incorporated in a model with a quadratic utility function and zero income effects, in a manner very similar to the model used in this chapter. In their model, they show that an explicit assumption is required for the noncooperative prices to converge to the competitive result. Essentially, it means that with an increased number of firms, it is necessary that the substitutes come closer together in the differentiation spectrum.³² This extension would generalize the results of this framework to a case of many firms, at the manufacturing level; although, maintaining the exclusive dealing arrangements.³³

Removing the exclusive dealing assumption to allow for inter-brand competition would be a more difficult extension in this model than merely increasing the number of retail firms per manufacturer. The important strategic issue would seem to be the effect of having retailers handling more than one brand of a good. Allowing for inter and intrabrand competition is the focus of a number of recent models, although they use different demand structures. Besanko and Perry (1989), using a logit model of demand, examine the role of exclusive dealing where manufacturers of different brands compete through retailers who are spatially differentiated. Porter and Perry (1990) add differentiation explicitly at the retail level, using a CES utility function in their analysis of the special services argument for resale price maintenance. It would be interesting to adapt the model used in this thesis to address similar issues.

³². See Shubik and Levitan (1980), p.92.

³³. With the differentiation used in this model and in Shubik and Levitan, the precise stage at which the differentiation occurs is unimportant when exclusive dealing is assumed. Without exclusive dealing, the nature and stage of the differentiation becomes important.

An additional line of research would be to set the above constituent game in a repeated game model. The analysis contained in this chapter is a static model and does not consider what might happen if the game is repeated a number of times. As is well known, the fact that constituent games are repeated a number of times often allows the set of equilibria to be expanded. For example, some collusive outcomes can be sustained if players are aware of their future interaction.³⁴ Furthermore, any future research in a repeated game framework must also consider whether the structure of the constituent game remains the same over time.

³⁴. Of critical importance to the analysis is whether the repeated game has a finite or infinite horizon. If it is a finite game, then a backward induction argument would generally unravel any equilibrium other than the equilibrium in the constituent game. For a good survey of these issues, see Friedman (1986).

Figure 1 (a): Retail Reaction Functions
Highly Differentiated Goods

Figure 1 (b): Retail Reaction Functions
Low Differentiated Goods

Figure 2: The Successive Monopoly Problem

Figure 3: Manufacturer Profits
Cournot versus Bertrand-Nash at the Retail Level

Figure 4: Retailer Profits
Cournot versus Bertrand-Nash at the Retail Level

VI. Tables

Table 2: Retail Equilibria for Collusion at Manufacturing Level

Retail Equilibria.	Prices	Quantities
Collusion	$P_C^* = (3\alpha + s)/4$	$q_C^* = (\alpha - s)/4(\beta + \tau)$
Cournot	$P_{CN}^* = \frac{[\alpha(3\beta + \tau) + s(\beta + \tau)]}{2(2\beta + \tau)}$	$q_{CN}^* = (\alpha - s)/2(2\beta + \tau)$
Bertrand	$P_{BN}^* = \frac{[\alpha(3\beta - 2\tau) + s\beta]}{2(2\beta - \tau)}$	$q_{BN}^* = (\alpha - s)\beta/(\beta + \tau)(2\beta - \tau)$

Table 3: Manufacturer and Retailer profits for Collusion at Manufacturing level.

Retail Equilibria:

Collusion	$\pi^M = (\alpha - s)^2/[8(\beta + \tau)]$ $\pi^R = (\alpha - s)^2/[16(\beta + \tau)]$
Cournot	$\pi^M = (\alpha - s)^2/[4(2\beta + \tau)]$ $\pi^R = (\alpha - s)^2\beta/[4(2\beta + \tau)^2]$
Bertrand	$\pi^M = [(\alpha - s)^2\beta/[4(\beta + \tau)(2\beta - \tau)]]$ $\pi^R = [(\alpha - s)^2\beta(\beta - \tau)/[4(\beta + \tau)(2\beta - \tau)^2]]$

Table 4: Optimal Manufacturing Prices (Bertrand-Nash competition at the Manufacturing Level).

Retail Equilibria:

Collusion	$m^{*B-N}_C = [(\alpha - s)(\beta - \tau)]/(2\beta - \tau)$
Cournot	$m^{*B-N}_{C-N} = [(\alpha - s)(2\beta - \tau)]/(4\beta - \tau)$
Bertrand	$m^{*B-N}_{B-N} = [(\alpha - s)(2\beta^2 - \tau^2 - \tau\beta)]/(4\beta^2 - 2\tau^2 - \tau\beta)$

Table 5: Retail Equilibria for Bertrand-Nash Competition at Manufacturing Level.

Retail Equilibria	Prices	Quantities
Collusion	$P_C^N = \frac{[\alpha(3\beta-2\tau)+s\beta]}{2(2\beta-\tau)}$	$q_C^N = \frac{[\beta(\alpha-s)]}{2(\beta+\tau)(2\beta-\tau)}$
Cournot	$P_{CN}^N = \frac{[\alpha(6\beta^2-\tau^2)+s2\beta(\beta+\tau)]}{(4\beta-\tau)(2\beta+\tau)}$	$q_{CN}^N = \frac{[2\beta(\alpha-s)]}{(2\beta+\tau)(4\beta-\tau)}$
Bertrand	$P_{BN}^N = \frac{[\alpha(\beta-\tau)(6\beta^2-2\tau^2)+s\beta\Omega]}{(2\beta-\tau)\Phi}$	$q_{BN}^N = \frac{[\beta(\alpha-s)(2\beta^2-\tau^2)]}{(2\beta-\tau)(\beta+\tau)\Phi}$

where $\Phi = 4\beta^2 - 2\tau^2 - \tau\beta$; $\Omega = 2\beta^2 - \tau^2$

Table 6: Manufacturer and Retailer Profits for Bertrand-Nash Competition at Manufacturing Level.

Retail Stage	
Collusion	$\pi^M = [(\alpha-s)^2\beta(\beta-\tau)]/[2(\beta+\tau)(2\beta-\tau)^2]$ $\pi^R = [(\alpha-s)^2\beta^2]/[2(\beta+\tau)(2\beta-\tau)^2]$
Cournot	$\pi^M = (\alpha-s)^2 2\beta(2\beta-\tau)/(2\beta+\tau)(4\beta-\tau)^2$ $\pi^R = [(\alpha-s)^2 4\beta^3]/[(2\beta+\tau)^2(4\beta-\tau)^2]$
Bertrand	$\pi^M = [(\alpha-s)^2\beta(\beta-\tau)(2\beta+\tau)\Omega]/[\Phi^2(2\beta-\tau)(\beta+\tau)]$ $\pi^R = [(\alpha-s)^2\beta(\beta-\tau)\Omega^2]/[(2\beta-\tau)^2(\beta+\tau)\Phi^2]$

where $\Phi = (4\beta^2 - 2\tau^2 - \tau\beta)$; $\Omega = (2\beta^2 - \tau^2)$

Table 7: Manufacturer and Retailer Profits for Bertrand-Nash Competition at Manufacturing Level : In terms of the product differentiation parameter θ .

Retail Stage	
Collusion	$\pi_C^M = [(\alpha-s)^2(1-\theta^{1/2})]/[2\beta(1+\theta^{1/2})(2-\theta^{1/2})^2]$ $\pi_C^R = (\alpha-s)^2/[2\beta(1+\theta^{1/2})(2-\theta^{1/2})^2]$
Cournot	$\pi_{CN}^M = [(\alpha-s)^2 2(2-\theta^{1/2})]/[\beta(2+\theta^{1/2})(4-\theta^{1/2})^2]$ $\pi_{CN}^R = [(\alpha-s)^2 4]/[\beta(2+\theta^{1/2})^2(4-\theta^{1/2})^2]$
Bertrand	$\pi_{BN}^M = [(\alpha-s)^2(1-\theta^{1/2})(2+\theta^{1/2})(2-\theta)]/[\beta(2-\theta^{1/2})(1+\theta^{1/2})\Phi^{*2}]$ $\pi_{BN}^R = [(\alpha-s)^2(1-\theta^{1/2})(2-\theta)^2]/[\beta(1+\theta^{1/2})(2-\theta^{1/2})^2\Phi^{*2}]$

where $\Phi^* = (4-2\theta-\theta^{1/2})$

Appendix I. Proofs

Proposition 1. Proof: This result is a particular feature of the model. Essentially, it is due to the linearity of the derived demand curve for a monopolist at the manufacturing level. The respective derived demands are $m = (\alpha - s) - 2(\beta + \tau)q^C$ for collusion at the retail level, $m = (\alpha - s) - (2\beta + \tau)q^{CN}$ for Cournot-Nash, and $m = (\alpha - s) - [(\beta + \tau)(2\beta - \tau)q]/\beta$ for Bertrand-Nash. While the slopes are different for each, the intercepts are the same, which implies a simple rotation of a linear demand curve for each case, resulting in the same monopoly price. QED.

Proposition 2. Proof: To show $P^{C*} > P^{CN*}$, use the expressions in table 2, define the difference, $\text{dif1} = P^{C*} - P^{CN*} = [\tau(\alpha - s)]/4(2\beta + \tau)$ after simplification. Since the goods are substitutes, $\tau > 0$, $\beta > 0$ and $(\alpha - s) > 0$, the difference is positive, therefore $P^{C*} > P^{CN*}$. To show $P^{CN*} > P^{B-N*}$, again use the expressions in table 2, define the difference, $\text{dif2} = P^{CN*} - P^{B-N*} = [(\alpha - s)\tau^2]/2(2\beta + \tau)(2\beta - \tau)$ after some simplification. Since $\tau > 0$ for substitutes, $\beta > 0$, $(\alpha - s) > 0$, the sign depends on $(2\beta - \tau)$. However, we know that $2\beta - \tau$ must be greater than zero for the reaction functions, or best reply mappings, to be contractions. QED.

Proposition 3. Proof: (i) Manufacturer's Profits. To show profits are higher from Bertrand competition at the retail level than for Cournot, use table 3, take the ratio, and cancel terms, yields $\pi_{B-N}^C > \pi_{CN}^C$ if $\tau > 0$ which is true if the goods are substitutes. To show profits from Cournot competition at the retail level are higher than Collusion, use table 3 and take the ratio, and cancel terms, yields $\pi_{CN}^C > \pi^C$ if $\tau > 0$, which is true since $\tau > 0$ if the goods are substitutes. QED.

(ii) Retailer's profits. Using table 3, and taking the ratio, yields, $\pi_R^C > \pi_R^{CN}$ if $\tau > 0$ which is true if the goods are substitutes. In addition, $\pi_R^{CN} > \pi_R^{B-N}$ if $\tau > 0$. QED.

Proposition 4. Proof: Taking the ratio of $m_{CN}^{B-N}/m_{B-N}^{B-N}$ and determining if it is greater than 1, by using Table 4 and simplifying yields

$$\frac{(2\beta - \tau)(4\beta^2 - 2\tau^2 - \tau\beta)}{(4\beta - \tau)(2\beta^2 - \tau^2 - \tau\beta)} > 1$$

which is equivalent to the condition,

$(2\beta - \tau)(4\beta^2 - 2\tau^2 - \tau\beta) > (4\beta - \tau)(2\beta^2 - \tau^2 - \tau\beta)$, which when expanded and simplified yields the condition that

$m_{CN}^{B-N} > m_{B-N}^{B-N}$ if $\tau > 0$, which is true if the goods are substitutes. The second part of the proposition states that $P_i^{CN} > P_i^{B-N}$. Suppose $m_{CN}^{B-N} = m_{B-N}^{B-N}$, and take the difference $P_C^{CN} - P_C^{B-N} = [(\alpha - (m + s))\tau^2]/[(2\beta + \tau)(2\beta - \tau)]$, which is positive if the goods are substitutes, since $\tau > 0$ and $(\alpha - m - s) > 0$. Since it holds if $m_{CN}^{B-N} = m_{B-N}^{B-N}$ it must also be true if $m_{CN}^{B-N} > m_{B-N}^{B-N}$. QED

Proposition 5. Proof: Manufacturer Profits. The expression for manufacturing profits for Bertrand competition at the manufacturing level and Cournot competition at the retail level, from Table 5, is $\pi_{C-N}^M = (\alpha-s)^2 2\beta(2\beta-\tau)/(4\beta-\tau)\Omega$, where $\Omega = (8\beta^2 + 2\beta\tau - \tau^2)$, this can be rewritten as $\pi_{C-N}^M = (\alpha-s)^2 2(2-\theta^{1/2})/\beta(4-\theta^{1/2})(8+2\theta^{1/2}-\theta)$, using the definition of product differentiation $\theta = \tau^2/\beta^2$. Evaluating at $\theta=1$, for perfect substitutes, yields, $\pi_{C-N}^M = (\alpha-s)^2 2/27\beta > 0$. Evaluating at $\theta=0$, independent demands, yields, $\pi_{C-N}^M = (\alpha-s)^2/8\beta$. Similarly, the expression for Bertrand competition at both stages can be written, after substituting the definition of product differentiation, as

$$\pi_{B-N}^M = [(\alpha-s)^2(2-\theta-\theta^{1/2})(2-\theta)]/[\beta(2-\theta+\theta^{1/2})(4-2\theta-\theta^{1/2})^2]$$

Evaluating at $\theta=1$, for perfect substitutes, yields $\pi_{B-N}^M = 0$. Evaluating at $\theta=0$, independent demands, yields $\pi_{B-N}^M = (\alpha-s)^2/8\beta$. Profits for manufacturers are higher for Cournot rather than Bertrand competition at the retail level for perfect substitutes; they are identical for independent demands.

Retailer Profits. Using the expression from Table 5 after substituting the definition of product differentiation for τ and τ^2 , $\pi_{C-N}^R = [(\alpha-s)^2 4/\beta(8+2\theta^{1/2}-\theta)^2]$. If $\theta=1$, perfect substitutes then, $\pi_{C-N}^R = (\alpha-s)^2/16\beta$; if $\theta=0$, independent demands, $\pi_{C-N}^R = (\alpha-s)^2/81\beta$.

For Bertrand competition, the retailer's profits are $\pi_{B-N}^R = [(\alpha-s)^2(2-\theta)^2(1-\theta^{1/2})]/[\beta(2-\theta^{1/2})^2(1+\theta^{1/2})(4-2\theta-\theta^{1/2})^2]$, after substituting for τ and simplifying. For perfect substitutes, $\theta=1$, $\pi_{C-N}^R=0$; for independent goods, $\theta=0$, $\pi_{B-N}^R = (\alpha-s)^2/16\beta$. As can see profits are identical for Bertrand and Cournot competition at the downstream stage if the demands are independent; for perfect substitutes, retailers earn higher profits from Cournot competition. QED.

X. References

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Chapter 3

Price Leadership and Resale Price Maintenance in a Perfect Equilibrium Model

3.1 Introduction

In this chapter, the vertical relationship between manufacturers and retailers is examined using the simple model of differentiated products introduced in Chapter 2. The model is used to address a number of issues in vertical control, particularly an analysis of the incentives for retail price leadership and resale price maintenance. In contrast to the special services argument, the model does not examine the role of pre-sale service but rather emphasizes the strategic elements in vertical relationships. The role of price restrictions at the retail level are examined in two ways, one by a retailer through price leadership, the second by the manufacturer through resale price maintenance, defined here as the manufacturer setting the retail price.

Despite the popularity of service argument, Telser thought it could only explain the use of RPM by a monopolist. In contrast, Telser's Manufacturing Cartel Theory has received much less attention. Telser argued that resale price maintenance may be used to maintain a cartel of manufacturers. That is, if price reductions at the retail level were prohibited, the incentives for manufacturers to reduce their price in hopes of obtaining higher sales would be eliminated. With an effective RPM policy, cutting price would only enrich retailers at the expense of the recalcitrant manufacturer. Telser's explanation has been criticized because

while it explains the use of resale price maintenance as a facilitating device it does not explain how the cartel agreement can be enforced.¹ It would appear necessary then to examine the relationship between manufacturers and retailers in order to outline clearly the incentives for vertical price restrictions.

In a perfect equilibrium framework, with two manufacturers and two retailers, I derive the optimal manufacturing prices and retail prices for two standard retail solution concepts: Bertrand-Nash and Price Leadership. The manufacturing prices are dependent upon the nature of competition at both stages. A "Vertical Separation" equilibrium is defined. It involves Bertrand-Nash competition at both levels which yields negligible profits for all players when goods are close substitutes. I show that for a range of differentiated products, price leadership at the retail level raises profits for both manufacturers and retailers over a "price war" equilibrium. The important assumption is that the products be relatively good substitutes. Resale price maintenance if part of a collusive arrangement can substitute for collusion on manufacturing prices. This may be viewed as a formalization of Telser's Cartel argument under certain information assumptions. Unilateral adoption by a manufacturer of RPM is never profitable in this model, if symmetry is assumed.

This chapter is organized as follows. Section 2 outlines the retail stage in which the nature of consumer demand is specified. In Sections 3 and 4, two retail solution concepts are considered, the Bertrand-Nash and the Price Leadership solutions. Sections 5 and 6 deal with the preceding stage in which manufacturers choose their prices noncooperatively and also discuss the solution concept for the two stage game. The optimal manufacturing prices for the Bertrand-Nash and Price Leadership equilibria at the retail level are subsequently derived. An important result is that manufacturers and retailers can *both* benefit from a *single*

¹. Overstreet (1983:22)

retail firm becoming a price leader.

Section 7 deals with resale price maintenance as a collusive agreement, outlining a number of propositions, the most important one showing that resale price maintenance can substitute for collusive price arrangements at the manufacturing level. Section 8 examines the profitability of a unilateral imposition of RPM by a manufacturer and finds that it is unprofitable, if symmetry is assumed.

3.2 Retail Stage: Bertrand-Nash and Price Leadership

For simplicity, the retail stage is modelled as a symmetric duopoly. Exclusive dealing is assumed, each retailer sells only the product associated with its manufacturer. Retailer i purchases a unit of the good at prices, m_i , and incurs a per unit selling cost, s_i , for $i=1,2$. These retail costs are necessary to sell the good but do not affect the demand curve.² It is also assumed that variable costs of production for manufacturers are zero and there are no fixed costs of production for retailers or manufacturers.

Demand is represented by a continuum of consumers of the same type with a utility function separable and linear in the numeraire good. The representative consumer maximizes

$W = U(q_1, q_2) - \sum p_i q_i$, $i=1,2$ where q_i is the amount of good i and p_i its price. U is assumed to be quadratic and strictly concave of the following form³:

². This model, therefore, is not examining the role of special services or quality certification.

³. See Singh and Vives (1984:547-548) for their discussion of this model. A more complete description of the model is available in Chapters 1 and 2 of this thesis. A model similar to the one used here can be found in Levitan and Shubik (1980).

$$U(q_1, q_2) = \alpha_1 q_1 + \alpha_2 q_2 - (\beta_1 q_1^2 + 2\tau q_1 q_2 + \beta_2 q_2^2)/2 \quad (1)$$

where α_i and β_i are positive, $i=1,2$, and $\beta_1\beta_2-\tau^2 > 0$, and $\alpha_i\beta_j-\alpha_j\tau > 0$ for $i=1, j=2$. An attractive feature of this utility function is that it yields linear demand curves. In inverse form they are,

$$p_1 = \alpha_1 - \beta_1 q_1 - \tau q_2 \quad (2)$$

$$\text{and} \quad p_2 = \alpha_2 - \tau q_1 - \beta_2 q_2 \quad (3)$$

Solving these two expressions for the quantities yields

$$q_1 = [\beta_2(\alpha_1 - p_1) - \tau(\alpha_2 - p_2)]/\sigma \quad (4)$$

$$q_2 = [\beta_1(\alpha_2 - p_2) - \tau(\alpha_1 - p_1)]/\sigma \quad (5)$$

(with $\sigma = \beta_1\beta_2 - \tau^2$) in the region of quantity space where prices are positive. Denoting $a_i = (\alpha_i\beta_j - \alpha_j\tau)/\sigma$ for $i=1, j=2$ and $c = \tau/\sigma$, $b_1 = \beta_2/\sigma$, $b_2 = \beta_1/\sigma$ (where a_i and b_i are positive, by assumption), the direct demand functions can be written as

$$q_1 = a_1 - b_1 p_1 + c p_2 \quad (4')$$

$$q_2 = a_2 - b_2 p_2 + c p_1 \quad (5')$$

provided that both quantities are positive.

Since many of the results depend on the parameter τ , expressions (4) and (5) rather than the corresponding expressions (4') and (5') will be used in the subsequent analysis.

Goods are substitutes, complements or independent, depending on whether τ is greater, less than, or equal to 0. For some of the analysis, the nature of the goods will be categorized over a zero-one interval. For example, when $\alpha_1 = \alpha_2$, the expression $\theta = \tau^2 / (\beta_1 \beta_2)$ characterizes the degree of product differentiation, $\theta = 0$ representing independent goods, $\theta = 1$ when the goods are perfect substitutes. An attractive feature of this latter approach is that many of the results are independent of the magnitudes of τ , and β_1 and β_2 .

Retailers select p_i to maximize profits defined as $\pi_i^R = (p_i - m_i - s_i)q_i$ for $i=1,2$. Two specific equilibria at the retail level, Bertrand-Nash and Price Leadership are outlined in the next section.

3.21 Retail Market Equilibrium: Bertrand-Nash Competition

For Bertrand-Nash competition, each retailer chooses a price to maximize

$$\pi_i = [p_i - (m_i + s_i)] q_i, \text{ for } i=1,2 \quad (6)$$

where p_i is the retail price for firm i , m_i is the manufacturing price set by firm i , s_i the selling cost of retail firm i , and q_i is the quantity sold by retailer i .

The first order conditions for $i=1,2$ are the following, assuming Bertrand-Nash conjectures, $\partial p_i / \partial p_j = 0$, and $\partial p_j / \partial p_i = 0$.

$$\partial \pi_1 / \partial p_1 = [p_1 - (m_1 + s_1)] \partial q_1 / \partial p_1 + q_1 = 0 \quad (7)$$

$$\partial \pi_2 / \partial p_2 = [p_2 - (m_2 + s_2)] \partial q_2 / \partial p_2 + q_2 = 0 \quad (8)$$

Using (4) and (5) to determine $\partial q_1/\partial p_1$ and $\partial q_2/\partial p_2$, and substituting for q_1 and q_2 , we obtain

$$\partial \pi_1/\partial p_1 = [p_1 - (m_1 + s_1)](-\beta_2)/\sigma + [\beta_2(\alpha_1 - p_1) - \tau(\alpha_2 - p_2)]/\sigma \quad (9)$$

$$\partial \pi_2/\partial p_2 = [p_2 - (m_2 + s_2)](-\beta_1)/\sigma + [\beta_1(\alpha_2 - p_2) - \tau(\alpha_1 - p_1)]/\sigma \quad (10)$$

These first order conditions can be rearranged to obtain retail reaction functions:

$$p_1 = (\alpha_1 + m_1 + s_1)/2 - \alpha_2\tau/2\beta_2 + \tau p_2/2\beta_2 \quad (9')$$

$$p_2 = (\alpha_2 + m_2 + s_2)/2 - \alpha_1\tau/2\beta_1 + \tau p_1/2\beta_1 \quad (10')$$

Since τ , β_1 , β_2 are positive, the reaction functions have positive slopes.⁴ The Bertrand-Nash equilibrium can be represented by the intersection of these reaction functions, denoted R1 for retailer 1 and R2 for retailer 2. This equilibrium is illustrated as point N in figure 1. It is a function of the parameters of the utility function, manufacturing prices and costs of production. Given the intercepts of the reaction functions (9') and (10'), it is clear that manufacturers could shift these curves and alter the equilibrium outcome through their choice of manufacturing prices if desired.

The determination of the equilibrium manufacturing prices will be addressed in the next section; however, it is useful at this stage to solve for the equilibrium Bertrand-Nash prices. Solving (9') and (10') simultaneously for the symmetric equilibrium, setting, $\beta_1 = \beta_2 = \beta$.

⁴. See chapter 2 for a discussion of the relationship between product differentiation and the position and slopes of the reaction functions.

$$P_1^{N*} = [2\beta^2(\alpha_1 + s_1 + m_1) + \tau\beta(m_2 + s_2 - \alpha_2) - \alpha_1\tau^2]/\Phi \quad (11)$$

$$P_2^{N*} = [2\beta^2(\alpha_2 + m_2 + s_2) + \tau\beta(m_1 + s_1 - \alpha_1) - \alpha_2\tau^2]/\Phi \quad (12)$$

where $\Phi = 4\beta^2 - \tau^2$

It is straightforward to determine what happens to these prices for two extreme cases.⁵ For independent goods, $\theta=0$, the Bertrand-Nash price is $P_1^{N*} = (\alpha_1 + m_1 + s_1)/2$ which is the monopoly retail price. For perfect substitutes, $\theta=1$, and if symmetry is assumed ($m_1=m_2=m$, and $s_1=s_2=s$), the Bertrand-Nash price is $P_1^{N*} = m+s$. That is, with identical goods and symmetry, the retail price is merely equal to the sum of the retailer's unit costs.

For completeness, the Bertrand-Nash quantities can also be derived by substituting the prices (11) and (12) into the expressions (4) and (5).

$$q_1^{N*} = [\alpha(\beta - \tau)(2\beta^2 + \tau\beta) - \beta(m_1 + s)(2\beta^2 - \tau^2) + \beta^2\tau(m_2 + s)]/\sigma\Phi \quad (13)$$

$$q_2^{N*} = [\alpha(\beta - \tau)(2\beta^2 + \tau\beta) - \beta(m_2 + s)(2\beta^2 - \tau^2) + \beta^2\tau(m_1 + s)]/\sigma\Phi \quad (14)$$

3.22 The Retail Market Equilibrium: Price Leadership

In this section, price leadership by one retailer is considered. In contrast to the simultaneous choice Bertrand-Nash equilibrium, a Price Leadership equilibrium involves one retailer incorporating the reaction function of the other retailer in its pricing decision. Price leadership is essentially a self-imposed price floor for a retailer. An equilibrium where retailer 1 is the price leader as well as a representative profit function for retailer 1 is

⁵. To determine what happens to the Bertrand-Nash prices for independent goods and perfect substitutes, substitute for $\tau^2 = \beta^2\theta$, and $\tau = \beta\theta^{1/2}$, in (11) and (12) and evaluate at $\theta=0$ for independent goods, and $\theta=1$ for perfect substitutes. See Appendix 1 for the expression.

depicted in figure 1 as point L*.⁶

It is important to note that the position of the reaction functions are determined by manufacturing prices which are themselves determined by the nature of the game played at the retail level. This means that it is not possible in a two stage game to simply compare the respective equilibria by observing the price leadership result on the reaction functions for the case of Bertrand-Nash competition at the retail level. In general, the prices chosen by manufacturers may not be the same if they are aware of the nature of the retail equilibrium. Therefore figure 1 applies only to the case of identical manufacturing prices for the two equilibria.

Formally, firm 1, the price leader, chooses p_1 to maximize $\pi_1 = (p_1 - m_1 - s_1) q_1$,

$$\partial \pi_1 / \partial p_1 = (p_1 - (m_1 + s_1)) \partial q_1 / \partial p_1 + q_1 = 0 \quad (15)$$

where $\partial q_1 / \partial p_1 = -\beta / \sigma + \tau (\partial p_2 / \partial p_1) / \sigma$. Substituting $\partial p_2 / \partial p_1 = \tau / 2\beta$ by using (10'), yields

$$\partial \pi_1 / \partial p_1 = (p_1 - (m_1 + s_1)) [-2\beta^2 + \tau^2] / 2\beta + q_1 = 0 \quad (16)$$

or, rearranging

$$p_1 = [(2\beta^2 - \tau^2)(m_1 + s_1) + 2\beta^2 \alpha_1 + 2\beta \tau (p_2 - \alpha_2)] / (4\beta^2 - \tau^2) \quad (16')$$

which when solved with (10) yields the Price Leadership equilibrium.

⁶. The Price Leadership equilibrium studied here is the one in which the isoprofit contour for retailer one is tangent to the reaction function of retailer two.

$$P_1^{L*} = (\alpha_1 + m_1 + s_1)/2 + \tau\beta(m_2 + s_2 - \alpha_2)/(2H) \quad (17)$$

$$P_2^{F*} = \tau(m_1 + s_1 - \alpha_1)/4\beta + [(m_2 + s_2)\Phi + \alpha_2 G]/4H \quad (18)$$

where $H=2\beta^2-\tau^2$; $\Phi=4\beta^2-\tau^2$; and $G=4\beta^2-3\tau^2$

The location of the initial Nash equilibrium and subsequent price leadership equilibrium is dependent on the degree of product differentiation. However, the two equilibria are equivalent if demands are independent or the goods are perfect substitutes. For independent goods $\theta=0$, retail prices are the simple monopoly prices $P_1^{L*}=(\alpha_1+m_1+s)/2$ and $P_2^{F*}=(\alpha_2+m_2+s)/2$. For perfect substitutes, $\theta=1$, and assuming symmetry of s , $P_1^{L*}=(m_1+s)/2 + (m_2+s)/2$, and $P_2^{F*}=(m_1+s)/4 + 3(m_2+s)/4$. Furthermore, if symmetry in manufacturing prices is assumed $m_1=m_2=m$, then $P_1^{L*}=m+s$ and $P_2^{F*}=m+s$. These are both equivalent to the Bertrand-Nash prices for these two extreme cases.

For intermediate ranges of product differentiation, $0<\theta<1$, the Nash equilibrium and the price leadership solution differ significantly.⁷ Furthermore, the location of the reaction functions for the Bertrand-Nash equilibrium will not necessarily be the same for the price leadership equilibrium. The precise nature of their relationship will be outlined in the context of the full equilibrium to the two stage game derived in the next section, where the equilibrium noncooperative manufacturing prices will be derived given the two retail equilibria. Subsequently, the profits of manufacturers and retailers for these two equilibria will be compared to determine whether price leadership at the retail level would be profitable for a manufacturer.

⁷. See Appendix 1 for these expressions in terms of the product differentiation parameter.

3.4 The Manufacturing Stage: Vertical Separation Equilibrium

In this section, the equilibrium for Bertrand-Nash competition at both stages, which can be called the Vertical Separation equilibrium, is derived.⁸ At the manufacturing stage, firms choose prices noncooperatively to maximize, $\pi_i^M = m_i q_i$, where m_i is the manufacturing price for firm i . With no loss in generality, the constant marginal costs of production and fixed costs at the manufacturing level are set to zero.

The first order conditions for the optimal choice of m_i for $i=1,2$ are the following.

$$\partial \pi_1^M / \partial m_1 = m_1 \partial q_1 / \partial m_1 + q_1 = 0 \quad (19)$$

$$\partial \pi_2^M / \partial m_2 = m_2 \partial q_2 / \partial m_2 + q_2 = 0 \quad (20)$$

The solution to this problem requires the derivatives $\partial q_1 / \partial m_1$, and $\partial q_2 / \partial m_2$ and the quantities q_1 and q_2 . It is assumed that manufacturers anticipate correctly the nature of the competition at the retail level which means that if retailers are Bertrand-Nash competitors, the quantities q_1^N and q_2^N given by (13) and (14) are substituted into (19) and (20). For the derivatives, the demand functions (4) and (5) are used, evaluated at the Bertrand-Nash prices (11) and (12). These are listed below.

$$\partial q_1^N / \partial m_1 = -[\beta \partial P_1^N / \partial m_1 - \tau \partial P_2^N / \partial m_1] / \sigma \quad (21)$$

$$\partial q_2^N / \partial m_2 = -[\beta \partial P_2^N / \partial m_2 - \tau \partial P_1^N / \partial m_2] / \sigma \quad (22)$$

⁸. This is the terminology used by Bonnano and Vickers (1988).

Using (11) and (12), the following derivatives can be evaluated; $\partial P_1^N/\partial m_1 = 2\beta^2/\Phi$, $\partial P_2^N/\partial m_1 = \tau\beta/\Phi$ and $\partial P_2^N/\partial m_2 = 2\beta^2/\Phi$, and $\partial P_1^N/\partial m_2 = \tau\beta/\Phi$, where $\Phi = 4\beta^2 - \tau^2$.⁹ Substituting these expressions into (21) and (22) and then into (19) and (20) yields the reaction functions for both manufacturers.

$$m_1 = (\alpha - s)(2\beta^2 - \tau^2 - \tau\beta)/2H + \tau\beta m_2/2H \quad (23)$$

$$m_2 = (\alpha - s)(2\beta^2 - \tau^2 - \tau\beta)/2H + \tau\beta m_1/2H \quad (24)$$

where $H = 2\beta^2 - \tau^2$

These expressions can also be rewritten in terms of the definition of product differentiation¹⁰, $\theta = \tau^2/\beta^2$.

$$m_1 = [(\alpha - s)(2 - \theta - \theta^{1/2}) + \theta^{1/2} m_2]/2(2 - \theta) \quad (23')$$

$$m_2 = [(\alpha - s)(2 - \theta - \theta^{1/2}) + \theta^{1/2} m_1]/2(2 - \theta) \quad (24')$$

Expressions (23') and (24') reveal that the position and slopes of the reaction functions of both manufacturers are dependent on the costs, willingness to pay parameter, and the degree of product differentiation. Two cases are illustrated in figures 2(a) and 2(b), where reaction functions for good substitutes (high θ) and poor substitutes (low θ) are presented.¹¹ As the demands become more independent, low θ , the intercepts become

⁹. Alternatively, the Bertrand-Nash quantities given by expressions (13) and (14), and the corresponding derivatives $\delta q_1^N = [-\beta(2\beta^2 - \tau^2)]/\Phi$ and $\delta q_2^N = [-\beta(2\beta^2 - \tau^2)]/\Phi$ can be substituted into the first order conditions (19) and (20).

¹⁰. Substitute using the definition $\theta = \tau^2/\beta^2$ for τ and τ^2 and cancel terms.

¹¹. The values of the parameters underlying the construction of figures 2(a) and 2(b) are as follows. Highly differentiated goods are given a measure of $\theta = .8$, low differentiated goods $\theta = .2$. The other parameters are $\alpha = 20$ and $s = 1$.

larger and the slopes become smaller. When $\theta=0$, the case of independent goods, the reaction functions are perpendicular at the values $(\alpha-s)/2$. These are the prices set by monopolists at the manufacturing level.

Solving (23) and (24) simultaneously yields m^{N*} the optimal manufacturing price.¹²

$$m^{N*} = [(\alpha-s)(2\beta^2-\tau^2-\tau\beta)]/(4\beta^2-2\tau^2-\tau\beta) \quad (25)$$

or in terms of the product differentiation parameter

$$m^{N*} = [(\alpha-s)(2-\theta-\theta^{1/2})]/(4-2\theta-\theta^{1/2}) \quad (25')$$

It is clear from the solution (25') that the optimal manufacturing prices are dependent on the degree of product differentiation, the parameter α and selling costs. However, an interesting feature of the result is that the manufacturing prices for Bertrand-Nash competition at the retail level are independent of β , the slope of the individual demand curves. When $\theta=0$ (independent goods) $m_1^{N*}=(\alpha-s)/2$ and $m_2^{N*}=(\alpha-s)/2$ are the manufacturing prices set by monopolist manufacturers. When $\theta=1$, (identical goods) $m_1^{N*}=0$ and $m_2^{N*}=0$ are the optimal two stage manufacturing prices which are equal to the manufacturer's marginal cost. In general, it can be shown that $\partial m_i^{N*}/\partial \theta < 0$, for $i=1,2$, that is the manufacturing prices fall as the goods become closer substitutes.¹³ That is, as θ

¹². It is important to remember this is the optimal manufacturing price which results from Bertrand-Nash competition at both the retail and manufacturing level.

¹³. Using (25') and taking the derivative, which equals $\partial m^{N*}/\partial \theta = -[(\alpha-s)2(1+1/2\theta^{1/2})]/(4-\theta-\theta^{1/2})^2$. This is less than zero since the denominator is positive, for $0 \leq \theta \leq 1$.

increases, Bertrand-Nash competition reduces the markup on manufacturing prices as the differentiation between the goods diminishes.

Now that the equilibrium manufacturing prices are determined, the complete Vertical Separation equilibrium can be obtained.

Vertical Separation Equilibrium

$$\begin{aligned}
 m^{N*} &= [(\alpha-s)(2\beta^2-\tau^2-\tau\beta)]/\epsilon \\
 p^{N*} &= [\alpha(\beta-\tau) + \beta(s+m)]/(2\beta-\tau) \\
 q^{N*} &= [(\alpha-s)\beta H]/[(2\beta^2+\beta\tau-\tau^2)\epsilon] \\
 \pi_M^{BN} &= [(\alpha-s)^2\beta(2\beta^2-\tau^2-\tau\beta)H]/(2\beta^2+\beta\tau-\tau^2)\epsilon^2 \\
 \pi_R^{BN} &= [(\alpha-s)^2\beta(\beta-\tau)H^2]/(2\beta-\tau)(2\beta^2+\beta\tau-\tau^2)\epsilon^2 \\
 &\text{where } \epsilon = (4\beta^2-2\tau^2-\tau\beta), H = 2\beta^2-\tau^2
 \end{aligned}$$

Table 1

3.4 Manufacturing Stage: Price Leadership by One Retailer

In this section, the effect on the manufacturing stage game of price leadership at the retail level will be examined. That is, suppose that retailer 1 becomes a price leader, incorporating the reaction function of retailer 2 in its pricing decision. Furthermore, suppose that both manufacturers anticipate correctly that the retail stage will be a Price Leadership equilibrium and also choose their manufacturing prices noncooperatively.¹⁴

Each manufacturer chooses m_i , $i=1,2$, to maximize $\pi_i^M = m_i q_i$. The first order

¹⁴. The model considered here is a two stage model of price leadership. It is acknowledged that this game may be part of a larger game in which the leader-follower decision is made.

conditions are with firm 1 being the price leader at the retail level.

$$\partial \pi_1^M / \partial m_1 = m_1 \partial q_1 / \partial m_1 + q_1 = 0 \quad (26)$$

$$\partial \pi_2^M / \partial m_2 = m_2 \partial q_2 / \partial m_2 + q_2 = 0 \quad (27)$$

Substituting (17) and (18) into (4) and (5) to obtain q_1^{L*} and q_2^{F*} and then taking the required derivatives $\partial q_1^{L*} / \partial m_1$ and $\partial q_2^{F*} / \partial m_2$ and then substituting into (26) and (27) yields manufacturer reaction functions, recalling that manufacturer 1 is selling to the retail price leader.

$$m_1 = (\alpha - s)(2\beta^2 - \tau^2 - \tau\beta) / 2H + \tau\beta m_2 / 2H \quad (28)$$

$$m_2 = (\alpha - s)(\beta G - \tau H) / 2\beta G + \tau H m_1 / 2\beta G \quad (29)$$

where $H = 2\beta^2 - \tau^2$; $G = 4\beta^2 - 3\tau^2$.

Solving (28) and (29) simultaneously yields the optimal manufacturing prices for the Price Leadership equilibrium.

$$m_1^{L*} = (\alpha - s)(2GH - \tau^2 H - \tau\beta G) / H(4G - \tau^2) \quad (30)$$

$$m_2^{F*} = (\alpha - s)(2\beta G - \beta\tau^2 - \tau H) / \beta(4G - \tau^2) \quad (31)$$

To avoid confusion, recall that the superscripts refer to the nature of the retail competition, not the nature of the manufacturing game. Manufacturers are still Bertrand-

Nash competitors; only the respective retail competition has changed.

Expressions (30) and (31) can be rewritten in terms of the product differentiation parameter $\theta = \tau^2/\beta^2$.¹⁵ Both manufacturing prices are zero for perfect substitutes, both equal $(\alpha-s)/2$ for independent goods which is the manufacturing price set by a monopolist manufacturer.

Using the equilibrium manufacturing prices, m_1^{L*} and m_2^{F*} , the retail prices can be obtained by using (17) and (18). Substituting the equilibrium retail prices into (4) and (5) yields the quantities sold by the two firms. Subsequently, the profits for the manufacturers and retailers can also be determined. The complete equilibrium is listed below.

Retail Price Leadership Equilibrium

$$\begin{aligned}
 m_1^{L*} &= (\alpha-s)(2GH-\tau^2H-\tau\beta G)/H(4G-\tau^2) \\
 m_2^{F*} &= (\alpha-s)(2\beta G-\beta\tau^2-\tau H)/\beta(4G-\tau^2) \\
 P_1^{L*} &= (\alpha+m_1+s)/2 + \tau\beta(m_2+s-\alpha)/[2H] \\
 P_2^{F*} &= \tau(m_1+s-\alpha)/4\beta + [(m_2+s)\Phi + \alpha G]/4H \\
 q_1^{L*} &= (\alpha-s)(2GH-\tau^2H-\tau\beta G)/[4\beta\sigma(4G-\tau^2)] \\
 q_2^{F*} &= (\alpha-s)(2\beta G-\beta\tau^2-\tau H)G/[4\sigma H(4G-\tau^2)] \\
 \pi_1^{M_L*} &= (\alpha-s)^2(2GH-\tau^2H-\tau\beta G)^2/E \\
 \pi_2^{M_F*} &= (\alpha-s)^2(2\beta G-\beta\tau^2-\tau H)^2G/E \\
 \pi_1^{R_L*} &= (\alpha-s)^2(2GH-\tau^2H-\tau\beta G)^2/2E \\
 \pi_2^{R_F*} &= (\alpha-s)^2(2\beta G-\beta\tau^2-\tau H)^2G^2/4HE \\
 \text{where } \sigma &= \beta^2-\tau^2, H=2\beta^2-\tau^2, G=4\beta^2-3\tau^2, E=4\beta\sigma H(4G-\tau^2)^2
 \end{aligned}$$

Table 2

In the next section, a comparison of the Vertical Separation and Price Leadership equilibria will be made.

¹⁵. See Appendix 1 for these expressions in terms of the product differentiation parameter.

3.5 A Comparison of the Price Leadership and the Vertical Separation Outcomes

(i) Manufacturing Prices

In this section, a comparison between the manufacturing prices in the two outcomes is made. To aid us in this task, I use the respective reaction functions for the manufacturers in the two outcomes. That is, how are the reaction functions, in manufacturing space, affected by a price leader-follower equilibrium at the retail level? A somewhat surprising result is that the reaction function for manufacturer 1 *does not* change when its retailer becomes a price leader. In this model, the reaction function for manufacturer 1 for the Bertrand equilibrium at the retail stage (23) remains the same when its retailer becomes a price leader (28). The intuition is that the retail equilibrium is still on the second retailer's reaction function; the retailer has not altered the nature of its response. Therefore, its manufacturer still responds in the same manner.

The simplest approach to a comparison of the equilibrium manufacturing prices would involve a direct examination of m^{N*} and m_1^{L*} and m_2^{F*} . For the model used in this chapter, no direct analytic comparison is possible between the manufacturing prices in the two equilibria. Therefore a more indirect method will be used.

First, a simple comparison will be made between m_1^{L*} and m_2^{F*} .

Proposition 1. The manufacturing price for the retail price leader (m_1^L) is lower than the manufacturing price for the retail price follower (m_2^F) for intermediate ranges of product differentiation.

Proof: see Appendix II.

Given Proposition 1, we know that $m_1^{L*} < m_2^{F*}$. What would also be of interest would be their relationship to m^{N*} .

Proposition 2. The manufacturing prices for the retail price follower and retail price leader, m_1^{L*} and m_2^{F*} , are higher than the manufacturing prices for Bertrand-Nash competition between retailers, m^{N*} , for intermediate degrees of product differentiation, $0 < \theta < 1$.

The proof of this proposition makes use of figure 3(a). In the figure is a dotted line which is the locus of all symmetric outcomes. The area above the line gives the set of all equilibria where $m_1^{L*} > m_2^{F*}$; the area below the line the set of all equilibria where $m_1^{L*} < m_2^{F*}$. Given proposition 1 we know that $m_1^{L*} < m_2^{F*}$; therefore the intersection must be below the symmetry line. Since the reaction function of the first manufacturer (R1) doesn't change, this means the intersection is on R1 below the line. Also of importance to the proof is the slope of the reaction function for manufacturer 1, R1. The slope defined as the ratio $\tau\beta/2H$ from (28) is positive because all parameters are greater than zero for the case of strategic complements. In this case then, by inspection, both manufacturer prices are above the Bertrand-Nash result. QED.

The equilibrium depicted in figure 3(a) is not the only diagram consistent with Propositions 1 and 2. For example, it is possible that the reaction function for the second manufacturer R2F shifts up and becomes flatter as retailer 1 becomes a price leader. To show that figure 3(a) is the correct illustration of the equilibrium, use will be made of the respective reaction functions for the manufacturers in the two games. As discussed, the reaction function for manufacturer 1, R1, remains unchanged in the two games.

$$R_2 = m_1 = -(\alpha-s)(H-\tau\beta)/\tau\beta + 2Hm_2/\tau\beta \quad (24')$$

$$R_1 = m_1 = (\alpha-s)(2\beta-\tau^2-\tau\beta)/2H + \tau\beta m_2/2H \quad (28')$$

$$R_2^F = m_1 = -(\alpha-s)[\beta G-\tau H]/H\tau + [2\beta G m_2]/H\tau \quad (29')$$

Using (24') and (29'), define the slope of the second manufacturer's reaction function for Bertrand-Nash competition as $S_N = 2H/\tau\beta$ and the corresponding slope when its retailer is a Price Follower as $S_F = (2\beta G)/H\tau$. Forming the ratio S_F/S_N , and expressing it in terms of the product differentiation parameter and cancelling terms yields the condition that the reaction function of the second manufacturer becomes steeper if $S_F/S_N = \theta(1-\theta) > 0$. Since $0 < \theta < 1$ for intermediate ranges of product differentiation, the slope of the reaction function for the second manufacturer becomes steeper when its retailer becomes a price follower rather than a Bertrand-Nash competitor. Similarly the intercepts of the two reaction functions (24') and (29') can be compared. Taking the ratio of the intercept of follower's reaction to the intercept of the Nash reaction function (in absolute value terms) yields the relationship that the reaction function for the second manufacturer shifts down when its retailer becomes a price follower if $[\beta(BG-\tau H)]/[H(H-\tau\beta)] > 1$. Substituting for the expressions and cancelling terms yields the condition that the intercept for the follower equilibrium is greater (in absolute value terms) if $\theta(1-\theta) > 0$, which is true since $0 < \theta < 1$.

It has been shown that both manufacturing prices, m_1^{L*} and m_2^{F*} are higher than the Bertrand-Nash prices, m^{N*} for all intermediate ranges of product differentiation, $0 < \theta < 1$, with the manufacturing price of the price follower being higher. This is illustrated in figure 3(b). Unlike the above proof which compares manufacturing prices between the vertical separation and price leadership equilibria, no simple analytic proof is possible for the respective retail prices or profits for manufacturers and retailers. Therefore, a global search over the entire range of product differentiation was undertaken to compare the equilibrium retail prices for the two equilibria.¹⁶ The comparisons are summarized below.

(ii) Retail Prices

Both retail prices, P_1^L and P_2^F are higher than the Bertrand-Nash retail prices, P^N , for all intermediate ranges of product differentiation, $0 < \theta < 1$. In addition, the retail price for the price leader P^L is higher than the retail price for the price follower P^F . This comparison is depicted in figure 4. The price leader sells fewer units than the Nash quantities, the price follower more.

However, the most important comparison is between the profits of manufacturers and retailers.

(iii) Profits of Manufacturers

Here we consider what happens to the respective profits of manufacturers for

¹⁶. For the global search, the parameters used were $\alpha=20$, $s=1$ and $\beta=5$. The measure of product differentiation $\theta=\tau^2/\beta^2$ ranged from 0 for independent demands to 1 for perfect substitutes.

various degrees of product differentiation. An important feature of the model used here is that the ratio of profits for the two equilibria is independent of any parameter other than θ , the measure of product differentiation. This means that a comparison of manufacturer profits for Retail Price Leadership and Vertical Separation, can be made for different degrees of product differentiation.

Using the expression in Appendix I, when $\theta=0$ all profits are equal to $(\alpha-s)^2/8\beta$, when $\theta=1$ all profits are zero. For intermediate degrees of product differentiation, the profits of the manufacturer whose retailer is a price leader also equals the vertical separation result when $\theta^*=.925$. This is solved numerically and is independent of any other parameters of the model. The profit comparison for manufacturers under both equilibria are depicted in figures 5(a) and 5(b). For $\theta < \theta^*$, a manufacturer earns higher profits from Bertrand-Nash competition at the retail level than if its retailer is a price leader. For θ greater than θ^* , price leadership by its retailer yields higher profits for the manufacturer than if its retailer is a Bertrand-Nash competitor. The intuition is that price leadership by a retailer becomes more important as the goods become relatively close substitutes. This restrains the adverse effect of price competition which raises profits for the manufacturer of the retail price leader.

Also of interest is the effect of price leadership by one retailer on the respective profits of the price follower. The manufacturing firm of the price follower earns higher profits under price leadership than under the Bertrand-Nash result. To complete the comparisons, we must investigate the respective profits earned by retailers under the two retail equilibria.

(iv) Profits of Retailers

In this model, the profits of retailers, like the profits of manufacturers, are independent of the size of β , the slope of the demand curve. Only the relationship of β to τ , in the expression $\theta = \tau^2/\beta^2$, is important in examining the role of product differentiation on profits. Comparing the profits of the retail price leader with the Bertrand-Nash result shows that the retail price leader always earns more profits for intermediate ranges of product differentiation. In addition, the retailer who is a price follower also earns more profits than the Bertrand-Nash result for intermediate ranges of product differentiation. This comparison is illustrated in figure 6.

The important conclusion is that there are possible gains for all manufacturers and retailers if one retailer engages in price leadership. Players other than the manufacturer of the retail price leader always gain from price leadership for intermediate ranges of product differentiation. The other manufacturer also gains when the products are relatively close substitutes.

The intuition for this result is as follows. Price leadership at the retail level restrains the price from falling to the Bertrand-Nash price at the retail level. This prevents manufacturers from being drawn into a price war which would result in few profits for both manufacturers and retailers when the products are relatively good substitutes. Essentially, a preferred noncooperative equilibrium is attained at the manufacturing level because the retail equilibria has provided a break to the destructive output expansion associated with Bertrand-Nash competition, especially when goods are almost identical. The perfect equilibrium assumption and noncooperative behaviour at the manufacturing level drives the result.

However, when the demands for the goods are more independent, $\theta < \theta^*$, the

manufacturer of the retail price leader earns fewer profits than if the retail competition was Bertrand-Nash and also fewer profits than the manufacturer of the retail price follower. While the manufacturing price is lower to the retailer who is a price leader, the retail price is *higher* than the corresponding retail price for the follower. The higher retail price provides a pecuniary benefit to the other manufacturer.

In the next section, this result is contrasted with the case where the impetus for the price restraint originates with a manufacturer.

3.6 Collusive Resale Price Maintenance

In outlining possible explanations for resale price maintenance, Lester Telser (1960) offered two theories, the Special Service argument, and the Manufacturing Cartel Theory. Telser argued the Special Service argument explains the use of resale price maintenance by one manufacturer, but could not explain why a group of competing manufacturers would support this policy.¹⁷ To explain this possibility, Telser formulated a Cartel Theory in which resale price maintenance was used as a device to aid cartel stability. Retailers were prohibited from reducing price below the agreed upon price, removing the incentive for manufacturers to cut their price in hopes of selling an increased share of the market. Telser argued that a necessary element of this explanation was exclusive dealing, that each retailer handled only the brand of one manufacturer.¹⁸ Otherwise, manufacturers could

¹⁷. See Telser (1960:96)

¹⁸. See Telser (1960:97)

still bribe retailers to give their product special treatment.

In this section, I examine these arguments in a formal model outlining the specific conditions required for this result. In addition to the assumptions of exclusive dealing and monopoly power on the part of manufacturers, I will assume that manufacturers know that the retail equilibrium will be Bertrand-Nash competition.

To show that colluding on resale price maintenance can be equivalent to colluding on m , the manufacturing price, I will first derive the latter result.¹⁹

(i) Colluding on the manufacturing price

Colluding manufacturers will choose m_1 and m_2 to maximize joint profits, or

$$\pi^T = m_1 q_1 + m_2 q_2$$

where all costs, fixed and variable have been set equal to zero.

The first order conditions are

$$\partial \pi^T / \partial m_1 = m_1 \partial q_1 / \partial m_1 + q_1 + m_2 \partial q_2 / \partial m_1 = 0 \quad (32)$$

$$\partial \pi^T / \partial m_2 = m_1 \partial q_1 / \partial m_2 + m_2 \partial q_2 / \partial m_2 + q_2 = 0 \quad (33)$$

Now, in general the solution to this problem will depend on the form of q_1 and q_2 , the nature of the demand curve. However, for the linear formulation given by (4) and (5), it has been shown²⁰ that the respective solution to (32) and (33) is invariant to the nature of the downstream competition. This is presented below.

¹⁹. A more extensive discussion of the case of manufacturers colluding on m can be found in Chapter 2 of this thesis.

²⁰. See Chapter 2, for proof of this proposition.

$$m^C = (\alpha - s)/2$$

where α is the willingness to pay from the utility function and s is the per unit selling cost. Depending on the nature of the downstream competition, collusion, Cournot, or Bertrand, the retail prices can subsequently be determined.

Suppose, the downstream competition was Bertrand-Nash. The Nash prices are given as $P^{N*} = [(\alpha + m + s)\beta - \alpha\tau] / (2\beta - \tau)$, where upon substitution of $m = (\alpha - s)/2$ yields $P^{N*} = [\alpha(3\beta - \tau) + s\beta] / 2(2\beta - \tau)$. Substituting into the demand function $q^* = (\alpha - P^N) / (\beta + \tau)$ yields $q^* = [\beta(\alpha - s)] / 2(2\beta - \tau)(\beta + \tau)$ and manufacturer profits of $\pi = [\beta(\alpha - s)^2] / 4(\beta + \tau)(2\beta - \tau)$.

(ii) Colluding on RPM

Given the preceding result, the question will be whether manufacturers can obtain the same outcome by colluding on RPM. That is, what conditions are required for RPM to replicate the outcome of collusion on the manufacturing price as claimed by Telser (1960)?

While what constitutes resale price maintenance is a matter of dispute²¹, for the analysis considered here I will make the following assumptions. First, manufacturers choose the retail prices collusively and second, manufacturers assume that the retail prices are related to the manufacturing prices by the Bertrand-Nash markup. In other words, there will be a divergence between the manufacturing price and retail price if the products are heterogenous.²² The first assumption generally incorporates a price ceiling and a price floor;

²¹. RPM is variously thought of as manufacturers setting the manufacturing and retail price, or manufacturers setting a price floor. See Tirole (1989:177) for a discussion of this point.

²². Tirole (1989) defines RPM as the manufacturer setting the manufacturer and retail price. This case is considered in Chapter 4 of this thesis. Telser (1960) considered RPM to be a price floor. See Chapter 1 of this thesis for a more extensive discussion of this point.

however, it is possible to relax this assumption to a price floor if it can be shown that there is no incentive for the retailers to raise price. The second assumption is much less straightforward. Given the information structure of the model, manufacturers know that the retail prices that obtain will affect the manufacturing prices that can be achieved. If manufacturing prices can be set along with retail prices then no discretion is left at the retail level. However, if that is not possible then a "wedge" will remain between the manufacturing prices and retail prices. To close the model, I make the assumption that manufacturers anticipate, correctly, that retail prices will be marked-up over manufacturing prices according to Bertrand-Nash competition.

The assumption that manufacturers know that retail prices are related to manufacturing prices by Bertrand-Nash competition implies that collusive manufacturers can invert (11) and (12) to obtain the equilibrium manufacturing prices conditional on the equilibrium retail prices.

$$m_1 = 2P_1 - \tau P_2/B + \alpha \tau/B - \alpha - s \quad (34)$$

$$m_2 = 2P_2 - \tau P_1/B + \alpha \tau/B - \alpha - s \quad (35)$$

Now the collusive RPM case can be considered. In this case, manufacturers choose retail prices P_1 and P_2 to maximize joint profits,

$$\pi^T = m_1 q_1 + m_2 q_2$$

subject to the constraint that the relationship between manufacturing and retail prices is given by the (34) and (35).

$$\partial \pi^T / \partial P_1 = m_1 \partial q_1 / \partial P_1 + q_1 \partial m_1 / \partial P_1 + m_2 \partial q_2 / \partial P_1 + q_2 \partial m_2 / \partial P_1 = 0 \quad (36)$$

$$\partial \pi^T / \partial P_2 = m_1 \partial q_1 / \partial P_2 + q_1 \partial m_1 / \partial P_2 + m_2 \partial q_2 / \partial P_2 + q_2 \partial m_2 / \partial P_2 = 0 \quad (37)$$

Substituting for m_1 and m_2 using (34) and (35), and taking the corresponding derivatives, and well as using (4) and (5), and performing the required differentiation, yields the following two first order conditions,

$$P_1 = [(\alpha(3\beta^2 - 5\tau\beta + 2\tau^2) + s(\beta^2 - \beta\tau) + 6\tau\beta P_2)] / 2(2\beta^2 + \tau^2) \quad (38)$$

$$P_2 = [(\alpha(3\beta^2 - 5\tau\beta + 2\tau^2) + s(\beta^2 - \beta\tau) + 6\tau\beta P_1)] / 2(2\beta^2 + \tau^2) \quad (39)$$

Solving simultaneously yields, after some simplification

$$P^{*RPM}_C = [\alpha(3\beta - 2\tau) + s\beta] / 2(2\beta - \tau) \quad (40)$$

or expressed in terms of the product differentiation parameter,

$$P^{*RPM}_C = [\alpha(3 - 2\theta^{1/2}) + s] / 2(2 - \theta^{1/2}) \quad (40')$$

These are the optimal collusive RPM prices, conditional on the assumption that manufacturing prices are related to these prices by the Bertrand-Nash equilibrium. For independent goods, $\theta=0$, the optimal collusive RPM price is $P^{*RPM}_C = (3\alpha + s)/4$; for perfect substitutes, $\theta=1$, $P^{*RPM}_C = (\alpha + s)/2$.

Given these collusive RPM prices, the corresponding manufacturing prices obtained by manufacturers are determined by (34) and (35). This is illustrated in figure 7,

where the retail reaction functions R_1 for retailer 1 and R_2 for retailer 2 are shown. Collusive RPM involves the setting of P^* for both retailers, which implicitly determines manufacturing prices using (34) and (35).

Collusion on RPM can be compared with collusion on manufacturing prices directly in the following proposition.

Proposition 3. Collusion on RPM results in the same equilibrium manufacturing price vector as collusion on manufacturing prices.

Proof: See Appendix.

Colluding on RPM, given the information assumptions, has allowed manufacturers to obtain the same result as colluding on manufacturing prices. However, this does not give the first best solution for the manufacturers since they are still allowing the retailers a markup over manufacturing prices.²³ Determining the equilibrium in this way, allows the strategic relationship of the model to be retained.²⁴ The collusive RPM equilibrium is summarized in the following table.

²³. The solution where manufacturers set P with a zero markup is derived in Chapter 4. This policy has been termed "consignment selling", a practice where the manufacturer sets the retail price and pays the retailer a commission.

²⁴. The first best outcome for manufacturers is for them to set P and m collusively, this gives the same outcome as collusion by two vertically integrated firms. See Chapter 4 for a proof of this result.

Collusive RPM

$$\begin{aligned}
 P^{*RPM}_C &= [\alpha(3\beta-2\tau) + s\beta]/2(2\beta-\tau) \\
 m^{*RPM}_C &= (\alpha-s)/2 \\
 q^* &= [\beta(\alpha-s)]/2(\beta+\tau)(2\beta-\tau) \\
 \pi^{*M} &= [\beta(\alpha-s)^2]/4(\beta+\tau)(2\beta-\tau) \\
 \pi^{*R} &= [\beta(\beta-\tau)(\alpha-s)^2]/4(\beta+\tau)(2\beta-\tau)^2
 \end{aligned}$$

Table 3

This result can be easily contrasted with that of Telser's Manufacturing Cartel argument. Telser viewed RPM as a facilitating device used to maintain cartel stability. In our model, the information assumptions necessary to achieve the cartel price are specified. Specifically, if manufacturers know the nature of the retail equilibrium, they can choose the RPM prices collusively to achieve the manufacturing cartel price vector. This result means that even without a formal agreement on manufacturing prices, an agreement on RPM prices can replicate the manufacturing cartel price solution. Agreements on retail price floors may be easier to monitor than agreements on manufacturing prices.²⁵

In the next section, the decision to select RPM unilaterally is studied.

3.7 Unilateral Imposition of RPM.

In this section, the existence of a unilateral RPM equilibrium will be considered. Specifically, we will assume a two stage game in which manufacturer 1 sets the RPM

²⁵. This is because retailers often post prices which can be verified by other manufacturers.

constraint in the first stage, and the manufacturing prices of both manufacturers m_1 and m_2 as well as the price of the second retailer are determined simultaneously in the second stage.²⁶ The task is to determine whether it would ever be in the interest of one manufacturer to set a retail price floor and whether this is a Nash equilibrium. In general, the determination of a Nash equilibrium involves examining the incentives of both manufacturers at the proposed equilibrium. However, showing that at least one manufacturer would wish to deviate from the candidate equilibrium is sufficient to rule out the existence of a Nash equilibrium.

To investigate the possibility of unilateral RPM three cases will be considered. Throughout the analysis, symmetry in demand and costs will be assumed. To aid in the exposition, reference will be made to figure 8.

(i) Case 1

Suppose manufacturer 1 sets the RPM price for its retailer, retailer 1 at P_0 in figure 8. That is, retail price reductions below P_0 are prohibited. This produces a kink in the reaction function of retailer 1, eliminating the portion of its reaction function below P_0 . An RPM price set at this level, however, does not alter the equilibrium which remains at point E. That is, the constraint is non-binding in this case.

²⁶. It is important to note that this is different from what might be considered a three stage game; where manufacturer 1 sets an RPM price in the first stage, equilibrium manufacturing prices are determined in the second stage, and equilibrium retail prices are determined in the third stage. The equilibrium of this game, which is the subject of further work, would undoubtedly depend on the nature of the information assumptions.

(ii) Case 2

In contrast, suppose manufacturer 1 sets the RPM price at P_1 in figure 8. Once again, this produces a kink in the reaction function of retailer 1, eliminating the portion of the reaction function now below P_1 . In this case, the intersection of the reaction function is above point E at point F. The question is whether this is a Nash equilibrium for the manufacturers.²⁷ To see why not, recall that the equation for the reaction function for retailer 1 is

$$R_1 = p_1 = (\alpha + m_1 + s)/2 - \alpha\tau/2\beta + \tau p_2/2\beta$$

As can be seen from figure 8, it is possible for manufacturer 1 to raise its price m_1 , which will shift upwards the reaction function of retailer 1 without changing the equilibrium at point F. The equilibrium retail prices do not change, but manufacturer 1 has raised its manufacturing price which raises its profits over the equilibrium at F. Therefore a point like F cannot be a Nash equilibrium.

(iii) Case 3

Now it will be determined whether an equilibrium will exist at a kink, for example at point E. The question is whether this retail equilibrium changes the incentive of either manufacturers. For this case, we will examine whether manufacturer 2 would like to deviate.

The following first order condition which comes from the objective function $\pi_M^2 = m_2 q_2$, will be useful.

²⁷. It is important to remember symmetry in costs and demands is assumed throughout.

$$\partial \pi_2^M / \partial m_2 = q_2 + m_2 \partial q_2 / \partial m_2 \quad (41)$$

The determination of whether manufacturer two would deviate from the candidate equilibrium with RPM in place will depend on a comparison between the $\partial q_2 / \partial m_2$ (with RPM) and the derivative $\partial q_2 / \partial m_2$ (without RPM).

To aid in the comparison, it is important to understand how changes in the manufacturing price, m_2 , alters the nature of the retail equilibrium. Recall that the reaction function for retailer two is given as the following.

$$R_2 = p_1 = \alpha - \beta(\alpha + m_2 + s)/\tau + 2\beta p_2/\tau$$

Graphically, a reduction (increase) in m_2 would shift up (down) the reaction function for retailer 2 in figure 8. Also in figure 8, the candidate equilibrium E is also represented along with the RPM constraint set at p_1^{RPM} . Now the comparison will be whether a reduction in m_2 , which shifts the reaction function for retailer 2 upwards, increases profits more for manufacturer 2 in the RPM case or the non-RPM case. The respective comparison is now between an equilibrium at point B and point C. With RPM the intersection of the reaction functions is, after a reduction in m_2 is at point C, without RPM the reaction functions intersect at point B.

The difference between the two will be dependent on the magnitude of $\partial q_2 / \partial m_2$. Assuming symmetry $\beta_1 = \beta_2 = \beta$, the derivative $\partial q_2 / \partial m_2$ can be written as

$$\partial q_2 / \partial m_2 = [\partial q_2 / \partial p_2 \partial p_2 / \partial m_2 + \partial q_2 / \partial p_1 \partial p_1 / \partial m_2] \quad (42)$$

which given $\partial q_2/\partial p_2 = \beta$ and $\partial q_2/\partial p_1 = \tau$ from the demand function yields $q_2 = [\beta(\alpha - p_2) - \tau(\alpha - p_1)]/\sigma$, where $\sigma = \beta^2 - \tau^2$, which is equivalent to expression (5). The derivative (42) will be examined for the case of No-RPM and with RPM.

(a) No-RPM

In the case of No-RPM, the derivative $\partial q_2/\partial m_2$ from (42) is evaluated at the Bertrand-Nash equilibrium. That is, in the case of No-RPM, the retail equilibrium will remain Bertrand-Nash for any alteration in manufacturing prices.

$$\partial q_2/\partial m_2 = [\beta(-\partial p_2^{N*}/\partial m_2) + \tau(\partial p_1^{N*}/\partial m_2)]/\sigma \quad (43)$$

The derivatives of the equilibrium Bertrand-Nash prices with respect to m_2 , $\partial p_2^{N*}/\partial m_2$ and $\partial p_1^{N*}/\partial m_2$ are using (11) and (12), $2\beta^2/\Phi$ and $\tau\beta/\Phi$ respectively. Substituting into (43) yields $\partial q_2/\partial m_2 = [-2\beta^3 + \tau^2\beta]/\sigma\Phi$, which can be rewritten as

$$[\partial q_2/\partial m_2]_{\text{No-RPM}} = -[\beta(2\beta^2 - \tau^2)]/(\beta^2 - \tau^2)(4\beta^2 - \tau^2) \quad (44)$$

(b) RPM

If manufacturer 1 has an RPM policy in place, p_1 is fixed and therefore the retail price of firm 1 does not change in response to alterations in m_2 , or $\partial p_1/\partial m_2 = 0$. Substituting into (42) yields $\partial q_2/\partial m_2 = (-\beta(\partial p_2/\partial m_2))/\sigma$, which now requires the derivative $\partial p_2/\partial m_2$. In the RPM case, the retail price for firm 2 responds to changes to m_2 , which is given by the slope of the retail reaction function. That is, the slope of the retail reaction function for firm 2 given by (10') will be substituted for $\partial p_2/\partial m_2 = 1/2$, which yields

$$[\partial q_2/\partial m_2]_{RPM} = -\beta/2(\beta^2-\tau^2) \quad (45)$$

The reason that the slope of the reaction function is used rather than the Bertrand-Nash equilibrium price is that the retail equilibrium will no longer be Bertrand-Nash if RPM is in place.

The difference between the slopes is given by

$$\begin{aligned} & \{[\partial q_2/\partial m_2]_{No-RPM} - [\partial q_2/\partial m_2]_{RPM}\} \\ &= [-[\beta(2\beta^2-\tau^2)]/(\beta^2-\tau^2)(4\beta^2\tau^2)] - [-\beta/2(\beta^2-\tau^2)] \\ &= \beta\tau^2/[2(\beta^2-\tau^2)(4\beta^2-\tau^2)] \end{aligned}$$

If substituting for τ^2 , using $\theta = \tau^2/\beta^2$, yields

$$= \theta/[2\beta(1-\theta)(4-\theta)]$$

which implies that

$$[\partial q_2/\partial m_2]_{No-RPM} < [\partial q_2/\partial m_2]_{RPM}$$

Therefore comparing the first order condition (41) and finding if

$$\partial \pi^M_2/\partial m_2 = q_2 + m_2 [\partial q_2/\partial m_2]_{No-RPM} \leq 0$$

so that a move from E to B is weakly profitable, then

$$\partial \pi^M_2/\partial m_2 = q_2 + m_2 [\partial q_2/\partial m_2]_{RPM} < 0 \text{ so that a move from E to C is strictly profitable.}$$

This has shown that there is no incentive for one manufacturer to impose resale price maintenance in a two stage game. The same technique can be extended to show that there is no noncooperative Nash equilibrium in this game, that is, both manufacturers have no

incentive to impose RPM unilaterally.²⁸

²⁸. This does not mean that unilateral RPM may not be used in equilibrium under other conditions. For example, asymmetry in costs, or a multistage game formulation might lead to unilateral RPM. For the strategic use of RPM see Shaffer (1989).

3.8 Conclusion

This chapter has demonstrated that in a two stage duopoly, for linear demands and costs, price leadership by one retailer raises profits for all manufacturers and retailers over a "price war" equilibrium where few profits are made by retailers or manufacturers, when the goods are close substitutes. Price leadership acts as a constraint on the downward pressure on prices enabling manufacturers to reach a preferable noncooperative equilibrium.

In contrast, resale price maintenance, if imposed unilaterally by a manufacturer, increases the incentives for price cutting by its rival. The competing manufacturer and its associated retailer, both gain from price cutting, since the RPM policy prevents the retailer from responding. Since the initiating manufacturer suffers losses from the policy, a policy of unilateral RPM cannot be an equilibrium. However, if RPM is chosen collusively by manufacturers it can substitute effectively for collusion on manufacturing prices. Collusion using RPM may be easier to implement than collusion on manufacturing prices. It is important to emphasize that these results depend largely on the nature of the model; symmetry in costs and demands, the type of product differentiation, exclusive dealing and market power on the part of retailers and manufacturers. Further work will be directed to examining the robustness of these results.

Figure 1 : Bertrand–Nash and Price Leadership Equilibria

Figure 2(a): Manufacturer Reaction Functions:
Good Substitutes

Figure 2(b): Manufacturer Reaction Functions:
Poor Substitutes

Figure 3(a): Manufacturing Price Equilibria
Bertrand-Nash and Price Leadership at the Retail Level

Figure 3(b): Manufacturing Prices
Bertrand-Nash, Price Leadership and Price Follower at the Retail Level

Figure 4: Retail Prices
Price Follower, Price Leader and Bertrand Competition at Retail Level

Figure 5(a): Manufacturer Profits
Price Leader, Price Follower, and Bertrand Competition at the Retail Level

Figure 5(b): Manufacturer Profits
Price Leader, Price Follower and Bertrand Competition at the Retail Level

Figure 6: Retailer Profits
Price Leader, Price Follower and Bertrand Competition at the Retail Level

Figure 7: Collusive RPM

Figure 8: Unilateral RPM

Appendix I. The Role of Product Differentiation

Vertical Separation Equilibrium

$$\begin{aligned}
 m^{N*} &= [(\alpha-s)(2-\theta-\theta^{1/2})]/\Phi \\
 p^{N*} &= [\alpha(1-\theta^{1/2}) + (s+m)]/(2-\theta^{1/2}) \\
 \pi_{BN}^M &= (\alpha-s)^2 [(2-\theta)(2-\theta-\theta^{1/2})]/[\beta(2-\theta+\theta^{1/2})\Phi^2] \\
 \pi_{BN}^R &= (\alpha-s)^2 [(1-\theta^{1/2})(2-\theta)^2]/[\beta(2-\theta^{1/2})(2+\theta^{1/2}-\theta)\Phi^2] \\
 \text{where } \Phi &= (4-2\theta-\theta^{1/2})
 \end{aligned}$$

Retail Price Leadership Equilibrium

Prices:

$$\begin{aligned}
 m^{L*} &= (\alpha-s)[(2-\theta)(8-7\theta) - \theta^{1/2}(4-3\theta)] / [(2-\theta)(16-13\theta)] \\
 m^{F*} &= (\alpha-s)[(8-7\theta) - \theta^{1/2}(2-\theta)] / (16-13\theta) \\
 p^{L*} &= (\alpha+m_1+s)/2 + [\theta^{1/2}(m_2+s-\alpha)]/[2(2-\theta)] \\
 p^{F*} &= [\theta^{1/2}(m_1+s-\alpha)]/4 + [\alpha(4-3\theta)+(m_2+s)(4-\theta)]/[4(2-\theta)]
 \end{aligned}$$

Quantities:

$$\begin{aligned}
 q^{L*} &= (\alpha-s)[(2-\theta)(8-7\theta) - \theta^{1/2}(4-3\theta)]/[4\beta(1-\theta)(16-13\theta)] \\
 q^{F*} &= (\alpha-s)(4-3\theta)[(8-7\theta) - \theta^{1/2}(2-\theta)]/[4\beta(1-\theta)(2-\theta)(16-13\theta)]
 \end{aligned}$$

Profits:

$$\begin{aligned}
 \pi^{ML} &= (\alpha-s)^2 [(2-\theta)(8-7\theta) - \theta^{1/2}(4-3\theta)]^2 / [4\beta(1-\theta)(2-\theta)(16-13\theta)^2] \\
 \pi_M^F &= (\alpha-s)^2 (4-3\theta) [8-7\theta - \theta^{1/2}(2-\theta)]^2 / [4\beta(1-\theta)(2-\theta)(16-13\theta)^2] \\
 \pi_R^L &= (\alpha-s)^2 [(2-\theta)(8-7\theta) - \theta^{1/2}(4-3\theta)]^2 / [8\beta(1-\theta)(2-\theta)(16-13\theta)^2] \\
 \pi_R^F &= (\alpha-s)^2 (4-3\theta)^2 [8-7\theta - \theta^{1/2}(2-\theta)]^2 / [16\beta(1-\theta)(2-\theta)^2(16-13\theta)^2]
 \end{aligned}$$

VIII. Appendix II.

Proposition 1. Proof: Subtracting (31) from (30) yields after simplification, $m_1^{L*} - m_2^{F*} = [(\alpha-s)\tau^3(\tau^2-\beta^2)]/H\beta(4G-\tau^2)$ if the definition of product differentiation $\theta=\tau^2/\beta^2$ is substituted in the above expression, $m_1^{L*} - m_2^{F*} = [(\alpha-s)\theta^{1/2}\theta(\theta-1)]/(16-13\theta)(2-\theta)$, since $0<\theta<1$ for intermediate ranges of product differentiation, $m_1^{L*} < m_2^{F*}$. QED.

Proposition 2. Proof: See text.

Proposition 3. Proof: It is straightforward to determine the manufacturing prices chosen, substitute P^{*RPM}_c into (34) or (35) and collecting terms yields $m^* = (\alpha-s)/2$. Substituting m^* into the expression P^{*RPM} and into the q^* yields the profits for manufacturers given by Table 3 which are equivalent to the profits of manufacturers from colluding on m . QED.

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Chapter 4

Strategic Considerations in Vertical Relationships: Vertical Integration and Consignment Selling

4.1 Introduction

This chapter extends the analysis of strategic considerations in vertical relationships by considering the decision between vertical integration and vertical separation on the part of manufacturers. Vertical separation is defined as selling through an independent retailer, as opposed to selling directly to consumers.

Previous chapters in this thesis have shown that manufacturers prefer Cournot competition at the retail level to Bertrand-Nash competition when Bertrand-Nash competition exists at the manufacturing stage. In Chapter 2, it was demonstrated that manufacturers and retailers may prefer Cournot to Bertrand competition because it results in higher retail prices which avoids a destructive price war equilibrium. This implies that "excessive" retail price competition may be undesirable for the manufacturer. In Chapter 3, two responses to this problem were considered, retail price leadership and resale price maintenance. It was shown that retail price leadership resulted in higher profits than the price war equilibrium for all manufacturers and retailers when goods are close substitutes while the unilateral adoption of resale price maintenance by a manufacturer was not a Nash equilibrium. RPM in our model would only be pursued as part of a collusive agreement.

This chapter considers a number of additional issues in the strategic approach to vertical relationships. One is vertical integration, the elimination of a stage in distribution while another is consignment selling, a contractual arrangement where the manufacturer sets the retail price and pays retailers a commission. Using a simple model of differentiated products with symmetric demands and costs, I show that when the products are close substitutes there are multiple Nash equilibria to a vertical integration-separation decision on the part of manufacturers; both firms vertically separated and both firms vertically integrated. The decision is set in the context of a specific game played between manufacturers. The vertically separated equilibrium always Pareto dominates the vertical integration result when multiple Nash equilibria exist. When the products are relatively poor substitutes, the only Nash equilibrium involves vertical integration by both firms. The possibility of an equilibrium where an integrated firm competes against an independent manufacturer and retailer is also discussed.

An alternative to vertical integration, consignment selling, is also considered. Consignment selling is defined here as the setting of the retail price by manufacturers and a commission paid to retailers to sell the product.¹ In particular, I determine the strategic implications of consignment selling and compare it with the vertical integration and vertical separation equilibria. I show that consignment selling gives manufacturers all the control of vertical integration.

A number of theories exist for why firms vertically integrate. It has been observed that firms may integrate for reasons of technological economies, transactional economies, or

¹. This might be viewed as a very simple consignment selling arrangement. More complex arrangements are discussed in the chapter.

market imperfections.² Two important papers which consider vertical integration in relation to market imperfections are Mathewson and Winter (1983) and Perry and Groff (1985).³ In particular these papers examine the motivation for forward integration by a monopolist when retailers are engaged in monopolistic competition.⁴ Conflicting effects of vertical integration on product price and welfare are found. Mathewson and Winter find small welfare gains from integration, while Perry and Groff find welfare losses. Mathewson and Winter show that a monopolist manufacturer can replicate the vertical integration solution by setting the wholesale price and using the appropriate contractual restraints.⁵ In that case, an examination of the welfare effects of contractual restraints involves essentially a welfare comparison of the integrated and the non-integrated solution. Their simulations show that the detrimental effect of lower prices on welfare through a reduction in the number of retailers is more than offset by the direct welfare benefits from lower prices. In contrast, Perry and Groff obtain the result that forward integration produces an overall welfare loss, the benefits of lower prices do not offset the losses from the significant reduction in the number of downstream firms and hence the reduction in product diversity. Allowing for oligopolists at the manufacturing level in Perry and Groff's model reduces the losses somewhat.

². This general categorization of explanations is attributed to M. Perry (1989), who provides an excellent synthesis of the vertical integration literature.

³. Other papers are Dixit (1983) and Salop (1979).

⁴. The approaches differ in the way they model consumer preferences. Perry and Groff (1985) and Dixit (1983) use a CES formulation, while Mathewson and Winter (1983) and Salop (1979) use a spatial model.

⁵. The restraints considered are retail price ceilings, minimum quantity restrictions and franchise fees. Resale price maintenance is not considered in this model.

Recently, a number of papers have emerged addressing strategic issues of vertical control. Fershtman and Judd (1987) examine the equilibrium incentive contracts in an oligopoly and show that the incentives depend on the nature of the competition in the product market. For Cournot-quantity competition, owners want to encourage their managers to increase sales in order to induce competing managers to reduce their output. For Bertrand-price competition with differentiated products, owners want their managers to set a high price to elicit higher prices from competing managers. In this case, owners choose an incentive structure that overcompensates the manager for increasing price at the margin. Bonanno and Vickers (1988) demonstrate that vertical separation, selling through a retailer, is more profitable for one manufacturer than a vertically integrated equilibrium if franchise fees are used to extract the retailer's surplus. They also show that it is more profitable for both manufacturers to vertically separate than to remain integrated, if rents can be stripped from retailers. E. Gal-Or (1990) shows, in a three stage model, that the decision to vertically separate depends on the size of the contracting costs⁶ and the number of like-minded firms. She finds that for high contracting costs, all firms sell directly to consumers; for low contracting costs, the benefit to using an agent increases with the number of firms, resulting in an equilibrium where all producers are represented by agents.

The model developed here differs from the existing literature in a number of important ways. In contrast to Mathewson and Winter (1983) and Perry and Groff (1985) who assume free entry, the model used in this chapter allows for profits at the retail level and models the relationship between the two stages in a perfect equilibrium framework. Also, the

⁶. Gal-Or assumes that producers incur a fixed contracting cost if goods are sold through agents.

model allows for oligopolists at both the manufacturing and retail levels and uses a quadratic utility function and hence linear demands.

The analysis is more closely related to the recent literature regarding strategic issues in vertical control. I use a simple model of differentiated products Bertrand competition, and examine equilibrium incentives for vertical integration by oligopolies much in the spirit of Fershtman and Judd and conduct the analysis using similar demand structures as Bonanno and Vickers, and Gal-Or. However, I obtain results similar to Bonanno and Vickers only for a range of differentiation by examining the Nash equilibrium to a specific vertical integration-separation game between manufacturers. In contrast to Gal-Or's results, the model shows that the decision to vertically separate or integrate depends on the degree of product differentiation. Producers bear no costs from selling through agents in the analysis contained here.

The chapter is organized as follows. Section 2 outlines the simple model of differentiated products used in the analysis. Section 3 outlines the retail equilibria for the vertical integration, vertical separation, and the mixed outcome case. The mixed outcome case involves an independent retailer competing against an integrated firm.⁷ Sections 4 and 5 show the complete solution for the vertical integration, vertical separation and mixed outcome cases. This involves examining the equilibrium to the manufacturing stage game taking into account the various retail equilibria. Section 6 discusses the relationship of the degree of product differentiation to these outcomes. Section 7 examines strategic elements which are present in the mixed outcome case. Section 8 characterizes the Nash equilibrium

⁷. It is important to note that this is to be distinguished from a mixed strategy equilibrium. In the vertical integration-separation game considered in this chapter only pure strategies are admitted. The term asymmetric equilibrium would not be appropriate because the results obtained here apply to the case of symmetric demands and costs.

to the complete game and shows that the nature and existence of the Nash equilibria are dependent on the degree of product differentiation.

In Section 9, the practice of consignment selling in this model is examined. It begins with a brief discussion of a number of cases in U.S. law, followed by a formal analysis. A number of equilibria are considered which include consignment selling by both manufacturers and unilateral adoption by one manufacturer. I show that the former case yields the same equilibrium as competition between two vertically integrated firms. The definition of consignment selling used in this paper is then contrasted with more sophisticated arrangements present in the case law. In section 10, the relevance of the analysis contained in this chapter is discussed, followed by a number of conclusions.

4.2 A Simple Model of Differentiated Products

The model, introduced by Dixit (1979) and used by Singh and Vives (1984), involves a continuum of consumers of the same type with a utility function separable and linear in the numeraire good.⁸ The representative consumer maximizes $W = U(q_1, q_2) - \sum p_i q_i$, $i=1,2$ where q_i is the amount of good i and p_i its price. U is assumed to be quadratic and strictly concave of the following form:

$$U(q_1, q_2) = \alpha_1 q_1 + \alpha_2 q_2 - (\beta_1 q_1^2 + 2\tau q_1 q_2 + \beta_2 q_2^2)/2 \quad (1)$$

⁸. A more complete specification of this model can be found in Chapters 1 and 2 of this thesis.

where α_i and β_i are positive, $i=1,2$, and $\beta_1\beta_2-\tau^2 > 0$, and $\alpha_i\beta_j-\alpha_j\tau > 0$ for $i=1, j=2$. This utility function yields linear demand functions. In inverse form they are,

$$p_1 = \alpha_1 - \beta_1 q_1 - \tau q_2 \quad (2)$$

and
$$p_2 = \alpha_2 - \tau q_1 - \beta_2 q_2 \quad (3)$$

in the region of quantity space where prices are positive. Denoting $\sigma = \beta_1\beta_2 - \tau^2$, $a_i = (\alpha_i\beta_j - \alpha_j\tau)/\sigma$ for $i=1, j=2$ and $c = \tau/\sigma$, $b_1 = \beta_2/\sigma$, $b_2 = \beta_1/\sigma$ (where a_i and b_i are positive, by assumption), the direct demand functions can be written as

$$q_1 = a_1 - b_1 p_1 + c p_2 \quad (4)$$

$$q_2 = a_2 - b_2 p_2 + c p_1 \quad (5)$$

provided that the quantities are positive. Expressions (4) and (5) can be written in terms of parameters of the utility function, which simplifies the algebra considerably.⁹

$$q_1 = [\beta_2(\alpha_1 - p_1) - \tau(\alpha_2 - p_2)]/\sigma \quad (4')$$

$$q_2 = [\beta_1(\alpha_2 - p_2) - \tau(\alpha_1 - p_1)]/\sigma \quad (5')$$

The parameter τ characterizes whether the goods are substitutes, independent, or complements according to whether τ is greater, less than, or equal to 0. When $\alpha_1 = \alpha_2$, $\theta = \tau^2/(\beta_1\beta_2)$ expresses the degree of product differentiation, $\theta=0$ representing independent goods, $\theta=1$ when the goods are perfect substitutes.

⁹. If $p_1 = p_2 = p$, and symmetry is imposed, the following expressions simplify to $q_i = (\alpha - p)/(\beta + \tau)$ for $i=1,2$.

Independent retailers are assumed to choose p_i , the retail price to maximize, $\pi_i^R = (p_i - m_i - s_i) q_i$, for $i=1,2$, where m_i is the manufacturing price, and s_i , the marginal and average selling costs. Manufacturers, on the other hand, choose m_i , their manufacturing price, to maximize $\pi_i^M = (m_i - k_i) q_i$, $i=1,2$, where k_i , is average and marginal cost of production, which has been set at zero, for convenience. It is assumed that there are no fixed costs of production at either the retail or manufacturing stage.¹⁰

The retail game for the case of vertical integration is considered in the next section. It is followed by the equilibrium for both firms separating, and the mixed outcome case, an integrated firm competing with an independent retailer.

4.3 Retail Stage

a) Vertical Integration Equilibrium

Each integrated firm chooses a retail price to maximize total profits which can be expressed as $\pi_i^T = \pi_i^R + \pi_i^M$, $i=1,2$, where π_i^R is retail profits, and π_i^M is manufacturer profits. This can be expressed as follows:

$$\pi_i^T = (p_i - s_i) q_i, \quad \text{for } i=1,2 \quad (6)$$

since the manufacturing price drops out because it is indeterminate.¹¹

¹⁰. This is not an innocuous assumption, as it is extremely important in issues regarding product diversity particularly whether firms are able to cover their fixed costs.

¹¹. The manufacturing price is an internal transfer price which is arbitrary for an integrated firm.

The first order conditions for this case are, assuming Bertrand-Nash conjectures for both firms.

$$\partial \pi^T_1 / \partial p_1 = (p_1 - s_1) \partial q_1 / \partial p_1 + q_1 = 0 \quad (7)$$

$$\partial \pi^T_2 / \partial p_2 = (p_2 - s_2) \partial q_2 / \partial p_2 + q_2 = 0 \quad (8)$$

Using (4') and (5') and taking the derivatives, yields the reaction functions for the integrated firms.

$$P_1^I = (\alpha_1 + s_1) / 2 - [\tau(\alpha_2 - P_2)] / 2\beta_2 \quad (9)$$

$$P_2^I = (\alpha_2 + s_2) / 2 - [\tau(\alpha_1 - P_1)] / 2\beta_1 \quad (10)$$

Equations (9) and (10) are depicted in figure 1 as the lines R1I for firm 1 and R2I for firm 2 respectively, which intersect at point I which is the retail Nash equilibrium for the two integrated firms. The slopes and intercepts of the reaction functions depend on the degree of product differentiation with the reaction functions becoming perpendicular as the goods become more independent.¹² Using (9) and (10) and imposing symmetry, $\alpha_1 = \alpha_2 = \alpha$, $s_1 = s_2 = s$, $\beta_1 = \beta_2 = \beta$ and $k_1 = k_2 = 0$, the equilibrium retail prices can be determined.

$$P_1^* = [\alpha(\beta - \tau) + \beta s] / (2\beta - \tau) \quad (11)$$

¹². See Chapter 2 for a more complete discussion of the role of product differentiation on the position and slopes of the reaction functions.

b) Vertically Separated Equilibrium

In the vertically separated equilibrium both retailers are independent. Each retailer chooses its price to maximize, $\pi_i^R = (p_i - m_i - s_i) q_i$, for $i=1,2$, assuming Bertrand-Nash conjectures. The first order conditions for this problem are as follows.

$$\partial \pi_1^R / \partial p_1 = (p_1 - s - m_1) \partial q_1 / \partial p_1 + q_1 = 0 \quad (12)$$

$$\partial \pi_2^R / \partial p_2 = (p_2 - s - m_2) \partial q_2 / \partial p_2 + q_2 = 0 \quad (13)$$

Using (4') and (5'), and taking the derivatives, yields the retail reaction functions for the case of vertical separation.

$$p_1^{NI} = (\alpha_1 + m_1 + s)/2 - [\tau(\alpha_2 - p_2)]/2\beta_2 \quad (14)$$

$$p_2^{NI} = (\alpha_2 + m_2 + s)/2 - [\tau(\alpha_1 - p_1)]/2\beta_1 \quad (15)$$

These reaction functions are depicted as the lines R1NI for retailer 1 and R2NI for retailer 2 in figure 1, intersecting at point S which is the Nash equilibrium for price competition between independent firms. A simple comparison of the reaction functions for the vertically integrated equilibrium (9) and (10) with the vertically separated case (14) and (15) reveals that the retail prices will be higher for the separated case whenever $m_1 > 0$, $m_2 > 0$, where m_1 and m_2 exceed the average and marginal cost of production of the manufacturing firm, (0 by assumption). The intercept for firm 1 is higher for the separated case, while the intercept for firm 2 is lower resulting in higher equilibrium retail prices. Solving (14) and (15)

simultaneously gives the vertically separated downstream equilibrium, setting $\alpha_1=\alpha_2=\alpha$ and $\beta_1=\beta_2=\beta$.

$$p_1^{NI*} = [(\alpha+m_1+s)2\beta^2 + \tau\beta(m_2+s-\alpha) - \alpha\tau^2]/D \quad (16)$$

$$p_2^{NI*} = [(\alpha+m_2+s)2\beta^2 + \tau\beta(m_1+s-\alpha) - \alpha\tau^2]/D \quad (17)$$

where $D=4\beta^2-\tau^2$

These expressions show that the retail prices are determined by the choice of manufacturing prices in the previous stage.

c) **The Mixed Outcome: Integrated Firm and Independent Retailer**

The retail stage in this model is an asymmetric duopoly. Equilibrium in the retail market involves the choice of p_1 by firm 1 to maximize integrated profits and the choice of p_2 by the non-integrated retail firm. The reaction functions for this equilibrium which intersect at a point like A in figure 1, are given by expressions (9) and (15). Therefore, to determine the equilibrium at the retail stage, (9) and (15) are solved simultaneously to yield the retail equilibrium for the mixed outcome case.

$$P_1^{I*} = [(\alpha+s)2\beta^2 - \alpha\tau^2 + (s+m_2-\alpha)\tau\beta]/D \quad (18)$$

$$P_2^{NI*} = [(\alpha+m_2+s)2\beta^2 - \alpha\tau^2 + (s-\alpha)\tau\beta]/D \quad (19)$$

where $D=4\beta^2-\tau^2$

Both equilibrium prices are functions of demand parameters for both goods, selling costs and the manufacturing price of firm 2, the unintegrated firm. A simple comparison of (18) and (19) shows that P_2^{NI*} is greater than, equal to, or less than P_1^{I*} depending on whether m_2 is greater than, equal to, or less than 0.¹³ In other words, only in the case that the optimal choice by the second manufacturer equals the cost of production of firm one, set at zero in this case, are the retail prices equal.

It is clear that apart from the vertically integrated solution, the retail reaction functions and hence the retail equilibria depend on the manufacturing prices chosen in the preceding stage. In the following section, the manufacturing stage is considered.

4.4 Manufacturing Stage

In this section, the decisions by manufacturers in the preceding stage will be addressed. Its purpose will be to determine the Nash equilibrium to a game where the strategy set on the part of manufacturers is [VS, VI] (where VS=Vertical Separation and VI= Vertical Integration) where for the VS case it also includes selecting the manufacturing price. That is, the strategy for a vertically separated manufacturer involves choosing to vertically separate and choosing its manufacturing price. To clarify the timing of the game, it is useful to examine the following diagram.

¹³. Subtracting (18) from (19) yields the condition that $P_2^{NI*} > P_1^{I*}$ if $[\beta(2\beta-\tau)m_2]/D$ is greater than zero. This can be simplified by recognizing that $D=4\beta^2-\tau^2$ to yield the condition that $P_2^{NI*} > P_1^{I*}$ if $\beta m_2/(2\beta+\tau) > 0$ which is true if $\beta, \tau, m_2 > 0$.

Figure 2: Timing of the Game

The timing of the game can be viewed from the perspective of the solution method; that is, by starting from the payoffs and working backwards. In the third stage, the retail prices are set depending on the nature of the competition; specifically, through competition between independent retailers, between integrated firms, or between an integrated firm and an independent retailer, which is termed the mixed outcome case.

The decision at the second stage, depends on the choice made by manufacturers in the first stage. If both manufacturers decide to integrate, then no decision regarding manufacturing prices is made at the second stage. If both manufacturers decide to vertically separate, then the manufacturing prices are chosen noncooperatively assuming Bertrand competition. It is also assumed that the manufacturers anticipate, correctly, that retailers will also be Bertrand competitors. This may be thought of as a two stage price war equilibrium. For the mixed outcome case, if one manufacturing firm decides to vertically separate, then it chooses its manufacturing price assuming that the retail stage game will involve retail price competition between an independent retailer and an integrated firm. That is, I assume that the independent manufacturer chooses its price assuming it knows the effect this will have on the retail pricing game. Finally, in the first stage, manufacturers decide whether to integrate or remain vertically separated.

Given this structure, the Nash equilibrium to the game between manufacturers will be determined. Specifically, a number of questions will be addressed: for example, if

manufacturer 1 vertically integrates is it is the interest of manufacturer 2 to follow suit? Or is it possible that a mixed outcome, one manufacturer vertically integrated and one separate, is a Nash equilibrium?

4.5 The Full Equilibria

a) Vertical Integration by Both Manufacturers

This equilibrium is the easiest to derive. Substituting (11) into (4') and (5') to determine quantities, and then substituting these expressions into the profit function yields the vertical integration equilibrium¹⁴:

Vertical Integration Equilibrium

$$P_I^* = [\alpha(\beta - \tau) + \beta s] / (2\beta - \tau)$$

$$q^{I*} = [(\alpha - s)\beta] / [(\beta + \tau)(2\beta - \tau)]$$

$$\pi^{I*} = [(\alpha - s)^2 \beta (\beta - \tau)] / [(\beta + \tau)(2\beta - \tau)^2]$$

Table 1

¹⁴. In contrast, the collusive equilibrium for vertically integrated firms is: $P_i = (\alpha + s)/2$, $q_i = (\alpha - s)/2(\beta + \tau)$ and profits, $\pi_C^I = (\alpha - s)^2/4(\beta + \tau)$ for $i=1,2$.

b) Vertical Separation by Both Manufacturers

As stated earlier, the solution to this two stage game is obtained by assuming manufacturers anticipate correctly the nature of the downstream competition. Specifically, each manufacturer is assumed to choose m_i , $i=1,2$ to maximize, $\pi_i^M = m_i q_i$, assuming Bertrand-Nash conjectures and given the retail equilibrium.

The first order conditions for this problem are:

$$\partial \pi_i^M / \partial m_i = m_i \partial q_i / \partial m_i + q_i = 0, \quad \text{for } i=1,2 \quad (20)$$

Under the above assumptions, reaction functions in manufacturing space are derived.

$$m_1 = (\alpha - s)/2 + [\tau\beta(m_2 + s - \alpha)]/2H \quad (21)$$

$$m_2 = (\alpha - s)/2 + [\tau\beta(m_1 + s - \alpha)]/2H \quad (22)$$

where $H = 2\beta^2 - \tau^2$

This equilibrium can be depicted in figure 3, where the Nash equilibrium in manufacturing space is given by point M. Solving (21) and (22) simultaneously, yields the equilibrium manufacturing price.

$$m^{N*} = [(\alpha - s)(2\beta^2 - \tau^2 - \tau\beta)]/(4\beta^2 - 2\tau^2 - \tau\beta) \quad (23)$$

The complete vertical separation equilibrium to the two stage game is achieved by substituting (23) into (16) and (17) and then (4') or (5') and determining the profits for manufacturers and retailers. The equilibrium is listed in table 2.

Vertical Separation Equilibrium

$$m^{N*} = [(\alpha-s)(2\beta^2-\tau^2-\tau\beta)]/(4\beta^2-2\tau^2-\tau\beta)$$

$$P^{N*} = [\frac{\alpha(\beta-\tau)(6\beta^2-2\tau^2) + s\beta(2\beta^2-\tau^2)}{(2\beta-\tau)(4\beta^2-2\tau^2-\tau\beta)}]$$

$$q^{N*} = [(\alpha-s)\beta(2\beta^2-\tau^2)]/[(2\beta-\tau)(\beta+\tau)\Phi]$$

$$\pi_N^{M*} = [(\alpha-s)^2\beta(\beta-\tau)(2\beta+\tau)(2\beta^2-\tau^2)]/[\Phi^2(2\beta-\tau)(\beta+\tau)]$$

$$\pi_R^{N*} = [(\alpha-s)^2\beta(\beta-\tau)(2\beta^2-\tau^2)^2]/[(2\beta-\tau)^2(\beta+\tau)\Phi^2]$$

where $\Phi \equiv 4\beta^2-2\tau^2-\tau\beta$

Table 2

c) The Mixed Outcome: Independent Retailer and an Integrated Firm

If the retail equilibrium involves competition between an independent retailer and an integrated firm, the manufacturing price of the independent manufacturer must be determined in the preceding stage. In this model, the objective of the second manufacturer is to choose m_2 to maximize, assuming, correctly, that the retail equilibrium will involve an equilibrium between its independent retailer and an integrated firm.

$$\pi_M^2 = (m_2 - k_2) q_2 \quad (24)$$

The first order condition for this expression is, setting k_2 equal to zero for convenience.

$$\partial \pi_M^2 / \partial m_2 = m_2 \partial q_2 / \partial m_2 + q_2 = 0 \quad (25)$$

Using (5'), (18) and (19), the expression $\partial q_2 / \partial m_2 = [-\beta \partial p_2 / \partial m_2 + \tau \partial p_1 / \partial m_2] / \sigma$, and substituting (18) and (19) into (25), and taking the above derivatives, we obtain the following expression for the optimal manufacturing price, m_2^* , using symmetry;

$$m_2^* = (\alpha-s)(2\beta^2-\tau^2-\beta\tau)/2(2\beta^2-\tau^2) \quad (26)$$

Once (26) is substituted into (18) and (19) we have the equilibrium retail prices in terms of demand parameters and firm costs. The complete mixed outcome case is presented below.

The Mixed Outcome Case

$$\begin{aligned}
m_2^* &= (\alpha-s)(2\beta^2-\tau^2-\beta\tau)/2H \\
P_1^* &= [\alpha(\beta-\tau)(2H+\tau\beta)+s\beta(2H^2-\tau\beta^2+\tau^2\beta)]/[(2\beta-\tau)2H] \\
P_2^* &= [\alpha(\beta-\tau)(3\beta^2-\tau^2)+s\beta(\beta^2-\tau^2+\beta\tau)]/[(2\beta-\tau)H] \\
q_1^* &= [(\alpha-s)\beta(2H+\beta\tau)]/[(\beta+\tau)(2\beta-\tau)2H] \\
q_2^* &= [(\alpha-s)\beta]/[2(\beta+\tau)(2\beta-\tau)] \\
\pi_1^{MI*} &= [(\alpha-s)^2\beta(\beta-\tau)(4\beta^2-2\tau^2+\tau\beta)]/[4H^2(\beta+\tau)(2\beta-\tau)^2] \\
\pi_2^{MNI*} &= [(\alpha-s)^2\beta(\beta-\tau)(2\beta+\tau)]/[4H(\beta+\tau)(2\beta-\tau)] \\
\pi_2^{RNI*} &= [(\alpha-s)^2\beta(\beta-\tau)]/[4(2\beta+\tau)(2\beta-\tau)^2]
\end{aligned}$$

where $H=2\beta^2-\tau^2$

Table 3

4.6 The Role of Product Differentiation

The three equilibria derived in this section can be expressed in terms of the product differentiation parameter $\theta=\tau^2/\beta^2$, by substituting for τ and τ^2 in the relevant expressions. These are summarized in Appendix I where the expressions are evaluated for two extreme cases $\theta=1$, perfect substitutes, and $\theta=0$, independent goods. These are discussed in turn.

(i) Perfect Substitutes, $\theta=1$

Not surprisingly, profits are zero for all firms, for the three respective equilibria. This is a natural result of Bertrand competition for identical goods.

(ii) Independent goods, $\theta=0$

When the demands are independent for the two goods, each manufacturer is a monopolist. It is useful to depict the results for this case in figure 3. It is drawn for the symmetric case, where, $q_1=q_2=q$, and $p_1=p_2=p$, which simplifies considerably the exposition.¹⁵

The vertically integrated price is $P^I=(\alpha+s)/2$ while the equilibrium quantity is $q^I=(\alpha-s)/2\beta$ shown as VI^* obtained in the usual manner¹⁶.

For the vertically separated case the equilibrium price is $P^{VS}=(3\alpha+s)/4$ while equilibrium quantity is $q^{VS}=(\alpha-s)/4\beta$ shown as V^S . This case is the double markup solution, since the retail price is obtained by marking up retailer costs, which are the monopoly manufacturing price plus the retail selling cost.¹⁷

¹⁵. Since this is a model of differentiated substitute products, to draw a diagram in (P, q) space requires an assumption about the price and quantity of the other firm. Symmetry forces them to be identical.

¹⁶. Given the symmetric demand curve, $p = \alpha - (\beta + \tau)q$, and setting $\tau=0$ for independent goods, yields $MR = \alpha - 2\beta q$. Setting $MR=s$, where $MC=s$, the retail selling cost, and solving for q yields, $q^*=(\alpha-s)/2\beta$. Substituting into the demand curve, yields, $P^*=(\alpha+s)/2$.

¹⁷. To obtain the double markup solution, subtract s from the symmetric demand curve for independent goods, $m=p-s=\alpha-\beta q$. That is, the derived demand curve for the manufacturer is $m=(\alpha-s)-\beta q$. Set marginal revenue equal to marginal cost, which is zero, and solve for the optimal quantity, $q^*=(\alpha-s)/2\beta$. Substituting into the derived demand curve yields $m^*=(\alpha-s)/2$. The retailer sets its MR equal to the new marginal cost, $MC=m^*+s$, and solves for the equilibrium quantity, $q_r^*=(\alpha-s)/4\beta$. Substituting into the retailer's demand curve yields $p_r^*=(3\alpha+s)/4$.

The mixed outcome case is a combination of the two solutions. The integrated firm replicates the integrated solution (P^{I*} , q^{I*}) while the nonintegrated firm reproduces the double markup solution.

4.7 Mixed Outcome Case: Strategic Elements

Before the Nash equilibrium for the case of less than perfect substitutes is considered, it is useful to examine the mixed outcome case in more detail. In particular the strategic implications of a vertically integrated manufacturer competing against an independent retailer.

The precise nature of the solution to the mixed case, for less than perfect substitutes, is presented below in the following proposition.

Proposition 1 For symmetric costs and demands; integration by one firm provides it with a strategic advantage for the range $0 < \theta < 1$. That is, the mixed outcome case results in higher profits for the integrated firm than the combined profits of the independent retailer and independent manufacturer.

Proof: See Appendix

This proposition shows that for the specific demand and cost functions used, integration by one firm provides it with a strategic advantage. Integration allows the firm to maintain a lower retail price, even when products are differentiated and these lower prices translate into higher sales for the integrating firm. It is able to eliminate competition at the

manufacturing stage and therefore the deleterious effect that competition has on prices and profits for both firms.

It is useful to contrast this result with that found in Tirole (1989)¹⁸. The business strategies considered by Tirole involve a decision by an incumbent regarding a strategy to be used in the first period in order to increase profits in the second period. Corresponding to the nature of the strategy, there is generally a strategic effect and a direct effect which occur. For example, if the strategy is a choice of capacity in the first period, there will be the direct effect of increased capacity costs reducing profits and a strategic effect which arises because of the competitive advantage the increased capacity yields to the incumbent in the post-entry game.¹⁹ The optimal strategy in this and similar contexts depends also on whether accommodation or entry deterrence is more profitable. In the two stage Nash equilibria considered here, there are essentially two incumbents, both manufacturers. Their strategic variable is the manufacturing price, which if increased, will result in the direct effect of higher retail prices and lower sales for manufacturers. However, the higher manufacturing price also yields a strategic effect.²⁰ The higher retail price results in the competing retailer also setting a higher price which yields higher equilibrium retail prices and profits for retailers. This is because prices are strategic complements in this case. Furthermore, since there are no fixed costs or sunk costs, entry deterrence is impossible. In Tirole's terminology, both

¹⁸. See Tirole (1989) for a discussion of the relation of the type of strategic variable and its implication for competition. Tirole considers the incentives of an incumbent facing potential entrants in a two period game. The optimal strategy for the incumbent depends on the nature of the strategic variable used, complements or substitutes, and the relative profitability of entry deterrence or accommodation.

¹⁹. See Dixit (1979) for an analysis of the strategic use of capacity by firms in a Cournot game.

²⁰. Tirole (1989:281) defines it as the indirect change on a competing firm's price.

manufacturers are following the "fat cat" strategy, since the higher manufacturing prices raise retail prices which through the retail price competition raises rivals retail prices and ultimately manufacturer's profits. That is, the sign of the strategic effect is positive and in the case of entry accommodation, each firm should overinvest, that is choose a higher manufacturing price. The question is now what is the strategic implications of integration by one manufacturer. By vertically integrating, firm 1 now makes firm 2 the "incumbent" in a sense, who now is a "fat cat" but should rather be a "puppy dog". Essentially, integration by one manufacturer gives it is a credible commitment to pass through the manufacturing price at cost. The absence of a decision at the manufacturing stage gives the integrated firm a strategic advantage.

While the benefits to the mixed solution have been demonstrated, the important question is whether the mixed solution can be a Nash equilibrium to the game when goods are less than perfect substitutes, $0 \leq \theta < 1$. It has already been shown that it is not for independent goods.

4.8 The Nash Equilibrium to the Complete Game

The game considered in figure 2 can also be represented using the normal form which is found in table 4. This form is attractive in that it illustrates the Nash equilibrium easily and clearly. A shortcoming, however, is that it hides the underlying move structure. Therefore, reference should be made to the timing of the game to ensure that the move structure is understood. In the table are payoffs which are the payoffs to manufacturers for the respective strategy combinations.

		Manufacturer 1	
		VS	VI
Manufacturer 2	VS	π_1^{MS} π_2^{MS}	π_1^{MI} π_2^{MNI}
	VI	π_1^{MNI} π_2^{MI}	π_1^I π_2^I

Table 4

where

$$\pi_i^{MS} = [(\alpha-s)^2\beta(\beta-\tau)(2\beta+\tau)(2\beta^2-\tau^2)]/[\Phi^2(2\beta-\tau)(\beta+\tau)]$$

$$\pi_i^{MNI} = [(\alpha-s)^2\beta(\beta-\tau)(2\beta+\tau)]/[4H(\beta+\tau)(2\beta-\tau)]$$

$$\pi_i^{MI} = [(\alpha-s)^2\beta(\beta-\tau)(4\beta^2-2\tau^2+\tau\beta)^2]/[4H^2(2\beta-\tau)^2(\beta+\tau)]$$

$$\pi_i^I = [(\alpha-s)^2\beta(\beta-\tau)]/(2\beta-\tau)^2(\beta+\tau)$$

for $i=1,2$ and where $\Phi=(4\beta^2-2\tau^2-\tau\beta)$, $H=2\beta^2-\tau^2$

Using table 4 and Appendix I it is straightforward to examine the Nash equilibrium to the game played between manufacturers for two extreme cases, independent goods and perfect substitutes.

a) Independent Goods and Perfect Substitutes

Proposition 2 For symmetry in costs and demand, (i) the Nash equilibrium in the game between manufacturers involves both manufacturers integrating when goods are independent; (ii) and all cells are Nash equilibria when the goods are perfect substitutes.

Proof: See Appendix

The Nash equilibria to the game played between manufacturers has been determined for two extreme cases, independent goods and perfect substitutes. Of more general interest is the case of less than perfect substitutes, $0 < \theta < 1$.

b) Less than Perfect Substitutes

This section determines the Nash equilibria to the integration-separation game played between manufacturers for the case of less than perfect substitutes. It is assumed that manufacturers cannot use franchise fees to remove profits from retailers.²¹

Proposition 3 There is a critical value of θ , $\theta^* = .867$, such that: for symmetric costs and demands (i) there is a single Nash equilibria, both firms integrating, for the range of product differentiation $\theta < \theta^*$; (ii) there are multiple Nash equilibrium, both firms integrating and both firms separated, for a range of $\theta^* < \theta < 1$.

Proposition 3 is solved numerically to determine the nature and existence of the Nash equilibria. The only Nash equilibria is Vertical Integration by both firms when products are highly differentiated. However, as the goods become less differentiated, a second Nash equilibrium, Vertical Separation by both firms appears. It is possible to rank these Nash equilibria in terms of the profits earned by manufacturers.

²¹. This is in contrast to Bonnano and Vickers (1988) where it is assumed that perfect competition exists between potential retailers. This allows manufacturers to extract all profits from retailers.

Proposition 4 When both Nash equilibria exist, the Vertical Separation Nash equilibrium Pareto dominates the Vertical Integration equilibrium.

For degrees of product differentiation greater than the critical θ^* but less than 1, numerical solution techniques show that manufacturers always earn higher profits from the Vertical Separation equilibrium than from the Vertical Integration equilibrium.

The intuition is that as the goods become closer substitutes, the higher price brought about by Vertical Separation produces a positive strategic effect on profits which overwhelms the loss in profits that results from the double mark-up externality. For degrees of differentiation less than θ^* , the loss from the double mark-up externality is greater than the increase brought about the strategic effect.

In the next section, an alternative to vertical integration is considered, consignment selling.

4.9 Consignment Selling

Consignment Selling, the practice by which an upstream firm fixes the downstream price and pays the downstream agent a commission, has been the subject of a number of important cases in U.S. Antitrust Law. These cases exhibit the ambivalence surrounding the operation of these marketing arrangements.

In *United States v. General Electric Co et al.* 272 U.S. (1926) the Court held that the consignment arrangement used by a group of companies was not a device to fix resale prices and therefore not a violation of the Sherman Anti-Trust act. An important element of the case was the ownership of patents which gave the companies complete control over the

making of modern electric lights. The case centred upon the type of distribution system in place, in particular whether one group of agents were in fact agents and not purchasers of the lamps from the companies. If ownership remained with the company, that is, no sale was made to the agents, no charge of resale price fixing could be levied.

The plan in place was for the dealers to sell the lamps at prices fixed by the company, the dealers were to pay all expenses except original delivery charge, and to make payments periodically to the company less a fixed commission. There were additional compensations for "prompt and efficient" service. The lamps remained the property of the company, and the company assumed a number of risks from the operation. The Court decided the dealers were in fact agents, therefore no violation of the Anti-trust Act occurred.

In *Simpson v. Union Oil Co. of California* 377 U.S. (1963), the Court held that the consignment selling scheme in place was actually a coercive scheme to implement resale price maintenance and was a violation of the antitrust laws. The Union Oil Company required virtually all lessees of its retail outlets to sign a consignment agreement. The agreement lasted for a year, terminable by either party at the end of the period, and enabled the Oil Company to set the price at which the retailer sold the gasoline. The retailer bore some risks, in terms of damage insurance, but the title to the gasoline remained with the Oil Company. Simpson was compensated by a minimum commission and paid all costs of operation of the retail outlet.²²

²². The compensation scheme was slightly more complicated than a fixed commission. Specifically, "the basic agreement in force during most of the period when Simpson was a consignee provided that his commission was 1 1/2 cents per gallon more than the amount by which the price at which the company "authorized" him to sell exceeded a posted "tank wagon" price applicable to those gallons. However, if the "authorized" price fell below a posted "minimum retail", the commission was reduced by 50% of the difference between "minimum retail" and "authorized" retail. In no event could the commission be less than 5.95 cents for regular and 5.75 cents for ethyl.

The case arose because Simpson, while instructed by the company to sell the gasoline at 29.9 cents per gallon, sold it at 27.9 cents per gallon, allegedly to meet a competitor's price. In response, the Union Oil Company refused to renew the lease.

An examination of these two cases reveals the consignment selling schemes to be fairly complex contractual arrangements. However, both arrangements feature the upstream firm setting the retail price and the downstream agent receiving a commission per unit. That is the sense in which consignment selling is used in what follows.

A number of specific equilibria regarding consignment selling are considered in the next section. Specifically these are (i) Consignment selling plans by both Manufacturers, (ii) Unilateral Use of Consignment Selling Plans.

a) Consignment Selling Plans by Both Manufacturers

In the arrangement considered here, manufacturers can select both manufacturing and retail prices which determines the degree of rent sharing between the two stages of distribution. Since there is no advantage to leaving rents at the retail stage in this model, it follows trivially that the relationship between the manufacturing and retail price is given as $P_i = m_i + s$. That is, the retail price exactly equals the retailer's marginal cost leaving zero profits for retailers.

Because of this relationship, we can view manufacturers as picking either m_i or P_i to maximize $\pi_i^M = m_i q_i$ for $i=1,2$. The retail equilibrium corresponding to this problem is

Shortly before Simpson ceased to be a consignee the program was changed. The guaranteed minimum was eliminated and the consignee absorbed 20% of the difference if "authorized" prices fell below "minimum retail". If the "authorized" price exceeded "minimum retail," the commission increased by 80% of the excess, as compared with 100% thereof under the former plan." Simpson v. Union Oil Company, 377 U.S. p. 21.

illustrated in figure 4. If we consider the manufacturers choosing P_i , the first order conditions are, assuming Bertrand-Nash conjectures:

$$\partial \pi_1^M / \partial P_1 = (P_1 - s) \partial q_1 / \partial P_1 + q_1 = 0 \quad (27)$$

$$\partial \pi_2^M / \partial P_2 = (P_2 - s) \partial q_2 / \partial P_2 + q_2 = 0 \quad (28)$$

As can be seen, the first order conditions are identical to the first order conditions for the noncooperative vertical integration solution (7) and (8). Consignment selling gives the manufacturer all the control of vertical integration.

Substituting for q_1 and q_2 , expressions (4') and (5'), yields the reaction functions in retail price space.

$$P_1 = [\beta s + \alpha(\beta - \tau) + \tau P_2] / 2\beta \quad (29)$$

$$P_2 = [\beta s + \alpha(\beta - \tau) + \tau P_1] / 2\beta \quad (30)$$

Solving simultaneously, yields the following equilibrium consignment selling price.²³

$$P^{CS*} = [\alpha(\beta - \tau) + \beta s] / (2\beta - \tau) \quad (31)$$

Recalling that $m^* = P^{CS*} - s$, yields

$$m^* = [(\alpha - s)(\beta - \tau)] / (2\beta - \tau) \quad (32)$$

$$q^* = [\beta(\alpha - s)] / (\beta + \tau)(2\beta - \tau) \quad (33)$$

$$\pi^{M*} = [\beta(\beta - \tau)(\alpha - s)^2] / (\beta + \tau)(2\beta - \tau)^2 \quad (34)$$

²³. If the consignment selling plans are chosen collusively, the equilibrium is $P^* = (\alpha + s)/2$, $m^* = (\alpha - s)/2$ and $\pi^M = (\alpha - s)^2 / [4(\beta + \tau)]$. This is equivalent to case of collusion by vertically integrated firms, see footnote 8.

By a comparison of the relevant terms, it is easy to show that this result is identical to the vertical integration case. Having each manufacturer pick the retail price, noncooperatively, has allowed manufacturers to replicate the vertical integration outcome.

b) Unilateral Adoption of a Consignment Selling Plan

Suppose one manufacturer adopts a consignment selling plan, that is, one manufacturer picks the retail price in competition with the other retailer. Manufacturer one chooses, P_1 to maximize,

$$\pi^M_1 = (P_1 - s) q_1, \text{ where } m_1 = P_1 - s \text{ has been substituted.}$$

The first order condition is

$$\partial \pi^M_1 / \partial P_1 = (P_1 - s) \partial q_1 / \partial P_1 + q_1 = 0 \quad (35)$$

The second retailer, chooses P_2 to maximize, $\pi^R_2 = (P_2 - m_2 - s_2) q_2$.

The first order condition is

$$\partial \pi^R_2 / \partial P_2 = (P_2 - m_2 - s_2) \partial q_2 / \partial P_2 + q_2 = 0 \quad (36)$$

The reaction functions associated with (29) and (30) are the following:

$$P_1 = s/2 + \alpha(\beta - \tau)/2\beta + \tau P_2/2\beta \quad (37)$$

$$P_2 = (m_2 + s)/2 + \alpha(\beta - \tau)/2\beta + \tau P_1/2\beta \quad (38)$$

Solving (37) and (38) simultaneously, yields

$$P_1^* = [(2\beta + \tau)(\beta - \tau)\alpha + (2\beta + \tau)\beta s + \beta \tau m_2]/(4\beta^2 - \tau^2) \quad (39)$$

$$P_2^* = [(2\beta^2 m_2 + \beta(2\beta + \tau)s + (\beta - \tau)(2\beta + \tau)\alpha)/(4\beta^2 - \tau^2) \quad (40)$$

The result is the same as that obtained from a vertically integrated firm competing against an unintegrated firm.

Substituting (39) and (40) into (5') yields the quantity sold for the second firm.

$$q_2 = B(B-\tau)(\alpha-s)/[\sigma(2B-\tau)] + B(\tau^2-2B^2)m_2/[\sigma(4B^2-\tau^2)]$$

Determining the choice of m_2 , by the second manufacturing firm, by maximizing $\pi_M^2 = m_2 q_2$, yields,

$$m_2^* = [(2B^2-\tau^2-B\tau)(\alpha-s)]/2(2B^2-\tau^2)$$

which is equivalent to (26), the manufacturing price chosen by an unintegrated manufacturer competing against an integrated firm. Since the retail prices are equivalent, all prices, and profits remain equivalent to the integrated firm competing against an unintegrated manufacturer and retailer. As can be seen, the use of a consignment selling plan has allowed a manufacturer to replicate the vertical integration solution.²⁴

²⁴. Note, however, that this may not be an equilibrium to a consignment selling-vertical separation game on the part of manufacturers.

4.10 Conclusion

The analysis contained here can be contrasted with that of Bonanno and Vickers (1988). They show that it is more profitable for manufacturers if they both vertically separate, that is, if they are both represented by independent agents, if strategic complements are considered. As is well known, prices are strategic complements under Bertrand competition and Bonanno and Vickers assume linear reaction functions. Using the same demand structure, I obtain this only when products are close substitutes. I show that manufacturers prefer to vertically separate when products are close substitutes; however, I obtain an additional Nash equilibrium, both firms vertically integrating when the goods are relatively imperfect substitutes. That is, I obtain multiple Nash equilibria which can be ranked according to the Pareto criterion. When the demands for the goods are relatively independent, but still strategic complements, the only Nash equilibrium is for both firms to vertically integrate. The Bonanno and Vicker's result depends on the assumption that manufacturers use franchise fees to extract rents from retailers. The results obtained here can also be contrasted with those of Lin (1988). He also obtains two Nash equilibria in a vertical separation-vertical integration game between manufacturers. Using a spatial model, he finds that vertical separation is also more profitable for manufacturers and argues the vertical integration result is unstable. I find that the vertical integration result is a Nash equilibrium when products are highly differentiated.

In addition, I show the vertical integration-separation game is equivalent to the practice of consignment selling. The strategic implications are equivalent, and result in the same equilibria, as the formal integration-separation decision.

Figure 1: Retail Reaction Functions
Vertical Separation versus Vertical Integration

Figure 3: Manufacturer Reaction Functions
Bertrand–Nash Competition

Figure 4: Independent Demands
Vertical Separation versus Vertical Integration

Appendix I. The Role of Product Differentiation.

I. Vertical Integration Solution

$$\begin{aligned} P_I^* &= [\alpha(1-\theta^{1/2}) + s]/(2-\theta^{1/2}) \\ q^{I*} &= [(\alpha-s)/[\beta(1+\theta^{1/2})(2-\theta^{1/2})] \\ \pi^{I*} &= [(\alpha-s)^2(1-\theta^{1/2})]/[\beta(1+\theta^{1/2})(2-\theta^{1/2})^2] \end{aligned}$$

	$\theta=0$	$\theta=1$
P^{I*}	$(\alpha+s)/2$	s
q^{I*}	$(\alpha-s)/2\beta$	$(\alpha-s)/2\beta$
π^{I*}	$(\alpha-s)^2/4\beta$	0

II. Vertical Separation Solution

$$\begin{aligned} m^{N*} &= [(\alpha-s)(2-\theta-\theta^{1/2})]/(4-2\theta-\theta^{1/2}) \\ P^{N*} &= [\alpha(1-\theta^{1/2})(6-\theta) + s(2-\theta)]/[(2-\theta^{1/2})\Omega] \\ q^{N*} &= [(\alpha-s)(2-\theta)]/[\beta(2-\theta^{1/2})(1+\theta^{1/2})\Omega] \\ \pi^{MN*} &= [(\alpha-s)^2(1-\theta^{1/2})(2+\theta^{1/2})(2-\theta)]/[\beta(2-\theta^{1/2})(1+\theta^{1/2})\Omega^2] \\ \pi_R^{N*} &= [(\alpha-s)^2(1-\theta^{1/2})(2-\theta)^2]/[\beta(2-\theta^{1/2})^2(1+\theta^{1/2})\Omega^2] \end{aligned}$$

where $\Omega = (4-2\theta-\theta^{1/2})$

	$\theta=0$	$\theta=1$
m^{N*}	$(\alpha-s)/2$	0
P^{N*}	$(3\alpha+s)/4$	s
q^{N*}	$(\alpha-s)/4\beta$	$(\alpha-s)/2\beta$
π_M^{N*}	$(\alpha-s)^2/8\beta$	0
π_R^{N*}	$(\alpha-s)^2/16\beta$	0

III. The Mixed Outcome

$$\begin{aligned}
m_2^* &= (\alpha-s)(2-\theta-\theta^{1/2})/2(2-\theta) \\
P_1^* &= [\alpha(1-\theta^{1/2})(4-2\theta+\theta^{1/2}) + s(4-\theta-\theta^{1/2})]/[2(2-\theta^{1/2})(2-\theta)] \\
P_2^* &= [\alpha(1-\theta^{1/2})(3-\theta) + s(1-\theta+\theta^{1/2})]/[(2-\theta^{1/2})(2-\theta)] \\
q_1^* &= [(\alpha-s)(4-2\theta+\theta^{1/2})]/[2\beta(1+\theta^{1/2})(2-\theta^{1/2})(2-\theta)] \\
q_2^* &= (\alpha-s)/[2\beta(1+\theta^{1/2})(2-\theta^{1/2})] \\
\pi_1^{M*} &= [(\alpha-s)(1-\theta^{1/2})(4-2\theta+\theta^{1/2})^2]/[4\beta(1+\theta^{1/2})(2-\theta)^2(2-\theta^{1/2})^2] \\
\pi_2^{M*} &= [(\alpha-s)^2(1-\theta^{1/2})(2+\theta^{1/2})]/[4\beta(2-\theta)(1+\theta^{1/2})(2-\theta^{1/2})] \\
\pi_2^{R*} &= [(\alpha-s)^2(1-\theta^{1/2})]/[4\beta(1+\theta^{1/2})(2-\theta^{1/2})^2]
\end{aligned}$$

	$\theta=0$	$\theta=1$
m_2^*	$(\alpha-s)/2$	0
P_1^*	$(\alpha+s)/2$	0
P_2^*	$(3\alpha+s)/4$	s
q_1^*	$(\alpha-s)/2\beta$	$(\alpha-s)3/4\beta$
q_2^*	$(\alpha-s)/4\beta$	$(\alpha-s)/4\beta$
π_1^{M*}	$(\alpha-s)^2/4\beta$	0
π_2^{M*}	$(\alpha-s)^2/8\beta$	0
π_2^{R*}	$(\alpha-s)^2/16\beta$	

Proofs:

Proposition 1. Proof: Taking the ratio of $\pi_i^{MI}/(\pi_j^{MNI} + \pi_j^{RNI})$ for $i=j$ and cancelling terms yields, expressed in terms of the product differentiation parameter, the condition that integration by one manufacturer produces higher profits for that firm then the independent manufacturer and retailer if

$$\frac{\pi_i^{MI}/(\pi_j^{MNI} + \pi_j^{RNI}) = (16-15\theta+8\theta^{1/2}-4\theta^{3/2}+4\theta^2)}{(12-10\theta+2\theta^2)} > 1$$

which is true for $0 \leq \theta \leq 1$. QED.

Proposition 2. Proof: (i) The respective profit functions are depicted in table 5.

		Manufacturer 1	
		VS	VI
Manufacturer 2	VS	$\pi_1^M = (\alpha-s)^2/8\beta$ $\pi_2^M = (\alpha-s)^2/8\beta$	$\pi_1^M = (\alpha-s)^2/4\beta$ $\pi_2^M = (\alpha-s)^2/8\beta$
	VI	-	$\pi_1^M = (\alpha-s)^2/4\beta$ $\pi_2^M = (\alpha-s)^2/4\beta$

Table 5

It is easy to show that a mixed outcome, VI by manufacturer 1 and VS by manufacturer 2, for example, is not a Nash equilibrium. If manufacturer 1 is vertically integrated, manufacturer 2 earns $(\alpha-s)^2/8\beta$ if it is vertically separated. If instead manufacturer 2 integrates it earns $(\alpha-s)^2/4\beta$, which is greater, therefore the cell in the northeast corner cannot be a Nash equilibrium. A similar argument holds for the mixed outcome VS by manufacturer 1 and VI by manufacturer 2.

Similarly the cell, VS-VS is not a Nash equilibrium, since if manufacturer 2 is vertically separated then manufacturer 1 earns more profits from integrating, therefore VS-VS cannot be a Nash equilibrium. Since unilateral deviation from the VI-VI results in a reduction in profits, therefore VI-VI is a Nash equilibrium.

(ii) For perfect substitutes all cells are zero. Therefore all cells are Nash equilibria. This completes the proof QED.

Proposition 3. Proof: (i) Consider first mixed outcomes. A comparison of the expressions for π_i^{MI} and π_i^I reveals that if a manufacturer's rival is integrated it will always pay for it to integrate as well, since $\pi_i^I \geq \pi_i^{MI}$. This condition guarantees that integration by both firms is always a Nash equilibrium. However, vertical separation by both firms will also be an equilibrium if $\pi_i^{MI} < \pi_i^{MS}$ or

$$\frac{\pi_i^{MI}}{\pi_i^{MS}} = \frac{[(4-2\theta+\theta^{1/2})^2 (4-2\theta-\theta^{1/2})^2]}{[4(2-\theta)^3(4-\theta)]} < 1$$

Solving this numerically reveals that (VS,VS) will be a Nash equilibrium if $\theta > .867$. Thus $\theta^* = .867$.

Proposition 4. Proof: The condition for the relative profits for the two Nash equilibria is given as

$$\frac{\pi^{MS}}{\pi^I} = \frac{(2-\theta)(4-\theta)}{(4-2\theta-\theta^{1/2})^2}$$

which is greater than 1, for all $\theta > \theta^* = .867$.

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