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TAXATION AND THE BIRTH OF  
FOREIGN SUBSIDIARIES

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ABSTRACT

The paper studies the influence of tax policy on foreign direct investment with a particular emphasis on immature subsidiaries. Among other things it shows that taxes on repatriations reduce the subsidiary's "birth weight", that lump sum taxes reduce its cost of capital, and that the possibility of deferral increases this cost. The paper rejects the popular weighted average specification of the subsidiary's cost of capital.

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## 1. *Introduction*

It has long been known that foreign direct investment is an inherently dynamic phenomenon with characteristic growth phases of the subsidiary. Typically, the subsidiary is set up with only a small nucleus of equity capital transferred from the parent, undergoes a period of self-financed growth thereafter, and pays dividends to the parent when an ultimate stage of maturity has been reached. Authors like Barlow and Wender (1955), Penrose (1956, 1959), or Robbins and Stobaugh (1973) have carefully described this pattern and have developed what may be called the "nucleus hypothesis" of direct investment.

The role of taxes in the context of the nucleus hypothesis is fairly unknown. A rich body of literature on the influence of taxation on direct investment does exist and includes such important contributions as those of Hamada (1966), Horst (1977), Kemp (1962, 1964), MacDougall (1960), P. Musgrave (1969), Richman (1963), and Sato and Bird (1975), or, to take more recent samples from the rapidly growing literature, Alworth (1986, 1988), Jun (1989), Keen (1990), Leechor and Mintz (1990), Razin and Slemrod (1990), Sørensen (1989), and Sinn (1989). However, the relationship between taxation and the time pattern of a subsidiary's development has found little attention in that literature.

Why are subsidiaries required to grow out of a nucleus of equity capital rather than being established in a single step with all the equity they need? How do taxes interfere with this process? How will host and home country taxes, withholding taxes, double taxation agreements, and royalties affect the size of the nucleus, how will they affect its growth? Does the subsidiary's "birth weight" determine its size at maturity? Will deferral really reduce the cost of equity finance? These are questions to which the existing literature on taxation and direct investment has provided rather incomplete answers, to say the least.

This paper tries to help fill the gap. It analyzes the role of capital income taxation in a dynamic model of direct investment which is fully compatible with the

nucleus hypothesis, even generating this hypothesis endogenously. The model is constructed from two main building blocks.

The first of these is the theory of the mature foreign subsidiary as developed by Hartman (1985) and Sinn (1984, 1985). Among other things, this theory implies that taxes on cross-border profit distributions will not affect a subsidiary's cost of capital even in the case where equity is chosen as the marginal source of finance, and it suggests that international double taxation agreements which aim at reducing the burden of such taxes should primarily be seen as satisfying distributional rather than allocative objectives.<sup>1</sup> Sinn's evaluation of double taxation agreements was derived from a model which included a rich set of taxes, but was limited to mature, dividend paying subsidiaries and did not consider the tax influence on the growth towards maturity. Hartman's article was more explicit on the distinction between mature and immature firms, and included a brief discussion of the latter. However, as will be clarified in section 7 below, not all of its views fit well in the framework developed here.

The second building block is Sinn's (1988) article on the dynamic effects of dividend taxation. That article derived the full growth path of the subsidiary, from birth towards maturity, and it showed that taxes on profit repatriations imply the nucleus hypothesis. However, the tax on repatriations was the only tax considered.<sup>2</sup>

The present paper combines the previous approaches by studying the firm's growth path under a richer set of taxes, including home taxes on the parent's interest income, home taxes on its capital gains, host taxes on the subsidiary's retentions, and home

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<sup>1</sup>The result is an application of what has become known as the so-called "new view" of corporate taxation which originates from the work of King (1974a, 1974b, 1977) and was further developed by Auerbach (1979, 1983), Bradford (1981), Edwards and Keen (1984), the author, and others.

<sup>2</sup>A similar approach has recently been chosen in a useful working paper by Hines (1989). Hines allows for a richer set of taxes and focusses on the firm's debt-equity choice, but he neither derives the nucleus hypothesis from an optimization model nor develops unambiguous comparative-static results concerning the tax influence on investment. The reader is also advised to consider a paper by King (1989) where the role of taxes for a corporation's birth is studied in a two-period framework.

and host taxes on cross-border profit distributions. Its novelty consists in the derivation of a number of comparative static results concerning the influence of taxation on the immature subsidiary's investment decisions. These results answer some of the questions posed.

Section 2 of the paper sets up the formal model and explains the solution which is derived in the appendix. Sections 3 – 6 offer the comparative static results, starting with the straightforward results and proceeding towards more sophisticated and unexpected ones. Section 7 compares the results with a frequently used weighted average approach and section 8 offers some conclusions.

While the paper is phrased in terms of direct investment, it should be emphasized that the model actually used is general enough to include the tax influence on the birth and development of a domestic corporation. The only difficulty with that interpretation is that a domestic corporation may be able to channel its profit distributions through share repurchases instead of dividends, a case that is of some importance in the US (but less so in other countries).<sup>3</sup> Apart from that, however, the reinterpretation of the model is straightforward when the "parent" is replaced with a shareholder household and the "subsidiary" with a domestic corporation. For the sake of clarity and convenience the terminology is limited to the case of direct investment.

## *2. Taxation and the Optimization Problem of the Parent*

Applying Jun's (1989) idea of the "parent-veil" it is assumed that the parent chooses a policy of direct investment that maximizes the subsidiary's market value net of some initial equity transfer  $K_1$ . This policy is in the interest of the parent's shareholders because it maximizes their wealth and lowers their intertemporal budget constraints as far as possible.

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<sup>3</sup>For extensive discussions of the tax incentives for share repurchases and acquisitions see Bagwell and Shoven (1989) and Sinn (1985, ch. 6).

Four separate tax rates are considered. The home country's rate of corporate tax  $\tau$  which is applied to the parent's return from alternative investment projects available in the domestic capital market; the host country's rate of corporate tax  $\tau^*$  which is applied to the subsidiary's reinvested earnings; the home country's rate of tax on capital gains  $c$  from an appreciation of the subsidiary's market value; and the overall tax rate on profit repatriations  $r$  which may consist of home and host country taxes.<sup>4</sup> All tax rates are bounded away from unity and may or may not be set equal to zero. In addition, there is a lump sum tax or royalty generating the revenue  $X$  in each period.

Following the general principle of income accounting for corporations, the capital gains tax is modelled as a tax on accrued rather than realized capital gains. In practice, such a tax is far less important than in accounting theory though. On the one hand, most tax laws do not require adjustment of the value of a subsidiary in the parent's tax balance sheet and limit taxation to the rare cases of realizations. On the other hand, principles of cautious book keeping (e.g. Niederstwertprinzip in Germany) make it often unnecessary for a company to revise the value of its marketable assets upwards even if those do not formally qualify for an exemption from capital gains taxation. Both provisions are captured indirectly by the present approach in that a relatively low equivalent tax on accrued capital gains is assumed.

The rate of tax on repatriated earnings,  $r$ , is a *mixtum compositum* that captures home country corporate taxes, host country corporate taxes, host country withholding taxes, and different rules for crediting and deductions.<sup>5</sup> When there is sufficient ownership of the parent (e.g. 10% or more in the US, where the parent is majority owned by US citizens), most countries use the credit-cum-deferral system. This system implies that the rate of tax on repatriated earnings is the higher of the home country's

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<sup>4</sup>The analysis abstracts from non-constant tax rates. For this the reader is referred to Hines (1989), Leechor and Mintz (1990), and Howitt and Sinn (1989).

<sup>5</sup>For details see Alworth (1988), Ault and Bradford (1990), Keen (1990), or Sinn (1985, ch. 7).

corporate tax rate and the sum of the host country's corporate and withholding tax rates. A number of countries apply the exemption instead of the credit system, sometimes also known under the name "international affiliation privilege". With the exemption system, the rate of tax on repatriations equals the sum of the host country's corporate and withholding taxes regardless of whether or not the home country's tax rate is higher than this sum. Another set of countries uses the credit system without deferral. This system is identical with the other two systems when the domestic corporate tax rate is low and parent companies are in an excess credit position. On the other hand, if the domestic corporate tax rate exceeds the average foreign tax rate on retained and repatriated earnings, then the domestic corporate tax rate is the relevant rate for these both kinds of earnings. Finally, in the case of insufficient ownership, most countries apply the deduction method. This method means that the repatriations net of the foreign corporate and withholding taxes are fully subject to the domestic corporate tax.

Detailed assumptions about which systems are being used are not necessary in this paper. However, it will be assumed that there is a preference for a deferral of profit repatriations in the sense that the overall tax burden on these repatriations exceeds that on profit retentions within the subsidiary:

$$(1) \quad r > 1 - (1 - \tau^*)(1 - c) .$$

This condition is feasible under all four systems described and it is certainly satisfied for direct investment in tax havens. It is the typical assumption of the literature on direct investment.<sup>6</sup>

Given the tax system described, the subsidiary's market value is implicitly determined by the following arbitrage calculus which requires the parent to be indifferent

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<sup>6</sup>If this assumption is not satisfied it is optimal for the subsidiary to finance all investment with transfers from the parent and return all profits to the parent when they accrue. In that case, no dynamic model of the firm is necessary.

between keeping and selling the subsidiary at each instant of time,  $t$ :

$$(2) \quad R(1-\tau) + (\dot{M} - T)(1-c) = Mi(1-\tau).$$

Here,  $i$  is the (time invariant) rate of interest at which the parent can borrow and lend in the capital market,  $R(t)$  is the flow of profit repatriations before foreign and domestic taxes,  $M(t)$  the market value of the subsidiary,  $\dot{M}(t)$  its derivative with respect to time, and  $T(t)$  a potential flow of equity transfers from the parent to the subsidiary. The left-hand side of equation (2) is the parent's implicit net-of-tax income from owning the subsidiary. The right-hand side is the opportunity cost of this ownership in terms of the net-of-tax interest income the parent could earn by selling the subsidiary and investing the proceeds in the capital market. Integration of (2) with respect to time gives an explicit expression for the subsidiary's market value<sup>7</sup> at arbitrary points in time  $t$ :

$$(3) \quad M(t) = \int_t^{\infty} \left[ R(v) \frac{1-\tau}{1-c} - T(v) \right] \exp \left[ -(v-t) i \frac{1-\tau}{1-c} \right] dv$$

The market value is defined up to an arbitrary integration constant; however, since this constant is irrelevant for the firm's optimization problem it is set equal to zero. To satisfy the transversality condition of the firm's optimization problem it must be assumed that  $\lim_{v \rightarrow \infty} \{ [R(v)(1-\tau)/(1-c)] - T(v) \} \exp [-(v-t) i (1-\tau)/(1-c)] = 0$ .

Let  $f(K)$  denote the subsidiary's profit (or output) as a function of its stock of equity capital  $K$ .<sup>8</sup> The function is assumed to be positive, increasing, unbounded from

<sup>7</sup>Alternatively, equation (2) can be shown to imply that the market value is the present net-of-tax value of the cash flow  $R(1-\tau) - T - c\dot{M}$  which is generated by the subsidiary where  $i(1-\tau)$  rather than  $i(1-\tau)/(1-c)$  is the discount rate. For a discussion of these two alternative, but economically equivalent formulations, see Sinn (1985, ch. 3). That discussion includes the case of a variable rate of interest.

<sup>8</sup>For simplicity and because of the overwhelming empirical importance of equity finance for direct investment, this paper abstracts from debt financing. The function  $f(K)$  may be



above, and strictly concave. The latter reflects the assumption that there is a fixed, non-marketable factor such as a natural resource or simply "entrepreneurship" in the background whose return accrues to the subsidiary. The flow of before-tax profit repatriations which the subsidiary generates is given by

$$(4) \quad R = f(K) - \dot{K} + T - X - \tau^* [f(K) - R - X]$$

where  $\tau^*$  is the foreign rate of corporate tax on retained earnings,  $\dot{K}$  is real net investment, and  $X$  is the lump sum tax or royalty. It is assumed that the royalty is sufficiently small to allow for  $\dot{K} > \epsilon$  in all stages of the subsidiary's development process, where  $\epsilon$  is an arbitrarily small, strictly positive constant.

The subsidiary is founded at time  $t_1$  where the investment opportunities characterized by  $f(K)$  become available. Let  $K_1$  be an initial stock transfer of equity which may or may not be amended by additional flow injections  $T$  at later points in time. Then the optimization problem can be written as

$$(5) \quad \max_{\{\dot{K}, T, K_1\}} M(t_1) - K_1 \quad \text{s.t.} \quad K_1, T, R \geq 0.$$

The state variable of this problem is  $K$  and the controls are  $\dot{K}$ ,  $T$ , and  $K_1$ . The constraints are essential to depict the fundamental tax asymmetry of the problem which consists in the fact that the government taxes the repatriations, but does not subsidize the equity transfers from the parent.<sup>9</sup> Share repurchases that could, in principle, be a justification for allowing

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interpreted as the firm's profit net of interest payments and other costs of debt financing resulting from an interior debt equity choice. Similarly,  $f(K)$  can be seen as the subsidiary's profit net of payments to other marketable factors like labor and intermediate inputs. These factors are assumed to be available at fixed prices and to be optimally employed by the subsidiary.

<sup>9</sup>A tax free return of the subsidiary's original capital can be allowed in the present model without any change in the results, provided this return cannot occur before the subsidiary's surplus capital has been returned. See note 18 and Sinn (1988, sec. 4.3) for a brief

$T$  to be negative, are forbidden.<sup>10</sup>

The formal solution of problem (5) by means of Pontryagin's Maximum Principle has been delegated to the appendix of this paper. The nature of the solution is the same as that found in Sinn (1988) for a variant of the model which has only a dividend tax.

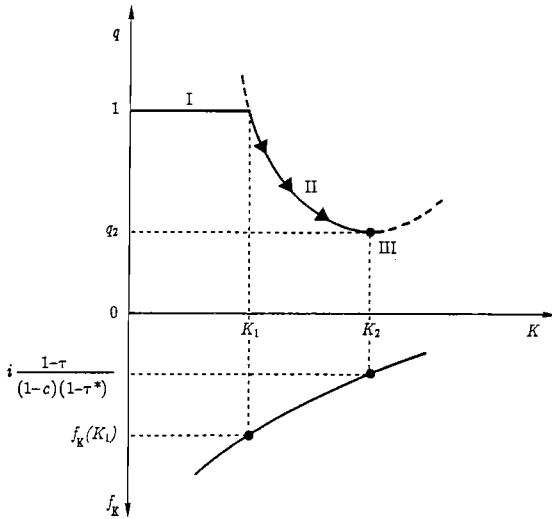


Figure 1: *The Nucleus Hypothesis*

Provided the investment projects described by the function  $f(K)$  are profitable enough to make the foundation of the subsidiary worthwhile, the three phases of development described by the nucleus hypothesis are endogenously generated by the model. At the time of foundation, Phase I, the subsidiary receives a strictly positive lump sum

discussion of this possibility.

<sup>10</sup>As far as is known, no country allows subsidiaries to repurchase their own shares from their parents, except for fundamental reorganizations of the conglomerate's ownership structure. Moreover, effective provisions exist against purchases of other companies' shares. For example, the Subpart-F rules of the US tax code classify such repurchases as profit repatriations and require that they be taxed in the US.

transfer  $K_1 > 0$ , the "nucleus". Then it enters a period of purely internal growth, Phase II, where no dividends are paid to the parent and no further transfers are received. Finally it reaches a stage of maturity, Phase III, which is characterized by a capital stock  $K_2$ ,  $K_2 > K_1$ , where it stays forever and repatriates its profits.

The solution is illustrated in Figure 1 which shows a diagram with the subsidiary's equity  $K$ , the marginal value of this equity  $q$ , and the (marginal) pre-tax rate of return to capital  $f_K(K)$  measured along the axes. The pre-tax rate of return to capital chosen at a particular stage of development equals the firm's cost of capital.

At the time of foundation,  $q$  equals one since the parent transfers capital to the subsidiary up to the point where the increase of the subsidiary's market value resulting from an additional dollar of capital just equals one dollar:

$$(6) \quad q = 1 \quad \text{for } K = K_1.$$

After this, during the phase of internal growth,  $q$  declines monotonically, and  $K$  increases monotonically. The change of  $q$  satisfies the equation

$$(7) \quad (1-c) [f_K(K) (1-\tau^*) + \dot{q}/q] = (1-\tau) i \quad \text{for } K_1 \leq K \leq K_2$$

and, because of (4) and  $R = T = 0$ , the change of  $K$  is given by

$$(8) \quad \dot{K} = [f(K) - X] (1-\tau^*) \quad \text{for } K_1 \leq K \leq K_2.$$

Equation (7) is the counterpart of the fundamental arbitrage condition (2). When  $R = T = 0$ , the latter implies that the subsidiary's market value appreciates at a rate that is sufficiently high to create net-of-tax capital gains which just match the net-of-tax interest income which a capital market investment would yield:  $(\dot{M}/M) (1-c) = i (1-\tau)$ .

The former shows that the rate of appreciation of the subsidiary's market value equals the rate of return from direct investment net of the host country's corporate tax,  $f_K \cdot (1-\tau^*)$ , minus the rate of decline in the *marginal* value of equity,  $-\dot{q}/q$ . Solving (7) for  $\dot{q}$  and dividing the result by (8) generates an expression for the slope of the optimal path in  $(q, K)$  space that will be useful for subsequent comparative static analyses:

$$(9) \quad \frac{dq}{dK} = \frac{\dot{q}}{\dot{K}} = \frac{q \left[ \frac{1-\tau}{(1-c)(1-\tau^*)} i - f_K(K) \right]}{f(K) - X} \quad \text{for } K_1 \leq K \leq K_2.$$

The reason for the decline in  $q$  is that the marginal value of equity available in the subsidiary will be given by

$$(10) \quad q = \frac{1-r}{(1-c)(1-\tau^*)} < 1 \quad \text{for } K = K_2$$

once the subsidiary has matured and profits are being repatriated to the parent. This value of  $q$  is the one which models sharing the so-called "new view" generate. It falls short of unity because of the basic assumption that the tax system favors deferral. Let  $q_2$  denote the mature subsidiary's value of  $q$ , as given by (10). The firm's cost of capital in the stage of maturity is given by the well-known equation

$$(11) \quad f_K(K) = i \frac{1-\tau}{(1-c)(1-\tau^*)} \quad \text{for } K = K_2$$

which describes the firm's investment behavior when retained earnings are the marginal source of finance.<sup>11</sup>

<sup>11</sup>The value of  $q$  as given in (10) could be derived from (11) by discounting the flow of after-tax profit repatriations resulting from an additional dollar of investment,  $f_K \cdot (1-\tau)$  with the net-of-tax interest rate  $i(1-\tau)$ , i.e. by setting  $q = f_K \cdot (1-\tau) / [i(1-\tau)]$  and replacing

Equations (9), (10), and (11), together with the starting condition  $q = 1$  from (6), will be used in the following sections to derive comparative static results for the effects of tax reforms on direct investment. It is obvious from the three equations that some of the taxes have similar effects and others have opposite ones. This feature reflects the fact that the model is basically a portfolio choice approach where the parent compares alternative investment strategies which all bear some sort of tax. The symmetries of the tax effects will help simplify the analysis.

### 3. *Taxes on Repatriations and World-wide Corporate Tax Reforms*

The main purpose of international double taxation agreements has always been to reduce the tax burden on cross-border profit repatriations and to find a fair compromise between the home and host country interests in revenue collection. Economists, on the other hand, have pointed to the allocative implications of the double taxation agreements, emphasizing that severe distortions in the international allocation of capital could result from taxes on profit repatriations. Most experts agree that taxes on repatriations scare direct investment away and may therefore not be in the interest of the country collecting the tax revenue. However, as mentioned in the introduction, even among economists there have been voices that have played down the allocative problems, arguing that taxes on profit repatriations are fairly neutral and that the double taxation agreements should indeed be seen primarily under distributional aspects. The present model is able to reconcile these diverging views.

On the one hand, equation (11) shows that the rate of tax on repatriations,  $\tau$ , is irrelevant for the mature subsidiary's optimal capital stock  $K_2$ . As this subsidiary repatriates its earnings, a reduction in the repatriations is always available as a marginal source of finance. Even a high tax rate does not discriminate against investment, since the

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$f_K$  with the value given in (11).

subsidiary's marginal investment outlay enjoys an immediate subsidy in terms of reduced taxes on repatriations that just compensates for the taxes on the future repatriations which this investment will generate.

On the other hand, equations (9) and (10) make clear that the subsidiary's starting stock of equity,  $K_1$ , will be smaller, and the initial cost of capital  $f_K(K_1)$  higher, the higher the rate of tax on repatriations  $r$ . Equation (9) describes a set of potential paths in  $(q, K)$  space that is independent of  $r$ , and equation (10) singles out one of these paths by determining the terminal value of  $q$ ,  $q_2$ . Since  $q_2$  declines with an increase in  $r$ , the starting stock of capital, determined by the intersection of the path with the  $q = 1$  locus, must do so too.

The result is illustrated in Figure 2 by the shift from the upper to the lower path of  $q$  and the corresponding shifts from  $q_2$  to  $q_2'$  and from  $K_1$  to  $K_1'$ .

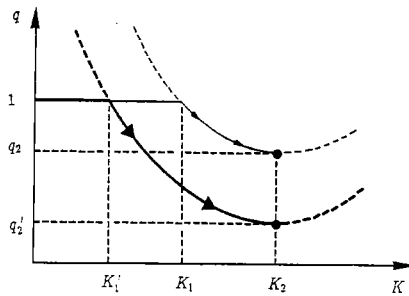


Figure 2: Taxes on Profit Repatriations

Obviously, unlike Sinn's (1984) contention, double taxation agreements that reduce the overall tax burden on profit repatriations will indeed stimulate direct investment. Parents endow their subsidiaries with a higher "birth weight" than they

otherwise would have done and the phase of growth towards maturity will be shorter. On the other hand, the final size of the subsidiary will indeed be independent of whether or not there are such double taxation agreements. In a mature subsidiary only the proportions of surplus and original capital are affected by the overall tax burden on profit repatriations, not the size of the sum of these two kinds of equity capital itself.

A corollary of the result is that double taxation agreements come too late when the tax burden on repatriations really hurts, for then the subsidiaries are mature and have reached their ultimate sizes. In order to be effective, the agreements must be known before the subsidiaries are founded because only then will they be able to affect a subsidiary's size at birth and the speed at which it grows to maturity.

Another corollary is that the actual, measurable tax burden on the subsidiary's profits does not reveal much about its cost of capital  $f_K$ . When this burden is high, because the subsidiary is mature and repatriates its earnings, the cost of capital is low; and when the burden is low, because the subsidiary is immature and does not yet repatriate, the cost of capital is high. If anything, there is an inverse relationship between the measurable tax burden and the cost of capital at any given point in time.

While the discussion has centered around the role of taxes on profit repatriations, the portfolio nature of the problem solved by the parent implies that analogous allocative results can be derived by changing other taxes. Suppose, for example, that there are no capital gains taxes ( $c = 0$ ) and that the host and home countries have the same corporate tax rates ( $\tau^* = \tau$ ) while withholding taxes continue to keep  $q_2$  below one. It is clear from equations (9) - (11) that in this case a world-wide cut in corporate taxes, accompanied by an increase in withholding taxes which just keeps the level of  $\tau$  constant, would have exactly the same effects as the isolated increase in  $\tau$  studied above. This tax reform, too, would reduce the subsidiary's optimal birth weight, increase its initial cost of capital, but leave its size at maturity unaffected.

#### 4. Domestic Tax Reforms with Excess Credits or Exemption

The way a domestic reform of corporate taxation affects direct investment depends very much on whether this reform will only affect the parent's opportunity cost of capital,  $i(1-\tau)$ , or whether it will also change the tax burden on profit repatriations  $\tau$  and possibly even the capital gains tax rate  $c$ . This section disregards any effect on the capital gains tax rate and assumes that the home country either employs the exemption method (as Germany does) or has tax rates low enough to create an excess credit position for the subsidiary considered (as perhaps in the US).<sup>12</sup> The two latter assumptions imply that variations in the home country's corporate tax rate  $\tau$  do not translate into variations in the overall rate of tax on repatriated profits. The case where they do will be analyzed in section 6. Note that, because of the possible existence of host country withholding taxes, the case considered does not exclude the preference for deferral as assumed with (1).

Under these conditions the parent's reactions to an increase in the domestic rate of corporate tax  $\tau$  is readily apparent from inspecting equations (9) - (11). The mature subsidiary's marginal value of equity  $q$ , as given by (10), does not change, but (11) reveals that its cost of capital  $f_K(K_2)$  decreases, implying that its stock of capital increases. Moreover, it follows from (9) that the slopes of the possible paths of  $q$  in Phase II, the period of internal growth, decrease in any given point of the  $(q, K)$  diagram (which means that the paths are becoming steeper). The unambiguous result is that the parent finds it optimal to provide its subsidiary with a larger starting stock of capital  $K_1$  and that the cost of equity capital at the time of foundation,  $f_K(K_1)$ , declines. Figure 3 illustrates the solution in  $(q, K)$  space where the primes again characterize post-reform values.

<sup>12</sup>While not more than 40% of US parents were in such a situation before the 1986 tax reforms, some observers had argued this fraction would jump to 70% after the reform, a prediction that turned out to be a strong overstatement though. Cf. Grubert and Mutti (1987) and Hines and Hubbard (1989). I am grateful to Jim Hines for providing me with this information.





Figure 3: *Lowering the Opportunity Cost of Direct Investment*

Once again the result is easy to explain intuitively if seen as an implication of the parent's portfolio choice problem. Under the given assumptions, an increase in the home country's corporate tax rate reduces the net rate of return from domestic investment and makes it attractive to channel more funds abroad both by increasing the initial equity transfer  $K_1$  and by allowing the subsidiary to keep a higher stock of capital at maturity.<sup>13</sup> In fact the result is indistinguishable from a decline in the pre-tax rate of return  $i$  on the parent's domestic investment opportunities [cf. equations (9) and (11)].

<sup>13</sup>Provided the third derivative of  $f(K)$  is positive, zero, or not too strongly negative – a condition satisfied by plausible production functions – it will even be the case that an increase in  $\tau$  raises the stock of surplus capital which the subsidiary accumulates during its growth towards maturity,  $K_2 - K_1$ . This result follows from equation (9). Since  $f_{KKK} \geq -\epsilon$  for  $\epsilon$  sufficiently small and  $f_K > 0$ , the slope  $dq/dK$  is greater (i.e. less strongly negative) for  $K'_2 - y$  than for  $K_2 - y$  whatever the value of  $y$  ( $y > 0$ ). Since  $q'_2 = q_2$ , this implies that  $K'_2 - K'_1 > K_2 - K_1$ .

### 5. Royalties, Lump Sum Taxes, and Intramarginal Deductibles

A fundamental wisdom which lobbyists tell their governments is that all taxes reduce investment, including pure lump sum taxes. And a fundamental wisdom which economic theorists tell their students is that lump sum taxes do not affect a firm's behavior because there is no income effect for competitive profit maximizing firms. The present model shows that they may both be wrong.

It is true that the flow of lump sum taxes  $X$  which the firm has to pay at each point in time during its existence cannot directly affect the subsidiary's investment conditions. The maturity conditions (10) and (11) stay unaffected, and so does the marginal investment condition (7) for the phase of internal growth. However, as shown by (8), the lump sum tax slows down the firm's accumulation of capital and implies that the slopes of possible paths in  $(q, K)$  space as given by (9) are getting smaller (i.e. more strongly negative) at each point left of  $K_2$ . Given  $K_2$  and  $q_2$ , this clearly implies that the initial capital transfer from the parent to the subsidiary rises and that, accordingly, the cost of capital  $f'(K_1)$  declines. Figure 4 illustrates the solution.

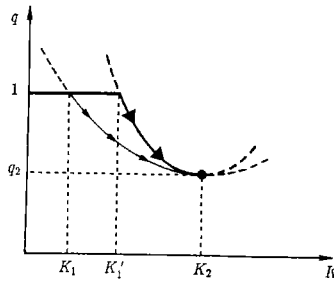


Figure 4: *Royalties and Lump Sum Taxes*

In the light of the opinions cited above, the result may, at first glance, seem counterintuitive. However, in fact, it describes a very rational response of the parent. With any given stock of initial capital  $K_1$ , the subsequent payment of lump sum taxes reduces the speed at which capital can be accumulated and at which the pre-tax rate of return  $f_K$  declines. Thus, an additional unit of equity made available to the subsidiary will grow at a higher rate and for a longer period of time, generating a higher present value of dividends than otherwise would have been the case. Lump sum taxes raise the initial value of  $q$  for any given value of the starting stock of equity  $K_1$  and make it wise to choose a higher value of this stock than would have been optimal without them.

The result is equally applicable to other lump sum payments made or received by the subsidiary. For example, it implies that a developing country that charges a foreign subsidiary with a fixed royalty per annum does not necessarily have to be afraid of scaring direct investment away. While it is true that a sufficiently large royalty can render the whole enterprise unprofitable and prevent it from being started, it is not the case that the country has to suffer from reduced equity injections by the parent or a reduced scale of the mature subsidiary's operations *if* the investment is going to take place. On the contrary, the royalty does not affect the size of the mature subsidiary and even stimulates the parent to endow its subsidiary with a larger initial stock of equity capital than it otherwise would have done.

An obvious corollary of the result is that lump sum subsidies or intramarginal deductibles in the host country's tax schedule reduce the investment. While these measures are neutral with regard to the subsidiary's size at maturity, they will increase the cost of capital for outside equity injections and reduce the subsidiary's optimal birth weight.

The ultimate reason for these surprising non-neutralities in a neoclassical model of the firm is to be found not in irrationalities, market imperfections, or flaws in economic theory. It is to be found in the asymmetries and rigidities of the tax laws. With an

advantage of deferral, the subsidiary is an equity trap that provokes other reactions in the prey than conventional wisdom suggests.

## 6. *Deferral and the Cost of Capital*

Another unproven folk theorem in the theory of taxation is that deferral reduces the cost of capital and increases the marginal value of equity with any given stock of equity capital. This wisdom, too, is being questioned by the present approach.

The wisdom is based on the belief that the increase in the subsidiary's market value that results from the advantage of accumulating foreign earnings at a reduced tax rate carries over to an increase in the marginal value of equity,  $q$ . The lower the taxes on retained earnings, it is maintained, the higher is the rate at which an additional dollar of equity injected can grow to maturity and the higher is the present value of dividends which the dollar is able to generate.

The flaw in the argument is that it neglects the fact that the accumulation of earnings induced by the deferral reduces the firm's pre-tax rate of return to capital  $f_K(K)$ . This reduction drives the post-tax rate of return in the case of profit repatriations,  $f_K \cdot (1-r)$ , to a value which is below the one available without the deferral. It is true, of course, that the firm's internal rate of return during the time of deferral,  $f_K \cdot (1-\tau^*)$ , will be above the no-deferral rate  $f_K \cdot (1-r)$ . However, the decline in the post-tax rate of return in the phase of profit repatriations shows that there is an ambiguity in the impact of deferral on  $q$  which a purely verbal reasoning tends to conceal rather than resolve. It is unclear whether an additional dollar of equity given to a subsidiary that is growing from a no-deferral steady state towards a steady state with deferral will generate a higher present value of repatriations than a dollar given to a firm remaining in the no-deferral steady state

would do.<sup>14</sup>

Unfortunately, an inspection of the three fundamental equations (9), (10), and (11) does not provide a quick answer either. A reduction in the tax rate on reinvested earnings,  $\tau^*$  (or  $c$ ), reduces the mature subsidiary's marginal value of equity  $q_2$  [see equation (10)], increases the corresponding stock of capital  $K_2$  [equation (11)], and makes the slopes of the possible paths in  $(q, K)$  space steeper [equation (9)]. Whether the intersection of the optimal path with the  $q = 1$  line will shift to the left or to the right, i.e., whether  $K_1$  will decrease or increase is again unclear.

Nevertheless, the three equations can be used to derive a sufficient condition for the cost of capital at birth to increase with the introduction of deferral.<sup>15</sup> Let us assume, to consider the standard case, that investment occurs in a foreign tax haven which is sufficiently attractive to render the parent credit-exhausted, i.e., assume that  $\tau = r$ . And let us compare the case of no deferral with that of deferral, characterising the optimal solutions for  $K_1$ ,  $K_2$ , and  $q_2$  in the latter case with primes.

Without deferral [ $1 - \tau = (1 - c)(1 - \tau^*)$ ] the domestic corporate tax rate applies uniformly to all earnings. The subsidiary will therefore be established in one step, receiving enough equity capital from the parent to satisfy the condition

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<sup>14</sup>The reduction in the post-tax rate of return could be avoided if the subsidiary did not operate under decreasing rates of return or could invest unlimited amounts in the capital market while still enjoying the tax advantages of deferral. For a number of reasons, these conditions are of limited relevance, however. First, direct investment typically exploits unique and limited investment opportunities where true economic rents can be captured. Second, tax authorities have reduced the incentive for unlimited deferrals where they were extensively used. For example, the US tax code (Subpart-F) categorizes interest income earned by subsidiaries as passive earnings and requires that it be taxed like profit repatriations. Third, excessive foreign financial investment progressively increases the parent's cost of monitoring, controlling, and protecting the assets. Fourth, there is the additional theoretical problem that the solution to the firm's planning problem would fail to exist if the subsidiary could invest at the same rate of interest as the parent, while still enjoying the advantages of deferral. Cf. Sinn's (1985, ch. 5.3.4) criticism of Stiglitz's (1973) neutrality result.

<sup>15</sup>The proof resembles one given in Sinn (1988, appendix). However, it is not identical since the latter referred to a variant of the model where  $X = \tau = c = \tau^* = 0$  and  $r > 0$ , and was not phrased in terms of the deferral problem.

$$(12) \quad f_K(K_1) = i, \quad K_1 = K_2 \quad (\text{no deferral}).$$

With deferral  $[1-\tau < (1-c)(1-\tau^*)]$  equations (9) - (11) become

$$(9') \quad \frac{dq}{dK} = \frac{q[q_2' i - f_K(K)]}{f(K) - X} \quad \text{for } K_1' \leq K \leq K_2',$$

$$(10') \quad q = q_2' \equiv \frac{1-\tau}{(1-c)(1-\tau^*)} < 1 \quad \text{for } K = K_2',$$

and

$$(11') \quad f_K(K) = q_2' i \quad \text{for } K = K_2'.$$

The question is: will the subsidiary's marginal value of equity  $q$  associated with the optimal no-deferral endowment  $K_1$  fall short of unity? If the answer is yes, deferral reduces the subsidiary's optimal endowment with equity ( $K_1' < K_1$ ) and increases its cost of capital at the time of birth [ $f_K(K_1') > f_K(K_1)$ ].

To find an answer, it is useful to introduce the two functions  $q(K)$  and  $s(K)$ . The former describes the optimal path of  $q$  in the phase of internal growth as predicted by the model, equations (9') and (10'). The latter is defined as

$$(13) \quad s(K) \equiv f_K(K)/i.$$

The function  $s(K)$  represents the marginal value of equity when all marginal profits are being repatriated. In the range  $q \leq 1$ , its graph in  $(q, K)$  space is the geometrical locus of feasible maturity states attainable with different combinations of the tax rates  $\tau = r, \tau^*$ , and  $c$ . Because of (12) and the definition of  $K_1'$ ,

$$(14) \quad q(K_1') = s(K_1) = 1$$

and, because of (10') and (11'),

$$(15) \quad q(K_2') = s(K_2') = q_2'.$$

The graphs of the two functions and other properties of the solution are represented in Figure 5.

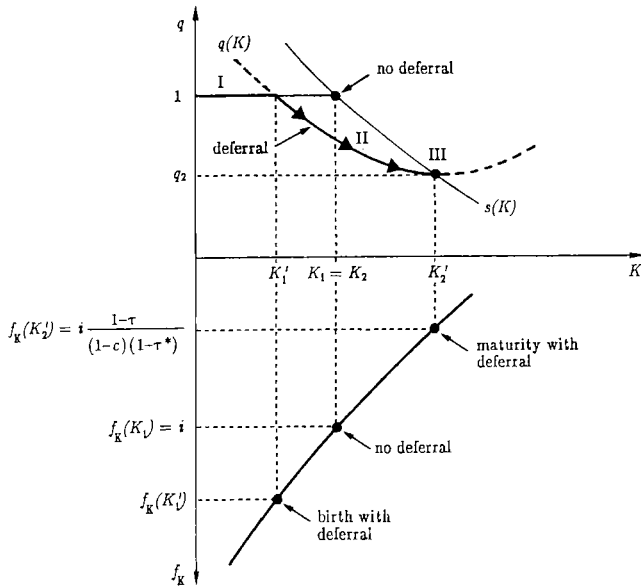


Figure 5: *The Role of Deferral*

The general solution represented in the figure is the same as that illustrated in Figure 1. However, the property that  $q(K_1) < 1$  has yet to be derived.

Because of  $-\infty < q_K(K) < 0$  for  $0 < K < K_2'$ , (14), and (15), a sufficient condition for a solution with  $q(K_1) < 1$  is

$$\frac{q_K'(K)}{q(K)} > \frac{s_K'(K)}{s(K)} \quad \text{for } K_1 \leq K < K_2',$$

where the subscripts denote derivatives. After using (9') and calculating  $s_K$  from (13), this inequality can be transformed to

$$\frac{q_2' i - f_K(K)}{f(K) - X} > \frac{f_{KK}(K)}{f_K(K)}$$

or

$$(16) \quad \frac{f_K - q_2' i}{f_K} < - \frac{f_{KK}}{f_K} K \cdot \frac{f}{f_K K} \left[ 1 - \frac{X}{f} \right].$$

To interpret this condition let  $f(K) \equiv \varphi(K, N)$  where  $\varphi$  is a linear homogeneous function of the factor capital and of a fixed factor  $N$  which is in the background and explains the existence of the subsidiary's rent. As mentioned earlier, this factor could, for example, be a local natural resource available to the subsidiary. Let  $\sigma(K, N)$  be the Hicksian substitution elasticity,  $\alpha(K, N)$  the hidden factor's partial production elasticity, and  $\beta(K, N)$  the partial production elasticity of capital whereby, because of the linear homogeneity,  $\alpha + \beta = 1$ . Then condition (16) can be written as

$$(17) \quad 1 - \frac{q_2' i}{f_K} < \frac{\alpha/\beta}{\sigma} \left[ 1 - \frac{X}{f} \right].$$

Now, it follows from (12) and  $f_{KK} < 0$  that  $i/f_K \geq 1$  in the relevant range where  $K \geq K_1$ . Using this property and (10') makes it possible to replace (17) with an even simpler sufficiency condition and to state the result that



$$\begin{aligned}
 (18) \quad & K_1' < K_1, \quad f_K(K_1') > f_K(K_1) = i, \quad q(K_1) < 1, \\
 & \text{if} \\
 & 1 - \frac{1-\tau}{(1-c)(1-\tau^*)} < \frac{\alpha/\beta}{\sigma} \left[ 1 - \frac{X}{f(K)} \right] \quad \text{for } K_1 \leq K < K_2'.
 \end{aligned}$$

This completes the proof that deferral may reduce the subsidiary's optimal endowment, increase the initial cost of capital, and reduce the value of  $q$  associated with the stock of capital chosen in the absence of deferral.

While (18) is only a sufficiency condition, it is an extremely weak condition when royalties are moderate or nonexistent. No detailed empirical investigation is necessary to see that the condition is very likely to be satisfied under realistic circumstances. An example may help clarify this. Suppose that  $\tau = 0.4$ ,  $\tau^* = 0.2$ ,  $X = c = 0$ ,  $\sigma = 1$  (Cobb-Douglas), and the subsidiary's pre-tax rate of return at maturity is 12% while the market rate of interest is 3%, both expressed in real terms. From the definition of  $\beta$  ( $\beta \equiv f_K \cdot K/f$ ) and equations (10') and (11') it follows that

$$\beta = \frac{1-\tau}{(1-c)(1-\tau^*)} \tilde{\beta}$$

where  $\tilde{\beta}$  is the ratio of the interest rate to the pre-tax rate of return to capital. In the example,  $\tilde{\beta} = 3\%/12\% = 0.25$  and  $(1-\tau)/[(1-c)(1-\tau^*)] = 0.6/0.8 = 0.75$ . Thus  $\beta = 0.1875$  and  $\alpha = 1-\beta = 0.8125$ . Condition (18) becomes

$$1 - 0.75 < \frac{0.8125/0.1875}{1}$$

or

$$0.25 < 4.\bar{3}.$$

Obviously, it is satisfied with a very wide "safety margin".

As shown by (18), the margin shrinks when the host country collects royalties or intramarginal taxes to participate in the rents from direct investment. For the reasons explained in the last section such payments reduce the speed at which  $f_K$  declines and thus reduce the cost of capital at the time of birth. In the extreme case, where the host government collects all rents that would occur under the no-deferral regime, i.e. where  $X/f(K_1) = \alpha$ , the right-hand side of (18) reduces to  $\alpha/\sigma$  or, in the example, to 0.8125. This is substantially less than  $4.\bar{3}$ , but it is still comfortably above 0.25.

Of course, it is possible to construct examples where the sufficiency condition (18) is no longer satisfied. However, under a very wide range of plausible assumptions there can be little doubt that (18) holds true. While it is clear from the results of Hartman (1985) and Sinn (1984) that deferral reduces the cost of capital at the time of maturity the model shows that it increases this cost at the time of birth. The fact that deferral reduces the birth weight of the subsidiary and creates an extended period of interior growth is the exact sense in which this model reproduces the nucleus hypothesis.

The economic reason for deferral making the initial capital shrink to a nucleus is the limitation of the available set of investment opportunities. If the deferral were possible up to a predetermined date at a fixed rate of return to capital, then it would of course be optimal to inject more equity capital into the firm to make use of these opportunities. The cost of capital at the time of birth would decline with the introduction of deferral. However, in the present model, where the investment opportunities are described by the concave production function  $f(K)$ , things are different. Here it is optimal to react to the possibility of deferral by injecting less equity into the subsidiary and accumulating more internally to exploit the tax advantages. Deferral creates an opportunity cost of equity transfers from the parent because it reduces the scope for useful internal investment. This opportunity cost increases the overall marginal cost of new equity injections above the cost of capital in the absence of deferral and implies that the birth weight sinks although the subsidiary's market value rises.

The section concludes with pointing to the similarities between the introduction of deferral and other tax reforms. It is obvious from equations (12), (9'), (10'), and (11') that deferral affects the model solution exclusively by reducing the maturity level of  $q$ ,  $q_2$ . Such a reduction can be, but does not have to be, brought about by a reduction in  $\tau^*$ . An increase in the home country's corporate tax rate  $\tau$  in a situation with deferral and credit exhaustion or a reduction in the capital gains tax rate  $c$  alter the solution of the model in exactly the same way. Starting from a situation with  $q_2 = 1$ , these measures too would reduce the cost of capital at the time of maturity and increase it at the time of birth.

The difference from the implications of an increase in the domestic tax rate in the case of excess credits (section 4) is particularly striking. In an excess-credit situation the domestic tax increase affects only the opportunity cost of direct investment,  $i(1-\tau)$ . This implies that the subsidiary receives a higher birth weight and is heavier when mature. In a situation of credit exhaustion, the increase in the domestic tax rate in addition increases the tax burden on profit repatriations which was studied in isolation in section 3. Obviously the latter effect dominates with regard to the birth weight and implies that the parent gives a lower endowment. However, for the new view's reasons, the increased tax on repatriations is irrelevant for the mature firm. After an increase in the domestic corporate tax rate, mature subsidiaries will employ a higher stock of capital even if the parent is credit exhausted.

## *7. A Comment on the Weighted Average Formulation of the Cost of Capital*

The result that deferral increases the cost of capital cannot be reconciled with the popular weighted average formulations of the subsidiary's cost of capital. This section briefly describes the differences and explains the reasons for them.

The traditional formulation of the subsidiary's investment decision which dates back to Horst's (1977) seminal article is (with my notation)

$$(19) \quad \rho = (1-\bar{\tau}) f_K(K)$$

where  $\rho$  is the parent's discount rate [which in the present model equals  $i(1-\tau)$ ] and  $\bar{\tau}$  is a weighted average of the home and host country tax rates:

$$(20) \quad \bar{\tau} = \gamma \tau + (1-\gamma) \tau^*.$$

The weights used in this expression are the dividend-pay-out ratio  $\gamma$  and one minus this ratio. Horst's approach is widely used in the public finance literature, however there are at least three basic theoretical problems.

The first is that, in all likelihood, the weighted average formulation cannot be derived from a neoclassical firm's intertemporal optimization problem such as the one set up in section 2 even if a constant dividend pay-out ratio is introduced as an additional constraint.<sup>16</sup> It is true that Jun (1989) has provided an explicit optimization model which uses such a constant ratio and generates equations (19) and (20). However he silently assumes that the subsidiary can repatriate its profits through a channel that avoids all taxes other than the host country's corporate tax on retained earnings  $\tau^*$ . In the equilibrium of the Jun model which is characterized by  $\dot{K} = 0$ , the flow of tax free repatriations equals  $(1-\gamma)(1-\tau^*)f(\bar{K})$  where  $\bar{K}$  is the stock of capital satisfying (19). A marginal dollar of investment undertaken in the subsidiary is entirely financed with a

<sup>16</sup>It is possible, however, to derive a weighted average formulation similar to (19) and (20) if the weights reflect the proportions of marginal investment financed with equity transfers from the parent and retained earnings within the subsidiary respectively and if it is assumed that all profits from this investment are repatriated. This is the approach chosen by Fullerton and King (1984) in a closed economy context. The other objections to Horst's specification, which will be given below, also apply to this approach. See Sinn (1988) for further details.

reduction in the tax free repatriation and the future flow of returns this dollar generates is channelled into taxed and tax free repatriations where the proportions are given by  $\gamma$  and  $1-\gamma$ . This feature explains the derivation of the weighted average formula.<sup>17</sup> The author describes his solution as one where "the subsidiary needs parent transfers in addition to retained earnings to finance investment" (p. 10), however he models an equilibrium where the subsidiary transfers its "retained" earnings through an unspecified tax loophole to the parent.<sup>18</sup>

The second problem is that the assumption of a fixed dividend-pay-out ratio may be a rather poor description of the subsidiary's actual financing behavior. Signalling arguments which may be appropriate for publicly traded companies are certainly inappropriate for subsidiaries. The parent at least should be able to look through the subsidiary's "corporate veil". The actual behavior of subsidiaries first observed by Barlow/Wender and Penrose cannot even be approximated by fixing the pay-out ratio, but it could be reproduced from the explicit optimization model derived in this paper.

The third problem is that even the most sophisticated econometrician would be unable to construct "equivalent" weights in formula (20) in any meaningful way from a firm's dividend-pay-out behavior, if this firm behaved as described in the model. In his famous article on mature firms Hartman (1985, p. 119) strongly defends the weighted average formulation for immature firms and he argues that "the [immature] subsidiary faces a tax rate between the host country tax rate and the home rate of taxing foreign source

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<sup>17</sup>See Jun's (1989) equations (17), (18), and (21)-(23).

<sup>18</sup>On p. 6 of his article, Jun mentions the possibility of returning the original capital after all surplus capital has been returned. If this is the channel his equations are meant to refer to, then the equilibrium would not only be of limited duration; what is worse, it would not be feasible since the rule cited by the author prevents the firm from replacing its original capital with surplus capital.

In the present model the possibility of returning the original capital after the surplus capital would be irrelevant for the solution since the firm would prefer to declare its repatriations as a return of original capital when  $q < 1$ , however, whenever  $q < 1$ , it has surplus capital which first must be returned (cf. Figure 1).

In a normal corporation a loophole of the kind Jun's formulae require could be share repurchases [see e.g. Goulder and Summers (1989)]. However, as mentioned earlier in note 10, for subsidiaries this is not an admissible legal possibility.

income, with the exact value depending on the timing of the deferred tax payments.<sup>19</sup> If this view were correct, then the effective rate of tax on foreign direct investment ( $\bar{\tau}$ ) would have to lie between the home and host country tax rates as long as the subsidiary is immature. Yet, the previous section showed that the effective tax rate on marginal equity injections by the parent exceeds the home country's tax rate.<sup>19</sup> The weight  $\gamma$  in equation (20) would have to be greater than one and  $1 - \gamma$  would have to be negative to justify the weighted average formulation.

The reason for some of these difficulties may be a conceptual mistake behind the weighted average formulation that relates to the cost of capital in the case of profit retentions. When all profits are retained ( $\gamma = 0$ ), equations (19) and (20) imply that

$$(21) \quad \rho = (1 - \tau^*) f_K(K) .$$

By way of contrast, this model's equation (7) implies for this case (with  $c = 0$ ) that

$$\rho = (1 - \tau^*) f_K(K) + \dot{q}/q , \quad \text{where } \dot{q}/q < 0 .$$

Equation (21) is certainly a plausible condition which looks right at first glance. However, it is clear from the analysis of this paper that the reinvestment of profits reduces  $q$  because it exhausts the available investment opportunities and drives the firm to a point where it no longer wants to reinvest. Only when this situation has been reached will  $q$  be a constant and only then is equation (21) correct [cf. equations (10') and (11')]. However, then all profits are distributed, not retained.

In the light of the present model, a false interpretation of equation (21) is that  $\tau^*$  is the tax on the returns from marginal investment projects. The true interpretation

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<sup>19</sup>In the present model, equation (19) can be written as  $i(1 - \tau) = (1 - \bar{\tau})f_K$ . As  $f_K > i$  when the subsidiary receives equity from the parent, it follows that  $\bar{\tau} > \tau > \tau^*$ .

is that  $\tau^*$  is a tax on the investment outlay that must be paid when an additional investment is financed with a reduction of the subsidiary's repatriations. Ignorance of this subtle, but important difference may have contributed to the popularity of the weighted average formula.<sup>20</sup>

### 8. *Conclusions*

This paper offered a model that describes the subsidiary's growth path from birth towards maturity, and it studied the effect of taxes on this growth path. In general, the tax influence on the optimal "birth weight" does not parallel that on the optimal "weight at maturity". Taxes on international profit repatriations reduce the optimal birth weight, but do not affect the stock of capital employed at maturity. Deferral increases the optimal stock of capital at maturity, but reduces the optimal birth weight and increases the cost of equity transfer from the parent. An increase in the domestic corporate tax rate increases the optimal stocks of capital at both birth and maturity, when the parent is in an excess credit position. However, when the parent is credit exhausted, the domestic tax increase may reduce the optimal stock at birth and increase the optimal stock at maturity. Lump sum taxes and royalties increase the subsidiary's equity endowment at birth and reduce its initial cost of capital, but they do not affect the subsidiary's behavior when mature.

Some of these results contradict the folk theorems of economics but they all follow from a straight-forward, purely neoclassical optimization model of the firm extended with the constraints imposed by the tax system. To understand them, it is crucial to see the subsidiary's cost of capital at birth in terms of the internal investment opportunities foregone when the initial equity endowment increases. As a rule, measures that facilitate or favor internal investment increase the opportunity cost of new equity injections and reduce

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<sup>20</sup>See Sinn (1990, section 3) for a more extensive discussion of the misinterpretation of equation (21).

the optimal starting stock of equity. This rule explains the seemingly perverse effects of deferral and lump sum taxation. Deferral increases the cost of equity transfers from the parent because it favors retentions and lump sum taxes reduce the cost of equity transfers because they impede retentions.

The opportunity cost element sharply distinguishes the investment behavior derived in this paper from the results of the previous literature on taxation and direct investment. Typically that literature makes the choice of financial alternatives exogenous to the firm. When this choice is endogenized along the lines suggested here, the opportunity cost interpretation of the subsidiary's cost of capital is a natural implication.

The financial alternatives considered were, for sources of finance, equity transfers from the parent and withheld profit repatriations and, for uses of profits, repatriations and retentions. Debt financing has been neglected because it does not seem to be the central issue in direct investment. An optimal debt-equity choice, just like an optimal choice of other non-specified input factors, was implicitly assumed to stand behind the function  $f(K)$  which indicated the firm's maximum level of earnings associated with alternative values of its stock of equity capital  $K$ . A more explicit treatment of debt financing may be useful, but it will probably not alter the conclusions of this paper if it includes factors that rule out the corner solutions resulting from a Modigliani-Miller specification.

Other extensions worth pursuing include a limitation of domestic investment opportunities, exchange risks, inflation, or international tax base differences. The present paper abstracted from these complications in order to focus on what arguably are the most important tax aspects of direct investment. However, it is clear that empirical models should pay more attention to the possible extensions than this theoretical study did.



## Appendix

This appendix derives the basic properties of a solution.

Solving (4) for  $R$ , using (3), and associating Kuhn-Tucker multipliers  $\mu_R$  and  $\mu_T$  with the flow constraints and the co-state variable  $q$  (Tobin's  $q$ ) with  $K$ , the Hamiltonian of problem (5) can be expressed as

$$\mathcal{H} = \left[ \frac{1-r}{1-c} + (1-\tau^*)\mu_R \right] \left[ f(K) - X - \frac{\dot{K}-T}{1-\tau^*} \right] + q\dot{K} - T(1-\mu_T).$$

The necessary conditions for a maximum of the Hamiltonian with regard to  $\dot{K}$  and  $T$  are

$$(A.1) \quad q = \frac{1-r}{(1-c)(1-\tau^*)} + \mu_R$$

and

$$(A.2) \quad \mu_R + \mu_T = 1 - \frac{1-r}{(1-c)(1-\tau^*)}$$

which together imply

$$(A.3) \quad \mu_T = 1 - q.$$

The canonical equation  $\partial \mathcal{H} / \partial K + \dot{q} = q i(1-\tau)/(1-c)$  can be specified as

$$(1-\tau^*) \left[ \frac{1-r}{(1-c)(1-\tau^*)} + \mu_R \right] f_K + \dot{q} = q i \frac{1-\tau}{1-c}$$

or, using (A.1), as

$$(A.4) \quad (1-c)[(1-\tau^*)f_K + \dot{q}/q] = i(1-\tau).$$

The Kuhn-Tucker conditions of the problem are

$$(A.5) \quad \mu_T T = 0, \quad \mu_T \geq 0, \quad T \geq 0,$$

$$(A.6) \quad \mu_R R = 0, \quad \mu_R \geq 0, \quad R \geq 0.$$

Since  $q(t) = \partial M(t) / \partial K(t)$ , the maximization of  $M(t_1)$  with regard to the initial equity injection  $K_1$  gives

$$(A.7) \quad q(t_1) = 1 \quad (\text{Phase I}).$$

The transversality condition is

$$(A.8) \quad \lim_{t \rightarrow \infty} q(t) K(t) \exp \left[ -(t-t_1) i \frac{1-\tau}{1-c} \right] = 0 \quad (\text{Phase III}).$$

It follows from the preference for deferral [assumption (1)] that the right-hand side of (A.2) is strictly positive implying that the Kuhn-Tucker multipliers cannot both be zero. Because of (A.5) and (A.6) this rules out the possibility that the subsidiary repatriates profits while it is receiving transfers from the parent. Note moreover that the subsidiary will never receive a flow of transfers from the parent in addition to the initial equity injection satisfying (A.7). If it did receive such a flow ( $T > 0$ ) in some non-degenerate interval of time, (A.3) and (A.5) would require that  $\mu_T = \dot{q} = 0$  and, according to (A.4),  $K$  would have to stay constant:  $\dot{K} = 0$ . This, however, contradicts the condition  $T > 0$  and its implication  $R = 0$  which would both result in  $\dot{K} > 0$ . Thus, the Kuhn-Tucker conditions (A.5) and (A.6) leave room only for two phases characterized by ( $T = R = 0$ ;  $\mu_T, \mu_R \geq 0$ ,  $t > t_1$ ) and ( $R > 0$ ,  $T = \mu_R = 0$ ,  $t > t_1$ ), in addition to an initial stock injection phase.

In the first of these phases (Phase II), the subsidiary has no transactions with the parent and thus  $K$  increases gradually because profits are reinvested as given by equation (8) of the text. The development of  $q$  is determined by the general condition (A.4) that has to hold throughout.

In the other phase (Phase III), it follows from  $\mu_R = 0$ , (A.1), and (1) that

$$(A.9) \quad q = \frac{1-\tau}{(1-c)(1-\tau^*)} < 1$$

and  $\dot{q} = 0$ . Together with (A.4) the latter produces the new view's marginal investment condition

$$(A.10) \quad f_K(K) = i \frac{1-\tau}{(1-c)(1-\tau^*)}$$

which in turn implies that  $\dot{K} = 0$ . Since the firm does not receive transfers from the parent ( $T = 0$ ) and does not grow, it repatriates all its profits.

The optimal growth path of the subsidiary is a combination of the three phases that satisfies the transversality condition (A.8) and the general requirement that there be no foreseen jumps in the co-state variable  $q$ . The only possibility is to start with Phase I, continue with Phase II where  $f_K$  is sufficiently large to make  $\dot{q}/q$  negative satisfying equation (A.4), and to end with Phase III where  $q$  stays at the constant level given by (A.9) and  $K$  remains at the level satisfying (A.10).

There cannot be an immediate move from Phase I to Phase III since this would require a downward jump of  $q$  from the level given in (A.7) to that given in (A.9). The subsidiary can neither begin with Phase II nor stay there forever. Beginning with this phase would mean starting with no capital and no profit with the result that the subsidiary never gets off the ground. Staying there forever means violating the transversality condition (A.8). As it was assumed that  $f(K)$  is unbounded from above and that  $X$  is sufficiently small to allow an internal growth with  $\dot{K} > \varepsilon > 0$  in all stages of the development process, internal accumulation must, in finite time, lead to a point after which

$$\frac{\dot{K}}{K} = \left[ \frac{f(K)}{K} - \frac{T}{K} \right] (1-\tau^*) > f_K \cdot (1-\tau^*) .$$

Because of (A.4), this implies that

$$\frac{\dot{K}}{K} + \frac{\dot{q}}{q} > i \frac{1-\tau}{1-c}$$

and that the transversality condition cannot be satisfied.

The terminal conditions (A.9) and (A.10), the starting condition (A.7) and the equations of motion for  $\dot{K}$  and  $\dot{q}$ , (4) and (A.4), uniquely determine the subsidiary's optimal path in  $(q, K)$  space as illustrated in figure 1.

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