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The Regulation Of Multinational Enterprises Under Asymmetric Information

Horst H. Raff

THE REGULATION OF MULTINATIONAL ENTERPRISES UNDER ASYMMETRIC INFORMATION

by

Horst H. Raff

Department of Economics

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Abstract

This thesis investigates the effects of asymmetric information on the relationship between multinational enterprises (MNEs) and host countries. With incomplete information about a MNE's technology, the threat of expropriation does not always deter foreign direct investment (FDI), so that expropriation may actually occur with nonzero probability. Improvements in a MNE's investment alternatives, a rise in production costs or tax rates diminish the likelihood of expropriation. Low-cost countries are more likely than high-cost countries to expropriate MNEs. Low-cost industries simultaneously face higher tariffs and a higher expropriation rate.

Chapter three uses a principal-agent model to examine optimal host country taxation of a horizontally and vertically integrated MNE. The host government lacks relevant information about the MNE's costs and transfer price. The optimal taxation mechanism consists of a lump-sum profit tax/quantity tax combination. The possibility of transfer pricing affects the government in two ways: First, the choice of tax mechanisms is reduced; second, the MNE has to be induced to reveal both costs and transfer price.

Chapter four uses data for the Jamaican bauxite industry in 1973 to simulate the optimal regulatory regime derived in chapter III. In 1974 Jamaica replaced its corporate income tax with a production levy on bauxite. We compare the effects on output and tax revenue of the actual pre-1974 and post-1974 taxes with those of the optimal policy. In fact, the optimal tax system closely resembles a combination of the two actual policies. We conclude that by using the optimal scheme Jamaica could have increased its tax revenue manyfold.

Chapter five uses a dynamic signaling game to investigate the effects of incomplete

information about host country demand on the government's tax and tariff policy, and MNE's choice between FDI and exporting. When investment costs are low relative to exporting costs and/or the MNE anticipates large host country demand, tariff walls are sufficient to induce FDI. If the MNE is pessimistic about host country demand, tariff walls have to be supplemented with tax holidays to obtain investment. Tax holidays always appear in combination with tariff walls.

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Any errors and omissions are my responsibility alone.

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CHAPTER I

INTRODUCTION

This thesis investigates the effects of incomplete information on the relationship between multinational enterprises (MNEs) and their host countries. In particular, we focus on the following basic problem: The activities of a MNE in a host country create economic rents which have to be divided between the MNE and the host country. The host country government negotiates explicitly or implicitly with the MNE over the regulatory regime that will determine the division of this rent. Incomplete information has potentially very large effects on the bargaining power of each party and should therefore be reflected in the regulatory mechanism.

Our analysis draws some inspiration from Caves' (1982) survey of the MNE literature. On one crucial regulatory outcome, the tax system, he writes on page 226:

> Beside the great issues of progress, sovereignty, and economic justice that swirl around the MNE, taxation sounds like a matter for petty minds that warm to accountancy. That instinct is squarely wrong, because it turns out that arrangements for taxing corporate net incomes constitute the dominant factor in the division of spoils between source and host countries.

It should be noted, however, that the papers summarized by Caves address the rent sharing issue from a slightly different angle than our study. In these papers the governments of the source and the host country are the active agents. Multinational investment is exogenously given. The governments impose tax regimes and the source country's MNEs react passively to the given tax system. Furthermore, both countries have complete information of all parameters that are relevant for their choice of strategy.

In our analysis we treat the MNE and the host country as the decision makers. The home (or source) country has no role in our analysis other than that of location of the MNE's shareholders who ultimately receive the MNE's after-tax profits. This modeling assumption allows us to (i) endogenize multinational investment and (ii) deal explicitly with MNE-host country relations. We take account of the MNE's outside opportunities, be they to export to the host country or to invest in other countries. Foreign direct investment (FDI) throughout our thesis follows from a firm's ownership of an intangible asset, such as knowledge of a specific production process or marketing strategy, that gives the MNE an advantage over other local and foreign firms. The MNE therefore enjoys monopoly power in the host country market. Once a firm has decided on investment abroad and selected a host country it enters into a bilateral monopoly situation with the host country government.

Most importantly, what sets this thesis apart from almost all other research on MNE-host government relations is our explicit modeling of incomplete information. In particular, we examine situations of asymmetric information in which one "bargaining" party has more information than the other party regarding parameters that are crucial to the division of the rent. Asymmetric information is likely to affect negotiation outcomes in the following ways: If only one party knows the exact amount of rent that is to be divided, the informed party might be able to appropriate a larger share than it would be able to obtain under complete information by simply understating the size of the rent. In general, the better informed an agent the greater his bargaining power is. Improving one's information usually requires spending resources on monitoring, or on inducements to an informed player to reveal his information. The acquisition of information from outside sources is also a possibility. Depending on the situation, however, information gathering might either reduce the total amount of rent or the rent earned by the uninformed agent.

Incomplete information also severely affects an agent's decision-making ability. Uninformed agents are prone to choose strategies that ex post - once the informational problem has been resolved - appear suboptimal, sometimes even irrational.

Problems of asymmetric information are very common in MNE-host country relations. Host country bureaucrats generally have less information on a MNE's technology or cost function than the firm's managers. MNEs might therefore be tempted to overstate their true costs in order to reduce their pre-tax profit and the resulting tax burden. Governments also do not observe the administrative transfer prices MNEs levy on intra-corporate transactions between subsidiaries in different countries (Eden, 1985, Prusa 1990). A MNE can shift profits out of a host country either by exaggerating the price of inputs shipped to the host country subsidiary by other affiliates, or by lowering the price on intra-corporate trade in the subsidiary's output. Incomplete information also affects the MNE's decisions. It must decide on an investment strategy before knowing the exact demand for its product in the host country. Uncertainty about the host government's future tax and regulatory policy might also be substantial. A MNE's investment in a particular host country might, in the light of better information, turn out to be unprofitable.

In this thesis FDI regulation under asymmetric information is approached from two different directions - normative and positive analysis. First, from a normative point of view we ask how the host country government should best react to some of the information problems discussed above. This leads to an examination of optimal regulatory policy and allows for comparisons between the mechanisms observed in practice and theoretically efficient regulation schemes. Second, we try to explain, as a matter of positive analysis, whether the actual policy regimes and the corresponding MNE investment behavior we see are the result of rational economic choices under incomplete information.

Each of the following chapters will address a different aspect of FDI regulation: expropriation, taxation, financial investment incentives (tax holidays) and tariff walls. However, even though we deal with positive as well as normative issues our analysis will follow a similar strategy throughout the thesis: First, we identify the empirical significance of the issue. Second, we derive the complete information solution. Third, we examine the incomplete information problem.

Chapter II examines a host country's choice between selective expropriation and taxation. Incomplete information is a crucial part of any explanation of expropriation. If MNEs and the host government all had complete and perfect information and behaved rationally, expropriation should never be observed: MNEs would never invest in a country where they know they will be expropriated. Instead, they would turn to countries that do not pursue such a policy. Our model of expropriation rests on the following stylized facts: Most nationalizations of FDI have occurred in less developed countries. The level of managerial and technological know-how in these countries is generally low. Thus, successful operation of an expropriated subsidiary by the host country depends upon the country's ability to seize enough of the MNE's operations-specific knowledge. If the host country lacks information on the MNE's technology, it might, ex ante, not be able to determine whether or not it can capture enough know-how. But it might be optimistic enough to want to go ahead with expropriation anyway. Chapter II demonstrates that the threat of nationalization does not always deter FDI, so that expropriation may actually occur with nonzero probability. The threat of expropriation serves, however, as a FDI screening mechanism in the sense that it might bias the distribution of MNEs towards firms whose technology makes them difficult to expropriate. Perfect sequential equilibria are derived for a vertical and a horizontal integration version of the model with one firm and one or more host countries. Improvements in the firm's

FDI alternatives, a rise in the costs associated with FDI or in tax rates diminish the likelihood of expropriation. Low cost industries simultaneously face higher tariffs and a higher probability of expropriation.

The third chapter uses a principal-agent approach to examine the normative issue of optimal host country taxation of a horizontally and vertically integrated MNE. The host government lacks relevant information about the MNE's costs and transfer price. We characterize the government's problem and discuss how the social optimum can be implemented. When the subsidiary's output can be observed by the government and there is no potential for errors in the production process, the host country can force the MNE to produce the socially optimal output. In the more realistic case of possible production errors a linear tax mechanism (quantity tax plus lump-sum tax) is shown to implement the host country's desired allocation. We find that transfer pricing makes the regulation of multinational enterprises inherently more costly than that of domestic firms. There are two reasons: First, the possibility of transfer pricing restricts the host country's choice of tax mechanisms. Second, the MNE has to be induced to not only reveal its costs but also its transfer price.

The fourth chapter uses the case of the Jamaican bauxite industry in 1973 to study optimal FDI taxation. In 1974 the Jamaican government replaced its corporate income tax with a production levy on bauxite in order to increase its share of rents. We apply tax mechanisms developed in Chapter III to simulate the effects on output and tax revenue of the actual pre-1974 and post-1974 tax regimes as well as those of the optimal policy mechanism. This allows us to judge whether the policy change has brought Jamaica closer to the optimal tax scheme. We also obtain some insights into the usefulness and practical applicability of tax schemes that evolve from the principal-agent literature. In fact, the optimal tax scheme for Jamaica closely resembles a combination of the actual pre-1974 and post-1974 regimes. Jamaica should thus not have traded one tax system for the other.

Chapter V uses a dynamic signaling game to investigate the effects of incomplete information about host country demand on the endogenous choice of government tax and tariff policy, and a MNE's choice between direct investment and exporting. We solve for perfect sequential equilibria and map the outcomes into investment cost/exporting cost space to provide predictions. When investment costs are low relative to exporting costs and/or the MNE anticipates large host country demand, then tariff walls are generally sufficient to induce first period investment. If the MNE is pessimistic about host country demand, tariff walls have to be supplemented with tax holidays in order to tilt the MNE's decision toward immediate investment. Tax holidays, however, are too costly to be used by themselves to influence the MNE's entry decision. Thus they always appear in combination with tariff walls. This analysis suggests a way of refining the concept of investment incentives. Our study thus might help resolve some of the confusion in the empirical literature about the effectiveness of direct investment incentives.

CHAPTER II

A MODEL OF EXPROPRIATION WITH ASYMMETRIC INFORMATION

1. Introduction

Expropriation[1] in the form of confiscation of private foreign assets was in widespread use especially among less-developed countries (LDCs) during the 1960s and 1970s and has featured quite prominently in both the economics and political science literature.[2] Williams (1975, 267–273) points out that between 1956 and 1972 foreign investment was expropriated by at least forty LDC governments with the total amount of nationalized foreign assets amounting to almost a quarter of the stock of foreign-owned capital invested in LDCs at the end of 1972. Among the acts of nationalization Andersson (1989, 17–18) distinguishes between mass nationalization and selective nationalization. Mass nationalization is defined as affecting MNEs in all sectors of the economy regardless of the specific characteristics of industries or firms. The motivations for mass nationalization generally appear to be political or ideological in nature. Selective expropriation targets single MNEs or industries and accounts for roughly 80 percent of all expropriations since 1968. Andersson (1989, 18) argues that this type of expropriation is closely linked to factors such as industry and host country characteristics that may be subject to systematic economic analysis.

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[1] The term nationalization will be used synonymously

[2] For a survey of the literature see Andersson (1989). Case studies of expropriation are provided by, e. g., Akinsanya (1980) or Sigmund (1980).

This paper presents a model of a host country's choice between selective expropriation and taxation of a MNE's subsidiary. Even though it may seem difficult to make a clear distinction between these two policy categories in practice, since a continuous increase in tax rates may over time approximate the expropriation outcome, some essential differences must be noted (Andersson, 1989). Taxation refers to the country's retention of a part of the MNE's rent that would otherwise be transferred back to the MNE's home country. The degree of sophistication of the host country's fiscal instruments and tax collection procedures imposes an upper bound on the country's share of the MNE's rent. This constraint might be binding especially for LDC governments. The effectiveness of taxation is also reduced by the firm's individual rationality constraint which requires the host country to leave the MNE with a payoff equal to at least the MNE's best outside opportunity. Expropriation, defined as the takeover of the MNE's assets, gives the host country control over all residual claims and might therefore be a rational choice. The use of expropriation is, however, limited by the host country's ability to continue the MNE's operations.

Our model is based on the stylized fact that as most nationalizations have occurred in LDCs where the endowment of managerial and technological skills may be rather small the success of expropriation depends critically on the host country's ability to capture the MNE's production and marketing know-how. Unlike the firm, however, the host country may not be able to identify the production technology and therefore may not know if it can seize enough of the firm's operation-specific knowledge to benefit from nationalization. This asymmetry of information regarding the profitability of expropriation is a crucial aspect of any explanation of selective expropriation. In a model where MNE and host country both have perfect information and behave rationally, the MNE would never invest in a country that pursues a policy of expropriation and therefore expropriation would never be an equilibrium outcome (Eaton and Gersovitz, 1984, 33). Case studies of nationalization (e. g., Sigmund, 1980) reveal that, indeed, there is some justification for the asymmetry assumption, for in a considerable number of cases host countries had to rely on foreign management and technical support to continue the operations of expropriated companies or even reverse their expropriation decisions.

Our paper extends the existing literature on nationalization by focusing on different information problems and by modeling these problems in a more rigorous way. This allows us to generate new predictions regarding the probability of expropriation and to gain new insights into the associated welfare consequences. Eaton and Gersovitz (1984) introduce a general form of uncertainty into their model by assuming that the host country's endowment of management skills is unknown to both firm and host country at the time of investment. The firm then enters if the expected return on investment is positive. Upon completion of the investment but before the host country makes its nationalization decision both parties observe the level of management expertise and the host country expropriates only if this level is sufficiently high. As a consequence, all acts of expropriation in the model are profitable, a result which does not account for the many instances of unsuccessful nationalizations that appear in the empirical literature. In our model the host country has incomplete information about the MNE's technology. Since this asymmetry of information is not resolved until after expropriation has actually been carried out, the host country does not know ex ante if a particular MNE is a suitable expropriation target. Ex post, nationalization of an MNE may thus reduce welfare.

Andersson (1989) tries to model expropriation in the context of complete information by having a host country randomly select its expropriation targets from a large number of MNEs. Expropriation does not preclude FDI if the number of

MNEs is sufficiently large so that each firm's expected payoff from FDI exceeds the profits afforded by its outside opportunity. This model suffers from the same problem as Eaton and Gersovitz' in that it only explains successful expropriation. Andersson's approach also seems unsuited for an explanation of selective expropriation because the form in which the host country is mixing its strategies requires it to be indifferent between expropriating different MNEs and neglects to take into account firm-specific characteristics.

FDI in our model follows from a firm's ownership of an intangible asset, e. g., knowledge on how to produce a specific good cheaper than the competition, and the resulting need to internalize market transactions (Caves, 1982), rather than from differences in factor prices as in Eaton and Gersovitz (1984). This framework allows us to generate predictions regarding the probability of expropriation for changes in the firm's technological and market constraints, as well as for different regulatory policy scenarios. Furthermore, these predictions provide a framework for assessing possible explanations for the decline in the number of expropriations in the late 1970s and the 1980s.

In the next section we develop a basic model of a vertically integrated MNE: The host country subsidiary produces an intermediate product (or extracts a natural resource) which is shipped to the home country for processing into a final good and then sold in the home country. Section 3 derives and interprets the perfect sequential equilibria of the basic model. Section 4 presents an extension of the basic model to a two-host-country version. This is followed in section 5 by an examination of equilibria for the case of a horizontally integrated firm, which must choose between FDI and exporting as means of supplying a final good to the host country market. Finally, we provide a summary and conclusions.

2. The Vertical Integration Model

A firm produces a final good, y, from an intermediate good, x, according to the production function $y = f(x)$ which is assumed to be twice continuously differentiable and to exhibit diminishing marginal productivity.[3] Good y is consumed only in the home country where its market is characterized by a downward sloping demand curve $p(y)$. Good x can be procured on the world market, where it trades at a constant price w^o, or through FDI in a foreign country (host country). The host country has no x industry of its own and also lacks the technology and management skills necessary to start production on its own.[4]

If the firm decides to purchase x on the world market, taking w^o as given, it receives the following profit,

$$\Pi^o(w^o) = \max_x \{p[f(x)]f(x) - w^o x\} . \tag{2.1}$$

The corresponding first order condition for profit maximization is $[1+1/\varepsilon_d]pf'(x) = w^o$, where ε_d represents the price elasticity of the demand for y. The first order condition implicitly defines a demand for input function $x^o(w^o)$ and an output supply function $y^o(w^o) = f(x^o(w^o))$.

FDI in the host country is associated with costs of plant, equipment and infrastructure, G, as well as of managerial and technical staff, M. In order to emphasize

[3] In the past, expropriation has frequently occurred in the resource sector. The interpretation of x as a natural resource and of the y industry as a resource processing stage is therefore of particular relevance.

[4] The firm has sole ownership of an efficient technology and the relevant management and marketing skills to produce x. The risks involved in giving other agents access to this know-how, e. g. through licensing arrangements, are assumed to provide a strong enough incentive for the firm to limit its choice of strategies to FDI and the purchase of x on the world market. See Caves (1982, 15–24) and Horstmann and Markusen (1986) for more detailed discussions of a firm's choice of market internalization over other modes of operation.

the differences between taxation and expropriation we assume that G and M are fixed rather than sunk costs. In the absence of expropriation the firm may leave the country at any time and transfer the fixed factors to alternative uses. Taxation observes the MNE's participation constraint and leaves it with enough revenue to cover fixed costs. Expropriation attempts to seize the rents associated with G and M.

The firm can be of two types, t_1 or t_2, distinguished from one another by differences in the relative magnitude of M and G. The type t_1 firm has a relatively high cost of plant and equipment, G_1, but requires only a modest outlay for managers and technicians, M_1. Its knowledge of the production process is embodied in the equipment installed in the host country. The t_2 firm's production of x, on the other hand is relatively intensive in management and technical skills but does not require large expenditures on plant and equipment, i. e., M_2 is relatively large compared to G_2. Its firm-specific know-how is contained in the skills of managers and technicians. For simplicity it is assumed that $M_1 = 0$, $M_2 = M$, $G_1 = G$, and $G_2 = 0$. There is also a variable cost of producing x which is identical for both types of firm, $C(x) = cx + h(x)$, where $c > 0$, $h'(x) > 0$ and $h''(x) > 0$. We assume that over the relevant output range, $[0, x']$, variable cost is lower than w^o, and that the MNE does not engage in trade on the world market. [5]

The firm's type is determined by an exogenous probability distribution. Information in the model is asymmetric. The firm is aware of its type but the host does not know what type of firm it is dealing with as it cannot observe the firm's costs

[5] This assumption does not affect the general results of the model. Allowing the firm to trade on the world market in addition to operating a production facility in the host country would require the following modifications. If $w^o > C'(x^*) + t$ the MNE would transfer x^* units of the intermediate good internally for use in the production of y and sell additional units of x on the world market until $w^o = C'(x) + t$. Similarly, if $w^o < C'(x^*) + t$ the firm could extract x until $w^o = C'(x) + t$ and then buy x on the world market up to the point where $[1 + (1/\varepsilon_d)]pf'(x) = w^o$.

or production technology. The host country's prior beliefs are that the firm is of type t_1 with probability δ, and of type t_2 with probability $(1-\delta)$, where $0 \leq \delta \leq 1$.

Since the host country does not consume x and as labor markets are undistorted the only benefit it receives from FDI is a share of the MNE's rents. We assume that for that purpose the country may impose a royalty fee of t per unit of resource extracted. A royalty fee seems to be an appropriate form of tax to use in this situation because the host country does not observe the firm's costs. Such a tax is also easy to administer for a LDC. [6]

In the absence of expropriation the firm's profit at the resource stage is determined by

$$\Pi_i^x(t) = \max_x \{wx - C(x) - tx - M_i - G_i\} \qquad \text{for } i = 1, 2. \tag{2.2}$$

Assuming that the MNE transfers x internally at average cost,[7] the corporate profit maximization problem can be stated as follows:

$$\Pi_i^N(t) = \Pi_i^x + \Pi_i^y = \max_x \{p[f(x)]f(x) - C(x) - tx - M_i - G_i\} \qquad \text{for } i = 1, 2. \tag{2.3}$$

The first-order condition is $[1 + (1/\varepsilon_d)]pf'(x^*) = C'(x^*) + t$.

If the conditions of the Implicit Function Theorem are satisfied, the first-order condition again defines an input demand function, $x(t)$, and a supply function, $y(t)$.

[6] Other tax instruments, e. g., profit or lump-sum taxes, would not eliminate the host country's incentive to expropriate the MNE since the rent associated with the fixed factors cannot be appropriated through taxation without driving the MNE out of the country. The fact that the MNE possesses the most efficient technology also prevents the host country from extracting all of the firm's rents by way of auctioning off the rights to exploit x.

[7] Tax avoidance through transfer price manipulation does not play a role in our model since the host country taxes output, a variable that it readily observes, and knows the MNE's variable costs. A different situation would arise if the host country were to use a profit tax. In this case the MNE might want to underinvoice its transfers of X in order to lower its tax bill creating an additional incentive to use expropriation. See Eden (1985) and Chapter III of this thesis for a discussion of the transfer pricing problem.

The royalty tax distorts the firm's optimal choice of input and output levels. Total differentiation of the first-order condition yields

$$\Pi_{xx}\,dx + \Pi_{xt}\,dt = 0, \tag{2.4}$$

or,

$$x_t(t) = \partial x/\partial t = -\Pi_{xt}/\Pi xx = 1/\Pi_{xx}, \tag{2.5}$$

which is less than zero by the second-order condition for profit maximization.

If it does not expropriate the firm the host country's national income, Y_i^N, equals tax revenue. The corresponding maximization problem is

$$Y_i^N = \max_t \{tx(t)\}, \qquad \text{subject to} \quad \Pi_i^N(t) \geq \Pi_i^o(w^o), \qquad \text{for i=1,2} \tag{2.6}$$

where $\Pi_i^N(t) \geq \Pi_i^o(w^o)$ represents the firm's individual rationality constraint. If the country were to impose a tax rate that violated this constraint, the firm would choose not to invest or, if it already operated a subsidiary, to leave the country. The host country's optimal tax rate is thus not only a function of production costs but also of world market conditions for x.

Once the firm has set up a subsidiary, the host country has to decide whether it can increase its share of the multinational's rent via expropriation. Since the host country's expertise in running production operations is limited, the success of expropriation crucially depends upon the amount of relevant know-how the country can seize in the expropriation process. A type t_1 firm is suitable for expropriation since the production-specific knowledge is incorporated in its plant and equipment which can be confiscated by the host government. Assuming that the host country faces the same variable cost function as the firm and that it can sell all of its output on the world market at price w^o, it is therefore in a position to continue operations efficiently.[8] National income in this case is

$$Y_1^E(w^o) = \max_x \{w^o x - C(x)\}. \tag{2.7}$$

The host country is better off expropriating a t_1 firm than taxing it, $Y_1^E > Y_1^N$, since the former allows it to collect the rent that was accruing to the firm's fixed factors. The t_1 firm loses plant and equipment and is forced to resort to the world market for its supply of x. The corresponding profit is

$$\Pi_1^E = \Pi_1^o(w^o) - G. \tag{2.8}$$

If the expropiated firm happens to be of type t_2, then the firm's production technology, which is embodied in the firm's management and technical staff, cannot be seized by the host government. Instead, the subsidiary's personnel returns home upon expropriation where it can be employed in alternative business ventures. In order to be able to continue the subsidiary's operations, the country has to turn to foreign management and technical assistance which can be obtained from some source other than the expropriated firm at a fixed cost $M^* > M$.[9] In particular, we assume that the host country's national income from expropriating a t_2 firm.

$$Y_2^E = \max_x \{w^o x - C(x) - M^*\}, \tag{2.9}$$

is lower than the revenue the country could obtain by imposing a royalty fee, $Y_2^N > Y_2^E$. Expropriation reduces the t_2 firm's profit, Π_2^E, to

$$\Pi_2^E = \Pi_2^o(w^o), \tag{2.10}$$

the profit it attains by buying x on the world market.

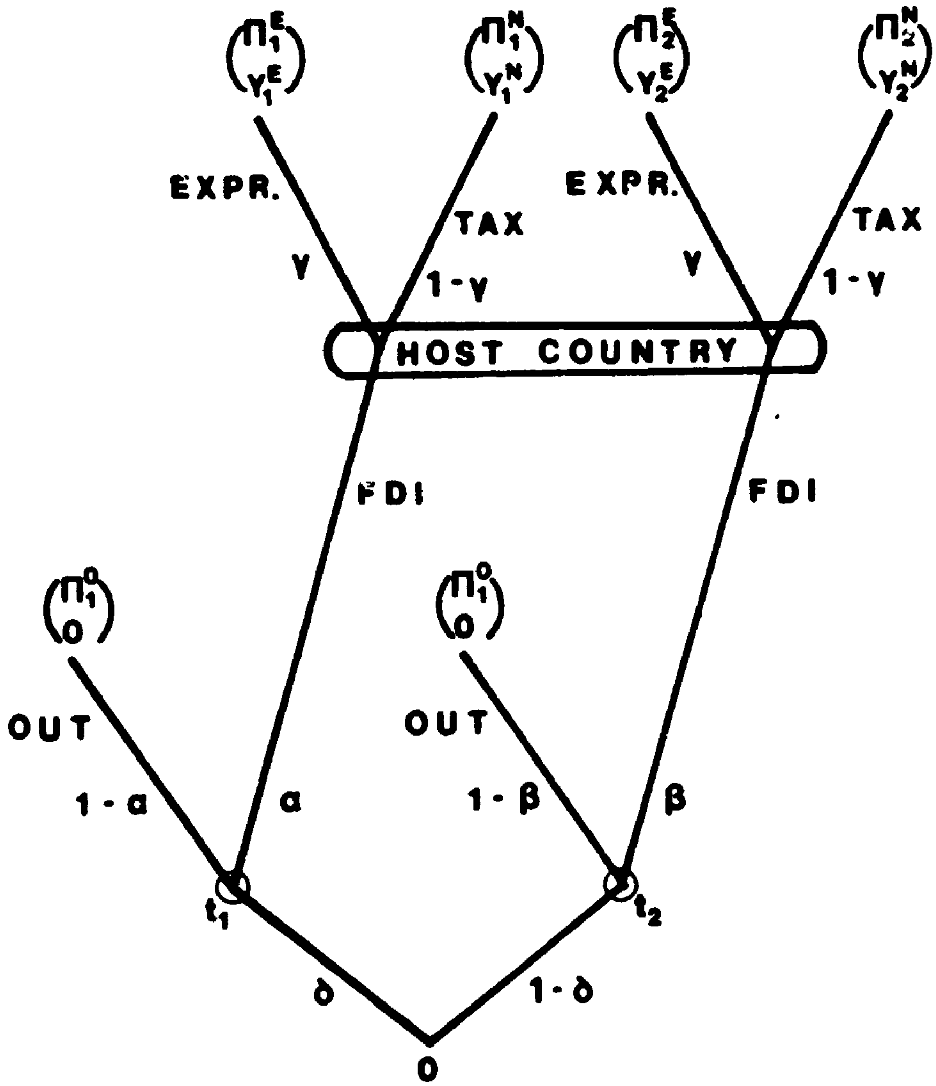
[8] We are, in fact, assuming that the host country is a competitive fringe supplier of x and thus regards w^o as parametric.

[9] If, on the other hand, the t_2 firm were to provide the necessary management and technical support, then the firm might even profit from expropriation and, for appropriate tax rates, would always choose to invest in the host country. As an alternative to the increase in M one might also consider that due to the lack of operations-specific knowledge variable cost rises to $C^*(x) > C(x)$.

3. Perfect Sequential Equilibria

The problem identified above can be characterized by a game of incomplete information with MNE and host country as the two players (see Figure I). In this game the MNE moves first and, being aware of its own type, must choose between investing in the host country and buying x on the world market. If the firm selects the latter strategy, the game ends and firm and host country receive payoffs of Π_i^0 and 0 respectively. If the MNE invests in the host country, the country gets to decide whether to expropriate the subsidiary or to impose a royalty fee. Payoffs for the firm are Π_i^E in the case of expropriation and Π_i^N otherwise. The host country's payoffs are Y_i^E and Y_i^N. For notational purposes let α denote the probability t_1 chooses for establishing a subsidiary and let $(1-\alpha)$ be the probability of the world market alternative. The choices of $\alpha = 0$ and $\alpha = 1$ represent the t_1 firm's pure strategies of acquiring x on the world market and of producing x in the host country, respectively. The t_2 firm opts for FDI with probability β and chooses to purchase x on the world market with probability $(1-\beta)$. So $\beta = 0$ and $\beta = 1$ denote the t_2 firm's pure strategies. Finally, let the host country select expropriation with probability γ and no expropriation with probability $(1-\gamma)$. Again, pure strategies are indicated by $\gamma = 0$ for no expropriation and $\gamma = 1$ for expropriation.

Figure I: The Expropriation Game with Vertical Integration



The equilibrium behavior of the two players is investigated using Grossman and Perry's (1986) notion of perfect sequential equilibrium. This equilibrium concept requires players to choose strategies that are best replies at each information set, and thus sequentially rational, given their beliefs. These latter beliefs must be consistent with the player's equilibrium moves which means that Bayes' rule must be used whenever possible to calculate beliefs from the equilibrium strategies. Perfect sequential equilibrium imposes more stringent "rationality" conditions than sequential equilibrium on the beliefs assigned to off-equilibrium information sets to which Bayesian updating does not apply. In particular, perfect sequential equilibrium helps eliminate sequential equilibria that are based solely on the threat to one player of the other player's beliefs no matter how incredible this threat may be. In terms of our signaling game, perfect sequential equilibrium specifies that the host country must not ignore whatever information is conveyed by the firm when it chooses its policy.

Perfect sequential equilibria of this model can be characterized by a tuple $(\alpha, \beta, \gamma; \mu)$, where μ denotes the host country's posterior beliefs about the firm's type. In analyzing the equilibria of the game we make the following assumption:

Assumption: *In the absence of host government policy both types of MNE prefer FDI to the outside opportunity, i. e.,* $\Pi_i^N(t=0) \geq \Pi_i^o(w^o)$ *for* $i = 1, 2$.[10]

The following definition will also prove useful.

Definition 1 $\delta^* \equiv (Y_2^N - Y_2^E)/[(Y_1^E - Y_1^N) + (Y_2^N - Y_2^E)]$.

It is easy to show that under the above assumptions about payoffs $0 < \delta^* < 1$.

[10] If the MNE always preferred the outside opportunity to FDI, a trivial pooling equilibrium would arise in which the MNE would never invest.

The three equilibria of the game are summarized in Propositon 1. The proof and a discussion of perfect sequentiality are provided in Appendix I.

Proposition 1 *The perfect sequential equilibria of the game are characterized by the following assessments and beliefs:*

(1.1) $(\alpha = 1, \beta = 1, \gamma = 0; \mu = \delta)$, *(i. e., the host country chooses taxation and both types of MNE invest), if*

(P1) $\delta \leq \delta^*$

(1.2) $(\alpha, \beta = 1, \gamma; \mu = (\alpha\delta)/(1 - \delta + \alpha\delta)$, *(i. e., the* t_1 *firm chooses FDI with probability*

$$\alpha = (1 - \delta)[Y_2^N - Y_2^E]/\delta[Y_1^E - Y_1^N],$$

and the t_2 *firm always invests. The host country chooses*

$$\gamma = [\Pi_1^N(t) - \Pi_1^o(w^o)]/[\Pi_1^N(t) - \Pi_1^o(w^o) + G],$$

the probability of expropriation), if

(SS1) $\delta > \delta^*$ *and*

(SS2) $G > 0$.

If the host country is pessimistic about its ability to run the subsidiary, $\delta \leq \delta^*$, the expected payoff from taxation is greater than that from expropriation. The host country therefore chooses taxation and both types of MNE invest, (1.1). Optimism on the country's part, $\delta \geq \delta^*$, leads to a semi-separating equilibirum in which both FDI and expropriation are carried out with positive probability, (1.2).

The pooling equilibrium, (1.1), is the only pure-strategy equilibrium of the game.[11] In equilibrium (1.1) the potential threat of expropriation has no effect on either the MNE's investment decision or the host country's welfare.

Looking at a cross-section of countries one can categorize potential host countries according to the kind of equilibrium they are in. If a host country receives FDI but no expropriation is ever observed then, assuming that prior beliefs do not change over time, the country belongs to the (1.1) class for which there is virtually no risk of expropriation. If expropriation is observed in select instances then the country must be in the semi-separating equilibrium (1.2).

We now analyze the expropriation equilibrium (1.2) in more detail. The welfare consequences of expropriation are demonstrated in the following proposition.

Proposition 2 *The host country would be better off if it could commit itself to refrain from expropriation, and to impose a royalty fee instead.*

Proof: In the semi-separating equilibrium foreign investment and expropriation both occur with nonzero probability and expected national income is:

$$E(Y) = \gamma[\alpha\delta Y_1^E + (1-\delta)Y_2^E] + (1-\gamma)[\alpha\delta Y_1^N + (1-\delta)Y_2^N]. \tag{3.1}$$

Noting that $\alpha = (1-\delta)[Y_2^N - Y_2^E]/\delta[Y_1^E - Y_1^N]$ in the semi-separating equilibrium one can eliminate γ to obtain

$$E(y) = (1-\delta)\frac{Y_1^N(Y_2^N - Y_2^E) + Y_2^N(Y_1^E - Y_1^N)}{(Y_1^E - Y_1^N)}. \tag{3.2}$$

[11] Another sequential pooling equilibrium in which the host country threatens the firm with expropriation and the MNE stays out fails the perfect sequentiality test. There are also no separating equilibria: Since the choice of separate strategies by the two types of firm allows the host country to discover which type of MNE is expropriable and which is not, the expropriable MNE either (i) mimics the nonexpropriable MNE (pooling), or (ii) stays out. However, an equilibrium where t_1 stays out and t_2 invests does not exist: The host country would choose taxation in equilibrium since only the nonexpropriable firm would invest. But in this case the expropriable MNE would deviate to FDI.

Transforming condition (SS1), $\delta > (Y_2^N - Y_2^E)/[(Y_1^E - Y_1^N) + (Y_2^N - Y_2^E)]$, into

$$(1-\delta) < (Y_1^E - Y_1^N)/[(Y_1^E - Y_1^N) + (Y_2^N - Y_2^E)], \tag{3.3}$$

we can establish the following inequality

$$E(y) = (1-\delta)\frac{Y_1^N(Y_2^N - Y_2^E) + Y_2^N(Y_1^E - Y_1^N)}{(Y_1^E - Y_1^N)} < \frac{Y_1^N(Y_2^N - Y_2^E) + Y_2^N(Y_1^E - Y_1^N)}{(Y_1^E - Y_1^N) + (Y_2^N - Y_2^E)}. \tag{3.4}$$

(SS1) also implies that

$$\frac{Y_1^N(Y_2^N - Y_2^E) + Y_2^N(Y_1^E - Y_1^N)}{(Y_1^E - Y_1^N) + (Y_2^N - Y_2^E)} < \delta Y_1^N + (1-\delta)Y_2^N, \tag{3.5}$$

where $\delta Y_1^N + (1-\delta)Y_2^N$ is the expected welfare obtained from the royalty fee. Combining inequalities (3.4) and (3.5) completes the proof. Q.E.D.

This result does not lack a certain irony. The very moment the host country believes that it is sufficiently likely that the firm is of type t_1 and thus can be easily expropriated, the expected return from nationalization falls below the expected tax revenue that could be obtained in the absence of expropriation. This conclusion follows from the fact that a nonzero probability of expropriation deters investment by the t_1 type firm in that it causes this type of firm to randomize between FDI and the world market alternative.

It is important to note that this welfare analysis applies only to a comparison between the expected payoff the host country can realize when following the proposed semi-separating equilibrium strategy and the payoff that would result if it could commit itself to a strategy of no expropriation. It is not the case that pooling equilibrium (1.1) Pareto-dominates the semi-separating equilibrium. In fact, if condition (i) of Proposition 1.1 is satisfied, i. e., $\delta \leq (Y_2^N - Y_2^E)/[(Y_1^E - Y_2^E) +$

$(Y_2^N - Y_2^E)]$, then the inequality signs in (3.4) and (3.5) change and expropriation becomes the Pareto-superior strategy.

In equilibrium (1.2) the host country is indifferent between taxation and expropriation. The exact combination of tax rate and expropriation probability the host government will choose can only be determined if government preferences are known. The characterization of such preferences is a problem of political economy and thus beyond the scope and purpose of this paper. However, based on equilibrium conditions we can explain the relationship between taxation and expropriation. In particular, there is an inverse relationship between the level of taxation and the probability of expropriation. Changes in the exogenous parameters of the model alter the MNE's trade-off between FDI and the outside opportunity and therefore lead to comovements in expropriation probability and tax rate. Proposition 3 summarizes the corresponding predictions.

Proposition 3

(i) $\partial\gamma/\partial t < 0$, (ii) $\partial\gamma/\partial w^o > 0$, (iii) $\partial\gamma/\partial M < 0$,

(iv) $\partial\gamma/\partial G < 0$, (v) $\partial\gamma/\partial c < 0$.

Proof: The host country's choice of tax rate affects the probability of expropriation, γ, as follows

$$\begin{aligned} \frac{\partial\gamma}{\partial t} &= \frac{\partial}{\partial t}\left(\frac{\Pi_1^N(t) - \Pi_1^o(w^o)}{\Pi_1^N(t) - \Pi_1^o(w^o) + G}\right), \\ &= \frac{\partial\Pi_1^N(t)}{\partial t}\left(\frac{1}{\Pi_1^N(t) - \Pi_1^o + G}\right)\left(1 - \frac{\Pi_1^N(t) - \Pi_1^o}{\Pi_1^N(t) - \Pi_1^o + G}\right). \end{aligned} \tag{3.6}$$

Let K be defined as follows

$$K \equiv \left[\left(\frac{1}{\Pi^N(t) - \Pi^o + G}\right)\left(1 + \frac{\Pi^N(t) - \Pi^o}{\Pi^N(t) - \Pi^o + G}\right)\right] > 0. \tag{3.7}$$

From the first-order envelope theorem we obtain $\partial \Pi^N(t)/\partial t = -x(t) < 0$ and therefore $\partial \gamma/\partial t < 0$. Similarly,

$$\partial \gamma/\partial w^0 = -(\partial \Pi_1^o/\partial w^o)K = xK > 0,$$

$$\partial \gamma/\partial M = (\partial \Pi_1^N/\partial M)K = -K < 0,$$

$$\partial \gamma/\partial G = -1/(\Pi_1^N - \Pi_1^o + G) < 0,$$

$$\partial \gamma/\partial c = (\partial \Pi_1^N/\partial c)K = -K < 0.$$

Q.E.D.

Cross-sectional and time series data on different resource industries can be used to test these predictions. In particular, one can test, using time series data, whether a rise in the royalty fee levied on a specific sector reduces the probability of expropriation in that sector. Cross-sectional data may help test the prediction that industries with higher royalty fees face a lower probability of expropriation. Similar tests may be run on the following results. An upward trend in the world market price of a particular resource x represents a deterioration in the firm's outside opportunity thus causing a rise in the expropriation probability. Firms that face costly input supply alternatives are more likely to be expropriated than firms that have access to cheap inputs elsewhere. An increase in M, the cost of management and technology, makes FDI less attractive for the firm and forces the country to lower its γ. A rise in G has similar effects since the decline in nonexpropriation profits and a rise in the expected loss from expropriation, $\gamma(-G)$, combine to reduce the payoff from investing in the host country. Variable costs are also negatively related to γ. To use an example from resource industries, if extraction costs tended to increase over time as resource deposits became less accessible, nationalization would be more likely to affect recent rather than long-standing investments. On a cross-sectional basis firms in high cost industries are less likely to be expropriated than those in low cost sectors.

4. A Model with Two Host Countries

The basic version of the model can be easily extended to one involving two host countries. This allows us to investigate the effects of differences in variable costs across countries. The equilibrium structure of this game is analogous with that of the basic one-country model. There exist the following types of equilibria:[12]

(i) Both countries choose taxation and both types of MNE mix (with the same probability) between FDI in country one and FDI in country two. However, the MNE mixes only if the country with the higher variable cost imposes a lower tax rate so that the MNE is indifferent between the two countries; (ii) both host countries mix between expropriation and taxation, and the expropriable MNE mixes between investing in any of the two host countries and staying out; the nonexpropriable MNE always invests (chooses a FDI probability for each country, where both probabilities add up to one). This equilibrium and the following result are formally stated in Proposition * in Appendix I.

Proposition 4 *Expropriation is more likely to occur in the country that has the lower variable cost.*

If variable costs differ internationally high cost countries have to compensate MNEs for the potentially smaller return from FDI with a lower probability of expropriation and/or a lower tax rate, a result that can be tested using cross-section country data.

[12] The proof of these equilibria is similar to the proof of Proposition 1.

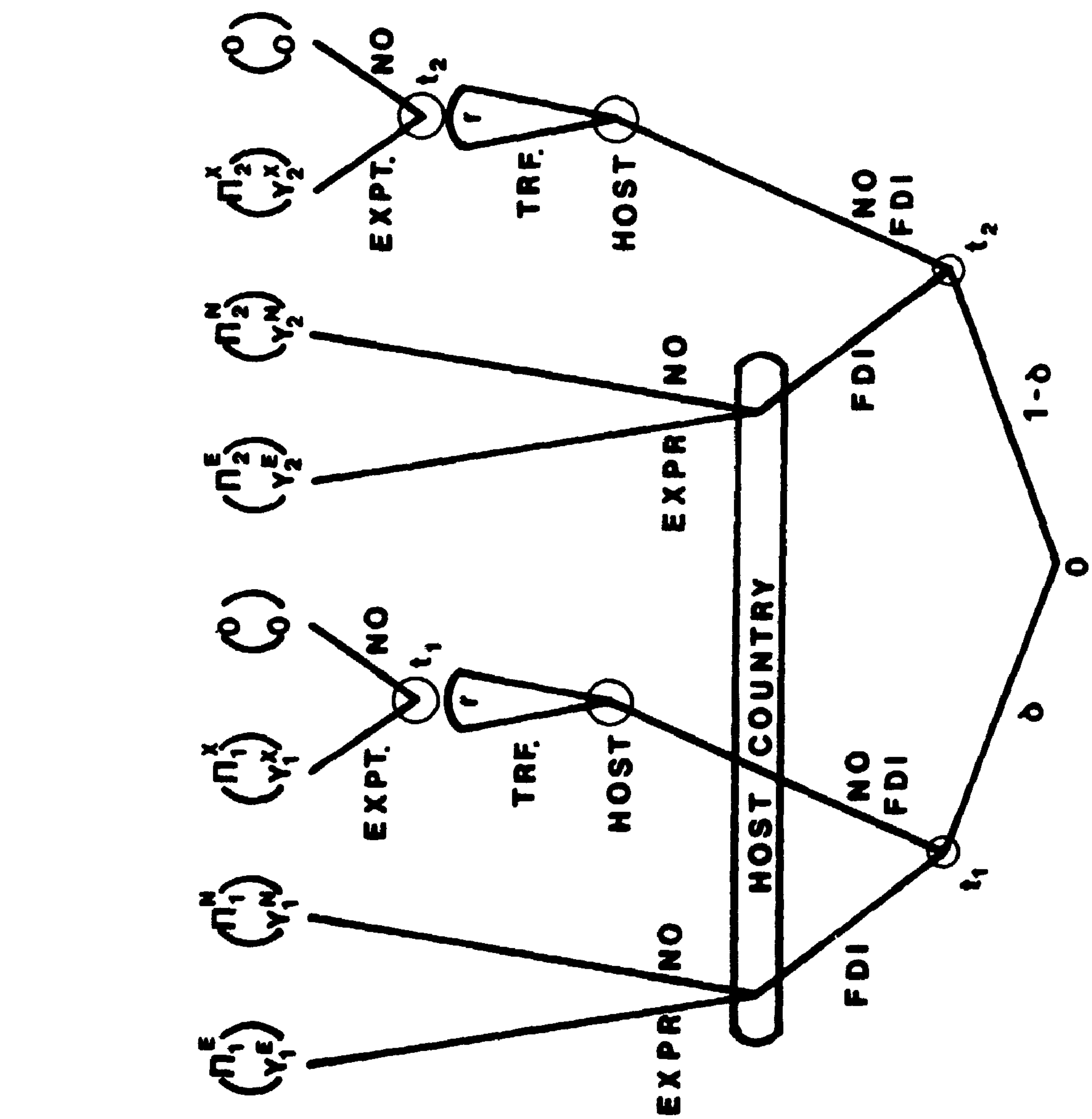
5. The Horizontal Integration Model

We now introduce a version of the basic model that allows us to assess the effect of trade policy on the probability of expropriation. As in Brander and Spencer (1987), the firm has to choose between two ways of marketing a homogeneous good y in the host country. It may either establish a subsidiary in the host country to produce the good locally or manufacture y at home and export it to the host country (see Figure II). The first alternative requires the firm to incur fixed cost of plant and equipment, G, and of management and technical support, M. Exporting does not require any fixed investment as the MNE already operates a production facility in the home country, but there are transportation costs of s per unit of output. The host country levies a tariff, R on the MNE's imports. As we are interested in the MNE's entry decision and the host country's share of profits we assume that this tariff, R, takes the form of a lump-sum fee.

Firm-specific knowledge, embodied in t_1's plant and in t_2's management, may be transferred to the new plant without affecting the marginal cost of production in the existing home country plant. The fixed cost creates increasing returns to scale which act as a deterrent to FDI. However, if the transportation cost and the host country's tariff are sufficiently high, then the firm may find FDI more profitable than exporting.[13]

[13] See Horstmann and Markusen (1987) for a proof of the existence of an MNE equilibrium under similar assumptions.

Figure II: The Expropriation Game with Horizontal Integration



The important informational aspects which drive the results of this version of the model can be summarized as follows: In the case of FDI, information about G and M is again distributed asymmetrically. Their exact values are private information of the firm. Incomplete information about investment costs, however, does not affect the host country's trade policy decision. The MNE already operates a production facility in the home country and fixed costs therefore do not enter into the appropriate MNE profit function. Since variable production costs are common knowledge, the host country has complete information of all parameters relevant for its trade policy decision. That is, the determination of the tariff becomes part of a proper subgame. In fact, since variable costs are identical across the two types of firm, the optimal tariff must be the same for both types of MNE.

The host country preferences over homogeneous goods y and z are be represented by a quasi-linear utility function, $U(z, y) = z + u(y)$. Good z is produced locally by a perfectly competitive industry and serves as the numéraire. The host country's demand for y is characterized by the inverse demand curve $p(y) = U'(y)$. Should the firm decide to export y to the host country, its profit is

$$\Pi_i^x(R, s) = \max_y \{p(y)y - C(y) - sy - R\}, \tag{5.1}$$

and a situation of balanced trade prevails in which the host country exports z to pay for the imports of y. The expenditure on y and z cannot exceed tariff revenue, i. e., $z + py = R$. Solving the expenditure constraint for z and substituting the resulting expression into the utility function, we obtain $U(z, y) = u(y) - py + R$.

It is clear from the structure of the subgame that the host country maximizes welfare by choosing the highest tariff that meets the MNE participation constraint, R^*,

$$R^* = \Pi_i^x(s) - \Pi^o, \tag{5.2}$$

where Π^o represents the MNE's outside opportunity. The corresponding host country payoff is $Y_i^x(R^*)$. The MNE's participation constraint prevents the host country form raising its tariff rate to levels that force the firm to sell nothing at all to the host country. The MNE's choice of not participating in the game represents a credibility constraint on the country's tariff policy. That is, tariff walls are only subgame-perfect as long as they do not preclude exports should the MNE actually choose this option. If there were no such choice, the country could simply set a very high tariff to force the MNE to invest and then expropriate or tax the MNE at will.

In the FDI case the host country's payoff is

$$Y_i^N = u(y) - py, \qquad \text{for i=1,2,} \tag{5.3}$$

when it refrains from nationalization and either

$$Y_1^E = \max_y \{u(y) - C(y)\}, \tag{5.4}$$

or

$$Y_2^E = \max_y \{u(y) - C(y) - M^*\}, \tag{5.5}$$

when it takes over the MNE's subsidiary. Again, we have that $Y_2^N > Y_2^E$ and $Y_1^N < Y_1^E$. The firm's profits from establishing a subsidiary in the host country are

$$\Pi_i^N = \max_y \{p(y)y - C(y) - M_i - G_i\}, \qquad \text{for i=1,2,} \tag{5.6}$$

and $\Pi_1^E = -G$, $\Pi_2^E = 0$.

The equilibria of this version of the model are the same as in the basic vertical integration case and need not be repeated here.[14] The probability of expropriation

[14] For M suficiently large compared to G, however, there also exists a semi-separating equilibrium in which the t_1 firm chooses FDI and the t_2 firm randomizes between FDI and exporting. In particular, this equilibrium requires

$$M > [p(y)y - C(y)][1 - \Pi_1^x/(\Pi_1^x + G)].$$

in the semi-separating equilibrium now is

$$\gamma = (\Pi_1^N - \Pi^o)/(\Pi_1^N + G). \tag{5.7}$$

In Brander and Spencer (1987) a tariff wall serves as a credible threat to induce FDI. In the course of their game the MNE never exports. In our model we obtain a similar result only if the host country is pessimistic about its ability to continue the operations of the subsidiary after expropriation. In this case, the host country never expropriates and the MNE always invests. This equilibrium is equivalent to the one in Proposition 1.1. But if the host country considers difficulties running the subsidiary itself unlikely, then our model yields very different conclusions. As in Proposition 1.2 we then observe a semi-separating equilibrium in which the host country chooses a probability of expropriation, the expropriable firm mixes between FDI and exporting and the nonexpropriable MNE always invests.

The equations indicating the equilibrium levels of the expropriation rate and the tariff, (5.7) and (5.2) respectively, can be used to derive predictions about the impact on policy of changes in exogenous variables. The results are reported in Proposition 6.

Proposition 6

(i) $\partial\gamma/\partial s = 0$, $\partial R/\partial s < 0$,

(ii) $\partial\gamma/\partial\Pi^o < 0$, $\partial R/\partial\Pi^o < 0$,

(iii) $\partial\gamma/\partial c < 0$, $\partial R/\partial c < 0$,

(iv) $\partial\gamma/\partial G < 0$, $\partial R/\partial G = 0$,

Proof: The proof follows from straightforward differentiation of equations (5.2) and (5.7), respectively.

In the semi-separating equilibrium, both the tariff and the probability of expropriation are set to reduce the MNE's expected profit to the outside opportunity payoff. Changes in the outside opportunity therefore lead to parallel movements in the expropriation rate and in the tariff. Increases in variable production costs also lead to a simultaneous reduction in γ and R. A rise in exporting costs only affects the tariff rate; the probability of expropriation is not affected. Changes in fixed investment costs, G, have a direct negative impact on the probability of expropriation, but do not affect tariff policy. Industries that are characterized by low variable production costs should therefore have both lower tariffs and lower probabilities of nationalization.

6. Summary and Results

This chapter investigated the problem of expropriation of MNEs in the context of signaling games. Two types of perfect sequential equilibria were shown to exist depending on the country's prior beliefs about the firm's type. If the country thinks it is sufficiently likely that the firm is costly to expropriate, a pooling equilibrium arises in which the firm undertakes FDI and the host country does not expropriate the MNE's subsidiary. According to this outcome the possibility of nationalization affects neither the firm's investment decision nor the host country's welfare. However, if the country is optimistic about its ability to expropriate the MNE without facing increased costs of management and technology, then we obtain a semi-separating equilibrium in which expropriation occurs with positive probability. In the last equilibrium the host country would benefit from being able to commit itself to a policy of no expropriation. In the semi-separating equilibrium the welfare loss stems from the fact that, due to the threat of expropriation, firms that are suitable for expropriation are less likely to engage in FDI relative to enterprises which the host country cannot profitably expropriate. The possibility of nationalization thus may act as a self-selection mechanism for foreign investors.

Taxation models, such as Bond and Samuelson (1988) and Brander and Spencer (1987), show that a host country's lack of commitment to initial policy agreements should induce MNEs to reduce the capital intensity of their investment, the reason being that capital, once it is in place, becomes a hostage to the host government's tax policy. When expropriation is at issue Magee (1977) claims MNEs may choose to adopt a more advanced and therefore more capital intensive technology in order to make it more difficult for the country to operate the firm after expropriation. However, empirical evidence (Caves, 1982, 268) suggests that production processes might be quite inflexible so that changes in technology would likely be costly. Indeed, such technological adaptations seem to have taken place rather infrequently. Our paper proposes a different solution: The firm's technology is assumed to be exogenously determined and fixed but the threat of expropriation might still lead to a bias in technology, in the sense that firms with a technology that makes them difficult to expropriate might be more likely to become MNEs than firms that could be operated efficiently by the host country.

The predictions that were generated for the different versions of the model may be tested using time series as well as cross-sectional data. They also provide some insight into the decrease in the number of expropriation cases over the last one and a half decades. In the vertical integration model an increase in the production tax leads to a reduction in the probability of expropriation. The availability of better tax instruments would also make expropriation less attractive. A fall in the world market price of a natural resource improves the outside opportunity of MNEs that use the resource as an input. Consequently, the likelihood of expropriation of these firms is diminished. Increases in the cost of technical and management staff, M, of plant and equipment, G, or in variable cost all serve to reduce the probability of expropriation.

An extension of the basic vertical integration model to one involving two countries led to the conclusion that low cost countries are more likely than countries with higher costs to expropriate MNEs. That is, high cost countries have to compensate MNEs for the difference in production costs with a lower probability of expropriation.

We also considered a model of horizontal integration in which the firm could sell a homogeneous good, y, in the host country either by establishing a subsidiary to produce the good locally, or by manufacturing y in an existing home country plant and exporting it to the host country. The host country again has incomplete information about fixed investment costs but knows all relevant parameters in the export case. The host country's optimal tariff is thus determined by a proper subgame. We found that the higher the variable cost of production the higher should be both tariff and expropriation probability.

CHAPTER III

THE TAXATION OF MULTINATIONAL ENTERPRISES WITH UNKNOWN COST AND TRANSFER PRICES

1. Introduction

It has been widely argued in the literature on MNEs that tax revenue represents one of the most important gains to host countries from FDI.[1] This seems especially true for less-developed countries (LDCs) where poor infrastructure and a frequently unskilled local labor force tend to reduce other potentially positive effects such as technology transfer, job creation and linkages with domestic industries. However, FDI taxation is no simple task. As with the regulation of domestic firms, the government often lacks relevant knowledge regarding the MNE's costs. The design of an optimal tax mechanism is also rendered more difficult by the fact that the government, in the case of FDI, has jurisdiction only over a part of the firm, the local subsidiary. This allows the MNE to use transfer pricing to shift profits across national boundaries so as to minimize its tax burden.[2]

We address the problem of optimal taxation of MNEs from the point of view of a host country which does not observe the production cost and transfer price of an MNE subsidiary producing an intermediate input. The MNE is vertically and horizontally integrated: It has internalized the market for an intermediate

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[1] Macdougall (1968) stresses the importance of host countries' first crack at MNE profits. In Markusen's (1984) general equilibrium model host countries can only benefit from FDI if they retain enough tax revenue from the MNE's activity. For a detailed study of the empirical literature see Caves (1982).

[2] See Rugman and Eden (1985) for a survey of the transfer pricing literature.

good which is supplied by subsidiaries located in the host country and one or more countries in the rest of the world, denoted by ROW, (horizontal integration). The intermediate good is demanded by a home country plant where it is used in the production of a final good (vertical integration).[3]

Technically, our study builds upon recent principal-agent models investigating the regulation of domestic monopolists under incomplete cost information (Laffont and Tirole, 1986, Baron and Myerson, 1982; Besanko and Sappington, 1987, survey the literature). In their papers the unobservability of production costs provides the firm with an opportunity to disguise its true profits by overstating costs. The government's optimal tax mechanism must therefore induce the MNE to both reveal its costs truthfully and produce the socially optimal output.

The taxation of MNEs differs from the regulation of domestic monopolists in two important respects. Firstly, the freedom to set an internal transfer price for the intermediate good introduces a moral hazard problem by providing the MNE with an opportunity to avoid host country taxes by underinvoicing the intermediate product. This restricts the host country's choice of regulatory mechanisms. In particular, it subjects the tax mechanism selection to the constraint that the MNE must have no incentive to "misreport" its transfer price by setting it at a level below marginal cost. The formulation of this constraint follows from the transfer pricing literature.

Secondly, the host country might not be able to infer the MNE's transfer price (and therefore calculate the rent it can extract from the subsidiary) even if it refrains from using tax schemes that by themselves do not induce transfer pricing. As has

[3] Examples of this type of MNE set-up are found very frequently in natural resource-based industries, in the computer industry and other sectors where labor-intensive assembly stages are located in low-wage countries. See Caves, 1982, pp. 18–24 for more empirical evidence.

been shown by Hirshleifer (1956), the MNE's optimal transfer price also depends on the cost structure of competing MNE subsidiaries and on the policy of other host country governments: The host country may not observe the production costs of the MNE's subsidiaries located in ROW. This leaves the host country unable to directly evaluate the MNE's outside opportunity and, therefore, gives the MNE an incentive to overstate the return from its investment alternatives abroad in order to limit its tax liability in the host country. The host country might also be unaware of the exact specifications of contracts governing the relationship between the MNEs and ROW governments.[4] As a result, the host country's tax mechanism must also induce the MNE to reveal the "level of competition" from other MNE subsidiaries.

Our paper improves upon the existing literature on MNE taxation in several ways: Firstly, the traditional transfer pricing literature (see Rugman and Eden's, 1985, survey) does not formally acknowledge the information problem underlying transfer pricing. In these models the host country knows all the parameters it technically needs to calculate the MNE's transfer price. The lack of knowledge regarding transfer prices is therefore introduced ad hoc.

Prusa (1990) states the transfer pricing problem in a formal way, as a problem of unknown cost: He uses the mechanism design framework provided by Baron and Myerson (1982) to check how the optimal regulation of a monopolist changes when the monopolist is a foreign-owned subsidiary instead of a local firm. The essential characteristic of the MNE in this setting is that the subsidiary imports intermediate inputs from the parent company. These inputs are priced at the parent's marginal production cost which cannot be observed by the host country's government. This

[4] In this paper we assume that there are no direct interactions between the host country and governments in ROW. That is, there is neither competition between countries for foreign direct investment (which would further reduce the amount of rent host countries could extract from the MNEs) nor is there co-operation between host countries (which could help increase the governments' share of MNE profits).

asymmetric information gives rise to transfer price manipulation in response to tax and tariff policies. Again following Baron and Myerson, Prusa's host government may regulate the price and quantity of the subsidiary's output and use tax policy to achieve its objective of maximizing a weighted sum of consumer and producer surplus.

In our paper the host country regulates the intermediate product stage. The prices of the intermediate and the final product cannot be regulated since the price of the former is unobservable and sales of the latter do not fall under the host country's jurisdiction. Since after-tax profits are remitted to the parent company, our host government only cares about the share of the MNE's rent it can extract through taxation and not (at least not directly) about total producer surplus of the foreign firm.

Another issue is the implementation of the host country's optimal FDI regime. Reports of the MNE's type in our model are costless. Therefore, the optimal mechanism must in some way be based on actual production figures. In Baron and Myerson (1982) and in Prusa (1990) this problem is circumvented as the regulator sets output targets for each type of firm. Enforcement of such targets with the help of heavy penalties is not, however, a realistic policy at least not in the context of FDI. A firm's true output is always likely to differ from the original target simply for technical reasons. The imposition of large fines for any output deviations however small would therefore prevent FDI. The "noise" in output quantities causes an additional moral hazard problem and requires the optimal mechanism to provide a balance between adverse selection and moral hazard. Laffont and Tirole (1986), McAfee and McMillan (1987), and Riordan and Sappington (1987) all provide very similar results on such trade-offs and show that under some conditions the socially opimal actions can be implemented by a linear mechanism.

2. The Optimal Mechanism with Observable Competition

The MNE produces intermediate good x in the host country at cost $C = c(x;\theta)$. θ is a cost parameter uniformly distributed over the interval $[\theta^-, \theta^+]$, $\theta^+ > \theta^- > 0$, with density $f(\theta) = F'(\theta)$. The distribution of θ is common knowledge but the particular realization of θ is only known by the MNE. We make the following assumptions regarding the host country subsidiary's costs.

Assumptions:

(2.1) $c_\theta(x;\theta) > 0$ for all x, θ,

(2.2) $c_{x\theta}(x;\theta) > 0$ for all x, θ,

(2.3) $c_{xx}(x;\theta) > 0$ for all x, θ,

(2.4) $c_{xx\theta}(x;\theta) > 0$ for all x, θ,

(2.5) $c_{x\theta\theta}(x;\theta) \geq 0$ for all x, θ,

Assumption (2.1) states that cost is increasing in θ. That is, the higher θ the more inefficient is the subsidiary. Assumption (2.2) is common in the mechanism design literature where it is known as "single crossing property" (Besanko and Sappington, 1987, 5). It states that marginal cost is also increasing in θ. According to assumption (2.3), the MNE's marginal cost curve is upward sloping. Assumption (2.4) states that the marginal cost curve is steeper for inefficient firms than for efficient ones. (2.5) requires that marginal cost not only rises with θ but increases faster the higher θ. Assumptions (2.4) and (2.5) guarantee that the socially optimal output decreases with θ.

The transfer price of x for the host country subsidiary is denoted by λ. The number of subsidiaries in ROW is assumed to be sufficiently large to justify modeling them as having constant marginal costs, equal to w.[5]

The parent company buys $x(\theta)$ units of the intermediate good from its subsidiary in the host country and x_r units from its ROW subsidiaries. The host country subsidiary's profit is

$$\Pi^x(\theta) = \max_x\{\lambda x(\theta) - c(x(\theta);\theta) - \Gamma(x,\theta)\}, \tag{2.1}$$

where $\Gamma(x,\theta)$ denotes taxes paid to the host government. The parent company uses x and several other inputs to produce final good y for which it faces a downward sloping demand function, $p(y)$.

For the purpose of simplicity we assume that the production of y allows no substitution between resource input x and other inputs $I(-)$, that is, the parent's technology can be summarized by a Leontief production function, $y = min(I(-), x)$, where $I(-)$ represents other variable inputs. The cost of $I(-)$ is a function of y and denoted by $C_I = C(x(\theta) + x_r(\theta))$ where one unit of x translates into one unit of y.

The following assumptions will also be helpful:

Assumptions:

(2.6) The policy mechanism is continuously differentiable in θ.

(2.7) The home country levies no taxes or tariffs on the operations of the MNE.

(2.8) The parent company's demand for x at price w is greater than the subsidiary's output $x(w)$ for all θ.

---

[5] This assumption considerably simplifies our analysis without changing the basic nature and interpretation of the optimal mechanism. However, one could also think of w as representing the equilibrium price on a world market for x.

Assumption (2.7) allows us to abstract from the effects on the optimal policy mechanism of the possible types of taxes and foreign tax treatments that might be adopted by the MNE's home country.[6] Assumption (2.8) implies that the MNE always buys some of its intermediate product from its ROW subsidiaries. Thus the total quantity of x used in the production of y is independent of the marginal costs of the host country subsidiary.

The MNE's "accounting" profit at the y stage given transfer price λ, is

$$\Pi^y(\theta) = \max_y\{p(y)y - C_I - \lambda x(\theta) - wx_r(\theta)\}. \tag{2.2}$$

Cancelling out λ, the total "economic" MNE profit is $\Pi(\theta) = \Pi^x(\theta) + \Pi^y$ or

$$\Pi(\Gamma(x,\theta);\theta) = \max_{x,x_r}\{p(x(\theta) + x_r(\theta))[x(\theta) + x_r(\theta)] - C_I(x(\theta) + x_r(\theta)) - wx_r(\theta) - c(x(\theta);\theta) - \Gamma(x,\theta)\}. \tag{2.3}$$

To facilitate notation we define $NR(\theta)$, net revenue of y, to be

$$NR(\theta) \equiv p(x(\theta) + x_r(\theta))[x(\theta) + x_r(\theta)] - C_I(x(\theta) + x_r(\theta)).$$

In order to ensure a unique interior solution to the firm's maximization problem, we need to make the following assumption about the concavity of the net revenue function.

Assumption (2.9): $\partial^2 NR(-)/\partial x^2 < 0$.

We also define $NMR(\theta)$, net marginal revenue of y, as

$$NMR(\theta) \equiv dNR(\theta)/dy = dNR(\theta)/dx.$$

[6] See Caves (1982) for a detailed discussion of tax regimes. The consequences of relaxing Assumption (2.7) will be discussed below.

$NMR(\theta)$ is positive over some range of x before becoming negative.

The host country seeks to maximize the MNE's contribution to the host economy, that is, its value added. We simplify the objective function of the host government by assuming that good x is not consumed in the host country and all factors of production are in perfectly elastic supply. This leaves tax revenue as the only benefit from FDI. The host government accordingly chooses a tax schedule that maximizes expected tax revenue

$$\max_{\Gamma(-)} \int_{\theta^-}^{\theta^+} \Gamma(x,\theta)\, f(\theta) d\theta, \quad \text{subject to} \tag{P1}$$

(IR) Individual Rationality

$$\Pi(\Gamma(x,\theta), x; \theta) \geq \bar{\Pi}(w), \tag{IR}$$

where $\bar{\Pi}(w)$ represents the MNE's option of purchasing all of x from its ROW subsidiaries.

(SS) Self Selection

$$\Pi(\Gamma(x(\theta),\theta);\theta) \geq \Pi(\Gamma(x(\hat{\theta}),\hat{\theta}),\hat{\theta};\theta),$$

where θ is the MNE's true type, $\hat{\theta}$ is reported, $x(\hat{\theta})$ is the profit maximizing output level given report $\hat{\theta}$ and $\Gamma(x,\hat{\theta})$ is the tax regime. Finally,

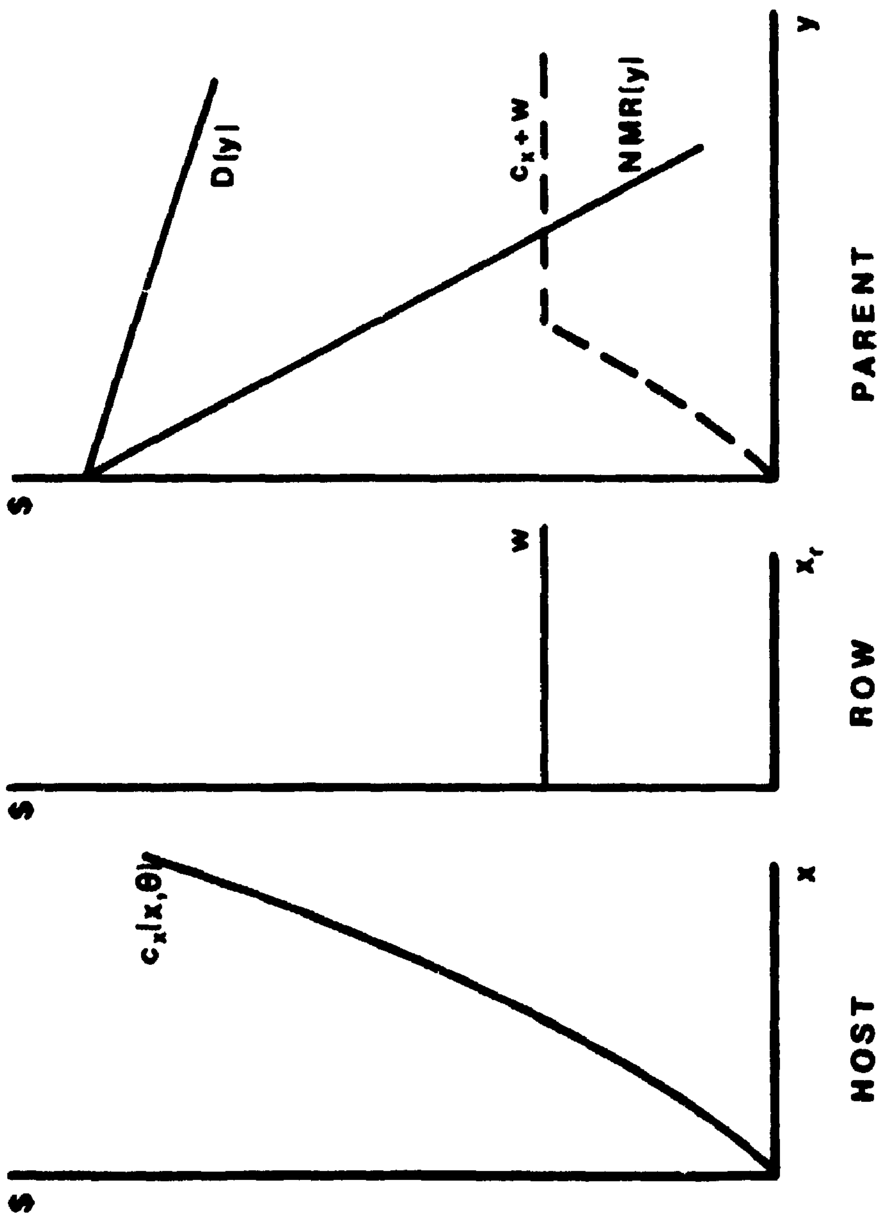
$$\Pi(\Gamma(x,\hat{\theta}), x, \hat{\theta}; \theta) = NR(\hat{\theta}) - wx_r(\hat{\theta}) - c(x(\hat{\theta});\theta) - \Gamma(x,\hat{\theta}). \tag{2.4}$$

(WP) World Price (Selection)

$$w = arg \max_{\lambda} \Pi(\Gamma(x,\theta);\theta).$$

The individual rationality constraint ensures participation of the MNE by providing it with a payoff that is at least as great as the outside opportunity profit. The self-selection condition gives the MNE's reaction, in terms of the choice of output and report, to the country's tax mechanism. It requires that the MNE does best reporting its true type and producing the output that corresponds to the reported type. The world price selection constraint prevents underinvoicing of the intermediate good in the absence of home country taxes. Figure III illustrates the country's problem in the context of the MNE's internal market.

Figure III: A Model of the MNE's Internal Market



If the host country had complete information about the MNE's costs and transfer price, then it could implement a first-best policy and capture all of the MNE's rent:

First-Best Policy

(i) $\Pi(\Gamma(\theta);\theta) = \bar{\Pi}(w)$ for all θ, and

(ii) $\lambda = w$.

With cost and transfer price observability the first-best solution can be implemented by a choice of lump-sum or profit taxes that satisfy (i) and by regulating the transfer price according to (ii). If the host country has complete information about costs but cannot regulate the MNE's transfer price, the first-best outcome can only be achieved with the use of a lump-sum tax. A profit tax would distort the firm's transfer price decision and thus violate (ii).

Lemma *With perfect cost observability and zero home country taxes, Assumption (2.8), the first-best solution cannot be implemented by a profit tax.*

Proof: Suppose the host country's optimal mechanism contains a profit tax, $\tau(-) > 0$. Then, the subsidiary's profit is

$$\Pi^x(\theta) = \max_x\{(1-\tau(\theta))[\lambda x(\theta) - c(x(\theta);\theta)] - \Gamma(x,\theta)\}, \tag{2.5}$$

and total MNE profit is

$$\Pi(\tau(\theta),\Gamma(x,\theta);\theta) = \max_{x,x_r,\lambda}\{NR(\theta) - wx_r(\theta) - \lambda x(\theta) \\ + \tau(-)[\lambda x(\theta) - c(x(\theta);\theta)] - \Gamma(x,\theta)\}. \tag{2.6}$$

The MNE's optimal choice of transfer price can be characterized by the following first-order condition:

$$\partial\Pi(\tau(-),\Gamma(-);\theta)/\partial\lambda = -\tau(-)x(\theta) < 0. \tag{2.7}$$

Thus, the optimal transfer price is $\lambda = 0$ and all profits are shifted to the MNE's home country.

Q.E.D.

In the case of incomplete information the structure of our model can be represented by the following principal-agent game with adverse selection:

1.) Nature chooses the MNE's cost parameter θ_i, unobserved by the host country.

2.) The host country offers the MNE a menu of tax contracts $\{\Gamma(x,\theta)\}$.

3.) The MNE accepts one contract or rejects all contracts.

4.) The MNE chooses output level and transfer price.

Under incomplete information the solution to the host country's tax revenue maximization subject to (IR), (SS) and (WP) generally yields lower tax revenue than under complete information, since the MNE must be given the incentive to reveal its costs truthfully in equilibrium. In particular, we can rewrite the host country's maximization problem (P1) by substituting for Γ from the (SS) constraint. This yields a much clearer picture of the optimal control problem involved. Ignoring the possibility of imposing profit taxes the host country chooses x and x_r to

$$\max_{x,x_r} \int_{\theta^-}^{\theta^+} \{NR(\theta) - wx_r(\theta) - c(x(\theta);\theta) - \Pi\} f(\theta)d\theta, \quad \text{subject to} \tag{P2}$$

$$\Pi(\theta, \Gamma(x,\theta), x; \theta) \geq \bar{\Pi}(w), \tag{IR}$$

$$\frac{\partial \Pi}{\partial \theta} = -c_\theta(x(\theta); \theta). \tag{2.8}$$

Since Π is decreasing in θ from equation (2.8) and the host country would like to extract as much profit as possible from the MNE, the highest-cost firm will make exactly $\bar{\Pi}(w)$. Thus, (IR) reduces to a terminal point condition:

$$\Pi(\theta^+) = \bar{\Pi}(w). \tag{IR'}$$

The Hamiltonian associated with (P2) is

$$H = [NR(\theta) - wx_r(\theta) - c(x(\theta); \theta) - \Pi]f(\theta) - \mu(\theta)c_\theta(x(\theta); \theta), \tag{2.9}$$

where $\mu(\theta)$ is the multiplier for constraint (2.8). The first-order conditions for the host country's maximization problem are presented in Proposition .

Proposition 1 *The necessary conditions for an interior maximum of (P2) are:*

$$NMR(\theta) - c_x(x(\theta); \theta) - (\theta - \theta^-)c_{\theta x}(x(\theta); \theta) = 0, \tag{2.10}$$

$$NMR(\theta) - w = 0, \tag{2.11}$$

$$\frac{\partial \Pi}{\partial \theta} = -c_\theta(x(\theta); \theta), \tag{2.8}$$

$$\Pi(\theta^+) = \bar{\Pi}(w). \tag{IR'}$$

Proof: From the Hamiltonian we obtain

$$\frac{\partial H}{\partial x} = [NMR(\theta) - c_x(x(\theta); \theta)]f(\theta) - \mu c_{\theta x}(x(\theta); \theta) = 0, \tag{2.12}$$

$$\frac{\partial H}{\partial x_r} = [NMR(\theta) - w]f(\theta) = 0, \tag{2.13}$$

$$\frac{d\mu}{d\theta} = -\frac{\partial H}{\partial \Pi} = f(\theta), \tag{2.14}$$

$$\frac{\partial H}{\partial \mu} = \frac{\partial \Pi}{\partial \theta} + c_\theta(x(\theta);\theta) = 0. \tag{2.15}$$

We also have conditions on the two terminal points, $\Pi(\theta^+) = \bar{\Pi}(w)$ and $\Pi(\theta^-)$ is free. From the latter we get $\mu(\theta^-) = 0$.

Integrating equation (2.14) and taking account of $\mu(\theta^-) = 0$, we get

$$\mu(\theta) = F(\theta). \tag{2.16}$$

Substituting for μ in equation (2.12) from (2.16) and dividing by $f(\theta)$ yields (2.10). The other necessary conditions follow directly.

Q.E.D.

Under Assumptions (2.4) and (2.9) optimization conditions (2.10) and (2.11) have a unique solution. Laffont and Tirole (1986, p. 639) show that in this case the necessary conditions are also sufficient.

The implementation and, therefore, the nature of the optimal contract depends on assumptions about the MNE's technical ability to produce a previously announced quantity of output. If, somewhat unrealistically, we assume that there is no potential for errors or technical difficulties, then the output observed by the host country corresponds exactly to the quantity of output the MNE intended to produce. In this case, the host country can force the MNE to produce the profit maximizing output that is associated with its report of type. The host country then has to deal only with the adverse selection problem. The corresponding optimal mechanism is analyzed in section 3. If one allows for the possibility of errors, then the observed MNE output will deviate with positive probability from the profit maximizing production level. If the country were to use a forcing mechanism, any such departure would trigger a heavy penalty and induce the MNE not to invest in the country (Laffont and Tirole, 1986, p. 623). The optimal mechanism should therefore be continuous in output. This mechanism is described in section 4.

3. Implementation with a Forcing Contract

The optimal forcing mechanism is characterized in Proposition 2. This mechanism uses a report-dependent lump-sum tax, $T(\theta)$, to induce the MNE to reveal its true type and extract all of the highest cost producer's excess rents. A severe penalty, $\Gamma = \infty$ is used to force the subsidiary to produce the amount of output that would maximize profits if the reported type were its true type. In other words, the penalty is designed to make lying costly.

Proposition 2 *Under assumptions (2.1)-(2.9) the host country's optimal forcing mechanism can be characterized as follows:*

$$\Gamma^f(x,\hat{\theta}) = \begin{cases} T^f(\hat{\theta}), & \text{if } x = x^*(\hat{\theta}); \\ \infty, & \text{otherwise,} \end{cases}$$

where

$$T^f(\hat{\theta}) = NR(\hat{\theta}) - wx_r(\hat{\theta}) - c(x(\hat{\theta});\hat{\theta}) - \int_{\hat{\theta}}^{\theta^+} c_\theta(x(t);t)dt - \Pi(w), \tag{3.1}$$

and $x^*(\hat{\theta})$ solves the planner's problem, equations (2.10) and (2.11).

Proof: See Appendix II.

The basic features of the host country's optimal mechanism, i. e., the low cost producer's positive rent and complete extraction of the high cost MNE's excess rents, are not sensitive to changes in assumption (2.7) regarding zero home country taxes. However, the exact formulation of the tax part of the mechanism may vary according to the home country's tax system and home's treatment of taxes paid by the MNEs to the host country. The United States' tax scheme, for example, is a combination of corporate income tax (CIT) and foreign tax credit. Under this system U.S. firms face the same overall tax rate no matter where profits are earned and in which country taxes are paid (assuming that MNEs repatriate their profits).

Since the host country has first crack at the MNE's profits, the optimal mechanism under a U.S. type home country tax regime could include a profit tax equal to the U.S. CIT rate and additional lump-sum taxes to extract the remaining difference between highest-cost firm profits and outside opportunity profits.

4. Implementation with a Continuous Mechanism

When the subsidiary's production is subject to random errors, the MNE's output will almost certainly deviate from the level prescribed by the host country. The government, therefore, cannot resort to the extreme penalties of the above forcing mechanism to induce the MNE to supply the socially optimal quantity of output. McAfee and McMillan (1987), however, have shown that at least the planner's problem in the case of noisy output can, with some reinterpretations, be mapped into the original mechanism design problem laid out in Proposition 1. In particular, let z denote the subsidary's expected output and $c(z(\theta);\theta)$ be the expected cost of producing z. The host country can then be modelled as selecting $z^*(\hat{\theta})$, the socially optimal expected output given that $\hat{\theta}$ is reported. Assumptions (2.1) to (2.9) carry over to this new problem. Thus, the planner's choice of expected output, $z^*(\hat{\theta})$, is derived from the equivalent of equations (2.10) and (2.11).

Given that a forcing contract can no longer be used, a different way of implementing the planner's optimum has to be found. In particular, the new mechanism should be continuous in observed output so as to reduce the negative effects of slight deviations of the observed from the expected output. Laffont and Tirole, 1986, McAfee and McMillan, 1987, and Riordan and Sappington, 1987 have shown that in situations such as ours linear mechanisms will implement the social optimum. The linear mechanism, which is presented in Propositon 3, is of the form $\Gamma^c(x,\theta) = t(\theta)x + T^l(\theta)$. The lump-sum part, $T^l(\theta)$ plays the same role as in

Proposition 2, i. e., inducing the MNE to report its true type and limiting the rents available to the highest cost producer. The production tax, $t(\theta)$, addresses the moral hazard problem, the basic intuition being that an output tax induces the MNE to produce the output associated with its cost report.

Proposition 3 *Under assumptions (2.1) to (2.9) and if output is noisy, the host country's o- 'mal mechanism is given by:*

$$\Gamma^l(x,\hat{\theta}) = t(\hat{\theta})x + T^l(\hat{\theta}).$$

where $z^*(\hat{\theta})$ maximizes the equivalent of equations (2.10) and (2.11) given that the MNE reports $\hat{\theta}$ and where

$$t(\hat{\theta}) = [NMR(z^*(\hat{\theta}) + z_r^*(\hat{\theta})) - c_z(z^*(\hat{\theta});\hat{\theta})], \tag{4.1}$$

and

$$T^l(\hat{\theta}) = NR(z^*(\hat{\theta}) + z_r^*(\hat{\theta})) - wz_r^*(\hat{\theta}) - c(z^*(\hat{\theta});\hat{\theta}) \\ - t(\hat{\theta})z^*(\hat{\theta}) - \int_{\hat{\theta}}^{\theta^+} c_\theta(z^*(t);t)dt - \Pi(w). \tag{4.2}$$

Proof: See Appendix II.

Corollary 1 *The optimal production tax is a decreasing function of cost reports $\hat{\theta}$. For the lowest cost report, θ^-, the production tax is zero.*

Proof: Taking the derivative of the optimal production tax, equation (4.1), with respect to $\hat{\theta}$ yields

$$dt(\hat{\theta})/d\hat{\theta} = -c_{z\theta}(-) < 0, \tag{4.3}$$

which is negative by assumption (2.2). The second part of the corollary follows from equations (2.10) and (4.1).

Q.E.D.

Corollary 2 *The optimal lump-sum tax for the lowest cost producer is the same under the forcing as under the linear mechanism.*

The production tax is decreasing in θ so that efficient high-output producers face a lower distortion than high-cost producers.

5. The Optimal Mechanism with Unobservable Competition

When marginal costs of the MNE's ROW subsidiaries are observable, the host country can implement a policy mechanism that induces the MNE to use ROW marginal cost as its internal transfer price. Since the host country, in this case, can infer the MNE's transfer price before designing its mechanism, the transfer pricing problem does not impose any restrictions on mechanism design other than the afore-mentioned exclusion of profit taxes.

In this section we assume that the marginal cost of the MNE's ROW subsidiaries is unknown to the host country government. It immediately follows that the host country now does not know the MNE's internal transfer price in advance. That is, the host country must now create a mechanism that induces the MNE to announce its transfer price (i. e., the marginal cost of its ROW subsidiaries). We try to make this point in as simple a way as possible by assuming that marginal costs in the host country and in ROW are perfectly correlated.[7] On economic grounds this can be justified by noting that it is quite likely that the MNE employs the same

[7] This preserves the costly nature of inducing the MNE to reveal additional information. In principle, however, the task of extracting information on (uncorrelated) local and foreign marginal costs is a multi-dimensional screening problem. In particular, there now is no one-to-one relationship between the subsidiary's type and output. That is, in order to induce the MNE to produce the output that would maximize profits for the reported type, the host country would have to observe additional choice variables of the MNE such as the quantity y or price $p(y)$ of final output, or x_r. Multi-dimensional screening problems are generally very hard to solve and clearly beyond the scope of this study. Nevertheless, multi-dimensional screening of MNEs might provide an interesting topic for future research.

kind of technology in all of its operations. Thus, if the MNE has high costs in the host country it is also likely to have high costs in ROW. ROW costs can now be represented by a constant marginal cost $w(\theta)$.[8]

The home country government levies no taxes or tariffs on either the x or the y sector. The transfer pricing problem associated with a proportional profit tax remains the same as above. We therefore restrict our analysis to tax schemes, such as lump-sum profit taxes, which do not distort the MNE's internal pricing decision. In addition to assumptions (2.1) to (2.9), which remain unchanged, the following will be assumed as well:

Assumptions:

(5.1) $w_\theta(\theta) > 0$ for all θ,

(5.2) $w_{\theta\theta}(\theta) > 0$ for all θ,

(5.3) $w_\theta(\theta) < c_{x\theta}(x(\theta);\theta)$.

Assumption (5.1) states that marginal cost in ROW is increasing in θ and assumption (5.2) states that the rate of this increase is positive. Assumption (5.3) represents an additional single-crossing property which guarantees that x is decreasing in θ, i. e., that low cost types produce a larger quantity of output than high cost firms.

[8] A lack of correlation may represent a case in which the MNE's ROW costs are influenced by tax policies or contracts implemented by ROW governments. This further increases the MNE's strategic possibilities to avoid tax payments. That is, in addition to claiming to operate a high cost subsidiary in the host country, the MNE may now also contend that its ROW subsidiaries are low cost (or pay low ROW taxes) and that therefore its outside opportunity is very profitable.

The MNE's profit is

$$\Pi(\Gamma(x,\theta);\theta) = NR(\theta) - w(\theta)x_r(\theta) - c(x(\theta);\theta) - \Gamma(x,\theta). \tag{5.1}$$

The host country maximizes tax revenue

$$\max_{\Gamma(-)} \int_{\theta^-}^{\theta^+} \Gamma(x,\theta)\ f(\theta)\ d\theta, \quad \text{subject to}$$

(IR) Individual Rationality

$$\Pi(\Gamma(x,\theta);\theta) \geq \Pi(w(\theta)),$$

where $\Pi(w(\theta))$ represents the firm's outside opportunity of purchasing all of x from its ROW subsidiaries at transfer price $w(\theta)$.

(SS) Self Selection

$$\Pi(\Gamma(x,\theta);\theta) \geq \Pi(\Gamma(x,\hat{\theta}),\hat{\theta};\theta),$$

where $x(\hat{\theta})$ maximizes the MNE's profit, given that $\hat{\theta}$ has been reported and

$$\Pi(\Gamma(x,\hat{\theta}),\hat{\theta};\theta) = NR(\hat{\theta}) - w(\hat{\theta};\theta)x_r(\hat{\theta}) - c(x(\hat{\theta});\theta) - \Gamma(x,\hat{\theta}). \tag{5.2}$$

The host country's first-best policy is similar to the one specified in the previous section. The MNE's profit is reduced to the outside opportunity payoff for no matter what type and the transfer price is set at the ROW subsidiary's marginal cost.

First-Best Policy

(i) $\Pi(\Gamma(\theta);\theta) = \Pi(w(\theta))$ for all θ, and

(ii) $\lambda = w(\theta)$.

The planner's problem can, with the obvious modifications, be set up as demonstrated in Proposition 1. The socially optimal output, $x^*(\hat{\theta})$, is then once again determined by the equivalent of equations (2.10) and (2.11). The optimal forcing mechanism under asymmetric information regarding both the MNE's cost and transfer price is summarized in the following proposition.

Proposition 4 *Under assumptions (2.1)-(2.7) and (5.1)-(5.3), the host country's optimal forcing mechanism is*

$$\Gamma(x,\theta) = \begin{cases} T(\theta), & \text{if } x = x^*(\theta); \\ \infty, & \text{otherwise,} \end{cases}$$

where

$$T(\theta) = NR(\theta) - w(\theta)x_r(\theta) - c(x(\theta);\theta) - \int_{\theta}^{\theta^+} [w_\theta(t)x_r(\theta) + c_\theta(x(t);t)]\, dt - \Pi(w(\theta^+)). \tag{5.3}$$

Proof: The proof is almost identical to the proof of Proposition 2.

A comparison of the tax rates under known and unknown transfer prices,

$$T(\hat{\theta}) = NR(\hat{\theta}) - wx_r(\hat{\theta}) - c(x(\hat{\theta});\hat{\theta}) - \int_{\hat{\theta}}^{\theta^+} c_\theta(x(t);t)dt - \Pi(w), \tag{3.1}$$

and

$$T(\theta) = NR(\theta) - w(\theta)x_r(\theta) - c(x(\theta);\theta) - \int_{\theta}^{\theta^+} [w_\theta(t)x_r(\theta) + c_\theta(x(t);t)]\, dt - \Pi(w(\theta^+)), \tag{5.3}$$

respectively, shows that with unknown transfer prices the host country has to expend additional resources to assess the potential rents that can be extracted from the MNE's operations. This suggests the following Corollary:

Corollary 3 *The forcing tax with unknown transfer prices is lower than the forcing tax under ex ante observation of transfer prices.*

6. Summary and Results

The optimal taxation of vertically and horizontally integrated MNEs by host governments differs considerably from the regulation of domestic firms. Host governments have jurisdiction over only a part of the MNE's operation. This allows the MNE to use transfer pricing in order to evade taxation by shifting profits to other affiliates in lower tax countries. The transfer pricing problem affects the optimal tax scheme in two distinctive and important ways: Firstly, even if the host country is able to infer the MNE's optimal transfer price - from known marginal costs in ROW - the possibility of transfer pricing still restricts the host country's choice of tax mechanism. Due to transfer pricing problems the optimal mechanism will generally employ lump-sum taxes which do not distort the MNE's pricing decisions. The optimal tax system reduces the highest-cost MNE's profit to its outside opportunity payoff. All other types of MNE earn a positive rent which is necessary to induce truthful reporting of cost. The host country might use a forcing mechanism to separate the different types of firm when the observed output is directly related to the MNE's intended output.

This type of mechanism is in line with the one developed by Prusa (1990). However, we refine this argument by noting that a forcing mechanism is not very realistic in the context of MNE investment: The host country is unlikely to be able to impose the same (transfer) price and quantity restrictions it might impose on a domestic public utility company. For example, if there are random shocks to the MNE's output, such forcing mechanisms do not work since the MNE would be penalized with positive probability even if it wanted to produce the output level desired by the host country. In this case, the optimal mechanism can be implemented through a combination of lump-sum tax and production levy. The lump-sum tax again eliminates the excess profit of the highest-cost MNE. The production tax is decreasing in cost reports and equal to zero for the lowest-cost producer.

Secondly, host countries may not be able in the absence of the relevant (but costly) inducements to compute the MNE's optimal transfer price, even if the government refrains from using transfer price distorting tax schemes. This is the case when the marginal costs of the MNE's subsidiaries in ROW are unknown. The host country is then forced to give up tax revenue to induce the MNE to report its transfer price truthfully. This shows that the regulation of MNEs is inherently more costly than that of a domestic firm. This result contrasts with Prusa (1990) who treats the MNE's subsidiary not unlike a domestic enterprise and arrives at the conclusion that Baron and Myerson's (1982) mechanism, designed for domestic firms, is almost directly applicable to MNEs.

Our conclusions seem particularly relevant in the context of FDI in less-developed countries. For these countries tax revenue probably represents the most important benefit of MNE activity. The design of optimal FDI taxation mechanisms is therefore of foremost importance. Our paper shows that the creation of such a mechanism might not be an easy task. Not only do less-developed countries lack the resources and the know-how to develop a sophisticated tax collection and auditing system, but the problem is further compounded by the specific difficulties associated with regulating FDI. Our analysis shows that tax revenue from a MNE is, in all probability, lower than the one the government could obtain from an otherwise identical local firm.

CHAPTER IV

THE OPTIMAL TAXATION OF THE JAMAICAN BAUXITE INDUSTRY: A CASE STUDY

1. Introduction

This chapter uses the case of the Jamaican bauxite industry in 1973 (before widespread nationalization) to study optimal FDI taxation. In particular, we want to apply the mechanisms developed in Chapter III to determine the usefulness and the practical applicability of tax schemes that evolve from the principal-agent literature (Laffont and Tirole, 1986, Baron and Myerson, 1982). The Jamaican bauxite industry in 1973, dominated by four North-American MNEs provides a very useful case study:[1] In 1974 the Jamaican government changed its tax structure from a corporate income tax to a production levy on bauxite in order to increase its share of the MNEs' rent. In addition to computing the tax revenue associated with the theoretical tax mechanisms discussed in Chapter III, this allows us to compare the theoretically optimal tax with the old and the new Jamaican tax regime. We can then judge whether the tax changes have brought Jamaica closer to the optimal incentive tax scheme. In fact, we conclude that the optimal tax scheme for Jamaica resembles a (more sophisticated) combination of the actual pre-1974 and post-1974 systems.

[1] Strictly speaking the optimal mechanism derived in Chapter III applies only to renewable resources since we are neglecting user cost from our analysis. However, in the case of Jamaican bauxite two reasons seem to justify this omission. Firstly, the abundant supply of bauxite, a clay, and the possibility of recycling aluminum limit the importance of bauxite stocks on actual policy making. Secondly, Jamaica's policy choices, which shall be contrasted here with the optimal mechanism, seem to have been motivated mostly by a desire to increase tax revenue and curb transfer pricing irrespective of the rate of extraction of bauxite over time.

In the 1970s the aluminum industry was dominated by vertically and horizontally integrated MNEs. Trade flows (mostly intra-firm) follow the traditional pattern of extraction of raw materials from developing countries (LDCs) for further processing in industrialized countries. In the case of the aluminum industry the raw material, bauxite, was produced in host LDCs, especially in the Caribbean. Some was processed into alumina, the intermediate product, the rest exported as is for processing in developed home countries, usually the United States.

The early 1970s were a period of increased tensions in host country-MNE relations in many natural resource industries. Near full capacity in many industrialized countries, coupled with high demand for natural resources, encouraged resource exporters to demand a larger share of the rents from their natural resources. Jamaica lobbied for the formation of a bauxite producer cartel, modelled on OPEC, with the expressed goal of shifting a larger share of the rents from the aluminum multinationals to the host countries. A cartel was finally formed in March 1974 under the name of International Bauxite Association. The original members were Jamaica, Surinam, Guinea, Guyana, Australia, Sierra Leone and Yugoslavia.

The Jamaican government led the way by imposing a production levy on bauxite, effective 1st January 1974, in lieu of its corporate income tax. The levy was a specific tax per ton of produced bauxite, tied to the world price of aluminum (the finished product) as set on the London Metal Exchange (initially set at 7.5 percent of the aluminum price), and payable in U.S. dollars. The levy payments were reduced by 50 percent when production reached more than 70 percent of installed capacity. Revenues from the levy were thus automatically tied to changes in world aluminum prices and Jamaican bauxite production, variables which could be easily monitored by the Jamaican government.

Starting in 1975, Jamaica also nationalized 51 percent of bauxite-alumina facilities that were in current production, and 100 percent of currently unused properties of the aluminum MNEs. Other, but not all, members of the International Bauxite Association (IBA) followed with nationalizations (Guyana) and somewhat lower levies (Guinea, Surinam). (See Banks, 1979, pp.68-69; Commonwealth Secretariat, 1983, p.48; Davis, 1980; and Gillis and McLure, 1975.)

Jamaica's levy policy was extremely successful—in the short run. Tax revenues from bauxite and alumina operations rose by 450% in nominal terms in the first year of the levy. Other IBA members were also able to obtain a much larger share of the aluminum MNEs' rents. The initial apparent success of the host countries soon evaporated, particularly for Jamaica. The failure of all IBA members to institute the same levy policy meant that the MNEs could turn elsewhere for supplies. The MNEs' reaction to Jamaica's levy policy was swift. While world bauxite output slightly increased between 1973 and 1976, Jamaica's bauxite production sank from 13.6 million (metric) tons to 10.31 million tons. During the same period ROW's output rose from 21.21 million tons to 26.07 million tons. U.S. production remained almost unchanged.

As bauxite production and exports in Jamaica fell, its balance of payments worsened. The devaluation of the Jamaican currency caused the cost of the production levy, payable in U.S. dollars, to rise sharply; a vicious circle that discouraged production in Jamaica. In addition, the recession that began in late 1974 reduced demand for bauxite and alumina at the same time that higher energy prices were making production more expensive. Jamaica, as an oil importer, was especially hurt by the oil shock. The net result was a severe drop in production by the IBA leaders, most notably Jamaica. The Jamaican government was forced to reduce the levy (to 6 percent after 1984) to deter a growing number of MNE exits from the country (Davis, 1980; James, 1984).

2. The International Aluminum Industry

The aluminum industry consists of three production stages: the extraction of bauxite, its refining into alumina, and the smelting of alumina into aluminum ingots. The market structure of the first three stages is a tight oligopoly of six vertically and horizontally-integrated multinational enterprises; in 1978/79 the "Big Six" produced more than 50 percent of Western output (Litvak and Maule, 1984, p.98). Four of these six MNEs, Alcoa, Alcan, Kaiser and Reynolds, had subsidiaries in Jamaica in 1973. Their shares of total bauxite capacity were approximately Alcoa (32%), Alcan (27%), Reynolds (22%) and Kaiser (19%), respectively (Moment, 1978).

At the upstream stages, bauxite and alumina, most trade is intrafirm trade between MNE affiliates carried on at transfer prices set by the multinationals. Aluminum is sold on the world market. In general, the pattern of trade is the typical "old industrial division of labor" one of multinationals producing bauxite in the LDCs for export to the industrialized countries for further processing ar l sale.

The International Bauxite Association, formed in March 1974, controlled 62 percent of mine production (about 60 million tons) and 63 percent of world bauxite reserves (Gillis and McLure, 1975, p.392; Banks, 1979, p.68). In 1972 at the bauxite stage five of the seven members of the IBA accounted for 70 percent of world bauxite production: Australia (25 percent), Jamaica (22 percent), Surinam (12 percent), Guyana (6 percent) and Guinea (5 percent), with total output evenly split between developed and developing countries. (The U.S. share of bauxite production was 3 percent.)

At the downstream stages, however, the IBA had a smaller share of output. In terms of alumina, developed OECD countries represented 75 percent of production capacity (29 percent in the U.S., 15 percent in Australia), with Jamaica the largest

LDC at 12 percent (Surinam 5 percent, Guinea 3 percent). IBA members did account for more than 75 percent of exports to the United States. At the aluminum stage, the IBA produced a negligible amount while the developed OECD countries controlled 90 percent of capacity (40 percent in the U.S. and 2 percent in Australia) with India the largest LDC at 2 percent (none in Jamaica or Guinea, 0.6 percent in Surinam). (See Gillis and McLure, 1975, p.393; Litvak and Maule, 1975, pp. 643-5.)

3. A Simulation Model of U.S. Aluminum Multinationals

In order to compare the impacts of the optimal tax mechanism and Jamaica's actual tax policies on bauxite output and tax revenue we adapt the theoretical model developed in Chapter III to the aluminum industry structure. The model is then calibrated to 1973 aggregate cost and output data gathered by Eden and Raff (1989) for their study of transfer pricing in response to Jamaica's tax policy changes.

There are three countries, Jamaica, the United States and ROW (consisting of Australia, Guinea and Surinam).[2] Total "world" bauxite production in 1973 was 36.72 million tons shared by Jamaica (37 percent), US (5 percent) and ROW (58 percent). All production in our model is assumed to be carried out by four "U.S." MNEs with bauxite subsidiaries in all three countries and both alumina and aluminum production concentrated in the United States. Also, each MNE imports bauxite from all of its subsidiaries.[3] Accordingly, total 1973 "world" output of baux-

[2] ROW does not include Guyana, another major bauxite supplier, because it produces calcined bauxite which is different from that produced in Jamaica, and 60 percent of its output was sold to Canada whereas almost all Jamaican bauxite was sold to the United States in the 1970s (Banks, 1979, p. 64).

[3] In practice, more than half of Jamaica's bauxite output was exported to the US, the rest used locally in alumina production; all US production was used internally;

ite is assumed to be equal to the U.S. MNEs' bauxite demand at the MNEs' internal transfer price of P_x. Given that the MNEs transform all of their bauxite into alumina and all of their alumina into aluminum, aggregate alumina and aluminum output can then be deduced from bauxite production.[4]

Three factors of production are used in the production of bauxite: capital K, labor L and energy E. Cost estimates are generated from CES production functions. The MNEs' Jamaican subsidiaries produce bauxite with a decreasing returns to scale technology. These decreasing returns to scale are introduced through a parameter θ, where $\theta > 1$, in the CES production function

$$x(J) = [a_{K_x} K^{-\rho_x} + a_{L_x} L^{-\rho_x} + (1 - a_{K_x} - a_{L_x}) E^{-\rho_x}]^{-1/(\theta \rho_x)}. \qquad (3.1)$$

where a_{K_x}, a_{L_x} and $(1 - a_{K_x} - a_{L_x})$ are distribution parameters for capital, labor and energy inputs, respectively.[5]The labor parameter, for instance, is given by

$$a_L = \frac{wL^{1+\rho_x}}{wL^{1+\rho_x} + rK^{1+\rho_x} + eE^{1+\rho_x}},$$

where w, r, e represent the prices of labor, capital and energy, respectively.[6]The parameter ρ_x is set to unity in our simulation (between Cobb-Douglas and Leontief), reflecting only limited possibilities for substitution between the three factors.

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and minimal ROW bauxite production was exported to the US. Jamaica sold all of its alumina to the US; the US used all of its alumina output locally and a majority of ROW alumina was also destined for the US. However, since the costs of alumina refining (including the costs of shipping the alumina to the U.S.) were approximately the same in ROW and the U.S., our trade flow assumption does not change global MNE profits and therefore has no significant effect on Jamaica's potential tax revenue.

[4] 2.4 tons of bauxite are required to produce one ton of alumina and 1.9 tons of alumina yield one ton of aluminum.

[5] See Layard and Walters (1978, Ch.9) on three-factor CES production functions.

[6] As ρ_x goes to zero the CES production function approaches a constant returns to scale Cobb-Douglas production function irrespective of θ. Also, the distribution parameters then become cost shares.

In general, the Jamaican government has knowledge only of aggregate bauxite industry data. However, from this aggregate information it can create a "standard" MNE subsidiary: It observes the number of MNEs operating in the bauxite industry (four) and total industry output, 13.60 million tons in 1973. It can therefore establish an average subsidiary size of $\hat{x} = 3.4$ million tons. Given aggregate data on wages, capital and energy costs, as well as on employment, energy consumption and capital inflows and an estimate of ρ_x, the Jamaican government should supposedly be able to generate some prediction of production costs for an average bauxite subsidiary.

It can use its estimate of the production function, (3.1), and average output to derive the θ of a typical subsidiary. We find an industry average of $\theta = 1.09356$. Evidently, individual subsidiaries can be more (or less) productive than the industry standard. However, it is reasonable to assume that the Jamaican government does not have access to enough detailed company data to assess the exact θ of each MNE.[7] θ thus remains private knowledge of the MNE, but the government can probably establish likely upper bounds, θ^{+}, and lower bounds, θ^{-}, for θ. For the purposes of our simulation we assume that the Jamaican government's prior beliefs about θ are given by a uniform distribution around a mean of 1.09356. In our simulation we provide the optimal tax revenue for the lowest and for the highest cost subsidiary assuming several different values for the boundaries.

The cost function for Jamaica's bauxite industry is

$$c(\hat{x}(\theta);\theta) = [\hat{a}_{K_x}^{\sigma_x} r_x^{1-\sigma_x} + \hat{a}_{L_q}^{\sigma_x} w_x^{1-\sigma_x} + (1-\hat{a}_{K_x}-\hat{a}_{L_x})^{\sigma_x} e_x^{1-\sigma_x}]^{1/(1-\sigma_x)} \hat{x}^{\theta}, \quad (3.2)$$

where $\sigma_x = 1/(1+\rho_x)$, r is the return to capital, w the wage rate and e the price

[7] The nationalizations of 1975 might have helped improve the government's information. Such measures seem, however, somewhat drastic when they are only intended to obtain more detailed information.

of energy.[8]

The marginal production cost is

$$c_x(x(\theta);\theta) = \theta[\hat{a}_{K_x}^{\sigma_x} r_x^{1-\sigma_x} + \hat{a}_{L_x}^{\sigma_x} w_x^{1-\sigma_x} + (1-\hat{a}_{K_x} - \hat{a}_{L_x})^{\sigma_x} e_x^{1-\sigma_x}]^{1/(1-\sigma_x)} \hat{x}^{(\theta-1)}. \quad (3.3)$$

The cost function of this type satisfies assumptions (2.1) to (2.5) of Chapter III as long as bauxite output, $\hat{x}$, is greater than one ton.[9]

The U.S. price of bauxite for each MNE is P_x. Again, there only exists aggregate data so that we assume that P_x is the same for all four MNEs. We also assume that the MNEs take P_x as their internal transfer price. The cost function together with the U.S. price of bauxite and transportation costs between Jamaica and the U.S. allows us to compute the expected rents created by a standard bauxite mining subsidiary in Jamaica:

$$\Pi(\theta) = (w - c(\hat{x}(\theta), \theta))\hat{x}(\theta). \quad (3.4)$$

The rent is given by the area between the U.S. price of bauxite (minus transportation costs between Jamaica and the U.S. of $2.10) and the marginal cost curve of the Jamaican subsidiary.

Under the optimal mechanism the Jamaican government must restrict the MNE's output to a level below the profit maximizing level for all but the most efficient firm. This helps induce MNEs to report their true costs. In particular, the socially optimal output, x^* is determined by (See Proposition 1 of Chapter III)

$$P_x - c_x(x(\theta), \theta) - (\theta - \theta^-)c_{\theta x}(x(\theta); \theta) = 0, \quad (3.5)$$

[8] When $\sigma = .99$ $(\rho \approx 0)$, the cost functions are Cobb-Douglas with smoothly shaped isoquants and unit elasticity of substitution between inputs. When $\sigma = .01$ $(\rho \approx \infty)$, the cost functions are Leontief; i.e., the isoquants are right angles with no possibility of substitution between inputs in response to a factor price change. In our case $\sigma = 0.5$, the intermediate case.

[9] This restriction seems not very severe given that we are dealing with millions of tons of bauxite.

The social optimum can be implemented via a forcing tax (Proposition 2 of Chapter III),[10]

$$T^f(\hat{\theta}) = (w - c(x^*(\hat{\theta}); \hat{\theta}))x(\theta) - \int_{\hat{\theta}}^{\theta+} c_\theta(x(t); t)dt - \Pi(w), \tag{3.6}$$

where $\hat{\theta}$ is the cost report. When bauxite production is subject to random (zero mean) errors, a forcing contract cannot be used. Let $\hat{z}$ denote the average subsidiary's expected output and let z^* denote socially optimal expected output, defined by the equivalent of (3.5). Then, the Jamaican government can implement a linear mechanism (Proposition 3 of Chapter III) that specifies a levy,

$$t(\hat{\theta}) = [w - c_z(z^*(\hat{\theta}); \hat{\theta})], \tag{3.7}$$

and a lump-sum tax

$$T^l(\hat{\theta}) = (w - c(z^*(\hat{\theta}); \hat{\theta}))z^*(\theta) - t(\hat{\theta})z^*(\hat{\theta}) - \int_{\hat{\theta}}^{\theta+} c_\theta(z^*(t); t)dt - \Pi(w). \tag{3.8}$$

[10] See Chapter III for proofs and Appendix III for a detailed description of the calculations.

4. Simulation Results

Since all factors of production are assumed to be mobile in this simulation, the results outlined below reflect a long run scenario with shifts in subsidiary locations. The perfect mobility of capital represents a bias of the simulation results in favor of tax mechanisms, like the optimal tax scheme, that do not distort the MNEs' location decision. For this reason the tax revenues generated in this study cannot be compared with Jamaica's actual (short-term) tax revenue.

Note that we have modeled only Jamaica, not ROW, as introducing the levy. This probably overestimates the levy's negative impact on Jamaica since other members of the IBA did also raise taxes at the same time. However, the Jamaican rate was far in excess of the others and close competitors took advantage of the opportunity to undercut Jamaica. Table I provides a summary of the long run effects on output and tax revenue of the optimal mechanism, the pre-1974 Jamaican corporate income tax and the production levy. Table II summarizes the data used in the simulation.[11]

[11] All data sources for this section are described in the appendix.

Table I: Simulation Results

[illegible] 09356		CIT (21.3%)		Forcing Contract		Linear Contract			
[illegible]		Output MM tons	Tax Revenue MM $	Output MM tons	Tax Revenue MM $	Output MM tons	Levy Rate $	Lump-sum Tax MM $	Total Tax Revenue MM $
θ^- θ^+	1.09306 1.09406	3.70 3.12	0.71 0.71	3.70 2.65	3.93 2.87	3.70 2.65	0.0 0.19	3.93 2.36	3.93 2.87
θ^- θ^+	1.09256 1.09456	4.04 2.87	0.66 0.66	4.04 2.08	4.26 2.29	4.04 2.08	0.0 0.37	4.26 1.51	4.26 2.29
θ^- θ^+	1.09206 1.09506	4.41 2.64	0.61 0.61	4.41 1.65	4.63 1.85	4.41 1.65	0.0 0.54	4.63 0.95	4.63 1.85
θ^- θ^+	1.09106 1.09606	5.27 2.24	0.52 0.52	5.27 1.07	5.48 1.24	5.27 1.07	0.0 0.86	5.48 0.33	5.48 1.24
θ^- θ^+	1.09006 1.09706	6.32 1.91	0.45 0.45	6.32 0.71	6.51 0.86	6.32 0.71	0.0 1.14	6.51 0.05	6.51 0.86
θ^- θ^+	1.08906 1.09806	7.61 1.64	0.39 0.39	7.61 0.49	7.76 0.62	7.61 0.49	0.0 1.39	7.76 -0.06	7.76 0.62
θ^- θ^+	1.08806 1.09906	9.21 1.40	0.34 0.34	9.21 0.34	9.29 0.45	9.21 0.34	0.0 1.63	9.29 -0.11	9.29 0.45

Table II: Summary of the Data

1973	Jamaica	U.S.	Row
Bauxite			
Output (MM tons)	13.60	1.91	21.21
U.S. Bauxite Price ($/ton)	-	14.56	-
Transportation Cost to U.S. ($/ton)	2.10	-	2.30
Taxes			
Corporate Income Tax (%)	21.30	45.00	30.00
Bauxite Levy ($/ton)	8.51	0.00	0.00
Input Prices			
W ($/hour)	1.19		
r ($/unit)	1.14	1.14	1.14
e ($/unit)	1.00		
Input Quantities (average Jamaican subsidiary)			
L (MM man hours)	1.93		
K (MM units)	3.62		
E (MM units)	1.20		

Parameters: $\rho = 1$; $E\theta = 1.09356$

Jamaica's pre-1974 corporate income tax (21.3%) does not induce the MNE to reveal its true costs. Thus, an efficient subsidiary will always misreport profit by overst-ting its costs. In the extreme case, illustrated in Table I, every subsidiary—independent of its true costs—claims to be of the least efficient type and, therefore, pays that type's income tax. At the same time it continues producing the profit maximizing output level corresponding to its true type. The 1974 production levy on bauxite, which amounted to \$8.51 per ton for 1973 data, completely erodes Jamaica's competitiveness and reduces bauxite production in Jamaica to a negligible amount in our long-run simulation. This latter result is, of course, in contrast to the actual short-run effect of the levy on Jamaica's tax revenue. Jamaica's actual tax revenue rose by more than 450% from 1973 to 1974 in nominal terms. In later years, however, the government had to reduce the levy rate to counter a growing number of MNE exits.

Taking the second entry in Table I, upper and lower bounds of $\theta^+ = 1.09456$ and $\theta^- = 1.09256$, respectively, we come to the following conclusions. A MNE's profit maximizing output varies between 2.87 million metric tons and 4.04 million metric tons, depending on its efficiency. Jamaica's pre-1974 21.3% corporate income tax amounts to \$0.66 million for the highest cost firm. All other subsidiaries likewise claim high costs and pay the same tax. Clearly, there exist opportunities to improve upon this outcome. As has been mentioned above the imposition of a high and indiscriminate production levy is no solution for the long run even if it might raise short-term tax receipts dramatically. Two alternatives remain, the forcing contract and the linear contract, both of which yield the same tax revenue in equilibrium. What distinguishes these two mechanisms is implementation of Jamaica's social optimum.

With a forcing contract the government has to calculate the socially desired bauxite output for each type of MNE. For the lowest cost producer the socially optimal and the profit maximizing output coincide (4.04 million tons): It is not beneficial to distort the output choice of the most efficient subsidiary. Higher cost MNEs, however, face quantity restrictions. In particular, the highest cost producer must produce an output of only 2.08 million tons, which is substantially lower than its profit maximizing level (2.87 million tons). Firms have to pay lump-sum taxes (extraction licenses) and are penalized if they deviate from their output targets. The most efficient MNE pays a tax of $4.26 million and the least efficient one a tax of $2.29 million. That is, the lowest cost firm pays about six times more in taxes than under the old corporate income tax regime. For the highest cost firm the tax bill under the forcing contract is still around three times as high than under the 21.3% income tax.

Under the linear tax scheme output and total tax revenue are the same as under the forcing mechanism. But the enforcement of output restrictions is more realistic. Production levies induce the subsidiaries to reduce their output voluntarily. Evidently the government does not want to impede the production of efficient firms and therefore imposes low levies (a zero levy on the most efficient operation). The highest cost subsidiary pays a levy of 37 cents, much below Jamaica's actual levy. Levy revenues from the highest cost producer amount to $780,000.00 and the lump-sum tax to $1.51 million for a total revenue of $2.29 million.

As our results in Table I show, the optimal production levy always stays in the same order of magnitude even for considerable changes in θ. This is encouraging. It suggests that there is, in practice, a substantial margin for error in estimating the differences in production costs. As long as the tax progression is retained, the basic incentive structure remains intact even when the exact optimal levy rates cannot be found.

Even if the Jamaican government ignored the information problem and settled on a pooling mechanism where the MNEs did not reveal their types, it could still increase its share of the MNEs' rent by a considerable margin by imposing the optimal tax for the highest cost report. However as a comparison between the optimal tax revenues of the most and the least efficient firm shows, potentially large gains could be made by inducing truthful reporting of cost by imposing an appropriate levy structure.

5. Summary and Results

In this chapter we analyzed Jamaica's attempt in 1974 to increase its share of the bauxite MNEs' profits by substituting a production levy for its corporate income tax. We modelled the aluminum industry as being dominated by four vertically and horizontally integrated MNEs with bauxite producing subsidiaries in Jamaica and ROW and downstream processing facilities for alumina and aluminum located in the United States, the MNEs' home country. The production technology for bauxite was characterized by a decreasing returns to scale CES production function for Jamaica. The ROW subsidiaries supplied bauxite at a constant price, reflecting the fact that the MNE has access, in the long run, to large bauxite reserves in various countries representing ROW. The subsidiaries' profits were assumed to be repatriated to the United States where they are subject to a 45% corporate income tax.

Asymmetric information was introduced through a parameter θ measuring the degree of homogeneity of the bauxite production function. θ was assumed to come from a uniform probability distribution with mean 1.09356.

Our analysis of Jamaica's tax system indicates that under the pre-1974 tax regime Jamaica's share of the MNEs' profits was indeed very low. There appear to be two reasons: a surprisingly low tax rate of only 21.3% (compared to the U.S. rate of 45%) and misreporting of true profits. As a first step the Jamaican government should therefore probably have raised its CIT rate to the U.S. level to take advantage of its first crack at the subsidiaries' profits. Instead, the Jamaican government opted for the short-term measure of imposing a production levy on bauxite. This levy gave an immediate boost to tax revenue at the expense of Jamaican bauxite's long-run competitiveness. Only a few years later Jamaica had to actually reduce its levy to stop the decline in bauxite output and prevent the number of exits from the industry.

Optimally the Jamaican government should have implemented a profit tax and a non-linear production levy. The levy should have been equal to zero for the lowest-cost MNE but positive for the highest-cost MNE so as not to distort output of the efficient firm.

We conclude that, since the actual levy introduced by the Jamaican government in 1974 was in fact non-linear in output, Jamaica should probably not have traded one tax regime for the other but rather kept and increased its CIT, and added a much lower but more progressive production tax.

CHAPTER V

TAX HOLIDAYS, TARIFFS AND FOREIGN DIRECT INVESTMENT UNDER ASYMMETRIC INFORMATION

1. Introduction

The expansion of a MNE into a new country is often impeded by a lack of information regarding local market conditions. Clearly, such information problems should be reflected in the MNE's choice between FDI and exporting, and in host country policy toward FDI. In particular, the risk of investing in a host country whose market might turn out to be too small to guarantee an appropriate return on investment is likely to bias the MNE's decision toward exporting from an existing home country plant. Host countries might thus have to actively encourage FDI to counteract the effects of incomplete information. Two means of FDI inducement stand out in the empirical and theoretical literature: tariff walls and investment incentives, such as tax holidays. Caves (1982) lists abundant empirical evidence for the importance of tariff walls in explaining cross-country patterns of FDI and for the use of direct investment incentives. In their study of foreign investment in less developed countries (LDCs) Reuber et al. (1973, pp. 120–127) list tax holidays, tariff reductions, capital subsidies, and the provision of infrastructure by the host country as the most frequently applied incentive schemes.

In the theoretical literature, tariff walls and direct incentives have so far been treated as separate strategies. On the one hand, papers investigating the effect of government policy on a MNE's choice between FDI and exporting (most recently Brander and Spencer, 1987, and Horstmann and Markusen, 1987) discuss tariff walls but do not discuss positive incentives for FDI. Models of investment incentives (such as King, McAfee and Welling, 1990, Mintz, 1989, Bond and Samuelson, 1986), on the other hand, stress competition between host countries or between regions of a single country as the principal determinant of such incentives and ignore their effect on a MNE's choice between FDI and exporting.

Most empirical studies of FDI incentives (e. g., Mintz, 1989, and Guisinger, 1985) follow this theoretical approach and interpret observed incentives as a sign of competition between governments. However, in some cases this causes curious theoretical problems: Roughly half of the FDI projects surveyed by Guisinger, 1985, for the World Bank were set up to serve a specific domestic market. By definition, competition between countries cannot explain the government incentives that were observed in these cases. Instead, incentives, such as tax holidays, must be aimed at influencing the MNE's FDI versus exporting decision. This suggests that, in fact, tariff walls and tax holidays might serve complementary purposes and should therefore be examined together in a more comprehensive model.

We use a dynamic signaling game to investigate the effect of incomplete information on the endogenous choices of both tax and tariff policy and MNE investment strategy: We solve this game for perfect sequential equilibria and map the equilibrium outcomes into investment cost/exporting cost space to provide predictions regarding government policy and investment strategy combinations. We show that the existing dichotomy between tax and tariff policy can only be maintained under complete information. If there is incomplete information about host country demand, tariff walls alone do not always constitute an optimal policy. Instead, tax holidays might have to be added to provide an optimal mix of tax and tariff policy.

Our analysis builds on the existing literature in the following ways: Brander and Spencer (1987) provide a one-shot complete information model of tariff wall jumping. They show that with complete symmetry between FDI and exporting (in particular with identical costs) the inducement of FDI through high tariffs is only credible if there is a positive externality associated with FDI but not with exporting. In their model the externality results from unemployment in the host country. FDI reduces unemployment, exporting does not. In Brander and Spencer's complete information model taxes and tariffs are isolated events: A policy is chosen only after the MNE has decided on its strategy and its capital stock. This means that taxes and tariffs are not chosen simultaneously in equilibrium: Along the equilibrium path the host country imposes an optimal tax while the tariff wall serves as (credible) off-equilibrium threat. That is, only if the MNE deviated to exporting, would a tariff policy ever be announced. Their model also does not provide any predictions regarding equilibrium policy and investment strategy outcomes. Rather it is fixed, due to the symmetry assumption, on the 45 degree line in investment cost/exporting cost space.

In our study, taxes and tariffs are chosen simultaneously and announced before the MNE's investment decision. Tariffs (and taxes) therefore are actually (not just hypothetically) chosen along the equilibrium path and explicitly enter into the MNE's investment decision. Tariff walls in our model are credible because they come in a "package" with tax rates. We also identify parameter regions in which FDI is induced by tariff walls alone and others where FDI is induced by a combination of tariff wall and tax holiday.

Bond and Samuelson (1986) examine a situation in which a MNE must choose between investing in a host country (where productivity is private information of the government) and investing in the home country (where productivity is known) to produce goods for sale to a third market (world market). That is, there is competition between countries for FDI, although the home government remains passive. High productivity host countries use tax holidays to signal their type in order to attract FDI from the home country. Tax holidays work as signals and therefore might help induce FDI only because they represent a verifiable cost to the host country (They provide the MNE with excess profits).

In our model, tax holidays also serve as signals but they are only one part of an equilibrium strategy which also includes tariff walls. We show that due to their costly character tax holidays are used much less extensively if there is a choice between FDI and exporting than if there is competition between countries for FDI as in Bond and Samuelson. Since tax holidays are only used in combination with tariff walls they never become so high as to turn the first-period tax rate negative. Furthermore, with incomplete information tariff walls lead to FDI over a much larger area of the parameter space than under complete information. Ex post, some MNEs therefore make losses on their FDI.

Furthermore, our research suggests a way of improving the definition of "incentives" by including tariff walls. This might help resolve the confusion in the empirical literature about the effectiveness of investment incentives: Guisinger (1985, p. 74) finds that in two-thirds of the cases studied incentives played a dominant role in the MNE's location decision. Reuber (1973, pp. 120–127) comes to a different conclusion. In his view, MNEs do not seem to put much weight on tax holidays in their investment choice.

2. The Model

We model a situation in which a host country bargains with a MNE over the division of rents that could be realized by the MNE in the host country market. The host country government knows market demand and at the beginning of period one announces a tax and tariff policy.[1] The MNE then tries to infer information from the government's policy and reacts by choosing between FDI and exporting from an existing home country plant. In the second period taxes and tariffs are renegotiated. If it has exported in the first period, the MNE must again choose between FDI and exporting. If investment has already occured in the first period, the MNE must then decide whether to stay or to leave and export.

The asymmetry of information is introduced in the following way: In each period the revenue from sales in the host country is $R_i(x)$, where x denotes the quantity of output and i the type of the host country. Revenue is either high, $i = h$, or low, $i = l$. We make the following assumptions:

Assumptions:

(A1) $R_h(x) > R_l(x)$, for all $x > 0$,

(A2) $R'_h(x) > R'_l(x)$, for all x,

(A3) $0 > R''_h(x) > R''_l(x)$, for all x.

In particular, the type h country has a strictly higher demand for x than the l type country. The MNE's prior beliefs about the host country's type are

[1] Factors contributing to the asymmetric information might include government purchases of the product (procurement policy) and cultural aspects which influence consumption patterns. Changes in the host government's economic policy such as the introduction of structural adjustment measures or social programs affect consumers' budget constraints and therefore also have an effect on market demand.

$\delta_h = prob(i = h)$ and $(1 - \delta_h) = prob(i = l)$. In the rest of the paper l and h will denote the type l country and the type h country, respectively. At the beginning of each period the host government announces taxes and tariffs. The MNE then uses Bayes' rule to update its beliefs to conform with the information revealed by the policy announcement. Updated beliefs are denoted by μ_h and $(1 - \mu_h)$. Given its beliefs the MNE chooses between (i) exporting, (ii) FDI, and (iii) staying home to pursue an outside opportunity. If it has invested in the first period, the MNE must decide in the second period between staying or leaving the host country. If it opts for leaving, it must then choose to export or to revert to the outside opportunity. If the MNE has exported in the first period, it faces the second period alternatives of continuing to export, investing in the host country, or taking the outside option.

Information is disseminated in the following ways. If the two types of host country select different policy mechanisms, the separation case, then the MNE learns the size of the market, i. e., $\mu_h = \{0, 1\}$, before choosing between FDI, exporting and the outside opportunity. If the two types adopt the same tax/tariff combination, the pooling case, then $\mu_h = \delta_h$ and the MNE has to decide on a strategy before observing the exact market size. If the MNE selects either FDI or exporting, it learns the host country's type in the first period and the second period becomes a complete information subgame. If the firm takes the outside opportunity, the type of the host country is not revealed and the second period again exhibits incomplete information.

The MNE's technology is characterized by a plant-specific fixed cost, F, and a constant marginal cost, c, which are identical across countries. The firm's fixed investment lasts for two periods; there is no depreciation. The discount factor, D, is the same for both host country and MNE. The MNE already operates a plant in the home country, so exporting does not require any additional capital investment.

However, there are transportation costs of s per unit of output.

The host country maximizes tax and tariff revenues, which are redistributed lump-sum to a representative consumer, and consumer surplus. Ignoring income effects we denote consumer surplus by $B_i(x_{ji})$, $j = 1,2$ and $i = h,l$, where j is the time index and i denotes the type of the host country. Let

(A4) $B_h(x) > B_l(x)$ for all x, $dB/dx > 0$ and $d^2B/dx^2 > 0$.

The host government's policy instruments include a lump-sum tax on profit, T_{ji}, and a lump-sum tax on imports, Γ_{ji}, where $j = 1,2$ and $i = h,l$.[2]

In the case of FDI the MNE chooses its output according to

$$\max_{x_{ji}} E\{R_i(x_{ji}) - cx_{ji}\}. \tag{2.1}$$

Given transportation costs of s, the MNE's maximization problem in the exporting case is

$$\max_{x^E_{ji}} E\{R_i(x^E_{ji}) - (c+s)x^E_{ji}\}. \tag{2.2}$$

For notational convenience we define

$$\Phi_{ji} \equiv \max\{R_i(x_{ji}) - cx_{ji}\} \quad \text{and} \quad \Phi^E_{ji} \equiv \max\{R_i(x^E_{ji}) - (c+s)x^E_{ji}\}.$$

We also note that with lump-sum taxes output, Φ_{ji}, Φ^E_{ji}, and consumer surplus will be the same in both periods. In the remainder of the paper we therefore drop the time subscripts for the Φ's and consumer surplus where possible without creating confusion.

[2] The choice of a lump-sum profit tax over the more realistic proportional profit tax does not change the results of the model but considerably facilitates the exposition of the equilibrium structure. The assumption of a lump-sum tariff makes the exporting side of the model tractable without, we believe, compromising the relevance of our results.

We also make the following assumptions:

(A5) $(\Phi_h - \Phi_h^E) > (\Phi_l - \Phi_l^E)$,

(A6) $(B_h - B_h^E) > (B_l - B_l^E)$.

Assumption (A5) states that it is always more profitable to invest in h than in l. In particular, if it is profitable for the MNE to invest in l, then it must also be profitable to invest in h. Assumption (A6) indicates that consumers in h benefit more than consumers in l from the MNE's choice of FDI over exporting. That is, in terms of consumer surplus h has more incentive to induce FDI than l.

With complete separation of host country types the MNE's single-period profit from investment is

$$\Pi_{ji}^I = \Phi_i - F - T_{ji}^S, \qquad \text{for } j = 1,2,\ i = h,l, \tag{2.3}$$

while exporting provides after-tax profits of

$$\Pi_{ji}^E = \Phi_i^E(s) - \Gamma_{ji} \qquad \text{for } j = 1,2,\ i = h,l \tag{2.4}$$

per period. Without loss of generality, the outside opportunity payoff is scaled down to zero.

Single-period expected FDI profits in a pooling equilibrium are

$$\Pi_{jp}^I = \delta_h \Phi_h + (1 - \delta_h)\Phi_l - F - T_{jp}, \qquad \text{for } j = 1,2. \tag{2.5}$$

The equivalent expression for exporting profits is

$$\Pi_{jp}^E = \delta_h \Phi_h^E(s) + (1 - \delta_h)\Phi_l^E(s) - \Gamma_{jp}, \qquad \text{for } j = 1,2, \tag{2.6}$$

where T_{jp} and Γ_{jp} represent h's and l's common pooling tax and entry fee.

In the second period the size of the host country market is known to the MNE only if there has been separation in the first period and/or the MNE has invested in or exported to the country in the first period. If the firm has invested in the first period and incurred the fixed cost, F, and if it decides to stay, its second period FDI profit is

$$\Pi_{2i}^{S} = \Phi_i - T_{2i}^{S}, \qquad \text{for } i = h, l. \tag{2.7}$$

If the host country has chosen a pooling strategy in the first period and the MNE has taken the outside opportunity, then the MNE is still uninformed about market size in the second period. In this case we could theoretically still have a second-period pooling equilibrium with payoffs given by (2.5) and (2.6).

If the MNE has chosen exporting or FDI in the first period and/or the host country has selected a separating strategy, then all information problems are resolved and in the second period both types of host country will use their tax and tariff policy to appropriate all of the firm's rent and reduce profits to zero. The maximum second period tax for which the MNE will stay in the country is

$$\bar{T}_{2i}^{S} = \Phi_{2i}, \qquad \text{for } i = h, l. \tag{2.8}$$

The MNE will only enter in the second period if taxes are below

$$\bar{T}_{2i}^{I} = \Phi_i - F, \qquad \text{for } i = h, l. \tag{2.9}$$

Furthermore, second period export will only occur if entry fees are no higher than

$$\bar{\Gamma}_{2i} = \Phi_i^{E}(s) \qquad \text{for } i = h, l. \tag{2.10}$$

From the MNE's point of view the present value of expected second period profits will be equal to zero for every type of country and all first period strategy choices. The MNE's first-period strategy choice therefore depends only on expected period one profits as described by equations (2.3) to (2.6). The maximum tax and entry fee a host country could charge in the first period are the ones that reduce the MNE's expected first period profit to zero. For the separation case the maximum tax rate is

$$\bar{T}_{1i} = \Phi_i - F, \qquad \text{for } i = h, l. \tag{2.11}$$

In a pooling equilibrium the maximum tax rate is

$$\bar{T}_{1p} = \delta_h \Phi_h + (1 - \delta_h)\Phi_l - F. \tag{2.12}$$

The highest entry fee the host country can charge is

$$\bar{\Gamma}_{1i} = \Phi_i^E(s) \qquad \text{for } i = h, l \tag{2.13}$$

in a separating equilibrium and

$$\bar{\Gamma}_{1p} = \delta_h \Phi_h^E(s) + (1 - \delta_h)\Phi_l^E(s) \tag{2.14}$$

in a pooling equilibrium.

3. Taxes and Tariffs with Complete Information

In this section we investigate endogenous tax and tariff policy under complete information to obtain a benchmark to assess the impact of asymmetric information on optimal tax/tariff combinations and the timing of FDI. With complete information one can solve the above model for subgame perfect equilibria (Selten, 1965).

We first look at the period two subgame. In the second period each type of host country sets the maximum tax rates and entry fees to extract all of the MNE's surplus. If the MNE has already invested in the first period, a comparison of maximum second period tax rates and entry fees, equations (2.8) and (2.10), shows that a host country of type i prefers the MNE to stay rather than to leave the country and export if

$$\bar{T}_{2i}^{S} + B_i \geq \bar{\Gamma}_{2i} + B_i^E(s), \qquad \text{for } i = h, l \text{ and } \forall s \geq 0, \tag{3.1}$$

which implies

$$(\Phi_i + B_i) - (\Phi_i^E(s) + B_i^E(s)) \geq 0 \qquad \text{for } i = h, l. \tag{3.2}$$

If the firm has exported or taken the outside opportunity in the first period then, in the second period, a host country of type i is better off inducing and taxing FDI than levying entry fees on exports whenever

$$\Phi_i - F + B_i \geq \Phi_i^E(s) + B_i^E(s) \qquad \text{for } i = h, l, \tag{3.3}$$

or, in other words, whenever

$$F \leq [\Phi_i + B_i] - [\Phi_i^E(s) + B_i^E(s)]. \tag{3.4}$$

Using equation (3.4) we can define the locus of (F,s)-combinations that make a host country exactly indifferent between second-period FDI and second-period exporting:

$$F_{2i}(s) \equiv [\Phi_i + B_i] - [\Phi_i^E(s) + B_i^E(s)] \qquad \text{for } i = h, l. \tag{3.5}$$

$F_{2i}(s)$ is an increasing function of s,

$$dF_{2i}(s)/ds = x^E_{2i}(s) - [dB/dx^E_{2i}(s)][dx^E_{2i}(s)/ds] > 0, \qquad \text{for } i = h, l. \tag{3.6}$$

Moving now to the first period we observe that when fixed costs are greater than

$$\bar{F}_i = (1 + D)[\Phi_i + B_i] \qquad \text{for } i = h, l, \tag{3.7}$$

a host country of type i will never induce FDI. Assuming that the demand curve for the MNE's product has a vertical intercept, we can also find a $\bar{s}_i$, defined as

$$\Phi^E_i(\bar{s}_i) + B^E_i(\bar{s}_i) \equiv 0, \qquad \text{for } i = h, l \tag{3.8}$$

such that exporting is not a viable choice for type i whenever transportation costs exceed $\bar{s}_i$. In the remainder of the chapter we will focus on the region in cost space for which the fixed cost is below $\bar{F}_l$ and the transportation cost is smaller than $\bar{s}_l$.

We now use equations (2.8) and (2.11), as well as (2.10) and (2.13) to determine which tax and entry fee regime will be implemented under complete information when fixed costs are below $\bar{F}_i$ and transportation costs are below $\bar{s}_i$. We start with a definition and a lemma that describe, for the complete information case, the conditions under which a host country prefers first-period FDI to first-period exporting (and vice versa).

Definition:

$$F_{1i}(s) \equiv (1 + D)[\Phi_i - \Phi^E_i(s) + (B_i - B^E_i(s))], \qquad \text{for } i = h, l, \tag{3.9}$$

where

$$dF_{1i}(s)/ds = (1 + D)[x^E_{1i}(s) - (dB/dx^E_{2i}(s))(dx^E_{2i}(s)/ds)] > 0, \qquad \text{for } i = h, l, \tag{3.10}$$

and $d^2F_{1i}/ds^2 < 0$.

Lemma 1: *A host country of type i prefers FDI to exporting when it is known to be of type i if, for any pair (s', F'), $F' \leq F_{1i}(s')$ for $i = h, l$.*

Proof: FDI yields a higher payoff than exporting if

$$\bar{T}_{1i} + D\bar{T}_{2i} + (1+D)B_i \geq \bar{\Gamma}_{1i} + D\bar{\Gamma}_{2i} + (1+D)B_i^E(s)], \qquad (3.11)$$

or,

$$(1+D)[\Phi_i + B_i] - F \geq (1+D)[\Phi_i^E(s) + B_i^E(s)], \qquad (3.12)$$

Solving (3.12) for F completes the proof. **Q.E.D.**

The results for the complete information game are summarized in Proposition 1.

Proposition 1: *If $F < \bar{F}_l$ and $s < \bar{s}_l$, then the complete information game has the following sub-game perfect equilibria:*

(1.1) For any s' and F' such that $F' > F_{1h}(s')$ the MNE exports in both periods and both types of country impose their maximum tariffs, $\bar{\Gamma}_{ji}$, where $j = 1, 2$ and $i = h, l$.

(1.2) For any s' and F' such that $F_{1h}(s') > F' > F_{1l}(s')$ the MNE invests in h in the first period and stays in the second period. The MNE exports to l in both periods. h levies its maximum taxes, $\bar{T}_{jh}$ and l its maximum tariffs, $\bar{\Gamma}_{jl}$, $j = 1, 2$.

(1.3) For any s' and F' such that $F' < F_{1l}(s')$ the MNE always invests in the first period, stays in the second period and both h and l charge their maximum taxes, $\bar{T}_{ji}$, $j = 1, 2$.

4. The Incomplete Information Game

Nature moves first and determines the type of the host country. The host country then announces first-period tax rates and entry fees. The MNE does not know the host country's type ex ante but must choose between FDI, exporting and the outside opportunity. If the MNE chooses FDI or exporting, it learns the type of the host country and can adjust its production level accordingly. When the outside opportunity is selected there is no exogenous resolution of the asymmetric information. At the beginning of the second period the host country again sets tax rates and entry fees. If the MNE has invested or exported in the first period, it may now choose to stay, or to leave in order to pursue its outside opportunity or exporting. If the MNE has exported or taken its outside opportunity in the first period, it can still enter in the second period or continue to export or select the outside option.

We solve this game for perfect sequential equilibria (Grossman and Perry, 1986). The notion of perfect sequential equilibrium combines Kreps and Wilson's (1982) sequential equilibrium with a rule for the "credible" updating of beliefs off the equilibrium path. We first define sequential equilibrium and then show how off-equilibrium beliefs are "tested" under perfect sequential equilibrium. A sequential equilibrium of a signaling game is characterized by a set of behavioral strategies for each player and beliefs at each information set about the type of the other player. It requires that a player's equilibrium strategy be a best reply to the strategy chosen by the other player at each information set. Furthermore. the beliefs specified at each information set must be consistent with the equilibrium strategies. That is, beliefs along the equilibrium path must be updated using Bayes' rule. Beliefs at off-equilibrium information sets, where Bayes' Rule does not apply, can be specified arbitrarily.

A pure strategy sequential equilibrium of this game consists of strategies for h and l in each of the two periods, a set of beliefs, μ specified for each of the MNE's information sets, the MNE's sequentially rational first period strategy (Z_1, x_{1i}) and the MNE's second period strategy choice, (Z_2, x_{2i}), where $Z_1 \in \{FDI, EXP, OUT\}$ and $Z_2 \in \{STAY, FDI, EXP, OUT\}$, respectively.

Definition: *A sequential equilibrium is described by:*

(h:) *h's actions:* $(T_{1h}, \Gamma_{1h}; T_{2h}, \Gamma_{2h})$,

(l:) *l's actions:* $(T_{1l}, \Gamma_{1l}; T_{2l}, \Gamma_{2l})$,

(M_1:) *MNE's period one actions:* (Z_1, x_{1i}),

(M_2:) *MNE's period two actions:* (Z_2, x_{2i}),

(μ:) $\mu = \{\mu_h, 1 - \mu_h\}$.

The lack of any rule concerning the specification of off-equilibrium beliefs frequently leads players to adopt sequential equilibrium strategies that seem "irrational" given the history of the game, i. e., that seem to ignore the inferences that could be made from the other player's choice of strategy. In such "irrational" equilibria off-equilibrium beliefs are used as threats to prevent players from deviating to strategies that would be optimal, or "rational", in the absence of any threats. In our model such threats support a continuum of pure and mixed strategy sequential equilibria.

Perfect sequential equilibrium imposes rationality conditions on the MNE's off-equilibrium beliefs and allows us to eliminate proposed sequential equilibria that are based on incredible threats. The MNE's out-of-equilibrium beliefs are tested as follows: For every proposed sequential equilibrium and the associated off-equilibrium beliefs it has to be checked that there is no type of host country that would want to deviate to another strategy (given that beliefs are updated to correspond to this deviation). If there is such a deviation, which makes at least one type of country better off without making the other type worse off, then the original off-equilibrium beliefs are not credible. That is, the original equilibrium is supported by an incredible beliefs.

In addition to identity (3.9) which describes the host country's preferences over FDI and exporting in the complete information case, two additional preference rankings are useful for the characterization of equilibria under incomplete information. We first define the (F,s)-combinations for which h is indifferent between FDI and exporting when it is believed to be l, $F_{l,h}(s)$; and the combinations for which l is indifferent between FDI and exporting when it is thought to be h, $F_{h,l}(s)$.

Definition:

$$F_{l,h}(s) \equiv F_{1h}(s) - [(\Phi_h - \Phi_h^E) - (\Phi_l - \Phi_l^E)], \tag{4.1}$$

$$F_{h,l}(s) \equiv F_{1l}(s) + [(\Phi_h - \Phi_h^E) - (\Phi_l - \Phi_l^E)], \tag{4.2}$$

Lemma 2: *A host country of type h prefers FDI to exporting when it is believed to be of type l in the first period if, for any pair (s', F'), $F' \leq F_{l,h}(s')$.*

Lemma 3: *A host country of type l prefers FDI to exporting when it is believed to be of type h in the first period if, for any pair (s', F'), $F' \leq F_{h,l}(s')$.*

The proofs of Lemmas 2 and 3 follow from the equivalent of equation (3.11).

Lemma 4: $F_{1h} > F_{h,l}(s) > F_{1l}(s)$ *and* $F_{1h} > F_{l,h}(s) > F_{1l}(s)$ *for all* $s > 0$.

Lemma 5: *There exists a* $0 < D' < 1$ *such that for any* $D > D'$, $F_{l,h}(s') > F_{h,l}(s')$ *for all* $s' > 0$.

For the proofs of Lemmas 4 and 5 note that by (A5)

$$[(\Phi_h - \Phi_h^E) - (\Phi_l - \Phi_l^E)] > 0. \tag{4.3}$$

Furthermore, $F_{l,h}(0) = F_{h,l}(0) = 0$,

$$dF_{l,h}(s)/ds = (1 + D)[dF_{1h}/ds] - x_h^E(s) + x_l^E(s) < dF_{1h}/ds, \tag{4.4}$$

$$d^2 F_{l,h}(s)/ds^2 = D(dx_h^E/ds) + dx_l^E/ds - (1 + D)[d^2 B_h/ds^2] < 0, \tag{4.5}$$

and

$$dF_{h,l}(s)/ds = (1 + D)[dF_{1l}/ds] + x_h^E(s) - x_l^E(s) > dF_{1l}/ds, \tag{4.6}$$

$$d^2 F_{h,l}(s)/ds^2 = D(dx_l^E/ds) + dx_h^E/ds - (1 + D)[d^2 B_l/ds^2] < 0. \tag{4.7}$$

Also note that

$$0 > d^2 F_{l,h}(s)/ds^2 > d^2 F_{h,l}(s)/ds^2. \tag{4.8}$$

In the second period of the game, strategies do no longer affect the players' beliefs since all information problems are resolved before strategies have to be chosen. This allows us to treat the second-period part of our model as an independent subgame and both sequential and perfect sequential equilibrium collapse to Selten's (1965) subgame perfect equilibrium. In the second period each type of country will induce the MNE to pursue the strategy that generates the largest rents given the MNE's first period strategy choice and then proceed to extract all of the MNE's surplus. The period two subgame is described by equations (3.1) to (3.4). In the following analysis of equilibria we therefore focus on first period strategies. Complete characterizations and proofs of the equilibria are provided in Appendix IV.

5. Perfect Sequential Equilibria

If fixed costs are so large relative to transportation costs such that h prefers FDI to exporting when it is known to be h, but the market of l is too small to support FDI (Region I in Figure IV), then a traditional full-information tariff wall equilibrium occurs:

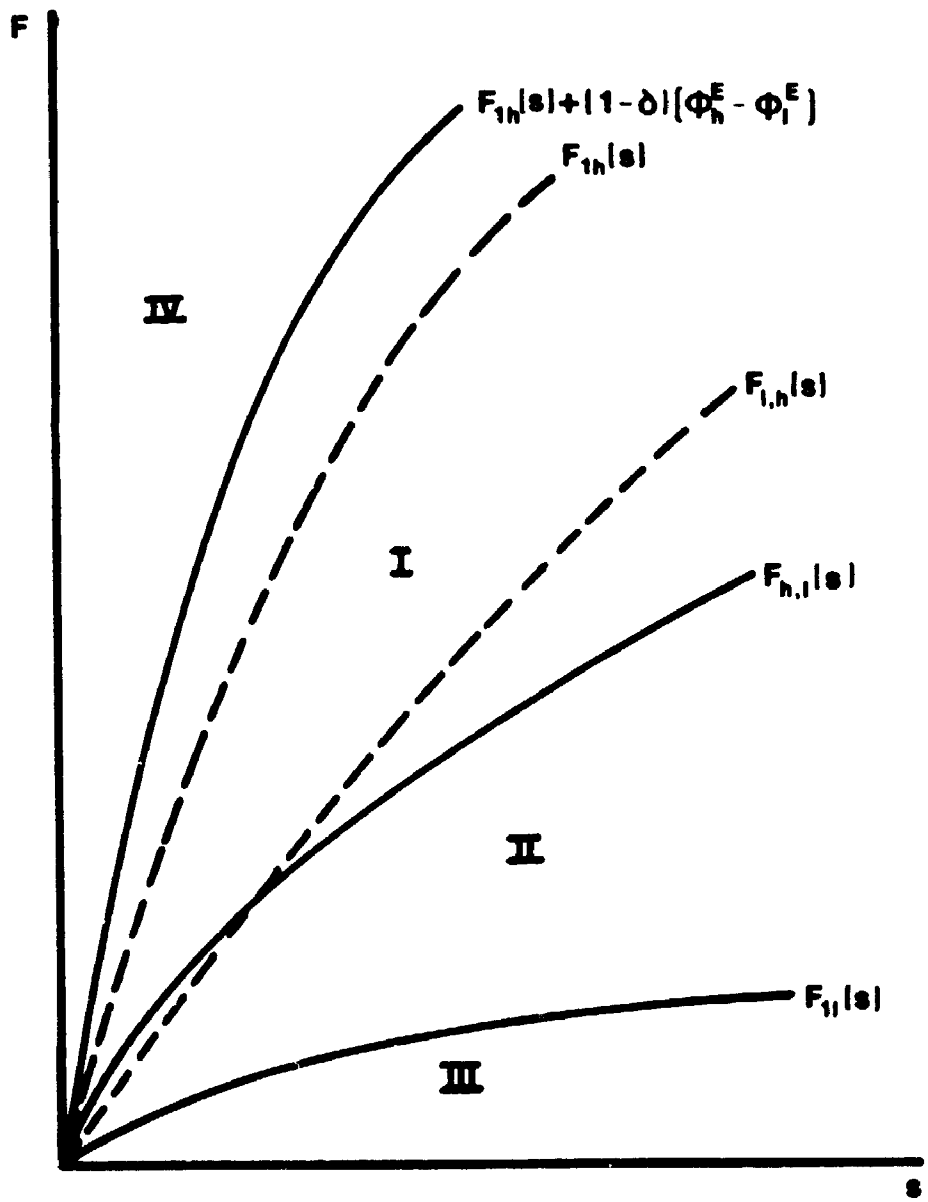
Proposition 2: *For any combination $\{s', F'\}$ in area I of Figure IV, i. e. for any F' that satisfies*

$$(S.1) \quad F_{1h}(s') + (1-\delta_h)[\Phi_h^E - \Phi_l^E] \geq F' \geq F_{h,l}(s'),$$

h imposes a tariff wall and charges its optimal first period tax, $\bar{T}_{1h}$. The type l country charges its maximum entry fee, $\bar{\Gamma}_{1l}$, and sets a tax that forces the MNE to export. The MNE accordingly invests in h and exports to l, and earns zero profits.

Type h does not need to grant tax holidays since l already discourages FDI and thereby reveals that its demand is low. A tariff wall is then sufficient to induce the MNE's entry into h. In the second period the host country/MNE contract is renegotiated to take account of the h's increased bargaining power. Taxes in h rise to the level at which the MNE just wants to remain in h. Tariffs do not change; so the MNE continues to export to l.

Figure IV: Tax Holidays and Tariff Walls under Incomplete Information



If fixed costs are substantial enough so that h prefers FDI to exporting, no matter what type it is believed to be, but l only wants FDI when it is believed to be h (Area II of Figure IV), then a tariff wall by itself might not constitute an optimal policy. The reason for this is that FDI is sufficiently attractive even for l so that the latter might be tempted to shirk and claim high demand. The MNE knows this and therefore invests only if taxes are adjusted downward to account for the increased market risk. Type h can react in one of two ways: (i) Unilaterally grant a tax holiday (in addition to the tariff wall) high enough to prevent duplication by l (separation), Proposition 3.1, or (ii) impose only a tariff wall, but accept shirking on the part of l (pooling), Proposition 3.2.

Which alternative h will choose depends on the MNE's prior beliefs. If the MNE believes that it is sufficiently unlikely (Condition S.3) that host country demand is high, then the maximum pooling tax h could impose is relatively small. In this case, a tax holiday-tariff wall is the best policy. However, if the MNE believes that the country is likely to have high demand then the maximum pooling tax approaches the maximum separating tax and separation (by means of a tax holiday) becomes too costly. In this sense, the pooling option puts an upper bound on the size of the tax holiday.

Proposition 3.1: *For any $\{s', F'\}$ in area II of Figure IV, i. e., for any F' satisfying*

(S.2) $\quad F_{h,l}(s') \geq F' \geq F_{1l}(s'),$

and for any prior belief

(S.3) $\quad \delta_h < 1 - [(\Phi_h^E - \Phi_l^E)/(\Phi_h - \Phi_l)]$

h grants a tax holiday by setting a tax $\tilde{T}_{1h} < \hat{T}_{1h}$, where $\tilde{T}_{1h} = \Phi_l - F_{1l}(s)$,

and a tariff wall that keeps the MNE from deviating to exporting. Type l imposes a prohibitively high tax and its maximum tariff, $\bar{\Gamma}_{1l}$. The MNE invests when it observes the tax holiday-tariff wall mechanism and exports otherwise.

In this equilibrium the MNE earns a positive return on its investment in h but makes zero profits when exporting to l. The tax rate $\tilde{T}_{1h}$ corresponds to the minimum tax holiday necessary to induce separation. At this tax rate, l is just indifferent between implementing its own export inducing policy and deviating to h's policy regime.[3]

If the maximum pooling tax is higher than $\tilde{T}_{1h}$, both h and l prefer to set the pooling tax and impose high tariffs to force entry by the MNE.

Proposition 3.2: *For any $\{s', F'\}$ in area II of Figure IV, that is for any F' such that*

(S.2) $\quad F_{h,l}(s') \geq F' \geq F_{1l}(s'),$

and for any prior belief

(P.1) $\quad \delta_h > 1 - [(\Phi_h^E - \Phi_l^E)/(\Phi_h - \Phi_l)]$

h sets a pooling policy $(\bar{T}_{1p}, \Gamma_{1p})$, which includes the maximum pooling tax, $\bar{T}_{1p} = \delta_h \Phi_h + (1-\delta_h)\Phi_l - F$, and a tariff wall, $\Gamma_{1p} > \bar{\Gamma}_{1p}$. Type l copies h's policy. The MNE invests in the first period if it observes the pooling mechanism.

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[3] Therefore, strictly speaking there exists a trivial semi-separating equilibrium which is identical in payoff to the tax holiday separating equilibrium and differs only to the extent that l randomizes between the two policies.

Corollary: *The equilibrium of Proposition 3.1 is indistinguishable from a semi-separating equilibrium in which l mixes between $(\tilde{T}_{1h}, \Gamma_{1h})$ and $(T_{1l}, \bar{\Gamma}_{1l})$ but all other strategies remain the same.*

In the latter equilibrium, the MNE earns zero expected profits. However, when the country ex post turns out to be of type l the MNE makes a loss in the first period.

Two polar cases remain to be discussed. First, if fixed costs are low enough relative to transportation costs so that both h and l prefer investment to exporting no matter what type they are believed to be, then tax holidays become very costly and we observe only tariff walls, Proposition 4. Second, if fixed costs are so high relative to exporting costs that both types of country always prefer exporting, then a pooling equilibrium with exporting occurs, Proposition 5. In this case taxes are set high enough to prevent FDI.

Proposition 4: *For any $\{s', F'\}$ in area III of Figure IV, i. e., any F' satisfying $F' \leq F_{1l}(s')$, h chooses a pooling mechanism $(\bar{T}_{1p}, \Gamma_{1p})$ which consists of the maximum pooling tax, $\bar{T}_{1p} = \delta_h \Phi_h + (1 - \delta_h)\Phi_l - F$, and a tariff wall policy, $\Gamma_{1p} > \bar{\Gamma}_{1p}$. l selects the same policy as h and the MNE invests in the first period.*

Proposition 5: *For any $\{s', F'\}$ in area IV of Figure IV, i. e., any F' that satisfies $F' \geq F_{1h}(s') + (1 - \delta_h)[\Phi_h^E - \Phi_l^E]$, h and l select a pooling strategy, $(T_{1p}, \bar{\Gamma}_{1p})$ which includes the maximum pooling tariff, $\bar{\Gamma}_{1p} = \delta_h \Phi_h^E + (1 - \delta_h)\Phi_l^E$, and a prohibitively high tax rate, $T_{1p} > \bar{T}_{1p}$. The MNE exports if the pooling strategy is observed.*

6. Summary and Results

This chapter has analyzed the impact of incomplete information about host country demand on the host country's tax and tariff policy and a MNE's choice between FDI and exporting. A dynamic signaling game was used to endogenize both government policy and the MNE's investment behavior. We have shown that in the presence of such information problems tax holidays and tariff walls can no longer be treated as independent strategies: Tariff walls alone are not always the most effective way of encouraging FDI. Instead, over some parameter regions they might appear in combination with tax holidays. Tax holidays, though, are generally too expensive to be used on their own to encourage import-substituting investment. In other words, tax holidays are only effective in some cases if there is also a tariff wall that helps induce FDI.

Empirical studies have come to controversial and conflicting conclusions regarding the effectiveness of FDI incentives. Our results suggest that in this context more emphasis should be put on MNE's strategy options. In particular, if exporting is an alternative, tariff walls should be seen as complements to tax holidays and should therefore be included in the definition of government incentives.

Depending on fixed costs and transportation costs, the following policy and investment regimes may arise in equilibrium. If fixed investment costs are so high relative to transportation costs that the host country itself prefers exporting, a pooling equilibrium prevails in which both types of host country charge the same entry fee and the MNE exports in both periods. If fixed costs are very low relative to transportation costs, then signaling via tax holidays becomes too expensive for the high-demand country and consequently a pooling equilibrium occurs in which both h and l impose the same tariff wall, but no tax holiday, and the MNE chooses FDI in the first period. The intermediate case, where h prefers FDI but l prefers exporting no matter what the MNE's beliefs, is characterized by a separating equilibrium. In this equilibrium information is complete, the MNE invests in h in the first period and exports to l in both periods. h imposes a tariff wall and charges its maximum tax and l discourages FDI. Finally, when h prefers FDI to exporting but fixed costs are low enough for l to want to mimic h, then one of two possibilities arises. The higher the probability that the host country is of type h, the higher will be the maximum pooling tax and the less willing will h be to use a tax holiday to separate itself from l. Thus, if the MNE believes that the host country is of type h with a high enough probability, then a pooling equilibrium will result in which FDI is induced by a tariff wall and no information will be passed on to the MNE in the first period. However, if the MNE is sceptical enough about market size in the host country, then tax holidays become a valuable signaling tool for h. The MNE will invest in the country that grants tax holidays and sets tariff walls but export otherwise.

CHAPTER VI

CONCLUSIONS

The second chapter investigated the problem of expropriation of MNEs. If the country believes it is sufficiently likely that the firm is costly to expropriate, a pooling equilibrium arises in which the firm undertakes FDI and the host country does not expropriate the MNE's subsidiary. According to this outcome the possibility of nationalization affects neither the firm's investment decision nor the host country's welfare. However, if the country is optimistic about its ability to expropriate the MNE without facing increased costs of management and technology, then we obtain a semi-separating equilibrium in which expropriation occurs with positive probability. In the last equilibrium the host country would benefit from being able to commit itself to a policy of no expropriation: The threat of expropriation leads to a bias in technology, in the sense that firms with a technology that makes them difficult to expropriate might be more likely to become MNEs than firms that could be operated efficiently by the host country.

An increase in production taxes and improvements in the MNE's outside opportunity lead to a reduction in the probability of expropriation. Increases in the cost of technical and management staff, M, of plant and equipment, G, or in variable cost all serve to reduce the likelihood of expropriation. Low cost countries are more likely than high cost countries to nationalize MNEs. Low cost industries simultaneously face both higher tariffs on their imports and a greater probability of expropriation.

Chapter III discussed the optimal taxation of vertically and horizontally integrated MNE. The optimal host country tax system consists of a combination of

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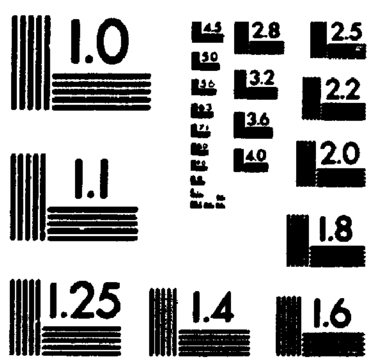

PRECISION℠ RESOLUTION TARGETS

U.S. rate of 45%) and misreporting of true profits. As a first step the Jamaican government should therefore probably have raised its CIT rate to the U.S. level to take advantage of its first crack at the subsidiaries' profits. Instead, the Jamaican government opted for the short-term measure of imposing a production levy on bauxite. This levy gave an immediate boost to tax revenue at the expense of Jamaican bauxite's long-run competitiveness. Only a few years later Jamaica had to actually reduce its levy to stop the decline in bauxite output and prevent the number of exits from the industry.

We conclude that, since the actual levy introduced by the Jamaican government in 1974 was in fact similar to the quantity tax in the optimal tax system, only higher, Jamaica should probably not have traded one tax regime for the other but rather kept and increased its CIT, and added a much lower but more progressive production tax.

Chapter V analyzed the impact of incomplete information about host country demand on the host country's tax and tariff policy and a MNE's choice between FDI and exporting. We showed that in the presence of such information problems tax holidays and tariff walls can no longer be treated as independent strategies: Tariff walls alone are not always the most effective way of encouraging FDI. Instead, over some parameter regions they appear in combination with tax holidays. Tax holidays, though, are generally too expensive to be used on their own to encourage import-substituting investment. In other words, tax holidays are only effective in some cases if there is also a tariff wall that helps induce FDI.

APPENDIX I

PROOFS OF CHAPTER II

1. Proof of Proposition 1

The proof of Proposition 1 follows from the definition of sequential equilibrium:

(1.1) According to Bayes' Rule posterior and prior beliefs are identical along the proposed equilibrium path since the MNE's pooling strategy does not yield any information to the host country. In order to proof sequential rationality we have to check for the following potential deviations from the proposed equilibrium path:

(i) The host country deviates if expected national income from expropriation is higher than expected national income from taxation:

$$\delta Y_1^E + (1-\delta)Y_2^E \geq \delta Y_1^N + (1-\delta)Y_2^N.$$

This is ruled out by condition (P1).

(ii) The MNE does not deviate to the outside opportunity since the host country's tax rate obeys the participation constraint.

Furthermore, for equilibrium (1.1) perfect sequential equilibrium poses no additional restrictions since there are no off-equilibrium information sets.

(1.2) The t_1 MNE is indifferent between FDI and the outside opportunity and therefore mixes between the two if

$$\gamma[\Pi_1^o(w^o) - G] + (1-\gamma)[\Pi_1^N(t)] = \Pi_1^o(w^o).$$

This equation can be solved for the host country's expropriation probability, γ. It is easy to verify that for this γ the t_2 firm's best reply is to choose FDI with probability one.

Given that t_1 invests with probability α and t_2 with probability one, the host country can update its priors. According to Bayes' Rule the posterior beliefs consistent with the MNE's equilibrium strategy is $\mu = (\alpha\delta)/(1-\delta+\alpha\delta)$. Again, the host country mixes between expropriation and taxation if expected national income from the two strategies is the same:

$$\left(\frac{\alpha\delta}{1-\delta+\alpha\delta}\right)Y_1^N + \left(\frac{1-\delta}{1-\delta+\alpha\delta}\right)Y_2^N = \left(\frac{\alpha\delta}{1-\delta+\alpha\delta}\right)Y_1^E + \left(\frac{1-\delta}{1-\delta+\alpha\delta}\right)Y_2^E.$$

This equation can then be solved for α, t_1's equilibrium strategy, and it can be shown that $0 < \alpha < 1$ only if $\delta > \delta^*$.

Since there are no off-equilibrium information sets, this sequential equilibrium is also perfect sequential.

Note that there also exists a pooling sequential equilibrium, characterized by $(\alpha = 0, \beta = 0, \gamma = 1; \mu \geq \delta^*)$, (i. e., the host country threatens the MNE with expropriation; both types of MNE stay out). But this equilibrium fails to be perfect sequential. *Q.E.D.*

2. The Semi-Separating Equilibrium with Two Host Countries

Let H_1 and H_2, the two host countries, have respective variable costs of $C(x) = cx + h(x)$ and $\bar{C}(x) = \bar{c}x + h(x)$, such that $\bar{c} > c$. Let α_1 and α_2 denote firm t_1's probability of investing in H_1 and H_2, respectively. Equivalently, for the t_2 type firm β_1 and β_2 represent the probabilities of investing in H_1 and H_2. H_1 expropriates with probability γ_1, H_2 with probability γ_2. Furthermore, let H_1's prior belief about firm types be δ, and H_2's prior be ϵ and let μ and ν be the posterior beliefs. The players' payoffs are equivalent to the ones specified in the basic model with $\bar{Y}_i^j$ and $\bar{\Pi}_i^j$, $i = 1, 2$ and $j = N, E$, denoting payoffs that are associated with country H_2. An equilibrium assessment for this model is of the form $(\alpha_1, \alpha_2; \beta_1, \beta_2; \gamma_1, \gamma_2; \mu, \nu)$.

Proposition * *The assessment $(\alpha_1, \alpha_2; \beta_1, \beta_2; \gamma_1, \gamma_2; \mu, \nu)$ forms a semi-separating equilibrium with*

$$\alpha_1 = \beta_1 \frac{(1-\delta)}{\delta}\frac{(Y_2^N - Y_2^E)}{(Y_1^E - Y_1^N)}, \qquad \alpha_2 = \beta_2 \frac{(1-\epsilon)}{\epsilon}\frac{(\bar{Y}_2^N - \bar{Y}_2^E)}{(\bar{Y}_1^E - \bar{Y}_1^N)},$$

$$\gamma_1 = \frac{\Pi_1^N(t) - \Pi_1^o(w^o)}{\Pi_1^N(t) - (\Pi_1^o(w^o) - G)}, \qquad \gamma_2 = \frac{\bar{\Pi}_1^N(t) - \Pi_1^o(w^o)}{\bar{\Pi}_1^N(t) - (\Pi_1^o(w^o) - G)},$$

where $\gamma_1 > \gamma_2$, if (SS1), (SS2) and (SS2') are satisfied, where

(SS2') $\epsilon > (\bar{Y}_2^N - \bar{Y}_2^E)/[(\bar{Y}_1^E - \bar{Y}_1^N) + (\bar{Y}_2^N - \bar{Y}_2^E)]$.

Proof: The proof is equivalent to the proof of Propositon 1. In addition, (SS2) and (SS2') are sufficient for $\alpha_1 + \alpha_2 < 1$. The difference in variable cost, $\bar{C}(x) > C(x)$, implies that for any t', $\bar{\Pi}_1^N(t') < \Pi_1^N(t')$. The t_1 MNE is indifferent between FDI and the world market option if:

$$\gamma_1[\Pi_1^o(w^o) - G] + (1-\gamma_1)[\Pi_1^N(t)] = \Pi_1^o(w^o).$$

and

$$\gamma_2[\Pi_1^o(w^o) - G] + (1-\gamma_2)[\bar{\Pi}_1^N(t)] = \Pi_1^o(w^o).$$

These two equations are satisfied if $\gamma_2 < \gamma_1$. Q.E.D.

APPENDIX II

PROOFS OF CHAPTER III

Proof of Proposition 2: (WP) follows immediately from the lemma. The rest of the proof is similar to the proof of Lemma 1 in Baron and Myerson (1982) (or of Lemma 3.1 in Besanko and Sappington (1987), or Proposition 2 in Prusa (1990)). However, a difference arises since the government in Baron and Myerson's paper not only sets tax and subsidy rates but also directly regulates the firm's price and quantity of the final output according to the firm's cost reports. In our paper the host government has no control over price and quantity of the relevant intra-firm transactions and, therefore, has to take the MNE's output response into consideration when deciding on a tax policy.

Since $\tau(\theta) = 0$, the optimal transfer price is w. Provided the conditions of the implicit function theorem hold, we can use equations (2.10) and (2.11) to show that

$$dx(\theta)/d\theta = -\frac{2c_{x\theta} + (\theta - \theta^-)c_{x\theta\theta}}{c_{xx} + (\theta - \theta^-)c_{\theta\theta x}} < 0 \qquad (I.1)$$

by assumptions (2.2) to (2.5). The penalty that is built into the mechanism ensures that the MNE chooses the output level desired by the host country.

We now prove that (IR) and (SS) imply the lump-sum tax $T^f(\hat{\theta})$. We define $\Pi(\theta) \equiv \Pi(T^f(\theta); \theta)$. Differentiating $\Pi(\theta)$ with respect to θ and invoking the first order envelope theorem we obtain

$$\Pi'(\theta) = -c_\theta(x(\theta); \theta) < 0, \qquad (I.2)$$

i. e., $\Pi(\theta)$ is strictly decreasing in θ by assumption (2.1). Integration of this equation yields

$$\Pi(\theta) = \int_\theta^{\theta^+} c_\theta(x(t); t)\; dt + \Pi(\theta^+). \qquad (I.3)$$

Since $\Pi(\theta)$ is strictly decreasing in θ, the (IR) constraint will hold with equality for the θ^+ type MNE. Thus,

$$\Pi(\theta) = \int_\theta^{\theta^+} c_\theta(x(t); t)\; dt + \Pi(w). \qquad (I.4)$$

Using the definition of $\Pi(\theta)$ we can then solve equation (I.4) for $T^f(\theta)$.

It remains to be shown that the tax mechanism satisfies (IR) and (SS). First note that $T^f(\hat{\theta})$ implies equation (I.4) which guarantees that

$$\Pi(\theta) \geq \Pi(w) \qquad \text{for every } \theta \in [\theta, \theta^+].$$

Second, we have

$$\begin{aligned}\Pi(\theta) - \Pi(\hat{\theta};\theta) &= \Pi(\theta) - \Pi(\hat{\theta}) \\ &- \{[NR(\hat{\theta};\theta) - NR(\hat{\theta})] - w[x_r(\hat{\theta};\theta) - x_r(\hat{\theta})] - [c(x(\hat{\theta});\theta) - c(x(\hat{\theta});\hat{\theta})]\}. \end{aligned} \quad (I.5)$$

Substituting for $\Pi(\theta) - \Pi(\hat{\theta})$ from the equivalent of equation (I.3) we obtain

$$\begin{aligned}\Pi(\theta) - \Pi(\hat{\theta};\theta) &= \int_{\theta}^{\hat{\theta}} c_{\theta}(x(t);t)\, dt \\ &- \{[NR(\hat{\theta};\theta) - NR(\theta)] - w[x_r(\hat{\theta};\theta) - x_r(\hat{\theta})] - [c(x(\hat{\theta});\theta) - c(x(\hat{\theta});\hat{\theta})]\}. \end{aligned} \quad (I.6)$$

Using the fact that $[NR(\hat{\theta};\theta) = NR(\theta)]$ and that $[x_r(\hat{\theta};\theta) = x_r(\hat{\theta})]$ we get

$$\Pi(\theta) - \Pi(\hat{\theta};\theta) = \int_{\theta}^{\hat{\theta}} [c_{\theta}(x(t);t) - c_{\theta}(x(\hat{\theta});t)]\, dt. \quad (I.7)$$

Given that $x(\theta)$ is decreasing in θ and assumption (2.2) holds, it can be easily shown that the right-hand side of equation (I.7) is positive and thus (SS) is satisfied.

Q.E.D.

Proof of Proposition 3: (WP) follows immediately from the lemma. The MNE's expected after-tax profit is

$$\begin{aligned}\Pi &= NR(z(\theta) + z_r(\theta)) - wz_r(\theta) - c(z(\theta);\theta) \\ &- [NMR(z^*(\hat{\theta}) + z_r^*(\hat{\theta})) - c_z(z^*(\hat{\theta});\hat{\theta})](z - z^*(\hat{\theta})) - NR(z^*(\hat{\theta}) + z_r^*(\hat{\theta})) \\ &+ wz_r^*(\hat{\theta}) + c(z^*(\hat{\theta});\hat{\theta}) + \int_{\hat{\theta}}^{\theta^+} c_{\theta}(z^*(t);t)dt + \Pi(w). \end{aligned} \quad (II.1)$$

Taking the derivatives of the profit function with respect to z and z_r we get the following conditions for the MNE's optimal output choice

$$NMR(z(\theta) + z_r(\theta)) - c_z(z(\theta);\theta) - NMR(z^*(\hat{\theta}) + z_r^*(\hat{\theta})) + c_z(z^*(\hat{\theta});\hat{\theta}) = 0, \quad (II.2)$$

and

$$NMR(z(\theta) + z_r(\theta)) - w = 0, \quad (II.3)$$

where $z^*(-)$ and z_r^* are solving the planner's problem equivalent to equations (2.10) and (2.11). Under Assumption (2.8), $z_r(-)$ is simply a residual of the choice of $z(-)$. Thus, the MNE chooses $\hat{z}$ according to

$$NMR(\hat{z}(\hat{\theta}) + \bar{z}_r(\theta)) - c_z(\hat{z}(\theta);\theta) = NMR(z^*(\hat{\theta}) + z_r^*(\hat{\theta})) - c_z(z^*(\hat{\theta});\hat{\theta}). \quad (II.4)$$

Applying assumptions (2.2) and (2.4) to (II.4) we obtain

$$\frac{\partial \hat{z}}{\partial \theta} = -\frac{c_{z\theta}(\hat{z}(\theta);\theta)}{c_{zz}(\hat{z}(\theta);\theta)} \leq 0. \qquad (II.5)$$

Furthermore,

$$\left.\frac{\partial \Pi}{\partial \hat{\theta}}\right|_{z=\hat{z}} = c_{z\theta}(z^*(\hat{\theta});\hat{\theta})(\hat{z}(\theta) - z^*(\hat{\theta})). \qquad (II.6)$$

Equation (II.4) yields

$$\left.\frac{\partial \Pi}{\partial \hat{\theta}}\right|_{\hat{\theta}=\theta} = 0, \qquad (II.7)$$

and from Assumption (2.2) and equation (II.5) we obtain

$$\frac{\partial^2 \Pi}{\partial \hat{\theta}\, \partial \theta} = c_{z\theta}\frac{\partial \hat{z}}{\theta} < 0. \qquad (II.8)$$

As a result we can show that reporting the truth, i. e., $\hat{\theta} = \theta$ is optimal:

$$\frac{\partial \Pi}{\partial \hat{\theta}} \begin{cases} > 0, & \text{if } \hat{\theta} < \theta; \\ = 0, & \text{if } \hat{\theta} = \theta; \\ < 0, & \text{if } \hat{\theta} > \theta. \end{cases}$$

This finally establishes the self-selection constraint. It is now easy to show that individual rationality is also satisfied. Provided that the MNE truthfully reports its type, $\hat{\theta} = \theta$ and produces $z^*(\theta)$ its expected after-tax profit is

$$\Pi(\theta) = \int_{\hat{\theta}}^{\theta+} c_{\theta}(z^*(t);t)dt + \Pi(w) \qquad (II.9)$$

which is greater than $\Pi(w)$ since the integrand is positive by Assumption (2.1).

APPENDIX III

DATA SOURCES AND TECHNICAL DETAILS OF CHAPTER IV

1. Data Sources

Capital costs were calculated from Auty (1983) and World Bank Annual Report 1974-82. Energy prices were calculated from Energy Decade (1980), OPEC (1980), Byer (undated) and MacAvoy (1982). Transport costs were based on equation 4 in Lipsey and Weiss (1974, p. 170). Distances were from Lloyd's Maritime Atlas (1977) and Fullard (1973). Jamaican wage rates were taken from Auty, 1983. Factor quantities were from Hashimoto, 1983, and the Jamaican Bauxite Institute.

All costs have been converted to U.S. dollars using actual average 1973 exchange rates from U.N., Statistical Yearbook 1977, New York, 1978. Mineral prices and quantities were from the U.S. Department of Mines Minerals Yearbook, Vols.I and III, various issues, 1973-79. Tariff rates were from Hashimoto, 1983. Actual quantities were used for bauxite production in Jamaica, the U.S., and ROW.

2. Technical Details

The optimal taxes are calculated in the following way. First, we derive the θ for the average Jamaican subsidiary which produces a profit maximizing output of 3.4 million metric tons. The MNE's profit maximization condition is $w = c_x(x, \theta) + s$, where s denotes the transportation cost between Jamaica and the U.S.. With the CES cost function we obtain the condition

$$w = \theta[a_{K_x}^{\sigma_x} r_x^{1-\sigma_x} + a_{L_x}^{\sigma_x} w_x^{1-\sigma_x} + (1 - a_{K_x} - a_{L_x})^{\sigma_x} e_x^{1-\sigma_x}]^{1/(1-\sigma_x)} x^{(\theta-1)} + s. \quad (III.1)$$

Given x, cost parameters, and an estimate of σ_x, this equation can be solved for a θ for the average firm, which turns out to be 1.09356.

For the sake of simplicity let us define the following constant:

$$A \equiv [a_{K_x}^{\sigma_x} r_x^{1-\sigma_x} + a_{L_x}^{\sigma_x} w_x^{1-\sigma_x} + (1 - a_{K_x} - a_{L_x})^{\sigma_x} e_x^{1-\sigma_x}]^{1/(1-\sigma_x)}$$

Now, assuming different values for θ we can again use equation (III.1) to solve for the profit maximizing output. Integration of (III.1) yields total bauxite rent which is taxed under Jamaica's pre-1974 corporate income tax.

The optimal mechanism restricts the output of all firms but the most efficient one. For the latter the optimal social output can be found using equation (III.1).

For the rest we have to solve equations (2.10) and (2.11) of Chapter III. That is, we have to solve

$$w = c_x(x(\theta);\theta) + (\theta - \theta^-)c_{\theta x}(x(\theta);\theta)$$

for x^*, the socially optimal output. In our case we obtain the following equation

$$w = \theta A x^{\theta-1} + (\theta - \theta^-)Ax^{\theta-1}[1 + \theta ln(x)]. \qquad (III.2)$$

Given x^*, we can then compute the optimal tax revenues. For the forcing mechanism we get

$$T^f(\hat{\theta}) = wx^* - Ax^{*\theta} - \int_{\hat{\theta}}^{\theta^+} Ax^{*^s} ln(x^*)ds. \qquad (III.3)$$

The continuous mechanism consists of a levy, $t(\hat{\theta})$ and a lump-sum tax, $T^l(\hat{\theta})$. They are, respectively,

$$t(\hat{\theta}) = w - \theta A x^{*^{\theta-1}}$$

and

$$T^l(\hat{\theta}) = wx^* - Ax^{*^\theta} - t(\hat{\theta})x^* - \int_{\hat{\theta}}^{\theta^+} Ax^{*^s} ln(x^*)ds. \qquad (III.4)$$

For the most efficient firm $t(\theta^-)$ is equal to zero.

APPENDIX IV

FORMAL STATEMENT AND PROOF OF PROPOSITIONS OF CHAPTER V

Proposition 2: *For any s' and F' such that*

(S.1) $F_{1h}(s') + (1-\delta_h)[\Phi_h^E - \Phi_l^E] \geq F' \geq F_{h,l}(s')$, *we observe a separating equilibrium with the following strategies and beliefs:*

(h:) $(\bar{T}_{1h}, \Gamma_{1h}; \bar{T}_{2h}, \bar{\Gamma}_{2h})$, where $\Gamma_{1h} \geq \bar{\Gamma}_{1h}$

(l:) $(T_{1l}, \bar{\Gamma}_{1l}; \bar{T}_{2l}, \bar{\Gamma}_{2l})$, where $T_{1l} \geq \bar{T}_{1l}$.

(M_1:)

$$\begin{array}{ll} (FDI, x_{1h}), & \text{if } (\bar{T}_{1h}, \Gamma_{1h}) \text{ is observed,} \\ (EXP, x_{1l}^E), & \text{if } (T_{1l}, \bar{\Gamma}_{1l}) \text{ is observed,} \\ (FDI, x_{1i}), & \text{if } T \leq \bar{T}_{1l} \text{ and } \Gamma_{1l} > \Phi_l^E(s) - \Phi_l + F + T_{1l}, \\ (EXP, x_{1l}^E), & \text{if } (\Gamma_{1l} \leq \bar{\Gamma}_{1l} \text{ and } \Gamma_{1l} \leq \Phi_l^E(s) - \Phi_l + F + T_{1l}, \\ (OUT, 0), & \text{if } (\Gamma_{1l} > \bar{\Gamma}_{1l} \text{ and } T_{1l} > \bar{T}_{1l}. \end{array}$$

(M_2:)

$$\begin{array}{ll} (STAY, x_{2h}), & \text{if } (\bar{T}_{2h}, \bar{\Gamma}_{2h}) \text{ is observed,} \\ (EXP, x_{2l}^E), & \text{if } (\bar{T}_{2l}, \bar{\Gamma}_{2l}) \text{ is observed.} \end{array}$$

(μ:)

$$\mu = \begin{cases} (1,0), & \text{if } (\bar{T}_{1h}, \Gamma_{1h}) \text{ is observed;} \\ (0,1), & \text{otherwise.} \end{cases}$$

Proof: The MNE does not deviate from the proposed equilibrium path in the first period since $\Gamma_{1h} \geq \bar{\Gamma}_{1h}$ and $T_{1l} \geq \bar{T}_{1l}$. Profitable deviations from the equilibrium path are ruled out for h if

$$(1+D)[\Phi_h + B_h] - F \geq \Phi_l^E(s) + B_h^E(s) + D \quad max \left\{ \begin{array}{c} \Phi_h^E + B_h^E(s) \\ \Phi_h + B_h - F \end{array} \right\} . (IV.1)$$

Case 1: If $F \geq F_{2h}(s)$ then (IV.1) reduces to

$$(1+D)[\Phi_h + B_h] - F \geq \Phi_l + B_h^E + D[\Phi_h^E + B_h^E(s)], \qquad (IV.2)$$

which is satisfied by condition (S.1).

Case 2: If $F < F_{2h}(s)$ then (IV.1) can be rewritten as

$$(1+D)[\Phi_h + B_h] - F \geq \Phi_l^E + B_h^E + D[\Phi_h + B_h - F], \qquad (IV.3)$$

or

$$F < \frac{1}{1-D}[F_{2h}(s') + (\Phi_h - \Phi_h^E)], \qquad (IV.4)$$

which holds by assumption.

Similarly, l does not deviate from its equilibrium strategy when

$$\Phi_l^E + B_l^E + D \quad max \begin{Bmatrix} \Phi_l^E(s) + B_l^E(s) \\ \Phi_l + B_l - F \end{Bmatrix} \geq \Phi_h + D\Phi_l + (1+D)B_l, (IV.5)$$

which is satisfied by condition (S.1), too.

Q.E.D.

Proposition 3.1: *If the following two conditions are satisfied*

(S.2) For any s' and F', $F_{h,l}(s') \geq F' \geq F_{1l}(s')$,

(S.3) $\delta_h < 1 - [(\Phi_h^E - \Phi_l^E)/(\Phi_h - \Phi_l)]$

a separating equilibrium exists in which:

(h:) $(\tilde{T}_{1h}, \Gamma_{1h}; \bar{T}_{2h}, \bar{\Gamma}_{2h})$, where $\tilde{T}_{1h} = \Phi_l - F_{1l}(s)$,

(l): $(T_{1l}, \bar{\Gamma}_{1l}; \bar{T}_{2l}, \bar{\Gamma}_{2l})$, where $t_{1l} \geq \bar{T}_{1l}$.

$(M_1:)$

(FDI, x_{1h}), if $(\tilde{T}_{1h}, \Gamma_{1h})$ is observed,
(EXP, x_{1l}^E), if $(T_{1l}, \bar{\Gamma}_{1l})$ is observed,
(FDI, x_{1i}), if $T \leq \bar{T}_{1l}$ and $\Gamma_{1l} > \Phi_l^E(s) - \Phi_l + F + T_{1l}$,
(EXP, x_{1l}^E), if $(\Gamma_{1l} \leq \bar{\Gamma}_{1l}$ and $\Gamma_{1l} \leq \Phi_l^E(s) - \Phi_l + F + T_{1l}$,
$(OUT, 0)$, if $(\Gamma_{1l} > \bar{\Gamma}_{1l}$ and $T_{1l} > \bar{T}_{1l}$.

(M_2:)

$(STAY, x_{2h})$, *if* $(\bar{T}_{2h}, \bar{\Gamma}_{2h})$ *is observed,*
(EXP, x^E_{2l}), *if* $(\bar{T}_{2l}, \bar{\Gamma}_{2l})$ *is observed.*

(μ:)

$$\mu = \begin{cases} (1,0), & \text{if } (\tilde{T}_{1h}, \Gamma_{1h}) \text{ is observed;} \\ (0,1), & \text{otherwise.} \end{cases}$$

Proof: $\tilde{T}_{1h}$ is the tax rate which makes l indifferent between exporting and FDI. Condition (S.2) is satisfied by Lemma 5. The proof of sequential rationality is similar to the proof of Proposition 2.

Deviations from the equilibrium path are ruled out for h if

$$\tilde{T}_{1h} + B_h + D[\Phi_h + B_h] \geq \Phi^E_l(s) + B^E_h(s) + D \quad max \begin{Bmatrix} \Phi^E_h + B^E_h(s) \\ \Phi_h + B_h - F \end{Bmatrix}. \quad (IV.6)$$

Case 1: If $F \geq F_{2h}(s)$ then (IV.6) reduces to

$$\Phi_l - F_{1l}(s) + B_h + D[\Phi_h + B_h] \geq \Phi_l + B^E_h + D[\Phi^E_h + B^E_h(s)], \quad (IV.7)$$

which reduces to $F_{l,h}(s) > F_{1l}(s)$ and therefore holds for all s.

Case 2: If $F < F_{2h}(s)$ then (IV.6) can be rewritten as

$$\Phi_l - F_{1l}(s) + B_h + D[\Phi_h + B_h] - F \geq \Phi^E_l + B^E_h + D[\Phi_h + B_h - F], \quad (IV.8)$$

which can be rewritten as

$$F_{1l}(s) - DF < (\Phi_l - \Phi^E_l) + (B_h - B^E_h), \quad (IV.9)$$

or

$$F > F_{2l} - (1/D)[B_h - B_l], \quad (IV.10)$$

which is satisfied by (S.2) as

$$F_{2l} - (1/D)[B_h - B_l] < F_{1l}. \quad (IV.11)$$

l does not deviate from its equilibrium strategy when

$$\Phi^E_l + B^E_l + D \quad max \begin{Bmatrix} \Phi^E_l(s) + B^E_l(s) \\ \Phi_l + B_l - F \end{Bmatrix} \geq \Phi_h + D\Phi_l + (1 + D)B_l - F, \quad (IV.12)$$

which is satisfied by condition (S.2), too.

Furthermore, the concept of perfect sequential equilibrium requires us to check off-equilibrium beliefs for their rationality. First, we have to establish that there is no pooling equilibrium which, when supported by the associated beliefs, would yield a higher payoff to the two types and invalidate the off-equilibrium threats of the above equilibrium. equilibrium. To rule out this possibility we require that $\tilde{T}_{1h} > \bar{T}_{1p}$ or

$$\Phi_l - F_{1l}(s) > \delta_h \Phi_h + (1 - \delta_h)\Phi_l - F, \qquad (IV.13)$$

or

$$F > F_{1l}(s) + \delta_h(\Phi_h - \Phi_l). \qquad (IV.14)$$

However, (S.2) requires that

$$F < Fh, l(s) = F_{1l}(s) + (\Phi_h - \Phi_l) - (\Phi_h^E - \Phi_l^E). \qquad (IV.15)$$

Inequalities (IV.14) and (IV.15) hold simultaneously under condition (S.3).

Second, we have to check if there exists a semi-separating equilibrium that leaves l as well off as in the proposed separating equilibrium but yields a higher payoff for h. In particular, there might be a semi-separating equilibrium in which l mixes between two first-period tax regimes, (T_1, Γ_1), where $T_1 > \tilde{T}_{1h}$, and (T_1', Γ_1'), where $\Gamma_1' < \bar{\Gamma}_{1l} < \Gamma_1$; the MNE mixes between FDI and exporting; and h always chooses (T_1, Γ_1). That is, l selects a probability β, the MNE a probability γ and h chooses its tax scheme with probability $\alpha = 1$.

Under this scenario l mixes if

$$\gamma[T_1 + D\Phi_l + (1+D)B_l] + (1-\gamma)[\Gamma_1 + D\Phi_l^E + (1+D)B_l^E] = (1+D)[\Phi_l^E + B_l^E], \qquad (IV.16)$$

or

$$\gamma = \frac{\Phi_l^E - \Gamma_1}{T_1 - \Gamma_1 + F_{1l} - (\Phi_l - \Phi_l^E)}. \qquad (IV.17)$$

The MNE mixes if

$$\frac{\delta_h}{\delta_h + (1-\delta_h)\beta}\Phi_h + \frac{(1-\delta_h)\beta}{\delta_h + (1-\delta_h)\beta}\Phi_l - F - T_1 =$$
$$\frac{\delta_h}{\delta_h + (1-\delta_h)\beta}\Phi_h^E \frac{(1-\delta_h)\beta}{\delta_h + (1-\delta_h)\beta}\Phi_l^E - \Gamma_1, \qquad (IV.18)$$

or

$$\beta = \frac{T_1 + F - \Gamma_1 - \delta_h(\Phi_h - \Phi_h^E)}{(1+D)[\Phi_l - \Phi_l^E]}. \qquad (IV.19)$$

Now suppose that h is better off under semi-separation than under separation. This requires that one of the following two conditions holds:

(i)

$$\gamma[T_1 + D\Phi_h + (1+D)B_h] + (1-\gamma)[\Gamma_1 + D\Phi_h^E + (1+D)B_h^E] > \Phi_l - F_{1l}(s) + D\Phi_h + (1+D)B_h, \qquad (IV.20)$$

or

$$\gamma > \frac{\Phi_l - F_{1l}(s) + F_{1h}(s) - \Gamma_1 - (\Phi_h - \Phi_h^E)}{T_1 - \Gamma_1 + F_{1h} - (\Phi_h - \Phi_h^E)}. \qquad (IV.21)$$

Substituting for γ from (IV.17) we obtain

$$\frac{\Phi_l^E - \Gamma_1}{T_1 - \Gamma_1 + F_{1l} - (\Phi_l - \Phi_l^E)} > \frac{\Phi_l - F_{1l}(s) + F_{1h}(s) - \Gamma_1 - (\Phi_h - \Phi_h^E)}{T_1 - \Gamma_1 + F_{1h} - (\Phi_h - \Phi_h^E)}, \qquad (IV.22)$$

or, after some simple algebraic transformations,

$$F_{h,l}(s) - (\Phi_h - \Phi_h^E) > F_{l,h}(s) + (\Phi_l - \Phi_l^E), \qquad (IV.23)$$

which contradicts (S.2).

(ii)

$$\gamma[T_1 + D\Phi_h + (1+D)B_h] + (1-\gamma)[\Gamma_1 + B_h^E + D(\Phi_h + B_h - F)] > \Phi_l - F_{1l}(s) + D\Phi_h + (1+D)B_h, \qquad (IV.24)$$

or

$$\gamma > 1 - \frac{T_1 - \Gamma_1 + (B_h - B_h^E) + DF}{T_1 - \Gamma_1 + DF - (B_h - B_h^E)}, \qquad (IV.25)$$

or

$$F_{1l}(s) - DF > (\Phi_l - \Phi_l^E) + (B_h - B_h^E), \qquad (IV.26)$$

which contradicts (4.22).

Q.E.D.

Proposition 3.2: *If the following two conditions are satisfied*

(S.2) For any s' and F', $F_{h,l}(s') \geq F' \geq F_{1l}(s')$,

(P.1) $\delta_h > 1 - [(\Phi_h^E - \Phi_l^E)/(\Phi_h - \Phi_l)]$

a pooling equilibrium exists in which:

(h:) $(\bar{T}_{1p}, \Gamma_{1p}; \bar{T}_{2h}, \bar{\Gamma}_{2h})$, where $\bar{T}_{1p} = \delta_h\Phi_h + (1-\delta_h)\Phi_l - F$, and $\Gamma_{1p} > \bar{\Gamma}_{1p}$,

(l:) $(\bar{T}_{1p}, \Gamma_{1p}; \bar{T}_{2l}, \bar{\Gamma}_{2l})$,

(M₁:)

$$\begin{array}{ll} (FDI, x_{1i}), & \text{if } (\bar{T}_{1p}, \Gamma_{1p}) \text{ is observed,} \\ (EXP, x_{1l}^E), & \text{if } (T_{1l}, \bar{\Gamma}_{1l}) \text{ is observed,} \\ (FDI, x_{1i}), & \text{if } T \leq \bar{T}_{1l} \text{ and } \Gamma_{1l} > \Phi_l^E(s) - \Phi_l + F + T_{1l}, \\ (EXP, x_{1l}^E), & \text{if } (\Gamma_{1l} \leq \bar{\Gamma}_{1l} \text{ and } \Gamma_{1l} \leq \Phi_l^E(s) - \Phi_l + F + T_{1l}, \\ (OUT, 0), & \text{if } (\Gamma_{1l} > \bar{\Gamma}_{1l} \text{ and } T_{1l} > \bar{T}_{1l}. \end{array}$$

(M₂:)

$$\begin{array}{ll} (STAY, x_{2h}), & \text{if } (\bar{T}_{2h}, \bar{\Gamma}_{2h}) \text{ is observed,} \\ (EXP, x_{2l}^E), & \text{if } (\bar{T}_{2l}, \bar{\Gamma}_{2l}) \text{ is observed.} \end{array}$$

(μ:)

$$\mu = \begin{cases} (\delta_h, 1 - \delta_h), & \text{if } (\bar{T}_{1p}, \Gamma_{1p}) \text{ is observed;} \\ (0, 1), & \text{otherwise.} \end{cases}$$

Proof: The proof of this proposition is similar to the proof of Proposition 3.1. The MNE does not deviate to exporting since $\Gamma_{1p} \geq \bar{\Gamma}_{1p}$. Furthermore, h does not deviate if

$$\bar{T}_{1p} + D\Phi_h + (1+D)B_h \geq \quad max \left\{ \begin{array}{l} \bar{\Gamma}_{1l} + (1+D)B_h^E + D\Phi_h^E(s) \\ \bar{\Gamma}_{1l} + B_h^E + D[\Phi_h + B_h - F] \\ \bar{T}_{1l} + D\Phi_h + (1+D)B_h \end{array} \right\}. \quad (IV.27)$$

Case 1: If $F \geq F_{2h}(s)$ then (IV.27) becomes

$$\bar{T}_{1p} + D\Phi_h + (1+D)B_h \geq \Phi_l^E + (1+D)B_h^E + D\Phi_h^E(s), \qquad (IV.28)$$

or

$$\delta_h[\Phi_h - \Phi_l] + \Phi_l + D\Phi_h + (1+D)B_h \geq \Phi_l^E + (1+D)B_h^E + D\Phi_h^E(s). \quad (IV.29)$$

Now note that by (P.1)

$$\delta_h[\Phi_h - \Phi_l] > (\Phi_h - \Phi_l) - (\Phi_h^E - \Phi_l^E). \qquad (IV.30)$$

Using (IV.30) in (IV.29) and collecting terms we obtain

$$F_{1h}(s) > F,$$

which is satisfied by assumption (S.2). Therefore (IV.28) is also satisfied.

Case 2: If $F < F_{2h}(s)$ then (IV.21) can be rewritten as

$$\delta_h[\Phi_h - \Phi_l] + \Phi_l + D\Phi_h + (1+D)B_h \geq \Phi_l^E + B_h^E + D[\Phi_h + B_h - F], \quad (IV.31)$$

or, using (IV.30),

$$[1/(1-D)]F_{2h} > F, \quad (IV.32)$$

which holds by assumption.

Case 3: trivial.

Deviations are not profitable for l if

$$\bar{T}_{1p} + D\Phi_l + (1+D)B_l \geq \quad max \begin{Bmatrix} (1+D)[\Phi_l^E + B_l^E] \\ (1+D)[\Phi_l + B_l] - F \end{Bmatrix} . (IV.33)$$

Case 1: $\bar{T}_{1p} > \tilde{T}_{1h}$ by (P.1) but $\tilde{T}_{1h}$ is constructed so that

$$\tilde{T}_{1h} + D\Phi_l + (1+D)B_l \geq (1+D)[\Phi_l^E + B_l^E]. \quad (IV.34)$$

Case 2: Holds since $F_{1l}(s) > F_{2l}(s)$.

Since the optimal pooling tax in this equilibrium is higher than the separating tax in Proposition (3.1), which in turn is preferred to the potential semi-separating equilibrium, a deviation to a semi-separating equilibrium can also be ruled out. The formal proof is identical to the proof of Proposition (3.1).

Q.E.D.

Proposition 4: *If the following condition is satisfied*

(P.2) For any s' and F', $F' \leq F_{1l}(s')$

a pooling equilibrium exists in which:

(h:) $(\bar{T}_{1p}, \Gamma_{1p}; \bar{T}_{2h}, \bar{\Gamma}_{2h})$, *where* $\bar{T}_{1p} = \delta_h\Phi_h + (1-\delta_h)\Phi_l - F$, and $\Gamma_{1p} > \bar{\Gamma}_{1p}$,

(l:) $(\bar{T}_{1p}, \Gamma_{1p}; \bar{T}_{2l}, \bar{\Gamma}_{2l})$,

(M_1:)

(FDI, x_{1i}), *if* $(\bar{T}_{1p}, \Gamma_{1p})$ *is observed,*
(FDI, x_{1i}), *if* $T \leq \bar{T}_{1l}$ and $\Gamma_{1l} > \Phi_l^E(s) - \Phi_l + F + T_{1l}$,
(EXP, x_{1l}^E), *if* $(\Gamma_{1l} \leq \bar{\Gamma}_{1l}$ and $\Gamma_{1l} \leq \Phi_l^E(s) - \Phi_l + F + T_{1l}$,
$(OUT, 0)$, *if* $(\Gamma_{1l} > \bar{\Gamma}_{1l}$ and $T_{1l} > \bar{T}_{1l}$.

(M_2:)

$(STAY, x_{2h})$, *if* $(\bar{T}_{2h}, \bar{\Gamma}_{2h})$ *is observed,*
(EXP, x_{2l}^E), *if* $(\bar{T}_{2l}, \bar{\Gamma}_{2l})$ *is observed.*

(μ:)

$$\mu = \begin{cases} (\delta_h, 1-\delta_h), & \text{if } (\bar{T}_{1p}, \Gamma_{1p}) \text{ is observed;} \\ (0,1), & \text{otherwise.} \end{cases}$$

Proof: The MNE does not deviate to exporting since $\Gamma_{1p} \geq \bar{\Gamma}_{1p}$. Furthermore, h does not deviate if

$$\bar{T}_{1p} + D\Phi_h + (1+D)B_h \geq \quad max \begin{Bmatrix} \bar{\Gamma}_{1l} + (1+D)B_h^E + D\Phi_h^E(s) \\ \bar{\Gamma}_{1l} + B_h^E + D[\Phi_h + B_h - F] \\ \bar{T}_{1l} + D\Phi_h + (1+D)B_h \end{Bmatrix}. \quad (IV.35)$$

Case 1: If $F \geq F_{2h}$ then (IV.35) becomes

$$\bar{T}_{1p} + D\Phi_h + (1+D)B_h \geq \bar{\Gamma}_{1l} + (1+D)B_h^E + D\Phi_h^E(s), \quad (IV.36)$$

which is satisfied by (P.2).

Case 2: If $F < F_{2h}$ then we require

$$\bar{T}_{1p} + D\Phi_h + (1+D)B_h \geq \Phi_l^E + B_h^E + D[\Phi_h + B_h - F], \quad (IV.37)$$

which, as in the proof of Proposition 3.2, reduces to $[1/(1-D)]F_{2h} > F$ and therefore holds by assumption.

Deviations are not profitable for l if

$$\bar{T}_{1p} + D\Phi_{1l} + (1+D)B_l \geq \quad max \begin{Bmatrix} (1+D)[\Phi_l^E + B_l^E] \\ (1+D)[\Phi_l + B_l] - F \end{Bmatrix}. \quad (IV.38)$$

Case 1: If $F \geq F_{1l}(s)$ then

$$\bar{T}_{1p} + D\Phi_l + (1+D)B_l \geq (1+D)[\Phi_l^E + B_l^E], \quad (IV.39)$$

which holds by (P.2).

Case 2: If $F < F_{2l}(s)$ then

$$\bar{T}_{1p} + D\Phi_l + (1+D)B_l \geq \Phi_l^E + B_l^E + D[\Phi_l + B_l - F]. \quad (IV.40)$$

Equation (IV.40) reduces to

$$F < [1/(1-D)][F_{2l}(s) + \delta_h(\Phi_h - \Phi_l)], \quad (IV.41)$$

which holds by assumption.

The rest of the proof is similar to the proof of Proposition (3.1). There does not exist a semi-separating equilibrium which could invalidate the off-equilibrium beliefs supporting the pooling equilibrium.

Q.E.D.

Proposition 5: *If the following condition is satisfied*

(S.3) *For any s' and F', $F' \geq F_{1h}(s') + (1-\delta_h)[\Phi_h^E - \Phi_l^E]$,*

a pooling equilibrium exists in which:

(h:) $(T_{1p}, \bar{\Gamma}_{1p}; \bar{T}_{2h}, \bar{\Gamma}_{2h})$, where $\bar{\Gamma}_{1p} = \delta_h \Phi_h^E + (1-\delta_h)\Phi_l^E$, and $T_{1p} > \bar{T}_{1p}$,

(l:) $(T_{1p}, \bar{\Gamma}_{1p}; \bar{T}_{2l}, \bar{\Gamma}_{2l})$,

(M_1:)

$$
\begin{array}{ll}
(EXP, x_{1i}^E), & \textit{if } (T_{1p}, \bar{\Gamma}_{1p}) \textit{ is observed,} \\
(FDI, x_{1i}), & \textit{if } T \leq \bar{T}_{1l} \text{ and } \Gamma_{1l} > \Phi_l^E(s) - \Phi_l + F + T_{1l}, \\
(EXP, x_{1l}^E), & \textit{if } (\Gamma_{1l} \leq \bar{\Gamma}_{1l} \text{ and } \Gamma_{1l} \leq \Phi_l^E(s) - \Phi_l + F + T_{1l}, \\
(OUT, 0), & \textit{if } (\Gamma_{1l} > \bar{\Gamma}_{1l} \text{ and } T_{1l} > \bar{T}_{1l}.
\end{array}
$$

(M_2:)

$$
(EXP, x_{2i}^E), \quad \textit{if } (\bar{T}_{2i}, \bar{\Gamma}_{2i}) \textit{ is observed.}
$$

(μ:)

$$
\mu = \begin{cases} (\delta_h, 1-\delta_h), & \textit{if } (T_{1p}, \bar{\Gamma}_{1p}) \textit{ is observed;} \\ (0,1), & \textit{otherwise.} \end{cases}
$$

Proof: The proof is similar to the proof of Proposition 4.

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