

**AN ECONOMIC ANALYSIS OF PRIVATE LABEL SUPPLY**  
**IN THE GROCERY INDUSTRY**

**by**

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*A Thesis submitted in conformity with the requirements for the Degree of Doctor of Philosophy, Faculty of Management, University of Toronto.*



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0-612-27781-X

## **ACKNOWLEDGEMENTS**

*This dissertation would not have been completed without the invaluable help, encouragement and guidance of Profs. Jack Mintz, Andy Mitchell and Gary Russell. Any errors or omissions are my own.*

*To David, Simon and Gavin for their tolerance and faith; and to Julia, for her constancy and courage when mine faltered, I am deeply indebted.*

## TABLE OF CONTENTS

<b>ABSTRACT</b> .....	5
<b>1. SLEEPING WITH THE ENEMY</b> .....	7
(i) Introduction .....	7
(ii) Price Discrimination / Market Segmentation .....	11
(iii) Entry Deterrence .....	18
(iv) Relationships and Power .....	23
(v) Competition .....	29
(vi) Capacity/Economies of Scale or Scope .....	34
(vii) Conclusions and Implications .....	39
<b>2. A BASELINE MODEL</b> .....	47
(i) Introduction .....	47
(ii) Linear demand in marketing models .....	48
(iii) Monopoly model .....	53
(iv) Duopoly .....	69
(v) Summary and Conclusions .....	77
<b>3. MODEL EXTENSION TO THE GROCERY PRODUCTS INDUSTRY</b> .....	105
(i) Introduction .....	105
(ii) The Grocery Products Industry .....	107
(iii) The Extended Model .....	111
(iv) The Private Label Supply Decision .....	119
(v) Discussion and Conclusions .....	134
<b>4. ESTIMATION OF DEMAND PARAMETERS</b> .....	165
(i) Introduction .....	165
(ii) Demand System in the Theoretical Model .....	168
(iii) Data .....	169
(iv) Heterogeneity and Nonstationarity .....	173
(v) Estimation of the System .....	180
(vi) Regression Results .....	184
(vii) Summary and Conclusions .....	189

<b>5. THE MODEL IN ACTION</b> .....	205
(i) Introduction .....	205
(ii) Key Assumptions of the Theoretical Model .....	208
(iii) Methodology .....	221
(iv) Results .....	238
(v) Scenario Analysis .....	246
(vi) Conclusions .....	253
<b>6. CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH</b> .....	271
(i) Summary .....	271
(ii) Contribution .....	276
(iii) Limitations .....	277
(iv) Future Research .....	279
(v) Concluding Comment .....	289

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**PH.D., 1996**

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**ABSTRACT**

With private labels growing in many grocery markets, manufacturers of national brands often find themselves in a dilemma. Private labels' gains are largely at the expense of national brands, with the result that manufacturers can have idle capacity due to stagnating sales. Retailers, for their part, are paying increasing attention to product quality as they develop premium private labels in an attempt to build store loyalty.

Supplying retailers' private labels can be attractive for national brand manufacturers. However, there are substantial risks: the manufacturer may end up substituting low-margin private label supply for more profitable national brand sales. As a result, some manufacturers are extremely reluctant to consider the idea.

The attractions of private label supply include the prospect of overall gains in sales volume, the ability to segment the market and deterrence of competitive supply. The drawbacks, on the other hand, can include loss of margin, the possibility of starting off a price war and production inefficiencies.

This dissertation proposes a dominant-firm model which predicts the conditions under which a manufacturer will supply a retailer's private label. While the linear-demand basis of the model is inherently simple, it is rich in insights about the considerations facing manufacturers in contemplating private label supply.

The model is applied to a case study of a grocery products firm. An econometric model is developed to develop demand functions and separate parameters are estimated to reflect heterogeneity among consumers and nonstationarity in consumption. The parameters are entered into a spreadsheet version of the theoretical model and results derived for this particular firm. The spreadsheet model is used to analyze how the profitability of private label supply changes in a variety of real-world scenarios.

It is found that private label supply is unprofitable for this firm, primarily because the competitive fringe keeps prices and profit margins low. However, this result is very sensitive to changes in private label costs. By contrast, changes in national brand costs or in the competing dominant firm's strategy have little impact on the profitability of private label supply for this manufacturer.

## 1. SLEEPING WITH THE ENEMY

*False facts are highly injurious to the progress of science, for they often endure long; but false views, if supported by some evidence, do little harm, for every one takes a salutary pleasure in proving their falseness.*

**Charles Darwin:**

*The Descent of Man*

### (i) Introduction

"Welcome to the brutal new world of brands", declared *Fortune* on August 23rd, 1993. Since April 2nd, the fateful day Philip Morris dropped the price of Marlboro in response to pressure from discount brands, the stock of 25 of the top packaged goods manufacturers in the U.S. had lost \$47.5 billion in market value.

"Marlboro Friday" forced Wall Street to recognize a trend that was already well established in Europe, and had been emerging in the U.S.: the increasing vulnerability of manufacturers' brands to retailers' private labels. With recession, improving product quality and increasing retailer power, private labels have reached a point at which industry analysts predict that only market leaders, No. 2 brands, and private labels will be carried by retailers. "Anything below that will get squeezed right off the shelf. It's doomsday", proclaimed one executive.

Retailers' private labels traditionally have been lower-cost, lower quality imitations of

national brands. In the dishwashing liquids category, for example, most Canadian retailers would offer two private labels: a yellow "lemon fresh" product packed in an opaque yellow bottle, which at a passing glance was very similar to Lever Brothers' Sunlight Liquid, the market leader; and a green "mild" product in a transparent bottle, which looked like Colgate-Palmolive's Palmolive Liquid. These private labels would sell for considerably less than their national brand counterparts, but would contain a lower concentration of detergent. Since they were unadvertised, their success depended on price comparison with national brands at the point of purchase.

Such "traditional" private label brands grew in most grocery categories through the late 1980's and the early 1990's, due to recessionary pressures on consumers. As Hoch (1993) argues, growth cycles in private label shares can be matched quite closely to economic cycles and their impact on consumers' incomes. Such an analysis is certainly relevant where we are talking about this category of "traditional" private label brands.

However, another type of private label is very successful in several markets - the U.K., Canada, and increasingly in the U.S. (Messinger and Narasimhan, 1995). This "premium" private label is a retailer's brand that offers comparable quality - in some cases, superior quality - to the equivalent national brand, usually at a slightly lower price.

The success of U.K. grocery retailers with such premium private labels has prompted Canadian retailers to follow suit with their own. The best known of these is Loblaw's President's Choice, but most major grocery chains have launched an equivalent line of products. President's Choice is positioned as an upscale, high quality, innovative range of grocery products. Unlike traditional private labels, President's Choice is advertised on television, with an emphasis on quality rather than on price.

In addition to earning higher margins for retailers, premium private labels play a significant part in the long-term strategies of retailers such as Loblaw's. As Crotty (1990) points out:

"Today's more sophisticated retailers use [private labels] to attract and retain customers, to differentiate themselves from their competition, and to avoid the inevitable and easy price-point comparison that is so easy with manufacturers' brands. The retailer's own label is an integral part of the marketing mix; it reflects the retailer's whole positioning in a way that manufacturers' brands never can."

In contrast to the opportunistic role played by traditional private labels, premium private labels are strategic tools used by retailers to communicate an overall image of high quality to consumers. For this reason, unlike traditional private labels, premium private labels should be relatively unaffected by economic cycles.

Small wonder, then, that grocery product manufacturers are showing increasing nervousness about the growth of private label brands in their (or rather, what were formerly their) markets. Premium quality private labels jeopardise the national brand by offering equivalent quality at a lower price, and can generate brand loyalty among consumers as national brands have traditionally done. In some cases, retailers lead the race to introduce innovative new products, as exemplified by Loblaw's introduction of "clear" soft drinks well in advance of major manufacturers.

Retailers make formidable competitors. By controlling distribution and shelf space, they have a great deal of influence over the success or failure of manufacturers' brands. Yet often it is in retailers' interest to place more emphasis on their own private labels than on national brands.

National brand manufacturers are thus faced with rivalry from a critical partner in their marketing strategy.

With retailers placing greater emphasis on private labels, it is natural that manufacturers' attention should turn to that sector and that they should consider supplying these brands themselves. However, grocery retailers are notorious for their readiness to switch private label suppliers in search of a better deal, with the result that competition for such contracts is intense. Supplying retailers' private labels often involves loss of margin, increased price sensitivity on the national brand and disclosure of sensitive information - and ultimately, increased dependence on the retailer.

If the drawbacks to private label supply for a national brand manufacturer are so apparent, why do some choose to do so? There are some strong arguments in favour of supply, which can be grouped as follows:

*Price Discrimination / Market Segmentation:* Manufacturers may agree to supply private label in order to serve high and low quality consumer segments separately.

*Entry Deterrence:* Manufacturers may supply the private label in order to prevent a new competitor from gaining a foothold in the market.

*Relationships and Power:* Retailers may give preferential treatment to the national brands of their private label suppliers, leaving manufacturers with little choice but to supply the private label.

*Competition:* If a manufacturer does not supply a retailer's private label, a competitor may do so, leaving the national brand vulnerable to sales losses to the private label but without the benefits of incremental profit and some (albeit minimal) degree of control over the private label's strategy.

*Costs and Capacity:* Private labels may be supplied in order to absorb excess capacity, or to gain economies of scale or scope.

While the topic of private label supply is highly relevant to managers, it has received little emphasis, to date, in the academic world. Premium private labels are a relatively new development, and their full implications for manufacturers' and retailers' strategies have yet to be recognized. The limited existing literature on private labels focuses primarily on differences between private label consumers and national brand consumers (a topic which has some relevance, as we shall see), but there is little research that considers the strategic options facing manufacturers with respect to private label supply. This dissertation fills this gap by proposing and empirically applying an economic model which predicts the conditions under which manufacturers will supply a retailer's private label.

The rest of this chapter looks at the degree of support available in the literature for each of the reasons for private label supply listed above. In the following chapters, a model is proposed which takes each of these reasons into consideration: in chapter 2, a "baseline" economic model is developed; in chapter 3, this baseline model is extended to replicate the conditions prevailing in the grocery industry and to develop hypotheses for testing. Chapter 4 estimates demand parameters for a manufacturer of grocery products, and chapter 5 provides model results along with simulations of a variety of business scenarios. Chapter 6 draws overall conclusions and suggests directions for future research.

## **(ii) Price Discrimination / Market Segmentation**

According to the price discrimination explanation, manufacturers may supply private labels

in order to appeal to two separate consumer segments with different products at different price levels. As a result, manufacturers can raise the price of their national brands and improve their overall profitability.

This is the thrust of Wolinsky's (1987) model. Wolinsky asks why manufacturers supply both labelled and "unlabelled" (private label) products, and proposes a model to explain the phenomenon as a form of price discrimination. He develops a duopolistic horizontal spatial model, and shows that the manufacturers will, in equilibrium, supply the unlabelled product. Manufacturers sort out buyers who strongly prefer their brand and charge them a higher price, while competing separately for the business of the remaining buyers through unlabelled products. The sub-market for unlabelled serves as a "buffer" between the two sub-markets for the labelled brands. Therefore, a change in the price of one of the labelled products has only an indirect effect (via the sub-market for the unlabelled product) on the sales of the other labelled brand.

Armed with this model, we might go forth and explain all manner of private label supply arrangements - particularly those in which a manufacturer will supply a low quality private label, but not a high quality one. The example of Pillsbury Green Giant comes to mind: this firm supplies lower quality private label vegetables with a higher proportion of leaves and stems than its national brand, but will not supply premium private labels.

But let's think about this a little more. The model still fails to explain why any national brand manufacturer would ever supply a *high quality* private label for retailers to sell at a price close to, or matching, the national brand. In supplying President's Choice, J.J. Kwinter, a manufacturer of high quality hot dogs, can hardly be said to be price discriminating. Nor can Colonial, the supplier of President's Choice Decadent Cookies. Wolinsky's model does not apply to these situations because

it was not developed to deal with premium private labels. Instead, it assumes that the unlabelled brand occupies an "intermediate" position in consumers' perceptions between the two manufacturers' brands.

Furthermore, retailers do not exist in Wolinsky's model - or, at any rate, do not influence the manufacturers' strategy. In reality, however, the proposal to launch a private label usually comes from retailers, not manufacturers. Nonetheless, Wolinsky's contribution is to show how price discrimination can play a part in the manufacturer's decision in some circumstances.

If manufacturers supply private labels as a means of price discrimination, then private label consumers must somehow be different from consumers of national brands - in their quality requirements, in their sensitivity to price, or in some other way. This is not an unreasonable idea if we are talking about traditional private labels, which offer unambiguously lower quality and price. However, it is less likely to apply to premium private labels whose quality is close to that of national brands. Since existing literature starts with the premise that private labels are low quality versions of national brands, it is audibly, if not deafeningly, silent on this aspect.

The assumption that the two groups of consumers differ is commonly held among practitioners and researchers alike. Lal's (1990) model of trade dealing and price promotion, for example, assumes that some consumers are "loyals" and some are "switchers". His conclusion that manufacturers will promote their national brands in alternating periods in response to a private label depends, in part, on the size of the switcher segment.

Similarly, Blattberg and Wisniewski's (1989) analysis of price competition between private labels and national brands is a "self-selection" model which assumes a heterogeneous utility function across consumers. In an analysis of scanner data in four categories of grocery products, Blattberg and

Wisniewski find that consumers tend to switch primarily within "price tiers" - higher-priced products tend to gain at the expense of other higher-priced products and lower-priced products, and lower-priced products at the expense of their lower-priced competitors.

This result seems to settle the issue. It looks as if consumers do tend to stick within their own "set" of brands - high- or low-priced, as the case may be, making price discrimination a potentially viable strategy. The only problem is that the price tiers in Blattberg and Wisniewski's analysis do not distinguish between private labels and national brands. So it would be a mistake to interpret this research as saying that private label users stick to private labels, and national brand users stick to national brands. With increasing private label quality, in fact, we can expect consumers to switch between national brands and private labels to a greater extent.

The issue of differences between the two types of consumers has, however, had quite a bit of attention in research on private labels and generics<sup>1</sup>. Uncles and Ellis (1989), for example, in an analysis of the U.S. ground coffee market, find that purchase patterns of private labels are very similar to those of comparably sized national brands; most people have a repertoire, and will buy other brands and the private labels of other chains. Just as some consumers are loyal to national brands, some are loyal to private labels. So it seems that a "loyal" private label segment exists, composed largely of light users of the category. However, there is a great deal of cross-switching between segments.

If loyal private label users tend to be light users, quality should be less important to them: the

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<sup>1</sup> Adopting a definition proposed by McEnally and Hawes (1984), a generic brand is "a distributor's brand that does not include a traditional brand name on its label". Typically, generics are of lower quality, and price, than either national brands or private labels: if there is such a thing as a "private label-prone" consumer, we would expect a "generics-prone" consumer to exist too. However, the existence of a "generics-prone" segment does *not* imply that a private label segment exists.

less frequently they use the product, the less important is poor performance. This would fit with Wolinsky's price discrimination model: manufacturers would supply a lower quality private label product to capture this group of light users. They would then have more flexibility to raise prices to heavy users, who care more about quality.

Great theory, but no cigar. The grocery products industry is replete with categories in which light users tend to have *higher*, not lower, quality requirements. In laundry detergents, for example, the heaviest users are, obviously, large families. These families spend more money annually on detergents than any other group; if they have a chance to save some precious dollars, they will be less concerned with getting their wash whiter than white. Smaller families that spend less on detergents are more amenable to superior performance. Similar patterns are likely to hold for other categories - such as soup, ketchup, peanut butter, etc.

This argument is supported by Murphy and Laczniak (1979). In this consumer survey on generic grocery products, there were strong positive associations with generic purchase by education, and by number of persons living in the household. The idea that private labels (or, at any rate, generics) are purchased by large families is supported by this study. So Uncles and Ellis' finding does not appear to generalize very well beyond the coffee category, in which it is to be expected that heavy users would be more concerned about quality.

Murphy (1978) attacks the issue of private label segmentation from another perspective: social class. In an experimental analysis of behaviour in the paper towels, soft drinks and laundry detergents industries, he compares brand name and brand choice frequency. His findings suggest that the frequency of store brand choice increases with social class. This appears to fit with Murphy and Laczniak's (1979) finding that private label consumers tend to have a higher level of education. The

idea that private label consumers tend to have high levels of education is supported by Cunningham, Hardy and Imperia (1982), who, in a study of canned foods, find that generic buyers are generally younger and better educated than private label or national brand buyers. Small wonder, then, that premium private labels are successful: if private labels in general appeal to higher social classes, brands such as President's Choice offer such people higher quality than traditional private labels at a saving compared with the national brand.

The upscale nature of private label consumers does not bode well for manufacturers wishing to use private label as a tool for price discrimination. It seems from this research that national brand users tend to come from lower social classes. So while they may be prepared to pay more for higher perceived quality, their lower disposable income constrains manufacturers from raising prices too much.

On the other hand, there is some research that suggests that there is really no difference between private label and national brand consumers. Livesey and Lennon (1978) analyze past research in an effort to determine the importance of socio-economic characteristics, consumer perceptions of quality, product-specific factors, family brand preferences and preferences for more expensive or cheaper brands - and find little evidence of a *general* predisposition towards private labels. This conclusion is supported by an empirical study across five grocery categories in the U.K.

In addition, Szymanski and Busch's (1987) meta-analysis of 400 studies of the generics-prone consumer finds that perceptions of product quality, price and overall product perceptions show the strongest correlation with the propensity to buy generics. In comparison with product perceptions, other factors such as demographics, psychographics and shopping behaviours are only weakly related to the purchase of generics.

Neither of these studies is flawless. Livesey and Lennon do not conduct any statistical tests, nor do they break the sample down into sub-groups in order to determine whether private label prone segments exist. Szymanski and Busch's paper, on the other hand, suffers from many of the classic drawbacks of meta-analysis: specifically, collapsing of several different measures into one, and the possible disproportionate influence of studies with larger numbers of subjects.

Nonetheless, there is enough in these studies to raise a warning flag against the idea that private label consumers are necessarily different, and that it is possible to discriminate between them and national brand consumers. If there is a difference, it seems to be a slight one, and varies by category.

### ***Conclusions***

If manufacturers supply private labels in order to price-discriminate, some segment of consumers who are prepared to pay a premium for the national brand must exist. Researchers have tried hard to establish whether there is a difference between private label consumers and those of national brands. However, most studies in this area are lacking in theory, with the result that their findings are open to several interpretations. Moreover, the statistical analysis of the empirical studies is often severely limited.

There is some limited evidence that private label and generic prone consumers tend to be more educated and have larger families than national brand consumers. However, there is also evidence to suggest that no difference exists.

Two factors would support the idea that there is no difference: first, as private label

penetration continues to grow, difference between the two groups of consumers are likely to disappear. The U.K. private label share of more than 30% across all food categories suggests that it would be very difficult to distinguish private label consumers from those of national brands in that country: there are probably few consumers who do not use a private label brand in some category.

Secondly, the emergence of premium quality private labels blurs the distinction between national brands and private labels to such a degree that it is unlikely that different consumers favour one over the other. Much of the research in this area refers to generics, and may not be extendable to traditional private labels. let alone the premium quality private labels now available.

In the final analysis, the price discrimination explanation for private label supply is only partly convincing. It may apply in some categories where the private label's quality is clearly much lower than that of the national brand. But it does not seem to work for President's Choice, nor for other premium private labels. A manufacturer supplying these brands solely on the basis of price-discrimination would be on a short road to failure.

### **(iii) Entry Deterrence**

Entry deterrence provides another potential explanation for private label supply: a manufacturer supplies the private label in order to keep a potential competitor out of the market. Private label supply, the theory goes, is an easy way for a manufacturer to enter a market: the retailer, not the manufacturer, takes most of the risks of holding inventory if the product is not successful: shelf distribution is assured, and the manufacturer is not subject to the uncertainties of trade promotions, slotting allowances and the host of other ways in which manufacturers can be separated from their money.

Indeed, there are success stories of manufacturers who have entered categories through private label supply. Cott Corporation, the high-profile supplier of private label soft drinks, grew from humble origins by supplying private label to Loblaw, and boasted earnings of \$35.4 million in 1994, up from \$12.8 million in the previous year. Cott is now an important competitor to Coca-Cola and Pepsi-Cola, which were formerly, for all practical purposes, duopolists in the soft drink industry.

Would the major soft drink manufacturers have been better off to have supplied private label and kept Cott out of the market? With 20-20 hindsight, it certainly appears this way. Brander and Eaton's (1984) model would also suggest that this is so. Brander and Eaton analyze firms' optimal decisions with regard to the number of products firms produce, which products they produce and their level of output.

Initially, they show that a monopolist would prefer to produce two products that are distant substitutes. In a duopoly, the firms may choose from four products (1,2,3,4), with product 1 closely substitutable for product 2, but less so for product 3, and so on. The *market segmentation* case describes a situation where firm A produces products 1 and 2, and firm 2 produces products 3 and 4. Under a *market interlacing* structure, on the other hand, firm A produces products 1 and 3, and firm B produces products 2 and 4. The product line decision is depicted in three stages: Product Scope (how many products), Product Line (which products), and output level.

Brander and Eaton show that a monopolist would prefer to minimize cannibalization of his existing product, and will therefore produce a distant substitute. For duopolists, Brander and Eaton show that producing close substitutes will lead to less intense price and output competition at a later stage. However, the threat of entry by an external competitor changes the picture: the more intense competition produced by an interlacing structure may deter entry and be more profitable for the

incumbent firms. Eaton and Lipsey (1979) also show that a farsighted monopolist would introduce a close substitute in a growing market before a rival.

The model has a good deal of relevance to the private label supply decision for a monopolist and for duopolists. A low quality private label can be seen as a distant substitute for a national brand (say, product 4 versus product 1), while a high quality private label can be seen as a closer substitute (product 3 or even product 2). Brander and Eaton's framework would suggest that a monopolist will be willing to produce a low quality private label, but not a high quality one. On the other hand, duopolists will prefer to produce a high quality private label and "carve up" the market between them if there are significant entry barriers. Where entry barriers are low, however, the duopolists will prefer to intensify competition by producing low quality private labels and prevent competitors from entering.

Applying this model to the soft drink example, Coca-Cola and Pepsi, facing low entry barriers, would have preferred to follow a market interlacing strategy: one manufacturer would supply a high quality national brand and a low quality private label (products 1 and 3), while the other would supply a lower quality national brand and a low quality private label (products 2 and 4). Had there been no threat of entry, each firm would have produced a high quality national brand (product 1 or 2) and a low quality private label (product 3 or 4).

However, Brander and Eaton's model focuses entirely on the demand side: all products are assumed to have equal, constant marginal costs. Capital costs are assumed equal across all products. In the soft drink example, it is quite possible that capacity and cost considerations prevented Coca-Cola and Pepsi from embarking on private label supply, and that they effectively had little choice but to admit a new competitor.

This is supported by media reports that Cott has a substantially lower cost structure than the major soft drink manufacturers (*Globe and Mail*, 1993). In spite of the confidentiality of cost data, we could guess that achieving comparable costs with Cott would have involved major capitalization and re-investment on the part of Coke and Pepsi. So the rational decision for them may well have been to allow Cott to enter.

In a similar vein, Scherer (1980) argues that entry deterrence by "product variety proliferation" is a profitable strategy for incumbent firms because of the fixed costs of developing a new product. We can see private label is a means of reducing this fixed development cost, making it more attractive for the competitor to enter, and less attractive for incumbent firms to deter entry.

The idea that a monopolist (or a cartel acting as a monopolist) will introduce a new product to deter a competitive entry originates in Bain's (1954) classic work, in which he stresses the role of product differentiation as one barrier to competitive entry. In economics literature, the phenomenon is termed "persistence of monopoly" and is also supported by the spatial models of Schmalensee (1978) and of Eaton and Lipsey (1979). Tirole (1992) contends that monopolies persist where preemption of entry by introducing a new product is effective and technology is deterministic. However, even in these conditions, a new firm may enter if it has a technological advantage over the incumbent, if the incumbent does not have time to pre-empt the entrant, or if the incumbent does not have complete information about the entrant. In the soft drink example, Cott may have had a technological advantage over Coca-Cola and Pepsi-Cola so that it was not worth their while to deter Cott from entering.

An example from outside the grocery industry is offered by Lele (1992) - the case of Amana in the microwave oven industry. Amana, the dominant manufacturer, was retailers' first choice as

private label supplier, but in refusing to produce retailers' brands, allowed lower-cost Japanese imports to enter the market. Lele argues that a firm, such as Amana, that is competing in the high quality segment of the market can effectively control the lower quality segment by private label contracting. In this sense, private label supply by a dominant firm can constitute an entry barrier.

### ***Conclusions***

Brander and Eaton's model gives a credible explanation of the strategic choices facing duopolists such as Coke and Pepsi, or Lever and Procter & Gamble. According to the model, one of these firms should be supplying high quality private labels, and the other low quality, if there is no great threat of entry by a competitor. If there is a threat of entry, however, both firms will produce low quality private labels. Similarly, Amana, the dominant firm in the microwave industry, should have supplied a low quality private label.

But in all these cases, these firms have refused to supply any private labels at all. Either these firms are behaving irrationally, or there is something going on here that is not being explained by Brander and Eaton's model. There are some hints in Tirole's contingency approach to monopoly: technology, timing and information may all play a part in the decision to pre-empt a competitor.

In all likelihood, Brander and Eaton's model holds some elements of truth. In some circumstances, it does make sense to supply private labels as an entry barrier. However, there are several other factors at work too. Entry deterrence is a credible explanation for private label supply, but by no means the only one.

#### **(iv) Relationships and Power**

Retailers control a scarce resource in the grocery industry - shelf space - and are becoming increasingly sophisticated in managing it. In the U.S., major consumer goods companies spend as much on trade promotion as on consumer promotions (coupons, contests, samples) and media advertising combined (*The Economist*, 1992). In this environment, manufacturers may supply private labels for positive or for negative reasons - in an attempt to further their relationship with retailers, or because they are co-erced into doing so. In this section, we consider both perspectives and develop some ideas about the conditions under which they might apply.

Davies (1990) sees private label supply in a positive light, arguing that private label supply can be part of a marketing programme to retailers. "Co-marketing" of national brands and private labels can have benefits for manufacturers:

"Supporters of co-marketing ... point to the reality that the retailer often welcomes the possibility of sourcing [national] brands and [private label] from one supplier, particularly where the supplier can offer an integrated marketing package"

Davies also claims that there is evidence from manufacturers who offer a mix of private label and national brands that supplying private label can be as profitable as, or more so than, supplying only national brands.

A Transaction Cost perspective (Williamson, 1985; Milgrom and Roberts, 1992) can be brought to this issue. Private label supply can be seen as a way of increasing the retailer's investment in the relationship with the manufacturer by creating specific assets which encourage the development of longer term contractual arrangements. In this case, one important specific asset may

be the expertise developed by the manufacturer in producing the retailer's product. In order to maintain its required quality standards, the retailer may be obliged to enter into a long-term partnership with the manufacturer. For a manufacturer, the benefits of such an arrangement might include, for example, the ability to raise price on his national brand. Hence a manufacturer may supply the private label in order to increase the retailer's dependence on him<sup>2</sup>.

Other researchers see retailer/manufacturer relationships in a more negative light. McGoldrick (1984), for example, claims that private labels' ability to maintain lower prices than their national brand counterparts is due to retailers' ability to play manufacturers off against one another:

"With overcapacity in most areas of grocery manufacturing, orders can be switched between suppliers. different items can be produced by different manufacturers ... sometimes one manufacturer is used in one region, another in a different area ... Supply does not appear to be a problem in most product areas; retailers are reporting numerous approaches from manufacturers with ideas for further generic items".(p.16)

This looks more like desperation on the part of manufacturers in the face of retailers' power to switch between suppliers. than a strategic effort to "co-market" private labels and national brands. If manufacturers are attempting to lock retailers into long-term relationships by creating specific assets, it seems that they are not being very successful. The picture painted here is rather of concentrated, powerful retailers promoting their private labels, with manufacturers following along, gathering the available scraps as they go.

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<sup>2</sup> To avoid sexist language while maintaining balance, I refer to the manufacturer as "he" and to the retailer as "she" throughout this dissertation.

While there are obvious differences between the textile industry and grocery products, Salmon and Cmar's (1987) study of the private label supply in textiles reaches similar conclusions. They contend that big profits for the supplier of private label goods are unlikely, and that even maintaining profits at a level equal to the cost of capital may be difficult due to retailers' readiness and ability to switch suppliers.

Stern and El-Ansary (1988) are also less than sanguine about private labels, commenting that they are a means for the retailer to secure channel control. They argue that, if generic product acceptance exists, the retailer can not only enter the market with her own brand, but can also play each of the leading brand suppliers off against one another by deciding which of these brands it will stock in order to obtain concessions.

Grocery retailers who follow this strategy of playing manufacturers off can do so because the primary factor differentiating manufacturers from each other is cost: with few technological differences between firms, private labels of equal quality can usually be obtained from any manufacturer. On the other hand, retailers cannot play national brands off against one another, since they are differentiated on the basis of quality and image.

*The Economist* (1992) expressed the risks faced by suppliers of "core" retailers, such as Marks and Spencer and Bennetton, in European supply networks, as follows:



Private label supply can leave a manufacturer excessively dependent on one customer. The allocation of capacity, time and energy to a private label brand can reduce the level of innovation behind national brands, with the result that the manufacturer has few alternatives should the retailer threaten to move to a new supplier. Hence the manufacturer finds himself caught in a web with a powerful retailer pulling the strings.

From these two streams of research, it seems that the effect of private label supply is either a) to make retailers more dependent on manufacturers, or b) to make manufacturers more dependent on retailers. In the former case, power should be an incentive to supply private labels; in the latter, it should be a disincentive. The literature suggests that there may be specific conditions in which each scenario holds: environmental uncertainty and "marginal" national brands would favour the first scenario, while proprietary information would favour the second.

The Transaction Cost perspective would argue that retailers are more likely to enter into long-term arrangements where environmental conditions are uncertain. If, for example, demand is subject to fluctuations, retailers' primary need may be to assure themselves of a source of supply.

Alternatively, if product quality is difficult to monitor, retailers may need to develop relationships with suppliers who can provide credible assurances of consistently high quality. This argument would be most convincing where a "premium" private label is concerned.

In a similar spirit, Heide and John (1988) show that small firms in channels (in this study, manufacturers' agents) engage in "dependence balancing" - making investments to increase the dependence of their channel partner where they are dependent on him/her. This fits with private label supply: manufacturers, faced with a powerful retail trade, attempt to balance their dependence on retailers by making retailers more dependent on them for their private label. We would thus expect manufacturers to be more prepared to supply a retailer's private label where they have some degree of power "deficit" *vis à vis* the retailer.

As an example of this, McGoldrick (1984), as outlined above, argues that private label supply can be a costly strategy over the long term. He claims that it is the "marginal" national brands that are at greatest risk of being delisted to make room for private labels, and that manufacturers of these brands are therefore more likely to accede to a retailer's request to supply. This seems to represent the experience of some firms in the grocery industry. E.D. Smith, the supplier of President's Choice Bottled Sauces, has a small national bottled sauce business. Procter & Gamble, manufacturer of several market-leading brands in household and food categories, does not supply private labels at all, perhaps because delisting is not a credible threat.

On the other hand, manufacturers may be unwilling to supply private labels where they perceive that they may be giving valuable information away to a retailer. The provision of information about formulations or costs, for example, allows the retailer to approach competing suppliers for supply. In particular, McMaster (1987) argues that providing R&D to retailers' brands

is giving "the advantage away to a competitor -- free ... [private label] producers benefit only from short-term gains". McMaster's major concern is not with the supply of low quality private labels that cannibalize national brands to only a limited extent, but rather with high quality private labels, where the retailer is the primary innovator.

Much of this can, however, be turned on its head. Where demand is uncertain, for example, manufacturers may have a greater need to secure distribution outlets. Manufacturers of small brands who supply a private label are still subject to delisting and may even be in a worse position than before if they have given away cost information. Application of these theories to private label supply is an uncertain science.

### ***Conclusions***

The discussion of channel power in the context of private labels is inconclusive. Although private label supply may increase a manufacturer's power in some conditions, it can reduce it in others.

While retailers are powerful in the grocery industry, it would appear that this power is as likely to work against private label supply as in its favour. In the long term, supplying a private label seems much less attractive than introducing a new national brand, and is likely to *increase* the manufacturer's dependence on the retailer, rather than reduce it. By devoting plant capacity, management time and even R & D to private labels, the manufacturer is reducing his alternatives and linking his future with the private label contract.

The dependence can be mutual, or "balanced", in Heide and John's terms. The manufacturer may in effect be a monopolist if none of his competitors have capacity, or refuse to supply for some

other reason. But the fact that grocery retailers carry a wide range of products means that, in most cases, they have greater flexibility to switch than the manufacturer does.

All things considered, private label looks like a better deal for the retailer than for the manufacturer, at least from the viewpoint of channel power. Yet there are potential benefits for manufacturers, particularly if there are few competitors and if the product category is an important one for the retailer. It may not be in the retailer's interest to look for the cheapest source of supply if she is in danger of being cut off from supply of an important national brand, for example. The retailer may prefer, as Davies claims, to buy the national brand and the private label from one source.

#### **(v) Competition**

Woven into the discussions of price discrimination, entry barriers and retailer power is a set of assumptions about the competitive environment faced by manufacturers. Schmalensee (1978) and Tirole (1992) are concerned with the role of production of a second brand in the persistence of monopoly. Wolinsky (1987) and Brander and Eaton (1994) assume that the manufacturers are duopolists. The power of retailers over manufacturers arises from the nature of competition among manufacturers for scarce resources. So manufacturers may agree to supply the private label even if it is not in their interest to do so, if they believe their competitors will supply should they refuse.

What is uncertain is whether manufacturers will be more or less inclined to supply the private label in different competitive environments. The purpose of this section is to consider whether the supply of private labels can be attributed to factors in the manufacturer's competitive environment. To this end, a range of competitive structures - monopoly, duopoly and oligopoly - is discussed in

turn.

### ***Monopoly***

In a monopoly, we would expect that retailer power would not be a significant factor in manufacturers' decision to supply private labels. After all, if the manufacturer refuses to supply, the retailer has nowhere else to go.

However, the other explanations discussed so far would apply equally to monopolists as to firms in duopolistic or oligopolistic environments. Certainly, it can be in a monopolist's interest to price-discriminate between consumers.

Brander and Eaton's (1984) approach to multiproduct firms is to use the monopoly case as a point of comparison with their later analysis of duopoly. They show that a monopolist who does not anticipate competitive entry would prefer to produce two products which are distant substitutes.

In itself, this is no great surprise: a monopolist will not normally choose to cannibalize his existing brand rather than establish a new one appealing to different consumers. Although Brander and Eaton do not explicitly analyze the case of a monopolist who fears a competitive entry, we can expect that, as in the duopoly case, the equilibrium will change. A monopolist who expects a competitor to enter with a close substitute for his product is more likely to be inclined to supply a close substitute as a pre-emptive strategy.

Schmalensee's argument is that a monopolist or cartel will supply several products if entry by a competitor is feared. If there is no expectation of competitive entry, there is no need to produce more than one product.

So it seems likely that a monopolist who anticipates entry by a competitor will be disposed

towards supplying a retailer's private label. However, a "pure" monopolist who does not anticipate entry may still have other reasons to supply the private label.

While the monopoly case may seem unusual, it does have some representation in grocery markets. In certain markets, such as detergents, some multinational manufacturers will refuse to supply as a matter of worldwide corporate policy, leaving the single manufacturer who is willing to supply, in effect, a monopolist. Whether there is a significant threat of competitive entry depends on whether the national brand manufacturers are likely to reconsider their corporate policy. There has been evidence of such reconsideration recently within some major packaged goods firms.

### *Duopoly*

Many grocery markets consist of two dominant firms which, in effect, control the category<sup>3</sup>. In such instances, a retailer may choose to "divide and conquer" in order to secure supply for her private label at the lowest possible cost.

Wolinsky's (1987) model considers the role played by the private label in softening competition between the duopolists. Retailers are passive in Wolinsky's world<sup>4</sup>, so the paper suggests why duopolists would have reasons to supply "unlabelled" products even if there were no pressure from retailers.

In this model, each firm is concerned solely about the actions of the competing duopolist. For categories in which entry is difficult, this seems realistic enough. However, if entry is relatively easy,

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<sup>3</sup> See Chapter 3 for more details on this.

<sup>4</sup> Retailers exist but are assumed to have no influence on the manufacturer's strategy.

both duopolists will be looking over their shoulders in anticipation of the arrival of a third firm. Brander and Eaton show that this prospect changes the equilibrium outcome: instead of close substitutes, the firms will produce distant substitutes. However, Brander and Eaton do not explicitly analyze the conditions under which the manufacturers will supply exactly two products each (as opposed to one, three or four) - instead, they claim only that it applies to an "intermediate range" of demand.

The key issue to consider in a duopolistic model of private label supply appears to be whether the duopolists are reacting primarily to each other, or whether they are concerned with the possibility of a competitive entry. In most grocery categories, for instance, there are a number of smaller firms which can be considered a competitive "fringe", and could be seen as a potential entrant according to Brander and Eaton's model. We would expect dominant firms to supply close substitutes to keep the smaller firms small.

### *Oligopoly*

The oligopoly case seems very similar to duopoly in its essentials - the only difference is that there are more firms, giving the retailer more options.

An interesting aspect of oligopoly is whether heterogeneous competitors have an equal probability of supplying private labels. As early as 1966, Stern (1966) predicted the results of the growth trend in private labels: the emergence of an oligopolistic core which emphasizes R&D and product innovation, along with "fringe" firms who will produce relatively undifferentiated private label items. Stern argued that small firms, because of capacity limitations, may have to forego national brand production to make room for the private label. As a result, they may have to accept

lower margins and be content with producing an undifferentiated product - and, as a result, be highly vulnerable to competitive entry. On the other hand, private labels for small manufacturers may assure short-run survival, which is often their most meaningful goal.

This appears to mirror the soft drinks and detergents markets, although the core in these categories, as in many others in the grocery industry, is duopolistic rather than oligopolistic. It also agrees with the suggestion in section (iv) that smaller brands are more vulnerable to delisting, and that their manufacturers would therefore be more amenable to private label supply. But smaller brands are not always produced by smaller manufacturers, and "core" manufacturers of national brands, such as Nabisco, H.J. Heinz and Scott Paper, do supply private labels.

Where does this leave us? Perhaps it is no longer enough for a firm simply to be a supplier of undifferentiated private labels. Premium private labels can require a great deal of R&D and innovation, which may not be available from smaller firms. So the assumption that firms will separate neatly between those who innovate and those who supply private labels is unlikely to hold water in the future: private label suppliers are likely to be innovators just as their national brand competitors are.

### *Conclusions*

Research on this aspect of private label supply is remarkably thin. Based on the literature that exists, we can identify three main areas of concern:

- (i) Risk of supply by an existing competitor:

- (ii)** Risk of entry by a new competitor;
- (iii)** Influence of heterogeneity among firms.

Brander and Eaton's model showed that there is a difference between the first two: the influence of an existing duopolistic competitor and that of a prospective third firm. The prospect of a new entrant may also change the equilibrium in a monopoly.

Firms in a duopoly or an oligopoly may also be heterogeneous. The primary distinction is between dominant firms and "fringe" competitors; according to Stern, fringe competitors are more likely to supply private labels. However, there are several readily available counterexamples.

Future research needs to consider these aspects of industry structure, both as influences on private label supply in themselves and as moderators of other influences.

#### **(vi) Capacity/Economies of Scale or Scope**

Perhaps private label supply can be boiled down to a trivial explanation. Manufacturers supply private labels not for grandiose strategic reasons, but simply to keep machines running which would otherwise be idle.

If there is a common thread that runs through the limited literature on private label supply, it is that private labels are primarily capacity fillers for manufacturers when sales of national brands are soft. Stern, El-Ansary and Brown (1989), for example, claim that private labels command a lower wholesale price than national brands because they are a way for manufacturers to transfer promotion

costs to the retailer. For this reason, they are appropriate as a capacity filler.

Bowersox and Cooper (1992) agree. They comment that "... the production of the private brand utilizes excess capacity, the cost of which would otherwise have to be absorbed by the manufacturers' own brands." (p.181). Firms with high fixed costs need private label production to spread their costs over a larger volume and make their national brands more competitive.

Consider also McGoldrick's (1984) portrayal of grocery manufacturers as engaged in a desperate search for products to fill their plants [see section **(iv)**]. Retailers seem to hold all the cards: the growth of private labels leaves national brands vulnerable and manufacturers with spare capacity, and retailers can readily switch between potential suppliers in search of the best price. In effect, manufacturers are replacing national brand volume with private label volume -at lower profit margins.

Spreading fixed costs across a larger number of units can keep unit costs down: from the economist's viewpoint, the second product can offer economies of *scale* or economies of *scope*. Baumol, Panzar and Willig (1982) define (product-specific) economies of scale as "the savings resulting from increasing the output of one product, holding the quantities of other products constant". Economies of scope, by contrast, are the "cost savings resulting from simultaneous production of several different outputs in a single enterprise" - pairs of items like wheat and straw, wool and mutton, and beef and hides. In general, economies of scope exist where two products share factors of production.

On the face of it, economies of scope would appear to be a more appropriate concept to apply to private label supply. However, private labels and national brands often share parts of the same production process. Depending on the similarity of the product formulations, processing and

packaging, private labels may offer economies of scale, economies of scope - or both - if the manufacturer has spare capacity.

In the processed vegetable industry, for instance, private label supply allows processors such as Pillsbury Green Giant to use up materials such as stalks and leaves that would not meet the quality standards of the national brand (the alternative would be to scrap these materials). This strategy of supplying a lower quality private label fits neatly within the definition of economies of scope: essentially, the private label and the national brand are complementary from a production point of view. However, in processed meats, the production of private label hot dogs on the same production line as the national brand allows the private label supplier to keep the fixed overhead costs of the national brand down: this is more a case of economies of scale.

Whether the issue is one of economies of scale or of scope, we have another intuitively reasonable explanation for private label supply, which seems to be represented in the world around us: private labels can be used by manufacturers to absorb plant overhead.

Glémet and Mira (1993) argue that no single strategy is appropriate in all market conditions. Glémet and Mira position capacity-filling as an "intermediate" strategy, one among several that a manufacturer might adopt: short of refusal to supply private labels at all, private labels can be used opportunistically to fill capacity with minimal threat to the national brand. Capacity-filling is appropriate where the national brand's distinctiveness is relatively high and where the manufacturer has a high market share.

Davies (1990) also takes a "contingency" approach to private label strategy. He contrasts the different strategies adopted by packaged goods manufacturers as (i) retaining channel control by appealing directly to the consumer, and (ii) relying on the retailer's marketing powers by offering

private label. In the first case, manufacturers invest in product innovation and heavy promotion: the emphasis in the second is on keeping costs down. This polarization is consistent with Glémet and Mira's claim that manufacturers commonly take a "black or white" approach -either refusing point blank to produce any private label, or supplying whenever there is an opportunity.

However, Davies argues that an intermediate strategy is open to manufacturers. A manufacturer could evolve packages with individual retailers that complement the retailer's own strategic objectives, by reducing her costs or building customer loyalty to the retailer. Davies argues for a marketing approach that takes into account retailers' needs as well as those of consumers. In the U.K., for example, Pedigree Petfoods works with the giant U.K. retailer Tesco to develop the petfoods market.

Capacity utilization and economies of scale are less important reasons for supplying private labels than channel control, according to Davies. Glémet and Mira contend that capacity utilization also has its place.

Perhaps the important difference between these two views is their degree of optimism about the viability of private label supply over the long haul. In the Davies camp, private label supply yields channel control to the retailer, which can result in excessive dependency on the retailer. The benefits of using excess capacity must be weighed against these long-term costs.

This is the prevailing view held by companies such as Lever Brothers and Kellogg's - while there are short-term benefits, private label supply carries heavy long-term costs. Interestingly, both these firms' production processes are quite capital-intensive, at least for some of their products, so one would expect them to be acutely aware of the costs of leaving machinery idle.

By contrast, Glémet and Mira are more positive about private label supply as a means of

using up spare capacity. Their view is more typical of firms in the meat processing industry. With tight margins and high fixed costs, these firms compete aggressively for private label supply contracts.

Certainly, it is difficult to understand why any manufacturer would supply private label, over the long term, purely to obtain economies of scale or scope. Since private label tends to carry low margins, such a manufacturer would surely be better off by developing a new national brand - even a low quality, economy brand. One answer to this is that the costs of developing a new brand are extremely high, and the costs and difficulty of getting it on shelf are enormous. Combined with the fact that competition from private label keeps margins low, it may take a long time for such a strategy to pay for itself.

Another explanation is that many manufacturers simply have a short time perspective, or, in economic jargon, discount the future heavily. This is Stern's (1966) argument, when he contends that short-term survival is the most meaningful goal for smaller manufacturers.

### *Conclusions*

In processed meat, keeping the plant running may be a matter of "bare bones" survival. The same is true of other low-margin, high-volume, high fixed cost industries.

But neither excess capacity nor economies of scale/scope rings true by itself as an explanation for private label supply. A manufacturer with any degree of ability to see beyond today's close of business will be concerned about which specific products should fill the plant. Other factors will certainly come into play in this decision: loss of channel control, the costs of developing a new

national brand, future relationships with retailers and consumers' needs, among others.

There is an important issue, though, which tends to be ignored by those who claim capacity-filling as an explanation for private label supply: with the increasing importance of premium private labels, opportunistic strategies such as this may not be enough to keep retailers interested. As retailers' quality demands become ever more stringent, they will be less willing to switch suppliers in search of spare capacity. In addition, they will require the investment of R & D in development of premium quality products - increasing fixed costs and reducing or even neutralizing whatever economies of scale might have been available.

We are left with another partial explanation for private label supply, one which rolls off the word processor easily, but does not stand up to closer scrutiny. Yes, capacity utilization is a factor, but not the only one, and not always.

#### **(vii) Conclusions and Implications**

Grocery manufacturers face a rapidly changing environment. Across all categories monitored by A.C. Nielsen, private label dollar sales in Canada grew by 13% in 1993. By comparison, manufacturers' brands were stagnant, at 3% dollar growth.

Imagine the manufacturers' dilemma. If they attempt to defend their national brands, the dice are loaded against them: their product quality is often no better than that of the private label, and their competitor controls vital access to the final consumer. Defending national brands through increased advertising and promotion can be expensive and risky.

Manufacturers may have spare capacity as a result of volume losses to private labels. New.

lower cost competitors may enter the market to supply retailers' brands, and erode category margins. Retailers may hint that private label suppliers will get preferential treatment on their national brands. Supplying private labels starts to look better and better.

But the opportunity is not without risk. Will the private label take away sales from the national brand? Will the manufacturer become overly dependent on the retailer? Will the private label earn a "reasonable" profit margin? Will new competitors enter anyway and undercut private label pricing?

The discussion in this chapter has attempted to identify the important dimensions of the private label supply decision for a national brand manufacturer. The support for each of the alternative explanations is summarized in Figure 1.1:

(Figure 1.1)

This chapter has emphasized that private labels are no longer just lower quality imitations of national brands. Increasingly, retailers are using them as tools to distinguish themselves from their competitors. Accordingly, many of the old assumptions made by researchers no longer apply. Figure 1.1 makes the distinction between traditional private labels and premium private labels, and shows that, in some cases, explanations that would have applied to traditional private label supply cannot be assumed to apply where premium private labels are concerned.

Another issue that emerges from Figure 1.1 is that both theoretical and empirical work are needed in the area of private label supply. Where there is theoretical support for the explanations discussed here, it is often tangential, based on models that were never intended to apply to private

labels. The amount of empirical support for any of the theories is sadly limited.

Each of the explanations for private label supply offered by researchers turns out to capture part of the decision, applying only in some circumstances but not in others. Manufacturers may indeed supply private labels because of pressure from powerful retailers, or because of the threat of entry by competitors, or because of capacity and cost considerations. However, there is no single model that evaluates the relative importance of these different motivations to manufacturers, and how they interact with each other, in the contemporary private label environment.

Such a model is proposed and applied in this dissertation. The considerations of private label quality, costs and competitive environment are included in a game theoretic model which predicts the conditions under which it will be profitable for a manufacturer to supply a retailer's private label. The model is applied empirically to the case of a major manufacturer of branded grocery products, and its behaviour tested under a variety of conditions.

The model considers private label quality, and it is shown that it is in manufacturers' interest to supply high quality private labels which do not excessively cannibalize their national brands. While consumers are assumed to be homogeneous, it is shown that manufacturer can take advantage of switching between brands and, in a sense, segment the market. The entry deterrence explanation for private label supply is analyzed by the inclusion of a competitive "fringe" which may consist of existing or potential competitors. It is also assumed that retailers can readily switch between manufacturers in search of a better deal on private label supply, and that they hold some power relative to manufacturers in this way. The model also analyzes three competitive environments: monopoly, duopoly and duopoly with a competitive fringe, and considers the implications of economies of scale and scope.

This is the first rigorous, comprehensive model of private label supply which evaluates the conditions under which it will be in manufacturers' interest to produce a retailer's brand. The model fills an important gap in the growing research on private labels, and, for practitioners, points the way towards factors that should be taken into account in this critical decision.

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**FIGURE 1.1**

**SUMMARY OF EXPLANATIONS FOR PRIVATE LABEL SUPPLY**

<b>THEORY</b>	<b>THEORETICAL SUPPORT</b>	<b>EMPIRICAL SUPPORT</b>	<b>TRADITIONAL PRIVATE LABEL</b>	<b>PREMIUM PRIVATE LABEL</b>	<b>OTHER COMMENTS</b>
<b>Price Discrimination</b>	Wolinsky (1987)	Blatteberg & Wisniewski (1989)  Literature on PL versus NB consumers	Possible	Unlikely	Empirical record is not clear on whether PL, NB consumers differ
<b>Entry Deterrence</b>	Schmalensee (1978)  Eaton & Lipsey (1979)  Brander & Eaton (1984)	None	Possible	Possible depending on industry structure	
<b>Power/ Relationship</b>	Williamson (1985)  Heide & John (1988)	None	Influence of power exists but is limited	Possible depending on industry	
<b>Competition</b>	Brander & Eaton (1984)	None	Possible	Possible	Key distinction is between existing competitors and new entrants
<b>Capacity/ Costs</b>	Baumol, Panzar & Willig (1982)	None	Possible	Unlikely given other considerations	

## **2. A BASELINE MODEL**

*Under every stone is another stone.*

**Robin Skelton:**

*A Devious Dictionary*

### **(i) Introduction**

The literature review of Chapter 1 explored a variety of possible explanations for private label supply by manufacturers. Nevertheless, there is as yet no comprehensive model that looks at the possible strategies open to manufacturers in different conditions. The purpose of this chapter is to develop a baseline model for extension and application to the grocery products industry.

Initially, the model is specified in a single retailer - single manufacturer world with linear demand. Equilibrium strategies for the manufacturer and the retailer are determined. The manufacturer's profitability with and without the private label are compared, and from this are determined the conditions under which the manufacturer will supply the retailer's brand. This baseline model shows that a profit-maximizing, monopolistic manufacturer will always supply a retailer's private label, because he will benefit from market expansion by the private label and from allowing consumers to switch brands rather than leave the market. This model readily extends to a situation in which the manufacturer faces multiple retailers.

In addition, this chapter explores manufacturers' propensity to supply private labels in a duopoly. It is shown that, under some conditions, one manufacturer will supply the private label.

However, there are also some ranges of parameters under which neither manufacturer will supply.

This chapter is organized as follows. To begin, some of the literature that is relevant to the linear-demand structure of the model is discussed; while Chapter 1 covered literature on the question of private label supply, the purpose of discussing the literature here is to draw out issues which concern the structure of the model itself. The baseline model and its assumptions are then specified, and propositions are developed for a monopolistic manufacturer in section 3. The model is extended to duopoly in section 4. The chapter concludes with a summary of the model's predictions and a discussion of its contribution and its limitations.

### **(ii) Linear demand in marketing models**

While Chapter 1 covered the literature on private label supply, the purpose of this section is to consider literature from other streams of research that has a bearing on this model's structure. The models discussed in this section have been developed with different objectives in mind: nonetheless, they are relevant because the models themselves bear similarities to that employed here. In particular, these models can offer some insights into the representation of consumer demand as a linear function of prices in a Stackelberg framework.

In the game theoretic literature on channel structure, McGuire and Staelin's (1983) seminal work demonstrates the role of demand substitutability in a manufacturer's decision to perform the functions of a retailer in the channel (i.e. an integrated channel structure) rather than allow an independent retailer to handle his product under a decentralized channel structure.

McGuire and Staelin propose a linear demand function of the form  $q_i = 1 - p_i + \theta p_j$ , where  $i$  and

$j$  refer to the competing manufacturers and  $\theta$  is a measure of product substitutability. Their demand function is a rescaling of the original demand functions

$$q'_1 = \mu S \{1 - [\beta/(1-\theta)]p'_1 + [\beta\theta/(1-\theta)]p'_2\};$$

$$q'_2 = (1-\mu)S \{1 + [\beta\theta/(1-\theta)]p'_1 - [\beta/(1-\theta)]p'_2\}$$

for the products of manufacturers 1 and 2, and  $0 \leq \mu \leq 1$ ;  $0 \leq \theta < 1$ ;  $\beta \geq 0$ ;  $S \geq 0$ .  $S$  is a scale factor which is equal to industry demand when the prices of both products are zero, while  $\mu$  represents the absolute difference in demand between the two products - intuitively, the inherent product "preference" for each brand.

So that demand does not increase in prices, McGuire and Staelin impose the additional constraint  $\theta/(1+\theta) \leq \mu \leq 1/(1+\theta)$ . This is shown graphically in Figure 2.1, with the shaded area representing the feasible region for  $\mu$  in terms of  $\theta$ .

(Figure 2.1)

As  $\theta$  increases, the feasible range for  $\mu$  becomes smaller and approaches 0.5 as  $\theta \rightarrow 1$ . In other words, the absolute difference in demand becomes smaller as product substitutability increases: two highly substitutable products will essentially split the market between them.

McGuire and Staelin's rescaled demand function, as shown in Appendix 2.1 and discussed below, for all its simplicity and tractability, is highly restrictive. The effect of the rescaling of the demand functions is to fix the consumer's utility and "preference" for the two products at equal levels, i.e. to set  $\mu = 0.5$  or the line AB in Figure 2.1. In other words, the products have identical

appeal to the consumer and identical own price response, but are not necessarily fully substitutable.

McGuire and Staelin's rescaled linear model is a special case of the more general demand function assumed in this dissertation. The structure of the baseline model is also similar to that of McGuire and Staelin - a Stackelberg framework with the manufacturer acting as leader - but there are some significant differences.

The linear demand function used here is derived from a quadratic utility function at the consumer level, and is more general than that proposed by McGuire and Staelin. The intercept of the demand curve (product preference) is allowed to vary between the two products, and own-price parameters may also differ. This captures situations in which a private label may have inferior, similar, or even superior quality to the national brand, and may respond differently to price changes - reflecting the distinction between traditional and premium private labels discussed in Chapter 1.

Coughlan and Wernerfelt (1989) use a more general form of linear demand function in their discussion of this class of models of channel integration. Their demand function is  $p_i = A - Bq_i + Eq_j$ ;  $i, j = 1, 2$ ;  $i \neq j$ ;  $E \in (-B, B)$ , which inverts to  $q_i = [A(B+E) - Bp_i - Ep_j](B^2 - E^2)^{-1}$ ;  $i, j = 1, 2$ ;  $i \neq j$ , a generalization of McGuire and Staelin's demand function.

Coughlan and Wernerfelt's linear demand function is consistent with that of McGuire and Staelin, but its general form is more flexible and consistent with reasonable assumptions about consumers' utility. However, both intercept demand and own-price response are still constrained to be equal across the two products.

Dixit (1979) develops a model of entry barriers with capacity constraints, and finds that two aspects of product differentiation have distinct effects: an absolute advantage in demand for the established firm makes competitive entry more difficult, while a lower cross-price effect facilitates

it. This distinction between absolute difference in demand and cross-price effects is the origin of the same distinction in McGuire and Staelin's paper; however, as we have seen, McGuire and Staelin in effect ignore absolute difference in demand by assuming that the products are identical.

Dixit derives a general model and illustrates its application to the case of a quadratic utility function

$$u = x_0 + \alpha_1 x_1 + \alpha_2 x_2 - 1/2(\beta_1 x_1^2 + 2\gamma x_1 x_2 + \beta_2 x_2^2),$$

yielding linear inverse demands:

$$p_1 = \alpha_1 - \beta_1 x_1 - \gamma x_2$$

$$p_2 = \alpha_2 - \beta_2 x_2 - \gamma x_1$$

Dixit then derives the "conventional" Stackelberg equilibrium and shows the impact of fixed costs on the equilibrium. He finds a counterintuitive effect for  $\gamma$ , the cross-price effect: a lower  $\gamma$ , making the products poorer substitutes, makes entry easier - product differentiation facilitates entry. Dixit argues that this is not an unreasonable result, since *in extremis* where  $\gamma = 0$ , the commodities are separate industries and the choices of the incumbent firm exert no power to prevent "entry".

Dixit makes a second point, however, which is critical in considering demand functions of this form. Product differentiation, he argues, can be split into two components: absolute difference in demand, reflected in the  $\alpha$ , and finite cross-price parameters, captured in  $\gamma$ . In Dixit's model, these separate constructs have opposing effects.

The private label model of this dissertation assumes a quadratic utility function similar to that proposed by Dixit. This results in linear demand functions with variable intercept and slope parameters. In this model, however, the players set prices rather than output: hence ordinary, rather than inverse, demand functions are used.

Choi (1991) analyzes optimal pricing and profitability in a two-manufacturer, one retailer channel. While the original model assumes the linear demand function  $q_i = a - bp_i + \gamma p_j$ , approximating conditions in the grocery industry, he also analyzes the equilibrium based on the nonlinear demand function  $q_i = \alpha p_i^{-\beta} p_j^{\delta}$ . Choi argues that it is critical to identify the underlying shape of the demand function if the study is to be applied in an industry, since his results differ according to the assumptions made about demand. Choi's linear demand function, like that of Coughlan and Wernerfelt, is quite restrictive in that it constrains intercept demand and own-price response to be identical across the two products.

Choi also notes a counterintuitive result under the linear demand function: prices and profits increase as the two products increase in substitutability. He comments

"Perhaps this [result] is due to the characteristics of the symmetric demand functions employed in this paper, and seems to be one of the major weaknesses of this class of linear demand functions"

As discussed later in this chapter, this property is not related to demand function symmetry, but to the structure of linear demand functions themselves. When the demand parameters are interpreted correctly, the mystery disappears.

From the foregoing discussion, it is evident that the linear demand function which is the basis of the model is well established in both the marketing channels and economics literature. In addition, it is appropriate to a wide range of problems, since it can be seen as an approximation of any demand function over a limited range.

However, some of the applications of this type of demand function are inappropriate to the problem of private label supply: in particular, it is important to allow for differences in inherent product preference, as well as own-price response, between the private label and the national brand. Dixit's framework allows for this; however, the McGuire and Staelin, Choi and Coughlan and Wernerfelt demand functions are too restrictive for our purposes. These can be seen as special cases of the demand function used in this dissertation. In addition, the derivation of the demand function in this chapter from a quadratic utility function allows for clearer interpretation of the results. Constraints on the utility function's parameters improve the model's intuitive appeal without loss of generality.

### **(iii) Monopoly model**

In this section, the basic assumptions behind the model of private label contracting are described, beginning with a baseline model in which a monopolistic manufacturer faces a monopolistic retailer. The manufacturer's profit with and without the private label are compared in order to derive the conditions under which he will supply the retailer's brand.

The assumption of the baseline model is that a monopolistic manufacturer faces a monopolistic retailer, both parties having constant marginal costs. The manufacturer has sufficient excess capacity to supply the private label. The manufacturer is assumed to be the Stackelberg leader, reflecting the common retailing practice of accepting manufacturers' prices and adding a markup. This simple model offers interesting insights into the private label supply decision.

The assumptions with respect to consumers, retailers and manufacturers are specified in turn. In each case, the situation when both the national brand and the private label are supplied, versus the national brand only, is considered.

### **Consumers**

#### *(a) National Brand and Private Label*

Consumers' preferences for the national brand and the private label are assumed to be homogeneous and are described by the following quadratic utility function:

$$U = aq_n - \frac{1}{2}bq_n^2 + cq_r - \frac{1}{2}dq_r^2 + eq_nq_r$$

where  $n$  and  $r$  represent the national brand and the retailer's brand. So that the consumer derives positive utility from each good, it is assumed that  $a > 0$  and  $c > 0$ . For nonsatiation, we require  $A + q'B > 0$ ,  $B$  negative definite, where  $A$  is a vector of intercept terms,  $B$  is the Hessian matrix of second-order partial derivatives, and  $q$  is a vector of quantities consumed (Intriligator, 1979). Hence  $b > 0$  and  $d > 0$ .

It is assumed that  $e < 0$ , i.e. that the brands are net substitutes<sup>5</sup>. This quadratic utility function can be viewed as a second-order approximation of an arbitrary utility function by Taylor's theorem (Chiang, 1984).

The demand functions

$$q_n = [1/(db - e^2)][(ad + ec) - dp_n - ep_r] \quad \text{and}$$

$$q_r = [1/(db - e^2)][(bc + ea) - bp_r - ep_n]$$

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<sup>5</sup> We assume that grocery products such as these account for a sufficiently small proportion of total expenditure that income elasticity approaches zero. Hence the products are also gross substitutes (Green, 1971: p. 69).

can be derived from this utility function (Appendix 2.1). So that quantities will always be positive, we require  $ad > ec$ :  $bc > ea$  and  $db > e^2$ .

Setting  $\alpha_n = [1/(db - e^2)](ad + ec)$ ,  $\beta_n = d/(db - e^2)$ ,  $\theta = -e/(db - e^2)$ ,

$\alpha_r = [1/(db - e^2)](bc + ea)$  and  $\beta_r = b/(db - e^2)$ , these demand functions take the familiar form

$$q_n = \alpha_n - \beta_n p_n + \theta p_r \quad \text{and}$$

$$q_r = \alpha_r - \theta p_n - \beta_r p_r.$$

The parameters of these demand functions are interpretable in the light of Dixit's (1979) discussion. The intercept parameters for each brand,  $\alpha_n$ , represent the maximum possible level of demand for a given cross-price response with the competing brand. They can therefore be seen as a measure of consumers' inherent preference for each brand. Distinct from this are each brand's response to changes in its own price,  $\beta_n$ , and its response to changes in its competitor's price,  $\theta$ .

Aggregate demand for the two products is

$$Q = (\alpha_n + \alpha_r) - (\beta_n - \theta)p_n - (\beta_r - \theta)p_r$$

We require  $\partial Q / \partial p_n < 0$  and  $\partial Q / \partial p_r < 0$ : hence  $\beta_n - \theta > 0$  and  $\beta_r - \theta > 0$ . or  $\beta_n > \theta$ .  $\beta_r > \theta$ . Intuitively, this condition is reasonable: each product must be more responsive to changes in its own price than to changes in that of its competitor.

In addition, positive demand for both products implies the constraints  $p_n \geq (1/\theta)(\beta_r p_r - \alpha_r)$  and  $p_r \geq (1/\theta)(\beta_n p_n - \alpha_n)$ . Hence a high price on either product must be accompanied by a low ratio between its competitor's own-price response and cross-response between the two products - i.e. by low demand substitutability - and/or high intercept demand, i.e. product preference.

*(b) National Brand Only*

Setting  $q_r = 0$ , consumers' utility for the national brand alone is

$$U = aq_n - \frac{1}{2}bq_n^2$$

where  $a > 0$ ,  $b > 0$  and  $q_n < 2a/b$ . This results in the following demand function (Appendix

2.1):

$$q_n = \alpha_n' - \beta_n' p_n$$

where  $\alpha_n' = a/b$  and  $\beta_n' = 1/b$ .

With these demand functions for the national brand and the private label, Proposition 2.1 deals with the effect of the introduction of a private label on aggregate demand and on demand for the national brand.

- Proposition 2.1:**
- (a) *With the introduction of a private label, aggregate demand increases in proportion to the private label's demand and substitutability between the private label and the national brand. The increase in aggregate demand is  $(1 - \theta/\beta_r)q_r$*
  - (b) *The introduction of a private label shifts intercept demand (product preference) for the national brand down by  $-\alpha_r\theta/\beta_r$  and increases the national brand's own-price response by  $+\theta^2/\beta_r$*

**Proof:** See Appendix 2.1 (iii)

The change in aggregate demand when a private label is introduced varies inversely with the ratio between cross-price response and the private label's own-price response, or demand substitutability - i.e. where the two products are relatively close substitutes, or  $\theta \sim \beta_r$ , aggregate demand will not change very much because the private label will cannibalize more of its volume from the national brand. With relatively independent products ( $\theta \ll \beta_r$ ), aggregate demand will shift more, and the private label may be seen as expanding the market by bringing in new users or new usage occasions for consumers. *In extremis*, as  $\theta \rightarrow 0$ , the private label and the national brand become independent and aggregate demand is the sum of individual quantities demanded of each of the two products.

The effect on the national brand of introducing a private label is shown in Figure 2.2. Note that because of the price constraints  $p_n \geq (1/\theta)(\beta_r p_r - \alpha_r)$  and  $p_r \geq (1/\theta)(\beta_n p_n - \alpha_n)$  from above, we are always in the region above the intersection of the demand functions. Below these prices,  $q_r < 0$ ; hence  $(1/\theta)(\beta_r p_r - \alpha_r)$  can be seen as the price the monopolist would set on the national brand if he wished to deter the entry of the private label.

(Figure 2.2)

The introduction of the private label reduces product preference (intercept demand) for the national brand in proportion to demand substitutability and the product preference for the private label, as might be expected: because consumers now have two brands to choose from, they are less interested in the original brand. Also, the national brand's own-price response is increased in proportion to demand substitutability and cross-price response: again, this is consistent with

intuition. Consumers are now prepared to switch to the private label, with the extent of the switch depending on how willing they are to substitute one brand for another.

***The Retailer***

It is assumed that the retailer is a Stackelberg follower who takes the manufacturer's wholesale price as given and marks it up taking into account her selling costs. While this assumption is a simplification, it represents the common practice in grocery retailing of adding standard markups to manufacturers' prices<sup>6</sup>. The results of the analysis are summarized here, with details in Appendix 2.2.

*(a) National Brand and Private Label*

The retailer maximizes aggregate profits across both products, as follows:

$$\begin{aligned} \text{Max } \pi^R &= \sum_i (p_i - w_i - s_i)q_i; && i \in \{n,r\} \\ &= (p_n - w_n - s_n)(\alpha_n - \beta_n p_n + \theta p_r) + (p_r - w_r - s_r)(\alpha_r - \beta_r p_r + \theta p_n) \end{aligned}$$

where  $w_i$  represents the manufacturer's wholesale price, and  $s_i$  represents the retailer's constant marginal selling costs. The retailer has positively-sloped "pricing rules", or reaction functions, for the national brand and the private label. These are derived in Appendix 2.2, and are as follows:

$$p_n^* = \frac{1}{2} [(\alpha_n \beta_r + \theta \alpha_r) / (\beta_n \beta_r - \theta^2) + w_n + s_n]$$

and  $p_r^* = \frac{1}{2} [(\alpha_r \beta_n + \theta \alpha_n) / (\beta_n \beta_r - \theta^2) + w_r + s_r]$

The pricing rule for the national brand is illustrated in Figure 2.3(a). The retail price is positively related to the wholesale price, giving a positively sloped pricing rule, analogous to a

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<sup>6</sup> The Stackelberg assumption is justified in more detail in chapter 5.

reaction function in a Cournot/Stackelberg game in quantities. In this sense, the actions of the manufacturer and the retailer are strategic complements (Tirole, 1988).

(Figure 2.3)

This result is consistent with Choi's (1991) finding that only half the change in the manufacturer's wholesale price is reflected in the retail price, and the other half is absorbed by the retailer; this is a common result for linear demand functions with constant marginal costs (Varian, 1992, p. 236-7). By setting  $\alpha_n = \alpha_r$ ,  $\beta_n = \beta_r$ , and  $s_n = 0$ , the model reduces to Choi's model, and we end up with identical results:  $p_n^* = \frac{1}{2}[\alpha_n / (\beta_n - \theta) + w_n]$ ;  $p_r^* = \frac{1}{2}[\alpha_n / (\beta_n - \theta) + w_r]$ .

The retailer also considers the ratio between the brands' product preference and substitutability in setting prices. The intercept of the reaction function is half the ratio of intercept demand to the difference between own-price response and cross-price response, or between product preference and substitutability. With inequality in the demand function parameters, both the denominator and the numerator are moderated by the different intercept and price response terms for the competing brand.

The perceptive reader will notice that  $\partial p_n^* / \partial \theta > 0$  and  $\partial p_r^* / \partial \theta > 0$ . This well-known result (see, for example, Choi, 1991), that prices rise with increases in cross-price response, seems counterintuitive. However, from eq. (6) recall that aggregate demand is  $Q = (\alpha_n + \alpha_r) - (\beta_n - \theta)p_n - (\beta_r - \theta)p_r$ . Hence an increase in the price of the national brand will raise aggregate demand through the cross-price response term,  $\theta$ , but reduce it through the own-price response term,  $\beta_n$ . Since we have constrained the model so that  $\beta_r > \theta$ , aggregate demand will never rise due to an increase in price.

Nonetheless, an increase in  $\theta$  alone will increase aggregate demand.

The intuitive interpretation of this is that, if the national brand increases its price, some proportion of consumers,  $f(\beta_n')$ , will leave the market altogether and others,  $f(\theta)$ , will switch to the private label<sup>7</sup>. As the cross-price response term rises, the proportion of consumers that choose to stay in the market rises. Hence the retailer who maximizes profit across both brands has more flexibility in increasing prices as cross-price response increases;  $\theta$  can be seen as a measure of category loyalty, or consumers' propensity to switch brands rather than leave the market.

With these prices, the retailer's derived demand for the two products is as follows, assuming she does not purchase excess inventory:

$$q_n^d = \frac{1}{2}[\alpha_n - \beta_n(w_n + s_n) + \theta(w_r + s_r)]$$

$$q_r^d = \frac{1}{2}[\alpha_r + \theta(w_n + s_n) - \beta_r(w_r + s_r)]$$

Since only half the change in wholesale price is passed on by the retailer, the responsiveness of derived demand to wholesale price changes is also half that of final demand to retail prices.

*(b) National Brand Only*

With  $q_r = 0$ , the retailer maximizes profits as follows:

$$\begin{aligned} \text{Max } \pi^R &= (p_n - w_n - s_n)q_n \\ &= (p_n - w_n - s_n)(\alpha_n' - \beta_n' p_n) \end{aligned}$$

With one product, the optimal retail price is

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<sup>7</sup> We have assumed that consumers are homogeneous. Hence all consumers have an equal *probability* of switching brands, but the net result is that some will switch and some will not.

$$p_n^* = \frac{1}{2}[(\alpha_n'/\beta_n') + w_n + s_n]$$

At this optimal price, the retailer will buy

$$q_n^d = \frac{1}{2}[\alpha_n' - \beta_n'(w_n + s_n)]$$

### ***The Manufacturer***

Assume now that the retailer approaches the manufacturer with a request to supply her private label. Under what conditions will the manufacturer agree to supply?

The manufacturer is aware of the retailer's pricing rule and derived demand and chooses his wholesale price to maximize his profit taking these functions into account, as illustrated in Figure 2.3(b): the manufacturer moves to the point of tangency between his isoprofit curve and the retailer's pricing rule.

The manufacturer's profitability when he supplies both the national brand and the private label to the retailer is compared here with his profit when supplying only the national brand.

#### *(a) National Brand and Private Label*

If the manufacturer agrees to supply the retailer's private label, his profit maximization problem is analogous to that of the retailer:

$$\pi^M = \sum_i (w_i - m_i) q_i^d; \quad i \in \{n, r\}$$

where  $m_i$  represents the manufacturer's constant marginal costs (= average costs). Where  $m_n \neq m_r$ , the manufacturer can recover the difference in costs by price discriminating between private label and national brand users.

From the retailer's problem above, derived demand is  $q'_n = \frac{1}{2}[\alpha_n - \beta_n(w_n + s_n) + \theta(w_r + s_r)]$  and  $q'_r = \frac{1}{2}[\alpha_r - \beta_r(w_r + s_r) + \theta(w_n + s_n)]$ . Then the manufacturer's profit can be expressed as

$$\pi^M = \frac{1}{2}(w_n - m_n)[\alpha_n - \beta_n(w_n + s_n) + \theta(w_r + s_r)] + \frac{1}{2}(w_r - m_r)[\alpha_r - \beta_r(w_r + s_r) + \theta(w_n + s_n)]$$

From this, the optimal wholesale prices are (Appendix 2.2):

$$w_n^* = \frac{1}{2}[(\alpha_n \beta_r + \theta \alpha_r) / (\beta_n \beta_r - \theta^2) - s_n + m_n] \quad \text{and}$$

$$w_r^* = \frac{1}{2}[(\alpha_r \beta_n + \theta \alpha_n) / (\beta_n \beta_r - \theta^2) - s_r + m_r]$$

Like the retailer, the manufacturer absorbs half of any increase in costs. The other half is passed on to the retailer. The manufacturer also takes account of intercept demand and substitutability in the same way as the retailer. However, the manufacturer also takes account of the retailer's selling costs: if these costs rise, the manufacturer takes account of this reduction in the retailer's ability to pay by reducing his wholesale price by half the increase in costs. The intercept terms of the manufacturer's equilibrium wholesale prices are identical to those of the equilibrium retail prices, and express the ratio of product preference and demand substitutability.

The manufacturer supplies the following quantities to the retailer at these optimal prices:

$$q_n^* = \frac{1}{4}[\alpha_n - \beta_n(s_n + m_n) + \theta(s_r + m_r)] \quad \text{and}$$

$$q_r^* = \frac{1}{4}[\alpha_r + \theta(s_n + m_n) - \beta_r(s_r + m_r)].$$

To simplify notation, let  $c_i = (s_i + m_i) \forall i \in \{n, r\}$ . At these prices and quantities, the manufacturer's profit is as follows:

$$\begin{aligned} \pi^M = \frac{1}{4} \{ & \frac{1}{2} [(\alpha_n^2 \beta_r + \alpha_r^2 \beta_n + 2\theta \alpha_n \alpha_r) / (\beta_n \beta_r - \theta^2)] \\ & - [(\alpha_n c_n - \frac{1}{2} \beta_n c_n^2) - (\alpha_r c_r - \frac{1}{2} \beta_r c_r^2) - \theta c_n c_r] \} \end{aligned}$$

The manufacturer's profitability is increasing in product preference and in demand substitutability, assuming that the manufacturer makes positive margins on both brands. Hence the most profitable strategy for the manufacturer is to increase consumers' preference for his national brand and its substitutability with the private label, since increases in these parameters allow him to increase prices and sales volumes. Profits are also decreasing in the manufacturing and selling costs of the two brands, and in their cross-product. The rate at which profits respond to cost increases is related to the intercept demand and price response terms - i.e. to product preference and the amount of volume change resulting from price increases or decreases.

*(b) National Brand Only*

Where  $q_p = 0$ , the manufacturer maximizes profit on the national brand only as follows, based on the retailer's derived demand function:

$$\text{Max } \pi_n^M = (w_n - m_n)q_n^d$$

The retailer's derived demand is  $q_n^d = \frac{1}{2}[\alpha_n' - \beta_n'(w_n + s_n)]$ . Hence

$$\pi_n^M = (w_n - m_n)\left\{\frac{1}{2}[\alpha_n' - \beta_n'(w_n + s_n)]\right\}$$

The optimal wholesale price for the national brand is

$$w_n^* = \frac{1}{2}\left[\frac{\alpha_n'}{\beta_n'} - s_n + m_n\right]$$

At this optimal price, the manufacturer supplies

$$q_n^* = \frac{1}{4}[\alpha_n' - \beta_n'(s_n + m_n)]$$

Again adopting the simplified notation  $c_n = s_n + m_n$ , the manufacturer makes a profit of

$$\pi_n^M = \frac{1}{4}\left[\frac{1}{2}\left(\frac{\alpha_n'^2}{\beta_n'}\right) - (\alpha_n'c_n - \frac{1}{2}\beta_n'c_n^2)\right]$$

As before, the manufacturer stands to benefit from increasing product preference relative to

own-price response on the national brand.

*(c) Comparison*

The profitability of private label supply is derived by comparing the manufacturer's profit under the two scenarios, i.e. by determining  $\Delta\pi^M = \pi^M - \pi^M_0$ :

$$\Delta\pi^M = \frac{1}{4} \left\{ \frac{1}{2} [(\alpha_n^2 \beta_r + \alpha_r^2 \beta_n + 2\theta \alpha_n \alpha_r) / (\beta_n \beta_r - \theta^2)] - [(\alpha_n c_n - \frac{1}{2} \beta_n c_n^2) - (\alpha_r c_r - \frac{1}{2} \beta_r c_r^2) - \theta c_n c_r] \right\} \\ - \frac{1}{4} \left[ \frac{1}{2} (\alpha_n^2 / \beta_n) - (\alpha_n c_n - \frac{1}{2} \beta_n c_n^2) \right]$$

After some algebraic manipulation (see Appendix 2.3), this reduces to

$$\Delta\pi^M = (1/8) [\alpha_r^2 / \beta_r + 2(\alpha_r / \beta_r)(\theta c_n - \beta_r c_r) + (1/\beta_r)(\theta c_n - \beta_r c_r)^2]$$

This is the profit difference for the manufacturer between supplying the private label and supplying the national brand. It is important to recall that this takes into account not only product preference and substitutability between the private label and the national brand, but also the shift in the national brand's demand function as a result of the introduction of the private label (see Proposition 2.1).

Where  $\Delta\pi^M$  is positive, the manufacturer will prefer to supply the private label along with the national brand; where it is negative, he will prefer to supply the national brand alone. However, as shown in Proposition 2.2,  $\Delta\pi^M$  is *always* positive:

**Proposition 2.2:** *A monopolistic, profit-maximizing manufacturer who is a Stackelberg leader will always supply a retailer's private label brand. The profitability of private label supply depends on relative costs of the private label and the national*

brand, and on demand substitutability.

***Proof:*** Let  $\mu = \theta c_n - \beta_r c_r$ : then

$$\begin{aligned}\Delta \pi^{M'} &= (1/8)[(\alpha_r^2/\beta_r) + 2(\alpha_r/\beta_r)\mu + (1/\beta_r)\mu^2] \\ &= (1/8\beta_r)(\alpha_r^2 + 2\alpha_r\mu + \mu^2) \\ &= (1/8\beta_r)(\alpha_r + \mu)^2 \\ &> 0\end{aligned}$$

Where  $\theta c_n - \beta_r c_r > 0$ , the profit difference increases with the difference in costs: where  $\theta c_n - \beta_r c_r < 0$ , it decreases with increasing cost difference. Hence the profitability of private label supply depends on the relative costs of the private label and the national brand, and on the difference between cross-response and own-price response for the private label. ***Q.E.D.***

Why would a monopolist always supply a retailer's private label brand? In Proposition 2.1 and Appendix 2.1, the change in aggregate demand with the introduction of a second brand was analyzed. Aggregate demand became

$$\begin{aligned}Q &= q_n + q_r \\ &= (\alpha_n + \alpha_r \theta / \beta_r) - (\beta_n - \theta^2 / \beta_r) p_n + (1 - \theta / \beta_r) q_r \\ &= \alpha_n' - \beta_n' p_n + (1 - \theta / \beta_r) q_r\end{aligned}$$

Since the expression  $(1 - \theta / \beta_r)$  is always positive (because  $\beta_r > \theta$ ), there is always a net increase in aggregate demand: the introduction of a private label shifts aggregate demand in proportion to the private label's volume and demand substitutability<sup>8</sup>. However, as  $\theta - \beta_r$ , the private

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<sup>8</sup> Since  $\theta = \partial q_r / \partial p_n$ , and  $-\beta_r = \partial q_n / \partial p_n$ , the ratio  $-\theta / \beta_r$  is demand substitutability.  $\partial q_n / \partial q_r < 0$ , or the degree to which the private label cannibalizes the national brand.

label sources relatively more of its volume from the national brand and the increase in aggregate demand approaches zero.

The introduction of the private label also reduces product preference for the national brand by  $-\alpha_r\theta/\beta_r$ , and increases its own-price response by  $+\theta^2/\beta_r$  (see Proposition 2.1 and Figure 2.2). As  $\theta \rightarrow \beta_r$ , the national brand loses more intercept demand to the private label and becomes more sensitive to changes in its *own* price. However, a private label which has little inherent attraction to consumers ( $\alpha_r \rightarrow 0$ ) will not affect product preference for the national brand, but may still increase its own-price response.

Moreover, as  $\theta$  rises to approach  $\beta_n$  and  $\beta_r$ , the prices of both brands rise, since this reduces the denominator  $\beta_n\beta_r - \theta^2$ . In other words, as consumers' readiness to switch between the private label and the national brand rather than leave the market increases, the manufacturer can take advantage of their increased loyalty to the category and increase prices.

These demand and price changes are behind the strong result of Proposition 2.2. Taking this a little further, we can express the profitability of private label supply as

$$\Delta\pi^{vl} = (1/8\beta_r)[\alpha_r + (\theta c_n - \beta_r c_r)]^2$$

For simplicity of exposition, let  $c_n = c_r$ ; then

$$\begin{aligned}\Delta\pi^{vl} &= (1/8\beta_r)[\alpha_r + c_n(\theta - \beta_r)]^2 \\ &= (1/8\beta_r)[\alpha_r + \beta_r c_n(\theta/\beta_r - 1)]^2\end{aligned}$$

From this expression, we can draw three interesting observations:

- Private label profitability *increases* with increasing product preference for the private label (as intercept demand,  $\alpha_r$ , increases);
- Private label profitability *falls* with increasing own-price response for the private

label (as  $\beta_r$  increases):

- Private label profitability *increases* as cross-price response between the private label and the national brand increases.

While private label contracting is always profitable for the monopolist, it nevertheless involves some trade-offs. The manufacturer wants to supply the strongest possible private label brand, in the sense of high product preference and low own-price response: a strong private label can expand the category to a greater degree and can command higher prices. So he is willing to trade off the loss in product preference for the national brand for greater market expansion and the ability to increase the national brand's price.

When we interpret the ratio  $-\theta/\beta_r$  as demand substitutability (see footnote 8), it can readily be seen that private label profitability *falls* with increases in substitutability. Hence the monopolist prefers a private label that does not cannibalize his national brand excessively - since the more independent the products are, the greater the expansion of aggregate demand. When we relax the assumption that  $c_n = c_r$ , the expression  $(\theta c_n - \beta_r c_r)$  becomes a comparison of the relative costs of the two brands, moderated by price response parameters. Even where the private label is more costly than the national brand, it is profitable for the manufacturer to supply it, and the profitability of private label supply increases with increasing cost difference in *either* direction.

To explain this, recall from Appendix 2.3 that the national brand's equilibrium price in terms of the private label's price was

$$w_n^* = (1/2\beta_n)[\alpha_n - \beta_n(s_n - m_n) + \theta(s_r - m_r)] + (\theta/\beta_n)w_r$$

Letting  $s_n = 0$  and hence  $m_n = c_n$ , this becomes

$$w_n^* = (1/2\beta_n)(\alpha_n + \beta_n c_n - \theta c_r) + (\theta/\beta_n)w_r$$

Similarly, the private label's price in terms of the price of the national brand can be written as

$$w_r^* = (1/2\beta_r)(\alpha_r + \beta_r c_r - \theta c_n) + (\theta/\beta_r)w_n$$

An increase in the wholesale price of the national brand causes the retailer, and ultimately consumers, to switch to the private label. As the costs of the private label decrease relative to those of the national brand, it becomes more profitable for the manufacturer to allow consumers to switch. So by maximizing profits across two brands, the manufacturer can take advantage of the switching process and raise national brand prices. As the ratio  $\theta/\beta_n$  increases, the price of the national brand and that of the private label become more responsive to each other, since this ratio represents the tendency of consumers to switch between brands rather than leave the category. However, as  $|c_n - c_r|$  rises, it also becomes more profitable to allow consumers to switch. Hence an increasing cost difference in either direction represents increasing profit opportunity for the manufacturer.

In this sense, the manufacturer can segment the market. Since the products are imperfect substitutes, not all consumers will switch to the cheaper of the two products; the manufacturer sets his prices so as to allow an optimal proportion of consumers to switch to the more profitable product.

To summarize, the monopolistic manufacturer supplies the private label in order (i) to profit from expansion of the total category, and (ii) to gain the flexibility to raise prices. While these conclusions have been derived under strong assumptions of a monopolistic manufacturer and a monopolistic retailer, they extend readily to other scenarios. It is shown in Appendix 2.4 that the model's essential predictions are unchanged if the single-retailer assumption is extended to multiple retailers. The next section looks at the impact of a second manufacturer in the category on an

individual manufacturer's private label supply decision.

**(iv) Duopoly**

In this section, the foregoing model is extended to a game in which two firms decide whether to supply a retailer's private label. In a duopoly, the manufacturer needs to anticipate and take into account the action of his competitor. In particular, the manufacturer has to allow for his competitor's national brand price in considering whether to raise his national brand price.

Assume that the duopolists offer differentiated national brands, but are identical with respect to private label supply; hence the private label supply cost of manufacturer 1 equals that of manufacturer 2. With a private label available to consumers, the demand functions are as follows:

$$\begin{aligned}
 q_{n1} &= \alpha_1 - \beta_1 p_{n1} + \sigma p_{n2} + \theta_1 p_r \\
 q_{n2} &= \alpha_2 - \sigma p_{n1} - \beta_2 p_{n2} + \theta_2 p_r \\
 q_r &= \alpha_r + \theta_1 p_1 + \theta_2 p_2 - \beta_r p_r
 \end{aligned}$$

where the subscripts  $ni$  indicate the national brand of manufacturer  $i$ ,  $r$  represents the private label.  $\sigma$  is substitutability between the two national brands, and the parameters for intercept demand, own-price response and cross-price response with the private label carry subscripts corresponding to each manufacturer and the retailer's brand.

We describe the game below, following Rasmusen's (1989) format and definitions. Figure 2.4 shows the game in extensive form.

(Figure 2.4)

- Players:** Manufacturer 1 and Manufacturer 2.
- Information:** Both parties know the demand function.  
Both parties know the retailer's pricing rule (reaction function).  
The manufacturers choose their actions simultaneously. Hence information is imperfect, certain, symmetric and complete.
- Actions & Events:** The manufacturers simultaneously choose to supply or not to supply the private label, by comparing payoffs under each scenario. Their strategies are to supply ( $\{S\}$ ), or not to supply ( $\{DNS\}$ ).  
The manufacturers set wholesale prices taking the retailer's pricing rule into account.
- Payoffs:** Payoffs are total profits to each manufacturer across both products if the private label is supplied, and for the national brand only if it is not.
- Outcomes:** Outcomes include wholesale prices and quantities for the national brand and the private label.

As shown in Appendix 2.5, a similar set of constraints applies to the parameters of this model as to the monopoly model:  $\alpha_1 > 0$ ,  $\alpha_2 > 0$ ,  $\alpha_r > 0$ ,  $\beta_1 > 0$ ,  $\beta_2 > 0$ ,  $\beta_r > 0$ ,  $\theta > 0$ ,  $\sigma > 0$ . Also,  $\sum_i \theta_i / \beta_r < 1$ ; as in the monopoly model, the private label is more sensitive to changes in its own price than in those of the national brands. For positive demand, we restrict the range of feasible prices to  $p_{n1} \geq (1/\theta_1)(\beta_r p_r - \theta_2 p_2 - \alpha_r)$ ,  $p_{n2} \geq (1/\theta_2)(\beta_r p_r - \theta_1 p_1 - \alpha_r)$  and  $p_r \geq (1/\theta_1)(\beta_1 p_{n1} - \sigma p_{n2} - \alpha_1)$ .

It is assumed that only one private label exists, whether supplied by one manufacturer or

both. Where both supply, the above private label demand function represents aggregate private label demand across both manufacturers.

Where no private label exists, demand is as follows:

$$q_{n1}' = \alpha_1' - \beta_1' p_{n1} + \sigma_1' p_{n2}$$

$$q_{n2}' = \alpha_2' + \sigma_2' p_{n1} - \beta_2' p_{n2}$$

Proposition 2.3 shows that the monopoly model's findings with respect to category expansion and cannibalization extend to the duopoly model.

- Proposition 2.3:**
- (a) *The introduction of a private label in a duopoly increases aggregate demand in proportion to the private label's demand and substitutability between the private label and the two manufacturers' national brands. The increase in aggregate demand is  $(1 - \sum_i \theta_i / \beta_r) q_r$*
  - (b) *The introduction of a private label shifts total intercept demand (product preference) for the two national brands down by  $-\alpha_r \sum_i \theta_i / \beta_r$  and increases national brand  $i$ 's own-price response by  $+\theta_i / (\sum_i \theta_i) \beta_r$*

**Proof:** See Appendix 2.5

As before, aggregate demand increases as a result of the introduction of the private label. However, the benefit of this increase in aggregate demand may differ between manufacturers. As shown in Appendix 2.5, manufacturer 1 experiences a change in demand for his national brand of  $(\sum, \theta / \beta_r) q_r - \Delta q_{n2}$ , where the notation  $\Delta$  represents change. In other words, the private label's substitution with the *competing* duopolist's brand reduces cannibalization of manufacturer 1's brand.

Focusing on the manufacturer's problem, we assume for this model and for the model of chapter 3 that the retailer's selling costs for the national brand,  $s_{n1}$  and for the private label,  $s_r$ , are zero. This assumption is justified in the grocery industry by the fact that, aside from manufacturers' unit prices, retailers' costs consist primarily of real estate rental, store personnel and store advertising - all of which are fixed and not associated with a specific product. The costs of product-specific retail activity, such as display and co-operative advertising, are also fixed (in the sense that they cannot be allocated on a per unit basis) and, in any event, are largely borne by the manufacturer.

Equilibrium wholesale prices and quantities for the duopoly model are derived in Appendix 2.6. If manufacturer 1 supplies the private label taking manufacturer 2's national brand price into account, his price for the national brand is

$$w_{n1}^* = \frac{1}{2} [(\alpha_1 \beta_r + \alpha_r \theta_1) / (\beta_1 \beta_r - \theta_1^2) + (\sigma \beta_r + \theta_1 \theta_2) w_{n2} / (\beta_1 \beta_r - \theta_1^2) + m_{n1}]$$

and for the private label,

$$w_r^* = \frac{1}{2} [(\alpha_r \beta_1 + \alpha_1 \theta_1) / (\beta_1 \beta_r - \theta_1^2) + (\sigma \theta_1 + \beta_1 \theta_2) w_{n2} / (\beta_1 \beta_r - \theta_1^2) + m_r]$$

As before, the manufacturer passes on half of any cost increase to the retailer. He takes into account the intercept demand of both his national brand and the private label, and the ratio between cross-price response and own-price response, in setting wholesale prices. However, in this model, he also takes into account the price of his competitor's national brand and substitutability between

the two national brands.

At these prices, he supplies the quantities

$$q_{n1} = \frac{1}{4}(\alpha_1 - \beta_1 m_{n1} + \theta_1 m_r + \sigma w_{n2})$$

$$q_r = \frac{1}{4}(\alpha_r + \theta_1 m_r + \sigma w_{n2} - \beta_r m_r)$$

With both manufacturers considering whether to supply the retailer's private label, the options open to them can be encapsulated in the normal form game shown in Figure 2.5.

(Figure 2.5)

Figure 2.6 compares the prices set by manufacturer 1 in the monopoly model and under each of the four strategy sets of the duopoly game. The results of the duopoly model are a straightforward extension of those of the monopoly model, with the additional considerations of competitive pricing and substitution between the two national brands.

(Figure 2.6)

Where both manufacturers supply with equal marginal costs, they become Bertrand competitors and bid each other's supply price to their marginal cost for the private label,  $m_r$ . The retailer splits the private label contract between the two manufacturers and each makes total profits of  $\pi_{m1} = q_{n1}(w_{n1} - m_{n1})$ .

If manufacturer 1 agrees to supply while manufacturer 2 does not, he will make positive profits on the private label while suffering cannibalization of his national brand. His total profit will

be  $\pi^M_i = q_{n_i}(w_{n_i} - m_{n_i}) + q_r(w_r - m_r)$ . However, if manufacturer 1 decides not to supply while manufacturer 2 supplies, he makes  $\pi^M_i = q_{n_i}(w_{n_i} - m_{n_i})$ . Since manufacturer 2 is supplying the private label at  $w_r > m_r$ , however, manufacturer 1 suffers less cannibalization of his national brand in this scenario than if both supply. If neither manufacturer supplies, the payoff for each is  $\pi^M_i = q_{n_i}(w_{n_i} - m_{n_i})$ .

We know that the payoff in Figure 2.5 to the non-supplying manufacturer from the strategy set {S,DNS} or {DNS,S} is higher than that under {S,S}. Hence, if manufacturer 2 supplies, manufacturer 1 will prefer not to supply for fear of increasing cannibalization of his national brand by reducing private label prices. The comparison of payoffs under {S,DNS} and {DNS,DNS} decides the equilibrium. Where each manufacturer can gain from supplying while his competitor does not, the Nash equilibria are {S,DNS} and {DNS,S}: one manufacturer will supply while the other refrains from supplying. Where the opposite holds, neither manufacturer will supply.

The analysis therefore rests on determining the conditions under which  $\pi^M_i(\{S,DNS\}) > \pi^M_i(\{DNS,DNS\})$  - i.e. under which one manufacturer gains by supplying, given that his competitor does not supply. Proposition 2.4 defines these conditions.

**Proposition 2.4:** *An asymmetric equilibrium in which only one manufacturer supplies the private label becomes more likely as*

- (i) *The private label's cross-price response with national brand  $i$ ,  $\theta_r$ , rises;*
- (ii) *The private label's cross-price response relative to the competing manufacturer's national brand,  $\theta_r$ , rises;*
- (iii) *The private label's intercept demand,  $\alpha_r$ , rises;*

- (iv) The private label's own price response,  $\beta_r$  falls.
- (v) The private label's costs,  $m_r$  fall relative to those of national brand  $i$ .

**Proof:** See Appendix 2.7

Each of the parameters of the model affects private label profitability in interaction with the difference in manufacturer 2's national brand price between the two scenarios; if manufacturer 2 reduces his price, the effect can overpower these parameter effects and reverse manufacturer 1's decision. From Appendix 2.7, the difference in payoffs to manufacturer 1 between supplying and not supplying given that manufacturer 2 does not supply is

$$\begin{aligned} \Delta \pi^{11} &= (1/8)\theta_1 m_r (S + T w_{n_2} - m_{n_1}) + (1/8)(U + V w_{n_2} - m_r)(\alpha_r - \beta_r m_r + \theta_1 m_{n_1} + \sigma w_{n_2}) \\ &\quad - (1/8)(\theta_1 / \beta_r)(\alpha_r + \theta_1 m_{n_1} + \theta_2 w_{n_2}') (S + T w_{n_2} - m_{n_1}) \\ &\quad + (1/8)(S + T w_{n_2} - m_{n_1}) \sigma (w_{n_2} - w_{n_2}') \end{aligned}$$

where  $S = (\alpha_1 \beta_r + \alpha_r \theta_1) / (\beta_1 \beta_r - \theta_1^2)$ ;  $T = (\sigma \beta_r + \theta_1 \theta_2) / (\beta_1 \beta_r - \theta_1^2)$ ;  $U = (\alpha_r \beta_1 + \alpha_1 \theta_1) / (\beta_1 \beta_r - \theta_1^2)$ ;  $V = (\sigma \theta_1 + \beta_1 \theta_2) / (\beta_1 \beta_r - \theta_1^2)$ ;  $w_{n_2}$  is manufacturer 2's national brand price when manufacturer 1 supplies the private label; and  $w_{n_2}'$  is manufacturer 2's national brand price when manufacturer 1 does not supply.

From the above expression, it is evident that the difference in competitive prices,  $(w_{n_2} - w_{n_2}')$ , can change the sign of the profit difference between supplying and not supplying.

Duopolists considering supplying a retailer's private label consider similar factors to a monopolist: substitutability, product preference for the private label and costs. Again, duopolists are

interested in supplying strong private labels that increase their overall sales volume without cannibalizing their national brand excessively. However, in this case they also take into account the possibility that the competing duopolist will change his price as a result of the introduction of the private label. Should the competitor reduce price, the benefits of supplying a private label could be wiped out; if, on the other hand, the competitor raises price, the manufacturer supplying the private label stands to gain.

When will the competing duopolist change his price in response to the private label introduction? Manufacturer 2's equilibrium price in the absence of a private label is

$$w_{n_2}^* = \frac{1}{2}[(\alpha_2\beta_r + \alpha_r\theta_2)/(\beta_2\beta_r - \theta_2^2) + (\sigma\beta_r + \theta_1\theta_2)w_{n_1} + m_{n_2}]$$

and when manufacturer 1 introduces a private label,

$$w_{n_2}^* = \frac{1}{2}[(\alpha_2/\beta_2) + (\sigma/\beta_2)w_{n_1} + (\theta_2/\beta_2)w_r]$$

The difference in manufacturer 2's price is

$$\begin{aligned} \Delta w_{n_2} &= w_{n_2}^{*'} - w_{n_2}^* \\ &= \frac{1}{2}(\theta_2/\beta_2)[(\alpha_r\beta_2 + \alpha_2\theta_2)/(\beta_2\beta_r - \theta_2^2) + (\beta_r\theta_1 + \sigma\theta_2)w_{n_1}/(\beta_2\beta_r - \theta_2^2) - \theta_2w_r] \end{aligned}$$

Hence manufacturer 2 will reduce his price where

$$(\beta_r\theta_1 + \sigma\theta_2)w_{n_1}/(\beta_2\beta_r - \theta_2^2) > \theta_2w_r - (\alpha_r\beta_2 + \alpha_2\theta_2)/(\beta_2\beta_r - \theta_2^2)$$

We can see from this expression that the competitor is more likely to cut price in response to a *low-priced* private label in relation to manufacturer 1's national brand, making the proposition

less attractive for manufacturer 1. Manufacturer 1 is therefore more likely to be interested in a higher priced private label which does not excessively threaten his competitor - such as a premium private label. In other words, if the manufacturers expect to set off a price war by supplying a low-priced private label, neither will supply.

### **(v) Summary and Conclusions**

The monopoly and duopoly models in this chapter provide a framework for analyzing the questions faced by manufacturers in deciding whether to supply a retailer's private label brand.

For a monopolist, the model's conclusions are clear: it is always in his interest to supply a retailer's private label. There are two reasons for this: first, not all of the private label's volume cannibalizes the national brand; there is some category expansion, from which the monopolist benefits. The exception to this is where product preference (intercept demand) for the private label approaches zero, and virtually all the private label's volume comes from the national brand. However, even in this instance, total category demand does not decline.

The second reason for a monopolist's interest in supplying private label is that it allows him to segment the market. It becomes profitable for the manufacturer to allow a proportion of consumers to switch to the private label, which he can encourage by raising the price of the national brand.

To maximize the profit he derives from the private label, the monopolist needs to strengthen the private label and minimize its costs and its substitutability with the national brand. Hence manufacturers look for private labels with high product preference, low own-price response and low

costs, to maximize their benefits from both market expansion and switching between brands. However, they will also want to minimize cannibalization of their national brands. In markets where quality is unidimensional - i.e. where there is just one attribute consumers look for - this would seem to be an impossible task. Strengthening the private label will necessarily move it closer in quality to the national brand and increase cannibalization.

However, where quality is multidimensional, there can be many opportunities to develop a high quality private label with different attributes from the national brand. The example of Loblaw's President's Choice Bottled Sauces comes to mind: here, the product is of high quality but differentiated from the supplier's brand, H.P. Sauce. It is in a manufacturer's interest to develop private label brands of this nature which can increase demand for the category as a whole but take away volume from the national brand only to a limited extent.

Retailers can take some comfort from this result. Even if a manufacturer dominates the category, it will still be in his interest to supply a high quality private label. Moreover, he will want the retailer's private label to have high demand from consumers and be relatively impervious to price increases. Nonetheless, he will be concerned that the private label be as different as possible from his own national brand - an aspect which may not accord with the retailer's objectives.

In a duopoly, the same considerations are in evidence. However, the introduction of a national brand competitor to the model means that the manufacturer now has to anticipate the reaction of the other duopolist to his strategy: the competitor may also bid to supply the private label, or may change his prices in response to the launch of the retailer's brand.

A duopolist will therefore take into consideration the degree to which the private label cannibalizes the competing duopolist's sales as opposed to his own, in addition to consumer

preference for the private label and relative costs. Segmenting the market will not be as easy for a duopolist as a monopolist, since a change in the competitor's equilibrium price may draw consumers away from the national brand without the compensating increase in private label demand.

Nevertheless, it is more likely that one duopolist will want to supply the private label where it has a high degree of consumer preference and low own-price response. So once again, the idea of supplying a "premium" private label which competes only indirectly with the national brand is likely to appeal to both manufacturers.

The baseline models presented in this chapter provide us with some important insights into the private label supply decision. However, simplifying assumptions have been used to derive clear results. In particular, the assumption of constant marginal costs suggests that manufacturers have no economies of scale or scope. In the next chapter, a more general cost function will be incorporated in order to determine the effect of cost changes on the private label decision.

In addition, there are few markets in the real world which can be described as pure monopolies or pure duopolies. In the next chapter, the model will be extended to consider the effect of other manufacturers on its predictions. In particular, a market with a "competitive fringe" will be analyzed - a structure which is representative of many grocery categories.

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**APPENDICES**

## APPENDIX 2.1

### PROPERTIES OF UTILITY/DEMAND SYSTEM

#### 1. Derivation of Demand Functions

##### *(a) Private Label and National Brand*

Consumers' utility is

$$U = aq_n - \frac{1}{2}q_n^2 + cq_r - \frac{1}{2}dq_r^2 + eq_nq_r$$

The consumer's maximization problem results in the Lagrangian

$$\mathcal{L} = aq_n - \frac{1}{2}bq_n^2 - cq_r - \frac{1}{2}dq_r^2 - eq_nq_r + m_n + \lambda(y_n - m_n - p_nq_n - p_rq_r)$$

where  $m$  is a numeraire good, and  $a > 0$ ,  $b > 0$ ,  $c > 0$  and  $d > 0$ . For substitutes,  $e < 0$ . First order conditions are

$$\mathcal{L}'_m: \quad 1 - \lambda$$

$$\mathcal{L}'_{q_n}: \quad a - bq_n + eq_r - p_n$$

$$\mathcal{L}'_{q_r}: \quad c - dq_r + eq_n - p_r$$

with second order conditions  $\mathcal{L}''_{q_n} < 0$  and  $\mathcal{L}''_{q_r} < 0$  as required for concavity, subject to constraint **(i)** below.

Setting the first and the third of the above equations equal to zero and solving, we find that

$$\lambda = 1$$

$$q_r = c/d + (e/d)q_n - (1/d)p_r$$

Substituting  $q_r$  in  $\mathcal{L}'_{q_n}$ :

$$a - bq_n + e[(c/d) + (e/d)q_n - (1/d)p_r] - p_n = 0$$

This solves to the demand function for the national brand

$$q_n = [1/(db - e^2)][(ad + ec) - dp_n - ep_r]$$

Similarly, the demand function for the private label is:

$$q_r = [1/(db - e^2)][(bc - ea) - bp_n - ep_r]$$

Let  $\alpha_n = [1/(db - e^2)](ad + ec)$ ,  $\beta_n = d/(db - e^2)$ ,  $\theta = -e/(db - e^2)$ ,  $\alpha_r = [1/(db - e^2)](bc + ea)$  and  $\beta_r = b/(db - e^2)$ ; then

$$q_n = \alpha_n - \beta_n p_n + \theta p_r \text{ and}$$

$$q_r = \alpha_r + \theta p_n - \beta_r p_r$$

##### *(b) National Brand Only*

Consumers' utility is described by

$$U = aq_n - \frac{1}{2}bq_n^2$$

Maximizing this, we have the Lagrangian

$$\mathcal{L} = aq_n - \frac{1}{2}bq_n^2 + m + \lambda(y - m - p_nq_n)$$

where  $m$  represents the quantity of "numeraire" good, such as money. Differentiating, we obtain

$$\mathcal{L}'_m = 1 - \lambda = 0 \Rightarrow \lambda = 1$$

$$\mathcal{L}'_{q_n} = a - bq_n - p_n = 0$$

$$\Rightarrow q_n = a/b - (1/b)p_n$$

By rescaling this demand function with  $\alpha_n' = a/b$  and  $\beta_n' = 1/b$ , the demand function becomes

$$q_n = \alpha_n' - \beta_n' p_n$$

*(iii) Demand for the National Brand: Proof of Proposition 1*

It is important to recognize that demand for the national brand in the absence of a private label,  $q_n$ , will not equal its demand when a private label is launched,  $q_r$ , except under very restrictive conditions: i.e. the demand function for product  $i$  will shift when a private label is introduced or withdrawn. At one extreme, the private label will source all its volume from the national brand, and aggregate demand for the two products will be the former level of demand for the national brand. At the other, demand for the private label will be completely incremental and will leave demand for the national brand unchanged, and aggregate demand will be the sum of the former demand for the national brand and that for the private label.

To identify the new demand function for the national brand after the private label is introduced, we express  $q_n$  in terms of  $p_n$  and  $q_r$  as follows:

$$q_n = \alpha_n - \beta_n p_n + \theta p_r$$

$$q_r = \alpha_r + \theta p_n - \beta_r p_r$$

$$\rightarrow \beta_r p_r = \alpha_r + \theta p_n - q_r$$

$$\rightarrow p_r = (1/\beta_r)(\alpha_r + \theta p_n - q_r)$$

Hence

$$q_n = \alpha_n - \beta_n p_n + \theta[(1/\beta_r)(\alpha_r + \theta p_n - q_r)]$$

Aggregate demand for the two products can now be expressed as follows:

$$Q = q_n + q_r$$

$$= \alpha_n - \beta_n p_n + (\theta/\beta_r)(\alpha_r + \theta p_n - q_r) + \alpha_r - \beta_r(1/\beta_r)(\alpha_r + \theta p_n - q_r) + \theta p_n$$

$$= (\alpha_n + \alpha_r \theta/\beta_r) - (\beta_n - \theta^2/\beta_r)p_n - (1 - \theta/\beta_r)q_r$$

Where  $q_r = 0$ , i.e. the private label does not exist.

$$q_n = Q = (\alpha_n + \alpha_r \theta/\beta_r) - (\beta_n - \theta^2/\beta_r)p_n$$

That is

$$\alpha_n' = \alpha_n + \alpha_r \theta/\beta_r \text{ and}$$

$$\beta_n' = \beta_n - \theta^2/\beta_r$$

Alternatively,

$$\alpha_n = \alpha_n' - \alpha_r \theta/\beta_r \text{ and}$$

$$\beta_n = \beta_n' + \theta^2/\beta_r$$

Thus the introduction of a private label shifts intercept demand for the national brand downwards, with the extent of the shift depending on intercept demand for the private label and substitutability (the ratio of the private label's own-price response to its cross-price response). In addition, the national brand's price response is increased, with the amount of increase depending on cross-price response between the two products.

In order for aggregate demand not to *decrease* when the private label is introduced, we need to impose the constraint that  $\theta/\beta_r < 1$ , or that  $\theta < \beta_r$ . In other words, demand for the private label is more responsive to changes in its own price than to changes in the price of its competitor.

**2. Constraints**

Several constraints are imposed on the model's parameters for analytical tractability and intuitive reasonableness:

- (i)**  $a > 0, c > 0$ : assumed so that the consumer derives positive utility from each good.  
 $b > 0, d > 0$ : required for concavity of U.  
 $a - bq + eq > 0, c - dq + eq > 0$  required for nonsatiation.
- (ii)**  $ad > ec$ : required so that the intercept of  $q_n$ ,  $(ad+ec)/(db-e^2)$  will always be positive.  
 Similarly,  $bc > ea$  so that  $q_r$  has a positive intercept.
- (iii)**  $bd > e^2$ :  
 From above,  $ad > ec \rightarrow a > ec/d$  and  $bc > ea \rightarrow a < bc/e$   
 $\therefore bc/e > ec/d$   
 $\rightarrow b/e > e/d$   
 $\rightarrow bd > e^2$ .
- (iv)**  $\beta_n > \theta, \beta_r > \theta$ : This constraint is necessary in order that aggregate demand for the two goods does not increase in the price of either good.

Aggregating the demand functions, we have

$$Q = (\alpha_n + \alpha_r) - (\beta_n - \theta)p_n - (\beta_r - \theta)p_r$$

We require  $\partial Q / \partial p_n < 0$  and  $\partial Q / \partial p_r < 0$ ; hence  $\beta_n - \theta > 0$  and  $\beta_r - \theta > 0$ , or  $\beta_n > \theta$ ,  $\beta_r > \theta$ . The latter constraint is also required to prevent aggregate demand from decreasing on the introduction of a second brand (see previous section).

For positive demand for both products, the following constraints are also imposed on prices:

$$p_n \geq (1/\theta)(\beta_n p_r - \alpha_r)$$

$$p_r \geq (1/\theta)(\beta_r p_n - \alpha_n)$$

For these constraints to be satisfied, a high price on either product must be accompanied by low price response and/or high intercept demand.

### 3. COMMENTS ON MCGUIRE AND STAEIN'S DEMAND FUNCTION

Recall that the demand function employed by McGuire and Staelin (1983) is

$$q_i = 1 - p_i + \theta p_j$$

which is a rescaling of the original demand functions

$$q'_i = \mu S [1 - \beta_n / (1 - \theta) p'_i - \beta_r \theta / (1 - \theta) p'_j]$$

$$q'_j = \mu S [1 - \beta_n \theta / (1 - \theta) p'_i - \beta_r / (1 - \theta) p'_j]$$

The rescaled demand function is a special case of the demand functions used in our model, derived by setting the utility function parameters as follows:  $[(ad+ec)/(db-e^2)] = [(bc+ea)/(db-e^2)] = [d/(db-e^2)] = [b/(db-e^2)] = 1$ , and  $[-e/(db-e^2)] = \theta$ . Then for product i:

$$d/(db-e^2) = 1 \Rightarrow d = db - e^2 \Rightarrow b = 1 + e^2/d$$

$$\begin{aligned} (ad+ec)/(db-e^2) = 1 &\Rightarrow ad+ec = db-e^2 \\ \Rightarrow ad+ec &= d(1+e^2/d)-e^2 = d \\ \Rightarrow ec &= d-ad \\ \Rightarrow e &= d/c(1-a) \end{aligned}$$

$$\begin{aligned} -e/(db-e^2) &= -e/d \\ &= -d(1-a)/cd \\ &= (a-1)/c \end{aligned}$$

for  $0 < \theta < 1$  as assumed by McGuire and Staelin,  $1 < a < c < 1$ . Similarly, for product j:

$$\theta = (c-1)/a \text{ and } 1 < c < a < 1.$$

Since  $[d/(db-e^2)] = [b/(db-e^2)] = 1$ , we know that  $d = b$ . Also,  $(ad+ec)/(db-e^2) = (bc+ea)/(db-e^2) = 1$

$$\begin{aligned} \Rightarrow ad+ec &= bc+ea \\ \Rightarrow ad-ea &= bc-ec \\ \Rightarrow a(d-e) &= c(b-e) \\ \Rightarrow a &= c \quad \quad \quad d = b. \end{aligned}$$

McGuire and Staelin's demand function therefore represents a special case of a quadratic utility function where the two products have identical linear and quadratic terms.

## APPENDIX 2.2

### OPTIMAL PRICES AND PROFITS: MONOPOLISTIC MANUFACTURER

#### 1. RETAILER'S PRICING RULE

(a) *National Brand and Private Label*

The retailer's problem is

$$\begin{aligned}\text{Max } \pi^R &= \sum_n (p_n - w_n - s_n) q_n \\ &= \sum_n (p_n - w_n - s_n) (1 - p_n + \theta p_r) \\ &= (p_n - w_n - s_n)(\alpha_n - \beta_n p_n + \theta p_r) + (p_r - w_r - s_r)(\alpha_r + \theta p_n - \beta_r p_r)\end{aligned}$$

Maximizing with respect to  $p_n$ , we obtain

$$\partial \pi^R / \partial p_n = -\beta_n (p_n - w_n - s_n) + (\alpha_n - \beta_n p_n + \theta p_r) + \theta (p_r - w_r - s_r)$$

Solving this for optimal  $p_n$ ,

$$p_n^* = (\alpha_n / 2\beta_n) + 1/2(w_n + \theta s_n) - (\theta / 2\beta_n)(w_r + s_r) + (\theta / \beta_n)p_r$$

The optimal price for the retailer's private label brand is similar:

$$p_r^* = (\alpha_r / 2\beta_r) + 1/2(w_r - \theta s_r) - (\theta / 2\beta_r)(w_n + s_n) + (\theta / \beta_r)p_n$$

Substituting  $p_r^*$  in the optimal price for the national brand to derive  $p_n^*$  in terms of the exogenous variables:

$$\begin{aligned}p_n^* &= (\alpha_n / 2\beta_n) + 1/2(w_n + \theta s_n) - (\theta / 2\beta_n)(w_r + s_r) + (\theta / \beta_n) \{ (\alpha_r / 2\beta_r) + 1/2(w_r + \theta s_r) \\ &\quad - (\theta / 2\beta_r)(w_n + s_n) + (\theta / \beta_r)p_n \}\end{aligned}$$

This yields the following expressions for the optimal retail price for the national brand or the private label:

$$p_n^* = 1/2[(\alpha_n \beta_r + \theta \alpha_r) / (\beta_n \beta_r - \theta^2) + w_n + s_n]$$

$$\text{and } p_r^* = 1/2[(\alpha_r \beta_n + \theta \alpha_n) / (\beta_n \beta_r - \theta^2) + w_r + s_r]$$

These are the retailer's pricing rules, or positively sloped "reaction functions", to the manufacturer's wholesale prices and to selling costs.

(b) *National Brand Only*

The retailer maximizes profit on a single product as follows:

$$\begin{aligned}\text{Max } \pi_n^R &= (p_n - w_n - s_n) q_n \\ &= (p_n - w_n - s_n)(\alpha_n' - \beta_n' p_n)\end{aligned}$$

$$\partial \pi_n^R / \partial p_n = (\alpha_n' - \beta_n' p_n) - \beta_n' (p_n - w_n - s_n) = 0$$

This solves to

$$p_n^* = 1/2[(\alpha_n' / \beta_n') + w_n + s_n]$$

the optimal retail price of a single product.

#### 2. DERIVED DEMAND

(a) *National Brand and Private Label*

With the retailer's pricing rule, the retailer's demand for the national brand can be expressed in terms of wholesale prices and selling costs.

$$q_n^d = \alpha_n - \beta_n p_n^* + \theta p_r^*$$

where  $q_n^d$  = Derived demand for the national brand.

$$= \alpha_n - \beta_n / 2 [(\alpha_n \beta_r + \theta \alpha_r) / (\beta_n \beta_r - \theta^2) + w_n + s_n] + \theta / 2 [(\alpha_r \beta_n + \theta \alpha_n) / (\beta_n \beta_r - \theta^2) + w_r + s_r]$$

This simplifies to

$$q_n^d = \frac{1}{2}[\alpha_n - \beta_n(w_n + s_n) + \theta(w_r + s_r)]$$

And similarly, for the private label:

$$q_r^d = \frac{1}{2}[\alpha_r + \theta(w_n + s_n) - \beta_r(w_r + s_r)]$$

(b) *National Brand Only*

From above, the final demand for the product is

$$q_n = \alpha_n' - \beta_n' p_n$$

At the optimal retail price,  $p_n^*$ , the retailer's derived demand is

$$\begin{aligned} q_n^d &= \alpha_n' - \beta_n' \frac{1}{2}[(\alpha_n'/\beta_n') + w_n + s_n] \\ &= \frac{1}{2}[\alpha_n' - \beta_n'(w_n + s_n)] \end{aligned}$$

### 3. WHOLESALE PRICES

(a) *National Brand and Private Label*

The manufacturer's profit maximization problem is

$$\begin{aligned} \pi^M &= \sum_n (w_n - m_n) q_n^d \\ &= \frac{1}{2}(w_n - m_n)[\alpha_n - \beta_n(w_n + s_n) - \theta(w_r + s_r)] + \frac{1}{2}(w_r - m_r)[\alpha_r - \beta_r(w_r + s_r) + \theta(w_n + s_n)] \end{aligned}$$

Maximize this with respect to  $w_n$ , as follows:

$$\frac{\partial \pi^M}{\partial w_n} = \frac{1}{2}[\alpha_n - \beta_n(w_n + s_n) + \theta(w_r + s_r)] - (\beta_n/2)(w_n - m_n) + \theta/2(w_r - m_r)$$

This yields optimal wholesale prices for the national brand and the private label

$$w_n^* = [1/(2\beta_n)][\alpha_n - \beta_n(s_n - m_n) + \theta(s_r - m_r)] + (\theta/\beta_n)w_r$$

$$\text{and } w_r^* = [1/(2\beta_r)][\alpha_r - \beta_r(s_r - m_r) + \theta(s_n - m_n)] + (\theta/\beta_r)w_n$$

Substitute  $w_r^*$  for  $w_r$  in the optimal price for the national brand to derive  $w_n^*$  in terms of exogenous variables:

$$w_n^* = [1/(2\beta_n)][\alpha_n - \beta_n(s_n - m_n) - \theta(s_r - m_r)] + (\theta/2\beta_n\beta_r)[\alpha_r - \beta_r(s_r - m_r) + \theta(s_n - m_n)] + (\theta^2/\beta_n\beta_r)w_n$$

This simplifies to

$$w_n^* = \frac{1}{2}[(\alpha_n\beta_r + \theta\alpha_r)/(\beta_n\beta_r - \theta^2) - s_n + m_n] \quad \text{for the national brand, and}$$

$$w_r^* = \frac{1}{2}[(\alpha_r\beta_n + \theta\alpha_n)/(\beta_n\beta_r - \theta^2) - s_r + m_r] \quad \text{for the private label.}$$

(b) *National Brand Only*

In the absence of a private label brand, the manufacturer maximizes profit as follows:

$$\begin{aligned} \pi^M_0 &= (w_n - m_n) q_n^d \\ &= \frac{1}{2}(w_n - m_n)[\alpha_n' - \beta_n'(w_n + s_n)] \end{aligned}$$

$$\frac{\partial \pi^M_0}{\partial w_n} = \frac{1}{2}[\alpha_n' - \beta_n'(w_n + s_n)] - (\beta_n'/2)(w_n - m_n) = 0$$

This solves to give the manufacturer's optimal wholesale price for the product:

$$w_n^* = \frac{1}{2}[(\alpha_n'/\beta_n') - s_n + m_n]$$

### 4. QUANTITY SUPPLIED

(a) *National Brand and Private Label*

At the optimal wholesale prices  $w_n^*$  and  $w_r^*$ , the quantity supplied by the manufacturer of the national brand is

$$\begin{aligned}
q_n^* &= \frac{1}{2}[\alpha_n - \beta_n(w_n^* + s_n) + \theta(w_n^* + s_n)] \\
&= \frac{1}{2}\left\{\alpha_n - (\beta_n/2)[(\alpha_n\beta_n + \theta\alpha_n)/(\beta_n\beta_n - \theta^2) - s_n + m_n] - \beta_n s_n + (\theta/2)[(\alpha_n\beta_n + \theta\alpha_n)/(\beta_n\beta_n - \theta^2) - s_n + m_n] + \theta s_n\right\}
\end{aligned}$$

which simplifies to

$$q_n^* = \frac{1}{4}[\alpha_n - \beta_n(s_n + m_n) - \theta(s_n + m_n)]$$

Similarly, for the private label brand

$$q_r^* = \frac{1}{4}[\alpha_r - \beta_r(s_r + m_r) + \theta(s_r + m_r)]$$

(b) *National Brand Only*

The manufacturer supplies the following quantity at the optimal wholesale price:

$$\begin{aligned}
q_n^* &= \frac{1}{2}\left\{\alpha_n^* - (\beta_n^*/2)[(\alpha_n^*/\beta_n^*) - s_n + m_n] - \beta_n^* s_n\right\} \\
&= \frac{1}{4}[\alpha_n^* - \beta_n^*(s_n + m_n)]
\end{aligned}$$

## 5. PROFIT

(a) *National Brand and Private Label*

At the optimal prices and quantities, the manufacturer's profit is

$$\begin{aligned}
\pi^M &= \sum_n (w_n^* - m_n) q_n^* \\
&= (w_n^* - m_n) q_n^* + (w_r^* - m_r) q_r^* \\
&= \left\{ \frac{1}{2} \left[ (\alpha_n \beta_n + \theta \alpha_n) / (\beta_n \beta_n - \theta^2) - s_n + m_n \right] - m_n \right\} \left\{ \frac{1}{4} [\alpha_n - \beta_n (s_n + m_n) - \theta (s_n + m_n)] \right\} \\
&\quad + \left\{ \frac{1}{2} \left[ (\alpha_r \beta_r + \theta \alpha_r) / (\beta_r \beta_r - \theta^2) - s_r + m_r \right] - m_r \right\} \left\{ \frac{1}{4} [\alpha_r - \beta_r (s_r + m_r) + \theta (s_r + m_r)] \right\} \\
&= (1/8) \left\{ (\alpha_n \beta_n + \theta \alpha_n) / (\beta_n \beta_n - \theta^2) - (s_n + m_n) \right\} [\alpha_n - \beta_n (s_n + m_n) + \theta (s_n + m_r)] \\
&\quad + (1/8) \left\{ (\alpha_r \beta_r + \theta \alpha_r) / (\beta_r \beta_r - \theta^2) - (s_r + m_r) \right\} [\alpha_r - \beta_r (s_r + m_r) + \theta (s_n + m_n)]
\end{aligned}$$

To simplify notation, let  $c_i = (s_i + m_i) \forall i \in \{n, r\}$ : then

$$\pi^M = (1/8) \left\{ (\alpha_n \beta_n + \theta \alpha_n) / (\beta_n \beta_n - \theta^2) - c_n \right\} (\alpha_n - \beta_n c_n + \theta c_r) + \left\{ (\alpha_r \beta_r + \theta \alpha_r) / (\beta_r \beta_r - \theta^2) - c_r \right\} (\alpha_r - \beta_r c_r - \theta c_n)$$

Expanding this expression and simplifying, the manufacturer's profit becomes

$$\pi^M = (1/8) \left\{ (\alpha_n^2 \beta_n + \alpha_r^2 \beta_r + 2\theta \alpha_n \alpha_r) / (\beta_n \beta_r - \theta^2) \right\} - 2\alpha_n c_n - 2\alpha_r c_r - 2\theta c_n c_r + \beta_n c_n^2 + \beta_r c_r^2$$

(b) *National Brand Only*

The manufacturer's profit for a single product at the optimal prices and quantities is

$$\begin{aligned}
\pi_n^M &= (w_n^* - m_n) q_n^* \\
&= \left\{ \frac{1}{2} \left[ (\alpha_n / \beta_n) - s_n + m_n \right] - m_n \right\} \frac{1}{4} [\alpha_n - \beta_n (s_n + m_n)] \\
&= (1/8) \left\{ (\alpha_n / \beta_n) - s_n + m_n \right\} (\alpha_n - \beta_n s_n - \beta_n m_n) \\
&= (1/8) \left\{ (\alpha_n^2 / \beta_n) - 2\alpha_n (s_n + m_n) + 2\beta_n m_n s_n + \beta_n (s_n^2 + m_n^2) \right\} \\
&= (1/8) \left\{ (\alpha_n^2 / \beta_n) - 2\alpha_n (s_n + m_n) + \beta_n (s_n + m_n)^2 \right\}
\end{aligned}$$

Again, to simplify notation, let  $c_n = s_n + m_n$ : then

$$\pi_n^M = (1/8) \left\{ (\alpha_n^2 / \beta_n) - 2\alpha_n c_n + \beta_n c_n^2 \right\}$$

This expression is quadratic in  $c_n$ , as can be seen from some further manipulation:

$$\begin{aligned}
\pi_n^M &= [1/(8\beta_n)] [\alpha_n^2 - 2\alpha_n \beta_n c_n + \beta_n^2 c_n^2] \\
&= [1/(8\beta_n)] (\alpha_n - \beta_n c_n)^2
\end{aligned}$$

**APPENDIX 2.3**  
**PROFIT COMPARISON**

Finally, we compare the manufacturer's profit with and without the private label, to determine the profitability of supplying the retailer's brand.

$$\pi^M - \pi^M_0 = \Delta \pi^M = (1/8) \{ [(\alpha_n^2 \beta_n + \alpha_n^2 \beta_n + 2\theta \alpha_n \alpha_n) / (\beta_n \beta_n - \theta^2)] - 2\alpha_n c_n - 2\alpha_n c_n - 2\theta c_n c_n + \beta_n c_n^2 + \beta_n c_n^2 \} \\ - (1/8) [(\alpha_n^2 / \beta_n) - 2\alpha_n c_n + \beta_n c_n^2]$$

Recalling that  $\alpha_n' = \alpha_n + \alpha_n \theta / \beta_n$ , and  $\beta_n' = \beta_n - \theta^2 / \beta_n$ , from Appendix 2.1, this expression becomes

$$\Delta \pi^M = (1/8) \{ [(\alpha_n^2 \beta_n + \alpha_n^2 \beta_n + 2\theta \alpha_n \alpha_n) / (\beta_n \beta_n - \theta^2)] - 2\alpha_n c_n - 2\alpha_n c_n - 2\theta c_n c_n + \beta_n c_n^2 + \beta_n c_n^2 \} \\ - (1/8) [(\alpha_n + \alpha_n \theta / \beta_n)^2 / (\beta_n - \theta^2 / \beta_n) - 2(\alpha_n + \alpha_n \theta / \beta_n) c_n + (\beta_n - \theta^2 / \beta_n) c_n^2] \\ = (1/8) \{ [(\alpha_n^2 \beta_n + \alpha_n^2 \beta_n + 2\theta \alpha_n \alpha_n) - \beta_n (\alpha_n + \alpha_n \theta / \beta_n)^2 / (\beta_n \beta_n - \theta^2)] - 2\alpha_n c_n \\ + 2(\alpha_n + \alpha_n \theta / \beta_n) c_n - 2\alpha_n c_n - 2\theta c_n c_n + \beta_n c_n^2 - (\beta_n - \theta^2 / \beta_n) c_n^2 + \beta_n c_n^2 \} \\ = (1/8) \{ [(\alpha_n^2 \beta_n - \alpha_n^2 \theta^2 / \beta_n) + 2\alpha_n \theta \alpha_n - (\alpha_n^2 \beta_n + 2\alpha_n \theta \alpha_n + \alpha_n^2 \theta^2 / \beta_n) / (\beta_n \beta_n - \theta^2)] \\ + 2(\alpha_n \theta / \beta_n) c_n - 2\alpha_n c_n + (\theta^2 / \beta_n) c_n^2 - 2\theta c_n c_n + \beta_n c_n^2 \} \\ = (1/8) \{ (\alpha_n^2 \beta_n - \alpha_n^2 \theta^2 / \beta_n) / (\beta_n \beta_n - \theta^2) - 2\alpha_n [(\theta / \beta_n) c_n - c_n] + (1 / \beta_n) (\theta c_n - \beta_n c_n)^2 \} \\ = (1/8) [(\alpha_n^2 / \beta_n) (\beta_n \beta_n - \alpha_n^2 \theta^2) / (\beta_n \beta_n - \theta^2) + 2(\alpha_n / \beta_n) (\theta c_n - \beta_n c_n) + (1 / \beta_n) (\theta c_n - \beta_n c_n)^2] \\ = (1/8) [(\alpha_n^2 / \beta_n) + 2(\alpha_n / \beta_n) (\theta c_n - \beta_n c_n) + (1 / \beta_n) (\theta c_n - \beta_n c_n)^2]$$

**APPENDIX 2.4**

**PRIVATE LABEL SUPPLY TO ALL R RETAILERS BY A MONOPOLIST**

**1. EFFECT OF RETAILER COMPETITION ON MANUFACTURER PROFITS**

Assume that the retailers sell only the national brand of a monopolistic manufacturer. Since the retailers are undifferentiated,  $p_n = w_n + s_n$ , and the retailers make zero profits. Derived demand for each of the  $R$  retailers is  $q_n^d = \alpha_n' - \beta_n'(w_n + s_n)$ . The manufacturer's profits across all retailers are

$$\pi^M_0 = (w_n' - m_n) R q_n^d \\ = (w_n' - m_n) R [\alpha_n' - \beta_n'(w_n + s_n)]$$

Maximizing with respect to wholesale price.

$$\partial \pi^M_0 / \partial w_n' = R [\alpha_n' - \beta_n'(w_n + s_n)] - R \beta_n' (w_n - m_n) = 0 \\ \Rightarrow w_n^* = [1 / (2\beta_n')] [(\alpha_n' - \beta_n'(s_n - m_n))]. \text{ unchanged from the baseline model.}$$

Quantity supplied at  $w_n^*$  is

$$R q_n^* = R [\alpha_n' - \beta_n'(w_n^* + s_n)] \\ = R \{ \alpha_n' - \beta_n' [(1/2\beta_n') (\alpha_n' - \beta_n'(s_n - m_n)) + s_n] \} \\ = 1/2 R [\alpha_n' - \beta_n'(m_n + s_n)]$$

Then the manufacturer's profit is

$$\pi^M_0 = \{ [1 / (2\beta_n')] [(\alpha_n' - \beta_n'(s_n - m_n)) - m_n] \} 1/2 R [\alpha_n' - \beta_n'(m_n + s_n)] \\ = [1 / (4\beta_n')] R [\alpha_n' - \beta_n'(m_n + s_n)]^2$$

or  $[1 / (4\beta_n')] [\alpha_n' - \beta_n'(m_n + s_n)]^2$  from each retailer. Recall that the manufacturer's profit in the baseline model was  $[1 / (8\beta_n')] [\alpha_n' - \beta_n'(m_n + s_n)]^2$ : hence his profit per retailer doubles in this model as compared with the baseline.

## 2. SUPPLY OF PRIVATE LABEL

Assume the manufacturer supplies both brands to all undifferentiated retailers. The demand functions faced by all retailers are

$$\begin{aligned} q_n &= \alpha_n - \beta_n p_n + \theta p_r \\ q_r &= \alpha_r + \theta p_n - \beta_r p_r \end{aligned}$$

Then each retailer's problem is

$$\max \pi^R = \sum_i (w_i - m_i) q_i \quad i \in \{n, r\}$$

Since the retailers are undifferentiated, their retail price for the national brand will be  $w_n + s_n$  and their profit on the national brand zero. However, since consumers do not compare private labels across stores, the retailers can charge prices above costs: the relevant comparison is with the national brand within each store. Hence their total profit is

$$\pi^R = (w_r - m_r)(\alpha_r - \beta_r p_r + \theta p_n)$$

The retailers choose private label prices to maximize profit, as follows:

$$\partial \pi^R / \partial p_r = \alpha_r - \beta_r p_r + \theta p_n - \beta_r p_r + \beta_r w_r + \beta_r s_r = 0$$

$$\Rightarrow p_r^* = \frac{1}{2}[(\alpha_r / \beta_r) + w_r + s_r] + \frac{1}{2}(\theta / \beta_r) p_n$$

which, since  $p_n = w_n + s_n$ , is

$$p_r^* = \frac{1}{2}[(\alpha_r / \beta_r) + w_r + s_r] + \frac{1}{2}(\theta / \beta_r)(w_n + s_n)$$

At these prices, the retailer's derived demand for the national brand is:

$$\begin{aligned} q_n^d &= \alpha_n - \beta_n (w_n + s_n) + \frac{1}{2}\theta[(\alpha_r / \beta_r) + w_r + s_r] + (\theta / \beta_r)(w_n + s_n) \\ &= [\alpha_n + (\theta \alpha_r / 2\beta_r)] - [\beta_n - (\theta^2 / 2\beta_r)](w_n + s_n) + \frac{1}{2}\theta(w_r + s_r) \end{aligned}$$

$$\begin{aligned} \text{and } q_r^d &= \alpha_r - \frac{1}{2}\beta_r[(\alpha_r / \beta_r) + w_r + s_r] + \frac{1}{2}(\theta / \beta_r)(w_n + s_n) + \theta(w_n + s_n) \\ &= \frac{1}{2}[\alpha_r - \beta_r(w_r + s_r) + \theta(w_n + s_n)] \end{aligned}$$

Hence the quantity demanded of the national brand increases by comparison with the baseline model due to competitive pricing, since intercept demand increases and own price response falls. However, the quantity demanded of the private label is unchanged.

The manufacturer, maximizing profit across all retailers, has the following problem:

$$\begin{aligned} \max \pi^M &= R \sum_i (w_i - m_i) q_i \quad i \in \{n, r\} \\ &= R(w_n - m_n) \{ [\alpha_n + (\theta \alpha_r / 2\beta_r)] - [\beta_n - (\theta^2 / 2\beta_r)](w_n + s_n) + \frac{1}{2}\theta(w_r + s_r) \} \\ &\quad + R(w_r - m_r) \frac{1}{2} [\alpha_r - \beta_r(w_r + s_r) + \theta(w_n + s_n)] \end{aligned}$$

The price of the national brand is derived as follows:

$$\partial \pi^M / \partial w_n = R \{ [\alpha_n + (\theta \alpha_r / 2\beta_r)] - [\beta_n - (\theta^2 / 2\beta_r)](w_n + s_n) + \frac{1}{2}\theta(w_r + s_r) \} - R[\beta_n - (\theta^2 / 2\beta_r)](w_n - m_n) + \frac{1}{2}R\theta(w_r - m_r)$$

Setting this to zero and solving, the optimal wholesale price becomes:

$$w_n^* = \frac{\frac{1}{2}[(2\alpha_n \beta_r + \theta \alpha_r) / (2\beta_n \beta_r - \theta^2) + m_n - s_n] + (\theta \beta_r)(s_r - m_r) / 2(2\beta_n \beta_r - \theta^2) + (\theta \beta_r) w_r / (2\beta_n \beta_r - \theta^2)}{1}$$

Similarly, the first order conditions with respect to the price of the private label are:

$$\partial \pi^M / \partial w_r = \frac{1}{2}R\theta(w_n - m_n) + \frac{1}{2}R[\alpha_r - \beta_r(w_r + s_r) + \theta(w_n + s_n)] - \frac{1}{2}R\beta_r(w_r - m_r)$$

and the private label's optimal price is

$$w_r^* = \frac{1}{2}[(\alpha_r / \beta_r) + (m_r - s_r) - (\theta / \beta_r)(m_n - s_n)] + (\theta / \beta_r) w_n$$

Substituting this expression into the national brand's price, we have

$$w_n^* = \frac{\frac{1}{2}[(2\alpha_n \beta_r + \theta \alpha_r) / (2\beta_n \beta_r - \theta^2) + m_n - s_n] + (\theta \beta_r)(s_r - m_r) / 2(2\beta_n \beta_r - \theta^2) + (\theta \beta_r) \{ \frac{1}{2}[(\alpha_r / \beta_r) + (m_r - s_r) - (\theta / \beta_r)(m_n - s_n)] + (\theta / \beta_r) w_n \} / (2\beta_n \beta_r - \theta^2)}{1}$$

which solves to

$$w_n^* = \frac{1}{2}[(\alpha_n \beta_r + \theta \alpha_r) / (\beta_n \beta_r - \theta^2) + (m_n - s_n)]$$

By substituting this into  $w_r^*$ , we also find that

$$w_r^* = \frac{1}{2}[(\alpha_n \beta_r + \theta \alpha_r) / (\beta_n \beta_r - \theta^2) + (m_r - s_r)]$$

Hence the manufacturer's optimal prices do not change from the baseline model. We calculate the quantity supplied by the manufacturer at these optimal prices as follows:

$$\begin{aligned} Rq_n^* &= R[\alpha_n + (\theta \alpha_r / 2\beta_r)] - [\beta_n - (\theta^2 / 2\beta_r)](w_n^* + s_n) + \frac{1}{2}\theta(w_r^* + s_r) \\ &= [\alpha_n + (\theta \alpha_r / 2\beta_r)] - [\beta_n - (\theta^2 / 2\beta_r)] \left\{ \frac{1}{2}[(\alpha_n \beta_r + \theta \alpha_r) / (\beta_n \beta_r - \theta^2) + (m_n - s_n)] + s_n \right\} \\ &\quad + \frac{1}{2}\theta \left\{ \frac{1}{2}[(\alpha_n \beta_r + \theta \alpha_r) / (\beta_n \beta_r - \theta^2) + (m_r - s_r)] + s_r \right\} \end{aligned}$$

which can be reduced to

$$Rq_n^* = \frac{1}{2}R\{[\alpha_n + (\theta \alpha_r / 2\beta_r)] - [\beta_n - (\theta^2 / 2\beta_r)](m_n + s_n) + \frac{1}{2}\theta(m_r + s_r)\}$$

Similarly, the quantity supplied of the private label is

$$Rq_r^* = \frac{1}{4}R\{[\alpha_r - \beta_r(m_r + s_r) + \theta(m_n + s_n)]\}$$

Hence one component only of the manufacturer's profit function has changed relative to the baseline model: the quantity of the national brand. Since prices remain unchanged, the equilibrium of the baseline model, namely, that a monopolist will always supply a retailer's private label, will always hold if the national brand does not lose any more volume in the extended model than in the baseline. We analyze the difference in volumes in each model as follows:

**Baseline Model:**

$$q_n^* - q_n^* = \frac{1}{4}[\alpha_n - \beta_n(m_n + s_n)] - \frac{1}{4}[\alpha_n - \beta_n(m_n + s_n) + \theta(m_r + s_r)]$$

Recalling from the baseline model that  $\alpha_n^* = \alpha_n - (\theta \alpha_r / \beta_r)$  and  $\beta_n^* = \beta_n - (\theta^2 / \beta_r)$ , this becomes

$$\begin{aligned} &= \frac{1}{4}\{[\alpha_n + (\theta \alpha_r / \beta_r)] - [\beta_n - (\theta^2 / \beta_r)](m_n + s_n) \\ &\quad - [\alpha_n - \beta_n(m_n + s_n) + \theta(m_r + s_r)]\} \\ &= \frac{1}{4}\{(\theta \alpha_r / \beta_r) + (\theta^2 / \beta_r)(m_n + s_n) - \theta(m_r + s_r)\} \end{aligned}$$

**Extended Model:**

For each individual retailer,

$$\begin{aligned} q_n^* - q_n^* &= \frac{1}{2}[\alpha_n - \beta_n(m_n + s_n)] \\ &\quad - \frac{1}{2}\{[\alpha_n + (\theta \alpha_r / 2\beta_r)] - [\beta_n - (\theta^2 / 2\beta_r)](m_n + s_n) + \frac{1}{2}\theta(m_r + s_r)\} \\ &= \frac{1}{2}\{[\alpha_n + (\theta \alpha_r / \beta_r)] - [\beta_n - (\theta^2 / \beta_r)](m_n + s_n) \\ &\quad - [\alpha_n + (\theta \alpha_r / 2\beta_r)] - [\beta_n - (\theta^2 / 2\beta_r)](m_n + s_n) + \frac{1}{2}\theta(m_r + s_r)\} \\ &= \frac{1}{4}\{(\theta \alpha_r / \beta_r) + (\theta^2 / \beta_r)(m_n + s_n) - \theta(m_r + s_r)\} \end{aligned}$$

Hence the loss of volume is identical across both models, and the baseline equilibrium continues to hold.

By determining whether the new expression for quantity of the national brand is similarly related to the model's parameters to that in the baseline model, we can ascertain whether the model's predictions as a whole have changed. In the baseline model,  $q_n^* = \frac{1}{2}R[\alpha_n - \beta_n(m_n + s_n) + \theta(m_r + s_r)]$ ; hence  $\partial q_n^* / \partial \theta > 0$ ,  $\partial q_n^* / \partial m_n < 0$ ,  $\partial q_n^* / \partial m_r > 0$ . In the extended model,

$$\begin{aligned} Rq_n^* &= \frac{1}{2}R\{[\alpha_n + (\theta \alpha_r / 2\beta_r)] - [\beta_n - (\theta^2 / 2\beta_r)](m_n + s_n) + \frac{1}{2}\theta(m_r + s_r)\} \\ \Rightarrow \partial Rq_n^* / \partial \theta &= \frac{1}{2}R\{(\alpha_r / 2\beta_r) + (\theta / \beta_r)(m_n + s_n) + (m_r + s_r)\} > 0; \\ \frac{\partial Rq_n^*}{\partial m_n} &= -R[\beta_n - (\theta^2 / \beta_r)] < 0 \quad (\because \text{This is the price response parameter in the demand function}) \\ \frac{\partial Rq_n^*}{\partial m_r} &= \frac{\theta}{4} > 0 \end{aligned}$$

There is one other parameter in the demand function in the multiple retailer model which is not present in the baseline,  $\beta_r$ , the private label's own-price response. This is negatively related to national brand demand, as follows:

$$\partial Rq_n^* / \partial \beta_r = \frac{1}{2}\{-(2\theta \alpha_r / 4\beta_r^2) - (\theta^2 / 4\beta_r^2)(m_n + s_n)\} < 0.$$

Since  $\beta_r$  is negatively related to propensity to supply in the baseline model, the result does not change with respect to this parameter.

APPENDIX 2.5

DEMAND AND PRICE CHANGES UNDER PURE DUOPOLY

**1. Demand**

The demand functions are

$$\begin{aligned} q_{n1} &= \alpha_1 - \beta_1 p_{n1} + \sigma p_{n2} + \theta_1 p_r \\ q_{n2} &= \alpha_2 + \sigma p_{n1} - \beta_2 p_{n2} + \theta_2 p_r \\ q_r &= \alpha_r + \theta_1 p_1 + \theta_2 p_2 - \beta_r p_r \end{aligned}$$

With  $q_r = 0$ , we have

$$\begin{aligned} q'_{n1} &= \alpha'_1 - \beta'_1 p_{n1} + \sigma' p_{n2} \\ q'_{n2} &= \alpha'_2 + \sigma' p_{n1} - \beta'_2 p_{n2} \end{aligned}$$

Aggregate demand with  $q_r > 0$  is

$$Q = (\alpha_1 + \alpha_2 + \alpha_r) - (\beta_1 - \sigma - \theta_1) p_{n1} - (\beta_2 - \sigma - \theta_2) p_{n2} - (\beta_r - \theta_1 - \theta_2) p_r$$

and with  $q_r = 0$ ,

$$Q' = (\alpha'_1 + \alpha'_2) - (\beta'_1 - \sigma') p_{n1} - (\beta'_2 - \sigma') p_{n2}$$

Inverting the demand function for the private label, we have

$$p_r = (1/\beta_r)(\alpha_r + \theta_1 p_{n1} + \theta_2 p_{n2} - q_r)$$

Substituting this price into the demand functions for the national brands,

$$\begin{aligned} q_{n1} &= \alpha_1 - \beta_1 p_{n1} + \sigma p_{n2} + \theta_1 (1/\beta_r)(\alpha_r + \theta_1 p_{n1} + \theta_2 p_{n2} - q_r) \\ q_{n2} &= \alpha_2 + \sigma p_{n1} - \beta_2 p_{n2} + \theta_2 (1/\beta_r)(\alpha_r + \theta_1 p_{n1} + \theta_2 p_{n2} - q_r) \\ q_r &= \alpha_r + \theta_1 p_1 + \theta_2 p_2 - \beta_r p_r \end{aligned}$$

So aggregate demand can be rewritten as

$$\begin{aligned} Q &= q_{n1} + q_{n2} + q_r \\ &= \alpha_1 - \beta_1 p_{n1} + \sigma p_{n2} + \theta_1 (1/\beta_r)(\alpha_r + \theta_1 p_{n1} + \theta_2 p_{n2} - q_r) \\ &\quad + \alpha_2 - \beta_2 p_{n2} + \sigma p_{n1} + \theta_2 (1/\beta_r)(\alpha_r + \theta_1 p_{n1} + \theta_2 p_{n2} - q_r) \\ &\quad + \alpha_r - \beta_r p_r + \theta_1 p_1 + \theta_2 p_2 \end{aligned}$$

which can be expressed as follows:

$$Q = [\alpha_1 + \alpha_2 + (\alpha_r \sum \theta_i) / \beta_r] - [\beta_1 - \sigma - (\theta_1^2 + \theta_1 \theta_2) / \beta_r] p_{n1} - [\beta_2 - \sigma - (\theta_2^2 + \theta_1 \theta_2) / \beta_r] p_{n2} + [1 - (\sum \theta_i / \beta_r)] q_r$$

Where  $q_r = 0$ , i.e. there is no private label.

$$Q = [\alpha_1 + \alpha_2 + (\alpha_r \sum \theta_i) / \beta_r] - [\beta_1 - \sigma - (\theta_1^2 + \theta_1 \theta_2) / \beta_r] p_{n1} - [\beta_2 - \sigma - (\theta_2^2 + \theta_1 \theta_2) / \beta_r] p_{n2}$$

Hence

$$\begin{aligned} \alpha'_1 + \alpha'_2 &= [\alpha_1 + \alpha_2 + (\alpha_r \sum \theta_i) / \beta_r] \\ \beta'_1 - \sigma' &= [\beta_1 - \sigma - (\theta_1^2 + \theta_1 \theta_2) / \beta_r] \\ \beta'_2 - \sigma' &= [\beta_2 - \sigma - (\theta_2^2 + \theta_1 \theta_2) / \beta_r] \end{aligned}$$

Assuming that brand 1's substitution with brand 2 is unchanged by the supply of private label, i.e.  $\sigma' = \sigma$ , we have

$$\begin{aligned} \beta'_1 &= [\beta_1 - (\theta_1^2 + \theta_1 \theta_2) / \beta_r] \text{ and} \\ \beta'_2 &= [\beta_2 - (\theta_2^2 + \theta_1 \theta_2) / \beta_r] \end{aligned}$$

This result is analogous to that seen in the monopoly model: the responsiveness of the national brand to changes in its own price increases as a result of the

introduction of the private label. We need to constrain the demand function so that  $\Sigma\theta/\beta_r < 1$ , or  $\Sigma\theta < \beta_r$ , so that aggregate demand does not decrease with the introduction of the private label. To find the change in volume for the national brand of manufacturer 1 as a result of introduction of the private label, we proceed as follows:

$$\begin{aligned} dq_{n1} &= q'_{n1} - q_{n1} \\ &= \alpha'_1 - \beta'_1 p_{n1} - \sigma' p_{n2} - (\alpha_1 - \beta_1 p_{n1} + \sigma p_{n2} + \theta_1 p_r) \\ &= (\alpha'_1 - \alpha_1) - (\beta'_1 - \beta_1) p_{n1} + (\sigma' - \sigma) p_{n2} - \theta_1 p_r \end{aligned}$$

From the above parameter changes, we have

$$\begin{aligned} \alpha'_1 - \alpha_1 &= [\alpha_2 - \alpha'_2 + (\alpha_2 \Sigma \theta_1) / \beta_r], \\ \beta'_1 - \beta_1 &= [\sigma' - \sigma - (\theta_1^2 + \theta_1 \theta_2) / \beta_r] \quad \text{and} \\ \sigma' - \sigma &= [\beta'_1 - \beta_1 - (\theta_1^2 + \theta_1 \theta_2) / \beta_r] \end{aligned}$$

So

$$\begin{aligned} dq_{n1} &= [\alpha_2 - \alpha'_2 + (\alpha_2 \Sigma \theta_1) / \beta_r] - [\sigma' - \sigma - (\theta_1^2 + \theta_1 \theta_2) / \beta_r] p_{n1} \\ &\quad + [\beta'_1 - \beta_1 - (\theta_1^2 + \theta_1 \theta_2) / \beta_r] p_{n2} - \theta_1 p_r \\ &= [(\Sigma \theta_1) / \beta_r] [\alpha_2 + \theta_1 p_{n1} + \theta_2 p_{n2} - (\theta_1 / \Sigma \theta_1) \beta_r p_r] - (\alpha'_2 - \alpha_2) - (\sigma' - \sigma) p_{n1} \\ &\quad + (\beta'_1 - \beta_1) p_{n2} \\ &= \{(\Sigma \theta_1) / \beta_r\} \{ \alpha_2 - \beta_r p_r + [1 - (\theta_1 / \Sigma \theta_1)] \beta_r p_r + \theta_1 p_1 + \theta_2 p_2 \} - (\alpha'_2 - \alpha_2) \\ &\quad - (\sigma' - \sigma) p_{n1} + (\beta'_1 - \beta_1) p_{n2} \\ &= [(\Sigma \theta_1) / \beta_r] (\alpha_2 - \beta_r p_r + \theta_1 p_1 + \theta_2 p_2) - (\alpha'_2 - \alpha_2) - (\sigma' - \sigma) p_{n1} + (\beta'_1 - \beta_1) p_{n2} \\ &\quad - [(\Sigma \theta_1) / \beta_r] [(\theta_2 / \Sigma \theta_1)] \beta_r p_r \\ &= [(\Sigma \theta_1) / \beta_r] (\alpha_2 - \beta_r p_r + \theta_1 p_1 + \theta_2 p_2) + (\alpha_2 - \beta_2 p_{n2} + \sigma p_{n1} + \theta_2 p_r) \\ &\quad - (\alpha'_2 - \beta'_2 p_{n2} - \sigma' p_{n1}) \\ &= [(\Sigma \theta_1) / \beta_r] q_r + (q'_{n2} - q_{n2}) \\ &= [(\Sigma \theta_1) / \beta_r] q_r - dq_{n2} \end{aligned}$$

As before, national brand volume is cannibalized by the private label according to the ratio of cross-price response and the private label's own-price response. However, the difference here is that cannibalization is also increased by the private label's cross-price response with the competing duopolist's brand, and reduced by cannibalization of the competitor's brand. While each manufacturer gains less from expansion of the category due to his smaller share than in the baseline model, he also loses less from cannibalization because some of the losses go to the competitor's brand.

## APPENDIX 2.6

### PRICES AND QUANTITIES IN A DUOPOLY

#### **1. General Form**

$$\pi^M_i = \sum_j w_{ij} q_j [w_i] - C[q_i, q_j] \quad i, j \in \{n, r\}$$

where  $q_j [w_i]$  is the demand function facing the manufacturer and  $C[q_i, q_j]$  is any cost function.

$$= w_{n1} q_{n1} [w_{n1}, w_{n2}, w_r] + w_{r1} q_{r1} [w_{n1}, w_{n2}, w_r] - C[q_{n1}, q_r]$$

$$\partial \pi^M_i / \partial w_{n1} = q_{n1} + w_{n1} (\partial q_{n1} / \partial w_{n1}) + w_{r1} (\partial q_{r1} / \partial w_{n1}) - (\partial C / \partial q_{n1}) (\partial q_{n1} / \partial w_{n1}) - (\partial C / \partial q_r) (\partial q_r / \partial w_{n1})$$

Setting this = 0, we have

$$w_{n1} (\partial q_{n1} / \partial w_{n1}) = (\partial C / \partial q_{n1}) (\partial q_{n1} / \partial w_{n1}) - (\partial C / \partial q_r) (\partial q_r / \partial w_{n1}) - w_{r1} (\partial q_{r1} / \partial w_{n1}) - q_{n1}$$

$$\Rightarrow w_{n1}^* = \frac{\partial C / \partial q_{n1} + (\partial C / \partial q_r) (\partial q_r / \partial w_{n1}) / (\partial q_{n1} / \partial w_{n1}) - w_{r1} (\partial q_{r1} / \partial w_{n1}) / (\partial q_{n1} / \partial w_{n1})}{-q_{n1} / (\partial q_{n1} / \partial w_{n1})}$$

as the equilibrium price for manufacturer 1's national brand when he supplies the private label.

Similarly,

$$w_r^* = \partial C / \partial q_r + (\partial C / \partial q_{n1}) (\partial q_{n1} / \partial w_r) / (\partial q_r / \partial w_r) - w_{n1} (\partial q_{n1} / \partial w_r) / (\partial q_r / \partial w_r) - q_r / (\partial q_r / \partial w_r)$$

To simplify notation, let  $q_{11} = \partial q_{n1} / \partial w_{n1}$ ;  $q_{rr} = \partial q_r / \partial w_r$ ;  $q_{rl} = \partial q_{n1} / \partial w_r$ ;  $q_{rl} = \partial q_r / \partial w_{n1}$ ;  $C_{n1} = \partial C / \partial q_{n1}$ ;  $C_r = \partial C / \partial q_r$ . Then

$$w_{n1}^* = C_{n1} + C_r q_{rl} / q_{11} - w_r q_{rl} / q_{11} - q_{n1} / q_{11}$$

and

$$w_r^* = C_r + C_{n1} q_{11} / q_{rr} - w_{n1} q_{11} / q_{rr} - q_r / q_{rr}$$

Substituting  $w_r^*$  into the expression for  $w_{n1}^*$ , we have

$$\begin{aligned} w_{n1}^* &= C_{n1} + C_r q_{rl} / q_{11} - [C_r + C_{n1} q_{11} / q_{rr} - w_{n1} q_{11} / q_{rr} - q_r / q_{rr}] q_{rl} / q_{11} - q_{n1} / q_{11} \\ \Rightarrow w_{n1} - w_{n1} (q_{rl} / q_{11}) (q_{rl} / q_{rr}) &= C_{n1} + C_r q_{rl} / q_{11} - [C_r + C_{n1} q_{11} / q_{rr} - q_r / q_{rr}] q_{rl} / q_{11} - q_{n1} / q_{11} \\ \Rightarrow w_{n1} [(q_{11} q_{rr} - q_{rl} q_{rl}) / (q_{11} q_{rr})] &= C_{n1} + C_r q_{rl} / q_{11} - C_r q_{rl} / q_{11} - C_{n1} (q_{11} / q_{rr}) (q_{rl} / q_{11}) \\ &\quad + (q_r / q_{rr}) (q_{rl} / q_{11}) - q_{n1} / q_{11} \end{aligned}$$

$$\begin{aligned} \Rightarrow w_{n1} &= (q_{11} q_{rr}) / (q_{11} q_{rr} - q_{rl} q_{rl}) \{ C_{n1} (q_{11} q_{rr} - q_{rl} q_{rl}) / q_{11} q_{rr} \\ &\quad - (1 / q_{11}) [q_{n1} - (q_{rl} / q_{rr}) q_r] \} \end{aligned}$$

Hence the equilibrium price in terms of quantities is

$$w_{n1}^* = C_{n1} + [1 / (q_{11} q_{rr} - q_{rl} q_{rl})] (q_{rl} q_r - q_{rr} q_{n1})$$

for the national brand, and similarly for the private label.

$$w_r^* = C_r + [1 / (q_{11} q_{rr} - q_{rl} q_{rl})] (q_{11} q_{n1} - q_{11} q_r)$$

To check this result, substitute the parameters from the baseline model into  $w_{n1}^*$  to recover the optimal price in the baseline model. (For simplicity, assume selling costs,  $s_n = 0$ ):

$$\begin{aligned} w_n &= \{ m_n + 1 / (\beta_n \beta_r - \theta^2) [\theta q_r - (-\beta_r) q_{n1}] \} \\ &= \{ m_n + 1 / [1/4 (\beta_n \beta_r - \theta^2)] [1/2 \theta^{1/2} (\alpha_r - \beta_r w_r - \theta w_n) - (-1/2 \beta_r)^{1/2} (\alpha_n - \beta_n w_n + \theta w_r)] \} \\ &= m_n + [\theta \alpha_r / (\beta_n \beta_r - \theta^2)] - [\theta \beta_r w_r / (\beta_n \beta_r - \theta^2)] + [\theta^2 w_n / (\beta_n \beta_r - \theta^2)] + [\alpha_n \beta_r / (\beta_n \beta_r - \theta^2)] \\ &\quad - [\beta_n \beta_r w_n / (\beta_n \beta_r - \theta^2)] + [\theta \beta_r w_r / (\beta_n \beta_r - \theta^2)] \\ &= m_n + (\alpha_n \beta_r + \alpha_r \theta) / (\beta_n \beta_r - \theta^2) - w_n \\ \Rightarrow w_n^* &= 1/2 [(\alpha_n \beta_r + \alpha_r \theta) / (\beta_n \beta_r - \theta^2) + m_n]. \quad \text{as before.} \end{aligned}$$

## 2. Pure Duopoly with Linear Demand

We assume that the retailer's selling costs,  $s = 0$  for the remaining extensions to the model. Hence retail prices and derived demand are analogous to those derived in the monopoly model, and we focus on the manufacturer's problem.

From the general model, we have the price for the national brand

$$w_{n1}^* = C_{n1} + [1 / (q_{11} q_{rr} - q_{rl} q_{rl})] (q_{rl} q_r - q_{rr} q_{n1})$$

With the linear demand functions specified in Appendix 2.5, this becomes

$$\begin{aligned} w_{n1} &= m_{n1} + [1 / (\beta_1 \beta_r - \theta_1^2)] (\theta_1 q_r + \beta_r q_{n1}) \\ &= m_{n1} + [1 / 4 (\beta_1 \beta_r - \theta_1^2)] [1/2 \theta_1^{1/2} (\alpha_r - \beta_r w_r + \theta_1 w_1 + \theta_2 w_2) + 1/2 \beta_r^{1/2} (\alpha_1 - \beta_1 w_{n1} + \theta_1 w_r)] \\ &= m_{n1} + (\theta_1 \alpha_r + \alpha_1 \beta_r) / (\beta_1 \beta_r - \theta_1^2) + (\beta_r \sigma + \theta_1 \theta_2) w_{n2} / (\beta_1 \beta_r - \theta_1^2) + w_{n1} \end{aligned}$$

Hence we have the equilibrium price

$$w_{n1}^* = 1/2 [m_{n1} + (\theta_1 \alpha_r + \alpha_1 \beta_r) / (\beta_1 \beta_r - \theta_1^2) + (\beta_r \sigma + \theta_1 \theta_2) w_{n2} / (\beta_1 \beta_r - \theta_1^2)]$$

for the national brand, and similarly

$$w_r^* = \frac{1}{2} [m_r + (\alpha_1 \beta_1 - \alpha_1 \theta_1) / (\beta_1 \beta_r - \theta_1^2) - (\beta_1 \theta_2 + \sigma \theta_1) w_{n2} / (\beta_1 \beta_r - \theta_1^2)]$$

for the private label.

At these prices, the manufacturer supplies the following quantities:

$$q_{n1}^* = \frac{1}{4} (\alpha_1 - \beta_1 m_{n1} + \theta_1 m_r + \sigma w_{n2})$$

$$q_r^* = \frac{1}{4} (\alpha_r - \beta_r m_r + \theta_1 m_{n1} + \theta_1 w_{n2})$$

**3. No Private Label**

If neither manufacturer supplies the private label, derived demand functions are

$$q'_{n1} = \frac{1}{2} (\alpha'_1 - \beta'_1 w_{n1} + \sigma' w_{n2})$$

$$q'_{n2} = \frac{1}{2} (\alpha'_2 - \beta'_2 w_{n2} + \sigma' w_{n1})$$

Manufacturer 1's problem is

$$\max \pi^{M1} = w_{n1} q'_{n1} - C[q_{n1}]$$

Solving this as before, we obtain the national brand price

$$w_{n1}^{**} = \frac{1}{2} [(\alpha'_1 / \beta'_1) - (\sigma' / \beta'_1) w_{n2} + m_{n1}]$$

and supply quantity

$$q_{n1}^{**} = \frac{1}{4} (\alpha'_1 - \beta'_1 m_{n1} + \sigma' w_{n2})$$

**APPENDIX 2.7**

**PROOF OF PROPOSITION 2.4**

**1. Profit Comparison**

With manufacturer 1 supplying the private label when his competitor does not, his profit is

$$\begin{aligned} \pi^{M1} &= w_{n1}^* q_{n1}^* - m_{n1} q_{n1}^* + w_r^* q_r^* - m_{n1} q_{n1}^* \\ &= \frac{1}{2} [m_{n1} + (\theta_1 \alpha_r + \alpha_i \beta_r) / (\beta_i \beta_r - \theta_i^2) + (\beta_r \sigma + \theta_1 \theta_2) w_{n2} / (\beta_i \beta_r - \theta_i^2)] \frac{1}{4} (\alpha_i - \beta_i m_{n1} + \theta_1 m_r + \sigma w_{n2}) \\ &\quad - m_{n1} [\frac{1}{4} (\alpha_i - \beta_i m_{n1} + \theta_1 m_r + \sigma w_{n2}) \\ &\quad + \frac{1}{2} [m_r + (\alpha_i \beta_i + \alpha_i \theta_i) / (\beta_i \beta_r - \theta_i^2) + (\beta_i \theta_2 + \sigma \theta_i) w_{n2} / (\beta_i \beta_r - \theta_i^2)] \frac{1}{4} (\alpha_i - \beta_i m_r + \theta_1 m_{n1} + \theta_1 w_{n2}) \\ &\quad - m_r [\frac{1}{4} (\alpha_i - \beta_i m_r + \theta_1 m_{n1} + \theta_1 w_{n2})] \end{aligned}$$

Where neither manufacturer supplies, manufacturer 1's profit is

$$\begin{aligned} \pi^{M1_0} &= w_{n1}^* q_{n1}^* - m_{n1} q_{n1}^* \\ &= \frac{1}{2} [(\alpha_i / \beta_i) + (\sigma / \beta_i) w_{n2} + m_{n1}] \frac{1}{4} (\alpha_i - \beta_i m_{n1} + \sigma w_{n2}) \end{aligned}$$

Then the difference in manufacturer 1's payoff between the two scenarios is

$$\begin{aligned} \Delta \pi^{M1} &= \frac{1}{2} [m_{n1} + (\theta_1 \alpha_r + \alpha_i \beta_r) / (\beta_i \beta_r - \theta_i^2) + (\beta_r \sigma + \theta_1 \theta_2) w_{n2} / (\beta_i \beta_r - \theta_i^2)] \frac{1}{4} (\alpha_i - \beta_i m_{n1} + \theta_1 m_r + \sigma w_{n2}) \\ &\quad - m_{n1} [\frac{1}{4} (\alpha_i - \beta_i m_{n1} + \theta_1 m_r + \sigma w_{n2}) \\ &\quad + \frac{1}{2} [m_r + (\alpha_i \beta_i + \alpha_i \theta_i) / (\beta_i \beta_r - \theta_i^2) + (\beta_i \theta_2 + \sigma \theta_i) w_{n2} / (\beta_i \beta_r - \theta_i^2)] \frac{1}{4} (\alpha_i - \beta_i m_r + \theta_1 m_{n1} + \theta_1 w_{n2}) \\ &\quad - m_r [\frac{1}{4} (\alpha_i - \beta_i m_r + \theta_1 m_{n1} + \theta_1 w_{n2}) \\ &\quad - \frac{1}{2} [(\alpha_i / \beta_i) + (\sigma / \beta_i) w_{n2} + m_{n1}] \frac{1}{4} (\alpha_i - \beta_i m_{n1} + \sigma w_{n2})] \end{aligned}$$

Recall from Appendix 2.5 that

$$\begin{aligned} \alpha'_i + \alpha'_2 &= [\alpha_i + \alpha_2 + (\alpha_2 \sum \theta_i) / \beta_r] \\ \beta'_i - \sigma' &= [\beta_i - \sigma - (\theta_i^2 + \theta_1 \theta_2) / \beta_r] \end{aligned}$$

Assuming that the private label introduction affects each national brand in proportion to its substitution with the private label, we have

$$\begin{aligned} \alpha'_i &= \alpha_i + (\alpha_i / \beta_r) \theta_i \\ \alpha'_2 &= \alpha_2 + (\alpha_2 / \beta_r) \theta_2 \\ \beta'_i &= \beta_i - (\theta_i^2 / \beta_r) \\ \beta'_2 &= \beta_2 - (\theta_2^2 / \beta_r) \\ \sigma' &= \sigma + (\theta_1 \theta_2 / \beta_r) \end{aligned}$$

Manufacturer 1's sales volume change under this assumption is derived as follows:

$$\begin{aligned} \Delta q_{n1} &= q_{n1}' - q_{n1} \\ &= \frac{1}{4} (\alpha_i' - \beta_i' m_{n1} + \sigma' w_{n2}') - \frac{1}{4} (\alpha_i - \beta_i m_{n1} + \theta_1 m_r + \sigma w_{n2}) \\ &= \frac{1}{4} \{ \alpha_i + (\alpha_i / \beta_r) \theta_i - [\beta_i - (\theta_i^2 / \beta_r)] m_{n1} + [\sigma + (\theta_1 \theta_2 / \beta_r)] w_{n2}' \} - \frac{1}{4} (\alpha_i - \beta_i m_{n1} + \theta_1 m_r + \sigma w_{n2}) \\ &= [\frac{1}{4} (\alpha_i - \beta_i m_{n1} + \theta_1 m_r + \sigma w_{n2}) + (\theta_i / \beta_r) [\alpha_i + \theta_1 m_{n1} + (\theta_2 / \beta_r) w_{n2}']] \\ &\quad - [\frac{1}{4} (\alpha_i - \beta_i m_{n1} + \theta_1 m_r + \sigma w_{n2})] \\ &= \frac{1}{4} (\theta_i / \beta_r) [\alpha_i + \theta_1 m_{n1} + \theta_2 w_{n2}'] + \frac{1}{4} \sigma (w_{n2}' - w_{n2}) \end{aligned}$$

Substituting the above parameter values into manufacturer 1's profit difference, we obtain

$$\begin{aligned} \Delta \pi^{M1} = & \frac{1}{2}[m_{n1}+(\theta_1\alpha_r+\alpha_l\beta_r)/(\beta_l\beta_r-\theta_1^2)+(\beta_r\sigma+\theta_1\theta_2)w_{n2}/(\beta_l\beta_r-\theta_1^2)]^{1/4}(\alpha_l-\beta_r m_{n1}+\theta_1 m_r+\sigma w_{n2}) \\ & - m_{n1}[\frac{1}{4}(\alpha_l-\beta_r m_{n1}+\theta_1 m_r+\sigma w_{n2}) \\ & + \frac{1}{2}[m_r+(\alpha_l\beta_r+\alpha_l\theta_1)/(\beta_l\beta_r-\theta_1^2)+(\beta_l\theta_2+\sigma\theta_1)w_{n2}/(\beta_l\beta_r-\theta_1^2)]^{1/4}(\alpha_r-\beta_r m_r+\theta_1 m_{n1}+\theta_1 w_{n2}) \\ & - m_r[\frac{1}{4}(\alpha_r-\beta_r m_r+\theta_1 m_{n1}+\theta_1 w_{n2})] \\ & - \frac{1}{2}[m_{n1}+(\theta_1\alpha_r+\alpha_l\beta_r)/(\beta_l\beta_r-\theta_1^2)+(\beta_r\sigma+\theta_1\theta_2)w_{n2}/(\beta_l\beta_r-\theta_1^2)](1/4\beta_r)[m_{n1}+(\theta_1\alpha_r+\alpha_l\beta_r)/(\beta_l\beta_r-\theta_1^2)+(\beta_r\sigma+\theta_1\theta_2)w_{n2}/(\beta_l\beta_r-\theta_1^2)] \end{aligned}$$

$$\text{Let } S = (\alpha_l\beta_r+\alpha_l\theta_1)/(\beta_l\beta_r-\theta_1^2):$$

$$T = (\sigma\beta_r+\theta_1\theta_2)/(\beta_l\beta_r-\theta_1^2):$$

$$U = (\alpha_r\beta_r+\alpha_l\theta_1)/(\beta_l\beta_r-\theta_1^2) \text{ and}$$

$$V = (\sigma\theta_1+\beta_l\theta_2)/(\beta_l\beta_r-\theta_1^2)$$

Then the profit difference simplifies to

$$\begin{aligned} \Delta \pi^{M1} = & (\frac{1}{8})\theta_1 m_r(S+T w_{n2}-m_{n1}) + (1/8)(U+V w_{n2}-m_r)(\alpha_r-\beta_r m_r+\theta_1 m_{n1}+\sigma w_{n2}) \\ & - (\frac{1}{8})(\theta_1/\beta_r)(\alpha_r+\theta_1 m_{n1}+\theta_2 w_{n2})(S+T w_{n2}-m_{n1}) + (1/8)(S+T w_{n2}-m_{n1})\sigma(w_{n2}-w_{n2}') \end{aligned}$$

## 2. Comparative Statics

Effect of  $\theta_1$

$$\begin{aligned} \Delta \pi^{M1} & = (w_{n1} - m_{n1})q_{n1}' + (w_r - m_r)q_r - (w_{n1}' - m_{n1}')q_{n1}' \\ d\Delta \pi^{M1}/d\theta_1 & = q_{n1}(\partial w_{n1}/\partial \theta_1) + w_{n1}(\partial q_{n1}/\partial \theta_1) + q_r(\partial w_r/\partial \theta_1) + w_r(\partial q_r/\partial \theta_1) \\ & \quad - q_{n1}'(\partial w_{n1}'/\partial \theta_1) - w_{n1}'(\partial q_{n1}'/\partial \theta_1) \end{aligned}$$

Taking the derivatives of prices with respect to  $\theta_1$ , we have

$$\partial w_{n1}/\partial \theta_1 = \frac{1}{2}\{[\alpha_l(\beta_l\beta_r-\theta_1^2)+2\theta_1(\alpha_l\beta_r+\alpha_l\theta_1)]/(\beta_l\beta_r-\theta_1^2)^2 - \theta_2(\beta_l\beta_r-\theta_1^2)+2\theta_1(\sigma\beta_r+\theta_1\theta_2)w_{n2}/(\beta_l\beta_r-\theta_1^2)^2\}$$

and

$$\partial w_r/\partial \theta_1 = \frac{1}{2}\{[\alpha_r(\beta_l\beta_r-\theta_1^2)+2\theta_1(\alpha_r\beta_r+\alpha_l\theta_1)]/(\beta_l\beta_r-\theta_1^2)^2 + \sigma(\beta_l\beta_r-\theta_1^2)+2\theta_1(\sigma\theta_1+\beta_l\theta_2)/(\beta_l\beta_r-\theta_1^2)^2\}$$

both of which are positive. Hence the sign of the profit difference derivative is positive where

$$q_{n1}(\partial w_{n1}/\partial \theta_1) + w_{n1}(\partial q_{n1}/\partial \theta_1) - q_r(\partial w_r/\partial \theta_1) + w_r(\partial q_r/\partial \theta_1) > q_{n1}'(\partial w_{n1}'/\partial \theta_1) + w_{n1}'(\partial q_{n1}'/\partial \theta_1)$$

As shown in the previous section, the national brand's volume change is

$$\Delta q_{n1} = \frac{1}{4}(\theta_1/\beta_r)[\alpha_r - \theta_1 m_{n1} + \theta_2 w_{n2}'] + \frac{1}{4}\sigma(w_{n2}' - w_{n2})$$

Private label sales volume will exceed this where

$$\frac{1}{4}(\alpha_r - \beta_r m_r + \theta_1 m_{n1} + \theta_1 w_{n2}) > \frac{1}{4}(\theta_1/\beta_r)[\alpha_r - \theta_1 m_{n1} + \theta_2 w_{n2}'] + \frac{1}{4}\sigma(w_{n2}' - w_{n2})$$

$$\Rightarrow [1 - (\theta_1/\beta_r)](\alpha_r - \beta_r m_r + \theta_1 m_{n1}) > (\theta_2 + \sigma)w_{n2}' - (\theta_1 + \sigma)w_{n2}$$

Hence manufacturer 1 will gain sales volume as a result of the private label introduction, so long as manufacturer 2 does not cut his price. Similarly,

$$\begin{aligned} \Delta w_{n1} & = w_{n1}' - w_{n1} \\ & = \frac{1}{2}[(\alpha_l/\beta_l') + (\sigma'/\beta_l')w_{n2}' - m_{n1}] - \frac{1}{2}[m_{n1} + (\theta_1\alpha_r+\alpha_l\beta_r)/(\beta_l\beta_r-\theta_1^2) + (\beta_r\sigma+\theta_1\theta_2)w_{n2}/(\beta_l\beta_r-\theta_1^2)] \\ & = \frac{1}{2}(\beta_r\sigma+\theta_1\theta_2)(w_{n2}' - w_{n2})/(\beta_l\beta_r-\theta_1^2) \end{aligned}$$

Manufacturer 1's price will change will only change if manufacturer 2's price changes. It can also be shown that, in these conditions,  $\partial w_{n1}/\partial \theta_1 \geq \partial w_{n1}'/\partial \theta_1$ , and

$\partial q_{n1}/\partial \theta_1 \geq \partial q_{n1}/\partial \theta_1$ . Hence if  $w_{n2} \geq w_{n2}'$ , the effect of  $\theta_1$  on private label profitability will be positive.

### Effect of $\theta_2$

As we saw in the case of  $\theta_1$ , the derivative of the profit difference with respect to  $\theta_2$  is

$$\begin{aligned} d\Delta \pi^{MI}/d\theta_2 &= q_{n1}(\partial w_{n1}/\partial \theta_2) + w_{n1}(\partial q_{n1}/\partial \theta_2) + q_1(\partial w_1/\partial \theta_2) + w_1(\partial q_1/\partial \theta_2) \\ &\quad - q_{n1}'(\partial w_{n1}/\partial \theta_2) - w_{n1}'(\partial q_{n1}/\partial \theta_2) \end{aligned}$$

The derivatives of prices with respect to  $\theta_2$  are

$$\begin{aligned} \partial w_{n1}/\partial \theta_2 &= \frac{1}{2}[\theta_1/(\beta_1\beta_r - \theta_1^2)]w_{n2} > 0 \\ \partial w_1/\partial \theta_2 &= \frac{1}{2}[\beta_1/(\beta_1\beta_r - \theta_1^2)]w_{n2} > 0 \end{aligned}$$

Recall that  $\partial q_{n1}/\partial \theta_2 = 0$ . Then the sign of the derivative is positive where

$$q_{n1}(\partial w_{n1}/\partial \theta_2) + w_{n1}(\partial q_{n1}/\partial \theta_2) + q_1(\partial w_1/\partial \theta_2) + w_1(\partial q_1/\partial \theta_2) > q_{n1}'(\partial w_{n1}/\partial \theta_2) + w_{n1}'(\partial q_{n1}/\partial \theta_2)$$

Again, the sign of this expression depends on the degree to which private label sales volume compensates for national brand volume losses, which in turn depends on manufacturer 2's price change. Unless manufacturer 2 reduces his national brand price in response to the introduction of the private label, the effect of  $\theta_2$  on private label profitability is positive.

### Effect of $\alpha_r$

Using the same method,

$$\begin{aligned} d\Delta \pi^{MI}/d\alpha_r &= q_{n1}(\partial w_{n1}/\partial \alpha_r) + w_{n1}(\partial q_{n1}/\partial \alpha_r) + q_1(\partial w_1/\partial \alpha_r) + w_1(\partial q_1/\partial \alpha_r) \\ &\quad - q_{n1}'(\partial w_{n1}/\partial \alpha_r) - w_{n1}'(\partial q_{n1}/\partial \alpha_r) \\ \partial w_{n1}/\partial \alpha_r &= \frac{1}{2}[\theta_1/(\beta_1\beta_r - \theta_1^2)] > 0 \\ \partial w_1/\partial \alpha_r &= \frac{1}{2}[\beta_1/(\beta_1\beta_r - \theta_1^2)] > 0 \end{aligned}$$

Again, the sign of this derivative depends on manufacturer 2's response. It is positive where  $w_{n2} \geq w_{n2}'$ .

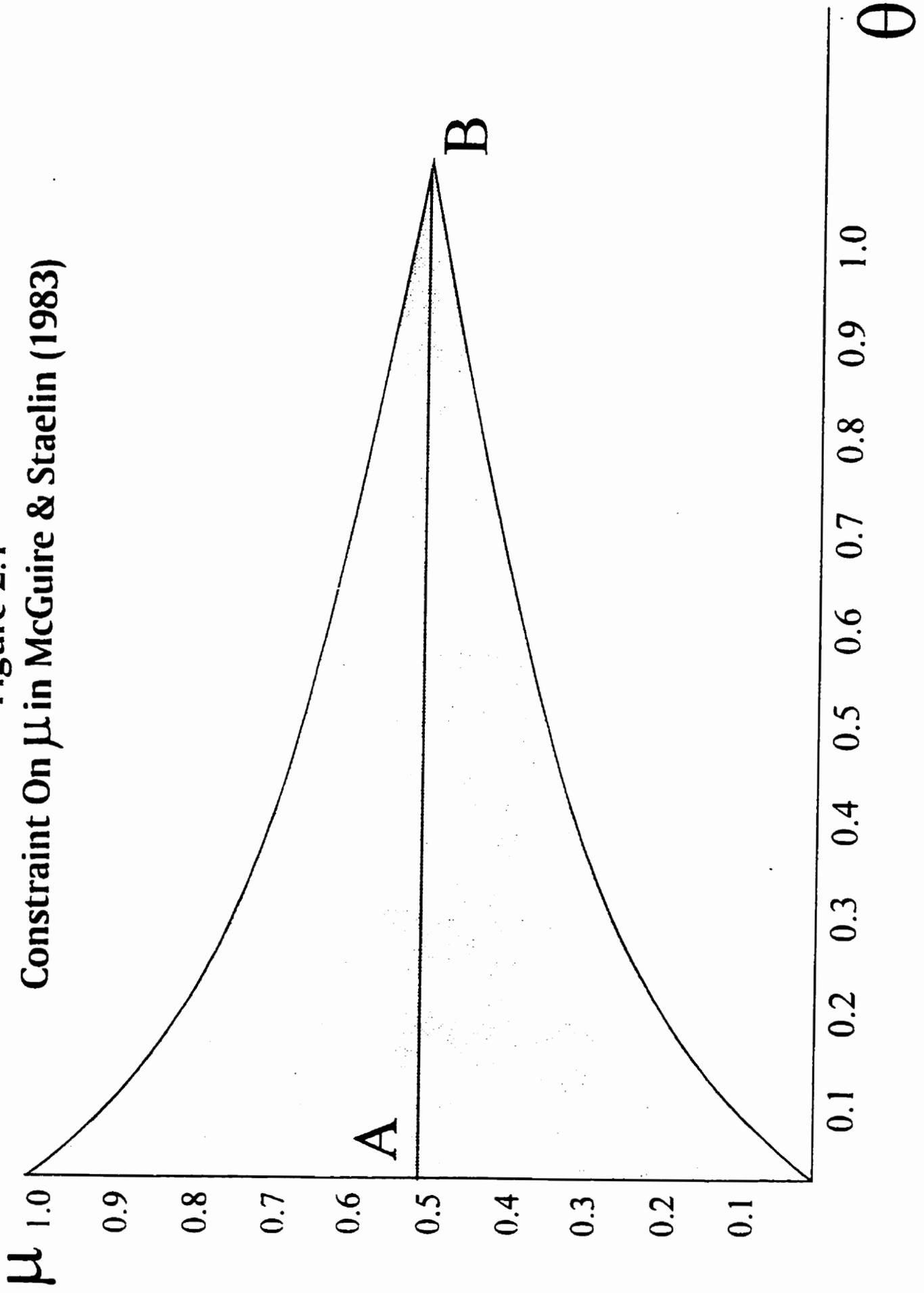
### Effect of $\beta_r$

$$\begin{aligned} d\Delta \pi^{MI}/d\beta_r &= q_{n1}(\partial w_{n1}/\partial \beta_r) + w_{n1}(\partial q_{n1}/\partial \beta_r) + q_1(\partial w_1/\partial \beta_r) + w_1(\partial q_1/\partial \beta_r) \\ &\quad - q_{n1}'(\partial w_{n1}/\partial \beta_r) - w_{n1}'(\partial q_{n1}/\partial \beta_r) \\ \partial w_{n1}/\partial \beta_r &= \frac{1}{2}[\alpha_r/(\beta_1\beta_r - \theta_1^2) - \beta_1(\alpha_1\beta_r + \alpha_r\theta_1)/(\beta_1\beta_r - \theta_1^2)^2 + \sigma/(\beta_1\beta_r - \theta_1^2) - \beta_1(\beta_1\sigma + \theta_1\theta_2)w_{n2}/(\beta_1\beta_r - \theta_1^2)^2] \\ &= \frac{1}{2}[-\theta_1(\alpha_1\theta_1 + \alpha_r\beta_1)/(\beta_1\beta_r - \theta_1^2)^2 - \beta_1(\sigma\theta_1 + \beta_1\theta_2)w_{n2}/(\beta_1\beta_r - \theta_1^2)^2] < 0 \\ \partial w_1/\partial \beta_r &= \frac{1}{2}[-\beta_1(\alpha_1\beta_1 + \alpha_r\theta_1)/(\beta_1\beta_r - \theta_1^2)^2 - \beta_1(\sigma\theta_1 + \beta_1\theta_2)w_{n2}/(\beta_1\beta_r - \theta_1^2)^2] < 0 \end{aligned}$$

Hence the effect is negative for  $w_{n2} \geq w_{n2}'$ .

**FIGURES**

Figure 2.1  
Constraint On  $\mu$  in McGuire & Staelin (1983)



**Figure 2.2**  
**Effect of Private Label Introduction on**  
**National Brand Intercept Demand and Own-Price Elasticity**

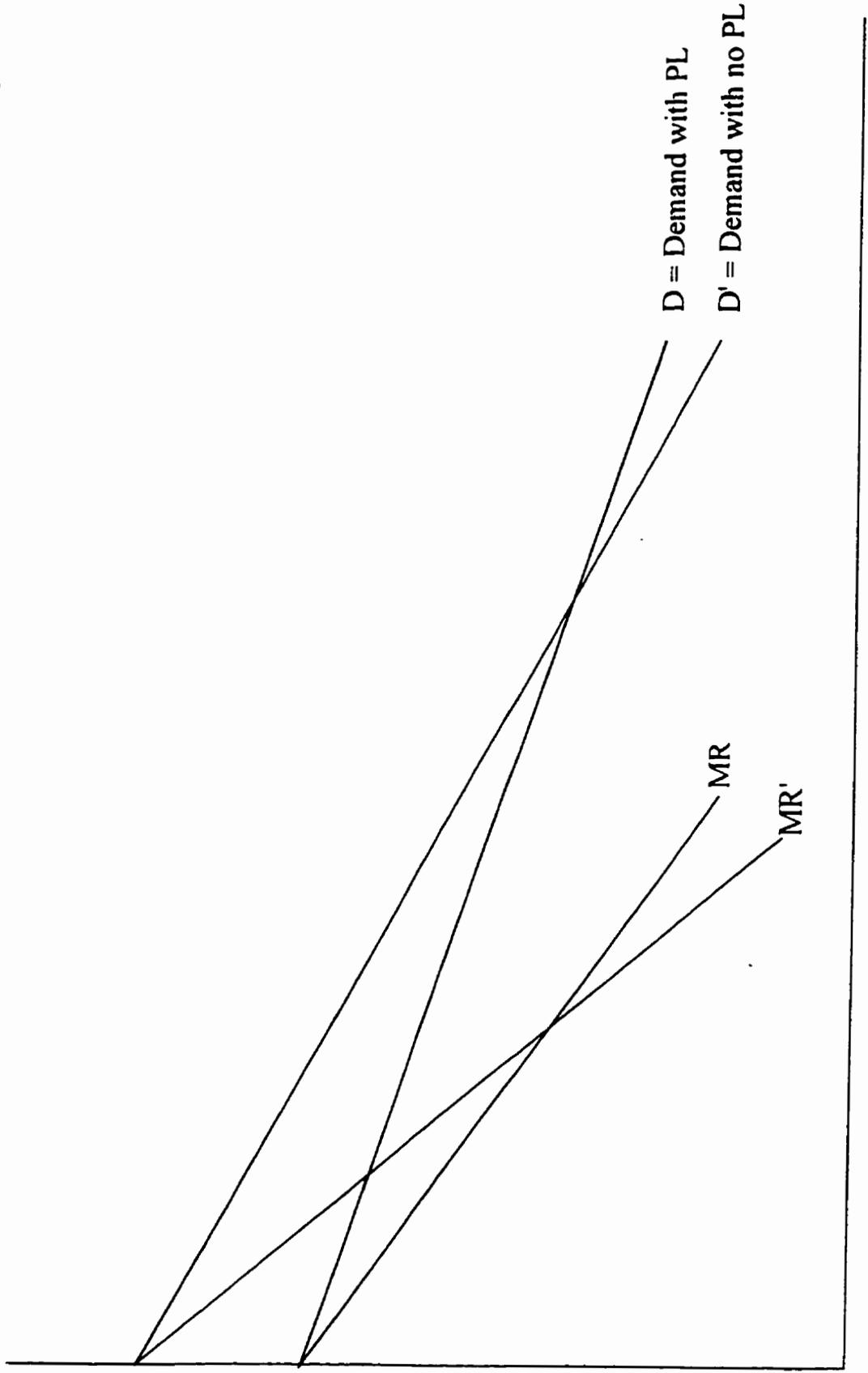
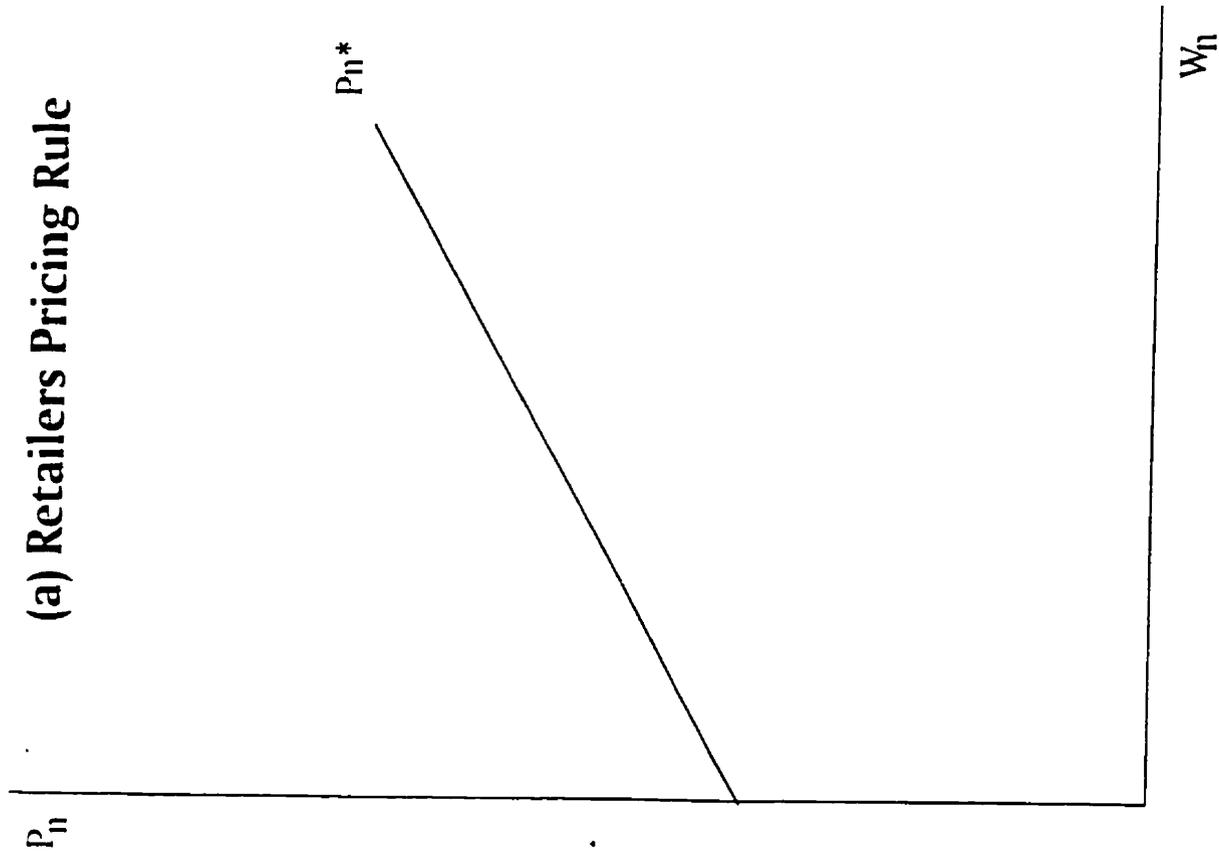
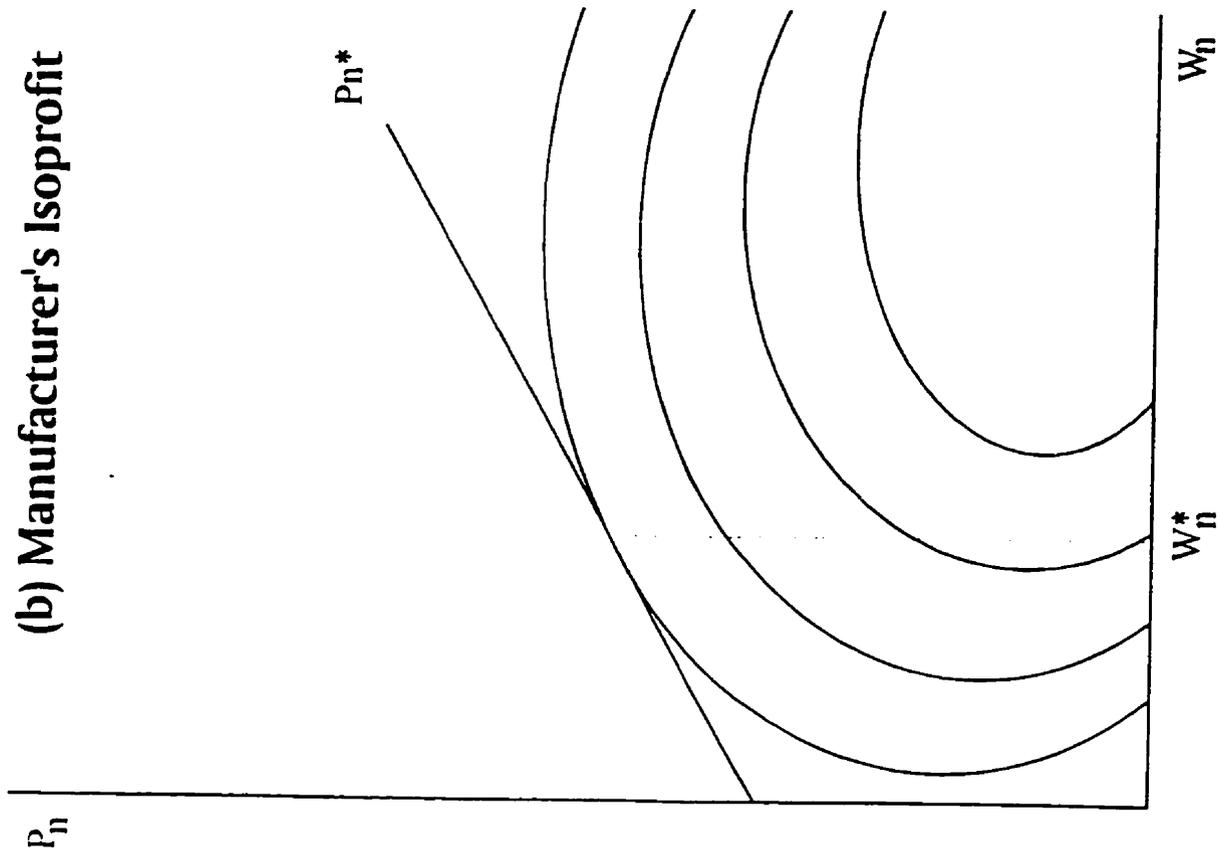


Figure 2.3

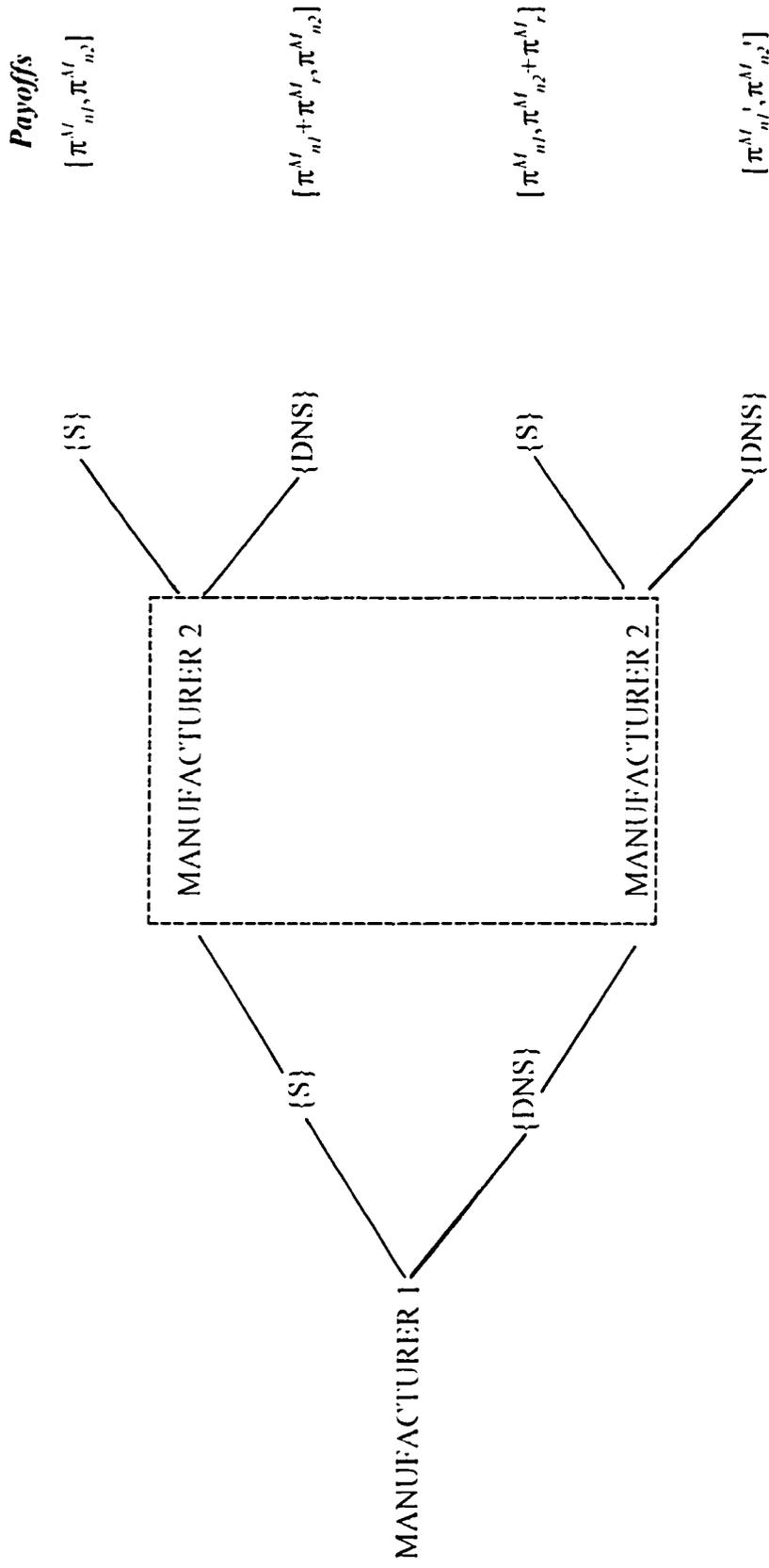
(a) Retailers Pricing Rule



(b) Manufacturer's Isoprofit



**FIGURE 2.4**  
**PURE DUOPOLY: EXTENSIVE FORM GAME**



**FIGURE 2.5**  
**PURE DUOPOLY: NORMAL FORM GAME**

	<u>Manufacturer 1</u>	
	<u>Supply</u>	<u>Do Not Supply</u>
<u>Supply</u>	$[\pi_n^M, \pi_n^M]$	$[\pi_n^M, \pi_n^M + \pi_n^M]$
<u>Do Not Supply</u>	$[\pi_n^M + \pi_n^M, \pi_n^M]$	$[\pi_n^M, \pi_n^M]$
<u>Manufacturer 2</u>		

$\pi_n^M$  is the manufacturer's profit from supplying brand  $i$ . Payoffs are to manufacturer  $\{1,2\}$ .

**FIGURE 2.6**  
**EQUILIBRIUM WHOLESALE PRICES FOR MANUFACTURER 1**

Model	Strategy Set	Price	
		National Brand	Private Label
Monopoly:	{S}	$w_n^* = \frac{1}{2}[(\alpha_n/\beta_n + \theta\alpha_n/(\beta_n\beta_n - \theta^2)) + m_n]$	$w_p^* = \frac{1}{2}[(\alpha_n/\beta_n + \theta\alpha_n/(\beta_n\beta_n - \theta^2)) + m_n]$
	{DNS}	$w_n^* = \frac{1}{2}[(\alpha_n/\beta_n) + m_n]$	
Duopoly:	{S,S}	$w_{n1}^* = \frac{1}{2}[(\alpha_n/\beta_n) + (\sigma/\beta_n)w_{n1} + m_{n1}]$	$w_{n1} = m_{n1}$
	{S,DNS}	$w_n^* = \frac{1}{2}[(\alpha_n/\beta_n + \theta\alpha_n/(\beta_n\beta_n - \theta^2)) + (\beta_n\sigma + \theta\beta_n w_{n1})/(\beta_n\beta_n - \theta^2) + m_{n1}]$	$w_p^* = \frac{1}{2}[(\alpha_n/\beta_n + \theta\alpha_n/(\beta_n\beta_n - \theta^2)) + (\beta_n\sigma + \theta\beta_n w_{n1})/(\beta_n\beta_n - \theta^2) + m_{n1}]$
	{DNS,S}	$w_{n1}^* = \frac{1}{2}[(\alpha_n/\beta_n) + (\sigma/\beta_n)w_{n1} + (\theta/\beta_n)w_n]$	
	{DNS,DNS}	$w_{n1}^* = \frac{1}{2}[(\alpha_n/\beta_n) + (\sigma/\beta_n)w_{n1} + (\theta/\beta_n)w_n]$	

### **3. MODEL EXTENSION TO THE GROCERY PRODUCTS INDUSTRY**

*I have hardly ever known a mathematician who was capable of reasoning.*

**Plato:**

*The Republic*

#### **(i) Introduction**

The baseline models of chapter 2 provide us with some insight to the dimensions of the decision to supply retailers' private labels. Nowhere is this decision more difficult than in the grocery products industry. Faced with a growing private label sector and an increasingly sophisticated retail trade, grocery product manufacturers are under significant pressure to supply their customers' store brands.

As we saw in chapter 2, it is in a manufacturer's interest to supply the strongest private label possible, but to minimize cannibalization of his national brand. For this reason, the manufacturer prefers to supply a private label which generates a high degree of loyalty from consumers, is not too price sensitive and expands the category rather than take too much of its sales volume from the national brand. In addition, the private label should have low costs, so that the manufacturer can obtain as high a profit margin as possible from those consumers who do switch.

While a monopolist will always supply a retailer's private label, a duopolist may have reasons not to do so. If cannibalization of his national brand is too high or profit margins too low, the idea

may be unattractive. The risk of setting off a price war is an additional factor for a duopolist to consider.

The purpose of this chapter is to derive a set of predictions, based on the model of chapter 2, which apply to the grocery products industry. To achieve this, we need to extend the baseline model to recognize the conditions prevailing in that industry. Specifically, the market structure should take account of the existence of a competitive sector which may supply the private label if the leading manufacturers choose not to do so. In addition, chapter 2's assumption of constant marginal costs will be relaxed in favour of a more general cost function, in order to take account of the effects of economies of scale and scope on the private label decision.

The extended model shows that, in addition to the demand factors considered in the baseline models, dominant firms take into account the relative economies of scale of the private label and the national brand, along with the dominant firm's cost advantage or disadvantage *vis à vis* the competitive sector.

This chapter begins with a discussion of the grocery industry and the applicability of the model. Section 3 extends the model in two ways: by assuming a market structure of two duopolists competing with each other in the presence of a group of smaller competitors, and by adopting a more general cost function. Section 4 derives propositions under these new conditions, while Section 5 discusses the overall results for this model and that of chapter 2.

## **(ii) The Grocery Products Industry**

The emergence and growth of strong private label brands has been one of the key trends in the food industry in recent years, according to a survey by *The Economist* in late 1993. This trend has been particularly evident in the U.K. As shown in Figure 3.1, penetration of private labels in U.K. grocery categories has reached 32%, a level which is closely followed by the Swiss and French grocery markets.

(Figure 3.1)

In Canada, private labels held a market share of 21% of all categories monitored by A.C. Nielsen in 1993. Market shares of private labels, generics and the leading manufacturers' brands are shown in Appendix 3.1. It can be seen that private label share varies widely across categories. In the Household Cleaners category, for example, private labels hold a share of only 2.5%, whereas private label Vinegars constitute 54.6% of the market.

It is also evident from Appendix 3.1 that grocery markets tend to be relatively concentrated. Figure 3.2 shows mean shares across A.C. Nielsen categories for the top three national brands, along with private label and generic brand shares. The top two national brands together account for almost 60% of the market, while the third national brand, on average, has a share under 8%. The shares of the top two national brands and private labels together account for over 80% of grocery markets. This pattern of two dominant national brands and a relatively small third brand holds across the vast

majority of grocery categories.

(Figure 3.2)

The reason for this pattern is open to speculation; however, one plausible explanation is that retailers are reluctant to use scarce shelf space on brands that do not generate sufficient volume, and tend to apply a "cutoff" rule of thumb in stocking only the top two national brands in addition to their private label.

Grocery markets are also known for their high level of channel conflict: with thousands of products competing for limited shelf space, manufacturers find themselves devoting an ever-increasing proportion of their marketing budgets to trade promotion (*The Economist*, 1992). In addition to promotional price discounts, manufacturers offer a plethora of allowances for shelf placement, co-operative advertising, display and volume buying.

Among manufacturers, conventional wisdom holds that large retail chains are powerful players that can exercise monopsony power in extracting favourable terms from manufacturers. However, there is little evidence of supranormal profits among grocery retailers. Appendix 3.2 lists reported profit figures for food manufacturers and retailers (*Globe and Mail*, 1994). It is evident that, while food retailers' sales revenues tend to be considerably higher than those of manufacturers, their average five-year return on capital (unadjusted for inflation) is lower than that of their suppliers.

Retailers' power versus manufacturers derives primarily from their control of a scarce resource, shelf space. Nevertheless, competition between the major chains is fierce. Appendix 3.3 shows the market shares of the major food retailing chains by province (*Canadian Grocer*, 1993):

it can be seen that the food retailing sector in most regions is quite fragmented. Although retailers in the industry form buying groups to obtain better deals from manufacturers, competitive pressure forces them to pass the bulk of these savings on to consumers. With overstoreing in grocery retailing as in other retail sectors (Stern and El-Ansary, 1988), consumers' search costs are often minimal and store switching is common. According to a 1991 survey by the *Canadian Grocer*, 45% of consumers gave "Lower Prices" as their main reason for switching stores, followed by "More Convenient Location" at 38%. Retailers' margins are under severe pressure, and any opportunity to obtain concessions from manufacturers will be exploited in the interests of survival. A recent study by Messinger and Narasimhan (1995) concludes that grocery retailers have not gained profitability at the expense of manufacturers in the last two decades, but that both manufacturers and retailers have experienced reductions in profitability.

The emergence of higher quality private labels in grocery markets is an indication of increasing sophistication among grocery retailers. In Canada, following Loblaw's success with its President's Choice range, other major retailers have followed suit with their own high quality private label lines. However, high quality private labels have been well established in grocery retailing in the U.K. for over 10 years, and in other retail sectors, such as apparel, for longer. High quality private labels not only allow retailers to improve their margins by offering added value to consumers, but can generate loyalty to a particular retailer by virtue of their exclusivity to that retailer. It is interesting that those grocery retailers who have introduced high quality private labels have not forsaken their traditional, lower quality store brands: by offering both, these retailers can appeal both to consumers who value high quality and to those who are more concerned about price.

In summary, grocery retailers face an oligopolistic<sup>9</sup> market in which prices are subject to severe competitive pressure. Private labels provide them with the opportunity to increase margins and offer consumers better value. In setting prices, the standard practice is for manufacturers to consider competing manufacturers' prices and consumer demand, taking into account standard levels of retail markup and prevailing levels of promotional allowances.

Manufacturers' cost structures vary widely within the industry, depending on the type of product. Detergents manufacturing is highly capital intensive, for example, due to the need for spray drying. A similar situation prevails in instant coffee manufacturing where freeze-drying is used extensively. On the other hand, bottled still beverages require little processing other than mixing and filling. However, almost all food manufacturers are affected by economies or diseconomies of scale and scope to some degree.

The extensions to the model proposed in the remainder of this chapter reflect the conditions described here. The typical market structure of two large firms and a group of smaller competitors is represented by using a "dominant firm" model (Scherer, 1980). This type of model also reflects the fact that smaller firms often enter grocery categories as private label suppliers. The cost structure of the industry is represented by a quadratic cost function with an interaction term to reflect economies or diseconomies of scope. These extensions are discussed in the next two sections. The standard retail pricing practice of adding a markup to manufacturers' prices is modelled, as in chapter 2, by assuming that the manufacturer is a Stackelberg leader who takes the retailer's markup rule into account in setting prices. As in the duopoly model of chapter 2, we focus on the manufacturer's

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<sup>9</sup> At a regional level, but competitive at a local level due to ready accessibility of stores in metropolitan areas and zone pricing (see chapter 5).

problem assuming that retailers' selling costs are fixed. Retailer power is represented in this model by the assumption that manufacturers' national brands are differentiated, but that the dominant manufacturers are otherwise identical. Thus the retailer can shop around to find a better deal on the private label, but her ability to do so on the national brands is limited.

### **(iii) The Extended Model**

#### ***Dominant Firm Model***

The dominant firm version of the model follows Scherer (1980). For the time being, we continue to assume constant marginal costs. This will be relaxed later.

We begin by specifying the final demand functions for the two national brands and the private label, following the structure laid out in the duopoly model of Chapter 2:

$$\begin{aligned} q_{n1} &= \alpha_1 - \beta_1 p_{n1} + \sigma p_{n2} + \theta_1 p_r \\ q_{n2} &= \alpha_2 + \sigma p_{n1} - \beta_2 p_{n2} + \theta_2 p_r \\ q_r &= \alpha_r + \theta_1 p_{n1} + \theta_2 p_{n2} - \beta_r p_r \end{aligned}$$

As before, parameters are constrained so that  $\alpha_1 > 0$ ;  $\alpha_2 > 0$ ;  $\alpha_r > 0$ ;  $\beta_1 > 0$ ;  $\beta_2 > 0$ ;  $\beta_r > 0$ ;  $\theta > 0$ ;  $\sigma > 0$ ;  $\sum \theta_i / \beta_r < 1$ ;  $p_1 \geq (1/\theta_1)(\beta_r p_r - \theta_2 p_2 - \alpha_r)$ ;  $p_{n2} \geq (1/\theta_2)(\beta_r p_r - \theta_1 p_1 - \alpha_r)$  and  $p_r \geq (1/\theta_1)(\beta_1 p_{n1} - \sigma p_{n2} - \alpha_1)$ . The underlying utility function is quadratic as in the monopoly model, with similar constraints on its parameters. It is assumed that there is only one retailer, although the model is generalizable to competitive retailers as is shown for the monopoly model in Appendix 2.4.

We assume that the market consists of two dominant manufacturers and a "fringe" which supplies only private labels; since private labels are typically unadvertised, barriers to entry in this segment of the market will be lower than for national brands (Bain, 1954), allowing fringe firms to enter. The fringe is assumed to be competitive, supplying private labels at prices equal to marginal cost. In Figure 3.3(a), assume that the lowest cost at which the competitive sector can supply the private label is  $m_c$ , higher than dominant firm 1's cost of  $m_1$ , but lower than its equilibrium wholesale price,  $w_r^*$ .

(Figure 3.3)

If the dominant firm wants to supply the private label, it must charge  $m_c$  or less. In effect, the demand curve facing the dominant firm is now  $ABD'$ , instead of  $DD'$  before. Hence the derived demand functions facing the dominant firms become:

$$\left. \begin{aligned} q_{n1} &= \frac{1}{2}(\alpha_1 - \beta_1 w_{n1} + \sigma w_{n2} + \theta_1 w_r) \\ q_{n2} &= \frac{1}{2}(\alpha_2 + \sigma w_{n1} - \beta_2 w_{n2} + \theta_2 w_r) \\ q_r &= \frac{1}{2}(\alpha_r + \theta_1 w_{n1} + \theta_2 w_{n2} - \beta_r w_r) \end{aligned} \right\} \text{For } w_r^* < m_c$$

and

$$\left. \begin{aligned} q_{n1} &= \frac{1}{2}(\alpha_1 - \beta_1 w_{n1} + \sigma w_{n2} + \theta_1 m_c) \\ q_{n2} &= \frac{1}{2}(\alpha_2 + \sigma w_{n1} - \beta_2 w_{n2} + \theta_2 m_c) \\ q_r &= \frac{1}{2}(\alpha_r + \theta_1 w_{n1} + \theta_2 w_{n2} - \beta_r m_c) \end{aligned} \right\} \text{For } w_r^* > m_c$$

Where  $w_r^* > m_c$ , the retailer demands a higher quantity of the private label,  $q_r$ ". As shown in Figure 3.3(b), this in turn shifts the demand function for the national brand further down than it would have done if the private label were supplied by equating the dominant firm's marginal cost with its marginal revenue. The new demand function for the national brand is DD".

With a competitive fringe, the duopolists' choice of strategy must take into account the fact that the fringe will supply if they do not. Hence each of the two dominant firms considers its strategy in the context of the anticipated reactions of both the competitive fringe and its "quasi-duopolistic" competitor. In this new set of circumstances, the trade-off faced by a dominant manufacturer is different from before: if he wants to supply the private label, he must bid below cost and lose money, knowing that, if he does not supply, the competitive sector will do so anyway.

### *Quadratic Cost Function*

The simplifying assumption of constant marginal costs (linear total costs) in the baseline model is now extended by adopting a more general cost function of the form

$$C = aq_n + \frac{1}{2}bq_n^2 + cq_r + \frac{1}{2}dq_r^2 + eq_nq_r.$$

assumed to be identical across both dominant firms, and subject to  $a > 0$ ;  $c > 0$ ;

$b \geq e$ ;  $a \geq c$  and  $d \geq e$ . Hence the national brand's costs are constrained to be at least as great as those of the private label, and  $\partial^2 C / \partial q_n^2 \geq \partial^2 C / \partial q_n \partial q_r$ , or product-specific scale economies for each product exceed economies of scope - it is more economical (from a cost minimization perspective) to produce more of one product than to start producing a second. For positive costs, we impose the

constraints  $q_n > (2/b)(eq_n - a)$  and  $q_r > (2/d)(eq_r - c)$  (see Appendix 3.4). We continue to assume that the retailer has constant marginal costs.

Marginal costs for each product are

$$C_n = a + bq_n + eq_n$$

$$C_r = c + dq_r + eq_r$$

Average Incremental Costs, the ratio of the total incremental costs of each brand to its sales volume, are

$$AIC_n = a + \frac{1}{2}bq_n + eq_n$$

$$AIC_r = c + \frac{1}{2}dq_r + eq_r$$

The initial fixed costs of production for the manufacturer will drop out in the profit comparison between the supply-do not supply scenarios, and are thus assumed to be zero. We also assume that the manufacturer incurs no incremental fixed costs in supplying the private label: in effect, we are assuming that the manufacturer has sufficient extra capacity available to supply the private label, and that the extra fixed costs associated with production of a second brand (e.g. printing plates for packaging) are small.

For different parameter values, the cost function exhibits different properties<sup>10</sup>. These are described below and illustrated in Figure 3.4:

(Figure 3.4)

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<sup>10</sup> With each of three parameters equal to, less than or greater than zero, there are a total of 27 possible combinations. A representative set is presented here.

**Case 1:  $b=d=e=0$**

In this case, the cost function reduces to  $C = aq_n + cq_r$ . Marginal costs are constant, equal to  $a$  for the national brand and  $c$  for the private label. Hence the baseline scenario of constant marginal costs is a special case of this quadratic cost function.

**Case 2:  $b>0, d>0$**

With positive parameters on both quadratic terms, the cost function is increasing and strictly convex<sup>11</sup>. Both the national brand and the private label exhibit decreasing product-specific returns to scale, since Marginal Costs exceed Average Incremental Costs.

**Case 3:  $e<0$**

A negative interaction term shifts the cost function downward with the introduction of a second brand. Cost complementarities exist, defined as  $C_{nr} < 0$  and  $C_{rn} < 0$  where the subscripts denote the second derivatives of the cost function. Gorman (1985) argues that economies of scope may arise from fixed costs rather than from cost complementarities. In this case, since fixed costs are assumed to be zero, economies of scope arise entirely from cost complementarities.

Hence this case represents a situation in which the total cost of producing two products in one firm are lower than the costs of producing the two goods separately<sup>12</sup> (Bailey

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<sup>11</sup>  $\partial C/\partial q_i > 0$  and  $\partial^2 C/\partial q_i^2 > 0$  for  $q_i > 0$ .

<sup>12</sup> Algebraically,  $C(q, q) < C(q, 0) + C(0, q)$ .

and Friedlaender, 1982; Baumol, Panzar and Willig, 1982). Economies of scope arise because of the use of shared machinery, labour or materials in production.

**Case 4:  $b < 0, d < 0$**

In this case, the cost function for each product becomes concave and exhibits increasing product-specific returns to scale:  $\partial C / \partial q_i > 0$  and  $\partial^2 C / \partial q_i^2 < 0$  for  $q_i > 0$ . Average Incremental Costs for each product lie above Marginal Costs.

**Case 5:  $e > 0$**

In contrast to Case 3, a positive interaction term represents diseconomies of scope (cost anticomplementarities, i.e.  $C_{nr} > 0$  and  $C_{rn} > 0$ ), under which producing two products in one firm is more costly than producing them separately.

**Profit Maximization**

In general, manufacturer  $i$  maximizes the objective function

$$\pi^i = \sum_j w_j(q_i, q_j)q_j - C(q_i, q_j)$$

As we saw in Chapter 2, a manufacturer facing a linear demand function passes on half of any cost increase to a retailer where his marginal costs are constant. This standard result for linear demand functions (see, for example, Varian, 1992, p.237-8) is due to the fact that the marginal revenue function has twice the slope of the demand function and marginal cost is constant [see Figure 3.5 (a)].

(Figure 3.5)

However, with a quadratic cost function, the result no longer holds. Consider a simplified case of a manufacturer facing the demand function  $q = \alpha - \beta w$  for a single product and having total costs of  $C = aq$ , or constant marginal costs of  $MC = a$ . Then the manufacturer chooses the price

$$w = \frac{1}{2}[\alpha/\beta + a]$$

as before, and the manufacturer passes on half of any increase in cost.

If the manufacturer's total costs are  $C = aq + \frac{1}{2}bq^2$ , marginal costs become  $MC = a + bq$ , and the manufacturer chooses the price

$$w = \frac{(\alpha + a\beta + \alpha\beta b)/(\beta^2 b + 2\beta)}$$

Where  $b = 0$ , this reduces to the above price based on constant marginal costs. However, where  $b \neq 0$ ,  $\partial w/\partial a = 1/(\beta b + 2)$  and  $\partial w/\partial b = \alpha(1 - \beta)/(\beta^2 b + \beta b + 4)$ . Hence the manufacturer no longer passes on half of cost changes as before, but will take into account the overall change in costs resulting from a change in one parameter.

This is shown in Figure 3.5 (b), which shows the effect of an increase in  $b$  on the equilibrium

price, for  $b > 0$ . In contrast to the situation in which marginal costs are constant, the proportion of cost increases which are passed on depends on the point at which marginal revenues and marginal costs intersect - i.e. the equilibrium price and quantity, *and* on the rate of increase in the parameter  $b$ .

Turning to the dominant firm model, equilibrium prices for a duopolistic manufacturer supplying a national brand and a private label are as follows (see Appendix 3.5):

$$w_{nl}^* = \frac{1}{2}[(\alpha_l \beta_r + \theta_l \alpha_r) / (\beta_l \beta_r - \theta_l^2) + (\sigma \beta_r + \theta_l \theta_2) w_{n2} / (\beta_l \beta_r - \theta_l^2) + C_{nl}]$$

$$q_{nl}^* = \frac{1}{4}(\alpha_l - \beta_l C_{nl} + \theta_l C_r + \sigma w_{n2})$$

for the national brand, and

$$w_r^* = \frac{1}{2}[(\alpha_r \beta_l + \alpha_l \theta_l) / (\beta_l \beta_r - \theta_l^2) + (\sigma \theta_l + \beta_l \theta_2) w_{n2} / (\beta_l \beta_r - \theta_l^2) + C_r]$$

$$q_r^* = \frac{1}{4}(\alpha_r - \beta_r C_r + \theta_l C_{nl} + \sigma w_{n2})$$

for the private label, where  $C_{nl}$  is the marginal cost of the national brand, and  $C_r$  is the private label's marginal cost. These prices and quantities are similar to those we have derived for the duopoly model. However, since marginal costs are now a function of demand, the explicit solution for prices in term of exogenous parameters is somewhat more complex:

$$w_{nl}^* = \frac{1}{2}[(A_l B_r + A_r \Theta_l) / (B_l B_r - \Theta_l^2) + (\Sigma B_r + \Theta_l \Theta_2) w_{n2} / (B_l B_r - \Theta_l^2)]$$

and  $w_r^* = \frac{1}{2}[(A_r B_l + A_l \Theta_l) / (B_l B_r - \Theta_l^2) + (\Sigma \Theta_l + B_l \Theta_2) w_{n2} / (B_l B_r - \Theta_l^2)]$

where

$$A_l = \alpha_l + (\beta_l a - \theta_l c) + \frac{1}{2} \alpha_l (\beta_l b - \theta_l e) - \frac{1}{2} \alpha_r (\theta_l d - \beta_l e)$$

$$A_r = \alpha_r + (\beta_r c - \theta_l a) + \frac{1}{2} \alpha_r (\beta_r d - \theta_l e) - \frac{1}{2} \alpha_l (\theta_l b - \beta_r e)$$

$$\begin{aligned}
B_l &= \beta_l + \frac{1}{4}\beta_l(\beta_l b - \theta_l e) + \frac{1}{4}\theta_l(\theta_l d - \beta_l e) \\
B_r &= \beta_r + \frac{1}{4}\beta_r(\beta_r d - \theta_r e) + \frac{1}{4}\theta_r(\theta_r b - \beta_r e) \\
\Theta_l &= \theta_l + \frac{1}{4}\theta_l(\beta_r d - \theta_r e) + \frac{1}{4}\beta_r(\theta_l b - \beta_r e) \\
\Theta_2 &= \theta_2 + \frac{1}{2}\theta_2(\beta_r d - \theta_r e) - \frac{1}{2}\sigma(\theta_l b - \beta_r e) \\
\Sigma &= \sigma + \frac{1}{2}\sigma(\beta_l b - \theta_l e) - \frac{1}{2}\theta_2(\theta_l d - \beta_l e)
\end{aligned}$$

It can readily be seen that these prices are again of the same form as those of the duopoly model. In Case 1, where  $b = d = e = 0$ , these prices reduce to the duopoly prices of the previous chapter. Instead of passing half of any increase in marginal cost, the manufacturer takes into account all the parameters of the cost function and relative elasticities of the two brands.

#### **(iv) The Private Label Supply Decision**

As in chapter 2, the two dominant firms each decide whether to bid to supply the private label and set prices, taking the retailer's pricing rule into account. Hence the strategy combinations in the game are  $\{B,B\}$ ,  $\{B,DNB\}$ ,  $\{DNB,B\}$  and  $\{DNB,DNB\}$  as before. Where neither of the dominant firms supplies, the competitive fringe does so, always setting its price equal to its marginal cost irrespective of the dominant firms' national brand prices. The competitive fringe is thus a non-player whose actions affect the outcome of the game between the dominant firms, but does not actively participate. Hence the structure of the game is unchanged from that described in chapter 2 and Figures 2.4 and 2.5, but the dominant firms' payoffs will change because of the presence of the competitive fringe.

Assume that the competitive fringe can supply the private label at the linearly increasing marginal cost  $C_c(q_r)$ . In contrast to the dominant firms in the industry, capacity is readily available

in the competitive sector, where new firms can enter or exit quite readily by using inexpensive technology or labour intensive production.

Figure 3.6 compares the cost function and profit-maximizing wholesale price of a dominant manufacturer with an increasing and convex cost function (i.e. diseconomies of scale and no economies of scope), with the linear cost of the fringe firms.

(Figure 3.6)

Where the competitive fringe's cost lies below the price charged by the dominant firms, the retailer will purchase from the fringe sector. However, even if a dominant firm's optimal price lies above the competitive fringe's cost, it may make positive profits on the private label by pricing at the competitive level.

Since  $w_r^* > C_r$  (from the manufacturer's optimal prices), the manufacturer will never set private label prices below costs. Similarly, he will not match the competitive fringe's price of  $C_c$  if it lies below his private label costs. Hence there are two interesting scenarios to consider:

$w_r^* > C_c > C_r$ : Since the retailer will not buy at  $w_r^*$ , the dominant manufacturers may reduce their price to  $C_c$ , since the competitive sector would otherwise supply at this price and the dominant firms can make positive profits by doing so.

$C_r < w_r^* < C_c$ : Dominant manufacturers may choose *not* to supply the private label, allowing the competitive sector to provide it at a higher price in order to minimize cannibalization of their national brands.

This reasoning can be applied to private label quality also: the cost to

the competitive sector of producing equivalent quality to the national brands may be high, but they may be able to supply a lower-quality substitute at a lower cost. So the dominant firms can limit cannibalization of their national brands by allowing the competitive sector to supply the lower quality private label<sup>13</sup>.

For the following discussion, we refer to the normal form game in Figure 3.7, which depicts the decision facing the two dominant firms in the same form as the duopoly game of Chapter 2. As before, the strategies open to each of the manufacturers are to supply the retailer's private label ( $\{S\}$ ) or to refuse ( $\{DNS\}$ ), taking into account its rival's payoffs. However, the key difference versus the duopoly game is that in this case, if both refuse to supply, the retailer will procure her private label from the competitive sector. One way or the other, therefore, the duopolists will face private label competition.

(Figure 3.7)

$$\underline{w_r^*} > C_c > C_r$$

The worst situation for both manufacturers occurs when both supply, since they

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<sup>13</sup> In the real world, dominant manufacturers may often have technological advantages over smaller competitive firms, so that the playing field may not appear as level as it is portrayed here. However, the cost functions in the model represent this disparity in technology: since patents are rare in the grocery industry, competitive firms' *costs to produce an equivalent product* to that supplied by the dominant firms may be higher if they do not have equivalent technology. This is the situation in the cold breakfast cereal category, where malting technology to produce Corn Flakes is prohibitively expensive and is owned by only one firm, Kellogg's. Private label cornflakes are not supplied by Kellogg's, but by smaller firms who are unable to match Kellogg's quality.

become Bertrand competitors and bid prices down to marginal costs; hence they make no profit on the private label. Furthermore, their profit on the national brand is reduced relative to the scenario in which one manufacturer supplies at  $C_c$ , because the private label will cannibalize more of its volume at this lower price.

Each manufacturer makes the same profit on the national brand when he supplies it at  $C_c$ , versus allowing the competitive sector to supply at that price. However, because  $C_c > C_r$ , he still makes positive profits on the private label. Hence there are two Nash equilibria:  $\{S, DNS\}$ , and  $\{DNS, S\}$ . Only one manufacturer will supply the private label.

It can be shown that  $\partial w_r^* / \partial \alpha_r > 0$ ;  $\partial w_r^* / \partial \beta_r < 0$ ;  $\partial w_r^* / \partial \theta_r > 0$ , as in the monopoly and duopoly models. Hence the supplying manufacturer's prices are highest, and this scenario is most likely to occur, where consumer preference for the private label is high, private label own-price response is low, or cross-price response between the national brand and the private label is high. These conditions, as we have already seen in Chapter 2, favour the supply of private labels by one manufacturer.

$$\underline{C_r} < w_r^* < C_c:$$

In this situation, the manufacturers can charge their equilibrium price. However, the presence of the competitive sector can change the outcome relative to the duopoly scenario of Chapter 2.

As before, each manufacturer is better off not supplying if his competitor supplies. However, it is the relative size of each individual manufacturer's payoff when he alone supplies, versus allowing the competitive sector to supply, that determines the equilibrium.

By supplying, he will provide the private label to the retailer at a *lower* price than the competitive fringe. As a result, his national brand will be cannibalized to a greater extent; however, he now has additional profit from the private label. The equilibrium depends on whether the extra profit from supplying the private label is sufficient to outweigh the loss due to "extra" national brand cannibalization. If it is, the equilibria are {S,DNS} and {DNS,S} as before: one manufacturer will supply. If not, the equilibrium is {DNS, DNS}: neither will supply.

From the foregoing discussion, it can be concluded that, in equilibrium, one dominant manufacturer will supply the private label, except where his supply price is lower than the competitive sector's costs. In this situation, the manufacturers will compare the national brand sales volume and profit lost by supplying the private label, with cannibalization where the competitive sector supplies.

To determine the equilibrium in this latter situation, we compare a manufacturer's total profits when he supplies the private label versus his profits when the competitive sector supplies, assuming  $C_r < w_r^* < C_c$ . The difference in profits between the two scenarios is (see Appendix 3.7)

$$\begin{aligned} \Delta \pi^{M1} = & \quad \frac{1}{2}[(\alpha_1 \beta_r + \theta_1 \alpha_r) / (\beta_1 \beta_r - \theta_1^2) + (\sigma \beta_r + \theta_1 \theta_2) w_{n2} / (\beta_1 \beta_r - \theta_1^2) \\ & + C_{n1}]^{1/4} (\alpha_1 - \beta_1 C_{n1} + \theta_1 C_r + \sigma w_{n2}) + \frac{1}{2}[(\alpha_r \beta_1 + \alpha_1 \theta_1) / (\beta_1 \beta_r - \theta_1^2) \\ & + (\sigma \theta_1 + \beta_1 \theta_2) w_{n2} / (\beta_1 \beta_r - \theta_1^2) + C_r]^{1/4} (\alpha_r - \beta_r C_r + \theta_1 C_{n1} + \sigma w_{n2}) - C \\ & - \frac{1}{2}[(\alpha_1 / \beta_1) + (\sigma / \beta_1) w'_{n2} + (\theta_1 / \beta_1) C_c + C'_{n1}] [^{1/4} (\alpha_1 - \beta_1 C'_{n1} + \theta_1 C_c + \sigma w'_{n2})] + C' \end{aligned}$$

This is similar to the profit difference in a pure duopoly seen in Chapter 2. with two important differences: (i) the cost function can change between the two options where it is assumed constant in the baseline model; (ii) the assumption that the competitive sector supplies if neither duopolist supplies means that the manufacturer's national brand price is different. Specifically, the national brand's price when neither manufacturer supplies is now

$$w'_{nl} = \frac{1}{2}[(\alpha_1/\beta_1) + (\sigma/\beta_1)w'_{n2} + (\theta_1/\beta_1)C_c + C'_{nl}],$$

versus

$$w'_{nl} = \frac{1}{2}[(\alpha_1\beta_r + \theta_1\alpha_r)/(\beta_1\beta_r - \theta_1^2) + (\sigma\beta_r + \theta_1\theta_2)w'_{n2}/(\beta_1\beta_r - \theta_1^2) + C'_{nl}]$$

in the pure duopoly model.

As shown in Appendix 3.6, the national brand's price will increase with supply of the private label if

$$\theta_1(w_r - C_r) > \frac{1}{2}(\beta_1\Delta C_{nl} + \theta_1C_c + \sigma\Delta w_{n2})$$

That is, the profit margin on the private label needs to exceed a function of marginal cost change, competitive sector marginal costs and the change in the competing duopolist's price. The higher the right-hand side of this expression, the less likely it is that the national brand's price will increase. Hence a higher competitive sector cost means that it becomes optimal to price the private label higher, and less attractive for the manufacturer to segment the market by pricing the private label low and the national brand high. Without the benefit of segmenting the market, private label becomes a less profitable proposition. Similarly, the more national brand costs increase (decrease) between the two scenarios, the less (more) likely it is that the national brand price will increase.

### Demand Function Parameters

From the profit comparison in Appendix 3.7, we have the following propositions with respect to the parameters of the demand function<sup>14</sup>.

**Proposition 3.1:**                    *Private label supply becomes more profitable for a dominant firm with increases in cross-price response between the private label and the national brand.*

**Proof:**                                *See Appendix 3.8*

Appendix 3.8 shows that  $\partial \Delta \pi^{Ml} / \partial \theta_j > 0$ . However, where competitive sector costs are high, the manufacturer may nonetheless prefer to allow the competitive fringe to supply.

The effect of  $\theta_j$  also interacts with the quadratic and cross-product terms of the cost function, b, d and e. e.g. where  $b > 0$ , increases in  $\theta_j$  *reduce* the profitability of private label supply. Since increases in  $\theta_j$  result in increases in national brand sales volume and  $b > 0$  means that there are diseconomies of scale, it becomes less profitable to produce both products with increases in b.

The positive effect of cross-price response was evident in the baseline model and is sufficiently important to repeat briefly here. While the effect appears counterintuitive, it is quite logical within the structure of the model. When the price of a brand rises, consumers have only two choices: to switch to another brand or not to buy any brand in the category. Cross-price response between brands is an indicator of consumers' propensity to switch brands *rather than leave the*

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<sup>14</sup> In this part of the analysis, we assume  $b=d=e=0$  as a starting point, since these terms interact with the demand parameters.

market<sup>15</sup>. The manufacturer that supplies both the national brand and the private label can take advantage of a high propensity among consumers to switch brands by segmenting the market and increasing national brand prices. Hence it is positively related to aggregate demand, prices and profitability.

**Proposition 3.2:**                      *Private label supply becomes less profitable for a dominant firm as the own-price response of the private label increases.*

**Proof:**                                  *See Appendix 3.9.*

As shown in Appendix 3.9,  $\partial \Delta \pi^M / \partial \beta_r < 0$ . The negative effect of private label own-price response which we saw in the baseline model also extends to the duopoly/competitive fringe model. As before, it is in the manufacturer's interest to supply a private label with low own-price response, because its price response is negatively related to category expansion and to private label prices.

**Proposition 3.3:**                      *The profitability of private label supply for a dominant firm increases with increases in intercept demand for the private label.*

**Proof:**                                  *See Appendix 3.10.*

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<sup>15</sup> Hence the issue is one of "category stability", rather than switching as such.

Appendix 3.10 shows that  $\partial \Delta \pi^M / \partial \alpha_r > 0$ , except where private label intercept demand interacts with private label marginal costs. In other words, to the extent that increasing intercept demand increases revenue, the manufacturer is better off; but increasing intercept demand can also increase private label costs through the parameters of the cost function, which reduces the profitability of private label supply.

Again, this effect is consistent with the baseline model. As the private label becomes a "stronger" brand, in the sense of higher intercept demand, the dominant firms become more interested in supplying it themselves rather than leave it to the competitive fringe.

In summary, one manufacturer will supply the retailer's private label unless the competitive sector's costs are much higher than the optimal prices of the dominant firms - in which case the manufacturers' national brands will not suffer excessive cannibalization if the competitive sector is allowed to supply - or the private label itself is unattractive. By similar intuition to that discussed in Chapter 2, the ideal private label has high consumer demand and low own-price response. Increased category loyalty, represented by the cross-price response parameter  $\theta_r$ , makes private label supply more profitable, since higher levels of category loyalty allow the manufacturer to raise prices on the national brand while using the private label to appeal to those consumers who switch brands.

### **Cost Parameters**

We now turn to the role played by economies of scale and scope in a dominant manufacturer's decision to supply the private label. Each of Cases 2-5 described in the previous section is considered in turn.



attractive for the manufacturer to consider supplying the private label.

This can be understood more fully by examining the relationship between  $b$  and private label profitability at optimal quantities<sup>16</sup>, from Appendix 3.11:

$$\frac{\partial \Delta \pi^{MI}}{\partial b} = \frac{1}{4} \{ (\theta_1 d - \beta_1 e) q_{nl}^* q_r^* + \theta_1 c q_{nl}^* - \beta_1 a \Delta q_{nl}^* + \theta_1 e q_{nl}^{*2} \} - \frac{1}{2} \Delta (q_{nl}^{*2})$$

Since the manufacturer cannot supply the private label at a higher price than the competitive sector, his national brand sales volume when he supplies the private label will be equal to or lower than that when the competitive sector supplies, i.e.  $\Delta q_{nl} \leq 0$ . Applying the constraints  $d \geq e$  and  $\theta_1 > \beta_1$ , the expression is clearly positive.

The positive impact of decreasing returns to scale on the national brand depends on the term  $\theta_1 d - \beta_1 e$ , which expresses the comparison between private label returns to scale and economies of scope, moderated by own-price and cross-price response. In other words, the effect interacts with the terms of the private label's cost function, and with substitutability.

Increases in  $d$  have the opposite effect, increasing the marginal costs of the private label in relation to that of the national brand. Private label supply thus becomes less profitable. The effect of  $d$  is as follows:

$$\frac{\partial \Delta \pi^{MI}}{\partial d} = -\frac{1}{4} (\beta_1 c - \theta_1 a) q_r^* - \frac{1}{4} (\beta_1 e - \theta_1 b) q_r^* q_{nl}^* - \frac{1}{4} (\beta_1 d - \theta_1 e) q_r^{*2} - \frac{1}{2} q_r^{*2}$$

The first term in this expression,  $-\frac{1}{4} (\beta_1 c - \theta_1 a) q_r^*$ , represents a trade-off by the manufacturer

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<sup>16</sup> The quantity terms are evaluated at their optimal levels, following the Envelope Theorem.

of the unit costs of the two brands (the intercepts of the marginal cost function). The second term,  $\frac{1}{4}(\beta_r e - \theta_l b) q_r^* q_{nl}^*$ , can be seen as a comparison between national brand diseconomies of scale and the economies of scope derived from producing both products together. The third term,  $\frac{1}{4}(\beta_r d - \theta_l e) q_r^{*2}$ , represents a similar comparison for the private label.

Assume for the moment that  $a=c$  and  $b=d=e$ ; then this reduces to

$$\partial \Delta \pi^{MI} / \partial d = -\frac{1}{4}a(\beta_r - \theta_l) q_r^* - \frac{1}{4}b(\beta_r - \theta_l) q_r^* q_{nl}^* - \frac{1}{4}b(\beta_r - \theta_l) q_r^{*2} - \frac{1}{2}q_r^{*2}$$

Since  $\beta_r > \theta_l$ , the overall effect of  $d$  is negative. However, its level is influenced by the manufacturer's comparison of the other cost terms. If national brand costs (the terms  $a$  and  $b$ ) are very high, they can outweigh the negative effect of decreasing returns to scale on the private label; in other words, if the national brand is very expensive to produce, the private label may appear attractive by comparison. If the national brand exhibits diseconomies of scale ( $b$  is high relative to  $e$ ), the private label can appear more attractive.

### **Case 3: $e < 0$**

The case of  $e < 0$  represents economies of scope, where the total cost of producing both products is less than the sum of their individual costs. The following proposition expresses their effect in the model.

**Proposition 3.5:** *For  $e < 0$ , increases in  $|e|$  have a positive effect on manufacturers' propensity to supply the private label.*

**Proof:** See Appendix 3.12.

The idea that a manufacturer would be more prepared to supply the private label where there are economies of scope is consistent with intuition. From Appendix 3.12, we have

$$\begin{aligned} \partial \Delta \pi^{M'} / \partial e &= -\frac{1}{4}(\beta_r a - \theta_l c) q_r^* - \frac{1}{4}(\beta_l c - \theta_r a) q_{nl}^* - \frac{1}{4}(\beta_r d - \theta_l e) q_{nl}^* q_r^* \\ &\quad - \frac{1}{4}(\beta_l e - \theta_r d) q_r^{*2} - \frac{1}{4}(\beta_l e q_r^{*2} - \theta_r b q_{nl}^{*2}) - q_{nl}^* q_r^* \end{aligned}$$

The sign of this derivative is negative: hence for  $e < 0$ , the effect is positive. Again setting  $a=c$  and  $d=b=e$ , this becomes

$$\begin{aligned} \partial \Delta \pi^{M'} / \partial e &= -\frac{1}{4}a(\beta_r - \theta_l) q_r^* - \frac{1}{4}a(\beta_r - \theta_l) q_{nl}^* - \frac{1}{4}d(\beta_r - \theta_l) q_{nl}^* q_r^* \\ &\quad - \frac{1}{4}d(\beta_r - \theta_l) q_r^{*2} - \frac{1}{4}b(\beta_l q_r^{*2} - \theta_r q_{nl}^{*2}) - q_{nl}^* q_r^* \end{aligned}$$

As before, the effect of this cost parameter rests on the relationship among the other cost parameters and on the own/cross response relationship. We can interpret the first two terms in the above expression as a comparison of intercept marginal costs between the two products; and the third, fourth and fifth terms as a comparison of the diseconomies of scale to be derived from producing one product with the economies of scope from producing both. The impact of economies of scope increases with the sales volume of either product. However, it is moderated by the other terms of the cost function and by elasticities.

**Case 4:  $b < 0, d < 0$**

With  $b$  and  $d$  negative, the manufacturer has increasing product-specific returns to scale on both the private label and the national brand. As the manufacturer produces more of the national brand or of the private label, his unit cost decreases. Proposition 3.6 is then the reverse of Proposition 3.4:

**Proposition 3.6:** (a) *Where  $b < 0$ , increases in  $|b|$  have a negative impact on dominant manufacturers' propensity to supply a retailer's private label.*

(b) *Where  $d < 0$ , increases in  $|d|$  have a positive impact on dominant manufacturers' propensity to supply a retailer's private label.*

**Proof:** *See Appendix 3.11.*

With negative  $b$  and  $d$ ,  $\partial^2 C / \partial q_n^2 < 0$  and  $\partial^2 C / \partial q_r^2 < 0$ . Hence, with positive marginal costs, the cost function is concave as shown in Figure 3.4(d). Increases in  $b$  or  $d$  increase the responsiveness of total costs to changes in sales volume.

Interpretation of the effect of these parameters is the reverse of our earlier discussion. The overall effect of  $b$  on private label supply for  $b < 0$  is negative since the national brand's marginal

costs fall in relation to those of the private label. However, the effect interacts negatively with relative own-price and cross-price parameters. Lower national brand costs discourage the manufacturer from supplying, but where there is a big difference between the manufacturer's equilibrium private label price and that of the competitive sector, the gains on the private label may outweigh the losses on the national brand. As before, the manufacturer compares the cost savings to be obtained by supplying the private label and own- and cross-price elasticities in making the decision.

Similarly, increasing returns to scale on the private label have a positive effect on private label supply propensity. Once again, the effect is moderated by the comparison of intercept marginal costs, returns to scale on the national brand, economies of scope and elasticities.

**Case 5:  $e > 0$**

Where  $e > 0$ , there are diseconomies of scope - the total cost of producing both products is greater than the sum of their individual costs. Proposition 3.7 is the reverse of Proposition 3.5:

**Proposition 3.7:** *For  $e > 0$ , increases in  $e$  have a negative effect on manufacturers' propensity to supply the private label.*

**Proof:** *See Appendix 3.12.*

With diseconomies of scope, the manufacturer is better off, from a cost perspective, producing one product rather than two. However, the trade-off is that the manufacturer may gain

from overall expansion of his sales volume and from cost savings due to changes in the product mix. Hence the negative effect of diseconomies of scope can be outweighed by the other cost function parameters and by own- and cross-price elasticities.

**(v) Discussion and Conclusions**

It is evident, even from this simplified model, that the decision to supply a private label can be difficult and complex, with a host of demand and cost factors pulling in conflicting directions. However, the findings of this model can be boiled down to a few key factors which favour and mitigate against private label supply. These are summarized in the following table and discussed individually below, with particular emphasis on their application to the grocery industry.

<b>FACTORS FAVOURING PRIVATE LABEL SUPPLY</b>	<b>FACTORS AGAINST PRIVATE LABEL SUPPLY</b>
<p>Category expansion</p> <p>Category stability/segmentation</p> <p>Competitive fringe pricing</p> <p>Private Label "attractiveness"</p> <p>Relative economies of scale (PL)</p> <p>Economies of scope</p>	<p>National brand cannibalization</p> <p>Possibility of price war</p> <p>Relative economies of scale (NB)</p> <p>Diseconomies of scope</p>

***Category Expansion***

It was evident from the baseline model that the introduction of a private label can expand

category demand. This result held consistently through the duopoly and dominant firm extensions of the model. If a manufacturer is in a position to benefit from category expansion, his total profitability can improve as a result of private label supply.

However, grocery categories generally are mature do not usually expand very much in practice. In terms of the model, this means that private label intercept demand is low, and private label own-price response and cross-response with national brands are relatively close. In other words, there is typically little consumer loyalty to private labels: they are seen primarily as cheaper substitutes for national brands.

For this reason, the "category expansion" explanation is less likely to hold in the grocery industry than in other categories, although there is anecdotal evidence of firms using private labels to develop a category: Kraft General Foods expanded its capacity and supplied private label Puddings for this reason. In addition, the emergence of "premium" private labels is likely to result in more category expansion.

### ***Category Stability/Segmentation***

The parameter  $\theta$  must be interpreted in the light of its effect on aggregate demand. Increases in  $\theta$  result in increases in aggregate demand, and as a result, in increased prices and profitability.

While this may appear to be an artifact of this type of model, it has an intuitive interpretation. The introduction of a private label means that consumers now have an opportunity to switch to another brand if the price of the national brand rises. Prior to this, their only choice would have been to purchase the national brand at the higher price or refrain from buying at all. So the introduction

of a private label increases *category loyalty* among consumers. Hence increases in cross-price response relative to own-price response can be interpreted as increases in category loyalty, or increases in consumers' reluctance to switch away from the category.

The private label supplier benefits from this. Instead of losing consumers to a competing category, or to a competing private label supplier, the manufacturer who supplies private labels can profitably raise the price of his national brand since he will retain some of those consumers who switch away.

### ***Competitive Fringe Pricing***

The amount of volume loss on the manufacturer's national brand depends, in part, on the relative price of the private label and the national brand. If the manufacturer has lower costs than fringe competitors, he may do better by allowing them to supply the private label at their higher cost. This would be particularly likely if the manufacturer's profit margins on the national brand were much higher than those on the private label. However, if his costs are close to those of the competitive fringe, he is likely to supply.

Another way of interpreting this is that the manufacturer may have proprietary technology, such as that owned by Kellogg's in the cereal category, which would be prohibitively expensive for a fringe competitor. This technology allows him to produce a superior product and limit cannibalization. He can afford to allow the competitive fringe to supply an inferior product, knowing that it would be much more expensive for them to produce a product equivalent to his own.

Again, in spite of the anecdotes, situations such as this are the exception rather than the rule in the grocery industry. Few grocery products have proprietary technology or are so capital intensive

as to prevent smaller competitors from producing a reasonably close substitute. In addition, fringe private label suppliers can have lower costs than their dominant competitors. On the other hand, some grocery manufacturers place great faith in the uniqueness of their brand's image, which fringe competitors could only imitate at great cost.

### ***Private Label "Attractiveness"***

The appeal of the private label to a potential supplier increases as product preference for the private label increases, its own-price response falls and its cannibalization of the national brand falls. Manufacturers would prefer private labels which generate extra sales and are not too price sensitive.

For this reason, we would expect national brand manufacturers to be more interested in supplying "premium" private labels *which do not excessively cannibalize their national brands*. This pattern is evident in the case of E.D. Smith, the supplier of President's Choice bottled sauces to Loblaw's: E.D. Smith's private label sauce business does not directly compete with its national brand. Similarly, Cott Beverages, the much-publicized supplier of President's Choice soft drinks, has only a small national brand, and is unlikely to be particularly worried about cannibalization; Cott's primary concern will be with the viability of the private label itself.

### ***Relative Economies of Scale***

Product-specific economies of scale have an influence on manufacturers' preparedness to supply private labels. However, the important point to bear in mind is that we are concerned with *relative* economies of scale. If the national brand becomes more economical to produce with increases in volume and the private label does not (or does to a lesser degree), the manufacturer will

be more interested in pursuing opportunities to increase his sales of the national brand, rather than supply the private label. Conversely, product-specific economies of scale on the private label relative to the national brand increase a manufacturer's interest in supplying.

### ***Economies of Scope***

Economies of scope, the degree to which it is cheaper to produce both products in one firm than individually, have a positive influence on manufacturers' propensity to supply private labels. Economies of scope are present where two products use common manufacturing facilities or raw materials.

In the grocery industry, manufacturers regularly use private labels as "capacity fillers", which use national brand manufacturing equipment that otherwise would be idle. Hence we would expect that the use of common manufacturing facilities is a motivator for private label supply. In addition, the use of common raw materials means that manufacturers can buy in bulk from suppliers and save on costs.

### ***National Brand Cannibalization***

We have seen that manufacturers can benefit from high private label/national brand substitutability, since it means that consumers are more likely to continue to purchase the product category as national brand prices rise. However, with stable markets for most grocery items, manufacturers may not be particularly concerned about category stability, but instead about the degree to which the private label cannibalizes their national brand. In particular, manufacturers face the risk of becoming Bertrand competitors on private labels, a risk which does not exist for

differentiated national brands.

Substitutability is represented in the model as the degree to which the private label responds to changes in the national brand's price, *as opposed to its own price*. For this reason it is the difference between the private label's own-price response and national brand/private label cross-price parameter,  $\beta_p - \theta_p$ , that measures substitutability.

Depending on the degree to which national brands are differentiated from private labels, private labels will often be quite sensitive to changes in national brand prices. We can expect this to happen particularly where the private label is a significantly cheaper imitation of the national brand. Thus manufacturers may be more interested in supplying premium private labels that are distinct from their national brands.

### ***Price War***

It was evident from the duopoly model of chapter 2 and the dominant firm model of this chapter that a significant consideration for a duopolist in deciding whether to supply a private label is the possible impact of private label supply on his competitor's pricing strategy. If the competing duopolist lowers his national brand price in response to the introduction of the private label, it may be unprofitable to become a private label supplier. In the presence of a competitive sector with costs higher than those of the dominant firms, the competing duopolist may also have less incentive to reduce his national brand price if the competitive firms are allowed to supply. Thus the prospect of sparking off a price war may turn firms away from private label supply.

The idea that private labels "devalue" a category by reducing prices overall is common among marketing executives in grocery manufacturing firms. However, what the model suggests is that

allowing a competitive fringe to supply may help insulate the dominant firms against price competition, if the competitive fringe's costs are sufficiently high.

The model indicates that these factors are the key driving forces behind the supply of private label products in the grocery industry. Nonetheless, there are some limitations to the model's generalizeability across other product categories. In other industries, for example, the assumption that manufacturers are Stackelberg leaders who set prices taking into account retailers' markup rule may not hold. Choi (1991), for example, has shown that a change in the assumption about Stackelberg leadership will change prices and profits in a linear-demand based model. Such a change may be expected to affect the equilibrium in this model also.

The model is capable of extension to future research on private labels. It can be adapted to derive optimal retail and wholesale prices for private labels and national brands, and the optimal price difference from the viewpoint of retailers and manufacturers. Future research should also consider the ability of retailers to differentiate their stores by introducing a private label.

The model's insights have significant implications for marketing practitioners also. It can readily be applied by manufacturers in considering likely competitive strategies, while retailers can determine from it which manufacturers are likely to offer them the best deal. A particularly interesting application would be to develop an expert system based on these theoretical foundations which can recommend optimal strategies to manufacturers for product mix, wholesale prices and price gaps between private labels and national brands. A full discussion of future research possibilities is given in chapter 6.

Having developed the theoretical model, we apply it empirically in the next two chapters. In

chapter 4, we estimate demand parameters for a grocery category; in chapter 5, we use these parameters, along with cost estimates, to make predictions about the profitability of private label supply for a manufacturer in the category.

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**APPENDICES**

**APPENDIX 3.1**  
**BRAND AND PRIVATE LABEL SHARES**

Source: A.C. Nielsen

<u>CATEGORY</u>	<u>#1</u>	<u>#2</u>	<u>TOTAL</u>	<u>#3</u>	<u>TOTAL</u>	<u>P.L.</u>	<u>GENERIC</u>	<u>TOTAL</u>	<u>TOP 2 SHARE</u>	<u>TOP 3 SHARE</u>
			<u>TOP 2</u>		<u>TOP 3</u>			<u>P.L./GEN.</u>	<u>OF NON-PL</u>	<u>OF NON-PL</u>
<b>PAPER PRODUCTS</b>										
BATHROOM TISSUE	34.8	14.2	49.0	6.4	55.4	35.1		35.1	75.5	85.4
FACIAL TISSUES	31.7	28.1	59.8	7.9	67.7	22.6		22.6	77.3	87.5
<b>WRAPPING AIDS</b>										
PLASTIC FOOD WRAPS	25.0	19.3	44.3	5.5	49.8	21.3	27.7	49.0	86.9	97.6
PLASTIC FREEZER BAGS	45.0	28.1	73.1	1.6	74.7	14.0	10.9	24.9	97.3	99.5
PLASTIC GARBAGE BAGS	43.9	26.4	70.3	0.0	70.3	14.2	14.0	28.2	97.9	97.9
- SMALL	43.7	8.0	51.7	3.0	54.7	27.5	14.3	41.8	88.8	94.0
- LARGE	38.6	2.8	41.4	1.1	42.5	34.0	16.9	50.9	84.3	86.6
- GARDEN	57.7	1.7	59.4	1.6	61.0	14.9	23.1	38.0	95.8	98.4
<b>HOUSEHOLD CLEANING</b>										
CHLORINE BLEACH	39.1	25.3	64.4	0.0	64.4	23.2	12.4	35.6	100.0	100.0
DISHWASHER DETS.	31.6	31.3	62.9	9.5	72.4	23.3		23.3	82.0	94.4
DISHWASHING LIQ.	33.9	22.9	56.8	11.3	68.1	16.9	10.7	27.6	78.5	94.1
FABRIC SOFTENERS	69.2	10.7	79.9	4.5	84.4	13.2		13.2	92.1	97.2
FLOOR WAX	65.8	21.2	87.0	11.7	98.7	1.2		1.2	88.1	99.9
FURNITURE POLISH	47.0	10.6	57.6	9.8	67.4	29.7		29.7	81.9	95.9
GLASS CLEANERS	50.5	6.7	57.2	4.8	62.0	18.0	15.1	33.1	85.5	92.7
BATHROOM CLEANERS	39.1	12.3	51.4	12.1	63.5	7.4	7.8	15.2	60.6	74.9
HOUSEHOLD CLEANERS	26.7	20.4	47.1	16.2	63.3	0.8	1.7	2.5	48.3	64.9
NON-CHLORINE BLEACH	40.1	39.7	79.8	8.7	88.5	0.0	0.0	0.0	79.8	88.5
OVEN CLEANERS	66.3	23.2	89.5	3.9	93.4	6.5		6.5	95.7	99.9
LAUNDRY DETERGENTS	50.2	24.5	74.7	11.2	85.9	5.0	6.4	11.4	84.3	97.0
PRE-WASH SOAKERS	31.5	31.4	62.9	26.3	89.2	2.5	2.8	5.3	66.4	94.2
SOAP	37.8	15.7	53.5	8.9	62.4	21.0		21.0	67.7	79.0
TOILET BOWL CLEANERS	36.3	18.1	54.4	17.1	71.5	21.7		21.7	69.5	91.3
<b>SNACKS</b>										
COOKIES	35.3	12.2	47.5	6.8	54.3	26.3		26.3	64.5	73.7
CRACKERS	68.9	10.7	79.6	6.2	85.8	8.9		8.9	87.4	94.2
MARSHMALLOWS	43.4	10.4	53.8	0.2	54.0	45.9		45.9	99.4	99.8
POPPING CORN	31.3	7.5	38.8	6.0	44.8	33.0		33.0	57.9	66.9
<b>PET FOODS</b>										
CAT FOOD	21.7	18.7	40.4	13.6	54.0	28.8		28.8	56.7	75.8
CANNED CAT FOOD	28.5	14.8	43.3	12.1	55.4	32.9		32.9	64.5	82.6
DRY CAT FOOD	48.9	10.5	59.4	4.5	63.9	26.9		26.9	81.3	87.4
SEMI-MOIST CAT FOOD	73.3	9.6	82.9	0.0	82.9	13.2		13.2	95.5	95.5
DOG SNACKS	48.9		48.9		48.9	16.6		16.6	58.6	58.6

<u>CATEGORY</u>	<u>#1</u>	<u>#2</u>	<u>TOTAL</u> <u>TOP 2</u>	<u>#3</u>	<u>TOTAL</u> <u>TOP 3</u>	<u>P.L. GENERIC</u>	<u>TOTAL</u> <u>P.L./GEN.</u>	<u>TOP 2 SHARE</u> <u>OF NON-PL</u>	<u>TOP 3 SHARE</u> <u>OF NON-PL</u>
<b>FROZEN FOOD</b>									
CONFECTIONS	39.8	12.7	52.5	6.1	58.6	12.7	12.7	60.1	67.1
DINNERS & ENTREES	16.2	12.4	28.6	7.6	36.2	9.4	9.4	31.6	40.0
JUICES & DRINKS	38.6	17.0	55.6	10.9	66.5	19.4	19.4	69.0	82.5
<b>ICE CREAM</b>									
- NATL	23.6	12.4	36.0	10.6	46.6	33.0	33.0	53.7	69.6
- MAR	23.8	18.8	42.6	3.4	46.0	33.0	33.0	63.6	68.7
- QUE	47.9	26.6	74.5	0.2	74.7	16.6	16.6	89.3	89.6
- ONT	46.5	29.0	75.5	15.8	91.3	7.8	7.8	81.9	99.0
- M/S	14.2	1.7	15.9	0.4	16.3	73.5	73.5	60.0	61.5
- ALTA	6.3	3.1	9.4	0.5	9.9	76.9	76.9	40.7	42.9
- B.C.	30.6	1.2	31.8	0.4	32.2	63.5	63.5	87.1	88.2
VEGETABLES	28.3	5.5	33.8	4.1	37.9	51.1	51.1	69.1	77.5
<b>BEVERAGES</b>									
FRUIT DRINKS	20.5	13.2	33.7	7.1	40.8	21.1	21.1	42.7	51.7
HOT CHOCOLATE	48.3	21.9	70.2	14.9	85.1	14.9	14.9	82.5	100.0
ICED TEA MIXES	53.6	6.0	59.6	1.7	61.3	31.8	31.8	87.4	89.9
INSTANT COFFEE	33.2	20.1	53.3	13.7	67.0	27.0	27.0	73.0	91.8
POWDERED DRINKS	70.5	6.2	76.7	4.9	81.6	13.4	13.4	88.6	94.2
REGULAR COFFEE	27.2	24.1	51.3	24.0	75.3	24.7	24.7	68.1	100.0
TEA BAGS	40.3	29.0	69.3	4.7	74.0	15.2	15.2	81.7	87.3
TOMATO/VEG JUICE	32.4	25.9	58.3	21.4	79.7	20.3	20.3	73.1	100.0
COLD FLAV. DRINKS	56.9	15.7	72.6	8.6	81.2	8.7	5.1	13.8	94.2
FLAV. SOFT DRINKS	32.5	33.1	65.6	5.4	71.0	18.0	18.0	80.0	86.6
SPECIALTY TEA	20.7	19.4	40.1	12.3	52.4	6.5	6.5	42.9	56.0
<b>CANNED &amp; PKGD. FOODS</b>									
BAKED BEANS	29.6	14.4	44.0	12.3	56.3	27.3	6.3	33.6	84.8
LUNCHEON MEAT	50.4	34.1	84.5	4.5	89.0	9.3	9.3	93.2	98.1
CANNED PEARS	38.9	17.0	55.9	0.0	55.9	38.5	38.5	90.9	90.9
CANNED PINEAPPLE	32.9	22.0	54.9	1.9	56.8	34.6	34.6	83.9	86.9
CANNED SALMON	32.9	6.2	39.1	4.8	43.9	15.5	5.3	20.8	55.4
SOUP	45.9	11.9	57.8	4.9	62.7	16.6	16.6	69.3	75.2
CANNED TUNA	42.0	10.8	52.8	9.5	62.3	13.4	6.1	19.5	77.4
FLAKED MEAT	59.8	28.6	88.4	5.0	93.4	4.3	2.2	6.5	99.9
CANNED PEACHES	35.0	12.3	47.3		47.3	44.6	44.6	85.4	85.4
FRUIT COCKTAIL	40.4	11.2	51.6	4.2	55.8	38.8	38.8	84.3	91.2
SPAGHETTI SAUCE	31.2	17.1	48.3	16.7	65.0		0.0	48.3	65.0
TOMATO PASTE	40.0	14.7	54.7	7.4	62.1	20.2	20.2	68.5	77.8
SPECIALTY VEG	33.8	5.3	39.1	4.3	43.4	37.7	37.7	62.8	69.7
CANNED VEG (TOTAL)	33.1	20.6	53.7	9.1	62.8	37.2	37.2	85.5	100.0

<u>CATEGORY</u>	<u>#1</u>	<u>#2</u>	<u>TOTAL</u>	<u>#3</u>	<u>TOTAL</u>	<u>P.L.</u>	<u>GENERIC</u>	<u>TOTAL</u>	<u>TOP 2 SHARE</u>	<u>TOP 3 SHARE</u>
			<u>TOP 2</u>		<u>TOP 3</u>			<u>P.L./GEN.</u>	<u>OF NON-PL</u>	<u>OF NON-PL</u>
<b>CONDIMENTS &amp; SAUCES</b>										
DRY MUSTARD	71.9	17.0	88.9	0.0	88.9	11.1		11.1	100.0	100.0
SAUCES/GRAVY MIXES	20.3	19.8	40.1	18.0	58.1	8.0		8.0	43.6	63.2
JAMS & JELLIES	11.9	10.5	22.4	10.3	32.7	36.4		36.4	35.2	51.4
KETCHUP	75.0	0.8	75.8	0.5	76.3	23.0		23.0	98.4	99.1
MAYONNAISE	47.6	15.5	63.1	10.9	74.0	22.4		22.4	81.3	95.4
PEANUT BUTTER	37.7	25.4	63.1	12.8	75.9	24.1		24.1	83.1	100.0
PICKLES	58.4	7.8	66.2	1.8	68.0	22.5		22.5	85.4	87.7
SALAD DRESSINGS	72.4	5.6	78.0	4.0	82.0	9.6		9.6	86.3	90.7
PREPARED MUSTARD	43.4	28.0	71.4	12.6	84.0	16.0		16.0	85.0	100.0
RELISH	42.9	14.0	56.9	6.0	62.9	37.0		37.0	90.3	99.8
SALAD & COOKING OILS	16.6	16.6	33.2	14.4	47.6	17.4	10.5	27.9	46.0	66.0
BBQ SAUCES	54.6	26.7	81.3	1.4	82.7	15.5		15.5	96.2	97.9
VINEGAR	25.7	12.7	38.4	6.1	44.5	35.7	18.9	54.6	84.6	98.0
<b>DRY GROCERY</b>										
ALL PURPOSE FLOUR	44.0	18.0	62.0	6.4	68.4	16.5	9.8	26.3	84.1	92.8
BAKING CHIPS	32.9	30.8	63.7	17.8	81.5	18.5		18.5	78.2	100.0
BAKING CHOCOLATE	91.4	3.4	94.8		94.8	4.8		4.8	99.6	99.6
CAKE & PASTRY FLOUR	59.2	27.4	86.6	3.6	90.2		7.2	7.2	93.3	97.2
COATING MIXES	78.7	4.6	83.3	0.4	83.7	15.7		15.7	98.8	99.3
PANCAKE PREPARATION:	55.6	8.2	63.8	4.3	68.1	31.0		31.0	92.5	98.7
DRY PASTA	52.3	19.9	72.2	4.1	76.3	18.7		18.7	88.8	93.8
HOT CEREALS	51.0	25.6	76.6	6.4	83.0	9.0		9.0	84.2	91.2
REMAINING FLOUR	62.4	19.1	81.5	5.2	86.7	0.6	0.6	1.2	82.5	87.8
RTE CEREALS	45.4	19.8	65.2	14.3	79.5	8.1		8.1	70.9	86.5
STUFFING MIXES	49.1	23.2	72.3	6.5	78.8	3.6		3.6	75.0	81.7
TEA BISCUIT MIXES	50.3	32.1	82.4	6.2	88.6	11.4		11.4	93.0	100.0
WHOLE WHEAT FLOUR	32.6	29.0	61.6	9.6	71.2	13.0	8.4	21.4	78.4	90.6
YEAST	73.6	22.0	95.6	2.2	97.8	0.4		0.4	96.0	98.2
MUFFIN MIXES	48.6	20.3	68.9	13.4	82.3	3.9		3.9	71.7	85.6
BROWNIE MIXES	45.9	26.4	72.3	12.0	84.3	7.4		7.4	78.1	91.0
RICE										
- REG.	32.7	22.9	55.6	16.2	71.8	26.2		26.2	75.3	97.3
- FAST	48.9	25.9	74.8	6.2	81.0	14.6		14.6	87.6	94.8
- SPEC.	37.6	26.6	64.2	12.9	77.1	10.3		10.3	71.6	86.0
SYRUPS	31.1	17.0	48.1	3.5	51.6	32.3		32.3	71.0	76.2
<b>MEAN VALUE</b>	<b>38.9</b>	<b>16.4</b>	<b>54.3</b>	<b>7.4</b>	<b>61.4</b>	<b>22.7</b>	<b>9.4</b>	<b>24.7</b>	<b>73.0</b>	<b>82.0</b>

**APPENDIX 3.2**  
**GLOBE AND MAIL "TOP 1000" 1994**

**1. PUBLIC COMPANIES**

<b>FIRM</b>	<b>SALES</b>		<b>PROFIT</b>		<b>1 YEAR</b>		<b>5 YEAR</b>	
	<b>\$000</b>	<b>RANK</b>	<b>\$000</b>	<b>ROC %</b>	<b>RANK</b>	<b>ROC %</b>	<b>RANK</b>	
Loblaw Cos.	9,359,700	8	93,400	12.32	327	14.35	144	
George Weston Ltd.	11,931,000	3	57,000	8.99	464	12.63	193	
Oshawa Group	5,730,600	21	50,200	10.66	396	13.65	168	
Westfair Foods	2,583,742	54	42,277	22.62	119	23.72	37	
Empire Co.	2,363,312	58	28,494	10.15	414	10.04	274	
Metro-Richelieu Inc.	2,772,700	100	26,200	16.00	222	9.33	301	
Silcorp Ltd.	599,735	148	2,242	9.20	458	-14.74	725	
Al. Couche-Tard	111,400	383	522	7.62	518	11.52	232	
Becker Milk Co.	406,443	195	(5,317 )	-6.39	865	3.74	470	
<b>RETAILER MEAN</b>	<b>3,984,292</b>		<b>32,780</b>	<b>10.13</b>		<b>8.08</b>		
Maple Leaf Foods	3,054,030	43	70,121	11.65	358	12.13	209	
Canada Malting Co.	375,490	206	23,801	11.72	354	13.37	178	
Corporate Foods	361,736	212	21,415	21.00	131	26.29	27	
BC Sugar Refinery	706,173	134	15,023	11.70	356	16.62	93	
Cott Corporation	331,551	225	12,796	31.62	65	14.94	130	
Schneider Corporation	727,487	132	7,688	13.48	292	9.80	285	
Dover Industries	112,624	378	5,063	18.36	169	20.71	50	
Lassonde Industries	126,166	359	4,676	14.16	272	14.34	145	
A.L. Van Houtte	35,640	584	3,220	19.98	148	21.79	48	
Canbra Foods	120,321	365	2,208	15.33	243	1.84	517	
MRRM Inc.	36,425	575	1,201	9.88	422	13.89	160	
Cobi Foods	54,799	492	(5,492 )	-7.09	874	-4.71	639	
FPI Ltd.	604,534	146	(15,367 )	-3.43	820	-4.64	637	
National Sea Products	270,737	251	(42,515 )	-29.11	963	-9.97	692	
<b>MANUFACTURER MEAN</b>	<b>494,122</b>		<b>7,417</b>	<b>9.95</b>		<b>10.46</b>		

<u>FIRM</u>	<u>\$000</u>	<u>RANK</u>	<u>\$000</u>	<u>ROC %</u>	<u>RANK</u>
Canada Safeway	4,456,600	6			
A&P	2,710,200	18	(36,894 )	-5.22	176
Sobeys Inc.	2,035,327	26			
Loeb Inc.	1,648,400	39	(62,100 )	-10.68	186
Southland Canada	689,179	91			
Home & Pitfield Foods	613,769	108	2,536	14.18	57
Grocery People	250,000	155			
CCorp Inc.	342,659	184	(43 )	8.57	94
<b>RETAILER MEAN</b>	<b>1,593,267</b>		<b>(24,125 )</b>	<b>1.71</b>	
McCain Foods	3,001,750	17			
Kraft General Foods Canada	1,788,165	31	136,912	27.65	12
Nestle Canada	913,000	66			
Beatrice Foods	822,700	77			
Burns Foods	793,561	82			
Nabisco Brands	743,274	85	35,165	17.55	36
Olymel Soc. en Command	676,800	95			
Borden Co.	569,474	117	9,859	11.82	71
Lantic Sugar	384,696	131	3,880		
Culinar Inc.	491,700	136			
Campbell Soup Co.	452,829	146			
General Mills Canada	449,015	149	(40,901 )	-20.18	192
Gainers Inc.	420,963	158			
Canada Starch Co.	407,058	161	3,223	7.81	99
Robin Hood Multifoods	397,462	164	30,327	43.90	4
Kellogg Canada	353,742	182	24,862	14.06	58
Ralston Purina Cda.	300,713	200	9,814	25.26	16
Quaker Oats Co.	281,890	212	14,429	26.08	14
Multi-Marques Inc.	268,000	221			
Redpath Industries	236,787	232	(3,889 )	2.20	151
Maple Lodge Farms	234,199	235			
Fletcher's Fine Foods	228,000	242			
Cadbury Bev. Cda.	212,155	253			
<b>MANUFACTURER MEAN</b>	<b>851,070</b>		<b>24,690</b>	<b>8.93</b>	

Source: Report on Business Magazine  
Globe and Mail, July, 1994

**APPENDIX 3.3**

**MAJOR GROCERY RETAILERS**

**MARKET SHARES (\$), 1992**

NATIONAL		BRITISH COLUMBIA		ALBERTA	
Loblaws Cos.	16%	Safeway	21%	Safeway	21
IGA Canada	10	Overwaitea	19	Co-op	18
Safeway Corp.	8	Save-on Foods	13	IGA	12
A & P Corp.	8	Real Cdn. Superstore	5	Real Cdn. Superstore	11
Provigo Dist.	7	Super Valu	4	Food for Less	7
Metro-Richelieu	6	Extra Foods	3	Save-on Foods	7
Co-op	6	IGA	3	Non Grocery Stores	13
Overwaitea Corp.	5	Non Grocery Stores	9		
Sobeys Corp.	3				
Other Traditional Grocery	16				
Other Non Grocery	9				
Total Membership Clubs	5				

SASKATCHEWAN		MANITOBA		ONTARIO	
Co-op	27%	Safeway	34%	A & P	11
Real Cdn. Superstore	20	Real Cdn. Superstore	19	Loeb Stores	8
Safeway	18	Co-op	9	Loblaws	7
IGA	6	IGA	5	Miracle Food Mart	7
OK Economy	6	Penner Food	3	IGA	6
Shop-Rite	4	Tom Boy	1	Zehrs	6
Non Grocery Stores	8	Non Grocery Stores	13	Food City	4
				Non Grocery Stores	15

**APPENDIX 3.3 (cont.)**

<b>QUEBEC</b>		<b>ATLANTIC</b>	
Metro	19%	Sobeys	31%
Provigo	17	Co-op	19
IGA	16	Save Easy	10
Heritage/Maxi	10	Real Atl. Superstore	8
Co-op	4	Village Food	4
Super Carnaval	4	Lofood	4
Non Grocery Stores	15	Non Grocery Stores	7

## APPENDIX 3.4

### PROPERTIES OF QUADRATIC COST FUNCTION

The duopolists' cost function is defined as

$$C = aq_n + \frac{1}{2}bq_n^2 + cq_r + \frac{1}{2}dq_r^2 + eq_nq_r$$

Then marginal costs are

$$MC_n = a + bq_n + eq_r \quad \text{and}$$

$$MC_r = c + dq_r + eq_n$$

Average Incremental Costs (Baumol, Panzar and Willig, 1982; Bailey and Friedlaender, 1982) are the ratio of the total incremental costs of supplying each brand to its sales volume. In the case of the national brand, this is

$$\begin{aligned} AIC_n &= C(q_n, q_r) - C(0, q_r) / q_n \\ &= [aq_n + \frac{1}{2}bq_n^2 + cq_r + \frac{1}{2}dq_r^2 + eq_nq_r - (cq_r + \frac{1}{2}dq_r^2)] / q_n \\ &= (aq_n + \frac{1}{2}bq_n^2 + eq_nq_r) / q_n \\ &= a + \frac{1}{2}bq_n + eq_r \end{aligned}$$

Similarly, for the private label.

$$AIC_r = c + \frac{1}{2}dq_r + eq_n$$

Product-specific economies of scale ( $S_i$ ) are represented by the ratio  $AIC_i/MC_i$ . Where this ratio exceeds 1, Marginal Costs lie below Average Incremental Costs and returns to scale are increasing; the reverse holds where the ratio  $AIC_i/MC_i < 1$ . Here,

$$AIC_n/MC_n = (a + \frac{1}{2}bq_n + eq_r) / (a + bq_n + eq_r) < 1, \text{ and}$$

$$AIC_r/MC_r = (c + \frac{1}{2}dq_r + eq_n) / (c + dq_r + eq_n) < 1.$$

Hence returns to scale are

- diminishing for the national brand where  $b > 0$ ;
- increasing for the national brand where  $b < 0$ ;
- diminishing for the private label where  $d > 0$ ;
- increasing for the private label where  $d < 0$ .

Economies of scope exist where the costs of producing both products within one firm are lower than those of producing them in two separate firms. i.e.

$$C(q_n, q_r) < C(q_n, 0) + C(0, q_r)$$

Hence economies of scope exist where

$$aq_n + \frac{1}{2}bq_n^2 + cq_r + \frac{1}{2}dq_r^2 + eq_nq_r < aq_n + \frac{1}{2}bq_n^2 + cq_r + \frac{1}{2}dq_r^2$$

→  $e < 0$ .

For positive costs for each product, we require

$$aq_n + \frac{1}{2}bq_n^2 > eq_nq_r$$

$$\Rightarrow a + \frac{1}{2}bq_n > eq_r$$

$$\Rightarrow q_n > (2/b)(eq_r - a), \text{ and}$$

$$q_r > (2/d)(eq_n - c).$$

**APPENDIX 3.5**

**PRICES AND QUANTITIES FOR DOMINANT DUOPOLY MODEL**

**Linear Demand/ Quadratic Costs**

From the general model developed in Appendix 2.6, we have the wholesale prices

$$w_{n1}^* = C_{n1} + \{1/(q_{11}q_{rr} - q_{r1}q_{1r})\}(q_{r1}q_r - q_{rr}q_{n1})$$

and

$$w_r^* = C_r + \{1/(q_{11}q_{rr} - q_{r1}q_{1r})\}(q_{11}q_{n1} - q_{1r}q_r)$$

Hence

$$w_{n1}^* = C_{n1} + C_r q_{r1}/q_{11} - w_r q_{r1}/q_{11} - (\alpha_1 - \beta_1 w_{n1} + \sigma w_{n2} + \theta_1 w_r)/q_{11}$$

$$- 2w_{n1}^* = C_{n1} - (\theta_1/\beta_1)C_r + (\theta_1/\beta_1)w_r + (1/\beta_1)(\alpha_1 + \sigma w_{n2} + \theta_1 w_r)$$

$$= w_{n1}^* = 1/2[C_{n1} - (\theta_1/\beta_1)C_r + (\alpha_1/\beta_1) + (\sigma/\beta_1)w_{n2}] + (\theta_1/\beta_1)w_r$$

Similarly,

$$w_r^* = 1/2[C_r - (\theta_1/\beta_1)C_{n1} + (\alpha_r/\beta_r) + (\theta_2/\beta_r)w_{n2}] + (\theta_1/\beta_r)w_{n1}$$

Substituting  $w_r^*$  into the expression for  $w_{n1}^*$ , we obtain

$$w_{n1}^* = 1/2[C_{n1} - (\theta_1/\beta_1)C_r + (\alpha_1/\beta_1) + (\sigma/\beta_1)w_{n2}] + (\theta_1/\beta_1)1/2[C_r - (\theta_1/\beta_r)C_{n1} + (\alpha_r/\beta_r) + (\theta_2/\beta_r)w_{n2}] + (\theta_1/\beta_r)w_{n1}$$

This solves to give the following expression for equilibrium wholesale prices:

$$w_{n1}^* = 1/2[(\alpha_1/\beta_1 + \theta_1\alpha_r)/(\beta_1\beta_r - \theta_1^2) + (\sigma\beta_r + \theta_1\theta_2)w_{n2}/(\beta_1\beta_r - \theta_1^2) + C_{n1}]$$

for the national brand, and

$$w_r^* = 1/2[(\alpha_r/\beta_r + \alpha_1\theta_1)/(\beta_1\beta_r - \theta_1^2) + (\sigma\theta_1 + \beta_1\theta_2)w_{n2}/(\beta_1\beta_r - \theta_1^2) + C_r]$$

for the private label.

**Quantity Supplied**

At these equilibrium prices, the manufacturer supplies the following quantity of the national brand:

$$q_{n1} = 1/2[\alpha_1 - (\beta_1/2)[(\alpha_1/\beta_1 + \theta_1\alpha_r)/(\beta_1\beta_r - \theta_1^2) + (\sigma\beta_r + \theta_1\theta_2)w_{n2}/(\beta_1\beta_r - \theta_1^2) + C_{n1}] + \sigma w_{n2} + (\theta_1/2)[(\alpha_1/\beta_1 + \alpha_1\theta_1)/(\beta_1\beta_r - \theta_1^2) + (\sigma\theta_1 + \beta_1\theta_2)w_{n2}/(\beta_1\beta_r - \theta_1^2) + C_r]$$

which solves to

$$q_{n1}^* = 1/4(\alpha_1 - \beta_1 C_{n1} + \theta_1 C_r + \sigma w_{n2}).$$

Similarly, the quantity supplied of the private label is

$$q_r^* = 1/4(\alpha_r - \beta_r C_r + \theta_1 C_{n1} + \sigma w_{n2}).$$

**APPENDIX 3.6**

**PRICE CHANGE ON NATIONAL BRAND**

From Appendix 3.7, the wholesale price of the national brand is

$$w_{n1}^* = 1/2[(\alpha_1/\beta_1 + \theta_1\alpha_r)/(\beta_1\beta_r - \theta_1^2) + (\sigma\beta_r + \theta_1\theta_2)w_{n2}/(\beta_1\beta_r - \theta_1^2) + C_{n1}]$$

When the competitive sector is allowed to supply, the national brand's price is

$$w_{n1}^* = 1/2[(\alpha_1/\beta_1) + (\sigma/\beta_1)w_{n2} + (\theta_1/\beta_1)C_r + C_{n1}]$$

Hence the difference between the two scenarios is

$$\begin{aligned}
\Delta w_{n1} &= \frac{1}{2}[(\alpha_1\beta_1 + \theta_1\alpha_1)/(\beta_1\beta_r - \theta_1^2) + (\sigma\beta_r + \theta_1\theta_2)w_{n2}/(\beta_1\beta_r - \theta_1^2) + C_{n1}] \\
&\quad - \frac{1}{2}[(\alpha_1/\beta_1) + (\sigma/\beta_1)w'_{n2} + (\theta_1/\beta_1)C_c + C''_{n1}] \\
&= \frac{1}{2}[(\theta_1/\beta_1)(\alpha_1\beta_1 + \theta_1\alpha_1)/(\beta_1\beta_r - \theta_1^2) + (\theta_1/\beta_1)(\theta_2\beta_1 + \sigma\theta_1)w_{n2}/(\beta_1\beta_r - \theta_1^2) - \\
&\quad - (\theta_1/\beta_1)C_c - (\sigma/\beta_1)\Delta w_{n2} + \Delta C_{n1}] \\
&= (\theta_1/\beta_1)(w_r - C_r) + (1/2\beta_1)\beta_1\Delta C_{n1} - (1/2\beta_1)(\theta_1C_c + \sigma\Delta w_{n2})
\end{aligned}$$

This is  $> 0$  (i.e. national brand price *increases* when manufacturer 1 supplies the private label) when

$$\theta_1(w_r - C_r) > \frac{1}{2}(\beta_1\Delta C_{n1} + \theta_1C_c + \sigma\Delta w_{n2})$$

In other words, the profit margin on the private label is compared with (i) the change in marginal cost on the national brand resulting from its reduced volume - where there are economies of scale on the national brand, marginal costs will rise, (ii) the competitive sector's marginal cost - the higher this is, the less likely is the manufacturer to increase national brand price, and (iii) the price change of the competing dominant firm.

---

### APPENDIX 3.7

#### PROFIT COMPARISON FOR DOMINANT DUOPOLY MODEL

If the duopolist chooses to supply the private label, his profit is

$$\begin{aligned}
\pi^{M1} &= \sum_i w_i^* q_i^* - C[q_i, q_i] \\
&= [C_{n1} + \{1/(q_{11}q_{rr} - q_{r1}q_{1r})\}(q_{r1}q_r - q_{rr}q_{n1})]q_{n1} \\
&\quad + [C_r + \{1/(q_{11}q_{rr} - q_{r1}q_{1r})\}(q_{11}q_{n1} - q_{11}q_r)]q_r - C \\
&= \{1/(q_{11}q_{rr} - q_{r1}q_{1r})\}[(q_{r1} + q_{1r})q_rq_{n1} - q_{rr}q_{n1}^2 - q_{11}q_r^2] \\
&\quad - (C - C_{n1}q_{n1} - C_rq_r)
\end{aligned}$$

If the duopolist allows the competitive sector to supply the private label at  $C_c$ , his profit is

$$\pi^{M1}_0 = w_{n1}^* q_{n1}^* (w_{n1}, w_{n2}, C_c) - C[q_{n1}^* (w_{n1}, w_{n2}, C_c)]$$

Then

$$\partial \pi^{M1}_0 / \partial w_{n1} = w'_{n1} q'_{11} + q'_{n1} - C'_{n1} q'_{11}$$

and the equilibrium wholesale price is

$$w'_{n1} = C'_{n1} - q'_{n1}/q'_{11}$$

The firm's profit is thus

$$\pi^{M1}_0 = (C'_{n1} - q'_{n1}/q'_{11})q'_{n1} - C'$$

Comparing the payoffs to the manufacturer under both scenarios gives us the difference in the profitability for the duopolist of supplying himself versus allowing the competitive sector to supply:

$$\begin{aligned}
\pi^{M1} - \pi^{M1}_0 &= \Delta \pi^{M1} \\
&= \{1/(q_{11}q_{rr} - q_{r1}q_{1r})\}[(q_{r1} + q_{1r})q_rq_{n1} - q_{rr}q_{n1}^2 - q_{11}q_r^2] \\
&\quad - (C - C_{n1}q_{n1} - C_rq_r) - [(C_{n1} - q'_{n1}/q'_{11})q'_{n1} - C'] \\
&= \{1/(\beta_1\beta_r - \theta_1^2)\}(\beta_1q_{n1}^2 + \beta_1q_r^2 + 2\theta_1q_{n1}q_r) - (1/\beta_1)q'_{n1} - (aq_{n1} + \frac{1}{2}bq_{n1}^2 + cq_r + \frac{1}{2}dq_r^2 + eq_{n1}q_r \\
&\quad - aq_{n1} - bq_{n1}^2 - eq_{n1}q_r - cq_r - dq_r^2 - eq_{n1}q_r) \\
&\quad + (aq'_{n1} + \frac{1}{2}bq_{n1}^2 - aq'_{n1} - bq'_{r1}^2)
\end{aligned}$$

$$\begin{aligned}
&= [1/(\beta_i\beta_r-\theta_i^2)](\beta_iq_{ni}^2) - (1/\beta_i)q_{ni}^2 + \{1/(\beta_i\beta_r-\theta_i^2)\}(\beta_iq_r^2 + 2\theta_iq_{ni}q_r) \\
&\quad + 1/2b(q_{ni} - q_{ni}') + 1/2dq_r^2 + eq_{ni}q_r \\
&= [\beta_i/(\beta_i\beta_r-\theta_i^2)](q_{ni}^2 - q_{ni}'^2) + \{\theta_i^2/[\beta_i(\beta_i\beta_r-\theta_i^2)]\}q_{ni}'^2 \\
&\quad + [1/(\beta_i\beta_r-\theta_i^2)](\beta_iq_r^2 + 2\theta_iq_{ni}q_r) + 1/2b(q_{ni} - q_{ni}') + 1/2dq_r^2 + eq_{ni}q_r
\end{aligned}$$

With the prices and quantities given in Appendix 3.6, the manufacturer's profit if he supplies the private label is

$$\begin{aligned}
\pi^{M'} &= \sum_i w_i q_i - C(q_i, q_i) & i, j \in \{n, r\} \\
&= 1/2[(\alpha_i\beta_r + \theta_i\alpha_r)/(\beta_i\beta_r - \theta_i^2) + (\sigma\beta_r + \theta_i\theta_r)w_{n2}/(\beta_i\beta_r - \theta_i^2) + C_{ni}]1/4(\alpha_i \\
&\quad - \beta_i C_{ni} + \theta_i C_r + \sigma w_{n2}) + 1/2[(\alpha_i\beta_r + \alpha_i\theta_i)/(\beta_i\beta_r - \theta_i^2) + (\sigma\theta_i + \beta_i\theta_r)w_{n2}/(\beta_i\beta_r \\
&\quad - \theta_i^2) + C_{ni}]1/4(\alpha_r - \beta_r C_r + \theta_r C_c + \sigma w_{n2}) - C
\end{aligned}$$

If the manufacturer allows the competitive sector to supply the private label, the price and quantity of the national brand are

$$\begin{aligned}
w'_{n2} &= 1/2[(\alpha_i/\beta_i) + (\sigma/\beta_i)]w'_{n2} + (\theta_i/\beta_i)C_c + C_{ni}] \\
q'_{ni} &= 1/4(\alpha_i - \beta_i C_{ni} + \theta_i C_c + \sigma w'_{n2})
\end{aligned}$$

The manufacturer's profit under this scenario is

$$\pi^{M''} = 1/2[(\alpha_i/\beta_i) + (\sigma/\beta_i)]w'_{n2} + (\theta_i/\beta_i)C_c + C_{ni}][1/4(\alpha_i - \beta_i C_{ni} + \theta_i C_c + \sigma w'_{n2})] - C$$

Comparing the profitability of the two scenarios:

$$\begin{aligned}
\Delta\pi^{M'} &= 1/8[(\alpha_i\beta_r + \theta_i\alpha_r)/(\beta_i\beta_r - \theta_i^2) + (\sigma\beta_r + \theta_i\theta_r)w_{n2}/(\beta_i\beta_r - \theta_i^2) + C_{ni}](\alpha_i \\
&\quad - \beta_i C_{ni} + \theta_i C_r + \sigma w_{n2}) + (1/8)[(\alpha_i\beta_r + \alpha_i\theta_i)/(\beta_i\beta_r - \theta_i^2) + (\sigma\theta_i + \beta_i\theta_r)w_{n2}/(\beta_i\beta_r \\
&\quad - \theta_i^2) + C_{ni}](\alpha_r - \beta_r C_r + \theta_r C_c + \sigma w_{n2}) - C \\
&\quad - (1/8)[(\alpha_i/\beta_i) + (\sigma/\beta_i)]w'_{n2} + (\theta_i/\beta_i)C_c + C_{ni}][(\alpha_i - \beta_i C_{ni} + \theta_i C_c + \sigma w'_{n2})] + C
\end{aligned}$$

which expands to

$$\begin{aligned}
&= 1/8\{(\alpha_i^2\beta_r^2 + 2\theta_i\alpha_i\alpha_r\beta_r + \alpha_i^2\theta_r^2)/\beta_i(\beta_i\beta_r - \theta_i^2) + 2[\alpha_i(\beta_r\sigma + \theta_i\theta_r) + \alpha_r(\theta_i\sigma + \beta_r\theta_r)]w_{n2}/(\beta_i\beta_r - \theta_i^2) - 2(\alpha_i\sigma/\beta_i)w_{n2} \\
&\quad + (\sigma\beta_r + \theta_i\beta_r + 2\sigma\theta_i\theta_r)w_{n2}^2/(\beta_i\beta_r - \theta_i^2) - (\sigma^2/\beta_i)w_{n2}^2 - \beta_i[(C_{ni})^2 - (C'_{ni})^2] - \beta_i(C_r)^2 \\
&\quad + 2\theta_i C_{ni} C_r - 2(\alpha_i\theta_r/\beta_i)C_c - 2(\sigma\theta_i/\beta_i)C_c w_{n2} - (\theta_i^2/\beta_i)C_c^2\} - (C - C')
\end{aligned}$$

## APPENDIX 3.8

### PROOF OF PROPOSITION 3.1

#### Cross-Price Response

$$\begin{aligned}
\partial\Delta\pi^{M'}/\partial\theta_i &= (1/8)\{[(2\alpha_i\alpha_r\beta_r + 2\alpha_i^2\theta_r)(\beta_i^2\beta_r - \theta_i^2\beta_r) - \\
&\quad (-2\beta_i\theta_r)(\alpha_i^2\beta_r + 2\theta_i\alpha_i\alpha_r\beta_r + \alpha_i^2\theta_r^2)/(\beta_i^2\beta_r - \beta_i\theta_i^2)^2] \\
&\quad + [(2\alpha_i\theta_r + 2\alpha_i\sigma)(\beta_i\beta_r - \theta_i^2) - \\
&\quad (-2\theta_i)(2\alpha_i\beta_r\sigma + 2\alpha_i\theta_r\theta_r + 2\alpha_i\theta_r\sigma + 2\alpha_i\beta_r\theta_r)w_{n2}/(\beta_i\beta_r - \theta_i^2)^2 \\
&\quad + (2\sigma\theta_i)(\beta_i\beta_r - \theta_i^2) - (2\theta_i)(\sigma^2\beta_r + \theta_i^2\beta_r + 2\sigma\theta_i\theta_r)w_{n2}^2/(\beta_i\beta_r - \theta_i^2)^2 \\
&\quad - \beta_i[(\partial C_{ni})^2/\partial q_{ni}] - (\partial C_{ni})^2/\partial q_{ni} - (\partial C_{ni})^2/\partial q_{ni} - (\partial C_{ni})^2/\partial q_{ni}] \\
&\quad + 2C_{ni}C_r - 2(\alpha_i/\beta_i)C_c - 2(\sigma/\beta_i)C_c w_{n2} - 2(\theta_i/\beta_i)(C_c)^2 \\
&\quad - (\partial q_{ni}/\partial\theta_i)(\partial C_{ni}/\partial q_{ni} - \partial C_{ni}/\partial q_{ni})\}
\end{aligned}$$

All terms in this expression are positive with the exception of those which contain competitive sector costs,  $C_c$ . Hence the cross-price parameter is positively related to private label supply propensity when competitive sector costs are low; but when competitive sector costs are high, their negative effect on private label supply outweighs the cross-price effect.

**APPENDIX 3.9**

**PROOF OF PROPOSITION 3.2**

***Private Label Own-price Parameter***

$$\begin{aligned} \partial \Delta \pi^{M1} / \partial \beta_i &= (1/8) \{ [-\beta_i^2 (\alpha_i^2 \beta_i^2 + 2\theta_i \alpha_i \alpha_i \beta_i + \alpha_i^2 \theta_i^2) / \beta_i^2 (\beta_i \beta_i - \theta_i^2)^2] \\ &+ [(2\alpha_i \sigma) (\beta_i \beta_i - \theta_i^2)^{-1}] \\ &- \beta_i (2\alpha_i \beta_i \sigma + 2\alpha_i \theta_i \theta_i + 2\alpha_i \theta_i \sigma + 2\alpha_i \beta_i \theta_i) w_{n_i} / (\beta_i \beta_i - \theta_i^2)^2 \} \\ &+ [\sigma^2 (\beta_i \beta_i - \theta_i^2)^{-2} - \beta_i (\sigma^2 \beta_i + \theta_i^2 \beta_i + 2\sigma \theta_i \theta_i) w_{n_i}^2 / (\beta_i \beta_i - \theta_i^2)^3] \\ &- \beta_i \{ (\partial(C_{n_i})^2 / \partial q_i) (\partial q_i / \partial \beta_i) \} - (C_{n_i})^2 - (\partial C / q_i) (\partial q_i / \partial \beta_i) \end{aligned}$$

All terms in this expression are negative with the exception of those which include costs. The private label's own-price response is negatively related to private label supply, but the effect can be overridden by costs, as before.

**APPENDIX 3.10**

**PROOF OF PROPOSITION 3.3**

***Private label Intercept Demand***

$$\partial \Delta \pi^{M1} / \partial \alpha_i = (1/8) \{ (1 / (\beta_i \beta_i - \theta_i^2)) \{ (1 / \beta_i) (2\beta_i^2 \alpha_i + 2\theta_i \alpha_i \beta_i) + (2\theta_i \sigma + 2\alpha_i \theta_i) w_{n_i} - \beta_i (\partial(C_{n_i})^2 / \partial q_i) (\partial q_i / \partial \alpha_i) \} - (\partial C / q_i) (\partial q_i / \partial \alpha_i) \}$$

Now

$$\begin{aligned} (\partial(C_{n_i})^2 / \partial q_i) &= 2ae + 2beq_{n_i} + 2e^2q_i \\ &> 0. \quad a + bq_n > eq_n \text{ required for } C_{n_i} > 0. \end{aligned}$$

Hence all terms in this expression are positive, with the exception of those which include costs. The effect of private label intercept demand is therefore positive, but is moderated by costs.

**APPENDIX 3.11**

**PROOF OF PROPOSITIONS 3.4 AND 3.6**

***Product-Specific Returns to Scale***

Expanding the cost-related terms in the profit difference function:

$$\begin{aligned} \Delta \pi^{M1} &= (1/8) \{ \dots - \beta_i [(a + bq_{n_i} + eq_{n_i})^2 - (a + bq_{n_i})^2] - \beta_i (c + dq_i + eq_{n_i})^2 + 2\theta_i (a + bq_{n_i} + eq_{n_i})(c + dq_i + eq_{n_i}) \\ &+ \dots \} - [(aq_{n_i} + 1/2bq_{n_i}^2 + cq_i + 1/2dq_i^2 + eq_{n_i}q_i) - (aq_{n_i} + 1/2bq_{n_i}^2)] \end{aligned}$$

$\Delta \pi^{M1}$  is now a function of exogenous parameters and of quantities. To find its derivative with respect to b, we proceed as follows:

$$d\Delta \pi^{M1} / db = (\partial \Delta \pi^{M1} / \partial q_{n_i}) (\partial q_{n_i} / \partial b) + (\partial \Delta \pi^{M1} / \partial q_i) (\partial q_i / \partial b) + (\partial \Delta \pi^{M1} / \partial q_{n_i}) (\partial q_{n_i} / \partial b) + \partial \Delta \pi^{M1} / \partial b$$

Since we are evaluating the profit difference at its maximum, we hold all quantities constant at their optimal levels,  $q_i^*$ . We apply the Envelope Theorem and  $d\Delta \pi^{M1} / db = \partial \Delta \pi^{M1} / \partial b$ .

***National Brand***

$$\partial \Delta \pi^{M1} / \partial b = 1/4 \{ (\theta_i d - \beta_i e) q_{n_i}^2 q_i^* + \theta_i c q_{n_i}^2 - \beta_i a \Delta q_{n_i}^* + \theta_i e q_{n_i}^2 \} - 1/2 \Delta (q_{n_i}^*)^2$$

We assume that  $\theta_i$  and  $\beta_i$  are close to each other (they cannot be equal), and that  $\Delta q_{n_i}^* \leq 0$ , justified by the fact that sales volume is higher if the manufacturer does not supply, when competitive costs exceed those of manufacturer 1 (from the demand function). Then, using our assumption that  $d > e$ , the above expression is

$$> 0 \text{ for } b > 0$$

$$< 0 \text{ for } b < 0$$

**Private Label**

$$\begin{aligned}\frac{\partial \Delta \pi^{MI}}{\partial d} &= -\frac{1}{4}(\beta, c - \theta, a)q_r^* - \frac{1}{4}(\beta, e - \theta, b)q_{n1}^* - \frac{1}{4}(\beta, d - \theta, e)q_r^{**} - \frac{1}{2}q_r^{**} \\ &< 0 \text{ for } d > 0 \\ &> 0 \text{ for } d < 0\end{aligned}$$

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**APPENDIX 3.12**

**PROOF OF PROPOSITIONS 3.5 AND 3.7**

**Economies of Scope**

Differentiating the expanded profit difference function in Appendix 3.11 with respect to e, we obtain

$$\begin{aligned}\frac{\partial \Delta \pi^{MI}}{\partial e} &= -\frac{1}{4}(\beta, a - \theta, c)q_r^* - \frac{1}{4}(\beta, c - \theta, a)q_{n1}^* - \frac{1}{4}(\beta, d - \theta, e)q_{n1}^* q_r^* \\ &\quad - \frac{1}{4}(\beta, e - \theta, d)q_r^{**} - \frac{1}{4}(\beta, e q_r^{**} - \theta, b q_{n1}^{**}) - q_{n1}^* q_r^*\end{aligned}$$

Setting a=c and d=b=e, this becomes

$$\begin{aligned}\frac{\partial \Delta \pi^{MI}}{\partial e} &= -\frac{1}{4}a(\beta, -\theta, )q_r^* - \frac{1}{4}a(\beta, -\theta, )q_{n1}^* - \frac{1}{4}a(\beta, -\theta, )q_{n1}^* q_r^* \\ &\quad - \frac{1}{4}d(\beta, -\theta, )q_r^{**} - \frac{1}{4}b(\beta, q_r^{**} - \theta, q_{n1}^{**}) - q_{n1}^* q_r^*\end{aligned}$$

which is

$$< 0 \text{ for } e > 0$$

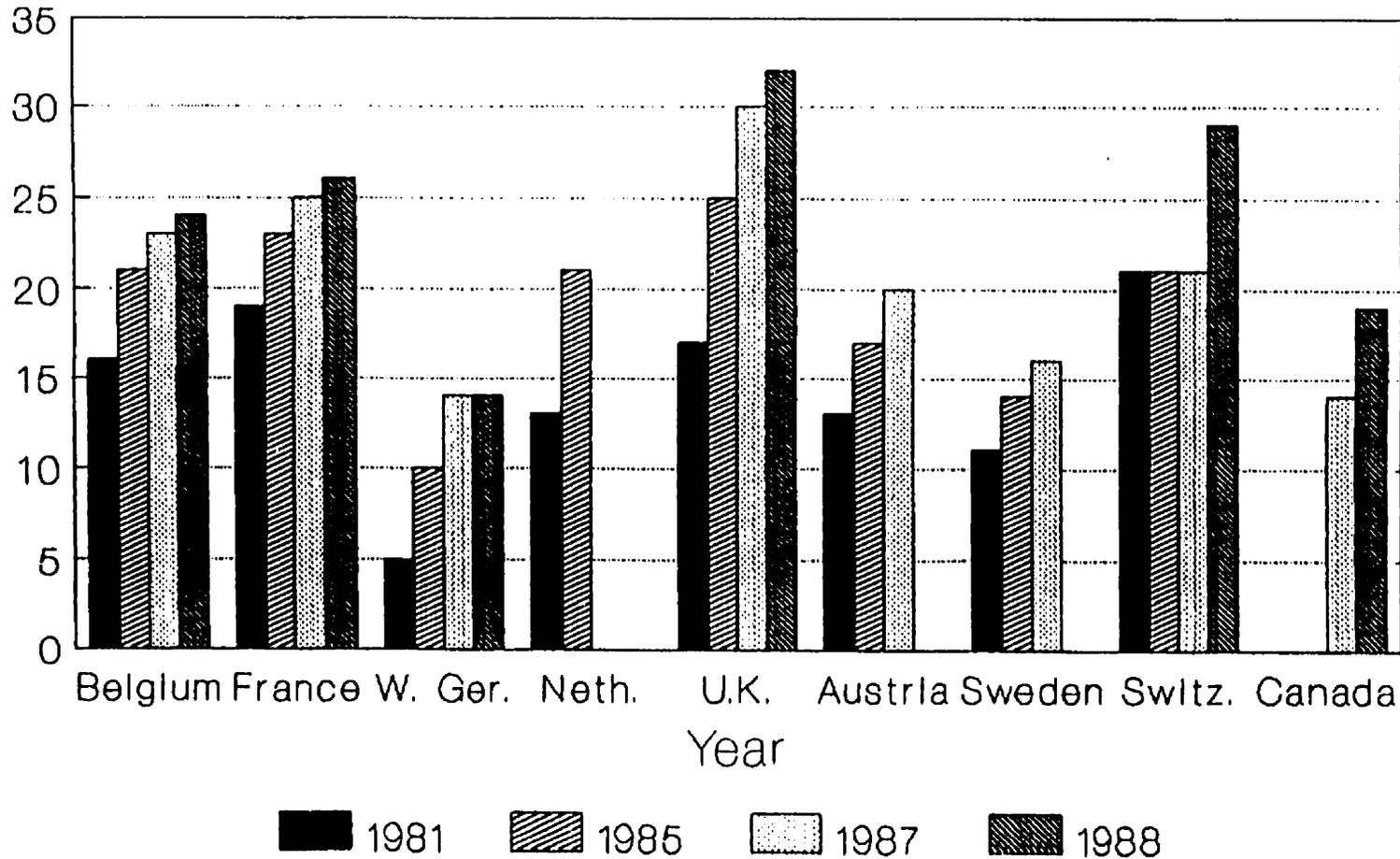
$$> 0 \text{ for } e < 0$$

within the boundaries  $q_{n1}^{**} \geq q_r^{**} - q_{n1}^* q_r^*$ .

**FIGURES**

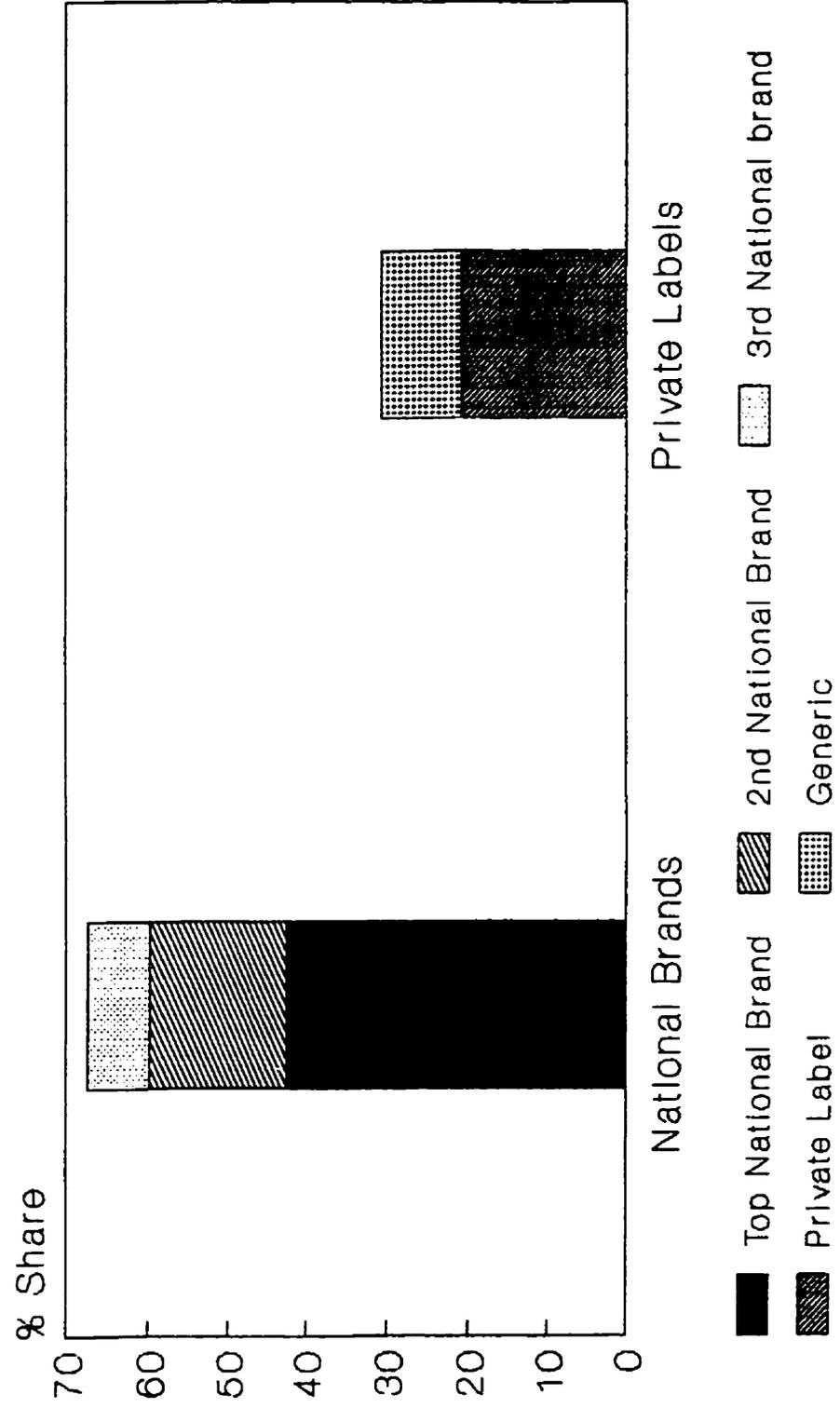
# FIGURE 3.1

## PRIVATE LABEL % FOOD SALES



Source: Euromonitor, 1991

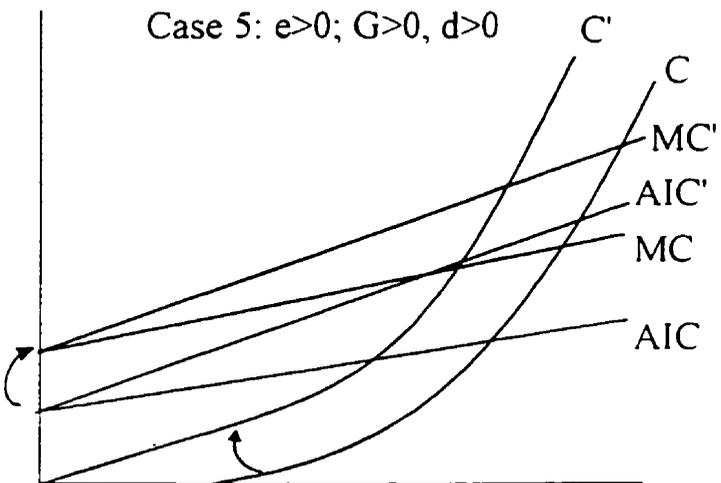
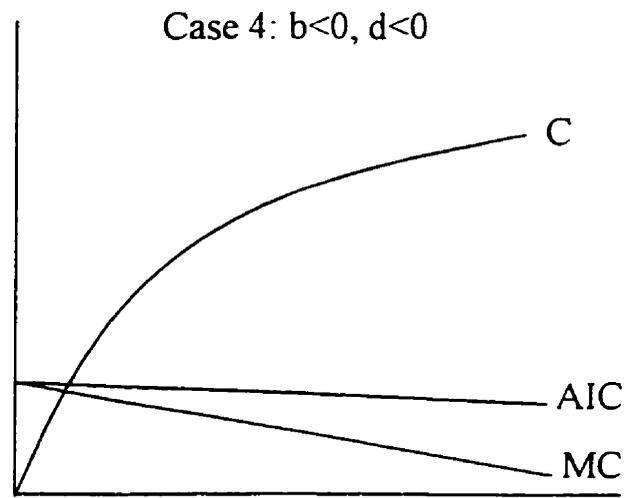
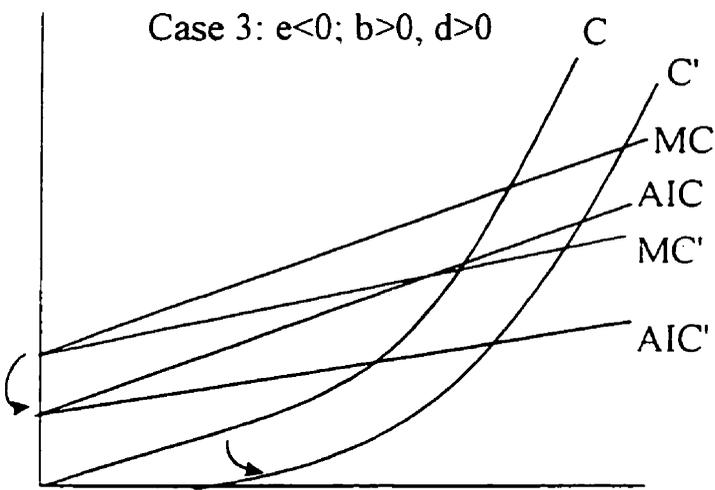
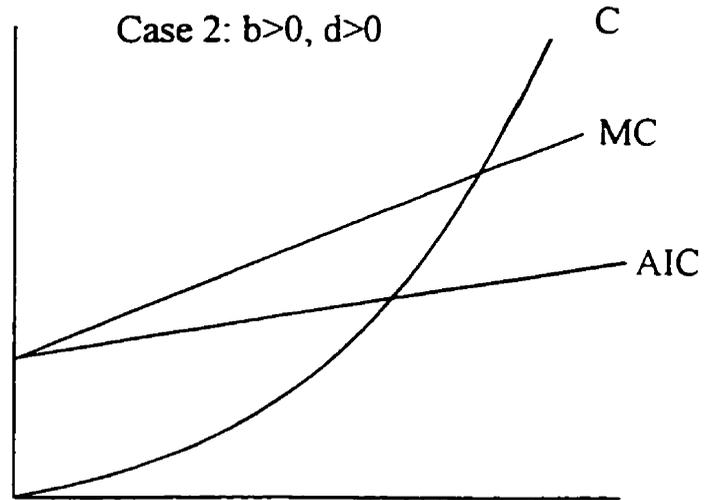
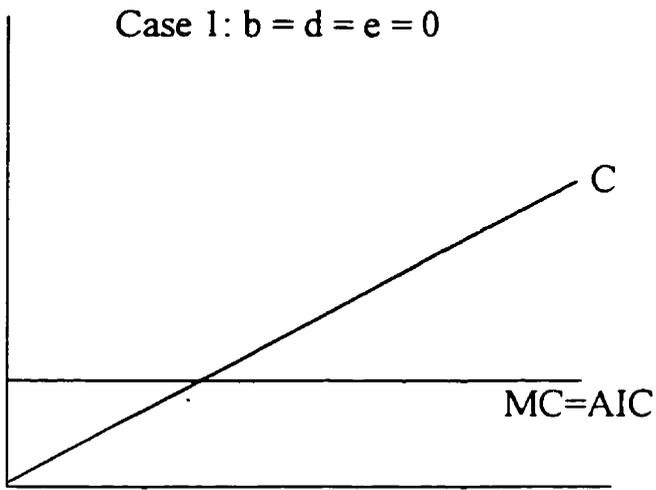
# FIGURE 3.2 GROCERY BRAND SHARES



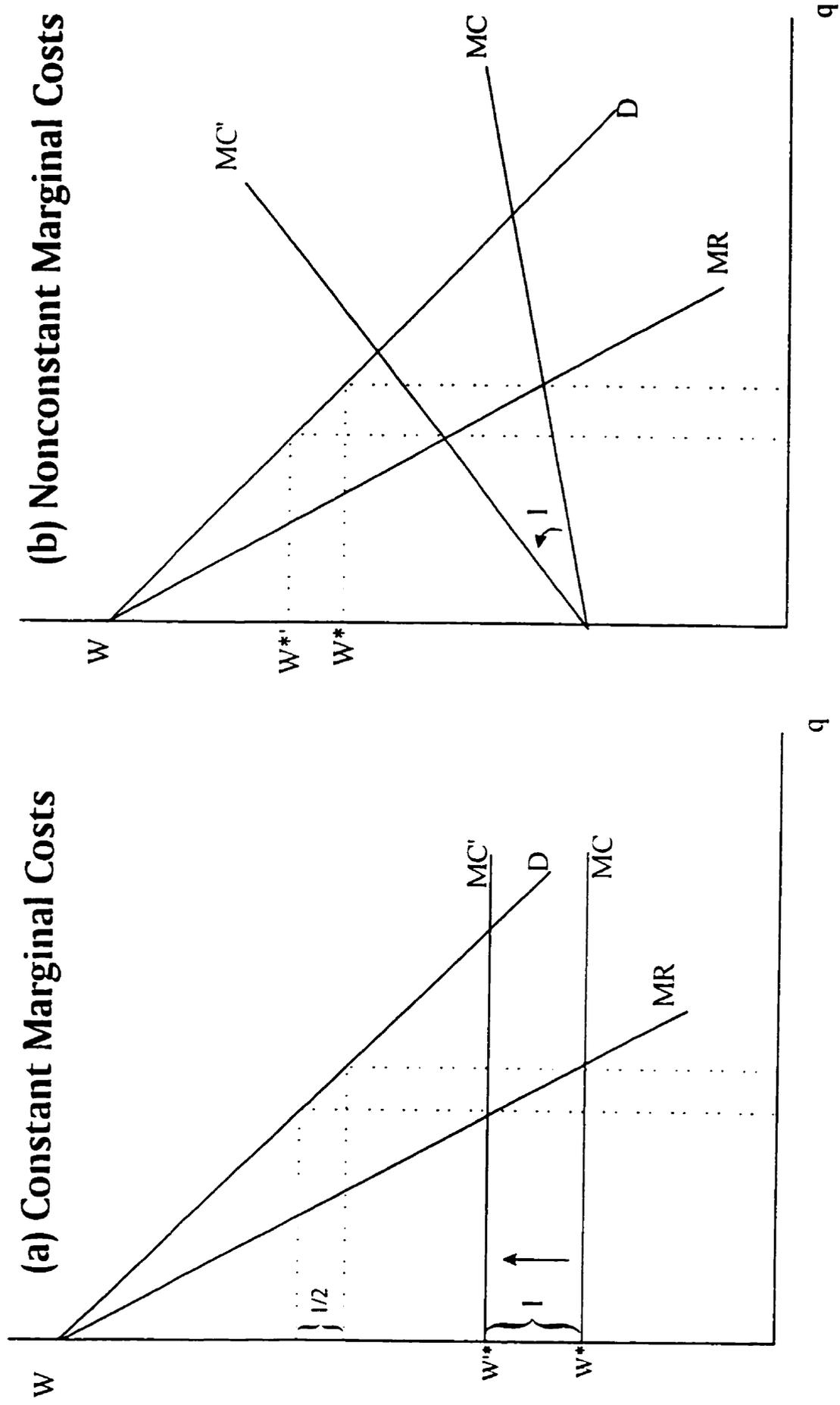
Source: A.C. Nielsen



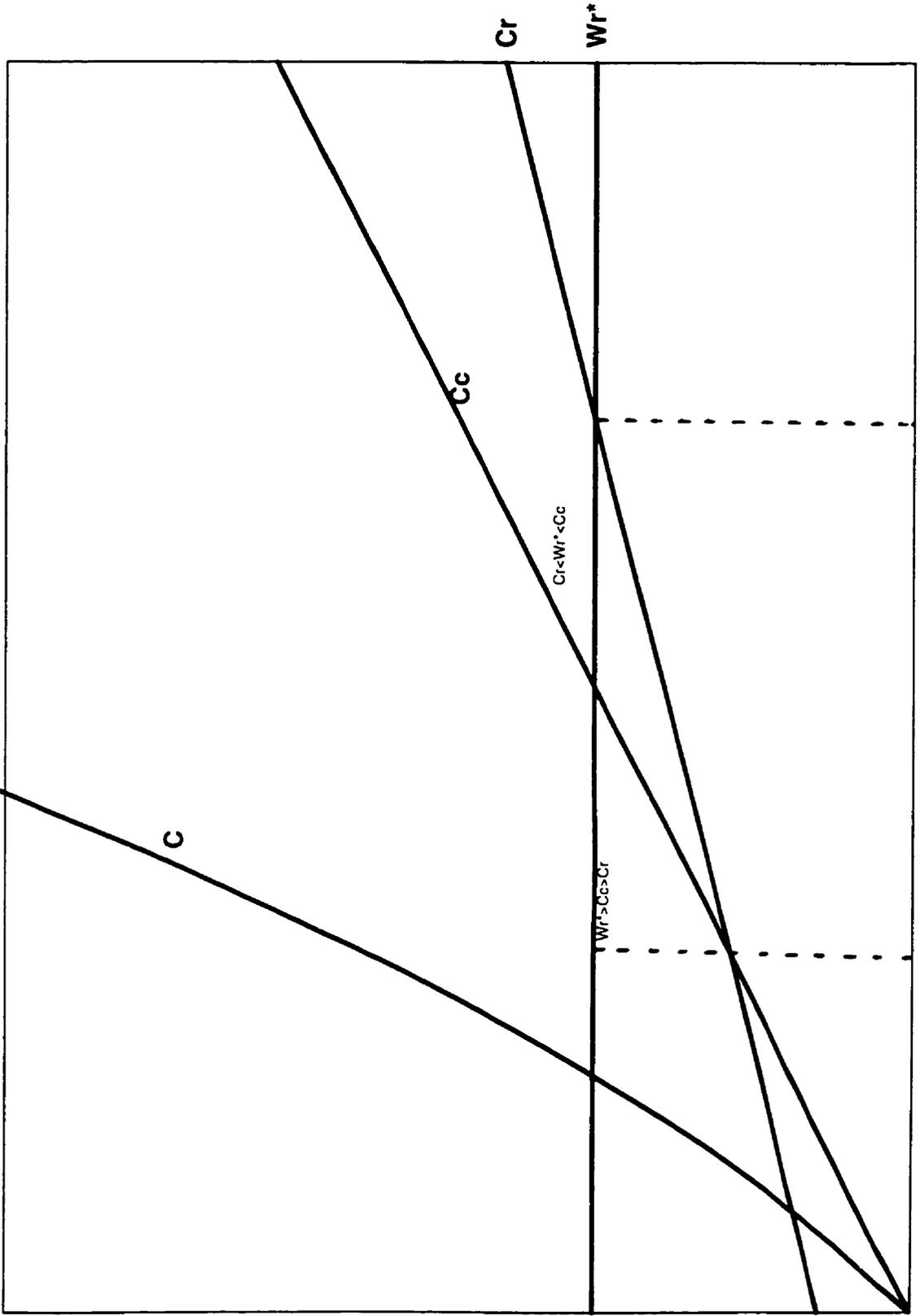
**Figure 3.4: Examples of Cost Functions**



**Figure 3.5**  
**Effect of Cost Changes on  $W^*$**



**Figure 3.6**  
**Dominant Firm Price vs. Competitive Fringe Costs**



**FIGURE 3.7**  
**NORMAL FORM GAME FOR TWO DOMINANT FIRMS**

		<b><u>Manufacturer 1</u></b>	
		<b><u>Supply</u></b>	<b><u>Do Not Supply</u></b>
<b><u>Manufacturer 2</u></b>	<b><u>Supply</u></b>	$[\pi^{M1}_n+0, \pi^{M2}_n+0]$	$[\pi^{M1}_n, \pi^{M2}_n+\pi^{M2}_r]$
	<b><u>Do Not Supply</u></b>	$[\pi^{M1}_n+\pi^{M1}_r, \pi^{M2}_n]$	$[\pi^{M1}_n, \pi^{M2}_n]$

$\pi^{M_i}_n, i \in \{1,2\}$ , is manufacturer  $i$ 's profit on the national brand when the private label is supplied at  $C_r$ .

$\pi^{M_i}_n$  is manufacturer  $i$ 's profit on the national brand when the private label is supplied at  $C_c$ , or at  $w_r^*$  where  $w_r^* < C_c$ .

$\pi^{M_i}_r$  is manufacturer  $i$ 's profit on the private label when he alone supplies

## **4. ESTIMATION OF DEMAND PARAMETERS**

*A researcher can survive everything but a misprint.*

Apologies to **Oscar Wilde**: *The Children of the Poets*

### **(i) Introduction**

The preceding two chapters specified a theoretical model of private label supply for a national brand manufacturer. Here, we take the first step towards applying the model to data on a category in the grocery products industry. Ultimately, our purpose is to demonstrate the model's value as a decision tool by applying it in a real-world context. The scenario analysis of Chapter 5 puts the model through its paces in applying it across a variety of decision environments: in this chapter, we address some of the challenges that are raised by the need to estimate the model's demand parameters from real data.

Towards the end of chapter 3, we summarized the key factors that favour and mitigate against the supply of private label by a manufacturer. In particular, we saw that manufacturers look for private labels that can expand the category with minimal cannibalization of their own national brand. We also saw that private labels which are more elastic with respect to their own price are less attractive to national brand manufacturers, and that the level of pricing by the competitive fringe can also influence manufacturers' analysis of the situation. We also examined the role of costs in the supply decision, finding that manufacturers prefer to supply the brand that offers higher economies

of scale, and that economies of scope also encourage manufacturers to supply.

The baseline model of chapter 2 dealt with the situation facing a monopolist or duopolists. Because refusal to supply in such industries means that the retailer is unable to market the private label, the baseline model, in effect, analyzes the impact on incumbent national brand manufacturers of a *new* private label entering the market - on the assumption that they can prevent private label entry by refusing to supply. By contrast, the dominant manufacturer of chapter 3 has no power to keep the private label out; if he refuses to supply, someone else will do so. Hence the manufacturer's decision in this model is the same whether or not the private label already exists. This extended model is therefore also appropriate to situations in which the private label is *already* being supplied by a competitor, and the manufacturer is considering whether to underbid the incumbent and take on private label supply.

This was the situation facing one of the manufacturers in this grocery category<sup>17</sup>: private labels were gaining in strength, and national brand manufacturers were under pressure to take over private label supply from the fringe sector. Market shares of the major brands are shown graphically in Figure 4.1:

(Figure 4.1)

The category fits the "competitive fringe" structure described in chapter 3 well: two dominant national brands compete against private labels, which are supplied by a competitive sector.

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<sup>17</sup> At the request of the manufacturer, details of the category and the retailer are withheld and regression parameters are disguised.

In this category, growth in private label market share has been an important issue for national brand manufacturers. Private label suppliers go to great lengths to convince retailers to promote private labels at the expense of national brands, providing a plethora of financial comparisons to further their cause. National brands, for their part, have responded with data of their own and with enriched promotional allowances for retailers to encourage featuring. One of the two dominant firms in fact supplied private labels in the late 1970's, but more recently has taken a more combative posture. Hence private labels are a highly topical issue, and private label supply may become a viable strategy for one or both of the national brand manufacturers as their sales volumes decline.

Our overall goal in this chapter is to estimate demand parameters which will be used as inputs to the theoretical model in chapter 5. To this end, we need to arrive at the most reasonable possible estimates of demand intercepts, own-price response and cross-price response for each of the three brands in the category, consistent with the underlying structure of the theoretical model. These parameters will be used, along with estimates of costs, to predict the profitability of supplying a private label for a specific manufacturer in the category.

We begin by reviewing the demand system underlying the theoretical model and its assumptions in the next section: this is followed by a description of the data that will be used to derive parameter estimates. Section (iv) considers the issues of consumer heterogeneity and nonstationarity in consumption as they apply to this estimation process. Section (v) specifies the estimation procedure, section (vi) discusses the results, and section (vii) draws overall conclusions about this phase of the analysis.

## (ii) Demand System in the Theoretical Model

In chapter 3, we specified demand functions in a three-product market of the form

$$\begin{aligned}q_{n1} &= \alpha_1 - \beta_1 p_{n1} + \sigma p_{n2} + \theta_1 p_r \\q_{n2} &= \alpha_2 + \sigma p_{n1} - \beta_2 p_{n2} + \theta_2 p_r \\q_r &= \alpha_r + \theta_1 p_{n1} + \theta_2 p_{n2} - \beta_r p_r\end{aligned}$$

based on a quadratic utility function. These are individual demand functions, based on the assumption that one consumer is purchasing on one purchase occasion. Since preferences are homothetic due to the presence of the numéraire good<sup>18</sup>, exact linear aggregation is possible.

The demand functions are constrained so that the cross price terms,  $\sigma$ ,  $\theta_1$  and  $\theta_2$  are equal across equations. As shown in Appendix 4.1 (a), this is equivalent to the "symmetry" restriction (e.g. Court, 1967; Allenby, 1989) that the ratio of cross-elasticities to budget share must be equal across brands, where income elasticity is zero.

Although price parameters are constrained across equations, this does not of course imply equality on the part of own and cross-elasticities. In this linear system, elasticities are estimated at mean prices and quantities, and elasticities will vary according to differences between the mean values for the brands.

The demand functions are also subject to the constraints  $\sum_i \theta_i < \beta_i$  and  $\sigma < \beta_i$ , i.e. that the

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<sup>18</sup> The numéraire absorbs any changes in income, so relative preferences between the two goods remain unchanged. This results from the assumption that the goods represent a small proportion of total expenditure.

own-price effect dominates the sum of the cross-price parameters. As shown in Appendix 4.1(b), the "homogeneity" restriction that all elasticities must add to zero requires that own-price elasticities exceed the sum of cross-elasticities. The constraints on own-price derivatives in the theoretical model are more restrictive since they hold even if there are big differences in sales volumes between the brands.

The model also assumes that all consumers are homogeneous and that their consumption patterns do not change over time. As simplifying assumptions, these were appropriate in deriving the theoretical model. However, there is a substantial body of evidence that consumers can be heterogeneous in their responsiveness to marketing variables (e.g. Gonul and Srinivasan, 1993), or that consumption may be nonstationary across time (Fader and Lattin, 1993).

We take account of these issues in the empirical model by allowing for different responses to promotional activity, and for different consumption patterns at different times of the year. How we do this is described in detail in section (iv); in the next section, we describe the data.

### **(iii) Data**

The data consist of weekly demand, prices and promotional influences for one pack size of the three brands in the category in a specific retailer in Ontario, Canada, for the years 1993 and 1994; in the full dataset, there are 104 data points. The data originate from store-level scanner data, aggregated across all sample retailers for the retail chain within the province, and is provided by A.C. Nielsen to the manufacturer.

We apply the model to a single size, rather than to the total brand, since in this category, the

packaging technology used for the other major size is quite different, and we can expect the private label decision to be made discretely between the two sizes. This issue is considered in more detail in chapter 5. The empirical model also considers the problem facing a manufacturer with respect to a single retailer. As we saw in chapter 2, the direction of the effects of parameters in the model is unchanged by the assumption of multiple retailers.

The level of data aggregation deserves some comment. Chen, Kanetkar and Weiss (1995) show that aggregation across stores can introduce bias in price elasticities; however, the direction of such bias is uncertain. As will be seen in the discussion of results, the elasticities all have the expected sign and magnitude in the light of other studies in similar categories [see, for example, Tellis' (1988) meta-analysis].

The variables used are weekly sales of a particular size of each brand in units, unit shelf prices and indices of display and co-op advertising. All three brands have identical pack sizes.

Since A.C. Nielsen does not pick up the influence of coupons or checkout discounts in its price measures, the prices used here represent shelf prices rather than those paid at the checkout. However, discussions with the manufacturer indicated that the influence of coupons and checkout discounts were negligible in the category over this period.

Some discussion of the promotional variables is warranted here, since they will be used in the analysis to indicate the entry and exit of different consumer types. The display index is a multiplicative index of the brand's display (according to an interval scale) by the % All-Commodity Volume (ACV) in which it is displayed. Thus a score of 150 in an individual store represents a full end aisle display, 100 a part end and 75 a wing. If a brand has a full end in 100% ACV, it scores 150. If it has a full end in 50% ACV, it scores 75 ( $150 \times 0.5$ ), and so on. The index for Co-op is similar:

here. 150 is a full page, 100 a block ad and 75 a line mention.

The promotional indices are therefore measuring two aspects of non-price store promotion simultaneously: promotion intensity within a store, and distribution of promotions across stores. With respect to the first of these, the display measure increases with increasing display size *or* improved position in-store; the distribution measure increases as displays become more widely distributed across stores. As a manufacturer increases his investment in promotion, the display or co-op index will rise due to *either* store-specific or distribution effects, or both.

As an example, say a manufacturer has a display level of 100 in 50% of stores in a particular retail banner, giving an index of 50. He may negotiate with the retailer to improve the position of the display in all stores where the product is displayed by 50% to 150, giving him a score of 75. Alternatively, he may negotiate to broaden the distribution of displays across stores by 50%, yielding the same result. Since the index is multiplicative, a combination of both changes will have a nonlinear effect; however, it is still monotonically related to increasing promotion intensity.

Table 4.1 gives means and standard deviations for each of the variables in the dataset. For most of the first year, measures of display are unavailable. For this reason, we restrict our analysis to 1994 and the last few periods of 1993, a total of 55 data points.

**TABLE 4.1**  
**DESCRIPTIVE STATISTICS**

BRAND	SALES (units/wk.)		PRICE (\$/unit)		DISPLAY		CO-OP	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
1	4341.25	1206.01	1.59	0.17	108.29	11.99	14.75	37.15
2	2637.91	473.76	1.75	0.08	12.51	22.58	0	0
r (Private Label)	9937.74	2339.39	0.94	0.09	88.31	15.48	15.45	40.58

As noted above, market shares in this category conform to the "dominant firm" pattern of the theoretical model in chapter 3. In this dataset, the private label has the lion's share of the market, reflecting both a national trend in this direction and aggressive pricing and promotion on the part of the retailer.

The three brands differ in the extent to which they are promoted. As is evident from Table 4.1, the private label has both the lowest prices and the highest co-operative advertising, while brand 1 has the highest level of display. Brand 2 over the period in question had the highest prices and virtually no promotion activity. In fact, the private label is displayed in *every* period, although it receives co-op advertising only occasionally. Brand 1 is promoted occasionally, while brand 2 is hardly promoted at all.

The category as a whole has two seasonal peaks, Summer and Christmas. However, mean sales for the category and for each brand vary by season, as shown in Figure 4.2:

(Figure 4.2)

In summary, this dataset offers information on demand and prices in a category which fits the conditions assumed by the theoretical model, allowing us to estimate the parameters of the demand functions for later use in the theoretical model. However, demand patterns in the category suggest that promotions and seasonality may have an influence on sales of each brand. How we build these consideration into the model is the subject of the next section.

#### **(iv) Heterogeneity and Nonstationarity**

The demand functions of the theoretical model are derived from a utility function which assumes that one consumer chooses quantities of each of the products on one purchase occasion, given a budget constraint and preferences for all other goods. For a firm to make a decision on private label supply, however, it needs to consider the utility functions of all potential consumers of its products. In aggregating across consumers, however, we need to consider (i) whether all consumers purchase according to the same demand function (heterogeneity), (ii) whether their consumption pattern shifts with time (nonstationarity).

There is ample evidence of heterogeneity among consumers in the marketing literature. Gonul and Srinivasan (1993), for example, find strong support for differences across households in intrinsic brand utility, response to marketing variables and switching behaviour. With this and other studies [e.g. Guadagni and Little (1983); Lattin and Bucklin (1989); Fader and Little (1992)], there appears to be sufficient evidence of consumer heterogeneity to prevent us from simply multiplying the demand function of the theoretical model by the number of consumers in the market.

In this model, we assume that consumers may differ in their intrinsic brand preference (intercept demand), own-price response and cross-price response according to whether they are

regular consumers of the category. Specifically, we assume that a core group of "regular" consumers purchases and switches between brands in homogeneous fashion, while a second group of "occasional" consumers moves in and out of the category in response to promotional activity. These two groups are heterogeneous in all the parameters of their demand functions: hence they differ in all three of the ways identified in Gonul and Srinivasan's study.

From the literature on this subject, there are two possibilities identified by Blattberg, Briesch and Fox (1995): that the majority of promotional volume comes from switchers within the category, or that promotions expand the category. Blattberg *et al.* find conflicting results on this issue, and suggest that the difference may depend on the potential of the category for expansion through (for example) increased consumption, store switching, purchase acceleration or stockpiling.

Our assumption that promotions draw in occasional consumers is based on the idea that this category is one that lends itself to expansion. The product's physical characteristics allow for easy storage: hence consumers who use the category irregularly can purchase it on promotion and stockpile it. In addition, nonalcoholic beverages such as this are likely to be purchased "on impulse" by some consumers rather than as a staple item.

A further issue in empirically estimating these demand functions is the possibility that consumers of either type may have different utility for the products at different times. As we saw earlier, there is evidence of seasonality in this category. In our estimation of the demand functions, we allow intercepts to shift according to seasonal differences, in response to expansion and contraction of total or individual brand consumption, within both consumer groups, by time of year.

We formalize these ideas with the assumptions given below.

## ***Heterogeneity***

- There is a group<sup>19</sup> of "regular" consumers, which purchases brands according to the demand function  $q_{it} = \alpha_i - \beta_i p_{it} + \sigma p_{jt} + \theta p_{kt}$  in time period  $t$ .
- A second group<sup>20</sup> of consumers, "occasional" consumers, enters the market irregularly, and is specifically drawn in when there is a promotion on any of the brands. We assume that these consumers purchase on impulse rather than compare prices across brands - typically, they see a product on display or in a retailer's ad, and buy accordingly. Hence their cross-price terms  $\theta_i = 0$  and  $\sigma = 0$ , and their demand function is  $q_{it}' = \alpha_i' - \beta_i' p_{it}$ .
- If there is a promotion on one of the brands, occasional consumers have some probability of encountering it, a function of the relative intensity of the brand's promotional activity versus that of other brands.

The above assumptions are operationalized by creating variables to indicate the prevailing conditions in the market in a given period:

- The probability of promotional consumers seeing a promotion on brand  $i$  in

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<sup>19</sup> The demand function applies to the group as a whole. We assume that there are  $V$  such homogeneous consumers, a constant proportion of which,  $\tau$ , buys in every period. Since both  $V$  and  $\tau$  are constant across periods, they simply represent a rescaling of the parameters of the individual demand functions and have been dropped from the group demand expression.

<sup>20</sup> The size of the occasional segment may differ from that of the regular segment. Hence the demand functions shown below should be weighted by segment size. To keep the notation simple, this weighting has been omitted.

period  $t$ , given that any of the brands is being promoted, is  $\lambda_{it}$ , which is in turn a function of the intensity of promotional activity on brand  $i$  relative to that on the other brands. Across brands, the  $\lambda_{it}$ 's add to unity. Where there are no promotions on any of the brands in a given period,  $\lambda_{it} = 0 \forall i$ .

- If there is no promotion on product  $i$  in period  $t$ ,  $\lambda_{it} = 0$  and product  $i$ 's demand function is that of regular consumers only. This applies whether or not there are promotions on other brands. While promotions on other brands draw occasional consumers to those brands, they do not have any effect on the demand function for the non-promoted brand: regular consumers may still switch between brands, however, based on price differences.

In a three-brand system such as this category, the above assumptions yield the following set of linear demand equations in general, for brands 1, 2 and  $r$  (private label) in time period  $t$ .

### *General Model*

$0 \leq \lambda_{it} = \{\text{prob}(i \text{ promotion seen, period } t)\} \leq 1$ ;  $\lambda_{it} = 0$  where no promotion on any brand.  
 else  $\sum_{i=1}^3 \lambda_{it} = 1$ ;  $i \in \{1,2,r\}$ ;  $\beta_i > \theta_i$ ;  $\beta_i > \sigma$  for  $i \in \{1,2\}$ .

$$q_{1t} = (\alpha_1 + \lambda_{1t}\alpha_1') - (\beta_1 + \lambda_{1t}\beta_1')p_{1t} + \sigma p_{2t} + \theta_1 p_r$$

$$q_{2t} = (\alpha_2 + \lambda_{2t}\alpha_2') + \sigma p_{1t} - (\beta_2 + \lambda_{2t}\beta_2')p_{2t} + \theta_2 p_r$$

$$q_{\pi} = (\alpha_r + \lambda_{\pi} \alpha_r') + \theta_1 p_{1t} + \theta_2 p_{2t} - (\beta_r + \lambda_{\pi} \beta_r') p_{\pi}$$

By setting  $\lambda_{it}$  to specific values, we can represent different combinations of brand promotional activity in different periods. The principal scenarios are given below.

#### *No Promotion on Any Brand*

Here, there are no occasional consumers, and demand functions refer to regular consumers only.

$$\lambda_{it} = 0 \quad \forall i.$$

$$q_{1t} = \alpha_1 - \beta_1 p_{1t} + \sigma p_{2t} + \theta_1 p_{\pi}$$

$$q_{2t} = \alpha_2 + \sigma p_{1t} - \beta_2 p_{2t} + \theta_2 p_{\pi}$$

$$q_{\pi} = \alpha_r + \theta_1 p_{1t} + \theta_2 p_{2t} - \beta_r p_{\pi}$$

The form of these equations is identical to that specified for the theoretical model. If there were no promotions, this set of equations would represent the theoretical model multiplied by the number of consumers in the market.

#### *Promotion on Brand 1 Only*

Occasional consumers enter the market as a result of seeing a promotion on brand 1. The demand function for brand 1 is an amalgam of regular and occasional groups.

$$\lambda_{1t} = 1; \lambda_{it} = 0 \text{ for } i \neq 1.$$

$$\begin{aligned}
q_{1t} &= (\alpha_1 + \lambda_{1t}\alpha_1') - (\beta_1 + \lambda_{1t}\beta_1')p_{1t} + \sigma p_{2t} + \theta_1 p_{\pi} \\
q_{2t} &= \alpha_2 + \sigma p_{1t} - \beta_2 p_{2t} + \theta_2 p_{\pi} \\
q_{\pi} &= \alpha_r + \theta_1 p_{1t} + \theta_2 p_{2t} - \beta_r p_{\pi}
\end{aligned}$$

### *Promotion on Brands 1 and 2*

Brands 1 and 2 compete for the occasional consumer group. Each of their demand functions amalgamates regular and occasional consumers.

$$0 < \lambda_{it} < 1 \text{ for } i \in \{1,2\}; \lambda_{\pi} = 0.$$

$$\begin{aligned}
q_{1t} &= (\alpha_1 + \lambda_{1t}\alpha_1') - (\beta_1 + \lambda_{1t}\beta_1')p_{1t} + \sigma p_{2t} + \theta_1 p_{\pi} \\
q_{2t} &= (\alpha_2 + \lambda_{2t}\alpha_2') + \sigma p_{1t} - (\beta_2 + \lambda_{2t}\beta_2')p_{2t} + \theta_2 p_{\pi} \\
q_{\pi} &= \alpha_r + \theta_1 p_{1t} + \theta_2 p_{2t} - \beta_r p_{\pi}
\end{aligned}$$

### *Promotion on Brands 1, 2 and 3*

All three brands compete for occasional consumers, and their demand functions are composed of both types.  $0 < \lambda_{it} < 1 \forall i$  and demand functions are as shown for the General Model above.

### ***Nonstationarity***

Just as the market expands with promotional activity, seasonal fluctuations can change the

pattern of consumption. In this case, however, we assume that the change is due to an increase in the consumption rate of regular and occasional consumers, rather than to the entry of new, different consumers. In a category with high penetration such as this one, such an assumption seems reasonable.

We assume that seasonal changes in the rate of consumption result in an increase in the quantity consumed at each of the brands at any given price - in other words, each brand's intercept demand increases, but its slope with respect to its own and to competitive prices is unaffected<sup>21</sup>.

In season 0, which we define as the "base" against which the other seasons are measured, regular consumers' demand for product *i* remains

$$q_{it} = \alpha_i - \beta_i p_{it} + \sigma p_{2t} + \theta_i p_{jt}$$

In season  $s \neq 0$ , this becomes<sup>22</sup>

$$q_{it} = (\alpha_i + \mu_{is}) - \beta_i p_{it} + \sigma p_{2t} + \theta_i p_{jt}$$

where  $\mu_{is}$  represents the intercept change in season *s* compared with season 0, and  $\mu_{is} <. >$  or = 0.

Similarly, the demand function for occasional consumers in season *s* is

$$q_{it}' = (\alpha_i' + \mu'_{is}) - \beta_i' p_{it}$$

Aggregating across both consumer groups<sup>23</sup>, we have the general model in season *s*,

$$q_{1t \in s} = [(\alpha_1 + \mu_{1s}) + \lambda_{1t}(\alpha_1' + \mu'_{1s})] - (\beta_1 + \lambda_{1t}\beta_1') p_{1t} + \sigma p_{2t} + \theta_1 p_{jt}$$

$$q_{2t \in s} = [(\alpha_2 + \mu_{2s}) + \lambda_{2t}(\alpha_2' + \mu'_{2s})] + \sigma p_{1t} - (\beta_2 + \lambda_{2t}\beta_2') p_{2t} + \theta_2 p_{jt}$$

<sup>21</sup> Note that this parallel shift in linear demand functions means that elasticities will change by season. Since elasticities are estimated at the means in this linear system, seasonal changes in means will result in elasticity changes. The theoretical model uses the linear parameters as inputs, however, so its predictions will be unaffected by elasticity changes.

<sup>22</sup> *s* is defined as a set of time periods  $s = \{1, 2, \dots, t, \dots, T\}$ .

<sup>23</sup> Dropping the group size weightings as before.

$$q_{\pi \varepsilon s} = [(\alpha_r + \mu_{rs}) + \lambda_{\pi}(\alpha'_r + \mu'_{rs}) + \theta_1 p_{1t} + \theta_2 p_{2t} - (\beta_r + \lambda_{\pi} \beta'_r)] p_{\pi}$$

where the terms  $\alpha_r$ ,  $\alpha'_r$ ,  $\beta_r$ ,  $\beta'_r$ ,  $\sigma$  and  $\theta_j$  are constant across all seasons; seasonal terms  $\mu_{rs}$  and  $\mu'_{rs}$  vary by season but are constant within seasons; and the promotional terms  $\lambda_{it}$  vary by period.

This the model which will be estimated as outlined in the next section.

### **(v) Estimation of the System**

To estimate the system described in the last section, we need to define a variable that measures  $\lambda_{it}$ , the probability that occasional consumers will encounter a promotion on one of the brands.

As outlined above, the dataset provides two indices which measure promotion: Co-op and Display, weighted by distribution. One approach to the problem of identifying promotions within the data would be to assign a dummy to each condition as previous authors (e.g. Sethuraman, 1995) have done. However, when more than one brand is on promotion, we need to have some way of "dividing up the spoils" - determining the relative probability of consumers seeing a particular promotion. We could assign a value of 1.0 when one brand is promoted, 0.5 when there are two, and so on. However, such an approach assumes that all promotions have an equal probability of being seen, irrespective of the size or location of display, prominence of the ad, or distribution of promotions across stores. For this reason, it is preferable to construct an index based on the available Co-op and Display variables. As discussed in section (iii), while the scale for these variables is arbitrary, it will be monotonically related to promotion intensity, and hence to the probability that an "occasional" consumer will encounter a promotion on one of the brands.

We construct an index of promotional activity based on these measures, first by identifying whether any of the brands is promoted (if not, recall that  $\lambda_{it} \equiv 0$ ), and then by calculating each brand's share of promotional activity in the category. Hence there are two aspects to the measure: whether any occasional consumers are in the market, and which promotion they are most likely to see.

To identify periods in which any brand is promoted, we define a dummy variable,  $D_t$ , which equals 1 if any brand is promoted in the period in question, 0 otherwise.

Share of promotion is calculated as each brand's *total* promotion activity (sum of co-op and display indices<sup>24</sup>), shared to total promotion activity across all brands. Defining  $\rho_{it} = (c_{it} + d_{it}) / \sum_j (c_{jt} + d_{jt})$ , where  $c$ =co-op and  $d$ =display, we have  $\lambda_{it} = D_t \rho_{it}$ . Hence  $\lambda_{it}$  varies between 0 and 1, with 1 indicating that brand  $i$  was the only brand promoted, and 0 indicating that brand  $i$  was not promoted, or that none of the brands was promoted.

As noted earlier, data on display are not available for most of the first year; hence the above promotion share can be used over only 55 weeks of data. As was evident from Table 4.1, brand 2 did not have any Co-op advertising in these 55 weeks; hence its promotional activity consists of display only. Over this time, however, at least one brand is on display in every period, making it difficult to distinguish promoted from unpromoted periods by this measure. Hence we use Co-op on any brand as the dummy promotion variable,  $D_t$ . In using Co-op as a measure of category promotional activity, we are accounting for the ability of promotions to draw consumers into the category. The promotion share variable, on the other hand, indicates which promotion consumers are most likely to encounter once they enter the category.

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<sup>24</sup> Note that this unweighted sum means that Display and Co-op are assumed to have the same degree of effect on promotion intensity.

The major flaw in this approach is that periods in which there are displays but no Co-op are excluded as promotional periods. However, since the alternative is to recognize that at least one brand was promoted in *every* period, we take the view that the presence of Co-op advertising in addition to display indicates, at least, a more "unusual" level of promotional activity, which is more likely to attract occasional consumers.

Since seasonality is a factor in this category, we define seasonal {0,1} dummies for Spring, Summer, Christmas and Winter, with Fall as the "base" season.

Based on these definitions, the model is estimated as follows:

$$\begin{aligned}
 1SALES = & [\alpha_1 + \mu_{11}(SPRING) + \mu_{12}(SUMMER) + \mu_{13}(XMAS) + \mu_{14}(WINTER)] \\
 & + [\alpha'_1(DCOOP*1PSHR) + \mu'_{11}(DCOOP*1PSHR*SPRING) \\
 & + \mu'_{12}(DCOOP*1PSHR*SUMMER) + \mu'_{13}(DCOOP*1PSHR*XMAS) \\
 & + \mu'_{14}(DCOOP*1PSHR*WINTER)] \\
 & + \beta_1(1PRICE) + \beta'_1(DCOOP*1PSHR*1PRICE) + \sigma(2PRICE) + \theta_1(rPRICE)
 \end{aligned}$$

$$\begin{aligned}
 2SALES = & [\alpha_2 + \mu_{21}(SPRING) + \mu_{22}(SUMMER) + \mu_{23}(XMAS) + \mu_{24}(WINTER)] \\
 & + [\alpha'_2(DCOOP*2PSHR) + \mu'_{21}(DCOOP*2PSHR*SPRING) \\
 & + \mu'_{22}(DCOOP*2PSHR*SUMMER) + \mu'_{23}(DCOOP*2PSHR*XMAS) \\
 & + \mu'_{24}(DCOOP*2PSHR*WINTER)] \\
 & + \sigma(1PRICE) + \beta_2(2PRICE) + \beta'_2(DCOOP*2PSHR*2PRICE) + \theta_2(rPRICE)
 \end{aligned}$$

$$\begin{aligned}
 rSALES = & [\alpha_r + \mu_{r1}(SPRING) + \mu_{r2}(SUMMER) + \mu_{r3}(XMAS) + \mu_{r4}(WINTER)] \\
 & + [\alpha'_r(DCOOP*rPSHR) + \mu'_{r1}(DCOOP*rPSHR*SPRING) \\
 & + \mu'_{r2}(DCOOP*rPSHR*SUMMER) + \mu'_{r3}(DCOOP*rPSHR*XMAS) \\
 & + \mu'_{r4}(DCOOP*rPSHR*WINTER)] \\
 & + \theta_r(1PRICE) + \theta_2(2PRICE) + \beta_r(rPRICE) + \beta'_r(DCOOP*rPSHR*rPRICE)
 \end{aligned}$$

where 1SALES, 2SALES and rSALES are sales of brands 1, 2 and r (Private Label) respectively; SPRING, SUMMER, XMAS and WINTER are seasonal dummies; DCOOP is a {1,0} dummy set at 1 if any brand has Co-op advertising in that period, the term  $D_t$  described above. 1PSHR, 2PSHR and rPSHR are shares of total promotional activity as described above,  $\lambda_{it}$ . 1PRICE, 2PRICE and rPRICE are retail prices of the three brands.

While this system of equations could be estimated by OLS, there are moderate correlations between the error terms of the equations, as shown in Table 4.2:

**TABLE 4.2**

**ERROR CORRELATIONS FROM OLS ESTIMATION**

	<b>BRAND 1</b>	<b>BRAND B</b>	<b>BRAND r</b>
<b>BRAND 1</b>	1	0.44	0.56
<b>BRAND 2</b>	0.44	1	0.50
<b>BRAND r</b>	0.56	0.50	1

With correlated error terms, the efficiency of the parameter estimates may be improved by the application of Seemingly Unrelated Regression Estimation (SURE; Zellner, 1962). We apply this technique here and estimate the system as a whole. Following the theoretical model, cross-price terms are symmetrical across equations.

Own price elasticities are estimated at mean prices and quantities, with these means estimated separately for promoted and for non-promoted periods. Where the  $\beta'_i$  parameter is significant, there is a difference in own price elasticities between regular and occasional consumers. From the specifications outlined above, the price parameter of brand  $i$  in period  $t$  is then  $(\beta'_i + \lambda_{it}\beta'_i)$ . To estimate price elasticity, we adjust  $\beta'_i$  by multiplying it by the mean of the variable  $\lambda_{it}$  and add the resulting parameter to  $\beta'_i$ . Elasticities are then estimated for brand  $i$  at overall mean prices and quantities.

Where any of the parameters  $\mu_{is}$  is significant, the demand intercept for regular consumers differs by season. Statistical significance in any of the promotion \* season interaction terms  $\mu'_{is}$  means that intercept terms for promotional consumers differ by season. Slopes of the demand

functions are assumed not to vary by season, although elasticities will vary because of differences in mean prices and quantities.

**(vi) Regression Results**

Table 4.3 reports parameter values and significances for each of the three brands.

**TABLE 4.3  
REGRESSION PARAMETERS<sup>25</sup>**

	BRAND 1		BRAND 2		PRIVATE LABEL	
	Notn.	Parameter	Notn.	Parameter	Notn.	Parameter
Intercept	$\alpha_1$	6866.37	$\alpha_2$	8297.83**	$\alpha_3$	14481.00*
Spring	$\mu_{11}$	2040.56**	$\mu_{21}$	233.15	$\mu_{31}$	1218.78
Summer	$\mu_{12}$	1920.04**	$\mu_{22}$	102.08	$\mu_{32}$	686.32
Xmas	$\mu_{13}$	766.02	$\mu_{23}$	1198.09**	$\mu_{33}$	289.79
Winter	$\mu_{14}$	942.61	$\mu_{24}$	490.27*	$\mu_{34}$	-422.75
Promotion	$\alpha_1'$	-6128.32	$\alpha_2'$	-88439.68**	$\alpha_3'$	58181.91**
Promotion X Spring	$\mu'_{11}$	-1029.50	$\mu'_{21}$	-10798.02	$\mu'_{31}$	1188.79
Promotion X Summer	$\mu'_{12}$	-2133.69	$\mu'_{22}$	0 <sup>26</sup>	$\mu'_{32}$	-9024.81**
Promotion X Xmas	$\mu'_{13}$	2780.64	$\mu'_{23}$	-8042.02	$\mu'_{33}$	5474.32
Promotion X Winter	$\mu'_{14}$	-1380.51	$\mu'_{24}$	-14711.80**	$\mu'_{34}$	-732.05
1PRICE	$\beta_1$	-6187.45**	$\sigma_1$	1087.93**	$\theta_1$	5210.67**
2PRICE	$\sigma_1$	1087.93**	$\beta_2$	-4079.78**	$\theta_2$	-113.57
3PRICE	$\theta_1$	5210.67**	$\theta_3$	-113.57	$\beta_3$	-11939.26**
Promotion X Own Price	$\beta_1'$	4444.83	$\beta_2'$	53106.78**	$\beta_3'$	-59709.28**

\* p < 0.1; \*\* p < 0.05; Weighted MSE for the system = 0.959 (138 d.f.); System weighted R<sup>2</sup>: 0.75

<sup>25</sup> Data are disguised by multiplying all raw scores by a random constant.

<sup>26</sup> There were no Summer promotions on Brand 2 in the year in question. Hence there were no nonzero data points for the Promotion \* Summer variable. This variable was omitted from the regression.

As expected, all intercepts are positive, own price parameters negative and cross-price parameters positive. With the exception of the cross-price term between brand 2 and the private label, all price parameters are statistically significant at the 0.05 level. It appears from these results that brand 1 substitutes with both brand 2 and private label, but that brand 2 substitutes only with brand 1. This "price tier" pattern (Blattberg and Wisniewski, 1989) is supported by the fact that brand 2 has the highest mean price of the three brands, brand 1 is second highest and the private label is lowest.

Recall from the theoretical model that we constrained the parameters so that  $\beta_i > \sum_j \theta_{ij}$  and  $\beta_i > \sigma$ : each brand must respond to changes in its own price to a greater degree than to changes in competitive prices. This constraint was imposed so that aggregate demand would always be negatively related to prices, and so that prices would always be positive. These results meet this constraint: in all cases, the own price term exceeds cross-price terms in absolute value. This was not, however, imposed as a constraint in the estimation since empirical demand studies consistently find that own-price elasticities exceed cross-elasticities (Blattberg, Briesch and Fox, 1995).

Since prices in this category tend to be uniform across stores within a retail chain, the data appear to preserve the essential relationships quite well in spite of their aggregation level. While there are promotion effects on brand 2 and the private label, the effects of promotions on brand 1 may be hidden by the aggregation level. Appendix 4.2 discusses the issue of promotion in more detail, along with a series of diagnostic tests of the regression model.

All three brands are subject to some seasonality; however, the seasonal effects are not consistent across brands. From this result, it would appear that not only does total consumption in

the category shift with changes in the seasons, but that brand preferences also change. In the case of brand 2, consumption appears to peak at Christmas, while brand 1 increases in Spring and Summer.

While price parameters do not vary by season, price elasticities do vary because of differences in mean quantities and prices. Table 4.4 gives the elasticity matrix for each of the seasons analyzed, with values that are not significant shown in parentheses:

**TABLE 4.4**

**ELASTICITY MATRICES BY SEASON**

**FALL**

	1	2	<i>r</i>
1	-1.78	0.37	1.01
2	0.54	-2.42	(-0.04)
<i>r</i>	0.72	(-0.02)	-1.12

**SPRING**

	1	2	<i>r</i>
1	-2.01	0.36	0.83
2	0.64	-2.45	(-0.04)
<i>r</i>	0.87	(-0.02)	-1.14

**SUMMER**

	1	2	<i>r</i>
1	-2.15	0.40	0.89
2	0.61	-2.48	(-0.03)
<i>r</i>	0.57	(-0.01)	-0.65

**XMAS**

	1	2	<i>r</i>
1	-1.89	0.39	1.07
2	0.41	-1.81	(-0.03)
<i>r</i>	0.77	(-0.02)	-1.20

**WINTER**

	1	2	<i>r</i>
1	-2.30	0.44	1.12
2	0.62	-2.53	(-0.04)
<i>r</i>	0.80	(-0.02)	-1.07

Own price elasticities on the national brands are in the neighbourhood of -2.0 to -2.5, while cross-elasticities are lower. The magnitude of these elasticities is consistent with other studies of

price elasticity [see, for example, Tellis' (1988) meta-analysis]. The private label's own price elasticity is lower than that of the national brands in all seasons; suggesting that the private label is relatively more responsive to changes in the prices of the national brands than to changes in its own price.

One striking feature of the regression results is the very high level of intercept demand for the private label in relation to that of the two national brands. From Proposition 3.3 in chapter 3, the profitability of private label supply is positively related to private label intercept demand, and negatively related to national brand intercept demand. Based on these parameters, private label looks like an attractive proposition for either manufacturer. The private label has high preference among consumers, and can potentially generate high sales volumes, and, if its profit margins are acceptable, may be a profitable addition.

However, the slope of the private label's demand function with respect to its own price is also much higher (more negative) than that of either national brand. According to Proposition 3.2, this should make private label supply relatively *unprofitable*.

For purposes of illustration, we estimate the optimal wholesale price of brand 1 as a function of its marginal costs and competitive prices, based on these parameters for a non-promoted period in Fall. Recall from the theoretical model in chapter 3 that manufacturer 1, supplying the private label, would set the wholesale prices:

$$w_{n1}^* = \frac{1}{2}[(\alpha_1\beta_r + \theta_1\alpha_r)/(\beta_1\beta_r - \theta_1^2) + (\sigma\beta_r + \theta_1\theta_2)w_{n2}/(\beta_1\beta_r - \theta_1^2) + C_{n1}]$$

for the national brand, and

$$w_r^* = \frac{1}{2}[(\alpha_r\beta_r + \alpha_r\theta_r)/(\beta_r\beta_r - \theta_r^2) + (\sigma\theta_r + \beta_r\theta_2)w_{n2}/(\beta_r\beta_r - \theta_r^2) + C_r]$$

Substituting the above parameters into these expressions, we obtain

$$\begin{aligned} w_1^* &= \frac{1}{2}\{[(6866.37)(11939.26)+(5210.67)(14481.00)]/[(6187.45)(11939.26)-(5210.67)^2] \\ &+ [(1087.93)(11939.26)+(5210.67)(113.57)]w_2/[(6187.45)(11939.26)-(5210.67)^2] + C_{n1}\} \\ &= 1.68 + 0.15w_2 + C_{n1}. \end{aligned}$$

and, for the private label,

$$\begin{aligned} w_r^* &= \frac{1}{2}\{[(14481.00)(6187.37)+(6866.37)(5210.67)]/[(6187.45)(11939.26)-(5210.67)^2] \\ &+ [(1087.93)(5210.67)+(6187.45)(113.57)]w_2/[(6187.45)(11939.26)-(5210.67)^2] + C_r\} \\ &= 1.34 + 0.07w_2 + C_r. \end{aligned}$$

Since the unit price of items in this category is low, the price of brand 2 will have relatively little influence in either of these expressions. With equal costs between the private label and the national brand, we would expect the wholesale price of the private label to be lower than that of brand 1. On examining the numerator of the intercepts of these two price expressions (the denominator is identical), we find that much of the difference is accounted for by the larger value for  $\beta_r$  (11939.26) in  $w_1^*$  than  $\theta_r$  (5210.67) in  $w_r^*$ . In other words, the lower private label price is, to a large extent, due to low substitutability between the brands: private label consumers respond to the private label's own price rather than to that of brand 1. As private label prices rise, consumers will tend to refrain from buying altogether, rather than switch to brand 1. In this situation, the

manufacturer maximizes his total surplus by setting a low price for the private label to capture these consumers, and a higher price for the national brand since its demand is relatively unaffected by the private label's price. In short, he segments the market.

Until we estimate the full model with all parameters, including costs, however, we do not know the net effect of these conflicting influences on private label supply profitability. This is the subject of chapter 5, in which we use these parameters to estimate the profitability of private label supply in a variety of business scenarios.

### **(vii) Summary and Conclusions**

The primary purpose of this chapter has been to develop intuitively reasonable estimates of demand parameters for input into the theoretical model. In the process of developing these estimates, it has become clear that, in order to apply a model such as this to real-world data, we need to make some assumptions about consumer behaviour.

Specifically, we have assumed that two types of consumers exist: "regular" consumers, who switch between brands based on price, and "occasional" consumers, who buy the first promoted brand they see. We have estimated separate demand functions for each of these groups. In addition, we assumed that each of these groups' demand functions varied by season.

The results we obtain from the theoretical model - the profitability for a firm of supplying private label - will depend on these assumptions, so we need to have some confidence that they are reasonable.

In the case of promotions, we have assumed that occasional consumers may differ in intercept demand and in own price parameters, but have cross-price effects that approach zero. The

origin of this assumption is the intuition that occasional consumers enter the market because they see a retail promotion. Such consumers use relatively little of the product and will purchase enough to last until the next promotion; the category, however, represents a small proportion of their total grocery bill. If consumers of this type are attracted to the category by a display or switch from another store because of an ad, it is reasonable to assume that they do not go to the shelf to compare prices, but purchase on impulse, reacting only to the price of the brand on display.

A limitation of this approach is that it does not allow for the possibility that regular consumers of the product may expand the category by switching stores. Store switching is certainly present in this category, but it is difficult to envisage consumers switching stores on a regular basis for an item that costs less than \$2. Where a major national brand is deeply discounted, we can expect some store switching, but for most promotions in this category, its extent is likely to be small.

The assumption that promotions draw new consumers into the category is supported by the promotions literature, as argued earlier in this chapter. An alternative assumption would be that the number of consumers in the category remains constant, but that regular consumers change their behaviour in response to a promotion. There is some evidence of this in the literature, but the evidence varies by category and is not conclusive. Given the properties of this particular product - its ease of storage and its "impulse" nature - the assumption that promotions increase category size by attracting occasional consumers appears reasonable.

In the case of seasonality, we have assumed that regular and occasional consumers' intercept demands rise or fall by season, but that own and cross price terms are unaffected. In this category, the key seasonal influences are weather and holidays. It is difficult to conceive of either of these having a great effect on price parameters, although they certainly could affect intercept demand. The

alternative assumption, that price terms vary by season. implies that some other seasonal influence, such as income fluctuations, affects the responsiveness of demand to prices. However, since the products account for a small outlay in proportion to income, this appears unlikely.

The linear specification of the empirical model fits well with the linear form of the theoretical model. This should not be taken to imply that the only way to estimate this model is according to a linear specification, which may not be appropriate with all datasets. Earlier estimates of this model used a log form, but did not show any material improvement in fit over the linear version. The closer correspondence between the theoretical and empirical models and the simplicity of the cross-elasticity constraint weighed the decision in favour of the linear version.

The results show some seasonal effects, and price effects are in the expected direction. Promotional effects, however, are limited. This may be due to the aggregate nature of the data, which is certainly a limitation of this empirical application.

With reasonable parameter estimates for demand, we are now in a position to move forward with a demonstration of what the model can do in a practical situation. The next chapter shows how these parameter estimates are entered into the model along with assumptions about costs, and develops an analysis of several strategic scenarios.

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**APPENDICES**

## APPENDIX 4.1 CROSS-EQUATION ELASTICITY CONSTRAINTS

### (a) Symmetry

The symmetry restriction on cross-price elasticities is

$$\eta_{ij}/w_j + \eta_{iY} = \eta_{ji}/w_i + \eta_{jY} \quad (i, j = 1, 2, \dots, n).$$

where  $\eta_{ij}$  are own and cross-elasticities,  $\eta_{iY}$  is income elasticity and  $w_i$  is share of total expenditures.

In the theoretical model of chapters 2 and 3, we assume that the products account for a small proportion of total expenditure: hence  $\eta_{iY} = \eta_{jY} = 0$ . Thus

$$\eta_{ij} w_i = \eta_{ji} w_j$$

$$\eta_{ij} = \eta_{ji} (w_j/w_i)$$

Substituting  $(\partial q/\partial p_i)(p/q_i)$  for  $\eta_{ij}$  and  $(\partial q/\partial p_j)(p/q_j)$  for  $\eta_{ji}$ , we have

$$(\partial q/\partial p_j)(p/q_j) = (\partial q/\partial p_i)(p/q_i)(w_j/w_i)$$

$w_i$  is the budget share of brand  $i$ , or  $p_i q_i/E$ , where  $E$  represents total expenditure on all goods. Then

$$(\partial q/\partial p_j)(p/q_j) = (\partial q/\partial p_i)(p/q_i)[p_j q_j/E]/[p_i q_i/E]$$

$$- \quad (\partial q/\partial p_j)(p/q_j) = (\partial q/\partial p_i)(p/q_i)[p_j q_j/p_i q_i]$$

$$- \quad \partial q/\partial p_j = (\partial q/\partial p_i)(p/q_i)(q_j/p_i)[p_j q_j/p_i q_i]$$

$$- \quad \partial q/\partial p_j = \partial q/\partial p_i$$

Hence the cross-price demand function derivatives are equal. While this result is well-known for compensated demand functions, the effect applies here because income elasticities are zero.

### (b) Homogeneity

The homogeneity restriction is

$$\sum_{j=1}^n \eta_{ij} + \eta_{iY} = 0 \quad (i = 1, 2, \dots, n)$$

In the theoretical model of chapters 2 and 3, we assume that the products account for a small proportion of total expenditure: hence  $\eta_{iY} = \eta_{jY} = 0$ . So the homogeneity restriction becomes

$$\sum_{j=1}^n \eta_{ij} = 0, \text{ or alternatively,}$$

$$\eta_{ii} + \sum_{j \neq i}^n \eta_{ij} = 0$$

across *all* goods the consumer buys. Assume that these products are substitutes for other goods, or that  $\eta_{ii} > 0$ , where  $i$  represents all other goods outside the category. Then

$$\eta_{ii} + \sum_{j \neq i}^n \eta_{ij} = -\eta_{ii}$$

$$- \quad \eta_{ii} + \sum_{j \neq i}^n \eta_{ij} < 0.$$

Since  $\eta_{ii} < 0$  and  $\eta_{ij} > 0 \forall j$ ,

$$|\eta_{ii}| > |\sum_{j \neq i}^n \eta_{ij}|$$

For a two-product market,

$$|(\partial q/\partial p_i)(p/q_i)| > (\partial q/\partial p_j)(p/q_j)$$

$$- \quad |(\partial q/\partial p_i)(1/q_i)| > (\partial q/\partial p_j)(1/q_j)$$

$$- \quad |(\partial q/\partial p_i)| > (\partial q/\partial p_j)(q_i/q_j)$$

Hence the homogeneity restriction is less restrictive than the restriction in our model that  $|(\partial q/\partial p_i)| > (\partial q/\partial p_j)$ , for *all* relative sales volumes of  $i$  and  $j$ .

## **APPENDIX 4.2**

### **REGRESSION DIAGNOSTICS**

In this Appendix, we discuss some of the issues arising from the regression analysis in more detail.

#### ***Model Identification***

In estimating the model empirically, we have found a relationship between quantity sold and prices. Although there is little likelihood of supply shocks during the 55 weeks over which the model is estimated, we need to be sure that we are estimating a demand function, rather than a series of supply functions.

One way of determining this is to consider whether there was adequate inventory to cover sales in retail stores over the period in question. If there was no supply constraint, demand would be less than supply and the quantity sold would reflect demand rather than supply.

Additional data were obtained on stockout levels from the manufacturer of brand 1. These data were derived from A.C. Nielsen's bimonthly store audit, not from the scanner database analyzed in the regressions. While these are not directly comparable with the model data, they give an indication of whether stockout levels were generally high at that time.

A.C. Nielsen's store audit extrapolates data from a panel of stores to regional and national levels. The stockout measure is the % of All Commodity Volume in which the products was out of stock. For the package size being analyzed here, the level in all periods in 1994 in the Ontario market was zero. Hence we can conclude that stockouts were not a major problem, and that the regression is measuring a demand function.

#### ***Exogeneity of Price***

In the theoretical model, the retailer's optimal price is shown to be a function of the parameters of the demand function. However, in estimating the demand function empirically, we use price as a predictor of sales. As a result, the possibility exists that price will be correlated with the error term in the regression.

We analyze this issue by the method proposed by Hausman (1978): we estimate prices for each product using lagged prices and all other regressors in the system, and add these estimated prices to the regression model for each brand. The joint significance of these added predictors is a test of the null hypothesis that prices and error terms are not correlated.

Hence the model for brand 1 is

$$\begin{aligned}
1\text{SALES} = & [\alpha_1 + \mu_{11}(\text{SPRING}) + \mu_{12}(\text{SUMMER}) + \mu_{13}(\text{XMAS}) + \mu_{14}(\text{WINTER}) \\
& + [\alpha_1'(\text{DCOOP}*1\text{PSHR}) + \mu_{11}'(\text{DCOOP}*1\text{PSHR}*\text{SPRING}) \\
& + \mu_{12}'(\text{DCOOP}*1\text{PSHR}*\text{SUMMER}) + \mu_{13}'(\text{DCOOP}*1\text{PSHR}*\text{XMAS}) \\
& + \mu_{14}'(\text{DCOOP}*1\text{PSHR}*\text{WINTER}) \\
& + \beta_{11}\text{PRICE} + \beta_{11}'(\text{DCOOP}*1\text{PSHR}*1\text{PRICE}) + \sigma_2\text{PRICE} \\
& + \theta_{1r}\text{PRICE} + \gamma_{11}\text{1HAT} + \gamma_{12}\text{2HAT} + \gamma_{1r}\text{rHAT}
\end{aligned}$$

$$\begin{aligned}
2\text{SALES} = & [\alpha_2 + \mu_{21}(\text{SPRING}) + \mu_{22}(\text{SUMMER}) + \mu_{23}(\text{XMAS}) + \mu_{24}(\text{WINTER}) \\
& + [\alpha_2'(\text{DCOOP}*2\text{PSHR}) + \mu_{21}'(\text{DCOOP}*2\text{PSHR}*\text{SPRING}) \\
& + \mu_{22}'(\text{DCOOP}*2\text{PSHR}*\text{SUMMER}) + \mu_{23}'(\text{DCOOP}*2\text{PSHR}*\text{XMAS}) \\
& + \mu_{24}'(\text{DCOOP}*2\text{PSHR}*\text{WINTER}) \\
& + \beta_{22}\text{PRICE} + \beta_{22}'(\text{DCOOP}*2\text{PSHR}*2\text{PRICE}) + \sigma_1\text{PRICE} \\
& + \theta_{2r}\text{PRICE} + \gamma_{21}\text{1HAT} + \gamma_{22}\text{2HAT} + \gamma_{2r}\text{rHAT}
\end{aligned}$$

$$\begin{aligned}
r\text{SALES} = & [\alpha_r + \mu_{r1}(\text{SPRING}) + \mu_{r2}(\text{SUMMER}) + \mu_{r3}(\text{XMAS}) + \mu_{r4}(\text{WINTER}) \\
& + [\alpha_r'(\text{DCOOP}*r\text{PSHR}) + \mu_{r1}'(\text{DCOOP}*r\text{PSHR}*\text{SPRING}) \\
& + \mu_{r2}'(\text{DCOOP}*r\text{PSHR}*\text{SUMMER}) + \mu_{r3}'(\text{DCOOP}*r\text{PSHR}*\text{XMAS}) \\
& + \mu_{r4}'(\text{DCOOP}*r\text{PSHR}*\text{WINTER}) \\
& + \beta_{r1}\text{PRICE} + \beta_{r1}'(\text{DCOOP}*r\text{PSHR}*r\text{PRICE}) + \theta_{11}\text{PRICE} \\
& + \theta_{22}\text{PRICE} + \gamma_{r1}\text{1HAT} + \gamma_{r2}\text{2HAT} + \gamma_{rr}\text{rHAT}
\end{aligned}$$

where  $i\text{HAT}$  in each equation represents the price for brand  $i$ , estimated from all the other variables in the system. The joint significance of the coefficients  $\gamma_{ij}$  is an indicator of whether significant error correlation exists.

The following table shows the coefficients estimated for actual and estimated prices in this revised model:

	BRAND 1	BRAND 2	PRIVATE LABEL
1PRICE	-10545.10**	1295.51	2161.12
2PRICE	1295.51	-3246.33**	-953.40
rPRICE	2161.12	-953.40	-17919.80**
1HAT	8848.14**	-433.56	-154.43
2HAT	1297.89	-2152.89	3890.50
rHAT	8495.81	2561.09	14370.54

\*p < 0.10; \*\*p < 0.05

The only significant individual coefficient among the predicted prices is the own-price coefficient on brand 1. The test for joint significance of all the price coefficients is not significant at the 0.05 level. Hence there is no evidence to indicate that prices are correlated with the error term.

### Model Specification

As an alternative to the formulation discussed in the chapter, a set of nonlinear demand functions was estimated. These functions were in log form, based on the ratio between the price of each brand and its competitors.

The model was estimated as follows:

$$\begin{aligned} \log(1SALES) = & [\alpha_1 + \mu_{11}(SPRING) + \mu_{12}(SUMMER) + \mu_{13}(XMAS) + \mu_{14}(WINTER) \\ & + [\alpha'_1(DCOOP*1PSHR) + \mu'_{11}(DCOOP*1PSHR*SPRING) \\ & + \mu'_{12}(DCOOP*1PSHR*SUMMER) + \mu'_{13}(DCOOP*1PSHR*XMAS) \\ & + \mu'_{14}(DCOOP*1PSHR*WINTER) \\ & + \beta_1 \log(1PRICE) + \beta'_1(DCOOP*1PSHR*1PRICE) + \sigma_1 \log(2PRICE/1PRICE) \\ & + \theta_1 \log(rPRICE/1PRICE) \end{aligned}$$

$$\begin{aligned} \log(2SALES) = & [\alpha_2 + \mu_{21}(SPRING) + \mu_{22}(SUMMER) + \mu_{23}(XMAS) + \mu_{24}(WINTER) \\ & + [\alpha'_2(DCOOP*2PSHR) + \mu'_{21}(DCOOP*2PSHR*SPRING) \\ & + \mu'_{22}(DCOOP*2PSHR*SUMMER) + \mu'_{23}(DCOOP*2PSHR*XMAS) \\ & + \mu'_{24}(DCOOP*2PSHR*WINTER) \\ & + \beta_2 \log(2PRICE) + \beta'_2(DCOOP*2PSHR*2PRICE) + \sigma_2 \log(1PRICE/2PRICE) \\ & + \theta_2 \log(rPRICE/2PRICE) \end{aligned}$$

$$\begin{aligned} \log(rSALES) = & [\alpha_r + \mu_{r1}(SPRING) + \mu_{r2}(SUMMER) + \mu_{r3}(XMAS) + \mu_{r4}(WINTER) \\ & + [\alpha'_r(DCOOP*rPSHR) + \mu'_{r1}(DCOOP*rPSHR*SPRING) \\ & + \mu'_{r2}(DCOOP*rPSHR*SUMMER) + \mu'_{r3}(DCOOP*rPSHR*XMAS) \\ & + \mu'_{r4}(DCOOP*rPSHR*WINTER) \\ & + \beta_r \log(rPRICE) + \beta'_r(DCOOP*rPSHR*rPRICE) + \theta_r \log(1PRICE/rPRICE) \\ & + \theta_2 \log(2PRICE/rPRICE) \end{aligned}$$

with notation as defined in the chapter. The coefficients for price ratios between any two brands are constrained to the product of their dollar share ratio and the corresponding coefficient in the other brand's equation. Hence in equation  $i$ ,

$$\sigma_i = (p_i q_j / p_j q_i) \sigma_j$$

where  $q_i$  and  $q_j$  are average sales volumes of brands  $i$  and  $j$ . This follows from the fact that  $\partial q_i / \partial p_j = \partial q_j / \partial p_i$  (see Appendix 4.1) and  $\sigma_i = \eta_{ij} = (p_j / q_i) (\partial q_j / \partial p_j)$  in the log model.

Using the fact that  $\log(p/q) = \log(p) - \log(q)$ , we calculate own price elasticity for each brand as its coefficient for own price less those for competitive prices, or

$$\eta_i = \beta_i - \sigma - \theta_1 \quad \text{for national brand } i \in \{1,2\}, \text{ and}$$

$$\eta_r = \beta_r - \theta_1 - \theta_2 \quad \text{for the private label.}$$

Cross-price elasticity is simply the coefficient for each brand's price ratio with each competing brand, or  $\sigma$  for cross-price elasticity between the two national brands, and  $\theta_1$  for cross-price elasticity between national brand  $i$  and the private label.

This model yields the following parameters:

	BRAND 1		BRAND 2		PRIVATE LABEL	
	Notn.	Parameter	Notn.	Parameter	Notn.	Parameter
Intercept	$\alpha_1$	8.50**	$\alpha_2$	8.72**	$\alpha_r$	8.93**
Spring	$\mu_{11}$	0.35**	$\mu_{21}$	0.08	$\mu_{r1}$	-0.08
Summer	$\mu_{12}$	0.27**	$\mu_{22}$	-0.06	$\mu_{r2}$	-0.02
Xmas	$\mu_{13}$	0.15	$\mu_{23}$	0.33**	$\mu_{r3}$	0.01
Winter	$\mu_{14}$	0.12	$\mu_{24}$	0.15**	$\mu_{r4}$	-0.02
Promotion	$\alpha_j'$	-0.28	$\alpha_2'$	-21.08*	$\alpha_r'$	2.85**
Promotion X Spring	$\mu_{11}'$	-0.12	$\mu_{21}'$	-2.28	$\mu_{r1}'$	0.05
Promotion X Summer	$\mu_{12}'$	-0.27	$\mu_{22}'$	0	$\mu_{r2}'$	-0.50
Promotion X Xmas	$\mu_{13}'$	0.33	$\mu_{23}'$	-1.20	$\mu_{r3}'$	0.49
Promotion X Winter	$\mu_{14}'$	-0.15	$\mu_{24}'$	-4.23**	$\mu_{r4}'$	-0.12
OWN PRICE	$\beta_1$	-0.35	$\beta_2$	-1.71**	$\beta_r$	-0.84
CROSS-PRICE RATIO	$\sigma_1$	0.58**	$\sigma_2$	0.46**	$\theta_1$	0.66**
CROSS-PRICE RATIO	$\theta_1$	0.46**	$\theta_2$	-0.13	$\theta_r$	-0.24
Promotion X Own Price	$\beta_j'$	0.28	$\beta_2'$	12.66**	$\beta_r'$	-2.79*

\*p<0.1; \*\*p < 0.05

These results are quite similar to the linear model: with only one exception, the same variables are statistically significant. The single exception is the coefficient for Summer on Private Label demand, which is significant at the 0.10 level in the linear model, but not significant here. Closer examination reveals that p=0.11 for this coefficient in the log model.

Elasticities, estimated according to the procedure outlined above, are as follows:

BRAND	1	2	r
1	-1.39	0.58	0.42
2	0.46	-2.04	(-0.13)
r	0.66	(-0.24)	-1.26

(Parentheses indicate lack of statistical significance)

As in the linear model, the cross-price term between the private label and brand 2 is not significant. Generally, both own and cross-price elasticities appear lower than those derived from the linear model.

We compare the overall fit and the degree of first-order serial correlation of this log model and the linear model discussed in the body of the chapter, as follows:

<b>FIT:</b>	<b>LINEAR</b>		<b>LOG</b>	
<b>System Wgt. R<sup>2</sup></b>	0.75		0.79	
<b>MSE</b>	0.96		0.91	
<b>SERIAL CORR.:</b>	<b>DW</b>	<b>ρ</b>	<b>DW</b>	<b>ρ</b>
<b>BRAND 1</b>	1.64	0.17	1.44	0.24
<b>BRAND 2</b>	2.21	-0.12	2.01	-0.04
<b>PRIVATE LABEL</b>	2.08	-0.08	1.86	0.00

The overall fit of the log model is similar to, or slightly better than, that of the linear model. The critical values of the Durbin-Watson statistic in this case are  $d_u = 1.78$  and  $d_l = 1.57$ . According to this test, the null hypothesis of no serial correlation is cannot be rejected for any of the linear submodels for each of the brands, although the test is indeterminate in the case of brand 1 (Pindyck and Rubinfeld, 1981, p.160). Results are similar for the log model, with the exception of brand 1, which exhibits significant serial correlation at the 5% level. In this respect, the log model fares slightly worse than the linear form.

Since the overall fit of the models and serial correlation are similar, and since the log model offers a similar pattern of results, there appears to be no reason to deviate from the linear form specified in the theoretical model. Hence further analysis is based on the linear model.

### **Promotions**

The results of the linear estimation of the model show limited evidence of significant effects of promotions: promotion has no effect on either the intercept or own-price coefficient of brand 1, and most Promotion X Season coefficients on each of the brands are not significant. However, promotion has a significant negative effect on the intercept of brand 2, a positive effect on its price coefficient and interacts positively with Winter seasonality. On the private label, promotion has a positive effect on the intercept, a negative effect on the price coefficient and interacts negatively with Summer seasonality.

Several reasons suggest themselves for this pattern. Recall that we defined promotion share as the sum of the brand's co-op and display indices shared to the sum of co-op and display for the category as a whole. While co-op advertising is usually co-ordinated across the chain as a whole, discussions with the manufacturer of brand 1 indicate that there can be wide variations in the level of display across stores. Stores may choose to build a larger or a smaller display, share it with

another product, or replace it altogether, at their discretion. Hence a combination of lack of co-ordination of displays and aggregation across stores may be responsible for these results on brand 1. On the private label, however, we can expect that a greater degree of store co-ordination will exist, because of retail chains' policy of giving priority to their own brands.

A further possibility is that high promotional frequency on brand 1 results in stockpiling by occasional consumers, and lower promotion responsiveness. This is supported by the fact that brand 2, the brand which promotes least frequently of all three products, shows promotional effects. Brand 2 also has the highest average price, and lowest average sales, of the three; hence it attracts few occasional consumers except when it is promoted and appears to be a great "deal". Hence promotion has a negative effect on brand 2's intercept: those consumers who enter the category to buy brand 2 on promotion are less loyal than those who buy it regularly.

To push this a little further, the following table gives average prices and own-price elasticities by season:

BRAND	FALL		SPRING		SUMMER		XMAS		WINTER	
	$\bar{p}$	$\eta$								
1	1.42	-1.80	1.74	-2.04	1.61	-2.17	1.45	-1.90	1.71	-2.32
2	1.69	-2.45	1.79	-2.48	1.71	-2.48	1.72	-1.83	1.85	-2.56
PL	.97	-2.57	.99	-2.62	.79	-1.49	.98	-2.76	.99	-2.46

The private label can be assumed here to have the weakest image of the three brands, as in many categories. At seasonal peaks such as Summer and Christmas, the product is used for entertaining and we would expect image to become a more important consideration. This is evident from the fact that brand 2 shows a significant effect of Christmas seasonality, in spite of its high price relative to competitors.

Because of their high frequency, therefore, individual promotions appear to have less impact than the combination of price movements and seasonal variations in brand preference, at least on brand 1. These effects, combined with the aggregation problem discussed above, conspire to hide the effect of promotions on brand 1 sales. However, promotional effects on brand 2 and the private label can be explained by lower promotional frequency and better co-ordination of displays, respectively.

A further possibility is that multicollinearity is responsible for the weak promotional effects. To check this, correlations between the variables were estimated. Correlations between the main promotional and seasonal variables were low, with few exceeding 0.2. However, some of the interaction terms were correlated. Within equations, the Promotion and Promotion X Price variables were found to be highly correlated for all three brands ( $\rho_1 = 0.992$ ,  $\rho_2 = 0.998$ ,  $\rho_r = 0.988$ ).

This collinearity traces to the construction of the variables. Recall that a brand's promotional share is defined as zero when there are no promotions, or when that brand does not promote. Where promotion share is zero, the Promotion X Price interaction will also be zero. The high correlation results from the fact that many data points are zero for both variables.

To check whether multicollinearity significantly affects the results, an alternative model was

specified to exclude the Promotion X Price interaction term. The results are shown in the following table:

	BRAND 1		BRAND 2		PRIVATE LABEL	
	Notn.	Parameter	Notn.	Parameter	Notn.	Parameter
Intercept	$\alpha_1$	6433.00*	$\alpha_2$	7494.38**	$\alpha_3$	30703.85**
Spring	$\mu_{11}$	1879.84**	$\mu_{21}$	172.32	$\mu_{31}$	-598.78
Summer	$\mu_{12}$	1581.15**	$\mu_{22}$	-154.30	$\mu_{32}$	-2125.67*
Xmas	$\mu_{13}$	774.43	$\mu_{23}$	1184.84**	$\mu_{33}$	591.65
Winter	$\mu_{14}$	770.02	$\mu_{24}$	412.92	$\mu_{34}$	258.04
Promotion	$\alpha_j'$	-71.74	$\alpha_2'$	-789.41	$\alpha_3'$	2208.80
Promotion x Spring	$\mu_{11}'$	579.39	$\mu_{21}'$	6031.85	$\mu_{31}'$	-1590.81
Promotion X Summer	$\mu_{12}'$	-231.25	$\mu_{22}'$	0	$\mu_{32}'$	1779.31
Promotion X Xmas	$\mu_{13}'$	2808.99	$\mu_{23}'$	2936.59	$\mu_{33}'$	3112.69
Promotion X Winter	$\mu_{14}'$	158.86	$\mu_{24}'$	5165.59	$\mu_{34}'$	-3685.71
1PRICE	$\beta_1$	-5557.28**	$\sigma$	1128.59**	$\theta_1$	4640.00**
2PRICE	$\sigma$	1128.59**	$\beta_2$	-3547.03**	$\theta_2$	-265.44
3PRICE	$\theta_1$	4641.00**	$\theta_3$	-265.44	$\beta_3$	-27641.40**

\*p<0.1; \*\*p < 0.05; Weighted R<sup>2</sup> for the system = 0.74

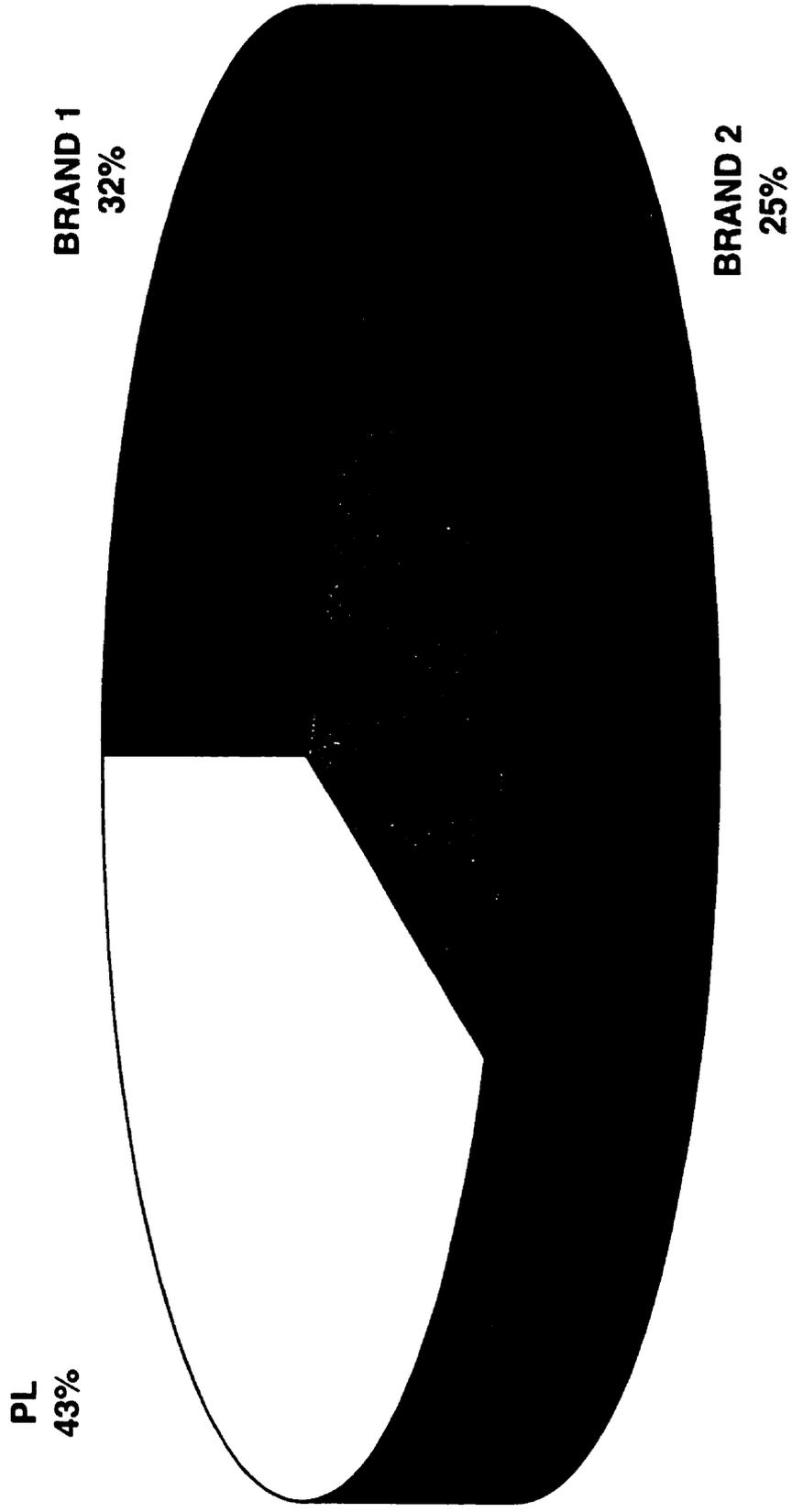
The pattern of these coefficients is similar to the full model. Overall, multicollinearity does not appear to have a great impact on the results.

The exception to this is that the promotion coefficients on brand 2 and the private label, which were significant in the full model, are no longer significant here. Hence the promotion effects seen in the analysis must be considered weak.

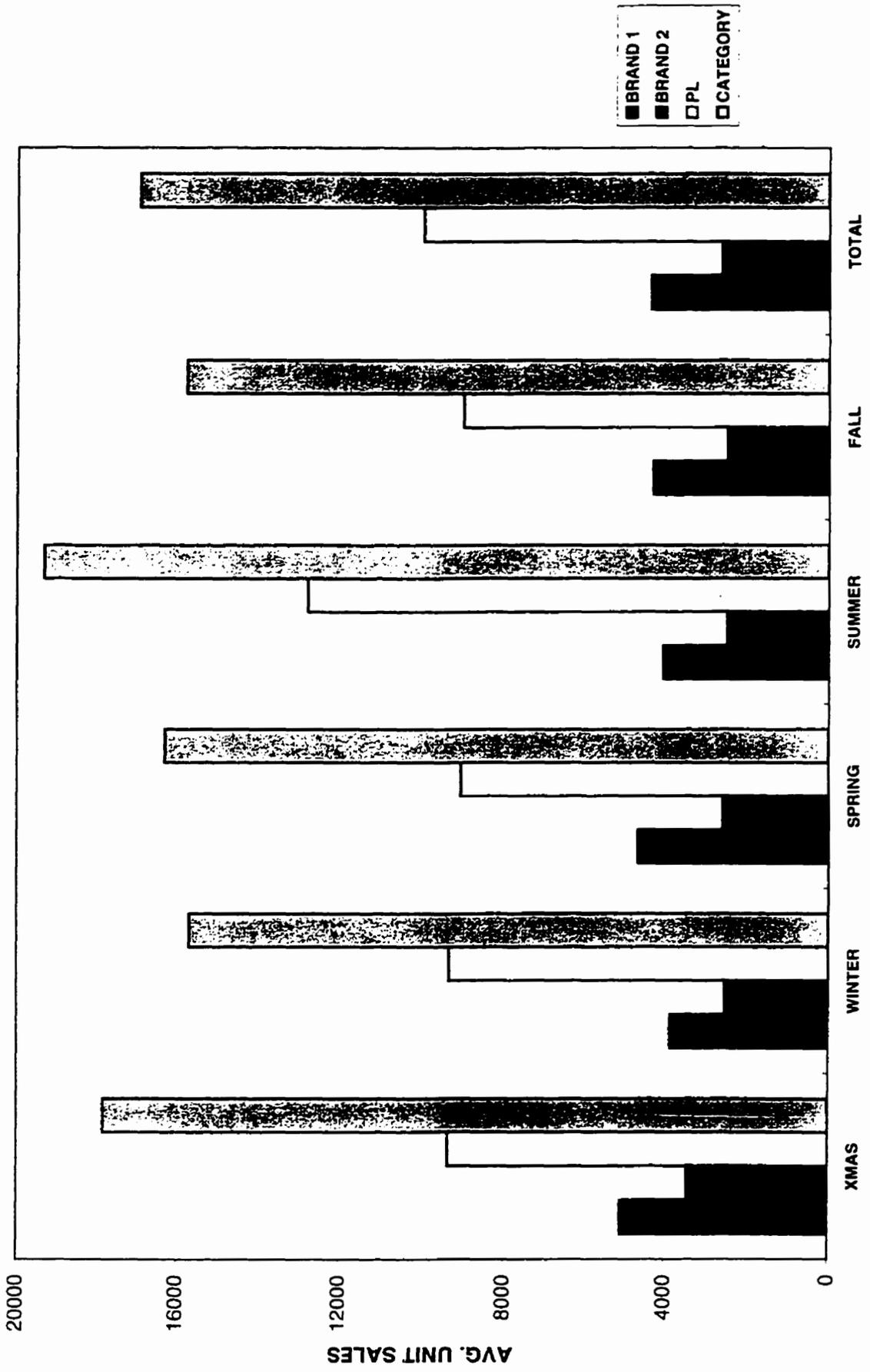
In summary, promotion does not appear to have a great effect on sales of any of the brands. The most likely causes of this are aggregation of display data across individual stores whose level of activity varies, and stockpiling due to high promotion frequency.

## **FIGURES**

**FIGURE 4.1**  
**MARKET SHARES (\$)**



**FIGURE 4.2  
SALES BY SEASON**



## **5. THE MODEL IN ACTION**

*To question all things; - never to turn away from any difficulty; to accept no doctrine either from ourselves or from other people without a rigid scrutiny by negative criticism; letting no fallacy, or incoherence or confusion of thought, step by unperceived; above all, to insist upon having the meaning of a word clearly understood before using it, and the meaning of a proposition before assenting to it; - these are the lessons we learn from ancient dialecticians.*

**John Stuart Mill:**

*Inaugural Address as Rector, University College of St. Andrews*

### **(i) Introduction**

Having developed a theoretical model and estimated its parameters, we are now in a position to apply the model to a "real world" problem: to determine the profitability of private label supply for a manufacturer in a grocery category. In this chapter, we use the parameters derived in chapter 4 as inputs to the theoretical model, along with cost estimates.

Our objective here is to tie together the theoretical model and the empirical estimation of its parameters. In particular, we set out to demonstrate the application of the model to a specific case study.

In chapter 4, we took the first step in applying the model to a real-world situation by analyzing demand data on a category of grocery products. The end result of this estimation was a set of weekly demand functions which varied by promotional activity and by time of year.

To apply these demand functions to the manufacturer's private label supply decision, we need to develop some way of aggregating them to reflect the fact that the decision period is longer than one week. In this chapter, we propose a method for aggregating the demand functions across a full year that preserves the essential relationships.

In addition, analysis of the profitability of private label supply requires some estimate of costs as well as of demand. In this chapter, we estimate costs, in the absence of explicit data from the manufacturer, using publicly available sources.

With estimates of annual demand functions and unit costs, we determine the profitability of private label supply for the national brand manufacturers, deriving the equilibrium outcome for this category. In addition, we consider how changes in the manufacturers' environment could affect the profitability of private label supply, by simulating changes in the model's parameters.

A second goal of this chapter is to identify problems in applying the model in this specific situation. Accordingly, the chapter begins with a discussion of the more important assumptions of the model, their impact on the model's predictions and whether they apply in this particular case.

As a starting point, we briefly review here the development of the model we will apply to the case study. Recall that in chapter 3, we assumed that the manufacturers were "dominant firms",

competing not only with each other but with a competitive fringe of potential private suppliers. The final consumer demand functions were

$$q_{n1} = \alpha_1 - \beta_1 p_{n1} + \sigma p_{n2} + \theta_1 p_r$$

$$q_{n2} = \alpha_2 + \sigma p_{n1} - \beta_2 p_{n2} + \theta_2 p_r$$

$$q_r = \alpha_r + \theta_1 p_{n1} + \theta_2 p_{n2} - \beta_r p_r$$

The derived demand functions facing the manufacturer, however, were discontinuous since the manufacturer's wholesale price for the private label could not exceed that of the competitive fringe.

We also introduced the quadratic cost function,

$$C = a q_n + \frac{1}{2} b q_n^2 + c q_r + \frac{1}{2} d q_r^2 + e q_n q_r$$

which allowed us to analyze the effects of (dis)economies of scale and scope. We found that, in this type of market, there existed conditions in which the manufacturer would prefer to allow the competitive fringe to supply the private label if the fringe's costs were sufficiently high, in order to limit cannibalization of his national brand. By analyzing comparative statics of the difference in profits between supplying and not supplying, we identified the factors that favoured private label supply as category expansion, opportunity for segmentation, fringe costs, private label "attractiveness", relative economies of scale and economies of scope. On the other hand, cannibalization of the national brand, the possibility of a price war, relative diseconomies of scale

and diseconomies of scope discouraged private label supply.

This chapter is organized as follows. The next section discusses the key assumptions of the theoretical model and their application in this specific situation. In section (iii), we propose a method for aggregating the demand functions and derive estimates of costs. The results for this manufacturer are then discussed in section (iv).

We analyze a series of scenarios in section (v), showing how the model can be used for "what if" analysis based on the prevailing conditions facing a particular manufacturer.

## **(ii) Key Assumptions of the Theoretical Model**

In this section, we consider the major underlying assumptions of the theoretical model, with a particular interest in whether they are replicated in this case. Specifically, we discuss the following:

***Manufacturer Market Structure:*** whether the model's assumption that the market is composed of two dominant firms and a competitive fringe applies to this category;

***Retail Market Structure:*** whether the assumption of a monopolistic retailer, or, alternatively, competitive retailers applies here;

***Stackelberg Leadership:*** whether the assumption that manufacturers are Stackelberg leaders in this category is realistic;

***One Product Category, One Size:*** the impact of the assumption that manufacturers have only one size of one national brand;

***Fixed Costs:*** the exclusion of fixed costs from the analysis;

***Advertising:*** the assumption that media advertising has no effect on either demand or costs.

## Manufacturer Market Structure

The baseline models developed in chapter 2 referred to the situation facing a monopolist, and were extended to duopoly. Since neither of these market structures reflects reality in the grocery industry, we extended the model in chapter 3 to a "dominant firm" structure, in which two firms face competition from a "competitive fringe" of smaller players. It was shown that this structure reflected prevailing conditions in a large number of grocery categories (see Appendix 3.1; Figure 3.2). We saw that the presence of a competitive fringe had a critical effect on the strategy of the dominant firms, since the fringe would always supply, at marginal cost, if the dominant firms declined. Here, we are interested in whether this structure of two dominant firms and a competitive fringe reflects reality in this category.

Table 5.1 gives market shares, in retail dollars, for the major manufacturers nationally and in the market of primary interest to us here, Ontario<sup>27</sup>:

**TABLE 5.1**  
**ONTARIO AND CANADIAN MARKET SHARES**  
**April-May, 1993**

<b>Brand</b>	<b>Ontario (%)</b>	<b>Total Canada (%)</b>
<b>1</b>	27.6	32.4
<b>2</b>	28.4	26.9
<b>Private Label</b>	30.0	29.0
<b>Others</b>	13.9	11.5

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<sup>27</sup> Source: a Harvard Business School case on the category. To keep the category confidential, we cannot provide a direct reference. An abstract of this and other relevant studies is provided in Appendix 5.1.

The market share data suggest that this category fits the "dominant duopoly" structure very well. Manufacturers 1 and 2, who supply only national brands, control approximately 60% of the Ontario and Canadian markets. Private labels, which have been growing rapidly in this category both in Canada and the U.S., account for a further 30%, with other brands taking up the remainder.

Although there is one dominant private label supplier in this category, there are several alternative manufacturers whom retailers may approach. Retailers in the grocery industry are quite prone to switching between private label suppliers, who are essentially undifferentiated from each other.

On the supply side, the dominant private label manufacturer sub-contracts part of the manufacturing process to local third parties, many of whom would be capable of producing a private label on their own but whose local scope of operations reduces their inclination to do so. National brand manufacturers also use third parties for their national brands, although they have moved progressively towards ownership and control of these plants in recent years. An additional factor is the availability of substantial excess capacity in the U.S. among both national brand manufacturers and private label suppliers. There is sufficient excess capacity within that market to supply the entire Canadian market. Since shipping costs are high in this category, U.S. manufacturers have not yet moved into the Canadian market.

Although one private label supplier is dominant, then, it is forced, by the existence of alternatives, to keep its prices low. This fits with the assumption of a competitive fringe in the model.

### Retail Market Structure

Our initial assumption in the baseline model of chapter 2 was that a monopolistic manufacturer faced a monopolistic retailer. However, we showed in Appendix 2.4 that the assumption of competitive retailers did not alter either the direction of the parameter effects or manufacturers' optimal wholesale prices. In later model extensions, we therefore assumed that the retailer was monopolistic. Hence we need to examine whether either a monopoly or a competitive market can be said to represent grocery retailing in the Ontario market.

In the Canadian grocery industry, retailers can be considered oligopolistic on an aggregate level; however, as shown in Appendix 3.3, the degree of concentration varies from region to region. Table 5.2 gives the combined market share of the top two, and the top four, retailers in each region:

**TABLE 5.2**  
**TOP GROCERY RETAILER SHARES BY REGION (\$), 1992**

<b>Region</b>	<b>Top 2 Share (%)</b>	<b>Top 4 Share (%)</b>
<b>National</b>	26	42
<b>B.C.</b>	40	58
<b>Alberta</b>	39	62
<b>Sask.</b>	47	71
<b>Manitoba</b>	53	67
<b>Ontario</b>	19	33
<b>Quebec</b>	36	66
<b>Atlantic</b>	50	68

In some regions, such as Atlantic, Manitoba and Saskatchewan, the existence of dominant retailers is evident and the market appears oligopolistic. However, other regions are much less concentrated and more closely approach a competitive market structure. The Ontario market, with which we are concerned here, exhibits the lowest level of concentration of any region.

What is most relevant to the model, however, is the manner in which prices are set. Most chain retailers set prices at a head office level, *taking account of local conditions*. One method of doing this is "zone pricing", whereby the retailer analyzes local competition within predetermined areas and sets separate prices for each zone. Within metropolitan areas, stores are sufficiently accessible to consumers that retailers are obliged to set prices that are close to, or match, competition.

Furthermore, Canadian grocery chains are essentially undifferentiated in service terms, so their prices do not differ greatly from those of their competitors. Numerous studies in retailing (e.g. Wilkinson, Mason and Paksoy, 1982; Arnold, Oum and Tigert, 1983) attest to the importance of price as a mix variable for grocery retailers: the Ontario market is no exception, as shown by the Arnold *et al* study. From discussions with one of the national brand manufacturers, it is evident that managers in the industry also believe that consumers are prepared to switch stores on the basis of price differences in this category alone. The category is regularly treated as a "traffic builder" by retailers and promotions are planned to attract consumers into the store.

There is little doubt that Ontario grocery retailers are very price competitive, as depicted by the model. The assumption that consumers compare national brand prices across stores is supported by this analysis.

## Stackelberg Leadership

The model assumes that manufacturers are Stackelberg leaders, taking into account retailers' "markup rule", and competitive prices, in setting wholesale prices to the retailer<sup>28</sup>.

In reality, the process is more complex. Retailers allocate promotional "slots" (feature periods) to brands on an annual or semi-annual basis after negotiating with manufacturers. Individual promotions are negotiated between manufacturers and retailers, with manufacturers offering (i) wholesale prices and "off-invoice" allowances, (ii) co-op advertising and display support, in return for (i) feature prices and (ii) co-op advertising features and displays from retailers. In this negotiation process, manufacturers attempt to minimize retail prices and maximize promotional support to maximize total sales. Retailers maximize their profit margins and manufacturer deals.

Normally, manufacturers will know retailers' regular and promotional markups based on past experience. They are unlikely to know competitive prices with precision; however, they will certainly be capable of estimating competitive prices within a reasonable range based on past experience. There will necessarily be some uncertainty associated with this estimate.

The Stackelberg assumption is thus a simplification of the actual process undergone by manufacturers and retailers in setting prices. It approximates reality in some essential ways: manufacturers take account of retailers' normal markups in setting prices, and do so with some estimate of competitive prices in mind. Nonetheless, its major failing is that it assumes that retailers are price takers, and does not recognize their degree of power in the negotiation process.

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<sup>28</sup> Prices here refer to net prices after deals.

### *One Product Category, One Size*

The empirical model is based on the assumption that the manufacturer produces only one product in one size. While the firms under study here market several brands in the product category, they market only one brand in the subcategory of concern here, and the subcategories are sufficiently independent that switching between them is not a major factor.

The product is, however, available in more than one package size and package form. Discussions with manufacturer 1 indicate that the degree of switching between package forms is minimal. The price elasticity estimates obtained in chapter 4 are consistent with those found in similar product categories (Tellis, 1988) which indicates that if size switching has been omitted, its effect is not large.

Iyer and Soberman (1993), in an empirical study of two grocery categories, find that consumers of larger sizes tend to be loyal to size rather than to brand, switching brands to find the size they prefer instead of switching to another size within the same brand. The size analyzed in this case is the largest in which the product is available; hence, if their results hold here, we would not expect switching to smaller sizes to be an important factor.

However, if our assumption is incorrect, the existence of a second size of the national brand can affect either the estimate of price elasticity in the demand function, through size switching, or the cost function, via economies or diseconomies of scope. We consider each of these possibilities separately below. Since the effect of a second size can vary, we comment on its most likely direction in this particular case.

## *Demand*

The effects of multiple sizes on the demand function can be subdivided into two categories: the empirical effect of omitting a variable from the regression, and the theoretical effect of substitution with either the private label or the national brand.

### *Empirical Effect*

From the empirical point of view, by omitting a variable from the regression we run the risk of obtaining biased parameters. If the omitted variable is *positively* correlated with any of the included variables, there is an upward bias in the estimated coefficient (Pindyck and Rubinfeld, 1981, p.129); the reverse is true if it is negatively correlated.

Although omission of the price of the second size could affect the price parameters of either the national brand or the private label, it is most likely to affect the own-price parameter of the national brand. The reason for this is that manufacturers in this category tend to promote all sizes in the same period, so that there may be a positive relationship between prices of each size. Hence, we would expect the national brand's own-price elasticity to be biased upwards. As a result, the model's optimal national brand prices will be too low. Since the national brand's price response is negatively related to private label profitability, upward bias in this parameter will have a *negative* effect on profit, causing the manufacturer to reject private label supply when he should agree to it.

### *Theoretical Effect*

If there is a second size which has been omitted, the manufacturer must also take its profit into account in deciding whether to supply the private label. The effect of size switching in the

theoretical model depends on the second size's degree of substitutability with the private label and with the first size of the national brand.

Supply of the private label by the national brand manufacturer results in a reduction in the private label's wholesale price to the retailer, as compared with the price that would be charged by the competitive fringe. Hence sales of a second size which substitutes with the private label will fall, and the manufacturer's overall profit when he supplies the private label will be overstated if the second size is omitted. Omission of size switching has a *positive* impact on private label profitability.

However, size substitution within the national brand is likely to be more important. Since the national brand's price rises as a result of private label supply, sales and profits of the second size should also rise. Hence its omission from the model will mean that the profitability of private label supply is understated. Omission of size switching within the national brand has a *negative* effect on private label profitability.

Since substitution within the sizes of the national brand is likely to exceed substitution with the private label, we expect the overall effect of omission of the second size on private label profitability to be *negative*. In addition, substitution with a second size will reduce national brand prices, so the model's optimal national brand prices will be too high.

### ***Economies of Scope***

The effect of a second size on costs depends on whether there are economies of scope due to shared materials or resources with the national brand or the private label. Alternatively, there may be diseconomies of scope due to competition for scarce resources.

If there are economies of scope between the second size and the national brand, the model will overstate national brand costs. As a result, private label supply will look *more* profitable than it should. However, another possibility is that there are economies of scope between the second size and the private label, in which case private label costs will be overstated and private label supply will look *less* profitable than it should. If there are economies of scope between the second size and *both* the national brand and the private label, the overall impact will depend on which effect is dominant.

The reverse holds for diseconomies of scope: where they exist between the second size and the national brand, private label supply will look less profitable than it should. Where there are diseconomies of scope between the second size and the private label, the profitability of private label supply will look too high.

Since we have assumed that the manufacturers have excess capacity available, it is most likely that economies of scope will exist between the national brand and the second size. Hence we expect national brand costs to be overstated, and national brand prices to be too high. The omission of a second size has a *positive* overall effect on the profitability of private label supply.

In this case, the product is available in two different package forms, so that economies of scope, if they exist, are likely to be limited to the use of common raw materials. As discussed later in this chapter, however, there is substantial evidence that marginal costs in this size are constant, i.e. no economies of scope exist.

In summary, we expect the omission of a second size from the model to have no effect. If there is any effect, demand side forces would suggest that the model's prediction of private label profitability is too low, while cost factors indicate that it is too high. The evidence suggests that the greater effect is likely to be on the demand side, leading to downward bias in the profitability of

private label supply.

### Fixed Costs

The quadratic cost function specified in chapter 3 assumes that all costs are variable. If, alternatively, we specified a cost function that included fixed costs, the fixed cost element would drop out of the profit comparison *so long as it was invariant between options*. The fixed startup costs associated with investing in plant and equipment would not be relevant, since the manufacturer would have to incur these anyway to produce the national brand. However, if supplying the private label means that the manufacturer must make some fixed investment (say, in a new production line), this could affect private label profitability.

In the case considered here, the private label would use existing manufacturing and distribution capacity, so there would be no plant investment involved in supplying. Similarly, R&D investment would be minimal, since the product would use existing formulations. However, there can be some fixed setup costs associated with the development and printing of packaging designs for the private label. These are usually not large in relation to total sales, and are often borne by the retailer rather than the manufacturer. If such costs exist, they can be handled by deducting them from the manufacturer's profit difference in favour of supplying the private label.

### Advertising

Although the demand functions estimated in the empirical model include terms reflecting

temporary price promotions. they do not consider the effect of media advertising, which may vary from week to week. The theoretical model is confined to price effects.

In our analysis, we assume that advertising levels do not change according to whether or not the national brand manufacturer supplies the private label. Hence the demand functions will remain unchanged between options; advertising costs are treated as fixed costs, and therefore drop out of the comparison.

A future model could take advertising into account as an alternative strategy to private label supply. This topic is taken up in chapter 6.

### **Interpretation of Parameters**

Before embarking on the estimation of private label profitability, we remind the reader of the model's parameters and their interpretation, as shown in Table 5.3:

**TABLE 5.3****MODEL PARAMETERS**

<b>Parameter Description</b>	<b>Notation</b>	<b>Sign</b>	<b>Interpretation</b>
<b><u>1. Demand:</u></b>			
Demand Intercepts	$\alpha_1, \alpha_2, \alpha_r$	+	Inherent consumer preference for national brand 1, 2, and private label
Own Price Parameter	$\beta_1, \beta_2, \beta_r$	-	Each brand's response, in units, to changes in its own unit price
Cross-Price Parameter	$\theta_1, \theta_2, \sigma$	+	Each brand's response, in units, to competitive price changes (substitutability)
<b><u>2. Costs:</u></b>			
Marginal Cost Intercept Term	<b>a, c</b>	+	Unit costs of national brand 1, 2 and private label (where $b=d=e=0$ )
Quadratic Term	<b>b, d</b>	(+).-	Product-specific (dis)economies of scale
Cross-product Term	<b>e</b>	(+).-	(Dis)economies of scope
Competitive Fringe Costs	$C_c$	+	Lowest marginal cost of the competitive fringe

The most subtle point to keep in mind is that the cross price parameter in the demand function refers to the consumer's propensity to switch between brands, as opposed to leaving the market. We discussed this at the end of chapter 3, in the context of category expansion: with increases in the  $\theta$  parameter, overall category size increases with the introduction of a private label since consumers tend to switch between brands, rather than leave the market, as prices rise.

The description "marginal cost intercept term" is somewhat cumbersome and refers to the fact that marginal costs are  $C_n = a+bq_n+eq_n$ , and  $C_r = c+dq_r+eq_r$ , for the national brand and the private

label respectively. Where there are no economies or diseconomies of scale, the parameters  $a$  and  $c$  represent marginal and average costs, or unit costs.

**(iii) Methodology**

To estimate the profitability of supplying a private label for manufacturer 1, we insert known values for each of the parameters into the theoretical model. The parameters fall into two categories: demand and costs. We consider each of these in turn.

**Demand Parameters**

To estimate the profitability for manufacturer 1 of supplying a private label, the model requires some, but not all, of the parameters of the demand system. Specifically, the underlined parameters in the following matrix are needed:

$$\begin{bmatrix} q_1 \\ q_2 \\ q_r \end{bmatrix} = \begin{bmatrix} \alpha_1 & \underline{-\beta_1} & \underline{\sigma} & \underline{\theta_1} \\ \alpha_2 & \sigma & -\beta_2 & \underline{\theta_2} \\ \alpha_r & \theta_1 & \theta_2 & \underline{-\beta_r} \end{bmatrix} \begin{bmatrix} 1 \\ p_1 \\ p_2 \\ p_r \end{bmatrix}$$

In other words, we need those parameters that have an impact on demand for either the national brand or the private label.

### *Aggregation Across the Year*

As we saw in chapter 4, the parameters of this system can vary according to whether each brand is on promotion, or by time of year. In particular,

- intercepts vary according to season, promotion activity and their interaction:
- own-price terms vary according to promotion activity, but are constant across seasons:
- cross-price terms are constant across seasons and promotion activity.

In addition, we can expect prices to vary by period, so we need to decide which set of prices we are referring to.

Since the demand parameters refer to a single week's demand, they are not useful for decision making in any case: manufacturers in the grocery industry are not likely to flit in and out of private label supply on a weekly basis, even though retailers tend to shop around for better prices regularly<sup>29</sup>. We adopt a year as the minimum decision period over which all variations in demand are represented.

Hence we need a demand system that

- (i) Shows the responsiveness of demand to some representative prices over the year, and
- (ii) Tells us what *annual* demand each brand would achieve, at a given set of prices.

Given the fact the intercepts and own-price terms vary from week to week, we cannot simply multiply these terms by 52. We need to estimate their value in each week and aggregate them across the year. With regard to prices, we take the mean price across the year as a representative price.

To illustrate the aggregation method, assume that there are only two periods and two brands, as follows. Subscripts refer to (brand, period):

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<sup>29</sup> It is possible to envisage industries in which this might happen (e.g. apparel), but they are rare.

*Period 1*

$$q_{11} = \alpha_{11} - \beta_{11}p_{11} + \theta p_{21}$$

$$q_{21} = \alpha_{21} + \theta p_{11} - \beta_{21}p_{21}$$

*Period 2*

$$q_{12} = \alpha_{12} - \beta_{12}p_{12} + \theta p_{22}$$

$$q_{22} = \alpha_{22} + \theta p_{12} - \beta_{22}p_{22}$$

Notice from the subscripts that intercepts, own price parameters and prices vary by brand and by period, while cross-price terms are invariant across brands and periods. The dataset has these same properties.

We aggregate these equations as follows:

$$q_1 = q_{11} + q_{12} = (\alpha_{11} + \alpha_{12}) - (\beta_{11}p_{11} + \beta_{12}p_{12}) + \theta(p_{21} + p_{22})$$

$$q_2 = q_{21} + q_{22} = (\alpha_{21} + \alpha_{22}) - (\beta_{21}p_{21} + \beta_{22}p_{22}) + \theta(p_{11} + p_{12}).$$

More generally,

$$q_i = \sum_{j=1}^2 \alpha_{ij} - \sum_{j=1}^2 \beta_{ij}p_{ij} + \theta \sum_{j=1}^2 p_{2j}.$$

Expressing the price parameters in terms of mean prices, we have

$$\begin{aligned} q_i &= \sum_{j=1}^2 \alpha_{ij} - \bar{p}_i \sum_{j=1}^2 \beta_{ij} p_{ij} / \bar{p}_i + 2\theta \sum_{j=1}^2 p_{2j} / 2 \\ &= \alpha^{\bullet}_i - \beta^{\bullet}_i \bar{p}_i + 2\theta \bar{p}_2 \end{aligned}$$

where  $\alpha^{\bullet}_i = \sum_{j=1}^2 \alpha_{ij}$ ;  $\beta^{\bullet}_i = (1/\bar{p}_i) \sum_{j=1}^2 \beta_{ij} p_{ij}$  and  $\bar{p}_i = (p_{i1} + p_{i2})/2 =$  mean price of brand  $i$ . Similarly, for brand 2,

$$q_2 = \alpha^{\bullet}_2 - \beta^{\bullet}_2 \bar{p}_2 + 2\theta \bar{p}_1$$

Hence, to derive aggregate parameters based on mean prices, the aggregation procedure is as follows:

- (i) *Intercepts* are added across periods;
- (ii) *Own Price Terms* are weighted by the ratio of each period's price to the mean price, and aggregated across periods;
- (iii) *Cross-Price Terms* are multiplied by the number of periods.

This procedure is outlined in Appendix 5.2 for a full year's data. In principle, the procedure is identical to the above, with the exception that intercepts and own price terms are calculated separately for each week according to the procedure described below.

### ***Estimation of Weekly Parameters***

Recalling the empirical model of chapter 4, the estimated volume for brand 1 in season 1, week 1 is

$$\hat{q}_{111} = [(\alpha_1 + \mu_{11}) + \lambda_{111}(\alpha'_1 + \mu'_{11})] - (\beta_1 + \lambda_{111}\beta'_1)p_{111} + \sigma p_{211} + \theta_1 p_{111}.$$

Here, subscripts denote (brand, season, week). The parameters  $\alpha_1$ ,  $\alpha'_1$ ,  $\beta_1$ ,  $\beta'_1$ ,  $\sigma$  and  $\theta_1$  are constant across all weeks in the year.  $\mu_{11}$  and  $\mu'_{11}$  (season and season X promotion) vary by season (but are constant within seasons), and  $\lambda_{111}$  (the promotional index) and prices vary weekly.

We introduce the following notation to signify the estimated weekly parameters for week 1, season 1:

$$\xi_{111} = [(\alpha_1 + \mu_{11}) + \lambda_{111}(\alpha'_1 + \mu'_{11})], \text{ the intercept term:}$$

$$\eta_{111} = (\beta_1 + \lambda_{111}\beta'_1), \text{ the own price term.}$$

Then the weekly demand function is

$$\hat{q}_{111} = \xi_{111} - \eta_{111}p_{111} + \sigma p_{211} + \theta_1 p_{r11}$$

This is aggregated across all weeks in the year<sup>30</sup>, to give the following demand system, in matrix form:

$$\begin{bmatrix} \hat{q}_1 \\ \hat{q}_2 \\ \hat{q}_r \end{bmatrix} = \begin{bmatrix} \xi^*_1 & -\eta^*_1 & 52\sigma & 52\theta_1 \\ \xi^*_2 & 52\sigma & -\eta^*_2 & 52\theta_2 \\ \xi^*_r & 52\theta_1 & 52\theta_2 & -\eta^*_r \end{bmatrix} \begin{bmatrix} 1 \\ \bar{p}_1 \\ \bar{p}_2 \\ \bar{p}_r \end{bmatrix}$$

where  $\xi^*_1 = \sum_{t=1}^{52} \xi_{111t}$ ;  $\eta^*_1 = (1/\bar{p}_1) \sum_{t=1}^{52} \eta_{111t} p_{111t}$ .

The parameters from this aggregated demand system are the final result of the aggregation step in the spreadsheet model, and are input into the profit estimation step along with costs.

### Costs

As noted earlier, cost data are not available for the manufacturers in question. However, we can estimate costs within a reasonable range based on publicly available data. In this section, we begin by defining the concept of costs as they apply to the model in this category. We then propose a procedure for estimating costs, and apply this to data from annual reports and previous studies to define a reasonable range for manufacturers' costs.

In developing the theoretical model, we implicitly defined costs according to economists' definition of "true" costs. The following definition is from Nicholson (1989):

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<sup>30</sup> Since there are 52 data points, we add all 52 and derive an "adjusted" yearly value by multiplying the parameters by 52/55. The impact of this is shown in Appendix 5.2.

"The *economic cost* of any input is the payment required to keep that input in its present employment. Equivalently, the economic cost of an input is the remuneration that input would receive in its best alternative employment." (p.309)

In essence, the difference between this definition and the accounting definition of costs lies in the inclusion of opportunity costs.

We assume that labour markets are efficient, and that the wage paid by these manufacturers is therefore equivalent to that paid in the best alternative employment available to workers. Similarly, with efficient financial markets, providers of capital to these publicly-quoted firms can readily switch to other firms or industries: hence we assume that investors do not incur opportunity costs by investing in this industry.

Since fixed costs and sunk costs are irrelevant to the decision to supply the private label, we exclude them from the analysis. Hence our concept of costs does not include depreciation, interest or R & D. The opportunity cost of applying machinery (defined as the rent the equipment would obtain in its best alternative use) to these products can also be considered to approach zero, since the equipment used in this category is either specialized or is readily available from other sources.

Our definition of costs therefore includes raw materials, labour, plant overhead and distribution: all the direct costs that are involved in manufacturing the product and transferring it to the retailer. We do not include the manufacturer's advertising or selling costs, assuming that these are unchanged by the private label supply decision.

## ***Functional Form***

Recall that we specified a quadratic cost function for manufacturer 1 in chapter 3, as follows:

$$C = aq_{nl} + \frac{1}{2}bq_{nl}^2 + cq_r + \frac{1}{2}dq_r^2 + eq_{nl}q_r$$

We saw that

- where  $b = d = e$ , marginal costs are constant:
- where  $b > 0$ , there are product-specific diseconomies of scale on the national brand:
- where  $b < 0$ , there are product-specific economies of scale on the national brand:
- where  $d > 0$ , there are product-specific diseconomies of scale on the private label:
- where  $d < 0$ , there are product-specific economies of scale on the private label:
- where  $e > 0$ , there are cost anticomplementarities (diseconomies of scope), and
- where  $e < 0$ , there are cost complementarities (economies of scope).

There is a substantial body of evidence to support an assumption of constant marginal costs in this case. Nicholson (1989) reviews the empirical evidence from a variety of industries and finds a consistent pattern: the industries studied exhibit increasing returns to scale ( $b < 0$  in our terms) up to some point, but constant returns to scale thereafter. There is no evidence that long-run average costs begin to rise after some point. Hence there is a "Minimum Efficient Scale" beyond which marginal costs are constant.

The classic meta-analysis of empirical studies on cost functions by Walters' (1963) finds that marginal costs tend to be constant in the short run. In industries other than public utilities, this finding also applies to long-run marginal costs: in Walters' analysis, nearly all of the observations were for output levels well below the "capacity" of the plants, consistent with our assumption of

excess capacity in this case.

This evidence, taken together, suggests that, in the short run at least, marginal costs can be regarded as constant so long as output exceeds the minimum efficient scale and falls within the manufacturer's capacity. We apply both assumptions here. Within this category, a 1991 econometric study<sup>31</sup> of demand and costs also assumed constant marginal costs for analytical and mathematical tractability, with the comment that "[t]his choice, however, seems to be an acceptable first-order approximation of the real cost functions in the ... industry".

Within a reasonable range of output, we can expect unit costs of raw materials, labour and distribution not to change a great deal: efficiencies in purchasing of raw materials tend to require large volume increments to have a significant impact, and raw material costs are, in any event, a small portion of total costs in this category. Assuming that capacity is available, the firms will not need to incur overtime and wage rates will therefore be constant; similarly, distribution rates will not change with quantity within the range we are considering.

Hence we assume constant marginal costs for the national brand and the private label, i.e. in the above quadratic cost function, we assume  $b = d = e = 0$ . However, we check the impact of this assumption in some of the simulations discussed later in this chapter.

## ***Data***

As already noted, we have no explicit data on costs: hence we use publicly available sources

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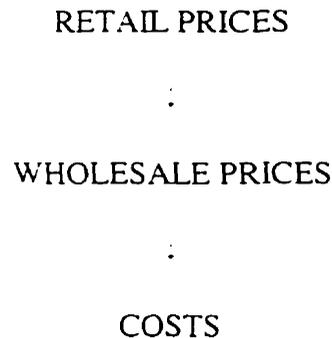
<sup>31</sup> The study was published in the *Advances in Econometrics*. To keep the category confidential, we cannot provide a direct reference. An abstract of this and other relevant studies is provided in Appendix 5.1.

to derive a range within which we can be reasonably confident that costs lie. Our data sources are as follows<sup>32</sup>:

- (i) A Harvard Business School case on the category;
- (ii) A study by J.P. Morgan Securities Inc.;
- (iii) A published econometric study on the category;
- (iv) Annual reports of the two national brand manufacturers and the private label supplier.

### *Analysis*

Our procedure for analysis is summarized in the following flowchart:



Starting with the retail prices in the dataset, our first step is to use the first two of the sources named in the previous section to estimate a range of retailer markups for the category. By subtracting these markups from retail prices, we estimate a range of net wholesale prices for each manufacturer.

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<sup>32</sup> See previous footnote. Direct references are avoided to preserve category confidentiality, but abstracts are given in Appendix 5.1

It should be noted that, while manufacturers' wholesale prices before promotional allowances are available from manufacturers' price lists, net wholesale prices after such deals are not published and must be estimated.

In step 2, we use the second two data sources to arrive at estimates of each manufacturer's costs (raw materials, labour, plant overhead and distribution) as a percentage of the estimated wholesale prices. From this, we calculate, in step 3, a dollar amount for unit costs.

### ***Step 1: Retailer Markups***

Our purpose here is to arrive at a range of estimates of manufacturers' wholesale prices to retailers. We achieve this by estimating the markup retailers apply to wholesale prices, and working backwards from retail prices in the dataset to find net wholesale prices.

Retailer markups have been the subject of much discussion in this category, due to a series of claims and counter-claims by national brand and private label suppliers, aimed at providing support for their brands with retailers. With the growth of private labels, national brand manufacturers are under pressure to demonstrate that their brands are more profitable for retailers than private labels, in spite of the fact that retailers typically earn higher markups on the wholesale prices of private labels than on those of national brands. Hence there has been a great deal of discussion of relative sales volume and of which costs should be allocated to each type of brand. For example, as we will see later in this chapter, national brand manufacturers deliver their products direct to retailers' stores, while the private label supplier distributes to retailers' warehouses only. Depending on the assumptions we make about the retailers' costs of internal distribution from warehouses to stores, national brands can appear more, or less, profitable for retailers than private

labels.

In this instance, however, we are interested only in the retailer's markup insofar as it gives us an indication of wholesale prices, from which we determine manufacturers' costs. We use information from two sources to help estimate retailer margins: first, a 1993 Harvard Business School case on the category, and secondly, a 1994 study by J.P. Morgan Securities Inc. These studies give estimates of retailer gross margins as a percentage of sales as shown in Table 5.4. By convention in this industry, all margins are expressed as a percentage of retail price:

**TABLE 5.4**  
**ESTIMATES OF RETAILER MARKUPS AS % OF SALES**

	Harvard Case Study (1993)		J.P. Morgan (1994)		
	Private Label	National Brand	Private Label est. A	Private Label est. B	National Brand
Gross Margin %	28.8%	11.6%	26.5%	33.4%	11.1%
Adjusted Gross Margin %	32.3%	24.4%	27.8%	35.4%	19.1%

The term "adjusted gross margin" refers to the retailer's markup after adding back marketing funds provided by the manufacturer, and thus reflects markup at net wholesale prices after deals. To estimate net wholesale prices, we apply this percentage to known retail prices from the dataset.

The Harvard case provides estimates for both private labels and national brands; the adjusted margin on the private label ranges from a low of 14.8% to the levels shown above. The J.P. Morgan study provides two sets of estimates for the private label, and one for the national brand. The first of these estimates, estimate A, is based on assumptions supplied by one of the manufacturers, while estimate B reflects J.P. Morgan's assertion that private label wholesale prices are lower than those

reflected in estimate A.

We estimate manufacturers' net wholesale prices by applying these adjusted gross margins to the retail prices in the dataset. Hence net wholesale price is (retail price)\*(100 - adjusted gross margin)/100. Since we are interested in defining a range, we take only the highest and lowest estimates of adjusted gross margin from Table 5.4, and estimate wholesale prices in Table 5.5:

**TABLE 5.5**  
**ESTIMATED RANGE OF NET WHOLESALE PRICES**

Brand	Mean Retail Price	Retail Gross Margin		Net Wholesale Price	
		High	Low	Low	High
1	\$1.59	24.4%	19.1%	\$1.20 <sup>33</sup>	\$1.29
2	\$1.75	24.4%	19.1%	\$1.32	\$1.42
PL	\$0.94	35.4%	14.8%	\$0.60	\$0.80

Based on the higher margins earned by retailers on the private label and on their lower retail prices, net wholesale prices are much lower than those of national brands.

***Step 2: Manufacturer Costs***

Our purpose in this section is to estimate manufacturers' costs as a percentage of wholesale price. Our data sources in this part of the analysis are an econometric study on this category published in 1991, and the annual reports of manufacturers 1 and 2 and the dominant private label supplier from 1991 to 1994.

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<sup>33</sup> Calculated as  $1.59(100-19.1)/100$

The 1991 study, described in Appendix 5.1, uses a full-information maximum likelihood procedure to assess the relative performance of manufacturers' strategies based on the assumption that the data are the equilibrium outcomes of noncooperative games in pricing and advertising. The study analyzes the strategies of manufacturers 1 and 2 in the category, but does not include the private label supplier.

In this study, manufacturers' constant marginal costs are specified as a linear function, with no intercept term, of prices of a key raw material, on wages and on each manufacturer's cost of capital. Hence

$$\begin{aligned}
 C_1 &= \beta_{11}R + \beta_{12}L + \beta_{13}CC_1 \\
 C_2 &= \beta_{21}R + \beta_{22}L + \beta_{23}CC_2
 \end{aligned}$$

where  $C_i$  refers to the real average costs of manufacturer  $i$ ,  $R$  represents the real price of a key raw material common to both manufacturers.  $L$  is the real unit cost of labour in the nondurable manufacturing sector and  $CC_i$  represents each firm's cost of capital, i.e. the firm's real bond yield. It should be noted that these costs do not include distribution or plant overhead.

The means of these three variables, and the parameters estimated in the study, are shown in Table 5.6:

**TABLE 5.6**  
**1991 STUDY RESULTS**

Cost Component <sup>34</sup>	Mean	Parameter <sup>35</sup> Firm 1	Parameter Firm 2
Raw Material	1.15	0.08	0.004
Labour	0.55	8.30	14.15
Cost of Capital	3.01	0.01	0.018

We estimate each firm's total costs at the means of each of the variables as follows:

$$\begin{aligned}
 C_1 &= 0.08(1.15) + 8.30(0.55) + 3.01(0.01) \\
 &= \$4.69
 \end{aligned}$$

$$\begin{aligned}
 \text{and } C_2 &= 0.004(1.15) + 14.15(0.55) + 0.018(0.01) \\
 &= \$7.84
 \end{aligned}$$

The large discrepancy in costs between firms is not explained in the study, but appears to trace primarily to differences in product mix (package sizes). Average wholesale prices for the two

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<sup>34</sup> Raw Material and Labour costs were obtained from the U.S. Bureau of Labor Statistics (BLS); Cost of Capital is proxied by Moody's AAA corporate rating and was also obtained from BLS.

<sup>35</sup> In the authors' selected model.

manufacturers are given in this study as \$8.16 and \$12.96 respectively. Since these prices refer to composite units across sizes, we express the above costs as a percentage of average wholesale price: 57.5% and 60.5%. When we express costs in terms of a common unit, the difference in costs between manufacturers 1 and 2 is not so great.

Our second data source is the annual reports of manufacturers 1, 2 and the private label supplier for the years 1991-94. We express total product costs (raw materials, labour, plant overhead and distribution) as a percentage of sales. These percentages are shown in Table 5.7 alongside the percentages from the above study:

**TABLE 5.7**  
**ESTIMATES OF UNIT COSTS % SALES**

	<b>1991 Study</b>	<b>Annual Reports (Average 1991-94)</b>
Manufacturer 1	57.4%	48.2%
Manufacturer 2	60.5%	38.5%

There are caveats associated with both sets of estimates. The model in the 1991 study is nested within a simultaneous equation system, so we have no indication of the explanatory power of their model. It also uses the cost of only one raw material, omitting that of other raw materials, packaging materials, plant overhead and distribution. In addition, this study includes the cost of capital, which we have excluded from our analysis; however, this is a very small component of total costs per unit.

The annual report data are also imperfect since all three manufacturers are multiproduct

firms whose costs will vary significantly by product and category. There are significant differences in costs between the three firms according to annual reports: the biggest difference is between the private label supplier, whose annual reports give costs at 83.4% of sales, versus firms 1 and 2 at 48.2% and 38.5% respectively. The private label supplier appears to be operating on much tighter profit margins than the national brand manufacturers; this fits with our theory that the private label supplier competes within the "fringe" by pricing at marginal cost.

The two methods give very different estimates of costs. Although the estimates refer to different years, this is unlikely to account for such a large difference. We take these estimates as low and high points and estimate a reasonable range of unit costs below.

### ***Step 3: Cost Estimates***

Having estimated net wholesale prices in step 1 and costs as a % of sales in step 2, we put these estimates together to derive an estimate of dollar unit costs for each manufacturer. Table 5.8 shows the range of estimated costs:

**TABLE 5.8**

**ESTIMATED RANGE OF UNIT COSTS**

	Low		High	
<b>Manufacturer 1</b> A. Wholesale Price (from Table 5.5)	\$1.20		\$1.29	
B. Unit Cost % Sales (from Table 5.6)	57.4%	48.2%	57.4%	48.2%
\$ Unit Costs (A*B)	\$0.69	<b>\$0.58</b>	<b>\$0.74</b>	\$0.62
<b>Manufacturer 2</b> A. Wholesale Price (from Table 5.5)	\$1.32		\$1.42	
B. Unit Cost % Sales (from Table 5.6)	60.5%	38.5%	60.5%	38.5%
\$ Unit Costs (A*B)	\$0.80	<b>\$0.51</b>	<b>\$0.86</b>	\$0.55
<b>PL Manufacturer</b> Wholesale Price = Cost	\$0.60		\$0.80	

Since we have two cost % sales estimates and two wholesale prices for each of the national brand manufacturers, we end up with four estimates of unit costs. In the case of the private label, we have only one cost % sales estimate and hence two cost estimates. We assume that the competitive fringe sets its wholesale price equal to its cost, as specified in the theoretical model<sup>36</sup>. In analyzing the results, we vary unit costs between the lowest and highest of the national brands' cost estimates, shown in bold type in Table 5.8.

In summary, we have obtained net wholesale prices by estimating retailers' markups within the category and applying these estimates to retail prices in the dataset. We have estimated unit costs

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<sup>36</sup> The cost range of \$0.60 to \$0.80 is based on a \$0.94 retail price adjusted for retailer markups of 35.4% (J.P. Morgan) and 14.8% (Harvard case study) respectively.

as a percent of sales, and applied this percentage to our estimated wholesale prices to arrive at unit costs. These costs include raw materials, labour, plant overhead and distribution: opportunity costs, however, are not a significant component of costs in this category.

We do not have any estimate of the national brand manufacturers' cost to supply the private label, since they do not currently do so. Since the range of private label costs is similar to that of the national brands, we assume initially that private label and national brand costs are equal, and later simulate changes in private label costs to find a "breakeven" cost at which the manufacturer is indifferent between supplying and not supplying.

#### **(iv) Results**

In this section, we discuss the results obtained when we substitute the demand parameters for brands 1, 2 and the private label into the spreadsheet version of the theoretical model, along with assumed costs and competitive prices. In addition, we show the impact of different assumptions about costs on the outcome.

The model is quite sensitive to the assumptions made: our starting assumptions are given below and variations in costs are simulated later.

- National brand unit costs, for each manufacturer, are at the mid-point of the range given in the last section, i.e.  $a = \$0.66$  for manufacturer 1 and  $a = \$0.69$  for manufacturer 2.
- There are no economies of scale or scope, i.e.  $b=d=e=0$ .

- The competitive fringe's unit cost for the private label,  $C_c$ , is equal to the mid-point of the cost range for the private label manufacturer, i.e.  $C_c = \$0.70$ .
- The national brand manufacturers' cost to supply the private label is also equal to that of the national brand, i.e.  $c = \$0.66$  for manufacturer 1 and  $c = 0.69$  for manufacturer 2.
- Each competing manufacturer's price when he does not supply the private label is equal to the mid-point of the range of his wholesale price based on mean prices from the dataset (see Table 5.5), i.e. when we are analyzing manufacturer 1's private label profitability,  $w_{n,2} = \$1.37$ ; when we are analyzing manufacturer 2's private label profitability,  $w_{n,1} = \$1.25$ .
- The competing manufacturer does not change price in response to supply by a particular manufacturer.

These assumptions represent a reasonable starting point for our analysis based on the data available. Appendix 5.3 summarizes these assumed values along with aggregated parameter values for each of the brands. Together, these constitute the inputs to the spreadsheet model.

Table 5.9 shows the results of the analysis for manufacturer 1, assuming that manufacturer 2 does *not* supply.

**TABLE 5.9**

**INITIAL RESULTS FOR MANUFACTURER 1**

	With Private Label		Without Private Label	
	Notation	Value	Notation	Value
Optimal NB Wholesale Price	$w_{nl}^*$	\$2.10	$w'_{nl}^*$	\$1.44
Optimal NB Quantity	$q_{nl}^*$	13,746	$q'_{nl}^*$	95,599
PL Wholesale Price <sup>37</sup>	$w_p$	\$0.70	n/a	n/a
PL Quantity	$q_p$	426,464	n/a	n/a
Total Profit	$\pi^{M1}$	\$36,891	$\pi^{M1}$	\$74,311

With these assumptions, manufacturer 1 makes substantially less profit by supplying the private label than by refusing to do so and allowing the competitive fringe to supply. The difference in annual profit between the two options is \$31,136.

The key reason for this result is that the manufacturer is unable to charge the optimal price for the private label: because the competitive fringe is capable of supplying at \$0.70, he cannot exceed this price. Since his costs approach those of the competitive fringe, his profit margin on the private label is very small.

The artificially low price on the private label results in very high sales, which greatly cannibalize national brand sales. Even at the high national brand price of \$2.08, the national brand does not produce enough profit to compensate for the low private label margin. Overall, the manufacturer is better off allowing the competitive fringe to supply the private label at the higher

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<sup>37</sup> Because the competitive fringe's cost (=price) is \$0.70, manufacturer 1's price cannot exceed this level. Hence neither private label price nor quantity is optimal. This also means that manufacturer 1 has to deviate from the optimal price for the national brand

cost of \$0.70 and reducing cannibalization of his national brand.

Manufacturer 2, on the other hand, finds it profitable to supply the private label under these assumptions. The results are summarized in Table 5.10:

**TABLE 5.10**  
**INITIAL RESULTS FOR MANUFACTURER 2**

	With Private Label		Without Private Label	
	Notation	Value	Notation	Value
Optimal NB Wholesale Price	$w_{n2}^*$	\$1.93	$w'_{n2}^*$	\$1.60
Optimal NB Quantity	$q_{n2}^*$	45,687	$q'_{n2}^*$	72,240
PL Wholesale Price	$w_p$	\$0.70	n/a	n/a
PL Quantity	$q_p$	324,460	n/a	n/a
Total Profit	$\pi^{M2}$	\$59,968	$\pi^{M2}_p$	\$65,584

For manufacturer 2, total annual profits when he supplies the private label are also lower than those when he does not, by \$5.616 - a much smaller difference than for manufacturer 1. In this instance, manufacturer 2 has a much lower cross-price response with the private label than manufacturer 1 (see Appendix 5.3). As a result, brand 2 is much less sensitive to price changes on the private label, and supply by the competitive fringe at a slightly higher price is less attractive than for manufacturer 1. Hence there is less difference, although he still prefers not to supply.

Since manufacturers 1 and 2 have a different outlook based on their different levels of substitution with the private label, it follows that the "breakeven" private label cost at which they would be willing to supply will differ between the two. This is shown in Figure 5.1, which graphs the profitability of private label supply against private label cost (the parameter  $c$ ) for each

manufacturer:

(Figure 5.1)

It is evident that the breakeven private label cost for manufacturer 1 is \$0.59. However, manufacturer 2 will tolerate a higher cost level, breaking even at \$0.68. Notice, however, that for *both* manufacturers, it is unprofitable to supply if their costs are equal to the competitive fringe's cost of \$0.70. Unless the national brand manufacturers have a cost advantage over the competitive fringe, they will not supply.

The scenarios given here assume that the competing manufacturer does not supply, i.e. they represent the strategy sets {S,DNS} and {DNS,S} in the normal form game of Figure 3.7 in chapter 3. We reproduce this game here, with the actual payoffs to each manufacturer<sup>38</sup>:

		<u>Manufacturer 2</u>	
		<u>Supply</u>	<u>Do Not Supply</u>
<u>Manufacturer 1</u>	<u>Supply</u>	(\$51,149, \$83,222)	(\$36,891, \$87,757)
	<u>Do Not Supply</u>	(\$88,309, \$59,968)	<u>(\$74,311, \$65,584)</u>

The equilibrium in this game, underlined in the above payoff table, is {DNS,DNS} - it is

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<sup>38</sup> Payoffs where the competitor bids assume that the competitor's national brand price is his optimal price when he supplies. Where both manufacturers bid, it is assumed that they bid down to the higher of the two manufacturers' marginal costs, 69¢, and set national brand prices accordingly. Details are given in Appendix 5.4.

in neither manufacturer's interest to supply. In fact, not supplying is a dominant strategy for both manufacturers, regardless of the competitor's strategy. The key reason for this is that the competitive fringe keeps private label prices so low that the manufacturers cannot make enough profit on it to make up for the losses on the national brand. The manufacturers cannot set optimal private label prices, and must take the "ceiling" price, the competitive fringe's cost, into account on setting national brand prices (see Appendix 5.5).

An interesting feature of these payoffs is that each manufacturer, if he chooses the off-equilibrium strategy of supplying, is better off if his competitor also supplies. This is because the competitor will charge a *higher* price for his national brand when he supplies the private label due to the "segmentation" effect of producing both brands, which allows each manufacturer to improve his national brand margins, while the private label profit margin is very tight or nonexistent.

Focusing on manufacturer 1, we consider the relative impact of national brand costs and private label costs on the supply decision. Recall that, in chapter 3, we discussed the relative impact of national brand and private label costs. As national brand costs fall, we expect it to become more profitable for the manufacturer to focus on the national brand, and less so to supply the private label; the reverse is true for private label costs. However, we do not know which effect is greater in this instance. Table 5.11 shows what happens when we vary national brand costs for manufacturer 1 while holding private label costs constant at \$0.66. Recall that a positive profit difference means that private label supply is profitable, while a negative profit difference means that it is unprofitable:

**TABLE 5.11**

**EFFECT OF MANUFACTURER 1 NATIONAL BRAND COSTS**

<b>National Brand Unit Cost a</b>	<b>Private Label Profit Difference <math>\Delta\pi^{MA}</math></b>
\$0.58	(\$37.608)
\$0.60	(\$37.566)
\$0.62	(\$37.524)
\$0.63	(\$37.482)
\$0.65	(\$37.440)
\$0.67	(\$37.398)
\$0.69	(\$37.356)
\$0.70	(\$37.314)
\$0.72	(\$37.272)
\$0.74	(\$37.230)

Increases in national brand costs make private label supply look better, as we expected. However, the effect is small, and insufficient on its own to make private label supply profitable for manufacturer 1. When we vary national brand and private label costs together, the effect is as shown in Table 5.12:

**TABLE 5.12****COMBINED VARIATIONS ON PRIVATE LABEL AND NATIONAL BRAND UNIT COSTS**

<b>National Brand Unit Cost</b>	<b>Private Label Unit Cost</b>	<b>Private Label Profit Difference</b>
<b>a</b>	<b>c</b>	<b><math>\Delta\pi'''</math></b>
\$0.58	\$0.51	\$35,560
\$0.60	\$0.55	\$15,528
\$0.62	\$0.59	(\$4,913)
\$0.63	\$0.64	(\$25,762)
\$0.65	\$0.68	(\$47,019)
\$0.67	\$0.72	(\$68,685)
\$0.69	\$0.76	(\$90,759)
\$0.70	\$0.81	(\$113,241)
\$0.72	\$0.85	(\$133,681)
\$0.74	\$0.89	(\$151,360)

Variations in both costs together can change the profitability of private label supply from positive to negative. However, the dominant effect is the cost of the private label.

In summary, the results discussed in this section show that private label supply is not profitable for either manufacturer 1 or manufacturer 2. In fact, the outcome of the game shown in this section is replicated in the real world: neither manufacturer 1 nor manufacturer 2 supplies the private label. Our simulations also show, however, that the profitability of private label supply differs for manufacturers 1 and 2: due to brand 1's greater level of substitutability with the private label, manufacturer 1 will be more reluctant to supply. For both manufacturers, the level of private label costs and of competitive fringe costs critically affect the outcome, although breakeven costs differ between the two firms. National brand costs have relatively little impact.

While private label supply is not profitable for the manufacturers at present, we explore in the next section whether it might become so if circumstances were to change. Our purpose in doing so is both to explore realistic scenarios that might occur in this category and to illustrate the use of the model in practice. We consider three scenarios: competitive response, type of private label and direct store delivery. In each case, we vary the parameters of the demand and/or cost functions and discuss their impact.

### **(v) Scenario Analysis**

Our purpose in this section is to illustrate the application of the model to a variety of scenarios which represent reality in this category. In each case, we describe the situation and how it can be represented by changes in the model's parameters, with all other parameters held at the initial levels of the last section. We focus on the issues facing manufacturer 1.

#### **Competitive Actions**

A significant concern for a manufacturer considering supplying a private label to a retailer is the possibility of setting off a price war among manufacturers of national brands. In this category, such a threat is very real. The two dominant firms see each other as their primary competition, and are unwilling to allow each other to gain any advantage from private label supply. While increased prices by firm 2 are a theoretical possibility (because it is in firm 1's interest to raise national brand prices), managers in the industry argue that firm 2 is likely to reduce prices in order to discourage

private label supply by manufacturer 1.

In chapter 2, we found that the possibility of a price change by a competing duopolist could have a negative effect on the profitability of private label supply, and that such a scenario was most likely when the price of the private label was low relative to that of the national brand. A major concern for a duopolist would be the possibility of setting off a price war with his competitor. As was shown in Appendix 3.7, it is also a concern for a dominant firm that the competing dominant firm may change its national brand price in response to private label supply.

A further reaction by a competitor might be to increase his investment in promotion with the retailer. Since manufacturer 2 has a very low share of total promotions, it may well be in his interest to react in this way, as well as reducing price.

The model can be used to anticipate both reactions and estimate their total impact on the profitability of private label supply for manufacturer 1. We classify the possible reactions of manufacturer 2 to private label supply by manufacturer 1 as mild, moderate, aggressive or highly aggressive by varying manufacturer 2's price, and by increasing his share of promotions.

The basis of our assumptions is to vary the price parameter by reducing prices by  $\frac{1}{2}$  standard deviation for each level: thus, since the standard deviation of manufacturer 2's price is 8¢, a mild response is manufacturer 2's initial price of \$1.37 less 4¢, or \$1.33, a moderate response is \$1.29, and so on. In the case of promotions, manufacturer 2's mean promotion share from the dataset is 5%, compared with shares of 52% for manufacturer 1 and 43% for the private label. We increase manufacturer 2's share in increments of 10% and reduce the shares of manufacturer 1 and the private label in proportion. Table 5.13 summarizes these assumptions:

**TABLE 5.13**

**ASSUMED COMPETITIVE RESPONSE**

<b>Competitive Response</b>	<b>Price <math>w_{n,2}</math></b>	<b>Promotion Share</b>
Mild	\$1.33	15%
Moderate	\$1.29	25%
Aggressive	\$1.25	35%
Highly Aggressive	\$1.21	45%

Since it is unprofitable for manufacturer 1 to supply the private label, we expect the reaction of manufacturer 2 to make it even more so. This is indeed the case, as is evident from Figure 5.2:

(Figure 5.2)

While it is not surprising that private label supply becomes less profitable for manufacturer 1 as manufacturer 2's reaction increases in intensity, what is surprising is that manufacturer 2's reaction does not make a great deal of difference: manufacturer 1's greatest loss, when manufacturer 2 is highly aggressive, is \$43,898, approximately \$6,000 more than his loss if manufacturer 2 does not react.

There are several reasons for the small size of this effect: first, manufacturer 2's prices do not vary greatly in the dataset, so that the range of price reduction is not very wide; secondly, the empirical study did not show great effects for promotions, so that increased promotions on the part of manufacturer 2 only have a small effect; and finally, the aggregated cross-price terms between brands 1 and 2 (49.326), and between brand 2 and the private label (-5.140) are small relative to that

between brand 1 and the private label (235.818). In sum, the price and promotion effects in the data are not strong enough for reaction by manufacturer 2 to have a great deal of influence on manufacturer 1's actions.

### **Premium versus Discount Private Label**

As noted in chapter 1, part of the growth in private labels in recent years has been due to the introduction of high quality, or "premium" private labels by many retailers, as opposed to the more traditional private label or generic which bases its appeal mainly on price. Many retailers, however, still market both premium and traditional private labels. This category has been strongly affected by the growth of premium private labels.

The demand functions estimated in chapter 4 referred to the two national brands and a "premium" private label marketed by a retail grocery chain in Ontario. We can expect a premium private label such as this to have a high level of consumer preference (intercept demand,  $\alpha_i$ ), and, due to its high quality, a low level of response to its own price ( $\beta_i$ ). We can also infer that it is a relatively close substitute for the national brand, and that its cross-price response with respect to the national brand ( $\theta_{ij}$ ) is relatively high. The manufacturer interested in supplying this private label can expect to obtain high private label volumes and profit margins, but suffer substantial cannibalization of his national brand.

By contrast, a "traditional" private label would have lower consumer preference, higher own-price response and lower cross-price response. A traditional private label may also cost less to produce than a premium product, due to lower raw material costs and possibly lower costs of

packaging material. Would manufacturer 1 be better off supplying this type of private label, as opposed to the premium product tested here?

On the demand side, the theory is quite clear. Reductions in private label intercept demand, increases in own-price response and reductions in cross-price response all reduce the profitability of private label supply (see Propositions 3.1, 3.2 and 3.3 in chapter 3). However, it is possible that a traditional private label may reduce costs enough to compensate for these effects. Accordingly, we simulate the effects of these parameter changes at three different private label unit cost levels: 51¢ (the low end of the range), 55¢ and 60¢.

Since the private label considered in this study is a premium product, we use this as the "premium" end of the range of simulation. In the absence of data on the hypothetical traditional private label, we simulate its parameters by reducing the intercept, increasing the own price parameter and reducing the cross-price parameter of the private label by 25% in equal increments. The results are shown in Figure 5.3.

(Figure 5.3)

In all three cases, private label profitability declines as the demand parameters approach the more "traditional" end of the range, as the theoretical model shows. However, lower costs on the private label can compensate for the loss of profitability. At 51¢, private label supply is profitable for manufacturer 1 across most of the range, while at 60¢ it is always unprofitable.

In all three cases shown, however, manufacturer 1 sets a price on the private label equal to the competitive fringe's cost: in other words, because of the low price charged by the competitive

sector, he is unable to set profit-maximizing prices on the private label, or, by extension, on the national brand (since he maximizes across both products). However, if the private label's parameters change by extreme amounts beyond those simulated here, his optimal price falls so low that he can beat the competitive fringe's price. In this situation, his profit margins improve, but the private label is so inherently unattractive because of its low consumer preference and high price response that it remains unprofitable.

### **Direct Store Delivery**

In this category, one significant difference between the national brand manufacturers and private label suppliers is that the former deliver their national brands direct to stores, but the latter deliver to retailers' warehouses. The national brand manufacturers claim that their method of distribution saves costs for retailers: at least some retailers, however, would prefer a warehouse-delivered product at lower cost. To date, national brand manufacturers have refused to comply with this on their national brands. Retailers are nevertheless unlikely to pay extra for a direct-delivered private label.

This leaves national brand manufacturers with a choice of using their existing direct-to-store distribution system for private labels as well as their national brands, or delivering to retailers' warehouses as private label suppliers do. In the former case, the manufacturer gains economies of scope by putting two brands through the same distribution system: in the latter, he can reduce the unit costs of the private label. Hence there is a trade-off between unit costs and economies of scope.

This simulation considers how manufacturer 1 might make such a trade-off.

Direct store delivery costs are largely fixed; while manufacturers might consider investing in extra DSD capacity to supply private label, this is highly unlikely since it would double unit costs. We therefore assume that excess capacity exists, in which case the incremental costs of delivering private label are confined to handling and some materials such as extra pallets. We assume, based on discussions with industry experts, that these costs are small.

We simulate the savings due to warehouse delivery by reducing private label unit costs by 1¢ and by 2¢ on costs ranging from 55¢ to 60¢. As we saw earlier, private label supply is profitable in this range, and we expect warehouse delivery to make it more so, as is evident when we examine the parallel shifts in profit due to these savings in Figure 5.4:

(Figure 5.4)

The solid line in Figure 5.4 shows the effect of economies of scope, the parameter  $e$  in the cost function, varied between 0 and -0.0000001. At the mean volumes from the dataset, this lowest level represents savings of approximately 4¢ per unit. However, since the effect of  $e$  is a function of output, the total savings will change as optimal output changes, as a result of changes in  $e$ .

From Figure 5.4, it is evident that economies of scope within this range have a limited effect, relative to savings in unit costs. Until the savings reach the higher end of the range, the manufacturer is better off delivering to retailers' warehouses and taking the savings in unit costs. In other words, it takes a large increase in efficiency to offset the savings the manufacturer might obtain if he delivered to retailers' warehouses.

This analysis, of course, does not take account of another reason why manufacturers might prefer direct store delivery - that it gives them more control of shelf position and display. However, this rationale disappears in the case of the private label, for two reasons: first, because retailers are very likely to prefer to merchandise their own private label, and secondly, because it is unlikely that truck jobbers hired by the national brand manufacturer will give the private label adequate exposure. This raises another interesting rationale for DSD, however: the manufacturer may prefer it because it allows him to *limit* the shelf exposure given to the private label, as opposed to the national brand.

In any event, a manufacturer wishing to deliver private label direct to stores will need to find strong justification for such a decision on the basis of strategic factors. In this analysis and in the foregoing, it has become evident that the unit costs of private label play a critical role in determining its profitability. Warehouse delivery is one way of reducing unit costs and making private label supply profitable.

#### **(vi) Conclusions**

In this chapter, we set out to learn more about the model both by identifying its limitations and by applying it to a case study. The results provide us with interesting observations about the model. The principal of these are outlined below.

- The fundamental assumptions of the model with respect to market structure and manufacturer-retailer interaction seem to represent reality in this category quite well. More generally, they approximate conditions in the grocery

industry as a whole.

- The major limitation of the model lies in the possibility of misspecification of the demand function. In particular, the model does not take account of other package sizes and advertising. The direction of bias that results from exclusion of these factors varies.
- The aggregate nature of the data (discussed in chapter 4) may lead us to erroneous conclusions. As we saw in the simulation of competitive actions, the lack of significant effects for competitive promotions suggests that competitors can have little influence on the private label supply decision. This conclusion could change if store-level data showed stronger promotional effects.
- The "dominant firm" structure of the model plays a pivotal role in the profitability of private label supply. Because the competitive fringe's costs are low, the national brands are heavily cannibalized if the manufacturers supply at low costs. However, the manufacturers' ability to recover their profits through supplying the private label is severely limited, since their price must always be lower than the competitive fringe's cost.
- The "market segmentation" effect of private label supply is an important

factor in this case. Because the manufacturer that supplies the private label raises his national brand price, the competing national brand manufacturer stands to gain. Hence each manufacturer is better off if his *competitor* supplies the private label, whether or not he chooses to do so.

- Throughout the simulations, it is clear that private label unit costs are also a critical factor in the supply decision. This ties in with the previous observation: with an upper bound on prices, manufacturers are unable to pass cost increases on to the retailer and hence private label supply rapidly becomes unprofitable with increases in costs.
- It is evident both from the theoretical model and from the simulations in this chapter that the manufacturers would be better off supplying a premium private label than a traditional private label. In addition, delivery of private labels direct to retailers' stores is unlikely to be justified relative to the competitive fringe's practice of warehouse delivery.

In the case analyzed here, we applied the parameters obtained in chapter 4, along with the most reasonable assumptions we could make about national brand and private label costs. Our findings fit with the strategy actually followed by the manufacturers in practice: private label supply is unprofitable, and the national brand manufacturers are better off leaving it to the competitive sector.

In summary, the model has provided a useful perspective on the profitability of supplying a private label for the manufacturers in this category. While it necessarily leaves out some issues, its use as a vehicle for simulation allows us to assess the effects of strategic changes on the profitability of supplying private labels.

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**APPENDICES**

## **APPENDIX 5.1**

### **ABSTRACTS OF RELEVANT STUDIES**

#### **1. Harvard Business School Case Study**

This case study takes a close look at the situation facing the dominant private label supplier in the category in 1993. The supplier was already well established in the Canadian market and had been making forays into the U.S. The two national brand manufacturers had reacted aggressively to the private label supplier's growth by reducing prices, and their likely reaction to the latter's ambitious plans for the U.S. market was uncertain. In addition, the private label supplier was considering expansion outside North America and into other product categories. The case provides detailed historical financial data (not including unit costs), market shares, case sales by retail account, and data on international market development.

#### **2. J.P. Morgan Study**

From the introductory section to this report:

"There has been a change in the North American corporate landscape with the emergence of strong private brand manufacturers and marketers. At the same time, traditional regional U.S. supermarket chains have come under sustained pressure not just from the recession but also from voracious new breeds of retail formats, deep discounters, clubs and supercentres. Larger, more marketing-driven chains have seized on private brand development as a survival tactic that protects retail profitability because it produces a superior gross margin mix, as well as a means of distinguishing a retailer from its less able regional competitors. For two reasons, it is important to determine whether private brand growth has been an unsustainable, recession-linked cyclical move:

- If so, private brand manufacturers ... would reverse.
- If so, supermarket chains would revert to an undifferentiated mass of regional sitting ducks."

The study responds to arguments made by one of the national brand manufacturers that national brands are more profitable for retailers than premium private labels. Most of these arguments are refuted using detailed data on category sales, prices and retailer costs.

### 3. Econometric Study (1991): published in *Advances in Econometrics*

This paper considers a differentiated market dominated by a duopoly and focuses on some simple models of noncooperative behaviours on two strategic variables: price and advertising. The methodology explicitly recognizes the gaming nature in the econometric modeling. Specifically, using quarterly data on the [manufacturers 1 & 2] markets from 1968 to 1986, the authors derive and estimate competing structural econometric models under the assumption that the data are the equilibrium outcomes of some noncooperative games in prices and advertising. The methodology presents two advantages. First, full-information estimates of the effect of advertising on market demand are obtained under specific game structures. Second, using recent model selection tests for nonnested models, the authors assess the relative performance of competing market conducts.

A later paper by the same authors, using the same data, was published in the *Journal of Economics and Management Strategy* in 1992. The abstract is as follows:

This paper proposes an empirical methodology for studying various (implicit or explicit) collusive behaviours on two strategic variables, which are price and advertising, in a differentiated market dominated by a duopoly. In addition to Nash or Stackelberg behaviours, the authors consider collusion on both variables, collusion on one variable and competition on the other, etc. Using data on the [manufacturers 1 & 2] markets from 1968 to 1986, full information maximum likelihood estimates of cost and demand functions are obtained allowing for various collusive behaviours. The collusive hypothesis is not rejected, and the best form of collusive behaviour is selected via nonnested testing procedures. Using the best model, Lerner indices are computed for both duopolists to provide summary measures of market power. Finally, the approach is contrasted with the conjectural variation approach and is shown to give superior results.



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 \text{Season 2, Week } N \\
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### Aggregate Parameters for Total Year

We sum across all 55 weeks as outlined in the text, to obtain the following:

$$\left[ \begin{array}{c} \hat{q}_1 \\ \hat{q}_2 \\ \hat{q}_r \end{array} \right] = \left[ \begin{array}{cccc} \xi^*_1 & -\eta^*_1 & 55\sigma & 55\theta_1 \\ \xi^*_2 & 55\sigma & -\eta^*_2 & 55\theta_2 \\ \xi^*_r & 55\theta_1 & 55\theta_2 & -\eta^*_r \end{array} \right] \left[ \begin{array}{c} 1 \\ \bar{p}_1 \\ \bar{p}_2 \\ \bar{p}_r \end{array} \right]$$

where  $\xi^*_1 = \sum_{t=1}^{55} \xi_{1t}$ ;  $\eta^*_1 = (1/\bar{p}_1) \sum_{t=1}^{55} \eta_{1t} p_{1t}$ . To adjust this to parameters representing one year, we multiply the above matrices by 52/55. In the case of the price parameter, this means

$$\begin{aligned}
 \eta^*_1(55) &= (52/55)(1/\bar{p}_1) \sum_{t=1}^{55} \eta_{1t} p_{1t} \\
 &= \sum_{t=1}^{55} \eta_{1t} (52 p_{1t} / 55 \bar{p}_1) \\
 &= \sum_{t=1}^{55} \eta_{1t} (52 p_{1t} / \sum_{t=1}^{55} p_{1t})
 \end{aligned}$$

If we were to aggregate this parameter across 52 weeks instead of 55, we would have

$$\begin{aligned}
\eta^*_i(52) &= (1/p_i) \sum_{t=1}^{52} \eta_{i,t} p_{i,t} \\
&= \sum_{t=1}^{52} \eta_{i,t} (p_{i,t}/p_i) \\
&= \sum_{t=1}^{52} \eta_{i,t} (p_{i,t}/\sum_{t=1}^{52} p_{i,t}/52) \\
&= \sum_{t=1}^{52} \eta_{i,t} (52 p_{i,t}/\sum_{t=1}^{52} p_{i,t})
\end{aligned}$$

For these parameters to be equal.

$$\eta^*_i(55) = \eta^*_i(52)$$

$$\begin{aligned}
\rightarrow \sum_{t=1}^{55} \eta_{i,t} (52 p_{i,t}/\sum_{t=1}^{55} p_{i,t}) &= \sum_{t=1}^{52} \eta_{i,t} (52 p_{i,t}/\sum_{t=1}^{52} p_{i,t}) \\
\rightarrow \sum_{t=1}^{52} \eta_{i,t} / \sum_{t=1}^{55} \eta_{i,t} &= \sum_{t=1}^{52} p_{i,t} / \sum_{t=1}^{55} p_{i,t}
\end{aligned}$$

In other words, the proportionally reduced parameter will be unchanged from the 52-week parameter if prices change in the same proportion. Any difference between the two incorporates deviations in the remaining three weeks.

**APPENDIX 5.3**

**INITIAL PARAMETER VALUES FOR THE CASE STUDY**

<b>Parameter</b>	<b>Brand 1 Analysis</b>	<b>Parameter</b>	<b>Brand 2 Analysis</b>
$\alpha_l$	312.213	$\alpha_2$	340,821
$\beta_l$	245,973	$\beta_2$	159,143
$\sigma$	49.326	$\sigma$	49.326
$\theta_l$	235.818	$\theta_2$	-5.140
$\alpha_r$	980.146	$\alpha_r$	980.146
$\beta_r$	880.101	$\beta_r$	880,101
a	\$0.66	a	\$0.69
b	0	b	0
c	\$0.66	c	\$0.69
d	0	d	0
e	0	e	0
$w_{n2}$	\$1.37	$w_{n1}$	\$1.25
$w_{n2}'$	\$1.37	$w_{n1}'$	\$1.25
$C_c$	\$0.70	$C_c$	\$0.70

## APPENDIX 5.4

### ITERATED PRICES WHERE BOTH MANUFACTURERS BID

Where both manufacturers bid to supply the private label, we assume that they bid each other down to the greater of the two manufacturers' marginal costs, here 69¢. We start by assuming that the competitor's national price is his optimal price from the {S,DNS} and {DNS,S} strategy sets. The model then computes optimal national brand prices where each manufacturer supplies; we use these prices as competitive prices in the next iteration, repeating the process until the prices converge.

The results of this procedure are as follows:

Iteration	$w_{n1}^*$	$w_{n2}^*$	$\pi_1$	$\pi_2$
1	\$2.10	\$1.93	\$48,201	\$81,339
2	\$2.16	\$2.06	\$50,937	\$82,952
3	\$2.17	\$2.07	\$51,149	\$83,222

## APPENDIX 5.5

### NATIONAL BRAND PRICE WHERE $w_1$ IS CONSTRAINED

The competitive fringe cost  $C_c$  is an upper bound on the manufacturer's private label price. Hence where the optimal private label price exceeds this cost, the manufacturer is constrained to a price of  $C_c$  if he wants to supply. The same principle holds where both manufacturers bid. Here, we set private label prices at marginal costs. We then set national brand prices given these prices, instead of optimizing across both brands as before.

From Appendix 3.5 to chapter 3, we have

$$w_{n1}^* = \frac{1}{2}[C_{n1} - (\theta_1/\beta_1)C_c + (\alpha_1/\beta_1) + (\sigma/\beta_1)w_{n2}] + (\theta_1/\beta_1)w_1$$

which is, in this case

$$w_{n1}^* = \frac{1}{2}[C_{n1} - (\theta_1/\beta_1)C_c + (\alpha_1/\beta_1) + (\sigma/\beta_1)w_{n2}] + (\theta_1/\beta_1)C_c$$

Recall that  $C_{n1} = a + bq_{n1}(w_{n1}^*) + eq_1(C_c)$ , and  $C_c = c + dq_c + eq_{n1}$ . Substituting these functions into  $w_{n1}$ , we have

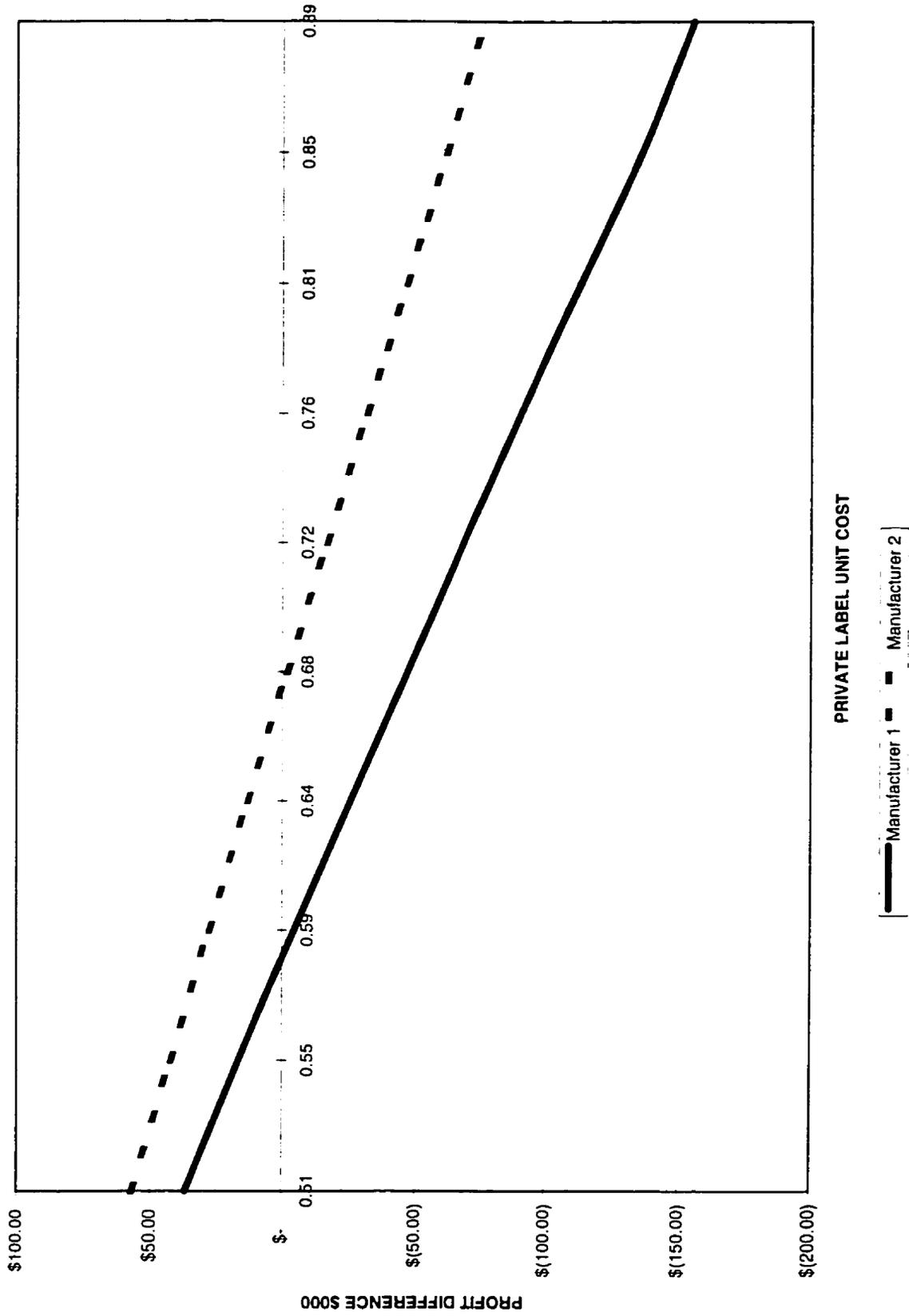
$$w_{n1} = \frac{1}{2}\{a+c+[b-(\theta_1 e/\beta_1)]\{1/2(\alpha_1-\beta_1)w_{n1}+\sigma w_{n2}+\theta_1 C_c\}+[c-(\theta_1 d/\beta_1)]\{1/2(\alpha_1-\beta_1)C_c+\theta_1 w_1+\theta_2 w_2\}+(\alpha_1/\beta_1)+(\sigma/\beta_1)w_{n2}\}+(\theta_1/\beta_1)C_c$$

Rearranging terms and solving, we obtain

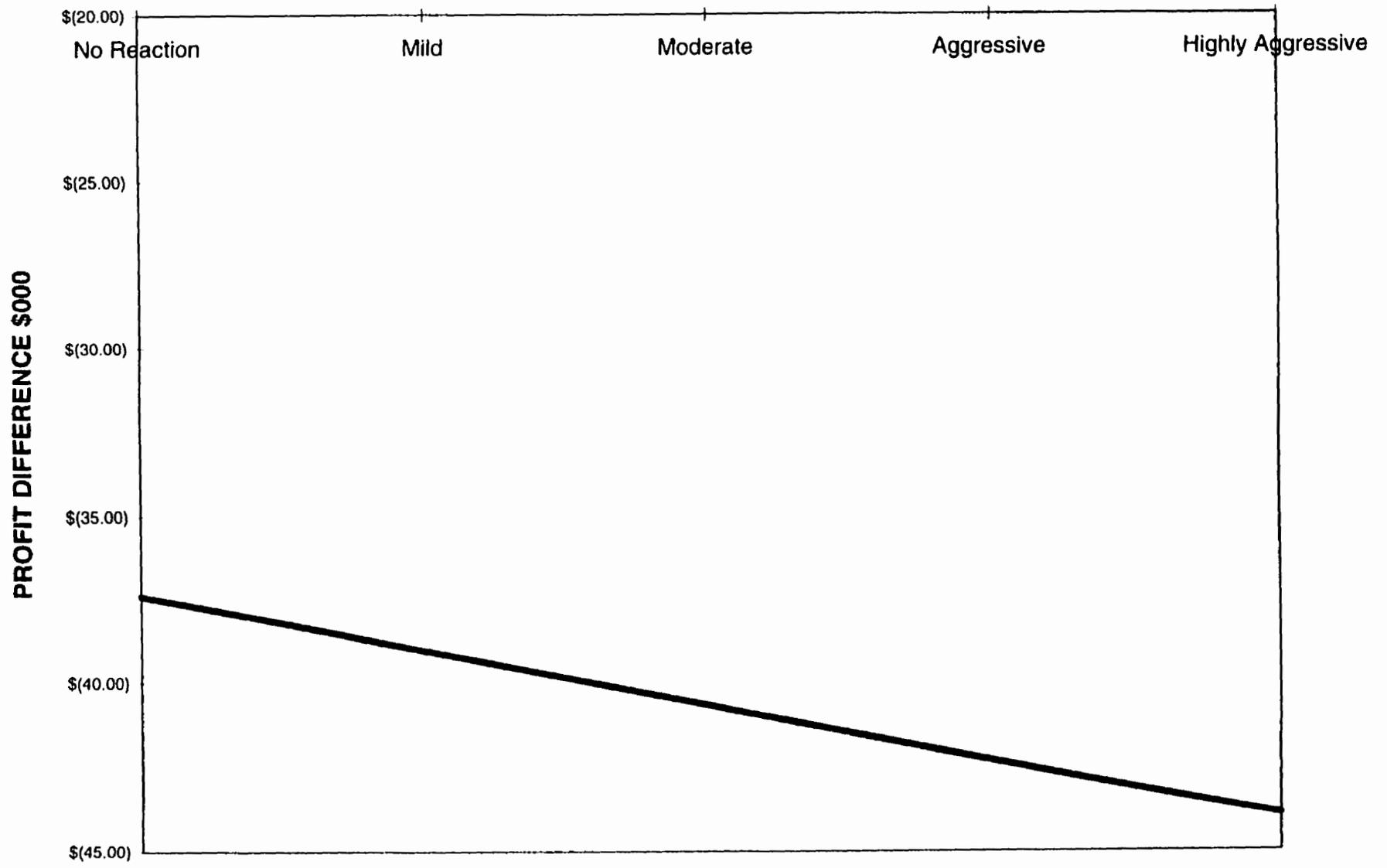
$$w_{n1}^* = [1/(1+1/4(\beta_1 b-\theta_1 e)-1/4(\theta_1/\beta_1)(\beta_1 e-\theta_1 d))]\{a+c+(\alpha_1/\beta_1)(1+1/2(\beta_1 b-\theta_1 e))-1/2(\alpha_1/\beta_1)(\beta_1 e-\theta_1 d) + [(\sigma/\beta_1)(1+1/2(\beta_1 b-\theta_1 e))+1/2(\theta_2/\beta_1)(\beta_1 e-\theta_1 d)]w_{n2}\} + (\theta_1/\beta_1)\{(1+1/4(\beta_1 b-\theta_1 e)-1/4(\beta_1/\beta_1)(\beta_1 e-\theta_1 d))/(1+1/4(\beta_1 b-\theta_1 e)-1/4(\theta_1/\beta_1)(\beta_1 e-\theta_1 d))\}C_c$$

**FIGURES**

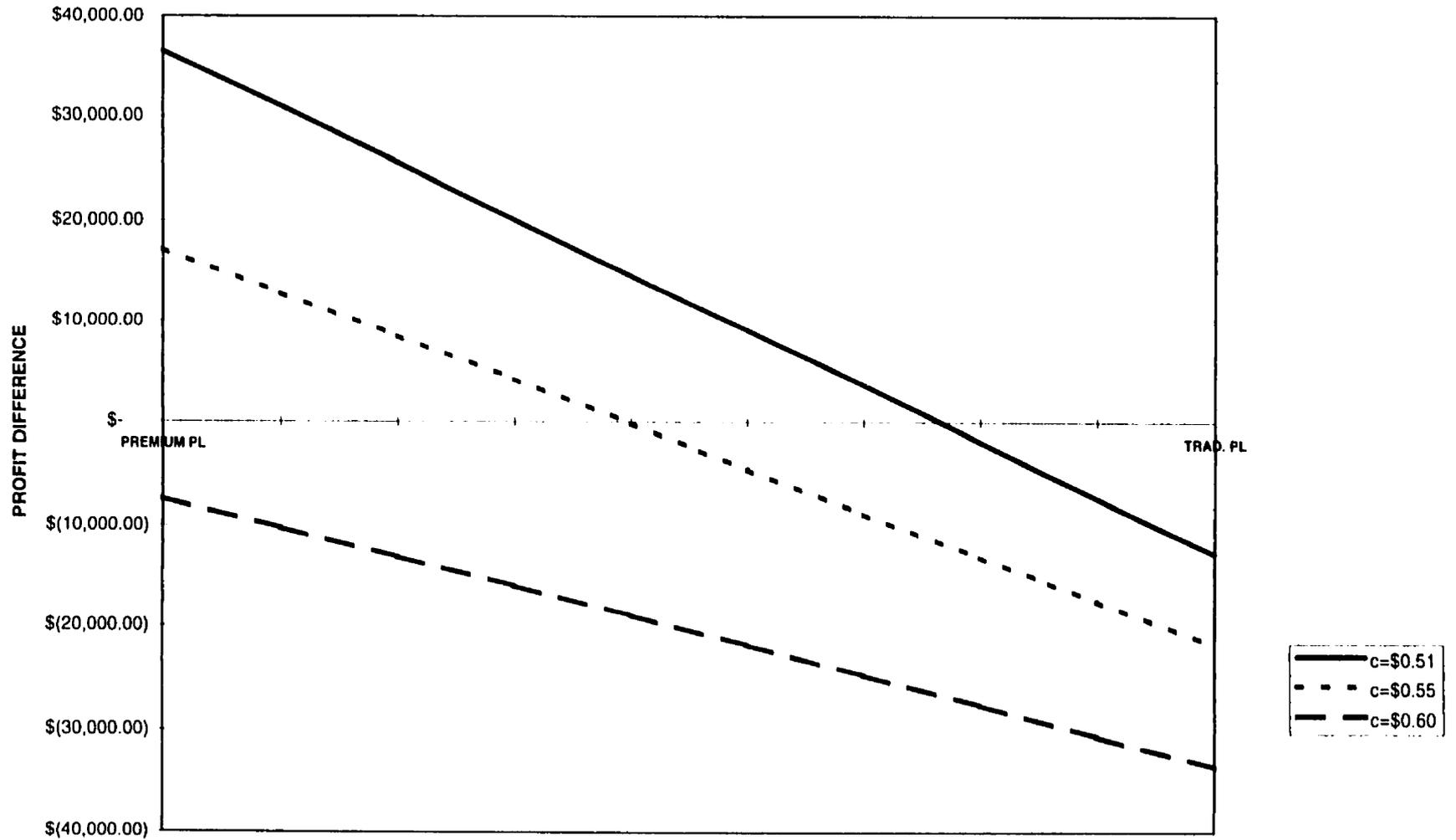
**FIGURE 5.1  
PRIVATE LABEL PROFITABILITY AND PL COSTS**



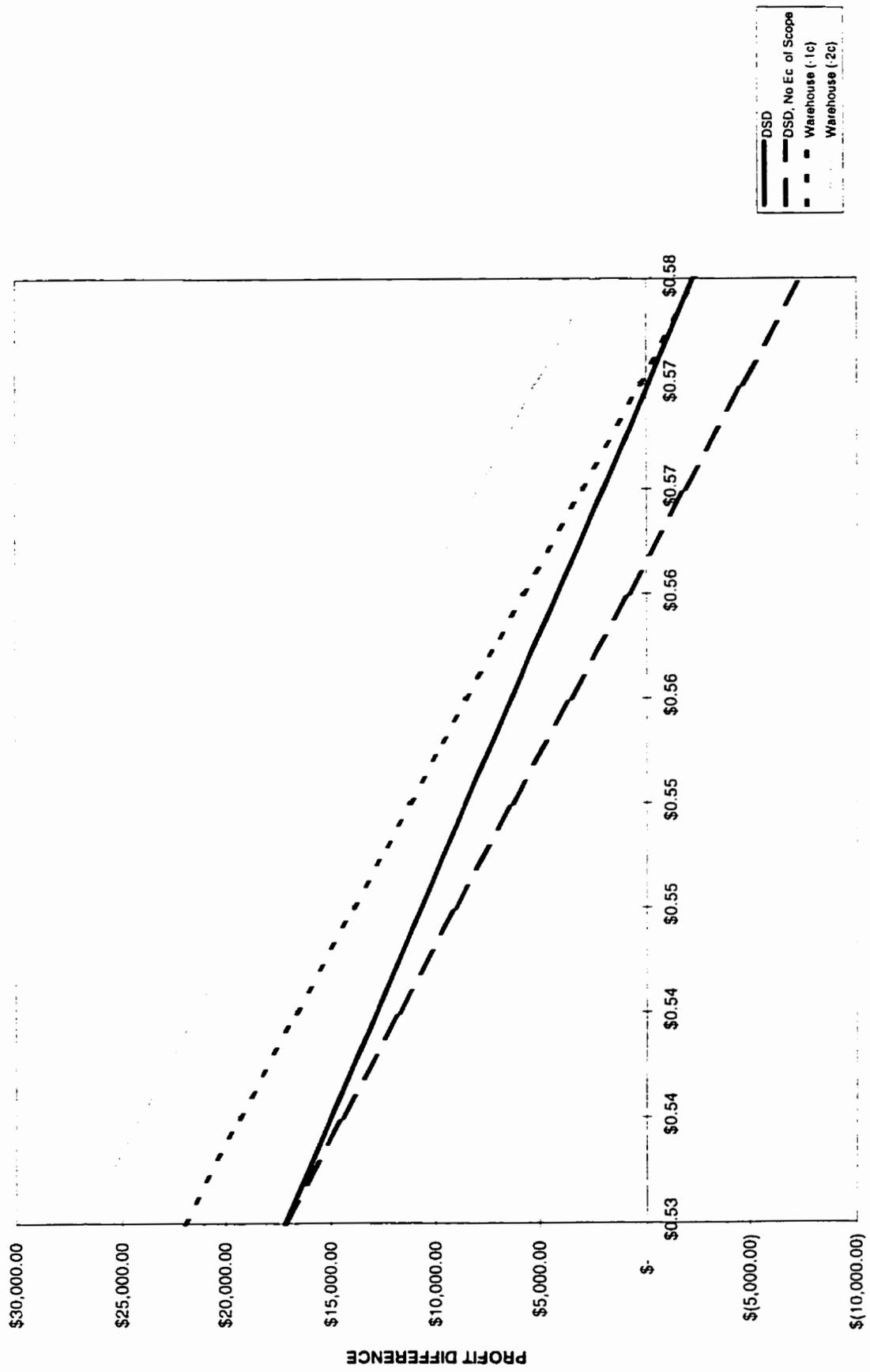
**FIGURE 5.2**  
**IMPACT OF COMPETITIVE REACTION**



**FIGURE 5.3  
PREMIUM VS. TRADITIONAL PL**



**FIGURE 5.4  
PROFITABILITY OF WAREHOUSE DELIVERY**



## **6. CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH**

*for life's not a paragraph*

*And death i think is no parenthesis.*

**e.e. cummings:**

*Since feeling is first*

### **(i) Summary**

This dissertation has been concerned with the conditions under which it is profitable for a manufacturer to supply a retailer's private label brand. We have focused our analysis on conditions approximating the retail grocery industry, and have applied the model to a specific category within that industry.

The model starts with a set of assumptions about consumer demand, industry structure, manufacturer and retailer behaviour and costs. Optimal prices and quantities are derived, and the profitability of private label supply determined by comparing a manufacturer's total profit when he supplies the private label, versus when he does not supply. By analyzing the response of this difference to each of the model's parameters, we develop predictions about the influence of exogenous conditions on private label supply profitability. We summarized these at the end of chapter 3. For the reader's convenience, this summary is repeated here:

FACTORS FAVOURING PRIVATE LABEL SUPPLY	FACTORS AGAINST PRIVATE LABEL SUPPLY
Category expansion Category stability/segmentation Competitive fringe pricing Private Label "attractiveness" Relative economies of scale (PL) Economies of scope	National brand cannibalization Possibility of price war Relative economies of scale (NB) Diseconomies of scope

In applying the model to a specific manufacturer, we derive consumer demand functions based on scanner data, with appropriate parameter constraints as suggested by economic theory. In a spreadsheet version of the economic model, we put this information together with the best available estimates of cost to estimate the profitability of private label supply for this manufacturer. We then simulate the impact of changes in costs or competitive strategy on our results.

In chapter 1, we identified several reasons why manufacturers would be prepared to risk cannibalization of their national brands to supply retailers' private labels. In assessing our progress, it is useful to refer back to these reasons and consider how the model encompasses them:

*Price Discrimination/Market Segmentation:* As we saw in chapter 1, manufacturers may supply private label in order to serve high and low quality segments separately. Theoretical support for this argument was offered by Wolinsky (1987).

An important outcome of our model is that national brand prices are higher when the

manufacturer also supplies the private label. The reason for this is that the manufacturer who sells two brands can extract some surplus from consumers of the lower-priced brand, allowing him to raise prices on the other. Hence the model supports this explanation for private label supply.

*Entry Deterrence:* The "entry deterrence" argument was that a manufacturer might supply a private label in order to prevent a new competitor from gaining a foothold in the market. Schmalensee (1978), Eaton and Lipsey (1979) and Brander and Eaton (1984) were cited as support for this explanation.

In the "dominant firm" model of chapter 3 and the subsequent case application, we analyzed a situation in which a manufacturer is faced with not only a quasi-duopolistic competitor, but also with a competitive fringe that will supply the private label if neither dominant firm does. In order to keep the competitive fringe out, the manufacturer has to offer a better price to the retailer for the private label. We found support in both theoretical development and in later simulations for the idea that, if the competitive fringe's costs are sufficiently high, it is optimal for the manufacturer to allow entry.

*Relationships and Power:* We also examined the idea that retailers in the grocery industry might use their power to force manufacturers to supply private label. However, we found that the influence of retailer power on private label supply is extremely uncertain. In addition, a recent analysis by Messinger and Narasimhan (1995) questions the idea that power has shifted towards retailers in the grocery industry. There is nonetheless evidence (e.g. Glémet and Mira, 1993) that private label market share is associated with retailer concentration; whether this says anything about private label

supply is another matter. At best, it can be said that the jury is still out on the influence of power on private label supply.

Retailer power is incorporated in the model in the assumption that manufacturers offer differentiated national brands, but are undifferentiated with respect to private label supply. Hence the retailer can readily switch from one supplier to another in search of the best price. The model therefore *assumes* that retailers are powerful with respect to the private label, but does not explicitly analyze the influence of differing levels of retailer power on manufacturers' actions.

*Competition:* The competitive environment faced by a manufacturer was considered as a possible influence in the supply of private labels: manufacturers may supply private labels in order to preempt competitive actions. While there was little research on this aspect of private label supply. Brander and Eaton (1984) did provide some support for the idea that manufacturers supplied different products in different competitive environments.

Our model analyzed three types of competitive environment: monopoly, duopoly and two dominant firms facing a competitive fringe. We found that, while it is always in a monopolist's interest to supply a private label, a duopolist will take into account the likely reaction of his competitor: should the competitor reduce price, private label supply may not be viable. A dominant firm, on the other hand, additionally has to consider the fact that if neither he nor his competing dominant firm supplies the private label, the competitive fringe will.

There is certainly room to analyze other competitive environments, an issue we will consider later in this chapter. However, the existing model not only provides "baseline" conditions via the monopoly and duopoly analysis, but examines the competitive environment that is most relevant to

the grocery industry.

*Capacity/Economies of Scale or Scope:* The idea that private labels are primarily a capacity-filler is pervasive in channels literature, both academic and popular. In addition, putting more volume through a plant can result in lower unit costs, if the manufacturer has declining marginal costs due to economies of scale or scope.

The model explicitly analyzes the effect of product-specific economies of scale and economies of scope on the profitability of private label supply, via the inclusion of quadratic and cross-product terms in the cost function. We find that product-specific economies of scale on the national brand negatively affect private label supply, since the manufacturer would prefer to fill the plant with more national brand volume than with private labels. Conversely, economies of scale on the private label positively affect profitability, as do economies of scope.

The model assumes that manufacturers have the capacity to supply the private label. This is representative of prevailing conditions in the contemporary grocery industry, where a substantial amount of spare capacity exists, largely due to volume declines on national brands.

The model, then, includes most of the key reasons for private label supply that have been suggested in the literature, at least insofar as they apply to the retail grocery industry. In the remainder of this chapter, we deal with the model's contribution, its limitations and directions for future work.

## **(ii) Contribution**

As was pointed out in chapter 1, private labels are an issue of great concern to manufacturers in the packaged goods industry due to their steady growth in recent years. Some manufacturers (e.g. Coca-Cola) and some academics (e.g. Hoch and Banerji, 1993) have expressed scepticism over whether they are a major long-term concern. However, based on the evidence from European markets, private labels can potentially capture in excess of one-third of total grocery sales. In addition, the success of premium quality private labels at close to parity pricing to national brands would suggest that retailers' brands are not completely a recession-related phenomenon.

With the growth of private labels, manufacturers have been under increasing pressure to provide retailers with high-quality substitutes for their national brands. No longer are retailers satisfied with private labels that offer the consumer low quality at a low price; increasingly, they are insisting on products that mimic national brand quality, at lower profit margins for manufacturers. Hence the concern among manufacturers that private labels will simply substitute low-margin sales for high-margin sales.

The primary contribution of this dissertation, then, lies in its identification of the microeconomic conditions that favour, and that mitigate against, the supply of private labels. In addition, the framework proposed here is adaptable to a variety of related business issues. The model, furthermore, can act as a decision tool for managers who are interested in analyzing the effect of changes in competitive strategy or environmental conditions on their decision.

### **(iii) Limitations**

The model has certain limitations which may render it less applicable in some situations, as was discussed in chapter 5. A summary of the most important limitations is given here.

*Retailers:* While retailers can choose between national brands and private labels based on price and substitutability, there are often other considerations that come into play. Because of limited shelf space, for example, retailers may choose not to stock the national brand if its margins are too low; on the other hand, they may give preference to the national brand of a manufacturer that supplies their private label.

The model also assumes that manufacturers are undifferentiated with respect to the private label. While this is a reasonable approximation of reality in the grocery industry as a whole, there may be individual situations in which some manufacturers are capable of providing a higher quality product or some extra service such as delivery to stores. Since there are few patents in the grocery industry, however, such differences are unlikely to be sustainable over time.

The decision to provide a private label to one retailer has also been assumed to be independent of all other such decisions. However, one can envisage situations in which supplying one retailer would create a "precedent" under which it would be difficult to resist demands for private label supply from other retailers. If the private label's marginal costs are increasing or decreasing, this could have a significant impact on the decision.

*Functional Form:* Both the quadratic utility function and cost function on which this model is based

are first-order approximations of any such function, and the model can therefore be seen as highly generalizable across different categories. However, in some situations the linear demand function may not fit as well with the data as, for example, a log form. However, log form demand functions are mathematically intractable in a model such as this (e.g. Choi, 1991).

One way of dealing with this is to estimate log demand functions where appropriate and approximate a linear function by Taylor Series expansion around a specific point. The major drawback to this is that even a small range on the (log) demand function is represented by an infinite number of linear functions, and a shift in price may invalidate the results of the model. Whether this is critical to the profitability of private label supply will vary from case to case.

*Costs:* The cost function given in chapter 3 represents the underlying total costs of the manufacturer, but in reality is very difficult to estimate. Allocation of costs across business units can often hide the true relationships between output and cost, so that the most realistic assumption, as in the case of our simulation in chapter 5, is of constant marginal costs.

We have also assumed here that costs are exogenous to the model, while in reality they are chosen by the manufacturer based on some production function in materials, labour and capital. For this decision, the assumption that costs are exogenous is justifiable for an established business where product formulae and technology are approximately constant.

*Competitive Fringe:* As was demonstrated in chapter 3, the "dominant firm" framework is descriptive of many categories in the grocery industry, including the category used for application of the model. Smaller competitive firms, in fact, are often the key source of private label supply for

retailers (Glémet and Mira, 1993).

The most likely reason for this is that, for a small firm, supplying private label can be an inexpensive way to enter a market. Hence national brand manufacturers may be concerned that such firms do not grow too large and present a greater threat to their national brands. For this reason, national brand manufacturers may prefer to deter entry by such smaller firms by supplying the private label.

Below the "entry-detering price",  $C_c$ , it is not in the competitive fringe's interest to supply. While it may not be profitable for a national brand manufacturer to supply a private label at this cost, this could change in a dynamic framework in which the competitive fringe enters and affects the national brand manufacturer's payoffs in future periods. The widespread existence of such competitive firms in the grocery industry would suggest, however, that this scenario does not arise very often.

#### **(iv) Future Research**

While the limitations outlined above suggest opportunities for future work in this area, there are, on a broader level, several directions in which research can proceed from here. Figure 6.1 provides a schematic of these areas:

(Figure 6.1)

***Extensions:*** The existing model can be extended in a number of ways both to

address some of the above limitations and to allow it to be generalized beyond the scenarios discussed in this dissertation.

*Differentiated Private Labels:* In this model, we have assumed that national brand manufacturers are undifferentiated from each other and from competitive fringe suppliers. All retailers have to do is find the supplier that can provide the cheapest product.

In some categories, however, manufacturers have different technology or R&D resources at their disposal, so that they can supply a higher quality product to the retailer. By doing so, they increase cannibalization of their own product, but also raise switching costs for the retailer.

A model such as this could be accommodated within the existing framework, but would need to be extended to a two-period sequential game in which manufacturers bid for supply of a high-quality private label in the first period, where the retailer's alternative is to go to the competitive fringe for a low-quality private label. Because the retailer makes a higher profit margin on the private label than on the national brand, he is better off with the higher quality version which substitutes more closely with the national brand and generates higher sales. The manufacturer evaluates his total payoff over both periods, weighing the benefits of lower cannibalization against those of continuing to supply the private label over two periods.

*Capacity Constraints:* The model assumes that all manufacturers, whether dominant or fringe, have sufficient capacity to supply the private label. This is a reasonable representation of prevailing conditions in the grocery industry as a whole. In addition, the quadratic cost function assumed can be seen as a continuous representation of capacity constraint: as a manufacturer approaches capacity on a particular product, his parameter for diseconomies of scale will approach infinity. However, the application of the model in other industries, and sometimes to individual firms within the grocery industry, may require us to represent a capacity constraint explicitly as a discontinuity in the cost function.

Such a model would continue to assume that the competitive fringe has unlimited capacity, but the dominant firms are constrained, so their marginal costs increase suddenly at a certain output. Where the optimal quantity exceeds a manufacturer's available capacity, the retailer will have to buy private label from more than one source. In this case, the secondary source will cannibalize the national brand to a lesser extent than the national brand manufacturer's own label, due to its higher cost. Since the manufacturer's private label output is less than optimal, he may be better off allowing the competitive fringe to supply the entire quantity at its higher cost.

*Dynamic/Sequential Games:* The present model's treatment of private label supply is static; however, as we saw in chapter 5, the decision period can be

as long as a year, or even longer. The issue in considering a dynamic game is not whether manufacturers have a short-term or a long-term orientation, but whether they have more than one opportunity to make decisions. Where private label supply tends to move around from manufacturer to manufacturer, this is a reasonable assumption.

As discussed previously, a dynamic framework may be most appropriate in considering the manufacturer's interest in deterring entry by a competitive firm. In addition, such a framework could accommodate a scenario in which the competing dominant firm responds to a manufacturer's supply of private label by supplying private label to a second retailer. In arriving at a subgame perfect equilibrium strategy, the manufacturer has to take into account cannibalization of his national brand at the second retailer should his competitor supply in the next period<sup>39</sup>.

#### *Alternatives to Private Label:*

The existing model assumes that the manufacturer is considering private label supply as an alternative to doing nothing; he either supplies the private label or he does not, holding all other strategies constant. However, private label supply may be one of an array of strategies open to the manufacturer. Here, we consider how some alternatives to private label

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<sup>39</sup> This idea was suggested by an expert on the soft drink industry, who argued that if a firm such as Pepsi were to supply a retailer such as A&P, it must take into account the possibility that Coke would respond by supplying Loblaw's.

supply might be incorporated in the model.

*Advertising:* As an alternative to private label supply, the manufacturer can choose to increase advertising on the national brand as a defence.

Increased advertising on the national brand would shift its demand function outwards and may also reduce its price elasticity. To assess the profitability of this alternative, we need to assume an advertising response function which relates the benefits of advertising to its extra cost. In addition, we need to derive results based on the national brand's present position on this function. As noted in chapter 5, increased advertising will make private label supply less profitable. Empirical application of such a model would require data over a sufficiently broad range to determine the shape of the advertising response function.

*Promotion:* In the parameter estimation of chapter 4, we empirically derived the response to promotional activity on the manufacturer's part, assuming that promotions draw occasional consumers into the category. Like the advertising model, evaluation of promotion as an alternative to private label supply in a theoretical model requires that we assume a response function. We would expect promotion to have a more dramatic short-term effect on sales than advertising would. However, it may also bring a quick response from the competing dominant firm.

*Product Development:* The strategic alternative of product development is rich in possibilities for further modelling. The manufacturer can choose to develop a new brand within the category, develop an improved private label product (similar to his competitor's national brand), or develop a new brand in another category.

This alternative can be represented by a dynamic game in which the manufacturer invests in R&D in the first period and launches the resulting new brand in a subsequent period. The effect of the launch depends on which of the above strategic choices a manufacturer makes. A line extension, for example, may cannibalize national brand volume more than a new brand, which can be positioned to take volume from the competing dominant firm or the private label. However, a new brand may be more costly, or more time-consuming, to develop than a line extension. An interesting combination of strategies would be to supply private label in the short term, replacing it with a new brand or line extension when development efforts are completed.

*Collusion:* The dominant manufacturers may collude to keep the competitive sector out by supplying the private label at less-than-optimal prices. Alternatively, they may collude to allow the existence of a competitive sector so long as it is not too threatening.

For the collusive arrangement to be sustainable, it must be optimal for each manufacturer to uphold it. Hence we need to consider simultaneously

the payoffs to both manufacturers of supplying the private label. If the manufacturers do supply, one would expect that private label output will be divided between the manufacturers in some way, and the model would determine the optimal split. This may have interesting ramifications where it is unprofitable to supply the private label; manufacturers may want to *minimize* the amount they produce, but produce just enough to prevent retailers from going to the competitive fringe for some of their private label needs.

***Similar Problems:***

The model is designed specifically to compare scenarios with respect to private label supply, but this structure can be applied to other problems. An outline of some of the most interesting possibilities follows.

*Retailer Profitability:* As noted elsewhere, high quality private labels have shown substantial growth as retailers grow more sophisticated. However, many retailers market *both* high and low quality private labels, perhaps segmenting the market as we have seen manufacturers do as an outcome of this model. In addition, some retailers place heavy emphasis on their private labels due to higher margins than their national brand counterparts, sometimes to the complete exclusion of some national brands.

A model of retailer profitability would consider the optimal prices and quantities sold of each manufacturer's national brand, and of high and low

quality private labels, in the context of an oligopolistic retail market. Based on the same manufacturer-Stackelberg structure and linear demand as employed here, we can analyze relative profit margins and the optimal mix of brands.

*Line Extensions/New Brands:* The problem of launching a line extension or a new brand bears strong similarities to the private label problem: in each case, the manufacturer is usually concerned with making extra profit contribution at the risk of some cannibalization.

In this case, however, the manufacturer chooses the level of substitution with his own and competitive brands. He must trade off the benefits he obtains from market and share expansion (which, as we saw in chapter 2, are closely linked with substitutability) against the risk of cannibalizing his own sales. He thus finds an "optimal" level of substitutability with his existing brand. As this optimal level approaches zero, it becomes more in his interest to launch a new, independent brand.

*Optimal Pricing:* The present model derives optimal prices for both retailers and manufacturers in a range of manufacturer-market structures, assuming retailers are price takers. These can readily be extended to express optimal prices as price differentials from other brands or private label.

An empirical application would follow a similar pattern to that

discussed in chapters 4 and 5, demonstrating the difference in profits for a manufacturer or a retailer between current prices and optimal prices. By broadening the empirical application to multiple categories, we can determine, as a whole, whether manufacturers and retailers tend to charge optimal, less-than-optimal, or higher-than-optimal prices.

***Applications:***

One of the interesting features of this model is that it has been possible to turn it into a managerial tool by expressing it in spreadsheet form. Although the spreadsheet is currently fairly rudimentary, it provided us with a number of interesting, and useful, analyses in chapter 5.

*Spreadsheet Models:* The present spreadsheet model can be simplified by linking it with some more sophisticated mathematical and graphics software. At present, all calculations (cell formulas) are entered directly from the theoretical model along with appropriate constraints expressed as if-then conditions. This process, while user-friendly, is cumbersome from a programming point of view. Ideally, we should be able to preserve the user-friendliness of the system while providing more power and analytical flexibility.

In addition, the present spreadsheet model does not do any of the required econometric analysis, relying on parameters derived in a separate program. In an ideal world, this should not be necessary; all we would have

to do is enter the data, and leave the program to run the regressions, extract the parameters and simulate changes in strategic variables.

Another shortcoming of the present spreadsheet model is that a thorough understanding of the model is required to interpret the results. The primary reason for this is that the results can change dramatically when the range of parameter variation takes us outside the model's constraints. A simpler, managerially interpretable model remains a goal for the future.

*Expert System/Negotiation Tools:* The logical extension of the spreadsheet models outlined above is to develop an "expert" system which can accept both verbal and numerical inputs to develop strategic recommendations. Like the spreadsheet model, such a system would combine a statistical package with mathematical simulation software; in this case, the user would choose from a number of available market structure assumptions and econometric methods. The system would provide a report analyzing the situation in numerical, graphical and verbal form.

One example of such an application would be a system which aids in developing positions for negotiations with channel counterparts. With appropriate inputs, the system would be capable of generating payoffs and developing judgements as to what would be an equilibrium strategy for each of the parties. Over time, actual outcomes could be entered so that the system could quantify each party's likely range of deviation from equilibrium, and

strategies could also take into account actual past behaviour.

The four broad areas for future development described here and outlined in Figure 6.1 are not, of course, mutually exclusive. It seems realistic to consider the first two categories, Extensions and Alternatives to Private Label Supply, as shorter term areas for exploration and the second two, Similar Problems and Applications, as longer term opportunities.

### **(v) Concluding Comment**

The overriding intent in this dissertation has been to bridge the gap between academic theory and managerial practice. To this end, we have developed a model that uses rigorous economic theory to derive managerially relevant conclusions and apply them empirically.

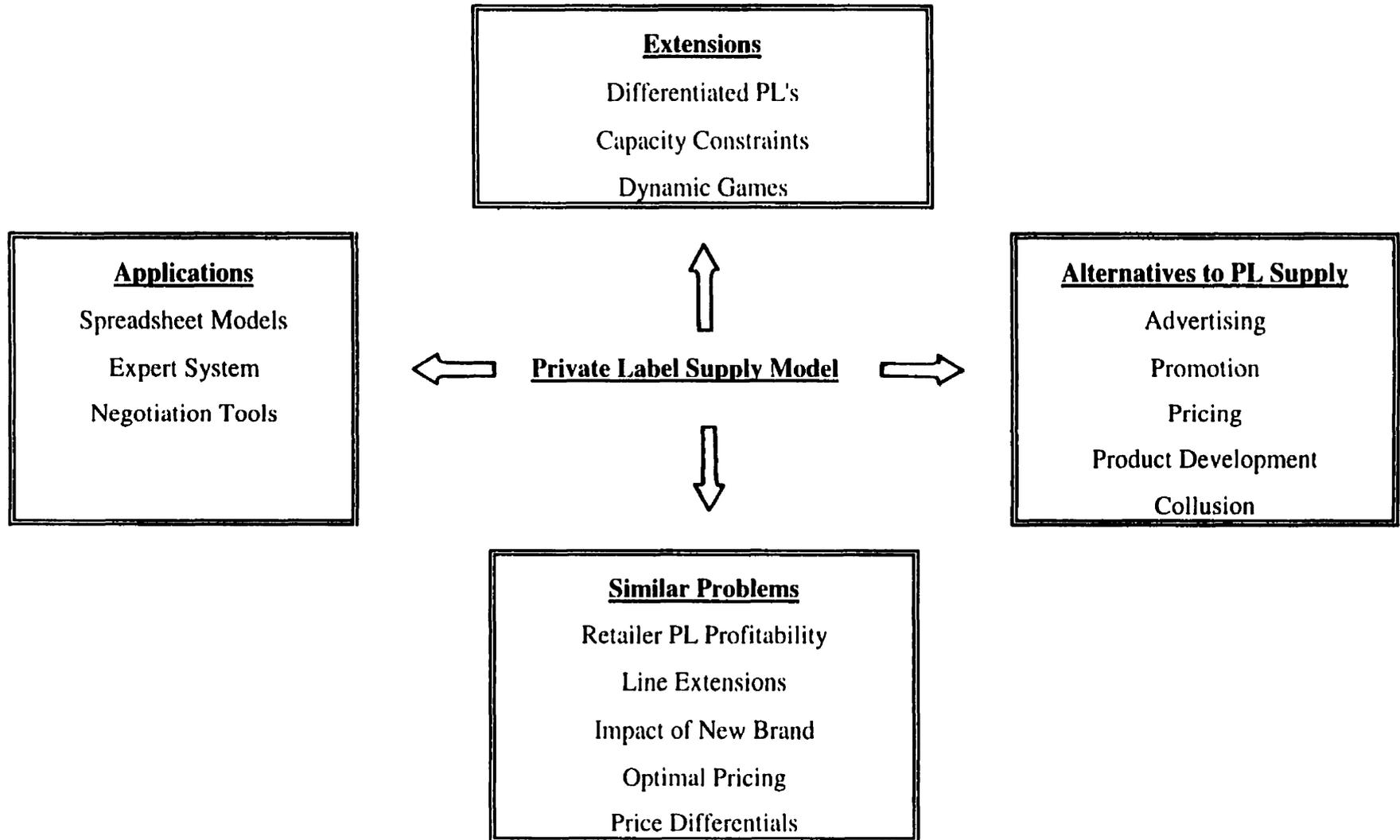
Certainly, the objective was ambitious from the start. Equally certainly, it cannot be said that this dissertation, alone, has come close to achieving it. Nonetheless, we have made a start. In the process, we have enhanced understanding of a particular type of managerial decision, shown how our understanding can be put to use, and laid the groundwork for a potentially fertile stream of research.

This dissertation is the first step on a long road.

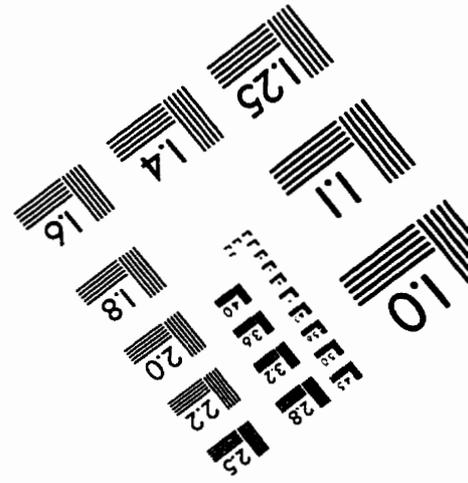
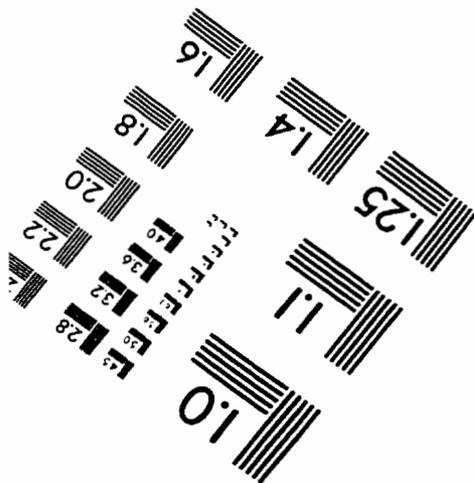
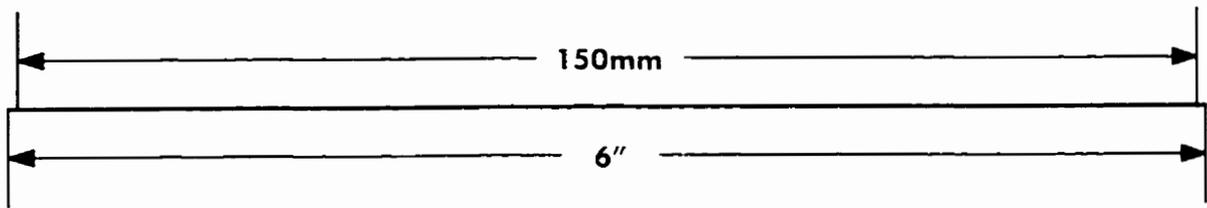
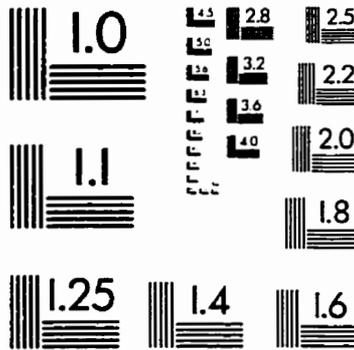
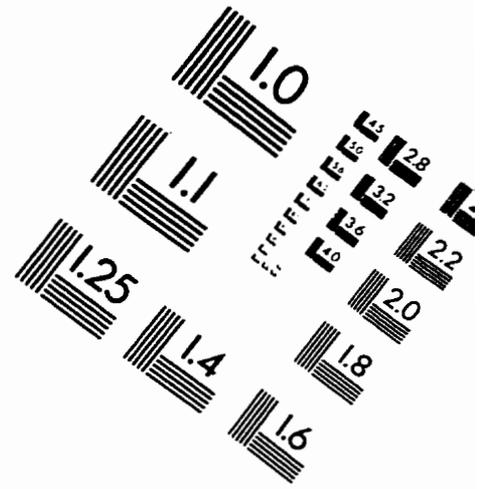
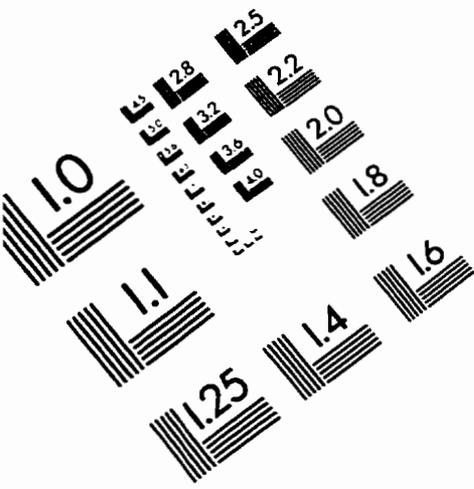
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**FIGURE 6.1**  
**DIRECTIONS FOR FUTURE RESEARCH**



# IMAGE EVALUATION TEST TARGET (QA-3)



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