



Internal financing of multinational subsidiaries: Debt vs. equity ¹

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Abstract

Multinational subsidiaries are generally financed with a mixture of internal debt and equity from the parent corporation. Yet, financial theory has relatively little to say regarding the debt-equity tradeoff and the timing of dividend repatriation in an international setting. In this paper, we derive optimal rules for financing multinational subsidiaries that take into account tax rate differentials and the exploitation of tax-loss credits. We develop a formal multi-period dynamic model to characterize the optimal dividend repatriation policy and the optimal choice of debt-equity mix. The model generates several testable empirical implications that are consistent with available empirical evidence and several others that have not been either discussed or empirically tested in the literature. © 1998 Elsevier Science B.V.

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1. Introduction

Subsidiaries of multinational corporations rely heavily on funds from parent corporations for their financing needs ². The advantage of intra-firm parent

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² Of the \$64.6 billion spent in 1989 by foreign investors acquiring or establishing U.S. businesses, \$44.1 billion or 68% were funded by the foreign parent group. Source: U.S. Department of Commerce, Survey of Current Business, May 1990.

financing over external subsidiary financing is that there are no bankruptcy costs associated with internal financing — even when it is in the form of debt. Stonehill and Stitzel (1969) argues [pp. 93] ³:

... parent loans to foreign affiliates are often regarded as equivalent to equity investment both by host countries and the investing corporations. A parent company loan... does not represent the same threat of insolvency as an external loan.

It is widely understood that the choice between intra-firm debt or intra-firm equity financing for the subsidiary is, to a large extent, influenced by rules on corporate taxation in the subsidiary as well as the parent country ⁴. If the tax-rate in the subsidiary country exceeds the tax-rate in the parent country, it pays to transfer as much funds as possible in the form of interest payments to the parent, since these are tax-deductible in the subsidiary country. Thus, income generated by the subsidiary gets taxed at the parent rate — the smaller of the two rates. This suggests that the subsidiary should be financed entirely by intra-firm parent debt. On the other hand, if the tax-rate in the parent country exceeds the tax-rate in the subsidiary country, it pays to transfer funds in the form of dividends. Thus, the income generated in the subsidiary is first taxed in the subsidiary country. This income is subject to additional taxation in the parent country at a rate equal to the difference in the two tax-rates, but the additional taxation in the parent country is levied only when funds are repatriated in the form of dividends. This suggests that the subsidiary should be financed entirely by intra-firm parent equity, since it allows the firm to postpone some taxes to a future date.

This is a knife-edged result that suggests that the capital structure of multinational subsidiaries should either be all intra-firm debt or all intra-firm equity. Empirical evidence, on the contrary, suggests that a typical capital structure of a multinational subsidiary involves the use of debt as well as equity ⁵. This can be explained by the following observations. First, the taxable income streams generated in the subsidiary and the parent are not always positive. Second, the taxation of profits and losses is always asymmetric in the sense that firms are required to pay taxes on profits but do not receive a tax refund if they report a loss. Instead, the firms are allowed to carry (forward or backward) tax-loss credits which can be used to offset taxes in another year. Apart from the fact that this involves a loss of the time value of money, this ability to carry forward tax-loss credits is usually

³ See also Eiteman et al. (1991), Shapiro (1992) and Chowdhry and Nanda (1994).

⁴ See, for instance, the popular textbook on taxation, Scholes and Wolfson (1992) and two popular textbooks on multinational financial management, Eiteman et al. (1991) and Shapiro (1992).

⁵ The fact that multinational subsidiaries tend to use debt as well as equity for their long-term and short-term financing needs is documented in Stobaugh (1970), Robbins and Stobaugh (1972) and Errunza (1979), among others.

limited. For instance, in the U.S., corporations are allowed to carry forward tax-loss credits five years forward and two years backward (Scholes and Wolfson, 1992)⁶. This raises the possibility that these credits may expire unused. We argue that an optimal tax management strategy for multinational corporations involves, in addition to the widely understood tradeoffs described above, taking into account the optimal exploitation of tax-loss credits⁷.

Consider again the case in which the tax-rate in the subsidiary country exceeds the tax-rate in the parent country. The benefit of debt, in this case, is that it transfers income from the subsidiary to the parent, where it gets taxed at the lower rate. A potential cost of debt, however, is that it increases the likelihood that the subsidiary's taxable income will be negative, and the firm will not be able to use the tax-loss credit fully. This suggests that an interior solution for the debt-equity choice may indeed be optimal. Further, consider the case in which the tax-rate in the parent country exceeds the tax-rate in the subsidiary country. Here, the advantage of flexibility in the timing of repatriation of dividends arises not merely from the fact that this postpones the payment of additional taxes to a future date, but also from the possibility that the firm may be able to time its repatriation to a period in which the parent incurs a loss⁸. Thus, the optimal capital structure of a subsidiary may involve the use of both intra-firm parent debt and intra-firm parent equity.

We develop a formal multi-period dynamic model that captures these various tradeoffs. The model allows us to characterize the optimal dividend repatriation policy under different assumptions about tax-rates in the two countries. We then derive the optimal choice of debt-equity mix. The model generates several testable empirical implications. We show that a subsidiary capital structure that involves the use of mainly debt or mainly equity is optimal only when the tax-rates in the two countries are sufficiently different. The subsidiary's debt-asset ratio is positively related to the tax-rate of the subsidiary, and negatively related to the tax-rate of the parent. Also, the debt-asset ratio is increasing in the size of the parent and decreasing in the size of the subsidiary. The relationship between the debt-asset ratio of the subsidiary and the variability of parent and subsidiary income is also

⁶ Many countries are more restrictive in their treatment of the carrying of tax-loss credits. For instance, the carry-back of tax losses is disallowed in Finland, Greece, and Luxembourg, while most countries in Africa, Latin America, and Eastern Europe do not allow firms to carry tax-loss credits at all.

⁷ An analogous argument, for the case of the capital structure choice in a domestic context has been discussed in DeAngelo and Masulis (1980).

⁸ This is similar to an argument in Scholes and Wolfson (1992), pp. 289: "... an advantage of equity financing of foreign subsidiaries is its flexibility in timing repatriation by way of dividends to coincide with a period of low tax-rates in the U.S., as well as its ability to allow foreign profits to be reinvested without imposing a current repatriation tax."

explored. Finally, the model generates predictions about the time-series behavior of dividend repatriations and interest payments.

2. The model

We model the behavior of a multinational firm in a multi-period setting. We consider a case in which the parent firm, located in the U.S., has a single, wholly-owned foreign subsidiary. The subsidiary, each period, generates an uncertain income (cash-flow) stream from its operations, denoted $A^s y_t^s$, where A^s can be thought of as the fixed level of real assets and y_t^s as the uncertain rate of return on these assets. For simplicity, we assume that y_t^s each period is independently and identically distributed. In addition to the cash-flow from operations, the subsidiary earns a non-stochastic rate of return, r^s , on its retained earnings from the previous period, R_{t-1}^s .

The transfer of earnings from the subsidiary to the parent can take place either through dividend payments or through interest payments on debt. The interest payments are transferred each period out of the subsidiary's pre-tax earnings, while any dividend payments are taken out of after-tax earnings⁹. The contractual interest payments at time t are committed to at time $t-1$, while dividends are decided at the time of transfer.

For simplicity, we assume that the subsidiary always makes the contractual interest payments to the parent corporation, and therefore the debt is risk-free. We are implicitly assuming here that if the subsidiary is not able to make these debt payments, it receives an intra-firm cash infusion from the parent in order to make these payments. We also assume, for simplicity, that the parent is all equity financed, and it can always raise more funds through equity financing without any costs. If we let r denote the economy's equilibrium after-tax risk-free rate that is exogenous to the model, then the parent will be able to charge an interest rate of $r^p = r/(1 - \tau^p)$ on its loan to the subsidiary (where τ^p denotes the corporate tax-rate in the parent country)¹⁰. If we let D_{t-1} denote the level of debt owed to the parent firm, then $r^p D_{t-1}$ represents the total interest payments that the subsidiary must make to the parent corporation. The total subsidiary income that will be subject to local taxation in the foreign country is given by:

$$Y_t^s = A^s y_t^s - r^p D_{t-1} + r^s R_{t-1}^s. \quad (1)$$

The subsidiary's pre-tax income Y_t^s , if positive, is taxed at rate τ^s in the foreign country. We assume, for simplicity, that tax credits cannot be carried forward (or

⁹ For simplicity, we assume that there are no withholding taxes on either the dividend repatriations or on interest payments by the subsidiary to the parent.

¹⁰ We are thus abstracting from issues discussed in Chowdhry and Nanda (1994), in which the question of determining an 'appropriate' rate of interest, when the subsidiary's cash flows are risky, is discussed.

backward). This assumption captures the idea that ability to carry tax credits forward or backward is limited. The after-tax, pre-dividend, 'cash' holdings of the subsidiary are, therefore, given by ¹¹:

$$C_t^s = \min[Y_t^s, (1 - \tau^s)Y_t^s] + R_{t-1}^s. \quad (2)$$

The cash holding is comprised of the after-tax operating income and the level of retained earnings carried from period $t - 1$ to period t . Retained earnings are just the previous period's cash holding net of any dividends paid to the parent in the previous period, d_{t-1}^s . Thus:

$$R_{t-1}^s = C_{t-1}^s - d_{t-1}^s.$$

Similar to the case of the subsidiary, the parent, each period, generates an uncertain income (cash-flow) stream from its operations, denoted $A^p y_t^p$, where A^p can be thought of as the fixed level of real assets and y_t^p as the uncertain rate of return on these assets. Again, for simplicity, we assume that y_t^p each period is independently and identically distributed. In addition to the cash-flow from operations, the parent earns a non-stochastic rate of return, r^p , on its retained earnings from the previous period, R_{t-1}^p . Also, the parent receives a dividend payment of d_t^s from its subsidiary. Let Y_t^p denote the total parent income before taxes and before inclusion of dividends from its subsidiary. This is given by:

$$Y_t^p = A^p y_t^p + r^p R_{t-1}^p + d_t^s. \quad (3)$$

The total parent income that will be subject to local taxation, at a tax-rate of τ^p , in the parent country (U.S.) is given by:

$$Y_t^p + \frac{1}{1 - \tau^s} \max\{0, d_t^s\}.$$

The above expression incorporates the following two aspects of multinational tax laws. First, when the dividends received from the subsidiary are positive, they are grossed up to include taxes deemed paid in the subsidiary country ¹². Second, cash infusions to the subsidiary (negative dividends) may not be taken from pre-tax parent earnings.

The parent will receive a foreign tax credit on taxes deemed paid by the subsidiary in the foreign country. The tax deduction in the current period,

¹¹ Here we are making an assumption that the subsidiary is able to invest its retained earnings in active investments so that the return on these investments is not subject to additional taxation in the parent country until these earnings are repatriated in the form of dividends. We make this assumption only for simplicity and analytical tractability. The central results of the paper will not be qualitatively affected if we were to assume that return on retained earnings is treated as Subpart F income and is taxed at the parent level in the year it is earned. The reason, as is discussed in Scholes and Wolfson (1992), is that there may still be an advantage to delaying the repatriation of earnings.

¹² See Scholes and Wolfson (1992), p. 250.

however, cannot exceed the total amount of U.S. taxes due on dividends received from the subsidiary. When the tax-rate in the parent country exceeds that in the subsidiary country, the total amount of parent taxes is as follows:

$$T_t^p = \max \left\{ 0, \tau^p Y_t^p + (\tau^p - \tau^s) \left(\frac{1}{1 - \tau^s} \max\{0, d_t^s\} \right) \right\}. \quad (4)$$

On the other hand, when the tax-rate in the subsidiary country exceeds the tax-rate in the parent country, any dividends repatriated from the subsidiary to the parent are not subject to any additional taxation in the parent country. In that case, parent country taxes simply equal

$$T_t^p = \max\{0, \tau^p Y_t^p\}.$$

The parent's after-tax cash holding can be expressed as:

$$C_t^p = Y_t^p - T_t^p + R_{t-1}^p + d_t^s. \quad (5)$$

The parent pays out a dividend of $d_t^p \leq C_t^p$ to its shareholders and retains and carries to the next period $R_t^p = C_t^p - d_t^p$.

The firm attempts to maximize the present-value of the stream of dividend payments to its shareholders. For simplicity, we assume that all agents are risk-neutral so that all future expected cash flows are discounted at the risk-free rate, r . Formally, the firm solves a dynamic programming problem with the value function defined as ¹³:

$$V(R_{t-1}^s, R_{t-1}^p, y_t^s, y_t^p, D_{t-1}) = \max_{d_t^s, d_t^p, D_t} \left[d_t^p + \frac{1}{1+r} E_t V(R_t^s, R_t^p, y_{t+1}^s, y_{t+1}^p, D_t) \right]$$

such that $d_t^s \leq C_t^s \forall t, \quad d_t^p \leq C_t^p \forall t.$

Notice that there are no cash-flow consequences of changing the level of debt from one period to the next, apart from the fact that it changes the contractual value of the interest payments that the subsidiary owes to the parent the following period. The firm simply announces the level of debt each period. Since all financing, in our model, is assumed to be internal financing by the parent, no net transfer of funds needs to take place between the parent and the subsidiary. In terms of actual accounting, any change in the level of debt can be thought of as being accomplished by a debt-equity swap.

In order to focus our analysis on issues relating to the relative timing flexibility associated with repatriating dividends, as compared to the interest payments, we now make some simplifying assumptions.

We first assume that it is costly for the parent firm to retain earnings and carry to the next period instead of paying them out its shareholders in the form of dividends. This could be formalized by assuming that the rate of return that the

¹³ The proof that value function exists and is concave in its arguments, follows from standard stochastic dynamic programming results described, for instance, in Stokey and Lucas (1989).

firm earns on its retained earnings, r^p is smaller than what the investors could earn on their own. This assumption can be justified on several grounds. First, the corporate income tax-rate may exceed personal income tax-rates. Second, the investors may be liquidity constrained and their discount rate may reflect the borrowing rather than the lending rate. Third, there may also be significant agency costs to having the firm retain large quantities of ‘free cash flow’ (see Jensen, 1986 and Stulz, 1990). We assume that r^p is sufficiently low, such that:

$$\frac{\partial}{\partial R_t^p} \left[\frac{1}{1+r} E_t V(R_t^s, R_t^p, y_{t+1}^s, y_{t+1}^p, D_t) \right] < 1.$$

Intuitively, this assumption implies that the present value of the firm reinvesting a dollar in the parent country is less than one dollar. This assumption guarantees that the parent will choose to pay all its available cash, C_t^p , to its shareholders as dividends in the current period, d_t^p . This implies that the parent will choose not to retain any earnings, i.e., $R_t^p = 0 \forall t$.

2.1. $\tau^s > \tau^p$: Subsidiary tax-rate exceeds parent tax-rate

2.1.1. Optimal dividend repatriation policy

When the tax-rate in the subsidiary country exceeds the tax-rate in the parent country, Eq. (5) simplifies to

$$C_t^p = \min [Y_t^p, (1 - \tau^p) Y_t^p] + d_t^s.$$

As in the case of the parent, we assume that r^s is sufficiently low, such that:

$$\frac{\partial}{\partial R_t^s} \left[\frac{1}{1+r} E_t V(R_t^s, y_{t+1}^s, y_{t+1}^p, D_t) \right] < 1. \tag{6}$$

Intuitively, this assumption implies that the present value of the firm reinvesting a dollar in the subsidiary country is less than one dollar when there is no additional taxation of dividends repatriated from the subsidiary. This assumption implies that the subsidiary will choose to pay all its available cash, C_t^s , to the parent as dividends in the current period, d_t^s . This implies that the subsidiary will choose not to retain any earnings, i.e., $R_t^s = 0 \forall t$.

2.1.2. Optimal debt-equity mix

The dynamic programming problem, in this case, simplifies to:

$$V(y_t^s, y_t^p, D_{t-1}) = C_t^p + \frac{1}{1+r} \max_{D_t \leq A^s} E_t V(y_{t+1}^s, y_{t+1}^p, D_t).$$

Differentiating the value function with respect to D_t , we get:

$$\frac{1}{1+r} \frac{d}{dD_t} E_t \left[C_{t+1}^p + \frac{1}{1+r} V(y_{t+2}^s, y_{t+2}^p, D_{t+1}) \right] = \frac{1}{1+r} \frac{d}{dD_t} E_t C_{t+1}^p,$$

where

$$C_{t+1}^p = \min[Y_{t+1}^p, (1 - \tau^p)Y_{t+1}^p] + \min[Y_{t+1}^s, (1 - \tau^s)Y_{t+1}^s],$$

$$Y_{t+1}^p = A^p y_{t+1}^p + r^p D_t, \quad Y_{t+1}^s = A^s y_{t+1}^s - r^p D_t.$$

Notice that the optimal level of debt, in this case, simplifies to solving a static maximization problem. This is because all subsidiary earnings are repatriated to the parent each period. Therefore the optimal level of debt only affects the after-tax parent cash flow the following period, C_{t+1}^p .

An explicit expression for $1/(1+r)(dE_t C_{t+1}^p/dD_t)$ is as follows:

$$(\tau^s - \tau^p) \text{Prob}[Y_{t+1}^p \geq 0, Y_{t+1}^s \geq 0] - \tau^p \text{Prob}[Y_{t+1}^p \geq 0, Y_{t+1}^s \leq 0] \\ + \tau^s \text{Prob}[Y_{t+1}^p \leq 0, Y_{t+1}^s \geq 0]. \quad (7)$$

The first term in the above expression denotes the benefit of increasing interest payments when the income streams in the subsidiary and the parent are such that each has positive taxable earnings. Clearly, the firm avoids taxation at the subsidiary level at a rate of τ^s but is taxed at the parent level at a rate τ^p . The difference in the tax rates ($\tau^s - \tau^p$) then represents the net benefit. Clearly, if this were the only possibility, it would pay to choose the subsidiary debt level to be as high as possible.

The second term in the above expression denotes the cost of increasing interest payments. When the subsidiary's taxable income is negative and the parent's taxable income is positive, interest payments get taxed at the parent level at a rate τ^p , whereas they would have gone untaxed at the subsidiary level.

Similarly, the third term in the above expression denotes the benefit of having committed to higher interest payments when the parent's taxable income is negative but the subsidiary's taxable income is positive. Here, an interest payment would go untaxed at the parent level whereas it would be taxed at a rate τ^s at the subsidiary level.

Notice that if both the parent's taxable income as well as the subsidiary's taxable income were negative, the firm would pay no taxes and thus would be indifferent between transferring funds in the form of dividends or interest payments.

The expression in Eq. (7) can be rewritten as follows:

$$\tau^s \text{Prob}[Y_{t+1}^s \geq 0] - \tau^p \text{Prob}[Y_{t+1}^p \geq 0]. \quad (8)$$

Proposition 1 *If the subsidiary tax-rate τ^s is sufficiently larger than the parent tax-rate τ^p , then it pays to choose the subsidiary debt level to be as high as possible.*

Proof. The expression for $dE_t C_{t+1}^p/dD_t$, from Eq. (8) is positive. \square

Intuitively, if the subsidiary tax-rate far exceeds the parent tax-rate, the benefit of avoiding subsidiary taxes is large compared to the potential cost associated with having to pay taxes at the parent level when the subsidiary income is negative.

If the tax-rates and the distribution of income streams are such that there is an interior solution for the optimal level of debt, the first order condition for determining the optimal level of debt is obtained by setting Eq. (8) equal to zero¹⁴:

$$\tau^s \text{Prob} \left[y_{t+1}^s \geq \frac{r^p D_t}{A^s} \right] - \tau^p \text{Prob} \left[y_{t+1}^p \geq -\frac{r^p D_t}{A^p} \right] = 0. \quad (9)$$

Notice that the optimal level of subsidiary debt D_t does not change from one period to the next. Since the subsidiary pays out all its available cash in the form of dividend repatriation, it does not retain any earnings. Thus, the optimization problem for selecting the level of debt is identical each period if the exogenous parameters do not change from one period to the next.

Proposition 2 *The optimal level of subsidiary debt-asset ratio D_t/A^s is: (1) increasing in the subsidiary tax-rate τ^s , (2) decreasing in the parent tax-rate τ^p , (3) increasing in the parent's level of fixed assets A^p , (4) decreasing in the subsidiary's level of fixed assets A^s , (5) increasing in the variability¹⁵ of return on parent assets y_{t+1}^p , (6) decreasing in the variability of return on subsidiary assets y_{t+1}^s .*

Proof. See Appendix A. \square

The intuition for these results is as follows. Increasing the subsidiary tax-rate τ^s increases the benefit of interest payments, as discussed above. In a similar vein, increasing the parent tax-rate τ^p decreases the benefit.

The larger is the size of the parent's assets, the larger is the probability that parent's taxable income will be negative and some of the tax-loss credits will be lost. In order to offset parent's losses, a larger amount of income from subsidiary need to be transferred to the parent in the form of interest payments. Similarly, the larger is the size of subsidiary's assets, the larger is the probability that the subsidiary's taxable income will be negative, and some of its tax-loss credits will be lost. In order to offset the subsidiary's losses, a smaller fraction of income from the subsidiary should be transferred to the parent in the form of interest payments.

The larger is the variability of return on the parent's assets, the larger is the probability that parent's taxable income will be negative and some of the tax-loss credits will be lost. In order to offset parent's losses, a larger amount of income from subsidiary need to be transferred to the parent in the form of interest

¹⁴ Concavity of the value function ensures the second order condition for the maximum is satisfied.

¹⁵ Here, we consider one distribution to be more variable than another if it is a symmetric mean preserving spread of the other. In the case of a normal distribution, variability corresponds to variance.

payments. Similarly, larger is the variability of return on subsidiary's assets, the larger is the probability that subsidiary's taxable income will be negative and some of the tax-loss credits will be lost. In order to offset subsidiary's losses, a smaller fraction of income from subsidiary should be transferred to the parent in the form of interest payments.

2.2. $\tau^P > \tau^S$: Parent tax-rate exceeds subsidiary tax-rate

2.2.1. Optimal dividend repatriation policy

We first analyze the subsidiary's optimal dividend repatriation policy for a given level of subsidiary debt that is owed to the parent.

If parent's taxable income before dividend repatriation is negative, i.e., $Y_t^P < 0$, then the maximum amount of dividends that can be transferred without the parent paying any taxes can be obtained by setting $T_t^P = 0$ in Eq. (4). Solving and rearranging, we get:

$$k(-Y_t^P),$$

where

$$k \equiv \frac{\tau^P(1 - \tau^S)}{\tau^P - \tau^S} > 1.$$

Thus, for each dollar that the parent loses, we can transfer more than one dollar of dividends to the parent without the parent paying any taxes at all. This makes intuitive sense, since for each dollar of parent loss, the parent will lose τ^P dollars of tax-loss credit if it is not offset by some other taxes in the current period. Now, each dollar of dividend transferred is subject to a maximum additional taxation of only $(\tau^P - \tau^S)/(1 - \tau^S)$ dollars. The term k , then represents the factor by which the parent loss is inflated to obtain the maximum dividend amount that can be transferred without the parent incurring any taxes.

From the expression for taxes of Eq. (4), it can be seen that any dividends transferred from the subsidiary to the parent are potentially subject to additional taxation in the parent country at a rate of $(\tau^P - \tau^S)/(1 - \tau^S)$ for each dollar of dividend transferred.

The optimal dividend policy, then, is not that straightforward. If the subsidiary faces additional parent-level taxes on dividend repatriation, it may not choose to transfer its entire cash balance to the parent. In this instance, the optimal strategy may involve retaining some earnings at the subsidiary level, waiting for a period in which the parent experiences a loss, and then repatriating the earnings without facing additional taxation.

Any marginal dollar of dividend transferred that gets additionally taxed in the parent country at a rate $(\tau^P - \tau^S)/(1 - \tau^S)$, is worth only $1 - (\tau^P - \tau^S)/(1 - \tau^S)$

$= (1 - \tau^p)/(1 - \tau^s) < 1$ dollars to the parent shareholders. Hence, if the two tax-rates are sufficiently different such that:

$$\frac{1 - \tau^p}{1 - \tau^s} < \frac{1}{1 + r} E_t V'(R_t^s), \tag{10}$$

where $V'(x)$ denotes $\partial V / \partial R_t^s |_{R_t^s = x}$, it will be worthwhile to retain some earnings at the subsidiary and delay repatriation of dividends until some date in future when they can possibly be repatriated without incurring any additional taxes in the parent country. The term $1/(1 + r) E_t V'(x)$ represents marginal present value (to the parent shareholders) of an additional dollar retained in the subsidiary after x dollars have been retained in the subsidiary. Clearly, since the likelihood that each additional dollar retained in the subsidiary will be transferred to the parent without incurring any additional taxes decreases as retained earnings increase (i.e., V is a concave function of R_t^s), there will be a maximum level of retained earnings, \bar{R} , beyond which it will not be optimal to retain any further earnings. Formally, \bar{R} can be defined as follows:

$$\frac{1 - \tau^p}{1 - \tau^s} = \frac{1}{1 + r} E_t V'(\bar{R}). \tag{11}$$

Notice that $E_t V'(\bar{R})$ is identical for all t , since y_t^p and y_t^s are *iid* and optimal level of D each period depends only on retained earnings.

The optimal dividend repatriation policy, then, can be summarized as follows. The subsidiary first transfers as much of its cash holding as possible to the parent without incurring any repatriation taxes (if the parent taxable income before repatriation is negative). Then, of the remaining cash holding, it retains up to a maximum of \bar{R} and transfers the rest in the form of dividend repatriation.

2.2.2. Optimal debt-equity mix

Given the optimal dividend policy, the dynamic programming problem to determine the optimal level of debt $D_t \leq A^s$ can now be written as:

$$V(R_{t-1}^s, y_t^s, y_t^p, D_{t-1}) = C_t^p + \frac{1}{1 + r} \max_{D_t \leq A^s} E_t V(R_t^s, y_{t+1}^s, y_{t+1}^p, D_t).$$

The parent cash holding in the current period, C_t^p , is not affected by the level of debt in the current period, D_t . Therefore, differentiating the expected value of next period's value function with respect to D_t (and multiplying by $(1 + r)$), we get:

$$\begin{aligned} \frac{d}{d D_t} E_t V(R_t^s, y_{t+1}^s, y_{t+1}^p, D_t) &= \frac{d}{d D_t} E_t \left[C_{t+1}^p + \frac{1}{1 + r} E_{t+1} V(R_{t+1}^s, y_{t+2}^s, y_{t+2}^p, D_{t+1}) \right] \\ &= E_t \left[\frac{d}{d D_t} C_{t+1}^p + \frac{1}{1 + r} V'(R_{t+1}^s) \frac{d}{d D_t} R_{t+1}^s \right]. \end{aligned}$$

Lemma 1

$$\begin{aligned} \frac{1+r}{r^p} \frac{d}{dD_t} E_t V(R_t^s, y_{t+1}^s, y_{t+1}^p, D_t) = & - \int_{p^+ s^- C^-} \int \tau^p + \int_{p^- s^+ C_L^+} \int \tau^s \\ & - \int_{p^- s^- C_M^+} \int \frac{\tau^s(1-\tau^p)}{\tau^p - \tau^s} \left[1 - \frac{1}{1+r} V'(R_{t+1}^s) \right] \\ & + \int_{p^- s^+ C_M^+} \int \frac{\tau^s(1-\tau^s)}{\tau^p - \tau^s} \left[-\frac{1-\tau^p}{1-\tau^s} + \frac{1}{1+r} V'(R_{t+1}^s) \right] \\ & - \int_{p^+ s^- C_M^+} \int \left[-(1-\tau^p) + \frac{1}{1+r} V'(R_{t+1}^s) \right] \\ & - \int_{p^+ s^+ C_M^+} \int (1-\tau^s) \left[-\frac{1-\tau^p}{1-\tau^s} + \frac{1}{1+r} V'(R_{t+1}^s) \right]. \quad (12) \end{aligned}$$

Here p^+ denotes that Y_{t+1}^p is positive and p^- denotes that it is negative. Similarly, s^+ denotes Y_{t+1}^s is positive and s^- denotes that it is negative. Lastly, C^- denotes that C_{t+1}^s is negative, C_L^+ denotes that $0 \leq C_{t+1}^s \leq k(-Y_{t+1}^p)$ and C_M^+ denotes that $\max\{0, k(-Y_{t+1}^p)\} \leq C_{t+1}^s \leq \bar{R}$. We define $\int_Z \int h(\dots)$ as the double integral of the function $h(\dots)$ over the region Z , where Z denotes a region for variables y_{t+1}^s and y_{t+1}^p described by one of the cases above.

Proof. Available from authors upon request. □

Eq. (12) describes the effect of a marginal increase in the subsidiary debt level on the firm value. Notice that all terms inside the integrals are positive. Therefore the sign outside each integral indicates the whether marginal debt is beneficial or costly in that particular region.

The first term, integrated over values of y_{t+1}^s and y_{t+1}^p where the parent pays taxes but the subsidiary does not, captures the cost associated with increasing debt and transferring untaxed subsidiary cash holdings to taxed parent earnings.

The second term represents the case where the subsidiary transfers all cash holding to the parent in the form of dividends without the parent incurring any taxes. Here, a marginal increase in debt is beneficial, as it transfers subsidiary earnings being taxed at τ^s , to the parent, where they go untaxed.

The third integral reflects the benefit of marginal debt in a very particular region. The subsidiary's earnings are negative and so no taxes are paid at the subsidiary. The parent's earnings, before dividend repatriation, are also negative. But, the subsidiary's cash holding is so large that it is able to exploit the parent's tax-loss credit fully and still has some more cash left over. Now, a marginal decrease in the interest payments would be beneficial to the firm. The reason is that a marginal decrease in the debt payments increases the subsidiary's taxable earnings. But since the subsidiary is not paying any taxes anyway, it does not

matter. However, since a marginal decrease in the interest payments also decreases the parent's earnings before dividend repatriation, the subsidiary is able to transfer even more funds in the form of dividends without incurring any taxes at the parent level. So, overall, a marginal decrease in subsidiary debt helps parent's shareholders.

The fourth term evaluates the region where the subsidiary records a profit and is able to fully exploit the parent's tax-loss credit through dividend transfer. In this case, the subsidiary also may be able to fully exploit the tax-loss credit by marginally increasing the interest payment. This will mean that the marginal dividend transfer is now worth $(1 - \tau^P)/(1 - \tau^S)$. But now, the firm is better off by actually retaining this marginal dividend, where it is worth more than $(1 - \tau^P)/(1 - \tau^S)$, as the subsidiary's retained earnings are less than \bar{R} . Hence, in this case, a marginal increase in subsidiary debt improves firm value.

Consider the fifth integral. Parent's taxable earnings, before dividend transfer, are positive. Therefore, the optimal dividend policy is to pay no dividends and carry all subsidiary cash to the next period. The net effect of a marginal increase in the level of debt, in this case is negative because a marginal dollar increase in debt payments to the parent is worth only $1 - \tau^P$ whereas retaining it with the subsidiary, from Eq. (10), is worth at least $(1 - \tau^P)/(1 - \tau^S)$.

The final integral captures the effect of marginal debt when profits are recorded at both the parent and the subsidiary, but subsidiary cash holdings are less than \bar{R} . Here, a marginal dollar increase in interest payments to the parent is worth only $1 - \tau^P$ whereas retaining it with the subsidiary yields $1 - \tau^S$, which from Eq. (10), is worth at least $(1 - \tau^P)/(1 - \tau^S)$ for each dollar retained. So, overall, the marginal retention is worth at least $1 - \tau^P$, and therefore the net effect of increasing the debt level is negative.

Proposition 3 *If the parent tax-rate τ^P is sufficiently larger than the subsidiary tax-rate τ^S , then it pays to choose the subsidiary debt level to be as low as possible.*

Proof. See Appendix A. \square

Intuitively, if the tax-rate differential is high, it is desirable to have as much flexibility as possible in timing the transfer of funds. Since debt commits the firm to transfer funds from the subsidiary to the parent in all states of the world, it makes sense to minimize the debt level.

If the tax-rates and the distribution of income streams are such that there is an interior solution for the optimal level of debt, the first order condition for determining the optimal level of debt is obtained by setting Eq. (12) equal to zero.

Proposition 4 *The optimal level of subsidiary debt-asset ratio D_t/A^s is: (1) increasing in the parent's level of fixed assets A^p , (2) decreasing in the subsidiary's level of fixed assets A^s .*

Proof. Available from authors upon request. \square

The intuition for this result is similar to, though not as straightforward as, the corresponding results in Propositions 2.3 and 2.4. For instance, consider the effect of changing A^p . Here, there are two possible costs associated with increasing the debt level as A^p increases. First, the region described by $Z = p^-s^-C_M^+$ may expand. Recall that in this region the firm prefers to exploit parent's loss using dividends rather than interest payments. Second, the region described by $Z = p^-s^+C_M^+$, where the firm prefers interest payments over dividends, may shrink. However, these possible costs are more than offset by benefits in other regions. The region $Z = p^+s^-C_M^+$, where the firm prefers dividends over interest payments, shrinks sufficiently to offset the first cost. Moreover, the region $Z = p^-s^+C_L^+$, where the firm prefers interest payments over dividends, expands sufficiently to offset the second cost.

The relationships between the optimal level of subsidiary debt to asset ratio and the subsidiary tax-rate τ^s , the parent tax-rate τ^p , the variability of parent income y_{t+1}^p , and the variability of subsidiary income y_{t+1}^s , cannot be signed unambiguously, in general, and depend upon the value of the exogenous parameters. For instance, consider the effect of increasing τ^s . Similar to the intuition for the corresponding Proposition 2.1, an increase in τ^s tends to increase the benefit of high debt. However, there may be a sufficiently large offsetting cost associated with the region described by $Z = p^-s^-C_M^+$ where the firm prefers dividends over interest payments.

Proposition 5 *The level of subsidiary debt D_t , as well as the expected cash-flow available for potential dividend repatriation, $E_t C_{t+1}^s$, is higher, the larger are the earnings retained in the subsidiary R_t^s .*

Proof. Available from authors upon request. \square

A higher level of retained earnings, R_t^s , implies a higher level of taxable subsidiary income next period. While the potential cost of a larger interest payment is unchanged — it still faces the same probability of parent-level taxation — the cost of earning potentially taxable income at the subsidiary level is unambiguously higher. There now exist more states of the world in which subsidiary earnings are taxed. Therefore, the firm increases subsidiary debt.

However, the increase in debt is not so large that it commits all of the increase in retained earnings (times $1 + r^s$) to be transferred next period in the form of interest payments. This is because there is some possibility that the subsidiary may

prefer to delay transferring earnings. Hence, next period's expected cash holding, available for dividend repatriation, is higher.

3. Empirical implications

We now summarize the empirical implications that follow from our analysis. The first two implications have been discussed in the literature and there are some studies that document evidence in support of these implications.

Implication 1 (1) *If the tax-rate in the subsidiary country is much larger than the tax-rate in the parent country, the subsidiary will be financed by the parent entirely with debt.* (2) *If the tax-rate in the parent country is much larger than the tax-rate in the subsidiary country, the subsidiary will be financed by the parent entirely with equity.*

These implications are from Propositions 1 and 3. Consistent with the above implications, Hines and Hubbard (1990) finds that in 1984, the average foreign tax-rate paid by firms that paid dividends but no interest was 34% whereas the average tax-rate paid by those that paid interest but no dividends was 51%. The effective tax-rate in the U.S., during this period, was between these two tax-rates. [Also, see Wolfson (1990)].

The following figures (Fig. 1), using our results in Propositions 1, 2.1, 2.2 and 3, describe the debt-asset ratio as a function of the parent tax-rate and as a function of the subsidiary tax-rate.

Notice that the relationship between the debt-asset ratio and the tax rates is monotonic only when the subsidiary tax-rate exceeds the parent tax-rate. But, the overall nature of the relationship is described by the following implication.

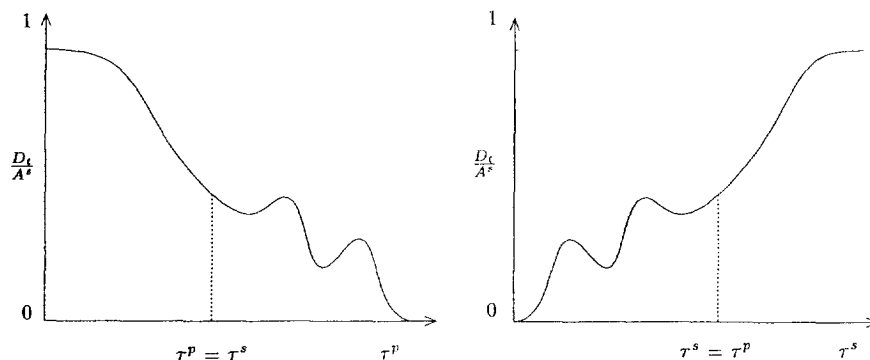


Fig. 1.

Implication 2 *The subsidiary's debt-asset ratio is positively related to the tax-rate in the subsidiary country and negatively related to the tax-rate in the parent country.*

Empirical evidence in Hogg and Mintz (1993) is consistent with this implication. They report that following a decrease in the U.S. tax-rates in the mid-1980s, U.S. multinationals increased the debt-asset ratio of their Canadian subsidiaries.

The implications that follow have not, at least to our knowledge, been examined empirically.

Implication 3 *The subsidiary's debt-asset ratio is larger: (1) the larger is the size of parent's assets. (2) the smaller is the size of subsidiary's assets.*

This implication follows from Proposition 2.3, 2.4 and 4.

Implication 4 *If the tax-rate in the subsidiary country exceeds the tax-rate in the parent country, then the subsidiary's debt-asset ratio is larger: (1) the smaller is the variability in subsidiary's income. (2) the larger is the variability in parent's income.*

Follows from Proposition 2.5 and 2.6.

Implication 6 *The subsidiary's debt-asset ratio is relatively more stable over time if the tax-rate in subsidiary country exceeds the tax-rate in the parent country than if the converse is true.*

This implication follows from Propositions 2 and 5. The reason is that if the subsidiary tax-rate exceeds the parent tax-rate, the subsidiary repatriates all its earnings each period. Therefore, the optimal level of debt stays constant. If, on the other hand, the parent tax-rate exceeds the subsidiary tax-rate, the subsidiary has incentives to delay repatriation of earnings. Since the level of debt varies with the size of the retained earnings, as the level of retained earnings changes over time, so does the level of subsidiary debt.

Implication 6 *(1) If the tax-rate in subsidiary country exceeds the tax-rate in the parent country, then there is no correlation between the dividend repatriation and the interest payments to the parent over time. (2) If the tax-rate in the parent country exceeds the tax-rate in the subsidiary country, then the dividend repatriation and the interest payments to the parent are positively correlated over time.*

If the tax-rate in subsidiary country exceeds the tax-rate in the parent country, the level of subsidiary debt, and therefore the level of interest payments each period, stays constant over time. Dividend payments, however, vary as the realized after-tax income of the subsidiary varies from period to period. The correlation between the two, therefore, is zero.

On the other hand, if the tax-rate in the parent country exceeds the tax-rate in the subsidiary country, the level of debt, and therefore the interest payments, are positively associated with the size of the retained earnings. Also, notice that the dividend repatriation is likely to be higher when the retained earnings are higher. This follows from Proposition 6. Therefore, we will tend to observe a positive correlation between interest payments and dividend repatriation.

Implication 7 *The correlation between the subsidiary income and the dividend repatriation is higher if the tax-rate in the subsidiary country exceeds the tax-rate in the parent country than if the converse is true.*

If the tax-rate in the subsidiary country exceeds the tax-rate in the parent country, the subsidiary repatriates all its earnings as dividends and therefore the correlation is equal to one. However, if the tax-rate in the parent country exceeds the tax-rate in the subsidiary country, the subsidiary sometimes retains and reinvests at least part of its earnings. This produces a correlation of less than one.

Implication 8 *If the tax-rate in the parent country exceeds the tax-rate in the subsidiary country, then the correlation between the subsidiary's income and dividend repatriation is higher when the level of the subsidiary's debt is higher.*

A higher level of the subsidiary's debt implies a higher level of retained earnings from Proposition 6. A higher level of retained earnings also implies a larger level of expected cash holding the following period. Therefore it is more likely that the cash holding would exceed the critical level (\bar{R}) beyond which the subsidiary repatriates all its cash holding. This implies that the correlation between the subsidiary's income and dividend repatriation will be higher.

4. Conclusion

We analyze an optimal tax management strategy for multinational corporations taking into account exploitation of tax-loss credits. We develop a formal multi-period dynamic model to characterize the optimal dividend repatriation policy under different assumptions about tax-rates in the two countries. We then derive the optimal choice of debt-equity mix. The model generates several testable empirical implications. We show that a subsidiary capital structure that involves the use of mainly debt or mainly equity is optimal only when the tax-rates in the two countries are sufficiently different. We also show the subsidiary's debt-asset ratio is positively related to the tax-rate of the subsidiary and negatively related to the tax-rate of the parent. Empirical evidence in the existing literature is consistent with this prediction.

The model generates several other empirical predictions that have not, at least to our knowledge, been either discussed or empirically tested in the literature. For instance, the model predicts that the subsidiary debt-asset ratio is increasing in the size of the parent and decreasing in the size of the subsidiary. The relationship between the debt-asset ratio of the subsidiary and the variability of the parent's and the subsidiary's incomes is also explored. Finally, the model generates predictions about the time-series behavior of dividend repatriations and interest payments. These results are derived under the assumption that asset returns are *iid*. It would be useful to extend the analysis to consider other cases as well. For instance, subsidiary earnings might be expected to grow over time. Also, earnings innovations might be correlated across time and between subsidiary and parent. The framework we have developed can be used to analyze such cases but would, in general, require complicated numerical procedures to solve. Nonetheless, the insights developed in the paper do shed some light on this challenging problem and provide a first step towards further understanding these important issues.

The model makes several simplifying assumptions that allow us to focus solely on internal financing of the subsidiary by the parent. However, we do know that subsidiaries, often, rely on external financing as well (Chowdhry and Nanda, 1994). It would be interesting and useful to extend the analysis to consider both internal as well as external financing in determining the optimal capital structure of subsidiaries.

We leave it to future research to explore the extensions of our model and empirically test the implications of our analysis.

Appendix A

A.1. Proof of Proposition 2

(1) Follows directly from differentiating the first order condition (Eq. (9)) with respect to τ^s .

(2) Follows directly from differentiating the first order condition (Eq. (9)) with respect to τ^p .

(3) A larger value of A^p implies that $\text{Prob}[y_{t+1}^p \geq -(r^p D_t)/A^p]$ decreases. The result then follows directly from differentiating the first order condition (Eq. (9)).

(4) A larger value of A^s implies that $\text{Prob}[y_{t+1}^s \geq (r^p D_t)/A^s]$ increases. Differentiating the first order condition (Eq. (9)), we know that D_t must also increase. This implies that $\text{Prob}[y_{t+1}^p \geq -(r^p D_t)/A^p]$ increases. In order to satisfy the first order condition, $\text{Prob}[y_{t+1}^s \geq (r^p D_t)/A^s]$ must also increase, which implies that D_t/A^s decreases.

(5) Since $E_t y_{t+1}^p > -(r^p D_t)/A^p$, a higher variability of return on the parent's assets implies that $\text{Prob}[y_{t+1}^p \geq -(r^p D_t)/A^p]$ decreases. The result then follows directly from differentiating the first order condition (Eq. (9)).

(6) If we assume that the after-tax rate of return on subsidiary's assets is at least as high as the risk-free rate r , and that the level of subsidiary debt D_t is no greater than the subsidiary assets A^s , then it follows that $E_t y_{t+1}^s \geq r/(1 - \tau^s) > r/(1 - \tau^p) = r^p \geq r^p(D_t/A^s)$. Then, a higher variability of return on the subsidiary's assets implies that $\text{Prob}[y_{t+1}^s \geq (r^p D_t)/A^s]$ decreases. The result then follows directly from differentiating the first order condition (Eq. (9)). \square

A.2. Proof of Proposition 3

First notice that we can put an upper bound on the integrand of the fourth term (which is positive) in Eq. (12) as follows:

$$\frac{\tau^s(1 - \tau^s)}{\tau^p - \tau^s} \left[-\frac{1 - \tau^p}{1 - \tau^s} + \frac{1}{1 + r} V'(R_{t+1}^s) \right] < \frac{\tau^s(1 - \tau^s)}{\tau^p - \tau^s} \left[-\frac{1 - \tau^p}{1 - \tau^s} + 1 \right] = \tau^s.$$

This allows us to put an upper bound on the entire expression in Eq. (12) as follows:

$$\frac{1 + r}{r^p} \frac{d}{dD_t} E_t V(R_t^s, y_{t+1}^s, y_{t+1}^p, D_t) < -\int_{p^+ s^- c^-} f_{\tau^p} + \int_{p^- s^- c_t^+} f_{\tau^s} + \int_{p^- s^+ c_M^+} f_{\tau^s}.$$

Clearly, if τ^p is sufficiently larger than τ^s , the right hand side of the above inequality is negative. \square

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