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STRATEGIC ADVERTISING BEHAVIOUR
AND PUBLIC POLICY IN THE
CANADIAN PHARMACEUTICAL INDUSTRY

by

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B.A. (Honours) Guelph, M.A. Carleton

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

CARLETON UNIVERSITY

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THE UNDERSTANDING OF PUBLIC POLICY AND THE
THE FACULTY OF GRADUATE STUDIES AND RESEARCH
ACCEPTANCE OF THE THESIS.

"Strategic Advertising Behaviour and Public Policy
in the Canadian Pharmaceutical Industry"

SUBMITTED BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
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ABSTRACT

This research draws from the recent Industrial Organization literature on Strategic Investment Behaviour to model the patentee-licensee relationship in the Canadian Pharmaceutical Industry. The focus of the research is on how patentees respond to different entry environments by employing both a strategic advertising strategy and a patentee's own generic version of the patented product. The entry environments, including two entry accommodating and three entry deterring ones, are influenced by the imposition of the following government policy instruments: the length of the exclusive period for the patentee; the severity of substitution laws; the level of royalty rates; and, the severity of entry requirements.

Important insights are gained by this research including a greater understanding of the relationship between patentees and licensees, and when it becomes welfare enhancing to introduce specific types of government policy. For example, the patentee's introduction of his own generic to compete with the licensee's generic version is welfare improving under many circumstances. In addition, a reduction in the period of exclusivity combined with an increase in the royalty rate is also welfare improving.

More generally, total welfare is enhanced by extending the patent period, increasing the severity of substitution laws, increasing royalty payments, and reducing entry requirements. However, the distribution of total welfare between consumers and producers depends on how producer (and foreign producer) profits are treated. This becomes an important part of the analysis because it is generally the case that producer profits and consumer welfare do not move in the same direction.

An extension of the exclusive period on advertising behaviour was statistically tested using data on new patented prescription drugs introduced in Canada. The important finding is that when guaranteed a longer period of exclusivity patentee's spend relatively more resources on "informing" consumers and less on "persuading" consumers.

DEDICATION

To my loving family
Carol, Nicholas and Jonas

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CHAPTER ONE

INTRODUCTION

1.0 INTRODUCTION

The Canadian pharmaceutical industry has been the subject of many academic and governmental studies over the last four decades. During the 1960's alone there were three federal commissions¹ established to examine the pricing practices of pharmaceutical companies. All these commissions concluded that prescription drugs in Canada were being priced substantially higher than in other OECD countries. The federal government reacted by instituting compulsory licensing in 1969. Under compulsory licensing, a licensee could apply to the Commissioner of Patents to obtain the right to market a generic equivalent of the patented drug in Canada. The licensee's only obligation to the patent holder was a nominal royalty payment based on the licensee's total sales. Amid concerns that the savings to be derived from the sale of generic drugs were not being passed on to consumers, provincial governments also became involved during the 1970's by passing legislation on price and product selection rules which were aimed at the

¹ See Restrictive Trade Practices Commission (1963), Hall Commission (1965), and the Harley Committee (1967).

practices of pharmacists. These rules were designed to complement compulsory licensing by encouraging the substitution of generic drugs for the higher priced brandname products.

As a result of these regulatory interventions by both levels of government, the market for lower-priced generic drugs increased. While the subsequent savings were welcomed in Canada, the large pharmaceutical companies based in the United States and Europe were disturbed by what they considered to be the infringement of intellectual property rights in Canada.

The U.S. trade administration took particular exception to Canadian practices regarding compulsory licensing and applied pressure on the Canadian government to provide greater patent protection under the threat of trade retaliation.² Largely as a result of this political pressure, in the Fall of 1987, the Canadian government went some way in meeting the U.S. concerns by amending the Canadian Patent Act. The amendment allows for patent holders of new prescription drugs to obtain exclusive protection for a period of seven to ten years.³

² See United States International Trade Commission (1988).

³ Prescription drugs introduced before the legislation

The 1987 legislation is a fundamental change from the former regime of compulsory licensing. The proponents of this legislation argue that granting exclusive patent protection to pharmaceutical companies more adequately recognizes international intellectual property rights. Further, proponents argue that a modified Canadian system would make Canada a more attractive location for greater production, and research and development (R&D) activities.

On the other hand, those who oppose the legislation point out that Canada accounts for only two percent of the world market for prescription drugs. By having such a small share of the world market for drugs, they argue that Canada's influence on a multinational patentee's decision to transfer production and R&D facilities is negligible.⁴

The opponents of this legislation are also concerned that health costs will escalate because past efforts by provincial governments to establish formularies (which serve to provide information to physicians and pharmacists on drug prices, quality and availability) and enforce substitution

fall under the former compulsory licensing regime (see chapter four).

⁴ This phenomenon whereby a small importing country appropriates the property rights of larger innovating countries has come to be known as the problem of 'National Free Riding'.

laws (which allow generic brands to compete more effectively) will be rendered ineffective. As a result, consumer surplus will be reduced substantially as demanders will be forced to pay higher prices through the patentee exploiting his monopoly position.

This research focuses on the Canadian Pharmaceutical industry and develops a model which examines the pricing and advertising behaviour of a monopolist (patentee) who is subject to the threat of entry through the introduction of compulsory licensing. It is shown that the patentee can use both informative and persuasive advertising strategically to deter potential compulsory licenses. It is also shown that by introducing a generic version of the brandname product the patentee can pre-empt the licensee from entering the market.

Other types of public policy which are shown to affect advertising behaviour are also examined. These include the stringency of substitution laws, the level of royalty rates, and the severity of entry requirements set by Health and Welfare Canada. Through careful examination of the above policy instruments we can begin to improve our understanding of how current public policy affects patentee and licensee behaviour. Furthermore, by introducing different policy combinations we can evaluate options to enhance total economic surplus in this industry.

1.1 GENERAL FRAMEWORK FOR ANALYSIS

The model uses a stylized two period framework to examine the price and advertising behaviour of the patentee and licensee. During the first period, the patentee is assumed to exercise monopoly power over the sale of the drug through an effective patent. In the second period, compulsory licensing is introduced and the licensee can obtain the right to enter the market. The patentee and licensee are assumed to entertain Bertrand/Nash conjectures with respect to second period prices and products are assumed to be differentiated.

To examine the behaviour of the patentee under the different policy environments, a taxonomy of different cases is investigated. Two of these cases fall under entry accommodation, and four cases fall under entry deterrence. These cases are developed and compared against an outright monopoly regime (full patent protection) with respect to advertising, pricing, profitability, and total economic surplus.

The model used to depict the relationship between the patentee and licensee draws heavily on recent developments in industrial organization theory. These new developments demonstrate how oligopoly models can be understood by

assuming whether the aggressive play by one firm (the incumbent) makes the second firm (potential entrant(s)) more or less aggressive depending on how the marginal profitability of the latter is effected. For example, an investment strategy by the incumbent may work to shift out the marginal revenue function (and profit function) of the entrant. The condition necessary for profits to increase in this case depends on the change in the elasticity of the entrant's demand curve with the shift. If the demand curve facing the entrant becomes more elastic/inelastic with the outward shift then profits will increase/decrease. This is referred to below as a strategic complement/substitute and is associated with non-aggressive play/aggressive play.

Fudenberg and Tirole (1984), and Bulow, Geanakoplos, and Klemperer (1985) (BGK), independently describe an oligopoly situation whereby an incumbent firm may use strategic investments to either deter or discipline potential entrants in a given market. Their research extends the work of Spence (1977) and Dixit (1980) on strategic investment but differs in one respect: BGK shows that to deter entry, "over-investment" in a strategy variable (ie. a sunk investment like capacity) is not required. Furthermore, for entry to be deterred under-investment may be an optimal strategy.

BGK show that whether a strategic variable is used heavily by an incumbent in one period or market to affect an entrant's decision in the second period or market, depends on whether the good is considered to be a strategic substitute or complement by the entrant, and secondly, whether there are joint economies or diseconomies across the markets or periods. The joint economies between the two periods or markets may come through the cost side as captured in learning curve type models, or through interrelated demand curves over markets or periods as represented in models which introduce goodwill effects. The effects of the strategy variables are different when markets are treated as simultaneous rather than sequential.

If markets are sequential, then the incumbent is able to exploit the first period by pre-committing to a strategy which the entrant can do little or nothing about. Models of this type have been referred to as two-stage, sub-game, perfect-equilibrium models. If there exist joint economies over the two periods and the goods are perceived as being strategic substitutes then the incumbent may find it profitable to under-invest in a strategy variable in period one to deter entry. By under-investing the incumbent is assumed to be threatening to play aggressively (in prices) in period 2--referred to as the "lean and hungry look". If goods are perceived as strategic complements then the

incumbent may overinvest in period one attempting to reduce aggressive play by the entrant in period two--referred to as the "Fat Cat" effect.⁵

1.2 THE PHARMACEUTICAL INDUSTRY⁶

When the Canadian pharmaceutical industry is operating under a compulsory patent licensing regime, which affects drugs introduced before the new (1987) legislation, generic firms (licensees) can apply to the Commissioner of Patents to import either the drug or the bulk active ingredient for sale in Canada. Generic firms are generally granted a license to sell the drugs as a matter of right. Licensees are obliged to pay a royalty set at four percent of licensee's sales to the holder of patents. The importing of the drug (usually the bulk active ingredient which is assembled into final dosage form in Canada) requires that generic firms spend resources on testing the drug before

⁵ On the other hand, a two-stage, perfect- equilibrium game which is not sequential may show that even if a firm is a monopolist in one market it cannot use a strategy variable to increase its profits if operating with an oligopolist in a second market.

⁶ For a detailed description of the Canadian pharmaceutical industry see the recent Report of the Commission of Inquiry on the Pharmaceutical Industry (Eastman Commission, (1985)).

sales can take place. The cost of meeting these health and safety standards is substantially lower if the drug is already being sold in Canada (usually by the multinational patentee). In other words, licensees are not required to duplicate the tests required by the patentee to demonstrate that the drug is therapeutically bio-equivalent.⁷

The time period required to meet health and safety standards for importation and sale of the drug in Canada by a generic firm may take a minimum of 18 months.⁸ This allows the patentee a minimum period in which to use strategic investments.

Under a regime of exclusive patent protection, however, the patentee is allowed a greater opportunity to pre-commit to a strategy in the first period for the purpose of either accommodating entry of the licensee in the second period or to deter the licensee from entering the market in the second period.

As this study shows, whether it is profitable or even

⁷ See chapter four.

⁸ The average time to process a new drug submission (receive a notice of compliance) by a patentee or licensee is approximately thirty months. There are exceptions including life saving drugs which under certain circumstances can be accessed more quickly.

possible for the patentee to deter entry depends on three types of factors. The first concerns the type of strategic investment available to the patentee during the incumbency (exclusive) period. Sunk capacity has been shown by Dixit (1979, 1980) and Spence (1977) to increase the incumbents advantage by lowering the incumbents second period marginal cost relative to the entrants. In the pharmaceutical industry, we examine if advertising can be used as a sunk investment in the first period to influence the entrant's decision to enter, and if entry occurs, to compete aggressively or not in prices in the second period. To accomplish either of these two objectives through advertising we examine two different types of advertising--informative advertising and persuasive advertising. The former is used mainly to develop the scale of the market for both the first and second period. The latter advertising is employed mainly to secure a portion of the market for the patentee in the second period. Strategic use of persuasive advertising and informative advertising is also shown to eliminate the licensee's market altogether. Another type of investment strategy available to the patentee is the introduction of a generic brand, along with the brandname product. This strategy is shown below to increase profits under both the entry accommodation and entry deterrence cases.

The second group of factors which are shown below to influence the patentee's decision to pursue an entry accommodating or entry deterring strategy, are referred to as market factors. These factors include; size of therapeutic class, therapeutic novelty (as given by the slopes of the demand curves), efficiency of advertising, discount rate, and life span of the drug. For example, it was found that in the presence of smaller markets patentees are less likely to introduce generic brands and prices are relatively lower. It was also found that the greater the therapeutic novelty, other things being equal, the higher are the prices and the amount of persuasive advertising incurred to preserve segments of the second period market.

The third group of factors which are found below to play a major role in influencing patentee behaviour are referred to as policy factors. These include the four policy instruments described above (length of exclusive period, substitution laws, royalty rates, and entry requirements). As shown below, the introduction of one or more of these policy instruments can influence whether the patentee chooses an entry accommodating strategy over an entry deterring strategy. For example, an increase in the period of exclusivity to 12 years or more dramatically changes the type of strategy adopted by the patentee. With less than 12 years of exclusivity the patentee threatens to

introduce a generic brand and uses extensive persuasive advertising in an attempt to deter entry.⁹ With greater than 12 years of exclusivity the patentee does not employ persuasive advertising, and does not threaten to introduce a generic.

Further, the introduction of policy combinations demonstrates how economic surplus can be enhanced and strategies can be altered. For example, decreasing the exclusive period and simultaneously increasing the royalty rate enhances consumer surplus while reducing profitability. The use of this policy combination causes the patentee to alter his strategy from an entry accommodation to entry deterrence.¹⁰

The study is organized as follows: Chapter Two develops the linear model which characterizes the relationship between the patentee and licensee; Chapter Three calibrates the linear model and performs simulations. This is necessary to examine the comparative static properties of the model, and to compare how discounted

⁹ The affect on advertising behaviour from increasing patent protection was tested with data on new drug introductions. It was found that the patentee's composition of advertising changed toward the use of relatively more informative advertising. See chapter Six.

¹⁰ See chapter five.

profits perform across the different strategies;
Chapter Four introduces the policy instruments and their impact on patentee behaviour; Chapter Five constructs welfare measures to determine how economic surplus can be enhanced by introducing different combinations of policy instruments; Chapter Six tests several hypothesis derived from the linear model. The data was obtained from Inter-Continental Medical Statistics Canada and covers all new prescription drugs introduced into Canada between 1982 and 1989; Finally, Chapter Seven provides a summary of the major findings and conclusions respecting their policy implications.

CHAPTER TWO

THE LINEAR MODEL

2.0 INTRODUCTION

This chapter investigates how a monopolist patentee's pricing and advertising behavior is affected by the threat of entry from a licensee who applies for a compulsory license to enter the market. To examine the patentee's behavior a two period, subgame, perfect equilibrium model is adopted.¹ The model assumes that the patentee and licensee entertain Bertrand/Nash conjectures with respect to second period prices, and that products are differentiated.²

The model is believed to be sufficiently general to capture most patentee-licensee relationships. The focus of this research is on the relationship between patentees and licensees in the Canadian pharmaceutical industry.

¹ Models of this type have been used by Spence (1977), Dixit (1979, 1980), Bulow, Geanakoplos, and Klemplerer (1984, 1985), and Fudenberg and Tirole (1984). These authors examine how strategic investments have been used to effect the post-entry equilibrium prices and quantities, as well as, the use of strategic investment to deter entry.

² The differentiated product assumption is partly motivated by the characteristics specific to the industry being investigated.

The economic environment of the monopolist patentee may be influenced by the introduction of four types of public policy³. The different public policy instruments include one or more of the following: (1) the length of the exclusive period; (2) the stringency of substitution laws; (3) the level of royalty rates; and, (4) the severity of entry requirements (set by the Health Protection Branch of Health and Welfare Canada). The above policy instruments fall under the purview of the federal government with the exception of substitution laws which are the responsibility of each provincial government. These policy instruments have been at one time or another under the scrutiny of industry analysts and are examined closely in chapter four to determine their effect on the behavior of patentees and licensees.⁴ A subsequent chapter focuses on the welfare implications and searches for the combination of policy instruments which maximizes total economic surplus.⁵

³ This is not to preclude the use of other types of public policy which may exist.

⁴ See for example Restrictive Trade Practices Commission (1963), Hall Commission (1965), Harley Committee (1967), and Report of the Commission of Inquiry on the Pharmaceutical Industry (1985).

⁵ Economic surplus is defined in this research as producer plus consumer surplus.

In this chapter the patentee's pricing and advertising behavior is examined under two fixed policy environments. First, the duration of the exclusive period is given and set at half the life span of the product. Second, the exclusive period is extended to cover the entire life span of the product. The above periods of exclusivity are assumed to be set by government authorities and allow us to investigate different patentee-licensee relationships.

More specifically, by varying the duration of the exclusive period three entry environments are investigated and compared with respect to pricing and advertising behavior of the patentee and licensee. First, two cases are examined in which the patentee is assumed to accommodate entry of the licensee in the second--compulsory licensing--period (only one entrant is assumed to enter). Given that entry cannot be prevented the patentee's profits can be increased by the judicious use of advertising and/or the introduction of a generic version of its brandname product. Case 1 examines the optimal advertising strategy and Case 2 examines the decision whether to introduce a generic. Second, given an exclusive period, the patentee may employ strategic advertising and a generic competitor to deter the licensee from entering the market in the compulsory licensing period (the cases falling in this category are referred to as cases 3, 4, and 5). When the

patentee has an extension of the patent period to span the life of the product, the patentee maintains exclusive monopoly power over the marketing of the product. The patentee's optimal strategy in this situation is analyzed in case 6.

The above cases are developed because they mimic the various policy regimes that have been imposed on patentees. For example, case 1 may be taken to characterize the policy regime facing patentees since compulsory licensing was instituted in 1969 and the dimension of patentee response. In this period the patentee's brandname product was forced to compete directly with the licensee's generic, and where this competition arose primarily in the form of advertising. The result was that brandname prices were generally 20 to 30 percent higher than the competing generic brand (see chapter four). Case 2 characterizes the patentee's more recent strategy of introducing a generic drug to compete with licensees generics.⁶ This case demonstrates how the patentee successfully segments the market and generates a two tier pricing structure that has increased profitability under most market conditions. Cases 3 to 5 are alternative entry deterrent strategies which can be shown to be

⁶ Two brandname companies have introduced generics since 1985. These include Upjohn and Syntex using generics under the names of Kenral and Syncare, respectively.

profitable under specific market conditions or policy environments.

The sections in this chapter are organized as follows: section one develops in some detail the consumer's utility maximization problem. Section two develops the producer's maximization problem which includes the important roles for advertising and the cases which are assumed to characterize both entry accommodation, entry deterrence, and full monopoly.

2.10 THE LINEAR MODEL

The entire economy is assumed to consist of an advertised (potentially duopolistic) patented sector, and an unadvertised competitive numeraire sector⁷. In the potentially duopolistic sector, the focus of our attention, the patentee incumbent chooses a pricing and advertising strategy to maximize profits over two periods.⁸ The first period represents a period of exclusivity where the potential entrant is prevented from entering by a patent. The second period introduces compulsory licensing thus permitting a potential competitor to compete through a generic licensed version of the patented drug. This problem becomes interesting because of the potential for strategic behaviour. In particular, during the first period the patentee is able to undertake a particular type of advertising strategy, and consequently, realize an advantage over the licensee entering in the second period.⁹ This

⁷ In the competitive sector the goods are known to all consumers.

⁸ A third period not addressed in this paper, is the post-patent period where licenses are not required. The length of the patent period in Canada is 17 years and this exceeds the economic life of most patented drugs.

⁹ Bond and Lean (1977) find that in the U.S. pharmaceutical firms entering a market first develops and successfully maintains market share through advertising.

advantage comes from capturing a portion of the market through first period persuasive advertising. Furthermore, because the patentee is able to pre-commit in the first period, the second period equilibrium prices will be strategically affected.¹⁰

The second type of advertising used by the patentee in the first period is informative advertising¹¹. Informative advertising is incurred to develop the scale of the market in both the first and second period. The conditions under which both types of advertising can be used by the incumbent to deter entry are an important part of our analysis¹².

In addition to the advertising strategies, the patentee

¹⁰ Fudenberg and Tirole (1984) have referred to the effect of strategic advertising on second period prices as the "Fat Cat" effect. Thus, the patentee uses advertising to cushion the impact of entry so that the licensee does not compete aggressively in the second period with respect to prices.

¹¹ Leffler (1982) distinguishes between informative and persuasive advertising where the former is assumed to shift out the market demand curve and the latter shifts out the patentee's demand curve at the expense of the licensee. Recently, Hurwitz and Caves (1988) discuss the use of informative and persuasive advertising as a means for the patentee to gain market share in the post patent period. In this paper we model the two types of advertising formally and show under what conditions either or both may be used.

¹² Salop (1979) and Cubbin (1980) discuss how the use of strategic advertising could be used to an incumbents advantage, for entry deterring purposes, providing the incumbent enjoyed a pre-entry asymmetric advantage over the entrant (i.e., that there exists a period of exclusivity).

may introduce its own generic product. In this case, the patentee introduces both a generic and a brandname product for the purpose that may be either entry-detering or entry-accomodating.

2.11 Utility Maximization and Demand

Utility is assumed to be separable and linear in the numeraire good (i.e., no income effects across sectors)¹³. In the first (exclusive) period individual consumers are assumed to have identical tastes. In the second period there are two groups of consumers: Group one individuals are those that are not influenced by the persuasive advertising of the patentee and purchase both the patentee's good(s) and the licensee's good based on price and perceived quality differences. These individuals make up the contested portion of the second period market. On the other hand, group two individuals are influenced by persuasive advertising which is assumed to alter individual preferences in the second period.¹⁴ These individuals purchase the patentee's brandname product only and do not consider the

¹³ This allows partial equilibrium analysis to be performed.

¹⁴ Dixit and Norman (1979) discuss how advertising by a monopolist changes consumers preferences. They conclude that advertising is largely socially excessive. See chapter five.

patentee's or licensee's generic at any price. These consumer comprise the uncontested segment of the second period market.¹⁵

Generally, individuals per period welfare can be represented by

$$W = Y + U(q_B, q_G, q_L). \quad (2.1)$$

Where Y denotes the utility function from the goods in the numeraire sector. q_B , q_G , and q_L denote the goods from the duopolistic sector, where q_B represents the patentee's brandname product, q_G represents the patentee's generic version of the brandname product, and q_L denotes the licensee's generic. U is an ordinary concave function ($U' > 0$ and $U'' < 0$) and where $q_B = q_G = q_L = 0$ when informative advertising is zero. To operationalize these ideas, a quadratic version of this function was chosen.¹⁶

¹⁵ A feature of the Canadian pharmaceutical industry is that the purchasers of prescription drugs are physicians while the actual consumers of drugs are patients. This type of principal-agent relationship combined with the existence of extensive insurance coverage for patients is argued to reduce the incentive of physicians to search for the lowest cost drug (Mathewson and Winter (1984)). However, the principal-agent relationship implicit in this research assumes that physicians behave in the "best" interest of their patients by searching for the highest quality drug at the lowest cost.

¹⁶ See for example, Vives and Singh (1984) and Dixit

Depending on the strategy chosen by the patentee, group one and group two consumer demand curves can be derived from the following quadratic and strictly concave utility functions¹⁷;

Group One Utility Function: Contested Market(c)

$$U(q_B^c, q_L, q_g) = \alpha_B q_B^c + \alpha_L q_L + \alpha_g q_g - (\beta_B q_B^{c2} + \beta_L q_L^2 + \beta_g q_g^2 + \gamma_{BL} q_B^c q_L + \gamma_{Bg} q_B^c q_g + \gamma_{gL} q_g q_L)/2. \quad (2.2).$$

Group Two Utility Function: Uncontested Market (u)

$$U(q_B^u) = \alpha_u q_B^u - 1/2 \beta_u q_B^{u2} \quad (2.3).$$

Below we derive the individual and market demand curves from the above utility functions for both the entry accommodating cases, 1 and 2, and the entry deterring cases, 3 to 5. Case 6 (full monopoly) demand curve is also derived. A summary of these cases are shown in table 2.1.

(1980).

¹⁷ Concavity of the utility function requires that $\beta_B > 0$, $\beta_g > 0$, $\beta_L > 0$; $\gamma_{BL} < \beta_B \beta_L$, $\gamma_{Bg} < \beta_B \beta_g$, $\gamma_{gL} < \beta_g \beta_L$; $\gamma_{BL} > 0$, $\gamma_{Bg} > 0$, $\gamma_{gL} > 0$ (< 0) indicates the products are substitutes (complements). $\gamma_{BL}^2 / \beta_B \beta_L$, $\gamma_{Bg}^2 / \beta_B \beta_g$, $\gamma_{gL}^2 / \beta_g \beta_L$ measures the degree of substitutability where a value of one represents a homogenous market and a value of zero represents independent goods.

Case 1: Entry without Generic Competition

Under this strategy the patentee accommodates entry without introducing a generic version of the brandname product ($q_g = 0$). Therefore, the group one utility function is given by (2.2) where q_g is set equal to zero. The individual maximization problem can be stated as

$$\text{Max } Z = U(q_B^c, q_L) - P_{2P} q_B - P_{2L} q_L$$

Their inverse demand curves are given by;¹⁸

$$P_{2P} = U_{q_B}(q_B^c, q_L) = \alpha_B - \beta_B q_B^c + \gamma_{BL} q_L, \text{ and}$$

$$P_{2L} = U_{q_L}(q_L, q_B^c) = \alpha_L - \beta_L q_L + \gamma_{LB} q_B^c.$$

The inverse demand functions can be transformed to yield the following direct demands¹⁹:

$$q_B^c = a_B - b_B P_{2P} + S P_{2L}, \text{ and} \quad (2.4)$$

$$q_L = a_L - b_L P_{2L} + S P_{2P}. \quad (2.5)$$

¹⁸ These and subsequent demand curves are restricted to quantities where prices are positive.

¹⁹ Where $a_B = (\alpha_B \beta_L + \alpha_L \gamma_{BL})/D$, $a_L = (\beta_B \alpha_L + \gamma_{BL} \alpha_B)/D$, $b_{2B} = -\beta_B/D$, $b_{2L} = -\beta_L/D$, and $S = \gamma_{BL}/D$ where $D = \beta_B \beta_L - \gamma_{BL}^2$. For markets to be locally stable $\beta_B \beta_L$ must be greater than γ_{BL}^2 .

The utility function of group two individuals is represented by (2.3). These individuals maximize $Z = U(q_B^u) - P_{2P} q_B^u$, giving rise to the inverse demand curve

$$P_{2P} = U_{q_B} = \alpha_u - \beta_u q_B^u.$$

and the corresponding direct demand curve

$$q_B^u = a_u - b_u P_{2P}.^{20} \quad (2.6)$$

The demands given by (2.4), (2.5), and (2.6) are summed horizontally to derive the following market demand curves.

$$Q_{2P} = \sum q_B^c + \sum q_B^u \quad (2.7)$$

$$Q_{2L} = \sum q_L. \quad (2.8)$$

Case 2: Entry with the Introduction of a Patentee's Generic

This case is similar to case 1 above except that the patentee introduces a generic version of the brandname product to compete with licensee's generic. Group two individuals remain unaffected by the patentee's decision to introduce a generic and continue to purchase the brandname

²⁰ Where $a_u = \beta_u / \alpha_u$, $b_u = 1 / \beta_u$.

product only. Their utility functions and corresponding demand curves are given by (2.18) and (2.19) below. On the other hand, group one individuals are now faced with three goods to choose from and their utility functions are given by (2.2) above. These individuals maximize

$$Z = U(q_B^c, q_g, q_L) - P_{2P} q_B^c - P_{2P}^g q_g - P_{2L} q_L$$

giving rise to the following inverse demand curves

$$P_{2P} = U_{q_B}(q_B^c, q_L, q_g) = \alpha_B - \beta_B q_B^c - \gamma_{BL} q_L - \gamma_{Bg} q_g$$

$$P_{2P}^g = U_{q_g}(q_B, q_L, q_g^c) = \alpha_g - \beta_g q_g^c - \gamma_{gL} q_L - \gamma_{gB} q_B^c$$

$$P_{2L} = U_{q_L}(q_L, q_B^c, q_g) = \alpha_L - \beta_L q_L - \gamma_{LB} q_B^c - \gamma_{Lg} q_g$$

The above inverse demand curves can be transformed to yield the following direct demands,

$$q_B^c = a_B - b_B P_{2P} + S_{BL} P_{2L} + S_{Bg} P_{2P}^g \quad (2.9)$$

$$q_g = a_g - b_g P_{2P}^g + S_{gL} P_{2L} + S_{gB} P_{2P} \quad (2.10)$$

$$q_L = a_L - b_L P_{2L} + S_{BL} P_{2P} + S_{Lg} P_{2P}^g \quad (2.11).$$

The demands given by (2.9), (2.10), and (2.11) are summed horizontally to derive the following market demand curves

$$Q_{2P} = \sum q_B^u + \sum q_B^c; \quad Q_{2P}^g = \sum q_g; \quad Q_{2L} = \sum q_L.$$

For purposes of this study group one consumers treat the patentee's brandname drug and the generic version as identical products.²¹ Therefore, these consumers place a zero marginal valuation on the variety offered by the patentee. This is captured in the utility function, (2.2), by setting $\gamma_{sg} = 0$; $\alpha_s = \alpha_g$; $\beta_s = \beta_g$; and $q_{2P} = q_g + q_s$. Rewriting (2.2) we obtain

$$U(q_{2P}, q_L) = \alpha_{sg}(q_{2P}) + \alpha_L q_L - (\beta_{sg} q_{2P}^2 + \beta_L q_L^2 + \gamma_L q_{2P} q_L)/2 \quad (22)$$

The individual maximizes $Z = U(q_{2P}, q_L) - P_g q_g - P_L q_L$ to derive the following inverse demand curves²²

$$P_{2P}^g = \alpha_{sg} - \beta_{sg} q_g - \gamma_L q_L$$

$$P_{2L} = \alpha_L - \beta_L q_L - \gamma_L q_g$$

The direct demand curves are

²¹ In other words, group one consumers are assumed to possess information that the patentee's generic is prepared from the same "batch" as the brandname drug.

²² The contested consumer demand curve for the patentee's drugs contain the generic drug only because the patentee assumes that group one individuals will not consume the brandname product if priced higher than the generic drug. P_{2P}^g is determined under a Bertrand equilibrium, the patentee, however, sets the brandname price P_{2P}^{ms} in the uncontested market. See case 2 in section 2.21 below.

$$q_g = a_{2g} - b_{2g} p_{2P}^g + SP_{2L} \quad (2.12)$$

$$q_L = a_{2L} - b_{2L} p_{2L} + SP_{2P}^g \quad (2.13).$$

The demand curves given by (2.6), (2.12) and (2.13) yield the following market demand curves for this case,

$$Q_{2P} = \sum q_g^u; \quad Q_{2g} = \sum q_g; \quad Q_{2L} = \sum q_L.$$

Case 3: Entry Deterrence by Limiting Informative Advertising

Under this strategy $q_g = 0$, and the patentee deters entry by restricting the size of the market through the employment of informative advertising only. Since entry is deterred ($q_L = 0$) group one and group two utility functions collapse and can be represented by

$$U(q_g) \Big|_{q_L=0} = \alpha_m q_g - 1/2 \beta_m q_g^2 \quad (2.14).$$

The corresponding demand curve derived from (2.14) is

$$q_g = a_{2m} - b_m p_{2P}^m \quad (2.15).$$

In this case the market demand curve is $Q_{2P} = \sum q_g$.

Case 4: Entry Deterrence and Strategic Advertising

Under this strategy the patentee does not introduce q_p but increases the size of the market by increasing informative advertising while simultaneously employing persuasive advertising. This serves to reduce the licensee market and make entry unattractive ($q_L = 0$). The utility functions and corresponding demand curves for group one and two consumers are identical to case 3 except that the β parameter is adjusted to reflect the larger market.

Case 5: Entry Deterrence by Pre-empting the Generic Market

Under this strategy the patentee introduces a generic version of the brandname product and thereby pre-empts the licensee from entering the second period market. The introduction of the patentee's generic is necessary to credibly signal to potential licensee's that entry will result in competition in the generic market only. This affects consumers as follows: group one consumers being aware that the patentee is offering identical products purchase the lower priced generic drug only. Group two consumers, on the other hand, remain committed to the brandname drug. This allows the patentee to set prices

separately in the two markets.²³ The utility function and corresponding demand curve for group one individuals are represented by

$$U(q_g) = \alpha_g q_g - \beta_g q_g^2 \quad (2.16)$$

$$q_g = a_g - b_g P_{2P}^{m2} \quad (2.17)$$

Similarly the utility function and corresponding demand curve for group two individuals are represented by

$$U(q_u) = \alpha_u q_u - \beta_u q_u^2 \quad (2.18)$$

$$q_u = a_u - b_u P_{2P}^{m1} \quad (2.19)$$

The market demand curves are derived by setting $Q_{2P} = \sum q_g$ and $Q_{2g} = \sum q_g$.

Case 6: Extended Patent Protection ($t_1 = N$)

Under an extended patent period the patentee is guaranteed full monopoly protection. Therefore, both persuasive advertising and generic introductions (q_g) may be considered unnecessary.²⁴ The utility function representing

²³ See case 5 in section 2.2 below.

²⁴ In the event that the patentee under full monopoly

group one consumers are affected by setting $q_L = q_g = 0$ and writing (2.2) and (2.3) to yield a total utility function which can be represented by

$$U(q_B) = \alpha_m q_B - \beta_m q_B^2 \quad (2.20)$$

The corresponding demand curve is²⁵

$$q_{iB} = a_m - b_m P_{iP} \quad i = 1, 2. \quad (2.21)$$

Equation (2.21) is summed horizontally to yield the market demand curve Q_{2P} for this case.

protection considers introducing a generic drug then profits in this case would simply be compared to profits earned in case 5 above.

²⁵ See Case 6 in section 2.23 below.

Table 2.1
SUMMARY OF CASES

	Case 1 C. 1	Case 2 C. 2	Case 3 C. 3	Case 4 C. 4	Case 5 C. 5	Case 6 C. 6
Patent Period	$t_1 = .5N$	$t_1 = .5N$	$t_1 = .5N$	$t_1 = .5N$	$t_1 = .5N$	$t_1 = N$
Patentee own Generic	NO	YES	NO	NO	YES	NO
Group One: Demand Param	a_u, b_u P_{2P}	a_u, b_u P_{2P}^{m1}	a_{2m}, b_{2m} P_{2P}^m	a_{2P} b_{2P}, P_{2P}^m	a_u, b_u P_{2P}^{m1}	a_{2m}, b_{2m} P_{2P}^m
Group Two: Demand Param	a_{2B} b_{2B}, P_{2P}	a_{2g} b_{2g}, P_{2P}^g	same as above	same as above	a_{2g}, b_{2g} P_{2P}^{m2}	same above
Use of Advert						
Informative	YES	YES	YES	YES	YES	YES
Persuasive	YES	YES	NO	YES	YES	NO

2.20 THE PATENTEE'S MAXIMIZATION PROBLEM

This section examines the advertising and pricing behaviour of the patentee under a monopoly regime compared to a regime of compulsory licensing (CL). The monopoly regime is set by public policy and is shown in chapter five to serve as a benchmark to compare welfare against a CL regime. Under the CL regime five cases are investigated. Two of the five cases are under entry accommodation, the remaining three cases are under entry deterrence. In all the CL cases the exclusive period is set at half the life-span of the drug and only one licensee is assumed to enter the market.

Before proceeding to analyze strategic advertising and pricing behavior under the different market structures, the functions describing the use and cost of informative and persuasive advertising are developed.

ROLE OF ADVERTISING

As discussed briefly in section 2.1, informative and persuasive advertising are incurred by the patentee in the first period to maximize profits over two periods. All advertising is incurred in the first period only²⁶. The licensee, on the other hand, is assumed not to engage in any type of advertising. The two types of advertising are shown below to have both entry accommodating and entry deterring roles. The decision on how to employ the different types of advertising may depend on a number of factors including; market conditions, cost and efficiency of advertising and the policy instruments in effect.

(A) Informative Advertising

Informative advertising, A_i is employed to inform members of the population regarding the safety and efficacy of the drug. This type of advertising does not affect consumers taste but simply informs consumers of the drugs

²⁶ The assumption of a first period advertising strategy only is to emphasize the investment aspects of the decision to engage in advertising (i.e., to treat advertising as an investment like capacity). The research does not model advertising behaviour between the patentee and licensee which may emerge in the compulsory licensing period.

existence along with its generic therapeutic characteristics. The informative advertising equation may take the following form:

$$K_I = 1 - e^{-\rho A_I} \quad (2.22)$$

The relationship between K_I and A_I is demonstrated in figure 2.1 below. K_I represents the proportion of the population which is informed of the drug. ρ denotes the efficiency of advertising with respect to informing members of the population. Therefore, the greater ρ the greater the proportion of the population informed for a given amount of A_I , thus $K_I(\rho_0) > K_I(\rho_1)$ when $\rho_0 > \rho_1$. $0 < K_I < 1$ and $K_I' > 0$ $K_I'' < 0$ (i.e., the function increases monotonically at a decreasing rate with the slope given by $\rho e^{-\rho A_I}$. The total cost of reaching K_I portion of the population is given by

$$C_I(K_I) = w_I A_I \quad (2.23)$$

w_I represents the unit cost of informative advertising, A_I represents the level of informative advertising.

Rearranging (2.22) we can write

$$A_I = -\frac{1}{\rho} \ln(1 - K_I) , \text{ inserting in (2.23) above}$$

Figure 2.1 Informing Consumers, K_1 , Using A_1

$$K_1 = 1 - e^{-\rho A_1}$$

K_1 represents the proportion of the population which is informed. $K_1 > 0$, and $K_1 < 1$. ρ denotes the efficiency of informative advertising.

Figure 2.2 Persuading Consumers, J_1 , Using A_0

$$J_1 = 1 - e^{-\mu A_0 / K_1}$$

J_1 represents the proportion of the informed population which has been captured i.e., uncontested market. $J_1 > 0$, and $J_1 < 1$. Under Monopoly J_1 is set exogenously equal to one, thus $A_0 = 0$. μ represents the efficiency of persuasive advertising.

$$C_I(K_1) = - \frac{w_I}{\rho} \ln(1 - K_1). \quad (2.23')^{27}$$

The marginal cost of informing K_1 members of the population becomes;²⁸

$$C_I(K_1) = \left\{ 1 - \frac{1}{K_1} \right\} \frac{w_I}{\rho}. \quad (2.24)$$

(B) Persuasive Advertising

Persuasive advertising, A_0 incurred during the first period works to capture segments of the first period market, K_1 , allowing the patentee a second period advantage over the licensee (i.e., $K_1 J_1$). Persuasive advertising emphasizes brandname aspects of the drug and is assumed to alter individual's preferences.²⁹ This type of advertising (unlike informative) is responsible for the *strategic effect* because it affects prices and marginal profitability of both

²⁷ The cost function appears with a negative sign because the logarithm of $(1-K_1)$ is negative. This also arises for the cost function for persuasive advertising.

²⁸ This function is used in the subsequent first order conditions for finding profit maximizing levels of informative advertising. The first order conditions for optimal advertising are taken with respect to K_1 and J_1 , instead of A_1 and A_0 . This is done strictly for convenience.

²⁹ More on the affect of advertising on utility in chapter five.

patentee and licensee. The persuasive advertising function is

$$J_1 = 1 - e^{-\mu(A_0/K_1)} \quad (2.25).$$

The $J_1 - A_0$ relationship is demonstrated in figure 2.2 above. J_1 represents the proportion of the informed population that is captured (uncontested). μ corresponds to the efficiency of persuasive advertising to secure a proportion of the informed population. $0 < J_1 < 1$ and $J_1' > 0$ and $J_1'' < 0$ thus, the J_1 function increases monotonically at a decreasing rate and $\mu e^{-\mu A_0}$ represents the slope of the function. The greater μ the greater the portion of the population captured for a given amount of A_0 . K_1 in (2.25) assumes that the proportion of the informed market secured is a function of the size of the market. Therefore, as the size of the market increases, through greater informative advertising, then ceteris paribus, the proportion of the market which is secured falls.³⁰ The total cost of capturing proportion J_1 of the population can be written as

$$C_0(J_1) = w_0 A_0 \quad (2.26)$$

³⁰ This has important implications for the cost of securing a proportion of the market because it implies that as the size of the market increases the cost of securing a given proportion of the market increases.

where w_o is the unit cost of persuasive advertising, A_o the level of persuasive advertising (in units).

Rearranging (2.25) we can write

$$A_o = - \frac{K_1}{\mu} \ln(1-J_1) \quad (2.25')$$

Therefore, total cost can be written as

$$C_o(J_1) = - \frac{K_1 w_o}{\mu} \ln(1-J_1) \quad (2.27).$$

The marginal cost of securing J_1 becomes

$$C_o'(J_1) = \left[\frac{1}{1-J_1} \right] \cdot \frac{K_1 w_o}{\mu} \quad (2.28).$$

This function appears in the first order conditions for optimal persuasive advertising.

In chapter Six advertising data on 51 new prescription drugs introduced into Canada between 1982 and 1988 is used to test several hypotheses relating to the strategic role of informative and persuasive advertising. In order to test hypotheses concerning the respective strategic role of informative and persuasive advertising they must be defined empirically. The most common type of advertising used by patentee's include; detail advertising (sending representatives to visit physicians), medical journal

advertising and free samples. Collectively, these forms of advertising can comprise up to 90 percent of a patentee's promotion budget. Other less common forms of advertising include direct mail, symposium, audio visual, and telemarketing.

Leffler (1982) conducted a study on several aspects (relevant to this research) of advertising in the U.S. pharmaceutical industry. His contention is that detail advertising provides important information to physicians regarding safety and efficacy of drugs and, therefore, will be focused more on newer drugs. Medical journal advertising, on the other hand, is primarily used as a reminder (persuasive) to physicians of the brandname aspects and is largely associated with older established drugs. To support his contention Leffler compares the composition of advertising between detail men and medical journals for new and older drugs. The author's findings supported his claim showing that for the fifteen most detailed drugs and the fifteen drugs most advertised in medical journals, the average age was 4.8 years and 9.1 years, respectively.³¹

³¹ We provide evidence in chapter six to support Leffler's findings by using the advertising data for our Canadian sample.

Leffler's findings are important because he establishes a link between detail men and informative advertising and medical journal and persuasive advertising. Given these relationships, we can proceed to test empirically whether informative and persuasive advertising are used strategically to accommodate entry (i.e., pro-competitive) or deter entry (i.e., anti-competitive) in different entry environments (described in section 2.1).³² In other words, under a compulsory licensing regime patentees may be more inclined to employ medical journal advertising as a means of preserving market share (or deterring entry). With a longer exclusive monopoly period, however, the patentee may employ greater detail advertising to inform more physicians and develop a larger market. This does not to exclude the possibility, however, that under an exclusive monopoly regime that both medical journal and detail advertising are not used. It argues, simply that medical journal advertising is more effective in delivering persuasive messages than detail advertising.

³² See chapter six.

TWO PERIOD PROFIT EQUATION

The present discounted profit equation for the patentee and licensee, corresponding to the two periods, are represented below (subscripts P and L indicate the patentee and the licensee respectively);

$$\begin{aligned}
 \pi_P &= \pi_{1P} + \pi_{2P} - F_{1P} \\
 &= \int_0^{t_1} \pi_{1P} dt + \int_{t_1}^N \pi_{2P} dt - F_{1P} \\
 &= \int_0^{t_1} \left[(P_{1P} - V) Q_{1P} \right] e^{-rt} dt - C_1(K_1(A_1)) - C_0(J_1(A_0)) \\
 &\quad + \int_{t_1}^N \left[(P_{2P} - V) Q_{2P} + \tau Q_{2L} \right] e^{-rt} dt - F_{1P} \tag{2.29}
 \end{aligned}$$

$$\begin{aligned}
 \pi_L &= \pi_{2L} - F_{2L} \\
 &= \int_{t_1}^N \pi_{2L} dt - F_{2L} \\
 &= \int_{t_1}^N \left[P_{2L} - V - \tau \right] Q_{2L} e^{-rt} dt - F_{2L} \tag{2.30}
 \end{aligned}$$

Where:

π_j corresponds to the present discounted value of profits from the respective periods. $j = P, L$.

${}_0s^t_1$ represents the exclusive period for the patentee.

${}_1s^N_{t_1}$ represents the compulsory licensing period ($t_2 = N - t_1$).

N represents the life span of the drug assumed to be fixed in duration.

r = the opportunity cost of capital.

$P_{i,j}$ = price of the drug in the i th period $i = 1, 2$ and $j = P, L$.

V = marginal cost of production assumed identical for both patentee and licensee (ie. no asymmetry in cost and no learning across periods), $V' = 0$.

F_{1P} = set up cost (or fixed cost) for the patentee incurred at the beginning of period one.

F_{2L} = set up cost (or fixed cost) for the licensee incurred at the beginning of period two.

$\tau = \alpha P_{2L}$ denotes the amount of royalty per unit owing the patentee. α represents the royalty rate (percent of sales).

$Q_{1P} = (a_{1P} - b_{1P}P_{1P})K_1$ represents the linear market demand facing the patentee in the first period.

Q_{2P} (and Q_{2L} under cases 2 and 5) represents the linear

market demand curves facing the patentee in the second period (see the preceding section). Second period demand is comprised of a uncontested and a contested market.

$Q_{2L} = (a_{2L} - b_{2L}P_{2L} + SP_{2P})K_1(1 - J_1)$ represents the second period linear market demand facing the licensee (derived in the preceding section). The cross term may vary depending on the strategy.

S represents the cross term or the degree of substitutability between the two drugs.

K_1 = the fraction of the market informed of the drug through informative advertising, A_1 in the first period.

J_1 = the fraction of the informed market secured by the patentee for the second period--referred to as the uncontested market. It is a function of persuasive advertising, A .

$C_1(K_1(A_1)) + C_0(J_1(A_0))$ = the total cost of advertising incurred in the first period.

The policy instruments described above enter the model through the following terms: t_1 , corresponds to the length of the exclusive period and enters through the discount term; F_{2L} and F_{2P} , introduces the effect of adjusting entry requirements for generic products in the second period by raising the fixed cost terms; τ , represents the royalty payment; and S , represents the degree of enforcement of

substitution laws. Chapter four focuses on how each of the above instruments effects the strategic behavior of the patentee and licensee. The remaining sections of this chapter hold the policy instruments constant by either setting $t_1 = N$ to investigate the behavior of the patentee as an extended (full) monopolist, or setting $t_1 = 1/2*N$ to examine how the patentee behaves under the cases of accommodating and strategic entry deterrence. S and F_{zL} are held constant, and τ is set at zero.³³

³³ The royalty payment is re-introduced into the model in chapter four.

2.21 ACCOMMODATING ENTRY

Case 1: Entry without Generic Competition³⁴

Given that the exclusive period is set at $t_1 = 1/2N$, the patentee's strategy is assumed to be one of accommodating the entry of a (single) licensee. After solving the integrals in equations (2.29) and (2.30) the profit expressions for the patentee and licensee can be written as

$$\begin{aligned} \pi_p = & M_{1p} \left[(P_{1p} - V) (a_{1p} - b_{1p} P_{1p}) K_1 \right] - C_I(K_1) - C_O(J_1) \\ & + g_{2p} M_{2p} \left\{ (P_{2p} - V) (a_u - b_u P_{2p}) K_1 J_1 + \right. \\ & \left. (P_{2p} - V) (a_{2p} - b_{2p} P_{2p} + SP_{2L}) K_1 (1 - J_1) \right\} - F_{1p} \quad (2.31). \end{aligned}$$

$$\begin{aligned} \pi_L = & g_{2L} M_{2L} \left[(P_{2L} - V) (a_{2L} - b_{2L} P_{2L} + SP_{2p}) K_1 (1 - J_1) \right] - F_{2L} \\ & (2.32). \end{aligned}$$

Where:

$$M_{2L} = (1 - e^{-rt_2})/r$$

$$g_{2L} = e^{-rt_1}.$$

³⁴ This case can be generally assumed to characterize the behaviour of the patentee during the compulsory licensing regime (1969-1987).

Given the nature of the sub-game perfect equilibrium model, second period prices are solved first and are fed back into the first period first order conditions to work out profit maximizing levels of advertising, A_0 , and A_1 . Therefore, second period profits for the patentee and licensee can be written as

$$\pi_{2P} = g_{2P} M_{2P} \left[(P_{2P} - V) \left[(a_U - b_U P_{2P}) K_1 J_1 + (a_{2B} - b_{2B} P_{2P} + SP_{2L}) \right] K_1 (1 - J_1) \right] \quad (2.33)$$

$$\pi_{2L} = g_{2L} M_{2L} \left[(P_{2L} - V) (a_{2L} - b_{2L} P_{2L} + SP_{2P}) K_1 (1 - J_1) \right] - g_{2L} \quad (2.34)$$

First order conditions for profit maximizing levels of second period prices (assuming Bertrand/Nash conjectures) are shown below:

$$\frac{\partial \pi_{2P}}{\partial P_{2P}} = g_{2P} M_{2P} \left[(a_U - 2b_U P_{2P} + Vb_U) K_1 J_1 + (a_{2B} - 2b_{2B} P_{2P} + b_{2B} V + SP_{2L}) K_1 (1 - J_1) \right] = 0. \quad (2.35)$$

$$\frac{\partial \pi_{2L}}{\partial P_{2L}} = g_{2L} M_{2L} \left[a_{2L} - 2b_{2L} P_{2L} + b_{2L} V + SP_{2P} \right] K_1 (1 - J_1) = 0. \quad (2.36)$$

Equations (2.35) and (2.36) represent the implicit form of the reaction functions for patentee and licensee³⁵:

Rearranging these expressions the explicit reaction functions are derived below.

$$P_{2P} = \frac{\left[(a_u + vb_u)J_1 + (a_{2B} + b_{2B}V)(1 - J_1) + SP_{2L}(1 - J_1) \right]}{2(b_u - b_{2B})J_1 + 2b_{2B}} \quad (2.37)$$

$$P_{2L} = \frac{a_{2L} + b_{2L}V + SP_{2P}}{2b_{2L}} \quad (2.38)$$

To obtain the reduced form equation for P_{2P} and P_{2L} Cramer's Rule was used to solve for equations (2.37) and (2.38), yielding

³⁵ The slopes of the patentee's and licensee's reaction functions, (dP_L/dP_P) are positive and given by $[(2(b_u - b_{2B})J_1 + 2b_{2B})/S(1-J_1)]$ and $S/2b_{2L}$, respectively. The slope of the patentee's reaction function is affected by J_1 , thus as J_1 approaches 1 the slope approaches minus infinity. This represents the monopoly price. The licensee's slope is not affected by J_1 .

$$\bar{P}_{2P} = \frac{\phi_o^P + \phi_J^P J_1}{\left[4b_{2L}b_{2B} - S^2\right] + \left[4b_{2L}b_u - 4b_{2L}b_{2B} + S^2\right]J_1}, \quad (2.39)$$

$$\bar{P}_{2L} = \frac{\phi_o^L + \phi_J^L J_1}{\left[4b_{2L}b_{2B} - S^2\right] + \left[4b_{2L}b_u - 4b_{2L}b_{2B} + S^2\right]J_1}. \quad (2.40)$$

Where:

$$\phi_o^P = (a_{2B} + b_{2B}V)2b_{2L} + S(a_{2L} + b_{2L}V).$$

$$\phi_J^P = (-Vb_{2B} + a_u + Vb_u - a_{2B})2b_{2L} - S(a_{2L} + Vb_{2L}).$$

$$\phi_o^L = (a_{2L} + Vb_{2L})2b_{2B} + S(a_{2B} + Vb_{2B}).$$

$$\phi_J^L = (a_{2L} + Vb_{2L})(2b_{2L} - 2b_{2B}) - SV(b_{2B} - b_u) - S(a_{2B} - a_u).$$

Thus equations (2.39) and (2.40) represent the reduced form equations for second period prices. Equilibrium prices are shown to be a function of persuasive advertising in the first period, marginal cost, and exogenous parameters of demand (including the cross term, S). In deriving equilibrium prices, it is seen that informative advertising, A_1 (through K_1) does not enter the solution. This occurs because K_1 works to scale the individual demand curves of the patentee and licensee while holding the elasticity of demand constant. Consequently, K_1 dropped out of the

solution. In other words, the use of K_1 shows that the patentee and licensee can reach a given proportion of the population at a constant price. J_1 , (or persuasive advertising) on the other hand, shifts the demand curve for the patentee such that equilibrium prices are affected. The licensee's demand curve is found to be influenced through the *strategic effect* caused by the increase in A_0 .³⁶

The second period equilibrium prices are used in the first period to determine profit maximizing levels of persuasive advertising, A_0 , and informative advertising, A_1 . Therefore, from equation (2.31),

$$\begin{aligned} \frac{d\pi_P}{dJ_1} = & C_0'(K_1) + g_{2P} M_{2P} \left\{ -V[a_u - a_{2B}] + [v[b_u - b_{2B}]] \right. \\ & \left. + [a_u - a_{2B}] \right\} \bar{P}_{2P} - [b_u - b_{2B}] \bar{P}_{2P}^2 + V S \bar{P}_{2L} - \\ & S \bar{P}_{2P} \bar{P}_2 \} K_1 = 0. \end{aligned} \quad (2.41)$$

³⁶ The strategic effect is the impact on prices through the movement along the reaction function as the patentee increases persuasive advertising and captures segments of the market. In other words, an increase in the patentee's price through persuasive advertising shifts the marginal profitability of the licensee. Under the perfect equilibrium model the patentee is assumed to predict the outcome, in terms of the impact on price and profits of the licensee, of his advertising behavior. This is demonstrated in figure 2.3 below. See Bulow, Geanakoplos, and Klemperer (1984), and Fudenberg and Tirole (1984).

The first term in (2.41) represents the marginal cost of securing J_1 proportion of the informed population. It is given by (2.27) and is proportional to K_1 .

From the above first order condition, J_1 is solved for by substituting (2.39) and (2.40) in (2.41). Rearranging equation (2.41) the following cubic equation must be solved to obtain optimal J_1 :

$$AJ_1^3 + BJ_1^2 + CJ_1 + D = 0.^{37} \quad (2.42)$$

Once the optimal J_1 has been determined from the first order condition optimal K_1 is found by taking the first order condition in (2.31) with respect to K_1 and inserting J_1 from the solved cubic equation. This is done recursively because in deriving optimal J_1 , K_1 cancelled. The canceling of K_1 , in the first order condition for J_1 , occurred because the cost of securing a proportion of the market was also scaled by K_1 . In other words, the cost of securing a proportion of the market is greater the greater the absolute size of the market. First order conditions for optimal K_1 becomes:

³⁷ The derivation of the expression for J_1 , and the method used to solve for J_1 is seen in appendix one.

$$\begin{aligned} \frac{d\pi_P}{dK_1} = & M_{1P} \left[\left(\bar{P}_{1P} - V \right) \left(a_{1P} - b_{1P} \bar{P}_{1P} \right) \right] - C_1'(K_1) + g_{2P} M_{2P}^* \\ & \left[\left(\bar{P}_{2P} - V \right) \left(a_u - b_u \bar{P}_{2P} \right) J_1 + \left(\bar{P}_{2P} - V \right) \left(a_{2B} - b_{2B} \bar{P}_{2P} \right. \right. \\ & \left. \left. + S \bar{P}_{2L} \right) \right] \left(1 - J_1 \right) = 0. \end{aligned} \quad (2.43)$$

Where $C_1'(K_1)$ represents the marginal cost of informing K_1 population through advertising (see equation (2.28) above). Solving for K_1 we obtain:

$$K_1 = \frac{\Omega - w_1/\alpha}{\Omega}, \quad (2.44)$$

$$\begin{aligned} \text{where } \Omega = & M_{1P} \left[\left(\bar{P}_{1P} - V \right) \left(a_{1P} - b_{1P} \bar{P}_{1P} \right) \right] + g_{2P} M_{2P} \left[\left(\bar{P}_{2P} - V \right) \left(a_{2B} \right. \right. \\ & \left. \left. - b_{2B} \bar{P}_{2P} + S \bar{P}_{2L} \right) + g_{2P} M_{2P} \left[\left(\bar{P}_{2P} - V \right) \left(a_u - a_{2B} + b_{2B} \right. \right. \right. \\ & \left. \left. - b_u + S \bar{P}_{2L} \right) \right] J_1. \end{aligned}$$

From equation (2.44) optimal informative advertising is shown to increase with optimal persuasive advertising. This suggests that it pays to increase the scale of the market the greater the proportion of the market that can be secured.

The remaining first order condition for profit

maximization is taken with respect to first period prices, therefore,

$$\frac{\partial \pi_P}{\partial P_{1P}} = M_{1P} \left[\left(a_{1P} - 2b_{1P}P_{1P} + Vb_{1P} \right) K_1 \right] = 0. \quad (2.45)$$

Equation (2.45) is the usual Lerner Mark-up condition:³⁸

$$\frac{P_{1P} - V}{P_{1P}} = \frac{1}{\epsilon_{q,p}} \quad (2.46)$$

where $\epsilon_{q,p}$ = the first period elasticity of demand.

The entry accommodation case is further illustrated in figure 2.3 (a) below. The Reaction functions for the patentee and licensee are given by RF_P and RF_L . Both reaction functions are upward sloping³⁹. In figure 2.3 (a) a change in informative advertising A_1 is shown not to affect the equilibrium prices of the patentee and licensee. Equilibrium prices, $\bar{P}_{2L}$ and $\bar{P}_{2P}$ are determined by the intersection of the reaction functions.

³⁸ The mark-up condition is derived independently of J_1 , and K_1 since first period equilibrium prices are independent of advertising.

³⁹ See footnote 34.

Figure 2.3 Strategic Advertising and Entry Deterrence

Using Informative advertising where $K_1^* < K_1^0$ to deter entry.

Using Persuasive advertising to capture the market and make entry unprofitable. $J_1^* < J_1^0$.

Figure 2.3 (b) demonstrates the strategic effect of using persuasive advertising. Thus persuasive advertising shifts the reaction function of the patentee, RF_P , rightward along the reaction function of the licensee, RF_L . This shift has the affect of increasing second period equilibrium prices, as well as, the marginal profitability of the patentee. Second period equilibrium prices are given by the intersection of the reaction curves once the profit maximizing amount of perusasive advertising has been incurred (point C).⁴⁰

A comparison of prices and advertising under accommodation and monopoly is done in chapter three and four to determine under which case prices, informative and perusasive advertising are greater. The next case examines the situation where the patentee introduces a generic drug to compete with the licensee's generic drug.

⁴⁰ Fixed cost of the licensee is represented by the discontinous line in figure 2.3 and shows the levels of strategic advertising which must be incurred by the patentee to make entry of the licensee unattractive. This is shown to be relevant for cases 3 to 5 below.

Case 2: Entry with the Introduction of a Patentee's Generic

In this situation the patentee is assumed to segment the contested and uncontested markets by introducing a generic brand, in addition, to the brandname product. The brandname product is marketed to those consumers who have been captured ($K_1 J_1$) through persuasive advertising. These consumers are charged the monopoly price. The generic drug⁴¹, on the other hand, competes with the licensee's generic drug and prices are determined under a Bertrand equilibrium. Thus, the profit equation for the patentee can be written as,

$$\begin{aligned} \pi_P = & \int_0^{t_1} \left[(P_{1P} - V) (a_{1P} - b_{1P} P_{1P}) K_1 \right] e^{-rt} dt - C_I(K_1) - C_O(J_1) \\ & + \int_{t_1}^N \left[(P_{2P}^{m1} - V) (a_u - b_u P_{2P}^{m1}) K_1 J_1 + (P_{2P}^g - V) (a_{2g} - \right. \\ & \left. b_{2g} P_{2P}^g + SP_{2L}) K_1 (1 - J_1) \right] e^{-rt} dt - F_{1P} \end{aligned} \quad (2.47)$$

⁴¹ Many have called this type of product the "fighting" brand. However, this has the connotation that the drug is used purposely to eliminate competition by pricing below marginal cost. This need not be the purpose of the patentee's generic.

All the terms in (2.47) are identical to case 1 above except that P_{2P}^{m1} represents the brandname drug used in the uncontested market, and P_{2P}^g is the generic product used to compete against the licensee's drug in the contested market. Profit maximizing second period prices are given by;

$$\bar{P}_{2P}^{m1} = \frac{a_u + Vb_u}{2b_u}, \quad (2.48)$$

$$\bar{P}_{2P}^g = \frac{(a_{2g} + b_{2g}V)2b_{2L} + S(a_{2L} + Vb_{2L})}{(4b_{2L}b_{2g} - S^2)}, \quad (2.49)$$

$$\bar{P}_{2L} = \frac{(a_{2L} + b_{2L}V)2b_{2g} + S(a_{2g} + Vb_{2g})}{(4b_{2L}b_{2g} - S^2)}. \quad (2.50)$$

Equations (2.48) - (2.50) represent the reduced form solutions for second period prices. Second period prices are shown to be unaffected by advertising (persuasive or informative). Thus, by introducing his own generic the patentee prices at the monopoly level in one market, and as a Bertrand duopolist in the other market⁴². Profit maximizing levels of persuasive and informative advertising are found by inserting the above equilibrium prices into the

⁴² The reaction functions for the patentee and licensee in this case are shown not to shift as persuasive advertising increases. Thus, the strategic effect is eliminated once market segmentation occurs.

profit equation (2.47), and taking the first order conditions with respect to J_1 and K_1 . Thus,

$$J_1 = \frac{\psi - w_o M_{1P}/\beta}{\psi} \quad (2.51)$$

where $\psi = g_{2P} M_{2P} [(\bar{P}_{2P}^{m1} - V)(a_u - b_u \bar{P}_{2P}^{m1}) - (\bar{P}_{2P}^g - V)(a_{2g} - b_{2g} \bar{P}_{2P}^g + S\bar{P}_{2L})]$,

$$K_1 = \frac{v - w_I M_{1P}/\alpha}{v} \quad (2.52)$$

where $v = g_{1P} M_{1P} (P_{1P} - V)(a_{1P} - b_{1P} P_{1P}) + g_{2P} M_{2P} [(\bar{P}_{2P}^{m1} - V)(a_u - b_u \bar{P}_{2P}^{m1})J_1 + (\bar{P}_{2P}^g - V)(a_{2g} - b_{2g} \bar{P}_{2P}^g + S\bar{P}_{2L})](1 - J_1)$.

By comparing equations (2.42) and (2.44) from case 1 to (2.51) and (2.52) in case 2 we can determine under which strategy informative and persuasive advertising is greater. This comparison is the subject of chapter three, for now it can be reported that other things being equal, the strategy of segmenting the market provides greater K_1 and J_1 , as well as, greater profits for the patentee.

The next three cases investigate how the patentee attempts to use strategic advertising (A_o and A_y), in the first period, and introducing a generic substitute in the second period, to deter the licensee from entering the market in the second compulsory licensing period.

2.22 STRATEGIC ENTRY DETERRENCE

The first two cases (referred to as case 3 and case 4) examine how informative and/or persuasive advertising by the patentee may be used to make entry for the licensee unprofitable in the second period. For this to occur the entrants fixed cost, F_{2L} , must be at a level where it cannot overcome the scale barrier created by the patentees advertising behavior.⁴³ Otherwise, strategic entry deterrence through advertising is not feasible. In essence the patentee uses strategic advertising in an attempt to create a natural monopoly situation for himself. The last case (referred to as case 5) investigates how the introduction of a generic by the patentee may serve to deter entry. Under this case, the patentee's generic is assumed to be an imperfect substitute for the licensee's generic.

Case 3: Entry Deterrence by Limiting Informative Advertising

The use of informative advertising to deter entry is illustrated in figure (2.3) above. In this case (see figure 2.3 (a)) the patentee uses only K_1 (A_1) to develop the

⁴³ An alternative interpretation is that fixed cost must be high enough so that the licensee is deterred from taking advantage of the scale "benefits" created by the patentee's advertising.

potential market for the drug (A_0 is set equal to zero).⁴⁴ Under this strategy the licensee finds the market too small to overcome its fixed cost constraint. This is reflected in the diagram by a shift in the fixed cost line as represented by the discontinuous line. If the fixed cost line ends up to the right of the intersection of the reaction functions, the licensee will be unable to meet his fixed cost constraint at the prevailing (monopoly) prices given by C. In other words, the lower the informative advertising the greater the equilibrium prices required to make entry worthwhile. In figure 2.3 (a) the price required given that K_1^1 is incurred becomes P_{2L}^c (or P_{2P}^c).⁴⁵

Formally, the patentee works from the licensee's profit equation to determine the profit maximizing entry deterring K_1 . Thus, by setting $\pi_L = F_{2L}$ in equation (2.32) and inserting the reduced form equations for second period prices, the following equation for entry deterring K_1 is derived:

⁴⁴ Under this strategy the patentee is deliberately establishing a small market so that the licensee does not free ride on his first period advertising.

⁴⁵ This case is similar to what Bulow, Geanakoplos, and Kemplerer (1984) refer to as using under-investment in a strategic variable, and playing aggressively (in prices) in the second period.

$$K_1 = \frac{F_{2L}}{g_{2L} M_{2L} (-Va_{2L} + (a_{2L} + Vb_{2L} \phi_o^L)/X - b_{2L} \phi_o^L/X^2 + S\phi_o^L \phi_o^P/X^2 - VS\phi_o^P/X}$$

$$\text{where } X = (4b_{2L} b_{2P} - S^2) . \quad (2.53)$$

It is seen from equation (2.53) that the lower the fixed cost of the licensee (i.e., entry requirements and set-up cost) the lower the K_1 required to make entry unprofitable, thus $dK_1/dF_{2L} > 0$. Other policy instruments are also shown to affect the amount of entry deterring K_1 , incurred by the patentee, through the S and $M_{2L} (t_1)$ terms (see chapter four). Chapter three and four demonstrate under what market conditions and policy environments case 3 becomes the dominant strategy.

Case 4: Informative and Persuasive Advertising

Under this case the patentee uses K_1 and J_1 simultaneously to deter the licensee from entering the market.⁴⁶ This case is illustrated in figure 2.3 (a) and (b) above. Figure 2.3 (a) already demonstrated the effect of

⁴⁶ Again by employing persuasive advertising on those consumers already informed the patentee is attempting to internalize the benefits coming from this advertising.

informative advertising on entry deterrence. Figure 2.3 (b) examines the additional effect coming from persuasive advertising on entry deterrence. The increase in A_0 works to shift the patentee's RF_P to the right along the licensee's RF_L . Equilibrium prices are shown to increase, through the strategic effect, as given by the intersection of the reaction functions at C. However, as A_0 (J_1^0) increases the licensee's market share decreases and therefore the (critical) price required to cover fixed cost also increases, given by $P_{2P}^C(J_1^0)$. This is shown by the rightward shift in the discontinuous fixed cost line. If the shift in the fixed cost line is to the right of C then entry is effectively deterred. It is evident that the use of both informative (by decreasing) and persuasive (by increasing) advertising will have a more pronounced impact on shifting the discontinuous fixed cost line.

To demonstrate this case formally the constraint for entry deterring K_1 is obtained from the licensee's profit equation (2.32) by setting $\pi_L = F_{2L}$ and rearranging to yield,

$$K_1 = F_{2L} / ((P_{2L} - V)(a_{2L} - b_{2L}P_{2L} + SP_{2P})(1 - J_1))g_{2L}M_{2L} \quad (2.54)$$

Equation (2.54) is then inserted into the patentee's two period profit equation to determine optimal entry deterring

J_1 . Hence, from the two period profit equation;

$$\pi_P = M_{1P} \left[\left(P_{1P} - V \right) \left(a_{1P} - b_{1P} P_{1P} \right) K_1 \right] - C_I(K_1) - C_o(J_1) + \\ g_{2P} M_{2P} \left[\left(P_{2P}^m - V \right) \left(a_{2P} - b_{2P} P_{2P}^m \right) K_1 - F_{1P} - F_{2P} \right] \quad (2.55)$$

Optimal J_1 is obtained by substituting (2.54) in (2.55) and taking the first order condition with respect to J_1 . The solution for J_1 becomes a cubic equation because prices are also a function of J_1 (see equation (2.39) and (2.40)).⁴⁷ Once the cubic equation is solved the least cost J_1 is inserted in (2.54) to obtain the entry deterring amount of K_1 .

⁴⁷ The solution for J_1 includes a non-linear term in addition to the cubic equation making it difficult to set-up the simulation procedure needed to solve the cubic equation. A simulation procedure was used, however, to determine maximum profits over a range of J_1 (between 0 and .99) for each exogenous variable (including policy variables).

Case 5: Pre-empting The Generic Market

In this case the patentee's generic is an imperfect substitute for the licensee's generic (i.e., $b_g b_L / s^2 > 1$).⁴⁸ The patentee's two period profit equation is written to include the generic market, therefore,

$$\begin{aligned} \pi_P = & \int_0^{t_1} \left[(P_{1P} - V) (a_{1P} - b_{1P} P_{1P}) K_1 \right] e^{-rt} dt - C_I(K_1) - C_o(J_1) \\ & + \int_{t_1}^N \left[(P_{2P}^{m1} - V) (a_u - b_u P_{2P}^{m1}) K_1 J_1 + (P_{2P}^{m2} - V) (a_{2g} - b_{2g} P_{2P}^{m2}) \right. \\ & \left. K_1 (1 - J_1) - F_{2P} - F_{1P} \right] dt \end{aligned} \quad (2.56)$$

In this case the patentee employs a pre-emptive strategy to deter the licensee from entering the market. This is accomplished by offering a generic brand, in addition, to the brandname product. The generic and brandname drugs are

⁴⁸ A variant of this case is where the patentee's brandname drug is considered a perfect substitute for the licensee's generic brand (i.e., $b_{2B} b_{2L} / S^2 = 1$). Under perfect substitution and Bertrand conjectures the generic market collapses to one of perfect competition where prices equal marginal cost. Since price is forced to marginal cost for the licensee, then, given $F_{2L} > \text{zero}$, the licensee has no incentive to enter the market.

priced separately. Hence, each price (P_{2P}^{m1} , P_{2P}^{m1}) is set according to their respective inverse elasticities of demand. The patentee's decision to introduce a generic brand is necessary to signal to the licensee that entry will result in a Bertrand duopoly in the generic market, only, and therefore it will be unprofitable for the licensee to enter the market. In other words, the patentee's secured market (P_{2P}^{m1}) is unaffected by entry and only a portion of the generic market ($K_1(1 - J_1)$) is up for grabs. In the latter market, prices (P_{2P}^{m2}) will be forced to their Bertrand level if entry takes place.

The patentee must work from the licensee's profit equation to determine the profit maximizing entry deterring J_1 and K_1 . Therefore, inserting the entry deterring constraint for K_1 , as given in equation (2.54), into the patentee's two period profit equation (2.56) and solving the integral we can write⁴⁹

⁴⁹ The difference between the optimal J_1 in this case and case 4 is that under market segmentation second period prices are not a function of persuasive advertising, therefore a cubic expression is not derived.

$$\begin{aligned}
\pi_P = & M_{1P}(P_1 - V)(a_{1P} - b_{1P}P_{1P})K_1 + g_{2P}M_{2P} \left[(P_{2P}^{m1} - V)(a_u - b_u P_{2P}^{m1})K_1 J_1 \right. \\
& \left. + (P_{2P}^{m2} - V)(a_{2g} - b_{2g} P_{2P}^{m2})K_1(1 - J_1) \right] - \frac{w_0}{\beta} (1 - \ln(1 - J_1)) \\
& - \frac{w_1}{\alpha} \ln(1 - K_1) = 0.
\end{aligned} \tag{2.57}$$

Where $K_1 = F_{2L}/(P_{2L} - V)(a_{2L} - b_{2L}P_{2L} + SP_{2P}^g)(1 - J_1)g_{2L}M_{2L}$ represents the constraint for entry deterrence. The cross price term, SP_{2P}^g represents that price which the licensee expects to face in the event of entry.

The first and second terms in (2.57) take into account the optimal size of developing the market through informative advertising. The fourth term in (2.57) corresponds to the trade-off between increasing persuasive advertising at the margin and its impact on the cost of informative advertising. The third term in (2.57) corresponds to the direct cost of persuasive advertising necessary for deterring entry. The optimal level of persuasive advertising is found by taking the first order condition of (2.57) with respect to J_1 . The optimal expression for J_1 becomes a quadratic equation which is defined as⁵⁰

⁵⁰ Chapter three examines the comparative static properties of this case by performing simulations.

$$AJ_1^2 + BJ_1 - C = 0.$$

$$\text{Where } A = -A_L \left[2A_{2P}^1 + 2A_{2P}^2 + w_o/\beta \right]$$

$$B = \left[\left(A_{1P} + A_{2P}^1 + 2A_{2P}^2 \right) A_L + \left(A_L + F_{2L} \right) \left(2A_{2P}^1 + 2A_{2P}^2 \right) + \left(\frac{w_I}{\alpha} A_L - (F_{2L} - 2A_L) w_o/\beta \right) \right]$$

$$C = \left[\left(-A_{1P} - A_{2P}^1 - 2A_{2P}^2 - w_o/\beta \right) \left(A_L - F_{2L} \right) - \frac{w_I}{\alpha} A_L \right]$$

$$A_{1P} = M_{1P} (P_{1P} - V) Q_{1P}$$

$$A_{2P}^1 = g_{2P} M_{2P} (P_{2P}^{m1} - V) Q_u$$

$$A_{2P}^2 = g_{2P} M_{2P} (P_{2P}^{m2} - V) Q_{2P}$$

$$A_L = g_{2L} M_{2L} (P_{2L} - V) Q_{2L}$$

Once the minimum J_1 required for entry deterrence is determined (using the calibrated model) it is inserted into the K_1 constraint to find the optimal level of informative advertising.

2.23 Case 6: Extended Patent Protection

Under an extended patent protection period J_1 is set exogenously equal to unity ($A_0 = 0$)⁵¹ and the profit equation in (2.29) reduces to

$$\pi_P = \int_0^{t_1} \left[(P_{1P} - V) (a_{1m} - b_{1m} P_{1P}) K_1 \right] e^{-rt} dt - C_1(K_1) \\ - \int_{t_1}^N \left[(P_{2P} - V) (a_{2m} - b_{2m} P_{2P}^m) K_1 \right] e^{-rt} dt - F_{1P} \quad (2.58)$$

For purposes of comparison with cases 1 to 5 above it is assumed that advertising in the monopoly regime is incurred during the first period only⁵². Solving for the integrals in (2.58) the profit equation for the monopolist patentee can be written as,

⁵¹ The assumption being made is that persuasive advertising is considered unnecessary because the threat of entry is absent. It also assumes that the patentee is not using persuasive advertising for the purpose of building up the brandname of the company. Therefore, J_1 under this case is set exogenously.

⁵² Under the extended monopoly regime t_1 corresponds to the advertising period. Since CL is not a threat it is important to maintain the benchmark in order to compare advertising and pricing under the different regimes.

$$\pi_P = M_{1P} \left[(P_{1P} - V) (a_{1m} - b_{1m} P_{1P}) K_1 \right] - C_I(K_1) + \\ g_{2P} M_{2P} \left[(P_{2P}^m - V) (a_{2m} - b_{2m} P_{2P}^m) K_1 - F_{2P} \right] \quad (2.59).$$

Where:

$$M_{1P} = (1 - e^{-rt_1})/r$$

$$M_{2P} = (1 - e^{-rt_2})/r$$

$$g_{2P} = e^{-rt_1}.$$

The first order conditions for profit maximization are:

$$\frac{\partial \pi_P}{\partial P_{1P}} = M_{1P} (a_{1m} - 2b_{1m} P_{1P} + Vb_{1m}) K_1 = 0. \quad (2.60)$$

$$\frac{\partial \pi_P}{\partial P_{2P}} = g_{2P} M_{2P} (a_{2m} - 2b_{2m} P_{2P}^m + Vb_{2m}) K_1 = 0. \quad (2.61)$$

$$\frac{\partial \pi_P}{\partial K_1} = M_{1P} (P_{1P} - V) (a_{1m} - b_{1m} P_{1P}) + g_{2P} M_{2P} (P_{2P}^m - V) * \\ (a_{2m} - b_{2m} P_{2P}^m) - C_I'(K_1) = 0. \quad (2.62)$$

Equation (2.62) represents the first order condition for optimal informative advertising. $C_I'(K_1)$ is given by (2.24) above. Equations (2.60) and (2.61) are the usual Lerner Mark-up conditions:⁵³

⁵³ Given that informative advertising and the discount term

$$\frac{P_{1P} - V}{P_{1P}} = \frac{1}{\epsilon_{q1,P}}, \text{ and} \quad (2.63)$$

$$\frac{P_{2P}^m - V}{P_{2P}^m} = \frac{1}{\epsilon_{q2,P}}. \quad (2.64)$$

Where $\epsilon_{q1,P}$ = first period elasticity of demand, and
 $\epsilon_{q2,P}$ = second period elasticity of demand.

Rearranging and dividing equation (2.64) by P_{1P} the advertising sales ratio is obtained:

$$\frac{\epsilon_{q1,A}}{\epsilon_{q1,P}} + G_{2P} M_{2P} \left(\frac{\epsilon_{q2,A}}{\epsilon_{q2,P}} \right) \frac{P_{2P}^m q_{2P}}{P_{1P} q_{1P}} = \frac{C_1'(K_1)}{P_{1P} q_{1P}} \quad (2.65)$$

Where $\epsilon_{q1,A}$ is the advertising elasticity of demand in period one, and $\epsilon_{q2,A}$ is the cross elasticity of demand of period two demand with respect to period one informative advertising.

do not effect prices and $a_{1m} = a_{2m}$, $b_{1m} = b_{2m}$, first and second period prices and quantitties are identical for the monopolist.

Under the extended monopoly regime the patentee advertises according to the Dorfman Steiner result extended to two periods.⁵⁴ Thus, advertising as a proportion of period one sales is equal to the elasticity of demand with respect to prices and advertising. Below, we examine how the introduction of CL can affect the advertising behavior of the patentee.

⁵⁴ Dorfman and Steiner (1954) show that optimal advertising by a monopolist is attained by setting the advertising - sales ratio equal to the elasticity of price with respect to advertising.

2.24 COMPARISON OF DIFFERENT STRATEGIES

It was shown that under the accommodating entry case the patentee's use of informative and persuasive advertising had a strategic effect through raising prices and profitability of both the patentee and licensee. This effect was also referred to as the Fat-Cat effect. The introduction of a generic by the patentee (case 2) was found to be a dominant strategy over the strategy of a one price market (case 1).

The strategic entry deterrence cases demonstrated that advertising could be used by the patentee in a number of different ways. First, the sole use of informative advertising could be used to develop a sufficiently small market (under-invest in advertising) to effectively create a natural monopoly situation. Second, the patentee may employ informative and persuasive advertising simultaneously to create a natural monopoly situation. This involves more informative advertising than in the previous case. Third, introducing a generic brand which is an imperfect substitute pre-empts the licensee from entering the market in the second period. Again the composition of advertising between informative and persuasive may be different than in the previous two cases.

Under the extended monopoly case ($t_1 = N$) persuasive

advertising is not used⁵⁵. Informative advertising is used to determine the scale of the market over both periods. The advertising sales ratio was expressed as a function of first and second period demand elasticities which is the Dorfman-Steiner result extended to two periods.

Which of the the above strategies become the dominant one for the patentee depends on the following types of factors: (1) market conditions as given given by size and availability of alternative therapies (i.e., a's and b's, respectively); (2) the efficiency of the J_1 or K_1 function (as given by ρ or μ); (3) the cost of advertising; (4) the life span of the drug; (5) the opportunity cost of capital, r ; and, (6) the type of policy instruments which are currently in effect.

The next chapter performs simulations on the linear model to investigate which of the above strategies are dominant under different market conditions, advertising technologies (i.e., elasticities), cost of different types of advertising, and discount rates. The impact on behavior from adjusting policy instruments is the topic of chapter four.

⁵⁵ It is important to keep in mind that the absence of persuasive advertising does not mean that medical journal advertising is zero, it means that persuasive advertising messages which are strongly correlated with medical advertising is minimal.

APPENDIX ONE

This appendix derives the cubic equation to solve for optimal J_1 . From the first order condition for profit maximization we obtain:

$$\begin{aligned} \frac{d\pi_P}{dJ_1} = & \frac{K_1 W_0}{\beta(1-J_1)} + d_{2P} M_{2P} \left[\left[-V(a_u - a_{2B}) + V(b_u - b_{2B}) \right. \right. \\ & \left. \left. + (a_u - a_{2B}) \right] \bar{P}_{2P} - (b_u - b_{2B}) \bar{P}_{2P}^2 + V S \bar{P}_{2L} - S \bar{P}_{2L} \bar{P}_{2P} \right] K_1 \\ & = 0. \end{aligned} \quad (A.1)$$

We can solve for J_1 by substituting (2.27) and (2.28) from the text into (A.1) above. In order to perform the substitution we explicitly derive $\bar{P}_{2P}^2$, and $\bar{P}_{2P} \bar{P}_{2L}$ below:

$$\bar{P}_{2P}^2 = \frac{\bar{s}_O^P{}^2 + 2\bar{s}_O^P \bar{s}_J^P J_1 + \bar{s}_J^P{}^2 J_1^2}{\epsilon}$$

$$\bar{P}_{2L} \bar{P}_{2P} = \frac{\bar{s}_O^L \bar{s}_O^P + 2\bar{s}_O^P \bar{s}_J^P J_1 + \bar{s}_J^L \bar{s}_J^P J_1^2}{\epsilon}$$

Where:

$$\bar{s}_O^P = (a_{2B} + b_{2B} V) 2b_{2L} + S(a_{2L} + b_{2L} V)$$

$$\bar{s}_J^P = \left[(-Vb_{2B} + a_u + Vb_u - a_{2B}) 2b_{2L} - S(a_{2L} + b_{2L} V) \right]$$

$$\bar{s}_O^L = (a_{2L} - b_{2L} V) 2b_{2B} + S(a_{2B} + b_{2B} V)$$

$$\bar{s}_J^L = \left[(a_{2L} - b_{2L} V) (2b_u - 2b_{2B}) - S V (b_{2B} - b_u) - S(a_{2B} - a_u) \right]$$

$$\epsilon = \left(4b_{2L}b_{2B} - S^2\right)^2 + 2\left(4b_{2L}b_{2B} - S^2\right)\left(4b_{2L}b_u - 4b_{2L}b_{2B} + S^2\right) \cdot \\ J_1 + \left(4b_{2L}b_u - 4b_{2L}b_{2B} + S^2\right)^2 J_1^2$$

After substituting and rearranging we can define the following terms;

$$D1 = -V\left(a_u - a_{2B}\right)\left(4b_{2L}b_{2B} - S^2\right)^2 + V\left(b_u - b_{2B}\right) + \left(a_u - a_{2B}\right)\Phi_o^P \cdot \\ \left(4b_{2L}b_{2B} - S^2\right) + VS\Phi_o^L\left(4b_{2L}b_{2B} - S^2\right) - \left(b_u - b_{2B}\right)\Phi_o^{P^2} - S\Phi_o^L\Phi_o^P \cdot$$

$$C1 = 2\left(4b_{2L}b_{2B} - S^2\right)\left(4b_{2L}b_u - 4b_{2L}b_{2B} + S^2\right) - v\left(a_u - a_{2B}\right) + \\ \left[V\left(b_u - b_{2B}\right) + \left(a_u - a_{2B}\right)\right]\left[\left(4b_{2L}b_{2B} - S^2\right)\Phi_J^P - S2\Phi_o^P\Phi_J^L - \right. \\ \left. \left(b_u - b_{2B}\right)\left(2\Phi_o^P\Phi_J^P\right)\right] \cdot$$

$$B1 = -V\left(a_u - a_{2B}\right)\left(4b_{2L}b_u - 4b_{2L}b_{2B} + S^2\right)^2 + \left[V\left(b_u - b_{2B}\right) + \left(a_u - a_{2B}\right)\right]\left(4b_{2L}b_u - 4b_{2L}b_{2B} + S^2\right)\Phi_J^P + VS\left(4b_{2L}b_u - 4b_{2L}b_{2B} + S^2\right)\Phi_o^L - S\Phi_J^L\Phi_J^P - \left(b_u - b_{2B}\right)\Phi_o^{P^2} \cdot$$

Inserting the above into the first order condition and multiplying through by $(1 - J_1)$ we can write:

$$\begin{aligned} \frac{K_1 w_o}{\beta} & \left[4b_{2L} b_{2B} - S^2 + D1g_{2P} M_{2P} \right] + g_{2P} M_{2P} \left[2 \left(4b_{2L} b_{2B} - S^2 \right) \left(4b_{2L} b_u \right. \right. \\ & \left. \left. - 4b_{2L} b_{2B} + S^2 \right) + \left(C1 - D1 \right) \right] J_1 + g_{2P} M_{2P} \left[\left(4b_{2L} b_u - 4b_{2L} b_{2B} \right. \right. \\ & \left. \left. + S^2 \right)^2 + \left(B1 - C1 \right) \right] J_1^2 + g_{2P} M_{2P} B1 J_1^3 . \end{aligned}$$

To solve for J_1 the above is expressed in cubic form and solved, therefore:

$$AJ_1^3 + BJ_1^2 + CJ_1 + D = 0$$

Where:

$$\begin{aligned} A = & g_{2P} M_{2P} \left[-V \left(a_u - a_{2B} \right) \left(4b_{2L} b_u - 4b_{2L} b_{2B} + S^2 \right)^2 + \left[V \left(b_u - \right. \right. \right. \\ & \left. \left. b_{2B} \right) + \left(a_u - a_{2B} \right) \right] \left(4b_{2L} b_u - 4b_{2L} b_{2B} + S^2 \right) \bar{\Phi}_J^P + VS \left(4b_{2L} b_u \right. \\ & \left. - 4b_{2L} b_{2B} + S^2 \right) \bar{\Phi}_O^L - S \bar{\Phi}_J^L \bar{\Phi}_J^P - \left(b_u - b_{2B} \right) \bar{\Phi}_O^{P^2} \end{aligned}$$

$$B = g_{2P} M_{2P} \left[\left(4b_{2L} b_u - 4b_{2L} b_{2B} + S^2 \right)^2 + \left(B1 + C1 \right) \right]$$

$$C = g_{2P} M_{2P} \left[2 \left(4b_{2L} b_{2B} - S^2 \right) \left(4b_{2L} b_u - 4b_{2L} b_{2B} + S^2 \right) + \left(C1 - D1 \right) \right]$$

$$D = \frac{K_1 w_o M_{2P}}{\beta} \left(4b_{2L} b_{2B} - S^2 \right) + D1 g_{2P} M_{2P} .$$

CHAPTER THREE

A CLOSER LOOK AT THE STRATEGIES

3.0 INTRODUCTION

In this chapter the patentee's strategies are examined more closely through the use of simulation.¹ To perform the simulations the linear demand model developed in chapter two is given specific parameter values and simulated over a specified range of the following exogenous variables: elasticity of advertising ρ , and μ ; slope of the various demand equations, b 's; Market size (therapeutic class)², a 's; opportunity cost of capital, r ; and, life span of the drug, N .

ρ and μ are the efficiency parameters of the persuasive and informative advertising functions, respectively. Hence, the greater ρ , and μ , for a given level of advertising, the greater the proportion of the population that can be

¹ Simulation was used because of the difficulty in obtaining closed form solutions for the equilibrium variables. The computer software packaged employed to perform all the simulations is MATHCAD.

² Given the population, market size can differ on the basis of therapeutic class. Therefore, *ceteris paribus*, drugs in the Psychotherapeutic Class (includes tranquilizers) will be used more frequently than drugs in the Antispasmodic Class (synthetics).

informed or secured, respectively³. Increases in the b 's (i.e., higher demand elasticities) may indicate that other forms of treatment are available. An increase in the quantity intercepts of the demand curves, a_{1P} , a_{2P} , a_U , a_{2B} , a_{2G} , and a_{2L} , demonstrates how the two suppliers behave in larger markets (across therapeutic classes). An increase in the opportunity cost of capital, r , and the life span of the drug, N , demonstrates the effect on equilibrium values when the discount term changes and when the exclusive period is allowed to change (but maintaining $t_1 = .5N$).

The sections in this chapter are organized as follows: Section one describes the relevant industry studies which are drawn upon to calibrate the linear model; Section two performs simulation over various exogenous variables to examine the comparative static properties of the model; Section three uses simulation to compare the strategies and determine the optimal strategy under the different market conditions.

3

For example, from $J_1 = 1 - e^{-\mu A_0}$, and given the amount of persuasive advertising (setting $A_0 = 1$), then setting $\mu = .2, .4, .8, 1.0, 2.0$, a unit of advertising will secure .4, .5, .6, .8, .85, .88 of the informed population. A similar exercise could easily be done for the α in the K function with respect to informing the population.

3.10 Industry Studies

There exists a limited number of empirical studies which can be drawn on for the purpose of fitting values to the parameters in our linear model. Four studies conducted in Canada are used to set a range for the price and quantity effects of entry of licensee's. Two U.S. studies are used to set different demand and advertising elasticities.

(1) Canadian Studies

Fulda and Dickens (1979) examine the price effects of compulsory licensing in Canada by using a sample of 16 prescription drugs for which compulsory licenses had been issued between 1970 and 1975. Of the 16 drugs 11 were considered to have experienced licensee competition, the remaining 5 drugs were assumed to remain uncompetitive. The criteria used to establish competitiveness was the size of the licensee's market share, thus when the licensee's market share was less than three percent no competition was assumed to occur. To determine the impact of compulsory licensing on price a benchmark approach was used. The benchmark was the U.S. where the same drugs were tracked and prices were compared over the same time period.

The authors found that for the 11 drugs which experienced licensee competition, price differences were on average 12.5 percent lower in Canada. This was found to be statistically significant at the .1 level. For the remaining five drugs for which there existed no licensee competition, they found no statistical difference in price (only a .03% difference).

Jackson (1975) conducted a study at the Department of National Health and Welfare on 42 prescription drugs to determine the impact on prices of compulsory licenses issued in Canada between 1970 and 1975. Jackson divided the sample into two groups; 11 drugs were considered to experience licensee market competition (licensee market shares were between 8 and 67 percent); 31 drugs were considered not to experience licensee competition (licensee market shares less than 8 percent). Jackson found that the average price decline for the 11 drugs was approximately 31 percent, this was in contrast to only 3.7 percent for the 31 uncompetitive drugs. Jackson adopted the same approach as Fulda and Dickens by using the U.S. as a benchmark.

Plet (1976) conducted a study on 41 prescription drugs at the federal Department of Consumer and Corporate Affairs. The methodology was similar to the above two studies by using the U.S. as the benchmark to compare prices, and

dividing the sample into 22 drugs for which competition was assumed not to occur and 19 drugs for which there was competition. Plet decided to use the published listed prices instead of actual acquisition cost of the pharmacist.⁴ The author found that for the 19 drugs which were assumed to be competitive that prices fell on average by 4 percent in Canada and increased on average by 18.6 percent in the U.S.. On the other hand, those 22 drugs experiencing no competition were found to experience similar price increases in both Canada and the U.S of approximately 20 percent.

Gorecki (1981) employed an alternative methodology to measure the impact of compulsory licensing on prescription drug prices. Gorecki's approach was to estimate the prescription drug bill in the absence of compulsory licensing then compare this to the actual or observed prescription drug bill. In order to obtain an estimate of the estimated drug bill Gorecki drew from the previous studies (Fulda and Dickens, and Plet) and adjusted the patentee's prices upward by 20 percent on those drugs experiencing competition. This procedure was then applied

⁴ It has been argued that the latter reflects the correct price because the published listed price does not account for the possibility of discounts or "kickbacks" (see Anis (1989)).

to the hospital market and four provincial retail markets (Ontario, Quebec, British Columbia, and Saskatchewan) for the period 1970 to 1978. Gorecki found that the total prescription drug bill throughout the period would have been 20 to 26 percent higher per year in the absence of CL. The patentee's price where competition was said to exist would have been at least 20 percent higher without compulsory licensing.

The above Canadian studies focused on examining the impact on prices when CL was introduced and licensees entered the market. With respect to the linear model these studies will serve as a guide in setting specific parameters of the model (including S) by restricting exogenous parameters to the range where price adjustments lie between 15 and 25 percent. The U.S. studies are employed to assign the other structural parameter values.

(7) U.S. Studies

In an earlier study Reekie (1978) examined the pricing strategy of pharmaceutical firms who introduced new chemical entities (NCE) in the U.S. over the period 1958-1975. The sample included 171 NCE of which 40 percent were introduced at a price lower than the leading available substitutes. Twenty percent of the NCE's were introduced at a "high" price and the remaining 40 percent of NCE's were introduced at a "moderate" price. Reekie found a strong positive correlation between high introductory price and therapeutic novelty. Reekie proceeded to estimate the elasticity of demand for NCE's classified into three groups: Important, Modest, or Little or no therapeutic gain. The elasticity of demand was estimated for each year over four years and was based on a non-linear demand equation of the form

$$Q_{it} = aP_{it}^b N_{it}^c u^e$$

where i and t correspond to a particular NCE and year respectively, Q is the ratio of new prescriptions written for the NCE to all new prescription in that therapeutic class, and P is the relative price of the NCE to all new prescription drug prices. N is one plus the cumulative number of competing NCE's introduced in the relevant

therapeutic class.⁵

The author found that the elasticity of demand for important NCE's ranged between 1.03 and 1.65 over the four years, and for modest therapeutic drugs between 1.11 and 2.83 over the same four years.

The information on elasticity of demand for modest and important therapeutic drugs can be combined with the equilibrium prices and quantities to obtain estimates for the b_{1P} , b_U , b_{2P} , and b_{2L} structural coefficients, and a_U , a_{2P} , a_{2g} , and a_{2L} intercept terms in the linear model⁶. Moreover, those elasticities derived from the "important" therapeutic drugs can be used to obtain estimates for b_{1P} and b_U which represent the first period and uncontested segment of the second period market, respectively. The elasticities derived from the "modest" therapeutic drugs are used to obtain estimates for b_{2P} and b_{2L} which correspond to the contested second period markets of the patentee and licensee, respectively.

⁵ The elasticity estimates were based on average prices of .8 and market share of the particular therapeutic class of .10.

⁶ Applying the elasticities obtained from Reekie to our linear demand model implies that elasticities are locally stable.

In Leffler's (1982) study regression analysis was performed to examine the relationship between a new entrants market share, advertising intensity, and therapeutic novelty. Since prescription drugs in the U.S. are patent protected for a period of 17 years⁷, advertising incurred by the patentee is considered to be "strictly" informative.⁸ With respect to our model Leffler's results are useful in assigning a value to ρ in the K_i function. The author found that an increase in promotion intensity by 10 percent increased market share by 8.8 percent. This is consistent with an ρ equal to .04 given the other parameters of the model.

The remaining unassigned structural coefficients are μ from the persuasive advertising function and S representing the substitution term in the demand function. However, since price adjustments before and after the introduction of compulsory licensing are restricted to approximately 20 percent an isoquant of values for S and μ was examined. Thus the isoquant defines different values for μ and S which

⁷ In 1984, an amendment to the Drug Price Competition and Patent Term Restoration Act (Waxman-Hatch Act) extended the patent period to 23 years. The purpose of the extension was to increase the effective period in which the patentee could exclusively market the drug due to the increasing amount of time it took to receive a notice of compliance.

⁸ "Strictly" informative is taken to mean that advertising strategy where the threat of entry is absent.

2

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

satisfy a given price adjustment constraint. This is seen in figure 3.1 below. The value for S is bounded by $\sqrt{b_{2L} b_{2B}}$ ⁹. μ is assumed to be bounded by the value given for ρ .

Given the above information the following demand equations from the calibrated model were assigned the following values:

$$Q_{1P} = (a_{1P} - b_{1P}P_{1P})K_1$$

$$Q_{2P} = (a_u - b_u P_{2P})K_1 J_1 + (a_{2B} - b_{2B}P_{2P} + SP_{2L})K_1(1 - J_1)$$

$$Q_{2L} = (a_{2L} - b_{2L}P_{2L} + SP_{2P})K_1(1 - J_1) \text{ for case 1, and}$$

$$Q_{2P} = (a_u - b_u P_{2P}^{m1})K_1 J_1 + (a_{2g} - b_{2g}P_{2P}^g + SP_{2L})K_1(1 - J_1)$$

$$Q_{2L} = (a_{2L} - b_{2L}P_{2L} + SP_{2P}^g)K_1(1 - J_1) \text{ for case 2.}$$

where: $K_1 = 1 - e^{-\rho A_1}$

$$J_1 = 1 - e^{\mu A_0}$$

and assigning the following parameter values

$$a_{1P} = a_u = 400; \quad a_{2B} = a_{2g} = a_{2L} = 200$$

$$b_{1P} = b_u = 6; \quad b_{2P} = b_{2L} = b_{2g} = 8$$

$$S = 4; \quad \rho = .04; \quad \mu = .02.$$

⁹ A value for S equal to $\sqrt{b_{2L} b_{2B}}$ would indicate perfect substitutes and the model would collapse (see footnote 46 in chapter two).

FIGURE 3.1

Price Adjustment Isoquant and Trade off
Between μ and S

The other variables in the model were assumed to take the following values;

$$r = .10; \quad N = 20; \quad V = 5; \quad W_I = 75; \quad W_O = 50; \quad \text{and } F_{2L} = .1F_{2P}.$$

r represents the discount rate of 10 percent, and N assumes a life span of 20 years. V represents marginal production cost derived from the mark-up rule.

3.2 COMPARATIVE STATICS THROUGH SIMULATION

In this section simulation is performed on each of the different cases developed in chapter two to examine how equilibrium prices, quantities and advertising are affected by changes in the exogenous variables.

(A) Entry Accommodation

For the first two simulations the patentee is assumed to accomodate entry of the licensee once granted exclusive protection for half the life span of the product. The effect on equilibrium prices, quantites, and advertising assuming different values for ρ , μ , a_{2P} , a_{2g} , a_{2B} , a_U , a_{2L} , and b_{2P} , b_U , b_{2g} and b_{2L} , r , and N are shown in table 3.1 and 3.2 below.

Case 1: Entry without Generic Competition

Under a uniform pricing strategy (i.e. $q_g = 0$) the simulation shows that (see table 3.1) that equilibrium prices, quantities, and advertising, are sensitive to advertising technology, demand elasticities, size of the (therapeutic) market, cost of capital, and life span of the

Table 3.1

Simulation over Different Market Conditions,
Advertising Technologies, and Discount Term.

Accommodating Entry Case

Entry without Generic Competition
(Case 1)

	Δ Market Size	Δ Slope b	Δ Advertising Technologies ρ μ		Δ O.C. r	Δ Life Span N
P_{1P}	+	-	n/c	n/c	n/c	n/c
P_{2P}	+	-	+	+	-	+
P_{2L}	+	-	+	+	-	-
Q_{1P}	+	-	+	n/c	-	-
Q_{2P}^c	+	-	+	-	+	+
Q_{2P}^u	+	-	+	+	-	-
Q_{2L}	+	-	+	-	+	+
K_1	+	-	+	n/c	-	-
J_1	+	-	+	+	-	-

u - uncontested market

c - contested market

drug. Thus, an increase in the efficiency of advertising, through ρ , and μ , tend to increase prices, quantities, and total advertising. Changes in market size as represented by a_{2g} , a_{2B} , a_{2L} , a_u , and a_{1P} indicated that in larger (therapeutic) markets prices and advertising are greater. Simulating over different values of the slopes b_{2B} , b_u , and b_{2L} indicates that when other treatments are becoming available perhaps in the form of another patented drug or a different therapeutic approach, the effect is to lower prices and advertising. An increase in the opportunity cost of capital has the effect of reducing both types of advertising and second period prices. The affect on quantity was mixed indicating that demand in the uncontested market falls and demand in the contested market rises¹⁰. An increase in the life span of the drug had a decreasing affect on persuasive advertising and second period prices, and an increasing affect on informative advertising.

¹⁰ The uncontested market represents those consumers who are successfully captured through persuasive advertising. The contested market represent those consumers who remain uninfluenced by persuasive advertising and whose decision to purchase the drug is based on perceived quality and price differences.

Case 2: Entry with the Introduction of a Patentee's Generic

Under this strategy the patentee introduces a generic version (see table 3.2) of the brandname product. Equilibrium prices, quantities, and advertising adjusted to changes in market size and the slope similarly to adjustments in case 1. The only exception being that q_{2P} falls as market size increases. This may be partly explained by the extraction of monopoly rents derived from capturing larger segments of the second period market. Changes in advertising technologies do not affect prices. A change in informative advertising technology is positively related to quantities and the level of informative advertising. A change in persuasive advertising technology was positively related to both levels of advertising, first period and second period uncontested demand, and negatively related to second period contested demand. This latter relationship confirms the previous finding that because of monopoly pricing in the uncontested market then as persuasive advertising becomes more efficient more consumers will be captured.

An increase in the opportunity cost of capital (smaller discount term) did not affect prices but demonstrated a negative relationship to informative and persuasive advertising. First period and second period uncontested

Table 3.2

Simulation over Different Market Conditions,
Advertising Technologies, and Discount Term.

Accommodating Entry Case
Introduction of a Patentee's Generic
(Case 2)

	Δ Market Size	Δ Slope b	Δ Advertising Technologies ρ μ		Δ O.C. r	Δ Life Span N
P_{1P}	+	-	n/c	n/c	n/c	n/c
P_{2P}^{m1}	+	-	n/c	n/c	n/c	n/c
P_{2L}	+	-	n/c	n/c	n/c	n/c
P_{2P}^g	+	-	n/c	n/c	n/c	n/c
Q_{1P}	+	-	+	+	-	-
Q_{2g}	-	-	+	-	+	+
Q_{2B}	+	-	+	+	-	-
Q_{2L}	-	-	+	-	+	+
K_1	+	-	+	+	-	-
J_1	+	-	n/c	+	-	-

demand fell and second period contested demand increased. The affect on second period demand is mainly a result of the lower persuasive advertising. Finally, an increase in the life span of the drug (holding $t_1 = .5N$) indicated no affect on pricing, but affected advertising and demand similarly to r .

(B) Strategic Entry Deterrence

Equilibrium values for the strategic entry deterrence cases were also examined with respect to changes in the exogenous variables described above. Changes in market size and slope values were found to be positively and negatively related to equilibrium values of endogenous variables, respectively for cases 4 and 5. (See tables 3.3 to 3.4). For case 3 an increase in market size has a positive impact on prices but a negative affect on quantities and advertising. This implies that in larger markets prices may increase but the patentee must reduce informative advertising (scale of the market) to make the prospect for entry of the licensee unattractive.

Changes in advertising technology does not affect first or second period prices but does affect quantity and the

levels of advertising. For example, an increase in μ has no effect on quantity but reduces the amount of A_0 required to meet the entry deterring level of J_1 . An increase in ρ is

found to increase quantity as well as the level of informative advertising. Thus, under entry deterrence the greater the efficiency of advertising in informing consumers the more consumers that will be informed holding constant the entry deterring J_1 .

Increases in the opportunity cost of capital, r , and the life span of the drug, N do not affect prices. Quantities are increased in cases 3, and 5, and unaffected in case 4 to changes in N .

Table 3.3 Simulation over Different Market Conditions,
Advertising Technologies, and Discount Term.

Strategic Entry Deterrence
Informative Advertising Only
(Case 3)

	Δ Market Size	Δ Slope b	Δ Advertising Technology ρ	Δ O.C. r	Δ Life Span N
P_{1P}	+	-	n/c	n/c	n/c
P_{2P}^m	+	-	n/c	n/c	n/c
Q_{1P}	-	-	n/c	+	+
Q_{2P}	-	-	n/c	+	+
K_1	-	-	n/c	+	+

Table 3.4 Simulation over Different Market Conditions,
Advertising Technologies, and Discount Term.

Strategic Entry Deterrence
Informative and Persuasive Advertising
(Case 4)

	Δ Market Size	Δ Slope b	Δ Advertising Technology ρ μ		Δ O.C. r	Δ Life Span N
P_{1P}	+	-	n/c	n/c	n/c	n/c
P_{2P}^m	+	-	n/c	n/c	n/c	n/c
Q_{1P}	+	-	+	n/c	n/c	n/c
Q_{2P}^c	+	-	+	n/c	n/c	n/c
Q_{2P}^u	+	-	+	n/c	n/c	n/c
K_1	+	-	+	n/c	n/c	n/c
J_1	+	-	n/c	n/c	-	-

u - uncontested market
c - contested market

Table 3.5

Simulation over Different Market Conditions,
Advertising Technologies, and Discount Term.

Strategic Entry Deterrence
Pre-empting the Generic Market
(Case 5)

	Δ Market Size	Δ Slope b	Δ Advertising Technology		Δ O.C. r	Δ Life Span N
			ρ	μ		
P_{1P}	+	-	n/c	n/c	n/c	n/c
P_{2P}^{m1}	+	-	n/c	n/c	n/c	n/c
P_{2P}^{m2}	+	-	n/c	n/c	n/c	n/c
Q_{1P}	+	-	+	n/c	-	+
Q_{2B}	+	-	+	n/c	-	+
Q_{2g}	+	-	+	n/c	-	+
K_1	+	-	+	n/c	-	+
J_1	+	-	+	n/c	-	-

3.3 COMPARISON OF STRATEGIES

This section, with the aid of simulation over exogenous variables, compares the discounted profits of the patentee over the different strategies developed in chapter two. Figures 3.2 to 3.8 illustrate how profits compare over the different strategies. Generally, the entry deterring strategy case 4 is found to be the dominant strategy over all the specified ranges of the exogenous variables. Hence, simultaneously using persuasive and informative advertising to deter entry consistently results in the largest discounted profits. The only exception is over smaller values of the contested demand slope, b_{2B} , b_{2L} (see figure 3.3). The second most frequent profitable strategy is under the accommodating entry strategy case 2. Here the patentee introduces a generic drug to compete with the licensee's generic. By introducing a generic the patentee creates a two tier pricing structure in the market. The secured market receives a monopoly price, and the generic market receives a Bertrand price. A comparison of the entry accommodation strategies only (cases 1 and 2) demonstrates that the use of the patentee's own generic to accommodate entry results in profits being 30 to 70 percent higher, depending on market conditions.

The least profitable strategy is consistently case

3, the only exception being in small (therapeutic) markets. Hence, only in small markets does it become relatively profitable to use K_1 , exclusively, as a means to deter entry (see figure 3.2).

Cases 5 and 1 consistently rank third and fourth, respectively, with respect to profitability. One exception is over relatively small values of the contested demand slope, b_{2B} , b_{2g} , and b_{2L} (see figure 3.3). The smaller the value of the contested demand slope (indicating a greater distant of alternative types of therapy) shows that a pre-emptive strategy of introducing a generic to deter entry and pricing as a discriminating monopolist receives the greatest discounted profits. Over the same range the entry accommodating strategy of introducing a generic (case 2) ranks second as the most profitable strategy. As the contested demand slope becomes larger, case 4 becomes the dominant strategy followed by case 2.

It should be noted that the above ranking of strategies were sensitive to changes in the value of the contested demand slope. This re-ranking of strategies indicates that simulations are to be treated with caution. Particularly, if the introduction of policy instruments are pursued with a specific strategy in mind.

The next chapter examines whether changes in policy instruments can alter the decision by the patentee to use any of the above strategies.

Figure 3.2

Patentee Profits Over Different Strategies

C.1 – C.5 refer to cases 1 to 5

Figure 3.3

Patentee Profits Over Different Strategies

Figure 3.4

Patentee Profits

Over Different Strategies

Figure 3.5

Patentee Profits Over Different Strategies

Figure 3.6

Patentee Profits Over Different Strategies

Figure 3.7

Patentee Profits Over Different Strategies

Figure 3.8

Patentee Profits Under Different Strategies

CHAPTER FOUR

STRATEGIC ADVERTISING AND GOVERNMENT INTERVENTION

4.0 Introduction

This chapter examines how government intervention through the use of different public policy instruments can influence the pricing and advertising behaviour of a patentee and licensee. The policy instruments under consideration include¹: (1) adjustment of the period of exclusivity; (2) changing the degree of enforcement of substitution laws; (3) varying the royalty rate; and, (4) adjusting entry requirements (through the Health Protection Branch of Health and Welfare Canada). The model developed in chapter two is employed to investigate the influence of public policy on pricing and advertising behavior, and to compare how the different strategies are affected under the different policy regimes.

By using one or more of the above instruments the government can substantively change the economic environment facing the patentee and licensee and, as a result, influence what type of strategic behaviour is

¹ This is not to preclude the use of other policy instruments which may be available.

persued by these two suppliers. For example, if Health and Welfare Canada decides to raise the entry requirements of licensees by forcing them to conduct more stringent and costly tests on meeting safety and efficacy requirements, then patentees may be less concerned with preserving a market share through persuasive advertising and concentrate more on expanding the market through informative advertising. Similarly, by simultaneously increasing the royalty rate and reducing the period of exclusivity the patentee may be induced to increase the scale of the market. As a result, licensees and consumers may benefit because of earlier entry and greater numbers of consumers being made aware of the drug. These are the types of issues we may begin to examine once we understand how the patentee and licensee react to changes in the policy instruments.

The sections in this chapter are organized as follows: Section one describes the policy instruments under consideration; Section two describes how equilibrium values of prices and advertising are affected under the different cases developed from chapter two; Section three shows the effect of each policy instrument on the patentee's ranking of strategies.

4.10 POLICY INSTRUMENTS

(1) The Exclusive Period

In the Fall of 1987 an amendment to sections 39.1-41.4 of the Canadian Patent Act allows for patent holders of new prescription drugs to obtain exclusive protection for a period of seven to ten years.² Prescription drugs introduced into Canada prior to June 1986 remain subject to the old regime of Compulsory licensing (CL). Under CL a licensee can apply to the Commissioner of Patents and for a nominal fee obtain a license to market the drug in Canada.³

The patent system in Canada permits patent holders a period of 17 years to realize the pecuniary benefits from his/her innovation. This period of exclusivity is considered important to ensure the efficient allocation of research and development resources. Thus the awarding of

² The amendment to the Patent Act became law on December 7, 1987. The period where exclusivity may become effective was June 1986. The criteria to determine exclusivity was based on when the notice of compliance was received from HPB and when the licensee applied for a license to the Commissioner of Patents. If both were received before June 1986 then the drug was subject to CL. If either occurred after June 1986 then the patentee was granted a period of exclusivity.

³ The fee to apply for a license increased in 1985 to \$2,500 from \$500.

technical property rights to the innovator is society's way of trading off the static welfare losses associated with monopoly against the dynamic welfare gains of introducing new and improved innovations by maintaining the incentive to conduct research and development. The decision to remove pharmaceuticals from this convention was the result of several studies commissioned by the federal government in the 1960's to examine the pricing practises of multinational drug firms in Canada.⁴ The major finding of these studies indicated that drug prices in Canada were excessive. These findings were based largely on comparisons with drug prices in other industrialized nations and culminated in the enactment of CL in 1969.

The Federal governments decision to remove CL in 1987 (previously known as Bill C-22) was based partly on the promise that multinational pharmaceutical companies would increase research and development expenditures in Canada. This was combined with concern from the industry that intellectual property was being violated and that this practice of appropriating intellectual property may spill

⁴ An Historical perspective on the events leading up to the enactment of CL is found in the Restrictive Trade Practices Commission (1963), Hall Commission (1965), and the Harley Committee (1967).

over to other countries.⁵

The exclusive period is introduced into the model through the discount terms defined in chapter two, hence

$$M_{1P} = 1 - e^{-rt_1}, \text{ and}$$

$$g_{2P}M_{2P} = g_{2L}M_{2L} = e^{-rt_1}(1 - e^{-r(N-t_1)}).$$

Where t_1 represents the length of the period of exclusivity (i.e., period one). N represents the life span of the drug, and r corresponds to the opportunity cost of capital. By allowing t_1 to vary we can investigate how the patentee's pricing and advertising strategy is affected.⁶ Furthermore, we may begin to search for an optimal t_1 which may serve to enhance economic surplus (see chapter five).

(2) Substitution Laws

Substitution laws were introduced by the provinces to complement compulsory licensing. The concern was that CL

⁵ There was also concern that the Free Trade Agreement between Canada and the U.S. may have been jeopardized.

⁶ For example, Huritz and Caves (1989) found that for every additional year of patent protection the patentee's market share rose by 1.6 percent and advertising fell indicating a substitution effect between t_1 and advertising.

alone may not be sufficient to ensure a reduction in prices from manufacturers through to consumers. Substitution laws, aimed at the practices of pharmacists, assist in the retailing of the drugs, and work to ensure that consumers are receiving the best available price. The effect of substitution rules and interchangeability on pricing and advertising behavior is introduced into the model through its effect on the cross term, S in the demand equations.⁷ In other words the degree of substitutability is assumed to be, *ceteris paribus*, a function of the type of substitution laws in effect. The more stringent the enforcement of the rules the larger the value of S .

Across Canada several different markets for prescription drugs can be said to exist at one time because each province has jurisdiction over the sale of all drugs. Not all provinces, however, have adopted substitution rules, and provinces which have adopted the rules have given their own interpretation of how they were to be implemented. Table 4.1 below demonstrates the variability in interpretation of substitution laws across the provinces. At one extreme are the provinces of PEI and British Columbia

⁷ The effect from Substitution laws may enter the model through other parameters including α and β in the advertising functions. For example, when government provides information on drug quality they may be enhancing the effectiveness of advertising to inform or persuade.

TABLE 4.1

SUBSTITUTION RULES IN CANADA

	Alberta	B.C.	Manitoba	N.B.	NFLD
Date Product Selection Introduced	1962	1974	1974	1975	1979
Permissive (P) or Mandatory (M)	P	P	M	P	P
Rules for Selection	none	none	form	4	form
Determination of Interchangeability	no form	no form	form	form	form
Determination of Cost	none	none	form	4	form
Legal Protection for Pharmacist and Physician	none	none	no liab	no liab	no liab

	N.S.	Ont.	PEI.	Queb.	Sask.
Date Product Selection Introduced	1983	1972	nps ^a	1974	1971
Permissive (P) or Mandatory (M)	P	P	nps	P	M
Rules for Selection	3	4	nps	none	none
Determination of Cost	none	5	nps	none	none
Determination of Interchangeability	form	form	nps	form	form
Legal Protection for Pharmacist and Physician	none	none	no liab	no liab	no liab

Notes:

3. Equal to or less than the brand prescribed
4. Lower priced brand to that prescribed
5. lowest priced brand in pharmacist's inventory

where no product selection rules (or very few rules) are in effect to govern the retailing of drugs. At the other extreme is Saskatchewan and Manitoba where product and price selection is mandatory, and in the case of the former manufacturers are invited to tender for the right to supply over 85 percent of the market.⁸ Provinces in the middle with respect to stringency include Ontario, Quebec, NFLD, Nova Scotia, New Brunswick, and Alberta (in that order)⁹.

The factors which reflect the degree of stringency of substitution rules (size of S) are listed in the table. These include the determination of cost at the retail level (i.e., whether price selection is mandatory or permissive), the availability of quality assurance and legal protection for pharmacists and physicians, and whether the product selection rules are permissive or mandatory. McRae and Tapon (1985) found that legal liability is a significant factor in explaining the difference in prices of similar drugs between provinces. Those provinces which removed legal liability (Ontario and Saskatchewan) priced drugs

⁸ This is referred to as a standing offer contract (SOC). Hence, pharmaceutical firms are invited to bid for the right to supply the market for high volume drugs for a six month period (usually January and July), and where the lowest price bidder wins.

⁹ See Gorecki (1986) and Anis (1989) for rankings of provinces with respect to the degree of stringency of substitution rules.

lower than provinces which did not remove legal liability (Quebec). These findings were also supported by Anis (1989) who found that availability of quality assurance, the removal of legal liability, and mandatory price selection are important factors leading to higher substitution rates for generic products.¹⁰ Gorecki (1986) provides evidence for Quebec that mandatory price selection is the vital factor which influences substitution rates.¹¹

(3) Royalty Payments

Royalty Payments in Canada are based on a 4 percent royalty on licensee's total sales. Thus,

$$\tau = rP_{2L}$$

where τ corresponds to the royalty payment per unit, r represents the royalty rate, and P_{2L} denotes the licensee's

¹⁰ Anis also shows that substitution rates are influenced by other types of government policy including deductible and copayment schemes, and mandatory consumers awareness practises.

¹¹ It should be mentioned that the above author's contention on which specific substitution rules are the most effective in influencing substitution rates are somewhat weakened by the fact that British Columbia does not have any substitution laws and yet has one of the highest substitution rates among generics.

per unit price. A rate of four percent is considered by many to be well below the rate which may arise in a voluntary licensing arrangement for this industry. This is supported by the fact that licensing arrangements in the U.S. have reached as high as 40 percent royalty rate for some drugs.¹²

Caves et al (1982) conducted a study on the market for technology licenses and found that the average royalty rate for the sample was 3.9 percent.¹³ This is more in keeping with royalty rates in most industries and may account for the establishment of the four percent royalty rate in the Canadian Pharmaceutical industry¹⁴

A royalty structure based on the percent of sales is similar to an *ad valorem* tax and is shown below to have distorting affects on price and output decisions. Other types of royalty structures have been examined including a

¹² High tech industries have also been known to have royalty payments in excess of 15 percent.

¹³ The focus of the study was to examine whether licensing arrangements are effective in assessing the optimal value of a license. Innovations operating in Canada, Britain and the U.S. comprised the sample.

¹⁴ A recommendation from the recent Report of the Commission of Inquiry on the Pharmaceutical Industry (Eastman Commission) was that the royalty rate on pharmaceuticals be raised to 14 percent.

two part tariff made up of a lump sum payment and royalty rate, and an auction market. These alternative methods can be shown to reduce the distorting affect caused by the ad valorem type arrangement.¹⁵

(4) Entry Requirements

The introduction of generic drugs for sale into Canada must meet certain Health and Welfare criteria¹⁶. Generally, this means that licensees must provide information that the drug meets minimum safety and efficacy requirements. This information may be obtained from published statistics and on occasion supplemented with modest clinical testing. These costs however, are substantially below the cost the patentee must incur when the drug is being introduced for the first time into Canada.¹⁷

¹⁵ Shapiro (1985) discusses the use of a two part tariff compared to a royalty rate as a potentially superior way of diffusing new technologies.

¹⁶ This is in addition to the required application to obtain a license from the patent office.

¹⁷ The patentee must provide comprehensive information on several different aspects of the drug. This consists of preclinical and clinical studies, and discussion and evaluation of clinical results. It has been claimed that licensee's cost of introduction is in the order of 1/100 of the patentee's costs (see Gorecki (1985)).

Another important factor is the time it takes HPB to process the notice of compliance for the licensee. This can take a minimum of 18 months.¹⁸ Therefore, under a CL regime where the licensee may apply immediately to obtain a license, there still exists an exclusive period, i.e., $t_1 \cong 30$ months.

¹⁸ The average time to process a new drug submission by patentee or licensee is approximately 30 months. There are exceptions including life saving drugs which under certain circumstances can be accessed immediately.

4.20 COMPARATIVE STATICS

This section investigates how changes in the policy instruments discussed above affect equilibrium prices, quantities, advertising and profits of the patentee and licensee. The policy instruments, defined as the vector $Z = (t_i, S, \tau, F_{2L})$, are examined under each of the cases developed in chapter two.

4.21 Entry Accommodation

Under entry accommodation it was found that the patentee strategically undertook investment in first period advertising, A_0 and A_1 , and/or introduced generic products to maximize profits over two periods. By implementing one or more of the vector Z of policy instruments¹⁹, we can examine the affect on pricing and advertising behaviour of the patentee.

Case 1: Entry without Generic Competition

The profit equation for the patentee and licensee in

¹⁹ The entry requirement policy instrument is not considered in the entry accommodation case for obvious reasons.

the uniform pricing strategy can be written as (see chapter two for a complete definition of all variables).

$$\begin{aligned} \pi_P = & \int_0^{t_1} \left[(P_{1P} - V) Q_{1P} \right] e^{-rt} dt - C_1(K_1) - C_0(J_1) + \\ & \int_{t_1}^N \left[(P_{2P} - V) Q_{2P} + \tau Q_{2L} \right] e^{-rt} dt - F_{1P} \\ \pi_L = & \int_{t_1}^N \left[(P_{2L} - v - \tau) Q_{2L} \right] e^{-rt} dt - F_{2L} \end{aligned} \quad (4.2)$$

After solving for the above integrals and expanding, the profit equations given by (4.1) and (4.2) can be written as:

$$\begin{aligned} \pi_P = & \left(1 - e^{-rt_1} \right) \left[(P_{1P} - V) \left(a_{1P} - b_{1P} P_{1P} \right) K_1 - C_1(K_1) - C_0(J_1) - \right. \\ & F_{1P} + e^{-rt_1} \left(1 - e^{-rt_2} \right) \left[(P_{2P} - V) \left(a_u - b_u P_{2P} \right) K_1 J_1 + \right. \\ & \left. \left[(P_{2P} - V) \left(a_{2P} - b_{2P} P_{2P} + SP_{2L} \right) + \tau \left(a_{2L} - b_{2L} P_{2L} + SP_{2L} \right) \right] K_1 \left(1 - J_1 \right) \right] \end{aligned} \quad (4.3)$$

$$\pi_L = e^{-rt_1} \left(1 - e^{-rt_2}\right) \left[\left(P_{2L} - v - \tau \right) \left(a_{2L} - b_{2L} P_{2L} + SP_{2P} \right) K_1 \left(1 - J_1 \right) - F_{2L} \right] \quad (4.4)$$

The direct effect of a change in the elements of Z (excluding F_{2L}) on first and second period prices can be seen immediately by taking the first order condition in (4.3) and (4.4) with respect to P_{1P} , P_{2P} and P_{2L} and writing the (quasi) reduced form equations, thus

$$\bar{P}_{1P} = \frac{a_{1P} + Vb_{1P}}{2b_{1P}}, \quad (4.5)$$

$$\bar{P}_{2P} = \frac{\phi_o^P + \phi_J^P J_1'}{\left[4b_{2L}b_{2B} - S^2 \right] + \left[4b_{2L}b_u - 4b_{2L}b_{2B} + S^2 \right] J_1'}, \quad (4.6)$$

$$\bar{P}_{2L} = \frac{\phi_o^L + \phi_J^L J_1'}{\left[4b_{2L}b_{2B} - S^2 \right] + \left[4b_{2L}b_u - 4b_{2L}b_{2B} + S^2 \right] J_1'}. \quad (4.7)$$

From (4.5) a change in the vector Z of policy instruments does not affect P_{1P} either directly or indirectly.²⁰ This information becomes useful in performing the following

²⁰ In other words, $dP_{1P}/dt_1 = dP_{1P}/dS = dP_{1P}/d\tau = 0$.

comparative static exercise because it reduces the task to having to evaluate a 2 by 2 matrix (instead of a 3 by 3). The quasi reduced form equations for second period prices can be used to evaluate the direct affect of a change in Z .²¹ Therefore, by writing the total affect of a change in Z on prices we obtain

$$dP_{2P}/dZ = \frac{\partial P_{2P}}{\partial Z} + \frac{\partial P_{2P}}{\partial J_1} \frac{\partial J_1}{\partial Z} + \frac{\partial P_{2P}}{\partial K_1} \frac{\partial K_1}{\partial Z}, \text{ and} \quad (4.8)$$

$$dP_{2L}/dZ = \frac{\partial P_{2L}}{\partial Z} + \frac{\partial P_{2L}}{\partial J_1} \frac{\partial J_1}{\partial Z} + \frac{\partial P_{2L}}{\partial K_1} \frac{\partial K_1}{\partial Z} \quad (4.9)$$

The partial (or direct) affect is simply $\partial P_{2P}/\partial Z$, and $\partial P_{2L}/\partial Z$ derived from (4.6) and (4.7) above. In addition, we can evaluate the first part of the second and last components of the above two expressions using (4.6) and (4.7)²². This also becomes useful information when performing the subsequent comparative static analysis.

To determine the comparative static affect from a change in Z on second period prices and first period

²¹ The reduced form equation derived in (4.6) and (4.7) are similar to (2.39) and (2.40) except that τ has been added to ϕ_o and ϕ_j .

²² For example, it is seen immediately from the reduced form equations that $\partial P_{2P}/\partial K_1$ and $\partial P_{2L}/\partial K_1$ are equal to zero.

advertising the first order conditions with respect to J_1 and K_1 are totally differentiated with respect to Z , K_1 and J_1 . Thus from the first order conditions:

$$\begin{aligned} \frac{\partial \pi_P}{\partial K_1} = & \left(\frac{1 - e^{-rt_1}}{r} \right) \left[\left(P_{1P} - V \right) \left(a_{1P} - b_{1P} P_{1P} \right) - C'_1(K_1) \right] + \\ & e^{-rt_1} \left(\frac{1 - e^{-rt_2}}{r} \right) \left[\left(P_{2P} - V \right) \left(a_u - b_u P_{2P} \right) J_1 + \right. \\ & \left. \left[\left(\left(P_{2P} - V \right) \left(a_{2B} - b_{2B} P_{2P} + SP_{2L} \right) + \tau \left(a_{2L} - b_{2L} P_{2L} + SP_{2P} \right) \right) (1 - J_1) \right] \right] \\ & = 0. \quad (4.10) \end{aligned}$$

$$\begin{aligned} \frac{\partial \pi_P}{\partial J_1} = & \left(\frac{1 - e^{-rt_1}}{r} \right) C'_0(J_1) + e^{-rt_1} \left(\frac{1 - e^{-rt_2}}{r} \right) \left[\left(P_{2P} - \right. \right. \\ & \left. \left. V \right) \left(a_u - b_u P_{2P} \right) K_1 - \left[\left(P_{2P} - V \right) \left(a_{2B} - b_{2B} P_{2P} + SP_{2L} \right) \right. \right. \\ & \left. \left. + \tau \left(a_{2L} - b_{2L} P_{2L} + SP_{2P} \right) \right] K_1 \right] = 0 \quad (4.11). \end{aligned}$$

Defining the following:

$H^K = \partial \pi_P / \partial K_1$ and $H^J = \partial \pi_P / \partial J_1$ then

$H_J^J = \partial H^J / \partial J_1$ and $H_K^J = \partial H^J / \partial K_1$ and $H_{P_{2P}}^J = \partial H^J / \partial P_{2P}$, etc.

We can write the total differential of (4.10) and (4.11) with respect to P_{2P} , P_{2L} , K_1 and J_1 and divide by dZ to yield

$$\begin{aligned}
\left[H_J^J + H_{P_{2P}}^J \partial P_{2P} / \partial J_1 + H_{P_{2L}}^J \partial P_{2L} / \partial J_1 \right] dJ_1 / dZ + H_K^J dK_1 / dZ = \\
- H_{P_{2P}}^J \partial P_{2P} / dZ - H_{P_{2L}}^J \partial P_{2L} / \partial Z - H_Z^J
\end{aligned}
\quad (4.12)$$

$$\begin{aligned}
\left[H_K^K + H_{P_{2P}}^K \partial P_{2P} / \partial K_1 + H_{P_{2L}}^K \partial P_{2L} / \partial K_1 \right] dK_1 / dZ + H_J^K dJ_1 / dZ = \\
- H_{P_{2P}}^K \partial P_{2P} / dZ - H_{P_{2L}}^K \partial P_{2L} / \partial Z - H_Z^K
\end{aligned}
\quad (4.13)$$

Using matrix notation (4.12) and (4.13) can be represented as:

$$\begin{vmatrix} H_{11} & H_{12} \\ H_{21} & H_{22} \end{vmatrix} \begin{vmatrix} \frac{dJ_1}{dZ} \\ \frac{dK_1}{dZ} \end{vmatrix} = \begin{vmatrix} A_1 \\ A_2 \end{vmatrix}$$

Where:

$$H_{11} = \left[H_J^J + H_{P_{2P}}^J \partial P_{2P} / \partial J_1 + H_{P_{2L}}^J \partial P_{2L} / \partial J_1 \right]$$

$$H_{22} = \left[H_K^K + H_{P_{2P}}^K \partial P_{2P} / \partial K_1 + H_{P_{2L}}^K \partial P_{2L} / \partial K_1 \right]$$

$$H_{12} = H_K^J$$

$$H_{21} = H_J^K$$

$$H = H_{11} H_{22} - H_{12} H_{21}$$

$$A_1 = - H_{P_{2P}}^J \partial P_{2P} / dZ - H_{P_{2L}}^J \partial P_{2L} / \partial Z - H_Z^J$$

$$A_2 = - H_{P_{2P}}^K \partial P_{2P} / \partial Z - H_{P_{2L}}^K \partial P_{2L} / \partial Z - H_Z^K$$

H represents the determinant of the 2x2 matrix. Sufficient conditions for profit maximization requires that $H > 0$, and the principal minors H_{11} and H_{22} are negative. The cross diagonals may be negative or positive. Using Cramer's Rule we can evaluate the affect of changes in each of the policy instruments in Z on equilibrium advertising and use the results to examine the changes in equilibrium prices. In general,²³

$$dJ_1/dZ = [A_1 * H_{22} - A_2 * H_{12}] / H \quad (4.14)$$

$$dK_1/dZ = [H_{11} * A_2 - H_{21} A_1] / H \quad (4.15)$$

(i) Exclusive Period

For changes in the exclusive period only ($Z| = t_1$) it is
 $\frac{\pi}{T} = .04, P_{2L} = 0$

straight forward to show that

$$\begin{aligned} dJ_1/dt_1 &< 0 \quad \text{if } H_K^J > 0 \quad \text{and} \\ dK_1/dt_1 &> 0 \quad \text{if } H_J^K > 0. \end{aligned}$$

²³ For each policy instrument in Z the precise elements in A_1 , A_2 , H_{11} , and H_{22} may differ.

Where;

$$H_K^J = e^{-rt_1} \left(\frac{1-e^{-rt_2}}{r} \right) \left[\left(P_{2P} - V \right) \left(a_U - b_U P_{2P} \right) - \left(P_{2P} - V \right) \left(a_{2B} - b_{2B} P_{2P} + SP_{2L} \right) \right] dK_1$$

$$H_J^K = e^{-rt_1} \left(\frac{1-e^{-rt_2}}{r} \right) \left[\left(P_{2P} - V \right) \left(a_U - b_U P_{2P} \right) - \left(P_{2P} - V \right) \left(a_{2B} - b_{2B} P_{2P} + SP_{2L} \right) \right] dJ_1$$

In other words, H_K^J and $H_J^K > 0$ when $(a_U - b_U P_{2P}) > (a_{2B} - b_{2B} P_{2P} + SP_{2L})$ i.e., uncontested market > contested market.

This implies that the longer the exclusive period, t_1 , the more resources the patentee will put into K_1 to develop the market. However, as the first period is extended the patentee focuses less on the second period and consequently reduces persuasive advertising.²⁴

If $H_K^J < 0$ and $H_J^K < 0$ (i.e., the contested market is greater than the uncontested market) then the sign of dJ_1/dt_1 and dK_1/dt_1 depends on the relative size of A_1 and

²⁴ These findings suggest that the composition of advertising may change but not necessarily the total amount of advertising. This is somewhat different from what Huritz and Caves (1988) found in the U.S. see *supra* note 6.

A_2 . If A_2 is greater than A_1 then H_K^J is negative, similarly for H_J^K . If this arises then $dJ_1/dt_1 > 0$ and $dK_1/dt_1 < 0$.

Using the above results we can evaluate the effect of a change in t_1 on second period prices. Hence, from (4.8) and (4.9) we can write;

$$dP_{2P}/dt_1 = \frac{\partial P_{2P}}{\partial J_1} \frac{dJ_1}{dt_1}, \text{ and } dP_{2L}/dt_1 = \frac{\partial P_{2L}}{\partial J_1} \frac{dJ_1}{dt_1}.$$

Thus, the impact of t_1 on second period prices is reduced to evaluating the affect of persuasive advertising on prices from the reduced form equations given by (4.8) and (4.9) above. Therefore if $dJ_1/dt_1 < 0$ then,

$$dP_{2P}/dt_1 < 0 \quad \text{and} \quad dP_{2L}/dt_1 < 0.$$

These findings imply that an increase in the period of exclusivity results in an overall larger market, and lower second period prices. First period prices remain at the monopoly level. Hence, a trade-off from granting a longer exclusive period arises. That is, first period prices remain at the monopoly level but more consumers are informed and second period prices are lower (because of lower persuasive advertising). The relationship between J_1 ,

prices, and t_1 are examined under simulation over different values of t_1 . The results of the simulation support the above findings.

(ii) Substitution Laws

Using the above results we can proceed to evaluate the effect on advertising and prices when tougher substitution laws are enforced. In this case all other policy instruments are held constant.²⁵ Using the reduced form equations to evaluate the direct effect, $\partial \bar{P}_{2P} / \partial S$, and $\partial \bar{P}_{2L} / \partial S$, we can turn to the results obtained from Cramer's rule to determine the total effect. This case is slightly more difficult than the previous case to sign and requires closer examination of the elements in A_1 and A_2 . After signing the terms in A_1 and A_2 we find that

$$dJ_1/dS < 0 \text{ if } H_K^J > 0, \text{ and}$$

$$dK_1/dS > 0 \text{ if } H_J^K > 0.$$

Thus persuasive advertising falls and informative advertising increases as substitution laws become more

²⁵ In other words, t is set at half the life span of the drug, the royalty rate is set equal to 4 percent of sales, and, the second period fixed cost of entering is set at a minimal level ($F_{2L} = .025 * F_{1P}$).

stringent. This implies that as the generic becomes a closer substitute for the brandname, there is less incentive to capture segments of the market and more resources are employed to increase the scale of the market.

The impact on second period prices using the above results become

$$dP_{2P}/dS = \frac{\partial P_{2P}}{\partial S} + \frac{\partial P_{2P}}{\partial J_1} \frac{dJ_1}{dS} < 0 \text{ and} \quad (4.16)$$

$$dP_{2L}/dS = \frac{\partial P_{2L}}{\partial S} + \frac{\partial P_{2L}}{\partial J_1} \frac{dJ_1}{dS} < 0 \quad (4.17)$$

The total effect given by (4.16) and (4.17) is positive if the first terms are greater than the second terms. Thus the two effects work against each other in determining the final effect on prices. If the licensee chooses to react non-aggressively in the second period then (4.16) and (4.17) are positive. On the other hand, if licensee's are aggressive prices will approach the competitive outcome as the drugs become closer substitutes, therefore (4.16) and (4.17) are negative. The relationship between J_1 , P_{2P} , P_{2L} , and S is examined under simulation. Given the parameters of the model, an increase in S is associated with an increase in P_{2P} , P_{2L} , and a decrease in J_1 .

(iii) Royalty Payments

The above results can be employed to examine how adjustments in royalty payments affect patentee behavior. Therefore, holding other policy instruments constant we proceed to adjust the royalty rate. Again using the reduced form equations for prices and the above results obtained from Cramer's rule we find

$$dJ_1/d\pi < 0, \text{ when } H_K^J > 0, \text{ and} \\ dK_1/d\pi > 0, \text{ when } H_J^K > 0$$

The effect of an increase in the royalty rate on advertising is found to increase informative advertising and reduce persuasive advertising. Thus by increasing π , other things being equal, the patentee focuses on developing the markets over both periods, and fewer resources are devoted to capturing segments of the second period market.²⁶ In this sense π becomes a substitute for capturing segments of the market because the opportunity cost of capturing increases as π increases.

The effect on prices is seen by examining (4.6) and

²⁶ This may have important welfare implications when more than one policy instrument is used simultaneously. More on this in chapter five.

(4.7) and making the correct substitutions, thus

$$dP_{2P}/d\alpha = \frac{\partial P_{2P}}{\partial \alpha} + \frac{\partial P_{2P}}{\partial J_1} \frac{dJ_1}{d\alpha} < 0 \text{ and} \quad (4.18)$$

$$dP_{2L}/d\alpha = \frac{\partial P_{2L}}{\partial \alpha} + \frac{\partial P_{2L}}{\partial J_1} \frac{dJ_1}{d\alpha} > 0 \quad (4.19)$$

The total effect on equilibrium prices from increasing α is ambiguous. The direct effect, derived from the reduced form equations, is positive. The indirect effect through persuasive advertising is negative. The use of simulation performed on the calibrated model, however, reveals that an increase in α has an overall positive (albeit small) effect on second period equilibrium prices. This suggests that licensees attempt to pass on the increase in the royalty rate by raising prices, and through the strategic effect the patentee's prices rise.

It becomes clear from the above results that a two part tariff will have less impact on second period prices and advertising. Moreover, the greater the fixed cost component of the two part tariff and the smaller the royalty rate component, the less the distorting affect.

Case 2: Entry with the Introduction of a Patentee's Generic

Under this case the patentee introduces a generic drug to compete with the licensee's drug. The profit equation is defined in equation (2.47) and is reproduced below:

$$\begin{aligned} \pi_P = & \int_0^{t_1} \left[(P_{1P} - V) (a_{1P} - b_{1P} P_{1P}) K_1 \right] e^{-rt} dt - C_0(J_0) - C_1(K_1) + \\ & \int_{t_1}^N \left[(P_{2P}^m - V) (a_u - b_u P_{2P}^m) K_1 J_1 + (P_{2P}^g - V) (a_{2g} - \right. \\ & \left. b_{2g} P_{2P}^g + SP_{2L}) (1 - J_1) + \tau (a_{2L} - b_{2L} + SP_{2P}^g) \right] e^{-rt} dt - F_{1P} - F_{2P} \end{aligned} \quad (2.47)$$

Profit maximizing second period prices are given by;

$$\bar{P}_{2P}^{m1} = \frac{a_u + Vb_u}{2b_u}, \quad (4.19)$$

$$\bar{P}_{2P}^g = \frac{(a_{2g} + b_{2g}V + \tau S)2b_{2L} + S(a_{2L} + (V + \tau)b_{2L})}{(4b_{2L}b_{2g} - S^2)}, \quad (4.20)$$

$$\bar{P}_{2L} = \frac{(a_{2L} + b_{2L}V + \tau S)2b_{2g} + S(a_{2g} + (V + \tau)b_{2g})}{(4b_{2L}b_{2g} - S^2)}, \quad (4.21)$$

The reduced form equation given by (4.19) indicates that monopoly prices are unaffected by a change in the vector Z.

Equation (4.20) and (4.21) demonstrate that the policy instruments have only a direct effect on second period prices (i.e., $\partial P_{2P}^i / \partial J_1 = \partial P_{2L} / \partial J_1 = \partial P_{2P}^i / \partial K_1 = \partial P_{2L} / \partial K_1 = 0$; $i = m, g$). Therefore using the reduced form equations for second period prices:

$$dP_{2P}^{m1} / dZ = \partial P_{2P}^{m1} / \partial Z$$

$$dP_{2P}^g / dZ = \partial P_{2P}^g / \partial Z$$

$$dP_{2L} / dZ = \partial P_{2L} / \partial Z \quad .$$

When Z represents the exclusive period, t_1 prices are unaffected. If Z corresponds to an increase in the enforcement of substitution laws, S , or an increase in the royalty rate, π , then P_{2P}^g and P_{2L} both increase.

The direction of the effect of a change in Z policy instruments on advertising is the same but the magnitude of the change is different than case 1. This occurs because $H_{11}|_{\text{case2}} < H_{11}|_{\text{case1}}$. In other words, because prices in case 2 are not a function of persuasive advertising the determinant H will be smaller in case 2 than in case 1. This implies that for a given change in Z , the change in persuasive advertising in case 2 is more pronounced. Thus, as the exclusive period increases, and, S and π increases, persuasive advertising increases less under case 2 relative to case 1. These findings are supported by performing

simulations on the linear model over different values of t_1 , τ and S .

4.22 STRATEGIC ENTRY DETERRENCE

Advertising and the introduction of a generic can be used to deter entry. There are several alternatives: First, under-investment in informative advertising develops a sufficiently small market and creates a natural monopoly situation--case 3; Second, the patentee may decide to increase the scale of the market through informative advertising while simultaneously increasing persuasive advertising to keep out the licensee--case 4; Third, the decision by the patentee to introduce a generic to pre-empt the licensee from entering the market--case 5. The above entry deterring strategies depend heavily on the size of the fixed cost constraint facing the licensee, and the prevailing market conditions. This section examines how use of the vector Z of policy instruments (including the entry requirement, F_{2L}) may affect the patentee's decision to use advertising and to introduce its own generic.

Under strategic entry deterrence the patentee faces the entire market demand curve over both periods and prices are determined according to the monopoly mark-up rule: (Inverse elasticity rule)

$$P_{2P}^m = \frac{a_u + Vb_u}{2b_u} = P_{1P} = \frac{a_{1P} - Vb_{1P}}{2b_{1P}}$$

Therefore, a change in policy instruments will not affect prices either directly or indirectly, (i.e., $dP_{2P}^m/dZ = 0$) for any of the strategic entry deterring cases.

Case 3: Entry Deterrence by Limiting Informative Advertising

Under this strategy it is straightforward to evaluate the impact of changes in Z on advertising behaviour. The effect of a change in Z on entry deterring informative advertising can be seen immediately by setting $\pi_L = F_{2L}$ and deriving the entry deterring equation for K_1 : (see equation 2.53 in chapter two.)

$$K_1 = \frac{F_{2L}}{g_{2L} M_{2L} (-Va_{2L} + (a_{2L} + b_{2L} \Theta_o^L)/X - b_{2L} \Theta_o^L/X^2 + S\Theta_o^L \Theta_o^P/X - VS\Theta_o^P/X)} \quad (4.22)$$

where:

$$X = (4b_{2L} b_{2m} - S^2)$$

$$\Theta_o^P = (a_{2m} + b_{2m} V + \tau)2b_{2L} + S(a_{2L} + b_{2L} V + \tau)$$

$$\Theta_o^L = (a_{2L} + b_{2L} V + \tau)2b_{2m} + S(a_{2m} + b_{2m} V + \tau)$$

Therefore,

$$dK_1/dt_1 > 0$$

$$dK_1/dS < 0$$

$$dK_1/d\tau > 0$$

$$dK_1/dF_{2L} > 0.$$

An increase in the exclusive period and an increase in entry requirements increases informative advertising. The impact of increasing substitutability through greater S is to reduce informative advertising, thus reducing the size of the market. Hence, licensees may be more inclined to enter the market the more the drugs are perceived as closer substitutes. An increase in the royalty rate, τ , increases informative advertising. Thus, the greater is the patentee's share of the post-entry profits the more interest he has in building up the market.

(2) Advertising and Generic Introductions

(Case 4 and Case 5)

To examine the affect of the above policy instruments on the pricing and advertising behaviour of the patentee under cases 4 and 5, simulation is performed on the calibrated model. Simulation is required to examine the comparative statics of the models because of the cubic equation in case 4 and the quadratic equation from case 5.

The respective comparative static effect of adjusting the four policy instruments are reported in tables 4.2 and 4.3 below for cases 4 and 5. An extension of the exclusive period increases the amount of informative advertising and

reduces the use of persuasive advertising for both strategies.

An increase in the substitution term does not affect informative advertising but increases the amount of persuasive advertising used. Thus, when the licensee perceives the drugs as being closer substitutes the patentee shows a greater incentive to preserve his monopoly status by increasing persuasive advertising. The use of persuasive advertising is more pronounced in case 4 because tougher substitution laws in this case threaten the patentee's brandname product. On the other hand, more stringent substitution laws in case 5 threaten the market share in the generic market, where prices and contributions to overall profits are lower.

An increase in the royalty rate decreases persuasive advertising in both cases. The logic is the same as above. Hence, as the royalty rate increases entry becomes less attractive, and the patentee can reduce the amount of resources required to deter entry. Similarly as entry requirements became more stringent less persuasive advertising was required to deter entry.

TABLE 4.2**Simulation over Public Policy Instruments****Strategic Entry Deterrence
Informative and Persuasive Advertising
Case 4**

	Δ Exclusive Period, t_1	Δ Substitution Laws, S	Δ Entry Req.	Δ Royalty Rate, τ
P_{1P}^m	n/c	n/c	n/c	n/c
P_{2P}^m	n/c	n/c	n/c	n/c
Q_{1P}	+	n/c	n/c	n/c
Q_{2P}	+	n/c	n/c	n/c
K_1	+	n/c	n/c	n/c
J_1	-	+	-	-

TABLE 4.3**Simulation over Public Policy Instruments****Strategic Entry Deterrence
Pre-emption of Generic Market
Case 5**

	Δ Exclusive Period, t_1	Δ Substitution Laws, S	Δ Entry Req.	Δ Royalty Rate, τ
P_{1P}^m	n/c	n/c	n/c	n/c
P_{2P}^{mi}	n/c	n/c	n/c	n/c
Q_{1P}	+	n/c	n/c	n/c
Q_{2g}	+	n/c	n/c	n/c
Q_{2B}	+	n/c	n/c	n/c
K_1	+	n/c	n/c	n/c
J_1	-	+	-	-

4.3 Profit Comparisons Over The Different Strategies

Figures 4.1 to 4.4 demonstrate how the patentee's discounted profits are affected by the different policy instruments. The decision to report and compare profits under each case allows us to examine the degree of dominance a particular strategy has over alternative strategies for a given set of policy parameters.²⁷

Turning to the adjustments of the exclusive period, figure 4.1 demonstrates that discounted profits from cases 1, 2, 4 and 5 varied between 5 and 15 percent as the period of exclusivity ranged between 2 and 18 years. Case 3 was the exception showing that under fewer years of exclusivity discounted profits were much lower. Case 4 is marginally the most profitable strategy over the full range of exclusive period adjustments. Case 2 ranked second followed by case 5 and 1 for exclusivity up to and including 12 years. For periods of exclusivity greater than 12 years profitability under case 1 increases to become as profitable as case 4 and case 2. Case 5 becomes the least profitable strategy for periods of exclusivity greater than 12 years.

²⁷ As discussed in chapter two these cases are developed because they mimic the various policy regimes imposed on patentees.

A comparison of discounted profits with monopoly profits, where $t_1 = N$ (case 6), shows the latter to be between 40 and 50 percent greater for periods of exclusivity less than 10 years. The discounted profit gap closes dramatically as the period of exclusivity approaches 18 years (see figure 4.1).

Figure 4.2 reports that different values of S (degree of enforcement of substitution laws) alters the ranking of strategies with respect to profitability. Over smaller values of S (between 0 and 4.75) case 4 is the dominant strategy followed by case 2 and case 1. Cases 3 and 5 are substantially less profitable over values of S between 0 and 3. However, case 5 increases in profitability through this range where case 3 decreases in profitability. For values of S greater than 4.75 case 5 becomes the dominant strategy followed by case 1, case 2 and case 4. This re-ranking of strategies over different values of S has important welfare implications because the decision to trade-off policy instruments to effect the patentee's strategy and enhance welfare depends on what the assumed value for S is.²⁸

The comparison of discounted profits from the above

²⁸ Chapter Five discusses this further.

strategies with (full) monopoly profits (case 6) shows that the latter varies between seven and 30 percent greater than any of the CL strategies, depending on the value of S .

The profitability of strategies over different entry requirements are reported in figure 4.3. It is revealed that the ranking of these strategies are sensitive to the severity of entry requirements. Given that entry requirements are minimal, then case 2 is dominant followed by case 4, 5, 1, and 3. As entry requirements become more stringent (up to 40 percent of patentee entry cost), the strategies are re-ordered where case 4 is dominant followed by cases 2, 1 and 5. As the entry requirements exceed 40 percent of the patentee's entry cost then case 3 becomes the dominant strategy. Again this re-ordering of strategies has important welfare implications.

Finally, figure 4.4 indicates that a change in the royalty rate has a minor affect on the ranking of the strategies. Thus, an increase in the royalty rate from 3 percent to 40 percent of the licensee's sales does not remove case 4 from being the dominant strategy. The remaining strategies are re-ordered indicating that as the royalty rate increases profitability increases in the entry accomodating strategies (cases 1 and 2) and decreases in the entry deterring strategy (case 5).

Figure 4.1

Patentee Profits Over Different Strategies

C.6 - Monopoly Case $T_1 = N$

Figure 4.2

Patentee Profits Over Different Strategies

C.6 - Monopoly Case $T_1 = N$

Figure 4.3

Figure 4.4

Patentee Profits Over Different Strategies

C.6 – Monopoly Case $T1 = N$

CHAPTER FIVE

WELFARE ANALYSIS

5.0 INTRODUCTION

This chapter develops the social welfare function which is used to evaluate the benefits and costs to society of introducing one or more of the public policy instruments discussed in chapter four. To evaluate the effect of policy changes on social welfare simulations are performed on the calibrated model.

In general, introducing compulsory licensing, substitution laws, royalty rate adjustments, and more or less stringent entry requirements in the Canadian pharmaceutical industry may be considered worthwhile if the change in welfare measured as the sum of producer surplus (PS) plus consumer surplus (CS) is positive, i.e., whether

$$\Delta W = \Delta PS + \Delta CS > 0.$$

If all the producer surplus is picked up as supernormal profits π , then the policy may be considered worthwhile when

$$\Delta W = \Delta \pi + \Delta CS > 0^1.$$

In the Canadian pharmaceutical industry both domestic and multinational firms are suppliers of drugs. Because foreign owned multinational firms play a key role in supplying ethical prescription drugs producer surplus is examined more closely. Thus, total producer surplus, PS_T , can be divided into two segments:

$$PS_T = PS_P + PS_L$$

where PS_P is the producer surplus generated by the patentee, and PS_L is the producer surplus generated by the licensee. This serves as a convenient way to classify producer surplus because, in Canada, foreign owned multinational firms comprise over 80 percent of the patentee market. Licensees, on the other hand, are generally smaller domestic firms comprising approximately 65 percent of the licensee market. If multinational firms are earning supernormal profits, it is arguable that foreign producer surplus should not be included in the evaluation of domestic welfare when formulating public policy.²

¹ This is often referred to as the Kaldor-Hicks criterion. See Waterson (1984) for a brief discussion.

² It can also be argued that the marginal contribution of profits from Canada make up part of the incentive for multinational firms to conduct research and development on

Exclusion or discounting of foreign surplus raises the issue of attenuation of international intellectual property rights³: Should Canada, being a small market for ethical prescription drugs, free ride off of foreign multinational's Research and Development efforts by introducing compulsory licensing?⁴ If this is the policy chosen by the domestic government, then it may follow that the drugs supplied by patentees and licensees are to be treated differently. A part of section five below describes how welfare is calculated when the government attaches different social weights to foreign and domestic producer surpluses.

The remaining sections in this chapter are organized as follows. Section one discusses briefly some problems discussed in the literature associated with the adoption of traditional measures of welfare. Section two reviews the

"new" products. These new products can then be introduced into Canada providing future benefits (i.e., surplus) to both consumers and producers.

3 The attenuation of intellectual property rights has become a growing concern for several innovating countries. This has resulted in Intellectual Property Rights being granted special status under the current Uruguay rounds of GATT negotiations.

4 Proponents of national free riding argue that Canada comprises only two percent of the world market for ethical prescription drugs and therefore will not affect the incentives of large innovating firms to conduct R&D. Opponents argue that Canada must contribute their fair share and that the larger innovating nations may retaliate against other markets.

relevant literature which discusses advertising and its impact on welfare. Section three develops the welfare measure used in this research by employing the quadratic utility function discussed in chapter 2. Measuring total surplus in this way demonstrates how the following effects on welfare can be calculated: spending on persuasive advertising; different social weights attached to foreign surplus; and, the use of public policy instruments to effect changes in patentee behaviour.

Simulation is then used in section four to calculate the amount of total economic surplus derived from the different cases examined in the preceding chapters. Within these cases the simulation is performed over different values of the cross terms, S (degree of substitutability), the fixed cost requirement term, F_{2L} (under the influence of Health and Welfare Canada), the duration of the exclusivity period, t_1 , the type and size of the royalty rate, τ , and, the degree of foreign ownership.

5.1 SOME PROBLEMS WITH WELFARE MEASURES

When applying welfare measures to evaluate the social benefits and cost of government policy economists have discussed several problems which must be considered (see for example, Silberberg (1972), Burns (1973), Boadway and Bruce (1984), and Blackorby and Donaldson (1990)).

Two measures of welfare change are equivalent and compensating variations (EV and CV), respectively. More specifically, (from Layard and Walters (1980)),

"The equivalent variation is the amount of money we would need to give an individual, if an economic change did not happen, to make him as well off as if it had happened".

Compensating variation is defined as,

"...the amount of money we can take away from an individual after an economic change, while leaving him as well off as he was before it..."

Willig (1976) demonstrates that consumer surplus is a good approximation for both EV and CV if income effects are small.

A major concern of the literature is that domestic income distribution or equity is ignored when calculating the potential gains from an economic change. Hence, the criteria has been that if the gainers can compensate the losers there is a potential for both parties to be made better off⁵.

Another problem in calculating consumer surplus is the path dependency problem. This problem illustrates how changes in consumer surplus depends on whether it is measured before or after economic change. The greater the income effect the greater the difference in the measure. The smaller the income effect, or equal and constant income elasticity across all goods reduces this problem. Finally, consumer surplus may be understated for goods which have a convex demand function. This occurs because as quantity approaches the price axis the area under the inverse demand curve approaches infinity, and therefore becomes virtually impossible to measure. Any linear approximation of the demand curve, however, will understate the true area of consumer surplus. This may have serious social implications if producers are using the profit criteria as a basis for deciding which good (or goods) to introduce out of a group

⁵ Or, when analyzing consumers and producers, then if consumers are assumed to own equally the shares of firms in the productive sector.

of close substitutes.⁶

The above problems associated with the use of traditional welfare measures show limitations of using the ensuing welfare calculations for policy making purposes. The following assumptions are made to facilitate the subsequent welfare calculations. First, demand curves are assumed to be linear. This assumption simplifies matters by taking the actual measurement of surplus under the inverse demand curve. Second, drugs are assumed to make up only a small proportion of an individual's budget, therefore income effects are assumed to be negligible. A zero income effect works to eliminate the path dependency problem, as well as, show that all three welfare measures (EV, CV and Consumer surplus) are identical.⁷ The next section examines the literature which studies advertising and its impact on welfare. This relationship is important because the introduction of public policy in shaping the economic environment may have a large impact on the patentee's pricing and advertising behaviour.

⁶ See Spence (1977) for a full discussion on the bias in product selection and its welfare implications.

⁷ This occurs because with zero income effects compensated and ordinary demand curves are identical.

5.2 ADVERTISING AND WELFARE--LITERATURE REVIEW

The issue of advertising composition under monopoly and its affect on welfare have been studied by Dixit and Norman (1978), Kotowitz and Mathewson (1979), Stigler and Becker (1978), Nichols (1985), and more recently by Usher (1989). The varied assumptions contained in the different approaches have given rise to quite different outcomes on the issue of whether or not advertising is considered to be socially excessive.

In this study advertising is used by the patentee as a strategic instrument to develop the market, as well as, secure a portion of the market. It becomes important, therefore, to understand the relationship between the use of advertising and it potential affect on welfare.

Dixit and Norman assume that advertising works to change consumer taste. Welfare is measured as the change in producer and consumer surplus where producer surplus is given by the change in profits. Through advertising the demand curve shifts outward where price and/or quantity are assumed to rise. This is demonstrated in figure 5.1 below. The post-advertising demand curve is represented by d_1 . A change in welfare is given by $\Delta\pi - q\Delta P$, where $\Delta\pi$ is equal to the area $P_1EDP_0 + DCFG$. The area EB CD is assumed to be of a

Figure 5.1

ADVERTISING AND WELFARE
(Dixit and Norman)

Change in Welfare:

$$\Delta W = \Delta CS + \Delta PS$$

Where:

$$\Delta CS = q_1 \Delta P = q_1 (P_1 - P_0)$$

$$\Delta PS = \Delta \Pi = P_1 EDP_0 + DCFG$$

Since $\Delta \Pi = \text{cost of advertising}$, then

$$\Delta W = -q_1 \Delta P$$

second order magnitude and is omitted from the welfare calculation. Therefore the change in welfare is approximately the same using either the pre- or post-advertising demand curve. Since the change in consumer surplus is $-q\Delta P$ and a profit maximizing monopolist incurs advertising up to the point where $\Delta\pi$ equals the cost of advertising, then $\Delta W < 0$. Hence, Dixit and Norman argue that advertising by a monopolist is socially excessive. Under a situation where demand elasticity does not change at a given price, the monopolist's decision is efficient.

An important part of Dixit and Norman's analysis is that for a given change in advertising, either the pre- or post- advertising demand curve must be used as the standard to evaluate changes in welfare.

Usher (1989) provides an extension to Dixit and Norman by examining large shifts in demand caused by persuasive advertising. In other words, the area EBCD alluded to above is large enough to warrant consideration. Usher examines two extreme cases; first, where persuasive advertising does not affect price but equilibrium quantity purchased increases; and, second, where the equilibrium quantity purchased is unaffected but price increases. These two cases are illustrated in figures 5.2 and 5.3 below. In the first case, consumers are persuaded to purchase more, but

Figure 5.2

PERSUASIVE ADVERTISING AND WELFARE
QUANTITY CHANGE (Usher)

Figure 5.3

PERSUASIVE ADVERTISING AND WELFARE
PRICE CHANGE (Usher)

their marginal valuation is given by the pre-advertising demand curve, d_1 . Therefore the area ABD represents the consumers loss. The monopolists gain is given by ABCF. On balance, to determine if consumers loss is greater than the monopolists gain depends on where the socially optimal output level q_s is in relation to the monopolists output level q_m ⁸. If $q_s > (<) q_m$ then the change in welfare is positive (negative).

In Usher's second case output is unaffected by advertising so that consumers loss equals the monopolists gain (straight transfer) P_2GHP_1 . If the monopolist advertises up to the point where the change in profit equals zero, then there is a net social cost associated with this type of advertising.

Usher's analysis differs from Dixit and Norman analysis in one important respect. He assumes that the pre-advertising demand curve represents the consumers "true preferences" and proceeds to evaluate changes in welfare

⁸ The socially optimal level of advertising occurs at the point where the last dollar of advertising generated by the extra demand (marginal consumer) is equal to the marginal cost of advertising. The difference between this and private optimality is that surplus is the benefit generated from the marginal consumer and not profit. As a result price equals marginal cost and the output is given by q_s as shown in figures 5.2 and 5.3.

under that standard. On the other hand, Dixit and Norman argue that either the pre- or post-advertising demand must be used as the standard when evaluating welfare implications.

Kotowitz and Mathewson assume that consumers tastes are not affected by advertising. In their model, both new and old consumers are assumed to have identical taste distributions. New consumers are assumed to have a latent demand for the product, demand elasticity remains constant at a given price, and the quantity purchased is not altered. This is demonstrated in figure 5.4 below. A shift in demand does not affect any previous demanders because price remains constant. Thus, d_1 represents demand from new consumers only. The shift in demand from informative advertising increases welfare by the area $PBCV + ABP$ minus the cost of advertising. Since advertising by a profit maximizing monopolist is assumed to be incurred up until the change in profits equals the cost of advertising, then the net welfare gain is given by ABP . According to Kotowitz and Mathewson advertising is under spent because the simple monopolist is unable to extract the full area of consumer surplus ABP .

Stigler and Becker (1978) and Nichols (1985) follow the Lancasterian approach to demand where advertising is simply a characteristic like any other characteristic of a good which affects an individuals utility. Increasing

Figure 5.4

ADVERTISING AND WELFARE
(Kotowitz and Mathewson)

Change in Welfare:

$$\Delta W = \Delta CS + \Delta PS$$

Where:

$$\Delta CS = ABP$$

$$\Delta PS = PBCV = \Delta \Pi$$

therefore, $\Delta W = ABCV$ - the cost of resources to advertise
(i.e., if $\Delta \Pi = 0$ then $\Delta W = ABP$)

advertising causes a movement along the characteristic demand curve (interpreted as a shift in the product demand curve in other approaches). The measure of consumer surplus is simply the area under the stable characteristic demand curve and above the shadow price. Advertising is believed to lower the shadow price of a characteristic by increasing the ability of the purchased good to produce the desired characteristic. Consumers are left to decide whether advertising is informative or persuasive.

5.30 MEASUREMENT OF SOCIAL WELFARE

Given the above authors analysis of the effects of advertising on welfare, we proceed to examine the impact that public policy may have on welfare, both directly through its immediate affect on entry conditions, and indirectly through its affect on advertising behaviour of the patentee. We begin by examining welfare under a monopoly regime. This serves as our benchmark case to compare the impact on welfare when other policy instruments are introduced and entry environments are altered. The other market structures examined include cases 1 to 5 developed in chapter two. The method used to evaluate welfare for each case is developed in this section. The following section calculates actual welfare measures for cases 2 and 4 only (the two most profitable cases) by performing simulations over different values of the policy paramaters. This is done recognizing that in moving from one set of policy parameters to another only one case will dominate under any given set of policy parameters. The decision to report welfare measures for both case 2 and case 4, over the entire range of policy parameters, allows us to examine more closely the sensitivity of these measures in both cases to changes in policy parameters.

In the present research we defined two distinct roles

for advertising: informing consumers and persuading consumers. We make the assumption that the former does not affect consumers preferences (as in Kotowitz and Mathewson) because prices and quantities, for the intra-marginal consumers, are unaffected by this type of advertising. The latter advertising is assumed to affect consumers preferences (as in Dixit and Norman) since price and quantities are affected.

Constructing a total surplus measure to evaluate policy in this industry requires the use of the representative individual's welfare function derived in chapter two, thus

$$W = Y + U(q_B, q_g, q_L) .$$

U denotes the quadratic utility function.⁹ Y denotes the unadvertised good which is assumed to be known to all consumers, and represents the competitive numeraire sector. q_B , q_g , and q_L denote the goods from the duopolistic sector, where q_B represents the patentee's brandname product, q_g represents the patentee's generic version of the brandname product, and q_L denotes the licensee's generic. If A_I equals zero then $q_B = q_g = q_L = 0$. Furthermore, under a monopoly regime consumers are restricted to consume only q_B .

⁹ The quadratic utility function includes both consumer and producer surplus.

therefore, $q_L = q_g = 0$ and the utility function collapses to become¹⁰

$$W = Y + U(q_m).$$

$$\text{where } U(q_m) = \alpha_m q_m - \frac{1}{2} \beta_m q_m^2.$$

(1) - Total Surplus and Extended Patent Protection
(Case 6--Benchmark)

Under a policy regime which guarantees the patentee extended (full) patent protection total discounted surplus, TS_m , is defined as

$$\begin{aligned} TS_m &= \int_0^{t_1} \left[U_{1m}(Q_{1B}) \right] e^{-rt} dt + \int_{t_1}^N U_{2m}(Q_{2B}) e^{-rt} dt \\ &\quad - F_{1P} - C(K_1) \end{aligned} \quad (5.6).$$

Where:¹¹

$$U_{im} = \alpha_m Q_{iB} - \frac{1}{2} \beta_{iB} Q_{iB}^2 \quad i = 1, 2.$$

¹⁰ Since utility is assumed to be additive and separable the evaluation of total surplus is restricted to the advertised sector. See Vives and Singh (1984), and Dixit (1980).

¹¹ In this section, total surplus for all cases is defined net of variable cost.

U_{im} represents the first and second period utility functions under a monopoly regime.¹² $C(K_1)$ and F_{1p} represent the cost of advertising and set-up cost (entry requirements) incurred in the first period. Under this case persuasive advertising is not used because the threat of entry is absent.

The monopoly case is demonstrated in figure 5.5 below. The patentee is granted full patent protection by the setting of $t_1 = N$. d_m , derived from the utility function given by U_{im} , denotes consumers per period demand over both periods, and price is set according to the inverse elasticity rule ($P_m = 1/\epsilon$). Equilibrium quantity per individual is given by q_m .¹³ Total surplus is given by the area ABCV where ABP_m is consumer surplus and P_mBCV represents producer surplus.

¹² See chapter two for a full discussion on the Utility functions and derivation of demand curves.

¹³ If the monopolist could practise price discrimination then quantity may be set at q_m per individual and price would equal marginal cost, V , for the marginal user.

Figure 5.5

**ADVERTISING AND WELFARE
(EXCLUSIVE PATENT PROTECTION)**

Period One and Two

TOTAL SURPLUS:

Consumer Surplus = ABP_m

Producer Surplus = P_mBCV

therefore, $TS = ABCV$ - cost of advertising and fixed cost.

5.31 Persuasive Advertising and Entry Accommodation

Under a compulsory licensing regime the patentee employs a strategy of using persuasive and informative advertising, and the introduction of his own generic to accommodate the entry of a licensee. The employment of the quadratic utility function measures the extent to which changes in policy instruments affects welfare, while simultaneously adjusting for the affect that persuasive advertising has on individuals preferences. Total discounted surplus, TS_{EA} , under entry accommodation (EA) is defined below:

(2) Total Surplus and Pre-Advertising Utility

$$\begin{aligned}
 TS_{EA} = & \int_0^{t_1} \left[U_{1m}(Q_{1P}) \right] e^{-rt} dt + \int_{t_1}^N \left[U_{2m}(Q_{2B}, Q_{2L}) \right] e^{-rt} dt \\
 & - F_{1P} - F_{2L} - C(K_1)
 \end{aligned} \tag{5.7}$$

Where:

$$\begin{aligned}
 U_{1m} &= \alpha_{1m} Q_{1P} - \frac{1}{2} \beta_{1B} Q_{1B}^2, \\
 U_{2m} &= \alpha_{2B} Q_{2B} + \alpha_{2L} Q_{2L} - \frac{1}{2} (\beta_{2B} Q_{2B}^2 + \beta_{2L} Q_{2L}^2 - \gamma_{BL} Q_{2B} Q_{2L})
 \end{aligned}$$

U_{1m} denotes the first period representative individuals utility function. In the first period, welfare is evaluated

under a monopoly regime where consumers are restricted from being able to choose between the brandname product and licensee's generic. U_{2m} denotes the pre- (persuasive) advertising utility function in period two. In other words, welfare during the CL period is evaluated by using the pre-advertising utility function as the standard.¹⁴ This recognizes that persuasive advertising alters individuals preferences in the second period (as in Dixit and Norman).¹⁵ F_{2L} represents the set-up cost (entry requirements) of the licensee at the beginning of period two.

By inserting the equilibrium quantities obtained from the entry accommodating case¹⁶ into the U function obtained under monopoly and then using the value for U to compute total discounted surplus, TS, we can determine the extent to which policy instruments are welfare reducing or enhancing, holding constant individual preferences.

¹⁴ The assumption being made is that although persuasive advertising is incurred during the exclusive period it only affects consumers choices during the compulsory licensing period. Therefore, welfare is evaluated in the second period by using the first period (pre-persuasive advertising) utility function as the standard.

¹⁵ See chapter two.

¹⁶ The equilibrium quantities Q_{2B} and Q_{2G} , from the entry accommodating case 2, were summed together and inserted into the U_{2m} function to calculate total surplus.

(3) Total Surplus and Post-Advertising Utility

Alternatively, because persuasive advertising is assumed to alter consumer preferences in the second period only, welfare may also be evaluated by using the post-advertising utility function as the standard. This is accomplished by inserting the quantities from the monopoly equilibria into the post-advertising utility function and comparing this measure of total surplus with the total surplus obtained by inserting the post-advertising equilibrium quantities. Thus total discounted surplus, TS_{EA} under cases 1 and 2 are defined below. (u denotes uncontested market and c denotes contested market).

Case 1: Entry Without Generic Competition

$$\begin{aligned}
 TS_{EA1} = & \int_0^{t_1} \left[U_{1m}(Q_{1P}) \right] e^{-rt} dt + \int_{t_1}^N \left[U_u(Q_{2P}^u) + \right. \\
 & \left. U_c(Q_{2P}^c, Q_{2L}) \right] e^{-rt} dt - F_{1P} - F_{2L} - C_I(K_1) - C_o(J_1)
 \end{aligned}
 \tag{5.8}$$

Where:

U_{1m} is defined in (5.6) above,

$$U_u(Q_{2P}^u) = \alpha_u Q_{2P} - \frac{1}{2} \beta_u Q_{2P}^2$$

$$U_c(Q_{2P}^c, Q_{2L}) = \alpha_B Q_{2P}^c + \alpha_L Q_{2L} - (\beta_B Q_{2P}^{c2} + 2\gamma_{BL} Q_{2L} Q_{2P}^c + \beta_L^2 Q_{2L}^2) / 2$$

Case 2: Price Discrimination and Patentee Generic

$$\begin{aligned}
 TS_{EA2} = & \int_0^{t_1} \left[U_m(Q_{1P}) \right] e^{-rt} dt + \int_{t_1}^N \left[U_u(Q_{2P}^u) + \right. \\
 & \left. U_c(Q_{2g}, Q_{2L}) \right] e^{-rt} dt - F_{1P} - F_{2L} - C_I(K_1) - C_O(J_1)
 \end{aligned}
 \tag{5.9}$$

Where:

U_m is defined in (5.6),

$$U_u(Q_{2P}^u) = \alpha_u Q_{2P}^u - \frac{1}{2} \beta_u Q_{2P}^{u2}$$

$$U_c(Q_{2g}, Q_{2L}) = \alpha_{BL} Q_{2g}^c + \alpha_L Q_{2L} - (\beta_{BL} Q_{2g}^{c2} + 2\gamma_{BL} Q_{2L} Q_{2g}^c + \beta_L^2 Q_{2L}^2) / 2$$

From (5.8) and (5.9) second period consumers are split into two groups: Group two contains those individuals whose preferences are assumed to have been altered (captured) by the patentee through A_o , and are represented by U_u ; Group one, represented by U_c , contain those individuals whose preferences are uninfluenced by persuasive advertising (as in the previous case), and whose decision to purchase the patentee's and licensee's drug is based on price and quality differences. In case 1, group one individuals consume the brandname product ($q_g = 0$), where in case 2, group one individuals consume only the generic product (see chapter two).

Total discounted surplus from (2) and (3) above are further illustrated in figures (5.6) and (5.7) below. In

Figure 5.6

FIRST PERIOD DEMAND UNDER PROTECTED
MONOPOLY AND QUASI-PROTECTED MONOPOLY

Figure 5.7

SECOND PERIOD DEMAND FACING
PATENTEE AND LICENSEE

figure (5.6) D_m represents the market demand curve facing the patentee during the exclusive period. This is shown to be outside the demand curve, D_{1P} , facing the patentee ($t_1 = 1/2N$) when compulsory licensing is anticipated in period two. The placement of these demand curves are determined by the amount of persuasive advertising incurred by the patentee when subjected to entry. Thus the patentee's advertising behaviour in attempting to secure a market share in the second period is shown to have an intertemporal affect on first period demand, given by D_{1P} . This occurs because the greater the persuasive advertising the greater the informative advertising.¹⁷ Total surplus in the first period is given by ADEV under entry accomodation and ABCV under monopoly, m . It is seen that $ABCv > ADEv$. In other words, the patentee will always incur more informative advertising under a regime where full patent protection is granted ($t_1 = N$) compared to a regime where CL is anticipated ($t_1 < N$).

Total surplus for the second period is less straight forward to analyze because of the effect of persuasive advertising in changing preferences of consumers (J_1K_1). In figure (5.7a) the demand curve facing the licensee is given by D_{2L} . Total surplus obtained from the licensee market is

¹⁷ This relationship was demonstrated in chapter two (see equation 2.32) and confirmed by performing simulations.

simply the area under the demand curve above marginal cost (i.e., producer surplus plus consumer surplus).

The patentee's second period market is represented in figure 5.7b. D_{2P}° denotes the demand facing the patentee when entry does not occur in the second period. As entry occurs the patentee uses persuasive advertising to prevent the demand curve from shifting inward to D_{2P}' (the no-persuasive advertising equilibria). Thus, the greater the J_1 the less the demand curve shifts inward and the more the demand curve pivots clockwise, as represented by D_{2P}'' . Furthermore, the greater the secured market, J_1 the greater the output and price for the patentee at the expense of the licensee. To calculate total surplus from the patentee market we can use either D_{2P}° or D_{2P}'' as the standard. Using D_{2P}'' (post-advertising demand) total surplus is given by the area, GHIV or alternatively under D_{2P}° (pre-persuasive advertising demand) total surplus becomes KLMV.

5.32 TOTAL SURPLUS UNDER ENTRY DETERRENCE STRATEGIES

Under Strategic entry deterrence the patentee attempts to exploit the first period, t_1 by incurring advertising so that entry becomes unattractive. For entry deterrence to be successful, the patentee must either capture a sufficient segment of the market, through a combination of persuasive and/or informative advertising (cases 3 and 4); Or, introduce a generic brand to pre-empt the licensee from introducing a generic brand (case 5). Either of these strategies may result in the patentee realizing a monopoly position in the second period. Total surplus for these cases are given below,

Case 3: Entry Deterrence by Limiting Informative Advertising

$$\begin{aligned}
 TS_{33} = & \int_0^{t_1} \left[U_{1m}(Q_{1P}) \right] e^{-rt} dt + \int_{t_1}^N U_{2m}(Q_{2P}) e^{-rt} dt \\
 & - F_{1P} - C_I(K_1)
 \end{aligned} \tag{5.9}$$

Case 4: Entry Deterrence and Strategic Advertising

$$\begin{aligned}
 TS_{44} = & \int_0^{t_1} \left[U_{1m}(Q_{1P}) \right] e^{-rt} dt + \int_{t_1}^N U_{2m}(Q_{2P}) e^{-rt} dt \\
 & - F_{1P} - C_I(K_1) - C_O(J_1)
 \end{aligned} \tag{5.10}$$

Case 5: Pre-empting the Generic Market

$$\begin{aligned}
TS_{\pi} = & \int_0^{t_1} \left[U_{1m}(Q_{1P}) \right] e^{-rt} dt + \int_{t_1}^N \left[U_{2m}^U(Q_{2P}) + U_{2m}^C(Q_{2g}) \right] e^{-rt} dt \\
& - F_{1P} - F_{2g} - C_I(K_1) - C_O(J_1)
\end{aligned} \tag{5.11}$$

U_{1m} and U_{2m} are given in equations (5.7) above. Q_{1P} and Q_{2P} in each case represents the first and second period equilibrium quantities of the patentee's brandname product, and Q_{2g} represents the second period equilibrium quantity of the patentee's generic version of the brandname product. All other terms have been defined previously.

5.40 Total Surplus and Policy Instruments: Simulation

This section performs simulations to evaluate how changes in government induced policy environments affect TS¹⁸. The affect on TS is confined to examining the two most profitable strategies--case 2 and case 4. The former strategy introduces a patentee generic to compete with the licensee under entry accommodation. The latter emphasizes the use of persuasive and informative advertising to deter the licensee from entering the market during the compulsory licensing period.

The effect of changes in policy instruments on TS are reported in tables 5.1 to 5.4 below. To examine how each policy instrument influences TS, one policy instrument is allowed to change at a time, holding all other policy instruments constant.

Table 5.1 reports how extending the exclusive period, t_1 , affects TS. TS is found to be greater in case 2 compared to case 4 over the full range of simulated values of the

¹⁸ Similarly, other welfare measures may be developed including consumer surplus and total domestic surplus. These measures could have equally been used as the standard in which to evaluate and compare the impact of the above government policy on welfare. These latter two measures are examined in the last section.

Table 5.1

Exclusive Period and Welfare

Policy Variable:	Case 2			Case 4		
	TS	π	TDS	TS	π	TDS
$t_1 = 2$	45.9	22.9	24.1	43.9	23.3	21.4
6	47.1	24.3	23.6	45.9	25.2	21.1
10	47.9	25.5	23.1	47.2	26.8	20.4
14	50.9	28.3	22.8	49.4	29.0	20.4
18	52.2	30.4	21.8	50.4	30.5	19.9
$S = 4$	Case 6: TS = 50.9					
$R = 4\%$	TDS = 19.2					
$F_{2L} = .1F_{2P}$	$\pi = 31.7$					

Table 5.2

Substitution and Welfare

Policy Variable:	Case 2			Case 4		
	TS	π	TDS	TS	π	TDS
$S = 0$	47.5	25.0	23.1	50.9	29.7	21.2
1.6	48.1	25.4	23.6	49.2	28.4	20.8
4.8	49.0	25.9	24.3	46.8	26.1	20.7
6.4	52.3	26.8	26.8	45.6	25.1	20.5
$t_1 = .5N$	Case 6: TS = 50.9					
$R = 4\%$	TDS = 19.2					
$F_{2L} = .1F_{2P}$	$\pi = 31.7$					

period of exclusivity. This is in contrast to profitability comparisons over the same periods of exclusivity, where case 4 is dominant. Comparison of TS and profitability to the benchmark case (Case 6) reveals that profitability (31.7) is always greater when the patentee is guaranteed full patent protection. Domestic surplus, however, is always lower in case 6 (19.2). Finally, TS is greater in case 6 (50.9) up to 14 years of exclusive protection. After 14 years case 2 yields the greatest TS. This occurs because after 14 years patentee profitability in case 2 rises substantially (to 30.4).

Table 5.2 shows the effect on TS, profitability and domestic surplus as substitution laws are varied. Under minimal substitution laws (given by values of S ranging between 0 and 1.6) case 4 yields greater TS and profits than case 2. As substitution laws become more stringent (S ranging between 4.8 and 6.4) case 2 provides greater TS and profitability. Domestic surplus is greater in case 2 for all ranges of S .

The above re-ranking of strategies with respect to both TS and profitability, as S is varied, may be explained by the use of advertising. Under case 2, the more the drugs are perceived as closer substitutes, given by larger values of S , the less the amount of persuasive advertising incurred

by the patentee and the more the amount of informative advertising.¹⁹ The reduction in persuasive advertising results in a larger generic market and lower generic prices²⁰. In addition, because informative advertising increases TS is enhanced. Hence, TS increases by about 10 percent and profitability increases by about 6 percent over the simulated range.

Comparison of TS and profitability under cases 2 and 4 with case 6 indicates that when there is no cross price affect (i.e., when substitution laws are at a minimum as given by $S = 0$) case 6 yields larger profitability (31.9) but identical TS to case 4. The lower profitability in case 4 is due to the extra cost that arises from the amount of persuasive advertising required to deter entry. As substitution laws become more stringent TS in case 4 decreases. Case 2, on the other hand, shows that when substitution laws are more strictly enforced TS is greater than in case 6 (see table 5.2). Domestic surplus (TDS) is shown to be greater in case 2 than case 4 and the gap increases as substitution laws are more stringently enforced.

¹⁹ This was demonstrated in chapter four (see page 121).

²⁰ The lower generic prices comes through the strategic effect (see chapter two).

The effect on TS from increasing the royalty rate is shown in table 5.3. Lower royalty rates (between 2 and 10%) reveals that case 2 yields larger TS than case 4. As royalty rates increase above 10 percent, TS from case 4 becomes larger. This re-ranking of TS may be explained by the effect on advertising as royalty rates increase. Under case 2, an increase in the royalty rate reduces the amount of persuasive advertising and consequently reduces prices. On the other hand, generic prices are raised because of the *ad valorem* type structure within which royalty rates are set.²¹ The overall affect on case 2 TS is a slight increase of approximately two percent. Under case 4 an increase in the royalty rate also reduces the amount of persuasive advertising required by the patentee to deter entry. This reduction in resources required to deter entry is enough to increase TS in case 4 beyond TS derived from case 2. The comparison of TS with the fully protected patentee (Case 6) shows that over the simulated range of royalty rates (between 2 and 34 percent) TS and profitability approaches but does not reach the amount of TS under case 6.

Adjusting entry requirements and its affect on TS is seen in table 5.4. TS is largest under case 2 when entry requirements are minimal. As entry requirements become more

²¹ See chapter four pages 105 and 120.

Resolution Test Chart Labels:

- 1.0
- 1.1
- 1.25
- 1.4
- 1.6
- 1.8
- 2.0
- 2.2
- 2.5
- 2.8
- 3.2
- 3.6
- 4.0

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

stringent TS under case 2 falls dramatically (by 16 percent over the specified range). Under case 4 TS increases as entry requirements are increased. Domestic surplus under minimal entry requirements are greater in case 2 relative to case 4. As entry requirements become more stringent domestic surplus falls for case 2 and rises for case 4.

5.50 Foreign Surplus and Social Welfare Weights

The above welfare measure treats producers and consumers equally. If policy makers are interested in calculating consumer surplus (CS) then producers profits are simply subtracted from the above total surplus measures.²² Comparing consumer surplus across the different market settings becomes important when distributional concerns arise. Thus, if governments are concerned that consumers are not receiving enough of the benefits derived from the marketing of drugs, they may decide to introduce policy which maximizes CS even at the expense of producer surplus (PS).

Similarly, when governments are concerned with the maximization of domestic welfare only, they will consider CS plus domestic PS (i.e., PS_L).

The subtraction of foreign profits (i.e., PS_F) from total surplus yields a measure of domestic welfare. In the above cases, assigning different "social" weights to foreign surplus may reflect the extent to which foreign surplus is believed to contribute towards the enhancement of domestic

²² See footnote 2.

welfare²³.

If the monopolist patentees are foreign owned multinational firms, then total surplus for the above cases can be written as;

$$TDS_j = TS_j - \lambda PS_f \quad 0 < \lambda < 1.$$

Where TDS represents total domestic surplus, and PS_f denotes foreign producer surplus. λ defines the weight attached to foreign producer surplus. If λ is set equal to zero then foreign surplus is considered to contribute fully toward domestic welfare.²⁴ A value for λ set equal to unity, on the other hand, may imply that foreign controlled multinationals contribute little toward domestic welfare.

Again, writing surplus this way serves to highlight the issue of attenuation of intellectual property rights. If local government authorities are concerned with maximizing domestic welfare only (i.e. consumer surplus and domestic producer surplus), they may set λ at or near unity, and

²³ This also demonstrates how policy can be implemented which shifts rents from foreign producers to domestic residents (domestic producers and/or consumers).

²⁴ This may be the case, for example, if no difference can be found in the behaviour of foreign or domestic firms.

introduce public policy to achieve this objective.²⁵

Table 5.5 below records how different welfare measures may be used to evaluate cases 1 to 6. The comparison was done holding the policy instruments constant at their initial calibrated levels. The full monopoly case (Case 6) yields the largest total surplus (TS), followed by cases 2, 4 and the remaining cases. Using total domestic surplus (TDS) as the welfare measure demonstrates that case two is dominant followed by case 1 and case 4. The full monopoly case yields a TDS approximately 15 percent below the dominant cases. Using consumer surplus (CS) as the welfare measure reveals the identical ranking as TDS.

The above findings demonstrate that the government's decision to effect changes in the policy environment may depend on which type of welfare measure is considered.

²⁵ Policy makers must assume that the profit constraints of patent holders are satisfied before setting policy to ensure that the drugs are introduced into the country. This problem is addressed formally in Berkowitz and Kotowitz (1982).

Table 5.5

Alternative Welfare Measures

Strategies	TS	CS	TDS ($\lambda=1$)
Case 1	47.0	20.9	22.1
Case 2	47.8	21.2	22.5
Case 3	11.1	10.1	10.1
Case 4	47.2	20.4	20.4
Case 5	45.1	20.3	20.3
Case 6	50.9	19.2	19.2

5.5 POLICY TRADE-OFFS AND WELFARE

This section examines how various combinations of policy instruments affect welfare under cases 2 and 4. The different policy combinations include:

(1) $(t_1 = 2 \ \tau = .34)$, $(t_1 = 4 \ \tau = .24)$, $(t_1 = 8 \ \tau = .12)$, $(t_1 = 10 \ \tau = .04)$, and $(t_1 = 14 \ \tau = 0)$ defined as $Z_{t_1, \tau} = 0, 1, 2, 3, 4$, respectively.

(2) $(t_1 = 2 \ F_{2L} = .6F_{2P})$, $(t_1 = 6 \ F_{2L} = .45F_{2P})$, $(t_1 = 8 \ F_{2L} = .25F_{2P})$, $(t_1 = 10 \ F_{2L} = .15F_{2P})$, and $(t_1 = 14 \ F_{2L} = .025F_{2P})$ defined as $Z_{t_1, F} = 0, 1, 2, 3, 4$, respectively.

Tables 5.6 and 5.7 below report on how changes in TS, TDS, and CS are affected under cases 2 and 4 when the above Z policy combinations are implemented. Turning to case 2, an increase in the exclusive period combined with a decrease in the royalty rate (see table 5.6) increases TS, TDS, and CS. Of the three welfare measures TS shows the largest increase of approximately 10 percent. This compares to a less than two percent rise in TDS and CS.

A similar pattern emerges, with respect to influencing TS and domestic surplus, for the $Z_{t_1, F_{2L}}$ policy combination--increases in both entry requirements and the

Table 5.6

POLICY COMBINATIONS

(Case 2)

	Total Surplus (TS)	Consumer Surplus (CS)	Total Domestic Surplus (TDS)	Profits (Π_p)
$Z_{t1, \tau}$				
0	45.1	21.6	22.0	23.1
1	46.4	21.6	22.1	24.8
2	47.0	21.8	22.3	25.2
3	47.6	21.8	22.3	25.9
4	49.6	21.9	22.4	27.7
$Z_{t1, F2L}$				
0	39.1	18.1	18.1	21.1
1	42.1	19.3	19.3	22.8
2	45.1	20.8	20.9	24.3
3	47.1	21.6	21.6	25.5
4	50.2	21.7	22.7	28.6

Table 5.7

POLICY COMBINATIONS
(Case 4)

	Total Surplus (TS)	Consumer Surplus (CS)	Profits (Π_p)	Total Domestic Surplus (TDS)
$Z_{t1, \tau}$				
0	45.7	21.2	24.5	21.2
1	46.7	20.8	25.8	20.8
2	46.7	20.9	25.9	20.9
3	47.2	20.5	26.7	20.5
4	49.3	19.9	29.6	19.9
$Z_{t1, F2L}$				
0	55.4	27.1	28.3	27.1
1	54.3	25.2	28.1	25.2
2	50.2	22.9	27.8	22.9
3	48.9	21.2	27.7	21.2
4	44.9	19.7	24.4	19.7

period of exclusivity. The extent of the impact on welfare was more pronounced using this policy combination, showing a decrease in TS of 25 percent, and a decrease in domestic surplus of 25 percent (see tables 5.6 and 5.7).

Under case 4 a different pattern emerges. In this case depending on which policy combination is chosen, TS, TDS, and CS may move in different directions. For example, implementing $Z_{u,r}$ increases TS by approximately 9 percent and reduces domestic surplus by approximately 4 percent.²⁶ Implementing $Z_{u,FZL}$, on the other hand, reduces TS and domestic surplus by approximately 20 and 28 percent, respectively.

To determine whether the above policy combinations causes the patentee to alter his strategy we compare how profitability is affected under the two cases. Tables 5.6 and 5.7 record profitability under the two cases. The decision to apply $Z_{u,r}$ demonstrates that case 4 is more profitable over all combinations and therefore entry deterrence is expected to prevail. Implementing the policy

²⁶ The increase in TS from the combined setting of the exclusive period and the royalty rate is consistent with Tandon (1982). He shows that welfare increases as the exclusive period increases and maximum welfare occurs at an infinite patent life. However, even if the patent period is set at 17 years the setting of a (optimal) royalty rate, under compulsory licensing, can enhance welfare.

combination, $Z_{11,F2L}$ causes the patentee to use an entry deterrent strategy (case 4) when $Z_{11,F2L} = (0, 1, 2, 3)$ and an entry accommodating strategy when $Z_{11,F2L} = (4)$.

To determine how sensitive the above results are to assigned values of the parameters, the simulations were re-run by assigning different values to the efficiency parameters in both advertising functions (ρ, μ). μ was assigned a value of .01 from .02, and ρ was assigned a value of .08 from .04. This represents a 100 percent increase in informative advertising efficiency, and a 50 reduction in persuasive advertising efficiency. The impact of changes in the Z policy combinations on surplus from the above changes in advertising efficiency is as follows: The increase in informative advertising efficiency (ρ), OTBE, raised all surplus measures (TS, TDS, and CS) between 10 and 15 percent; a reduction in persuasive advertising efficiency (μ), OTBE, lowers TS by approximately five percent and raises TDS and CS by approximately ten percent. The important effect on surplus is how changes in advertising efficiency over at least one of the Z policy combinations causes a re-ranking of the strategies. Thus, for $Z_{11,R} = 0$, TS and profitability is greater under Case 4, as $Z_{11,R}$ approaches 3,4, TS and profitability is larger under Case 2. The $Z_{11,F2L}$ policy combination does not alter the ranking of the strategies.

CHAPTER SIX

EMPIRICAL ANALYSIS

6.0 INTRODUCTION

In the preceding chapters a two period, sub-game, perfect equilibrium model was employed to investigate the pricing and advertising behaviour of a patentee in the Canadian pharmaceutical industry. Within this model several policy instruments¹ were introduced to determine their affect on the patentee's decision to set advertising, price and output over two periods--the exclusive period and the compulsory licensing period. In addition, strategies, corresponding to different entry environments, were examined to compare how policy instruments affect the ranking of these strategies.² The above comparisons were facilitated by the use of simulation over different market conditions and policy environments. According to the simulations two strategies were consistently dominant: The use of

1

The policy instruments include: (1) the length of the exclusive period; (2) the stringency of substitution laws; (3) the level of royalty rates; and, (4) the severity of entry requirements. See chapter four.

2

The criteria to assess strategy dominance was discounted profitability and discounted total surplus. See chapters four and five.

persuasive and informative advertising to deter entry (Case 4), and the introduction of a patentee's generic to compete with a licensee's generic (case 2).

The central focus of this chapter is to design a statistical test which operationalizes the above two period model and allows us to evaluate it's predictive power. This is accomplished by employing advertising data on drugs³ introduced into Canada between 1982 and 1988 to examine the patentee's first period advertising behaviour. The null hypothesis to be tested can be stated as:

Ho: An increase in the exclusive period (decrease in CL period)⁴ does not affect first period medical journal advertising as a proportion of total advertising (medical journal plus detail advertising).

This is tested against the hypothesis that the null is not true. It was shown from simulations performed in chapter four that an increase in the exclusive period leads to an increase in informative advertising and a reduction in persuasive advertising. In other words, the composition of advertising is expected to change once the Patentee is

³ Only (ethical) prescription drugs are examined.

⁴ Thus in 1987 the Patent Act was ammended to permit the patentee exclusive protection for a period of seven to ten years. Previous to 1987 patented drugs were immediately subjected to compulsory licensing.

guaranteed a longer period of exclusivity. The above use of advertising data can provide a direct test of this finding once we have established a relationship between the use of advertising (between persuasive and informative) and the composition of advertising (medical journal and detail).

This relationship between the use and type of advertising is examined by Leffler (1982) among others⁵. Leffler's contention is that detail advertising is strongly related to informative advertising, and medical journal advertising is strongly related to persuasive advertising. In section three below we provide further evidence to support this claim by using Canadian advertising data to compare the composition of advertising for new drugs with established drugs. Established drugs include those drugs which have been marketed for at least 10 years.

The remaining sections in this chapter are organized as follows: section one outlines other hypotheses which can be extracted from the model developed in previous chapters but

⁵ See Coleman, Katz and Menzel (1966) and Mathewson and Winter (1984). The former draws from survey data to discuss the importance of detail advertising in providing information to physicians. The latter, provides a strong theoretical argument linking a physician's costly search to the value from information in advertising. Leffler makes a similar argument regarding the opportunity cost of a physician's time.

may not lend themselves to empirical testing; Section two describes the data used for the empirical analysis; Section four presents the statistical model; and, Section five discusses the results.

6.1 OTHER HYPOTHESES

The model developed in chapters two to five contain several predictions on how the patentee and licensee behave under various market conditions and policy environments. Many of these predictions are statistically untestable because either the data were not available, or because the policy instruments have never been implemented.⁶ Below we provide a list of predictions from the model on first period advertising behaviour when market conditions (described in chapter three) and policy environments (described in chapter four) have been altered:⁷

(1) Market Condition Changes

- An increase in advertising efficiency, other things being equal (OTBE), leads to greater levels of both types of advertising, (see tables 3.1-3.2).

⁶ Nonetheless, through simulation we were able to investigate how economic surplus is affected, and how the decision by the patentee to adopt one of the strategies is affected, in the event the government does decide to introduce one or more of these policy instruments. See chapters four and five.

⁷ See the respective chapters for the impact on prices, output, profitability, and economic surplus.

- An increase in the relative cost of persuasive advertising, OTBE, leads to a reduction in the level of persuasive advertising.⁸ (This affect on advertising is tested below).
- An increase in market size, OTBE, leads to greater levels of both types of advertising under all strategies with the exception of case 3 (see tables 3.1-3.5).
- An increase in the discount term (cost of capital, and life span of the drug), OTBE, reduces informative and persuasive advertising (see tables 3.1- 3.5) under entry accomodation and entry deterrence with the exception of case 5.
- The less substitutable are alternative therapies, given by the b's, the lower the advertising under all strategies.

⁸ Simulations on the relative cost of persuasive and informative advertising were not reported in chapter four because they demonstrated the identical affect on prices, output, profitabililty, and advertising as a reduction in advertising efficiency. See tables 3.1-3.5 and figures 3.4 and 3.5.

(2) Policy Instrument Changes

- The greater the degree of enforcement of substitution laws, OTBE, the less is the amount spent on persuasive advertising and the greater the amount spent on informative advertising.
- The more stringent the entry requirements, OTBE, the less the amount spent on persuasive advertising and the greater the amount spent on informative advertising.
- The greater the royalty rate, OTBE, the less the amount spent on persuasive advertising and the greater the amount spent of informative advertising.

6.2 DATA

The primary source of data for the statistical model is the "Canadian Promotion Audit: Detailing" and "Canadian Promotion Audit: Journal" published by Intercontinental Medical Statistics (IMS) Canada Ltd. These audits are published monthly and contain information on detail calls to physicians; and journal advertisements in medical, dental, hospital, and drug trade journals, respectively.

Fifty one drugs were used to perform the statistical analysis. Of these 51 drugs, 27 were introduced before the patent act was amended in 1987.⁹ The remaining 24 drugs were introduced during the current regime of exclusive protection. The drugs cover five therapeutic classes¹⁰ including: thirteen Antiinfectives (antibiotics); five Antispasmodics/Antisecretory (urinary tract and receptor antagonists); five Bronchial Therapy (general and asthma); twenty one Cardiovascular Therapy (antihypertensives and vasodilators); and, seven

⁹ The amendment to the patent act became law in December 1987, however, new drugs were affected retroactively from June 1986. See chapter four

¹⁰ All drugs in the sample are ethical prescription drugs which are taken orally.

Psychotherapeutics (tranquilizers and psychostimulants).

The dependent variable created from the data was the ratio of medical journal advertising to total advertising (medical journal plus detailing). This variable represents the proportion of persuasive advertising to total advertising expenditure incurred by the patentee when faced with the two separate policy regimes: compulsory licensing vs exclusive protection. In other words, the dependent variable is constructed to capture whether the patentee alters the composition of advertising between persuasive or informative when faced with a different entry environment shaped by public policy.

The data for the independent variables were obtained from the following sources: Information on therapeutic novelty of each new drug was gathered from medical and pharmacological experts¹¹; Data on the relative cost of medical journal to detail advertising were generated from the Detail and Journal audits described above. The cost of

¹¹ The experts were sent the list of 51 prescription drugs used in this study and were asked to classify each drug on the basis of whether they considered the drug to be a "major", "moderate" or "little/no" therapeutic improvement over existing drugs in their respective therapeutic class. Of the 51 drugs, 6 were major, 8 were moderate, and 37 showed little/no improvement.

using medical journal is measured on the basis of number of pages used and the cost per page for each drug¹². Detail cost is based on the number of visits by a detail person multiplied by the average time spent on promoting a particular drug during the detail visit¹³; The age of each therapeutic class were also obtained from the above audits; Finally, dummy variables representing each of the therapeutic classes were constructed.

6.3 COMPOSITION OF ADVERTISING

Before proceeding to the statistical model we use advertising data on new and established drugs to examine the relationship between the informative and persuasive aspects of advertising and the composition of advertising. As Leffler (1982) states (p.62)

" The relevance of noninformative reminder....promotion is also indicated by the mix of promotion (detail versus journal) as related to product age. Since detail men can

12 Staff members at Intercontinental Medical Statistics (IMS) are responsible for examining each medical journal sold in Canada and recording the amount of advertising (full page, half page, etc) for each drug.

13 IMS follows up each detail visit by sending a form to physicians requesting that they record the proportion of time spent by the detail person on the promotion of each drug.

engage in an interchange with the physician, this form of promotion is hypothesized to be especially well suited for the provision of information..... Journal advertising, however, is better suited for reminders of a products name..."

Leffler uses data on the 15 most detail advertised drugs and the 15 most journal advertised drugs (over four separate years) and finds that the average age is approximately 5.1 years and 9 years, respectively. Using our data we compare the composition of advertising in 1984 for drugs that have been introduced within two years, to the composition of advertising for drugs that have been marketed for at least 10 years (average is 12 years over the sample). Our sample was composed of 14 new drugs and 16 established drugs. It was found that the ratio of journal advertising to total advertising is 50 percent greater for established drugs (statistically significant at the 1% level). This adds support to Leffler's hypothesis that the composition of advertising is linked to the informative and persuasive aspects of advertising.

6.4 STATISTICAL MODEL

To study the effect of adjusting the exclusive period (compulsory licensing period) on advertising behaviour the data were analyzed by postulating the following linear model:

$$C_i = \gamma_0 + \gamma_1 L_i + \sum_k \gamma_{2k} X_{ki} + \sum_j \gamma_j D_{ij} + u_{it} \quad \begin{matrix} i = 1, \dots, N \\ j = 1, \dots, 4 \end{matrix} \quad (6.1).$$

where C_i denotes the average composition of advertising for the i th new drug in the first two years after its introduction.¹⁴ γ_0 represents the intercept term. u_{it} is the error term with mean zero and constant variance σ^2_u . N is the number of drugs.

L represents a dummy variable equal to one if the drug was introduced during the CL regime and zero if the drug was introduced during the extended patent period (post-CL legislation, see chapter four).

X are other variables which may affect the patentee's decision to alter the composition of advertising. These include: the relative cost of medical journal advertising to detail advertising, RELP; therapeutic novelty (NOV), where NOV represents a binary variable equal to one if the drug was considered to be a major therapeutic improvement, and zero otherwise (moderate or little improvement); and, age (CLASSAGE) of therapeutic class,

¹⁴ The average over the first two years was used to capture the investment aspects of advertising. Advertising expenditures does fall by approximately 65 percent, however, in the third year. This lends support to the view that advertising is used for investment purposes.

defined as year of introduction of the new drug minus the first year the first drug was introduced in that therapeutic class.

D denote a set of dummy variables to represent the different therapeutic classes from which the drugs were drawn¹⁵. This is to reflect other factors (eg. riskiness, and severity of illness, i.e., life threatening diseases) which may account for differences in advertising composition.

From the linear model postulated in equation (6.1) the following relationship between the dependent variable and independent variables are expected to emerge. The compulsory licensing variable, L, is expected to carry a negative coefficient because the ratio of medical journal (persuasive) advertising to total advertising (medical journal plus detail) is expected to fall once the patentee is guaranteed a period of exclusivity.

The variable representing relative cost of medical journal advertising to detail advertising is expected to have a negative coefficient. Hence, as the price of medical

¹⁵ Therapeutic categories were constructed by IMS. Our sample covers those therapeutic categories which contain ethical prescription drugs only. See section 6.2 above.

journal advertising rises, OTBE, the level of medical journal advertising will fall.

Theoretically, it is difficult to establish priors on the sign of the therapeutic novelty variable (NOV). Leffler (1982) finds that new drugs receive a significantly greater advertising intensity the greater the therapeutic novelty of the drug. He associates greater advertising intensity of the more novel drugs to the use of more informative advertising. This implies that the coefficient of NOV is negative.

It is also difficult to establish theoretical priors on the sign of CLASSAGE variable. It can be argued that the more established a given therapeutic class, OTBE, the more persuasive advertising may be necessary to convince physicians that the new drug is as good or better than the more established drugs. This implies that the coefficient of CLASSAGE is positive.

To the extent that the therapeutic classes represent treatments of illnesses which are considered life threatening then it may be argued that the use of persuasive advertising, OTBE, may be less. Therefore, the greater the importance of the therapeutic class the smaller is the relative importance of persuasive advertising.

Empirical Results:

Table 6.2 reports the results of estimating ordinary least squares on the linear equation given by (6.1). Equation (1) emphasizes the importance of the change in regime from compulsory licensing to exclusive protection on the composition of advertising. The coefficient is negative and statistically significant at the 1% level. The coefficient indicates that the change in regime reduced the ratio of medical journal advertising to total advertising by 16 percent, on average. This is consistent with the simulations performed in chapter five. It was shown that for the two most profitable strategies, cases 2 and 4, an increase in the exclusive period from 2 to 10 years changed the mix of persuasive advertising as a proportion of total advertising by 15 and 11 percent, respectively.

Equation (2)¹⁶ includes the additional affect of the relative cost, RELP, the age of the therapeutic, CLASSAGE, and the novelty of the new drug, NOV. All the variables carry the expected sign but only NOV is statistically

¹⁶ Total advertising for each drug was included to capture the possible scale effects from advertising. Inclusion of this variable was not statistically significant, however, and this may be attributed to the fact the the composition of advertising and total advertising are jointly determined.

TABLE 6.1

Dependent Variable: C, ratio of medical journal to total advertising.

Independent Variables:	(1)	(2)	(3)
Constant	0.594* (0.051)	0.685* (0.173)	0.713* (0.246)
Change in CL regime, L	-0.164** (.071)	-0.195* (.075)	-0.193* (.078)
Relative Cost medical journal advertising, RELP		-3.396 (3.312)	-2.348 (3.617)
Age of Therapeutic class, CLASSAGE		0.045 (0.042)	0.051 (0.043)
Therapeutic Novelty, NOV		-0.161 (.139)	-0.210*** (.152)
Antitoxics Class			0.056 (.1430)
Antispasmodic Class			-0.194 (.1671)
Cardiovascular Class			-0.099 (.1333)
Psychotherapeutic Class			-0.014 (.170)
R ² =	.09	.13	.26
adjusted R ² =	.08	.10	.14
SSE =	3.28	3.19	3.10

*** significant at 10% level, ** significant at 5% level
* significant at 1% level. Standard errors appear in Parenthesis.

significantly at the 10 % level. Equation (3) includes the therapeutic class dummies. Therapeutic class do not seem to affect the composition of advertising.

6.4 SUMMARY

The empirical analysis strongly supports the hypothesis that amendments to patent legislation which guarantee pharmaceutical patentees a minimum period of exclusivity have affected the mix of advertising employed by these firms. The implications of this have been explored in chapter five. Taking the two most profitable strategies for the patentee (case 2 and case 4) we find that an increase in the period of exclusivity has the effect of increasing total surplus while at the same time reducing total domestic surplus (see table 5.1).

Other factors which may affect the patentee's use of advertising were also examined including therapeutic novelty, relative cost of advertising, classage, and dummies representing the different therapeutic classes. These factors do not appear to have a statistically significant influence on the composition of advertising.

CHAPTER SEVEN

SUMMARY AND CONCLUSIONS

This study in modelling the advertising and pricing behaviour of patentees in the Canadian pharmaceutical industry developed several theoretical cases including two entry accommodating strategies and three entry deterring strategies. The focus then turned to the assessment of how various forms of government intervention could be employed to influence the ranking of the above strategies and enhance economic welfare (total surplus). The policy instruments examined included: length of exclusive period (patent period); stringency of substitution laws; level of royalty rates; and, severity of entry requirements.

In examining the impact of the above policy instruments on patentee behaviour the analysis focused on the use of advertising, as an investment, similar in many respects to investment in capacity. This use of advertising was shown "strategically" to influence the second period compulsory licensing equilibrium by providing the patentee an advantage over the licensee. In addition, the decision by the patentee to introduce a generic version of the brandname drug to segment the second period market was found to be a profitable strategy.

Generally, it was found that government intervention in this industry can influence the patentee's decision to use different types of advertising under both entry accommodation and entry deterrence strategies, and consequently, affect total surplus (TS).¹ More specifically:

- The decision by government authorities to allow for greater periods of exclusivity was found unambiguously to raise TS and profitability in cases 2 and 4, but reduce total domestic surplus (TDS).
- The decision to increase the stringency of substitution laws increases TS, total domestic surplus, and profitability under case 2 while decreasing TS, TDS, and profitability under case 4.
- An increase in royalty rates raises TS and profitability (marginally) under both case 2 and 4. TDS was virtually unaffected in both cases.
- Finally, a reduction in entry requirements increased TS, TDS, and profitability for case 2 and had the opposite affect for case 4.

¹ Two strategies were examined for this exercise, the entry accommodation strategy where the patentee introduces a generic brand (case 2), and the entry deterring strategy where the patentee uses strategic advertising (case 4).

The extent of the impact on TS, TDS, and profitability of each policy instrument varied considerably.² For example, adjusting the length of the exclusive period from two years to 18 years increases TS and profitability by approximately 15 percent and 25 percent in both cases 2 and 4. TDS, however, fell by approximately 11 percent in case 2 and eight percent in case 4. An increase in royalty rates from two percent to 34 percent of licensees sales had a less than two percent affect on TS and TDS and increased profitability only marginally at three percent for case 2 and seven percent for case 4 (see tables 5.1 to 5.4).

Several policy combinations were also examined to determine their impact on economic welfare and whether they could alter the ranking of strategies. It was generally found that TS was enhanced and TDS fell by greater periods of exclusivity combined with any other policy. An important factor in evaluating welfare, however, was in the choice of measure to be adopted. The use of TS, for example, includes producer surplus (foreign plus domestic) and consumer surplus, while total domestic surplus ignores foreign producer surplus.

² See table 5.2 and 5.3.

SUMMARY OF FINDINGS FOR INDIVIDUAL CASES:³**Case 1: Entry Accommodation Without Generic Competition**

In this case, the patentee's brandname product was shown to compete directly with the licensee's generic product. The introduction of compulsory licensing in the second period indicated that second period prices fell by approximately 20 to 25 percent below first period monopoly prices. Comparison of profits over different strategies found that case 1 was relatively profitable under a regime of tougher substitution laws, greater periods of exclusivity (greater than 12 years), and as entry requirements became more severe (greater than 50 percent of entry cost of brandname product).

Case 2: Entry with the Introduction of a Patentee's Generic

In the market segmentation case, the patentee introduces a generic product along with the brandname product. This allows the patentee the opportunity to segment the drugs into two separate markets: the uncontested market, which was built up through persuasive advertising.

³ These findings were based on simulations performed in the preceding chapters.

and receive a monopoly price; and, the contested market (generic market), where the Bertrand/Nash game is played and prices are determined according to the Bertrand/Nash equilibrium.⁴ Because prices were no longer found to be a function of persuasive advertising the strategic effect was eliminated. The change in price from the exclusive period regime indicated that no change in prices occurred in the uncontested market, and a forty percent reduction in prices occurred in the contested (generic) market. The profitability of this strategy is ranked near the top under the following policy conditions: exclusive periods up to 12 years, entry requirements less than 45 percent of the brandnames entry requirements, substitution laws which ranged between minimal and medium with respect to stringency, and for royalty rates up to 35 percent of licensee's total sales.

Case 3: Entry Deterrence By Limiting Informative Advertising

This strategy did not employ persuasive advertising but relied exclusively on informative advertising to deter entry. This was accomplished by developing a sufficiently small market to make the prospect for entry of a licensee

⁴ Prices are above marginal cost because the generics are differentiated.

unattractive. This use of informative advertising showed that the patentee's intention is to play aggressively because informative advertising is under-invested and second period prices (in the event of entry) are much lower. The use of this strategy was profitable when markets are relatively small, and when entry requirements exceed 37 percent of the brandname entry cost.

Case 4: Entry Deterring Strategic Advertising

This case employed informative and persuasive advertising to deter the licensee from entering the market. It was shown to dominate the other strategies over most policy changes and market conditions. The only exception where this strategy did not demonstrate dominance was when entry requirements exceeded 37 percent of the brandname's entry cost, and when substitution laws were very strict.

Case 5: Pre-empting the Generic Market

In the case of market segmentation the patentee decides to pre-empt the second period market by introducing his own generic. This was done in combination with strategic advertising to deter the licensee from entering the market. Under successful entry deterrence the patentee markets the two drugs and sets prices according to their respective

inverse elasticity of demands. On the other hand, if the licensees decide to enter the market he would be forced to compete with the patentee in the generic market and prices would then be determined according to a Bertrand/Nash equilibrium. The latter price is substantially below the monopoly price the patentee enjoys in the uncontested market. A comparison of strategies demonstrated that this case was dominant when substitution laws were more stringent and when entry requirements were minimal (less than 10 percent of the brandname entry cost).

CONCLUSION

It is important to bear in mind that the impact of the above policy instruments on patentee behaviour were sensitive to the assigned values of parameters in the calibrated model. It was demonstrated, for example, that changes in the size of the market, changes in advertising efficiency (ρ, μ), and changes in the magnitude of the slope parameters (b 's), re-ordered the strategies with respect to profitability and TS. This implies that further work on the calibrated model is required which examines the impact on welfare from assuming different parameters values. In addition, experimenting with different policy combinations to determine their impact on welfare can be done.

The empirical analysis in this study employed advertising data on new prescription drugs to provide strong support for the predictions of the theoretical model. This was accomplished by showing that the composition of advertising between medical journal (persuasive) advertising and detail (informative) advertising is affected by the length of the exclusive period. This analysis could be extended empirically by controlling for other important factors including: severity of substitution laws; the introduction of the patentee's own generic; and, the size of therapeutic class.

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