THE EFFECT OF PROTECTION UPON THE BEHAVIOUR AND PERFORMANCE OF FIRMS

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May 1996

A thesis submitted for the degree of Doctor of Philosophy of The Australian National University.

The analysis in Chapter 3 was jointly devised by myself and my supervisor, Dr Neil Vousden. The remaining chapters are completely my own original work.

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Acknowledgements

I wish to express my thanks to my supervisor, Dr Neil Vousden, for invaluable assistance rendered throughout the writing of this thesis; also to Dr Rod Falvey, Dr David Kelsey, Dr Paul Sheard and Dr Peter Forsyth for assistance at certain times.

Abstract

This thesis examines the idea that removing protection can improve the performance of the formerly protected industry. Using a principal-agent framework it is shown that a reduction in protection can, under certain circumstances, cause managerial effort to be increased and that this increase in effort can be seen as a welfare improvement. A simple decision-theoretic model is used to show that it is possible for an investment in a cost-reducing technology to be rejected while the protection is in place but then accepted once the protection is removed. The issue of whether a reduction in protection on intermediate goods can affect product quality is analysed using a Nash bargaining model. Plausible cases are shown where a protection reduction results in improved product quality. A Nash bargaining model is also used to analyse the relationship between the protected firm and its unionized workforce. It is shown that the easing of an import quota can result in the union agreeing to the elimination of some restrictive work practices. Both Spence-Dixit and Milgrom and Roberts type models are used to show that changes in protection can affect a domestic incumbent's choice as to whether to deter or accommodate entry.

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CHAPTER 1: AN INTRODUCTION

It is a well known result from international trade theory that protectionist policies have welfare costs associated with them. Protection is shown to be costly because it causes resources to be allocated so that the potential gains from trade are not fully exploited. This is a powerful argument against governments engaging in protectionist policies. At a popular level this argument has to share the limelight with the argument that protection is bad because industries receiving protection will perform less well than if they faced the competitive pressure associated with free trade. This argument characterizes the poorly performing protected firm as having; lazy managers, unions that insist on restrictive work practices, outdated technology, and a tendency to produce low quality products. The implication of this argument is that a benefit of trade liberalization is improved performance by the previously protected firms (an effect which can be labelled 'a cold shower'). The problem with sustaining such a position is the need to provide an explanation for why the removal of protection should act as an incentive to improve certain aspects of a firm's performance.

As economists we face the question of what to make of the cold shower argument. One option is simply to dismiss it as a piece of ad hoc populism. However this option has been made unacceptable by the significant empirical support for cold showers accompanying reductions in protection. For a survey of the empirical literature on the relationship between protection and technical efficiency see Chapter 2, Section VII. The contention that reduced protection can induce a firm to somehow improve its technical efficiency deserves serious attention. The analysis of this question by Corden

(1974) serves as a useful illustration of how economists can contribute to understanding the cold shower issue. Corden simply borrows the standard theory of the individual worker's labour-leisure choice and applies it to a utility-maximising entrepreneur who has to choose how much cost-reducing effort to supply. If the income effect toward leisure is sufficiently strong, a reduction in protection will increase the supply of cost-reducing effort. Here we have a cold shower explanation which is methodologically sound since it involves the decision maker acting to maximise a quite uncontroversial objective function. Contrast this with the following approach: 'If protection is reduced then the owner/manager may put more effort into reducing costs so as to continue making an acceptable level of profit'. This approach abandons the basic methodological tenet that an economic agent acts to maximise some objective. It can not be rescued by devising an objective which if maximised would give the desired cold shower story. For instance, it could be assumed that there is some target level of income below which utility falls to a very low level. Such an analysis would fall into the trap of being a tautology which assumes what it purports to 'prove'.

Chapters 3 to 7 contain a variety of models of protected firms in different situations. In all cases the objective is to analyse the effects of the removal of protection. The decision makers; that is, the owners, the owner/managers and the managers, all act to maximise profit or utility. Where utility is maximised the arguments contained within the utility function are quite uncontroversial. In no cases is it claimed that the models have universal applicability. It is simply intended to look at a variety of situations, all of which can be characterised as reasonably plausible.

In Chapter 3 the issue of protection and managerial effort is considered using a standard principal-agent framework. The protected firm has a profit-maximising owner who employs a manager to run the firm. The manager is a utility-maximiser with a utility function consisting of income less the disutility of effort. The owner is unable to observe the manager's level of effort and productivity type. If certain restrictions are placed upon the firm's technology then a decrease in protection will cause managerial effort to increase. Clearly this model is particularly applicable to large corporations since in general there is a substantial separation between ownership and control within such firms. It is worth noting that the firm would not be judged by the capital market as failing to make the most profitable use of its assets. Profits are being maximised given the existence of the asymmetry of information between the owner and the manager. The most striking result which emerges from Chapter 3 is that given certain conditions a protection-induced reduction in effort will represent an additional welfare cost of protection.

Chapter 4 considers the case of a firm which faces the decision as to whether to invest in a cost-reducing technology with an uncertain return. This decision is made by the firm's utility-maximising owner/manager whose utility is a function of his/her lifetime discounted income stream. It is shown that it is possible for the investment to be rejected while the protection is in place but then accepted once the protection is removed. The idea is that once the protection is removed the owner/manager must undertake the risky strategy of making the investment in order to stand any chance of staying in the industry. Leaving the industry involves a considerable sacrifice in anticipated future income since the owner/manager loses his/her industry specific human capital. Hence this chapter sits very comfortably with the folklore notion of trade liberalization putting firms under competitive pressure so that they are forced to lower their operating costs.

Chapter 5 examines how a change to the level of protection on intermediate goods can affect the level of product quality. A Nash bargaining model is used to consider the removal of protection from a component supplier which gives the downstream firm greater bargaining power since the option of turning to a foreign component supplier becomes more viable. This examination of protection and product quality is a departure from the cold shower literature which has focused upon the cost of producing a given good. Similarly the literature on the economics of innovation has focused upon cost-reducing innovations rather than product improving innovations (see Tirole, 1988, Chapter 10). In the introduction to Chapter 5, some other studies which have touched on protection and product quality are discussed. Unlike the analysis in Chapter 5 these studies focus upon imperfect competition in the output market.

Chapter 6 looks at the issue of whether it is likely that trade liberalization will result in reforms to restrictive work practices. It is widely believed that when industries are protected and/or regulated a substantial amount of the rents frequently go to unionized labour in the form of restrictive work practices as well as higher wages. If trade liberalization does lead to reforms to restrictive work practices then this is another reason why we might expect to observe an improvement in technical efficiency being associated with a reduction in protection. To analyse the relationship between the firm and the union, a Nash bargaining framework is used. In the standard union bargaining model wages and employment are the two variables which the firm and the union take into account when engaging in negotiations. However a relatively new literature has emerged which also includes an effort variable. In this context the term 'effort' refers to observable work practices rather than the unobserved actions which the term 'effort' is used for in the principal-agent literature.

Chapter 7 examines how a change in protection affects an incumbent firm's choice between deterring or accommodating a potential entrant. Unlike earlier chapters the incumbent domestic monopolist has no way of lowering its costs in response to a reduction in protection. In this chapter a reduction in protection may facilitate the entry of a firm with lower costs. Consideration is given to the case where the entrant is a foreign firm as well as the case where the entrant is a domestic firm. Two frameworks are utilized. The first framework involves the incumbent committing to a post-entry level of output by investing in productive capacity. The second framework is based on the assumption that the potential entrant has incomplete information as to the incumbent's cost.

CHAPTER 2: A LITERATURE REVIEW

I: Introduction

The idea that uncompetitive market structures result in technical inefficiency has received support from a number of eminent economists including such luminaries as Smith (1776, p.165) and Hicks (1935, p.8). The closely related proposition that a firm will respond to reduced protection by improving technical efficiency has received support from Lipsey (1960, p.512). However this support for the proposition has come primarily in the form of casual comments. More formal theoretical approaches give support of a far more circumspect nature. In almost all cases a model which can be used to show protection removal encourages technical efficiency can also be used to show the opposite case where technical efficiency is actually discouraged.

This chapter is arranged as follows. Section II outlines the cold shower effect and summarizes the X-efficiency debate. This literature, essentially from the 1960s and 1970s, focuses on firms which are benefiting from either border protection or monopoly power. As a theoretical basis for claiming there is an X-inefficiency cost associated with protection it is fundamentally flawed. Section III turns to the literature based on the principal-agent model of the firm. Using this paradigm it becomes possible to talk about managerial effort deviating from its efficient, that is the full information, level. Section IV outlines an analysis of how domestic oligopolistic considerations can result in protection reduction inducing technical efficiency. Section V examines some work on how trade policy may affect research and development. Section VI discusses explanations for a protection - technical efficiency link which are based upon the protected firm's actions being able to affect the level of protection it receives. Lastly Section VII considers empirical studies. While there are inherent difficulties associated with this research, significant support is found for the hypothesis that protection induces technical inefficiency.

II: Cold Showers and the X-Efficiency Debate

The term 'cold shower' dates back at least to the debate in the 1960s over whether Britain should join the then European Economic Community (Corden, 1974, p.227). At a popular level the argument simply is that reducing protection increases competitive pressure forcing firms to act in a more technically efficient manner. Clearly it is implicitly being assumed here that the protected firm is not acting as a profit maximiser. This point has been made formally by Rodrik (1990). Here imports are subject to a quota so as to protect a single domestic firm. The domestic firm's constant marginal cost c is assumed initially to be higher than the foreign firms' constant marginal cost c^*. By investing in technological effort, c can be reduced to c^* over time. The speed at which this cost reduction takes place depends upon the expenditure made on technological effort. The size of this expenditure is decided so as to maximise profit. That is the marginal cost of technological effort is set equal to the discounted sum of its benefits over the period of time taken for c to fall to c^*. This condition can be used to show that allowing an increased number of imports (reducing protection) will result in less being spent on technological effort. This result is hardly surprising. The benefit of an investment which reduces the cost of producing a unit of output will depend upon how many units of output are produced. Since a decrease in protection reduces the domestic firm's sales, the profit maximising investment in technological effort will be reduced.

Commenting on the possibility of a cold shower effect, Lipsey (1960, p.512) states that protected firms

> "....may not be adopting methods known to be technically more efficient than those now in use due to inertia, a dislike of risk-taking, a willingness to be content with moderate profits, or a whole host of other reasons."

The idea of being content with moderate profits lies at the centre of Leibenstein's X-efficiency idea. Leibenstein (1966) considers the issue of monopoly however, in general, protection also makes it possible for firms to deviate from profit maximisation without breaking the solvency constraint. Essentially what Leibenstein argues is that, without the pressure of a competitive market structure, firms will operate so that the cost of producing a unit of output is higher than the technically efficient cost level. Leibenstein concludes that the really significant cost of monopoly is the deviation from technical efficiency resulting in more resources being used to produce each unit of output. The label of X-inefficiency is used to distinguish this from the conventional allocative inefficiency stemming from the monopoly under-producing output.

Following strong criticism by a number of authors, it now seems fairly clear that Leibenstein's X-efficiency argument suffers from flawed logic[1]. The best known and probably the most lucid criticism of X-efficiency comes from Stigler (1976). The

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1. For a survey of the X-efficiency critics see Frantz (1988).

Leibenstein entrepreneur can be thought of as acting to maximise outputs for given inputs (excluding managerial effort). The lower the manager's 'motivation' the lower is the efficiency with which the manager acts to maximise output and hence for a given output the more inputs are used. Now contrast this story with the conventional approach to understanding the behaviour of individual agents. The entrepreneur maximises utility[2]. In this utility function, profits represent a positive argument and managerial effort represents a negative argument. Suppose that a change in relative prices causes the entrepreneur to choose to put in less effort. A reduced effort level implies that for a given output more inputs are required as long as effort is not included as an input. However once it is recognised that effort represents another input, a decision to reduce effort can not be seen as a reduction in efficiency with an associated social cost. It is because of this point that the title of Stigler's article is "The Xistence of X-Efficiency". Essentially Stigler dismisses X-efficiency as being a useless concept. If some factor such as income tax causes the entrepreneur to make a distorted effort choice then this is an allocative inefficiency.

At the heart of the objections to Leibenstein is that the behaviour of the entrepreneur is not satisfactorily explained. All that we are really given is the assertion that the entrepreneur will behave in a particular way when positive economic profits become possible. To be able to consider whether we can, at least loosely, talk about X-inefficiency providing us with a rationale for the occurrence of a cold shower, it is necessary to consider under what circumstances a utility-maximising entrepreneur will increase effort in response to a reduction in protection. This insight is due to Corden

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2. Modelling the entrepreneur or manager as a utility rather than a profit maximiser is a tradition which goes back to Scitovsky (1943).

(1970, 1974) and is treated in somewhat more formal terms by Martin (1978). Corden considers the case where increased managerial effort reduces the firm's costs. The justification is that at a given point in time it requires effort to search for the best methods of production which are available. The two arguments in the managerial utility function are leisure and profit. Increased leisure is regarded as being synonymous with reduced effort. Indeed, using an algebraic approach it is analytically convenient to directly include effort as a 'bad' in the utility function. A reduction in protection reduces the entrepreneur's real income. The entrepreneur will only put in more effort if the supply of managerial effort curve is negatively sloped over the relevant range. The important point is that there is no particular reason to believe that this is the typical case. If the substitution effect outweighs the income effect from a protection reduction then the supply curve for managerial effort will be positively sloped and so cutting protection will actually reduce managerial effort. An additional point is the general equilibrium consideration that, if a cut in protection does result in a cold shower in the importables sector, then the increase in real incomes in the exportable sector may result in a 'warm sun effect'. That is the supply of managerial effort curve in the exportables sector may also be negatively sloped resulting in lower effort being supplied in this sector.

In the light of the anti-X-efficiency literature the question arises as to what the welfare implications are of protection-induced changes to managerial effort. Vousden (1993) uses a general equilibrium framework to derive an expression for the welfare effect of a tariff which consists of a constant-effort component and a component attributable to changes in effort levels in both the importables and exportables sector. When the above components are combined we get the deadweight loss associated with the tariff. Thus, provided the correct compensated import demand curve is used, the

X-efficiency welfare effect is fully accounted for within the standard measure of welfare loss. This analysis supports Stigler's intuition which rejects the idea that X-efficiency can be thought of as something separate from allocative efficiency. The correct demand curve is an import demand curve estimated on the basis of, say, different tariff levels, rather than different observed world prices. The reason why a world price change and an equivalent tariff change can not be regarded as synonymous is that the model used takes into account that tariff revenue is recycled, affecting the size of the income effect.

A particularly important insight that comes from this analysis is that if protection does reduce managerial effort then this type of X-inefficiency effect will actually mitigate the overall welfare cost of protection. This is because protecting an industry causes it to produce 'too much' output. With an X-inefficiency effect this increase in output is smaller than would be the case if managerial effort stayed constant. So to be able to say that an X-inefficiency effect adds to the cost of protection there must be some additional factor that is not included in a straightforward labour-leisure choice type model. An example of where an X-inefficiency effect does yield an additional cost of protection is Vousden (1991) where a subsidy is determined by a policy maker operating without full information[3].

III: Competition and Managerial Slack: Asymmetric Information within the Firm

A stream of literature closely related to the X-efficiency debate deals with the

3. This paper is discussed further in Section VI.

separation of ownership and control. In this literature a fundamental question to ask is does a competitive market structure, as opposed to a monopolistic market structure, result in a higher level of managerial effort. The older managerial theory of the firm literature suggests that this would be the case. The more recent principal-agent literature indicates that it is actually very difficult to give a definite answer to this seemingly simple question.

The label 'managerial theory of the firm' is used to refer to the idea that, as long as a minimal level of profit is achieved, managers are free to pursue their own goals. For example Baumol (1958) examines the case where the manager maximises revenue subject to a minimum profit constraint. If this minimum profit is zero, the manager is only constrained to act in a profit-maximising manner if the market structure is perfectly competitive (with every firm having a homogenous cost structure). Thus the general conclusion which comes through from this literature is that, only if the market structure is non-competitive (so that positive profits can be made) is it possible for managers to engage in non-profit-maximising behaviour (see Williamson, 1974). It follows from this reasoning that if one of the managerial objectives is to minimise effort, effort will only fall below somekind of maximal level if the product market is not perfectly competitive.

The managerial theory of the firm literature does not give any explicit treatment of the relationship between owners and managers. Implicitly the owner is treated as being virtually without any information at all to monitor the manager's performance. This may be an appropriate treatment for very small individual shareholders however it hardly seems reasonable when large institutional shareholders are considered. The informational and contractual relationship between an owner and a manager lies at the heart of the principal-agent literature on managerial slack. In this literature the owner (the principal) cannot directly observe the manager's (the agent's) effort but does have sufficient other information to set a contract so that the manager will put in the profit-maximising effort, *given the information asymmetry*. A number of relatively recent papers use this framework to address the question of whether a competitive market structure encourages more managerial effort than a monopolistic one.

Hart (1983) analyzes a case in which the competitive price mechanism limits the opportunities for managerial slack to occur. Suppose that there are two types of firms within an industry; entrepreneurial and managerial. The entrepreneurial firms are conventional profit-maximisers. The managerial firms have a profit-maximising owner who cannot observe the effort of a utility-maximising manager. The owner is also unable to observe the 'state of the world' that is certain (exogenous) costs faced by the firm. In order to obtain Hart's results it is necessary to place some strong restrictions upon the manager's utility function. The manager is very averse to the possibility of not achieving a certain level of income $\bar{I}$. Any income above $\bar{I}$ will not increase utility. That is, rather than receive any income above $\bar{I}$, the manager would prefer to put in less effort. Hart shows that the optimal contract is for the owner to commit to paying the manager $\bar{I}$ provided that a target profit is reached. This target profit is the profit consistent with the highest possible cost outcome and the maximum level of managerial effort. Hence, if the cost outcome is below the highest possible level, the manager will put in effort below the maximum level.

In Hart's model all of the firms have costs which are positively correlated. This allows us to say that, when costs are reduced, entrepreneurial firms will expand and consequently the output price falls. The reduction in costs allows the manager, in managerial firms, to reduce effort while still achieving the target level of profit.

However the extent to which effort can be reduced is moderated by the reduction in the output price. If this managerial firm had been a monopoly then the cost reduction could be used entirely for increasing managerial utility by reducing effort.

This result of Hart's supports Hicks' (1935) intuition that monopoly provides 'a quiet life'. However Scharfstein (1988) shows that once the strong restrictions are removed from the manager's utility function, the opposite result can emerge - ie competition can increase managerial slack. In Scharfstein's model there are two states of the world; high productivity and low productivity. Scharfstein shows that the optimal incentive scheme consists of paying the manager I_H if a profit of Π_H is achieved (that being the higher productivity target profit) and paying the manager I_L if a profit of Π_L is achieved (that being the low productivity target profit). I_L needs to be set sufficiently below I_H to give the manager enough incentive, in the high productivity case, to put in the extra effort required to achieve Π_H rather than Π_L. It is shown that this incentive compatibility constraint results in a below-optimal level of effort, output and profit when productivity is low.

As with Hart, competition comes from the entrepreneurial firms. These firms do not have an agency problem and so operate efficiently whether productivity is high or low. When productivity is low an entrepreneurial firm will produce more output than the comparable managerial firm. Hence, the more entrepreneurial firms in the industry, the greater industry output and consequently the lower the output price. A lower price is shown to imply a lower Π_L. To maintain incentive compatibility it is necessary to extend the difference between I_H and I_L, further decreasing the low productivity effort level below what it would be in the full information case.

McAfee and McMillan (1991) also use a principal-agent model to examine the effect of product market competition upon the total costs of production. Unlike the Hart-Scharfstein analysis the manager's private information only consists of the productivity type. Also there is no assumption that type is correlated across firms. It is shown how the total cost of producing a given output can be divided between conventional production costs and the information rent which the manager receives. To obtain an index of technical efficiency, production cost (the full information or lowest possible total cost) is divided by production cost plus information rent (the actual total cost). They consider an increase in the price elasticity of demand for the firm's output as a device for reflecting an increase in competitiveness of the market structure. Whether such an increase in competition increases technical efficiency depends upon the form which the cost function takes. The general cost function used has two arguments; quantity, q, and type, t, with minimal and uncontroversial restrictions ($C^0_t \leq 0$, $C^0_{qt} \leq 0$, $C^0_q > 0$, $C^0_{qq} \geq 0$). An increase in competition is synonymous with an increase in q. An increase in q only increases efficiency if $q.C^0_q/C^0$, the elasticity of cost with respect to output, exceeds $q.C^0_{tq}/C^0_t$, the elasticity of the rate of change in cost with respect to type. McAfee and McMillan conclude from this that their analysis does not give general support to the proposition that competition results in increased technical efficiency.

Horn, Lang, and Lundgren (1995) use an asymmetric information approach to examine how trade liberalization affects managerial effort. In their general equilibrium model the owners of firms are unable to observe either managerial effort or the firm's productivity type. In response to this information asymmetry between owners and managers each owner offers the respective manager a contract which induces the profit-maximising effort level. By assuming a specific technology and Cournot competition, results are obtained which give some support to the cold shower proposition. A bilateral trade liberalization is considered by comparing effort levels under free trade and autarky. It is demonstrated that effort levels will be higher under free trade. A number of effects are identified that when taken together give this result. Firstly there is the 'home market effect'. This refers to domestic firms' decreasing output, and consequently effort, in response to the introduction of foreign competition. Secondly there is the 'market enlargement effect'. Free trade gives the domestic firms access to the foreign market. The domestic firms respond by increasing output and consequently effort. Where the home and foreign countries are symmetric the market enlargement effect dominates the home market effect. Lastly the 'factor market effect' refers to how effort will be affected by changes in wages induced by free trade.

IV: Protection and the Strategic Choice of Technology

Rodrik (1990) presents a protection - technical efficiency analysis which requires its own separate classification. The focus is on a domestic oligopoly rather than a single domestic firm. The problem that these firms face is that competition erodes the potential profits. The impact of this competition may be reduced if the firms can commit themselves to lower sales. One device for achieving this commitment is for the firms to choose outdated or costly technology. The analytical framework used is an adaption of the investment in capacity - entry-deterrence models[4]. It is shown that under certain conditions the higher potential profit associated with protection acts as a stronger inducement for firms to make a low investment in technological effort. Rodrik makes

4. For an example of this type of model see Dixit (1980).

it clear that this result lacks generality since it is necessary to assume that the firms will engage in 'excessive' competition[5]. The most extreme version of this excessive competition concept is the Bertrand paradox where competition (or aggressive behaviour) reduces potential profits to zero.

V: Protection and Research and Development (R&D)

The R&D literature has traditionally been concerned with how market failure can result in a non-optimal level of innovative activity[6]. If a firm invests in R&D and discovers a new process or product then the rents from this invention may be appropriated by other firms engaging in imitation. The patent system allows the innovating firm to recoup its R&D costs, however in doing so, it confers monopoly power upon this firm. For a lucid discussion of the public good nature of R&D see Arrow (1962). In addition to the public good problem there is also the patent race issue. There is quite an extensive literature associated with this issue[7]. The essential idea is that competing firms 'race' to be the first to make an innovation so that there is an excess amount of innovative activity.

Clemenz (1990) examines how protection may influence the level of R&D using a two-country model. The industry consists of two firms. Firm A is the foreign firm. Firm B is the domestic firm. At least initially, the foreign firm has the lower marginal

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5. For an overview of the literature on strategic investment see Dixit (1986).

6. For an overview of the literature on R&D see Tirole (1988 Chapter 10).

7. Dasgupta (1988) sets the concept of a patent race in context with other literature on the economics of innovation.

cost; $c_A<c_B$. The only way for either of these firms to reduce their costs is to engage in R&D. That is, imitation and buying the licence to new technology, are assumed not to occur. Clemenz models R&D as making an investment which allows the firm to make a random draw from a probability distribution of possible marginal costs. If the drawn marginal cost is lower than the existing marginal cost then the new technology is adopted. The firm will continue to invest in R&D until the 'reservation unit cost level' is reached. This is where the cost of making the investment equals its expected return. Thus R&D is being treated as a 'search process'. If there is a state of autarchy obviously the two firms will both be monopolists. If free trade prevails, then the two firms engage in Bertrand competition.

Clemenz describes the innovative process, in the context of a Bertrand duopoly, as a 'winner-takes-all R&D race'. The firm with the higher cost will make zero profit. Clearly, at the start of such a race, the domestic firm will be the one that makes zero profit. However, following some R&D, the situation may be reversed. The extent to which the domestic firm engages in R&D depends upon how likely it is to achieve a cost which is lower than the foreign firm. This will be dependent upon the size of the initial cost gap between the domestic and foreign firms. Clemenz shows that shifting from autarky to free trade may stimulate or may retard R&D by the domestic firm. Shifting to free trade increases the combined sales of the two firms. This is shown to stimulate R&D in at least one country. If the initial cost gap is sufficiently small, then R&D in the home country will increase. With a larger initial cost gap, free trade is shown to be an obstacle to home country R&D. Think of it this way, suppose domestic and foreign costs are both reduced but the foreign firm remains the low cost firm. While this would result in a welfare improvement for the domestic consumers, it would not increase the profit of the domestic firm above zero. By way of contrast, in autarchy an identical reduction in cost would increase the domestic firm's profit (gross of R&D expenditure). Clemenz goes on to show that a direct R&D subsidy is a more efficient instrument, than the imposition of autarchy, for shifting the level of R&D closer to the social optimum.

VI: Endogenous and Made-to-Measure Protection: The Implications for Technical Efficiency

So far all the literature treats protection as something that the protected firm's actions cannot affect. Such a treatment can be justified on the basis of being a useful simplification. Recognising that protected firms behaviour may be partly explained in terms of influencing the level of protection provides us with further rationalizations for the belief that protection adversely affects technical efficiency.

Corden (1974, p.228-229) briefly considers how a made-to-measure tariff system may encourage managerial slack. Suppose government policy is to reduce the tariff whenever increased profits occur in the previous period. Given this policy an exogenous rise in the price of imports may result in import-competing entrepreneurs reducing their effort level so as to keep profit constant. A view, based on a similar idea, is expressed by Bergsman (1974, p.413) in a discussion of his framework used to attempt to measure the 'X-inefficiency costs' of protection:

> "Producers do not necessarily minimize costs or maximize profits, at least in the sense of simpler economic analysis that assumes.....,no political dangers from driving one's competitors out of business,...."

The footnote to this reads:

"This.... may be especially important in LDCs, where the most efficient firms are often subsidiaries of foreign companies and some of the higher cost firms are purely local."

Bergsman goes on to observe that it is common in Brazil for industries to be made up of firms with greatly differing productivity. In general the firms with more advanced technology avoid taking market share from the other firms.

Tornell (1991) presents a formal model showing how made-to-measure protection can fail to achieve government objectives. Here, as a result of unmodelled political pressures, government policy is to prevent industry employment falling below $\bar{N}$. The industry consists of a single domestic profit-maximising firm that faces a perfectly competitive international market. Without government intervention the firm would set employment below $\bar{N}$. However if the firm makes a sufficient investment in cost-reducing technology (investment $\bar{K}$) it would become profit-maximising to employ $\bar{N}$. The government attempts to achieve this by use of an investment-contingent subsidy. At time t_0 the investment-contingent subsidy is granted together with the announcement that this subsidy will be terminated at time t_1. The subsidy scheme is set so that the firm would choose to invest $\bar{K}$ if the firm believed that no further protection would be provided beyond time t_1. However the announcement that protection will be terminated at time t_1 is not something to which the government can credibly commit. The firm knows that if it invests below $\bar{K}$ then following time t_1 the firm will receive sufficient protection so as to insure employment of $\bar{N}$. Consequently Tornell describes the government's made-to-measure protectionist program as time-inconsistent and shows that the firm chooses to invest less than $\bar{K}$[8]. By reducing the investment below $\bar{K}$ the firm loses some benefit in terms of cost reduction and investment-contingent subsidy. However these losses are more than offset by the gain in the form of an increased rate of protection at time t_1. Tornell goes on to show that for an investment-contingent subsidy to induce investment $\bar{K}$ it is necessary to set an 'oversubsidization rate' equal to the present value of any future protection which may be induced.

Matsuyama (1990) is another example of an analysis which shows how a policy of temporary protection can fail due to being time-inconsistent. The overall message from Matsuyama is the same as that from Tornell. That is, temporary protection can prove ineffectual due to government being unable to credibly commit to the future removal of protection. Matsuyama's 'liberalization game' has an infinite horizon with the two players being the government and the firm. Prior to the game starting, the firm is a protected domestic monopolist. Then a new government is elected. The government wants to remove the protection and it wants the firm to make a cost-reducing investment. The government has the first move in the game (at the beginning of period 1). The government has to choose between liberalizing (L) and not liberalizing (NL). If L is chosen then the foreign firm enters and that is the end of the liberalization game. If NL is chosen then the firm has to choose between investing (I) and not investing (NI). If I is chosen then at the beginning of period 2 the government chooses L and the foreign firm enters with the liberalization game ending here. If NI is chosen then the government at the beginning of period 2 has to once again choose between L

8. Kydland and Prescott (1977) is regarded as the seminal work in the time consistency of optimal economic policy literature. Much of this literature is concerned with fiscal and monetary policy. For another example of time inconsistency problems in protection policy see Staiger and Tabellini (1987).

and NL. If the government continually chooses NL and the firm continually chooses NI the game can go on for an infinite number of periods. Matsuyama argues that subgame-prefect Nash equilibria, which involve the policy of temporary protection achieving the government's objective, should be rejected on the grounds that they fail the 'renegotiation-proof' criteria. The idea being that the firm can always choose NI and negotiate another period of protection.

Miyagiwa and Ohno (1995) consider a case where initially, the foreign firm has adopted a new technology, while the domestic firm has not adopted this technology. Consequently the foreign firm has lower production costs. The cost of acquiring the new technology decreases over time. Miyagiwa and Ohno examine whether protection speeds up or delays the adoption of the technology. They first consider the case of where the protection is permanent (that is, where protection is exogenous with respect to the domestic firm's choice as to when to adopt the new technology). They then go on to consider the case of conditional protection. In this case the protection is removed once the new technology has been adopted.

Miyagiwa and Ohno set out the domestic firm's intertemporal profit maximisation problem based on the assumption that the firms engage in Cournot competition. They show that the first-order-condition can be arranged so that the marginal benefit of adopting at time t equals the marginal cost. The marginal benefit, or as they call it the *marginal value of technology*, is the increase in momentary profits from adopting at t. The marginal cost of adoption refers to the marginal opportunity cost of adopting at t instead of at $t+\epsilon$. A permanent tariff increases the marginal valuation of the technology so that the technology is adopted at an earlier date than would have been the case with free trade. With a permanent quota, the story is the same provided that the quota is binding both before and after the adoption. However, it is shown that, if the quota ceased to bind following the adoption, then the increase in non-adoption momentary profit can result in the quota actually delaying the adoption. Turning to conditional protection, they note that if protection was sufficiently high, then adoption would never take place. As is to be expected, they concentrate upon the case where there is an internal solution. Conditional protection is shown, not surprisingly, to delay the adoption since once the adoption takes place the firm receives no more protection.

While Tornell, Matsuyama and Miyagiwa and Ohno abstract from the political process which determines the level of protection there is a substantial body of literature which treats this issue in an explicit fashion[9]. Here a common approach is to model the government as maximising a political support function. This involves setting protection so that the marginal benefit in terms of support from the protected industry equates with the marginal cost in terms of lost support from parties who are adversely affected. Vousden (1991) modifies this approach by dispensing with the assumption that the government can perfectly observe the protected firm's cost. To do this, the principal-agent paradigm is used with the government being the principal and the protected industry, assumed to be a single firm, being the agent. This paradigm has been used extensively in the literature on regulatory mechanisms[10]. The specific version of the principal-agent model used by Vousden was devised by Laffont and Tirole (1986) working within this regulatory literature. The government can not observe the firm's level of effort and is unaware of the firm's productivity type. To maximise political

9. For an overview of the political economy of protection literature see Hillman (1989).

10. See Baron (1989) for a survey of this literature.

support the government uses an incentive-compatible subsidy package. The package consists of both a conventional subsidy payed on each unit of output plus another component which depends upon the observed level of cost at the end of the production period. This latter component acts as a disincentive for the firm to pretend to be a higher-cost type than it is in reality. The political support - maximising subsidy package will imply a certain level of effort. The paper shows that, under certain conditions, the level of effort which such a subsidy induces is lower than the effort level which would be chosen in the free trade case. These (sufficient) conditions consist of the following extra restrictions upon the firm's cost function:

$$\frac{C_{x\theta}}{C_{\theta}} \geq \frac{C_{xe}}{C_{e}} \quad \text{and} \quad \frac{C_{e\theta}}{C_{\theta}} \geq \frac{C_{ee}}{C_{e}}$$

where x is output, e is effort and θ is productivity type. Vousden notes that these conditions bear some similarity to the McAfee and McMillan (1991) conditions for monopoly to reduce efficiency (discussed earlier). It is also noted that it is not difficult to devise cost functions which comply with these restrictions. As an example $C(\theta, e, x) = (\theta - e).x$ is cited. This is the special case used by Laffont and Tirole.

Another result from the Vousden paper is that, if lobbying by the protected firm increases the weight placed upon its interests by the government, then this will imply lower effort levels. It is a result which offers a rationale for the idea that protected firms put in low effort levels because managerial attention is diverted toward lobbying.

VII: Trade Liberalization as a Cause of Improved Technical Efficiency: Empirical Evidence

Suppose it was observed that technical inefficiency was correlated with those industries which received higher levels of protection. There is an obvious problem in ascribing causation. It might be that the protection has caused the technical inefficiency. However it might be that those industries which are technically inefficient lack comparative advantage and hence are granted protection so as to allow their survival[11]. It may also be the case that such industries receive higher marginal gains from lobbying for increases in protection. A methodology designed to overcome this problem would be to observe technical efficiency both before and after a change in protection. Tybout, de Melo and Corbo (1991) do this using Chile's dramatic trade liberalization which occurred in the 1970s. This study uses industry census data, at the plant level, for 1967 and 1979. In 1967 protection levels were very high. In addition there were substantial differences in the protection levels between industries. By 1979 protection levels had become very low and very uniform. It seems that the size of the protection reduction for any given industry was purely determined by the initial level of protection. Thus industries with particularly high levels of protection, prior to the trade liberalization, experienced the largest reduction in protection. Tybout et al examine whether there is a tendency for these industries to have had the greatest increase in technical efficiency. To do this, 1967 and 1979 production functions are estimated for each industry. This

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11. Such a policy of made-to-measure protection is consistent with Corden's famous conservative social welfare function (Corden 1974 p.107-109).

allows changes in technical efficiency to be measured independently of scale effects. Using Spearman rank correlations, a strong association is found between improved technical efficiency and reductions in protection. An interesting point made by this study is that over the 1970s the measured productivity growth (total factor productivity growth) made by Chilean industries was actually quite poor. Taking the manufacturing sector as a whole, there actually would appear to have been a fall in total factor productivity between 1967 and 1979. Tybout et al consider one reason for this to have been the relatively slack demand for manufactured products in 1979. They consider that the major macroeconomic shocks which Chile experienced could mask the effects of commercial policy. There was hyperinflation during 1973, a major recession in the mid-1970s, and during the latter half of the 1970s an exchange rate appreciation and an increase in the real interest rate. Other reasons cited why a fall in productivity may be observed include changing technology and measurement errors associated with capital stocks and the price deflators. Since the methodology of Tybout et al is comparative in nature, these problems associated with interpreting productivity growth should largely be abstracted from. That is, they judge that all Chilean industries have been roughly subject to the same macroeconomic shocks and measurement errors.

Mexico is another country which has experienced a dramatic trade liberalization. In 1985 there was a substantial reduction in protection. Initially the impact was lessened by a substantial devaluation but in 1987 an appreciation resulted in Mexican industries facing the full competitive pressure of the reduction in protection. Tybout and Westbrook (1995) use plant level data from annual surveys for 1984 to 1990 to examine the proposition that foreign competition had made manufacturing industries more technically efficient. Using similar technique to the Chilean study, productivity growth for each industry is decomposed into various components. These are scale effects, share effects and residual effects. The term 'share effects' refers to an industry's productivity being increased as a result of the more technically efficient plants producing a greater share of total industry output. The term 'residual effects' refers to productivity growth which is not accounted for by either scale or share effects. Tybout and Westbrook describe it as a collection of hard-to-measure effects like capacity utilization, externalities, technical innovation, learning-by-doing and managerial effort. A variety of measures of international competition are utilised. These are; effective rates of protection, import licence coverage, official tariff rates, import penetration rates, and export shares. The results of the analysis suggest that increased exposure to international competition cause an increase in productivity and that this increase in productivity is mainly driven by the residual effects. It is found that improvements in scale efficiency are not associated with increased international competition. Thus both this and the Chilean study are consistent with the cold-shower argument.

Naturally it would be desirable to obtain evidence of this sort for more than two countries. Unfortunately drastic across-the-board trade liberalizations which are both preceded and followed by detailed industry censuses or surveys are uncommon occurrences. It is worth noting two purely cross-sectional studies which are consistent with the findings of the Chilean and Mexican studies. Carlsson (1972) uses establishment data for 26 Swedish manufacturing industries from 1968 for the purpose of investigating for evidence that competitive pressure affects technical efficiency. Carlsson estimates a production function for each industry allowing him to give each industry an efficiency index. Altogether four measures of freedom from competitive pressure are considered. The four-firm concentration ratio is used as an indicator of domestic market power. As Carlsson notes, the concentration ratio is a very imperfect indicator. It fails to take into account the effect of close substitutes. More importantly, in the case of a small open economy, there is the problem of the concentration ratio ignoring the effect of foreign competition. Three measures of foreign competition are considered; the nominal tariff level, the export/output ratio and the import/consumption ratio. The results of the regression analysis indicate that the tariff is significant in explaining the variation in the efficiency index. Industries that are both heavily protected and inefficient include breweries, dairies and textiles and apparel. The export/output ratio and the import/consumption ratio are found not to be significant. This is judged to be probably due to the industries being defined too broadly. The concentration ratio is actually positively correlated with the efficiency index. Carlsson explains this by saying in the case of a small open economy it is likely that the concentration ratio reflects economies of scale and specialisation rather than market power.

The other purely cross-sectional study considered is Caves and Barton (1990). They give a book-length treatment to efficiency in U.S. manufacturing industries. Their methodology for estimating efficiency is very similar to that of Carlsson. The data for these estimates is taken from the 1977 Annual Survey of Manufacturers. They choose 1977 partly because it is a year when the Census of Manufactures was taken. Data from this census is used as a source for exogenous variables in their analysis of interindustry differences in technical efficiency. A large number of exogenous variables are considered. Caves and Barton classify these variables under the following headings; competitive conditions, product differentiation and heterogeneity, occurrence of change and innovation, geographic market heterogeneity and organisational influences. The variables considered with respect to competitive conditions are; the four-firm concentration ratio, an adjusted four-firm concentration ratio (adjusted to take into account various factors such as international competition), the number of indictments for anticompetitive agreements from 1958 to 1977, the imports/consumption ratio averaged from 1972 to 1976 and the export/output ratio averaged from 1972 to 1976. They do not consider protection because of data problems. They describe the econometric procedure which is followed as being "somewhat inductive"(p. 88). The problem which they, and any similar study, face is that there is no single neat theory of technical efficiency to dictate which model should be tested. Their approach involves, starting with the variables which have the strongest theoretic claim for being included and the fewest missing observations, and then following this, experimenting with the inclusion of some of the other variables. The results from this study are consistent with competitive pressure inducing technical efficiency. A positive correlation is found between import competition and technical efficiency in those industries with a highly concentrated domestic market structure. The obvious interpretation to put on this, is that, firms which would be fairly 'safe' from competition in autarchy, are subject to competitive pressure from imports.

One other study which is worth mentioning is a recent contribution to the productivity growth and technical efficiency literature by Fecher and Perelman (1992). This study uses a database which covers 13 OECD countries by sector from 1971 to 1986. Using pooled data an, estimation is made for each sector's production function. Technical efficiency is measured in terms of the distance between the estimated production frontier and the observed output. That is the technical efficiency for a particular sector in a given country and year is considered in terms of the difference between the observed output and the output which would be predicted by the production function estimated for that sector. Thus to say that a particular sector in a given country is technically inefficient is to say that it performs inefficiently in comparison with the sector taken as a whole across all 13 OECD countries. A number of factors which may explain differences in technical efficiency are tested. The explanatory effect of each variable is shown by country, sector and time period. Import competition is shown to be significant for three small countries; Belgium, the Netherlands and Norway. Export competition is shown to be significant for Germany, France, Norway and the US. However it is somewhat surprising to note that in some cases a negative relationship is found between import and/or export competition and technical efficiency. Overall the authors conclude that competition is the main determinant of technical efficiency. It is found that tariff and nontariff barriers are not significant. This may be due to incomplete data. The data does not extend to the sectoral level and only pertains to a single year (1980 for tariff barriers and 1983 for nontariff barriers). The variable used for tariff barriers is national customs and import duties divided by the values of imports. For nontariff barriers two variables are used; effective protection by national quantitative restrictions on manufacturing imports and effective protection by all national nontariff barriers to manufacturing imports. Finally it is worth mentioning a caveat made by the authors that their methodology is unsuited to detecting the lagged effect which possible explanatory variables may have upon technical efficiency.

CHAPTER 3: PROTECTION AND MANAGERIAL EFFORT REVISITED

I: Introduction

In this chapter a principal-agent model is used to provide another explanation for the cold shower effect[1]. As is to be expected the cold shower effect only occurs under certain conditions. It will be shown that if particular restrictions are placed upon the protected firm's technology there will be a negative relationship between protection and managerial effort. The cold shower effect in this analysis has welfare implications which are not included within the standard deadweight loss associated with protection. Given certain conditions we can say that the occurrence of protection-induced managerial slack will contribute to the cost of protection. This result is quite striking when it is remembered that, with a model based upon a backward bending supply of effort curve, a decrease in managerial effort will mitigate the cost of protection since the gap between free trade output and protected output is lessened.

The principal-agent framework used is quite standard. In this case, the principal is the owner and the agent is the manager. While the owner can observe the cost of production, he is unable to observe the manager's level of effort and productivity type. The arguments in the firm's cost function are output, effort and productivity type. The restrictions placed upon this cost function are minimal and uncontroversial. This allows

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1. The analysis contained in this chapter is presented in journal article form in Vousden and Campbell (1994).

identification of which restrictions are necessary for a cold shower to take place and have an X-inefficiency cost of protection associated with it.

In the case where a cold shower does occur this result is being driven by the asymmetry in information. The owner is a conventional risk-neutral profit maximiser. If the owner had full information then an increase in protection would, if anything, result in an increase in the use of managerial effort. Hence this chapter represents a distinct departure from the utility-maximising entrepreneur or the utility-maximising manager with essentially passive owners. Without full information the owner has to pay the manager an information rent to illicit a truthful revelation of productivity type. Hence, when deciding upon the profit-maximising level of effort, the owner has to take into account what the associated information rent will be. If protection increases, the profit-maximising owner responds by increasing output. With some technologies the increase in output increases the marginal information costs of extra effort. If this is the case, then it is profit-maximising for the owner to require a lower level of effort as well as a higher level of output. Examples of plausible technologies which will give this outcome are provided.

The popular preconception is that if protection induces a reduction in managerial effort then this must be bad for society. This analysis shows that only under certain conditions is it possible to talk about there being an X-inefficiency cost of protection. Consider the following case. Suppose that the firm's technology is such that the levels of effort and output are initially below their full information levels. Now suppose further that the technology is such that if protection is increased then effort will be reduced. Here the distortion in the choice of effort caused by the information asymmetry is magnified. That is, the gap between the socially efficient choice of effort and the privately chosen effort has been made larger by the increase in protection. This is a cost of protection which is in addition to the standard deadweight loss associated with protection.

This chapter is arranged as follows. Section II sets out the model which is used. It goes on to establish the conditions for the profit-maximising choice of effort and output given the asymmetry of information. Section III considers the comparative statics associated with a change in protection. Examples are shown of some technologies which give a cold shower result. Section IV contains the welfare analysis. Finally some concluding comments are made in Section V.

II: Optimal choice of Effort with Asymmetric Information

For simplicity, the domestic industry consists of a single firm selling its output on a competitive world market. The owner of the firm is an expected-profits maximiser. The firm is run by a manager who maximises expected utility. The manager's utility function consists of income less the disutility of effort. The disutility of effort function is denoted $\psi(e)$ where $\psi'>0$, $\psi''>0$. The more effort the manager puts in, the lower will be the expected cost of production. The manager's effort can not be observed by the owner and thus the setting of the effort level can be regarded as a hidden action. The owner is unable to deduce the effort level by observing the realized cost of production because of the effect of stochastic disturbances. The owner is also unable to observe θ, the manager's productivity type. This can be thought of as representing either the manager's inherent ability or particular circumstances which affect the firm but are beyond the manager's control. Since θ cannot be affected by the manager it needs to be thought of as hidden information rather than a hidden action. The owner does know the probability distribution of all possible productivity types; $F(\theta)$. θ_1 is the lower limit of this distribution, that is the most productive type. θ_2 is the upper limit, that is the least productive type. The expected cost of production obviously needs to be written as a function of productivity type and effort as well as output:

$$C(\theta,e,x), \; (C_\theta>0, \; C_{\theta\theta}\geq 0, \; C_e<0, \; C_{ee}>0, \; C_x>0, \; C_{xx}>0, \; C_{xe}<0)$$

It can be noted from this that we are assuming effort is not an inferior input since increasing effort reduces both total and marginal cost. The cost, which is actually observed by the owner after production has taken place, is subject to the conditional probability distribution

$$H(z \mid C(\theta,e,x)), \qquad H_1=h>0, \qquad H_2<0,$$

where h is the density function derived from H and H_2 represents the partial derivative of H with respect to the mean cost C[2].

This type of principal-agent problem was developed by Laffont and Tirole (1986) to examine government regulation of natural monopolies when the regulator can observe ex post cost even though effort and productivity type are unobservable. They show that the asymmetric effort level differs from the full information effort level. Hence this framework is particularly suitable for looking at the question of managerial effort within a profit-maximising firm. For reasons of tractability Laffont and Tirole treat both the principal and the agent as risk-neutral. Hence in this chapter the manager is treated as risk-neutral rather than risk-averse. This is desirable since here managerial risk aversion can be eliminated as a factor causing increased protection to result in lower managerial

2. For a survey of the different informational relationships which occur between principals and agents see Baron (1989).

effort.

This section proceeds to derive the conditions for the owner optimally choosing effort and output. The owner, of course, cannot simply order the manager to put in the required level of effort. Rather, the owner chooses the payment function T which induces the profit-maximising choice of e and x by the manager. This payment function is dependent upon the variables which the owner can observe. These are; θ* the productivity type the manager reports, x the level of output, and z the realized production cost. Prior to solving the owner's profit maximisation problem, it is necessary to devise the constraints which the owner faces. The incentive compatibility constraint can be thought of in terms of the requirement that the manager has no incentive to falsely report his productivity type. Hence we require that a relatively high-productivity manager cannot gain an advantage from pretending to be a low-productivity manager in order to be able to hide a low level of effort. The reason why we require the incentive compatibility constraint to hold is that we are told by the Revelation Principal[3] that an incentive scheme which elicits a truthful response yields at least as high a value of the principal's objective function as any other incentive scheme. To establish the incentive compatibility constraint we need to consider the manager's expected utility maximisation problem:

$$u(\theta) = \max_{\theta^*,e,x} \int_z T(\theta^*,x,z)h(z \mid C(\theta,e,x))dz - C(\theta,e,x) - \psi(e) \qquad (1)$$

where θ^* is the value of θ reported by the manager.

Here the manager receives a payment of T from which he must cover the production

3. See Myerson (1979).

costs. The actual value of the payment is stochastic since the observed cost z is a affected by a random disturbance. For a given payment function the manager's choice of effort will satisfy

$$C_e[\int_z Th_2 dz - 1] - \psi'(e) = 0. \tag{2}$$

It is convenient to rewrite this as

$$\int_z Th_2 dz - 1 = \frac{\psi'(e)}{C_e}. \tag{2a}$$

Let us now consider the incentive compatibility constraint. For this to hold we must have $\theta^*=\theta$. If this is the case, then, using the envelope theorem:

$$u'(\theta) = \frac{\partial}{\partial\theta}[\int_z T(\theta^*,x,z)h(z \mid C(\theta,e,x))dz - C(\theta,e,x) - \psi(e)]$$

$$= C_\theta[\int_z Th_2 dz - 1]. \tag{3}$$

The interpretation which can be placed upon this condition is that any gain to the manager from misrepresenting his productivity type will be offset by the effect upon the incentive payment T. The more productive managers need to receive a higher payment so as to deter them from understating their productivity type in order to obtain a larger cost reimbursement. Using (2a) the incentive compatible condition can be written as

$$u'(\theta) = \gamma\psi'(e), \quad \text{where } \gamma = \frac{C_\theta}{C_e} < 0. \tag{4}$$

From this it is clear that $u'(\theta)<0$. That is as θ increases (as the manager's type becomes less productive) the manager's utility decreases. So it can be said that the high productivity manager will receive a higher information rent so as to insure that θ is correctly reported.

The other constraint which the owner faces is the participation constraint. That is, the owner must offer the manager a contract which is at least as attractive as the manager's next best alternative. The manager's reservation utility is assumed to be zero. Hence the participation constraint is $u(\theta)\geq 0$. What this is saying is that, whatever the manager's type, his expected utility must be non-negative. From the incentive compatibility constraint, it is clear that the least productive type of manager will have the lowest level of utility. Consequently if the incentive scheme is such that the least productive manager would expect to obtain non-negative utility then the participation constraint would be satisfied since all other types of managers would receive positive utility (an information rent). So the participation constraint may be written as

$$u(\theta_2) \geq 0 \,. \tag{5}$$

We are now in a position to formulate the owner's profit maximisation problem. It is convenient to write the owner's expected cost (the payment to the manager) in terms of covering the manager's production costs, providing the manager with an information rent and compensating the manager for the disutility of effort:

$$\int_z T(\theta,x,z)h(z\,|\,C(\theta,e,x))dz = C(\theta,e,x) + u(\theta) + \psi(e) \;.$$

Hence we can write the owner's expected profit as

$$E\pi(\theta) = (p^* + s)x - C(\theta,e,x) - u(\theta) - \psi(e) \,,$$

where p* is the given world price for output and s is a per unit production subsidy financed by lump sum taxes. It is analytically convenient to state the owner's problem in terms of choosing $x(\theta)$, $e(\theta)$, $u(\theta_1)$ and $u(\theta_2)$ to maximise

$$\int_{\theta_1}^{\theta_2} E\pi(\theta)f(\theta)\,d\theta = \int_{\theta_1}^{\theta_2} [(p^* + s)x - C(\theta,e,x) - u(\theta) - \psi(e)]f(\theta)\,d\theta \,, \tag{6}$$

subject to the incentive compatibility and participation constraints (4) and (5) where $f(\theta)$ ($=F'(\theta)$) denotes the owner's probability density function for θ. This is a free-end point, optimal-control problem with control variables $e(\theta)$ and $x(\theta)$ and state variable $u(\theta)$. The necessary conditions for a maximum are given in Appendix 3.1. These yield the following conditions determining e and x for each θ:

$$[p^* + s - C_x]f(\theta) = -\mu(\theta)\gamma_x\psi', \tag{7}$$

$$[-C_e - \psi']f(\theta) = -\mu(\theta)[\gamma_e\psi' + \gamma\psi''], \tag{8}$$

where $\mu(\theta)$ is the costate variable for the optimal control problem (6) and, as such, represents the owner's shadow price of information rents. In Appendix 3.1 it is shown that $\mu(\theta)=F(\theta)$. $F(\theta)$ is the cumulative distribution function associated with the density $f(\theta)$.

To examine the implications of the optimal output condition (7) it is useful to rewrite its right-hand side using the incentive compatibility condition (4):

$$[p^* + s - C_x]f(\theta) = -\mu(\theta)\frac{\partial u'(\theta)}{\partial x}, \tag{7a}$$

The left-hand side represents the expected marginal profits with respect to output in the absence of hierarchic effects. The right-hand side represents the marginal information cost of output since $-\partial u'(\theta)/\partial x$ is the change in the slope of the informational rent profile with respect to a change in output. Condition (7a) can be used to establish what we need to assume for the asymmetric information output level to be lower than the full information level of output. In the full information case output must be chosen so that the left-hand side will be zero. In the asymmetric information case if $\gamma_x<0$ (so that $\partial u'(\theta)/\partial x<0$) output must be chosen so that the left-hand side will be positive. Hence assuming $\gamma_x<0$ insures that the asymmetric information level of output will be lower than the level of output which would prevail if the owner had full information.

Turning to consider the optimal effort condition (8) it is again useful to use (4) to rewrite the right-hand side:

$$[-C_e - \psi']f(\theta) = -\mu(\theta)\frac{\partial u'(\theta)}{\partial e}. \tag{8a}$$

The left-hand side represents the expected net marginal benefit of increased effort in the absence of hierarchic effects. The right-hand side represents the marginal information cost of effort since $-\partial u'(\theta)/\partial e$ is the change in the slope of the informational rent profile with respect to a change in effort. Examining the right-hand side of (8) it is clear that $\gamma_e \leq 0$ is sufficient for $-\partial u'(\theta)/\partial e>0$ and hence a positive right-hand side. Consequently if $\gamma_e \leq 0$ the optimal level of effort will be below the level of effort which would have prevailed if the owner had full information.

It is commonly perceived that hierarchical relationships lead to both slack and low levels of output[4]. Therefore this chapter concentrates upon the case where effort and output are set below the full information levels. From the above discussion we can write a sufficient condition for this case as

$$\gamma_x \leq 0 \text{ and } \gamma_e \leq 0. \tag{9}$$

When considering this condition it is useful to remember how γ is defined. That is, since $\gamma = C_\theta/C_e$, γ can be described as the marginal rate at which effort must be substituted for inherent productivity to maintain a given cost of production. Assuming that $\gamma_x<0$ is saying that as output increases, the cost-reducing effect of a marginal increase in inherent productivity will proportionately exceed the cost-reducing effect of increased

4. See, for example, Dearden et al. (1990).

effort. Assuming that $\gamma_e<0$ is saying that as effort increases, more effort needs to be substituted for a given fall in productivity so as to maintain a given cost.

III: When will Reducing Protection cause Increased Managerial Effort?

In this section we examine what assumptions are necessary for us to be able to obtain comparative static results which are consistent with the cold shower hypothesis. Let us consider a reduction in the subsidy[5]. To do this we differentiate (7) and (8) with respect to s, we obtain

$$\frac{\partial x}{\partial s} = -\frac{f(\theta)}{\mathcal{H}}\frac{\partial^2 \mathcal{L}}{\partial e^2}, \quad \frac{\partial e}{\partial s} = \frac{f(\theta)}{\mathcal{H}}\frac{\partial^2 \mathcal{L}}{\partial e \partial x},$$

where $\mathcal{L}$ is the Hamiltonian for the optimisation problem (6) and • >0 is the Hessian determinant of $\mathcal{L}$. Since $\mathcal{L}$ is assumed to be strictly concave in (x,e) it follows that $\partial x/\partial s>0$ and

$$\text{sgn}\,\frac{\partial e}{\partial s} = \text{sgn}\,\frac{\partial^2 \mathcal{L}}{\partial e \partial x} = \text{sgn}\,[-f(\theta)C_{ex} + F(\theta)[\gamma_{ex}\psi' + \gamma_x \psi'']]. \tag{10}$$

Consider the expression on the right-hand side of (10). The first term ($-f(\theta)C_{ex}$) represents how with increased output it is profit maximising to increase the level of effort given that effort is not an inferior good ($C_{ex}<0$). So according to this effect a decrease in protection would reduce effort since with lower output there would be less marginal return from expending effort. If a reduction in protection does increase effort it is purely due to the owner's marginal informational cost of effort being increased as

5. The reason for selecting a subsidy as the protective instrument being considered is that all the relevant effects are on the production side. There would be nothing to be gained by looking at the standard consumption side distortions which accompany a tariff.

output is reduced. This can be seen from looking at the following necessary condition for $\partial e/\partial s<0$;

$$\gamma_{ex}\psi' + \gamma_x\psi'' = \frac{\partial[\gamma_e\psi' + \gamma\psi'']}{\partial x} = \frac{\partial[\partial u'(\theta)/\partial e]}{\partial x} < 0 . \tag{11}$$

Clearly this condition will only hold for certain cost functions. If condition (9) holds γ_x will be non-positive. However γ_{ex} is actually a third derivative and hence very little can be said about what its sign might be. What can be said is that it is easy to come up with examples of cost functions where (11) holds such as

$$C(\theta, e, x) = A - ex^2 + \theta x^3 .$$

A class of cost function which is interesting to consider are those where effort only affects fixed costs. An example of such a cost function is

$$C(\theta, e, x) = A - e + \theta x .$$

In this case condition (11) holds and since $C_{ex}=0$ we can say from (10) that $\partial e/\partial s<0$. Now let us consider the general form of this class of function;

$$C(\theta, e, x) = g(e) + r(\theta, x), \quad g_e < 0, g_{ee} > 0, r_\theta > 0, r_{\theta\theta} \geq 0, r_x > 0, r_{xx} > 0 .$$

It is simple to show that this will yield $\partial e/\partial s<0$ if it is assumed that productivity type is not an inferior input. This assumption means that the more productive the manager is (the lower θ is) the lower marginal cost (r_x) will be; $r_{x\theta}>0$. We can say that if this is the case then condition (11) will hold. That is

$$\gamma_x = \frac{r_{x\theta}}{g_e} < 0 , \gamma_{ex} = -\frac{g_{ee}r_{x\theta}}{g_e^2} < 0 \quad \text{if } r_{x\theta} > 0 .$$

This case where effort only reduces fixed cost seems quite plausible. This is because in many situations the primary role of a manager is to set up a particular productive process. If a reduced level of managerial effort is devoted to this task then one would expect that greater quantities of other inputs would be used in setting up. That is fixed costs (or perhaps more exactly quasi-fixed costs[6]) would be higher.

IV: An 'X-inefficiency Cost' of Protection

The comparative static results in the previous section are of interest in their own right. However they prompt the question as to whether, from a social welfare view point, we should care about a reduction in effort caused by an increase in the subsidy. In this section it is shown that it is possible to identify a welfare cost associated with a such a reduction in effort. A change in the subsidy affects the owner, the manager and the taxpayers. Obviously an increase in the subsidy will make the taxpayers worse off. However we can not make any general comment as to whether the manager is made worse or better off. From Appendix 3.2 it is clear that the owner is made better off:

$$\frac{d}{ds}\int_{\theta_1}^{\theta_2} E\pi(\theta)f(\theta)\,d\theta = \int_{\theta_1}^{\theta_2} x(\theta)f(\theta)\,d\theta > 0 . \qquad (12)$$

Total social surplus W consists of the owner's expected profit plus the expected utility of the manager minus the cost of the subsidy to the taxpayers (financed by lump-sum taxes). Hence for a given value of θ it is defined as

$$W(\theta) = E\pi(\theta) + u(\theta) - sx . \qquad (13)$$

Using (12) we can write out the following expression for the effect of an increase in the subsidy on the social surplus:

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6. See Varian (1993, p.342).

$$\frac{d}{ds}\int_{\theta_1}^{\theta_2} W(\theta)f(\theta)\,d\theta = \int_{\theta_1}^{\theta_2}\left[x(\theta) + \frac{du(\theta)}{ds} - x(\theta) - s\frac{dx(\theta)}{ds}\right]f(\theta)\,d\theta$$

$$= -s\frac{d}{ds}\int_{\theta_1}^{\theta_2} x(\theta)f(\theta)\,d\theta + \frac{d}{ds}\int_{\theta_1}^{\theta_2} u(\theta)f(\theta)\,d\theta\,. \qquad (14)$$

Here the overall welfare change is decomposed into two components. The first term on the right-hand-side represents the standard marginal deadweight loss associated with the subsidy. The second term is labelled the 'organisational cost of protection'. This term is only present because the manager receives an information rent. Clearly it could be positive in which case we would be dealing with an organisational benefit. There will only be an organisational cost if an increase in the subsidy causes a reduction in information rents. This result may seem somewhat counter-intuitive. However it needs to be remembered that the payment of information rent is simply a transfer between the owner and the manager. In principle the organisational cost of an increase in the subsidy could be measured by the change in incentive payments. In practice it would seem very difficult to isolate pure managerial incentive payments.

The X-inefficiency cost of protection is that component of the organisational costs which represents the welfare costs associated with the change in effort caused by the change in information rent paid. The organisational costs can be rewritten such that

$$\frac{d}{ds}\int_{\theta_1}^{\theta_2} u(\theta)f(\theta)\,d\theta = -\int_{\theta_1}^{\theta_2} F(\theta)\left[\gamma_x\psi'\frac{dx}{ds} + (\gamma_e\psi' + \gamma\psi'')\frac{de}{ds}\right]d\theta \qquad (15)$$

as can be seen from Appendix 3.2. Hence the X-inefficiency cost can be written as

$$-\int_{\theta_1}^{\theta_2} F(\theta)\left[(\gamma_e\psi' + \gamma\psi'')\frac{de}{ds}\right]d\theta\,.$$

The case that we focus upon here is where output and effort are below their full information values (condition (9)) and there is a negative relationship between the size of the subsidy and the level of effort (a cold shower effect). Here $\gamma_x\psi'(dx/ds)$ will be negative (since dx/ds>0) and $(\gamma_e\psi'+\gamma\psi'')(de/ds)$ will be positive. Thus if there is an organisational cost (rather than a benefit) this outcome will be driven by the X-inefficiency cost of protection being sufficiently large to offset the organisational benefit effect associated with the change in output. This is a particularly appealing result since it links a welfare cost with a cold shower. However it should be noted that if output and effort are above their full information levels a cold shower would have an X-inefficiency benefit associated with it.

V: Concluding Comments

Like the earlier cold shower literature this analysis only gives qualified support for the contention that increasing the level of protection will reduce the level of managerial effort. However, unlike the Corden/Martin model it gives a cold shower story which is not a strawman. The tenor of Corden's discussion of the cold shower story is to treat it as an idea that should be regarded with suspicion. The general attitude is that a backward bending supply of effort curve would not be a particularly wide spread phenomena. Suppose that we try applying the Corden/Martin model to the situation where the firm in question is a corporation rather than an entrepreneurial firm. To do so it would be necessary to assume that the corporation's management is free to determine its level of effort. This is rather a strong assumption since it requires the owners of the corporation to be essentially passive and hence it ignores the influence of sophisticated institutional investors. By contrast, the principal-agent framework used in this chapter reflects reasonably well the hierarchical nature of the corporate firm. That is the firm is treated as a profit-maximising entity which has the problem of the owner who makes the profit-maximising decisions not having full information. It should also be noted that if the information asymmetry was, say, between a supervisor and workers, the important results from the analysis still stand.

Finally it is worth noting that the cold shower effect identified in this chapter does not represent a formalisation of the folklore notion of trade liberalization causing managerial effort to increase due to the increased competitive pressure which the previously protected firms now face. Both before and after a trade liberalization our owner acts to maximise profit and our manager responds to the incentives given by the owner. That is, neither the owner nor the manager are affected by a fear of the firm getting into financial difficulties once the protection is removed.

APPENDIX 3.1: FIRST ORDER CONDITION FOR THE OWNER'S PROBLEM

The Hamiltonian for the problem (6) is

$$\mathcal{L} = [(p^{*} + s)x - C(\theta, e, x) - u(\theta) - \psi(e)]f(\theta) + \mu(\theta)\gamma\psi'(e),$$

where $\mu(\theta)$ is the costate variable. The necessary conditions satisfied by a solution to the problem are:

$$\frac{\partial \mathcal{L}}{\partial x} = [p^{*} + s - C_x]f(\theta) + \mu\gamma_x\psi' = 0, \tag{A1}$$

$$\frac{\partial \mathcal{L}}{\partial e} = -[C_e + \psi']f(\theta) + \mu[\gamma_e\psi' + \gamma\psi''] = 0, \tag{A2}$$

$$u'(\theta) = \gamma\psi'(e), \tag{A3}$$

$$\mu'(\theta) = -\frac{\partial \mathcal{L}}{\partial u} = f(\theta), \tag{A4}$$

$$\mu(\theta_1) = 0, \tag{A5}$$

$$\mu(\theta_2) \geq 0, \quad u(\theta_2) \geq 0, \quad \mu(\theta_2)u(\theta_2) = 0. \tag{A6}$$

Note that (A1) and (A2) yield equations (7) and (8) in the body of the chapter. Also, from (A4) and (A5), we have

$$\mu(\theta) = F(\theta) > 0. \tag{A7}$$

APPENDIX 3.2: DISTRIBUTIONAL AND WELFARE EFFECTS OF A CHANGE IN THE SUBSIDY

Derivation of Equation (12). Using the definition of the Lagrangian, integrating by parts and using (A4), (A5) and (A6), the owner's expected profits are

$$\int_{\theta_1}^{\theta_2} E\pi(\theta)f(\theta)\,d(\theta) = \int_{\theta_1}^{\theta_2} [\mathcal{L} - \mu(\theta)u'(\theta)]\,d\theta$$

$$= \int_{\theta_1}^{\theta_2} \mathcal{L}\,d\theta + \int_{\theta_1}^{\theta_2} u(\theta)f(\theta)\,d\theta$$

$$= \int_{\theta_1}^{\theta_2} \{[(p^{*} + s)x - C(\theta, e, x) - \psi(e)]f(\theta)$$

$$+ \mu(\theta)\gamma\psi'\}\,d\theta.$$

Differentiating with respect to s and using the first order conditions (A1) and (A2) yields equation (12) in the body of the chapter.

Derivation of Equation (15). Use integration by parts to obtain

$$\int_{\theta_1}^{\theta_2} u(\theta)f(\theta)\,d\theta = [u(\theta_2)F(\theta_2) - u(\theta_1)F(\theta_1)] - \int_{\theta_1}^{\theta_2} u'(\theta)F(\theta)\,d\theta$$

$$= -\int_{\theta_1}^{\theta_2} u'(\theta)F(\theta)\,d\theta, \text{ using (A5)-(A7).}$$

Noting that

$$\frac{d}{ds}u'(\theta) = \frac{d}{ds}(\gamma\psi') = \gamma_x\psi'\frac{dx}{ds} + (\gamma_e\psi' + \gamma\psi'')\frac{de}{ds}$$

[from (4)] and differentiating with respect to s yields equation (15) in the body of the chapter.

CHAPTER 4: PROTECTION REDUCTIONS AND INVESTMENT IN NEW TECHNOLOGY

I: Introduction

This chapter uses a simple decision-theoretic model to provide a possible rationalisation for the idea that a reduction in protection can facilitate investment in new technology. Consider the case where the removal of a firm's protection would result in it ceasing to survive with its current cost structure. To many non-economists it would be almost axiomatic that removing the firm's protection increases its incentive to invest in cost-reducing new technology[1]. However if the question is given greater attention it becomes clear that the benefit from a cost-reducing investment would be greater prior to the removal of protection[2]. The approach taken here hinges on regarding the outcome of the investment as being stochastic[3]. For simplicity a two-point distribution is assumed. The good outcome is a reduction in cost sufficient for the firm to continue production with or without the protection. The bad outcome is a reduction in costs which is not sufficient for the resulting operating profits to cover the cost of the investment so that bankruptcy occurs. The decision as to whether or not to make the investment is made by an owner/manager whose utility is solely a function of income. Thus there is a departure from the X-efficiency tradition which focuses on managerial

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1. Knight (1967), writing in the business administration literature, describes this as 'distress innovation'.

2. For a formal treatment of this point see Rodrik (1990).

3. The US Congressional Budget Office (1986 p.9) consider that protected firms may be less inclined to make large and risky investments in cost-reducing technologies.

effort.

The 'cold shower scenario' which will be formalised runs in the following manner. The owner/manager first evaluates the investment while the firm is protected. The investment is rejected since the expected utility from proceeding with it is exceeded by the utility to be gained by continued use of the old technology. With the removal of the protection the investment is re-evaluated. The return from the good outcome is, of course, reduced. The return from the bad outcome remains the same because of limited liability. That is, with or without the protection, the owner/manager receives the income stream associated with bankruptcy. The return from not making the investment is reduced to the income stream associated with exiting from the industry. If the fall in utility associated with not investing exceeds the fall in utility associated with the good outcome, weighted by the probability that the good outcome occurs, then it is possible that the removal of the protection will result in the investment being made.

Essentially this analysis is an application of the fundamental insight from Golbe (1981) that imminent bankruptcy can affect equity holders' risk preferences with respect to the firm's returns. When bankruptcy is imminent the lower tail of the distribution of equity holders' returns is truncated because of limited liability. Hence equity holders who are risk-neutral or risk-averse with respect to their own returns may prefer the firm to engage in behaviour which would imply risk-loving preferences if it were not for the effect of imminent bankruptcy.

A point which is emphasised in this chapter is that the more averse the owner/manager is to losing the firm the more likely the cold shower scenario will occur. While the protection is in place there is only a positive probability of losing the firm (due to bankruptcy) if the investment is made. Once the protection is removed, deciding not to invest is synonymous with deciding to exit from the industry (losing the firm voluntarily). It seems reasonable to believe that the discounted income stream associated with losing the firm, either by voluntary exit or bankruptcy, is relatively low. With voluntary exit the owner/manager is taken to suffer a loss in industry-specific human capital. With bankruptcy, the penalty is taken to be even more severe since an association with a bankruptcy injures managerial reputation. Smith and Stulz (1985) consider bankruptcy aversion as one of a number of factors which may impact upon the extent of hedging by value-maximising corporations. Hedging reduces the variability of the value of the firm, hence reducing the probability of incurring the transaction costs associated with bankruptcy.

The contractual relationship between the owner/manager and the financial institution which funds the investment is clearly important. One stream within the bankruptcy literature consists of developing formal principal-agent models to investigate what type of incentive-compatible debt contracts may be entered into by a firm and its creditor. Both Diamond (1984) and Gale and Hellwig (1985) show asymmetric information cases where the optimal debt contract requires the debtor firm to be declared bankrupt if fixed payments on the debt are not met. The idea is that if the creditor is committed to the threat of inflicting bankruptcy upon the firm then the firm will have an incentive to meet its contractual payments if it has the ability to do so. This ability to pay, that is the success of the investment, is the information asymmetry featured in these two papers. The model used in this chapter does not have a firm-creditor informational relationship which is tailored to fit the principal-agent paradigm. Initially it is assumed that the creditor is unaware of how risky the investment is, but does know that bankruptcy represents a substantial penalty for default. The other case examined is where the creditor does know the probability of the bad outcome occurring and so is able to attach to a risk premium to the rate of interest. In both cases the firm is declared bankrupt if the required payment to the creditor can not be made. That is, the penalty for default is the owner/manager losing the status of being the residual claimant with control over the firm.

It is convenient to work using the assumption that a single, initially subsidized, domestic firm faces a price determined by a competitive world market. However the chapter also looks at the case where there are just two firms; the domestic firm and one foreign firm. This oligopolistic version of the model is useful for comparing the effect of the removal of a tariff with that of a quota. It is also useful for comparing the implications of Stackelberg behaviour with the implications of Cournot behaviour. An oligopolistic version of the model with n foreign firms is used to consider the relationship between the market power of the protected firm and the likelihood of a cold shower occurring.

The chapter is organized in the following manner. Section II specifies the situation which is being modelled. Sections III and IV establish criteria for whether to invest in the cost reducing technology. In Section V a condition is devised for the removal of protection to make the acceptance of the investment more likely. Section VI illustrates the cold shower scenario with a numerical example. In Section VII the case where the creditor knows the probability of the bad outcome is considered. Section VIII utilizes an oligopolistic version of the model with one domestic firm and one foreign firm. In Section IX the case where there are n foreign firms is considered. Finally Section X makes a number of concluding comments including some consideration of what normative implications can be drawn out of the analysis.

II: Introducing the Model

This model is designed to establish conditions under which firms will respond to a withdrawal of assistance by investing in cost-reducing technology. While, the model explicitly deals with a firm controlled by an owner/manager, the model is still relevant to firms where ownership is separated from control. The situation being modelled in this section has the following features:

(a) The industry structure is characterized by a large number of foreign firms and a single domestic firm.

(b) Operating costs differ between firms allowing supernormal profits to be made by the lower cost firms with the rents going to those fixed factors which give the cost advantage.

(c) The domestic firm's minimum average cost of production is higher than the market price p. Hence, given its cost structure, it is only able to operate profitably with the assistance of the output subsidy, s, which it receives.

(d) The utility of income function for the owner/manager of this firm has the following standard restrictions:

$$u'(.) > 0, \; u(0) = 0.$$

(While risk aversion would be a natural assumption to make, a case is shown where risk aversion is not required in order to get a cold shower result.)

If the owner/manager's discounted income stream falls below T then the decision is taken to cease operating, sell the firm's assets for scrap, pay any contractual compensation due to workers, and then engage in the next best alternative. Taking this action leaves the owner/manager with T. If the firm incurs debts and then is unable to meet its obligations to its creditor, the now bankrupt owner/manager's discounted income stream falls to Z (where Z < T). The firm's bankruptcy can be thought of two in ways. The creditor may take the firm's assets and sell them for scrap so as to recover some proportion of the debt. This leaves the owner/manager labelled as a failed manager who is hence only able to earn Z from any future employment. Alternatively bankruptcy could be interpreted as the creditor intervening in the affairs of the firm and requiring the owner/manager to work for Z with the surplus of operating profit going to the creditor.[4] This stylized representation of bankruptcy being viewed as costly by managers is consistent with recent empirical studies. Gilson (1989) examines a large sample of firms that experienced extreme common stock price declines. Gilson finds the turnover of top managers is far higher for those firms classed as being 'financially distressed'. It is of particular interest that Gilson finds that the managers who lost their position from a financially distressed firm did not find similar management positions in the following three years. Gilson also notes that following a default the creditors have a considerable influence over decision making within the firm. Hence managers, who did not immediately lose their position, would probably experience a substantial fall in utility.

4. For a discussion of the creditor's choice between opting for bankruptcy or continuing to extend credit see Bulow and Shoven (1978).

(e) The firm has the option of investing in a cost-reducing technology[5] but is uncertain about the extent to which costs would actually be reduced. For simplicity, it is assumed that there are only two possible outcomes; good and bad, the lower cost curves being respectively denoted $C_G(.)$ and $C_B(.)$.

(f) The good outcome refers to when the present value of the increase in operating profits summed to infinity exceeds the cost of the investment. Thus the firm can repay the interest on the investment cost to its creditor and gain some surplus on top of that.

(g) The bad outcome refers to when the resulting present value of operating profits summed to infinity is less than the cost of the investment. That is, the bad outcome breaks the bankruptcy constraint since the firm is making insufficient operating profits to be able to cover the interest on the cost of the investment.

(h) If the owner/manager decides to make the investment, then for simplicity it is assumed that the cost of the investment I is borrowed from a single creditor in perpetuity. Initially it is assumed that the creditor is uninformed with respect to the expected return on potential investments. However the creditor can observe which potential borrowers, such as the owner/manager, have a high aversion to bankruptcy. Hence the aversion of borrowers to bankruptcy mitigates the adverse selection problem by tending to deter 'bad-risk' borrowers from

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5. This technology is assumed to be mature in the sense that the firm has nothing to gain by deciding to delay its adoption. Jensen (1982) shows that delaying adoption may be optimal if the firm gathers information on the new technology's profitability over time. It would be interesting to know if there are instances of protection slowing down such an information gathering process.

applying for loans. Thus if the owner/manager does apply for the loan of I, the creditor's 'rule of thumb' is to approve this loan at the market clearing interest rate i.

III: The Investment Decision While Assisted

The condition is now derived for the owner/manager to reject the investment in cost-reducing technology while the regime of assistance remains in place.

Operating profits with a subsidy are;-

$$\delta_0^s = (p + s).x_0^s - C_0(x_0^s) > 0$$

$$\delta_G^s = (p + s).x_G^s - C_G(x_G^s) > 0$$

$$\delta_B^s = (p + s).x_B^s - C_B(x_B^s) > 0 \qquad \delta_0^s < \delta_B^s < \delta_G^s$$

where δ_0^s refers to when the new technology is not adopted,

δ_G^s ,δ_B^s refer respectively to the 'good' and 'bad' outcomes from adopting the new technology. These outcomes are a result of the cost curves shifting downward.

Ex post utility levels of the possible outcomes following the decision as to whether to adopt the new technology when subsidized are:-

No Investment:

$$u(\pi_0^s) > u(T) , \qquad \pi_0^s = \frac{\delta_0^s}{i}$$

Good Outcome:

$$u(\pi_G^s - I) > u(T) , \qquad \pi_G^s = \frac{\delta_G^s}{i}$$

Bad Outcome:

$$u(Z) , \text{ since } \pi_B^s - I < 0, \ \pi_B^s = \frac{\delta_B^s}{i}$$

Clearly if the return in terms of expected utility, Eu_I^s, is negative the owner/manager will reject the investment in new technology;

$$Eu_I^s = g.u(\pi_G^s - I) + (1 - g).u(Z) - u(\pi_0^s) \qquad (1)$$

$$= g.[u(\pi_G^s - I) - u(Z)] + [u(Z) - u(\pi_0^s)] \qquad (1a)$$

where g is the probability that the good outcome will occur.

The first term of expression (1) represents the ex ante utility from the good outcome. The second term represents the ex ante utility from the bad outcome. The third term represents the utility from not making the investment. For the investment to be rejected the third term will need to outweigh the first and second terms. Eu_I^s is more likely to be negative, for higher values of I, and π_0^s, and lower values of g, Z and π_G^s.

IV: The Investment Decision with Assistance Removed

Here the condition is derived for the owner/manager to accept the previously rejected investment once the assistance is removed.

Operating profits with the subsidy removed are;-

$\delta_0 = 0$ since by assumption $p.x_0^* - C_0(x_0^*) < 0$ where x^* is any x

$\delta_G = p.x_G - C_G(x_G) > 0$

$\delta_B = p.x_B - C_B(x_B) > 0$ or < 0.

Ex post utility levels of the possible outcomes following the decision of whether to adopt new technology or exit the industry are:

No Investment:

$u(T)$

Good Outcome:

$u(\pi_G - I) > u(T)$

Bad Outcome:

$u(Z)$ since $\pi_B^s - I < 0$ (Bankruptcy condition) $\Rightarrow \pi_B - I < 0$

An obvious difference in circumstances from the protected case is that now using the old technology it is not possible to make a non-negative operating profit. Clearly this is a sufficient condition for the decision not to invest to be synonymous with the 'voluntary exit' option being taken which gives a payoff of u(T). The assumption of $u(\pi_G\text{-}I) > u(T)$ is clearly necessary for there to be any possibility that the owner/manager will attempt to remain within the industry by deciding to invest. The bad outcome must result in bankruptcy since it has already been assumed that this occurs even with the benefit of the subsidy. Bearing this in mind, it is clearly unimportant whether the operating profit from the bad outcome falls below zero without the subsidy since the owner/manager's choice between exit and investment is unaffected by it.[6]

Expected utility from adopting the new technology is now;-

$$Eu_I = g.u(\pi_G - I) + (1 - g).u(Z) - u(T) \tag{2}$$

$$= g.[u(\pi_G - I) - u(Z)] + [u(Z) - u(T)] \tag{2a}$$

- note that $Eu_I = g.[u(\pi_G - I) - u(Z)]$ when $Z = T$.

6 This can be said because $\delta_B < iI$ which follows from the initial assumption that $\delta_B^s < iI$.

It can be seen from expression (2) that both the expected payoff from investing and the payoff from not investing are, as one would expect, reduced by the removal of the subsidy. So it cannot be said definitely whether the removal of the subsidy moves the net expected utility from the investment in either a positive or negative direction. Before going on to look at this ambiguity in the next section it is worth noting the importance of T being higher than Z. If Z was to actually be equal to T it would be the extreme case where it is no more costly to be 'driven from' the industry by bankruptcy than to make an 'orderly retreat' by deciding to exit from the industry in response to the removal of assistance. In this case the previously rejected technology would be adopted no matter how close g is to zero. The reason for this result is that choosing to invest gives the owner/manager some chance (however small) of avoiding the low utility outcome of u(T) = u(Z) which would be incurred with certainty if the 'no-investment' - 'voluntary exit' option were to be taken. As long as T > Z, there needs to be a large enough expected profit from investing to offset u(Z) - u(T) for Eu_I to be positive (see expression (2a)). Hence self selection protects the creditor from applications from 'really bad risks'.

V: <u>A Cold Shower Condition</u>

Here a condition is derived for the removal of the subsidy to encourage the adoption of cost reducing technology. This 'cold shower condition' summarizes this analysis by identifying when the adoption of such technology is less likely prior to the removal of the subsidy. The cold shower condition is defined as;-

$$Eu_I - Eu_I^s > 0 \qquad (3)$$

This condition is consistent with the following three scenarios;-

(a) $Eu_I^s < 0$, $Eu_I > 0$; $Eu_I^s < Eu_I$

That is, the cost-reducing technology is not adopted when assisted but is adopted once the subsidy is removed.

(b) $Eu_I^s > 0$, $Eu_I > 0$; $Eu_I^s < Eu_I$

That is, the cost-reducing technology is adopted in the presence of the subsidy however the incentive to do so becomes greatest once the subsidy is removed.

(c) $Eu_I^s < 0$, $Eu_I < 0$; $Eu_I^s < Eu_I$

That is, the cost-reducing technology is not adopted either prior to or following the removal of the subsidy however without the subsidy the incentive not to adopt the cost-reducing technology is weaker.

From expressions (1a) and (2a) the cold shower condition can be written as:

$$[u(\pi_0^s) - u(T)] - g.[u(\pi_G^s - I) - u(\pi_G - I)] > 0 \tag{3a}$$

The first term represents the difference between the utility from not investing when subsidized and the utility from not investing when not subsidized. The second term represents the expected value of the difference between the utility from the good outcome when subsidized and the good outcome when not subsidized. Clearly the lower g is, the more likely it is that the cold shower condition holds. However, as noted in the last section, if g is too low then the investment will be rejected in the not-subsidized situation as well as the subsidized situation. It can be noted that the losses from the bad outcome do not appear in this expression. This is because the expected fall in utility associated with obtaining a bad outcome does not change with the removal of the subsidy.

VI: A Numerical Illustration

At this point it is useful to provide an example of where a previously rejected investment is accepted following the removal of the subsidy. The following cost functions represent the initial technology, the good outcome technology, and the bad outcome technology respectively.

$$C_0 = 0.04x^3 - 0.8x^2 + 20x \rightarrow \min AC_0 = 16$$

$$C_G = 0.04x^3 - 0.8x^2 + 10x \rightarrow \min AC_G = 6$$

$$C_B = 0.04x^3 - 0.8x^2 + 18x \rightarrow \min AC_B = 14$$

The values for the variables are:

$p = 15$, $s = 2$, $I = 1000$, $T = 10$, $Z = 5$, $g = 0.1$, $i = 0.1$.

To emphasize that it is not always necessary to assume risk aversion, utility is initially treated as being synonymous with income.

Calculating the possible profits and hence the returns from investing gives the cold shower scenario:

$$\pi_0^s = 105.6,\ \pi_G^s = 1537.3,\ \pi_B^s = 344.0,\ \pi_G = 1209.6,\ \pi_B = 105.6$$

$$Eu_I^s = 0.1(537.3) + 0.9(5) - 105.6 = -47$$

$$Eu_I = 0.1(209.6) + 0.9(5) - 10 = 15$$

Here, making the investment is clearly taking 'a long shot' since g = 0.1. This bet becomes worth taking when the removal of protection makes not investing synonymous with leaving the industry and receiving only T. The relatively low values of T and Z represent the penalty the owner/manager faces for losing the firm. Without the subsidy the only strategy which will give a chance of not incurring this penalty is to invest.

If this example is modified by making the owner/manager risk-averse then it is possible to impose a far higher probability of success and still have the investment rejected while receiving the subsidy. The modifications introduced consist of:

$u = (.)^{1/10}$ and $g = 0.5$.

The returns which result are:

$$Eu_I^{s} = 0.5(1.8751) + 0.5(1.1746) - 1.5936 = -0.07$$

$$Eu_I = 0.5(1.7066) + 0.5(1.1746) - 1.2589 = 0.18$$

VII: When the Expected Value of the Investment is Known by the Creditor

Assuming the creditor operates on the basis of having no information about the expected returns on individual investments obviously underrates the information available to financial institutions. In this section it is assumed that the creditor knows both the potential profit flows and the probabilities associated with the good and bad outcomes. Competition in the credit market insures that the rate of interest charged by the creditor is only high enough to insure a normal rate of return in expected terms. Without a positive probability of default a normal return upon the loan would be the payment of i.I each period with a present value, over an infinite number of periods, of

I. Taking into account the probability of the bad outcome, and hence default, the creditor requires a rate of interest which is higher than i. Consequently the costs of making the investment when subsidized and when not subsidized are defined respectively as;-

$$K^s = \frac{r^s}{i}.I \quad K = \frac{r}{i}.I$$

where r^s and r are respectively the rates of interest charged with and without the subsidy. Now the relationship between I and the present-value cost of the loan is;-

$$g.K^s + (1-g).B^s = I \Rightarrow K^s = \frac{I-(1-g).B^s}{g}$$

Similarly

$$K = \frac{I-(1-g).B}{g}$$

where B^s and B refer to the present value of the loan to the creditor if the bad outcome has eventuated and so bankruptcy has been declared.

If the bankrupt firm continued to operate under the ownership of the creditor with the former owner/manager paid Z, then;-

$$B^s = \pi_B^s - Z$$

and

$$B = \pi_B - Z, \quad \text{if } \pi_B \geq Z$$

or

$$B = 0, \quad \text{if } \pi_B < Z$$

Deciding upon this particular functional form is somewhat arbitrary. The important idea is that the reduction in bad-outcome operating profits when the subsidy is removed implies that the cost of getting the loan to make the investment increases. So, instead of the utility associated with the good outcome being reduced from $u(\pi_G^s - I)$ to

$u(\pi_G - I)$, it is reduced from $u(\pi^*_G - K^*)$ to $u(\pi_G - K)$. However a cold shower effect can still occur even though removing the subsidy does cause a greater fall in the utility associated with the good outcome. Limited liability still means that removing the subsidy does not affect the payoff from the bad outcome. It is easy to modify the numerical illustration presented in Section VI to illustrate this point. The modifications to the initial illustration consist of:

$$I = 600\ ,\ g = 0.5\ ,\ \text{and}\ u = (.)^{1/10}.$$

The returns which result are:

$$\begin{aligned} Eu_I^* &= g.u(\pi^*_G - K^*) + (1-g).u(Z) - u(\pi^*_0) \\ &= 0.5(1.9187) + 0.5(1.1746) - 1.5936 \\ &= -0.05 \end{aligned}$$

$$\begin{aligned} Eu_I &= g.u(\pi_G - K) + (1-g).u(Z) - u(T) \\ &= 0.5(1.6004) + 0.5(1.1746) - 1.2589 \\ &= 0.13\ . \end{aligned}$$

It is important to note that in this illustration, making the investment cannot be thought of as taking a 'long shot'. A very small g would result in the creditor insisting on a prohibitively high interest rate. So that making the investment in response to removal of the subsidy would result in bankruptcy even if the good outcome did eventuate. With g=0.5 the investment represents a bet which a risk-neutral owner/manager would accept, with or without the subsidy, but our risk-averse owner/manager rejects when subsidized. With the removal of the subsidy the payoff from rejecting the investment (voluntary exit) is little more than the payoff from the bad outcome (bankruptcy). Hence the 'one way bet' aspect of the investment negates the effect of risk aversion so that the owner/manager accepts the investment.

VIII: Imperfect Competition Issues

In this section the assumption of a competitive world market is dispensed with. Instead there is a duopoly consisting of a foreign firm and a domestic firm. For simplicity both firms are assumed to have a constant marginal cost technology and it is assumed that demand is linear. Just as before, the domestic firm faces the choice of whether to invest in cost-reducing technology. It is assumed that the new technology simply has the effect of lowering the domestic firm's constant marginal cost. In addition, the analysis is restricted to the risk-neutral case with the 'uninformed' creditor. It is analytically convenient to adopt a static one-period framework where I (investment) is simply treated as a fixed cost.

The first issue to be considered here is whether the likelihood of a cold shower is affected by whether it is a tariff or a quota which is removed[7]. If the firms engage in Cournot competition, following the choice as to whether to make the investment, the cold shower effect is more likely if the protective instrument in question is a quota[8]. It will be shown that with a quota in place making the investment has a lower expected return than if an equivalent tariff had have been in place. The consequence of this is that it is more likely in the case of the quota that the investment is rejected if protection is in

7. For a guide to the standard trade policy literature on the differing effects of tariffs and quotas see Vousden (1990).

8. In this analysis the domestic firm needs to know the potential price/quantity outcomes associated with investing or not investing. This does not sit comfortably with the Cournot model having conjectural variations equal to zero. Hence perhaps it should be said that "the firms compete Cournot style". Kreps (p448,1990) uses this label for when firms simultaneously and independently set quantity with price clearing the market.

place but is accepted if the protection is not in place.

To begin the analysis, consider the following expression for profit when there is a tariff upon imports:

$$\pi^{t} = x.[a-b.(x+y)]-c.x$$

$$\pi^{*t} = y.[a-b.(x+y)]-c^{*}.y-t.y$$

where;

x and y refer respectively to the domestically produced and imported quantities sold;

c and c^* refer respectively to the domestic and foreign firm's marginal cost;

t refers to the tariff levied on each unit imported.

The reaction functions for each of the firms are as follows:

$$x = \frac{a-c-b.y}{2b}$$

$$\text{or} \quad y = \frac{a-c-2b.x}{b} \qquad (RF)$$

$$y = \frac{a-b.x-(c^{*}+t)}{2b} \qquad (RF_t^{*}).$$

The Cournot equilibrium profit for the domestic firm is

$$\pi^{t} = \frac{[a-2c+(c^{*}+t)]^{2}}{9b}. \qquad (4)$$

Hence the payoff from not investing is

$$\pi_0^{t} = \frac{[a-2c_0+(c^{*}+t)]^{2}}{9b} > T.$$

The payoff from investing when the good outcome occurs is

$$\pi_G^t - I = \frac{[a - 2c_G + (c^* + t)]^2}{9b} - I > \pi_0^t.$$

If investment takes place and the bad outcome occurs then bankruptcy results giving the owner/manager a payoff of Z.

Hence the expected return from investing if protected by a tariff is

$$Eu_I^t = g.(\pi_G^t - I) + (1 - g).Z - \pi_0^t.$$

With the removal of the tariff deciding not to invest is synonymous with the owner/manager deciding to exit from the industry. That is;

$$\pi_0 = \frac{[a - 2c_0 + c^*]^2}{9b} < T.$$

Hence the payoff from not investing is T.

If investment takes place and the good outcome occurs then the payoff is

$$\pi_G - I = \frac{[a - 2c_G + c^*]^2}{9b} - I > T.$$

Consequently the expected return from investing becomes;

$$Eu_I = g.(\pi_G - I) + (1 - g).Z - T.$$

Now we consider how the investment decision would be affected if the protective instrument being considered were a quota. To make this comparison the tariff is set so exactly the same level of domestic output would be sold if there was a quota of Q. This output equivalence is applied to the situation where no investment is made. If the investment were to be made then it is assumed that there would be no change to t or Q. Assuming that the quota is binding, the domestic firm solves the following problem to find its profit maximising output:

$$\underset{x}{\text{Max}} \quad \pi_0^Q = x.[a - b.(x + Q)] - c_0.x$$

$$\Rightarrow x = \frac{a - b.Q - c_0}{2b}. \tag{5}$$

That is with the binding quota the foreign firm's best response is to set y=Q. If a tariff is used, domestic output is set at

$$x = \frac{a - 2c_0 + c^* + t}{3b}. \tag{6}$$

Equating (5) and (6) allows us to obtain an expression for the tariff which results in a quota-equivalent output. This tariff is given by:

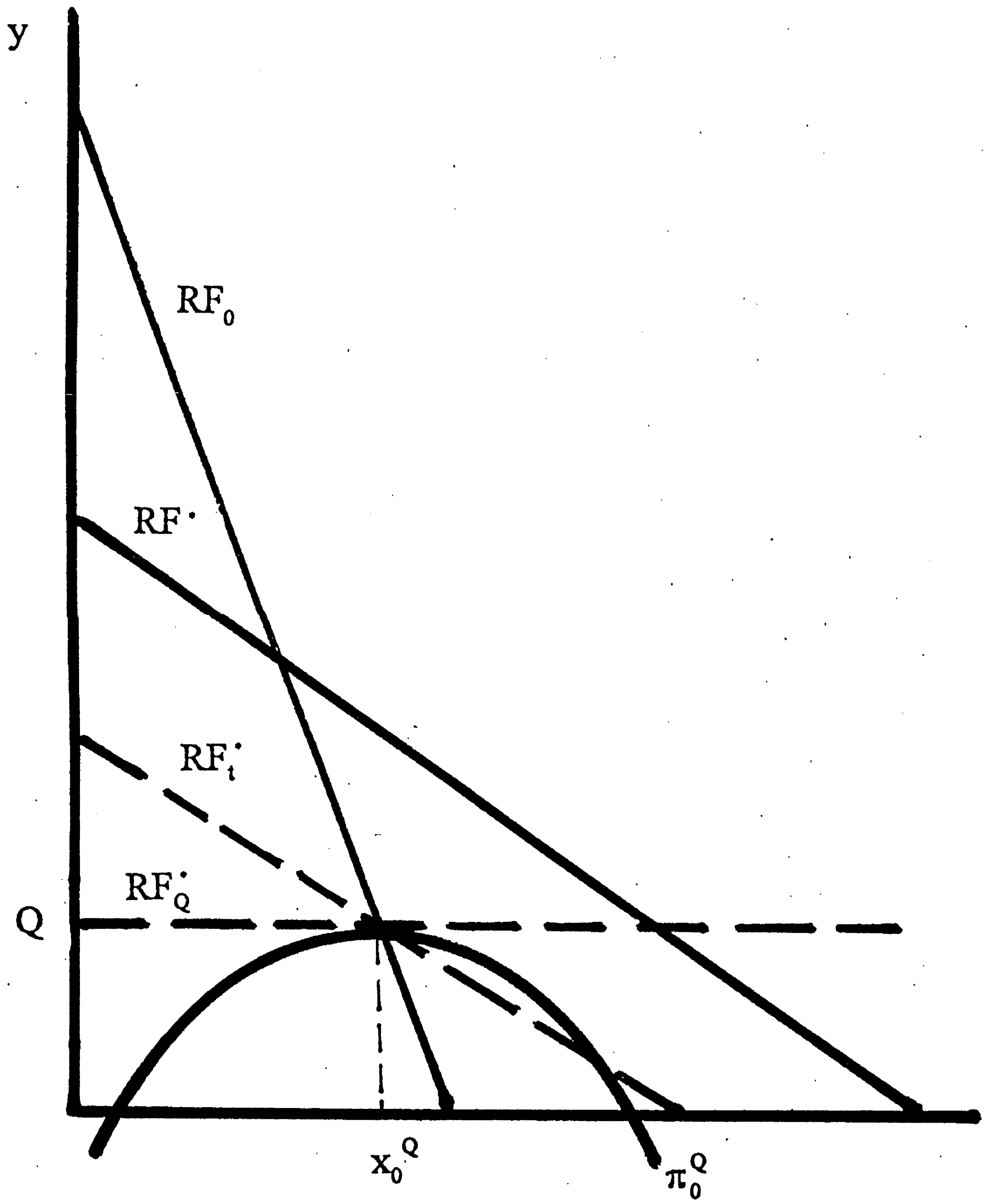
$$t = \frac{a - 3b.Q + c_0 - 2c^*}{2}. \tag{7}$$

Substituting (7) into (4) gives the profit associated with this tariff level:

$$\pi_0^Q = \frac{(a - b.Q + c_0)^2}{4b}. \tag{8}$$

If the quota had been used an identical profit level would have been obtained. This result may initially seem surprising. To rationalize it consider Figure 4.1 . If imports of y are restricted to Q then the foreign firm's reaction function becomes RF_Q^*. The resulting Cournot-Nash equilibrium yields a domestic output of x_0^Q, imports of Q and a domestic firm's profit of π_0^Q. The use of a tariff shifts the foreign firm's reaction function RF^* downward. So when the tariff is set so that x_0^Q is produced the foreign firm's reaction function is RF_t^*. Once again the equilibrium quantities sold are x_0^Q and Q. Hence again profit is π_0^Q.

Figure 4.1: Cournot Equilibrium Without the Investment



Now consider profit if the quota remains at Q but the investment is made with the good outcome so that the domestic firm's marginal cost falls from c_0 to c_G :

$$\pi_G^Q - I = \frac{(a - b.Q - c_G)^2}{4b} - I$$

$$= \frac{(3a - 3c_G - 3b.Q)^2}{36b} - I.$$

Similarly, consider the good outcome profit if the tariff remains at t:

$$\pi_G^t - I = \frac{(a - 2c_G + c^* + t)^2}{9b} - I$$

$$= \frac{(3a - 4c_G + c_0 - 3b.Q)^2}{36b} - I.$$

Now:

$-4c_G + c_0 > -3c_G$, since $c_0 > c_G$.

Therefore $\pi_G^t > \pi_G^Q$.

Using this result it is simple to show that there would be cases where with tariff protection or no protection the investment would be accepted while with quota protection the investment would be rejected. Recalling the cold shower expression (3), consider:

$$(Eu_I - Eu_I^Q) - (Eu_I - Eu_I^t)$$

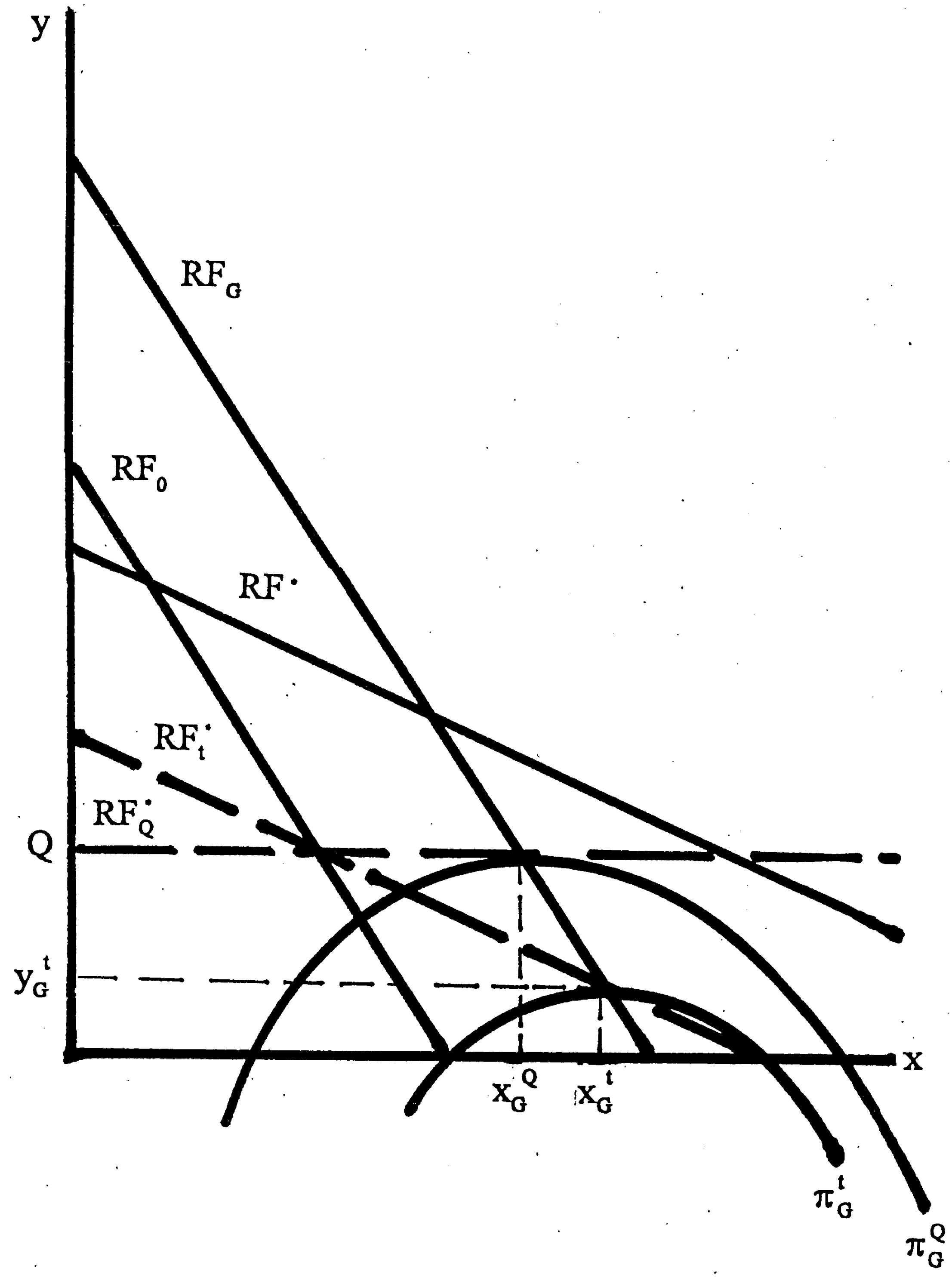
$$= Eu_I^t - Eu_I^Q$$

$$= g.(\pi_G^t - I) + (1-g).Z - \pi_0^t - g.(\pi_G^Q - I) - (1-g).Z + \pi_0^Q$$

$$= g.(\pi_G^t - \pi_G^Q) > 0.$$

To understand why $\pi_G^t > \pi_G^Q$ examine Figure 4.2 . The effect of the reduction in

Figure 4.2: Cournot Equilibrium With the Good Outcome



marginal cost associated with the good outcome is represented by the outward shift of the domestic firm's reaction curve (RF_0 to RF_G). In the case of the quota this does not affect the quantity of imports because the foreign firm's reaction curve is horizontal. In contrast, with a tariff the foreign firm's reaction curve RF_t^* has the conventional downward slope. Consequently imports fall from Q to y_G^t. So with the tariff the domestic firm is closer to its monopoly position (that being where RF_G touches the x axis). π_G^t exceeds π_G^Q not only because a higher quantity of x is sold but also because the price is higher. The prices are respectively;

$$p_G^t = \frac{3a + 2c_G + c_0 - 3b.Q}{6}, \quad p_G^Q = \frac{3a + 3c_G - 3b.Q}{6}.$$

Brander and Spencer (1988) contrast tariffs and quotas within a Cournot framework. In their model the domestic firm bargains with a trade union over wages. When a binding quota is used the union will negotiate higher wages because the increased cost of production will not affect the quantity of imports and hence there will be a relatively small impact upon employment.

Another imperfect competition issue is whether the domestic firm's market power affects the likelihood of a cold shower. Here it is shown that when the domestic firm is a Stackelberg leader rather than a Cournot competitor the cold shower condition is more likely to hold. That is, an investment which has been rejected, while a tariff is in place, may be accepted with the removal of the tariff if the domestic firm is a Stackelberg leader, while remaining rejected if the domestic firm is a Cournot competitor. To consider what is necessary for this result to hold it is useful to restate the cold shower condition in the form used in expression (3a):

$$[\pi_0^t - T] - g.[\pi_G^t - \pi_G] > 0. \quad (9)$$

The greater the magnitude of (9) the greater the difference between Eu_I^t and Eu_I and so for a given $Eu_I^t < 0$ the more likely $Eu_I > 0$. Considering the first term of (9) it is clear that this would be larger in the Stackelberg leader case. However for the Stackelberg case to make a cold shower more likely it is necessary for:

$$[\pi_0^t - T]_{SL} - [\pi_0^t - T]_C > g.[\pi_G^t - \pi_G]_{SL} - g.[\pi_G^t - \pi_G]_C .$$

From this it should be clear that the result that the Stackelberg case is more likely to induce a cold shower is a result which is not intuitively obvious.

The potential payoffs that the firm faces in the Stackelberg case differ from the Cournot case in that the profit becomes;

$$\pi^t = \frac{[a - 2c + (c^* + t)]^2}{8b}. \qquad (10)$$

This allows us to write comparable cold shower expressions for both cases:

$$(Eu_I - Eu_I^t)_{SL}$$
$$= \frac{1}{8b}[(1-g)t^2 + 2t(1-g)(a + c^*) + 4t(g.c_G - c_0)$$
$$+ (a - 2c_0 + c^*)^2] - T$$

$$(Eu_I - Eu_I^t)_C$$
$$= \frac{1}{9b}[(1-g)t^2 + 2t(1-g)(a + c^*) + 4t(g.c_G - c_0)$$
$$+ (a - 2c_0 + c^*)^2] - T.$$

Now $[(1-g)t^2 + 2t(1-g)(a + c^*) + 4t(g.c_G - c_0)$ $+ (a - 2c_0 + c^*)^2] > 0$ since we are only interested in the cases where the cold shower condition holds, $Eu_I - Eu_I^t > 0$.

Hence $(Eu_I - Eu_I^t)_{SL} > (Eu_I - Eu_I^t)_C$.

This result is saying that Stackelberg leadership will provide a stronger cold shower tendency and hence makes it more likely that a cold shower will actually occur.

IX: Cournot Competition with n Foreign Firms

In the previous section there is only one foreign firm. In this section there are n identical foreign firms, as well as the one domestic firm, selling on the domestic market. This allows us to further consider the question of the relationship between market power and the strength of cold shower effect. The relevant payoffs now become:

$$\pi_0^t = \frac{[a-(n+1).c_0+n.(c^*+t)]^2}{b.(n+2)^2} > T$$

$$\pi_G^t - I = \frac{[a-(n+1).c_G+n.(c^*+t)]^2}{b.(n+2)^2} - I > \pi_0^t$$

$$\pi_B^t - I = \frac{[a-(n+1).c_B+n.(c^*+t)]^2}{b.(n+2)^2} - I < 0$$

$$\pi_0 = \frac{[a-(n+1).c_0+n.c^*]^2}{b.(n+2)^2} < T$$

$$\pi_G - I = \frac{[a-(n+1).c_G+n.c^*]^2}{b.(n+2)^2} - I > T$$

$$\pi_B - I = \frac{[a-(n+1).c_B+n.c^*]^2}{b.(n+2)^2} - I < 0.$$

A reduction in n means that there are fewer firms selling on the domestic market and hence the market power of the domestic firm is increased. To examine whether a lower n would imply an increase in strength in the cold shower we need to look at the sign of

$d[Eu_I - Eu_I^t]/dn$.

$Eu_I - Eu_I^t = \pi_0^t - T + g.(\pi_G - \pi_G^t)$ by simply rewriting (9).

Let us consider the derivative of this in two separate parts.

$$\frac{d\pi_0^t}{dn} = \frac{-2[a - (n+1).c_0 + n.(c^* + t)][a + c_0 - 2(c^* + t)]}{b.(n+2)^3}$$

From examining the expressions for the profit maximising levels of output, for both the domestic firm and the representative foreign firm, it is clear that $d\pi_0^t/dn$ is negative as we are only concerned with cases where:

$$x = \frac{[a - (n+1).c_0 + n.(c^* + t)]}{b.(n+2)} > 0 \qquad y_i = \frac{[a + c_0 - 2(c^* + t)]}{b.(n+2)} > 0 .$$

Now consider the second part of the derivative.

$$\frac{d[g.(\pi_G - \pi_G^t)]}{dn} = \frac{2g}{b.(n+2)^3}[(n+2)\{[a-(n+1).c_G + n.c^*][c^* - c_G] - [a-(n+1).c_G + n.(c^*+t)][(c^*+t) - c_G]\} + \{[a-(n+1).c_G + n.(c^*+t)]^2 - [a-(n+1).c_G + n.c^*]^2\}]$$

The sign of this derivative is ambiguous. The term within the first set of {.} brackets is negative. However the term within the second set of {.} brackets is positive. So we can not say for certain that $d[Eu_I - Eu_I^t]/dn$ is negative. Hence it is useful to provide a numerical illustration showing a reduction in n strengthening the tendency for the cold shower to occur. The strategy used to devise this illustration is to begin with n set equal to 100 then select parameter values which gives the cold shower scenario of the investment being rejected when the tariff is in place but accepted when the tariff is removed. To consider an increase in market power the calculations are repeated with n set equal to 99. The parameter values selected are:

a=820, b=1, t=5, c_0=20, c_G=10, c_B=20, c*=15, FC=10, I=120, g=0.2, T=10, Z=5.

Note that a fixed cost term has been included to facilitate getting the required cold shower scenario. With n=100 the following results are obtained:

$$\pi_0^t = 51.5,\ \pi_G^t - I = 184.9,\ \pi_B^t - I = -68.5,\ \pi_0 = -1.3,\ \pi_G - I = 34.9,$$

$$Eu_I^t = 0.2(184.9) + 0.8(5) - 51.5 = -10.5,$$

$$Eu_I = 0.2(34.9) + 0.8(5) - 10 = 1,$$

$$Eu_I - Eu_I^t = 11.5.$$

Now consider how these results change when n=99:

$$\pi_0^t = 52.7,\ \pi_G^t - I = 187.6,\ \pi_B^t - I = -67.3,\ \pi_0 = -0.9,\ \pi_G - I = 36.9,$$

$$Eu_I^t = 0.2(187.6) + 0.8(5) - 52.7 = -11.2,$$

$$Eu_I = 0.2(36.9) + 0.8(5) - 10 = 1.4,$$

$$Eu_I - Eu_I^t = 12.6.$$

So here the tendency for a cold shower is stronger if the domestic firm has more market power. Partly this result is being driven by π_0^t being larger when market power is greater. π_0^t is the profit which is given up if the investment is made while the tariff is in place. Obviously the larger this is, ceteris paribus, the less attractive the investment will be while the tariff is in place. Clearly the weighted return from the good outcome, $g.(\pi_G^t\text{-}I)$, increases as well but not enough to offset the increase in π_0^t. The other contributing factor to the increase in the strength of the tendency for a cold shower is the increase in $g.(\pi_G\text{-}I)$. This increase means that, following the removal of the tariff, the expected return from deciding to invest, rather than leave the industry, is increased.

X: Concluding Comments

This chapter represents a departure from the standard approach to the cold shower question which focuses on managerial effort. Rather its focus is on how protection can affect the technological investment decisions made within firms. While, in reality, managerial effort considerations may well influence investment decisions, this issue is abstracted from here. Also a reluctance to invest in new technology may be influenced by fears that reducing cost would result in the removal of protection. However in this chapter protection policy is regarding as being exogenous to the firm. The removal of the protection can be thought as the government having a change in attitude to whether, in general, protection can be seen as beneficial or not.

No pretence is made that this analysis has universal applicability to protected industries. Clearly there are cases where, even with the best possible outcome from investment in cost-reducing technology, the industry will not survive without protection. Examples of such industries in OECD countries are to be found within the textiles and apparel sectors[9]. There would also be cases where the issue of limited liability is irrelevant. Think of a subsidy being paid on the sales of a commodity which is produced by a small division of a large multidivisional, or M-form, firm[10]. If this subsidy is removed, and then investment takes place with the bad outcome occurring, the solvent M-form firm will face the full cost of having made the investment.

In the case where the creditor is well informed about the potential investment, the creditor's behaviour is uncontroversial given the credit market is competitive. In the

9. For detailed industry studies see OECD (1988).

10. For a discussion of the M-form concept see Williamson (1975, Ch.8).

case where the creditor's only knows that the owner/manager is averse to bankruptcy a somewhat arbitrary treatment of creditor is required. Essentially the creditor's 'rule of thumb' is; be prepared to lend to the firm even though uniformed about the expected return, but immediately declare the firm bankrupt if it defaults upon agreed payments.

An obviously important question is whether the investment being made in response to the removal of protection should be seen as a social benefit. In the case of the example discussed in Section VII the answer is that it can. That is the risk-averse owner/manager fails to make the investment, prior to the removal of the subsidy, because of the non-existence of the appropriate 'insurance' market. This failure to invest can be seen as an example of the under investment in risky enterprises problem discussed by Arrow (1962). By way of contrast, responding to the removal of protection by making a 'long shot' investment is, from an ex ante view point, socially undesirable. Consider the example of a 'long shot' investment shown in Section VI where g=0.1. Here the owner/manager is able to take a 'one way bet' because the creditor is unaware of the high probability of default. It is a case of the creditor mistakenly continuing to believe that the owner/manager's aversion to bankruptcy would deter an application for a loan if the investment was a 'bad risk'.

Finally, it is worth commenting upon any possible alternative applications for this analysis. One such application may be in industrial relations. Anecdotes about an increase in competitive pressure inducing firms to 'confront' unions might be explained in terms of the cost of the strike being interpreted as an investment with an uncertain outcome. The good outcome would consist of either a reduction in wages or improved work practices. The added complication with such an application would be the need to model union as well as managerial behaviour. Another application may be a contribution to the literature on whether recessions induce investment in new technology. The existing literature focuses on the idea that during a recession there is a lower opportunity cost connected with the disruption of current production necessary for the development or adoption of new technology[11]. A potentially important difference between a recession and the subsidy removal is that an output price reduction associated with a recession is temporary. However, given the difficulty in differentiating between structural and cyclical price reductions, recession-induced distress innovation seems to be an idea which is worth pursuing.

11. For an example of this work see Cooper and Haltiwanger (1990).

CHAPTER 5: PRODUCT QUALITY AND PROTECTION

I: Introduction

So far we have only examined how changing protection may affect the protected firm's cost of production. In this chapter we consider how changing protection may affect the quality of the protected firm's products. Consider the recent history of the Australian Automobile Industry which has been particularly well documented. Over the past few years the industry has received reduced levels of assistance and has appeared to narrow the quality gap between domestically produced and imported vehicles[1]. The non-economist would probably explain stylised facts such as these in terms of 'competitive pressure'. That is, with reduced protection the domestic firm is forced to increase product quality so as to mitigate the losses in sales resulting from the now lower-priced inputs. An obvious theoretical objection to such reasoning is that if increasing product quality leads to higher profits then surely this action would already have been taken independently of any reduction in protection. This chapter develops a simple model which shows how the removal of protection from an intermediate good can result in increased product quality without violation of the profit maximisation assumption.

The model is applicable to a vertically separated industry with the quality of the final good being dependent upon the quality of the intermediate goods (components) used in its production. Examples of intermediate goods which frequently receive

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1. See Automotive Industry Authority (1990) and (1991), particularly Chapter 11 from 1991.

protection include steel, textiles and motor vehicle components. The model consists of a single domestic producer of intermediate goods (the supplier) providing components for a single final goods producer (the assembler) which sells the finished good as a price taker on the world market. The removal of protection from the supplier gives the assembler greater bargaining power since the option of turning to a foreign supplier becomes more attractive. The single domestic supplier assumption is necessary to utilize a bilateral bargaining framework. The supplier could be thought of as a number of domestic suppliers behaving collusively. Assuming that the assembler is a price taker in the output market allows the analysis to focus upon the effect of the supplier-assembler relationship upon product quality. This differentiates the analysis from the literature which addresses how imperfect competition in the output market impacts upon quality. Spence (1975) and Sheshinski (1976) show that a monopoly can distort the provision of quality just as it distorts the quantity of output. In contrast, in the present analysis quality differs from its competitive level as a result of inefficient bargaining in the intermediate goods market. It is argued that an inefficient bargaining regime which is analogous to the 'right-to-manage' model from the union bargaining literature (see Ulph and Ulph (1988)) represents a plausible case which provides an intuitively appealing explanation why removing protection from suppliers can be expected to increase product quality.

Other studies which have touched on the question of changes in protection affecting product quality are concerned with imperfect competition in the output market. Donnenfeld, Weber and Ben-Zion (1985) consider the imposition of a minimum quality standard upon imports. In their model this policy measure implies negative protection and one result of it is that the domestic producer increases quality. The market structure assumed is that of a domestic monopolist facing competition from a large number of foreign firms. The foreign firms are assumed to be unable to establish a reputation for product quality above some minimum level. This gives the single domestic firm its monopoly power. The imposition of a minimum quality standard upon imports raises the quality of imports above the previous minimum level. Consequently, sales of the imported good increase and sales of the domestically produced goods decrease. They show that the domestic firm increases quality so as to avoid the loss of buyers with a high willingness to pay for quality. Das and Donnenfeld (1989) consider the imposition of a quota on imports using a Cournot-Nash duopoly model with one domestic and one foreign firm. These firms compete in the domestic market where the consumers can perfectly observe quality at the time of purchase. Under certain circumstances reducing the quantity of imports by using a quota is shown to result in the domestic firm increasing output and decreasing quantity.

The chapter is organized in the following manner. Section II specifies the relationship between the supplier and the assembler. Section III shows how a change in intermediate goods protection can affect quality. First the case is shown where the parties bargain over a 'basic price' and a 'quality premium'. This is followed by the case where only the quality premium is bargained over.

II: Introducing the Model

In this model the supplier produces x units of the component and then the assembler transforms these into x units of the finished product. The assembler does this using a composite input y which has a price per unit of w. To ensure a finite profit maximising quantity for the assembler the production function is assumed to exhibit decreasing returns to scale; $x = x(y)$, $x_y > 0$, $x_{yy} < 0$. The price received for a unit of the finished product is a function of the quality (q) of the component embodied within it; $P = P(q)$, $P_q > 0$, $P_{qq} < 0$. That is, it is assumed that the marginal valuation of quality declines. Think, for example, of quality being some index of reliability. Consumers regard products which are very unreliable as having a low value. However at higher, and hence more acceptable, levels of reliability, consumers place a relatively low value on a further increment of reliability. It is assumed that at any given level of quality, say q^*, there are, on a world-wide basis, a sufficient number of sellers offering the product, at a quality of q^*, for the market to be perfectly competitive.

The supplier's cost of production is determined by both the level of quality at which the components are produced and the quantity of components produced; $C = C(q, x)$. The only restrictions placed upon the cost function are $C_q > 0$, $C_x > 0$, $C_{qq} > 0$. Since the supplier does not set output in response to a competitive market price, it is not necessary to restrict its technology to decreasing returns to scale. Hence there is no problem in thinking of the possibility that the supplier's technology is characterized by some economies of scale[2]. The restriction that the marginal cost of quality increases with quality seems a quite natural assumption. The idea is that it becomes increasingly costly to get closer and closer to the unobtainable limit of every single component being perfect. The supplier's revenue received in payment from the assembler is some agreed function of the quantity and quality of the components which are supplied. That is in

2. If the assembler and supplier are thought of as a single firm then the Hessian determinant from the profit maximisation problem is
$H = (P_{qq}.x - C_{qq}).[(P - C_x).x_{yy} - C_{xx}.x_y^2] - [(P_q - C_{qx}).x_y]^2$.
Clearly for this to be positive it is necessary for $|C_{xx}|$ to be not too large.

general terms supplier's revenue (the contractual payment schedule for components) is defined as $R = R(q, x)$. To summarize, profits for the assembler and supplier are respectively:-

$$\pi = P(q).x(y) - R(q, x(y)) - w.y$$

$$\Sigma = R(q, x(y)) - C(q, x(y))$$

Given that the assembler and supplier are in a bilateral relationship it is natural to assume that neither is in a position to make a take-it-or-leave-it offer. That is, it is assumed they engage in a bargaining process. The standard assumption is made that this process results in a Nash bargaining equilibrium outcome. The form of bargaining used is known from the union bargaining literature as 'right-to-manage'. Here it involves the assembler and supplier bargaining over a schedule of component prices for a range of possible quality levels and then the assembler deciding upon the required quality and quantity of the component. That is, in general terms, the price of a single component is some agreed function of quality, $S = S(q)$, and hence the payment to the supplier is $R(q, x) = S(q).x$.

In the union bargaining literature, the standard objection to right-to-manage bargaining is it is inefficient. From the subsequent analysis it will become clear that the assembler's profit-maximising choice of quantity to purchase will not, in general, coincide with the choice that will maximise the joint surplus. The obvious justification for working with this form of bargaining is that there are instances when it does appear to be taking place. The objection that the parties are not behaving optimally can be countered by arguing that there are unmodelled prohibitive transaction costs associated with so-called efficient bargaining. Nickell and Andrews (1983) argue in the union bargaining context that employers prefer to simply bargain with unions over wages and have the right to make continual adjustments to employment unilaterally. An analogous argument can be made with regard to components bargaining. That is an assembler may find it valuable to be able to adjust quality and quantity without incurring bargaining costs. As an example think of the case which has typified the automobile industry[3]. When the assembler requires a component for a new model it asks a number of potential suppliers to quote a price for an order specifying both quantity and quality. It is common for the assembler to enter into bilateral negotiations with an individual supplier to attempt to gain a lower price by using threats of turning to alternative suppliers. It is interesting to note in the case of this industry that something resembling efficient bargaining has typically been limited to Japan[4]. Here the supplier is asked to devise a cost-quality compromise for a new component taking into account demand for finished vehicle considerations. Presumably the long term relationship between Japanese suppliers and assemblers insures that the component cost-quality outcome leads to an 'acceptable' level of profit for both the assembler and supplier.

Two bargaining frameworks are considered for the component price schedule:-

$$S = N + \gamma . q \quad (1)$$

$$S = \gamma . q \quad (2)$$

In case (1) both a 'basic price' N and a 'quality premium' γ are bargained over. In the next section it is shown that this results in the assembler ordering the efficient level of quality given the quantity of components ordered. The efficient level of quality is where

3. This method of organizing production is described as 'mass production' by Womack, Jones and Ross (1990). It refers to the practices developed in the US and generally used throughout the world with the exception of Japan.

4. Womack, Jones and Ross (1990) essentially conclude that the Japanese success is due to the adoption of what they term 'lean production'. One aspect of lean production is the relationship between assemblers and suppliers.

the marginal benefit of quality in terms of a higher price for the final good equals its marginal cost in terms of a higher average cost for producing the component. In case (2) only γ is bargained over. The choice of quality in this case will in general not be efficient. However it may be that the parties prefer to only have to focus on a single variable when bargaining.

The respective payoffs from failure of the assembler and supplier to agree are assumed to be $(\pi_o, 0)$. The assembler's next best alternative to coming to agreement with the supplier is purchasing the component from a foreign supplier and receiving profits π_o[5]. The removal of protection which the model is used to look at is any measure which results in it being less expensive for the assembler to fail to come to an agreement with the domestic supplier and instead turn to a foreign supplier. Hence the removal of the supplier's protection is modelled by considering an increase in π_o. An example of intermediate goods protection being removed is the recent abolition of the local content scheme used for protecting Australian automobile component suppliers[6]. These suppliers have largely continued to supply domestic assemblers. However, now a threat by an assembler to turn to a foreign supplier has gained credibility.

III: Removal of Protection

This section uses the model to show how the removal of protection can cause an improvement in product quality. The analysis is developed using the case where the

5. An alternative 'prior to protection removal' next-best-alternative would be the option of in-house production of the component with the assumption that the in-house production cost is greater than the production cost of the foreign supplier plus transport cost.

6. See Automotive Industry Authority (1990) Chapter 9.

parties bargain over N and γ to determine the component price schedule. Following this, the analysis is used to examine the special case where bargaining is restricted to γ. Prior to using the Nash product to engage in comparative statics it is necessary to determine how the assembler responds to changes in N and γ. These responses are obtained from the first order conditions for the assembler's profit maximisation problem:

$$\pi(N,\gamma) = \underset{q,y}{\text{Max}}\,[P(q).x(y) - (N+\gamma.q).x(y) - w.y].$$

$$\text{Let } L = P(q).x(y) - (N+\gamma.q).x(y) - w.y.$$

The first order conditions for this problem are:

$$\frac{\partial L}{\partial q} = P_q.x - \gamma.x = 0$$

$$\Rightarrow \quad P_q = \gamma \qquad (3)$$

$$\therefore \quad \frac{dq}{d\gamma} = \frac{1}{P_{qq}} < 0$$

$$\frac{\partial L}{\partial y} = P.x_y - (N+\gamma.q).x_y - w = 0$$

$$\Rightarrow \quad (P-N-\gamma.q).x_y = w \qquad (4)$$

$$\therefore \quad \frac{dy}{d\gamma} = \frac{q.x_y}{(P-N-\gamma.q).x_{yy}} < 0$$

and $$\frac{dy}{dN} = \frac{x_y}{(P-N-\gamma.q).x_{yy}} < 0 \qquad \text{(using (3)).}$$

Also,

$$\pi_N(N,\gamma) = \frac{\partial L}{\partial N} = -x < 0$$

$$\pi_\gamma(N,\gamma) = \frac{\partial L}{\partial \gamma} = -q.x < 0$$ using the envelope theorem.

The solution to the Nash bargaining problem involves choosing γ, N to maximise the Nash Product:

$$\eta = [\pi(\gamma,N)-\pi_o].[N.x(y(\gamma,N)) + \gamma.q(\gamma).x(y(\gamma,N)) - C(q(\gamma),x(y(\gamma,N)))].$$

The first order conditions for this problem are:

$$\eta_\gamma = -q.x.\Sigma + [\pi - \pi_o].[q.x + q.b + \frac{(\gamma.x-C_q)}{P_{qq}}] = 0 \qquad (5)$$

$$\eta_N = -x.\Sigma + [\pi - \pi_o].[x + b] = 0 \qquad (6)$$

$$\text{where } b = \frac{(N + \gamma.q - C_x).x_y^2}{(P-N-\gamma.q).x_{yy}}.$$

These conditions imply that the condition for the efficient choice of quality is:

$$\gamma = \frac{C_q}{x}$$

$$\Rightarrow P_q = \frac{C_q}{x}$$ (since from (3) the assembler's first order condition for choosing quality is $P_q = \gamma$)

It is instructive to compare the solution to this problem with the solution to the efficient bargaining problem. The latter is solved in Appendix 5.1 and yields the following condition for equilibrium quantity:

$$(P - C_x).x_y = w. \qquad (5.1.2)$$

Comparing this with (4), it is clear that right-to-manage bargaining results in an inefficient choice of quantity. This is explained as follows. The assembler chooses y (and consequently x) such that the value of the marginal product of y equals its price w. Under right-to-manage bargaining the net value of producing an extra unit of the final product equals the physical marginal product of y times the price of the final product net of the cost of purchasing the component. This value will only equal the true resource cost of producing the component if the price of the component, which results from bargaining, happens to equal the supplier's marginal cost of production.

Now totally differentiating (5) and (6) yields

$$\frac{d\gamma}{d\pi_o} = \frac{\begin{vmatrix} -\eta_{\gamma\pi_o} & \eta_{\gamma N} \\ -\eta_{N\pi_o} & \eta_{NN} \end{vmatrix}}{\Delta} = \frac{-\eta_{\gamma\pi_o}\cdot\eta_{NN} + \eta_{N\pi_o}\cdot\eta_{\gamma N}}{\Delta}$$

where $\Delta > 0$ is the Hessian determinant of the system.

$$\eta_{\gamma\pi_o} = -[q.x + q.b + \frac{(\gamma.x - C_q)}{P_{qq}}] \tag{7}$$

$$= \frac{-q.x.\Sigma}{[\pi - \pi_o]} \quad \text{(using the condition } \eta_\gamma = 0\text{)}$$

$$\eta_{N\pi_o} = -[x + b] \tag{8}$$

$$= \frac{-x.\Sigma}{[\pi - \pi_o]} \quad \text{(using the condition } \eta_N = 0\text{).}$$

Hence:

$$-\eta_{\gamma\pi_o}\cdot\eta_{NN} + \eta_{N\pi_o}\cdot\eta_{N\alpha} = \frac{x.\Sigma}{[\pi - \pi_o]}[q.\eta_{NN} - \eta_{N\alpha}].$$

Consequently:

$$\frac{d\gamma}{d\pi_o} = \frac{-x.\Sigma.x_y^2(\gamma - C_{qx})}{\phi}, \text{ where } \phi = \frac{(P-N-\gamma.q).x_{yy}.P_{qq}}{\Delta} > 0.$$

So if $\gamma > C_{qx}$ then $\frac{d\gamma}{d\pi_o} < 0$ and hence $\frac{dq}{d\pi_o} > 0$ since $\frac{dq}{d\pi_o} = \frac{1}{P_{qq}}.\frac{d\gamma}{d\pi_o}$.

The condition for $\frac{dq}{d\pi_o} > 0$ can be written as $C_{qx} < \frac{C_q}{x}$ since for the quality outcome to be efficient $\gamma = \frac{C_q}{x}$. So a supplier with a technology such that $C_{qx} < 0$ would satisfy this condition.

Appendix 5.2 demonstrates that an increase in the assembler's bargaining power changes the agreed γ and N so that the profitability of producing a unit of final output at the margin is increased causing the profit maximising assembler to increase output and hence the quantity of the components ordered. If 'economies of quality' occur ($C_{qx} <$ 0) an order for a higher quantity will be accompanied by an order for a higher quality. A supplier technology which has decreasing marginal costs of quality with increased output seems plausible[7]. For instance think of a highly automated piece of capital equipment which if installed would result in it becoming cheaper to produce the component at a finer tolerance standard. The adoption of such capital equipment may require a relatively high output level to insure full capital utilization.

The preceding discussion of a technology which would imply $C_{qx} < 0$ can be

7. This statement is not meant to imply that the opposite case of 'diseconomies of quality' is in any way implausible.

formalized using the following production functions:

$$x = M(K, L) \quad , \quad q = G(K, I)$$

where:

$$M_K > 0 \, , M_{KK} < 0 \, , M_L > 0, M_{LL} < 0, M_{LK} > 0;$$

$$G_K > 0 \, , G_{KK} < 0 \, , G_I > 0 \quad , G_{II} < 0 \quad , G_{IK} > 0 \, .$$

Here the production function M specifies the number of components produced for a given combination of capital K and 'fabrication' labour L. The production function G specifies the level of quality at which the component is produced for a given combination of capital K and 'inspection' labour I. The obvious special feature of this technology is that capital is a joint input. A brief examination of the managerial-engineering quality control literature indicates that it is common for capital equipment used in fabricating products to also have a role in achieving the required level of quality[8].

The other feature of this technology which is critical to the outcome of $C_{qx} < 0$ is the assumption that $G_{IK} > 0$. That is, it is assumed that the marginal product of the quality inspectors is increased as more capital is employed. So, since the amount of capital employed and the level of output are positively related, intuitively we would expect that the cost of increasing quality would be smaller at a higher level of output, that is $C_{qx} < 0$. This is confirmed in Appendix 5.3 along with $C_q > 0$, $C_x > 0$ and $C_{qq} > 0$ which are the general restrictions which have been placed on the supplier's cost function in this analysis.

8. Hansen (1963) describes such capital equipment as 'tooling used as media of inspection', page 266.

When bargaining is restricted to γ only, represented by price schedule (2), the problem collapses to that of choosing γ to maximise:

$$\eta = [\pi(\gamma)-\pi_o].[\gamma.q(\gamma).x(y(\gamma)) - C(q(\gamma),x(y(\gamma)))].$$

The first order condition for this problem is

$$\eta_\gamma = -q.x.\Sigma - [\pi - \pi_o].[q.x + q.\frac{(\gamma.q-C_x).x_y^2}{(P-\gamma.q).x_{yy}} + \frac{(\gamma.x-C_q)}{P_{qq}}] = 0. \qquad (9)$$

Totally differentiating (9) yields:

$$\frac{d\gamma}{d\pi_o} = -\frac{\eta_{\gamma\pi_o}}{\eta_{\gamma\gamma}} = \frac{q.x.\Sigma}{[\pi-\pi_o].\eta_{\gamma\gamma}} < 0$$

where $\eta_{\gamma\gamma} < 0$ is the second order condition for maximising the Nash product.

Hence $\frac{dq}{d\pi_o} = \frac{1}{P_{qq}}.\frac{d\gamma}{d\pi_o} > 0.$

The explanation for quality now unambiguously increasing is that γ must decrease in order to reflect the improvement in the assembler's bargaining position. The analogous case for a union bargaining right-to-manage model would be a change in bargaining positions resulting in a lower wage and hence the employer offering more employment. In the previous case γ does not necessarily decrease, rather it adjusts so that the efficient choice of quality continues to be made. In the present case γ has to decrease because N is not available to help reflect the improvement in the assembler's bargaining position.

IV: Concluding Comments

The objective of this chapter has been to show a reduction in protection may plausibly lead to an improvement in product quality. Both the assembler and supplier act to maximise their respective profits. Collective profit is not maximised because of the restrictions placed upon assembler-supplier bargaining as a result of unspecified transaction costs. This is broadly analogous to the standard case of the failure of monopoly to maximise social welfare when the monopolist is restricted to setting a single output price.

There seem to be two literature streams within which this chapter fits. Clearly it can be seen as a variant upon the literature where imperfect competition in the finished product market distorts the provision of product quality. Here the bilateral monopoly in the intermediate good market distorts the quality of the intermediate good and consequently the quality of the final good. From another perspective, the analysis sits comfortably with the disparate collection of literature on the effects of protection upon the performance of the protected firm[9]. A general theme running through the results from these analyses is that some imperfection or distortion is required for protection to adversely impact upon performance. There are two such imperfections upon which this analysis is reliant. The first is that the domestic market for the intermediate good is not perfectly competitive giving the supplier, or cartel of suppliers, some bargaining power. The second is the inability of the supplier and the assembler to bargain efficiently.

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9. This comment refers to both the other analyses in this thesis and the related literature discussed in Chapter 2.

APPENDIX 5.1: THE FIRST ORDER CONDITIONS FOR THE EFFICIENT PROVISION OF QUALITY AND QUANTITY.

This appendix first considers the case when the assembler and supplier merge. This establishes the efficiency conditions since the merged firm acts to maximise combined profits. The appendix then shows that these conditions are satisfied if γ , q and y are all bargained over.

The Merged Firm Case

$$\pi = \underset{q,y}{\text{Max}}\ [P(q).x(y) - C(q,x(y)) - w.y].$$

FOCs:

$$P_q.x - C_q = 0 \quad \text{or} \quad P_q.x = C_q \qquad (A5.1.1)$$

$$P.x_y - C_x.x_y - w = 0 \quad \text{or} \quad (P-C_x).x_y = w. \qquad (A5.1.2)$$

The Efficient Bargaining Case

$$\eta = \underset{y,\gamma,q}{\text{Max}}\ [P(q).x(y) - \gamma.q.x(y) - w.y - \pi_o].[\gamma.q.x(y) - C(q,x(y))].$$

FOCs:

$$\eta_y = [P.x_y - \gamma.q.x_y - w].[\gamma.q.x - C] + [P.x - \gamma.q.x - w.y - \pi_o].[\gamma.q.x_y - C_x.x_y] = 0 \qquad (A5.1.3)$$

$$\eta_q = [P_q.x - \gamma.x].[\gamma.q.x - C] + [P.x - \gamma.q.x - w.y - \pi_o].[\gamma.x - C_q] = 0 \qquad (A5.1.4)$$

$$\eta_\gamma = -q.x.[\gamma.q.x - C] + q.x[P.x - \gamma.q.x - w.y - \pi_o] = 0 \qquad (A5.1.5)$$

$$\Rightarrow [P.x - \gamma.q.x - w.y - \pi_o] = [\gamma.q.x - C].$$

Substituting (A5.1.5) into (A5.1.4)

$$[P_q.x - \gamma.x] = -[\gamma.x - C_q]$$

$$\Rightarrow P_q.x - C_q = 0.$$ Condition for the efficient choice of q.

Substituting (A5.1.5) into (A5.1.3)

$$P.x_y - \gamma.q.x_y - w = C_x.x_y - \gamma.q.x_y$$

$$\Rightarrow (P - C_x).x_y = w.$$ MRP=w condition for the choice of y.

APPENDIX 5.2: COMPARATIVE STATICS FOR QUANTITY IN THE TWO PART COMPONENT PRICE CASE.

The purpose of the appendix is to show $\frac{dy}{d\pi_o} > 0$ which implies that a reduction in protection increases the number of the components ordered.

$$\frac{dy}{d\pi_o} = y_\gamma . \frac{d\gamma}{d\pi_o} + y_N . \frac{dN}{d\pi_o}$$

$$= \frac{x_y}{(P-N-\gamma.q).x_{yy}} . \left(q.\frac{d\gamma}{d\pi_o} + \frac{dN}{d\pi_o}\right).$$

Now $\frac{d\gamma}{d\pi_o}$ is available from the text but $\frac{dN}{d\pi_o}$ needs to be obtained:

$$\frac{dN}{d\pi_o} = \frac{\begin{vmatrix} \eta_{\gamma\gamma} & -\eta_{\gamma\pi_o} \\ \eta_{N\gamma} & -\eta_{N\pi_o} \end{vmatrix}}{\Delta}$$

$$= \frac{x.\Sigma}{[\pi - \pi_o]} . \left[\frac{\eta_{\gamma\gamma} - q.\eta_{N\gamma}}{\Delta}\right]$$

$$= \frac{x.\Sigma.[x.(P-N-\gamma.q).x_{yy} + (\gamma - C_{qx}).x_y^2.q]}{\phi}.$$

Therefore:

$$\frac{dy}{d\pi_o} = \frac{x_y.x.\Sigma}{(P-N-\gamma.q).x_{yy}} . \left[\frac{-(\gamma - C_{qx}).x_y^2.q + x.(P-N-\gamma.q).x_{yy} + (\gamma - C_{qx}).x_y^2.q}{\phi}\right] > 0.$$

APPENDIX 5.3: AN EXAMPLE OF SUPPLIER TECHNOLOGY

This appendix uses the supplier's cost minimisation problem to show that the technology discussed in Section V of the text is consistent with $C_x > 0$, $C_q > 0$, $C_{qq} > 0$ and $C_{qx} < 0$.

$$C(r,w,x,q) = \min_{K,L,I} \; [r.K + w.(L + I)]$$

Subject to: $x = M(K, L)$

$q = G(K, I)$.

$$\mathcal{L} = r.K + w.(L + I) + \lambda_1.(x - M(K,L)) + \lambda_2.(q - G(K,I))$$

FOCs:

$$\frac{\partial \mathcal{L}}{\partial K} = r - \lambda_1.M_K - \lambda_2.G_K = 0$$

$$\frac{\partial \mathcal{L}}{\partial L} = w - \lambda_1.M_L = 0$$

$$\frac{\partial \mathcal{L}}{\partial I} = w - \lambda_2 G_I = 0$$

$$\frac{\partial \mathcal{L}}{\partial \lambda_1} = x - M(K,L) = 0$$

$$\frac{\partial \mathcal{L}}{\partial \lambda_2} = q - G(K,I) = 0.$$

Since $\lambda_1 = C_x$ and $\lambda_2 = C_q$ it is clear from $\frac{\partial \mathcal{L}}{\partial L} = 0$ and $\frac{\partial \mathcal{L}}{\partial I} = 0$ respectively that $C_x > 0$ and $C_q > 0$.

Differentiating wrt q gives:

$$\frac{d\lambda_2}{dq} = C_{qq} = \frac{1}{\bar{H}}. \begin{vmatrix} -(\lambda_1 M_{KK} + \lambda_2 . G_{KK}) & -\lambda_1 . M_{KL} & -\lambda_2 . G_{KI} & -M_K & 0 \\ -\lambda_1 . M_{LK} & -\lambda_1 . M_{LL} & 0 & 0 & 0 \\ -\lambda_2 . G_{IK} & 0 & -\lambda_2 G_{II} & -G_I & 0 \\ -M_K & -M_L & 0 & 0 & 0 \\ -G_K & 0 & -G_I & 0 & -1 \end{vmatrix}$$

$$= \frac{1}{\bar{H}} . [\lambda_1 . \lambda_2 . (G_I . G_{KI} - M_K . G_{II}) . (M_{LK} . M_L - M_{LL} . M_K)] .$$

Since $\bar{H}$ is positive, $C_{qq} > 0$.

Differentiating wrt x gives:

$$\frac{d\lambda_2}{dx} = C_{qx} = \frac{1}{\bar{H}}. \begin{vmatrix} -(\lambda_1 . M_{KK} + \lambda_2 . G_{.KK}) & -\lambda_1 . M_{KL} & -\lambda_2 . G_{KI} & -M_K & 0 \\ -\lambda_1 . M_{LK} & -\lambda_1 . M_{LL} & 0 & 0 & 0 \\ -\lambda_2 . G_{IK} & 0 & -\lambda_2 . G_{II} & -G_I & 0 \\ -M_K & -M_L & 0 & 0 & -1 \\ -G_K & 0 & -G_I & 0 & 0 \end{vmatrix}$$

$$= \frac{1}{\bar{H}} . \lambda_1 . [\lambda_2 . M_K . M_{LL} . G_{IK} . G_I - \lambda_2 . M_K . M_{LL} . G_{II} . G_K$$
$$+ \lambda_1 . G_I^2 . (M_{KL}^2 - M_{LL} . M_{KK}) - \lambda_2 . G_I^2 . M_{LL} . G_{KK}$$
$$+ \lambda_2 . G_I . M_{LL} . G_{KI} . G_K] .$$

Assuming strict concavity of M in (K, L) implies $M_{KL}^2 < M_{LL} . M_{KK}$ so that when $M_K = M_L = 0$ the second order conditions for a maximum are fully satisfied.

It then follows from the signs of the derivatives of M and G that $C_{qx} < 0$.

CHAPTER 6: PROTECTION AND WORK PRACTICES

I: Introduction

In this chapter a reduction in protection is considered in the context of a unionized workforce. The question which is asked is; will a reduction in protection lead to an agreement with the union which results in less restrictions being placed on work practices? The analysis in this chapter suggests that it is quite plausible that this will be the case if the instrument of protection is an import quota. Easing quantitative import restrictions reduces the market power of the protected firm. Casual observation of the deregulation experience in transport and communication suggest that associated with a reduction in market power has been a willingness on the part of unions to accept the winding back of restrictive work practices[1]. In Chapter 2 various pieces of empirical evidence are presented which associate reductions in production cost with decreases in protection. Part of the reduction in production costs may be as a result of reforms to work practices.

The chapter uses the firm-union Nash bargaining framework. The firm is a domestic monopolist which faces import competition from a perfectly competitive world market. Since the firm receives protection in the form of a quota it has a degree of monopoly power in the domestic market. The firm's employees are all represented by a single union. In Section II the firm and union bargain over wages and 'effort'. In section III they bargain over wages and the labour/capital ratio. Both effort and the

1. For a discussion of this issue with respect to the aviation industry see Forsyth (1984).

labour/capital ratio can be thought of as reflecting work practices. Effort parameters which may be bargained over include the length of the tea break, the maximum acceptable time to do certain standardized tasks and the range of unpleasant tasks which are regarded as acceptable for employees to undertake. The labour/capital ratio becomes a work practices issue when there is contention over the number of employees required to operate a particular piece of capital equipment.

Essentially what this chapter does is to take relatively recent developments in the union bargaining literature as a framework to address the issue of protection and work practices. The framework used is basically a development of the 'right-to-manage' approach discussed in the previous chapter. Effort or the labour/capital ratio is bargained over as well as wages. Andrews and Simmons (1995) in a review of the literature refer to this as the 'joint wage-effort bargain'. Layard, Nickell and Jackman (1991) also make use of this bargaining framework. Their justification for restricting bargaining to wages and effort with employment unilaterally decided by firms is based on empirical work by Oswald (1987). Oswald surveys both US and British unions and finds that there are very few cases where bargaining over employment takes place. Examining the joint wage-effort bargaining literature allows us to identify two separate strands. The first strand consists of the literature which contrasts different bargaining regimes. Johnson (1990) contrasts efficient bargaining, semi-efficient bargaining and bargaining solely over wages. Johnson uses the term 'semi-efficient' to refer to bargaining over wages and effort and bargaining over wages and the labour/capital ratio. Bulkley (1992) contrasts the effort levels associated with competitive and unionized labour markets considering both the risk-neutral and risk-averse cases. The second strand in the literature focuses upon comparative static applications. Both Andrews and

Simmons and Layard, Nickell and Jackman consider the effects of changes in union power and outside opportunities. Obviously the results of such analyses are highly relevant to understanding changes which occurred in the British economy over the 1980s. Layard, Nickell and Jackman also show that in their model an increase in product market competition results in a reduction in effort. However their worker utility function is less general than the worker utility function used in the analysis presented in the next section. In Section II it is shown that an increase in an import quota (reducing the market power of the domestic firm) has an ambiguous effect upon effort. It is however argued that the case where an increase in the quota causes an increase in effort is highly plausible.

II: Joint Wage-Effort Bargaining

In this section a case is shown where reducing protection causes an increase in effort. The reduction in protection comes in the form of an increase of a quota on the volume of imports. Later it is shown that changing a tariff or a subsidy will not affect effort.

Following the standard approach used in the union bargaining literature efficiency units of labour are defined as

$$L \equiv e.N.$$

N represents the number of homogenous workers employed all 'working' some standard number of hours. e is an effort scaling factor applied to N. That is a higher e may be thought of as being a reduction in the number of tea breaks meaning for a given N more efficiency units of labour will be supplied. The production function used is as simple as possible;

$$x = L.$$

That is one efficiency unit of labour is needed to produce one unit of output. Including capital in this case would not contribute anything to the analysis.

The union has the following utility function:

$$U = [\phi(w,e) - \bar{\phi}].N$$

$$\phi_e < 0 \ , \quad \phi_w > 0$$

$$\phi_{ww} < 0 \ , \quad \phi_{ee} < 0 \ , \quad \phi_{ww}\phi_{ee} - \phi_{we}^2 > 0.$$

Where: ϕ is the utility which an individual member gains from being employed by the firm.

$\bar{\phi}$ is the reservation utility which an individual member would receive if not employed by the firm. For simplicity $\bar{\phi}$ is set equal to zero.

The firm and the union engage in joint wage-effort bargaining. This involves the firm and the union bargaining over both wages and effort and then the firm unilaterally determining employment. From the previous chapter it should be clear that this form of bargaining is inefficient. Bargaining over the three variables w, e and N would give an efficient outcome. However in general it seems that employment is not a variable which is bargained over. A standard explanation for this (see Brown and Ashenfelter 1986 and Johnson 1990) is that for an agreement to be made about employment over a period of time it would be necessary to specify how employment would be adjusted in response to fluctuations in costs and demand. The problem with such an agreement is that the firm is likely to have better information than the union on fluctuations in costs and demand. That is the firm would have the opportunity to cheat the union. Hence the union would regard a 'commitment' by the firm to employ above the profit-maximising level as worthless.

To establish how effort changes in response to a change in the quota Q the first step is to establish the direct effect upon L of changes in e, w and Q. Demand for the output is assumed to be linear. The firm's problem of selecting the profit maximising level of employment is

$$\pi(e,w) = \underset{L}{\mathrm{Max}}\left[L.\{a - b.(Q + L)\} - w.\frac{L}{e}\right].$$

$$\text{Let } \Pi = L.\{a - b.(Q + L)\} - w.\frac{L}{e}.$$

The first order condition for this problem is

$$\frac{\partial \Pi}{\partial L} = a - b.Q - 2L.b - \frac{w}{e} = 0$$

$$\Rightarrow L = \frac{(a - b.Q) - w/e}{2b}.$$

Therefore:

$$L_e = \frac{w}{2e^2.b} \qquad L_w = \frac{-1}{2e.b} \qquad L_Q = -\frac{1}{2}$$

$$\pi(e,w) = \frac{[a - b.Q - w/e]^2}{4b}.$$

The solution to the Nash bargaining problem involves choosing e and w to maximise the Nash product:

$$\eta = \beta.\ln\left[\phi(e, w).\frac{L}{e}\right] + (1 - \beta).\ln\frac{[a - b.Q - w/e]^2}{4b}$$

where β is the union bargaining power parameter, $0<\beta<1$.

The first order conditions for this problem are

$$\eta_e = \beta.\frac{\phi_e}{\phi} - \frac{\beta}{e} + \beta.\frac{w}{2e^2.b.L} + (1 - \beta).\frac{2w}{e^2.[a - b.Q - w/e]} = 0 \qquad (1)$$

$$\eta_w = \beta.\frac{\phi_w}{\phi} - \beta.\frac{1}{2e.b.L} - (1 - \beta).\frac{2}{e.[a - b.Q - w/e]} = 0. \qquad (2)$$

Multiplying (2) by w/e and then equating this with (1) yields

$$e.\phi_e + w.\phi_w = \phi. \tag{3}$$

This is exactly the same expression for the contract curve in wage-effort space that Andrews and Simmons (1995) derive. The slope of the contract curve is

$$\frac{dw}{de} = -\frac{e.\phi_{ee} + w.\phi_{ew}}{w.\phi_{ww} + e.\phi_{ew}}. \tag{4}$$

Clearly it is ambiguous whether the contract curve is upward sloping or downward sloping. However it is interesting to note that Andrews and Simmons argue that the contract curve is, at least in the British case, upward sloping. That is, various pieces of evidence are presented indicating that, particularly over the early 1980s, higher wages have been conceded in return for a commitment to increase productivity (increased effort).

Using (1) and (2) a condition is derived for when an increase in the import quota results in an increase in effort.

Totally differentiating (1) and (2) yields

$$\frac{de}{dQ} = \frac{\begin{vmatrix} -\eta_{eQ} & \eta_{ew} \\ -\eta_{wQ} & \eta_{ww} \end{vmatrix}}{\Delta}$$

where $\Delta > 0$ is the Hessian determinant of the system.

$$\eta_{eQ} = \frac{w}{e} . \frac{(2-\beta)}{4e.b.L^2}$$

$$\eta_{wQ} = -\frac{(2-\beta)}{4e.b.L^2}$$

$$\eta_{ew} = \beta.\frac{\phi_{ew}}{\phi} - \beta.\frac{\phi_e.\phi_w}{\phi^2} + \frac{(2-\beta)}{2e^2.b.L} + \frac{w(2-\beta)}{4e^3.b^2.L^2}$$

$$\eta_{ww} = \beta.\frac{\phi_{ww}}{\phi} - \beta.\frac{\phi_w^2}{\phi^2} - \frac{(2-\beta)}{4e^2.b^2.L^2}$$

$$\therefore \quad \frac{de}{dQ} = \frac{(2-\beta)}{4e.b.L^2.\Delta}.\left[-\frac{w}{e}.\eta_{ww} - \eta_{ew}\right]$$

Now consider the sign of:

$$-\frac{w}{e}.\eta_{ww} - \eta_{ew}$$

$$= -\beta.\frac{\phi_{ww}.w}{\phi.e} + \beta.\frac{w.\phi_w^2}{\phi^2.e} + \frac{(2-b).w}{4e^3.b^2.L^2} - \beta.\frac{\phi_{ew}}{\phi} + \beta.\frac{\phi_e.\phi_w}{\phi^2} - \frac{(2-\beta)}{2e^2.b.L} - \frac{(2-\beta).w}{4e^3.b^2.L^2}$$

$$= \frac{\beta}{\phi^2.e}.[-\phi_{ww}.\phi.w + w.\phi_w^2 - \phi_{ew}.\phi.e + \phi_e.\phi_w.e - \phi_w.\phi]$$

since from (2); $\frac{(2-\beta)}{2e^2.b.L} = \beta.\frac{\phi_w}{\phi.e}$

$$= \frac{\beta}{\phi^2.e}.[-\phi_{ww}.\phi.w + w.\phi_w^2 - \phi_{ew}.\phi.e + \phi_w.\phi - w.\phi_w^2 - \phi_w.\phi]$$

since from (3); $e.\phi_e = \phi - w.\phi_w$.

$\therefore$ if $\quad -\phi_{ww}.w - \phi_{ew}.e > 0$

then $\frac{de}{dQ} > 0$.

The obvious question to ask is how plausible is the condition $[e.\phi_{ew} + w.\phi_{ww}] < 0$? Andrews and Simmons show that if this condition holds then an increase in union power will result in reduced effort[2]. That is if the union is in a position to get a higher wage for a given effort the result of bargaining will be characterized by a reduced effort requirement. Since the idea of a powerful union achieving a variety of slack work practices for its members seems very plausible it is not unreasonable to assume in many cases that the condition $[e.\phi_{ew} + w.\phi_{ww}] < 0$ holds.

It is instructive to now examine this comparative static result diagrammatically in e,w space. From (3) it is clear that the contract curve will not shift. Rather there will be a movement along it. To show the direction of this movement one of the first order conditions for the Nash bargaining problem is used. First order condition (2) is arbitrarily selected and following Mezzetti and Dinopoulos (1991) is labelled the 'Nash bargaining curve' (NBC):

$$\eta_w(e, w, Q) = 0. \quad \text{(NBC)}$$

The NBC can be thought of as the relationship between the two parties' rents which needs to hold for the Nash product to be maximised. To see this (2) can be rewritten as

$$\frac{1}{\phi_w}.\left[\frac{\phi}{e}\right] = \frac{2\beta}{2-\beta}.b.L. \tag{2a}$$

By substituting $L = (a - b.Q - w/e)/2b$ into the inverse demand function we can now rewrite (2a) as

$$\frac{1}{\phi_w}.\left[\frac{\phi}{e}\right] = \frac{2\beta}{2-\beta}.\left[p - \frac{w}{e}\right].$$

Here $[\phi/e]$ represents the union's rents per unit of output and $[p - w/e]$ represents the

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2. For details about their comparative statics see Andrews and Simmons (1993); the working paper version of their article.

firm's rents per unit of output. The slope of the NBC may be either positive or negative:

$$\frac{dw}{de} = -\frac{\eta_{we}}{\eta_{ww}}.$$

Here η_{ww} needs to be negative for the second-order conditions to hold however the sign of η_{we} is ambiguous. If $\phi_{ew} \geq 0$ then this is a sufficient condition for $\eta_{we} > 0$ and hence the NBC having a positive slope. It is simple to show that an increase in Q will cause a downward shift in the NBC in e,w space (irrespective of its slope):

$$\left.\frac{dw}{dQ}\right|_{NBC} = -\frac{\eta_{wQ}}{\eta_{ww}}$$

$$\eta_{wQ} = -\frac{(2-\beta)}{4e.b.L^2} < 0$$

$\eta_{ww} < 0$ (Second-order condition for maximisation of the Nash product).

Hence $\left.\frac{dw}{dQ}\right|_{NBC} < 0$.

To be able to consider how this shift in the NBC affects effort it is necessary to consider the slope of the NBC relative to the slope of the contract curve (CC). The contract curve expression can be rewritten in a more general form:

$$\frac{w}{e}.\eta_w + \eta_e = 0. \tag{3a}$$

Hence the slope of the contract curve in the neighbourhood of equilibrium, $\eta_w = 0$, can be written as

$$\left.\frac{dw}{de}\right|_{CC} = -\frac{(w/e).\eta_{we} + \eta_{ee}}{(w/e).\eta_{ww} + \eta_{ew}}.$$

Now defining the slope of the contract curve as S_C and the slope of the NBC as S_N:

$$S_C - S_N = -\frac{\eta_{ww}.\eta_{ee} - \eta_{ew}^2}{\eta_{ww}\left[(w/e).\eta_{ww} + \eta_{ew}\right]}.$$

Assuming η is strictly concave in (e,w) allows us to say that the sign of S_C -S_N will be the same as the sign of

$$\frac{w}{e}.\eta_{ww} + \eta_{ew}.$$

Now in the neighbourhood of η_w=0:

$$\frac{w}{e}.\eta_{ww} + \eta_{ew} = \frac{\partial}{\partial w}\left[\frac{w}{e}.\eta_w + \eta_e\right]$$

$$= \beta.\frac{\partial}{\partial w}\left[\frac{\phi_e}{\phi} + \frac{w}{e}.\frac{\phi_w}{\phi} - \frac{1}{e}\right]$$

$$= \beta\left[\frac{\phi_{ew}}{\phi} - \frac{\phi_e\phi_w}{\phi^2} + \frac{\phi_w}{e.\phi} + w.\frac{\phi_{ww}}{e.\phi} - w.\frac{\phi_w^2}{e.\phi^2}\right]$$

$$= \frac{\beta}{e.\phi}.[e.\phi_{ew} + w.\phi_{ww}] \qquad \text{using (3).}$$

So if $[e.\phi_{ew} + w.\phi_{ww}] < 0$, the condition for $de/dQ > 0$, then S_N>S_C. Since we are not in a position to place a sign on either S_N or S_C there are three diagrammatic possibilities for representing how an increase in the quota causes an increase in effort. Figure 6.1 shows the case where S_N is positive and S_C is negative. Figure 6.2 shows the case where both S_N and S_C are negative but S_N is less negative. Figure 6.3 shows the case where both S_N and S_C are positive. In this latter case the increase in effort is accompanied by an increase in wages because the contract curve is upward sloping. A positive relationship between wages and effort would seem a particularly plausible case. It is interesting to note that from a qualitative view point it does not matter whether the NBC has a positive or a negative slope.

Figure 6.1

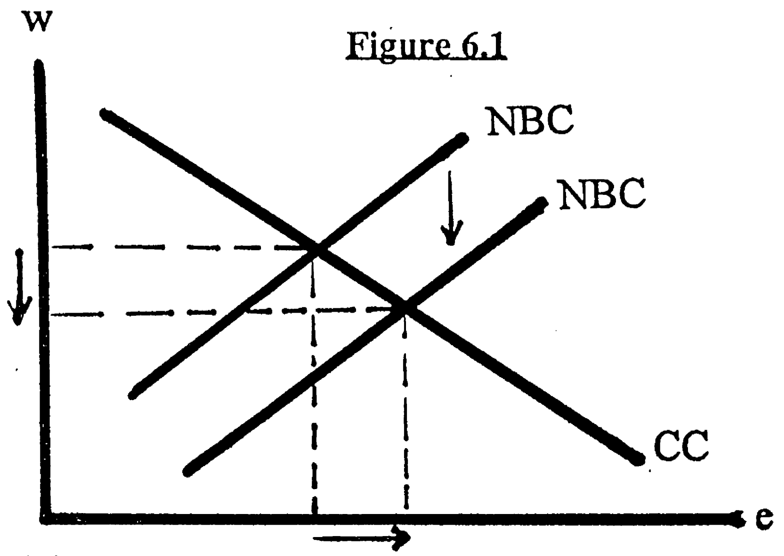


Figure 6.2

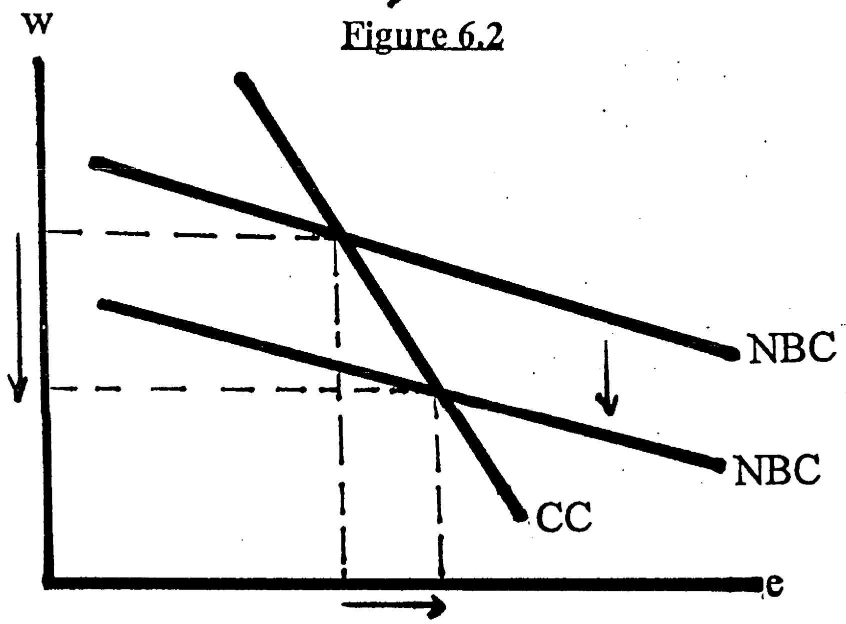
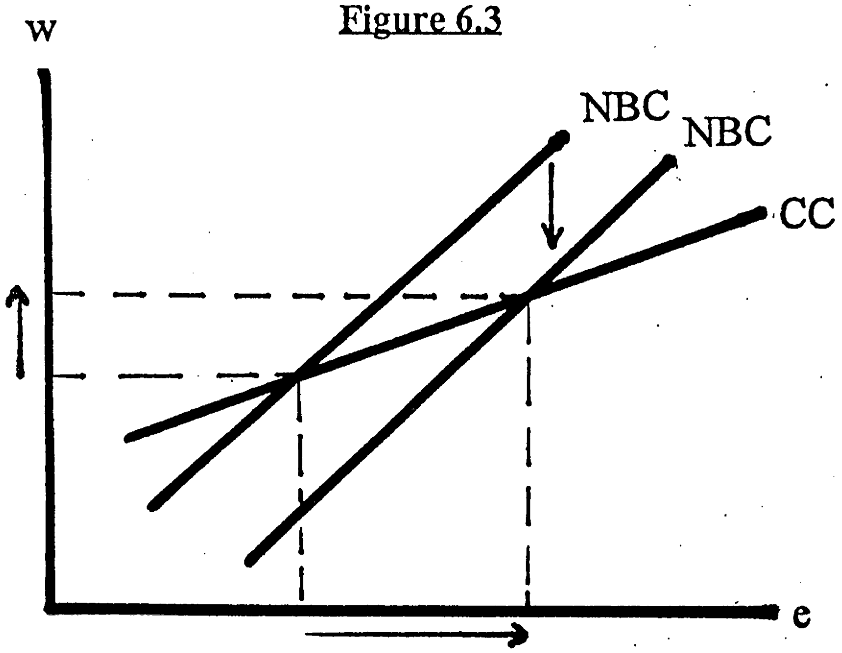


Figure 6.3



It is interesting to analyse the welfare implications of an increase in Q. To do this, domestic welfare, in the presence of a quota[3], is defined as

$$V(L,Q) = S(L+Q) - P.L - P.Q \qquad \text{(consumer surplus)}$$

$$+ L.\left[P - \frac{w}{e}\right] \qquad \text{(firm's rent)}$$

$$+ L.\frac{\phi(w,e)}{e} \qquad \text{(union's rent)}$$

which can be rewritten as

$$V(L,Q) = S(L+Q) - P.Q - L.\frac{w}{e} + L.\frac{\phi(w,e)}{e} \qquad (5)$$

where $P(L+Q) = a - b.(L+Q)$ is the inverse demand curve,

$S(L+Q)$ is the area under the inverse demand curve.

Differentiating (5) with respect to Q, and using the property that $S'(L+Q) = P(L+Q)$, yields

$$\frac{dV}{dQ} = \frac{dL}{dQ}.\left[P - \frac{w}{e} + \frac{\phi}{e}\right] - Q.P'.\left[\frac{d(L+Q)}{dQ}\right] + \frac{L}{e}.\frac{dw}{dQ}.(\phi_w - 1) + \frac{L}{e}.\frac{de}{dQ}.\left[\frac{w}{e} + \phi_e - \frac{\phi}{e}\right].$$

Using (3) this can be rewritten as

$$\frac{dV}{dQ} = \frac{dL}{dQ}.\left[P - \frac{w}{e} + \frac{\phi}{e}\right] - Q.P'.\left[\frac{d(L+Q)}{dQ}\right] + L.(\phi_w - 1).\frac{d(w/e)}{dQ}. \qquad (6)$$

The first term on the right-hand side of (6) represents how rents accruing to the domestic firm-cum-union will be affected by an increase in Q. The second term represents how domestic consumers will be affected by an increase in Q. The third term is a special term which only exists because this is an effort-bargaining model. It

3. It is assumed that any quota rents are reflected in foreign firm profits.

represents how welfare is affected by the change in w/e (the change in the marginal cost of production) which is induced by an increase in Q. It is convenient to label this term the 'X-efficiency effect'. Obviously to comment on the sign of this term we want to know the sign of d(w/e)/dQ. To do this we use the solutions for dw/dQ and de/dQ:

$$\frac{d(w/e)}{dQ} = \frac{1}{e^2}.\left[e.\frac{dw}{dQ} - w.\frac{de}{dQ}\right]$$

$$= \frac{1}{e^2.\Delta}.\left[-e.\eta_{ee}.\eta_{wQ} + e.\eta_{we}.\eta_{eQ} + w.\eta_{eQ}.\eta_{ww} - w.\eta_{wQ}.\eta_{ew}\right].$$

This can now be rewritten with the expressions for η_{eQ} and η_{wQ} substituted in:

$$\frac{d(w/e)}{dQ} = \frac{1}{4b.L^2.e^4.\Delta}.\left\{e^2.\eta_{ee} + w.e.\eta_{we} + w.e.\eta_{ew} + w^2.\eta_{ww}\right\}. \tag{7}$$

The term within the {.} brackets is negative. This is because it is the quadratic form of the matrix given by Δ and for the second order conditions to hold Δ needs to be negative definite. Hence we can say that d(w/e)/dQ is negative. So what we have is

$$sgn\left[L.(\phi_w - 1).\frac{d(w/e)}{dQ}\right] = sgn\left[1 - \phi_w\right]$$

Thus a decrease in (w/e), the 'effective wage', (and the firm's marginal cost of production) will only increase welfare if the loss in utility from \$1 less being paid in effective wages, ϕ_w, is less than the \$1 gained by the firm. Hence we can say that it is quite possible that a reduction in protection, in the form of an increase in Q, can result in a X-efficiency welfare gain.

Now we turn to considering the signs of the first two right-hand side terms from (6). To do this we need to establish the signs of dL/dQ and d(L+Q)/dQ . Provided that the assumption of strict concavity of ϕ holds, it can be established that dL/dQ<0. To show this (2a) is rewritten as

$$L = A.\frac{\phi}{e.\phi_w} \qquad \text{where } A = \frac{2-\beta}{2b.\beta}.$$

Differentiating this with respect to Q:

$$\frac{dL}{dQ} = \frac{A}{(e.\phi_w)^2}.\left\{\frac{dw}{dQ}.\left[e.\phi_w^2 - e.\phi.\phi_{ww}\right] + \frac{de}{dQ}.\left[e.\phi_w.\phi_e - e.\phi.\phi_{we} - \phi.\phi_w\right]\right\}.$$

From (3) and (4) we can write

$$e.\phi_w.\phi_e - \phi_w.\phi = -w.\phi_w^2 \tag{3a}$$

$$\frac{dw}{dQ} = -\left[\frac{e.\phi_{ee} + w.\phi_{ew}}{w.\phi_{ww} + e.\phi_{ew}}\right]\frac{de}{dQ}. \tag{4a}$$

Using (3a) and (4a) we obtain:

$$\frac{dL}{dQ} = \frac{A}{(e.\phi_w)^2.\left[w.\phi_{ww} + e.\phi_{ew}\right]}.\frac{de}{dQ}.\left\{e^2.\phi.\left[\phi_{ww}.\phi_{ee} - \phi_{ew}.\phi_{we}\right] - \phi_w^2.\left[e^2.\phi_{ee} + 2w.e.\phi_{ew} + w^2.\phi_{ww}\right]\right\} \tag{8}$$

Using reasonable assumptions about the individual worker's utility function, ϕ, we can say that the term in the {.} brackets on the right-hand side of (8) is positive. The assumption that $\left[\phi_{ww}.\phi_{ee} - \phi_{ew}.\phi_{we}\right] > 0$ holds if ϕ is strictly concave. This assumption also implies that $\left[e^2.\phi_{ee} + 2w.e.\phi_{ew} + w^2.\phi_{ww}\right] < 0$ since ϕ's quadratic form is negative definite. Hence

$$sgn\,\frac{dL}{dQ} = sgn\left[w.\phi_{ww} + e.\phi_{ew}\right].\frac{de}{dQ}$$

and it has already been shown that

$$sgn\,\frac{de}{dQ} = -\,sgn\left[w.\phi_{ww} + e.\phi_{ew}\right].$$

Therefore $\dfrac{dL}{dQ} < 0$.

Now turning to consider the sign of d(L+Q)/dQ we can note that

$$L + Q = \frac{a - (w/e)}{2b} + \frac{Q}{2}.$$

Differentiating this with respect to Q gives

$$\frac{d(L+Q)}{dQ} = -\frac{1}{2b}.\frac{d(w/e)}{dQ} + \frac{1}{2} > 0 \quad \text{since} \quad \frac{d(w/e)}{dQ} < 0.$$

This is, of course, what is to be expected. An increase in the quota causes the total domestic sales of the good to increase.

The first and second terms on the right-hand side of (6) can now be seen to be respectively negative and positive:

$$\frac{dL}{dQ}.\left[P - \frac{w}{e} + \frac{\phi}{e}\right] < 0 \tag{9}$$

$$-\,Q.P'.\left[\frac{d(L+Q)}{dQ}\right] > 0 \tag{10}$$

(9) represents the decrease in home firm-cum-union rents that results from an increase in Q. (10) represents the increase in consumer welfare that results from an increase in Q. The consumers benefit both from a greater volume of sales and a lower price. Together, (9) and (10) give the quite standard story as to the distributional effects of trade liberalization.

Finally in this section it is shown that protection in the form of either a tariff or a subsidy will not affect effort in this model. A change in a tariff or a subsidy, while affecting the price which the firm receives, does not affect the price elasticity of demand. Using the small country assumption, the demand for the firm's output remains infinitely elastic. This contrasts with the quota case where an increase in the quota shifts the firm's downward sloping demand curve inwards so at any given price the elasticity of demand increases.

To consider a protection policy change which only affects price and leaves the price elasticity of demand unchanged at infinity, the model needs to be slightly modified. That is, for the profit-maximising output to be finite it is necessary to have diseconomies of scale since the firm is now a price taker. To achieve this, a Cobb-Douglas production function is used:

$$x = L^{\alpha}.K^{\delta} \qquad \text{where} \quad \alpha + \delta < 1.$$

Hence the firm's profit maximisation problem, following the determination of e and w, becomes

$$\pi(w,e) = \underset{L,K}{\text{Max}} \left[p.L^{\alpha}.K^{\delta} - w.\frac{L}{e} - r.K \right].$$

$$\text{Let } \Pi = p.L^{\alpha}.K^{\delta} - w.\frac{L}{e} - r.K.$$

The first order conditions for this problem are

$$\frac{\partial \Pi}{\partial L} = p.\alpha.L^{\alpha-1}.K^{\delta} - \frac{w}{e} = 0 \tag{11}$$

$$\frac{\partial \Pi}{\partial K} = p.\delta.L^{\alpha}.K^{\delta-1} - r = 0. \tag{12}$$

Taking the total derivatives of (11) and (12) with respect to w and then solving simultaneously for L_w and K_w gives

$$L_w = \frac{\delta - 1}{e.\alpha.p.L^{\alpha-2}.K^{\delta}.[1 - (\alpha+\delta)]}$$

$$K_w = \frac{-1}{e.p.L^{\alpha-1}.K^{\delta-1}.[1-(\alpha+\delta)]}.$$

Taking the total derivatives of (11) and (12) with respect to e and then solving simultaneously for L_e and K_e gives

$$L_e = \frac{-w.(\delta-1)}{e^2.p.\alpha.L^{\alpha-2}.K^{\delta}.[1-(\alpha+\delta)]} = -\frac{w}{e}.L_w$$

$$K_e = \frac{w}{e^2.p.L^{\alpha-1}.K^{\delta-1}.[1-(\alpha+\delta)]} = -\frac{w}{e}.K_w.$$

Taking the total derivatives of (11) and (12) with respect to p and then solving simultaneously for L_p and K_p gives

$$L_p = \frac{L}{p.[1-(\alpha+\delta)]}$$

$$K_p = \frac{K}{p.[1-(\alpha+\delta)]}.$$

We can now show that the derivatives with respect to p of the first-order conditions for the Nash bargaining product, η_{ep} and η_{wp}, are equal to zero.

Following some manipulation η_{ep} can be written as follows:

$$\eta_{ep} = \frac{(1-\beta).w.L}{e^2.\pi^2.p.[1-(\alpha+\delta)]}.\left\{w.\frac{L}{e} - r.K + p.(\alpha+\delta).L^{\alpha}.K^{\delta}\right\}$$

$$= \frac{(1-\beta).w.L}{e^2.\pi^2.p.[1-(\alpha+\delta)]}.\left\{p.(\alpha+\delta).L^{\alpha}.K^{\delta} - \alpha.p.L^{\alpha}.K^{\delta} - \delta.p.L^{\alpha}.K^{\delta}\right\}$$

using (11) and (12)

$$= 0.$$

η_{wp} is also equal to zero since it is straightforward to show that $\eta_{wp} = -(w/e).\eta_{ep}$. So it is clear that the NBC will not be affected by a change in price:

$$\left.\frac{dw}{dp}\right|_{NBC} = -\frac{\eta_{wp}}{\eta_{ww}} = 0.$$

Hence e and w are not affected by the price the firm receives for its output and so are not affected by a tariff on imports.

III: Joint Wage-Labour/Capital Ratio Bargaining

In one sense, bargaining over effort, as done in the previous section, can be seen as indirectly bargaining over employment. That is, for a given output, a reduced effort level implies a higher number of employees. Thus taking a longer tea break not only reduces the disutility of work for the individual union member but also potentially contributes to union utility because the number of employed union members would be increased for a given level of output. Johnson (1990) explores this concept of indirect employment bargaining by considering the concept of labour/capital ratio bargaining as well as intensity of work (effort) bargaining. Like effort bargaining, bargaining over the labour/capital ratio can be thought of as bargaining over work practices. That is the issue of how many employees are required to operate a particular piece of equipment is frequently a work practices issue which employers and unions bargain over.

In this section it is shown that, when the two variables which are bargained over are wages and the labour/capital ratio, an increase in the import quota decreases the labour/capital ratio. The labour/capital ratio is defined as $z = \frac{N}{K}$. The union's utility function is just the same as in the previous section except that effort is no longer included:

$$U = \phi(w).N = \phi(w).z.K.$$

The firm's production function is Cobb-Douglas with constant returns to scale:

$$x = K^{1-\alpha}.N^{\alpha}$$

$$= K.z^{\alpha} \qquad , \ 0 < \alpha < 1.$$

The first step is to consider how, for a given z and w, the firm decides upon the profit maximising K (and hence N):

$$\pi(z,w) = \underset{K}{\text{Max}} \ [K.z^{\alpha}.\{a - b.(Q + K.z^{\alpha})\} - w.z.K - r.K].$$

$$\text{Let} \quad \Pi = K.z^{\alpha}.\{a - b.(Q + K.z^{\alpha})\} - w.z.K - r.K.$$

The first order condition for the problem is

$$\frac{\partial \Pi}{\partial K} = z^{\alpha}.\{a - b.(Q + K.z^{\alpha})\} - b.K.z^{2\alpha} - w.z - r = 0$$

$$\Rightarrow K = \frac{z^{\alpha}.[a - b.Q] - w.z - r}{2b.z^{2\alpha}}$$

$$= \frac{\gamma}{2b.z^{2\alpha}}, \quad \text{where} \quad \gamma = z^{\alpha}.[a - b.Q] - w.z - r,$$

$$\Rightarrow \pi = \frac{\gamma^2}{4b.z^{2\alpha}}.$$

The solution to the Nash bargaining problem involves choosing z and w to maximise the Nash product:

$$\eta = \beta.\ln[\phi(w).z.K(z,w)] + (1 - \beta).\ln\pi(z,w).$$

The first order conditions for this problem are:

$$\eta_z = \frac{\beta - 2.\alpha}{z} + \frac{\gamma_z}{\gamma}.(2 - \beta) = 0 \tag{13}$$

$$\eta_w = \beta.\frac{\phi_w}{\phi} - \frac{z.(2 - \beta)}{\gamma} = 0. \tag{14}$$

Totally differentiating (13) and (14) yields

$$\frac{dz}{dQ} = \frac{\begin{vmatrix} -\eta_{zQ} & \eta_{zw} \\ -\eta_{wQ} & \eta_{ww} \end{vmatrix}}{\Delta}$$

where $\Delta>0$ is the Hessian determinant of the system.

$$\eta_{zw} = \frac{(2-\beta).(\gamma_z.z-\gamma)}{\gamma^2}$$

$$\eta_{ww} = \beta.\frac{\phi_{ww}}{\phi} - \beta.\frac{\phi_w^2}{\phi^2} - z^2.\frac{(2-\beta)}{\gamma^2}$$

$$\eta_{zQ} = \frac{(2-\beta).b.z^{\alpha-1}.(\gamma_z.z-\alpha.\gamma)}{\gamma^2}$$

$$\eta_{wQ} = \frac{-(2-\beta).z^{\alpha+1}.b}{\gamma^2}.$$

Hence:

$$\frac{dz}{dQ} = \frac{1}{\Delta}.\left[-\beta.\frac{\phi_{ww}}{\phi}.\frac{(2-\beta).b.z^{\alpha-1}.(\gamma_z.z-\alpha.\gamma)}{\gamma^2}\right] \tag{15}$$

using both conditions (13) and (14).

To determine the sign of $(\gamma_z.z-\alpha.\gamma)$ condition (13) can be rewritten as

$$(2-\beta).(z.\gamma_z-\gamma) = -2(1-\alpha).\gamma$$

$$\Rightarrow z.\gamma_z - \gamma < 0.$$

Again (13) can be rewritten this time as

$$\frac{2(z.\gamma_z-\alpha.\gamma)}{\beta} = z.\gamma_z - \gamma.$$

So:

$$z.\gamma_z - \gamma < 0$$

$$\Rightarrow z.\gamma_z - \alpha.\gamma < 0.$$

So from (15):

$$\frac{dz}{dQ} < 0.$$

What this result is saying is that if protection is reduced by increasing the volume of a quota applied to imports, the agreed number of employees required to operate a particular piece of capital equipment would be reduced. It is a result which is essentially driven by the form of bargaining which is used. Bargaining over w and z while leaving K (and hence employment N and output x) to be unilaterally determined by the firm is not fully efficient. That is, the bargaining does not achieve a result where joint surplus is maximised. A simple example of where joint surplus is maximised is the competitive labour market case. Here each identical worker is prepared to work for a wage which equals the participation constraint. Clearly in this situation the firm gets all the surplus which it maximises by choosing the optimal quantity of K and N to use. In Appendix 6.1 this profit maximisation problem is written in terms of K and z. It is shown that changing Q has no effect upon the choice of z in this case. Now in the case where w and z are bargained over, N is determined by the firm acting to maximise its own profit rather than joint surplus. This is understood by both parties when bargaining over w and z. Agreeing to adjusting z has implications for the agreed w and the value of N decided by the firm. An increase in Q means that the total surplus to be bargained over is reduced. The union is prepared to agree to a reduced z so as to get the utility maximising w and N given the bargaining position which it finds itself in.

IV: Concluding Comments

To conclude, it is useful to consider other approaches to questions of protection and the relationship between firms and unions. The political economy of protection literature characterizes the firm and the union as a coalition which lobbies a politically self-interested policy maker for protection. To achieve greater lobbying power it may be in the interest of this coalition for the firm to increase employment if this expands the number of individuals in the union (see Hillman 1989). Obviously if there were relatively unambiguous results with respect to the effect of lobbying upon work practices these would be of considerable interest.

An entirely different approach would be to consider the effect of increased 'competitive pressure' upon the management decision as to whether to 'confront' the union over a work practices issue. That is using a decision-theoretic framework, similar to that used in Chapter 4, the cost of confronting the union could be interpreted as an investment with an uncertain outcome. The cost of eliminating a restrictive work practice might be a strike with the benefit being reduced costs where the actual extent of the reductions are stochastic. The decision to take the risk of eliminating such a work practice may be made more likely by the removal of protection. This is because without protection the firm may cease to exist if its production costs can not be reduced. Clearly such an approach would be very different to the axiomatic bargaining approach taken in this chapter. The bargaining model is cooperative. That is while the firm and the union may threaten each other with strikes and lockouts these threats are not actually carried out. Rather it is assumed that these two parties are well informed about each other and so can come to an agreement based upon the relative bargaining strengths.

Another approach, again based on Chapter 4, may be to take into account the union's aversion to the firm, and hence the domestic industry, ceasing to exist. In an unprotected environment the union may recognise that if the firm fails to maintain international 'best practice' then there is a high probability that in the future the firm will be terminated. This recognition would tend to dissuade the union from advocating the continuation of work practices which prove to be inimical to the adoption of best practice techniques.

APPENDIX 6.1: THE COMPETITIVE LABOUR MARKET CASE

Here with both competitive capital and labour markets the firm's problem is to select the profit maximising amounts of labour and capital to employ. However it is analytically convenient to write this problem in terms of choosing z and K. This allows us to use the first order conditions to show that $\frac{dz}{dQ} = 0$ in this case.

$$\pi(w, r, Q) = \max_{z,K} \left[K.z^{\alpha}.\{a - b.(Q + K.z^{\alpha})\} - w.z.K - r.K \right].$$

$$\text{Let} \quad \Pi = K.z^{\alpha}.\{a - b.(Q + K.z^{\alpha})\} - w.z.K - r.K.$$

The first order conditions are

$$\frac{\partial \Pi}{\partial z} = \alpha.(a - b.Q).K.z^{\alpha-1} - 2\alpha.b.K^2.z^{2\alpha-1} - w.K = 0 \qquad (6.1.1)$$

$$\frac{\partial \Pi}{\partial K} = (a - b.Q).z^{\alpha} - 2b.K.z^{2\alpha} - w.z - r = 0. \qquad (6.1.2)$$

Totally differentiating (6.1.1) and (6.1.2) yields

$$\frac{dz}{dQ} = \frac{\begin{vmatrix} -\Pi_{zQ} & \Pi_{zK} \\ -\Pi_{KQ} & \Pi_{KK} \end{vmatrix}}{\Delta} \quad \text{(where } \Delta > 0 \text{ is the Hessian determinant of the system)}$$

$$= \frac{1}{\Delta}.[(a - b.Q).b.z^{2\alpha-1} - 2\alpha.b^2.Kz^{3\alpha-1} - w.b.z^{\alpha}].$$

Now from (6.1.1)

$$(a - b.Q).b.z^{2\alpha-1} = 2\alpha.b^2.Kz^{3\alpha-1} + w.b.z^{\alpha}$$

hence $\frac{dz}{dQ} = 0.$

CHAPTER 7: PROTECTION AND ENTRY DETERRENCE

I: Introduction

In Chapters 3 and 4 the protected firm is a local monopolist which can take action to affect its costs. In this chapter the protected local monopolist's marginal cost is treated as exogenous. However there is the possibility that another domestic firm will enter the industry and be able to operate at a lower marginal cost. The idea here is that an existing firm's history may prevent it from operating at a cost which is as low as the cost of a new firm. For example it may be prohibitively costly to eliminate work practices that are no longer appropriate due to newly available technology. Similarly it may have become appropriate to shift away from in-house production of certain intermediate inputs. Here the firm's managers may not have the organisational ability to successfully make this shift. One of the best documented accounts of new firms operating in a more technically efficient manner is the rise of the so-called mini-mills in the US steel industry[1]. This chapter examines what circumstances are necessary for a reduction in protection to facilitate entry by a new domestic firm. That is, this chapter examines whether a case can be found where a reduction in protection makes the incumbent firm less likely to take action to prevent entry by other firms.

There are two well known approaches to modelling how an incumbent monopolist reacts to the expectation that another firm may enter causing the market

1. Barnett and Crandall (1986) document the emergence in recent years of small scale seel mills. These mills use the latest technology and do not suffer from the restrictive work practices which are prevalent within the large and long established steel companies.

structure to become a duopoly[2]. The first of these approaches involves the incumbent being able to commit to a post-entry level of output by investment in productive capacity. The second approach involves assuming the entrant has incomplete information about the incumbent allowing the incumbent to engage in behaviour which is aimed at convincing the entrant that the expected profits from entry would not be positive. The development of both of these approaches was motivated by a desire to provide sound theoretic justifications for the contention that monopolies may engage in 'limit pricing'. Limit pricing consists of a monopoly charging a price below the profit maximising monopoly price so as to discourage entry. This idea at least goes back to Kaldor (1935) and had become part of the mainstream by the 1950s with leading authors such as Bain (1949) having a major role in its development. The problem with this idea is that there needs to be some justification for why a rational entrant would believe that the pre-entry settings of price and output would serve as indicators of post-entry profitability. With the increased use of non-cooperative game theory in economics the limit-pricing strategy as characterised by Bain and his contemporaries came to be seen as a non-credible threat. Friedman (1979) shows formally that the traditional limit pricing story does not represent a game-theoretic equilibrium. The capacity commitment and incomplete information approaches to the issue of entry deterrence has saved the term 'limit pricing' from being confined to text books on the history of economic

2. In this chapter even if entry does take place the firm which did have the monopoly position is known as the incumbent. Similarly the firm considering entry is known as the entrant whether entry takes place or not.

thought[3].

This chapter examines the effect of the change in protection upon entry deterrence using both of the above approaches. The chief aim of the analysis is to see how a case may arise where the incumbent initially deliberately acts to deter entry and then following a reduction in protection the incumbent accommodates entry (that is, acts to maximise profit given the entrant is going to enter). Hence the focus of the chapter is upon the protected incumbent's choice between deterrence and accommodation. After a moment's thought it should be clear that it is by no means intuitively obvious whether a decrease in protection will push the incumbent toward deterrence or accommodation. This is because we can identify two competing tendencies:

(i) Reducing protection leads to the reward from remaining a monopolist being diminished. That is, the incentive to engage in behaviour designed to deter entry has been reduced.

(ii) Reducing protection leads to the reward from entering the industry being diminished. Hence with reduced incentive to enter the industry the incumbent finds it easier to deter entry.

The following analysis shows that the effect of reducing protection is not quite as ambiguous as may initially be thought. In Section II a simple model based upon the ability to use capacity to commit to post-entry behaviour is used. Here a reduction in protection will definitely not facilitate entry by a *domestic* firm. Instead it is an increase in protection which may induce the incumbent to shift from deterrence to

3. It should be noted that it is generally acceptable to talk about limit pricing in the context of a dominant firm discouraging entry of a 'competitive fringe'. That is, discouraging entry by firms which are so small that they regard price as being parametric. Scherer and Ross (1990) discuss limit pricing in this context. It is a model applicable to situations where the dominant firm has an advantage in either cost competitiveness or appeal to buyers.

accommodation. However this result is reversed if the entrant is in fact a foreign firm which is advantaged by a reduction in protection. Section III uses a Milgrom and Roberts type model to illustrate a case where reducing protection does cause the incumbent to shift from deterrence to accommodation of a domestic entrant. This is because reducing protection reduces the incumbent's motivation to remain a monopolist to a greater extent than it reduces the cost of deterring entry.

II: Protection and Entry Deterrence with a Spence-Dixit Type Model[4]

The model used in this section relies upon the incumbent's ability to commit to a particular post-entry productive capacity to provide a theoretic justification for the contention that incumbent firms may limit price to deter entry. The model has two periods. In the first period the incumbent is a monopolist. In the second period the entrant will enter the industry if it can make a positive profit by doing so. The two firms act sequentially with the incumbent being the leader and the entrant being the follower. In the first period the incumbent decides upon how much productive capacity to invest in. This commits the incumbent to producing this level of output in the second period. The justification for treating second period output as being synonymous with the investment in capacity is that the second period marginal cost of producing up to the productive capacity is relatively low[5]. The literature in this area shows that in general,

4. Tirole (1988 Ch.8) uses the label 'Spence-Dixit' for a basic entry deterrence model based upon the work of both Spence (1977, 1979) and Dixit (1979, 1980).

5. See Dixit (1980).

once an investment has been sunk in productive capacity, this capacity will be used[6]. The entrant observes the incumbent's choice of capacity and then makes its own capacity/output choice. Obviously a choice of zero capacity is synonymous with the entrant choosing not to enter the industry. If the incumbent sets its capacity sufficiently high the entrant will not enter since doing so would not yield a positive profit.

For a given set of parameters there are three possible outcomes. Entry may be blockaded, deterred or accommodated[7]. If entry is blockaded, the incumbent acts as a conventional profit-maximising monopolist but even so the entrant decides not to enter. If entry is deterred the incumbent deters entry by committing to a larger output than would maximise profit if there were no threat of entry. Thus the incumbent can be said to be limit pricing since if the entrant did not exist the incumbent would be charging a higher price. If entry is accommodated, the incumbent acts like a conventional Stackelberg leader committing to an output which maximises profit given the reaction of the entrant. This contrasts with deterring entry where the incumbent needs to commit to an output which would result in zero or negative profit for the entrant if entry took place. The smaller the entrant's fixed costs, the higher the capacity commitment needed to deter entry. Hence the smaller the entrant's fixed costs, the more likely it is profit-maximising to choose to accommodate entry rather than deter entry.

The form of protection considered here is a quota on the volume of imports. The effect of changing protection on the likelihood that an incumbent will accommodate an entrant may initially seem surprising. Accommodation of the entrant is unambiguously made more likely by an increase in protection. Reducing the volume of imports reserves

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6. For a good review of this literature see Gilbert (1989).

7. This classification of possible forms of behaviour by incumbents is due to Bain (1956).

more demand for the domestic firms. With greater demand the significance of the entrant's fixed costs is reduced. It is a standard result from the Spence-Dixit model that if the entrant's fixed costs are sufficiently low the incumbent will choose accommodation over deterrence. This is because the cost of deterrence in terms of setting output above the accommodation level overwhelms the benefit of deterring entry.

The domestic inverse demand function and the cost function are respectively:

$$p = a - b.(Q + K_I + K_E)$$

$$C_I(K_I) = c_I.K_I$$

$$C_E(K_E) = f + c_E.K_E$$

where Q is the allowed volume of imports,
K_I and K_E are the respective productive capacities of the incumbent and the entrant,
c_I and c_E are the respective marginal costs of the incumbent and the entrant with $c_I > c_E$,
f is the entrant's fixed cost.

If entry is blockaded then the incumbent's monopoly capacity and profit are:

$$K_I^M = \frac{a - b.Q - c_I}{2b},$$

$$\pi_I^M = \frac{(a - b.Q - c_I)^2}{4b}.$$

If the incumbent acts to deter entry or chooses to accommodate it, the incumbent needs to take into consideration the entrant's reaction function:

$$K_E = \frac{a - b.Q - c_E}{2b} - \frac{K_I}{2} \qquad \text{if } \pi_E > 0,$$

$$K_E = 0 \qquad \text{if } \pi_E \leq 0.$$

To deter entry the incumbent sets K_I so that the entrant will respond by setting K_E=0.

That is K_I is set so π_E=0:

$$\pi_E = \left[a - b.Q - b.K_I - b.\left(\frac{a - b.Q - c_E}{2b}\right) + b.\left(\frac{K_I}{2}\right) - c_E\right]\left[\frac{a - b.Q - c_E}{2b} - \frac{K_I}{2}\right] - f = 0.$$

Solving this gives the entry deterring capacity:

$$K_I^D = \frac{a - b.Q - c_E - 2\sqrt{b.f}}{b}.$$

The incumbent's profit associated with the entry deterrence strategy is:

$$\pi_I^D = \frac{1}{b}.\left[c_E - c_I + 2\sqrt{b.f}\right].\left[a - b.Q - c_E - 2\sqrt{b.f}\right].$$

If the incumbent decides against entry deterrence, the profit maximisation problem becomes:

$$\underset{K_I}{\text{Max}} \quad \pi_I = \left[a - b.Q - b.K_I - b.\left(\frac{a - b.Q - c_E}{2b}\right) - b.\left(\frac{K_I}{2}\right) - c_I\right]K_I.$$

This is simply the standard problem faced by a Stackelberg leader. That is K_I is chosen so as to maximise profit taking into account how the entrant will react to this choice. From the first order condition the capacity associated with accommodation is:

$$K_I^A = \frac{a - b.Q + c_E - 2c_I}{2b}.$$

The entrant's reaction to K_I^A is:

$$K_E = \frac{a - b.Q - 3c_E + 2c_I}{4b}.$$

With these choices of capacity the incumbent's profit is:

$$\pi_I^A = \frac{1}{8b}.\left[(a - b.Q - c_I) + (c_E - c_I)\right]^2.$$

Figure 7.1 represents how π_I^M, π_I^D, and π_I^A change as Q is increased (that is as protection is reduced). The broken line shows the envelope of these curves and indicates where entry is respectively blockaded, deterred and accommodated. While appropriate parameter values are required for all three cases to be possible, there is a general tendency as the quota is reduced for the incumbent to shift from acting to deter entry (or having entry blockaded) to acting to accommodate entry. The first step in understanding this diagram is to note the signs of the first and second derivatives:

$$\frac{d\pi_I^M}{dQ} = \frac{-(a - b.Q - c_I)}{2} < 0 \qquad \text{provided} \quad K_I^M > 0,$$

$$\frac{d^2\pi_I^M}{dQ^2} = \frac{b}{2} > 0,$$

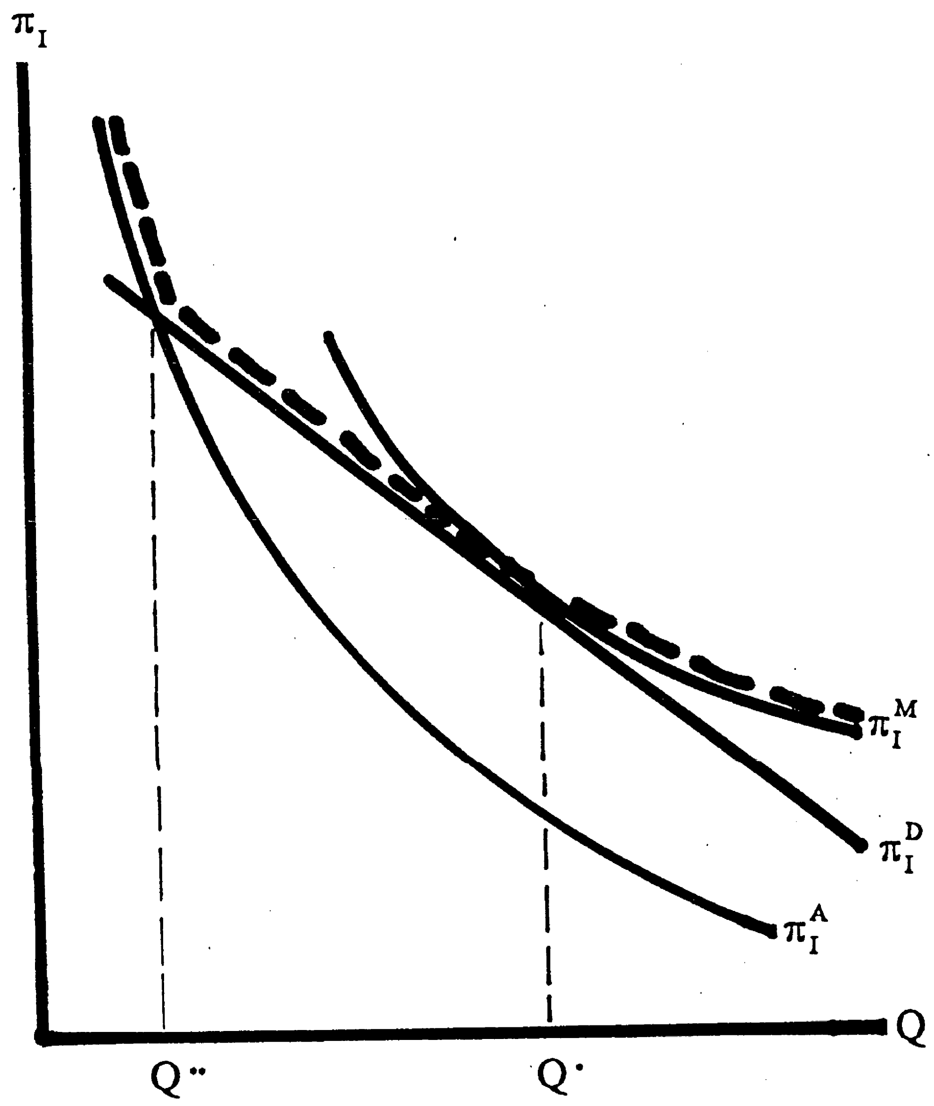
$$\frac{d\pi_I^D}{dQ} = -(c_E - c_I + 2\sqrt{b.f}) < 0 \qquad \text{provided} \quad \pi_I^D > 0,$$

$$\frac{d^2\pi_I^D}{dQ^2} = 0,$$

$$\frac{d\pi_I^A}{dQ} = \frac{-(a - b.Q - 2c_I + c_E)}{4} < 0 \qquad \text{provided} \quad K_I^A > 0,$$

$$\frac{d^2\pi_I^A}{dQ^2} = \frac{b}{4} > 0,$$

Figure 7.1: Profit as a Function of Q



For any given value of Q, π_I^M will be higher than π_I^A. This is illustrated using a standard diagram in K_I, K_E space (Figure 7.2). The monopolist sets K_I in the knowledge that K_E will always equal zero. The accommodating incumbent sets K_I in the knowledge that K_E will be set according to the entrant's reaction function. From Figure 7.2 it can be seen that the isoprofit curve associated with monopoly represents a higher profit level than the isoprofit curve associated with accommodation. Accommodating entry obviously means that the incumbent has to share the market with the entrant. The entrant's output pushes the price down and thus pushes down the incumbent's profit.

With appropriate parameter values there will be a value of Q; Q* where $\pi_I^M=\pi_I^D$ (see Figure 7.1). To examine this special case consider Figure 7.3. Here K_I^M coincides with where the entrant's reaction function coincides with the K_I axis, that is K_I^D. To deter entry at Q* the incumbent simply needs to act like a conventional profit-maximising monopolist. If Q>Q* the incumbent does not need to set capacity equal to K_I^D since with the incumbent acting like a conventional profit maximising monopolist the entrant will choose not to enter. To see this, consider what happens to the profit the entrant would make from entering if Q increased above Q*:

$$\frac{d\pi_E}{dQ} = \frac{\partial \pi_E}{\partial Q} + \frac{\partial \pi_E}{\partial K_I}.\frac{dK_I^M}{dQ} = -\frac{b}{2}.K_E.$$

Here K_E will be set equal to the capacity that the entrant would choose if the entrant chose to enter where K_I was set equal to K_I^M. Hence:

$$\frac{d\pi_E}{dQ} = -\frac{1}{4}\left[K_I^M + (c_I - c_E)\right] < 0.$$

Since at Q* , π_E=0 , at Q>Q* we must have π_E<0. Thus we can say that if Q≥Q* then

Figure 7.2: Accommodation and Monopoly

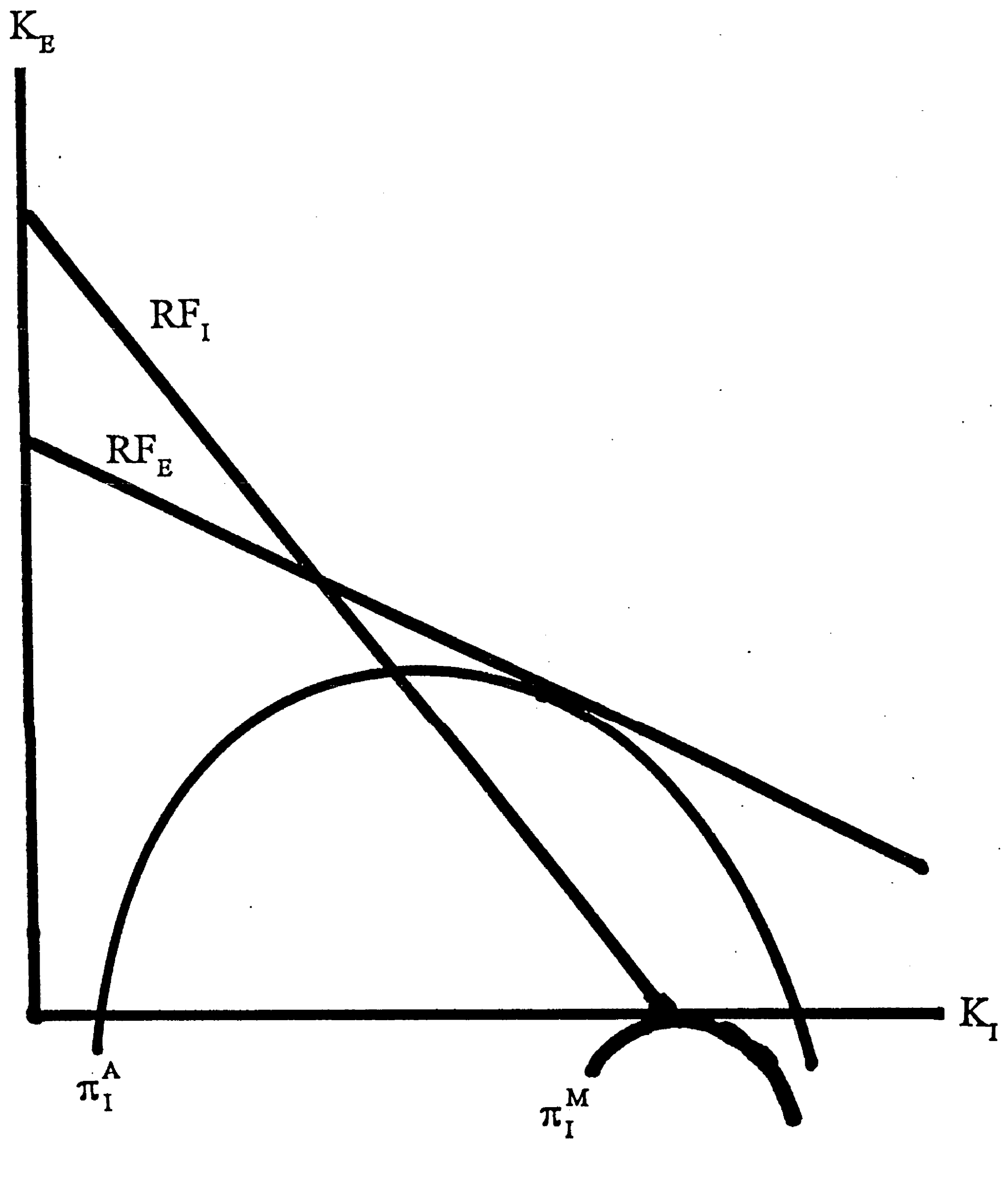
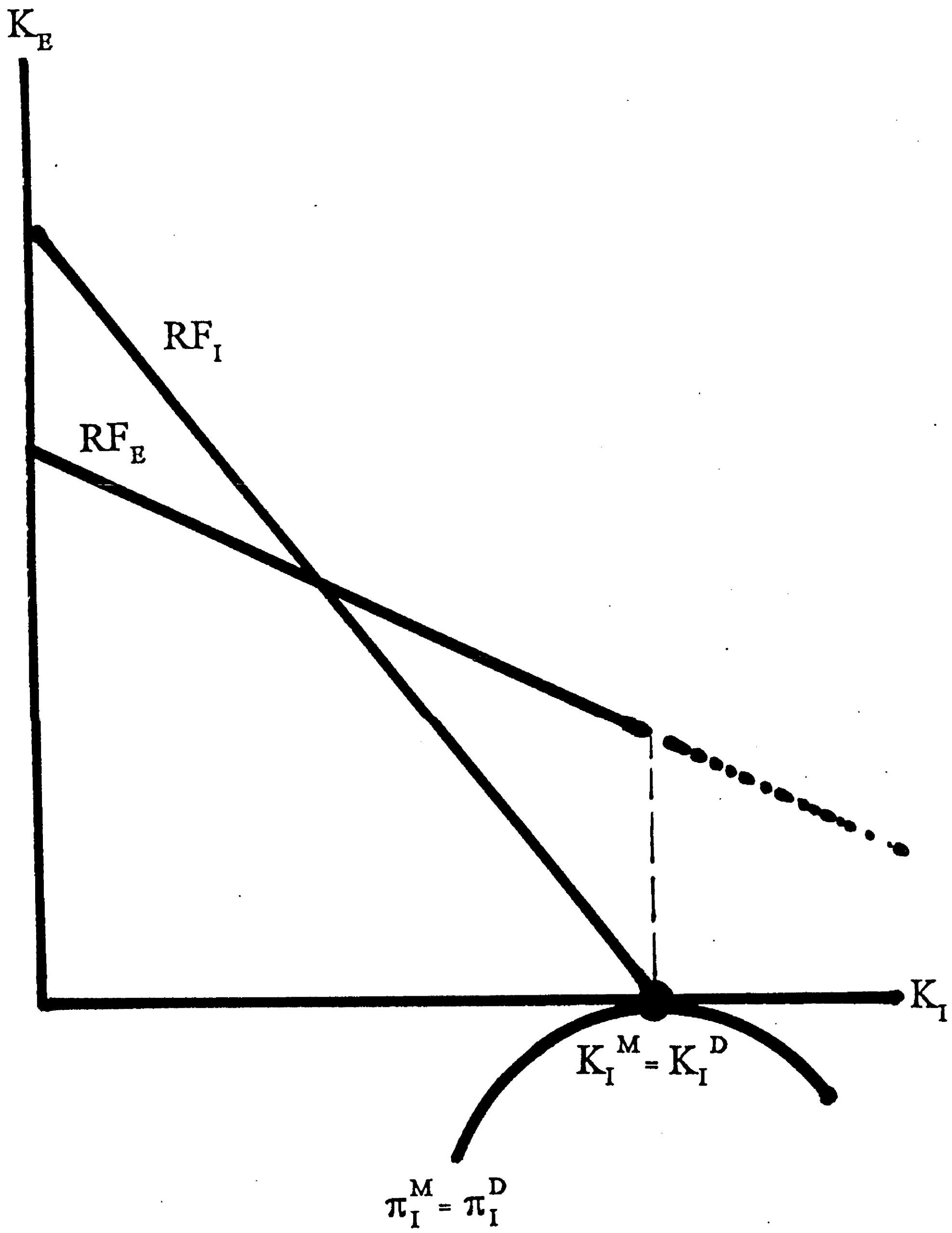


Figure 7.3: When Monopoly and Deterrence Profits are Equal



entry is blockaded. Similarly if $Q<Q^*$, then the strategy of acting like a conventional monopolist is inappropriate and so the incumbent has to choose between deterring entry or accommodating it.

In Figure 7.1 if Q is reduced below Q^{**} the incumbent will choose to accommodate rather than deter entry since $\pi_I^A>\pi_I^D$. To understand what is causing this result consider Figure 7.4 which shows a reduction in Q from Q_0 to Q_1. When $Q=Q_0$, entry deterrence is chosen since $\pi_I^D(Q_0)>\pi_I^A(Q_0)$. When $Q=Q_1$, entry accommodation is chosen since $\pi_I^A(Q_1)>\pi_I^D(Q_1)$. What is important to note from this diagram is the changing ratio between where the reaction function of the entrant is discontinuous, K_I^D, and where the entrant's reaction function would intersect the K_I axis if there were no fixed costs (denoted as K_I^E). Considering this ratio analytically we have:

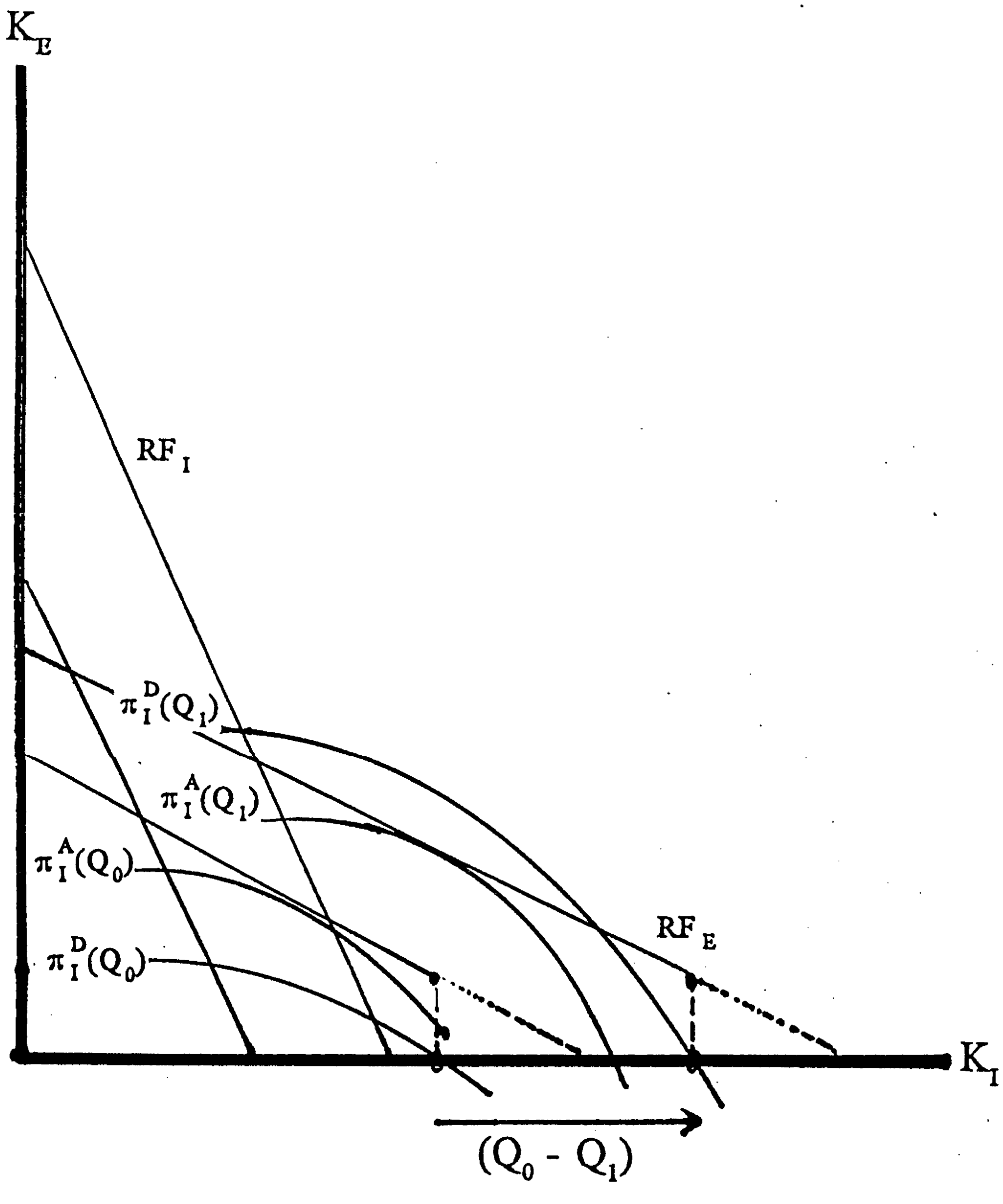
$$R = \frac{K_I^D}{K_I^E} = \frac{\frac{1}{b}.\left(a - b.Q - c_E - 2\sqrt{b.f}\right)}{\frac{1}{b}.\left(a - b.Q - c_E\right)}.$$

Now consider how a change in Q affects R:

$$\frac{\partial R}{\partial Q} = \frac{-2\sqrt{b.f}}{(a - b.Q - c_E)^2} < 0.$$

So both from this and the diagram we can see that, as the entrant's reaction function shifts out in response to a decrease in Q, the relative gap between K_I^D and K_I^E is reduced. That is the relative importance of the entrant's fixed costs, f, is reduced. If fixed costs are of minimal importance then it should be clear that the problem comes to resemble the standard Stackelberg story where the incumbent maximises profit by accommodating entry. The Spence-Dixit model requires the entrant's fixed costs to be of some importance for the incumbent to deter entry.

Figure 7.4: When Q Decreases so that Deterrence changes to Accommodation



This model also proves useful for analysing the case where a domestic incumbent faces the threat of a foreign entrant moving into the domestic market. In this case it is supposed that the protective instrument is a tariff placed upon any goods sold by the entrant. In analytical terms a decrease in the tariff is equivalent to a decrease in c_E, the entrant's marginal cost. Figure 7.5 represents how π_I^M, π_I^D, and π_I^A change as c_E is increased (that is as protection is increased). The broken line shows where entry is respectively blockaded, deterred and accommodated. While appropriate parameter values are required for all three cases to be possible, there is a general tendency as the tariff is reduced for the incumbent to shift from acting to deter entry (or having entry blockaded) to acting to accommodate entry. As with Figure 7.1 it is useful to begin by noting the signs of the relevant first and second derivatives:

$$\frac{d\pi_I^M}{dc_E} = 0$$

$$\frac{d\pi_I^D}{dc_E} = \frac{a - 2c_E + c_I - 4\sqrt{b.f}}{b}$$

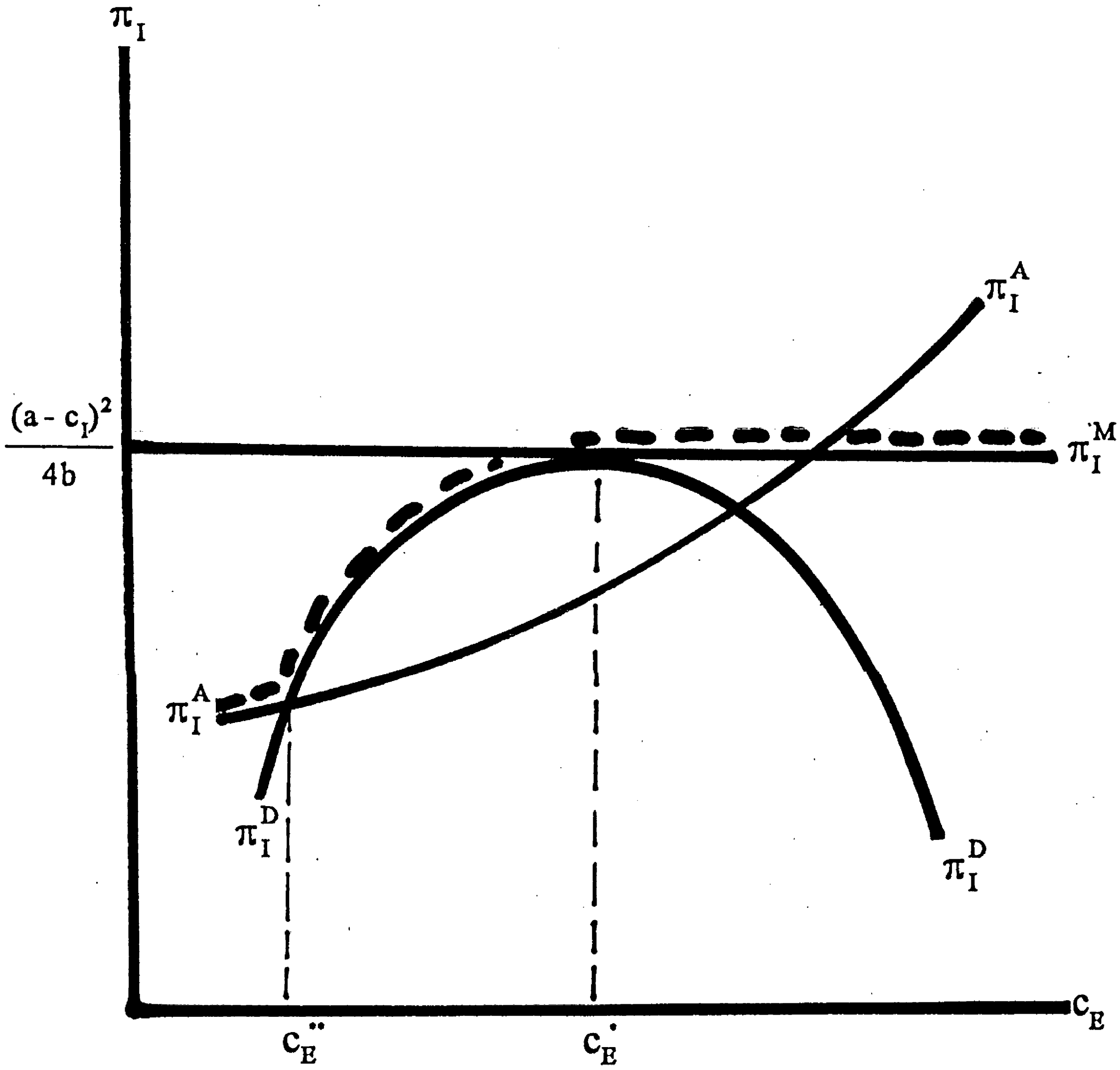
$$\frac{d\pi_I^D}{dc_E} > 0 \quad \text{if} \quad c_E < \frac{a + c_I - 4\sqrt{b.f}}{2b}$$

$$\frac{d\pi_I^D}{dc_E} < 0 \quad \text{if} \quad c_E > \frac{a + c_I - 4\sqrt{b.f}}{2b}$$

$$\frac{d^2\pi_I^D}{dc_E^2} = -\frac{2}{b} < 0$$

$$\frac{d\pi_I^A}{dc_E} = \frac{a + c_E - 2c_I}{4b} > 0 \qquad \text{provided} \quad K_I^A > 0$$

Figure 7.5: Profit as a Function of c_E



$$\frac{d^2\pi_I^A}{dc_E^2} = \frac{1}{4b} > 0 .$$

The level of protection where $\pi_I^M = \pi_I^D$ is at c_E*. To confirm, that c_E* is at the turning point of the π_I^D curve, $c_E = (1/2b).[a + c_I - 4\sqrt{b.f}]$ is substituted into π_I^D:

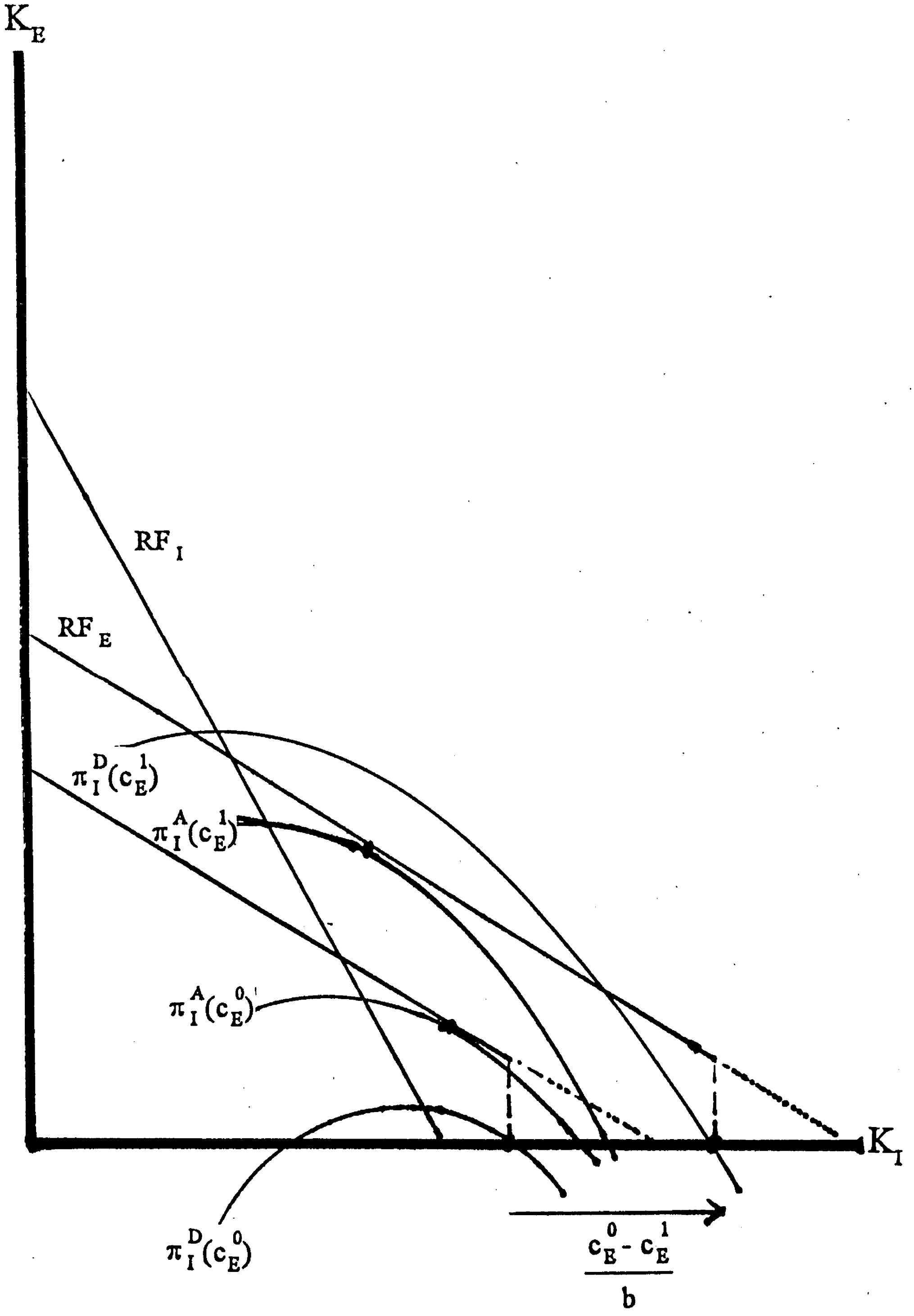
$$\pi_I^D(c_E^*) = \frac{(a - c_I)^2}{4b} = \pi_I^M .$$

With the appropriate parameter values there will be a level of protection, c_E**, below which the profit from accommodation exceeds that from entry deterrence. To understand the intuition for the result that trade liberalization can facilitate the entry of a foreign firm consider Figure 7.6 which shows a reduction in c_E from c_E^0 to c_E^1. When $c_E = c_E^0$ entry deterrence is chosen since $\pi_I^D(c_E^0) > \pi_I^A(c_E^0)$. When $c_E = c_E^1$ entry accommodation is chosen since $\pi_I^A(c_E^1) > \pi_I^D(c_E^1)$. In this case it is a reduction in protection that causes the entrant's fixed costs to become less important. This can be confirmed by showing R is increased when c_E is reduced:

$$\frac{\partial R}{\partial c_E} = \frac{-2\sqrt{b.f}}{(a - c_E)^2} < 0 .$$

To summarise this section, the analysis represents an application of the standard Spence-Dixit model result that, the greater the relative importance of the entrant's fixed costs, the more likely the incumbent will choose to deter entry. If the entrant is a domestic firm and protection is decreased (in the form of an import quota being increased) then the incumbent is more likely to choose to deter entry since the relative

Figure 7.6: A Decrease in c_E so that Deterrence changes to Accommodation



importance of the entrant's fixed costs have been increased. If the entrant is a foreign firm and protection is decreased (in the form of a tariff being decreased) then the incumbent is more likely to choose to accommodate entry since the relative importance of the entrant's fixed costs have been decreased.

III: Protection and Entry Deterrence with Incomplete Information

In their seminal paper on entry deterrence Milgrom and Roberts (1982) demonstrate how incomplete information can be used to justify the notion that an incumbent may be able to deter entry by engaging in limit pricing. Consider a full information case to begin with. In period 1 a potential entrant observes both demand and the incumbent monopolist's cost function. In period 2 the entrant enters if it is able to make nonnegative profits in a Cournot type duopoly with the incumbent. Now suppose that the entrant in period 1 is unable to observe whether the incumbent is 'high-cost' or 'low-cost'. If the incumbent is high-cost then entering in period 2 would result in the entrant making positive profits. However if the incumbent is low-cost then entering in period 2 would result in the entrant making negative profits. An incumbent which is in fact high-cost may set its first-period price as if it were low-cost. That is, it may set price below the standard profit-maximising monopoly price. Hence it can be said that limit pricing may occur. The entrant will be deterred from entering if, from its prior beliefs, it considers the probability of the incumbent being high-cost to be below a critical level. This critical level is the probability which, if used to calculate expected second-period profit, will yield an outcome equal to zero.

In this section a Milgrom and Roberts type model is used to illustrate how reducing protection can facilitate entry[8]. The protective instrument is a quota on the volume of imports. The first equilibrium considered is devised so that a high-cost incumbent will deter an entrant (assumed to have lower costs) from entering by setting its first period price as if it were a low-cost incumbent. A second equilibrium is considered where the only change in the parameters used is an increase in the volume of imports. This results in it no longer being profit-maximising for the incumbent to replicate the behaviour of a low-cost incumbent in the first period. That is the sacrifice in first-period profits is no longer worth the gain in second-period profits from remaining a monopolist. The reason why this can happen is that the reduction in protection causes a greater fall in profit for the incumbent when being a monopolist than when being a Cournot duopolist.

The domestic inverse demand function and respective cost functions are as follows:

$$p = a - b.(Q + x_I + x_E)$$

$C_I^H(x_I^H) = f + c_I^H.x_I^H$ (The high-cost incumbent.)

$C_I^L(x_I^L) = f + c_I^L.x_I^L$ (The low-cost incumbent.)

$C_E(x_E) = f + c_E.x_E$ (The entrant.)

Where c_I^H, c_I^L and c_E are the respective marginal costs of the high-cost incumbent, the low-cost incumbent and the entrant;

8. This numerical illustration represents a modification of a numerical illustration used by Kreps (1990 Ch.13) to introduce the basic idea of the Milgrom and Roberts analysis.

x_I^H, x_I^L and x_E are the respective levels of output which would be set by the high cost-incumbent, the low-cost incumbent and the entrant;

x_I is the incumbent's level of output irrespective of whether the incumbent happens to be high-cost or low-cost.

The parameter values are as follows:

$a = 9$, $b = 1$, $Q = 0$, $f = 2$, $c_I^H = 3.5$, $c_I^L = 1$, $c_E = 3$.

There are two more parameter values which need to be set:

$\delta = 0.35$ The rate at which second-period profits need to be discounted for comparison with first-period profits.

$\rho = 0.05$ The entrant's prior belief as to the probability of the incumbent being high-cost.

Obviously the future is discounted very heavily. This is necessary since once protection is reduced the aim is to show a situation where the period 1 benefits of not deterring entry outweigh, in present value terms, period 2 costs of not having deterred entry. Setting δ equal to 0.35 may seem somewhat extreme. It may perhaps be rationalized as a reflection of concerns about unpredictable shocks adversely affecting profitability in period 2. To reflect the idea that protection can discourage the entry of low-cost firms, the entrant has lower marginal cost than the high-cost incumbent. This means if the entrant does enter it will gain a higher proportion of the collective duopoly profit than the high cost-incumbent. Therefore the high-cost incumbent behaving as if it was low-cost will only deter the entrant from entering if the entrant believes that the probability that the incumbent is not low-cost is very low. Hence ρ has been set very low so that the entrant will believe the expected profit from entry is negative if the incumbent behaves as if it was low-cost.

Now consider the following results associated with the high-cost incumbent operating as a monopolist:

$$x_I^H = \frac{a - b.Q - c_I^H}{2b} = 2.75$$

$$p_I^H = \frac{a - b.Q + c_I^H}{2} = 6.25$$

$$\pi_I^H = \frac{(a - b.Q - c_I^H)^2}{4b} - f = 5.56 .$$

Now consider the following results associated with the low-cost incumbent operating as a monopolist:

$$x_I^L = \frac{a - b.Q - c_I^L}{2b} = 4$$

$$p_I^L = \frac{a - b.Q + c_I^L}{2} = 5$$

$$\pi_I^L = \frac{(a - b.Q - c_I^L)^2}{4b} - f = 14 .$$

The profit associated with the high-cost incumbent behaving like the low-cost incumbent:

$$\pi_I^{H(L)} = (p_I^L - c_I^H).x_I^L - f = 4 .$$

The profit associated with the low-cost incumbent behaving like the high-cost incumbent:

$$\pi_I^{L(H)} = (p_I^H - c_I^L).x_I^H - f = 12.44 .$$

The Cournot reaction functions are as follows:

$$x_I^H = \frac{a - b.Q - c_I^H}{2b} - \frac{x_E}{2} \quad (1)$$ (The high-cost incumbent's reaction function.)

$$x_I^L = \frac{a - b.Q - c_I^L}{2b} - \frac{x_E}{2} \quad (2)$$ (The low-cost incumbent's reaction function.)

$$x_E^{(H)} = \frac{a - b.Q - c_E}{2b} - \frac{x_I^H}{2} \quad (3)$$ (The entrant's reaction function if the incumbent is high-cost.)

$$x_E^{(L)} = \frac{a - b.Q - c_E}{2b} - \frac{x_I^L}{2} \quad (4)$$ (The entrant's reaction function if the incumbent is low-cost.)

Hence the duopoly outputs, price and profits for the high-cost incumbent case are as follows:

$$x_{I(D)}^H = \frac{a - b.Q - 2c_I^H + c_E}{3b} = 1.67$$

$$x_E^H = \frac{a - b.Q - 2c_E + c_I^H}{3b} = 2.17$$

$$p_D^H = \frac{a - b.Q + c_I^H + c_E}{3} = 5.17$$

$$\pi_{I(D)}^H = \frac{(a - b.Q - 2c_I^H + c_E)^2}{9b} - f = 0.78$$

$$\pi_E^H = \frac{(a - b.Q - 2c_E + c_I^H)^2}{9b} - f = 2.69 .$$

Similarly the duopoly outputs, price and profits for the low-cost incumbent case are as follows:

$$x^L_{I(D)} = \frac{a - b.Q - 2c_I^L + c_E}{3b} \approx 3.33$$

$$x^L_E = \frac{a - b.Q - 2c_E + c_I^L}{3b} \approx 1.33$$

$$p^L_D = \frac{a - b.Q + c_I^L + c_E}{3} \approx 4.33$$

$$\pi^L_{I(D)} = \frac{(a - b.Q - 2c_I^L + c_E)^2}{9b} - f \approx 9.11$$

$$\pi^L_E = \frac{(a - b.Q - 2c_E + c_I^L)^2}{9b} - f \approx -0.22 .$$

Prior to going on to consider the game-theoretic equilibrium using a game tree it is necessary to check whether setting period 1 price equal to $p_I^L=5$ will deter the entrant from entering in the second period. The entrant's decision making process is as follows:

(a) The entrant observes the first-period price.

(b) The entrant uses this information to assist with deciding upon the probability of the incumbent being high-cost (denoted $\mu(p_I)$). If $p_I>p_I^L$ then the incumbent must be high cost since it would be irrational for a low-cost incumbent to price above the profit-maximising level, hence $\mu(p_I)=1$. However if $p_I\leq p_I^L$ the entrant cannot infer whether the incumbent is high-cost or low-cost and consequently must rely upon its prior beliefs, hence $\mu(p_I)=\rho$.

(c) The entrant then uses $\mu(p_I)$ to calculate its expected profit in period 2 if it decided to enter. Clearly if the expected profit from entry is negative, entry will not take place.

So it is necessary to establish that the $\mu(p_I)$ which is consistent with $E\pi_E=0$, denoted $\mu(p_I)_{E\pi=0}$, is greater than ρ for entry to be deterred. The entrant's reaction function for maximising expected profit for this illustration can be written as;

$$x_E = \frac{6 - [\mu(p_I).x_I^H + (1 - \mu(p_I)).x_I^L]}{2}. \qquad (5)$$

Using (5) and the respective reaction functions for the high-cost and low-cost incumbents, (1) and (2), we can write x_E, x_I^H and x_I^L as functions of $\mu(p_I)$:

$$x_E = \frac{4 + 2.5\mu(p_I)}{3}$$

$$x_I^H = \frac{6.25 - 1.25\mu(p_I)}{3}$$

$$x_I^L = \frac{10 - 1.25\mu(p_I)}{3}.$$

This allows us to be able to write the expected post entry price and hence the expected post entry entrant's profit as functions of $\mu(p_I)$:

$$Ep_D = \frac{13 + 2.5\mu(p_I)}{3}$$

$$E\pi_E = \frac{(4 + 2.5\mu(p_I))^2}{9} - 2.$$

By setting $E\pi_E=0$ we can show $\mu(p_I)_{E\pi=0} \simeq 0.0971$. Therefore since $\rho=0.05$ a high-cost incumbent can successfully deter entry by behaving like a low cost incumbent.

Figure 7.7 shows the game set out in extensive form. At each terminal node the payoffs are shown for the incumbent and the entrant respectively. Each payoff consists of the sum of the first period profit and the discounted second period profit. The game tree is constructed with 'Nature' moving first choosing whether the incumbent is to be high-cost or low-cost. Next the incumbent needs to choose what price to charge in the first period. Clearly there are more than two possible prices which the incumbent may choose. However for expository purposes, the only prices shown are those which maximise period 1 profits for the respective types of incumbents. Following the choice of p_I the entrant has to choose whether to enter in the second period. Since the entrant is unaware of Nature's choice it does not know whether the payoff from entering will be -0.08 or 0.94. If the incumbent was to set p_I=6.25 then the entrant would conclude that Nature had chosen 'high-cost'. However if the incumbent was to set p_I=5 then it is assumed that the entrant believes that there is only a probability of 0.05 that Nature has chosen 'high-cost' and so the expected payoff from entry is -0.03. Obviously a low-cost incumbent will set p_I=5 since this will yield a higher payoff whatever the subsequent choice made by the entrant. A high-cost incumbent will also set p_I=5 since it knows that the entrant's reaction to this will be to choose not to enter and that the payoff from this entry-deterrence strategy of 5.95 will exceed the payoff from setting p_I=6.25. If a high-cost incumbent was to set p_I=6.25 it would maximise period 1 profits but lose its monopoly position in period 2 yielding a payoff of 5.83. Thus we have a pooling equilibrium since both types of incumbent choose p_I=5 so that the incumbent's true type is not revealed to the entrant[9].

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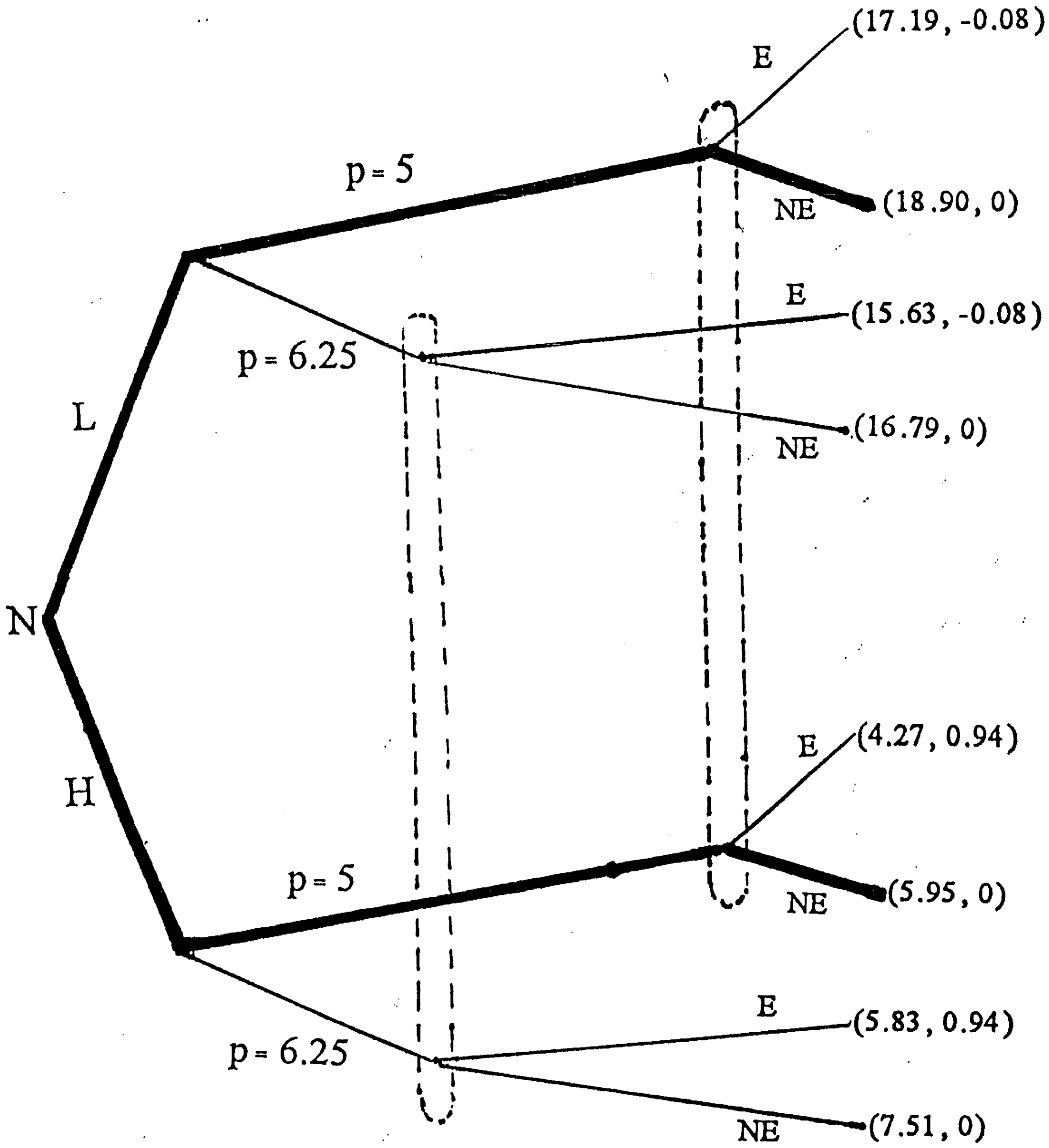
9. For a discussion of equilibrium concepts for games of incomplete information see Tirole (1988 Ch.11).

Figure 7.7: A Pooling Equilibrium



Now consider the effect of decreasing protection by increasing Q from 0 to 0.5. Remaking the above calculations gives the following:

$x_I^H=2.5,\ p_I^H=6,\ \pi_I^H=4.25;$

$x_I^L=3.75,\ p_I^L=4.75,\ \pi_I^L\approx 12.06;$

$\pi_I^{H(L)}\approx 2.69,\ \pi_I^{L(H)}\approx 10.5;$

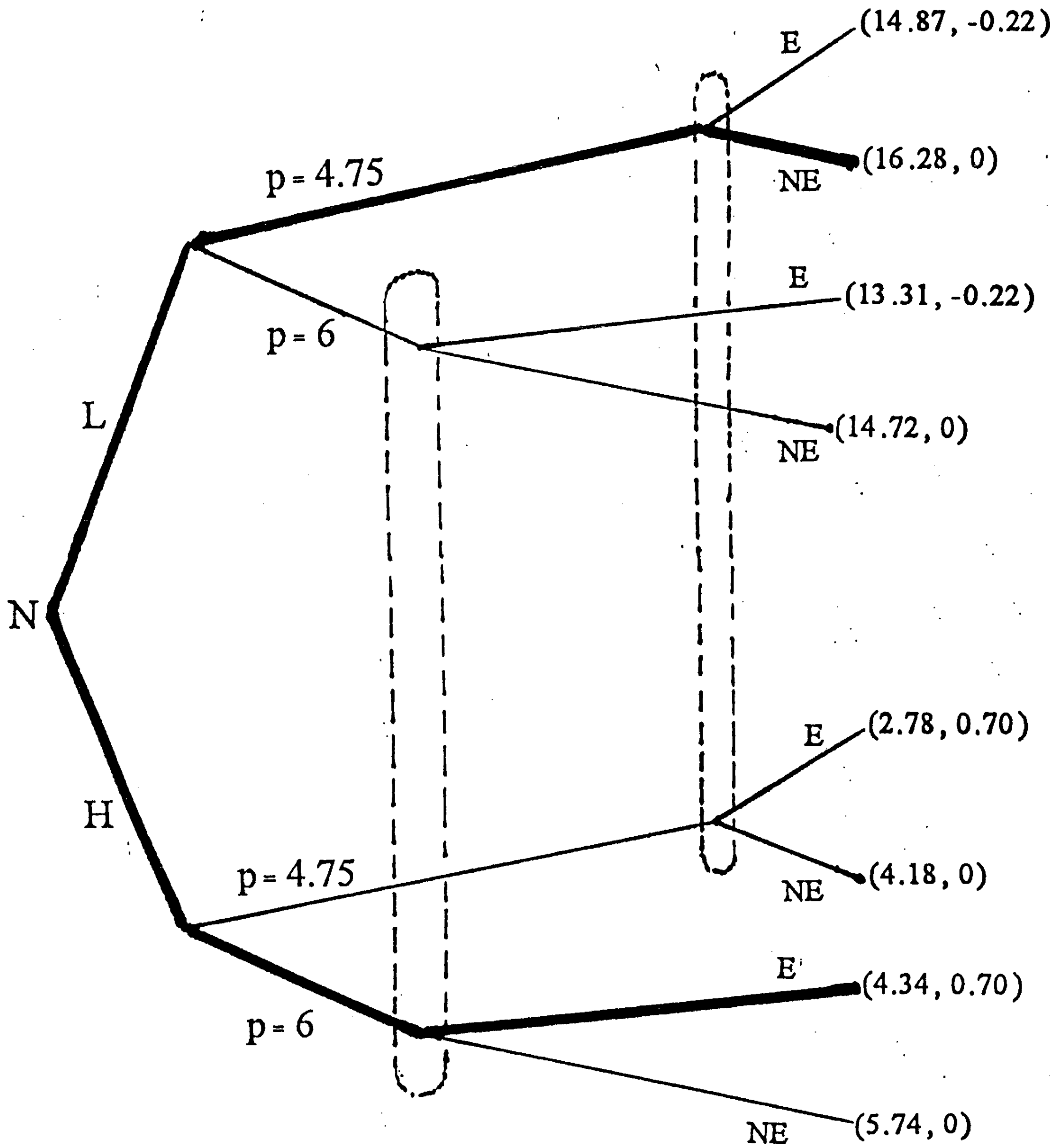
$x_E^H=2,\ x_{I(D)}^H=1.5,\ p_D^H=5,\ \pi_E^H=2,\ \pi_{I(D)}^H=0.25;$

$x_E^L\approx 1.17,\ x_{I(D)}^L\approx 3.17,\ p_D^L\approx 4.17,\ \pi_E^L\approx -0.64,\ \pi_{I(D)}^L\approx 8.03.$

The associated payoffs are shown in Figure 7.8. As one would expect both the payoffs and the profit-maximising period 1 prices are lower when a comparison is made with Figure 7.7. The important thing to be noticed is that it no longer pays a high-cost incumbent to pretend to be a low-cost incumbent. Setting p_I=4.75 sacrifices period 1 profit so as to deter entry in period 2 and yields a payoff of 4.18. Setting p_I=6 maximises period 1 profit and reveals to the entrant that the incumbent is high-cost yielding a payoff of 4.34. Hence there is now a separating equilibrium; if the incumbent is high-cost p_I=6 and if the incumbent is low-cost p_I=4.75. The Milgrom and Roberts analysis considers a separating equilibrium which occurs because ρ is too high for pricing like a low-cost incumbent to deter entry. In the case shown here the high-cost incumbent could deter entry but chooses not to since there is a higher payoff from accommodating entry.

Lastly consider why a reduction in protection can cause a high-cost incumbent to turn from deterring entry to accommodating entry. In the numeric example the payoff from deterring entry decreases by 1.77 when protection is reduced. However the payoff from accommodating entry only decreases by 1.49. The reason for the difference is that

<u>Figure 7.8: A Separating Equilibrium</u>



if entry is accommodated, there will be a Cournot duopoly in period 2. It can be shown that increasing Q leads to a smaller reduction in the profits of a firm if it is a Cournot duopolist rather than a monopolist:

$$\frac{\partial \pi_I^H}{\partial Q} = -\frac{(a - b.Q - c_I^H)}{2}$$

$$\frac{\partial \pi_{I(D)}^H}{\partial Q} = -\frac{2(a - b.Q - 2c_I^H + c_E)}{9}$$

$$A = \left|\frac{\partial \pi_I^H}{\partial Q}\right| - \left|\frac{\partial \pi_{I(D)}^H}{\partial Q}\right|$$

$$= \frac{5a - 5b.Q - c_I^H - 4c_E}{18}.$$

It is simple to show that A must be positive for the high-cost incumbent to be in the industry in the first place:

$$5a - 5b.Q - c_I^H - 4c_E > 5(a - b.Q - c_I^H) \quad \text{since} \quad c_I^H > c_E.$$

$$5(a - b.Q - c_I^H) > 0 \quad \text{if} \quad x_I^H = \frac{a - b.Q - c_I^H}{2b} > 0.$$

To use Tirole's (1988 ch.8) terminology this result is closely related to the concept of the 'persistence of monopoly'. Essentially this is the idea that there will be a tendency for monopoly to persist since the incumbent monopolist has more to lose than the entrant to a duopoly has to gain. Here an increase in Q which reduces the market power of the domestic firm(s) causes a more substantial fall in profits for the domestic monopolist since there are greater profits to be lost. The greater competition associated with a duopoly is destructive of profits and a substantial proportion of duopoly profits go to the new entrant rather than the former incumbent.

IV: Concluding Comments

It is useful to begin this section with a list summarising the results contained within this chapter.

(i) With the Spence-Dixit type model an increase in a quota (a reduction in protection) will not facilitate entry if the entrant is a domestic firm.

(ii) However this model does show that a reduction in a tariff will facilitate entry if the entrant is a foreign firm.

(iii) With the Milgrom and Roberts type model an increase in a quota can facilitate entry by a domestic firm. A numerical illustration is used to show a case where an increase in a quota causes the incumbent to switch from deterring entry to accommodating entry.

Clearly there is a striking contrast between the results obtained using the Spence-Dixit type model and those obtained using the Milgrom and Roberts type model. It is only the Milgrom and Roberts type model which will show a reduction in protection facilitating entry when the entrant is a domestic firm. However the Spence-Dixit type model does show a reduction in protection facilitating entry when the entrant is a foreign firm. These comparative static results illustrate the substantially different nature of these two types of models.

It should of course be remembered that in many instances of the threat of entry there is no 'deter' option available to the incumbent. Both of the models considered here rely upon specific circumstances. For example an entrant maybe quite convinced that the incumbent is a high cost-type. However there is an extensive empirical literature which indicates that it is relatively common for incumbent firms to make an aggressive response to the threat of entry[10].

Future work in this area could perhaps focus upon instances of protectionist programs which favour incumbent firms over potential new entrants. A political economy of protection model might be developed to indicate what circumstances such protectionist programs might arise from. Another possibility for future work arising from this chapter is to consider analytically why an incumbent firm may have higher costs than a firm that has newly entered the industry.

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10. For a guide to this literature see Scherer and Ross (1990 ch.10).

CHAPTER 8: CONCLUDING COMMENTS

This thesis has considered a number of models analysing the effects of protection on firms' performance. In particular, it has developed a number of new arguments why reductions in protection may yield a cold shower effect. The results of the thesis are summarised below.

In Chapter 3 a well known principal/agent framework is used to model the protected firm. To simplify the analysis, a subsidy is chosen as a protective instrument. The case which is concentrated upon is that where effort and output are below their full information levels. It is shown that an increase in the subsidy can result in a reduction in managerial effort. However this is only the case for some classes of cost functions. It is interesting to note that one class of cost function in which this result holds is that for which managerial effort only affects fixed costs. Probably the most important result from Chapter 3 is that we can identify a welfare effect associated with the subsidy, which is separate from the standard deadweight loss. This effect is labelled the 'organisational cost of protection' since it only exists because of the asymmetry of information within the organisational structure of the firm. If this effect is positive then it is an organisational benefit. A component of this effect is labelled the 'X-inefficiency cost of protection'. This is the welfare effect associated with the change in effort caused by the change in information rent received by the manager. If managerial effort increases in response to a fall in the subsidy, and output and effort are below their full information levels, then an organisational welfare improvement will be driven by a decrease in the X-inefficiency cost of protection.

Chapter 4 models a firm choosing whether to invest in a cost-reducing technology or not. The outcome of making such an investment is uncertain. If the good outcome occurs then the investment will have a positive return. If the bad outcome occurs the result will be bankruptcy. A condition is derived for the removal of protection to make it more likely that the investment is accepted. This 'cold shower condition' can be written as follows:

> The difference between the utility from *not investing* when protected and the utility from *not investing* when not protected,

exceeds

> the expected value of the difference between the utility from the *good outcome* when protected and the utility from the *good outcome* when not protected.

Generally in this chapter the creditor funding the investment is assumed not to know the expected return on the individual investment being considered. However it is shown with a numerical illustration that, if the creditor is aware of both the potential profit flows and the probabilities associated with the good and bad outcomes, the cold shower scenario can still occur. That is, the investment is rejected while the protection is in place but accepted with the removal of the protection. While the analysis, is initially conducted with the assumption that the world market for the product concerned is perfectly competitive, in the latter part of the chapter imperfect competition issues are considered with an oligopolistic version of the model. It is shown, in the case of Cournot competition, that a cold shower is more likely if a quota rather than a tariff is the protective instrument. It is also shown that a cold shower is more likely if the domestic firm is a Stackelberg leader rather than a Cournot competitor. The theme of ~~the relationship between~~ the domestic firm's market power is continued by using a

Cournot market structure to consider a reduction in the number of foreign firms (an increase in the domestic firm's market power). It is argued that it is likely that this will increase the likelihood of a cold shower occurring.

Chapter 5 uses a Nash bargaining model to examine the relationship between a domestic component supplier and the downstream domestic firm which uses the component. The removal of protection from the domestic component supplier is considered. This makes it more feasible for the downstream firm to turn toward foreign component suppliers. Hence the removal of protection from the component supplier strengthens the bargaining power of the downstream firm. The form of bargaining engaged in involves the supplier and the downstream firm bargaining over a schedule of component prices for a range of possible quality levels and then the downstream firm deciding upon the required quality and quantity of the component. For the actual bargaining, two frameworks are considered. If the parties bargain over a 'basic price' N and a 'quality premium' γ then it can be shown that the removal of protection will result in a higher level of quality being agreed to if there are 'economies of quality'. Economies of quality refer to a supplier technology which has decreasing marginal costs of quality with increased output. An illustration of such a technology is provided where capital is a joint-input being used both to fabricate the component in the required numbers and insure the components are of required quality. With this technology it is assumed that the marginal product of the quality inspectors is increased as more capital is employed. If it is the case that only γ (the quality premium) is bargained over, then the removal of protection unambiguously results in an increase in quality. This is because γ must decrease in order to reflect the improvement in the downstream firm's bargaining position.

Chapter 6 uses a Nash bargaining model to analyse the relationship between the protected firm and its unionized workforce. Initially the chapter considers the case where wages and effort (work practices) are bargained over with employment being unilaterally determined by the firm. It is shown that a change in an import quota does affect the effort level while a change in a tariff or a subsidy does not. A condition is derived for when an increase in the quota (a reduction in protection) will result in an increase in effort. This condition is consistent with an increase in union power resulting in reduced effort. The chapter also considers the case where wages and the labour/capital ratio are bargained over with employment being unilaterally determined by the firm. It is shown that an increase in the quota will cause a reduction in the labour/capital ratio. This is consistent with the idea that a decrease in protection will lead to fewer workers being required to operate given pieces of capital equipment.

Chapter 7 uses two distinctly separate frameworks to analyse how entry deterrence by a domestic incumbent firm is affected by a change in protection. Initially a Spence-Dixit type model is used. It is shown that, if the potential entrant is a domestic firm, then a *decrease* in a quota has the potential to shift the incumbent from a strategy of deterrence to accommodation. It is also shown that, if the potential entrant is a foreign firm, then a *decrease* in a tariff has the potential to shift the incumbent from a strategy of deterrence to accommodation. The second half of the chapter uses a Milgrom and Roberts type model. Here a numerical illustration is used to show how an *increase* in a quota can shift the incumbent from a strategy of deterrence to accommodation.

One thing which can be noted from the above list of results is that many of them provide reasons why we should not be surprised to observe a reduction in protection being accompanied by improvements in technical efficiency within the protected industries[1]. The principal-agent analysis in Chapter 3 shows that with some technologies a reduction in protection will result in reduced managerial effort. Chapter 4 shows that, if a reduction in protection threatens the existence of a firm, then the owner/manager may respond to this by making a risky investment in a cost-reducing technology. In Chapter 6 it is shown that easing quantitative import restrictions can result in restrictive work practices being negotiated away. The Milgrom and Roberts type model used in Chapter 7 allows a case to be shown where a reduction in protection can facilitate the entry of a new low cost domestic firm causing the average cost of production across the domestic industry.

While there are substantial differences in the analytical approaches taken in this thesis there is the common theme of treating protection policy as exogenous. That is, it is considered how the performance of the protected firm is affected by a *given* change in protection. The analysis does not say why a policy maker may put protection in place or why it may be removed. The formation of policy goes beyond the scope of this thesis. However we can loosely talk about the policy context within which these analyses fit. It is easy to think of various historical examples of an overall change in a government's attitude to whether protection is beneficial or not. In Chapter 2 the example of Chile is mentioned in the discussion of the empirical literature. Following the coup in the early 1970s the military junta took a particularly antiprotectionist attitude. In Australia there is currently a mild antiprotectionist consensus among the major political parties[2]. The

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1. In Chapter 2 it is shown that the empirical literature lends significant support to the hypothesis that protection induces technical inefficiency.

2. For an excellent discussion of the attitude of Australian policy makers to protection see Anderson and Garnaut (1987).

origin of this Australian antiprotectionist consensus can be traced back to the 1960s when a disenchantment began to occur with respect to the arguments in favour of protection. At an intellectual level the infant industry argument was becoming increasingly threadbare. Leading authors such as Corden (1974) emphasised the second-best nature of this argument. For example, if an industry has difficulty establishing itself due to capital market failure, then the first-best policy response would involve measures to improve the functioning of the capital market. The unimpressive performance of manufacturing industries in the 1970s, particularly those industries with a long history of high levels of protection, left the image of a group of infants who would never grow-up[3]. The advent of official calculations of Effective Rates of Protection emphasised the high levels of protection which had been received by such industries as textiles, clothing and footwear[4]. Aside from the infant industry argument, the other historic justification for Australian protectionism is the supposed redistribution of income toward real wages and the consequent incentive for workers to immigrate to Australia. This argument has now lost its relevance. Redistributing income from farm households to the real wages of those employed in the protected manufacturing sector hardly seems particularly equitable given that average farm household incomes tend to be relatively low. Also it is no longer seen as a national priority to increase Australia's population with European immigration. It is interesting to note is that Anderson and Garnaut (1987, p115-116) conclude:

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3. The Industries Assistance Commission Annual Report for 1978-79 (Chapter 1) describes how over the 1970s the highly protected manufacturing industries experienced poor growth and a loss of employment. Import penetration increased even in some cases where the level of protection increased.

4. See Krause (1984, p290).

> ".., it would seem that the climate of opinion among leaders as to the effect of protection on the public or national interest has been more important in determining the average level of protection and its changes over time than in determining the inter-industry dispersion of protection rates. Private vested interest groups, on the other hand, have affected mainly the levels of protection in individual industries,..."

As a final example of the attitude to protection changing it is useful to recall that the new Roosevelt administration reversed the substantial growth in U.S. protectionism which had occurred through the 1920s and into the early 1930s[5]. The Roosevelt administration realised that worldwide high levels of protection had led to a dramatic reduction in world trade and with this realization the U.S. was prepared to enter into trade liberalization on a bilateral basis[6].

To finish, we can note that, while no new or novel policy prescriptions arise from this analysis, it does provide support for the argument that trade liberalization not only attains benefits from the conventional gains from trade but also tends to improve the performance of the previously protected industries. Clearly the analysis is only relevant to certain situations. Obviously there are many cases where the removal of protection will in no way enhance the performance of the formally protected firm. It also needs to be remembered that under certain conditions most of the models in this thesis will show a case where a decrease in protection will lead to a deteration in the technical efficiency of the firm. However given the empirical evidence in favour of cold showers occurring this consideration does not seem of overwhelming concern. It should, of course, be kept

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5. See Ethier (1983, p222-223).

6. This is, of course, strategic behaviour by a large country. Such an issue has not been looked at in this thesis.

in mind that a cold shower does not necessarily represent a benefit to society. However it is reassuring to recall from Chapter 3 that a case can be easily shown where an increase in managerial effort, in response to a reduction in protection, represents a benefit to society. Similarly, it is also reassuring to recall from Chapter 6 that a case can be shown where a work-practices concession by the union, in response to a reduction in protection, represents a benefit to society.

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