Strategic Policy Towards Multinationals for Oligopolistic Industries

by

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Abstract

I consider an environment with two firms, one domestically owned and one a foreign-owned multinational corporation (MNC), both producing in the host (domestic) country. I find that there are three distinct dimensions that affect a country's strategic policy towards domestically-owned firms and foreign-owned firms: the number of policy instruments available to the host government (whether or not it can tax/subsidize both types of firms), the location of the market (in the host country or a third country) and the extent of spillover of the foreign-owned firms' production.

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1 Introduction

According to conventional trade theory, under the condition of perfect competition with no market failure, it is optimal for a country to adopt free trade, open freely to foreign direct investment (hereinafter FDI) and practice laissez faire in domestic production. To the extent that the multinational corporation's (MNC's) production might generate technological spillovers to the local firms, the optimal response is to subsidize the multinational's production, while maintaining non-intervention in all other aspects. The strategic trade policy literature suggests that the optimal trade policy can be quite different for oligopolistic industries, since there are rents to be gained by the domestic firms. The purpose of this paper is to examine the host country government's optimal policy towards domestic firms and MNCs, all of which produce in the host country and compete in an oligopolistic market.

According to the strategic trade policy literature, ignoring consumers' welfare, it would seem optimal for the host country to tax the MNCs' production (like taxing imports), and to subsidize the production of the domestic firm(s) (like subsidizing exports). The primary purpose of such policy would be for a government to shift rents to the firm(s) owned by its citizens by increasing the marginal cost of the rivals or lowering that of its own firm(s).

On the other hand, there are incentives for developing countries to seek more foreign investment from advanced countries because of the positive technological spillovers from the technology transfer to the domestic firm(s). Thus, the MNCs' production is different from import in one important aspect — if the source country firm has technological advantage in the product in question, there are positive spillovers effect on the domestic firms in the host country. It has been argued that the spillovers of the MNCs' production come mainly from the MNCs' hiring and training of local workers, technicians, engineers and managers, who might eventually be hired away by the local competitors. Moreover, the presence of more advanced firms gives rise to a demonstration effect in the developing country, providing motivation for improvement. This spillovers effect was also called 'contagion effect' by Findlay (1978), and it has been widely documented. See, for example, Bloomstrom and Persson (1983), Das (1987) and Muniagurria and Singh (1997).

This paper fills a gap in the literature by studying the simultaneous determination of host government's tax policy towards domestic firms and MNCs, with the presence of technological spillovers from the latter. First of all, we shall consider a model with two firms, one is domestically-owned and one is a foreign-owned MNC, both producing in the host (domestic) country. Then we shall generalize to the case with many firms. We can think of the source country as a developed country (DC) and the host country as a less developed country (LDC), although the model can equally apply to one DC's MNCs in another DC. The host country government sets tax/subsidy on firms in the first stage of a two-stage game. Following the literature, I assume that the host government can commit to a scheme of taxing/subsidizing firms in the first stage. The firms then compete strategically in a Cournot fashion in a host-country/third-country market in the second stage. I assume that the MNC's production might have some positive spillovers effect on the domestic firm. The purpose of the paper is to study the subgame perfect equilibrium tax/subsidy policies of the host government. I focus on the benchmark case of linear demand and try to generalize the results to other cases.

I find it useful to distinguish between three dimensions that affect a country's strategic policy towards domestically-owned firms and foreign-owned firms: the number of policy instruments available to the host government (whether or not it can tax/subsidize both types of firms), the location of the market (in the host country or a third country) and the extent of spillover of the foreign-owned firms' production on the domestic economy. The paper explains how each of the above dimensions affects the domestic government's tax/subsidy policy towards these firms.

First, start with Brander and Spencer's (1985) two-firm case, with no spillovers from the MNC and all goods being sold in a third country, as the benchmark. The fact that the host government can tax/subsidize both firms reverts the optimal policy towards the domestic firms from subsidy to tax (Proposition 1). Second, consider the case when the host government can only tax/subsidize the host-country firm. The former would want to subsidize the latter when spillovers are weak (similar to Brander and Spencer's (1995) result), but tax it when spillovers are strong, regardless of where the market is (Proposition 2). Third, consider the case when the host government can tax/subsidize both firms. I find that the host government wants to tax the MNC's production when spillovers from the MNC's production are weak, but subsidize it when spillovers are strong. This is true regardless of where the market is (Proposition 3). In other words, when spillovers are weak, the host government acts like it imposes 'countervailing duty' on the MNC. But when spillovers are sufficiently strong, the host government wants to speed up the inward diffusion of advanced technology by subsidization of MNCs' production. Another interesting result is that the host country government wants to subsidize the host country firm when all goods are sold in the host country, but tax it when all goods are sold in a third country. This is true regardless the degree of spillovers from the MNCs (Proposition 4). The motive for the subsidy, however, is not to shift rent from the rival firm, but a consideration for domestic consumers' welfare. Fourth, I check that Proposition 3 and 4 can be generalized to the case with any number of firms in both countries (Proposition 5).

2 The General Model

First of all, consider there is one domestic firm and one MNC producing in the host country. For convenience of discussion, let us call the source country North, the host country South, the MNC firm N, and the host country firm S. Both firms produce in South.

I assume that marginal costs are independent of outputs. Assume that the marginal cost of firm N in South is lower than that of Firm S because of North's technological superiority in the product in question. Examples that come to mind are US companies producing automobiles or high-tech equipment in China.

2.1 Two Policy Instruments are Available

Consider a two stage game. At the first stage, Southern government sets tax/subsidy on firm N's and firm S's production. In the second stage, firms play a simultaneous move homogeneous-good Cournot game. It may be argued that international trade agreements prohibit discrimination between domestically-owned and foreign-owned firms in the same country. However, in the real world, there are many subtle ways for a government to favor firms owned by its own citizens, e.g. many countries grant tax exemptions to domestic start-up firms or directly subsidize state-owned enterprises, etc.

As usual, the model is solved by backward induction, starting from stage two.

2.1.1 Second Stage

Firm N.

Variables with an asterisk are those of firm S or Southern government. Variables without an asterisk are those of firm N.

Firm N's profit is given by

$$\pi = r(x, x^*) - cx + u^* x \tag{1}$$

The variable x is output of firm N; x^* is output of firm S; c is the pre-subsidy marginal cost of firm N's production; u^* is Southern government's subsidy to Firm N's production. The variable $r(x, x^*) \equiv x f(x + x^*)$ is the total revenue of firm N; $f(.)$ is the inverse demand function, and its value is the price charged to consumers; and $f'(.) < 0$. I assume that $r_{xx} < 0$. That is, the marginal revenue of firm N is decreasing with its own output. I also assume that

$r_{xx^*} < 0$. That is, the marginal revenue of firm N is decreasing with the rival's output. A sufficient condition for the above two conditions is $f''(.) \leq 0$, i.e. the market demand curve is (weakly) concave, which I assume to be the case.

At the second stage, the reaction function of firm N is the first order condition for profit maximization, that is, maximization of π by choosing x, given x^* and u^*.

It is straightforward to obtain the reaction function of firm N:

$$\pi_x = r_x - c + u^* = 0 \tag{2}$$

It is assumed that u^* is sufficiently small that $c > u^*$ in equilibrium. Therefore, in equilibrium, $r_x > 0$. That is, given the output of firm S, the own marginal revenue of firm N is positive in equilibrium.

<u>Firm S</u>.

Firm S's profit is given by

$$\pi^* = r^*(x, x^*) - a(x)c^*x^* + \sigma^*x^* \tag{3}$$

where the term $a(x)c^*$ is the marginal cost of production of firm S, and $a(x)$ decreases with x. That is, there is a spillover effect of firm N's production in South. I assume that $a(0) = 1, a'(.) < 0, a''(.) \geq 0$ and $a'(\infty) = 0$. The marginal spillover effect (weakly) diminishes as x increases. (This assumption of diminishing spillovers is also made in other models, such as Das (1987).) Moreover, it is assumed that $a(\infty)c^* > c$ always, i.e. the spillover will never be complete no matter how large the scale of firm N's production is, due to some inherent technological advantage of firm N over firm S. The variable σ^* is the specific production subsidy per unit of output from Southern government to firm S. The variable $r^*(x, x^*) \equiv x^*f(x + x^*)$ is the total revenue of firm S. Similar to the case of firm N, I assume that $r^*_{x^*x^*} < 0$ and $r^*_{x^*x} < 0$. A sufficient condition for these to hold is again $f'' \leq 0$. I further assume that $r^*_{x^*xx} \leq 0$ i.e. $\partial|r^*_{x^*x}|/\partial x \geq 0$. A sufficient condition of this is $f''' = 0$ and $f'' \leq 0$ (linear demand is an example), which we assume to hold throughout this paper.

By differentiating the above expression of π^* with respect to x^*, I obtain the reaction function of firm S:

$$\pi^*_{x^*} = r^*_{x^*} - a(x)c^* + \sigma^* = 0 \tag{4}$$

Again, it is assumed that $\sigma^* < a(x)c^*$ in equilibrium. Hence, $r^*_{x^*} > 0$ in equilibrium, i.e. given firm N's output, the own marginal revenue of firm S is positive in equilibrium.

<u>Slopes of Reaction Functions</u>.

We totally differentiate the first order condition (2) with respect to x and x^* to obtain the slope of the reaction function of firm N:

$$(dx^*/dx)|_N = -(\pi_{xx}/\pi_{xx^*}).$$

We know that

$$\pi_{xx} = r_{xx} = xf'' + 2f' < 0 \tag{5}$$

given the assumption $r_{xx} < 0$. Moreover,

$$\pi_{xx^*} = r_{xx^*} = xf'' + f' < 0 \tag{6}$$

by assumption. Hence, the reaction function of firm N is downward sloping in the (x, x^*) space, as shown in Figure 1. They are represented by the N_1N_1 or N_2N_2 curve.

Similarly, I obtain the slope of the reaction function of firm S:

$$(dx^*/dx)|_S = -(\pi^*_{x^*x}/\pi^*_{x^*x^*}).$$

Moreover, we have

$$\pi^*_{x^*x} = -a'(x)c^* + r^*_{x^*x} = \delta(x) + r^*_{x^*x} = x^*f'' + f' + \delta(x)$$

where $\delta(x) \equiv |a'(x)|c^* \equiv$ the magnitude of spillovers effect; and

$$\pi^*_{x^*x^*} = r^*_{x^*x^*} = x^*f'' + 2f' < 0$$

given the assumption $r^*_{x^*x^*} < 0$. Hence, the reaction function of firm S is upward sloping iff $\pi^*_{x^*x} = \delta(x) + r^*_{x^*x} > 0$.

Now, $\pi^*_{x^*x} = \delta(x) + r^*_{x^*x} = \delta(x) - |r^*_{x^*x}|$. Since I assume the spillover effect to be positive but (weakly) diminishes on the margin, $a'(x) < 0$ and $a''(x) \geq 0$, which implies that $\partial|a'(x)|/\partial x \leq 0$. Moreover, recall the assumptions $r^*_{x^*x} < 0$ and $\partial|r^*_{x^*x}|/\partial x \geq 0$. It is clear that $d\pi^*_{x^*x}/dx < 0$. It is also clear that, *provided that the spillover effect of firm N's production in the host country is large enough*, the equilibrium value of $\pi^*_{x^*x}$ is positive when $x = 0$. As x increases, $\pi^*_{x^*x}$ decreases and will eventually turn negative. That is, the reaction function of firm S is upward sloping when x is small, and its slope eventually turns negative as x increases. Formally, the condition for the reaction function of firm S to be upward sloping when $x = 0$ is $-a'(0)c^* + r^*_{x^*x}(0, x^*_0) > 0$ where x^*_0 is the best response output of firm S when the output of firm N is zero. In fact, x^*_0 is exactly the monopoly output of firm S. For linear demand function and constant marginal cost $f(x + x^*) = A - B(x + x^*)$, the condition for SS to be upward sloping at $x = 0$ is $|a'(0)|c^* - B > 0$.

If the above condition is satisfied, the reaction function of firm S first slopes upwards when x is small, then slopes downwards as x gets sufficiently large. This reaction function is shown in Figure 1 as the S_1S_1 curve. The asymptotic slope of S_1S_1 is equal to the slope of S_2S_2 (corresponding to no spillovers) when the demand curve is linear. The subgame perfect equilibrium outputs x and x^* are determined by the intersection of the NN and SS curves. There are two equilibrium scenarios. The first scenario is when the two reaction functions intersect at the upward sloping part of firm S's reaction function (N_1N_1 and S_1S_1). In this case, the equilibrium value of x is small. This will occur when c is large, c^* is small, the spillover effect is strong and diminishes slowly, or a combination of these conditions. The second scenario is when they intersect at the downward sloping part of firm S's reaction function (N_2N_2 and S_1S_1). In this case, the equilibrium value of x is large. This will occur when c is small, c^* is large, the spillover effect is weak and diminishes quickly, or a combination of the these conditions.

Define

$$M \equiv \begin{bmatrix} \pi_{xx} & \pi_{xx^*} \\ \pi^*_{x^*x} & \pi^*_{x^*x^*} \end{bmatrix}$$

and its determinant as $\Lambda \equiv \pi_{xx}\pi^*_{x^*x^*} - \pi_{xx^*}\pi^*_{x^*x}$. It can be easily shown that $\Lambda > 0$ since $|\pi_{xx}| > |\pi_{xx^*}|$; and $|\pi^*_{x^*x^*}| > |\pi^*_{x^*x}|$ if $\pi^*_{x^*x}$ is negative. (If $\pi^*_{x^*x}$ is positive, then it is trivial to show that $\Lambda > 0$, since π_{xx^*} is always negative.)

Hence, $(dx^*/dx)|_N < (dx^*/dx)|_S$, which means that no matter whether firm S's reaction function is upward sloping or not, firm N's reaction function always intersect it from above — when they intersect in the downward sloping part of firm S's reaction function, firm N's reaction function is steeper than firm S's, as in the standard case with no production externalities (see, for example, Brander and Spencer 1985). This is shown in Figure 1.[1] It also implies that there is no possibility of multiple equilibria, in the sense that the NN curve cuts the SS curve twice, once from above and once from below, since the NN curve can never cut the SS curve from below.

Isoprofit lines.

As in the conventional analyses, the reaction function of firm N is the locus of all the peaks of the isoprofit lines. The isoprofit lines are concave and profit decreases as x^* increases, as in the standard case with no spillovers. This is shown in Figure 2.

However, the reaction function of firm S is the locus of the *troughs* of isoprofit lines of firm S when the reaction function is upward sloping in the (x, x^*) space. When the reaction function is downward sloping, it is the locus of the peaks of isoprofit lines as in the standard case with no spillovers. Hence, the isoprofit lines are a set of closed curves with a center at the peak of the reaction function of firm S, as shown by the light dotted lines in Figure 3.

2.1.2 First Stage

In order to understand how the location of market affects the policy outcome, let us consider two distinct cases, namely Case I: all goods are sold in South, and Case II: all goods are sold in a third country.

Case I: All goods are sold in South.

In the first stage of the game, Southern government will choose a subsidy to firm S, σ^*, and a subsidy to firm N, u^*, so as to maximize the country's welfare. Since goods are sold only in South, national welfare in host country is the same as the net-of-subsidy profit of firm S minus the total subsidy to firm N, plus Southern consumer surplus (denoted by Z). Let G^* be the national welfare of South. Then, $G^* = \pi^* - \sigma^* x^* - u^* x + Z$.

Define $dZ/d\sigma^* \equiv \Omega$. Therefore,

$$\begin{aligned} dG^*/d\sigma^* &= (d\pi^*/d\sigma^*) - x^* - \sigma^* \cdot (dx^*/d\sigma^*) - u^* \cdot (dx/d\sigma^*) + dZ/d\sigma^* \\ &= \pi^*_x \cdot (dx/d\sigma^*) + \pi^*_{x^*} \cdot (dx^*/d\sigma^*) + \pi^*_{\sigma^*} - x^* - \sigma^* \cdot (dx^*/d\sigma^*) - u^* \cdot (dx/d\sigma^*) + \Omega \\ &= (\pi^*_x - u^*) \cdot (dx/d\sigma^*) - \sigma^* \cdot (dx^*/d\sigma^*) + \Omega \end{aligned}$$

where the second equality comes from the first order condition (or reaction function) of firm S as well as the fact that $\pi^*_{\sigma^*} = x^*$. Moreover, $\pi^*_x = r^*_x - a'(x)c^* x^* = x^* f' + \delta(x) x^*$. To calculate $dx/d\sigma^*$ and $dx^*/d\sigma^*$, I totally differentiate the reaction functions of firm S and firm N. Totally differentiating the reaction function of firm S with respect to x, x^* and σ^*, then note that $\pi^*_{x^*\sigma^*} = 1$ and $\pi_{x\sigma^*} = 0$, we obtain

$$M \begin{bmatrix} dx \\ dx^* \end{bmatrix} = \begin{bmatrix} 0 \\ -d\sigma^* \end{bmatrix}$$

Using Cramer's Rule, we obtain

$$dx/d\sigma^* = (1/\Lambda) \cdot (\pi_{xx^*}) < 0 \qquad \text{and} \qquad dx^*/d\sigma^* = -(1/\Lambda) \cdot (\pi_{xx}) > 0$$

Hence, the first order condition with respect to the choice of σ^* is

$$dG^*/d\sigma^* = (\pi^*_x - u^*)(\pi_{xx^*})/\Lambda + \sigma^* \cdot (\pi_{xx}/\Lambda) + \Omega = 0 \tag{7}$$

where $\Omega = (x + x^*) \cdot (f')^2/\Lambda > 0$.[2]

To find the optimal u^*, I define $\Gamma \equiv dZ/du^*$, then compute

$$dG^*/du^* = \pi^*_x \cdot (dx/du^*) + \pi^*_{x^*} \cdot (dx^*/du^*) - \sigma^* \cdot (dx^*/du^*) - u^* \cdot (dx/du^*) - x + \Gamma$$

By Cramer's Rule, we can easily solve for the total derivative of x and x^* with respect to u^* as follows:

$$dx/du^* = (1/\Lambda)(-\pi^*_{x^*x^*}) > 0$$
$$dx^*/du^* = (1/\Lambda)(\pi^*_{x^*x}) = (1/\Lambda) \cdot [f' + x^*f'' + \delta(x)]$$

Moreover, $\pi^*_{x^*} = 0$ due to the first order condition (or reaction function) of firm S.

Hence, the first order condition with respect to the choice of u^* is

$$dG^*/du^* = (\pi^*_x - u^*)(-\pi^*_{x^*x^*}/\Lambda) - \sigma^*\pi^*_{x^*x}/\Lambda - x + \Gamma = 0 \tag{8}$$

where $\Gamma = (x + x^*) \cdot |f'| \cdot (|f'| + \delta)/\Lambda > 0$. (Hence, $\Gamma > \Omega$.)

The last two first order conditions (7) and (8) can be re-written as

$$\begin{bmatrix} \pi_{xx^*} & -\pi_{xx} \\ \pi^*_{x^*x^*} & -\pi^*_{x^*x} \end{bmatrix} \begin{bmatrix} u^* \\ \sigma^* \end{bmatrix} = \begin{bmatrix} \pi^*_x\pi_{xx^*} + \Omega\Lambda \\ \Lambda x + \pi^*_x\pi^*_{x^*x^*} - \Gamma\Lambda \end{bmatrix}$$

Using Cramer's Rule, we get the optimal value of u^*:

$$\hat{u}^* = x \cdot (xf'' + 2f') + x^*f' + \delta(x) \cdot x^* - \Omega \cdot [f' + x^*f'' + \delta(x)] - \Gamma \cdot (xf'' + 2f') \tag{9}$$

with the detail given in the appendix.

Similarly, using Cramer's rule, we obtain the optimal value of σ^*:

$$\hat{\sigma}^* = x \cdot (f' + xf'') - \Omega \cdot (2f' + x^*f'') - \Gamma \cdot (f' + xf'') \tag{10}$$

with the detail given in the appendix.

(The second order conditions for this bivariate maximization problem with linear demand are shown in the appendix.)

When $\delta(x)$ or f'' is not zero, the signs of $\hat{u}^*$ and $\hat{\sigma}^*$ are not obvious. Therefore, I want to use a simple special case — linear demand — to further our study of Case I in Section 3.

Case II: All goods are sold to a third country.

In this case, $Z = 0$. Therefore, $\Omega = \Gamma = 0$.

Equation (9) becomes

$$\hat{u}^* = x \cdot (xf'' + 2f') + x^*f' + \delta(x) \cdot x^* \tag{11}$$

Equation (10) becomes

$$\hat{\sigma}^* = x \cdot (f' + xf'') < 0. \tag{12}$$

Therefore, the Southern government always wants to tax Firm S when all goods are sold to a third country. When δ is zero or very small, it is also optimal to tax Firm N. Comparing (11) with (12), we see that the optimal tax rate on Firm N is higher than that on Firm S.

2.2 Effects of the Number of Policy Instruments

In Brander and Spencer (1985), when South can have only one policy instrument, namely tax/subsidy of Firm S, the optimal policy is subsidy so as to shift rent from Firm N. However, in the environment of this paper, Southern government has two policy instruments, namely tax/subsidy of Firm S and Firm N. An additional source of Southern welfare is tax revenue from Firm N. Therefore, in the absence of spillovers from the MNC, it is optimal to *tax* Firm N. However, there is a tax Laffer Curve that limits the optimal tax rate on Firm N for a given tax/subsidy rate on firm S. It turns out that it is also optimal to tax Firm S (at a lower tax rate than that on Firm N). This set of policy can achieve both shifting rent to Firm S and collecting the optimal tax revenue from Firm N. Although taxing Firm S tends to shift rents to Firm N (which can be corrected by taxing Firm N even more), it increases the tax base for Firm N, thus allowing more tax revenue to be collected from N. Therefore, we have

Proposition 1 *Suppose all goods are sold in a third country and spillovers are weak. If there is only one policy instrument available (viz. tax/subsidy of Firm S only), it is optimal for the Southern government to subsidize Firm S. (This is the Brander-Spencer result.) If there are two policy instruments available (viz. tax/subsidy of Firm S and Firm N), it is optimal for the Southern government to tax Firm S.*

2.3 Effects of Spillovers with One Policy Instrument Available

Case I: All goods are sold in South.

When the South can only tax/subsidize Firm S, we set $u^* = 0$ in equation (7), then consider the sign of σ^* from the resulting equation. From the equation, we get

$$\sigma^* = \frac{-(x + x^*)(f')^2 - x^*[f' + \delta(x)](xf'' + f')}{xf'' + 2f'}$$

Therefore, $\sigma^* > 0$ (a subsidy to Firm S) when $\delta(x)$ is zero or small, and $\sigma^* < 0$ (a tax on Firm S) when $\delta(x)$ is sufficiently large.[3]

Case II: All goods are sold to a third country

When all goods are sold in a third country, the equation above becomes

$$\sigma^* = \frac{-x^*[f' + \delta(x)](xf'' + f')}{xf'' + 2f'}$$

Therefore, $\sigma^* > 0$ iff $\delta(x) + f' < 0$, i.e. iff spillovers are sufficiently weak or nil (the Brander-Spencer case). This is true when SS curve is downward sloping. Conversely, $\sigma^* < 0$ iff SS curve is upward sloping. Therefore, the same qualitative result applies to both Case I and Case II. Diagrammatically, the case when all goods are sold in a third country is shown in Figure 3. Therefore, we have

Proposition 2 *Suppose there is only one policy instrument available to Southern government. Then it is optimal for the Southern government to subsidize Firm S when there are no spillovers. (The Brander-Spencer case.) However, when spillovers are sufficiently strong, it is optimal for Southern government to tax Firm S. These results hold regardless of whether all goods are sold in South or to a third country.*

3 Linear Demand

Assume that the demand curve is linear of the form $f(x^* + x) = A - B(x^* + x)$ where $A, B > 0$, and $a''(x) = 0$ (that is, spillover effect does not diminish with x, which means that $a'(x)$, and hence $\delta(x)$, is constant.) Hence, $f(0) = A$, $f' = -B$ and $f'' = 0$. Moreover, $\Lambda = \pi_{xx}\pi^*_{x^*x^*} - \pi_{xx^*}\pi^*_{x^*x} = 4|f'|^2 - |f'| \cdot (|f'| - \delta) = 3|f'|^2 + |f'|\delta > 0$.

The reaction function NN for firm N is

$$x^* = -2x + \alpha$$

where $\alpha \equiv (1/|f'|)[f(0) - c + u^*]$ is assumed to be greater than zero.

The reaction function SS of firm S is

$$x^* = \beta x + \gamma$$

where $\beta = (1/2|f'|)(\delta - |f'|) > -(1/2)$ and $\gamma = (1/2|f'|)[f(0) - c^* + \sigma^*]$ is assumed to be greater than zero. This implies that the monopoly output of firm S is positive. Also, $(dx^*/dx)|_S = \beta$. Hence SS is upward sloping iff $\beta > 0$, or $\delta > |f'|$.

Solving for x and x^* from the reaction functions, we get

$$x = (\alpha - \gamma)/(2 + \beta).$$

Also,

$$x^* = (2\gamma + \alpha\beta)/(2 + \beta).$$

3.1 Subsidy to Firm N

Case I: All goods are sold in South.

From (9), when $f'' = 0$, we have $\Omega = [(x + x^*)B^2]/(3B^2 + B\delta)$, $\Gamma = [(x + x^*)B(B + \delta)]/(3B^2 + B\delta)$, where $B \equiv |f'|$. Therefore,

$$\begin{aligned} \hat{u}^* &= -2x|f'| - x^*|f'| + \delta x^* - \frac{(x + x^*)|f'|^2}{3|f'|^2 + |f'|\delta}(-|f'| + \delta) + \frac{2(x + x^*)|f'|^2(|f'| + \delta)}{3|f'|^2 + |f'|\delta} \\ &= \delta x^* - |f'|x \end{aligned} \tag{13}$$

which is less than zero if $\delta = 0$. When all goods are sold in South and $\delta = 0$, the above result is like a country imposing 'countervailing duties' on goods produced by foreign firms, although the goods are not imported but produced locally by an MNC. See Dixit (1984) for a similar discussion.[4]

Since x decreases with δ and x^* increases with δ, u^* is greater than zero if δ is sufficiently large. See Figure 4. That is, it is optimal to subsidize the MNC when spillovers are sufficiently large. Here, we see that part of the motive for subsidy is for consumer welfare and part is to encourage the inflow of advanced technology that can have strong spillovers effect on the local economy. The consideration for consumer welfare can be seen from the fact that, when goods are sold in a third country, δ has to be larger to justify subsidy of Firm N, as shown below.

Case II: All goods are sold to a third country.

If all goods are sold in a third country, then $\Omega = \Gamma = 0$, so that $\hat{u}^* = -2x|f'| - x^*|f'| + \delta x^*$. Therefore, in order to make $\hat{u}^* > 0$, δ has to be larger than that when all goods are sold in South. This is because, when all goods are sold in a third country, Southern consumers do not benefit from the higher output resulted from subsidy of Firm N. Hence, we have

Proposition 3 *When demand is linear, and spillovers are weak, it is optimal for Southern government to tax Firm N's production. When spillovers from Firm N's production is sufficiently strong, it becomes optimal for Southern government to subsidize Firm N's production. This is true regardless of where the market is.*

3.2 Subsidy to Firm S

Case I: All goods are sold in South.

When $f'' = 0$, (10) becomes

$$\begin{aligned} \hat{\sigma}^* &= -x|f'| + \frac{(x+x^*)|f'|^2}{3|f'|^2 + |f'|\delta}(2|f'|) + \frac{(x+x^*)|f'|^2(|f'|+\delta)}{3|f'|^2+|f'|\delta} \\ &= |f'|x^* \end{aligned} \tag{14}$$

which is always positive.[5]

When spillovers are weak, by taxing firm N, Southern government earns tax revenue as well as shifts rents to firm S. By subsidizing firm S, Southern government encourages the production of firm S, and thereby increasing Southern consumers' welfare. This combination of tax and subsidy is optimal to South.[6]

When the spillovers are sufficiently strong that SS is not only upward sloping, but is sufficiently steep, then both $\hat{u}^*$ and $\hat{\sigma}^*$ would be positive, i.e. Southern government will subsidize the production of both firm N and firm S. This increases the output of both firms, which benefits consumers. Although the subsidization of firm N shifts some rents to the source country firm, it lowers the cost of firm S (due to increased spillovers) as well as benefits consumers, making South better off.

Case II: All goods are sold to a third country.

Note, however, that if all products are exported to a third country, then consumer welfare in South is of no concern to Southern government. Therefore $\Omega = \Gamma = 0$. In that case, (10) implies that $\hat{\sigma}^* < 0$ regardless of the magnitude of $\delta(x)$, i.e. the host government will want to tax firm S, a policy which is completely opposite from the case when all products are sold in South. This is because Southern consumers now do not benefit from increased production of firm S anymore. Hence, we have

Proposition 4 *When demand is linear and Southern government can tax/subsidize both firms, the Southern government always wants to subsidize Firm S when all goods are sold in South, due to consideration for consumers' welfare. When all goods are sold in a third country, the Southern government always want to tax firm S. These are true regardless of the degree of production spillovers from the MNCs.*

4 Summary and Extension

Because of the inter-relationship among the different propositions obtained above, it seems useful to tabulate the results that we have obtained so far. The summary of the major results are shown in Table 1. In the first panel, there are no spillovers from the MNC; in the second, spillovers are strong.

Note that Southern policy is affected by three important dimensions: 1. the number of policy instruments available; 2. where the goods are sold; and 3. the magnitude of the spillovers effect. In Brander and Spencer (1985), there is only one policy instrument, all goods are sold in a third country, and there are no spillovers from Firm N. In this paper, there are two policy instruments, all goods are sold in South, and there are spillovers from Firm N. These three factors account for the differences between the two sets of policy.

Many Firms from Each Country

When there are many firms in each country, a firm's increase in output does not only lower the profits of all the foreign firms, as before, but also has negative pecuniary externality on the profits of all other firms from the same country, since the price is lowered. However, despite this factor, I show in an appendix, available upon request, that Proposition 3 and 4 still hold. Therefore, we have

Proposition 5 *Propositions 3 and 4 hold for any number of firms in the host and source country. The critical δ above which it is optimal for the host government to subsidize MNCs' production gets smaller as the number of host country firms increases.*

In other words, the case for subsidizing MNCs' production gets stronger as the number of host country firms gets larger. The intuition: the spillovers are non-rival among the Southern firms. Therefore, the more firms there are in the South, the more the country benefits from the same amount of MNCs' production, which increases the marginal benefits from subsidizing MNCs' production.

Based on our assumptions, in a dynamic setting with many periods, the spillovers effect would gradually diminishes with firm N's cumulative output. Therefore, a conjecture arising from Propositions 3, 4, and 5 is that, if the future is discounted sufficiently heavily, the host country will find it optimal to subsidize MNCs' production in the initial periods (when spillovers are strong), but it will want to tax it in the later periods (when spillovers are weak). At the same time, the Southern government will find it optimal to subsidize Firm S

all the time. As shown in Figure 2 and 3, if NN intersects SS when the latter is downward sloping, the optimal policy, which is to tax N and subsidize S, will increase x^* and reduce x. If NN intersects SS when the latter is upward sloping, the optimal policy, which is to subsidize N as well as S, will increase x^* but have ambiguous effect on x. Hence, the Southern government's optimal policy would tend to expand the output of firm S anyway, even when there are strong spillovers from the MNCs. This is a protectionist measure for both domestic firms and consumers.

5 Conclusion

I find it useful to distinguish between three dimensions that affect a country's strategic policy towards domestically-owned firms and foreign-owned firms: the number of policy instruments available to the host government (i.e. whether or not foreign-owned firms can be taxed), the location of the market, and the extent of spillover from the foreign-owned firms' production. The paper explains how each of the above dimensions affects the domestic government's tax/subsidy policy towards these firms.

Consider the most interesting case with the domestic firms and MNCs competing in an oligopolistic market in the host country. A tax on MNCs' production by the host government has four effects on domestic welfare: 1. it reduces the scale of operation of MNCs and thereby reduces the technological spillovers from MNCs to domestic firms; 2. it increases the profits of the domestic firms by increasing their competitiveness relative to the MNCs; 3. it contributes to government revenues; 4. it reduces domestic consumers' welfare by increasing the market price. An optimal tax will find the best balance among these effects. Similar considerations apply to a tax on domestic firms. We find that the host country wants to subsidize the domestic firms all the time, but tax (subsidize) the MNCs when spillovers are weak (strong).

Based on our assumptions, in a dynamic setting with many periods, the spillover effect would gradually diminishes with the MNCs' cumulative output. Therefore, I conjecture that if the future is discounted sufficiently heavily, the host country will find it optimal to subsidize MNCs' production in the initial periods, but it will want to tax it in the later periods. At the same time, the host government will find it optimal to subsidize the domestic firm all the time.

It must be noted that I have not considered any increasing returns to scale or learning by doing with regard to the domestic firms. It seems obvious that such effects tend to increase the host government's incentive to subsidize the domestic firms.

Appendix

A Second Order Conditions

With linear demand $f(x+x^*) = A - B(x+x^*)$ and constant spillovers δ:

$$dG^*/d\sigma^* = (1/\Lambda)\cdot[(-Bx^* + \delta x^* - u^*)(-B) + \sigma^*(-2B) + (x+x^*)B^2]$$

$$\begin{aligned}
d^2G^*/d\sigma^{*2} &= (1/\Lambda)\left[B^2\cdot(dx^*/d\sigma^*) - \delta\cdot(dx^*/d\sigma^*)\cdot B - 2B + B^2[(dx/d\sigma^*) + (dx^*/d\sigma^*)]\right] \\
&= (1/\Lambda)\left[B^2\cdot(1/\Lambda)\cdot(2B) - 2B - (\delta B)(2B/\Lambda) + (B^2/\Lambda)\cdot(-B+2B)\right] \\
&= (B/\Lambda)\left[(2B/\Lambda)\cdot(B-\delta) - 2 + (B^2/\Lambda)\right] < 0 \text{ since } \Lambda > 3B^2
\end{aligned}$$

$$\begin{aligned}
d^2G^*/du^*d\sigma^* &= (1/\Lambda)\left[B^2\cdot(dx^*/du^*) - (dx^*/du^*)\cdot\delta B + B + B^2[(dx/du^*) + (dx^*/du^*)]\right] \\
&= (1/\Lambda)\left\{B(B-\delta)\cdot[(\delta-B)/\Lambda] + B + (B^2/\Lambda)\cdot(-B+\delta+2B)\right\} \\
&= (B/\Lambda)\left[1 - [(B-\delta)^2/\Lambda] + (B/\Lambda)\cdot(B+\delta)\right]
\end{aligned}$$

$$\begin{aligned}
dG^*/du^* &= (1/\Lambda)\cdot\{(-Bx^* + \delta x^* - u^*)(2B) - \sigma^*(-B+\delta)\} - x \\
&\quad +(1/\Lambda)(x+x^*)(-B)(-B-\delta)
\end{aligned}$$

$$\begin{aligned}
d^2G^*/du^{*2} &= (1/\Lambda)\{-2B^2\cdot(dx^*/du^*) + \delta\cdot(dx^*/du^*)(2B) - 2B\} - (dx/du^*) \\
&\quad +(B/\Lambda)(B+\delta)[(dx/du^*) + (dx^*/du^*)] \\
&= (2B/\Lambda)\{(\delta-B)(1/\Lambda)(-B+\delta) - 1\} - (2B/\Lambda) + (B/\Lambda^2)\cdot(B+\delta)^2 \\
&= (2B/\Lambda)\{-[(\delta-B)^2/\Lambda] - 2 + [(B+\delta)^2/2\Lambda]\} \\
&= (B/\Lambda^2)[-(B-\delta)^2 - 12B^2] < 0.
\end{aligned}$$

Define $\theta \equiv B - \delta < B$ and note that $\Lambda = 3B^2 + B\delta$, we obtain

$$\begin{aligned}
&(d^2G^*/du^{*2})\cdot(d^2G^*/d\sigma^{*2}) - (d^2G^*/du^*d\sigma^*)^2 \\
&= (2B^2/\Lambda)[(2B/\Lambda)\cdot\theta - 2 + (B^2/\Lambda)]\cdot\{(-\theta^2/\Lambda) - 2 + [(B+\delta)^2]/(2\Lambda)\} \\
&\qquad -(B^2/\Lambda^2)\cdot[1 - (\theta^2/\Lambda) + (B/\Lambda)(B+\delta)] \\
&> (2B^2/\Lambda^2)(2)(2/3)[(\theta^2/\Lambda) + 2] - (B^2/\Lambda^2)[1 - (\theta^2/\Lambda) + (B/\Lambda)(B+\delta)] \\
&> (8B^2/3\Lambda^2)(2) - (B^2/\Lambda^2)(2) > 0.
\end{aligned}$$

B Derivation of expressions for u^* and σ^*

$$
\begin{aligned}
\hat{u}^* &= \begin{vmatrix} \pi_x^*\pi_{xx^*} + \Omega\Lambda & -\pi_{xx} \\ \Lambda x + \pi_x^*\pi_{x^*x^*}^* - \Gamma\Lambda & -\pi_{x^*x}^* \end{vmatrix} \cdot (1/\Lambda) \\
&= (1/\Lambda) \cdot \left[\begin{vmatrix} 0 & -\pi_{xx} \\ \Lambda x & -\pi_{x^*x}^* \end{vmatrix} + \begin{vmatrix} \pi_x^*\pi_{xx^*} & -\pi_{xx} \\ \pi_x^*\pi_{x^*x^*}^* & -\pi_{x^*x}^* \end{vmatrix} + \begin{vmatrix} \Omega\Lambda & -\pi_{xx} \\ -\Gamma\Lambda & -\pi_{x^*x}^* \end{vmatrix} \right] \\
&= (\Lambda x \pi_{xx}/\Lambda) + \pi_x^* - (\Lambda\Omega\pi_{x^*x}^*/\Lambda) - (\Lambda\Gamma\pi_{xx}/\Lambda) \quad \text{since} \quad \Lambda \equiv \pi_{xx}\pi_{x^*x^*}^* - \pi_{xx^*}\pi_{x^*x}^* \\
&= x\pi_{xx} + \pi_x^* - \Omega \cdot (\pi_{x^*x}^*) - \Gamma \cdot (\pi_{xx}) \\
&= x \cdot (xf'' + 2f') + x^*f' + \delta x^* - \Omega \cdot (f' + x^*f'' + \delta) - \Gamma \cdot (xf'' + 2f')
\end{aligned}
$$

which is (9).

Similarly, using Cramer's rule, we obtain

$$
\begin{aligned}
\hat{\sigma}^* &= \begin{vmatrix} \pi_{xx^*} & \pi_x^*\pi_{xx^*} + \Omega\Lambda \\ \pi_{x^*x^*}^* & \Lambda x + \pi_x^*\pi_{x^*x^*}^* - \Gamma\Lambda \end{vmatrix} \cdot (1/\Lambda) \\
&= \left[\begin{vmatrix} \pi_{xx^*} & \pi_x^*\pi_{xx^*} \\ \pi_{x^*x^*}^* & \pi_x^*\pi_{x^*x^*}^* \end{vmatrix} + \begin{vmatrix} \pi_{xx^*} & 0 \\ \pi_{x^*x^*}^* & \Lambda x \end{vmatrix} + \begin{vmatrix} \pi_{xx^*} & \Omega\Lambda \\ \pi_{x^*x^*}^* & -\Gamma\Lambda \end{vmatrix} \right] \cdot (1/\Lambda) \\
&= (\Lambda x \pi_{xx^*}/\Lambda) - \Omega\pi_{x^*x^*}^* - \Gamma\pi_{xx^*} \\
&= x(f' + xf'') - \Omega \cdot (2f' + x^*f'') - \Gamma \cdot (f' + xf'')
\end{aligned}
$$

which is (10).

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Notes

1. The fact that the NN curve always intersects the SS curve from above ensures that the Nash equilibrium is stable.

2. $Z = \int_0^{x+x^*} f(\phi)d\phi - (x+x^*)f(x+x^*)$. Therefore,
$\Omega \equiv dZ/d\sigma^* = (dZ/dx) \cdot (dx/d\sigma^*) + (dZ/dx^*) \cdot (dx^*/d\sigma^*) =$
$(x+x^*) \cdot |f'| \cdot (dx/d\sigma^*) + (x+x^*) \cdot |f'| \cdot (dx^*/d\sigma^*) = [(x+x^*) \cdot |f'|^2]/\Lambda$. The expression for Γ is derived similarly.

3. In the simple case that δ is constant, x^* increases and x decreases as δ increases. Moreover, $x+x^*$ increases with δ, but the increase in $x+x^*$ is less than that of x^*. Therefore, σ^* can be positive when δ is sufficiently large.

4. Brander and Spencer (1984) consider Cournot competition between a domestic firm and a foreign firm that exports to the domestic market, and find that an import tariff (corresponding to $u^* < 0$ in this paper) raises welfare if price rises by less than the tariff (which is true when demand is linear). Therefore, there is consistency between their result and mine.

5. If $f'' < 0$, then when $|f''|$ is large, the sign of $\hat{\sigma}^*$ may be reversed. When $|f''|$ is large, the curvature of the demand curve is large, and the benefits to consumers of increased production drops quickly with total output. Thus, the benefits of a subsidy are lowered. Here is a highlight of the proof. Suppose $\delta = 0$ and $f'' < 0$. From (10), the term that involves f'' is $-\{x^2 - [(x+x^*)^2|f'|]/[(x+x^*)|f''| + 3|f'|]\} \cdot |f''|$. Therefore, for given x, x^* and $|f'|$, the negative component of $\hat{\sigma}^*$ increases in magnitude as $|f''|$ increases, and it can eventually dominate the positive component if $|f''|$ is sufficiently large.

6. A subsidy to Firm S is optimal as long as the demand curve is not too concave, so that the benefits of increased output to domestic consumers do not fall too quickly as total output expands.

No spillovers		All goods sold in	
		South	Third country
No. of policy instruments	1	(Subsidy, —)†	(Subsidy, —)
	2	(Subsidy, Tax)	(Tax, Tax)

Strong spillovers		All goods sold in	
		South	Third country
No. of policy instruments	1	(Tax, —)	(Tax, —)
	2	(Subsidy, Subsidy)	(Tax, Subsidy)

Table 1. Summary of Southern Policy Towards Firm S and Firm N

† Policy: (a, b), where a = policy towards Firm S; b = policy towards Firm N.

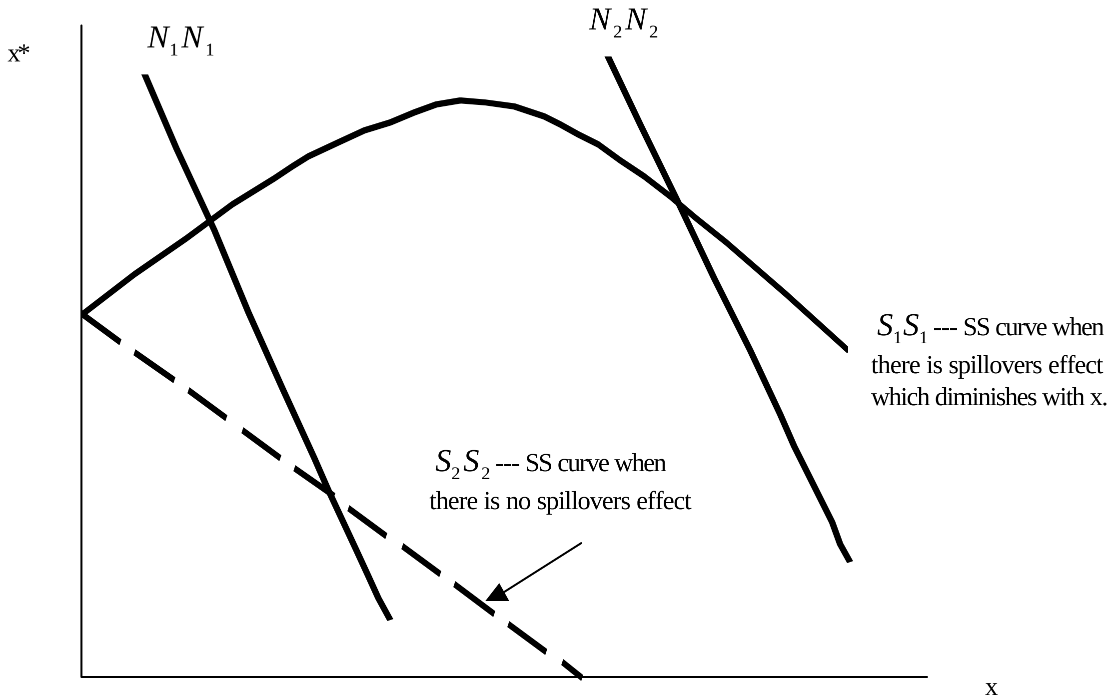

Figure 1. Two types of subgame perfect equilibria.

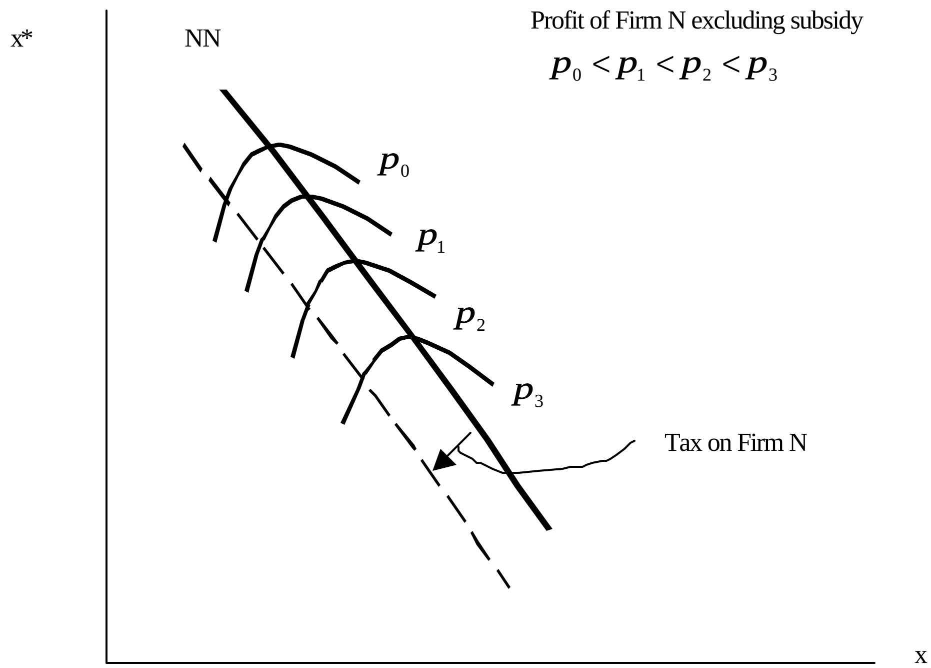

Figure 2: Isoprofit lines for Firm N.

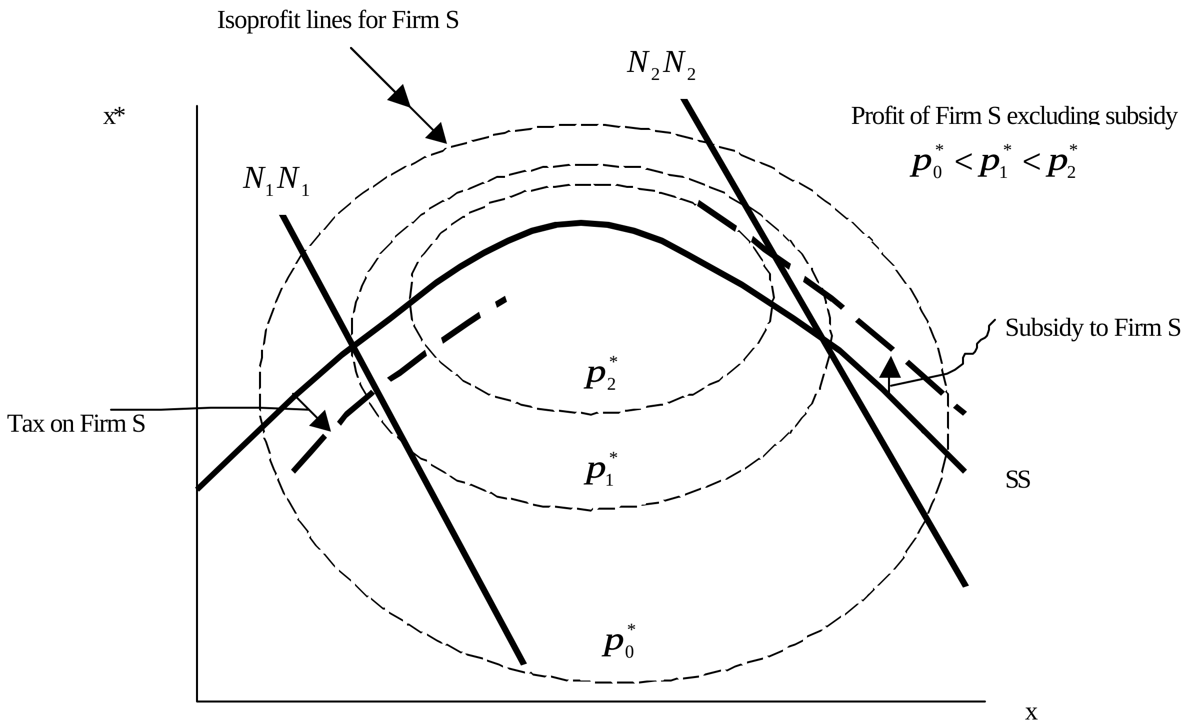

Figure 3. Two types of optimal Southern policy.

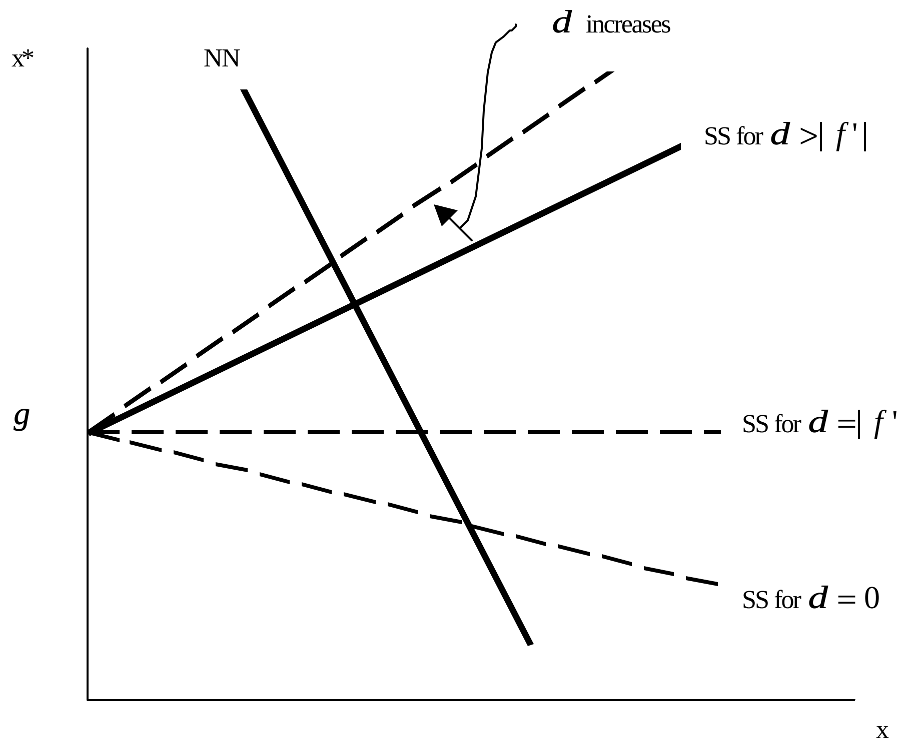

Figure 4. Equilibrium when demand is linear and d is constant