THE JOURNAL OF FINANCE • VOL. XLV, NO. 5 • DECEMBER 1990

International Capital Structure Equilibrium

JAMES E. HODDER and LEMMA W. SENBET*

ABSTRACT

This paper develops a theory of capital structure in an international setting with corporate and personal taxes. We generalize the Miller analysis to an international equilibrium characterized by differential international taxation and inflation in otherwise perfect international capital markets. Our analysis highlights the key role that corporate tax arbitrage plays in generating an international capital structure equilibrium, and we set forth a number of mechanisms for tax arbitrage transactions. We close the paper by outlining some implications of our analysis for national differences in capital structure, the International Fisher Effect, and international tax effects on yield differentials.

AMONG MAJOR QUESTIONS REGARDING corporate capital structure which arise in an international setting are how (or whether) multiple tax jurisdictions and multiple currencies affect firm financing decisions and the international bond market equilibrium. We examine some of these questions by way of generalizing Miller's (1977) "Debt and Taxes" model into an international setting. This setting allows for different tax regimes across countries as well as the possibility of differential inflation across currencies, with consequent exchange rate movements.

In the first part of this paper, we find that an international Miller-type equilibrium obtains under differential international taxation with capital market conditions which are otherwise analogous to those required for a domestic Miller equilibrium. Our analysis particularly highlights the role that corporations play in Miller's analysis as vehicles for tax arbitrage. We show that, if corporations engage in international tax arbitrage transactions on an equal footing, no optimal capital structure exists for individual firms. Consequently, without further restrictions, differences in international tax rates alone are incapable of dictating a particular capital structure for an individual firm.

In the second part of the paper, we extend the analysis to consider differential inflation rates, with a consequent exchange rate movement, and draw additional implications for the international analog of the Miller equilibrium. With differential inflation and taxation, we begin by showing the existence of the International Fisher Effect for both equity and bonds. Although inflation (and/or exchange rate movements) may affect real corporate tax subsidy rates and real

* Hodder is from Stanford University, and Senbet is from the College of Business and Management, University of Maryland. We gratefully acknowledge helpful comments on previous drafts of the paper by René Stulz, Robert Dammon, Eugene Flood, Dennis Logue, Steven Raymar, Robert Taggart, Adrian Tschoegl, anonymous referees for this Journal, and seminar participants at Osaka, Stanford, Wisconsin, and Illinois. Previous versions of this paper were also presented at the annual meetings of the American, Western, and European Finance Associations.

personal tax penalties, there exists no induced preference for corporate borrowing in a particular currency. We show again that the basic results of the international Miller equilibrium remain intact even under differential inflation (or exchange rate movements).[1] We then draw additional implications of the international equilibrium for such phenomena as national capital structures and tax effects on international parity relationships. The last section concludes the paper with some commentary on the implications of national differences in capital structure, international tax and inflation effects on equilibrium yield differentials in the bond market, and possible motivations for foreign exchange risk hedging.

Much of our analysis in this paper assumes that government restrictions do not preclude corporate and individual responses to differences in international tax rates. Clearly this is an idealized situation. For example, the 1986 U.S. Tax Reform Act contains several provisions aimed at restricting the international tax arbitrage capabilities of multinational firms. Such restrictions can have important implications, and we comment on several during the course of our analysis. However, we primarily focus on the more idealized situation, since it is important to first understand how market forces would act in the absence of governmental restrictions. This allows us to see clearly why differential taxation or inflation rates by themselves are not sufficient to preclude an international analog of the Miller equilibrium.[2]

I. Capital Structure under International Taxation

In this section, we establish the international analog of the Miller equilibrium under differential international taxation in otherwise perfect international markets. Thus, capital structure irrelevance at the individual firm level holds under the same conditions required for the domestic Miller equilibrium.

A. The Tax Environment and Arbitrage Valuation: An Initial Analysis

For simplicity consider the case of a binational firm operating in two distinct tax regimes. For the moment, we take the investment and financing decisions as

[1] Our analysis contrasts with the conclusions of Lee and Zechner (1984), who consider a similar extension of Miller's model. They find that Miller equilibria are "generally not consistent" with an international equilibrium in which either inflation rates or corporate tax rates differ across countries. With differential inflation, they also find that firms will have an induced preference for borrowing in a particular currency. As will become clear during the course of our analysis, the Miller equilibrium fails to hold in the Lee and Zechner paper not because of differential corporate tax or inflation rates across countries, but because of additional (implicit) restrictions on international capital market access imposed on firms and investors.

[2] As in a purely domestic context, the introduction of firm-specific imperfections, such as agency or financial distress costs, can result in an optimal combination of financial services for individual firms. These financial services may include the split between debt and equity financing and the currency composition of debt. Optimal currency composition can be viewed as a hedging activity, and hence hedging can be rationalized as a natural outcome from the process of optimizing international capital structure when such hedging activities cannot be replicated costlessly through forward markets. With costless forward contracts, of course, domestic currency debt can be effectively transformed into foreign currency debt, or vice versa. However, the firm still takes optimal positions (debt plus forward contracts) in foreign currencies. See Hodder and Senbet (1990).

fixed and wish to determine the firm's valuation. We then look at the strategic behavior of the firm and the binational capital structure equilibrium under an integrated capital market. In what follows, we will use the term domestic to denote country 1, with the term foreign limited to country 2 items. Thus, foreign source income refers to income from country 2, regardless of whether the firm or individual is domiciled in country 2. Corporate income from domestic operations is taxed at the rate of τ_c, and corporate income from foreign operations is taxed at a potentially different rate τ_c^* with symmetric treatment of income and losses under each country's tax code.[3] Likewise, personal taxes may also differ between the domestic and foreign locations.[4] We assume for the moment that personal taxation is by income source, with domestic personal income taxed at a uniform rate of τ_p and foreign personal income taxed at a uniform rate of τ_p^*. Investment income from stocks is essentially untaxed in either location.[5] The first stage of our analysis maintains uniform corporate and personal taxation within each national origin and hence focuses only on *differential* international taxation by source of income. The more realistic case of heterogeneous personal tax rates and the possibility of personal taxation based on residence (rather than income source) is introduced in Section I.*B*, where we develop the analog of the Miller equilibrium for fully integrated international capital markets.

We conduct our initial analysis for fixed investment and financing decisions. The binational firm is levered by raising debt capital of D at an interest rate r_c in the domestic bond market and D^* at r_c^* in the foreign market. For the moment, we assume a known exchange rate of unity; consequently, the currency denomination of debt is immaterial for our analysis at this stage. For purposes of presentation, the analysis is conducted using the domestic currency as numeraire.

[3] We are assuming that τ_c is the same for all corporations with income generated in country 1 regardless of where their parent firms are located (domiciled), and similarly for τ_c^*. This is clearly the case if tax rates are uniform within each country and income is taxed based explicitly on its national source. This situation can also hold if income earned by a subsidiary abroad (e.g., country 2) is taxed in the parent's home country (e.g., country 1) with a credit for taxes paid by the subsidiary. In this latter situation, the amount of the credit is frequently limited to the parent's tax liability on earnings actually repatriated from the subsidiary. The tax deferral of unrepatriated earnings effectively allows the parent to have such earnings taxed at the subsidiary's tax rate, regardless of whether that rate is above or below the parent's tax rate in the home country. This is obviously advantageous for the firm if the subsidiary's rate is lower. If the subsidiary's rate is higher, the limit on the parent's country tax credit means that, even if subsidiary earnings are repatriated, they will be effectively taxed at the subsidiary's rate (since the parent cannot utilize the "excess" credit).

[4] We do not wish to make any distinction between regular income taxes and special taxes, such as dividend withholding taxes, because they can be consolidated into a single effective tax rate. (See Horst (1971), p. 1061). Also see Sato and Bird (1975) for a general discussion of international tax laws. For more recent information on international taxation, see Price Waterhouse (1989).

[5] As in the domestic case, the tax exemption of equity income is not essential to obtaining a Miller-like equilibrium. What is required is that the effective tax rate on bond income be substantially higher than the tax rate on equity income in at least one of the countries. Even though the recent tax overhaul bill in the United States has capital gains taxed at the same rate as interest income, the ability to defer capital gains taxes still makes it possible for the equity income to be taxed at a significantly lower rate on an effective basis. Furthermore, there are countries where capital gains are not taxed. This was the general rule until recently on equity gains for individuals in Japan. Further discussion of the issue is postponed until Section I.*C*.

The firm's operating earnings are $\tilde{\theta}^*X^*$ from foreign operations and $\tilde{\theta}X$ from domestic operations, where $\tilde{\theta}$ and $\tilde{\theta}^*$ are random variables with means of one.

To derive an arbitrage valuation, it is convenient to consider an equivalent unlevered firm with random earnings of $\tilde{Y} = \tilde{\theta}X + \tilde{\theta}^*X^*$. Suppose that the value of the levered binational firm is $V_L = S_L + D + D^*$, where S_L is the value of equity, and the unlevered counterpart is valued at $V_U = S_U$. Like Miller, we assume riskless debt, although the results pertaining to the tax impact of financing on firm value can hold even under risky debt with complete markets.[6]

Utilizing an approach analogous to that in Modigliani and Miller (1969), an investor (from either country) can employ alternative strategies yielding equivalent return streams. Under strategy 1, the investor holds a fraction α of the unlevered binational firm's stock. Under strategy 2, the investor holds a fraction α of the levered firm's stock and lends in both the domestic and foreign capital markets so as to generate an identical return stream as strategy 1.

Strategy	Return Stream
1	$\alpha[\tilde{\theta}X(1-\tau_c) + \tilde{\theta}^*X^*(1-\tau_c^*)]$
2	$\alpha[(\tilde{\theta}X - r_cD)(1-\tau_c) + (\tilde{\theta}^*X^* - r_c^*D^*)(1-\tau_c^*)] + \alpha r_cD(1-\tau_c) + \alpha r_c^*D^*(1-\tau_c^*)$

The net investments for both strategies are, respectively, as follows:[7]

$$I_1 = \alpha S_U = \alpha V_U, \tag{1.1}$$

$$I_2 = \alpha S_L + \alpha D\left(\frac{1-\tau_c}{1-\tau_p}\right) + \alpha D^*\left(\frac{1-\tau_c^*}{1-\tau_p^*}\right). \tag{1.2}$$

Note that the investor's interest income on foreign loans is taxed at a rate τ_p^* while τ_p applies to interest income from domestic loans. We can now invoke the law of one price and equate (1.1) and (1.2) to obtain the value of the binational levered firm under these circumstances:

$$V_L = V_U + D\left[\frac{\tau_c - \tau_p}{1-\tau_p}\right] + D^*\left[\frac{\tau_c^* - \tau_p^*}{1-\tau_p^*}\right]. \tag{1.3}$$

The aggregate tax subsidy is split into the values associated with D and D^*, which are the domestic tax subsidy and the foreign tax subsidy, respectively. Leverage would be a matter of indifference if corporate and personal tax rates were identical for each country. Alternatively, if corporate tax rates are identical across countries and personal tax rates are also identical, the national origin of

[6] Assuming riskless debt, of course, implies that $\tilde{\theta}$ and $\tilde{\theta}^*$ are bounded from below. See Taggart (1980) and Dammon (1988) regarding the implications of risky debt for the existence of a Miller equilibrium in an incomplete market.

[7] Following the tradition of Miller, tax arbitrage through personal borrowing is prohibited. Such a tax arbitrage restriction is critical to sustaining the Miller equilibrium. (See Schaefer (1982) or Aivazian and Callen (1987).) Note that the return stream under strategy 2 is due to personal lending. The alternative strategy of utilizing personal borrowing to generate matching return streams would be inconsistent with the Miller environment once we allow for heterogeneous personal tax brackets. Dammon (1988) has shown that, without such a tax arbitrage restriction, leverage irrelevance at the firm level is still possible if personal tax rates are *endogenously* progressive and markets are complete.

debt financing is of no consequence even if leverage matters. If, further, the tax rate on personal income equals that on equity income (assumed here to be zero), it can be shown that the model collapses to its well known counterpart—the familiar tax-adjusted valuation of Modigliani and Miller (1963).

It is instructive to introduce a third kind of firm, namely an unlevered and purely domestic firm with operating earnings of $\tilde{\theta}X_D$ equal to $\tilde{\theta}X + \tilde{\theta}^*X^*$. Thus, by construction, this unlevered domestic firm belongs to an operating risk class equivalent to that of the binational levered and unlevered firms. The after-corporate-tax operating earnings for this unlevered domestic firm are then $(\tilde{\theta}X + \tilde{\theta}^*X^*)(1 - \tau_c)$, while for the unlevered binational firm they are $(\tilde{\theta}X)(1 - \tau_c) + (\tilde{\theta}^*X^*)(1 - \tau_c^*)$. Again the principle of value additivity enables us to generate the (expanded) valuation for the levered binational firm relative to an unlevered and purely domestic firm of the same operating risk class:

$$V_L = V_{UD} - (\gamma\phi)G + D\left(\frac{\tau_c - \tau_p}{1 - \tau_p}\right) + D^*\left(\frac{\tau_c^* - \tau_p^*}{1 - \tau_p^*}\right), \tag{1.4}$$

where

V_{UD} = the value of the unlevered domestic firm,
G = the value of the tax claim $[\tau_c(\tilde{\theta}X + \tilde{\theta}^*X^*)]$ held by the domestic government,

while γ and ϕ satisfy:

$\tau_c^* = (1 + \gamma)\tau_c$,
ϕ = the degree of international operations
$= V(\tilde{\theta}^*X^*)/V(\tilde{\theta}X + \tilde{\theta}^*X^*)$.

One can infer from (1.4) a set of conditions that render various kinds of international involvement irrelevant. By irrelevance we mean that such international characteristics of the firm's investment or financing decisions are of no consequence to its valuation.[8] For instance, the origin of debt financing is a matter of indifference when the *relative* tax rates are identical between countries. The relative tax rates are defined as the ratio of the complements of corporate and personal tax rates. That is, when $(1 - \tau_c)/(1 - \tau_p) = (1 - \tau_c^*)/(1 - \tau_p^*)$, national origin is immaterial for financing decisions. Also, financial leverage would be irrelevant altogether if, in each country, there existed no differential between corporate tax rates and personal tax rates. However, tax rates can be different across national boundaries. Shortly we shall investigate the extent to which such tax rate differences can be sustained in an equilibrium with an integrated international capital market.

B. Equilibrium Implications and the International Miller Theorem

Up to this point our analysis has focused on valuation effects of alternative international tax structures. The analysis has also been partial because it does

[8] Note that (1.4) is a generalization of Senbet's (1979) model. Senbet does not pursue the equilibrium implications of his analysis, which are the principal subjects of the current paper.

not consider the strategic behavior of both firms and investors regarding their supply and demand adjustments. We now wish to pursue a more general equilibrium analysis of the model. As before, corporate income is taxed at constant but potentially differing effective rates on the basis of its national origin. To illustrate the process of attaining an international capital structure equilibrium, let us assume that $\tau_c > \tau_c^*$ and that firms face the same effective rates regardless of their parents' domiciles. We also assume that investors are taxed based on their residence rather than source of income, although we relax this assumption in the next section. This situation can be explored using Figure 1.

Figure 1 is a modification of Miller (1977) for differential international taxation. A similar figure is employed in Lee and Zechner (1984). Following Miller, one could begin the analysis by arguing that domestic corporations will supply debt through the solid stretch of the horizontal curve intercepting the vertical axis at $r_s/(1 - \tau_c)$, with r_s denoting the certainty equivalent return on common stock.[9] Recall that the return on common stock is assumed to be tax-exempt, so international arbitrage forces this certainty equivalent rate to be the same in both countries. Foreign firms apparently supply debt at $r_s/(1 - \tau_c^*)$.

In the development of equation (1.4), we assumed for simplicity that individuals faced uniform tax rates. Now, to explore the possibility of a Miller-type equilibrium, we adopt his assumption that individual investors face exogenously progressive personal tax rates. With integrated international capital markets, this results in an upward sloping demand schedule by individual investors such as that passing through AC.[10] The elasticity of this schedule varies depending upon the progressivity of the tax rates and the collective wealth of investors within each tax bracket. Another possibility is a schedule progressing through DB. Heterogeneously higher personal tax brackets in each country result in upward sloping national demand schedules which are aggregated horizontally to generate curves like those progressing through DB and AC. Of course, this international aggregation blurs information on purely national tax brackets, but it is consistent with the notion that the international bond market equilibrates through an international marginal tax bracket group.

[9] If we view the endpoint Q_2 of the domestic supply curve as determined by total corporate income in the domestic economy, then the discrete downward jump in the supply curve at Q_2 is actually inappropriate. Instead, there should be a continuous transition, with domestic corporations borrowing greater amounts at lower interest rates such that their total tax shields remain constant. This transition would occur between debt levels of Q_2 and $Q_2[(1 - \tau_c^*)/(1 - \tau_c)]$, at which point country-2 firms would begin supplying debt at an interest rate of $r_c^* = r_s/(1 - \tau_c^*)$. As we shall see shortly, this transition is not important for our analysis.

[10] Under the U.S. tax law, there is now a very limited set of marginal federal tax rates on personal income. However, when we also consider state and local income taxes, the schedule of effective marginal rates is more continuously progressive. Furthermore, when we aggregate progressive schedules across countries (as discussed below), the use of a continuously progressive schedule is a reasonable approximation. It is also worth mentioning that, although the maximum U.S. federal tax rate on personal income (33%, including the 5% surcharge) is less than the maximum corporate rate (34%), there are several states (including New York and California) where the maximum personal tax rate exceeds the corporate rate. Consequently, the overall effective rate on individual interest income can exceed the effective corporate tax rate even in the U.S. Furthermore, after aggregation across countries, a demand schedule with a maximum effective personal tax rate greater than τ_c or τ_c^* is easily possible.

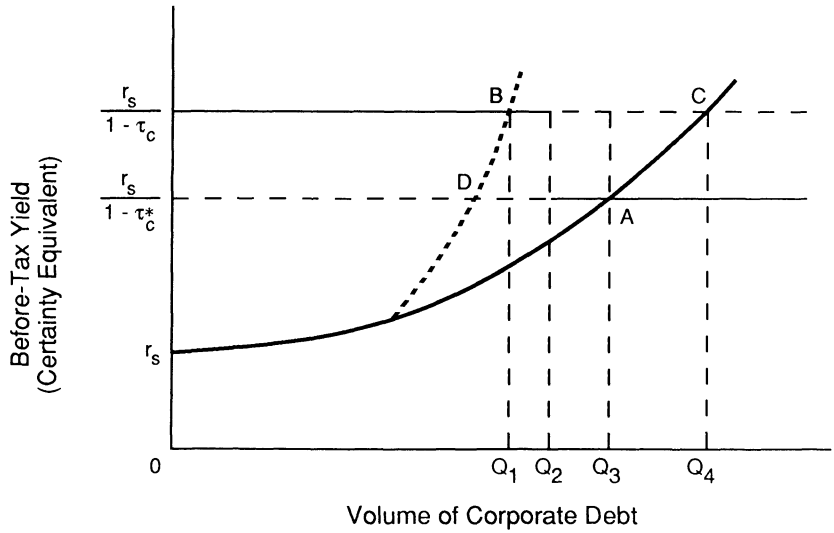

Figure 1. International equilibrium. In country 1, firms supply debt through the solid stretch of the horizontal curve intercepting the vertical axis at $r_s/(1 - \tau_c)$, with r_s denoting the equity return and τ_c denoting the corporate tax rate in country 1. The equity return is assumed to be tax-exempt. Firms in country 2 initially supply debt at $r_s/(1 - \tau_c^*)$, with τ_c^* denoting the corporate tax rate in country 2. For illustration, it is assumed that $\tau_c > \tau_c^*$. The international demand curve for corporate debt assumes integrated markets, with individuals taxed based on their residence at exogenously progressive tax rates. This results in an upward sloping curve such as that passing through DB or, with more elastic demand, through AC. It initially appears that an equilibrium at intersection A is possible, with country 1 firms being fully debt financed. However, the potential for international corporate tax arbitrage induces all firms to borrow in country 1. This results in an equilibrium point such as C, where there is a determinate aggregate international capital structure but no optimal capital structure for individual firms.

As illustrated in Figure 1, the equilibrium rate of interest and volume of corporate bonds outstanding are apparently determined by the intersection points between the individual demand and corporate supply schedules for debt. As described in Lee and Zechner (1984), this suggests two initial equilibria reflecting intersection points A and B. At point A, 1) the equilibrium interest rate is $r_s/(1 - \tau_c^*)$, 2) capital structure is indeterminate for foreign corporations but determinate internationally at the aggregate level of Q_3, and 3) domestic corporations go to a corner solution in their preference for debt financing. At point B, 1) the equilibrium interest rate is $r_s/(1 - \tau_c)$, 2) capital structure is indeterminate for individual domestic corporations but determinate in the aggregate at a level of Q_1, and 3) foreign corporations go to a corner solution in their preference for equity financing.

However, the above equilibrium analysis ignores the possibility of firms engaging in simultaneous adjustments of not only *how much* they borrow but *where* they borrow. In other words, these equilibria require restrictions on corporate supply-side behavior and the attendant corporate tax arbitrage transactions across the two countries. Actually, all multinational firms have an incentive to raise debt capital through an entity (parent or subsidiary) in the country with

the highest tax rate (in our example, country 1—the domestic economy). In other words, an initial intersection point such as A is not sustainable because it implies unexploited opportunities for corporate tax arbitrage. To illustrate this point, consider first a domestic parent with a levered foreign subsidiary. Clearly, the multinational firm's overall tax bill can be reduced through parent borrowing with an equivalent equity infusion into the subsidiary, which is used to repay its debt. This simply shifts the interest deduction to the higher tax entity—in this case, the parent firm.

As an alternative scenario, imagine a foreign parent which either has a domestic subsidiary or has decided to acquire one as a financing vehicle. Suppose the parent has outstanding foreign debt which is partially financing its operations. Now the multinational firm engages in a financial restructuring whereby the domestic subsidiary borrows and uses the loan proceeds to purchase newly issued equity in the foreign parent. The parent then uses the proceeds from equity issuance to repay the outstanding foreign debt. On a consolidated basis, the multinational firm's capital structure would remain unchanged. If the parent pays no dividends, the effect once again is simply to shift the interest deduction to a subsidiary in the high tax country.[11] If there were legal restrictions on subsidiary ownership of parent shares, the same effect could be accomplished by setting up a levered holding company (new parent) in the high tax country which then acquired the previous parent firm and repaid its outstanding debt.

In each of the foregoing strategies, the physical investment positions of the multinational firm remain unchanged. All that has taken place is a financial reshuffling to shift interest deductions to an entity in the high tax country. With any such strategy, the country 1 entity may end up with redundant tax shields. However, with symmetric tax treatment of corporate income and losses or (equivalently) perfect marketability for tax shields, the corporate tax schedule would be uniform across all corporations irrespective of national origins of their parent firms.

Under these circumstances, all firms face the same supply schedule, and hence an intersection point such as C renders capital structure indeterminate for all firms. A new equilibrium level such as Q_4 will be determined in the aggregate for the integrated international bond market. Depending on the demand curve's elasticity, an equilibrium could also occur at point B. However, now this equilibrium may involve borrowing by multinational firms with parents located in country 2, and capital structure becomes irrelevant for all firms, regardless of their national origin. At first glance, it appears that capital structure must be relevant for any nonmultinationals domiciled in country 2 since they turn out to

[11] As an alternative mechanism, the multinational entity can engage in a lease transaction whereby the domestic subsidiary borrows and uses the proceeds to "purchase" some of the parent firm's operating assets (plant and equipment). The operating assets are then immediately leased back to the parent for an annual payment equal to their annual depreciation. The parent uses the proceeds from the "sale" to repay the equivalent foreign debt. This leasing transaction leaves both the parent and subsidiary with the same operating incomes. The parent loses the depreciation deduction, but that deduction is exactly offset by the equivalent lease payment, with the reverse situation for the subsidiary. The overall effect is merely to shift the interest deduction to the subsidiary, where it is more valuable.

be financed completely by equity. However, such firms can freely become multinational for financing purposes; consequently, their choice of all-equity financing is irrelevant in terms of their valuation. Thus, the nationality of the parent firm becomes irrelevant for capital structure decisions.

The Miller equilibrium is restored above with essentially the same set of conditions as in the domestic context.[12] One could argue that, in fact, tax codes do not treat corporate income and losses symmetrically, and, consequently, an equilibrium at point C will not occur. However, symmetric tax treatment of corporate losses or perfect tax shield marketability is necessary for a Miller equilibrium in the domestic context; otherwise, we wind up with an analysis such as that in DeAngelo and Masulis (1980).

It is worth noting that one mechanism for (implicitly) marketing tax shields is the creation of an interfirm debt market in country 2, even though equilibrium with regard to bonds purchased by individual investors occurred at point C (or point B depending on the elasticity of the individual demand curve for debt). Under this mechanism for transferring tax shields, domestic firms borrow in country 1 and use the proceeds for an equity investment in a foreign subsidiary which in turn relends the funds to foreign firms. Since foreign source income (interest receipts of the foreign subsidiary) is taxed at τ_c^*, whereas interest payments on the initial loan are tax deductible at the higher rate of τ_c, this represents yet another mechanism for firms to transform higher taxed domestic income into lower taxed foreign income.[13]

For any given domestic interest rate r_c, the corporate demand schedule in the country 2 debt market would be horizontal at an interest rate of $r_c^* = r_c(1 - \tau_c)/(1 - \tau_c^*)$. At any greater value for r_c^*, there would be an arbitrage profit available to domestic firms for engaging in this relending operation. For an equilibrium interest rate of $r_c = r_s/(1 - \tau_c)$ in the domestic economy, the corporate demand schedule in the foreign debt market would thus be horizontal at $r_c^* = r_s/(1 - \tau_c^*)$. This corresponds exactly to the location of the corporate

[12] This conflicts with the analysis of Lee and Zechner (1984), who are unable to generate the international analog of the Miller equilibrium. They contend that international capital market segmentation or barriers to international portfolio capital are needed to undo the international tax effects of capital structure decisions at the level of individual firms. What they actually ignore is the corresponding strategic behavior of firms.

[13] This mechanism is somewhat restricted (but not eliminated) for U.S. multinationals by the tax treatment of "subpart F income." It is also interesting to note that restricting this mechanism seems to be a target for some provisions in the 1986 U.S. Tax Reform Act. (See RIA, Inc. (1986).) In particular, there are provisions which require an allocation of global interest expenses of the parent to foreign and domestic income. The allocation would be based on the percentage of firm assets located in the U.S. and abroad, with the requirement applying to corporate groups which are eligible to file a consolidated U.S. tax return. Thus, the restriction appears to exclude some U.S.-based multinationals as well as foreign parent corporations with U.S. subsidiaries. Also, there are exceptions to the general interest allocation rule for interest on nonrecourse debts which can be traced to the funding of particular assets. In addition, when the U.S. is the relatively low tax country, the new law appears to allow U.S. firms to use foreign subsidiary borrowing to reduce global taxes. Given the above exceptions plus substantial reduction in the U.S. corporate marginal tax rate, the interest allocation requirement in the U.S. may do relatively little to reduce the incentive for multinational firms to raise debt capital via subsidiaries in high tax countries. Furthermore, it is the marketability of excess tax shields in the high tax country which is crucial to a Miller-type equilibrium.

supply schedule in country 2. Thus, debt markets would exist in both countries. However, the country 2 market would be strictly interfirm since individuals (who are taxed by residence) would all choose to lend at the higher domestic interest rate r_c. Note that the size of the interfirm debt market is indeterminate due to the coincident horizontal demand and supply curves in that market. Consequently, both aggregate capital structures for foreign domiciled firms and for domestic domiciled firms are indeterminate. This is in addition to the standard Miller result of capital structure indeterminacy for individual firms. However, the aggregate capital structure for all firms (foreign and domestic) is determinate at a level, such as Q_4.

To provide further intuition, one may think of the international equilibrium at point C as analogous to a domestic Miller equilibrium in the high tax country. However, the additional international feature is that in our equilibrium both foreign individuals and multinationals with foreign parents may be participating in the debt and equity markets of the high tax country. The significance of this feature is that international capital market integration not only aggregates individual lenders across countries but also provides a vehicle for corporations to exploit tax rate differences across countries. In the absence of restrictions on such activities, multinational corporations are able to arbitrage those tax rate differences by altering their borrowing across countries to the point where the international analog of the Miller equilibrium is reestablished and capital structure becomes irrelevant for all individual firms. In the more complex situation with an interfirm debt market in country 2, the analogy to the simple domestic Miller equilibrium is less applicable. However, the basic underlying forces and results are the same. Corporations can employ various mechanisms to arbitrage tax rate differences across countries. Unless such activities are restricted, an equilibrium is once again reestablished where capital structure is irrelevant at the firm level with debt markets in both countries.

Our results highlight the critical role that corporations play in Miller's analysis as vehicles for tax arbitrage. We can use this role to provide further intuition about the international capital structure equilibrium. In the domestic Miller model, investors cannot engage in tax arbitrage, but corporations can. For example, corporations can issue fully taxable securities (debt) and buy tax-exempt securities (equity) if the tax rate at which the marginal investor is indifferent between taxable and tax-exempt securities is below the corporate rate. The converse is true if the marginal tax rate is above the corporate tax rate. Thus, corporate arbitrage activities can force an equilibrium at which the marginal personal tax rate just equals the corporate rate. At the international level, we have just seen that mechanisms exist for analogous corporate tax arbitrage activities across the two countries. Indeed, this result should carry through in a model with multiple countries. In such a model, corporate tax arbitrage activities across national boundaries dictate an international equilibrium where the marginal investor tax rate in world markets is equal to the highest of the various corporate tax rates among different nations. Further, it should be recognized that an optimal capital structure cannot be determinate for any individual firm because corporations are engaging in these arbitrage transactions on an equal footing.

C. Robustness of the International Capital Structure Equilibrium

There are numerous differences in tax codes across countries which suggest deviations from the simplifying assumptions underlying the model in Section I.B. For example, the tax rate on realized capital gains on equity is currently equal to the rate on ordinary income for U.S. individuals although taxes can still be deferred on unrealized gains. By contrast, preferential tax treatment of such gains is quite common in other countries. In the extreme, such gains may be tax-exempt. Until recently, this was the general situation for individuals in Japan. Since April 1989, Japanese residents with realized equity gains must choose between a 1% tax on the selling price (effectively a transfer tax) and a 25% tax on the amount of the gain. Clearly, the transfer tax approach is advantageous for substantial gains, and, considering the deferral of unrealized gains, the effective tax rate on equity gains for Japanese individuals remains quite low.

Another frequent difference in tax codes is the treatment of dividends. In the U.S., dividends are fully taxable at a personal level but not deductible by corporations. However, in other countries such as Germany and Japan, there have been attempts to mitigate this "double taxation" of dividends through such practices as a lower tax rate on corporate income paid out as dividends plus tax credits for dividends received at the individual level. One consequence of such differences in the treatment of both dividends and capital gains is that equity income may be subject to differing effective tax rates for individuals residing in different countries.

An additional complication is the possibility of individual taxation based on income source rather than residence. At least in principle, taxation by residence for individuals is the basic approach in many industrialized countries. (See Price Waterhouse (1989).) However, this approach is frequently implemented by an individual being taxed in the country of residence, with a credit for foreign taxes paid. If there are limitations on that credit (e.g., it cannot exceed the domestic tax on the foreign income), it is possible to have cases where the individual's effective tax rate differs between foreign and domestic source income (i.e., effective taxation by income source).

We now explore how these differences in national tax codes affect the international capital structure equilibrium by relaxing some of our previous assumptions.

C.1. Differing Equity Tax Rates

As discussed earlier, consider the possibility of positive but differing equity tax rates in a two-country framework. Denote equity tax rates by τ_{pe} and τ_{pe}^* for country 1 and country 2, respectively. For the moment, we assume that these rates are constant. Let r_s continue to denote a tax-exempt rate, and define taxable equity rates of r_e and r_e^* for countries 1 and 2, respectively. Assuming personal taxation by *residence*, individuals in country 1 will demand $r_e = r_s/(1 - \tau_{pe})$ while individuals in country 2 will demand $r_e^* = r_s/(1 - \tau_{pe}^*)$.

Assuming that $\tau_{pe}^* < \tau_{pe}$, all corporations (foreign and domestic) will attempt to supply equity to foreign residents since $r_e^* < r_e$. The supply rate of corporate bonds now shifts upward so that it is "grossed up" by both the corporate tax

rate and the marginal equity tax rate (in this case τ_{pe}^*). With reference to Figure 1, domestic corporations now face an initial supply schedule through $r_s/(1 - \tau_c)(1 - \tau_{pe}^*)$. With this adjustment, the analysis in Section I.*B*. goes through, along with the corporate tax arbitrage mechanisms specified there.[14] Of course, shifts in the debt supply schedules result in a new intersection point, comparable to point C in Figure 1, which again renders capital structure indeterminate for individual firms.

The relevant marginal equity tax rate (τ_{pe}^*) facing all corporations, foreign or domestic, is identical since their taxes are not influenced by their shareholders' identities (who in this case are all country 2 residents). If there were a binding constraint on the total amount of equity which residents of country 2 would absorb and if firms also issued equity to country 1 residents, the analysis would be basically unaltered except that the cost of equity would rise until the implicit marginal tax rate equaled τ_{pe} (in order to induce country 1 residents to purchase equity). Under these circumstances, debt supply schedules would shift upward by a greater amount since we assume that $\tau_{pe} > \tau_{pe}^*$. However, the basic analysis of Section I.*B* continues to hold.

If equity tax rates are heterogeneous in each country, then investors across countries are aggregated into an upward sloping equity demand curve analogous to that for debt in Figure 1. In equilibrium, a single marginal equity tax rate ($\tau_{pe} = \tau_{pe}^*$) separates individuals in each country into those who hold equity and those who do not. The rest of the analysis goes through as previously. Thus, differing international tax rates on individuals' equity income are not sufficient to disrupt the previously described international equilibrium as long as capital markets are fully accessible.[15]

[14] We continue to assume (as mentioned in footnote 5) that the effective tax rate on interest income for the marginal lender is substantially higher than the implicit rate for equity income (e.g., due to unrealized capital gains). Otherwise, it is well known that a Miller equilibrium is not feasible since the upward sloping demand curve illustrated in Figure 1 would not reach high enough to intersect the corporate supply curve for debt. In other words, debt issue would always be advantageous for firms. A special case of this situation is the equality of personal tax rates on equity income and bond income, which results in the Modigliani and Miller (1963) tax-adjusted model.

[15] At this juncture, we should mention a caveat. When positive effective tax rates on equity are considered, it is reasonable to assume that such rates largely reflect taxation of dividend receipts. That is, the type of dividend "laundering" strategies suggested in Miller and Scholes (1978) is not completely effective. Under these circumstances, dividend payment rates which differ across firms (even within one country) generally result in effective tax rates on equity income which are firm-specific. This complicates the Miller equilibrium even in a domestic context—see Haugen, Senbet, and Talmor (1986) for further discussion of this issue. Since we are focusing on capital structure, we have chosen to abstract from dividend policy considerations by assuming that equity tax rates are uniform across firms (at least within each country).

In a similar context, Litzenberger (1986) argues that the Miller equilibrium does not hold in a multiperiod framework if markets are complete with dividends and interest taxed at the same ordinary rate even when capital gains are taxed preferentially. His argument is predicated on the notion that an increase in leverage requires the firm to use the corporate tax savings either to increase its ordinary payouts (i.e., dividends plus interest) *or* to increase its share repurchases, holding investment fixed. As pointed out in Dammon and Senbet (1988, footnote 8), though, dividend payments must be reduced to satisfy the sources-and-uses-of-funds constraint in both cases whether share repurchases are held constant or increased (as in Litzenberger's analysis). This increases the firm value because dividend payments are taxed more heavily than capital gains. Thus, this effect follows from changing both the firm's dividend policy and its financial leverage.

C.2. Personal Taxation by Income Source

Individual taxation based on residence is a key ingredient in the above analysis as well as that in Section I.*B*. Others (e.g., Lee and Zechner (1984) and Senbet (1979)) also assume (implicitly) that investors are taxed based on residence. As mentioned previously, this is consistent with the basic structure of tax codes in many developed economies. However, it is also instructive to examine the implications of the alternative possibility that individuals are taxed based on the national origin of their investment income. Under that assumption, national debt and equity markets are differentiated for each investor by the tax rates applicable to income from the respective markets. These markets are also differentiated on the supply side because corporate tax rates are based on the source of income and expenses.

Clearly, individuals can choose to invest and lend in either market, subject to potentially differing tax rates on income from different sources. If firms can also freely choose to issue equity as well as borrow in either market, the result is that each national debt market has its own Miller-type equilibrium with potentially differing interest rates. To see this result, we need to first consider the situation in the two equity markets. Firms will choose to issue equity in the lowest cost market while investors will demand $r_e = r_s/(1 - \tau_{pe})$ and $r_e^* = r_s/(1 - \tau_{pe}^*)$ for equity income from country 1 and country 2, respectively. Once again, this results in a single marginal equity tax rate (either τ_{pe} or τ_{pe}^*) determining the cost of equity.

Since equity tax rates now depend on the income's source rather than the investor's residence, we are assuming that foreign and domestic individuals face the same tax rate for a given income source (e.g., country 1 equity income). This clearly holds at the margin if equity tax rates are heterogeneous. Furthermore, with heterogeneous rates we again have $\tau_{pe} = \tau_{pe}^*$ for marginal equityholders. If equity tax rates are constants which differ by both source and national tax code, we have a set of potentially four different equity tax rates (differentiated by income source and investor residence). However, only one of these four will be the implicit marginal tax rate on equity income due to firms' attempts to issue equity in the lowest cost market.

To illustrate the situation in the two debt markets, assume that $\tau_{pe} = \tau_{pe}^*$. Cost minimizing behavior by firms implies a supply side condition across debt markets of $r_c(1 - \tau_c)(1 - \tau_{pe}) = r_c^*(1 - \tau_c^*)(1 - \tau_{pe}^*) = r_s$. On the demand side, each individual adjusts his or her debt and equity purchases to maximize after-tax income subject to his or her personal wealth constraint. For the marginal investor, the first-order conditions from this problem imply that $r_c(1 - \tau_p) = r_c^*(1 - \tau_p^*) = r_s$. Equating the demand and supply side conditions implies that in equilibrium $(1 - \tau_p) = (1 - \tau_c)(1 - \tau_{pe})$ and $(1 - \tau_p^*) = (1 - \tau_c^*)(1 - \tau_{pe}^*)$. This is the requirement for the irrelevance of financial leverage for firms in both economies, and it is clearly analogous to the single-economy irrelevance condition in Miller (1977). If equity income is effectively untaxed ($\tau_{pe} = \tau_{pe}^* = 0$), this irrelevance condition collapses to $\tau_p = \tau_p^*$ and $\tau_c = \tau_c^*$ as in equation (1.3). Thus, taxation by income source and free market access on *both* demand and supply sides lead to related national Miller equilibria and leverage irrelevance at the firm level. It should, however, be emphasized that multinational firms may be issuing equity

as well as debt in either country's or both countries' markets, in constrast to the purely domestic Miller equilibrium.

On a consolidated basis, firms with country 1 parents may be more or less levered on average than those with country 2 parents. Thus, even if corporate entities located in country 2 (this includes subsidiaries of country 1 parents) issue more debt, we cannot argue that country 2 firms (based on parent nationality) tend to be more levered on average. This emphasizes the need to carefully distinguish between multinational capital structures on consolidated versus unconsolidated bases, as well as the actions of corporate entities located (domiciled) in a particular country versus multinationals with parents from that country.

This subsection has explored the robustness of the international analog of the Miller equilibrium to a variety of differences in international tax codes. This is not to suggest that the equilibrium is robust to everything. We have already mentioned situations where it breaks down, but those conditions resulted not from differences in international taxation but from restrictions which precluded firms from exploiting those tax differences. Consequently, the conditions necessary for the domestic Miller equilibrium result in its international analog. Such international equilibria break down and capital structure becomes relevant at the firm level when we introduce firm-specific restrictions. However, once we introduce such restrictions, we are effectively in the same vein as DeAngelo and Masulis (1980) or Barnea, Haugen, and Senbet (1981). Under such circumstances, optimal financing behavior by individual firms may require not only determination of the level of debt capital but also the currency composition of the debt itself if costless hedging is unavailable through forward markets. This issue is beyond the scope of the current paper.

In the following section, we pursue further implications of the international debt equilibrium and its robustness to differential inflation. For that purpose, we return to our simplifying assumption that equity is effectively untaxed.

II. Inflation and Implications of the International Miller Equilibrium

Up to this point we have focused on the effect of multiple tax jurisdictions but have abstracted from another international characteristic, namely the impact of differential inflation/exchange rate movements on corporate financial behavior. We now examine how differential inflation in the two countries can affect the international capital structure equilibrium as well as relative bond yields.

A. Currency and Location Preferences

To focus on the implications of differing inflation rates, we assume in this section that $\tau_c = \tau_c^*$ and that inflation rates as well as movements in exchange rates are perfectly anticipated. In particular, the known domestic (country 1) inflation rate is b, there is no inflation in the foreign economy (country 2), and Purchasing Power Parity (PPP) holds so that the exchange rate moves to exactly offset inflation. With no taxes on equity returns or barriers to equity investments between the two countries, the law of one price implies that equity returns in both countries are equivalent in real terms. Thus, the International Fisher Effect

(IFE) holds for equity returns, which fully reflect the perfectly anticipated inflation. That is,

$$r_s = r_s^* + b + br_s^*, \tag{2.1}$$

where r_s and r_s^* denote domestic and foreign equity returns, respectively.

We now consider whether the IFE also holds for interest rates. Although our perfect foresight and PPP assumptions have eliminated the possibility of a currency risk premium, we still need to examine the possibility that distortions introduced by nominal tax rates in an inflationary environment cause a preference for borrowing or lending in a particular currency.[16] In other words, does an international analog of the "Darby Effect" (see Darby (1975)) disrupt the IFE for interest rates?[17]

For the time being, we will again assume that investors are taxed by residence. With this added assumption, the IFE holds for interest rates. To see this, consider first the perspective of a marginal lender from country 2. The after-tax receipts on a currency 2 loan are $r_c^*(1 - \tau_p^*)$, whereas the after-tax receipts on a loan denominated in currency 1 are $[(1 + r_c)/(1 + b) - 1](1 - \tau_p^*)$.[18] Equating these after-tax receipts results in $((1 + r_c)/(1 + b) - 1)(1 - \tau_p^*) = r_c^*(1 - \tau_p^*)$, which is equivalent to

$$r_c = r_c^*(1 + b) + b. \tag{2.2}$$

A similar argument holds for country 1 investors lending in both currencies, which again results in equation (2.2) as the condition for equivalent after-tax returns. Furthermore, symmetric arguments hold for firms as borrowers. Consider a domestic domiciled firm facing a nominal tax rate τ_c with full deductibility of foreign currency losses. The after-tax cost of borrowing in currency 2 is

$$[(1 + r_c^*)(1 + b) - 1](1 - \tau_c) = [r_c^*(1 + b) + b](1 - \tau_c). \tag{2.3}$$

[16] With uncertain exchange rates and incomplete markets, bonds issued by the same firm but denominated in different currencies are not perfect substitutes. Depending on their currency/consumption preferences, individuals will view default-free debt in one or both currencies as risky. Risky debt and incomplete risk sharing complicate the Miller equilibrium even in a domestic context—see the references cited in footnote 6 for the implications of risky debt in an incomplete market. We have abstracted from this issue in order to focus on the tax-induced consequences of differential inflation.

[17] In several previous papers, the IFE failed to hold with inflation and taxation of interest income due to assumptions which differ from ours. For example, in Ben Zion and Weinblatt (1984) as well as Howard and Johnson (1982), personal taxes on interest income are not progressive. On the other hand, Lee and Zechner (1984) implicitly assume that individuals can lend only in their home currency. Both of these assumptions appear less realistic than those in our analysis. In Levi (1977), both covered interest rate parity and the IFE break down due to a capital gains (losses) treatment of exchange gains (losses). Although this treatment is probably realistic under many tax codes, it was essentially eliminated for U.S. lenders by the 1986 U.S. Tax Reform Act.

[18] In a one-period model, exchange gains or losses are realized in the same period as the exchange rate movement. With multiperiod debt, some national tax codes require that exchange gains or losses be deferred until the debt is repaid. See Shapiro (1984) for a discussion of this situation. We abstract from the possibility of such deferrals and also assume that exchange gains or losses on loans are treated as ordinary income items for tax purposes, which corresponds to the current U.S. tax code.

Equating this to the after-tax cost of borrowing in the domestic currency, $r_c(1 - \tau_c)$, results in equation (2.2). Again, an analogous argument holds for corporate borrowers domiciled in country 2.

Thus, equation (2.2) represents an indifference condition for both borrowers and lenders, and, in the absence of constraints on borrowing/lending behavior, it is an equilibrium condition for relative interest rates on loans in the two currencies. Phrased somewhat differently, (2.2) must hold for debt denominated in both currencies to coexist in an unrestricted international capital market.

Note that, with investor taxation by residence, the validity of equation (2.2) does not depend on the respective domiciles of firms and lenders. Instead, the issue is whether investors in country 2 (and country 1) can purchase debt denominated in both currencies. If so, equation (2.2) must hold whether both types of debt are issued by firms from country 2 or from country 1. Thus, under these conditions, allowing investors to lend freely in any currency they choose means that the IFE holds for interest rates *as well as* for equity returns despite the differing inflation rates and nominal tax rates.

Despite this currency neutrality result, domestic firms have an advantage relative to their foreign counterparts because the *real* value of the interest tax shield is larger for firms in country 1. However, that advantage is *location* rather than currency specific. This advantage derives from the fact that, with specified nominal tax rates and inflation, the effective real tax subsidy rate exceeds its nominal counterpart for country 1 firms. Following Schall (1984), we can derive the relationship between nominal and effective real tax rates. Per unit of currency 1 debt, a corporation in country 1 obtains a nominal interest tax shield of $\tau_c r_c$ or $\tau_c r_c/(1 + b)$ in real terms. By definition, the real interest rate on currency 1 debt is $(r_c - b)/(1 + b)$, so we can define an effective real tax rate (τ_c^{R}) for domestic domiciled firms such that

$$\tau_c^{\mathrm{R}}\left(\frac{r_c - b}{1 + b}\right) = \frac{\tau_c r_c}{1 + b},$$

or

$$\tau_c^{\mathrm{R}} = \tau_c\left(\frac{r_c}{r_c - b}\right). \tag{2.4}$$

There is an equivalent effective real tax rate for currency 2 borrowing by firms located in country 1. The nominal interest tax shield per unit of such debt is $\tau_c[r_c^*(1 + b) + b]$, and the real interest rate is r_c^*. Consequently,

$$\tau_c^{\mathrm{R}} r_c^* = \frac{\tau_c[r_c^*(1 + b) + b]}{1 + b},$$

$$\tau_c^{\mathrm{R}} = \tau_c\left[1 + \frac{b}{(1 + b)r_c^*}\right] = \tau_c\left(\frac{r_c}{r_c - b}\right), \tag{2.5}$$

where the last equality in (2.5) makes use of equation (2.2). Thus, with equation (2.2) holding, τ_c^{R} denotes the effective real tax rate for domestic domiciled firms (borrowing in either currency) and r_c^* represents the real cost of borrowing (which

is identical to the interest rate on debt denominated in the noninflating currency).

Using reasoning analogous to the above, it is easily seen that τ_c^* is the effective real tax rate for firms located in country 2 and borrowing in either currency. Thus, with inflation ($b > 0$) and equal nominal corporate tax rates ($\tau_c = \tau_c^*$), firms located in country 1 face a greater real tax rate ($\tau_c^R > \tau_c = \tau_c^*$) and consequently would be willing to pay a greater interest rate than foreign domiciled firms. For example, if $b = 0.10$ and $r_c^* = 0.05$, with $\tau_c = \tau_c^* = 0.50$, then the real value of the interest tax shield is 7.05 percent for firms located in country 1, whereas it is only 2.5 percent for firms in country 2.

The supply side condition for firms in country 1 to issue both debt (in either currency) and equity can be represented in real terms as

$$r_c^* = \frac{r_s^*}{1 - \tau_c^R}. \tag{2.6}$$

The comparable supply side condition for foreign domiciled firms is

$$r_c^* = \frac{r_s^*}{1 - \tau_c^*}. \tag{2.7}$$

It is clear that, with $b > 0$ and $\tau_c^* = \tau_c$, equations (2.6) and (2.7) cannot hold simultaneously with internationally integrated markets. In fact, we have a situation analogous to that analyzed in Section I, but with the corporate tax differential now in real instead of nominal terms.

B. The International Equilibrium

Assuming a continuous progression of personal tax rates in both countries, we can analyze the possible international equilibria using Figure 2 (which is similar to Figure 1 but with real yields on the vertical axis). For the moment let us restrict the ability of firms to engage in international tax arbitrage using the mechanisms discussed in Section I. Under these circumstances, one possibility is that the economy of country 1 is sufficiently small so that equilibrium occurs at point A with $r_c^* = r_s^*/(1 - \tau_c^*)$. In this "small country" case, total corporate debt is Q_3, of which Q_2 (a corner solution) represents borrowing by country 1 firms. Alternatively, if the supply of bonds from firms located in country 1 is large relative to investor demand, we have the "large country" case. For this situation, we can represent the equilibrium as occurring at a point such as B. Firms located in country 1 absorb all available loans (Q_1) at $r_c^* = r_s^*/(1 - \tau_c^R)$, a rate which is greater than foreign domiciled firms are prepared to pay.

It is also useful to consider the effects of inflation on marginal personal tax rates. For foreign investors, τ_p^* represents both the real and nominal tax rates. However, for domestic investors, the effective real tax rate (τ_p^R) on interest income exceeds the nominal rate (τ_p) due to the "inflation tax" on nominal interest receipts. Using the same approach as in deriving (2.5), the relationship between real and nominal effective tax rates on interest income for the marginal domestic lender is

$$\tau_p^R = \tau_p\left[1 + \frac{b}{(1 + b)r_c^*}\right] = \tau_p\left(\frac{r_c}{r_c - b}\right). \tag{2.8}$$

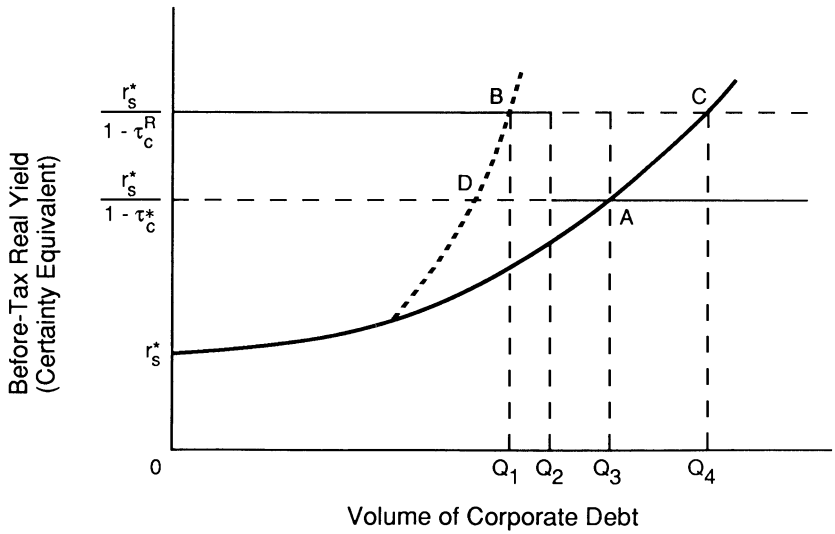

Figure 2. International equilibrium in real terms. Both financial returns and tax rates (corporate as well as personal) are in real terms (i.e., adjusted for inflation). For illustration, there is no inflation in country 2 and firms there apparently supply debt at $r_s^*/(1 - \tau_c^*)$, where r_s^* is the *real* equity return (tax-exempt) and τ_c^* is the corporate tax rate in country 2. Firms in country 1 supply debt at $r_s^*/(1 - \tau_c^R)$, where τ_c^R is the *real* corporate tax rate in country 1. The real personal tax rates of international investors give rise to the upward sloping demand schedules progressing through DB or AC. As in Figure 1, international corporate tax arbitrage forces the equilibrium to occur at a point such as C, where there is a determinate aggregate capital structure but no optimal capital structure for individual firms.

Let us first consider an equilibrium at point A. With continuously progressive personal taxes in both countries and with maximum rates at least equal to τ_c^*, the real tax rates of marginal lenders from the two countries must be equal at point A. That is, $\tau_p^R = \tau_p^* = \tau_c^*$. This implies that the marginal nominal rate τ_p is below τ_c and that country 1 investors with personal tax rates between τ_p and τ_c are driven from the bond markets (in both currencies) by the inflation tax. Now, let us examine the "large country" case with an equilibrium at point B. Assuming that inflation is not so large that τ_c^R exceeds the maximum personal tax rate for country 2 lenders, an equilibrium at B implies that $\tau_p^R = \tau_p^* = \tau_c^R$. Under these circumstances, foreign investors with personal tax rates exceeding τ_c^* have been induced to become lenders by the higher interest rates offered by firms located in country 1.

The above analysis has abstracted from the possibility that foreign firms can issue debt via country 1 subsidiaries with full marketability of tax shields as discussed in Section I. If that possibility exists, foreign firms can borrow via their country 1 subsidiaries in order to exploit the associated tax advantage. The equilibrium then occurs at either B or C (depending on the relevant demand curve for investors) with $r_c^* = r_s^*/(1 - \tau_c^R)$. The distribution of debt between domestic parent firms and the domestic subsidiaries of foreign firms is indeterminate. Likewise, individual capital structures for both foreign multinationals and domestic firms are indeterminate.

In this "subsidiary borrowing" case, as well as the "large country" case, the real interest rate r_c^* (in both currencies) rises relative to r_s^*. This analog of the Darby Effect can be seen by noting that (2.6) holds in both of these cases and that

$$r_c^* = \frac{r_s^*}{1 - \tau_c^R} > \frac{r_s^*}{1 - \tau_c^*}. \tag{2.9}$$

Assuming that r_s^* is unchanged by inflation, $r_s^*/(1 - \tau_c^*)$ represents the real interest rate without inflation for both economies since $\tau_c = \tau_c^*$ and $r_s = r_s^*$ when $b = 0$. Note that this Darby Effect does not occur in the "small country" case.

Returning to the subsidiary borrowing case, the indeterminate capital structures mean that firm values in both countries are unaffected as long as r_s^* remains unchanged. In this situation, the apparent tax advantage for borrowing by domestic firms results in "grossing up" interest rates to the benefit of foreign lenders. Domestic investors also benefit by earning the same interest income with less lending, which makes more of their funds available for equity investment. Thus, foreign and domestic lenders benefit from inflation at the expense of the domestic government, while firms in both countries are neither hurt nor helped.

Clearly, the ability of lenders in each country to freely lend in either currency is quite important since it results in the IFE holding for both interest rates and equity returns. Our analysis has also shown that, with differential inflation and equal nominal corporate tax rates (or differential *real* tax rates), the equality of nominal personal and corporate tax rates cannot hold at the margin in both countries. However, if foreign firms can freely borrow via domestic subsidiaries, we obtain an equilibrium which is again very similar to Miller's—including a leverage irrelevance result at the firm level. In addition to this irrelevance result, our international analog of the Miller equilibrium with inflation once again implies that the nationality of a parent firm does not influence its capital structure. This is simply due to the ability of firms to effectively engage in tax arbitrage across international debt markets as well as between equity and debt. Thus, even with differential international inflation and taxation, we obtain the international analog of the Miller equilibrium due to integrated international financial markets.[19]

It is now worthwhile to reflect briefly once again on the implications of individual taxation based on source of income rather than residence (as assumed throughout this section). As discussed in Section I.*C*, the taxation of individual as well as corporate incomes based on national origin effectively differentiates national debt markets (by the borrower's location but not according to the currency denomination of the debt). As previously, this results in related Miller equilibria in these markets. However, with inflation, the real corporate tax subsidy rate for each borrowing market will equilibrate with the real personal tax rate in each country for interest income from that source.

With lender taxation by income source, the IFE still holds across currencies for loans to entities from the *same location* but not across locations. Assuming

[19] Since it is the effective real tax rates which matter in the above analysis, nothing substantive would be altered by having nominal corporate tax rates which differed across countries.

that real equity returns are unaffected by inflation, the Darby Effect holds in the inflating domestic economy with additional (higher nominal tax bracket) foreign investors induced to enter country 1 loan markets (in both currencies) by their higher real interest rates. Total lending in the foreign economy declines as some domestic lenders leave that market. Thus, domestic inflation under these taxation assumptions influences total lending in the foreign economy. With these related Miller equilibria across countries, the overall effects of domestic inflation are once again to benefit foreign lenders and domestic investors while maintaining capital structure irrelevance for firms in both economies.

III. Conclusions

This paper has developed an international analog of the Miller equilibrium. We have shown that the Miller analysis is robust to an international equilibrium characterized by differential international taxation and inflation in otherwise perfect capital markets. Our analysis highlights the key role that corporate tax arbitrage plays in equilibrating the debt markets, and we set forth a number of mechanisms for such tax arbitrage transactions across national boundaries.

The paper has abstracted from the role of national government responses to corporate and individual tax arbitrage. In our model, investors and corporations are allowed to optimize relative to a given set of tax rules and inflation conditions. More generally, however, the process is dynamic, with governments reacting to tax avoidance schemes by changing their tax codes. In response, individuals and corporations devise new tax avoidance strategies, triggering further government reactions, and so on. Studying this dynamic process is an important research agenda which should yield additional insights regarding international capital structure and financial innovation. However, before pursuing such an agenda, we feel that it is important to understand how market forces would react in the absence of governmental restrictions. Consequently, this paper focuses on a more idealized situation where corporations and individuals can freely respond to differential international taxation and inflation rates. Under a relatively wide range of conditions, this results in an international analog of the Miller equilibrium.

We close the paper by outlining some implications of our analysis. First, apparent international differences in capital structure based on the nationality of parent firms are not due solely to differences in corporate and personal tax rates or inflation across countries. Some market access restriction is also necessary; otherwise, multinational firms can arbitrage real tax differentials without regard to the nationality of the parent firm. This contrasts, for instance, with a view that relatively heavy corporate reliance on debt by Japanese firms is due to low personal taxes relative to corporate taxes in Japan (e.g., Flath (1984)).

Second, whether individuals are taxed by residence or source of income can be important. If tax rates on investment income are differentiated by income source, this results in partially segmenting the international capital markets. Under such circumstances, capital structure irrelevance can still hold at the firm level, with each national market having a (related) Miller equilibrium.

Third, the International Fisher Effect holds for both equity returns and bond yields despite taxes and differential inflation. However, higher inflation in the domestic economy tends to benefit foreign lenders and domestic investors. This is true for individual taxation by both source of income and residence. This result is particularly striking since both groups of individual investors benefit at the expense of the inflating country's government while corporate borrowers are neither hurt nor helped.

Fourth, integrated international capital markets imply that marginal lenders and borrowers may be from any country. In contrast, empirical literature on tax-induced yield differentials has typically focused on the U.S. tax environment (e.g., McCulloch (1975) or Skelton (1983)), where the measured implicit tax rates are compared with the U.S. corporate tax rates to test the validity of the Miller hypothesis. However, the results of such studies need to be interpreted with care since the origin (and consequent tax codes) of the marginal bondholder is no longer clear-cut in an international context. Nevertheless, there are conditions under our international model whereby the implicit tax rates estimated by such studies may still constitute legitimate evidence against the Miller hypothesis. If both borrowers and lenders are taxed by origin of income, comparisons between implicit tax rates in the U.S. market and the U.S. tax code are appropriate since national debt markets are differentiated by tax treatment. Alternatively, if lenders are taxed based on residence but the estimated implicit tax rate is below the U.S. corporate rate, this also constitutes evidence against the Miller hypothesis. To see this latter point, recall that our international analog of the Miller equilibrium occurs in the country with the highest corporate tax rate. Consequently, an implicit tax rate below any country's corporate rate must be below the maximum corporate tax rate and thus represents evidence against the Miller hypothesis.

Fifth, our analysis has abstracted from firm-specific imperfections, such as agency costs and nonmarketable investment-based deductions, which would have resulted in capital structure relevance for individual firms even in a purely domestic setting. Introduction of such imperfections will result in not only an optimal level of total borrowing for a firm but also an optimal currency composition of that debt if costless hedging in forward currency markets is not possible.

REFERENCES

Aivazian, V. A. and J. J. Callen, 1987, Miller's irrelevance mechanism: A note, *Journal of Finance* 42, 169–180.

Barnea, A., R. A. Haugen, and L. W. Senbet, 1981, An equilibrium analysis of debt financing under costly tax arbitrage and agency problems, *Journal of Finance* 36, 569–581.

Ben Zion, U. and J. Weinblatt, 1984, Purchasing power, interest rate parities and the modified Fisher effect in presence of tax agreements, *Journal of International Money and Finance* 3, 67–73.

Dammon, R., 1988, A security market and capital structure equilibrium under uncertainty with progressive personal taxes, in A. Chen, ed.: *Research in Finance*, Vol. 7 (JAI Press, Inc.).

——— and L. W. Senbet, 1988, The effect of taxes and depreciation on corporate investment and financial leverage, *Journal of Finance* 43, 357–373.

Darby, M. R., 1975, The financial and tax effects of monetary policy on interest rates, *Economic Inquiry* 13, 266–276.

DeAngelo, H. and R. W. Masulis, 1980, Optimal capital structure under corporate and personal taxation, *Journal of Financial Economics* 8, 3–29.

Flath, D., 1984, Debt and taxes: Japan compared with the U.S., *International Journal of Industrial Organization* 2, 311–326.

Haugen, R. A., L. W. Senbet, and E. Talmor, 1986, Debt, dividends, and taxes, in A. Chen, ed.: *Research in Finance*, Vol. 6 (JAI Press, Inc.).

Hodder, J. E. and L. W. Senbet, 1990, Agency problems and international capital structure, in R. P. Chang and S. G. Rhee, eds.: *Pacific Basin Capital Markets Research*, Vol. 2 (Elsevier, North-Holland, New York).

Horst, T., 1971, The theory of the multinational firm: Optimal behavior under different tariff and tax rates, *Journal of Political Economy* 79, 1059–1072.

Howard, D. H. and K. H. Johnson, 1982, Interest rates, inflation and taxes: The foreign connection, *Economics Letters* 9, 181–184.

Lee, M. H. and J. Zechner, 1984, Debt, taxes, and international equilibrium, *Journal of International Money and Finance* 3, 343–355.

Levi, M. D., 1977, Taxation and "abnormal" international capital flows, *Journal of Political Economy* 85, 635–646.

Litzenberger, R. H., 1986, Some observations on capital structure and the impact of recent capitalizations on share prices, *Journal of Financial and Quantitative Analysis* 21, 59–71.

McCulloch, J. H., 1975, The tax adjusted yield curve, *Journal of Finance* 30, 811–830.

Miller, M. M., 1977, Debt and taxes, *Journal of Finance* 32, 261–275.

——— and M. Scholes, 1978, Dividends and taxes, *Journal of Financial Economics* 6, 333–364.

Modigliani, F. and M. M. Miller, 1963, Corporate income taxes and the cost of capital: A correction, *American Economic Review* 53, 433–443.

——— and M. M. Miller, 1969, Reply to Heins and Sprenkle, *American Economic Review* 59, 592–595.

Price Waterhouse, 1989, *Individual Taxes and Corporate Taxes: Worldwide Summary* (Price Waterhouse World Firm Ltd., New York).

Research Institute of America, Inc., 1986, *RIA Complete Analysis of the '86 Tax Reform Act* (RIA, Inc.).

Sato, M. and R. M. Bird, 1975, International aspects of the taxation of corporations and shareholders, *IMF Staff Papers* 22, 384–455.

Schaefer, S. M., 1982, Taxes and security market equilibrium, in W. F. Sharpe and C. M. Cootner, eds.: *Financial Economics: Essays in Honor of Paul Cootner* (Prentice-Hall, Englewood Cliffs, NJ).

Schall, L. D., 1984, Taxes, inflation and corporate financial policy, *Journal of Finance* 39, 105–126.

Senbet, L. W., 1979, International capital market equilibrium and the multinational firm financing and investment policies, *Journal of Financial and Quantitative Analysis* 14, 455–480.

Shapiro, A. C., 1984, The impact of taxation on the currency-of-denomination decision for long-term borrowing and lending, *Journal of International Business Studies* 15, 15–25.

Skelton, J. L., 1983, Banks, firms and the relative pricing of tax-exempt and taxable bonds, *Journal of Financial Economics* 12, 343–355.

Taggart, R. A., Jr., 1980, Taxes and corporate capital structure in an incomplete market, *Journal of Finance* 35, 645–659.