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Analysis of national brand - store brand competition

Sethuraman, Rajagopalan, Ph.D.

Northwestern University, 1989

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ANALYSIS OF

NATIONAL BRAND - STORE BRAND COMPETITION

A DISSERTATION

SUBMITTED TO THE GRADUATE SCHOOL
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

for the degree

DOCTOR OF PHILOSOPHY

Field of MARKETING

By

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EVANSTON, ILLINOIS

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ABSTRACT

ANALYSIS OF

NATIONAL BRAND - STORE BRAND COMPETITION

RAJAGOPALAN SETHURAMAN

This dissertation analyzes the competition between national brand and store brand using simple game-theoretic models. It attempts to answer the following questions: What is the incentive for a retailer to carry a store brand? Why do we see store brands pervasive in certain product categories and not in certain others? Are they mechanisms through which the retailer gains channel control? What pricing strategy should the retailer adopt with respect to the national brand and the store brand? What impact does the presence of a store brand have on the marketing strategy of the national brand manufacturer?

The model focuses on two parameters - the level of price competition or the price substitutability, and the level of advertising competition or the advertising sensitivity. The analysis of the models identify the conditions under which it would be most beneficial for the retailer carrying a store brand. Specifically, it is shown that the higher is the price substitutability and the lower

is the advertising sensitivity of the store brand, the higher are the channel profits and channel power for the retailer. An intuitive free-rider explanation is provided for these results. The strategic implications for the retailer and the manufacturer are also discussed.

From the model, several empirically testable hypotheses are derived that relate store branding (measured by market share of store brands and number of retailers carrying a store brand) to market characteristics. Specifically, we hypothesized that there is a positive relationship between store branding and price competition and a negative relationship between store branding and advertising competition. Our preliminary cross-category analysis results show that there is some evidence to believe that store branding and price sensitivity are positively related. But there is mixed evidence regarding the relationship between store branding and advertising competition.

TO

MY FATHER

late SHRI. G. SETHURAMAN

He did not invest in Stock

He did not invest in Bond

He invested in His Kids

Of whom He was Fond

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It gives me pleasure to write this first page of the dissertation which hopefully marks the culmination of the thesis work. Two professors who have guided me throughout the execution of this project and are instrumental in bringing this thesis to the current state are, my chairperson Anne Coughlan, and Birger Wernerfelt. I thank Anne for her patient and intense scrutiny of my sometimes almost non-readable drafts and guiding me particularly when things looked gloomy. Her ability to think broadly and intuitively, provided direction for this project. Birger was always ahead of me in my own work and I thank him for his sharp thinking which helped me overcome some of the technical difficulties.

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Outside of academia, I thank my wonderful wife Madhu who married me recently without knowing what she was getting into. Every evening, when I came home, she asked if I made any progress with my thesis. On several occasions, I couldn't think of a number greater than zero. I thank her for being patient and understanding. Finally, I thank my dear father for giving me the mental support during the initial phase of my education. He always wondered when I would grow up. Unfortunately, he couldn't wait long enough to see me graduate.

All remaining errors and omissions are, of course, my responsibility. May be the nose is twitched a little, may be it's a little rough on the edges, but.. it's my baby and I'm proud of it.

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CHAPTER I

INTRCDUCTION

> **There was a time, about 40 years ago, when manufacturers of goods themselves determined the marketing strategies behind their products. Making use of the power of their brands, these companies sought to motivate consumers to buy their products through the then passive trade distribution system .. Now, however this formula of brand differentiation and mass advertising .. is drastically losing ground. The distribution is assuming a much bigger role.**

Achenbaum and Mitchell, Harvard Business Review, May-June 1987, p. 38.

Marketing practitioners and marketing scholars (Stern and El-Ansary 1982, Cohen and Jones 1978) have emphasized the fact that, in the past three decades, retailers have begun to play an increasingly important role in the total marketing process, and are gaining market power over well established manufacturers. This shift in the balance of power has been highlighted in the cover story of a recent Marketing News edition (Felgner 1989). There are a number of factors which have led to this changed marketing environment:

1. increased concentration at the retail level.
2. increased competition at the manufacturer level.
3. increased use of sophisticated management tools and techniques by the retailers.
4. improved information collection systems at the retail

level.

5. retailer's ability to introduce a competing brand of its own.

These marketers call for an explicit consideration of the retailers' role when manufacturers decide on their brand strategy (Farris and Albion 1980). However, literature in mainstream marketing that specifies brand strategies for the manufacturer (Lilien and Kotler 1983, Kotler 1984, Day 1985) has generally concentrated on the manufacturer - consumer interface and has ignored the role of the intermediary. A perusal of modeling literature in industrial organization (Friedman 1977) also indicates that competition is often modeled as a game between manufacturers where distributors play no part. It has now become increasingly important, both from the manufacturers' perspective and from a total marketing perspective, that we acknowledge the presence of the retailer and explicitly incorporate it in our understanding of the marketing process.

One phenomenon in this process that has witnessed tremendous growth in the past three decades is the phenomenon of store branding. Store brands (or private labels) are brands marketed by a retailer under a brand name owned by the retailer. Currently sales of store brands account for about 12% of the total dollar sales in grocery items (Private Label and Generic Analysis Report 1988) and

is widely prevalent in durable goods and even in some in some industrial goods as well. This pervasiveness and proliferation of store brands has generated great interest among retailers, manufacturers and public policy makers.

The government has been closely monitoring the performance of store brands to identify the implications of store branding for manufacturers and retailers, and to understand if it is in the interest of the consumers to have several store brands. In a thorough analysis of the food marketing industry, the National Commission for Food Marketing seeks to understand the role of store brands in the present day marketing context (Report of the National Commission for Food Marketing 1966). They concluded that private labels are carried by retailers primarily in standard or generic product categories in order to gain higher product margins.

The proliferation of store brands has been of great concern to the manufacturers of national brands. Consumer goods marketers with heavy financial investments in branded items have been increasingly concerned about the channel power that retailers have been able to gain by selling merchandise under their own labels. Retailers, on their part, are themselves trying to understand in which product categories they should introduce store brands and what strategies they should adopt with respect to the store brand

and the national brand. A case in point is the indiscriminate store branding strategy adopted by The Great Atlantic and Pacific Co. (A&P) in the 1970s (Giges 1974). A&P since had to cut back on its store brand production and resort to selective store branding.

In summary, the following specific questions seem to be of interest to marketers:

1. Why do store brands exist?
2. What is the incentive for a retailer to carry a store brand?
3. Why do we see store brands pervasive in certain product categories and not in certain others?
4. Are they mechanisms through which retailers manipulate the manufacturers of national brand manufacturers in some sense or gain higher channel profits?
5. Or, are they merely brands with the specific purpose of catering to a generic price sensitive market segment?
6. What strategy does the retailer adopt with respect to the national brand and the store brand?
7. What impact does the presence of a store brand have on the marketing strategy of the national brand manufacturer?

Several researchers have hypothesized that the retailer

can gain market power by introducing a store brand (Stern 1966, Industry Week 1975). This notion attains special significance in light of Porter's theory on market power (Porter 1974, 1976). According to Porter, in a frequently purchased convenience goods industry, a manufacturer with strong demand pull obtained through advertising will absorb power from the retailer and will garner all channel profits. This suggests that perhaps retailers may be able to develop some countervailing mechanism through which they can gain power and thus garner a higher share of channel profits. One likely mechanism is the ability to sell a store brand and to set the retail price of the widely advertised national brand and the store brand in such a way that he gets the maximum benefit. This calls for investigation of the competition between a national brand and a store brand that includes the manufacturer -retailer interface. Farris and Albion (1980) have also emphasized the need for an expanded model incorporating the retailer's role for understanding the phenomenon of store brands. Most models in industrial organization and marketing that have attempted to analyze competition between national brands and store brands have not considered the retailer - manufacturer interface. The only exception is the recent work by Lattin (1987). But his major emphasis is on price promotion. He examines the nature of promotional pricing arrangements

between the manufacturer and the retailer in the presence and absence of store brand competition. He finds that in the absence of store brand competition manufacturers will never offer trade deals to the retailers. When a store brand is present, manufacturers of those brands which do not enjoy high brand loyalty will offer trade deals to achieve favorable retail pricing.

The objective of this thesis is to provide an analytical investigation of the competition between national brands and store brands and provide answers to the questions raised above. The specific focus of our analysis will be to understand the market conditions under which the retailer gains higher overall profits and a higher share of total channel profits (a measure of channel control) by introducing a store brand. Based on the analysis, we will derive implications regarding proliferation of store brands and the strategies for the national brand manufacturer and the retailer. We will also derive some empirically testable hypotheses regarding store brands and test them. We believe this theoretical development backed by some empirical evidence will enhance our understanding of the phenomenon of store branding, and its marketing implications.

The rest of this dissertation is organized as follows. In chapter II, we review the mainstream literature on national brands and store brands, and some related studies

in marketing channels and industrial organization. The purpose of this chapter is to motivate the analysis of national brand - store brand competition and show that the issue has not has not been adequately addressed by the extant literature. In chapter III, we provide the basic models which address the questions raised, and discuss the results obtained. In chapter IV we extend the basic models and test the robustness of the results with respect to relaxation in model assumptions. In chapter V, we derive some hypotheses regarding proliferation of store brands and provide some empirical evidence. In chapter VI, we provide our conclusions from the theoretical and empirical analysis and discuss future research directions.

CHAPTER II

LITERATURE REVIEW

2.1. Introduction

The literature review will cover the following three broad areas related to national brand - store brand competition:

1. Literature on Store brands: We will review some of the important literature on the practice and extent of store branding as well as discuss some theories proposed about the phenomenon.
2. Literature in industrial organization on advertising and market power: Here we will review the relevant literature on the interaction of advertising and market power, and provide a motivation for the issues we have raised.
3. Literature in marketing channels: The literature in marketing channels is growing. The purpose here will be to show that the issue of store branding has not been adequately emphasized by the extant literature.

There have been several definitions and interpretations provided for the terms national brand, store brand and market power or channel power. Before proceeding with the literature review we would provide some formal definitions that will form the basis for our ensuing discussion.

2.2. Definitions

National Brand : Manufacturer's or producer's brand of merchandise having wide distribution and supported by heavy advertising and/or promotion nationally to the public. We will use the terms manufacturer's brand, producer's brand and national brand interchangeably. The term "manufacturer" will connote the manufacturer of the national brand.

Store Brand or Private Label: Merchandise packaged mainly to a retailer's specifications either by a retailer or by a manufacturer for resale only by a retailer, under a brand name owned by a retailer. Store brand, retailer's brand and private label are synonymous by our definition.

Conceptualization and Measurement of Channel Power

Researchers dealing with behavioral aspects of marketing channel relationships have extensively studied the concepts of channel power and control (see Gaski 1984 for a recent review). A number of definitions and operationalizations have been provided. According to Wilemon (1972), power refers to the ability of one channel member to induce another channel member to change his behavior in favor of the objectives of the channel member exerting influence. According to El-Ansary and Stern (1972), the power of a channel member is his ability to control the decision variables in the marketing strategy of another member in a given channel. The concept of power has

been operationalized in many ways and power has been measured primarily through self-reports. In the industrial economics and game theory literature, power has been conceptualized in terms of the ability of one's action to affect or change the economic returns of another. Power has been operationalized through performance measures like return on investment, profits and relative profits of the parties involved in the transaction (Porter 1974). Consistent with this, our operational definition of channel power or channel control is based on performance measures: specifically, profits. We define a member's share of the total channel profits as an index of his channel power or control. We will use market power, channel power and channel control interchangeably to connote the proportion of total channel profits accruing to the channel members.

2.3. Literature on Store Brands

2.3.1. Practice and Extent of Private Labeling

There is an abundance of literature written by marketing practitioners and scholars on the aspect of store branding. Most of the early works were done in the sixties when people began to take serious note of the phenomenon. Three important and comprehensive studies were done during this time.

As a part of understanding the overall food marketing

system, the National Commission for Food Marketing conducted an extensive survey on private labels to

a. estimate the extent and importance of private labeling in food distribution.
b. assess the pricing, merchandising and gross profitability of private label goods.
c. determine consumer's attitudes towards store brands.

In general, their findings have been as follows:

- A large number of private label products are concentrated in a small number of product categories, the most important ones being: canned fruits and vegetables, dairy products, bakery products, coffee, salad dressings, milk and peanut butter.
- Most of the important private label products can be classed as standard products. They have been on the market for a relatively long period and there is very little scope for differentiation among brands in those categories.
- There is a relatively strong advertising and promotion program for the branded counterpart of the private label.

On the aspect of pricing, merchandising and profitability, the food commission reported the following:

- the average retail prices of the store brand were lower than those of the national brand in almost all cases.
- the price differential between the national brand and the store brand varied from 5% to 40%.
- In general, there were more price specials on the store brand than on any one national brand.
- retailers did not give more advantageous shelf position to store brands relative to advertised brands.
- The retailer's average gross margin was about 2.4% higher for the store brand than for a national brand. The gross profits and sales per facing were poorly measured and had a wide variation.

When retailers were asked why they introduced a store brand, several reasons were given:

- our competitors stock private label
- we obtain greater profits from the store brand
- provides variety to the consumer
- develops consumer loyalty to the retailer

Though this report is dated, by and large, it still reflects the trends in store branding. We still find store brands offered in predominantly standard categories and they are typically lower priced than national brands. More recently Marketing News (1985) has stressed the point that the

quality of private label creates consumer loyalty for the label and for the retailer who sells it.[1]

One of the most comprehensive articles on store branding in the sixties was by written by Stern (1966). In this article Stern suggests several reasons why retailers have resorted to store brands. He calls this phenomenon the "new world of private brands," and affirms that private labels are here to stay and will grow. Manufacturers will have to recognize and respond to the increasing prevalence of private branding. According to him there appear to be two primary determinants of private label introduction form a retailer's viewpoint:

- The extent to which a product has become a "commodity". By commodity, he refers to undifferentiated products for which strong generic consumer demands have been established and are typified by a high level of consumer switching based on price, high retail sales volume and rapid in-store turnover.

Private labels are being sought after and accepted by many retailers capable of generating high turnover for generically used products, a notion that has been observed

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[1] No further reports were done by the food commission since 1966. In fact, a congressional committee decided against setting up a similar commission in 1976.

by the food commission, and many others. When such is the case, Stern remarks, the manufacturers should do everything possible to differentiate the product in real terms by innovation and product research, or resort to dual branding.[2]

- The level of manufacturer's gross margins and concomitantly, the level of wholesale and retail prices.

A retailer can determine through trade sources whether or not the cost of making a product is low relative to its wholesale price. If it is, then the profit margin remaining represents the "gains" of the manufacturers which can be, in part, garnered by the retailer through the introduction of a private label on which relatively little promotional money may be expended.

Under the aegis of the Marketing Science Institute, Cook and Schutte (1967) conducted an extensive study on brand proliferation. Unlike the food commission report, they cover food and non-food items and the crux of their report is private branding and its implications for the manufacturer's brand policy. They identified trends in store branding with respect to several economic and market

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[2] Dual branding refers to the brand policy where the manufacturer produces and sells both a national brand and a private label.

characteristic variables. They find

- a positive relationship between store brand share and concentration in production
- a negative relationship between store brand share and advertising/sales ratio
- that private brands have their maximum market share in product categories which are in the mature or decay stages of the product life cycle.

This is in line with earlier observations that private labels make the most dent in standard products. However, their observations about the pattern of growth of store brands is interesting. First, private branders seem to capitalize on favorable trends in market demand. When product demand is growing at an increasing rate, so is private brand share, and often at a faster rate than product demand itself. Second, whatever inroads private brands are going to make will probably be made during the growth stage of the product life cycle, rather than when the product becomes a fixed part of consumption pattern. That is, they typically grow in the initial phase, make most in roads in the growth phase of the product category life cycle, and remain steady during the mature and decline phase. This is interesting and slightly different from popular belief that private labeling is generally dormant in the growth stages

of the product life cycle and enjoys a high level of growth when the product has matured.

- Distributors would resort to store branding if the expected product demand is greater than a threshold volume and if the gross margins are high.

There have been some changes in private labeling trends in recent times. Store brands have spread to other non-traditional items like electronic goods and fashion goods. Salmon and Cmar (1987) assert that strong brand names and private labels, originally confined mainly to packaged goods businesses, have become very important in durable goods like appliances, computer equipment and even in the fashion clothing industry. However, they observe, there have been contradicting developments in the private label industry. Macy's has boosted its private label sales from 6% in 1980 to 20% in 1986, and currently has more than 50 in-house brands. The Limited sells 70% under private label. However, Sears and JC Penney are adding more national brands into their assortment and deemphasizing their store brands. Safeway, Kroger and A&P are also changing their product mix, and are reemphasizing national brands.

The reasons for these contradictory developments may be many. In this age of heterogeneous life-styles, many

customers prefer to shop in mall-oriented specialty chains targeted to their specific needs. Specialty retail chains are especially well suited to developing targeted private label merchandise. With the improved information technology available with them, they can thoroughly research the customers' needs and focus their buying, design, and procurement functions on a limited range of styles. In contrast to specialty stores, Sears and Penney cater to a wide spectrum of consumers. As a result of efforts to appeal to everybody, much of their private label merchandise has turned out to be unexciting. Such an assortment appealed to a declining portion of the American public. To repair this damage, they have added national brands to their assortments. In the food industry, however, retailers had to add national brands for different reasons. In order to boost their margins, many retailers acquired facilities to produce store brands. But failure to keep up with technology and difficulty in attracting top-flight manufacturing talent to these essentially non-manufacturing businesses diminished their competitiveness and reduced their overall product profitability. Hence retailers like Safeway and Kroger have shifted their assortments to put more emphasis on national brands and less on their own brands.

In summary, the phenomenon of store branding is in a

state of flux. While retailers have benefited from store brand introduction, many have been cautious about indiscriminate store branding. The phenomenon of store branding on the one hand raises questions for the manufacturer trying to cope with the competitive threat, and, on the other hand, raises issues for the retailer regarding his store brand strategy.

2.3.2. Theories of Store Branding

Market Segmentation Theory

Perhaps the most popular among existing theories on store branding is the notion of market segmentation at the retail level. In general, the basic distinction between national brands and store brands lies in the differences in the pricing and promotional strategies adopted. Store brands are lower in price and promoted locally. National brands are higher in price and promoted nationally. It is a simple step to the market segmentation notion that consumers who respond to store brands are those more readily influenced by a price appeal than by a promotional appeal. So, the purpose of a store brand is to corner a generic price sensitive and promotion insensitive segment (Stern 1966).

This popular segmentation notion does not explain the fact that we see store branding in several durable goods

industries and that we observe several retailers increasing the promotional support for their store brand. It also does not explain large retailers like Sears and The Limited promoting their store brands at the national level.

Price Discrimination Theory

Economic theory suggests that differential price elasticity, that is, a tendency for one group of consumers to respond to a price change differently from another group, is a potentially useful criterion for segmentation, particularly in low cost consumer goods. Hence, introducing a store brand is a mechanism by which national brand manufacturers price discriminate between consumers with different elasticity. According to proponents of this theory, it would explain why some national brand manufacturers would resort to dual branding. The Federal Trade Commission (FTC) used this explanation to bring charges of price discrimination against manufacturers who resorted to dual branding.[3]

A classic case related to this theory is the FTC vs. Borden case. In 1962, the FTC originally found that Borden sold evaporated milk of identical quality under private

[3] See for example cases against Hansen Inoculator Co., Inc., FTC Decisions Vol 26, p.303-311; against U.S. Rubber Co., FTC Decisions, Vol 28, p. 1489-1506.

labels and its own brand name, and charged Borden with price discrimination, a violation of section 2 of the Robinson-Pattman act. In 1964, the appeals court reversed the ruling and said that, "manufacturer's evaporated milk which bore manufacturer's own label and manufacturer's evaporated milk which bore private brand labels were not products of 'like grade and quality' .. where manufacturer's brand name had demonstrable commercial significance." (Borden company vs FTC 1964)

Even though the court ruled against FTC, manufacturers practicing dual branding must be aware of the potential legal consequences of producing private labels to be sold at a significantly lower prices than physically identical branded items.

Retailer Power Theory

According to this theory, retailers gain leverage through store branding and the pricing and merchandising independence that go with it. Manufacturers expending large sums of money on various forms of selling and advertising effort enjoy substantial gross profits on the sale of their products. Their materials and factory production costs may be relatively small compared to the wholesale prices they charge. Such monopoly power stems from two abilities:

- the physical ability to develop and to produce an

item efficiently.

- the intangible ability to differentiate that item through consumer advertising and other promotional merchandising mechanisms.

The existence of a store brand will neutralize and reduce the monopoly power of the manufacturer. Retailers have found that private labels are a useful weapon in gaining concessions from national brand manufacturers as well as a good tool for increasing their overall profits (Dubbs 1965, Stern and El-Ansary 1988). However, this theory is advanced more on the basis of observation than on any theoretical underpinnings. It is not clear if the existence of private labels per-se results in power for the retailer. It is important to know how the introduction of private labels enhances the market power of the retailer. In this dissertation, we will provide some models to test this hypothesis and trace the process by which retailers would gain leverage by introducing a store brand.

Exploitation of Fringe Firms Theory

There are two types of firms in a given industry: the core firms and the fringe firms. The core firms are those manufacturers who produce and market brands which are highly differentiated from other brands in the market. These brands typically have high market shares and command high

brand loyalty. The fringe firms, on the other hand, produce brands which have little differentiation from other brands in the market. They are typically small manufacturers who do not have any brand loyal segment.

According to this theory (Porter 1976), manufacturers of strongly differentiated products (core firms) enjoy high bargaining power vis-a-vis the retailer and would not make any trade concessions. This reduces the margins of the retailer. However, retailers can demand and obtain trade concessions from the fringe firms. By selling these brands under their own name, they can decide on the pricing and merchandising strategy of these brands and thus increase their margins. The fringe firm manufacturer is forced by his lack of bargaining power to accept the status of producing for private label distributors.

The private label producing small manufacturer faces severe competition because of ease of entry and lack of product differentiation and also must bargain with economically powerful buyers. Even with this double jeopardy (Stern 1966) these fringe firms will continue to provide private label, for such production may at least ensure his short run survival. Porter (1976) argues that A&P's store branding in the fifties (Adelman 1959) was due to its ability to gain concessions from these fringe firms.

Production Efficiency Theory

Peles (1976) reasons that if thousands of private labels exist in spite of the price discrimination law, there must be some reason for private labeling other than price discrimination. He attributes the existence of store brands to the differences between the processes of production and distribution. In general, economies of scale in production and economies of scale in distribution are likely to be different. Three scenarios exist:

- the same degree of economies of scale in production and distribution: under these conditions, we may expect the distributor to handle the same quantity produced by one producer.
- greater economies of scale in distribution than in production: here the optimum scale of production will be less than the optimum scale of distribution. We would expect to see one distribution unit selling the products of several producers.
- greater economies of scale in production than in distribution: the production - distribution mix will contain one producer selling his products through several distributors or alternatively, selling his product under several different brand names. For instance, the producer may own one

> brand (the manufacturer's brand) and the distributor own the others (the store brands or the private labels). All decisions and expenditures on sales promotion are carried out by the distributors for their private brands and by the producer for his own brand.

Peles cites some evidence supporting the theory from the study by Cook and Schutte (1967) which found a positive correlation between concentration in production and the percentage of merchandise sold under private label.

Store Loyalty Theory

This theory of store branding is gaining acceptance in recent times. The retailer is faced with stiff competition from other retailers. In order to combat this, each retailer has to develop a loyal customer segment. One way of accomplishing this is through his store brand strategy. Since the store brands are associated with the retailer, they provide a signal about the quality of the retailer. They carry the retailer's image to the consumer. Thus through proper positioning, marketing, and merchandising of store brands, the retailer can manage his image and develop a store-loyal segment. This theory explains why there is an increased emphasis on quality of store brands (Marketing News 1987) and why several retailers like Sears, K-Mart and

A&P promote their own line of brands (Felgner 1989).

Excess Capacity Theory

This theory also stems from production economies of scale. Proponents of this theory argue that manufacturers sometimes build large production facilities. As they begin to experience a drop in demand, they look for ways to sell additional volume. One such outlet may be through private label distributors. This theory was tested by Cook and Schutte and their study did not support a relationship between excess capacity and private branding.

Summary

In summary, none of the theories may provide a complete explanation for the phenomenon. Most theories are based on observation or after the fact explanations. They do not have strong empirical support, nor do they explain the underlying process.

2.3.3. Consumer Attitude Towards Store Brands - Empirical Studies

Many have pondered the question of who buys national brands and who buys store brands. Several attempts have been made to identify the consumers of store brands. Most of these studies have based their hypotheses on the

segmentation theory that, in very general terms, private brand consumers are more price conscious and less promotion conscious. Specifically, measures of social class, income and product class salience and other direct and indirect measures have been used to represent price and promotional sensitivity.

Burger and Schott (1972) attempted to identify the private brand buyer based on several demographic variables, and three attitude variables (measured through direct questioning) - price attitude, advertising attitude, and careful shopping attitude. The product categories selected were one food item (jams and jellies) and one durable (irons). They found that advertising attitude and careful shopping attitude did not discriminate a private brand buyer from a national brand buyer. Nor were demographic variables and amount of product consumed useful in identifying a store brand consumer. However, price consciousness and brand loyalty were useful identifying measures. In jams and jellies, private brand buyers were more price conscious and less brand loyal. In irons, private brand buyers were more price conscious, less brand loyal and felt the store was important.

Similarly, Myers (1967) used attitudinal constructs to measure price and promotional sensitivity and related them to another construct which he termed 'private brand

attitude.' The emphasis of the empirical work was on testing the degree to which psychological and sociological characteristics might explain differences in private brand attitude. He concluded that these variables do not explain large amounts of attitude variance. Respondents classified as private brand acceptors showed some tendency to be more enthusiastic, sensitive and submissive. Socio economic characteristics like income, occupation were also not strong predictors of private brand attitude. Housewives showed a somewhat greater acceptance of private brands than working women.

The Food Commission (1966) in its analysis of consumer attitude toward private brands found that consumers believe store brands are reasonably priced for like quality, and price conscious consumers generally switch. Age, education and income influenced their understanding of the private label concept. Older people and higher income families seemed to understand the private label concept better. However, this test related only to an understanding of the concept as opposed to actual purchase behavior. Their study did not report any relationships between store brand purchases and demographic or other variables.

Rao (1969) observed that a consumer's store loyalty and her purchases of private brand coffee were positively related. Bellizzi et al (1981) investigated consumer

perceptions of national, private and generic brands. Respondents in their study showed clear differences in their perceptions. National brands were perceived as superior in terms of reliability, prestige, quality and other characteristics. Generic brands were said to be generally inferior and private brands were psychologically positioned between generics and national brands, on many aspects.[4] Private brands were reported to be a particularly good value. Consumers felt that while national brands were superior to store brands, the use of store brands did not entail significant trade offs.

More recently, Russell and Winer (1988) hypothesized that store brand consumers were likely to be more advertising sensitive than national brand consumers. Their argument was that the national brand consumers were generally brand loyal and not likely to be swayed by advertising. But store brand consumers, being switchers and less knowledgeable about the product, were more likely to be influenced by advertising. They employed an advertising exposure panel data and found weak support for their hypothesis.

In summary, there seems to be some evidence that store

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[4] This finding is in line with the three tier brand system observed by empirical researchers more recently (Blattberg and Wisniewski 1987).

brand consumers are more price sensitive than national brand consumers. But there is no strong support for identifying store brand consumers on the basis of demographic, psychological or advertising sensitivity variables. However, most studies employed indirect measures of price sensitivity and advertising sensitivity. The low predictive power of social, psychological, and economic determinants suggests the need for further theoretical and empirical investigation of the issue of identification of store brand consumers.

2.4. Literature on Advertising and Bilateral Market Power

Most of the literature on oligopolies or monopolies dealing with competition and strategy have ignored the role of the retailer. Porter (1974, 1976) was among the first to highlight this gap in the marketing and industrial economics literature. In his seminal work on interbrand choice and bilateral market power, he asserted that the interaction between the manufacturing and retailing stages is an important determinant of manufacturer marketing strategies and of market power at both the manufacturing and retailing levels. He equates market power to relative profits and theorizes on the effect of product differentiation obtained through advertising on market power.

According to him, goods can be classified into

convenience goods and nonconvenience goods according to consumer buying habits and, consequently, the characteristics of the retail outlets. He defines convenience outlets as those retail outlets where little or no sales assistance (information transfer) in the form of salesperson interaction is provided with the sale and the locational density of outlets is high. Convenience goods are products sold through convenience outlets. Nonconvenience outlets, on the other hand, are retail outlets where sales assistance (information transfer) is provided with the sale, and outlets are selectively rather than densely located. Products sold through such nonconvenience outlets are classified as nonconvenience goods.[5]

Using this classification, Porter has provided insights into the interaction among the manufacturer, the retailer and the consumer that affect the role of advertising in the marketing mix. In convenience goods, the consumer demands a nearby retail outlet, is unwilling to shop around and desires no sales help. In view of these buying characteristics, the manufacturer's prime strategy is to

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[5] This division is similar to the convenience goods/shopping goods classification provided by Holton (1958) and the notion of search goods and experience goods that Nelson (1974) proposed in his economic model of advertising.

develop a strong brand image through advertising. If the manufacturer can develop a brand image, the retailer has very little power because he is unable to influence the purchasing decision of the consumer in the store, and because a strong brand image creates consumer demand for the product and reduces the retailer's credible bargaining power. Hence the manufacturer garners all the channel profits through advertising.

However, in the case of nonconvenience goods, the retailer is influential in the consumers' purchase decision, even though manufacturer advertising can lead the consumer to consider a particular product. The retailer can negate the effect of advertising by changing his mind in the store, and thus is in a more advantageous position.

In summary, advertising is a strong measure of a manufacturing firm's market power or profitability in the case of convenience goods while it may at best be only a weak measure of the manufacturer's profitability in the case of nonconvenience goods. He also suggests that the optimal strategy for a convenience goods manufacturer is to differentiate his product through advertising. In the case of nonconvenience goods, the marketing effort should consist of a judicial mix of advertising and retailer incentives.

Porter found some empirical evidence for his theory. The relationship between profits and advertising measure is

positive and significant in the convenience goods industry (groceries, drugs, books etc.) and not significant in the nonconvenience goods industry (clothing, furniture, electronic goods etc.).

While Porter's theory looks at a product at a point in time, Steiner (1973, 1978) extends Porter's work by examining product markets over time. The central concept of Steiner's model is that the retailer and the manufacturer face different demand functions, both of which must be considered in order to understand the movement of prices and the issue of relative market power in consumer goods industry. According to Steiner, the manufacturer's advertising generates strong consumer demand. This results in increased retail price competition as retailers must stock the product and compete heavily with other retailers. As a consequence of increased competition, the retailer has to lower his prices in order to be competitive with other retail outlets, and the retail margins go down. Thus advertising a) increases the universe of potential purchases through increases in distribution, b) increases retailer support, and c) diminishes the gross margin earned by the retailer. This places the manufacturer in a stronger position, decreasing the factory price elasticity for its output, as retailers compete for acquiring the product. Thus advertising decreases factory price elasticity at the

manufacturer level and increases consumer price elasticity at the retail level. This results in an increase in wholesale price and decrease in the retail price, thereby shifting the power to the manufacturer. Ferguson (1982) argues that Steiner's model is inconsistent with the economic theory of derived demand. According to him, the more elastic the demand facing the retailers, the more elastic will be the manufacturer's derived demand. Thus the margins and the prices at the retailer and the manufacturer level have to be positively related. Recently Lynch (1986) has provided a model that refutes Ferguson's contention and shows that in a monopolistically competitive market it is possible for the retailer demand elasticity to increase while the manufacturer's derived demand elasticity decreases.

In summary, both Porter and Steiner highlight the importance of the retailer in the understanding of the marketing process. They contend that in consumer goods industry, advertising is a mechanism by which manufacturers gain a higher share of total channel profits and thus gain market power over the retailers. As stated earlier, it is interesting to examine whether the introduction of a store brand (private label) would alter this power structure, and, if so, in what ways. An analysis of price and profit movements in a model which allows for advertising and store

branding would reveal answers to this question and provide insights on related issues like the existence of store brands and manufacturer and retailer strategies.

2.5. Game Theoretic Models in Marketing Channels

In the marketing channels area, most models have addressed the question of whether it is profitable for a firm to integrate, and the resulting consumer welfare implications. They have typically assumed a franchisor-franchisee structure (Coughlan 1985, Coughlan and Wernerfelt 1989, McGuire and Staelin 1983, Moorthy 1988), where one manufacturer sells through only one retailer, who is exclusive. However, in the real world, channel structures are usually well established and a more important question seems to be understanding how members of the channel manage their business within these structures. Related to this, Jeuland and Shugan (1983) and Moorthy (1987) have discussed how cooperation can be achieved in a marketing channel relationship. Doraiswamy, McGuire and Staelin (1979) have addressed the issue of advertising strategies available to competing manufacturers, each selling through an exclusive outlet. These studies have primarily considered a single product manufacturer - retailer structure. In the industrial economics literature, a number of models have been proposed relating to vertical market

structures and vertical integration (Berger 1972). To the best of our knowledge, there are very few studies which incorporate multiple manufacturers, multiple retailers, or multiple products. Notable among them are Bresnahan and Reiss (1985), Chu (1987) and Lattin (1987).

Bresnahan and Reiss examined manufacturer and retailer margins in a bilateral monopoly where the manufacturer distributed several brands or versions of the product through a distributor (an automobile dealership is a good example). They find that the ratio of dealer to manufacturer margin will be the same across products (or brands) in a product line. They provide some empirical support for their theoretical result.

Chu (1987) models multiple brands carried by multiple retailers. He investigates the effect of differentiation (measured by cross price inelasticity) at the retailer level and the manufacturer level on consumer prices and profitability. He finds that as products become less differentiated, consumer retail prices fall, wholesale prices fall,and manufacturer and retailer profits fall. As retailers become less differentiated, retailer prices and margins fall, while manufacturer prices and profits increase. However he assumes symmetry (equal own price and cross price effects) among retailers and among manufacturers and does not take into account any element of the marketing

mix besides price.

Lattin explicitly incorporates competition between national brands and store brands. He studies the impact of store brands on the nature of manufacturer trade deals and retail price promotion. He finds that manufacturers will never offer trade deals to the retailers in the absence of store brand competition (i.e. when the retailer does not carry a store brand). When a store brand is present, manufacturers with a strong brand franchise will not offer trade deals, but manufacturers with moderate brand franchise (neither too low nor too high) will need to offer trade deals in order to induce the retailer to price promote its product. Manufacturers with low brand loyalty will not offer trade deals and their brands will never be promoted by the retailer. Related to this, Rao (1986) presents a model predicting that store brands will never be promoted in equilibrium and national brands' promoted price will be less than the regular price of the store brand. However he does not incorporate the retailer into the model. Store brand is offered by an independent manufacturer without a loyal segment.

All these models consider price as the only decision variable and do not include any other element of the marketing mix. Thus there seems to be a dearth of modeling effort in the channels area which analyze situations where

the retailers carry multiple brands and which include marketing mix variables like advertising. As Schmalensee (1986) points out with reference to advertising and market structure, "very little theoretical exploration of two stage models, involving both producers and retailers has been done. More work would seem here especially worthwhile," (p. 377).

2.6. Conclusion

In conclusion, while the literature on store brands is extensive, most theories seem to be convenient after the fact explanations with weak theoretical support and weaker empirical support. While the literature in channels is growing, little work seems to have been done related to the analysis of situations where retailers carry multiple brands and specifically in the area of analyzing competition between national brand and store brand.

In this dissertation, we extend the existing literature in the following ways:

1. We analyze the competition between a national brand and a store brand by explicitly incorporating the role of the retailer.
2. We introduce advertising as a strategic decision variable of the manufacturer, in addition to price.

3. We derive strategic implications for the manufacturer of the national brand and for the retailer selling both the national brand and the store brand.
4. We also make some theoretical predictions about the phenomenon of store branding and provide empirical support for them.

CHAPTER III

NATIONAL BRAND - STORE BRAND COMPETITION

THE BASIC MODELS

3.1. Introduction

Over the last three decades, a marketing process that has witnessed tremendous growth is the phenomenon of store branding. Currently sales of store brands account for about 12% of the total sales in grocery items (Private Label & Generic Analysis 1988). The phenomenon of store branding has also spread to other durable product categories like appliances, clothing and electronic goods. This pervasiveness and proliferation of store brands has generated great interest among manufacturers, retailers, and public policy makers.

The government has been closely monitoring the performance of store brands to understand if it is in the interest of the consumers to have several store brands. The National Commission on Food Marketing which made a thorough analysis of the food marketing industry had as one of its objectives, understanding the role of store brands in the present day marketing context. Their purpose was to understand if the retailers were gaining undue advantage or usurping monopoly power, to the detriment of the public (Report of the National Commission for Food Marketing 1966).

The proliferation of store brands has been of great concern to the manufacturers of national brands. Consumer goods marketers with heavy financial investments in branded items have been increasingly concerned about the channel power that retailers have been able to gain by selling merchandise under their own labels. Retailers, on their part, are themselves trying to understand in which product categories they should introduce store brands and what strategies they should adopt with respect to the store brand and the national brand. A case in point is the indiscriminate store branding strategy adopted by A&P in the 1970s (Giges 1974). A&P since had to cut back on its store brand production and resort to selective store branding.

In summary, the following specific questions seem to be of interest to marketers:

1. Why do store brands exist?
2. What is the incentive for a retailer to carry a store brand?
3. Why do we see store brands pervasive in certain product categories and not in certain others?
4. Are they mechanisms through which retailers gain a higher share of channel profits, and thereby channel control?
5. Or, are they merely brands with the specific purpose of catering a generic price sensitive

market segment?

6. What strategy does the retailer adopt with respect to the national brand and the store brand?
7. What impact does the presence of a store brand have on the marketing strategy of the national brand manufacturer?

The hypothesis that a store brand is a brand introduced by the retailer to gain market power (or channel power) has been advanced by several researchers (Stern 1966, Industry Week 1975). This notion attains special significance in light of Porter's theory on market power (Porter 1974,1976). According to Porter, in a frequently purchased convenience goods industry, a manufacturer with strong demand pull obtained through advertising will absorb power from the retailer and will garner all channel profits. This gives rise to the speculation that the retailer may develop some countervailing mechanism to gain power and thus garner a higher share of channel profits. One likely mechanism is his ability to sell a store brand and set the retail price of both the widely advertised national brand and the store brand such that he can maximize his profits and gain market power. This calls for investigation of the competition between a national brand and a store brand that includes the manufacturer - retailer interface and incorporates

manufacturer advertising.

Most models in industrial organization and marketing that have attempted to analyze competition between national brands and store brands have not considered the retailer - manufacturer interface. The only exception is the recent work by Lattin (1987). But his major emphasis is on price promotion. Specifically he analyzes the conditions under which a national brand will be price promoted by the retailer. His model does not incorporate manufacturer advertising. In this chapter we will develop two basic models that will analyze the competition between a National brand manufacturer and a downstream retailer who sells both the national brand and his own store brand. The manufacturer - retailer structure is described in Figure 3.1.

The specific focus of our analysis will be to understand the market conditions under which the retailer gains higher overall profits and a higher share of total channel profits (a measure of channel control) by introducing a store brand. We will attempt to derive implications regarding the following with respect to the phenomenon of store brands:

1. The way the profits of the retailer and the manufacturer change with national brand advertising?

2. Whether the store brand represents a mechanism through which a retailer gains channel control?
3. What strategy a retailer should adopt with respect to the pricing and positioning of his store brand?
4. What implication the presence of a store brand has for the optimal advertising and pricing policy of the manufacturer?

We will provide two models to answer the above questions. The first model attacks the first issue above. Porter's theory would predict that as the manufacturer increases advertising, he would gain higher profits and a higher share of the total channel profits. Our model investigates whether the introduction of a store brand does indeed reverse this situation and provide market power to the retailer. This model (Model I) treats advertising as an exogenous variable and provides a partial test of Porter's theory. Later, in model II, we treat advertising as an endogenous variable and address the other issues raised above.

3.2. MODEL I

3.2.1. Assumptions and Model Form

A1. Decision Variables

There are two decision variables for the national brand

manufacturer: the manufacturer's wholesale or transfer price to the retailer and the level of advertising for the national brand. There are two decision variables for the retailer: the retail price of the national brand and the retail price of the store brand. In this model, we fix the level of advertising and let the manufacturer and the retailer play the pricing game. That is, manufacturer advertising is deemed exogenous in the present model.

Discussion

The assumption of exogenously given advertising has been made here for the following reasons:

i) as explained above, it helps us understand the movement of equilibrium prices, quantities and profits for small changes in national brand advertising. This enables us to discuss results in light of Porter's theory.

ii) it is consistent with a decision process where advertising budgets are usually determined annually, while prices are set much more frequently.

iii) it provides a motivation and direction for Model II where advertising will be deemed to be endogenously determined by the national brand manufacturer.

A2 Game Structure

The pricing game between the manufacturer and the retailer is played in two stages as follows:

In the first stage, the manufacturer sets the wholesale price (w_1) of the national brand given a certain level of advertising (A).

In the second stage, the retailer sets the retail prices of both the national brand (p_1) and the store brand (p_2), given the wholesale price and advertising for the national brand (w_1 and A).

The manufacturer is a Stackelberg leader in this game. That is, the manufacturer knows how the retailer will behave (his reaction function) and takes this knowledge into account, while choosing his decision variable(s). The retailer is a Stackelberg follower in that he takes the manufacturer price as given, while deciding on his retail prices. This structure is represented in figure 3.2.

Discussion

The assumption of Stackelberg leader-follower behavior requires some elaboration. Modelers in the marketing channels and vertical integration areas have predominantly assumed Stackelberg behavior (McGuire and Staelin 1983, Coughlan 1985) based on the belief that, typically, manufacturers move first and that the retailers are price takers. There have been a few models which have assumed

Nash behavior in which the players move simultaneously (Jeuland and Shugan 1982, Chu 1987). That is, retail and wholesale prices are set simultaneously. Their idea is that many retailers, like Sears, are powerful enough not to be price takers. Assuming Nash Competition or that the retailer is the Stackelberg leader may be areas of future research.

A3. Demand Function

The demand function is assumed linear in prices and additively separable in advertising.

Discussion

Linearity in prices is a common assumption made in the marketing and economics literature for analytical tractability and to obtain interpretable results. Further, linearity may not be so restrictive for analyzing comparative statics results since the assumption may be reasonable in a small neighborhood around equilibrium.

The effect of advertising is represented only as an outward shift in demand for the national brand and an inward shift in demand for the store brand. Advertising has been posited to decrease own price elasticity (Comanor and Wilson 1974) or increase own price elasticity (Nelson 1974). It has also been posited to increase or decrease cross price sensitivity. Empirical evidence is not conclusive. However, what can be stated with reasonable certainty is

that the overall impact of advertising is to increase the demand for the brand (Shubik and Levitan 1980, Scherer 1980). This has also been shown through a meta analysis of empirical results (Assmus, Lehmann and Farley 1984). Accordingly our model interpretations are made based on this assumption. In Appendix 3.1, we show that a linear demand function with an additively separable advertising effect can be derived from a quadratic consumer utility function. Further, while our discussion focuses on the effects of advertising, our results may be interpreted as pertaining to any non-price demand shifting component, like quality.

A4. Cost Structure

We assume that the marginal costs of manufacturing the national brand and the store brand are equal and constant. We set the marginal costs to zero.

Discussion

The assumption of equal marginal cost is reasonable particularly in the case of frequently purchased products where quality differences are not substantial enough to warrant higher costs. The assumption of constant marginal costs permits us to set the marginal costs to zero without affecting the results. This assumption is commonly made in economic models where economies of scale in production are not of interest.

3.2.2. Notation

Subscript 1 denotes national brand and 2 denotes store brand.

p_1, p_2 = retail price of the national brand and the store brand.

w_1 = wholesale price of the national brand.

A = manufacturer's advertising on the national brand.

R_m, Π_m = manufacturer revenues and profits from the national brand.

R_1, R_2, R = retailer revenues from the national brand, retailer revenues from the store brand and total retailer revenues respectively.

Π_1, Π_2, Π_r = retailer profits from the national brand, retailer profits from the store brand and total retailer profits respectively.

R_t, Π_t = total channel revenues and total channel profits.

It is useful to provide the algebraic definitions for the above notations:

$R_m = w_1 \cdot q_1 \qquad \pi_m = w_1 \cdot q_1 - A \qquad R_1 = p_1 \cdot q_1 \qquad \pi_1 = (p_1 - w_1) \cdot q_1$

$R_2 = \Pi_2 = p_2 \cdot q_2$ (since cost of store brand = 0)

$R = R_1 + R_2 \qquad \Pi_r = \Pi_1 + \Pi_2 \qquad \Pi_t = \Pi_m + \Pi_r$

3.2.3. Demand Function

The demand functions for the national brand (1) and the store brand (2) are given in simple form as

$$q_1 = a_1 - b_1 p_1 + c_1 p_2 + f(A)$$

$$q_2 = a_2 - b_2 p_2 + c_2 p_1 - g(A)$$

It is reasonable to assume the following with respect to the demand functions:

$a_i > 0 \quad b_i > 0 \quad c_i > 0 \quad i = 1,2$

$f(A) > 0 \; g(A) \geq 0 \; f'(A) > 0 \; g'(A) \geq 0 \; f'(A) \geq g'(A)$

$b_i > c_i \quad i = 1,2$ since own price effects are greater than cross price effects.

3.2.4. Pricing Game

The retailer sets p_1 and p_2 given w_1 and A and solves

$$\underset{p_1,\, p_2}{\text{Maximize}} \; (p_1 - w_1).q_1 \; (p_1,p_2,A) + p_2.q_2 \; (p_1,p_2,A).$$

The manufacturer sets w_1 given A and solves

$$\underset{w_1}{\text{Maximize}} \; w_1.q_1 \; (p_1^R(w_1,A), p_2^R(w_1,A), A) - A.$$

where $p_1^R(w_1,A)$, $p_2^R(w_1,A)$ are the reaction functions from the retailer's problem.

3.2.5. Solutions for Model I

First order conditions for the retailer problem are,

$$p_1 (-2b_1) + p_2 (c_1+c_2) + a_1 + f(A) + b_1 w_1 = 0 \qquad (3.1)$$

$$p_1 (c_1+c_2) + p_2 (-2b_2) + a_2 - g(A) - c_1 w_1 = 0 \qquad (3.2)$$

The second order sufficient condition is $4b_1b_2 - (c_1+c_2)^2 > 0$ which implies $b_1b_2 > c_1c_2$ (shown in Appendix 3.2).

Solving the retailer's FOC equations (3.1) and (3.2) yield,

$$p_1^R(w_1,A) = \frac{2b_2[a_1+f(A)]+(c_1+c_2)[a_2-g(A)]+ w_1[2b_1b_2-c_1(c_1+c_2)]}{4b_1b_2-(c_1+c_2)^2} \quad (3.3)$$

$$p_2^R(w_1,A) = \frac{(c_1+c_2)[a_1+f(A)]+2b_1[a_2-g(A)]+b_1(c_2-c_1)w_1}{4b_1b_2-(c_1+c_2)^2} \quad (3.4)$$

$$q_1^R(w_1,A) =$$

$$\frac{[a_1+f(A)][2b_1b_2-c_2(c_1+c_2)]+[a_2-g(A)][b_1(c_1-c_2)]-w_1[2b_1(b_1b_2-c_1c_2)]}{4b_1b_2-(c_1+c_2)^2} \quad (3.5)$$

The manufacturer solves his profit maximization problem

$$\underset{w_1}{\text{Maximize}} \quad w_1.q_1^R(w_1,A) - A.$$

which yields the following first order condition

$$q_1 + w_1.\partial q_1/\partial w_1 = 0$$

Substituting for q_1^R and solving the manufacturer's problem yields the following equilibrium prices and quantities:

$$w_1^*(A) =$$

$$\frac{[a_1+f(A)]\ [2b_1b_2-c_2(c_1+c_2)] - [a_2-g(A)]\ [b_1(c_2-c_1)]}{4b_1\ (b_1b_2-c_1c_2)} \quad (3.6)$$

$$p_1^*(A) =$$

$$\frac{\{[a_1+f(A)]\ \{4b_1b_2\ (b_1b_2-c_1c_2) + (2b_1b_2-c_1c_2)\ [4b_1b_2-(c_1+c_2)^2]\}}{+\ [a_2-g(A)]\ \{2b_1(c_1+c_2)\ (b_1b_2-c_1c_2) + b_1c_1\ [4b_1b_2-(c_1+c_2)^2]\}\}} \quad (3.7)$$

$$[4b_1(b_1b_2-c_1c_2)]\ [4b_1b_2-(c_1+c_2)^2]$$

$$p_1^*(A) - w_1^*(A) =$$

$$\frac{\{[a_1+f(A)]\ \{4b_1b_2\ (b_1b_2-c_1c_2) + c_2^2\ [4b_1b_2-(c_1+c_2)^2]\}}{+\ [a_2-g(A)]\ \{2b_1(c_1+c_2)\ (b_1b_2-c_1c_2) + b_1c_2[4b_1b_2-(c_1+c_2)^2]\}\}}{[4b_1(b_1b_2-c_1c_2)]\ [4b_1b_2-(c_1+c_2)^2]} \quad (3.8)$$

$$p_2^*(A) =$$

$$\frac{\{[a_1+f(A)]\ \{2b_1(c_1+c_2)\ (b_1b_2-c_1c_2) + b_1c_2\ [4b_1b_2-(c_1+c_2)^2]\}}{+\ [a_2-g(A)]\ \{4b_1^2\ (b_1b_2-c_1c_2) + b_1^2\ [4b_1b_2-(c_1+c_2)^2]\}\}}{[4b_1(b_1b_2-c_1c_2)]\ [4b_1b_2-(c_1+c_2)^2]} \quad (3.9)$$

$$q_1^*(A) =$$

$$\frac{[a_1+f(A)]\ [2b_1b_2-c_2(c_1+c_2)] - [a_2-g(A)]\ [b_1(c_2-c_1)]}{2\ [4b_1b_2-(c_1+c_2)^2]} \quad (3.10)$$

$$q_2^*(A) =$$

$$\frac{\{[a_1+f(A)]\ \{2b_1b_2\ (c_2-c_1) + c_2\ [4b_1b_2-(c_1+c_2)^2]\}}{+\ [a_2-g(A)]\ \{2b_1\ [2b_1b_2-c_1(c_1+c_2)] + b_1\ [4b_1b_2-(c_1+c_2)^2]\}\}}{4b_1\ [4b_1b_2-(c_1+c_2)^2]} \quad (3.11)$$

3.2.6. Existence of Equilibrium

Proposition 3.1

Given assumptions A1 to A4, the existence of an equilibrium solution with non-negative prices, quantities and profits is ensured under the following sufficient conditions:

a. $a_1 + f(A) \geq a_2 - g(A) \geq 0$

b. $b_1 > c_2 \geq c_1$ and $b_2 > c_2 \geq c_1$

c. $4b_1b_2 - (c_1+c_2)^2 > 0$

Proof

The non-negativity of w_1 and q_1 is shown in Appendix 3.3. The non-negativity of p_1, p_2 and q_2 can be seen from the fact that the coefficients of $a_1+f(A)$ and $a_2-g(A)$ in expressions (3.7), (3.9) and (3.11) are positive.

Discussion

Condition (a) implies that there is always a non-negative demand for the brands when they are sold freely on the market, and that this demand is greater for the national brand. That is, the intercept terms of q_1 and q_2 (when $p_1 = 0$ and $p_2 = 0$) are always non-negative and the intercept for q_1 is greater than that for q_2.

Condition (b) implies that the own price effects are greater than either of the cross price effects and that the price of national brand has a greater impact on store brand demand than vice versa. This is reasonable, since the national brand has stronger loyalty and hence more insular to store brand prices. This assumption can be empirically tested. We will denote the set of conditions as K1 and assume they hold for the rest of the analysis.

Given the existence of a unique equilibrium solution, we are now ready to investigate the phenomenon of store branding with specific reference to whether or not the

introduction of a store brand implies higher profitability for the retailer, and if so, under what specific conditions.

The first step in understanding the phenomenon is to investigate whether the retailer has an incentive to introduce a store brand in the first place. This calls for explicit consideration of the case where the retailer carries only the national brand. This is a special case of the general model where $b_2 = c_1 = c_2 = g(A) = 0$. We compare the special case where the retailer carries only the national brand (denoted by N) with the general case where the retailer carries both the national brand and the store brand (denoted by NS). We show that, given the model assumptions, it is always profitable for the retailer to carry a store brand.

3.2.7. Model IA: Case of National Brand Alone

When the retailer carries only the national brand, the relevant demand function is

$$q_1 = a_1 - b_1 p_1 + f(A)$$

Solving the retailer maximization problem and then the manufacturer problem as before, we obtain the following results:

$$w_1(A)|_N = [a_1 + f(A)] / 2 b_1 \qquad (3.12)$$

$$q_1(A)|_N = [a_1 + f(A)] / 4 \qquad (3.13)$$

$$p_1(A)|_N = 3 [a_1 + f(A)] / 4 b_1 \qquad (3.14)$$

$$p_1(A) - w_1(A)|_N = [a_1 + f(A)] / 4\ b_1 \qquad (3.15)$$

Total Revenues $p_1q_1 = 3\ [a_1+f(A)]^2 / 16b_1$

Manufacturer Revenues $w_1q_1 = 2\ [a_1+f(A)]^2 / 16\ b_1$

Retailer Profits = $(p_1-w_1)q_1 = [a_1+f(A)]^2 / 16b_1$

Results from Model IA

The following interesting observations can be made from the above:

- The above results can be obtained from the original model by simply setting the cross price effects to zero, i.e. $c_1 = c_2 = 0$. This is to be expected since, when there are no substitution effects, the retailer is operating in two independent markets.
- The margin obtained by the retailer on the national brand is always half the margin obtained by the manufacturer. This proportion has been reported in the literature. Bresnahan and Reiss (1985) developed a successive monopoly model (like ours) to explain pricing arrangements between an automobile manufacturer and a dealer. In the case of a linear demand curve, they show that the dealer margin is always one half the manufacturer margin. It is not difficult to see why this should be so. The explanation is provided in Figure 3.3. The demand function that the retailer faces is q_1. From economic theory, we know that the marginal revenue curve MR1 bisects the angle between OA and q_1. This is the derived demand

curve faced by the manufacturer which in turn yields the marginal revenue curve for the manufacturer MMR1. The manufacturer and the retailer set their price or quantity levels to equate marginal revenue to marginal cost. If the cost of manufacturing is zero, the equilibrium quantity sold is q_1^* and the corresponding prices are w and p. This is the situation no matter what the level of advertising is or what the slope and intercept of the demand functions are. It is a matter of simple application of the properties of similar triangles to show that the ratio of retailer margin to manufacturer margin is one-half.

- Consequently the retailer's share of the total revenues from the market is <u>always 1/3.</u>
- Both the manufacturer and the retailer will gain in revenue when the manufacturer increases his advertising. But the manufacturer will gain higher absolute revenues than would the retailer, since the share of revenues remains the same (1/3).

<u>3.2.8. Comparison of Cases with and without Store Brand</u>

<u>Case of Symmetry $C_1 = c_2$</u>

In the case of symmetry, we have the following:

$$w_1|_{NS} = \frac{a_1 + f(A)}{2\ b_1} \qquad (3.16)$$

$$q_1|_{NS} = \frac{a_1 + f(A)}{4} \qquad (3.17)$$

$$p_1|_{NS} = \frac{[a_1 + f(A)]\ (3\ b_1\ b_2 - c^2) + [a_2 - g(A)]\ 2\ b_1\ c}{4\ b_1\ (b_1\ b_2 - c^2)} \qquad (3.18)$$

$$[p_1 - w_1]|_{NS} = \frac{a_1+f(A)}{4b_1} \cdot \frac{(b_1b_2+c^2)}{b_1b_2-c^2} + \frac{a_2-g(A)}{4b_1} \cdot \frac{2b_1c}{b_1b_2-c^2} \qquad (3.19)$$

$$p_2|_{NS} = \frac{a_1+f(A)}{2} \cdot \frac{c}{b_1b_2-c^2} + \frac{a_2-g(A)}{2} \cdot \frac{b_1^2}{b_1b_2-c^2} \qquad (3.20)$$

$$q_2|_{NS} = \frac{a_1+f(A)}{4} \cdot \frac{c}{b_1} + \frac{a_2-g(A)}{2} \qquad (3.21)$$

What happens to manufacturer and retailer prices and profits when the retailer introduces a store brand?

Proposition 3.2

The manufacturer revenues are unaffected by the retailer's introduction of a store brand. The retailer, however, gains higher profits on both the national brand and the store brand. Further, retailer's share of the total revenues increases and is always greater than 1/3.

i.e. $R_m|_{NS} = R_m|_N \qquad \Pi_1|_{NS} > \Pi_1|_N \qquad \Pi_2|_{NS} > \Pi_2|_N = 0$

$\Pi_r|_{NS} > \Pi_r|_N = \Pi_1|_N \qquad (\Pi_r/R)|_{NS} > (\Pi_r/R)|_N$

Proof: See Appendix 3.4

Note: a) The above results hold in the case of asymmetry as well. b) The demand functions we have assumed for the cases with and without store brand, allow for a both a shift from

national brand to store brand and an increase in primary or category demand. While it is possible to visualize this situtation, in some cases, the primary demand may not increase with the introduction of a store brand. Our results will hold in such cases as well.

Discussion

Since advertising is exogenous we can only talk about the manufacturer revenues or advertising excluded profits. An explicit consideration of manufacturer profits will require advertising to be endogenously determined. We do that in model II wherein we provide a more detailed comparison of the cases with and without store brand and discuss why a store brand is more profitable.

The curious result that the manufacturer's revenues are unaffected by the introduction of a store brand in the case of symmetry arises out of the mathematics of the problem, but has a somewhat intuitive reasoning for it. This can be explained by observing the expression for $q_1^R(w_1,A)$, the derived demand that the manufacturer faces. When a store brand is introduced, the national brand can have a potential loss equal to the maximum of the store brand demand, $a_2 - g(A)$, the intercept term for given A. However, not all of it is lost. It loses proportional to what can be taken away by the store brand through its substitutability (c_2) and gains a quantity proportional to what it can draw for the

store brand (c_1). The net loss is $[a_2-g(A)]\ [b_1\ (c_2-c_1)]$. In the case of symmetry ($c_1 = c_2$), the gains and losses cancel out and the manufacturer's derived demand curve remains unaltered by the introduction of a store brand. However this is the case only when the costs are zero. In an extension to the model incorporating variable costs, we will show that the manufacturer profits may be affected by the introduction of a store brand.

Of equal interest is the effect of a store brand on retailer profits. It is not surprising that the retailer is always better off with a store brand, since the cost of obtaining the brand is zero. We will discuss the mechanism by which the retailer gains profits in detail in model II. Right now it is sufficient to know that, for any given level of advertising, the retailer always has the incentive to carry a store brand.

We next investigate what happens to prices, quantities and respective profits when the manufacturer increases his advertising by a small amount.

3.2.9. Results from Model I

The following comparative statics results with respect to changes in advertising can be calculated:

$$\frac{dw_1}{dA} = \frac{f'(A)\ [2b_1b_2 - c_2(c_1+c_2)] + g'(A)\ [b_1(c_2-c_1)]}{4b_1(b_1b_2-c_1c_2)} \qquad (3.22)$$

$$\frac{dq_1}{dA} = \frac{f'(A)\ [2b_1b_2-c_2(c_1+c_2)] + g'(A)\ [b_1(c_2-c_1)]}{2\ [4b_1b_2-(c_1+c_2)^2]} \tag{3.23}$$

$$\frac{dp_1}{dA} = \frac{\{f'(A)\ \{4b_1b_2(b_1b_2-c_1c_2) + (2b_1b_2-c_1c_2)[4b_1b_2-(c_1+c_2)^2]\} - g'(A)\ \{2b_1(c_1+c_2)(b_1b_2-c_1c_2) + b_1c_1\ [4b_1b_2-(c_1+c_2)^2]\}\}}{[4b_1(b_1b_2-c_1c_2)]\ [4b_1b_2-(c_1+c_2)^2]} \tag{3.24}$$

$$\frac{d(p_1-w_1)}{dA} = \frac{\{f'(A)\ \{4b_1b_2\ (b_1b_2-c_1c_2) + c_2^2\ [4b_1b_2-(c_1+c_2)^2]\} - g'(A)\ \{2b_1(c_1+c_2)(b_1b_2-c_1c_2)+b_1c_2[(4b_1b_2-(c_1+c_2)^2]\}\}}{[4b_1(b_1b_2-c_1c_2)]\ [4b_1b_2-(c_1+c_2)^2]} \tag{3.25}$$

$$\frac{dp_2}{dA} = \frac{\{f'(A)\ \{2b_1(c_1+c_2)\ (b_1b_2-c_1c_2) + b_1c_2\ [4b_1b_2-(c_1+c_2)^2]\} - g'(A)\ \{4b_1^2\ (b_1b_2-c_1c_2) + b_1^2\ [4b_1b_2-(c_1+c_2)^2]\}\}}{[4b_1(b_1b_2-c_1c_2)]\ [4b_1b_2-(c_1+c_2)^2]} \tag{3.26}$$

$$\frac{dq_2}{dA} = \frac{\{f'(A)\ \{2b_1b_2(c_2-c_1) + c_2[4b_1b_2-(c_1+c_2)^2]\} - g'(A)\ \{2b_1[2b_1b_2-c_1(c_1+c_2)] + b_1\ [4b_1b_2-(c_1+c_2)^2]\}\}}{4b_1\ [4b_1b_2-(c_1+c_2)^2]} \tag{3.27}$$

In what direction do the prices and profits move? The following propositions describe the results from the comparative statics analysis. Proposition 3.3 concerns the manufacturer side of the problem, while propositions 3.4 through 3.6 concern the retailer side of the problem.

Proposition 3.3 - Manufacturer Profits

The manufacturer's wholesale price, quantity sold of the national brand and manufacturer revenues increase with advertising. The rate of increase increases with national brand advertising sensitivity (f'(A)) and is non-decreasing in store brand advertising sensitivity (g'(A)). That is

$$\text{(i)} \quad \frac{dw_1}{dA} > 0 \qquad \frac{dq_1}{dA} > 0 \qquad \frac{dR_m}{dA} > 0$$

$$\text{(ii)} \quad \frac{d}{df'(A)}\left[\frac{dw_1}{dA}\right] > 0 \qquad \frac{d}{df'(A)}\left[\frac{dq_1}{dA}\right] > 0 \qquad \frac{d}{df'(A)}\left[\frac{dR_m}{dA}\right] > 0$$

$$\frac{d}{dg'(A)}\left[\frac{dw_1}{dA}\right] \geq 0 \qquad \frac{d}{dg'(A)}\left[\frac{dq_1}{dA}\right] \geq 0 \qquad \frac{d}{dg'(A)}\left[\frac{dR_m}{dA}\right] \geq 0$$

Proof: See Appendix 3.5

Discussion:

The result (i) is not very surprising. We would expect the manufacturer's revenue returns to increase when the demand for his brand shifts outward. But, what is of interest is how the rate of increase of quantity sold and revenue returns will change. Part (ii) shows that the higher is the demand sensitivity of the national brand (f'(A)) and the higher is the demand sensitivity of the store brand (g'(A)), the higher will be the returns for the manufacturer through increased advertising. This is also

intuitive. The more favorable the demand for the national brand due to advertising, the higher the marginal returns from advertising.

Of further interest is understanding how an increase in manufacturer advertising affects the retailer decisions and profitability. Propositions 2.4 through 2.8 describe the results. After presenting the propositions, we provide an example and intuitive discussion to motivate the results.

Proposition 3.4 - Retailer profits from the national brand

i) The retailer margins and profits on the national brand always increase with advertising under the following conditions (K2): a) symmetry: $b_1 = b_2$, $c_1 = c_2$. b) the advertising sensitivity of store brand ($g'(A)$) is small.

That is $$\frac{dp_1}{dA} > 0 \qquad \frac{d(p_1-w_1)}{dA} > 0 \qquad \frac{d\Pi_1}{dA} > 0$$

ii) The rate of increase of retailer margins and retailer profits on the national brand increases with advertising sensitivity of the national brand and decreases with advertising sensitivity of the store brand.

$$\frac{d}{df'(A)}\left[\frac{dp_1}{dA}\right] > 0 \quad \frac{d}{df'(A)}\left[\frac{d(p_1-w_1)}{dA}\right] > 0 \quad \frac{d}{df'(A)}\left[\frac{d\Pi_1}{dA}\right] > 0$$

$$\frac{d}{dg'(A)}\left[\frac{dp_1}{dA}\right] < 0 \quad \frac{d}{dg'(A)}\left[\frac{d(p_1-w_1)}{dA}\right] < 0 \quad \frac{d}{dg'(A)}\left[\frac{d\Pi_1}{dA}\right] < 0$$

Proof: See Appendix 3.6

Note: The above result almost always holds under conditions of asymmetry as well. Since it was difficult to sign the comparative statics analytically, the result is shown by numerical analysis.

Procedure for Numerical Analysis

The numerical analysis was performed using a Fortran program. For the purposes of the analysis we assumed $f(A) = \alpha\sqrt{A}$ and $g(A) = \beta\sqrt{A}$. The parameters a_i, b_i, c_i, α, β were allowed to vary over a wide range of values from 0.1 to 100. α is the advertising sensitivity of the national brand and β is the advertising sensitivity of the store brand. The Fortran program computes the values of the comparative statics whose signs were then analyzed. The parameter values used for the numerical analysis are given in Table 3.1. The results from the analysis are given in Table 3.2. The computer program is given in Appendix A.

Proposition 3.5 - Retailer profits from the store brand

i) The effects of advertising on the retail price of the store brand, quantity sold of the store brand and retailer profits on the store brand are ambiguous. For a given $f'(A)$, as $g'(A)$ increases from zero to $f'(A)$, the marginal profits on the store brand due to an increase in advertising

monotonically decrease from positive to negative. This implies that there exists a $g'(A)^*$ such that $d\Pi_2/dA = 0$ for any given $f'(A)$. Above this, marginal returns are negative and below this marginal returns are positive. Specifically when $g'(A) = 0$, profits <u>increase</u> with advertising and when $g'(A) = f'(A)$ profits <u>decrease</u> with advertising.

That is $\left.\frac{d\Pi_2}{dA}\right|_{g'(A)=0} > 0 \qquad \left.\frac{d\Pi_2}{dA}\right|_{g'(A)=f'(A)} < 0$

ii) The rates of increase of retailer margins and quantity of the store brand sold, given an increase in advertising, <u>always increase</u> with advertising sensitivity of the national brand and <u>decrease</u> with advertising sensitivity of the store brand. For small $g'(A)$, the rate of increase of retailer profits on the store brand, given an increase in advertising, <u>increases</u> with the advertising sensitivity of the national brand and <u>decreases</u> with the advertising sensitivity of the store brand.

$$\frac{d}{df'(A)}\left[\frac{dp_2}{dA}\right] > 0 \qquad \frac{d}{df'(A)}\left[\frac{dq_2}{dA}\right] > 0 \qquad \frac{d}{df'(A)}\left[\frac{d\Pi_2}{dA}\right] > 0$$

$$\frac{d}{dg'(A)}\left[\frac{dp_2}{dA}\right] < 0 \qquad \frac{d}{dg'(A)}\left[\frac{dq_2}{dA}\right] < 0 \qquad \frac{d}{dg'(A)}\left[\frac{d\Pi_2}{dA}\right] < 0$$

Proof: See Appendix 3.7

Note: The above results almost always hold for any value of $g'(A)$ as evidenced from numerical analysis (Table 3.3).

Proposition 3.6 - Retailer's Total Profits

i) The effect of advertising on retailer's total profits is ambiguous. When the advertising impact on the store brand (g'(A)) is small, profits increase with advertising. The marginal profits from advertising monotonically increase with advertising sensitivity of the national brand and monotonically decrease with advertising sensitivity of the store brand.

$$\frac{d\Pi_r}{dA} > 0 \quad \text{(for small } g'(A)\text{)}$$

$$\frac{d}{df'(A)}\left[\frac{d\Pi_r}{dA}\right] > 0 \qquad \frac{d}{dg'(A)}\left[\frac{d\Pi_r}{dA}\right] < 0$$

Proof: $\Pi_r = \Pi_1 + \Pi_2$

$$\frac{d\Pi_r}{dA} = \frac{d\Pi_1}{dA} + \frac{d\Pi_2}{dA} > 0 \quad \text{(from Propositions 3.4(i) and 3.5(i))}$$

It follows from Propositions 3.4(ii) and 3.5(ii) that

$$\frac{d}{df'(A)}\left[\frac{d\Pi_r}{dA}\right] = \frac{d}{df'(A)}\left[\frac{d\Pi_1}{dA}\right] + \frac{d}{df'(A)}\left[\frac{d\Pi_2}{dA}\right] > 0$$

$$\frac{d}{dg'(A)}\left[\frac{d\Pi_r}{dA}\right] = \frac{d}{dg'(A)}\left[\frac{d\Pi_1}{dA}\right] + \frac{d}{dg'(A)}\left[\frac{d\Pi_2}{dA}\right] < 0$$

For clarity, a summary of all the comparative statics results discussed so far are provided in Table 3.4

Illustration

To understand the movement of equilibrium profits and

the mechanism by which this happens, it is useful to illustrate the results for a specific example. As in the case of numerical analysis, we use a specific functional form $f(A) = \alpha \sqrt{A}$ and $g(A) = \beta \sqrt{A}$. α and β represent the advertising sensitivity of the national brand and the store brand respectively. For our illustration (Figures 3.4 through 3.8) we have used the following parameters $a_1 = 1$ $a_2 = 0.8$ $b_1 = 0.5$ $b_2 = 0.7$ $c_1 = 0.3$ $c_2 = 0.4$ $\alpha = 0.9$ $\beta = 0 - 0.9$ and $\sqrt{A} = 1\text{-}10$.

Figure 3.4 indicates how manufacturer revenues move with advertising. As can be seen, revenues increase with advertising always. However, when $\beta = 0$, the revenues increase from 0.2 to 0.47 only, whereas when $\beta = 0.9$, the revenues increase from 0.2 to 0.55. The slope is steeper, that is, the manufacturer gets marginal revenues due to advertising (bang for the buck) when β is high. This is because, when the manufacturer can draw store brand consumers by advertising, he can command a higher wholesale price and the retailer will also be forced to support the product by selling higher quantities of it.

Figure 3.5 tells the story about retailer profits from the national brand. His profits also increase with manufacturer advertising. But the rate of increase is in the opposite direction to that of the manufacturer. When $\beta = 0$ profits increase from 0.4 to 0.87 when $\sqrt{A}$ increases from

1 to 7. Since the units of advertising are not specified in the model, we may view advertising as being measured in relevant units (say thousands of dollars). However when β = 0.9, the retailer profits increase only up to 0.65. The retailer profits is always lower for any level of advertising, when β is high than when β is low.

The effect of advertising on the retailer profits on the store brand is ambiguous (Figure 3.6). In fact, when β is high (0.9), profits decrease from 1.05 to 0.75 when advertising increases ($\sqrt{A}$ from 1 to 7). When β is small (0), store brand profits increase steeply from 1.2 to 1.75. The retailer's total profits (Figure 3.7) also reflect a similar trend. As advertising ($\sqrt{A}$) increases from 1 to 7, profits increase steeply from 1.62 to 2.63 when β = 0, but decrease from 1.47 to 1.42 when β = 0.9. Figure 3.8 tells us how the marginal profits ($d\Pi_m/dA$, $d\Pi_r/dA$ etc.) are affected by the advertising sensitivity of the store brand (β).

We have so far analyzed the effect of an increase in manufacturer advertising on manufacturer and retailer profits. A related question is, given a level of advertising, how do the profits move with changes in advertising sensitivity parameters?

Effect of Advertising Sensitivities

For this analysis we restrict ourselves to the functional forms $f(A) = \alpha \sqrt{A}$ and $g(A) = \beta \sqrt{A}$. α and β represent advertising sensitivities of the national brand and the store brand respectively.

Proposition 3.7

For a given level of advertising, as the advertising sensitivity of the store brand (β) decreases

- manufacturer profits are non-increasing
- retailer profits on the national brand increase (case of symmetry)
- retailer profits on the store brand increase (always)
- Total retailer profits increase (case of symmetry)
- ratio of retailer profits to total profits increase

Proof: See Appendix 3.8

Note: The above result almost always holds in the case of asymmetry as well, as shown by numerical analysis. The parameter values are given in Table 3.1. The results are provided in Table 3.5.

Proposition 3.8

For a given level of advertising, as the advertising sensitivity of the national brand (α) increases

- manufacturer profits increase
- retailer profits on the national brand increase
- retailer profits on the store brand increase

- total retailer profits increase

Proof: See Appendix 3.9

Illustration

The effect of advertising sensitivity of store brand, β, on profits is illustrated in figures 3.4 through 3.7. Notice that in figure 3.4, for any given advertising manufacturer profits are greater when $\beta = 0.9$ than when $\beta = 0$. Figures 3.5 through 3.7 show that retailer profits are greater when $\beta = 0$ than when $\beta = 0.9$.

We will provide an intuitive explanation for these results after we deal with the other parameter of interest, price substitutability

Effect of Cross Price Substitutability

We will only consider the case of symmetry, $c_1 = c_2 = c$. This yields interpretable analytical results. Moreover, one can think of c as the level of price competition at the category level. What happens when the level of price competition increases? Is it good for the retailer?

Proposition 3.9

The manufacturer's profits are unaffected by changes in cross price substitutability. The retailer's profits on the national brand, the store brand and retailer's total profits increase with cross price substitutability.

$$\frac{d\Pi_m}{dc} = 0 \qquad \frac{d\Pi_1}{dc} > 0 \qquad \frac{d\Pi_2}{dc} > 0 \qquad \frac{d\Pi_r}{dc} > 0$$

Proof: See Appendix 3.10

Proposition 3.10 - Effect of Price Substitutability on the Advertising Impact

When g'(A) is small, an increase in cross-price substitutability has no effect on the manufacturer's marginal profits due to advertising; but the retailer's marginal profits on both the store brand and the national brand increase with an increase in cross price substitutability.

$$\frac{d}{dc}\left[\frac{d\Pi_m}{dA}\right] = 0 \quad \frac{d}{dc}\left[\frac{d\Pi_1}{dA}\right] > 0 \quad \frac{d}{dc}\left[\frac{d\Pi_2}{dA}\right] > 0 \quad \frac{d}{dc}\left[\frac{d\Pi_r}{dA}\right] > 0$$

Proof: See Appendix 3.11

Discussion of Propositions 3.4 - 3.10

Why should the retailer gain higher profits and higher marginal profits from advertising when the advertising sensitivity of the store brand is low and price substitutability is high? This not so intuitive result can be reasoned as follows: when the manufacturer advertises, the national brand's demand curve shifts outward and the store brand's demand curve shifts inward. Due to the outward shift, the manufacturer and the retailer increase

their margins and the retail price on the national brand. There are two effects on the retail price of the store brand: one due to the inward shift in the demand curve due to advertising ($g'(A) = \beta$), and the other due to the price increase of the national brand which increases store brand demand (c). If the inward shift in demand due to national brand advertising ($g'(A)$) is low, and the outward shift due to the price increase is high, then the net effect is an increase in the retail price and the retail margin on the store brand. That is, the store brand gets a "free ride" on the deepening of the national brand market. This is explained in Figure 3.9. q_1 and q_1' represent the national brand demand curve before and after advertising. MR_1 and MR_1' represent the marginal revenue curve for the retailer which is the derived demand curve that the manufacturer faces. MR_n and MR_n' are the marginal revenue curves for the manufacturer. Since marginal cost is assumed zero the manufacturer will set w_1 before and w_1' after advertising and the retailer will correspondingly set p_1 and p_1' as indicated, so as to equate their marginal revenue to marginal cost. If the shift $(q_1'-q_1)$ is large, then the retailer margin increases, $(p_1'- w_1') > (p_1-w_1)$. The effect of the increase in price p_1' is to shift the demand curve of the store brand from q_2 (p_1) to q_2 (p_1'). This outward shift depends on the price substitutability parameter, c. The

higher is c, the higher is the degree of rotation. This combined with an inward shift in demand due to national brand advertising, results in the final demand curve q_2', with corresponding prices p_2 and p_2'. If the inward shift due to $g'(A)$ is not too large, then $p_2' > p_2$, and $q_2' > q_2$, and the retailer increases his profits on the store brand and increases his total profits.

3.2.10. Summary

We motivate our modeling of national brand - store brand competition from Porter's theory. According to Porter, advertising provides market power for the manufacturer, and the manufacturer can wean away profits from the retailer through advertising pull. We conjecture that a store brand may be a mechanism by which retailers countervail this power and gain a higher share of channel profits. We set up a simple model to provide a partial test of this hypothesis. We first compare the models where the retailer operates with and without the store brand. We show that it is always in the interest of the retailer to carry a store brand, given the model assumptions. It enables him to gain higher prices and higher share of total market revenues. This result is not very surprising given that fixed and variables costs are zero. Given the store brand, we then proceed to understand what happens when the

manufacturer increases his advertising and when it is most beneficial for the retailer to carry a store brand.

We focus on two parameters - advertising substitutability and price substitutability. We show that when the manufacturer increases his advertising, his revenues always increase. Retailer profits on the national brand almost always increase with advertising. This is because both the retailer and the manufacturer take advantage of the outward shift in demand due to advertising. But, his profits on the store brand and total profits may increase or decrease with advertising, depending upon the two factors: advertising sensitivity and price substitutability. Specifically, we show that the retailer's profits are higher and increase with advertising when the store brand is more insular to national brand advertising or the advertising sensitivity is small. Further, the retailer's profitability is higher when the brands are more price substitutable, and his marginal returns from manufacturer advertising also increase.

We provide an intuitive explanation for our results. When the manufacturer increases advertising, the market for the national brand deepens (i.e. the demand curve shifts outward). The manufacturer and the retailer can increase their price of the national brand. If the store brand's demand does not weaken substantially due to advertising and

if price substitutability is high the retailer can free ride on the deepening of the national brand market and can support a higher price on the store brand also. So, one can hypothesize that the store brand is most beneficial to the retailer in terms of profitability when advertising substitutability is low and price substitutability is high.

The obvious limitation of this model is that it treats one of the manufacturer's decision variables (advertising) as an exogenous variable. The manufacturer may not increase his advertising level indiscriminately. It is reasonable to assume that the manufacturer will behave optimally with respect to setting his advertising levels. Would our results of Model I still go through when advertising is endogenous to the model? Model II treats advertising as an endogenous variable.

3.3. Model II

3.3.1. Assumptions and Model Form

The assumptions A3 and A4 concerning the form of demand and costs remain the same. Assumptions A1 and A2 are modified as follows:

A1'. Decision Variables:

In this model the decision variables are wholesale price and advertising for the national brand manufacturer

and retail prices of the national brand and the store brand for the retailer.

A2'. Game Structure:

There are three stages in the game. In the first stage, the manufacturer sets the advertising level for the national brand. In the second stage, the manufacturer sets his transfer price to the retailer and in the third stage, the retailer sets the retail price of both the national brand and the store brand. This is described in Figure 3.10.

Discussion

The assumption that the manufacturer chooses advertising first, and then price, has been made here primarily for ease of computation. So long as the appropriate second order conditions are met, the optimal solution remains the same whether the manufacturer chooses advertising first and then price or both simultaneously. In this case, splitting the game into three stages enables us to use the results from the pricing game (model I) for deriving the optimal advertising levels.

Our three stage model also reflects real world situations where advertising budgets are usually set annually (e.g. at the beginning of the accounting period) whereas pricing decisions are made more frequently. It is also worth noting that several models in industrial

organization have solved the price equilibrium with qualities (in our case advertising) fixed and then considered the quality choice problem (cf. Shaked and Sutton 1982).

3.3.2. Solutions for Model II

The manufacturer is assumed to know the outcome of the pricing game when deciding on the level of advertising. The stage II and Stage III games were solved earlier. The optimal advertising level is obtained by solving the stage I advertising game:

$$\underset{A}{\text{Max}} \qquad \Pi_m \quad (= R_m(A) - A)$$

In order to get a closed form solution and for analytical tractability, we will restrict ourselves to the following functional form: $f(A) = \alpha A^{\tau}$ and $g(A) = \beta A^{\tau}$. The variable τ can be interpreted as the advertising effectiveness parameter. $\tau = 1$ implies constant returns to scale in advertising. Similarly, $\tau > 1$ implies increasing returns to scale and $\tau < 1$ implies decreasing returns to scale. The variables α and β represent advertising sensitivities of the national brand and the store brand respectively. We will make the reasonable assumption that $0 \leq \beta \leq \alpha$.

Necessary conditions for a profit maximizing interior solution to exist are $f''(A) < 0$ and $g''(A) < 0$, that is $\tau <$

1. When $\tau \geq 1$, the profit function is strictly convex and the profit maximizing strategy for the manufacturer is to either advertise up to his budget (exogenously determined) or not advertise at all. That is, the equilibrium solution is a corner solution.

We will consider the most reasonable case $\tau < 1$, and specifically discuss the case $\tau = 0.5$. Later, as an aside, we will treat the cases yielding corner solutions and show that the results go through even in such cases.

$f(A) = \alpha \sqrt{A} = \alpha s \qquad g(A) = \beta \sqrt{A} = \beta s \qquad (\sqrt{A} = s)$

The square root advertising effect is commonly used in the economics and marketing literatures (Doraiswamy, McGuire and Staelin 1979) since it yields interpretable closed form solutions.

$$\text{Manufacturer} \quad \underset{A}{\text{Max}} \quad w_1 . q_1 - A.$$

$$\underset{s}{\text{Max}} \; \frac{\{(a_1+\alpha s)\ [2b_1b_2-c_2(c_1+c_2)] - (a_2-\beta s)\ [b_1(c_2-c_1)]\}^2}{8b_1(b_1b_2-c_1c_2)\ [4b_1b_2-(c_1+c_2)^2]} - s^2.$$

The first order condition (FOC) is

$$\{(a_1+\alpha s^*)\ [2b_1b_2-c_2(c_1+c_2)] - (a_2-\beta s^*)\ [b_1(c_2-c_1)]\}$$

$$\{\alpha\ [2b_1b_2-c_2(c_1+c_2)] + \beta\ [b_1(c_2-c_1)]\}$$

$$- s^*\ \{8b_1\ (b_1b_2-c_1c_2)\ [4b_1b_2-(c_1+c_2)^2]\} = 0 \qquad (3.28)$$

$$\text{SSOC} \quad \{\alpha\ [2b_1b_2-c_2(c_1+c_2)] + \beta\ [b_1(c_2-c_1)]\}^2 -$$

$$8b_1\ (b_1b_2-c_1c_2)\ [4b_1b_2-(c_1+c_2)^2] < 0 \qquad (3.29)$$

Solving the FOC yields $\sqrt{A}^* = s^* =$

$$\frac{\alpha[2b_1b_2-c_2(c_1+c_2)]+\beta[b_1(c_2-c_1)]\}\{a_1[2b_1b_2-c_2(c_1+c_2)]-a_2[b_1(c_2-c_1)]}{[8b_1(b_1b_2-c_1c_2)][4b_1b_2-(c_1+c_2)^2]-\{\alpha[2b_1b_2-c_2(c_1+c_2)]+\beta[b_1(c_2-c_1)]\}^2} \quad (3.30)$$

The equilibrium profits for the manufacturer can be written as $\Pi_m^* =$

$$\frac{\{a_1[2b_1b_2-c_2(c_1+c_2)]-a_2[b_1(c_2-c_1)]\}^2}{[8b_1(b_1b_2-c_1c_2)][4b_1b_2-(c_1+c_2)^2]-\{\alpha[2b_1b_2-c_2(c_1+c_2)]+\beta[b_1(c_2-c_1)]\}^2} \quad (3.31)$$

3.3.3. Proposition 3.11 - Existence of Equilibrium

Given A1', A2', A3 and A4 and condition K1, the following second order condition (K3) is necessary and sufficient for the existence of an equilibrium solution with non-negative prices, quantity sold, advertising and profits.

$[8b_1(b_1b_2-c_1c_2)][4b_1b_2-(c_1+c_2)^2]>\{\alpha[2b_1b_2-c_2(c_1+c_2)]+\beta[b_1(c_2-c_1)]\}^2$

Proof:

In Proposition 3.1 we have shown the non-negativity of prices and quantities for any A, f(A) and g(A). This is a special case with $f(A) = \alpha\sqrt{A}$ and $g(A) = \beta\sqrt{A}$. We now only need to show the non-negativity of advertising (A) and manufacturer profits (Π_m). This clearly holds under condition K3 as can be seen from (3.30) and (3.31). We will assume condition K3 also holds for the ensuing analysis.

Given the existence of a unique equilibrium solution, we are now ready to investigate the phenomenon of store branding with specific reference to whether or not the

existence of a store brand implies channel control for the retailer, and if so, under what specific conditions.

As in model I, the first step in understanding the phenomenon is to investigate whether the retailer has an incentive to introduce the store brand in the first place. This calls for explicit consideration of the case where the retailer carries only the national brand. This is a special case of the general model where $b_2 = c_1 = c_2 = \beta = 0$. We compare the special case where the retailer carries only the national brand (denoted by N) with the general case where the retailer carries both the national brand and the store brand (denoted by NS). We show that, given the model assumptions, it is always profitable for the retailer to carry a store brand.

3.3.4. Model IIA: Case of National Brand Alone

When the retailer carries only the national brand, the relevant demand function is

$$q_1 = a_1 - b_1 p_1 + \alpha \sqrt{A}$$

Solving the retailer maximization problem and then the manufacturer problem as before, we obtain the following results:

Optimal advertising $s^*|_N = \sqrt{A^*}|_N = a_1 \alpha / (8 b_1 - \alpha^2)$ (3.32)

Substituting for s^*, we have

$$w_1|_N = 4 a_1 / (8 b_1 - \alpha^2) \quad (3.33)$$

$$q_1|_N = 2\ a_1\ b_1\ /\ (8\ b_1 - \alpha^2) \qquad (3.34)$$

$$p_1|_N = 6\ a_1\ /\ (8\ b_1 - \alpha^2) \qquad (3.35)$$

$$p_1 - w_1|_N = 2\ a_1\ /\ (8\ b_1 - \alpha^2) \qquad (3.36)$$

$$R_m|_N = 8\ a_1^2\ b_1\ /\ (8b_1 - \alpha^2)^2$$

$$\Pi_m|_N = a_1^2\ /\ (8b_1 - \alpha^2)^2$$

$$\Pi_r|_N = 4\ a_1^2\ b_1\ /\ (8b_1 - \alpha^2)^2$$

$$R|_N = p_1 \cdot q_1 = 12\ a_1^2\ b_1\ /\ (8b_1 - \alpha^2)^2$$

$$\Pi_t|_N = (12a_1^2b_1 - a_1^2\ \alpha^2)\ /\ (8b_1 - \alpha^2)^2$$

$$(\Pi_r/R)|_N = 1/3$$

$$(\Pi_r/\Pi_t)|_N = 4\ b_1\ /\ (12\ b_1 - \alpha^2)$$

Results from Model IIA

The following observations which were made for Model I still hold.

- The above results can be obtained from the original model by simply setting the cross price effects to zero, i.e. $c_1 = c_2 = 0$. This is to be expected since, when there are no substitution effects, the retailer is operating in two independent markets.
- The margin obtained by the retailer on the national brand is always half the margin obtained by the manufacturer.
- Consequently retailer share of the total revenues from the market is always 1/3.

3.3.5. Comparison of cases with and without store brand

Case of Symmetry $C_1 = c_2$

In the case of symmetry, we have the following:

$$\sqrt{A}|_{NS} = s|_{NS} = \frac{a_1 \alpha}{8 b_1 - \alpha^2} \quad (3.37)$$

$$w_1|_{NS} = \frac{4 a_1}{8 b_1 - \alpha^2} \quad (3.38)$$

$$q_1|_{NS} = \frac{2a_1 b_1}{8 b_1 - \alpha^2} \quad (3.39)$$

$$p_1|_{NS} = \frac{(a_1 + \alpha s)(3 b_1 b_2 - c^2) + (a_2 - \beta s) 2 b_1 c}{4 b_1 (b_1 b_2 - c^2)} \quad (3.40)$$

$$[p_1 - w_1]|_{NS} = \frac{(a_1+\alpha s)}{4b_1} \cdot \frac{(b_1 b_2 + c^2)}{b_1 b_2 - c^2} + \frac{(a_2 - \beta s)}{4b_1} \cdot \frac{2b_1 c}{b_1 b_2 - c^2} \quad (3.41)$$

$$p_2|_{NS} = \frac{a_1+\alpha s}{2} \cdot \frac{c}{b_1 b_2 - c^2} + \frac{a_2 - \beta s}{2} \cdot \frac{b_1^2}{b_1 b_2 - c^2} \quad (3.42)$$

$$q_2|_{NS} = \frac{a_1+\alpha s}{4} \cdot \frac{c}{b_1} + \frac{a_2 - \beta s}{2} \quad (3.43)$$

What happens to manufacturer and retailer prices and profits when the retailer introduces a store brand?

Proposition 3.12

The manufacturer profits are unaffected by the retailer's introduction of a store brand. The retailer, however, gains higher profits on both the national brand and the store brand and higher share of total profits.

i.e. $\Pi_m|_{NS} = \Pi_m|_N \quad \Pi_1|_{NS} > \Pi_1|_N \quad \Pi_2|_{NS} > \Pi_2|_N = 0$

$\Pi_r|_{NS} > \Pi_r|_N = \Pi_1|_N \quad (\Pi_r/\Pi_t)|_{NS} > (\Pi_r/\Pi_t)|_N$

Proof: See Appendix 3.12

Note: This result parallels that in proposition 3.2 above, when advertising is exogenously given. This makes sense, since proposition 3.2 holds for any given advertising level for the national brand, including the optimal level given in equation (3.37) above.

Case of Asymmetry ($c_2 > c_1$)

In the case of asymmetry it is difficult to show the results analytically. By numerical analysis we show the following results:

When a store brand is introduced,

1. The manufacturer's wholesale price, quantity sold of the national brand and profits almost always decrease.
2. The retailer prices and margins on the national brand and retailer profits on the national brand and total retailer profits almost always increase.
3. The retailer's share of total channel profits always increase.

i.e. $w_1|_{NS} < w_1|_N \quad q_1|_{NS} < q_1|_N \quad s|_{NS} < s|_N \quad \Pi_m|_{NS} > \Pi_m|_N$

$p_1|_{NS} > p_1|_N \quad p_1-w_1|_{NS} > p_1-w_1|_N \quad \Pi_1|_{NS} > \Pi_1|_N \quad \Pi_r|_{NS} > \Pi_r|_{NS}$

$(\Pi_r/\Pi_t)|_{NS} > (\Pi_r/\Pi_t)|_N$

Proof: See Appendix B for the Fortran program designed to execute the numerical analysis. See Table 3.6. for the

numerical values used in the analysis and Tables 3.7 and 3.8 for the results obtained from the numerical analysis.

Discussion

It is not very surprising that the retailer gains by introducing a store brand, since we have assumed zero fixed costs and zero marginal costs associated with the introduction of the store brand. At worst, he can introduce the store brand and sell zero quantity of it and make as much profits as when he sells the national brand alone. What is interesting is the process by which the retailer gains by introducing a store brand. The introduction of a store brand forces the manufacturer at the optimum to reduce his wholesale price. The retailer however increases the selling price of the national brand and consequently sells a lower quantity of it. However the gain in the margins obtained from the national brand more than offsets the decrease in quantity demanded, so that the retailer gains higher profits on the national brand and a higher proportion of total channel profits as well.

We have established that in general, it is in the interest of the retailer to carry a store brand. Our next issue is trying to understand under what demand conditions the existence of a store brand is most beneficial to the retailer from a profitability and channel control standpoint. Two parameters that describe the demand

substitutability between the national brand and the store brand and hence the level of competition between them are the price substitutability parameters or the cross price effects (c_1 and c_2) and the advertising substitutability or the advertising sensitivities (α and β). Specifically, we ask the questions:

- What is the impact of advertising sensitivities on the respective profits of the manufacturer and the retailer, and on channel control? If the manufacturer can influence demand through his advertising, is it to the detriment of the retailer?
- What is the effect of price substitutability on the profits and relative profits of the retailer and the manufacturer? Does an increase in price substitutability help or harm the manufacturer? the retailer?

3.3.6. Results from Model II

Effect of Advertising Sensitivities

In propositions 3.3 through 3.6 we motivated the process of looking at advertising sensitivities when the advertising was deemed exogenous to the model. Specifically, we showed that as the advertising sensitivity of the national brand increases and the advertising sensitivity of the store brand decreases, the retailer gains higher profits from manufacturer advertising. It is now of

interest to see if the results hold when the manufacturer can set the advertising level optimally. The following propositions describe the movement of profits and relative profits with respect to the advertising sensitivities of the national brand and the store brand.

Proposition 3.13 - Effect of β

a) Case of Symmetry $c_1 = c_2$

As the advertising sensitivity of store brand (β) decreases

i) manufacturer profits are unaffected

ii) retailer profits on the national brand increase

iii) retailer profits on the store brand increase

iv) total retailer profits and revenues increase

v) the retailer's share of total channel profits increases

vi) the quantity and revenue share of the store brand increase

That is

$$\frac{d\Pi_m}{d\beta} = 0 \qquad \frac{d\Pi_1}{d\beta} < 0 \qquad \frac{d\Pi_2}{d\beta} < 0 \qquad \frac{d\Pi_r}{d\beta} < 0 \qquad \frac{d(\Pi_r/\Pi_t)}{d\beta} < 0$$

$$\frac{d(R_2/R)}{d\beta} < 0 \qquad \frac{d(q_2/q)}{d\beta} < 0$$

Proof: See Appendix 3.13

b) Case of Asymmetry ($c_2 > c_1$)

As the advertising sensitivity of store brand (β) decreases

i) manufacturer profits are always decreasing

ii) retailer profits on the national brand may increase or

decrease (ambiguous)

In almost all cases,

iii) retailer profits on the store brand increase

iv) total retailer profits and revenues increase

v) the retailer's share of total channel profits increases

vi) the quantity and Revenue share of the store brand increase

Proof:

The proof of part (i) can be easily seen from the fact that $ds/d\beta > 0$ (from 3.30) and $d\Pi_m/d\beta > 0$ (from 3.31)

The actual computation being messy is relegated to Appendix 3.14.

Parts (iii) to (vi) are shown by numerical analysis. The parameters used for the analysis are given in Table 3.6. The results are provided in Tables 3.9 and 3.10. The computer program for the analysis is provided in Appendix C. It is easy to see that

$d\Pi_m/d\beta > 0$ & $d\Pi_r/d\beta < 0$ => $d(\Pi_r/\Pi_m+\Pi_r)/d\beta = d(\Pi_r/\Pi_t)/d\beta < 0$.

See Appendix 3.15 for proof.

Discussion of Proposition 3.13

To understand the mechanism by which the retailer loses profits and the manufacturer gains profits when the store brand advertising sensitivity increases, we look at the price, quantity, and advertising movements for a specific

example illustrated in Figures 3.11 and 3.12. When the advertising sensitivity of the store brand, β, increases, the manufacturer increases his advertising level because he can draw more consumers from the competing store brand. Consequently, he increases his wholesale price.

This increase in advertising shifts the national brand demand curve outward. The retailer has the incentive to support the brand and sell higher quantities of it. Does he get any price advantage? He may not and, in most cases, he will not. The store brand demand is considerably weakened because β is high. So the retailer cannot hope to free ride on the national brand demand. He may be forced to lower the price of the national brand from 2.87 to 2.8 here. He cannot support a high price on the store brand either, and the price goes down from 1.82 to 1.74 as β increases. Consequently, retailer profits and the retailer's share of total channel profits (channel control) go down as illustrated in Figures 3.13 and 3.14. The quantity and revenue share of the store brand sold will decrease with advertising sensitivity (Figures 3.15 and 3.16). These results are consistent with our findings from model I.

Note: It seems from Figure 3.14 that the retailer gets the lion's share (80-90%) of total channel profits. This large number has been obtained because of the specific parameter values chosen for the illustration and the fact

that the retailer gains profits from both the national brand and the store brand, while the manufacturer gets profits only from the national brand. Hence these values do not necessarily reflect division of profits in the real world. Here they should be viewed only as a guide to understanding the directional movement of the profit ratios with changes in parameter values (β).

Proposition 3.14 - Effect of α

As the advertising sensitivity of the national brand (α) increases

i) manufacturer profits increase always

ii) retailer profits on the national brand increase

iii) retailer profits on the store brand increase (small β)

iv) total retailer profits increase (for small β)

v) the quantity and revenue share of the store brand decrease always

$d\Pi_m/d\alpha > 0 \quad d\Pi_1/d\alpha > 0$

$d\Pi_2/d\alpha > 0 \quad d\Pi_r/d\alpha > 0$ (for small β)

$d(q_2/q)/d\alpha < 0 \quad d(R_2/R)/d\alpha < 0$

Proof: See Appendix 3.16

Discussion of Proposition 3.14

The logic is analogous to our discussion of proposition 3.13. When α increases, the manufacturer has the incentive

to increase his advertising level. The retailer will be able to take advantage of this and support a high price on the national brand and the store brand only if it does not impair the store brand demand, which is the case when β is small. If β is high, the retailer prices and profits will be lower.

Case of Corner solution

We have so far considered the case yielding an interior solution, where $\tau < 1$ and Sufficient Second Order Conditions hold. This is most reasonable. However when these conditions do not hold, the equilibrium is a corner solution. In this case, either the firm allocates its entire advertising budget (A_b) or the firm does not advertise at all.

So the optimal advertising level is given by

$$A^* = \begin{cases} 0 & \text{if } \Pi_m(A_b) < \Pi_m(0) \\ A_b & \text{if } \Pi_m(A_b) > \Pi_m(0) \end{cases}$$

We will make the assumption $\Pi_m(A_b) > \Pi_m(0)$, so that the optimal advertising level is A_b. The other case is uninteresting from our standpoint as the manufacturer will not advertise at all. Two questions arise in this case:

1. For a given level of exogenously determined advertising budget (A_b), how do the profits and share of profits shift with changes in advertising sensitivities?

2. For a small change in advertising budget (A_b), how do the profit allocations change and what is the impact of advertising sensitivities on this allocation?

These questions have been answered by the results derived in model I where advertising was indeed exogenous by assumption. A summary of the results are provided here.

For a given level of advertising, as the advertising sensitivity of the store brand (β) decreases

i) manufacturer profits are non-increasing

ii) retailer profits on the national brand increase (case of symmetry)

iii) retailer profits on the store brand increase (always)

iv) total retailer profits increase (case of symmetry)

v) the retailer's share total profits increases

For a given level of advertising, as the advertising sensitivity of the national brand (α) increases

i) manufacturer profits increase

ii) retailer profits on the national brand increase

iii) retailer profits on the store brand increase

iv) total retailer profits increase

How do the profit allocations change for a small change in advertising budget?

For a small increase in advertising budget:

i) manufacturer profits increase (Proposition 3.3 (i))

ii) retailer profits on the national brand increase (Proposition 3.4(i))

When advertising sensitivity of the store brand (β) is small,

iii) retailer profits on the store brand increase (Proposition 3.5(i))

iv) total retailer profits increase (Proposition 3.6(i))

As the advertising sensitivity of the store brand (β) decreases

i) marginal profits (through increased advertising) for the manufacturer decrease (Proposition 3.3 (ii))

ii) marginal profits for the retailer from the national brand increase (Proposition 3.4(ii))

iii) marginal profits from the store brand increase (Proposition 3.5(ii))

iv) retailer's total marginal profits increase (Proposition 3.6(ii))

3.3.7. Effect of Price Substitutability

A logical first step in understanding the effect of price substitutability is to consider the case of symmetry, $c_1 = c_2 = c$. c is the measure of product category price

substitutability. Higher c implies the brands are more substitutable. The optimal decision variables w_1, p_1 etc. are given in equations (3.37) through (3.43). We will omit the subscript "NS" since we will only be dealing with the case where the retailer sells both the national brand and the store brand. We will derive results analogous to proposition 3.9 in model I. These results are unaffected.

Proposition 3.15

When the brands become more price substitutable (as c increases)

i) manufacturer profits are unaffected

ii) retailer profits on the national brand increase

iii) retailer profits on the store brand increase

iv) total retailer profits increase

v) the retailer's share of total channel profits (channel control) increases

vi) the quantity and revenue share of the store brand increase

Proof: See Appendix 3.17.

A table summarizing the results of model II are provided in Table 3.11.

Discussion

This result is interesting. In the case of symmetry, the manufacturer decisions and profits are unaffected by changes in price substitutability. An explanation for this

has been provided in our discussion of proposition 3.2. The retailer increases his price on the national brand and the store brand and thus increases his profits. This has been illustrated for a specific example in Figures 3.17 through 3.21. Figure 3.17 shows the movement of equilibrium prices and quantities with price substitutability (c). As c increases from 0.1 to 0.6, the retail prices of the national brand and store brand increase. The national brand price increases more steeply, and the differential between the national brand price and store brand price increase. This enables the retailer to sell more quantities of the store brand, without affecting the quantity of national brand sold. This enable the retailer to increase his profits on the two brands and thus increase his total profits (Figure 3.18). Consequently, the retailer's share of total channel profits increase (Figure 3.19). The revenue and quantity share of store brand sold also increase (Figures 3.20 and 3.21).

3.3.8. Impact of Advertising Substitutability and Price Substitutability on Profits

We will now examine the interactive effect of price and advertising substitutability on the retailer's profits. As before we will deal with the special case of symmetry. We have shown that the lower is the advertising sensitivity of

the store brand, the higher is the retailer profits. Is the effect of advertising sensitivity enhanced by price substitutability?

Proposition 3.16

The increase in retailer profits obtained from decreased advertising sensitivity of the store brand is higher when price substitutability is large than when it is small.

$$\frac{d}{dc}\left[\frac{d\Pi_1}{d\beta}\right] < 0 \qquad \frac{d}{dc}\left[\frac{d\Pi_2}{d\beta}\right] < 0 \qquad \frac{d}{dc}\left[\frac{d\Pi_r}{d\beta}\right] < 0$$

Proof See Appendix 3.18.

Discussion

When the advertising sensitivity of the store brand is small, that is, the store brand is insular to national brand advertising, the retailer can increase the price of the national brand and the store brand. Since price of the national brand is high, consumers will switch to the store brand. If the cross price substitutability is high, more people will switch to the store brand and the retailer increases his profits on the store brand and his total profits.

3.4. Summary and Contributions

We provide two models to analyze the competition between a national brand and a store brand. In one,

advertising is exogenous to the model. In the other, advertising is endogenously determined in the model. All the other model assumptions and model structure remain the same. Together, these two models provide some intuitive results and interesting implications. We will refer to these two models (I&II) together as the "Basic Model" in our subsequent discussion.

In summary, we proceed to answer the following questions we posed in the beginning of the chapter.

1. Are store brands mechanisms by which retailers gain channel control?

Our model results show that perhaps by having a store brand, retailers can gain higher overall profits and thus wean away market power from the manufacturer.

2. If so, under what conditions is a store brand most beneficial to the retailer?

Our model finds that the retailer gains higher total profits and higher share of total channel profits (a measure of channel control), when the advertising sensitivity of the store brand is low and the price substitutability is high.

Private brands are usually lower in price and are promoted locally. National brands are usually higher in price and promoted nationally. It is a simple step to the market segmentation notion that consumers who respond differently to private brands are those more readily

influenced by a price appeal than by a promotion appeal. That is, the segmentation theory states that private brands exist primarily to cater to a price sensitive segment. Our model goes beyond the segmentation explanation. It provides a market power explanation for the existence of store brands. By having a store brand in a market that is highly price sensitive and not so advertising sensitive, retailer can manipulate the manufacturer and gain higher profits on both the national brand and the store brand and thus gain higher share of overall profits.

3. Why are store brands pervasive in certain product categories and not in certain others?

Our model provides a possible answer. If profitability is the drive for introducing a store brand, we should see store brands in markets with high price substitutability and low advertising substitutability. This provides a possible explanation for why we see several store brands in certain product categories like milk, groceries etc., but not in certain others like toothpaste and cosmetics where, presumably, advertising substitutability is relatively high and price substitutability is relatively low.

4. What pricing strategy does the retailer adopt with respect to the national brand and the store brand?

When the store brand's advertising sensitivity is small, the retailer can command a high price on the national

brand because of manufacturer advertising. Because the national brand does not draw consumers from the store brand, the quantity of national brand sold will go down. Because of the increase in the national brand's price, more consumers will shift to the store brand if price substitutability is high. Due to the increase in demand, the retailer can support a higher price on the store brand. In a sense, the store brand takes a free ride on the national brand advertising.

The strategy for the retailer is to increase the price of the national brand and suitably increase the price of the store brand such that he sells a lower quantity of the national brand and a higher quantity of the store brand. The bulk of his revenues and profits come from the store brand. Furthermore, the retailer can also influence advertising substitutability (i.e. reduce advertising sensitivity of the store brand) by countering the advertising attack through packaging, shelf facing, and other marketing efforts.

4. What impact does the presence of a store brand have on the pricing and advertising strategy of the manufacturer?

Our model provides some implications for the optimal advertising strategy of the manufacturer. There are at least three viewpoints from which to look at advertising strategy of the manufacturer in the presence of store

branding (Cook and Schutte 1967). One might be labeled a "view with alarm" approach which says the store brand is a threat and a challenge to advertising agencies and manufacturers. They have to devise strategies to effectively combat this threat (Advertising Age 1975). Not unrelated to this is the second viewpoint, "advertise a lot to keep out private brands." A third neutral viewpoint is that national brand advertising is not related to store branding.

We do not take the second or third viewpoint. We take the "view with alarm" position, but in a different way. Our model shows $dA/d\alpha > 0$ and $dA/d\beta > 0$. That is, it is optimal to increase advertising when the market is more advertising sensitive, but to reduce advertising if the market is not very advertising sensitive.

Several manufacturers seem to take the second view and believe an increase in their advertising budget is the only way to combat store brand competition. Aaker and Carman (1982) call this "overadvertising." A substantial amount of advertising for established, frequently purchased consumer brands today represent overadvertising, advertising under conditions of saturation. A look at some firm's advertising budgets as a percentage of after tax profits (General foods -177%, P&G - 90%, Unilever - 407% in 1979) suggests that perhaps there is some evidence of overadvertising. A

reduction in advertising could have a significant effect on profits.

Our model suggests that for frequently purchased items for which the advertising substitutability is low and the price substitutability is high, the manufacturer's best strategy is to decrease advertising and decrease wholesale price.

3.5. Limitations of the Model

The basic model has several limitations which arise primarily from the assumptions imposed in the model structure. We discuss the major limitations below. In chapter III, we provide some extensions to the basic model where we relax some restrictive assumptions. We show that the key comparative statics results listed in Tables 3.4 and 3.11 are valid even in such cases.

Introduction of Fixed and Marginal Costs

In the basic model we have set the marginal costs and fixed costs to zero. Because of these assumptions, we find that the retailer will always introduce a store brand. If fixed and marginal costs are non zero, the retailer may or may not introduce a store brand. Specifically we show in chapter IV that the higher is the price substitutability (c) and the lower is the advertising substitutability (β), the more likely it is that the retailer will introduce a store brand. The other comparative statics results remain

unchanged in general.

Quantity Setting versus Price Setting

The game envisaged by us in the present models is a price setting Bertrand model where both the manufacturer and the retailer set their prices to maximize profits. But, in several instances in the real world, the retailer may decide on the quantities of the national brand and the store brand to "move," particularly when faced with some kind of total quantity constraint that may arise from a shelf space constraint or total market saturation constraint. The appropriate model then would be a quantity setting Cournot model at the retailer level. In chapter IV we set up a quantity setting model and show that when the total quantity constraint is not binding, the price setting model and the quantity setting model are identical. When the quantity constraint is binding, the solutions are different and complex and can not be easily analyzed. By numerical analysis, we show that the key results still hold in such cases.

Introduction of Competition

Assuming away competition at the retail level and the manufacturer level is one of the serious limitations of the basic model. However, introducing competition made the problem intractable. Several other assumptions like symmetry, unitary own price elasticity etc. have to be

imposed for analytical tractability which make the model unrealistic. So parsimony, and the ability to derive some intuitive and interesting results with a simple model are the driving force behind our basic model. In defense of these assumptions, we may make a few observations. The assumption of a single retailer may not be very restrictive in some cases. As Solomon and Hymowitz (1987) point out, in several metropolitan areas, retailers wield monopoly power because of their size and strategic geographic location. Econo Foods and Eagle in Iowa City, for example, fall in that category. Note, however, that this formulation does not presume literal or pure monopoly. In an oligopolistic or monopolistically competitive market, these demand functions can be interpreted as firm specific demand curves (Greenhut and Ohta 1979). Further, a casual look at some of the grocery stores and some other retailers indicates that, in several product categories, the retailer sold just one national brand and one store brand (e.g. milk, butter, some frozen foods and even appliances).

Promotional support at the retail level

Our model assumes that the retailer does not engage in price or non-price promotional activities. The support given at the retail level through shelf positioning, display, and the retailer's ability to price promote at different times can be important factors in the selling

process. Any attempt to derive implications about price promotion requires a two period model (Varian 1980). It is difficult to solve such a model when advertising is also a choice variable, and in any case, price promotion is beyond the scope of this thesis.

Form of Demand Function

A linear demand function is commonly used because of analytical tractability. But it is of interest to see if the results will hold for a more general demand function. This extension is left to future work.

3.6. Conclusion

In conclusion, despite these assumptions, we believe our model makes a significant contribution for several reasons:

1. The scope of the paper is to analyze national brand - store brand competition from the perspective of channel control. We believe this is the first model of this nature.
2. We motivate our modeling effort based on theories in industrial organization and introduce advertising as a decision variable. To the best of our knowledge, no modeling effort has incorporated manufacturer advertising thus far.
3. We identify conditions under which it will be most profitable for the retailer to introduce a store brand.

Specifically, we show that the higher is the cross price substitutability between the national brand and the store brand and the lower is the advertising sensitivity of the store brand, the higher are the retailer's profits and share of channel profits (a measure of channel control).

4. While the common segmentation theory of store branding states that store brands are primarily designed to attract the more price sensitive and less advertising or quality sensitive segment, we provide an alternate market power theory to explain the phenomenon.

5. We also analyze the movement of equilibrium prices and advertising and discuss some strategic implications for the retailer.

6. The model also provides some implications for the proliferation of store brands. Proliferation of store brands is used generically to mean the number of store brands in the market and sales share of store brands. Though our model looks at a single retailer, we can aggregate the results over several retailers to get insights at the market level. Obviously, we are ignoring interactions across product categories and across retailers. Our model implies that the share of store brands sold at the retail level and at the market level will increase with price substitutability and decrease with advertising substitutability (advertising sensitivity of store brand).

CHAPTER IV

EXTENSIONS TO THE BASIC MODEL

4.1. Introduction

In chapter III we discussed the basic model and several limitations with respect to the assumptions imposed on it. Here we set up several models that relax one or more of those assumptions. We show that most of the key results remain unchanged. We also derive implications regarding the retailer's decision to introduce a store brand. Unlike in the basic model, we will not devote a lot of effort to rigorously show the existence of equilibrium or work out all the comparative statics results. These will be merely a massive algebraic exercise involving long complex expressions and, we believe, they do not result in gaining further insights. All assumptions regarding the demand function and demand structure remain unchanged from the basic model.

4.2. MODEL III - Incorporating Fixed Costs

4.2.1. Model Structure

Let F_1 be the fixed cost incurred by the manufacturer for production of the national brand.

F_1' be the fixed cost that the retailer incurs for carrying the national brand.

F_2 be the fixed cost related to the store brand.

Then the problem can be written as

Pricing Game Retailer $\underset{p_1,p_2}{\text{Max}}$ $(p_1-w_1)\ q_1 + p_2\ q_2 - F_1' - F_2$.

Manufacturer $\underset{w_1}{\text{Max}}$ $w_1\ q_1 - A - F_1$.

Advertising game Manufacturer $\underset{A}{\text{Max}}$ $w_1\ q_1 - A - F_1$.

4.2.2. Results of Model III

It is easy to see that the equilibrium prices and quantities are identical to those in the basic model (Models I and II). This is obvious since the fixed costs do not affect the first order conditions. The only result that changes will be the one regarding the introduction of a store brand. In model I and model II, because of the assumption of zero fixed costs, we arrived at a situation where the retailer will always introduce a store brand. Here it is not so clear. The retailer will introduce a store brand i) if he gains positive profits from the store brand.

$$\Pi_2 = p_2\ q_2 - F_2 > 0$$

ii) if total profits are greater when he introduces a store brand

$$\Pi_r|_{NS} = \Pi_1 + \Pi_2 > \Pi_r|_N = \Pi_1|_N$$

In this context F_2 can be thought of as the minimum profits that the retailer will accept for introducing a store brand. The decision to introduce a store brand will depend on F_1'

and F_2 as well as values of other parameters. The following proposition describes the conditions under which the retailer is more likely to introduce a store brand.

Proposition 4.1 - Introduction of a store brand

The retailer is more likely to introduce a store brand when the advertising substitutability (advertising sensitivity of the store brand, β) is lower and the cross price substitutability (c) is higher.

Proof:

The proof follows simply from Proposition 3.13 which holds for this model as well. We have $d\Pi_2/d\beta < 0$ and $d\Pi_r/d\beta < 0$. Hence, the lower is the advertising substitutability, the higher are the profits from the store brand and total profits, and hence, more likely it is that $\Pi_2 > 0$ and $\Pi_r|_{NS} > \Pi_r|_N$ or more likely that a store brand will be introduced.

Similarly from observing that $d\Pi_2/dc > 0$ and $d\Pi_r/dc > 0$ (proposition 3.15) and making the same argument as above, we can show that the retailer's propensity to introduce a store brand is directly proportional to price substitutability.

All other results remain unaffected.

4.3. MODEL IV - Incorporating Fixed Costs and Constant Marginal Costs

4.3.1. Model Structure

Let k_1 be the constant marginal cost of production for

the national brand.

k_2 be the constant marginal cost of production for the store brand.

The problem formulation is as follows:

Pricing game Retailer $\underset{p_1,p_2}{\text{Max}}$ $(p_1-w_1)\ q_1 + (p_2-k_2)\ q_2 - F_1' - F_2.$

Manufacturer $\underset{w_1|A}{\text{Max}}$ $(w_1-k_1)\ q_1 - F_1 - A.$

Advertising game Manufacturer $\underset{A}{\text{Max}}$ $(w_1-k_1)\ q_1 - F_1 - A.$

4.3.2. Solutions for Model IV

The formulae for equilibrium prices and quantities are a little long and complex. However they can be simplified by writing it in terms of the expressions from the basic model. The only additional terms are the coefficients of k_1 and k_2. Because of the length of the expressions, they have been relegated to Appendix 4.1.

4.3.3. Results of Model IV

Advertising Exogenous - Effect of Advertising

The results from the basic model given in propositions 3.3 through 3.8 and summarized in Table 3.4. are unchanged. The proof of this can be seen from inspecting the equilibrium solutions. The additional terms containing k_1 and k_2 do not depend on the advertising level or advertising

sensitivities α and β. So the comparative statics with respect to advertising and with respect to advertising sensitivities remain unaffected from the basic model.

Advertising Endogenous - Effect of β

The comparative statics results are unchanged from the basic model. In the case of symmetry, it is easy to see from the equations that the additional expressions coefficients of k_1 and k_2, do not depend upon β. Hence the comparative statics results are unaffected.

In the case of asymmetry however, the expressions for s^* contains β. The fact that the comparative statics results are unaffected is shown by numerical analysis. The parameter ranges are provided in table 4.1 and the results are given in table 4.2.

Advertising Endogenous - Effect of c

The comparative statics results of prices and profits with respect to price substitutability (c) also remain unchanged from the basic model. These results are also shown by numerical analysis (table 4.3).

Introduction of Store brand

The result stated in proposition 4.1 hold in this case as well since $d\Pi_2/d\beta < 0$ and $d\Pi_r/d\beta < 0$ and $d\Pi_2/dc > 0$ and

$d\Pi_r/dc > 0$.

The lower the advertising substitutability and the higher the price substitutability the more likely that the retailer will introduce a store brand.

4.4. MODEL V - Quantity Setting Equilibrium

4.4.1. Model Structure

In chapter III we had pointed out that the retailer may decide on the quantities of the national brand and the store brand to "move," particularly when faced with some form of total quantity constraint. This puts us in the quantity setting framework as described below.

The retailer sets quantities instead of prices.

Retailer $\quad \underset{q_1, q_2}{\text{Max}} \quad (p_1(q_1,q_2) - w_1)\ q_1 + p_2(q_1,q_2)\ .\ q_2.$

$$\text{s.t } q_1 + q_2 \leq q_u$$

Manufacturer $\quad \underset{w_1 | A}{\text{Max}} \quad w_1\ .\ q_1 - A.$

Manufacturer $\quad \underset{A}{\text{max}} \quad w_1\ .\ q_1 - A.$

There are two possible interpretations for the quantity constraint q_u. One is the market saturation interpretation, which says the market demand is fully served and the retailer can not sell any more than q_u, whatever the price. This gives raise to a kinked demand curve, as shown in Figure 4.1. The other interpretation is that the demand may

be linear in the entire price domain, but the retailer has a shelf capacity constraint, and can not stock more than q_u. In other words the retailer's marginal cost shoots up to infinity for any quantity greater than q_u, as shown in Figure 4.2.

We have $q_1 = a_1 - b_1 p_1 + c_1 p_2 + f(A)$

$q_2 = a_2 - b_2 p_2 + c_2 p_1 - g(A)$

To solve the above maximization problem we invert these demand functions and get

$$p_1 = h_1 - m_1 q_1 - n_1 q_2 + m_1 f(A) - n_1 g(A)$$

$$p_2 = h_2 - m_2 q_2 - n_2 q_1 + n_2 f(A) - m_2 g(A)$$

where $h_1 = (a_1 b_2 + a_2 c_1) / Y$ $\quad h_2 = (a_1 c_2 + a_2 b_1) / Y$

$m_1 = b_2 / Y$ $\quad m_2 = b_1 / Y$

$n_1 = c_1 / Y$ $\quad n_2 = c_2 / Y$

$$Y = b_1 b_2 - c_1 c_2$$

4.4.2. Solutions for model V

The solutions for the model are provided in Appendix 4.2. for the two cases - quantity constraint binding and quantity constraint not binding.

4.4.3. Results From Model V

Proposition 4.2 - Quantity Constraint Not Binding

The equilibrium solutions (prices, quantities and

advertising) in the quantity setting model and the price setting model are identical.

Proof of this can be easily seen by substituting for h_i, m_i, n_i (i=1,2) in the expression for equilibrium values given in Appendix 4.2. and converting the expressions to read in terms of a_i, b_i, c_i. It follows from these results that the comparative statics results remain unchanged from the basic model. In a pure monopoly case this result will not be surprising since there is one to one correspondence between prices and quantities. However, it is nice to see that the result holds in the case of successive monopoly as well, where the downstream retailer has multiple products.

Proposition 4.3 - Quantity Constraint is Binding

As the advertising sensitivity of the store brand (β) decreases

i) retailer profits on the store brand always increase

ii) total retailer profits almost always increase

iii) the retailer's share of channel profits increase

iv) revenue share of store brand sold increase

The results are ambiguous otherwise.

The above results are shown only by numerical analysis. The setups used along with the range of values and the results are given in table 4.4.

These results show that the basic result on the impact of advertising sensitivity on retailer profits and channel control hold in the quantity setting model as well.

4.5. Summary

In chapter III we pointed several limiting assumptions imposed on the basic model for analytical tractability. In this chapter we relax several of those assumptions. We incorporate fixed and marginal costs into the model. We find that all the comparative statics results derived in the basic model hold good in these extended models as well. This implies that the main results are fairly robust. We then proceed to develop a quantity setting model where the retailer sets quantities instead of prices. We find that several of the key results hold in this case as well.

CHAPTER V

EMPIRICAL ANALYSIS

5.1. Introduction

One aspect of store branding that has been of interest to marketers and marketing researchers is the proliferation of store brands. Proliferation of store brands in a category is generally measured by the volume or dollar share of store brands in that category (Cook and Schutte 1967, Albion 1983) and number of retailers carrying a private label or store brand in that product category (Report of the National Commission for Food Marketing 1966). An understanding of the proliferation of store brands enables the national brand manufacturer to identify those product categories where store branding is pervasive and devise suitable marketing strategies. It also helps the retailers to introduce store brands in those categories which are conducive to private label growth. Because of this great interest in the proliferation of store brands, companies like Selling Areas Marketing Inc. (SAMI) and A.C. Nielsen & Co. compile data on store brand proliferation for commercial purposes.

Empirical researchers interested in understanding proliferation of store brands have tried to identify the antecedents and consequences of store brand proliferation. These researchers have analyzed the data at two levels. One

is at the level of the retailer. For example Albion (1983) used the "Wholesale Analysis Report" of a supermarket chain with over $300 million in sales as the database for his extensive study on brand gross margins and store branding. The second is at the total market level where analysis is done based on the aggregation of data from several retailers (Cook and Schutte 1967). This enables us to better understand the overall market conditions at the industry level.

The basic model and its extensions provide some implications regarding proliferation of store brands. Two parameters that were of interest to us in our comparative statics analysis were the price substitutability (c) and the advertising sensitivities of the national brand and the store brand (α and β). Broadly, 'c' can be thought of as indicative of the level of price competition, and α, β as the levels of advertising competition at the product category level. These will form the determinant market characteristics or the independent variables. They will be related to the characteristics of store branding viz. the share of store brands (dependent variables). Since our model focuses on a single retailer, we will first derive some testable hypotheses at the retailer level and provide some empirical results. We will then discuss some market level hypotheses that can be obtained from the model by

aggregation, and discuss some preliminary empirical findings.

Before deriving the empirical hypotheses, we first discuss the operationalization of the variables of interest.

5.2. Operationalization

Store Brand Proliferation

Store brand Proliferation is operationalized by the quantity and revenue share of store brands in a product category which is measured by the quantity (revenue) of store brand sold as a percentage of total quantity (revenue) of sold in that product category.

Price Substitutability or Level of Price Competition

It is difficult in general to obtain a measure of cross price substitutability at the category level. Since the cross price matrix has several elements (one for the effect of each brand on all other brands), trying to get a single category level measure may involve some arbitrariness. Researchers have used the average category own price sensitivity as a measure of the level of price competition (Tellis 1988). These measures are obtained by regression of brand sales on own price and other factors. It includes dimensionless estimates called price elasticities and those with dimensions, usually called price coefficients. If q = sales and p = price, then the price coefficient is $\delta q/\delta p$ and

price elasticity is $(\delta q/\delta p)$ (p/q). It can be easily seen that the coefficient of the regression of q on p is the elasticity, if we include the logarithms or percentage changes in the regression. Measures of price coefficients are not comparable across product categories, unless all the variables are measured in the same units (which they usually are not). The price elasticity is the ideal measure for our purpose, being both unit-free and easily interpreted. Thus we will use category own price elasticity (simply called price elasticity) as a measure of the level of price competition.

Another surrogate measure of price competition is the percentage of goods sold on deal in that product category. Such data are not available with us at this time.

Advertising Competition or Advertising Sensitivity

Measures of advertising sensitivity are more difficult to obtain and cross advertising elasticities are in general unavailable. Two commonly used measures of category advertising competition are the category own advertising elasticity and Advertising/Sales (A/S) ratio.

We will discuss how these variables are related to store branding.

5.3. Retailer level Hypotheses

5.3.1. Share of Store Brand and Price Competition

From proposition 3.15, we have the following

hypothesis: The quantity and revenue share of store brands sold is positively related to price substitutability.

Based on the operationalizations discussed in section 5.2., we have the following operational or working hypotheses.

HR1.[1] The volume share of the store brand sold in a product category is positively related to the category own price elasticity.

HR2. The dollar sales share of the store brand in a product category is positively related to the category own price elasticity.

5.3.2. Share of Store Brands and Advertising Competition

From propositions 3.13 and 3.14 we have the following hypothesis: The quantity and revenue share of the store brand is negatively related to the advertising sensitivity of the national brand (α) and negatively related to the advertising sensitivity of the store brand (β). As mentioned earlier, the common operationalizations of advertising competition at the category level are the own advertising elasticity and the category advertising/sales ratio. Since advertising of the national brand is done at the national level, the A/S ratio is not appropriate at the

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[1]This should be read as hypothesis 1 at the retail level.

retail level. The only suitable independent measure is the (own) advertising elasticity. Accordingly, we have the following operational hypotheses:

HR3. The volume share of the store brand in a product category is negatively related to the category advertising elasticity.

HR4. The dollar sales share of store brand in a product category is negatively related to the category advertising elasticity.

5.3.3. Data

The measures of price elasticity and advertising elasticity for 10 frequently purchased grocery product categories were obtained from the extensive analysis of the Jewel chain store data performed by Wisniewski and Blattberg (1988) under an NSF grant. The other relevant data on market shares were provided by Ken Wisniewski. The product categories are: cooking oils, canned dog food, flour, detergent, margarine, ice cream, peanut butter, bath tissue, paper towels, and tuna fish. The data analyzed were the Universal Product Code (UPC) retail store scanning data provided by Jewel, the largest grocery chain store in Chicagoland. The UPC scanning data provide unit sales and unit price information by UPC code (brand/item/size) by store by week. These data were available for about 26-79

weeks during the period 1984-87. In addition, newspaper feature advertising and in-store display information used in the analysis were collected by the Center for Marketing Research, University of Chicago for selected product categories. The procedure used for the estimation of price and advertising elasticities is briefly explained below.

5.3.4. Estimation of Price and Advertising Elasticities

The estimation procedure of Blattberg and Wisniewski employed the following variables.

Dependent variable:	brand level sales in units
Independent variables:	regular price of the brand observed price of the brand observed price of competing brands deal discount deal period advertising non deal period advertising deal correction factor deal decay variable seasonal adjustment variable

After testing several functional forms including the linear, semi-log and log-log models, the semi-log[2] model was selected for the analysis since it performed well empirically and could also be justified theoretically.

The coefficient of regular price represents the own price effect and the coefficients of competitors' prices

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[2]A semi-log model in this context is a linear relationship between the log of the dependent variable and raw independent variables.

represent cross price effects. Advertising is captured here by non deal period or later period newspaper advertising dummy. The effects of price and advertising are estimated after accounting for dealing and seasonal trends. In most cases the adjusted R^2 ranged from 0.85 to 0.95. This indicated that the model provided a good fit and the coefficients could be meaningfully interpreted. These coefficients were converted to elasticities and were combined to get an average category level measure of price and advertising elasticities. The data along with other market share information are provided in Table 5.1.

There are some points worth noting about the data. There was at least one store brand or private label in all the product categories except ice cream. This is typical of several frequently purchased consumer items. Price elasticity data are available for all 10 products and advertising elasticity for 9 products. Quantity shares are available for 8 products. Dollar shares were imputed from quantity share and regular prices and are available for only 6 products. We recognize that the sample is small. Nevertheless, direct estimates of price and advertising elasticities are difficult to obtain and we believe this is the first test of this nature. While we can not make any broad generalizations from the data, we hope it will provide some preliminary evidence and insights.

5.3.5. Methodology

Since the hypotheses specify a direction of relationship between each dependent variable (store brand share) to each independent variable (elasticities) one on one, we employed the Pearson Correlation technique to test the relationships. This is equivalent to running a simple regression between the two variables and testing the sign of the regression coefficient. A joint test that simultaneously takes into account all the variables in a multiple regression or structural equation modeling context would be appropriate here and would have provided additional insights about the unique and interactive effects. But the small sample size precludes such analysis.

5.3.6. Results

The Pearson correlation between price elasticity and quantity (volume) share of store brand (hypothesis HR1) is 0.72 and that between price elasticity and dollar share (HR2) is 0.79. Both are significant at the 95% confidence level.

The correlation between advertising elasticity and volume share (HR3) is -0.46 (n=6, p=0.36). The correlation between advertising elasticity and dollar share of store brand (HR4) is -0.53 (n=5, p=0.36). Both correlations are not significant even at the 90% confidence level.

5.3.7. Discussion of the results

The significance of the correlations between price elasticity and store brand share indicates that there is some evidence of positive relationship between price competition and store brand proliferation. This relationship is intuitive and may be obvious in some cases, say when we compare a food item like milk, where consumers are price sensitive, to a cosmetic item, like lipstick where consumers are less price sensitive. However, it is of interest to see if this relationship holds across several product categories - say dog food, ice cream and peanut butter. This relationship has not been empirically tested before. Our results show some preliminary evidence of a positive relationship and suggests further testing with data from other stores and with other product categories.

The correlations between advertising elasticity and store brand share are negative but not significant. It is interesting to see that the relationship is in the hypothesized direction and opposite in sign to that of the relationship between store branding and price competition. The lack of significance should not lead one to conclude that there is no relationship between advertising competition and store branding. This occurrence may be due to several reasons: a) the sample size is small (5-6). The variance of the correlation and the significance level in a

correlation test is sensitive to sample size. Thus caution should be exercised in interpreting the significance level. b) advertising is captured here as newspaper advertising dummy and hence may not a be good measure of brand advertising which may lead to a downward bias in the correlation estimates. Despite the lack of significance, we may conclude that there is some directional evidence of a negative relationship between store branding and advertising. But further testing is required to validate this relationship.

5.4. Market Level Hypotheses

5.4.1. Introduction

Though the modeling is done at the retail level, we can derive implications at the market level if we can think of the market as comprising of several independent retail outlets. In this case we can aggregate the results of the retail level model to derive hypotheses similar to the ones stated earlier (HR1-HR4). Obviously, we are ignoring cross product and cross retailer interactions. We stated in chapter III that inclusion of such factors destroys the analytical tractability of the model. As we will see below, the market level implications provide some intuitive and empirically testable interesting hypotheses, despite these shortcomings.

5.4.2. Share of Store Brand and Price Competition

The hypotheses are a result of direct aggregation of the results of proposition 3.15: The quantity and revenue share of the store brand sold is positively related to the price substitutability. Based on the operationalizations stated in section V.2, we have the following working hypotheses.

HM1.[3] The volume market share of the store brand in a product category is positively related to the category own price elasticity.

HM2. The dollar sales market share of the store brand in a product category is positively related to the category own price elasticity.

5.4.3. Share of Store Brands and Advertising Competition

From propositions 3.13 and 3.14 we have the following hypothesis: The quantity and revenue share of store brand sold is inversely related to the advertising sensitivity of the national brand (α) and inversely related to the advertising sensitivity of the store brand (β). As mentioned in section 5.2, the common operationalizations of advertising competition at the category level are the own advertising elasticity and category Advertising/Sales ratio.

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[3]Here it should be read as hypothesis 1 at the market level.

Accordingly, we have the following operational hypotheses:

HM3. The volume market share of the store brand in a product category is negatively related to the product category advertising elasticity.

HM4. The volume share of the store brand sold in a product category is negatively related to the category Advertising/Sales ratio.

HM5. The dollar sales market share of the store brand in a product category is negatively related to the category advertising elasticity.

HM6. The dollar sales share of the store brand in a product category is negatively related to the category Advertising/Sales ratio.

5.4.4. Number of Store brands and Price Competition

One measure of store branding used by empirical researchers is the number (proportion) of retailers carrying a store brand. This can be derived from proposition 4.1 which states that the retailer is more likely to introduce a store brand when the cross price substitutability is higher. Mathematically, we can state that the probability (p) of a retailer carrying a store brand in a product is directly related to the price competition (c). If there are n retailers, the expected number of retailers carrying a store brand is np. Thus, the number of retailers in the market

carrying a store brand in a product category is directly related to its price substitutability. With the operationalization mentioned earlier, we have the following hypotheses:

HM7. The proportion of retailers carrying a store brand in a product category is positively related to the product category own price elasticity.

5.4.5. Number of Store Brands and Advertising Competition

We can derive some implications about this relationship from proposition 4.1 which states that the retailer's propensity to introduce a store brand is negatively related to the advertising sensitivity of the store brand (β). The relationship between the propensity and advertising sensitivity of the national brand is ambiguous. If β is low, then retailer profits and hence the likelihood of introducing a store brand increase with α. If not, they may decrease with α. So the net effect of category advertising competition is likely to be to decrease the retailer's incentive to introduce a store brand. Thus the number of retailers in the market carrying a store brand is expected to be negatively related to advertising competition. Analogous to the price competition case, we have the following working hypotheses:

HM8.The proportion of retailers carrying a store brand in a

product category is negatively related to the product category own advertising elasticity.

HM9. The proportion of retailers carrying a store brand in a product category is negatively related to the product category Advertising/Sales ratio.

5.4.6. Data

For testing the above hypotheses, we require market level estimates of store brand share and proportion of retailers carrying store brands (dependent variables) and estimates of price and advertising competition (independent variables). Unlike the retail level data, there is no single source from which these data may be obtained.

Independent Variables

There are no readily available direct estimates of product category price and advertising elasticities. So we proceeded to get measures of price and advertising elasticities from available published data. Several econometric studies have been done to measure price and advertising elasticities. Recently, researchers have tried to integrate these studies through a meta-analysis. Tellis (1988) conducted a meta-analysis on price sensitivity of

selective demand[4] and analyzed 424 price estimation models obtained from 42 studies ranging from 1961-85. Assmus, Lehmann and Farley (1984) provided a meta-analysis of advertising-sales coefficient from about 20 studies published over the period 1960-82. Meta-analysis is a systematic and "objective" way of explaining inter-study differences and summarizing past results. The underlying belief in meta analysis is that these studies, even though done at different times and different market locations, should provide comparable results. Any inter study variation can be explained by systematic differences among the studies. We used these studies as the basis for getting measures of advertising and price elasticities. There were about 60 studies in all. However these measures, even if not measured at the same time or place, can be integrated only if they are comparable with respect to systematic factors like:

- model used for estimation viz. linear, log-linear, semi-log
- estimation procedure viz. OLS, GLS etc..
- units of measurement viz. dollar sales or unit sales, relative sales or absolute sales etc..

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[4]The term "selective demand" means demand for a particular firm's branded product, measured as its sales or market share, as opposed to "primary" or category demand.

Unfortunately our efforts were not fruitful. Many studies did not identify the product by name. Among the ones which reported the product names, no two studies were comparable with respect to the factors described above. There was no scope for integration of these studies. So we selected 5 individual studies which reported category own price elasticity and own advertising elasticity for multiple products: Tellis (1988), Wisniewski and Blattberg (1988), Stowsand and Wenzel (1979), Lambin (1976), and Metwally (1975). The studies by Lambin and Stowsand et al use data from European markets collected during early seventies. The study by Metwally is on data from Australian firms. Data on store brand share in U.S. are available only for the eighties. Hence, trying to find a relationship between the two will amount to asynchronous comparisons of data from possibly different type of markets. No direct comparisons were done using this data. Nevertheless we use these studies as well as the integration work of Tellis to identify some consistent patterns of advertising and price competition and make observations about their relationship with store brand share. The study by Wisniewski et al provide measures of price and advertising elasticity at the retail level in the U.S. market for the period 1984-87. Nevertheless we use these estimates to ascertain some relationships at the market level, since no global measure

of price competition is available. This analysis is tentative and preliminary. One can not make strong conclusions from this analysis.

The Advertising/Sales ratio data is a global industry level measure. It is available for several years from Advertising Age. These measures are provided for broad product category classifications based on SIC codes.

Dependent Variables

The data relating to share of store brands was obtained from Selling Areas Marketing Inc. (SAMI). The only comprehensive data on proportion of retailers carrying a store brand that are currently available with us is the data compiled by the Food Commission (Report of the National Commission for Food Marketing 1966). This data so old and we believe we can not gain meaningful insights about the current market. Further, since the independent variables have been measured in the eighties, any correlational analysis would be asynchronous. Nevertheless we employ the data to make some preliminary observations about the hypothesis relating to proportion of store brands (HM7-HM9).

5.4.7. Results

Price Competition and Store Brand Share

The relationship between price competition and store brand penetration is assessed by the correlation between

price elasticity obtained from Wisniewki and Blattberg, and sales share from SAMI. The data and results are provided in Table 5.2. The correlation of price elasticity with volume share is 0.26 (p=0.53, n=8) and correlation with dollar share is 0.25 (p=.25, n=10). The relationships are in the hypothesized direction. Neither of the correlations is significant at the 90% level. But this does not necessarily indicate that there is no relationship between store branding and price competition at the market level. The lack of relationship may be spurious and may be due to small sample size and the fact that the independent variable is a local measure (measured at the retail level) and the dependent variable is an industry level measure. Both these factors tend to reduce the significance level.

To gain further insights about the relationship one can make some general observations. Aggregating several studies, Tellis found that the detergents category with price elasticity of -2.77 was the most price sensitive category followed by food, then toiletries, and then pharmaceuticals. If this pattern were true we should find store brand share to be the highest in detergents and the least in pharmaceutical. The 1987 dollar and volume share indicate that in terms of broad category classification, food has the maximum brand share in both dollar terms and pound volume terms. The data are given in Table 5.3. This

may mean either that the estimates may not be correct i.e. the detergent market may not be more price sensitive than food or that there may be other factors that influence store brand penetration besides price elasticity. But, the toiletries category which has low price sensitivity has only 3.85% dollar share of private label. The relationship seems to hold in this case. The dollar share of store brands for pharmaceuticals (6.7%) was obtained from Private Label Magazine (July 1988). This is higher than that for toiletries. Thus, there seems to be mixed evidence about whether or not strong price competition leads to store brand penetration. Another price elasticity ordering consistently found in the literature (Wisniewski and Blattberg 1988, Stowsand and Wenzel 1979) is that pet food has substantially lower price sensitivity than other food products. We do find the dollar share of store brand in pet food (5.2%) is lower relative to other food items. In general, from past studies, we can categorize detergents, household cleaning products and food (excluding pet food) items as having high price elasticity. Toiletries, pharmaceutical, and pet food belong to low price sensitive category. We do find that the store brand share in the high price elasticity items are indeed high (5-21%) compared to those in the low price sensitive products (0-6%). The only anomaly is the case of detergents where despite the high price elasticity reported

in some literature, the dollar share of store brand is only 3.2%.

Advertising Competition and Store Brand Penetration

The relationship between advertising competition and store branding at the market level was assessed by the correlation between advertising elasticity of Wisniewski et al and market shares from SAMI. The correlation is -0.57 for volume share and -0.32 for dollar share. It is interesting to note that these correlations are in the hypothesized direction and opposite in sign to that of price competition. However these correlations were not significant at the 90% level. The reasons for this may be the small sample size or the use of local measures. One can not conclude that there is no relationship.

Past studies do not produce any consistent ordering of advertising elasticities and hence no analysis was done. The global measure of advertising competition available with us is the A/S ratio. We related these measures to the corresponding store brand measures in that year for two years, 1985 and 1988. The data and results are provided in Table 5.4 and Table 5.5. The correlation between A/S ratio and dollar sales share (-0.57) and A/S ratio and volume share (-0.54) are significant at 95%, for the year 1988. In 1985, the relationship with dollar share (-0.47) is

significant at the 90% level. This shows that there is some strong evidence of a negative relationship between store branding and advertising competition.

Cook and Schutte (1967) studied the relationship between A/S ratio and dollar shares of private brands in 12 different consumer product lines. They concluded that although the relationship is far from perfect, there is a tendency for a greater advertising to sales ratio to be associated with a lower private brand share. However they used A/S ratio as a measure of national brand advertising and not a measure of advertising competition. In contrast to this we find a significant relationship between dollar share and A/S ratio.

Number of Store Brands and Price Competition

The data on proportion of retailers carrying a store brand is dated and our observations based on the data are therefore tentative. According to the study by Tellis, price elasticities were ordered as detergents, food, toiletries and pharmaceuticals, detergents being the most price sensitive. A perusal of the data on retailers carrying store brands in these categories (table 5.3) shows that this measure of store branding matches the price competition pattern. 78% of the retailers carried a store brand in the detergent category, 74% in food and 31% in

toilet items. In general, in the high price sensitive categories like food, detergents and household cleaning products a large number of retailers carried private label products (50-78%) relative to low price sensitive categories like toiletries and pet food (0-38%).

Number of Store Brands and Advertising Competition

The assessment of the relationship was done by correlating A/S ratio of 1976 with the proportion of retailers carrying a store brand. The data are given in Table 5.6. The correlation is -0.63 (p=.04) and significantly different from zero. There seems to be some evidence of a negative relationship between proportion of retailers carrying a store brand and A/S ratio.

5.5. Summary and Conclusion

From the model results we derive several empirically testable hypotheses at the retail level and at the market level. Broadly, we hypothesize that there is a positive relationship between store branding and price competition and a negative relationship between store branding and advertising competition. We test these hypotheses using pearson correlation. We find that there is some strong evidence of a positive relationship between price competition and store brand penetration at the retail level.

There is only directional evidence of a negative relationship between store brand shares and advertising competition. The correlation is not statistically significant. The lack of significance may be due to data characteristics and it should not be concluded that there is no relationship until further tests are done with larger samples using better measures.

At the market level, there is mixed evidence for a positive relationship between price competition and store branding. Our general observation is that store brand penetration is larger in high price sensitive categories and lower in low price sensitive categories.

We find a significant negative relationship between advertising to sales ratio and store branding and a negative but non-significant relationship between advertising elasticity and store brand shares. As we stated earlier this lack of relationship may be due to the nature of the data. It is interesting to see that the relationships are opposite in direction to the relationship between price competition and store branding, thereby highlighting the differing nature of the impact of these characteristics on store brand penetration. In conclusion, one can state that based on the preliminary analysis, there is some evidence of a positive relationship between price competition and store branding and a negative relationship between store branding

and advertising competition.

This finding has implications for the manufacturers of the national brand and the retailers. National brand manufacturers should recognize the market characteristics that influence store branding. In those conditions where store branding will prevail they should develop suitable strategies - decrease advertising, reduce their margin and may be resort to dual branding. Retailers should also selectively introduce store brands in markets which are price sensitive and advertising insensitive.

CHAPTER VI

CONCLUSIONS AND FUTURE RESEARCH

The phenomenon of store branding has been of great interest to retailers, manufacturers, and public policy makers. Faced with severe competition from the store brands or private labels, the manufacturers of national brands have to decide on the appropriate pricing and advertising strategies to tackle the situation. The retailers also have the problem of deciding whether to introduce a store brand in a product category, and, having introduced, they have to decide on what strategies to adopt when marketing both the national brand and the store brand.

In this dissertation we analyze some simple game-theoretic models that look at the competition between a national brand manufacturer, and a retailer who sells both the national brand and the store brand. We obtain and discuss some intuitive results regarding a retailer's incentive to introduce a store brand and the equilibrium marketing strategies that will (or should) be adopted by the national brand manufacturer and the retailer. Based on the model results, we conclude the following:

1. Retailer has the incentive to introduce a store brand in product markets characterized by high price sensitivity and low advertising substitutability.
2. This is because the retailer gains higher profits from

the store brand and gains higher total profits under such demand conditions.

3. In this process, the retailer gains a higher share of total channel profits which we denote as a measure of channel control. Thus the store brand is a mechanism by which a retailer gains channel control when price substitutability is high and advertising sensitivity of the store brand is low.

4. The reason for this occurrence can be explained as follows. Taking advantage of the national brand advertising, the retailer increases the price of the national brand. Since the store brand is insular to national brand advertising the retailer will not lose store brand consumers to the national brand, because of advertising. Since price substitutability is high, consumers will shift from the national brand to the store brand, thereby increasing the demand for the store brand. Due to the increase in demand, the retailer can increase the price of the store brand and thus gains higher profits from the store brand and higher overall profits.

5. So in such conditions, the retailer sells higher quantities of the store brand and derives most of his revenues from selling the store brand.

6. In such conditions, the appropriate strategy for the national brand manufacturer is to decrease his advertising

and decrease his transfer price to the retailer.

From these results we obtain some empirical implications regarding proliferation of store brands or store brand penetration. We hypothesize that store brand penetration, is positively related to the level of price competition and negatively related to advertising competition. We test these hypotheses at the retail level and at the market or industry level. Store brand penetration is measured by the market share of store brands. Price competition is operationalized by category own price elasticity and advertising competition by advertising elasticity and Advertising/Sales Ratio. Our preliminary cross-category analysis reveals some directional evidence of a positive relationship between store branding and price competition and a negative relationship between store branding and advertising competition. It is interesting to empirically observe that these two market characteristics impinge on store brand proliferation in opposite directions. No empirical testing has been done on this aspect before. However, we obtain mixed evidence regarding the statistical significance of these relationships which we believe is primarily due to the limited data available with us. Our analysis is therefore preliminary and further testing is required to validate these relationships. This would enable the manufacturer to recognize those categories where store

branding will be pervasive and devise suitable strategies for the national brand and, resort to dual branding if need be. It will also help the retailer identify those markets conducive to store branding so that he may resort to selective store branding.

However, there are several limitations that arise primarily from the assumptions imposed on the simple basic model. This has been discussed in chapter III. In chapter IV we tested the robustness of our results and found that the results did hold even when we relaxed some assumptions regarding fixed costs, marginal costs, and price setting decision structure. Future research should attempt to generalize the results obtained from the basic model specifically in the following ways.

1. It will be interesting to see if the results will hold for more general non-linear demand functions.
2. One of the facets of today's consumer markets is the severe competition at the national brand manufacturer level and at the retail level. Future modeling should capture this important element of competition. It will be interesting to test if introducing a store brand would enable the retailer diffuse competition at the retail level.
3. In our models we have assumed that the retailer does not provide price or non-price promotional support to the brands. There are a number of ways in which the retailer

can promote the product at the point of sale. We should try to incorporate these elements of retail support. It will again be interesting to see whether the retailer will spend his promotion dollar on the national brand or on the store brand.

Our preliminary empirical analysis also suffers from several limitations primarily because of the lack of appropriate measures of price competition and advertising competition. No global measures are available to test market level implications. A global measure of price sensitivity at the category level is the percentage of goods sold on deal. We could not obtain this measure currently. We hope to obtain this in the future and provide a better test of the proliferation of store brands.

The model provides some indirect implications regarding the characteristics of store brand and national brand consumers. Specifically we can argue that store brand consumers are more price sensitive and less advertising sensitive and national brand consumers are more advertising sensitive and less price sensitive. Empirical researchers who have tried to identify private label consumers have used surrogate measures. However with the recent availability of single source scanner data that tracks consumer purchases, prices and advertising exposures, it will be possible to provide rigorous test of the hypotheses regarding national

brand and store brand consumers.

Future research will improve upon the present analysis by generalizing the model results obtained, obtain new insights, and provide rigorous empirical test of the aspect of store brand proliferation.

FIGURES

Figure 3.1. Manufacturer - Retailer Structure

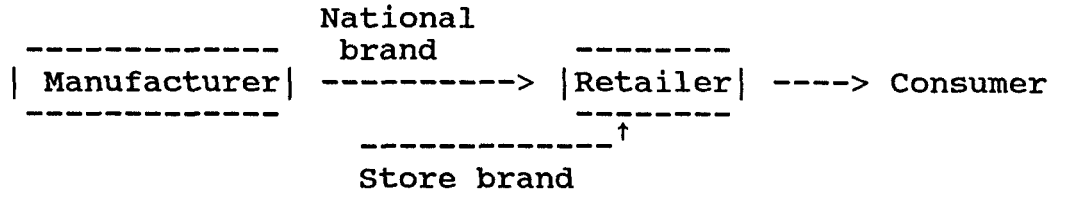


Figure 3.2. Manufacturer - Retailer Decision Structure

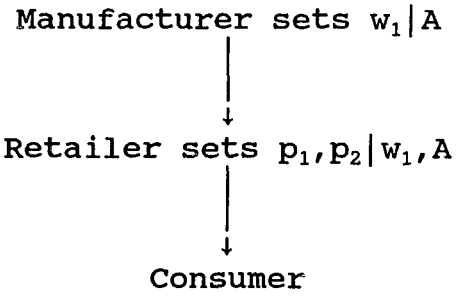
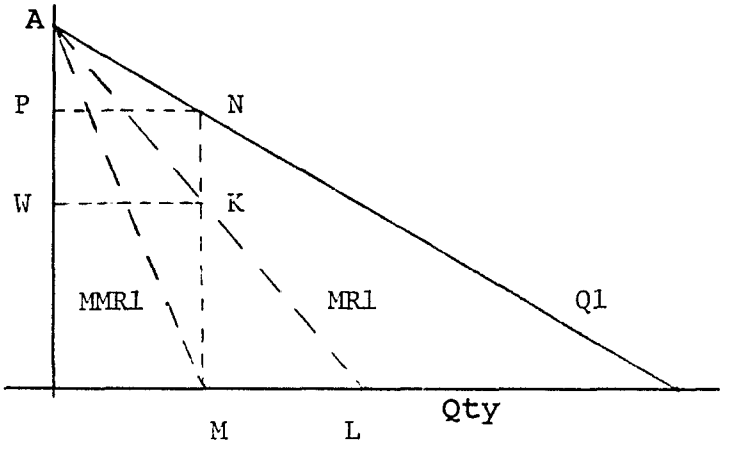


Figure 3.3. Equilibrium Prices when the Retailer Sells National brand Only.



OM = MB = 1/2 OB

OL = LM = 1/4 OB

Triangles AWK and OAM are similar.

hence AW/OA = WK/OM = 1/2 => AW = 1/2 OA = OW

Triangles OAB and APN are similar.

hence AP/OA = PN/OB =1/4 => AP = 1/4 OA = WP

Retailer Margin = WP = 1/2 OA

Manufacturer Margin = OW = 1/2 OA

Retailer Margin = 1/2 Manufacturer Margin

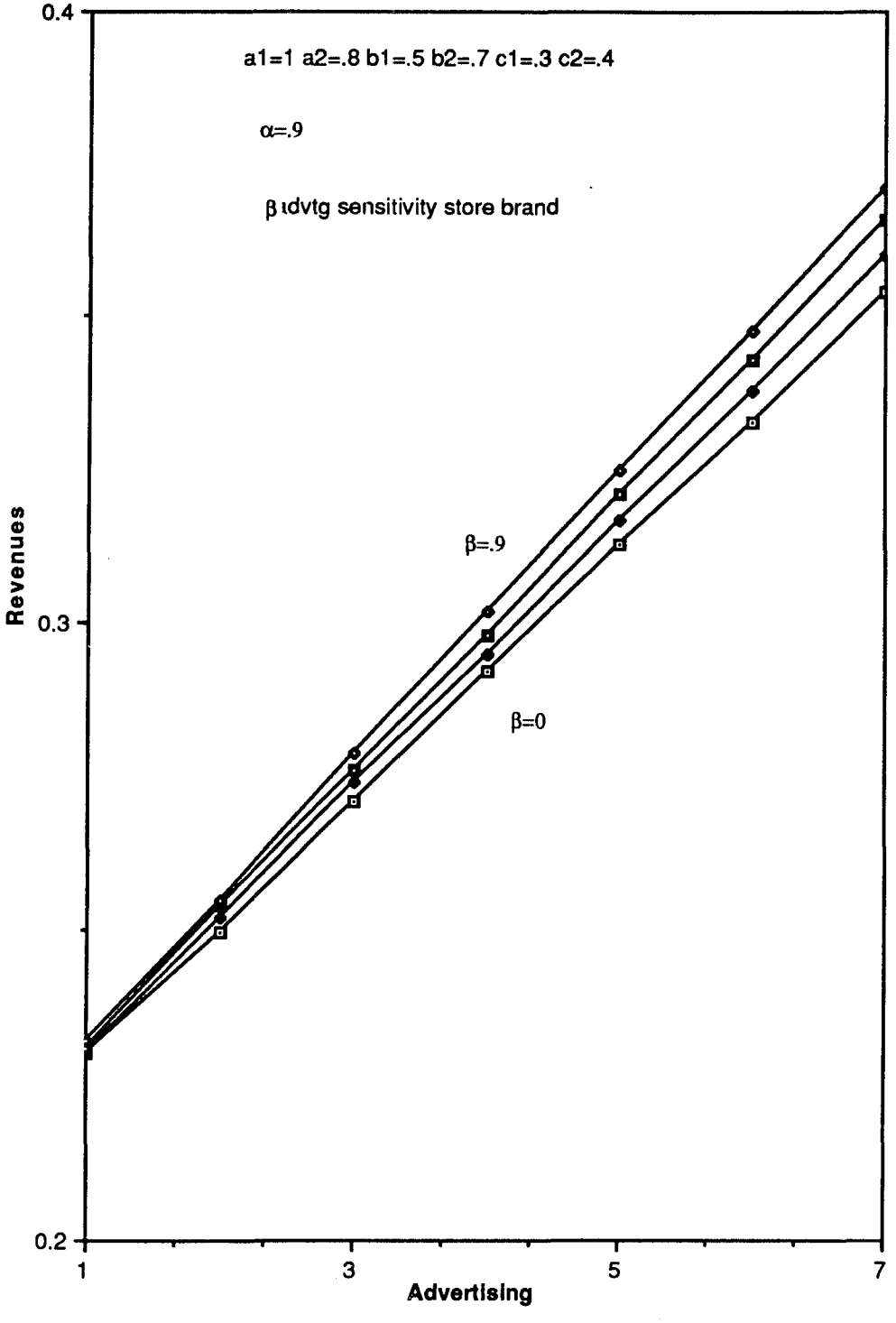


Figure 3.4. Effect of Advtg on Mfr Revenues

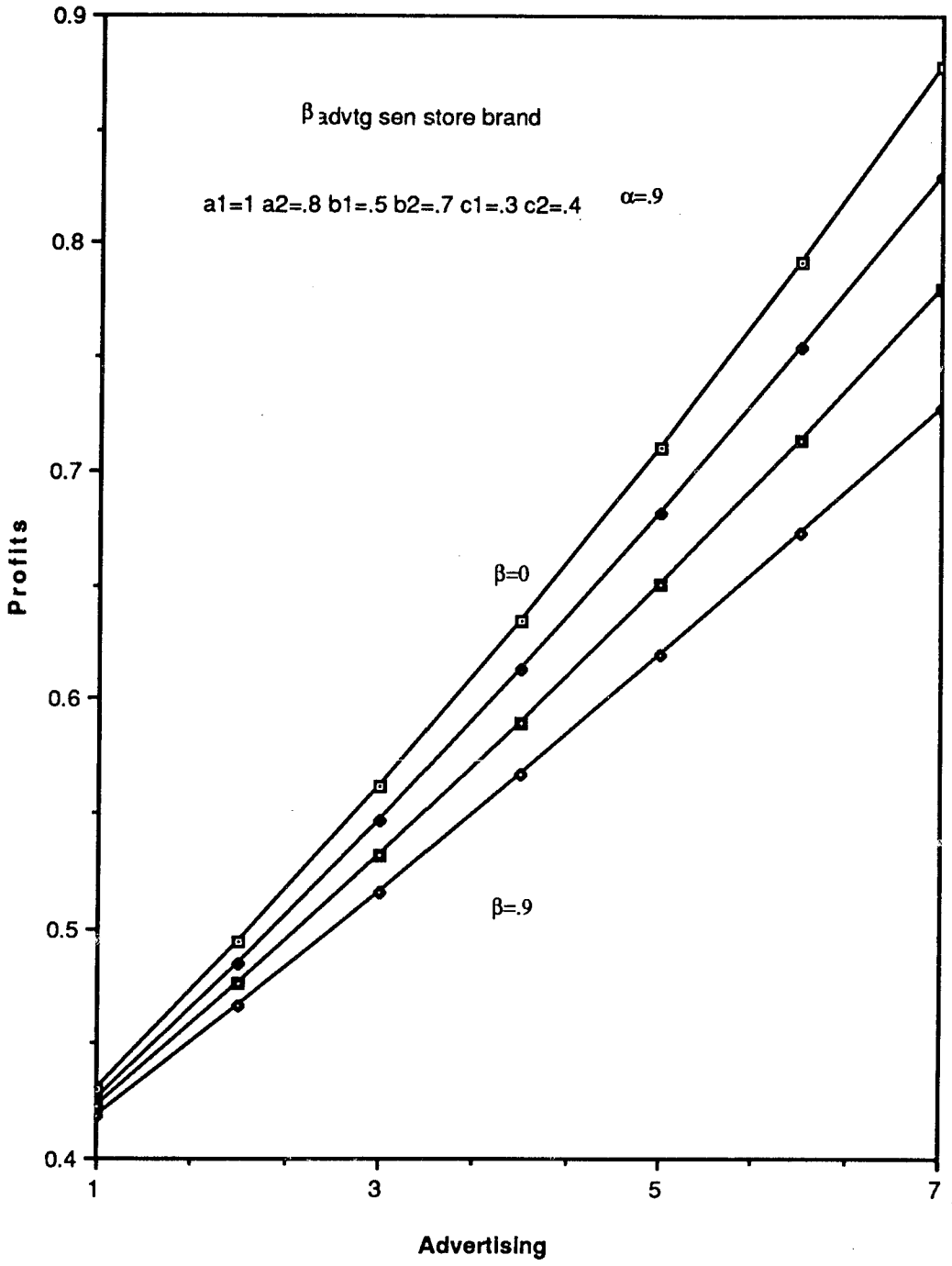


Figure 3.5. Effect of Advertising on Retailer Profits of the National Brand

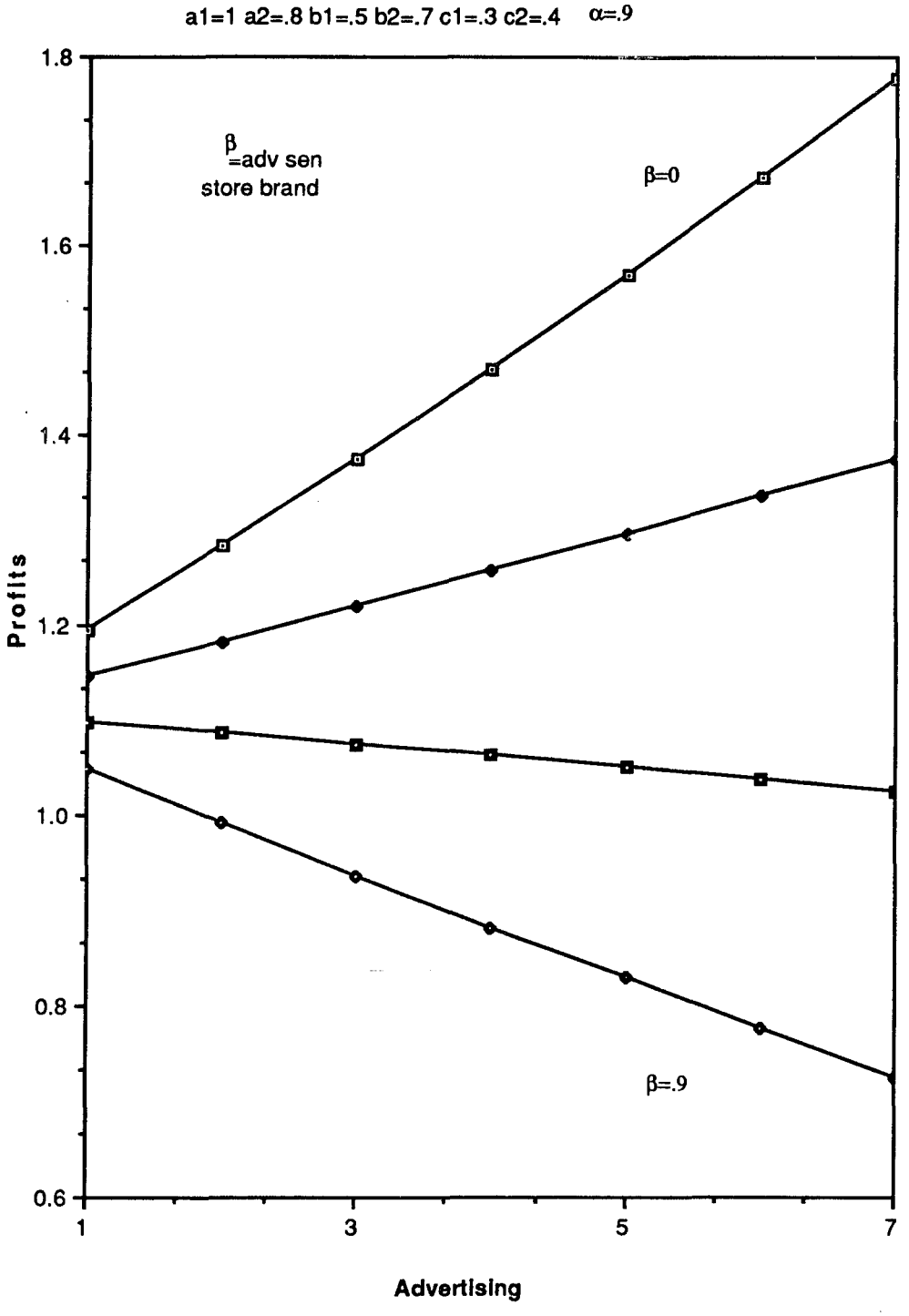


Figure 3.6. Effect of Advtg on Retailer Profits from the store brand

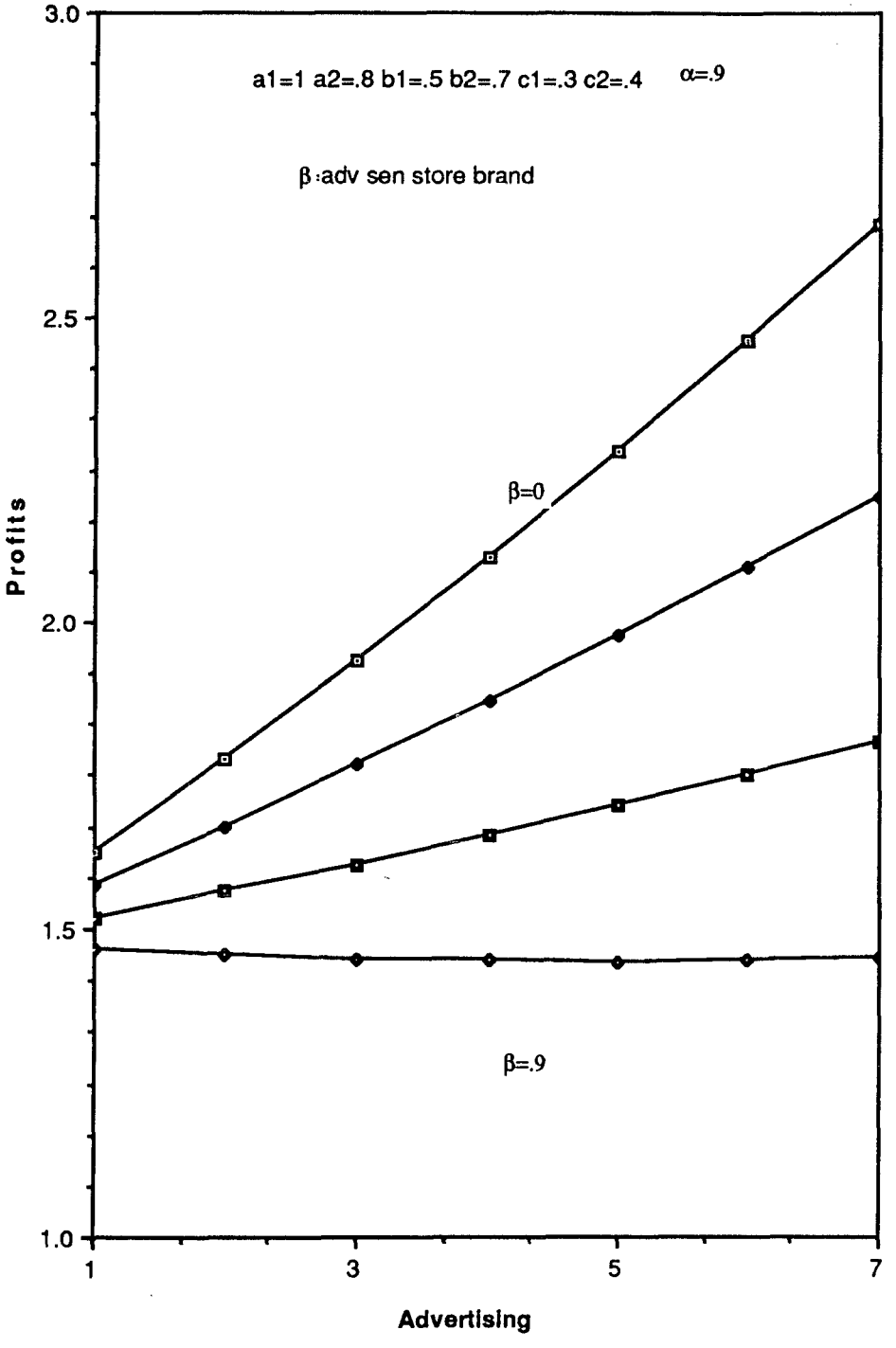


Figure 3.7. Effect of Advertising on Total Retailer Profits

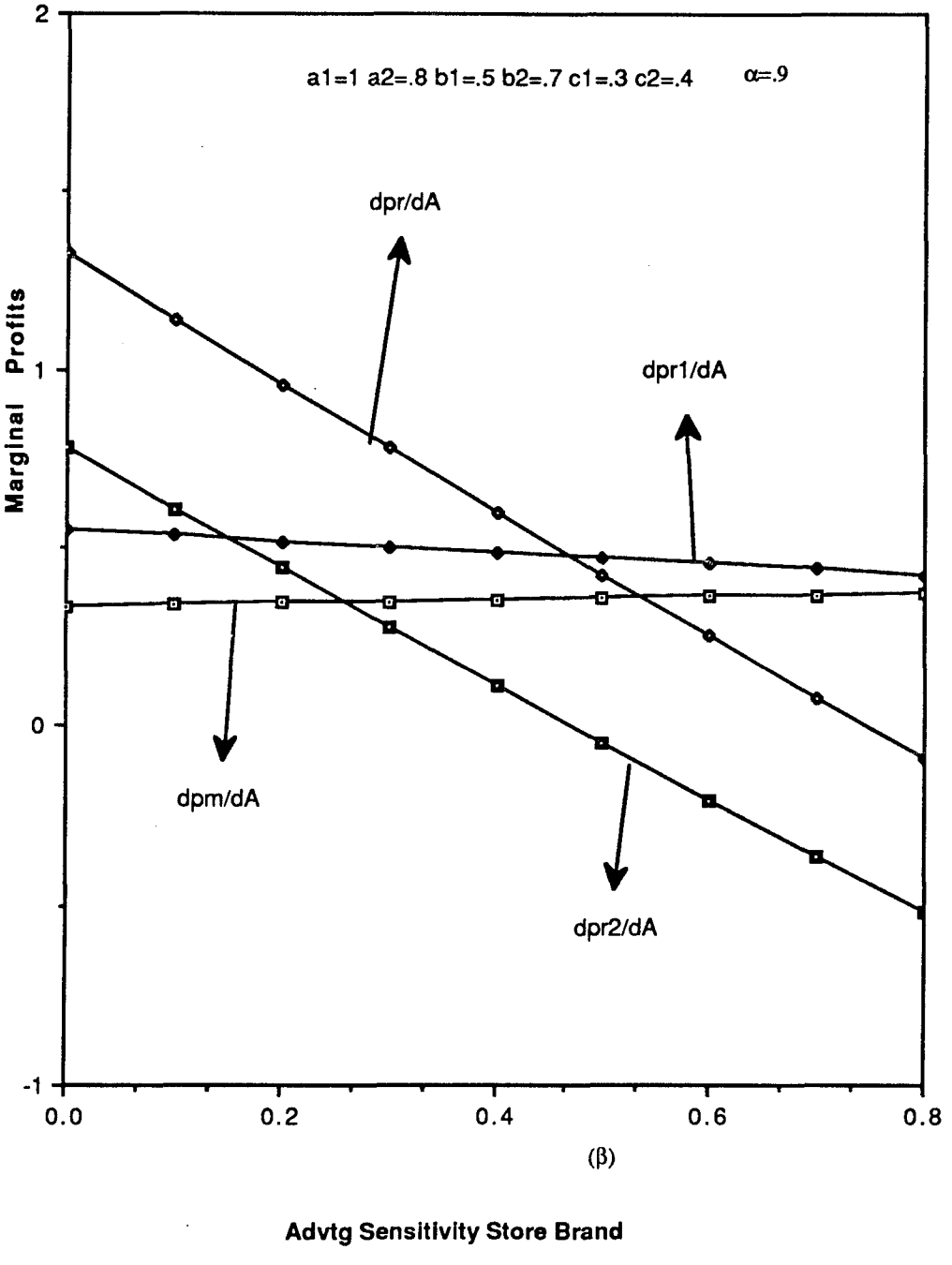
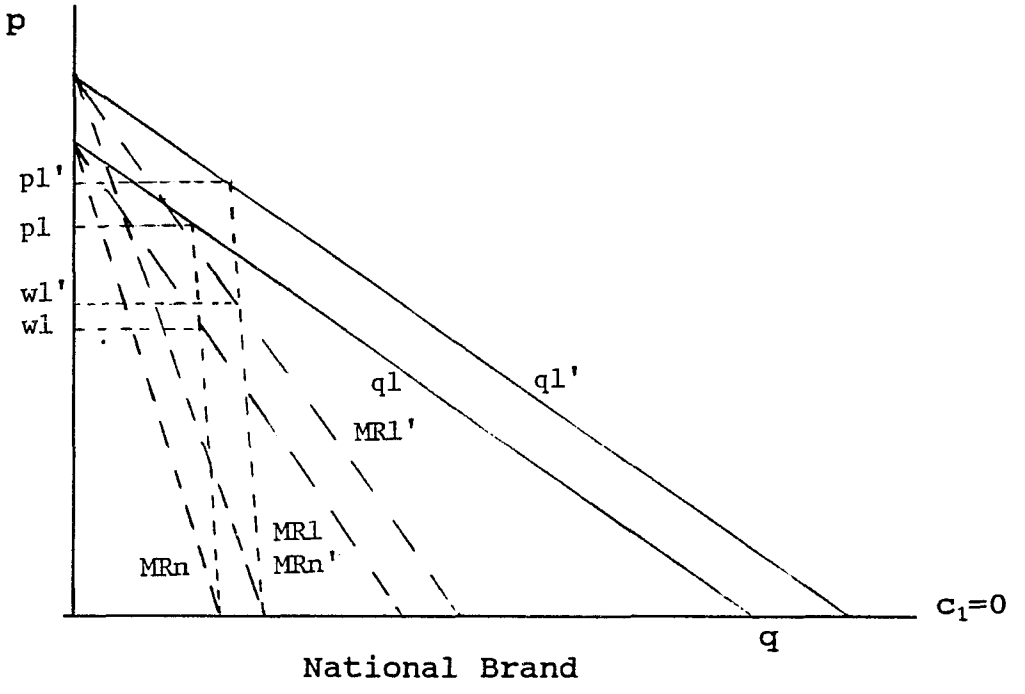
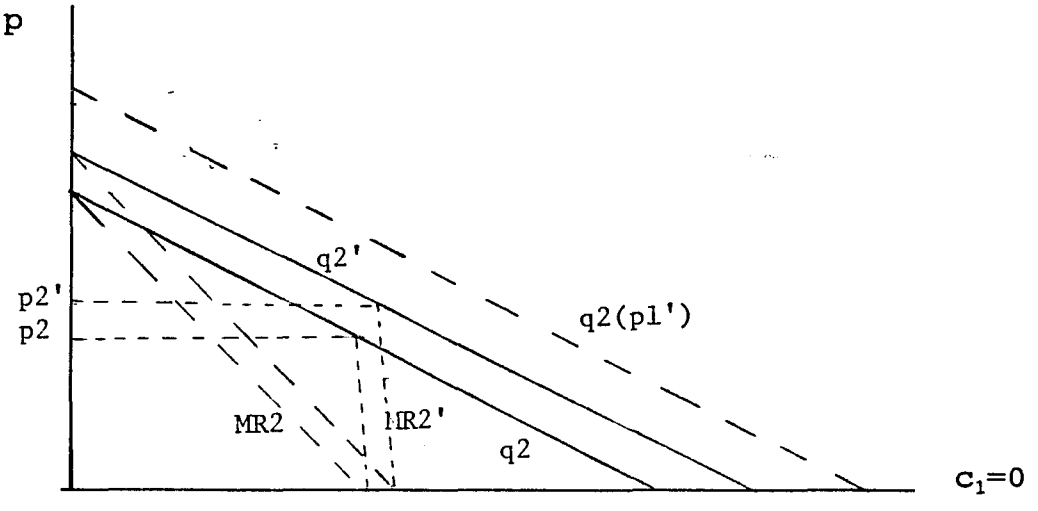


Figure 3.8. Effect of Advtg Sensitivity on Marginal Profits from Advtg.

Figure 3.9. Movement of Prices With Advertising - Model I

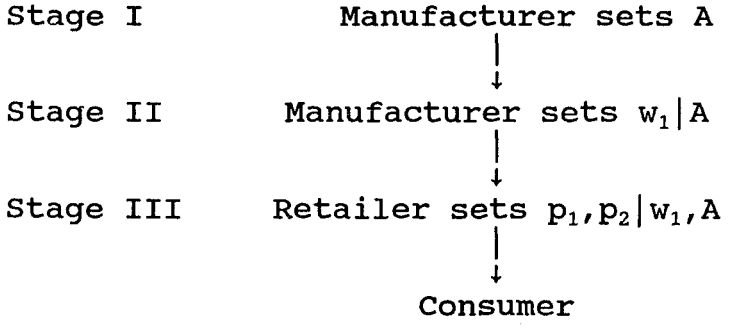


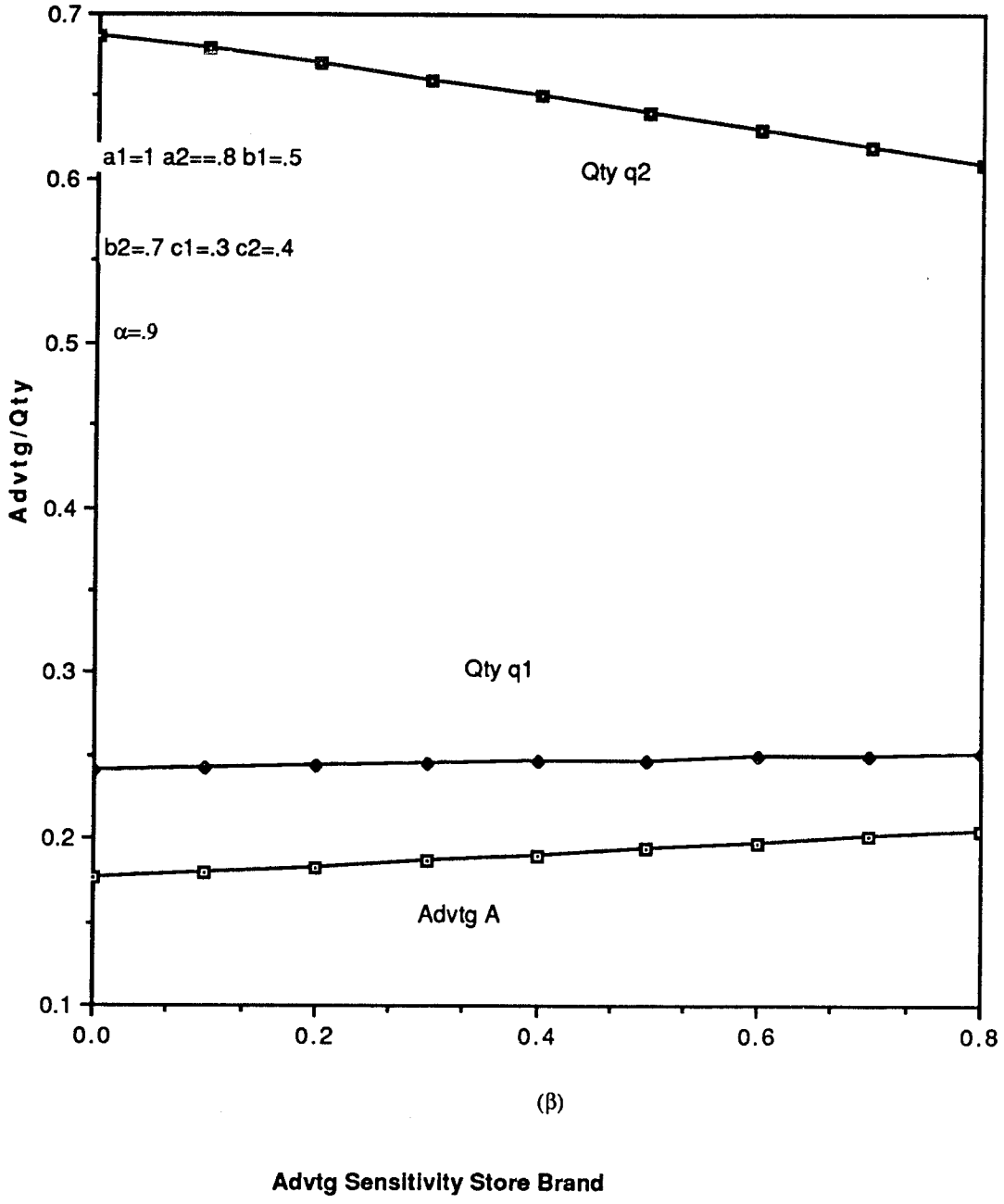
National Brand



Store Brand

Figure 3.10. Manufacturer - Retailer Decision Structure





Advtg Sensitivity Store Brand

Figure 3.11. Effect of Advtg Sensitivity on Advtg and Quantities

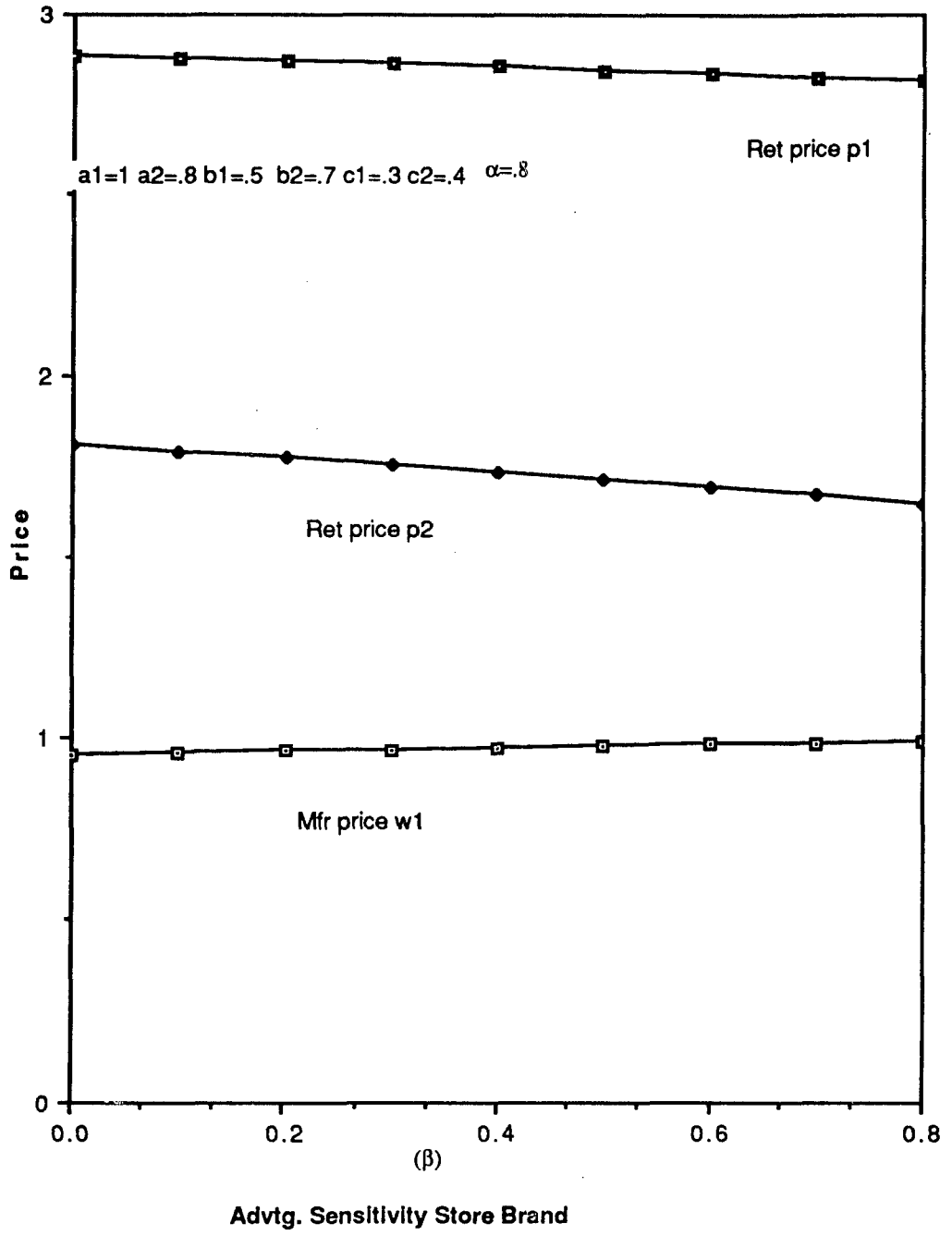


Figure 3.12. Effect of Advtg Sensitivity on Prices

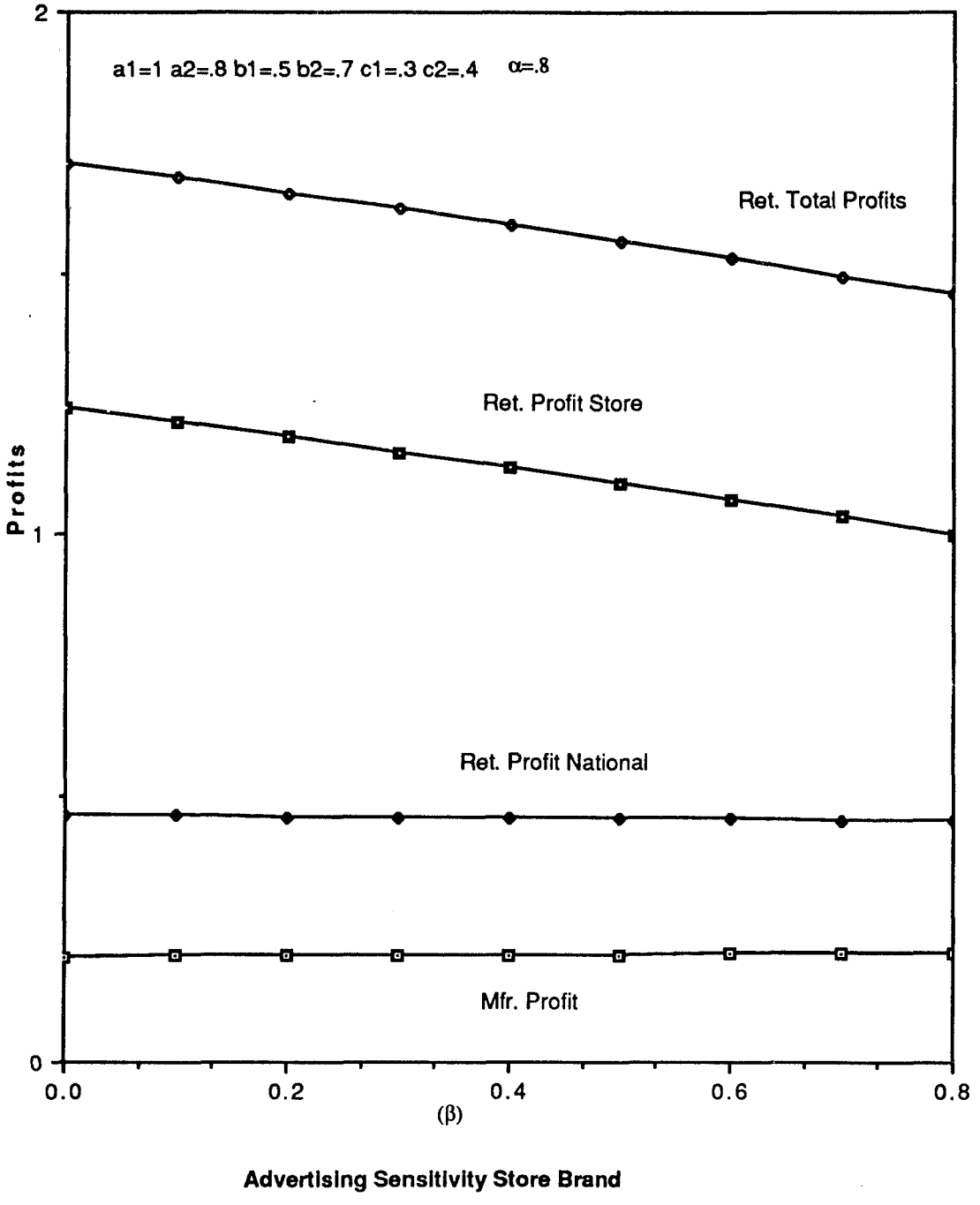


Figure 3.13. Effect of Advtg Sensitivity on Retailer and Manufacturer Profits

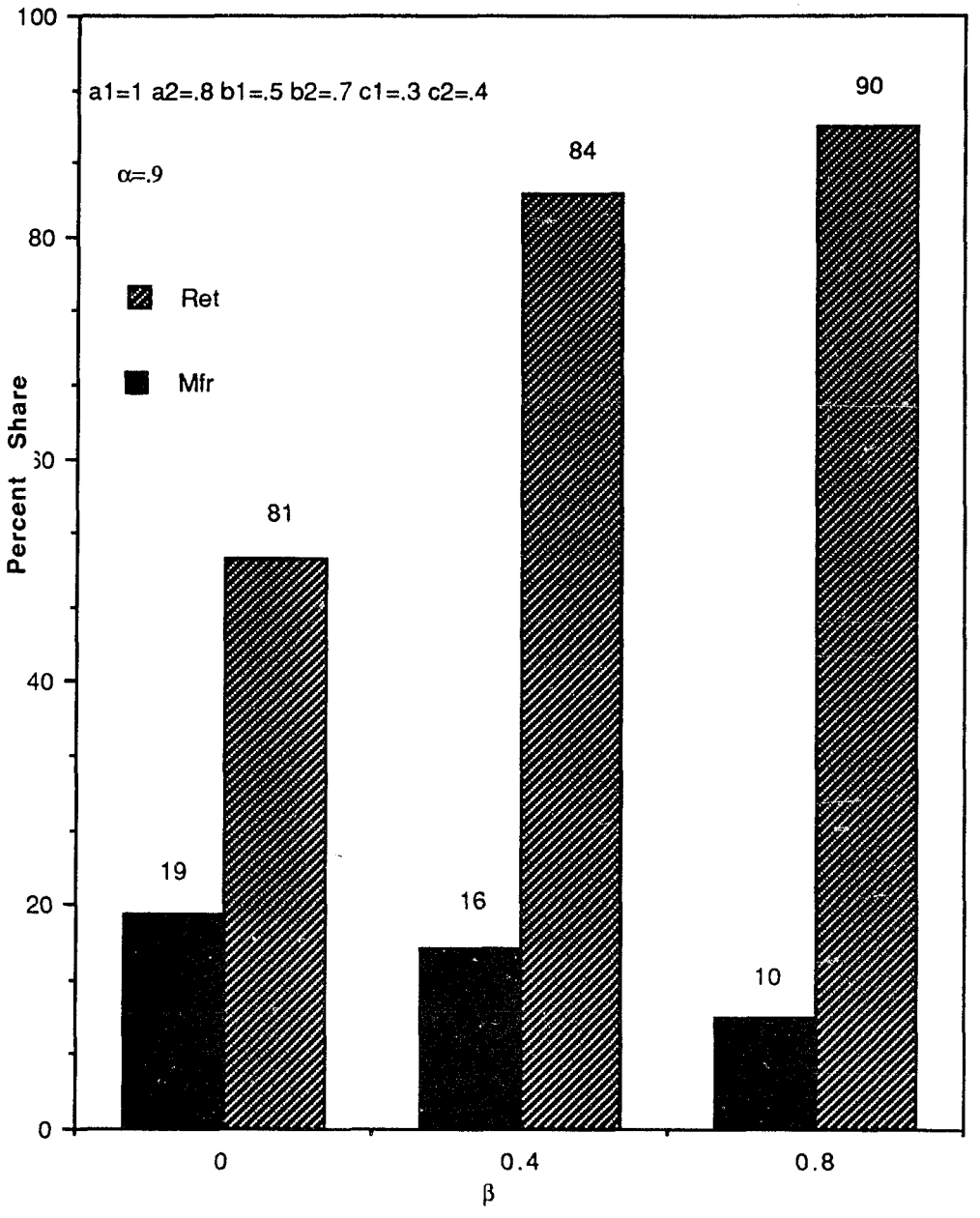


Figure 3.14. Effect of Advtg Sensitivity on Mfr. and Ret. Share of Channel Profits

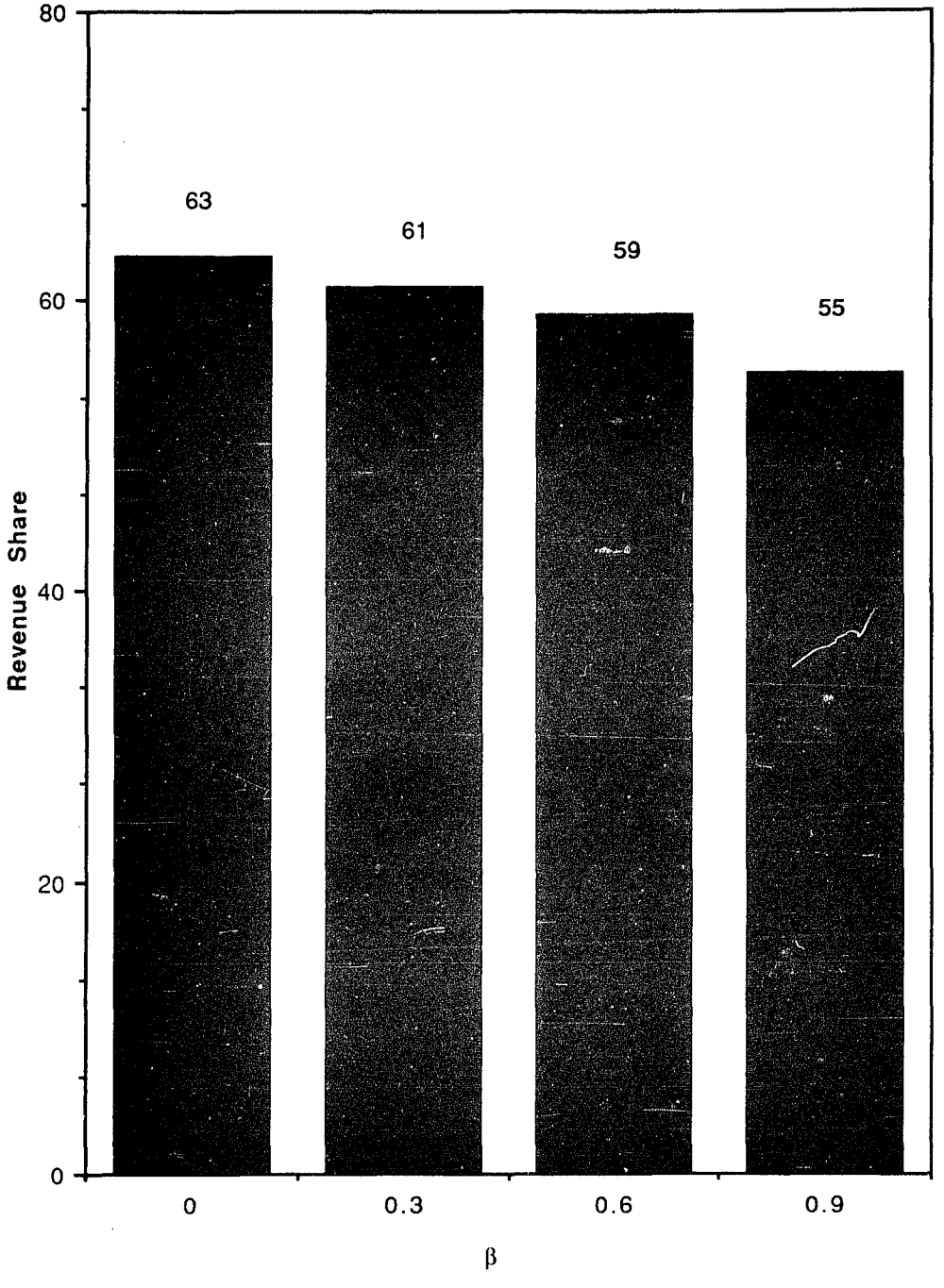


Figure 3.15. Effect of Advtg Sensitivity on Revenue Share of Store Brand

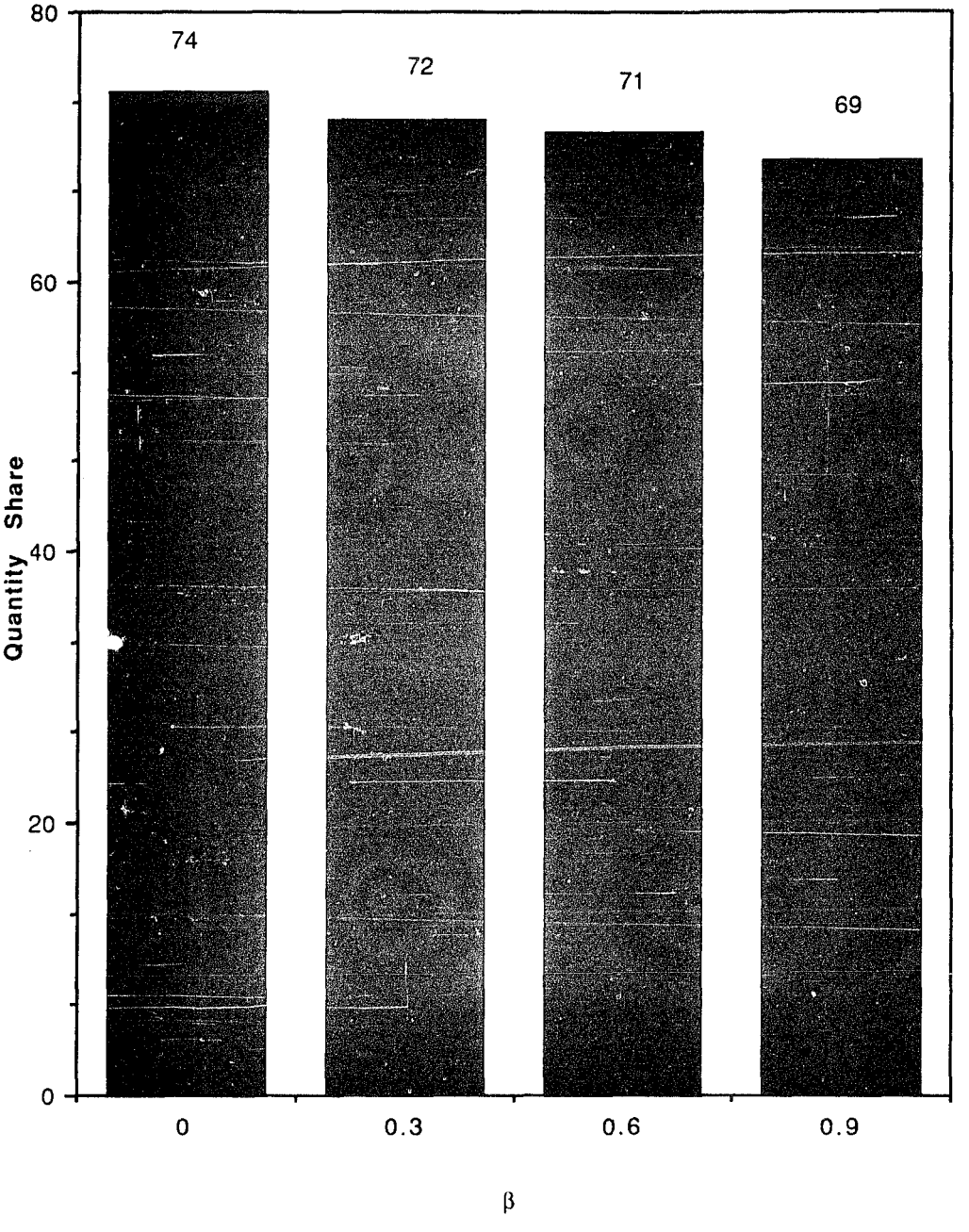


Figure 3.16. Effect of Advtg Sensitivity on Quantity Share of Store Brand

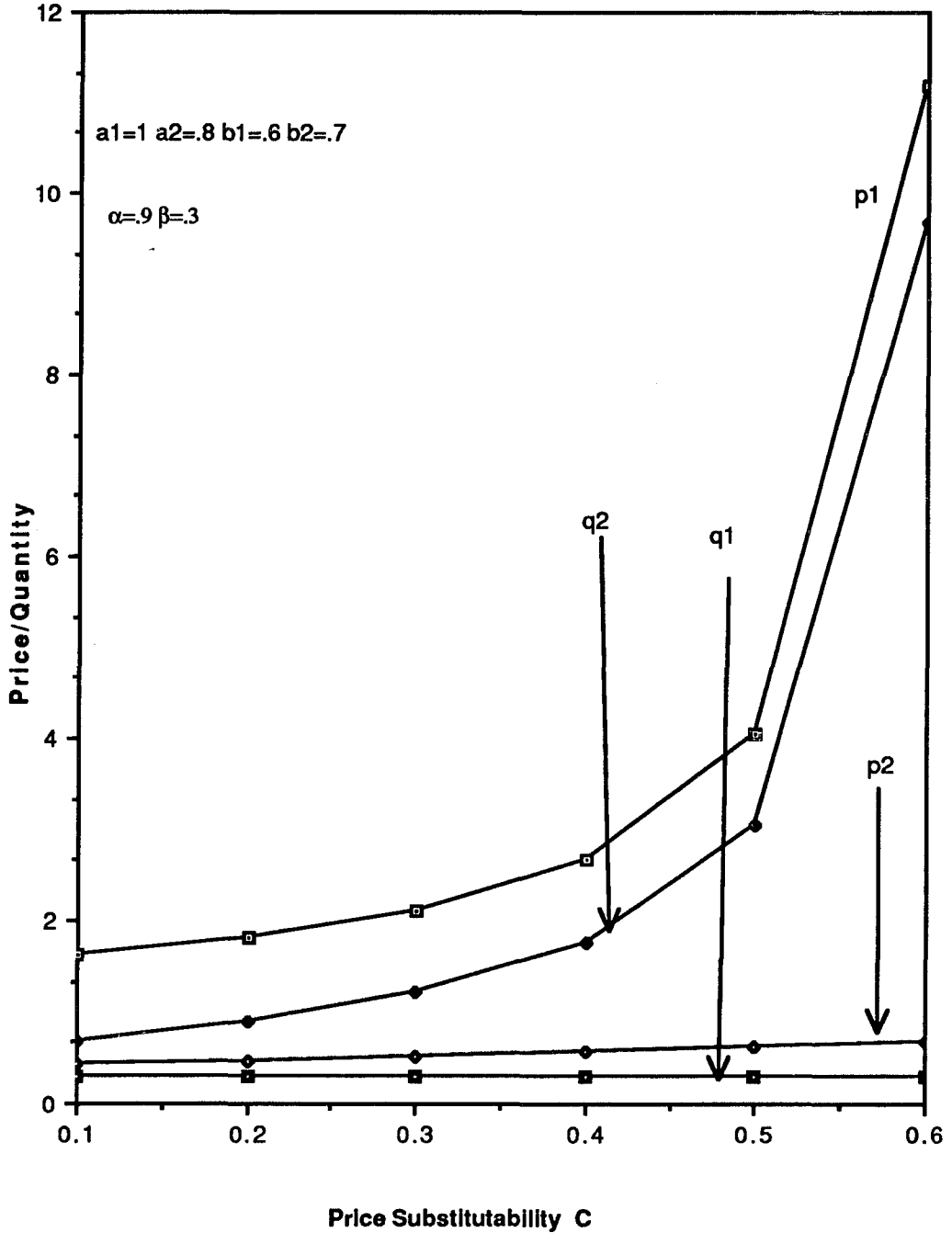


Figure 3.17. Effect of Price Substitutability on equilibrium Prices and Quantities

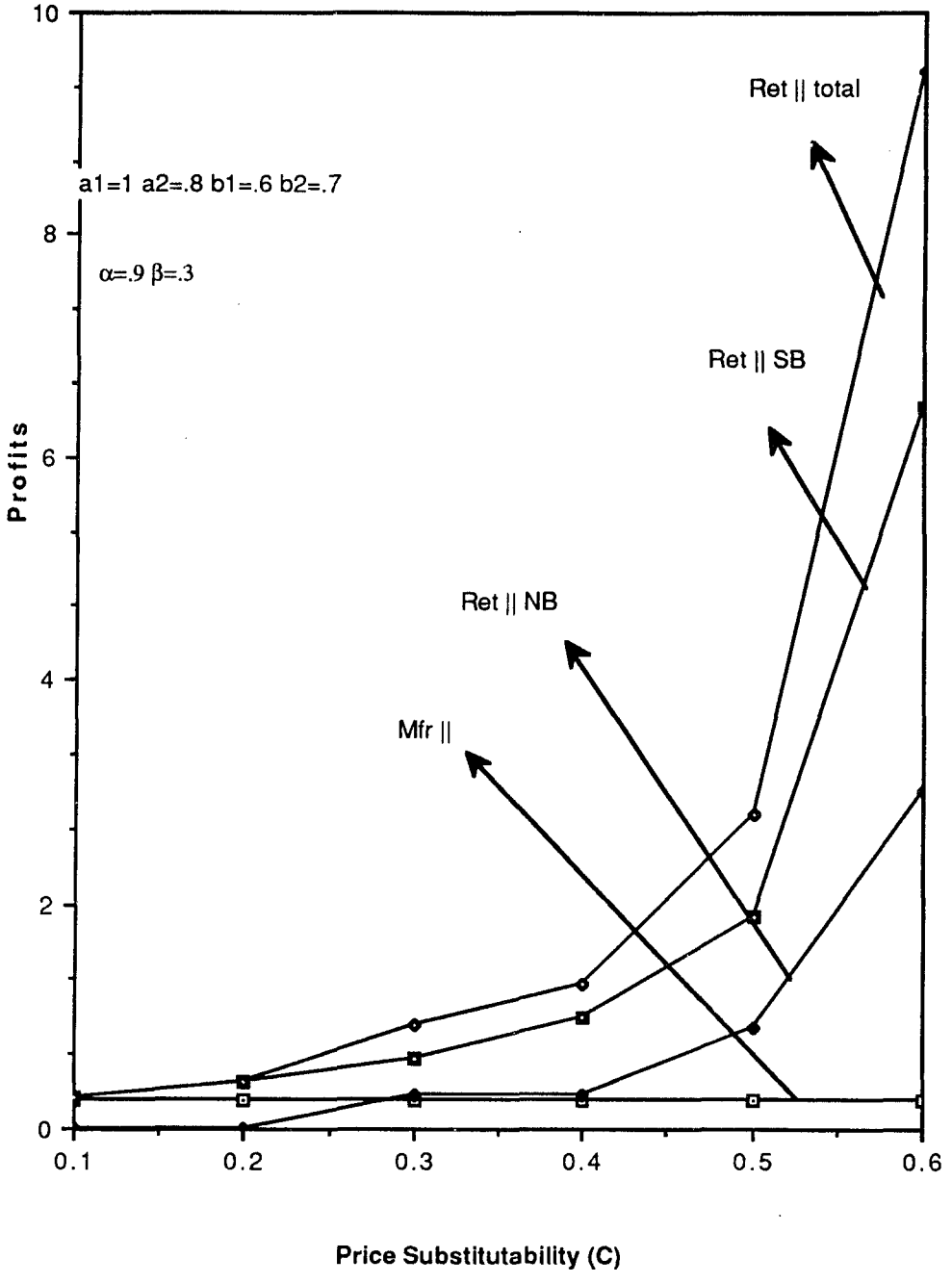


Figure 3.18. Effect of Price Substitutability on Manufacturer and Retailer Profits

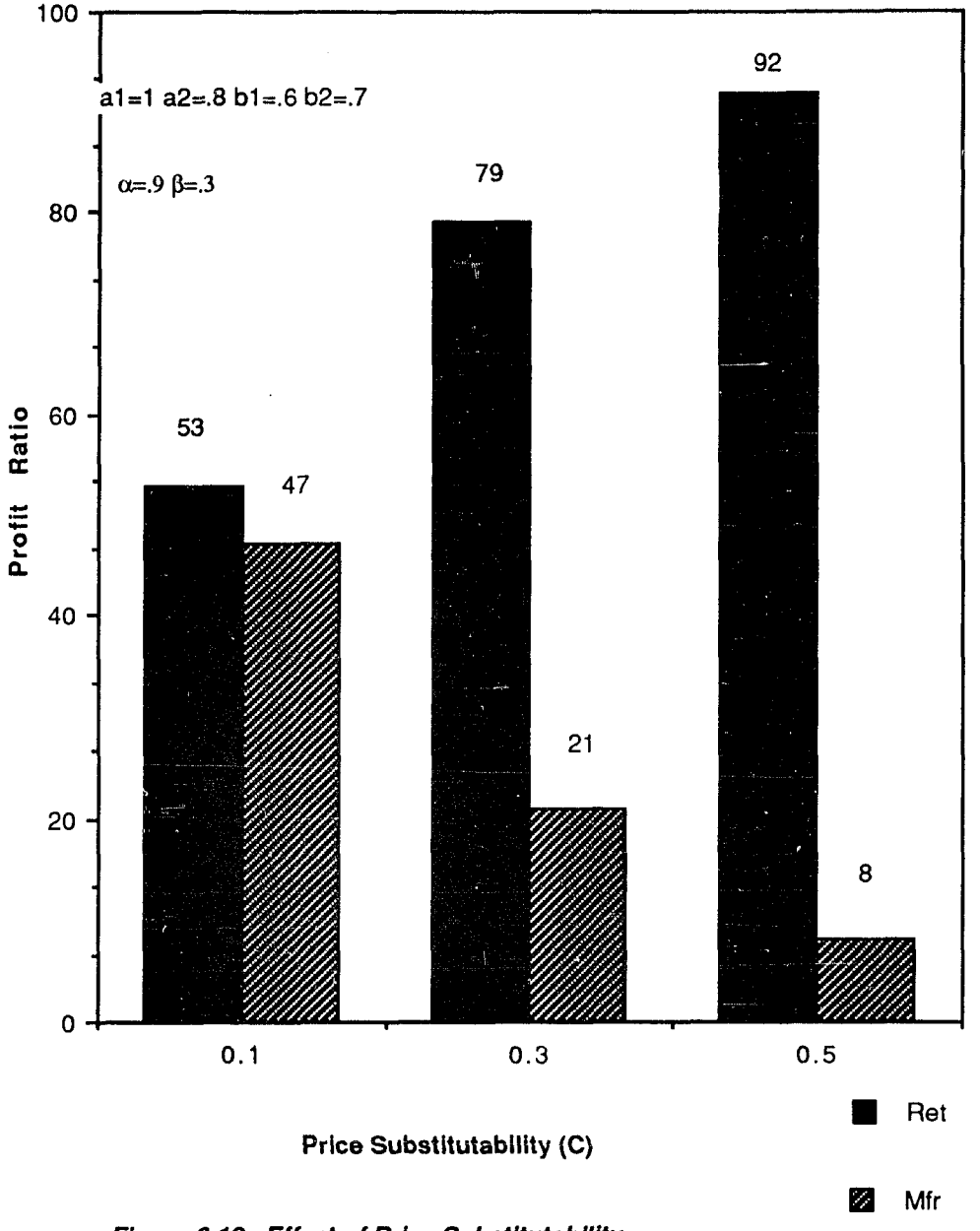


Figure 3.19. Effect of Price Substitutability on Share of Channel Profits (Channel Control)

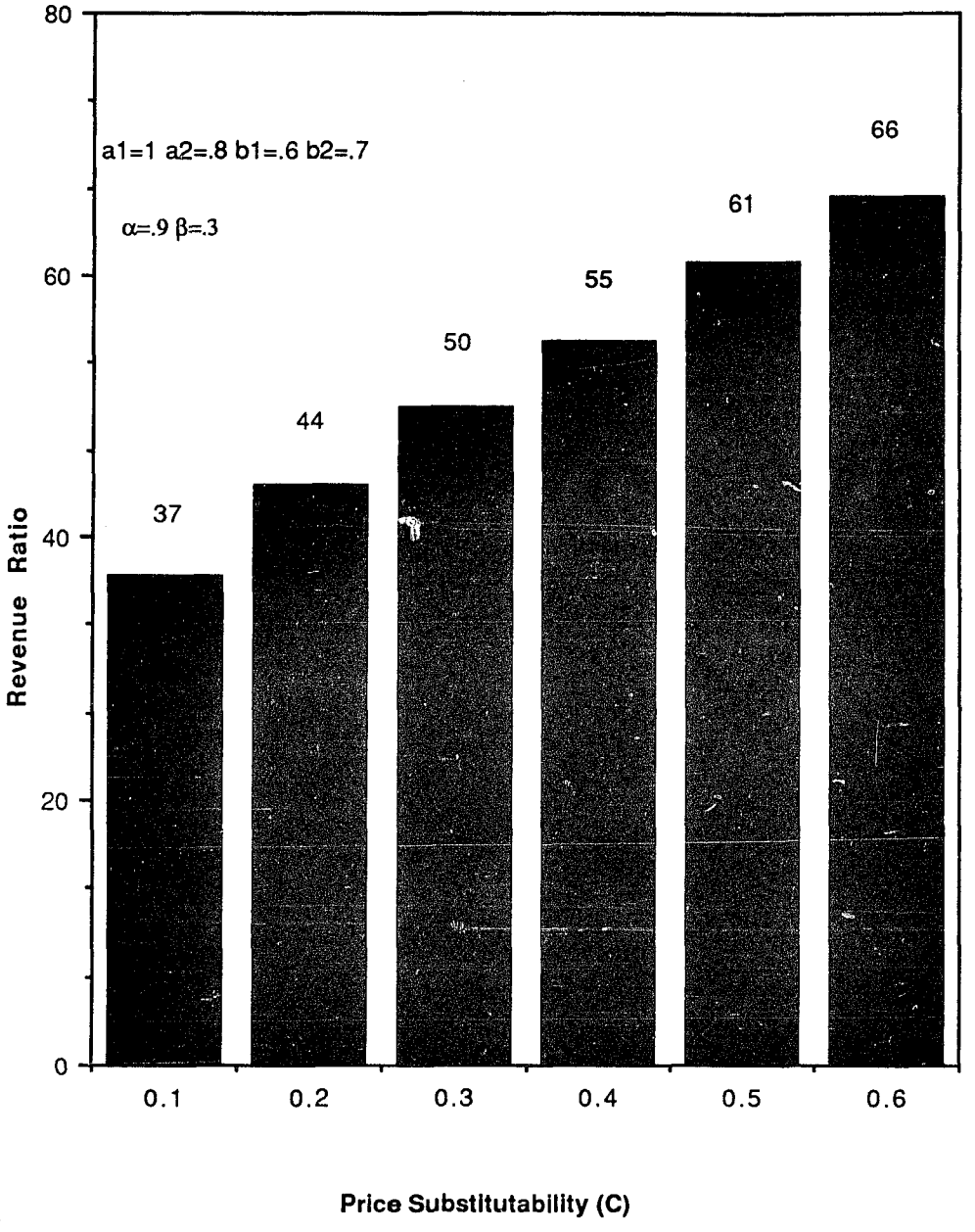


Figure 3.20. Effect of Price Substitutability on Revenue Share of Store Brands

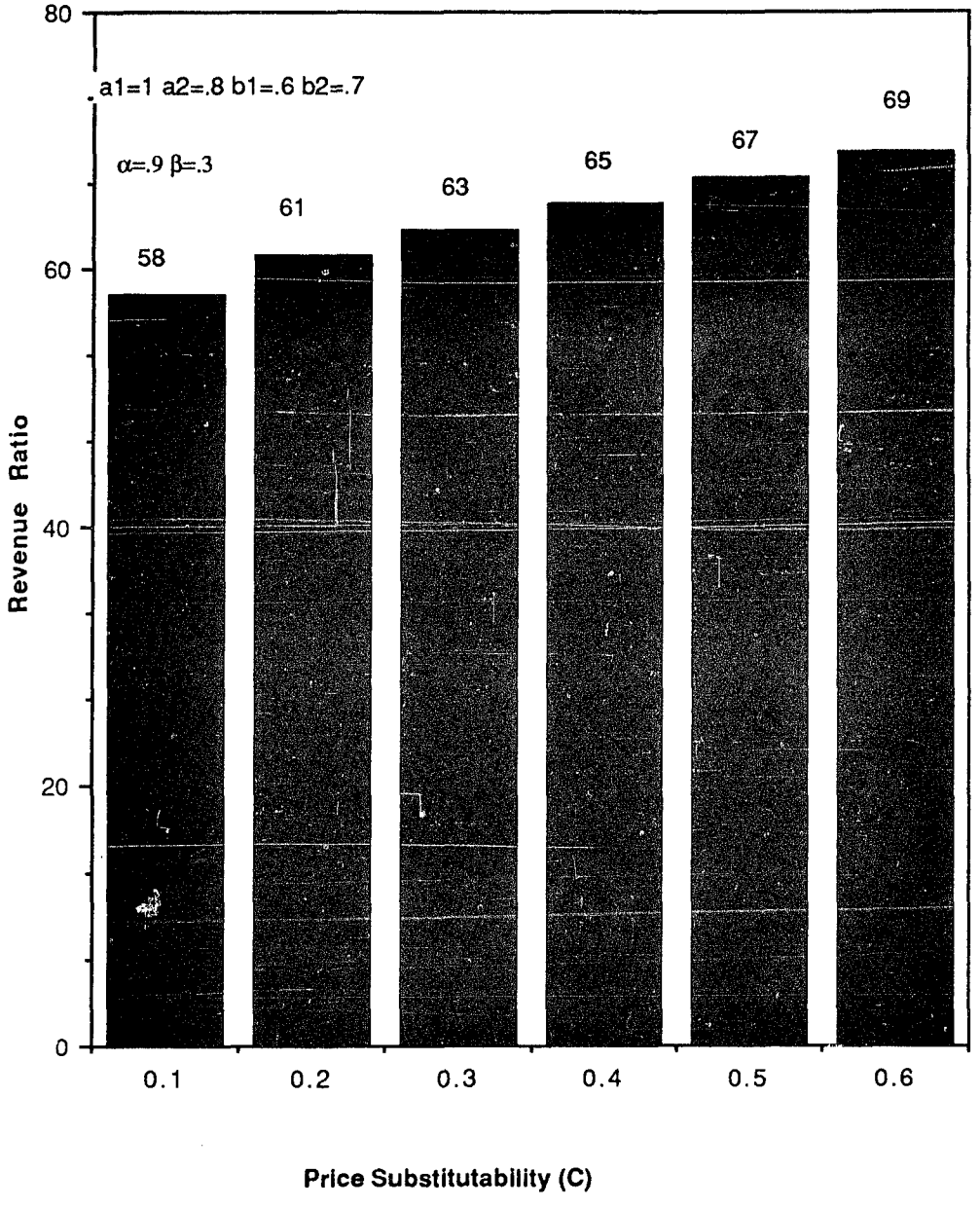


Figure 3.21. Effect of Price Substitutability on Quantity Share of Store Brands

Figure 4.1. Quantity Constraint Binding (Market Saturation)

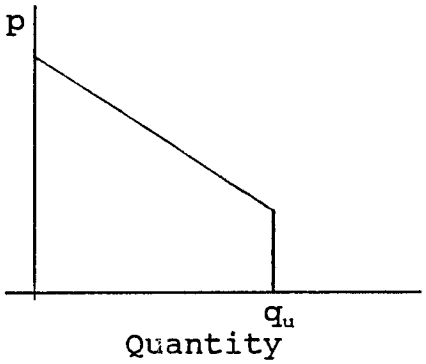
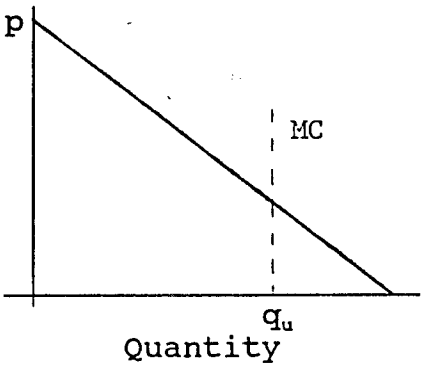


Figure 4.2. Quantity Constraint Binding (Shelf Space)



TABLES

Table 3.1. Parameter Values for Numerical Analysis
Propositions 3.4 - 3.7

Setup	Advertising		a_1, a_2, b_1, b_2		c_1, c_2		α, β	
	Range	Step	Range	Step	Range	Step	Range	Step
1	.1-.9	.2	.1-.9	.2	.1-.9	.2	0-.9	.1
2	.1-.9	.2	1-9	2	1-9	2	0-9	1
3	.1-.9	.2	10-90	20	10-90	20	0-90	10
4	1-9	2	.1-.9	.2	.1-.9	.2	0-.9	.1
5	1-9	2	1-9	2	1-9	2	0-9	1
6	1-9	2	10-90	20	10-90	20	0-90	10
7	10-90	20	.1-.9	.2	.1-.9	.2	0-.9	.1
8	10-90	20	1-9	2	1-9	2	0-9	1
9	10-90	20	10-90	20	10-90	20	0-90	10
10	1-9	2	10-90	20	10-90	20	0-9	1
11	10-90	20	1-9	2	1-9	2	0-.9	.1
12	.1-.9	.2	1-9	2	1-9	2	0-90	10

Table 3.2. Results of Numerical Analysis - Proposition 3.4

Setup	#cases valid	#cases $d(p_1-w_1)/dA > 0$	#cases $d\Pi_1/dA > 0$	#cases $\frac{d}{d\beta}\left[\frac{d\Pi_1}{dA}\right] < 0$
1	11884	11884 (100)	11884 (100)	11709 (98.5)
2	33197	33197 (100)	33197 (100)	32880 (99)
3	35532	35532 (100)	35532 (100)	35151 (98.9)
4	0	0	0	0
5	6529	6529 (100)	6529 (100)	6529 (100)
6	12616	12616 (100)	12616 (100)	12607 (100)
7	0	0	0	0
8	1149	1149 (100)	1149 (100)	1149 (100)
9	5777	5777 (100)	5777 (100)	5777 (100)
10	11884	11884 (100)	11884 (100)	11709 (98.5)
11	0	0	0	0
12	13916	13916 (100)	13916 (100)	13903 (99.9)
Total	132284	132284 (100)	132284 (100)	131414 (99.3)

Note: Figures in parentheses indicate percentage of valid cases.

Table 3.3. Results of Numerical Analysis - Proposition 3.5

Setup	#cases valid	#cases $\frac{d}{d\alpha}\left[\frac{d\Pi_2}{dA}\right]>0$	# cases $\frac{d}{d\beta}\left[\frac{d\Pi_2}{dA}\right]<0$
1	11884	11884 (100)	11884 (100)
2	33197	33134 (99.8)	33135 (99.8)
3	35532	35460 (99.8)	35463 (99.8)
4	0	0	0
5	6529	6490 (99.4)	6490 (99.4)
6	12616	12561 (99.6)	12561 (99.6)
7	0	0	0
8	1149	1149 (100)	1149 (100)
9	5777	5777 (100)	5777 (100)
10	11884	11884 (100)	11884 (100)
11	0	0	0
12	13916	13820 (99.3)	13820 (99.3)
Total	132284	132159 (99.9)	132159 (99.9)

Note: Figures in parentheses indicate percentage of valid cases.

Table 3.4. Summary of Comparative Statics Results - Model I

Effect Of / Effect On	increased Advtg (A)	increased f'(A) on marginal advtg effect	increased g'(A) on marginal advtg effect
Manufacturer Revenues, R_m	↑	↑	↑
Retailer Profits on NB, Π_1	↑	↑	↓
Retailer Profits on SB, Π_2	?	↑[1]	↓
Retailer's Total Profits, Π_r	?	↑[1]	↓
Manufacturer Price of NB, w_1	↑	↑	↑
Retail Price of NB, p_1	↑	↑	↓
Retail Margin of NB, p_1-w_1	↑	↑	↓
Retail Price of SB, p_2	?	↑[1]	↓
Qty of NB Sold, q_1	↑	↑	↑
Qty of SB Sold, q_2	?	↑[1]	↓

[1] only when g'(A) is small.

Note: NB = National Brand SB = Store Brand
f'(A) = advertising sensitivity of the national brand
g'(A) = advertising sensitivity of the store brand

Table 3.5. Results of Numerical Analysis - Proposition 3.7

Setup	#cases $d\Pi_1/d\beta<0$	#cases $d\Pi_2/d\beta<0$	#cases $d\Pi_r/d\beta<0$	# cases $d(\Pi_r/\Pi_t)/d\beta<0$
1	11296 (95.1)	11884 (100)	11884 (100)	11884 (100)
2	31715 (95.5)	33197 (100)	33197 (100)	33197 (100)
3	33773 (95)	35532 (100)	35532 (100)	35532 (100)
4	0	0	0	0
5	6501 (99.6)	6529 (100)	6529 (100)	6529 (100)
6	12491 (99)	12616 (100)	12616 (100)	12616 (100)
7	0	0	0	0
8	1149 (100)	1149 (100)	1149 (100)	1149 (100)
9	5777 (100)	5777 (100)	5777 (100)	5777 (100)
10	11884 (100)	11884 (100)	11884 (100)	11884 (100)
11	0	0	0	0
12	13746 (98.8)	13916 (100)	13916 (100)	13916 (100)
Total	128332 (96.87)	132484 (100)	132484 (100)	132484 (100)

Note: Figures in parentheses indicate percentage of valid cases.

Table 3.6. Parameter Values for Numerical Analysis
Propositions 3.12, 3.13

Setup	a_1, a_2		b_1, b_2, c_1, c_2		α		β	
	Range	Step	Range	Step	Range	Step	Range	Step
1	.1-.9	.2	.1-.9	.2	.1-.9	.2	0-.9	.1
2	1-9	2	1-9	2	1-9	2	0-9	1
3	10-90	20	10-90	20	10-90	20	0-90	10
4	1-9	2	1-9	2	.1-.9	.2	0-.9	.1
5	1-9	2	.1-.9	.2	.1-.9	.2	0-.9	.1
6	10-90	20	10-90	20	.1-.9	.2	0-.9	.1
7	10-90	20	10-90	20	1-9	2	0-9	1
8	10-90	20	1-9	2	.1-.9	.2	0-.9	.1
9	10-90	20	1-9	2	1-9	2	0-9	1
10	10-90	20	.1-.9	.2	.1-.9	.2	0-.9	.1

Table 3.7. Results of Numerical Analysis - Proposition 3.12

Setup	# cases $\Pi_m\|_{NS}<\Pi_m\|_N$	# cases $\Pi_1\|_{NS}>\Pi_1\|_N$	# cases $\Pi_r\|_{NS}>\Pi_r\|_N$	# cases $\Pi_r/\Pi_t\|_{NS}>\Pi_r/\Pi_t\|_N$
1	8916 (100)	8916 (100)	8916 (100)	8916 (100)
2	3926 (98.8)	3165 (79.7)	3764 (94.7)	3973 (100)
3	569 (90.5)	629 (100)	629 (100)	629 (100)
4	9000 (100)	9000 (100)	9000 (100)	9000 (100)
5	8916 (100)	8916 (100)	8916 (100)	8916 (100)
6	9000 (100)	9000 (100)	9000 (100)	9000 (100)
7	8916 (100)	8916 (100)	8916 (100)	8916 (100)
8	9000 (100)	9000 (100)	9000 (100)	9000 (100)
9	3926 (98.8)	3165 (79.7)	3764 (94.7)	3973 (100)
10	8916 (100)	8916 (100)	8916 (100)	8916 (100)
Total	71085 (99.8)	69623 (97.7)	70821 (99.4)	71239 (100)

Note: Figures in parentheses indicate percentage of valid cases.

Table 3.8. Results of Numerical Analysis - Proposition 3.12

Setup	# cases $w_1\|_{NS} < w_1\|_N$	# cases $q_1\|_{NS} < q_1\|_N$	# cases $A\|_{NS} < A\|_N$	# cases $p_1\|_{NS} > p_1\|_N$	# cases $p_1 - w_1\|_{NS} > p_1 - w_1\|_N$
1	8916 (100)	8916 (100)	8710 (97.7)	8916 (100)	8916 (100)
2	3772 (94.9)	3838 (96.6)	3717 (93.6)	2907 (73.2)	3765 (94.8)
3	554 (88.1)	554 (88.1)	528 (83.9)	629 (100)	629 (100)
4	9000 (100)	9000 (100)	8836 (98.2)	9000 (100)	9000 (100)
5	8916 (100)	8916 (100)	8710 (97.7)	8916 (100)	8916 (100)
6	9000 (100)	9000 (100)	8840 (98.2)	9000 (100)	9000 (100)
7	8916 (100)	8916 (100)	8710 (97.7)	8916 (100)	8916 (100)
8	9000 (100)	9000 (100)	8836 (98.2)	9000 (100)	9000 (100)
9	3772 (94.9)	3838 (96.6)	3717 (93.6)	2907 (73.2)	3765 (94.8)
10	8916 (100)	8916 (100)	8710 (97.7)	8916 (100)	8916 (100)
Total	70762 (99.33)	70894 (99.52)	69314 (97.3)	69107 (99.78)	70823 (99.41)

Note: Figures in parentheses indicate percentage of valid cases.

Table 3.9. Results of Numerical Analysis - Proposition 3.13

Setup	#cases valid	#cases $d\Pi_2/d\beta<0$	#cases $d\Pi_r/d\beta<0$	# cases $d(\Pi_r/\Pi_t)/d\beta<0$
1	8916	8916 (100)	8916 (100)	8916 (100)
2	3973	3772 (94.9)	3699 (93.1)	3868 (97.4)
3	629	554 (88.1)	554 (88.1)	573 (91.1)
4	9000	9000 (100)	9000 (100)	9000 (100)
5	8916	8916 (100)	8916 (100)	8916 (100)
6	9000	9000 (100)	9000 (100)	9000 (100)
7	8916	8916 (100)	8916 (100)	8916 (100)
8	9000	9000 (100)	9000 (100)	9000 (100)
9	3973	3772 (94.9)	3611 (90.9)	3868 (97.4)
10	8916	8916 (100)	8916 (100)	8916 (100)
Total	71239	70762 (99.3)	70528 (99)	70973 (99.6)

Note: Figures in parentheses indicate percentage of valid cases.

Table 3.10. Results of Numerical Analysis
Propositions 3.13 and 3.14

Set up	# cases $d(R_2/R)/d\alpha<0$	# cases $d(R_2/R)/d\beta<0$	# cases $d(R_2/R)/dc>0$
1	13160 (100)	13160 (100)	21971 (100)
2	4694 (100)	4694 (100)	9829 (99.9)
3	799 (100)	799 (100)	1421 (100)
4	13500 (100)	13500 (100)	22250 (98.9)
5	13160 (100)	13160 (100)	21971 (99.6)
6	13500 (100)	13500 (100)	22250 (98.9)
7	13160 (100)	13160 (100)	21971 (99.6)
8	13500 (100)	13500 (100)	22250 (98.9)
9	34676 (100)	34676 (100)	9813 (99.9)
10	13160 (100)	13160 (100)	21971 (99.6)
Total	133309 (100)	133309 (100)	175697 (99.1)

Note: Figures in parentheses indicate percent of valid cases.

Table 3.11. Summary of Comparative Statics Results
Model II

Effect Of / Effect On	increased advtg sen of SB β	increased advtg sen of NB α	increased price substitute[2] c
Manufacturer Profits, Π_m	↑	↑	0
Retailer Profits on NB, Π_1	↓	↑	↑
Retailer Profits on SB, Π_2	↓	↑[1]	↑
Retailer's Total Profits, Π_r	↓	↑[1]	↑
Channel Control (Π_r/Π_t)	↓	?	↑
Manufacturer Price of NB, w_1	↑	↑	0
Retail Price of NB, p_1	?	↑	↑
Retail Margin of NB, p_1-w_1	↓	↑	↑
Retail Price of SB, p_2	↓	↑[1]	↑
Qty of NB Sold, q_1	↑	↑	0
Qty of SB Sold, q_2	↓	↑[1]	↑
Manufacturer Advtg, A	↑	↑	0
Qty Share of SB, (q_2/q)	↓	↓	↑
Revenue Share of SB, (R_2/R)	↓	↓	↑

[1]Only when β is small, ambiguous otherwise.

[2] Case of symmetry $c_1 = c_2 = c$.

Note: NB = National Brand
SB = Store Brand

Table 4.1. Parameter Values for Numerical Analysis
Model IV

Setup	MC k_1, k_2		a_1, a_2, b_1, b_2		c_1, c_2		α, β	
	Range	Step	Range	Step	Range	Step	Range	Step
1	.1-.9	.2	.1-.9	.2	.1-.9	.2	0-.9	.1
2	.1-.9	.2	1-9	2	1-9	2	0-9	1
3	.1-.9	.2	10-90	20	10-90	20	0-90	10
4	1-9	2	.1-.9	.2	.1-.9	.2	0-.9	.1
5	1-9	2	1-9	2	1-9	2	0-9	1
6	1-9	2	10-90	20	10-90	20	0-90	10
7	10-90	20	.1-.9	.2	.1-.9	.2	0-.9	.1
8	10-90	20	1-9	2	1-9	2	0-9	1

Table 4.2. Results of Numerical Analysis - Model IV
Effect of β

Setup	#cases valid	#cases $d\Pi_2/d\beta<0$	#cases $d\Pi_r/d\beta<0$	# cases $d(\Pi_r/\Pi_t)/d\beta<0$
1	44580	44580 (100)	44580 (100)	44580 (100)
2	3249	3249 (100)	3206 (98.7)	3249 (100)
3	19730	19310 (97.9)	19730 (100)	19690 (99.8)
4	1806	1735 (96.1)	1806 (100)	1806 (100)
5	3290	3290 (100)	3290 (100)	3290 (100)
6	0	0	0	0
7	239	212 (88.7)	239 (100)	239 (100)
8	2716	2716 (100)	2716 (100)	2716 (100)
Total	75610	75092 (99.3)	75567 (99.94)	75570 (99.95)

Note: Figures in parentheses indicate percentage of valid cases.

Table 4.3. Results of Numerical Analysis - Model IV
Revenue Share of Store Brands

Set up	# cases $d(R_2/R)/d\alpha<0$	# cases $d(R_2/R)/d\beta<0$	# cases $d(R_2/R)/dc>0$
1	44580 (100)	44580 (100)	109855 (99.6)
2	2989 (92)	3249 (100)	795 (100)
3	19730 (100)	19730 (100)	49145 (99.9)
4	1626 (90)	1806 (100)	250 (100)
5	3023 (91.9)	3290 (100)	754 (100)
6	0	0	0
7	215 (90)	239 (100)	34 (100)
8	2496 (91.9)	2716 (100)	725 (100)
Total	74749 (98.9)	75610 (100)	161670 (99.7)

Note: Figures in parentheses indicate percent of valid cases.

The conditions $d\Pi_2/dc>0$, $d\Pi_r/dc>0$, $d(\Pi_r/\Pi_t)/dc>0$ are met by <u>all</u> 162145 cases and hence are not reported in tabular form.

Table 4.4. Results of Numerical Analysis - Model V

Qty q_u	a - β	#cases $d\Pi_2/d\beta<0$	#cases $d\Pi_r/d\beta<0$	# cases $d(\Pi_r/\Pi_t)/d\beta<0$
0.1-1	0.1-1	191245 (100)	185924 (99.1)	191245 (100)
0.1-1	10-100	4590 (100)	4140 (90.2)	4590 (100)
0.1-1	1-10	77504 (100)	66661 (85.9)	77504 (100)
1-10	0.1-1	191284 (100)	189562 (99.1)	191284 (100)
1-10	1-10	66086 (100)	56768 (85.9)	66086 (100)
1-10	10-100	10221 (100)	7697 (75.3)	10221 (100)
10-100	10-100	0	0	0
10-100	10-100	9321 (100)	6873 (73.7)	9321 (100)
Total		550251 (100)	461225 (83.8)	550251 (92.1)

Note: Figures in parentheses indicate percentage of valid cases.

Table 5.1. Retailer Data - Wisniewski and Blattberg (1988)

Product	Price Elasticity	Advtg Elasticity	Volume Share SB	$ Share SB
Cooking Oils	-2.59	-	7.8	6.9
Dog Food	-2.02	6.7	5.2	5.7
Flour	-1.84	1.20	9.2	-
Detergent	-2.14	2.17	5.4	4.7
Margarine	-3.02	1.09	39.7	-
Peanut Butter	-2.16	1.28	11.2	10.4
Paper Towels	-2.50	1.92	7.0	7.5
Ice Cream	-2.21	-	0	0
Tuna Fish	-4.79	1.23	-	-
Bath Tissue	-3.43	0.98	-	-

Pearson Correlations

	Vol share SB	$ share SB
Price Elasticity	0.72 (.04) n=8	0.79 (.04) n=7
Advertising Elasticity	-0.46 (.36) n=6	-0.53 (.36) n=5

Note: Figures in parentheses indicate significance (p) levels.

SB = Store Brand

Table 5.2. Data Wisniewski and Blattberg and SAMI

Product	Price Elasticity	Advtg Elasticity	Volume Share SB	$ Share SB
Margarine	-3.02	1.09	17.75	11.18
Cooking Oils	-2.59	1.28	21.24	14.46
Detergent	-2.14	-	5.04	3.1
Ice Cream	-2.21	-	0	0
Dog Food	-2.02	1.06	8.5	5.1
Peanut Butter	-2.16	1.28	23.11	18.78
Flour	-1.84	1.20	15.15	10.14
Tuna Fish	-4.79	1.23	16.19	12.67
Paper Towels	-2.50	1.92	-	10.12
Bath Tissue	-3.43	0.98	-	7.86

Pearson Correlations

	Vol share SB	$ share SB
Price Elasticity	0.26 (.53) n=8	0.25 (.49) n=10
Advertising Elasticity	-0.57 (.24) n=6	-0.32 (.45) n=8

Note: Figures in parentheses indicate significance (p) levels. SB = Store Brand

Table 5.3. Data Tellis (1988) and SAMI

	Price Elasticity	Prop of Retailers	Volume Share SB	$ Share SB
Detergents	-2.77	78	5.2	3.23
Food	-1.65	74	21.82	13.6
Toiletries	-1.38	31	8.17	3.85
Pharmaceutical	-1.12	-	-	6.7

Note: SB = Store Brand

Table 5.4. Data Advertising Age and SAMI

Product	A/S 1985	Vol.Share 1985	$ Share 1985
Food & Kindred	5.2	21.85	14.14
Meat Products	1.7	19.37	16.12
Dairy Products	5.1	29.05	27.86
Canned Pres, Fruits & Veg.	5.3	46.11	39.44
Flour & other Grain Prod	1.6	16.92	12.45
Prepared Feed for Animals	8.9	9.38	5.34
Bakery Products	1.5	31.11	18.62
Beet Sugar	0.3	33.58	31.27
Candy & Confectionery	6.5	9.06	3.4
Drugs	8.9	21.87	5.06
Soap & Detergents	7.9	4.82	2.79
Perfumes & Cosmetics	13.1	7.62	3.48

Pearson Correlation

	Vol share SB	$ share SB
A/S Ratio	-0.36 (.21) n=13	-0.47 (.09) n=13

Note: Figures in parentheses indicate significance (p) levels.
SB = Store Brand A/S = Advertising to Sales Ratio

Table 5.5. Data Advertising Age and SAMI (1988)

Product	A/S 1988	Vol.Share 1988	$ Share 1988
Bakery Products	1.9	31.7	17.63
Bottled & Can Softdrinks	1.4	58.3	50.2
Can Fruit,Veg,Pres,Jam	2.0	28.52	26.8
Candy & other Confectionery	5.8	9.27	3.34
Can Preserve Fruit,Veg	6.8	46.1	37.19
Cookies & Crackers	4.8	54.22	46.67
Dairy Products	4.9	26.6	25.62
Drugs	4.4	25.52	6.54
Food & Kindred products	7.3	21.96	13.41
Grain Mill Product	9.3	18.48	12.84
Ice Cream & Frozen Desserts	7.9	22.68	17.62
Perfume,Cosmetic,Toilet Prep.	10.2	8.44	4.18
Soap,Detergent	7.6	4.65	2.67
Sugar & Confec. Products	10.8	47.8	19.62

Pearson Correlation

	Vol share SB	$ share SB
A/S Ratio	-0.54 (.07) n=14	-0.57 (.05) n=14

Note: Figures in parentheses indicate significance (p) levels.
SB = Store Brand A/S = Advertising to Sales Ratio

Table 5.6. Data FTC (1976) and Food Commission Report

Product	A/S 1976	% of retailers carrying SB
Meat products	0.6	52
Poultry,Egg	0.8	75
Evaporated Milk	0.7	70
Frozen Fruit Juice	3.7	58
Breakfast Cereal	10.8	7
Dog and Pet Food	10.7	38
Cookies and Cracker	2.3	27
Confectionery	2.6	26
Fats and Oils	0.9	63
Soft Drinks	3.4	47
Roasted Coffee	2.8	66
Toiletries, Perfume	14.3	31
Soap, Cleaning	8.0	32

Pearson Correlation = - 0.630 (.04)

Note: Figures in parentheses indicate significance (p) levels.

SB = Store Brand
A/S = Advertising to Sales Ratio

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APPENDICES

Appendix 3.1. Derivation of Linear Demand Function

Let the utility function for consumer i for two products x and y.

$U_i(x,y,A_x) = r_i\ x - s_i\ x^2 + t_i\ y - u_i\ y^2 - v_i\ xy + f_i.x.A_x^{\tau} - g_i.x.A_x^{\tau}$.

where $r_i, s_i, t_i, u_i, v_i, f_i, g_i$ are all positive constants.

Interpretation:

One can view x as the national brand and y as the store brand. Only brand x is advertised (A_x). Advertising enters the utility function in such a way that it increases the utility for quantity of x and decreases the utility for y.

Assuming that marginal utility for money remains constant, the first order conditions equate the marginal utility of each product with its price.

The following set of equations is obtained

$\partial u_i/\partial x = r_i - 2\ s_i\ x - v_i\ y + f_i\ A_x^{\tau} = p_x$

$\partial u_i/\partial y = t_i - 2\ u_i\ y - v_i\ x - g_i\ A_x^{\tau} = p_y$

Solving these equations simultaneously, yields the individual demand functions

$$x_i(p_x,p_y,A_x) = \frac{2r_iu_i - v_it_i}{G_i} - \frac{2u_i}{G_i}\,p_x + \frac{v_i}{G_i}\,p_y + \frac{(2u_if_i+v_ig_i)}{G_i}\,A_x^{\tau}$$

$$y_i(p_x, p_y, A_x) = \frac{2r_it_i - v_ir_i}{G_i} + \frac{v_i}{G_i} p_x - \frac{2si}{G_i} p_y + \frac{(2s_ig_i+f_iv_i)}{G_i} A_x^{\gamma}$$

$$G_i = 4r_is_i - v_i^2$$

Aggregating demand over all consumers, we get the aggregate demand function

$$\Sigma x_i(p_x, p_y) = \Sigma(2r_iu_i - v_it_i)/G_i - \Sigma(2u_i/G_i)\, p_x + \Sigma(v_i/G_i).p_y + \Sigma[(2u_if_i+v_ig_i)/G_i]\, A_x^{\gamma}$$

$$\Sigma y_i(p_x, p_y) = \Sigma(2r_it_i - v_ir_i)/G_i - \Sigma(2s_i/G_i)\, p_y + \Sigma(v_i/g_i)\, p_x + \Sigma[(2s_ig_i+f_iv_i)/G_i]\, A_x^{\gamma}$$

Making the appropriate notational changes we have,

$$\Sigma x_i = q_1 = a_1 - b_1 p_1 + c_1 p_2 + \alpha A^{\gamma}$$

$$\Sigma y_i = q_2 = a_2 - b_2 p_2 + c_1 p_1 - \beta A^{\gamma}$$

This is the demand function we use in model II (case of asymmetry). It further highlights that symmetry may be a reasonable assumption. In model I, we impose less restrictions on the demand function. We assume the cross price effects are unequal and use a general functional form for advertising effect, f(A) and g(A) which yield the following demand functions:

$$q_1 = a_1 - b_1 p_1 + c_1 p_2 + f(A)$$

$$q_2 = a_2 - b_2 p_2 + c_2 p_1 - g(A)$$

Appendix 3.2 - SSOC for Model I

To show SSOC $4b_1b_2 - (c_1+c_2)^2 > 0 \Rightarrow b_1b_2 > c_1c_2$

SSOC of retailer problem $4b_1b_2 - (c_1+c_2)^2 > 0$

$\Rightarrow 4b_1b_2 > (c_1+c_2)^2$

$\Rightarrow 2b_1b_2 + 2b_1b_2 > c_1^2 + c_2^2 + 2c_1c_2$

Assume $2b_1b_2 < 2c_1c_2$

$\Rightarrow 2b_1b_2 > c_{12} + c_2^2$ (from SSOC)

$\Rightarrow 2\ c_1c_2 > 2b_1b_2 > c_1^2 + c^2_2$

$\Rightarrow c_1^2 + c_2^2 - 2c_1c_2 = (c_1 - c_2)^2 < 0$ which is not possible.

hence it must be that $2b_1b_2 > 2c_1c_2$ or $b_1b_2 > c_1c_2$.

Appendix 3.3 - Proof of Proposition 3.1

Existence of Equilibrium

$$w_1^*(A) = \frac{[a_1+f(A)][2b_1b_2-c_2(c_1+c_2)] - [a_2- g(A)][b_1(c_2-c_1)]}{4b_1(b_1b_2-c_1c_2)} \quad (3.6)$$

When $c_1 = c_2 = c$, $b_1(c_2-c_1)=0$

$W_1^*(A) = [a_1+f(A)] / 2b_1 > 0$ clearly

When $c_2 > c_1$

$2b_1b_2-c_2(c_1+c_2) > 2b_1b_2 - b_1(c_1+c_2)$ since $b_1 > c_2$ by assumption

$= 2b_1b_2 - 2b_1c_2 + b_1c_2 - b_1c_1$

$= 2b_1(b_2-c_2) + b_1(c_2-c_1)$

$> b_1(c_2-c_1)$ since $b_2 > c_2$ by assumption

Also $a_1 + f(A) > a_2 - g(A)$ by assumption - condition K1.

$$\text{Hence } w_1^*(A) = \frac{[a_1+f(A)][2b_1b_2-c_2(c_1+c_2)]-[a_2-g(A)][b_1(c_2-c_1)]}{4b_1(b_1b_2-c_1c_2)} > 0$$

From Equations (3.6) & (3.10) we see that ,

$$q_1^*(A) = \frac{2b_1(b_1b_2-c_1c_2)}{4b_1b_2-(c_1+c_2)^2} \cdot w_1^*(A) > 0$$

Appendix 3.4 - Proof of Proposition 3.2.

Comparison of Cases With and Without Store Brand

$w_1|_{NS} = w_1|_N$ from (3.12) and (3.16)

$q_1|_{NS} = q_1|_N$ from (3.13) and 3.17)

==> $R_m|_{NS} = R_m|_N$

Notice that $p_1|_N = p_1|_{NS}$ when $c = 0$.

$$\frac{dp_1|_{NS}}{dc} = \underset{(+)}{\frac{a_1+f(A)}{5b_1}} \cdot \underset{(+)}{\frac{4b_1b_2c}{(b_1b_2-c^2)^2}} + \underset{(+)}{\frac{a_2-g(A)}{2b_1}} \cdot \underset{(+)}{\frac{b_1(b_1b_2+c^2)}{(b_1b_2-c^2)^2}} > 0$$

$$\left.\frac{dp_1|_{NS}}{dc}\right|_{c=0} = \frac{a_2 - g(A)}{2b_1b_2} > 0$$

The derivative exists everywhere (including at zero) and is positive. Hence p_1 is increasing in c or $p_1|_{NS} > p_1|_N$

Hence $p_1|_{NS} - w_1|_{NS} > p_1|_N - w_1|_N$

==> $[(p_1-w_1)\cdot q_1]|_{NS} = \Pi_1|_{NS} > \Pi_1|_N = [(p_1-w_1)\cdot q_1]|_N$

clearly $p_2|_{NS} > 0$ and $q_2|_{NS} > 0$ from (3.20) and (3.21)

==> $\Pi_2|_{NS} > 0$ ==> $\Pi_r|_{NS} > \Pi_r|_N$

$R_m|_{NS} = R_m|_N$ & $\Pi_r|_{NS} > \Pi_r|_N$ ==> $R_t|_{NS} > R_t|_N$

==> $(R_m/R)|_{NS} < (R_m/R)|_N = 1/3$ ==> $(\Pi_r/R)|_{NS} > (\Pi_r/R)|_{NS}$

Appendix 3.5 - Proof of Proposition 3.3

Manufacturer Profits

(i) $dw_1/dA > 0$ since coefficient of $f'(A)$ and $g'(A)$ in (3.22) are positive.

Similarly $dq_1/dA > 0$ (from 3.23)

$$dR_m/dA = w_1 \cdot dq_1/dA + q_1 \cdot dw_1/dA > 0$$

(ii)
$$\frac{d}{df'(A)}\left[\frac{dw_1}{dA}\right] = \frac{2b_1b_2 - c_2(c_1+c_2)}{4b_1(b_1b_2-c_1c_2)} > 0$$

$$\frac{d}{dg'(A)}\left[\frac{dq_1}{dA}\right] = \frac{2b_1b_2 - c_2(c_1+c_2)}{2[4b_1b_2-(c_1+c_2)^2]} > 0$$

$$\frac{d}{df'(A)}\left[\frac{dR_m}{dA}\right] = \frac{d}{df'(A)}\left[w_1 \cdot \frac{dq_1}{dA} + q_1 \cdot \frac{dw_1}{dA}\right]$$

Using the multiplication rule,

$$= \underset{(+)}{\frac{dw_1}{df'(A)}}\left[\underset{(+)}{\frac{dq_1}{dA}} + w_1 \underset{(+)}{\frac{d}{df'(A)}}\left[\underset{(+)}{\frac{dq_1}{dA}}\right]\right] + \underset{(+)}{\frac{dq_1}{df'(A)}}\left[\underset{(+)}{\frac{dw_1}{dA}} + q_1 \underset{(+)}{\frac{d}{df'(A)}}\left[\underset{(+)}{\frac{dw_1}{dA}}\right]\right] > 0$$

Similarly,
$$\frac{d}{dg'(A)}\left[\frac{dw_1}{dA}\right] = \frac{b_1(c_2-c_1)}{4b_1(b_1b_2-c_1c_2)} \geq 0$$

$$\frac{d}{dg'(A)}\left[\frac{dq_1}{dA}\right] = \frac{b_1(c_2-c_1)}{2[4b_1b_2-(c_1+c_2)]^2} \geq 0$$

Hence $\frac{d}{dg'(A)}\left[\frac{dR_m}{dA}\right] \geq 0$ (by the same logic as above)

Appendix 3.6 - Proof of Proposition 3.4

Retailer Profits from National Brand

$$\frac{dp_1}{dA} = \frac{\{f'(A)\ \{4b_1b_2(b_1b_2-c_1c_2)+(2b_1b_2-c_1c_2)[4b_1b_2-(c_1+c_2)^2]\} - g'(A)\ \{2b_1(c_1+c_2)(b_1b_2-c_1c_2)+b_1c_1[4b_1b_2-(c_1+c_2)^2]\}\}}{[4b_1(b_1b_2-c_1c_2)]\ [4b_1b_2-(c_1+c_2)^2]}$$

$b_1, b_2 > c_1, c_2$ (Condition K1)

$$\Rightarrow 4b_1b_2(b_1b_2-c_1c_2) > 2b_1(c_1+c_2)(b_1b_2-c_1c_2)$$

$$2b_1b_2 = b_1b_2 + b_1b_2 > b_1c_1 + c_1c_2 \Rightarrow 2b_1b_2-c_1c_2 > b_1c_1$$

hence coefficient of $f'(A)$ > coef of $g'(A)$ element by element

$$f'(A) \geq g'(A) \Rightarrow dp_1/dA > 0$$

$$\frac{d(p_1-w_1)}{dA} = \frac{\{f'(A)\ \{4b_1b_2(b_1b_2-c_1c_2)+c_2^2[4b_1b_2-(c_1+c_2)^2]\} - g'(A)\ \{2b_1(c_1+c_2)(b_1b_2-c_1c_2)+b_1c_2[4b_1b_2-(c_1+c_2)^2]\}\}}{4b_1(b_1b_2-c_1c_2)[4b_1b_2-(c_1+c_2)^2]}$$

Case of Symmetry $b_1=b_2=b$ $c_1=c_2=c$

$$\frac{d(p_1-w_1)}{dA} = \frac{f'(A)\ (b^2+c^2) - g'(A)\ .\ 2bc}{4b\ (b^2 - c^2)} > 0 \text{ since } b^2+c^2 > 2bc$$

$g'(A)$ small $(= 0)$ $d(p_1-w_1)/dA > 0$ since effect of $g'(A)$ is negligible and coefficient of $f'(A)$ is positive clearly.

$dq_1/dA > 0$ (Prop 2.2)

$$d\Pi_1/dA = (p_1-w_1)\ .\ dq_1/dA + q_1\ .\ d(p_1-w_1)/dA > 0$$

$$dR_1/dA = p_1\ .\ dq_1/dA + q_1\ .\ dp_1/dA > 0$$

Proposition 3.4 (ii)

$$\frac{d}{df'(A)}\left[\frac{dp_1}{dA}\right] > 0 \text{ since coefficient of } f'(A) \text{ in (3.24)}$$

is positive.

Similarly $\dfrac{d}{df'(A)}\left[\dfrac{d(p_1-w_1)}{dA}\right] > 0$ (from 3.25)

$$\frac{d}{df'(A)}\left[\frac{d\Pi_1}{dA}\right] = \frac{d}{df'(A)}\left[(p_1-w_1)\cdot\frac{dq_1}{dA} + q_1\cdot\frac{d(p_1-w_1)}{dA}\right]$$

$$= \underset{(+)}{\frac{d(p_1-w_1)}{df'(A)}}\ \underset{(+)}{\frac{dq_1}{dA}} + \underset{(+)}{(p_1-w_1)}\ \frac{d}{df'(A)}\underset{(+)}{\left[\frac{dq_1}{dA}\right]} + \underset{(+)}{\frac{dq_1}{df'(A)}}\ \underset{(+)}{\frac{d(p_1-w_1)}{dA}} +$$

$$\underset{(+)}{q_1}\ \frac{d}{df'(A)}\underset{(+)}{\left[\frac{d(p_1-w_1)}{dA}\right]} > 0 \text{ (under condition K2)}$$

Proposition 3.4(ii)

$$\frac{d}{dg'(A)}\left[\frac{dp_1}{dA}\right] < 0 \quad \text{(from 3.24)}$$

$$\frac{d}{dg'(A)}\left[\frac{d(p_1-w_1)}{dA}\right] < 0 \quad \text{(from 3.25)}$$

$$\frac{d}{dg'(A)}\left[\frac{d\Pi_1}{dA}\right] = \frac{d}{dg'(A)}\left[(p_1-w_1)\cdot\frac{dq_1}{dA} + q_1\cdot\frac{d(p_1-w_1)}{dA}\right]$$

$$= \frac{d(p_1-w_1)}{dg'(A)}\ \frac{dq_1}{dA} + (p_1-w_1)\ \frac{d}{dg'(A)}\left[\frac{dq_1}{dA}\right] + \frac{dq_1}{dg'(A)}\ \frac{d(p_1-w_1)}{dA} +$$

$$q_1\ \frac{d}{dg'(A)}\left[\frac{d(p_1-w_1)}{dA}\right] < 0.$$

Case of Symmetry $c_1 = c_2$

$$\frac{d}{dg'(A)}\left[\frac{dq_1}{dA}\right] = 0 \qquad \frac{dq_1}{dg'(A)} = 0$$

$$\frac{d}{dg'(A)}\left[\frac{d\Pi_1}{dA}\right] = \underset{(-)}{\frac{d(p_1-w_1)}{dg'(A)}} \underset{(+)}{\frac{dq_1}{dA}} + \underset{(+)}{q_1} \underset{(-)}{\frac{d}{dg'(A)}\left[\frac{d(p_1-w_1)}{dA}\right]} < 0$$

Appendix 3.7 - Proof of Proposition 3.5

Retailer Profits from Store Brand

$$\frac{dp_2}{dA} = \frac{\{f'(A)\{2b_1(c_1+c_2)(b_1b_2-c_1c_2) + b_1c_2[4b_1b_2-(c_1+c_2)^2]\} - g'(A)\{4b_1^2(b_1b_2-c_1c_2) + b_1^2[4b_1b_2-(c_1+c_2)^2]\}\}}{[4b_1(b_1b_2-c_1c_2)][4b_1b_2-(c_1+c_2)^2]}$$

$$\frac{dq_2}{dA} = \frac{\{f'(A)\{2b_1b_2(c_2-c_1) + c_2[4b_1b_2-(c_1+c_2)^2]\} - g'(A)\{2b_1[2b_1b_2-c_1(c_1+c_2)] + b_1[4b_1b_2-(c_1+c_2)^2]\}\}}{4b_1b_2-(c_1+c_2)^2}$$

$g'(A) = 0 \Rightarrow dp_2/dA > 0$ and $dq_2/dA > 0$ since $4b_1b_2-(c_1+c_2)^2>0$ and $b_1b_2>c_1c_2$ and $c_2 \geq c_1$ by assumption

$$d\Pi_2/dA = p_2 \cdot dq_2/dA + q_2 \cdot dp_2/dA > 0$$

$g'(A) = f'(A)$

$$\frac{dp_2}{dA} = \frac{f'(A)\{(b_1b_2-c_1c_2)[2b_1(c_1+c_2)-4b_1^2]+[4b_1b_2-(c_1+c_2)^2](b_1c_2-b_1^2)\}}{[4b_1(b_1b_2-c_1c_2)][4b_1b_2-(c_1+c_2)^2]} < 0$$

since $2b_1(c_1+c_2)-4b_1^2 < 0$ $\quad b_1c_2 - b_1^2 < 0$ by condition K1.

$$dq_2/dA =$$

$$\frac{f'(A)\{[4b_1b_2-(c_1+c_2)^2](c_2-b_1)+2b_1\{[b_2(c_2-c_1)]-[2b_1b_2-c_1(c_1+c_2)]\}\}}{4b_1\,[4b_1b_2-(c_1+c_2)^2]} < 0$$

since $c_2 < b_1$ condition K1

and $2b_1b_2-c_1(c_1+c_2) > 2b_1b_2-b_2(c_1+c_2)$ since $b_2>c_1$

$= 2b_1b_2-2b_2c_2+b_2c_2-b_2c_1$

$= 2b_1(b_2-c_2)+b_2(c_2-c_1)$

$> b_2(c_2-c_1)$ since $b_2>c_2$

$$d\Pi_2/dA = p_2 \cdot dq_2/dA + q_2 \cdot dp_2/dA < 0$$

Proposition 3.5 (ii)

$$\frac{d}{df'(A)}\left[\frac{dp_2}{dA}\right] > 0 \text{ (from 3.26)} \qquad \frac{d}{df'(A)}\left[\frac{dq_2}{dA}\right] > 0 \text{ (from 3.27)}$$

$$\frac{d}{df'(A)}\left[\frac{d\Pi_2}{dA}\right] = \frac{d}{df'(A)}\left[p_2 \cdot \frac{dq_2}{dA} + q_2 \cdot \frac{dp_2}{dA}\right]$$

$$= \underset{(+)}{\frac{dp_2}{df'(A)}}\ \underset{(+)}{\frac{dq_2}{dA}} + p_2 \cdot \underset{(+)}{\frac{d}{df'(A)}}\ \underset{(+)}{\left[\frac{dq_2}{dA}\right]} + \underset{(+)}{\frac{dq_2}{df'(A)}}\ \underset{(+)}{\frac{dp_2}{dA}} + q_2 \cdot \underset{(+)}{\frac{d}{df'(A)}}\ \underset{(+)}{\left[\frac{dp_2}{dA}\right]}$$

> 0 when $g'(A)$ is small.

Similarly,

$$\frac{d}{dg'(A)}\left[\frac{dp_2}{dA}\right] < 0 \text{ (from 3.26)} \qquad \frac{d}{dg'(A)}\left[\frac{dq_2}{dA}\right] < 0 \text{ (from 3.27)}$$

$$\frac{d}{dg'(A)}\left[\frac{d\Pi_2}{dA}\right] = \frac{d}{dg'(A)}\left[p_2 \cdot \frac{dq_2}{dA} + q_2 \cdot \frac{dp_2}{dA}\right] =$$

$$\underset{(-)}{\frac{dp_2}{dg'(A)}} \cdot \underset{(+)}{\frac{dq_2}{dA}} + p_2 \cdot \underset{(+)}{\frac{d}{dg'(A)}}\ \underset{(-)}{\left[\frac{dq_2}{dA}\right]} + \underset{(-)}{\frac{dq_2}{dg'(A)}}\ \underset{(+)}{\frac{dp_2}{dA}} + q_2 \cdot \underset{(+)}{\frac{d}{dg'(A)}}\ \underset{(-)}{\left[\frac{dp_2}{dA}\right]}$$

< 0 for small $g'(A)$.

Appendix 3.8 - Proof of Proposition 3.7

Effect of β - Model I

When advertising is fixed $ds/d\beta = 0$ in which case

$dw_1/d\beta \geq 0$ (from 3.6)

$dq_1/d\beta \geq 0$ (from 3.10)

$d\Pi_m/d\beta = w_1 \cdot dq_1/d\beta + q_1 \cdot dw_1/d\beta \geq 0$

In the special case of symmetry, $dq_1/d\beta = dw_1/d\beta = d\Pi_m/d\beta = 0$

$d(p_1-w_1)/d\beta < 0$ (from 3.8)

$d\Pi_1/d\beta = (p_1-w_1) \cdot dq_1/d\beta + q_1 \cdot d(p_1-w_1)/d\beta < 0$

$dp_2/d\beta < 0$ (from 3.9) $dq_2/d\beta < 0$ (from 3.11)

Hence $d\Pi_2/d\beta = p_2 \cdot dq_2/d\beta + q_2 \cdot dp_2/d\beta < 0$

$d\Pi_r/d\beta = d\Pi_1/d\beta + d\Pi_2/d\beta < 0$

$d\Pi_m/d\beta > 0$ and $d\Pi_r/d\beta < 0 \Rightarrow d(\Pi_r/\Pi_t)/d\beta < 0$

Appendix 3.9 Proof of Proposition 3.8

Effect of α - Model I

Since advertising is fixed, $ds/d\alpha = 0$.

$dw_1/d\alpha = \partial w_1/\partial s \cdot ds/d\alpha + \partial w_1/\partial \alpha > 0$ (from 3.6)

Similarly $dq_1/d\alpha > 0$ (from 3.10)

$d\Pi_m/d\alpha = w_1 \cdot dq_1/d\alpha + q_1 \cdot dw_1/d\alpha > 0$

$d(p_1-w_1)/d\alpha > 0$ (from 3.8)

Hence $d\Pi_1/d\alpha = (p_1-w_1) \cdot dq_1/d\alpha + q_1 \cdot d(p_1-w_1)/d\alpha > 0$

$dp_2/d\alpha > 0$ (from 3.9)

$dq_2/d\alpha > 0$ (from 3.12)

Hence $d\Pi_2/d\alpha = p_2 \cdot dq_2/d\alpha + q_2 \cdot dp_2/d\alpha > 0$

$d\Pi_r/d\alpha = d\Pi_1/d\alpha + d\Pi_2/d\alpha > 0$

Appendix 3.10 Proof of Proposition 3.9

Effect of Price Substitutability (c)

In the case of symmetry the equilibrium solutions are provided in equations (3.16) through (3.21). It is easy to see that

$dw_1/dc = 0 \quad dq_1/dc = 0 \Rightarrow d\Pi_m/dc = 0$

$d(p_1-w_1)/dc > 0$ clearly since the numerator in (3.19) is increasing in c and the denominator is decreasing in c. Hence $d\Pi_1/dc > 0$.

Similarly $dp_2/dc > 0$ from (3.20)

$dq_2/dc > 0$ from (3.21)

$\Rightarrow \quad d\Pi_2/dc > 0$

$\Rightarrow \quad d\Pi_r/dc = d\Pi_1/dc + d\Pi_2/dc > 0$

Appendix 3.11 Proof of Proposition 3.10

In the case of symmetry

$$\frac{d}{dc}\left[\frac{dw_1}{dA}\right] = \frac{d}{dc}\left[\frac{dq_1}{dA}\right] = \frac{d}{dc}\left[\frac{dR_m}{dA}\right] = 0$$

$$\frac{d}{dc}\left[\frac{d(p_1-w_1)}{dA}\right] = \frac{f'(A)\ (16b_1^2b_2c) - g'(A)\ [8b_1^2\ (b_1b_2+c^2)]}{[4b_1\ (b_1b_2-c^2)]^2}$$

> 0 when $g'(A)$ is small $(= 0)$

$$\frac{d}{dc}\left[\frac{dp_2}{dA}\right] = \frac{f'(A)\ (2b_1b_2 + c^2) - g'(A)\ (8b_1^2c)}{4(b_1b_2-c^2)^2}$$

> 0 for small $g'(A)$

$$\frac{d}{dc}\left[\frac{d\Pi_1}{dA}\right] = \frac{d}{dc}\left[(p_1-w_1)\ \frac{dq_1}{dA} + q_1\ \frac{d(p_1-w_1)}{dA}\right]$$

$$\underset{(+)}{\frac{d(p_1-w_1)}{dc}}\ \underset{(+)}{\frac{dq_1}{dA}} + \underset{(+)}{(p_1-w_1)}\ \underset{(+)}{\frac{d}{dc}\left[\frac{dq_1}{dA}\right]} + \underset{(+)}{\frac{dq_1}{dc}}\ \underset{(+)}{\frac{d(p_1-w_1)}{dA}} + \underset{(+)}{q_1}\ \underset{(+)}{\frac{d}{dc}\left[\frac{d(p_1-w_1)}{dA}\right]}$$

> 0 when $g'(A)$ is small

Similarly, it can be shown that $d/dc\ (d\Pi_2/dA) > 0$

Hence $d/dc\ (d\Pi_r/dA) > 0$

Appendix 3.12: Proof of Proposition 3.12

$\sqrt{A} = s|_{NS} = s|_N$ from (3.32) and (3.37)

$w_1|_{NS} = w_1|_N$ from (3.33) and (3.38)

$q_1|_{NS} = q_1|_N$ from (3.34) and (3.39)

$\Longrightarrow \Pi_m|_{NS} = \Pi_m|_N$

Notice that $p_1|_N = p_1|_{NS}$ when $c = 0$.

$$\underset{dc}{\frac{dp_1|_{NS}}{}} = \underset{(+)}{\frac{(a_1+\alpha\ s)}{5b_1}}\cdot\ \underset{(+)}{\frac{4b_1b_2c}{(b_1b_2-c^2)^2}} + \underset{(+)}{\frac{(a_2-\beta\ s)}{2b_1}}\cdot\ \underset{(+)}{\frac{b_1(b_1b_2+c^2)}{(b_1b_2-c^2)^2}} > 0$$

$$\left.\frac{dp_1|_{NS}}{dc}\right|_{c=0} = \frac{a_2 - \beta\ s}{2b_1b_2} > 0$$

The derivative exists everywhere (including at zero) and is positive. Hence p_1 is increasing in c or $p_1|_{NS} > p_1|_N$

Hence $p_1|_{NS} - w_1|_{NS} > p_1|_N - w_1|_N$

$\Longrightarrow [(p_1-w_1)\cdot q_1]|_{NS} = \Pi_1|_{NS} > \Pi_1|_N = [(p_1-w_1)\cdot q_1]|_N$

clearly $p_2|_{NS} > 0$ and $q_2|_{NS} > 0$ from (3.42) and (3.43)

$\Longrightarrow \Pi_2|_{NS} > 0 \Longrightarrow \Pi_r|_{NS} > \Pi_r|_N$

$$\Pi_m|_{NS} = \Pi_m|_N \;\&\; \Pi_r|_{NS} > \Pi_r|_N \;\Longrightarrow\; \Pi_t|_{NS} > \Pi_t|_N$$

$$\Longrightarrow\; (\Pi_m/\Pi_t)|_{NS} < (\Pi_m/\Pi_t)|_N \Longrightarrow (\Pi_r/\Pi_t)|_{NS} > (\Pi_r/\Pi_t)|_{NS}$$

Appendix 3.13: Proof of Propositon 3.13(a)

Effect of β - Model II

When $c_1 = c_2$

$ds/d\beta = 0$ and $d\Pi_m/d\beta = 0$ from (3.30) & (3.31)

Manufacturer profits are unaffected by advertising sensitivity in the special case of symmetry.

$dp_1/d\beta = \partial p_1/\partial s \;.\; ds/d\beta + \partial p_1/\partial \beta = \partial p_1/\partial \beta < 0$ (from 3.7)

$d(p_1-w_1)/d\beta = \partial(p_1-w_1)/\partial s \;.\; ds/d\beta + \partial(p_1-w_1)/\partial\beta$

$= \partial(p_1-w_1)/\partial\beta < 0$ (from 3.8)

$dp_2/d\beta = \partial p_2/\partial s \;.\; ds/d\beta + \partial p_2/\partial\beta = \partial p_2/\partial\beta < 0$ (from 3.9)

$dq_2/d\beta = \partial q_2/\partial s \;.\; ds/d\beta + \partial q_2/\partial\beta = \partial q_2/\partial\beta < 0$ (from 3.11)

It follows directly from these that

$$d\Pi_1/d\beta = (p_1-w_1) \;.\; dq_1/d\beta + q_1 \;.\; d(p_1-w_1)/d\beta < 0$$

$$dR_1/d\beta = p_1 \;.\; dq_1/d\beta + q_1 \;.\; dp_1/d\beta < 0$$

$$d\Pi_2/d\beta = dR_2/d\beta = p_2 \;.\; dq_2/d\beta + q_2 \;.\; dp_2/d\beta < 0$$

$$d\Pi_t/d\beta = d\Pi_1/d\beta + d\Pi_2/d\beta < 0$$

$$dR/d\beta = dR_1/d\beta + dR_2/d\beta < 0$$

Total channel profits $\Pi_t = \Pi_m + \Pi_r$

$$d\Pi_t/d\beta = d\Pi_m/d\beta + d\Pi_r/d\beta = d\Pi_r/d\beta < 0$$

Ratio of channel profits to the retailer = Π_r/Π_t

$$\frac{d(\Pi_r/\Pi_t)}{d\beta} = \frac{\Pi_t \;.\; d\Pi_r/d\beta - \Pi_r \;.\; d\Pi_t/d\beta}{\Pi_t^2} = -\frac{d\Pi_r/d\beta\;(\Pi_t - \Pi_r)}{\Pi_t^2} < 0$$

Appendix 3.14: Proof of Proposition 3.13 (b)

Effect of β - Model II

$$s^* = NUM1 / DEN \quad \text{(from 3.30)}$$

$$NUM1 = \{\alpha[2b_1b_2-c_2(c_1+c_2)]+\beta[b_1(c_2-c_1)]\}\ \{a_1[2b_1b_2-c_2(c_1+c_2)]-a_2[b_1(c_2-c_1)]\}$$

$$DEN = [8b_1(b_1b_2-c_1c_2)][4b_1b_2-(c_1+c_2)^2]-\{\alpha[2b_1b_2-c_2(c_1+c_2)] + \beta[b_1(c_2-c_1)]\}^2$$

$$\Pi_m^* = NUM2 / DEN \quad \text{(from 3.31)}$$

$$NUM2 = \{a_1[2b_1b_2-c_2(c_1+c_2)]-a_2[b_1(c_2-c_1)]\}^2$$

$$dNUM1/d\beta = [b_1(c_2-c_1)]\ \{a_1[2b_1b_2-c_2(c_1+c_2)-a_2[b_1(c_2-c_1)]\} > 0$$

$$dNUM2/d\beta = 0$$

$$dDEN/d\beta = -\{\alpha[2b_1b_2-c_2(c_1+c_2)]+\beta[b_1(c_2-c_1)]\}\ [b_1(c_2-c_1)] < 0$$

$$ds/d\beta = (DEN \cdot dNUM1/d\beta - NUM1 \cdot dDEN/d\beta) / DEN^2 > 0$$
$$(+)\quad (+)\quad (+)\quad (-)\quad +$$

$$d\Pi_m/d\beta = - NUM2 \cdot dDEN/d\beta > 0$$
$$+\quad -$$

Similarly, it is easy to show $ds/d\alpha > 0$ $\quad d\Pi_m/d\alpha > 0$

Appendix 3.15: Proof of Propositon 3.13 (b)

To show $d\Pi_m/d\beta > 0$ and $d\Pi_r/d\beta > 0 \Rightarrow d(\Pi_r/\Pi_t)/d\beta < 0$

$$\Pi_t = \Pi_m + \Pi_r$$

$$d\Pi_t/d\beta = d\Pi_m/d\beta + d\Pi_r/d\beta$$

$$> 0 \quad \text{if} \quad d\Pi_m/d\beta > |d\Pi_r/d\beta|$$

then $d(\Pi_r/\Pi_t)/d\beta = (\Pi_t \cdot d\Pi_r/d\beta - \Pi_r \cdot d\Pi_t/d\beta) / \Pi_t^2 < 0$
$(+)\quad (-)\quad (+)\quad (+)\quad (+)$

$d\Pi_t/d\beta < 0$ iff $d\Pi_m/d\beta < |d\Pi_r/d\beta|$ => $\Pi_r \cdot d\Pi_t/d\beta < 0$

then $|d\Pi_t/d\beta| < |d\Pi_m/d\beta + d\Pi_r/d\beta| < |d\Pi_r/d\beta|$

=> $|\Pi_t \cdot d\Pi_r/d\beta| > |\Pi_r \cdot d\Pi_t/d\beta| \geq d(\Pi_r/\Pi_t)/d\beta < 0$

Appendix 3.16: Proof of Proposition 3.14

Effect of α

$ds/d\alpha > 0$ (Appendix 3.14)

$d\Pi_m/d\alpha > 0$ (Appendix 3.14)

Similarly $\partial(p_1-w_1)/\partial\alpha > 0$ (from 3.8)

$\partial q_1/\partial\alpha > 0$ (from 3.6)

$\partial\Pi_1/\partial\alpha = q_1 \cdot \partial(p_1-w_1)/\partial\alpha + (p_1-w_1) \cdot \partial q_1/\partial\alpha > 0$

$\partial\Pi_1/\partial s > 0$ (from Prop 3.4)

Hence $d\Pi_1/d\alpha = \partial\Pi_1/\partial s \cdot ds/d\alpha + \partial\Pi_1/\partial\alpha > 0$

$\partial\Pi_2/\partial s > 0$ for small β (from Prop 3.5)

$\partial p_2/\partial\alpha > 0$ (from 3.9)

$\partial q_2/\partial\alpha > 0$ (from 3.11)

$\partial\Pi_2/\partial\alpha = p_2 \cdot \partial q_2/\partial\alpha + q_2 \cdot \partial p_2/\partial\alpha > 0$

Hence $d\Pi_2/d\alpha = \partial\Pi_2/\partial s \cdot ds/d\alpha + \partial\Pi_2/\partial\alpha > 0$ (for small β)

$d\Pi_r/d\alpha = d\Pi_1/d\alpha + d\Pi_2/d\alpha > 0$ (for small β)

$d(R_2/R)/d\alpha < 0$ is shown by numerical analysis table 3.10.

Appendix 3.17: Proof of Proposition 3.15

Effect of Price Substitutability (c)

It is clear from (3.37), (3.38) and (3.39) that

$$dw_1/dc = 0 \;\&\; dq_1/dc = 0 \;\&\; ds/dc = 0 \Longrightarrow d\Pi_m/dc = 0$$

Differentiating (3.41)

$$\frac{d(p_1-w_1)}{dc} = \frac{(a_1+\alpha\ s)\ (4b_2c) + (a_2-\beta\ s)\ (b_1b_2+c^2)}{4\ (b_1b_2 - c^2)} > 0$$

Similarly,

$$\frac{dp_2}{dc} = \frac{(a_1 + \alpha\ s)\ (b_1b_2) + (a_2 - \beta\ s)\ b_1c}{2\ (b_1b_2 - c_2)^2} > 0$$

$$\frac{dq_2}{dc} = \frac{(a_1 + \alpha\ s)}{4\ b_1} > 0$$

$$d\Pi_1/dc = (p_1-w_1)\ .\ dq_1/dc + q_1\ .\ d(p_1-w_1)/dc > 0$$

$$d\Pi_2/dc = p_2\ .\ dq_2/dc + q_2\ .\ dp_2/dc > 0$$

$$d\Pi_r/dc = d\Pi_1/dc + d\Pi_2/dc > 0$$

$$\frac{d(\Pi_r/\Pi_t)}{dc} = \frac{\Pi_t.d\Pi_r/dc - \Pi_r.d\Pi_t/dc}{\Pi_t^2} = \frac{(\Pi_t-\Pi_r)\ d\Pi_r/dc}{\Pi_t^2} > 0$$

$d(R_2/R)/dc > 0$ shown by numerical analysis Table 3.10.

Appendix 3.18 Proof of Proposition 3.16

Effect of β and c

In the case of symmetry, $ds/d\beta = 0$

$$\frac{d(p_1-w_1)}{d\beta} = -\ s\ \frac{2b_1c}{b_1b_2 - c^2}$$

$$\frac{d}{dc}\left[\frac{d(p_1-w_1)}{d\beta}\right] = -\ \frac{(b_1b_2-c^2)\ 2b_1 + 4b_1c^2}{b_1b_2 - c^2} < 0$$

$$\frac{dq_1}{d\beta} = \frac{d}{dc}\left[\frac{dq_1}{d\beta}\right] = 0$$

$$\frac{d}{dc}\left[\frac{d\Pi_1}{d\beta}\right] = \underset{(+)}{\frac{dq_1}{dc}} \quad \underset{(-)}{\frac{d(p_1-w_1)}{d\beta}} + \underset{(+)}{q_1} \quad \underset{(-)}{\frac{d}{dc}\left[\frac{d(p_1-w_1)}{d\beta}\right]} < 0$$

Similarly $$\frac{dp_2}{d\beta} = - s \cdot \frac{b_1^2}{b_1b_2-c^2}$$

$$\frac{d}{dc}\left[\frac{dp_2}{d\beta}\right] < 0$$

$$\frac{d}{dc}\left[\frac{dq_2}{d\beta}\right] = 0$$

$$\frac{d}{dc}\left[\frac{d\Pi_2}{d\beta}\right] = \underset{(+)}{\frac{dq_2}{dc}} \quad \underset{(-)}{\frac{dp_2}{d\beta}} + \underset{(+)}{q_2} \quad \underset{(-)}{\frac{d}{dc}\left[\frac{dp_2}{d\beta}\right]} < 0$$

Appendix 4.1

Equilibrium Solutions - Model IV

$$w_1^*(A)|_B = w_1^*(A)|_B + \frac{k_1[2b_1(b_1b_2-c_1c_2)]+k_2[(b_1b_2-c_1c_2)(c_1+c_2)]}{4\,b_1\,(b_1b_2 - c_1c_2)}$$

$$q_1^*(A) = q_1^*(A)|_B - \frac{k_1[2b_1(b_1b_2-c_1c_2)]-k_2[(b_1b_2-c_1c_2)(c_1+c_2)]}{2[4b_1b_2 - (c_1+c_2)^2]}$$

$$p_1^*(A)=p_1^*(A)|_B + \frac{\{\{k_1\{2b_1(b_1b_2-c_1c_2)[2b_1b_2-c_1(c_1+c_2)]\} + k_2\{(b_1b_2-c_1c_2)\{c_1[4b_1b_2-(c_1+c_2)^2]-2b_1b_2(c_2-c_1)\}\}\}}{[4b_1\,(b_1b_2 - c_1c_2)]\,[4b_1b_2 - (c_1+c_2)^2]}$$

$$p_1^*-w_1^*(A)=p_1^*-w_1^*(A)|_B - \frac{\{k_1\{2b_1(b_1b_2-c_1c_2)[2b_1b_2-c_2(c_1+c_2)]\}+ k_2(b_1b_2-c_1c_2)\{c_2[4b_1b_2-(c_1+c_2)^2]+2b_1b_2(c_2-c_1)\}\}}{[4b_1\,(b_1b_2 - c_1c_2)]\,[4b_1b_2 - (c_1+c_2)^2]}$$

$$p_2^*(A) = p_2^*(A)|_B + \frac{\{\{k_1\{2b_1^2(c_2-c_1)(b_1b_2-c_1c_2)\} + k_2(b_1b_2-c_1c_2)\{4b_1[2b_1b_2-c_2(c_1+c_2)]+b_1(c_2^2-c_1^2)\}\}\}}{[4b_1\,(b_1b_2 - c_1c_2)]\,[4b_1b_2 - (c_1+c_2)^2]}$$

$$q_2^*(A) = q_2^{*(A)}|_B + \frac{\{\{k_1\,\{2b_1(c_1+c_2)(b_1b_2 - c_1c_2)\} - k_2\,\{[8b_1b_2 - (c_1+c_2)^2]\,[b_1b_2 - c_1c_2)\}\}\}}{[4b_1b_2 - (c_1+c_2)^2]}$$

$$S^*=s^*|_B - \frac{\{\{k_1[2b_1(b_1b_2-c_1c_2)]-k_2\ [(b_1b_2-c_1c_2)(c_1+c_2)]\}\ \{\alpha[2b_1b_2-c_2(c_1+c_2)]+\beta[b_1(c_2-c_1)]\}\}}{\{8b_1(b_1b_2-c_1c_2)[4b_1b_2-(c_1+c_2)^2]-\{\alpha[2b_1b_2-c_2(c_1+c_2)]+\beta[b_1(c_2-c_1)]\}\}}$$

Case of Symmetry $c_1 = c_2 = c$

$$w_1^*(A) = w_1^*(A) + \frac{k_1}{2} + k_2 \frac{c}{2b_1}$$

$$q_1^*(A) = q_1^*(A)|_B - k_1 \frac{b_1}{4} + k_2 \frac{c}{4}$$

$$p_1^*(A) = p_1^*(A)|_B + \frac{k_1}{4} + k_2 \frac{c}{4b_1}$$

$$p_1^*-w_{1(A)}^* = p_1^*-w_1^*(A)|_B - \frac{k_1}{4} - k_2 \frac{c}{4b_1}$$

$$p_2^*(A) = p_2^*(A)|_B + \frac{k_2}{2}$$

$$q_2^*(A) = q_2^*(A)|_B + k_1 \frac{c}{4} - k_2 \frac{2b_1b_2 - c^2}{4b_1}$$

$$w_1^*(A) - k_1 = w_1^*(A)|_B - \frac{k_1}{2} + k_2 \frac{c}{2b_1}$$

$$p_2^*(A) - k_2 = p_2^*(A)|_B - \frac{k_2}{2}$$

$$s^* = s^*|_B + \frac{ck_2 \cdot \alpha}{8b_1 - \alpha^2}$$

$$f(A) = \alpha s^* \qquad g(A) = \beta s^*$$

Case Without Store Brand

$$W_1^* = W_1^*|_B + \frac{k_1}{2} = W_1^*|_B + \frac{k_1}{2}$$

$$w_1^* - k_1 = w_1^* - k_1|_B - \frac{k_1}{2} = w_1^* - k_1|_B - \frac{k_1}{2}$$

$$q_1^* = q_1^*|_B - \frac{b_1 k_1}{4} = q_1^*|_B - \frac{b_1 k_1}{4}$$

$$p_1^* = p_1^*|_B + \frac{k_1}{4} = p_1^*|_B + \frac{k_1}{4}$$

$$p_1^* - w_1^* = p_1^* - w_1^*|_B - \frac{k_1}{4} = p_1^* - w_1^*|_B - \frac{k_1}{4}$$

$$s^* = s^*|_B - k_1 \frac{b_1 \alpha}{8b_1 - \alpha^2} = s^*|_B - k_1 \frac{b_1 \alpha}{8b_1 - \alpha^2}$$

Appendix 4.2

Results of Model 5

$$t_1 = h_1 + m_1 f(A) - n_1 g(A)$$

$$t_2 = h_2 + n_2 f(A) - m_2 g(A)$$

$$w_1(A) = \frac{2m_2t_1 - t_2(n_1 + n_2)}{4m_2}$$

$$q_1(A) = \frac{2m_2t_1 - t_2(n_1 + n_2)}{2[4m_1m_2 - (n_1 + n_2)^2]}$$

$$q_2(A) = \frac{t_1[-2m_2(n_1 + n_2)] + t_2[8m_1m_2 - (n_1 + n_2)^2]}{4m_2[4m_1m_2 - (n_1 + n_2)^2]}$$

$$p_1(A) = \frac{\begin{array}{c} t_1[12m_1m_2^2 - 6m_2n_1n_2 - 4m_2n_2^2 - 2m_2n_1^2] \\ + t_2[2m_1m_2n_2 - 6m_1m_2n_1 + n_1(n_1 + n_2)^2] \end{array}}{4m_2[4m_1m_2 - (n_1 + n_2)^2]}$$

$$p_2(A) = \frac{t_1[2m_2^2(n_1 - n_2)] + t_2[8m_1m_2^2 - m_2(n_1 + n_2)(3n_1 + n_2)]}{4m_2[4m_1m_2 - (n_1 + n_2)^2]}$$

$f(A) = \alpha\sqrt{\bar{A}} = \alpha s$ and $g(A) = \beta\sqrt{\bar{A}} = \beta s =$

$$S = \frac{[h_1\ 2m_2 - h_2(n_1 + n_2)]\{\alpha[2m_1m_2 - n_2(n_1 + n_2)] + \beta[m_2(n_2 - n_1)]\}}{8m_2[4m_1m_2 - (n_1 + n_2)^2] - \{\alpha[2m_1m_2 - n_2(n_1 - n_2)] + \beta[m_2(n_2 - n_1)]\}^2}$$

Quantity Constraint (q_u Binding)

$$w_1(A) = \frac{q_u[2m_2 - (n_1 + n_2) + h_1 - h_2 + f(A)(m_1 - n_2) + g(A)(m_2 - n_1)}{2}$$

$$q_1(A) = \frac{q_u[2m_2 - (n_1 + n_2)] + h_1 - h_2 + f(A)(m_1 - n_2) + g(A)(m_2 - n_1)}{4[(m_1 - n_2) + (m_2 - n_1)]}$$

$$p_1(A) = \frac{\begin{array}{l} h_1[3(m_1 - n_1) + 4(m_2 - n_2)] + h_2(m_1 - n_1) \\ - q_u[(m_1 - n_1)(2m_2 + 3n_1 - n_2) + 4n_1(m_2 - n_2) \\ + f(A)[(m_1 - n_1)(3m_1 + n_2) + 4m_1(m_2 - n_2)] \\ - g(A)[(m_1 - n_1)(3n_1 + m_2) + 4n_1(m_2 - n_2)] \end{array}}{4(m_1 - n_1) + (m_2 - n_2)}$$

$$p_1(A) - w_1(A) = \frac{\begin{array}{l} h_1[(m_1 - n_1) + 2(m_2 - n_2)] + h_2[3(m_1 - n_1) + 2(m_2 - n_2)] \\ + f(A)[(m_1 - n_2)(m_1 + 3n_1 - 2m_2 + 2n_2) + (m_1 - n_1) \cdot 4m_1] \\ - g(A)[(m_2 - n_1)(n_1 + 3m_1 + 2m_2 - 2n_2) + (m_1 - n_2) \cdot 4n_1] \end{array}}{4[(m_1 - n_2) + (m_2 - n_1)]}$$

$$p_2(A) = \frac{\begin{array}{l} h_1(m_2 - n_2) + h_2[4(m_1 - n_1) + 3(m_2 - n_2)] \\ - f(A)[4n_2(m_1 - n_1) + 3n_2(m_2 - n_2) + m_1(m_2 - n_2)] \\ - g(A)[4m_2(m_1 - n_1) + 3m_2(m_2 - n_2) + n_1(m_2 - n_2)] \\ - q_u[4m_2(m_1 - n_1) + 2m_2(m_2 - n_2) + (n_1 + n_2)(m_2 - n_2)] \end{array}}{4[(m_1 - n_1) + (m_2 - n_2)]}$$

$$q_2(A) = \frac{q_u[4(m_1 - n_2) + 3(m_2 - n_1) - (m_2 - n_2)] - h_1 + h_2 - f(A)(m_1 - n_2) - g(A)(m_2 - n_1)}{4[(m_1 - n_2) + (m_2 - n_1)]}$$

$$s^* = \frac{\{q_u[2m_2 - (n_1 + n_2)] + (h_1 - h_2)\}[\alpha(m_1 - n_2) + \beta(m_2 - n_1)]}{8[(m_1 + m_2) - (n_1 + n_2)] - [\alpha(m_1 - n_2) + \beta(m_2 - n_1)]^2}$$

Writing these expressions in terms of a, b, c we have

$$w_1(A) = \frac{q_u[2b_1 - (c_1 + c_2)] + [a_1 + f(A)](b_2 - c_2) - [a_2 - g(A)](b_1 - c_1)}{2(b_1b_2 - c_1c_2)}$$

$$q_1(A) = \frac{q_u[2b_1 - (c_1 + c_2) + [a_1 + f(A)](b_2 - c_2) - [a_2 - g(A)](b_1 - c_1)}{4[(b_1 - c_1)_1 + (b_2 - c_2)_2]}$$

$$p_1(A) = \frac{\begin{array}{l}[a_1 + f(A)][(b_2 - c_1)(3b_2 + c_2) + 4b_2(b_1 - c_2)] \\ + [a_2 - g(A)][(b_2 - c_1)(b_1 + 3c_1) + 4c_1(b_1 - c_2)] \\ - q_u[(b_2 - c_1)(2b_1 + 3c_1 - c_2) + 4c_1(b_1 - c_2)]\end{array}}{4(b_1b_2 - c_1c_2)[(b_1 - c_2) + (b_2 - c_1)}$$

$$p_1(A) - w_1(A) = \frac{\begin{array}{l}[a_1 + f(A)][(b_2 - c_2)(b_2 + 3c_1 - 2b_1 + 2c_2) + (b_1 - c_1)\cdot 4b_2] \\ + [a_2 - g(A)][(b_2 - c_2)4c_1 + (b_1 - c_1)(c_1 + 3b_2 + 2b_1 - 2c_2)] \\ -q_u[(b_2 - c_1)(4b_2 - 6b_1 + 3c_1 + 3c_2) + (b_1 - c_2)(4b_2 - 4b_1 + 2c_1 + 2c_2)]\end{array}}{4[(b_1 - c_1) + (b_2 - c_2)](b_1b_2 - c_1c_2)}$$

$$p_2(A) = \frac{\begin{array}{l}[a_1 + f(A)][4c_2(b_1 - c_1) + (3c_2 + b_2)(b_1 - c_2) \\ + [a_2 - g(A)][4b_1(b_2 - c_1) + 3(b_1 + c_1)(b_1 - c_2) \\ - q_u(4b_1(b_2 - c_1) + [2b_1 + (c_1 + c_2)](b_1 - c_2)\end{array}}{4(b_1b_2 - c_1c_2)[(b_1 - c_2) + (b_2 - c_1)]}$$

$$q_2 = \frac{\begin{array}{l}- [a_1 + f(A)](b_2 - c_2) + [a_2 - g(A)](b_1 - c_1) \\ + q_u[4(b_2 - c_2) + 3(b_1 - c_1) - (b_1 - c_2)]\end{array}}{4[(b_1 - c_1) + (b_2 - c_2)}$$

$$s^* = \frac{\{q_u[2b_1 - (c_1 + c_2)] + (a_1b_2 + a_2c_1)\}\ [\alpha(b_2 - c_2) + \beta(b_1 - c_1)]}{8[(b_1 + b_2) - (c_1 + c_2)] - [\alpha(b_2 - c_2) + \beta(b_1 - c_1)]^2}$$

Appendix A - Fortran Program for Numerical Analysis
Proposition 3.4, 3.5

```
// JOB (),'RAJ SET',
// TIME=(3,0)
/*PASSWORD SMPR8
// EXEC FORTRAN
//FORT.SYSIN DD *

      N = 0
      N1= 0
      N2= 0
      N3= 0
      N4= 0
      N5= 0
      N6= 0
      N7= 0
      N8= 0
      N9= 0
      N10=0
      N11=0
      N12=0
      FN= 100.0

       DO 6900 IS = 100,900,200
       DO 7000 IA1= 10,90,20
       DO 7100 IA2= 10,IA1,20
       DO 7200 IC1= 10,90,20
       IL = IC1 + 20
       DO 7300 IC2= IL,90,20

        IK = IC2 + 20

       DO 7400 IB1= IK,90,20
        DO 7500 IB2= IK,90,20
         DO 7600 IF = 10,90,20
          DO 7700 IG =0,IF,10
          S= IS*1.0/10.0
          A1= IA1*1.0/10.0
          A2= IA2*1.0/10.0
          B1= IB1*1.0/10.0
          B2= IB2*1.0/10.0
          C1= IC1*1.0/10.0
          C2= IC2*1.0/10.0
          F = IF*1.0/10.0
          G = IG*1.0/10.0


      IF ((4*B1*B2-(C1+C2)**2).LE.0.0) GOTO 7700
```

```
W1    =  4 *B1*(B1*B2-C1*C2)
W2    =  4*B1*B2-(C1+C2)**2
W3    =  2*B1*B2-C2*(C1+C2)

W4    =  B1*(C2-C1)
W5    =  4*B1*B2*(B1*B2-C1*C2)
W6    =  2*B1*B2-C1*C2
W7    =  2*B1*(C1+C2)*(B1*B2-C1*C2)
W8    =  2*B1*B2-C1*(C1+C2)

V1 = W3
V2 = W4
V3 = W5 + W6 * W2
V4 = W7 + B1*C1*W2
 V5 = W5 + C2*C2*W2
 V6 = W7 + B1*C2*W2
 V7 = B1*B1*W2+B1*W1
V8 = C2*W2+2*B2*W4
 V9 = B1*W2+2*B1*W8
 V10 = W1*W2
 V11 = 4*B1*W2
 V12 = A1*V1-A2*V2


IF (G*S.GT.A2) GOTO 7700

W = ((A1+F *S)*V1 -(A2-G*S)*V2) / W1

P1 = ((A1+F *S)*V3 + (A2 - G  *S)*V4) / V10

R1 = ((A1+F*S)*V5 + (A2-G*S)*V6)/ V10

P2 = ((A1+F*S)*V6 + (A2-G*S)*V7) / V10

Q1 = ((A1+F*S)*V1-(A2-G*S)*V2)/(2*W2)

Q2 = ((A1+F*S)*V8 + (A2-G*S)*V9) / V11

RM = W * Q1

PM = RM - S*S

IF(PM.LE.0.0.OR.S.LE.0.0) GOTO 7700

PR1 = R1 * Q1
PR2 = P2 * Q2
PR = PR1 + PR2
PT  = PM + PR
PRAT  = PR/ PT
```

```
      DWDA = (F * V1 + G * V2) / W1
      DP1DA =  (F * V3 - G  * V4)/ V10
      DR1DA = (F * V5 - G * V6)/ V10
      DP2DA = (F * V6 - G * V7)/ V10
      DQ1DA = (F * V1 + G * V2) / (2*W2)
      DQ2DA = (F * V8 - G * V9) / V11


      DFWA = V1/W1
      DFP1A = V3/V10
      DFR1A = V5/V10
      DFP2A = V6/V10
      DFQ1A = V1/(2 * W2)
      DFQ2A = V8/V11

      DGWA = V2/W1
      DGP1A = -V4/V10
      DGR1A = -V5/V10
      DGP2A = -V7/V10
      DGQ1A = V2/(2*W2)
      DGQ2A = -V9/V11

      DPMDA = W * DQ1DA + Q1 * DWDA
      DPR1DA = R1 * DQ1DA + Q1 * DR1DA
      DPR2DA = P2 * DQ2DA + Q2 * DP2DA
      DPRDA = DPR1DA + DPR2DA

      DWDF = (VI * S)/W1
      DP1DF = (V3 * S)/V10
      DR1DF = (V5 * S)/V10
      DP2DF = (V6 * S)/V10
      DQ1DF = (V1 * S)/(2 * W2)
      DQ2DF = (V8 * S)/V11

      DWDG = (V2 * S)/W1
      DP1DG = -(S * V4)/V10
      DR1DG = -(S * V6)/V10
      DP2DG = -(S * V7)/V10
      DQ1DG = (S * V2)/(2 * W2)
      DQ2DG = -(S * V9)/V11

 DFPMA = DWDF * DQ1DA + W * DFQ1A + DQ1DF * DWDA + Q1 * DFWA
DFPR1A = DR1DF * DQ1DA + R1 * DFQ1A + DQ1DF * DR1DA + Q1 *
           DFR1A
DFPR2A = DP2DF * DQ2DA + P2 * DFQ2A + DQ2DF * DP2DA + Q2 *
       DFP2A
    DFPRA  = DFPR1A+ DFPR2A

  DGPMA = DWDG * DQ1DA + W *DGQ1A + DQ1DG * DWDA + Q1 * DGWA
```

```
      DGPR1A = DR1DG * DQ1DA + R1 * DGQ1A + DQ1DG * DR1DA + Q1 *
     1   DGR1A
      DGPR2A = DP2DG * DQ2DA + P2 * DGQ2A + DQ2DG * DP2DA + Q2 *
     1   DGP2A
            DGPRA = DGPR1A + DGPR2A

            DPMDF = W * DQ1DF + Q1 * DWDF
            DPR1DF = R1 * DQ1DF + Q1 * DR1DF
            DPR2DF = P2 * DQ2DF + Q2 * DP2DF
            DPRDF = DPR1DF + DPR2DF

            DPMDG = W * DQ1DG + Q1 * DWDG
            DPR1DG= R1  * DQ1DG + Q1 * DR1DG
            DPR2DG = P2 * DQ2DG + Q2 * DP2DG
            DPRDG = DPR1DG + DPR2DG
            DPTDG = DPRDG + DPMDG
            DRATDG = (PT*DPRDG-PR*DPTDG)/(PT*PT)
            N = N+1
            IF (DR1DA.LT.0.0001) GOTO 101
            N1 = N1 + 1
     101    IF (DPR1DA.LT.0.0001) GOTO 102
            N2 = N2 + 1
     102    IF (DGPR1A.GT.0.0001) GOTO 103
            N3 = N3 + 1
     103    IF (DFPR2A.LT.0.0001) GOTO 104
            N4 = N4 + 1
     104    IF (DGPR2A.GT.0.0001) GOTO 105
            N5 =N5 + 1
     105    IF (DPRDA.LT.0.0001) GOTO 106
            N6  = N6  + 1
     106    IF (DFPRA.LT.0.0001) GOTO 107
            N7  = N7  + 1
     107    IF (DGPRA.GT.0.0001) GOTO 108
            N8  = N8  + 1

     108    IF (DPR1DG.GT.0.0001) GOTO 109
            N9 = N9 + 1

     109    IF (DPR2DG.GT.0.0001) GOTO 110
            N10 = N10 + 1
     110    IF ( DPRDG.GT.0.0001) GOTO 111
            N11 = N11 + 1
     111    IF (DRATDG.GT.0.0001) GOTO 7700
            N2 = N12 + 1

    7700    CONTINUE
    7600    CONTINUE
    7500    CONTINUE
    7400    CONTINUE
    7300    CONTINUE
```

```
7200  CONTINUE
7100  CONTINUE
7000  CONTINUE

      IF (N.EQ.0.0) GOTO 6900

      FN1 = (N1 * 100)/(N * 1.0)
      FN2 = (N2 * 100)/(N * 1.0)
      FN3 = (N3 * 100)/(N * 1.0)
      FN4 = (N4 * 100)/(N * 1.0)
      FN5 = (N5 * 100)/(N * 1.0)
      FN6 = (N6 * 100)/(N * 1.0)
      FN7 = (N7 * 100)/(N * 1.0)
      FN8 = (N8 * 100)/(N * 1.0)
      FN9 = (N9*100)/(N*1.0)
      FN10 = (N10*100)/(N*1.0)
      FN11 = (N11*100)/(N*1.0)
      FN12 = (N12*100)/(N*1.0)

      WRITE(6,299) IS,N,N1,N2,N3,N4,N5,N6,N7,N8
 299  FORMAT(10I7)

      WRITE(6,309) IS,FN,FN1,FN2,FN3,FN4,FN5,FN6,FN7,FN8
309   FORMAT(I7,9F7.1)
      WRITE(6,319) IS,N,N9,N10,N11,N12
319   FORMAT(6I7)

      WRITE (6,329) IS,FN,FN9,FN10,FN11,FN12
329   FORMAT(I7,5F7.1)
6900  CONTINUE
      STOP
      END
```

Appendix B - Fortran Program for Numerical Analysis
Proposition 3.12

```
// JOB (),'V1 RAJ'
/*PASSWORD SMPR8
// EXEC FORTRAN

//FORT.SYSIN DD *

      N = 0
      N1= 0
      N2= 0
      N3= 0
      N4= 0
      N5= 0
      N6= 0
      N7= 0
      N8 =0
      N9= 0
      FN= 100.0

       DO 7000 IA1= 100,900,200
       DO 7100 IA2= 100.IA1,200
       DO 7200 IC1= 1,9,2

       IL =IC1 + 2
        DO 7300 IC2= IL,9,2

          IK = IC2 + 2

       DO 7400 IB1= IK,9,2
         DO 7500 IB2= IK,9,2
          DO 7600 IF = 1,9,2
           DO 7700 IG = 0,IF,1


            A1= IA1*1.0/10.0
            A2= IA**1.0/10.0
            B1= IB1*1.0/10.0
            B2= IB2*1.0/10.0
            C1= IC1*1.0/10.0
            C2= IC2*1.0/10.0
            F = IF*1.0/10.0
            G = IG*1.0/10.0


      IF ((4*B1*B2-(C1+C2)**2).LE.0.0) GOTO 7700

          W1    =   4 *B1*(B1*B2-C1*C2)
```

```
      W2    =  4*B1*B2-(C1+C2)**2
      W3    =  2*B1*B2-C2*(C1+C2)
      W4    =  B1*(C2-C1)
      W5    =  4*B1*B2*(B1*B2-C1*C2)
      W6    =  2*B1*B2-C1*C2
      W7    =  2*B1*(C1+C2)*(B1*B2-C1*C2)
      W8    =  2*B1*B2-C1*(C1+C2)

     IF (W2.LE.0.0) GOTO 7700

 V1 = W3
 V2 = W4
 V3 = W5 + W6 * W2
 V4 = W7 + B1*C1*W2
 V5 = W5 + C2*C2*W2
 V6 = W7 + B1*C2*W2
  V7 = B1*B1*W2+B1*W1
  V8 = C2*W2+2*B2*W4
   V9 = B1*W2+2*B1*W8
  V10 = W1*W2
  V11 = 4*B1*W2
  V12 = A1*V1-A2*V2

  DEN = (2*V10)-((F*V1+G*V2)**2)

 IF (DEN.LE.0.0) GOTO 7700

 S = ((F*V1 +G*V2)*(A1*V1-A2*V2))/DEN

IF (G*S.GT.A2) GOTO 7700

 W = ((A1+F *S)*V1 -(A2-G*S)*V2) / W1
 P1 = ((A1+F *S)*V3 + (A2 - G  *S)*V4) / V10
 R1 = ((A1+F*S)*V5 + (A2-G*S)*V6)/ V10
 P2 = ((A1+F*S)*V6 + (A2-G*S)*V7) / V10
Q1 = ((A1+F*S)*V1-(A2-G*S)*V2)/(2*W2)
Q2 = ((A1+F*S)*V8 + (A2-G*S)*V9) / V11

 RM = W * Q1
 PM = RM - S*S
 IF(PM.LE.0.0.OR.S.LE.0.0) GOTO 7700

   PR1 = R1 * Q1
   PR2 = P2 * Q2
   PR = PR1 + PR2
   PT  = PM + PR
  PRAT  = PR/ PT

    N = N + 1
```

```
      IF ((8*B1-F*F).LE.0.0) GOTO 101

      PN = (6*A1)/(8*B1-F*F)
      WN = (4*A1)/(8*B1-F*F)
      RN = (2*A1)/(8*B1-F*F)
      QN = (2*A1*B1)/(8*B1-F*F)
      SN    = (A1*F)/(8*B1-F*F)

      PRN = RN*QN
      PMN = WN*QN
      RATN=PRN/(PMN+PRN)

      N1 = N1 + 1

101   IF (Q1.GT.QN) GOTO 102
      N2 = N2 + 1

102   IF (S.GT.SN ) GOTO 103
       N3 = N3 + 1

103 IF (PM.GT.PMN) GOTO 104
      N4 = N4 + 1

104 IF (P1.LT.PN) GOTO 105
      N5 = N5 + 1

105   IF (R1.LT.RN) GOTO 106
      N6 = N6 + 1

106   IF (PR1.LT.PRN) GOTO 107
      N7 = N7 + 1

107   IF (PR.LT.PRN) GOTO 108
      N8 = N8 + 1

108   IF(PRAT.LT.RATN) GOTO 7700
      N9 = N9+1

7700 CONTINUE
7600 CONTINUE
7500 CONTINUE
7400 CONTINUE
7300CCONTINUE
7200 CONTINUE
7100 CONTINUE

      IF(N.EQ.0.0) GOTO 7000

      FN1=(N1*100)/(N*1.0)
      FN2=(N2*100)/(N*1.0)
```

```
      FN3=(N3*100)/(N*1.0)
      FN4=(N4*100)/(N*1.0)
      FN5=(N5*100)/(N*1.0)
      FN6=(N6*100)/(N*1.0)
      FN7=(N7*100)/(N*1.0)
      FN8=(N8*100)/(N*1.0)
      FN9=(N9*100)/(N*1.0)

      WRITE (6,209) IA1,N,N1,N2,N3,N4,N5,N6,N7,N8,N9
209   FORMAT(11I7)

WRITE (6,219) IA1,FN,FN1,FN2,FN3,FN4,FN5,FN6,FN7,FN8,FN9
219   FORMAT(I7,10F7.1)


7000 CONTINUE

      STOP
      END
```

Appendix C - Fortran Program for Numerical Analysis
Proposition 3.13

```
// JOB (),'V1 RAJ'
/*PASSWORD SMPR8
// EXEC FORTRAN
//FORT.SYSIN DD *

  N = 0
  N1= 0
N2= 0
N3= 0
N4= 0
N5= 0
N6= 0
N7= 0
N8= 0
N9= 0

  FN=100

    DO 7000 IA1= 1,9,2
        DO 7100 IA2= 1,IA1,2
          DO 7200 IC1= 1,9,2

         IL = IC1 + 2
          DO 7300 IC2= IL,9,2
          IK = IC2 + 2

      DO 7400 IB1= IK,9,2
         DO 7500 IB2= IK,9,2
           DO 7600 IF = 1,9,2
             DO 7700 IG = 0,IF,1

             A1= IA1*1.0/10.0
             A2= IA2*1.0/10.0
             B1= IB1*1.0/10.0
             B2= IB2*1.0/10.0
             C1= IC1*1.0/10.0
             C2= IC2*1.0/10.0
             F = IF*1.0/10.0
             G = IG*1.0/10.0

             IF((4*B1*B2-(C1+C2)**2).LE.0.0) GOTO 7700

       W1    =  4 *B1*(B1*B2-C1*C2)
       W2    =  4*B1*B2-(C1+C2)**2
       W3    =  2*B1*B2-C2*(C1+C2)
       W4    =  B1*(C2-C1)
```

```
 W5    =  4*B1*B2*(B1*B2-C1*C2)
 W6    =  2*B1*B2-C1*C2
 W7    =  2*B1*(C1+C2)*(B1*B2-C1*C2)
  W8    =  2*B1*B2-C1*(C1+C2)

   V1 = W3
   V2 = W4
   V3 = W5 + W6 * W2
   V4 = W7 + B1*C1*W2
   V5 = W5 + C2*C2*W2
   V6 = W7 + B1*C2*W2
   V7 = B1*B1*W2+B1*W1
   V8 = C2*W2+2*B2*W4
   V9 = B1*W2+2*B1*W8
   V10 = W1*W2
   V11 = 4*B1*W2
   V12 = A1*V1-A2*V2

    DEN = (2*V10)-((F*V1+G*V2)**2)

 IF (DEN.LE.0.0) GOTO 7700

 S = ((F*V1 +G*V2)*(A1*V1-A2*V2))/DEN

 IF (G*S.GT.A2) GOTO 7700

 W = ((A1+F *S)*V1 -(A2-G*S)*V2) / W1
 P1 = ((A1+F *S)*V3 + (A2 - G  *S)*V4) / V10
 M1 = ((A1+F*S)*V5 + (A2-G*S)*V6)/ V10
 P2 = ((A1+F*S)*V6 + (A2-G*S)*V7) / V10
 Q1 = ((A1+F*S)*V1-(A2-G*S)*V2)/(2*W2)
 Q2 = ((A1+F*S)*V8 + (A2-G*S)*V9) / V11

RM = W * Q1
PM = RM - S*S

IF(PM.LE.0.0.OR.S.LE.0.0) GOTO 7700

  R1 = P1 * Q1
 PR1 = M1 * Q1
 PR2 = P2 * Q2
 PR = PR1 + PR2
 PT  = PM + PR
 PRAT  = PR/ PT

DWDA = (F * V1 + G * V2) / W1
 DP1DA =  (F * V3 - G  * V4)/ V10
   DM1DA = (F * V5 - G * V6)/ V10
    DP2DA = (F * V6 - G * V7)/ V10
     DQ1DA = (F * V1 + G * V2) / (2*W2)
```

```
            DQ2DA = (F * V8 - G * V9) / V11

DSDF = (DEN*V1*V12 +((F*V1+G*V2)**2)*V12*2*V1)/(DEN*DEN)
DSDG = (DEN*V2*(V12)    + ((F*V1+G*V2)**2)*(V12)
         *2*V2)/(DEN*DEN)
DWDF = (F*V1*DSDF + G*V2*DSDF + S*V1)/W1
DWDG = (F*V1*DSDG + G*V2*DSDG + S*V2)/ W1

     DM1DF= (F*V5*DSDF - G*V6*DSDF + S*V5)/V10
     DM1DG= (F*V5*DSDG - G*V6*DSDG - S*V6)/ V10

     DQ1DF= (F*V1*DSDF + G*V2DDSDF + S*V1)/(2*W2)
     DQ1DG= (F*V1*DSDG + G*V2*DSDG + S*V2)/(2 *W2)

     DP2DF= (F*V6*DSDF - G*V7*DSDF + S*V6)/V10
     DP2DG (F*V6*DSDG - G*V7*DSDG - S*V7)/ V10

     DQ2DF= (F*V8*DSDF - G*V9*DSDF + S*V8)/V11
     DQ2DG= (F*V8*DSDG - G*V9*DSDG - S*V9)/ V11

     DP1DF= (F*V3*DSDF - G*V4*DSDF + S*V3)/V10
     DP1DG= (F*V3*DSDG - G*V4*DSDG - S*V4)/ V10

     DPMDF= Q1*DWDF + W*DQ1DF - 2*S*DSDF
     DPMDG = Q1 * DWDG + W * DQ1DG - 2*S*DSDG

     DPR1DF = Q1 * DM1DF + M1 * DQ1DF
     DPR1DG = Q1 * DM1DG + M1 * DQ1DG

     DPR2DF = Q2 * DP2DF + P2 * DQ2DF
     DPR2DG = Q2 * DP2DG + P2 * DQ2DG

     DPRDF = DPR1DF + DPR2DF
     DPRDG = DPR1DG + DPR2DG

     DR1DF = Q1 * DP1DF + P1 * DQ1DF
     DR1DG = Q1 * DP1DG + P1 * DQ1DG

     DPTDG = DPRDG + DPMDG
      DRDG = DR1DG + DPR2DG
       DRATDG  =(PT * DPRDG - PR * DPTDG) / (PT*PT)

        N = N + 1

     IF (DPR1DG.GT.0.0001) GOTO 102
          N1 = N1 + 1

102  IF (DPR2DG.GT.0.0001) GOTO 103
               N2 = N2 + 1
```

```
 103 IF (DPRDG.GT.0.0001) GOTO 104
           N3 = N3 + 1

  104 IF (DRATDG.GT.0.0001) GOTO 105
           N4 = N4 + 1

 105  IF (DR1DG.GT.0.0001) GOTO 106
           N5 = N5 + 1

 106  IF (DRDG.GT.0001) GOTO 107
           N6 = N6 + 1

 107   IF (DPR1DF.LT.0.0001) GOTO 108
           N7 = N7 + 1

 108  IF (DPR2DF.LT.0.0001) GOTO 109
           N8 = N8 + 1

 109  IF (DPRDF.LT.0.0001) GOTO 7700
       N9 = N9 + 1

7700       CONTINUE
7600        CONTINUE
7500        CONTINUE
7400       CONTINUE
7300       CONTINUE
7200       CONTINUE
7100       CONTINUE

           IF (N.EQ.0.0) GOTO 7000

      FN1 = (N1*100)/(N*1.))
       FN2 = (N2*100)/(N*1.0)
        FN3 = (N3*100)/(N*1.0)
         FN4 = (N4*100)/(N*1.0)
          FN5 = (N*100)/(N*1.0)
           FN6 = (N6*100)/(N*1.0)
            FN7 = (N7*100)/(N*1.0)
             FN8 = (N8*100)/(N*1.0)
               FN9 = (N9*100)/(N*1.0)

     WRITE(6,299) IA1,N,N1,N2,N3,N4,N5,N6,N7,N8,N9
 299 FORMAT(I5,10I6)

   WRITE (6,309) IA1,FN,FN1,FN2,FN3,FN4,FN5,FN6,FN7,FN8,FN9
  309   FORMAT (I5,10F6.1)

7000   CONTINUE
      STOP
      END
```

Vita

Name: **Rajagopalan Sethuraman**

Date of Birth: 26 June 1957

Marital Status: Married with no children

Educational Background

Degree	Year	Institution	Major Field
Ph.D	1989	Northwestern University	Marketing
M.B.A.	1981	Indian Institute of Mgmt. Calcutta India	Marketing
B.Tech	1979	Regional Engg. College Trichy India	Chemical Engineering

Awards and Honors

1987 AMA Doctoral Consortium Fellow

1979 University Rank in Undergraduate Engineering

1976-77 College Merit Scholarship Holder

Research Work

Publications/Conference Papers

Sethuraman Raj, James C. Anderson and James A. Narus, "Partnership Advantage and its Determinants in a Distributor and Manufacturer Working Relationship," Journal of Business Research (December 1988).

Sethuraman Raj, and Anne C. Coughlan, "Analysis of National Brand -Store Brand Competition", paper presented at the ORSA/TIMS Conference, October 1988.

Business Experience

Firm	Year	Position
Hindustan Petroleum India (affiliate of Exxon Corp.)	1981-84	Senior Sales Officer - Market Planning
Scientific Instruments India	1980 (Summer)	Research Analyst


3 5556 019 340 751