NBER WORKING PAPER SERIES

TAXATION OF INVESTMENT AND SAVINGS IN A WORLD ECONOMY: THE CERTAINTY CASE

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Working Paper No. 1723

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
October 1985

I would very much like to thank Jack Mintz, Michelle White, participants of a seminar at NBER, and especially Jay Wilson, for comments on an earlier draft. Much of this paper was written while I was a visitor at Tel-Aviv University and at the University of Bonn. The research reported here is part of the NBER's research program in Taxation and projects in Government Budget, Productivity and Industrial Change in the World Economy, and Taxation and Capital Formation. Any opinions expressed are those of the author and not those of the National Bureau of Economic Research.

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ABSTRACT

This paper explores the characteristics of individual portfolio holdings in a world economy with a unified securities market where there are many countries, each with its own tax rates and inflation rate. When nominal interest is taxable but income to equity owners is tax exempt in all countries, I show that the highest tax bracket investors specialize in equity and, among the remaining investors, those with lower tax rates buy bonds of countries with higher inflation rates.

Because of the tax system, countries with a higher inflation rate must pay a higher *real* interest rate on their debt. This is necessary in equilibrium to compensate those who purchase the debt for their higher taxable income. This diversity of real rates of return in the world securities market has a variety of effects on the optimal tax policy of a small open economy.

I also explore a model where there is a unified world market in bonds, but no international trade in equity. Here, I find a strong tax incentive for firms owned by investors in countries with high personal tax rates to become multinationals and invest abroad. If domestic investors do end up purchasing both bonds and domestic equity, then the optimal corporate tax rate on *real* corporate income in a small open economy would be quite high relative to the personal tax rate on *nominal* interest income, in order not to distort the portfolio composition of domestic investors.

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TAXATION OF INVESTMENT AND SAVINGS IN A WORLD ECONOMY: THE CERTAINTY CASE

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Traditionally, papers examining the effects of taxes on the amount of investment, the composition of individual portfolios, the determination of market interest rates, and economic efficiency, have assumed that the economy is closed. There have been a few recent exceptions to this rule, among them Feldstein and Hartman(1979), Hartman(1981,1985), Frisch(1983), and Goulder, Shoven, and Whalley(1983). These papers, however, have generally made quite restrictive assumptions about the determinants of international movements of capital. For example, Feldstein and Hartman, Hartman(1981), and Frisch, restrict their discussion to the incentives faced by multinationals based in the U.S. who consider investing abroad, while Hartman(1985) focuses on direct investment in the U.S. by foreigners. Goulder, Shoven, and Whalley adopt a more flexible specification in which movement of capital depends on interest rate differentials, but not on taxes.

The first objective of this paper is to develop a general model of how taxes affect the amount and form of international flows of capital. Among other questions, it will examine how taxes affect relative interest rates in different countries, the ownership pattern of financial and real assets, and relative capital intensities in different countries. The model also suggests a possible tax explanation for the importance of multinationals. The other objective of the paper is to analyse the implications of this model for the optimal tax policy of a small open economy.

Throughout the paper, in order to keep the model simple, I assume that there is no uncertainty, that all firms have the same technology, and that capital and output are freely mobile between countries. To obtain an equilibrium, I assume a sufficient set of constraints on portfolio behavior, following the approach used in Miller(1977). As in Miller(1977), each individual will either be completely indifferent or prefer a corner solution when choosing among any pair of assets.[1]

In section 1, I develop a model of equilibrium savings, portfolio composition, and capital allocation in an open economy assuming either that all assets are traded internationally or alternatively that only bonds are traded internationally. In section 2, I explore the implications of each of these models for optimal tax policy.

1. Equilibrium portfolios and capital allocation

[1] Galper and Toder(1982) used a similar set of assumptions to analyze savings and investment incentives in a closed economy with many assets, each treated differently for tax purposes.

1. Equilibrium portfolios and capital allocation

1.1 Characteristics of the model

Because of the focus on effects of differences in tax laws in different countries, I adopt a very simple representation of production, the tax law, and the types of financial assets in each country. To begin with, assume that output in country i is produced using a constant returns to scale production function. Labor supply in country i is denoted by L_i, and is a positive function of the net wage rate. If capital investment in the country equals K_i, then output, net of depreciation, equals $f(K_i, L_i)$, where $f_K > 0$ and $f_{KK} < 0$. Investment takes place for only one period, and at the end of the period the capital is returned to the individual investors.

Investors in country i can invest in government bonds of country i, paying interest at a nominal rate r_i, or corporate equity of firms of that country, the entire return from which takes the form of capital gains which accrue at a nominal rate denoted by e_i per period. I assume that all investors in country i face the same basic personal income tax rate t_i when they invest. Nominal interest payments are assumed to be fully taxable, while capital gains are assumed to be tax exempt.

In order to have a well defined equilibrium in the securities market in this setting, some constraints must be imposed on individual trading. Otherwise individuals could profitably engage in infinite amounts of tax arbitrage, as emphasized by Stiglitz(1983). Following Miller(1977), I assume that individuals must invest a nonnegative amount in an asset, so by assumption cannot borrow and cannot sell equity short. Some justification for these assumptions can be found in institutional limitations in the equity market, and in tax law regulations which at least in the U.S. prevent unlimited interest deductions and rule out capital gains treatment of short sales of equity.[2]

All production is assumed to be done by corporations, which act competitively. A corporation producing in country i faces a proportional corporate income tax at rate τ_i on its real return to capital. I assume that corporations must invest solely in real assets, but can borrow to finance up to an exogenous fraction d of their capital with debt.[3] The nominal income to the equity holders of corporations in country i, assuming full use of

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[2] A preferable, but much messier, approach would be to allow for uncertainty in both asset returns and in exchange rates, and use risk aversion to limit tax arbitrage. An analysis of taxation of stochastic income must face many further complications, however.

[3] U.S. tax law prevents a corporation from investing too heavily in financial assets. Agency and bankruptcy costs presumably limit use of debt finance. Implicitly, I am assuming that each firm has idiosyncratic risk which limits use of debt but does not give rise to any market risk.

debt finance,[4] therefore equals

$$e_i K_i(1-d) = (f(K_i, L_i) - w_i L_i - dr_i K_i)(1-\tau_i) + \pi_i K_i, \tag{1}$$

where w_i is the local wage rate and π_i is the local inflation rate.

1.2 Equilibrium in a closed economy

Competition in the securities market in country i implies that investors in that country will be indifferent between investing in the government bonds or the corporate equity of that country. The net of tax rate of return on the two securities must therefore be equal, implying that in equilibrium $r_i(1-t_i) = e_i$. Corporations, acting competitively, will invest until the return, net of corporate taxes, earned on additional capital is just sufficient to attract investors. Substituting for e_i in equation (1), differentiating with respect to K_i and simplifying implies that

$$f_{iK} = (r_i(1-t_i)(1-d) + dr_i(1-\tau_i) - \pi_i)/(1-\tau_i), \tag{2}$$

where $f_{iK} = f_K(K_i, L_i)$.[5]

1.3 Equilibrium in an open economy

I now assume, in contrast to the previous assumptions, that capital and output are freely mobile among the N countries. [6] As before, any investment takes place for only one period. When the investment is made, it requires b_i units of currency of the base country[7] to buy one unit of currency in country i. When the investment is repaid in the following period the same transaction requires a_i units of currency of the base country. Let $c_i = a_i/b_i$. Without loss of generality, assume that $c_1 > c_2 > \ldots > c_n$. In addition, assume that the traded goods are perfect substitutes, so that purchasing power parity must exist at both dates. This implies that $c_i = \delta/(1+\pi_i)$ for some value of δ. Without loss of generality, assume that $\delta = 1$. Given purchasing power parity, lower numbered countries have lower inflation rates.

Individual investors in each country can now invest in any of $2N$ assets: government bonds and corporate equity in each of the N countries. If an investor of country i buys a bond of country k, he receives a nominal income in his own currency of $(1+r_k(1-t_i))c_k/c_i$. Similarly, an investment in equity of country k yields an income of $(1+e_k)c_k/c_i$.

An equilibrium exists when all assets are owned, each investor earns the same after-tax rate of return on the assets he owns, and each investor would earn a lower after-tax rate of return on the other assets. Several basic characteristics of an equilibrium for this economy can easily be described. First,

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[4] It is easy to show in this setting that corporations would choose to borrow in a closed economy only if $\tau \geq t$. Whether or not they would choose to borrow in an open economy depends on a more complicated condition, as seen in Proposition 6. If τ is small enough that corporations do not gain through use of debt finance, then d should be set equal to zero.

[5] Similar results appear in Auerbach(1979) or Gordon(1984).

[6] Technically, either capital or output, but not both, must be mobile.

[7] The choice of a base country is arbitrary and has no implications for the analysis.

Proposition 1. *The coupon rate on bonds of country m will be lower than the coupon rate on bonds of country n whenever $m < n$.*

Proof. In equilibrium, some investor, say from country i, will own bonds of country n, and can do no better with bonds of country m. Therefore, $c_n(1+r_n(1-t_i)) \geq c_m(1+r_m(1-t_i))$. Since $c_m > c_n$, whenever $m < n$, it follows that $r_n > r_m$. ∎

All this proposition says is that a country with a higher inflation rate must have a higher nominal interest rate. The next two propositions characterize who owns which assets.

Proposition 2. *The tax rate of any investor in equity will be at least as high as the tax rate of any investor in bonds.*

Proof. Assume to the contrary that in equilibrium an investor with tax rate t_i owns equity of some country m, while an investor with tax rate t_j, with $t_j > t_i$, owns bonds of some country n. For this to be an equilibrium, each investor must prefer his asset to the alternatives. Therefore, $(1+e_m)c_m/c_i \geq (1+r_n(1-t_i))c_n/c_i$, and $(1+r_n(1-t_j))c_n/c_j \geq (1+e_m)c_m/c_j$. Since $t_j > t_i$, it follows that $(1+e_m)c_m \geq (1+r_n(1-t_i))c_n > (1+r_n(1-t_j))c_n \geq (1+e_m)c_m$, a contradiction. ∎

Intuitively, an asset exempt from personal tax is relatively most attractive to the investor in the highest tax bracket. Similarly,

Proposition 3. *The tax rate of any investor in bonds of country m will be at least as high as the tax rate of any investor in bonds of country n when $m < n$.*

Proof. Assume to the contrary that an investor with tax rate t_i owns bonds of country m, an investor with tax rate t_j owns bonds of country n, and $t_j > t_i$. Then, the equilibrium conditions imply $(1+r_m(1-t_i))c_m \geq (1+r_n(1-t_i))c_n$ and $(1+r_n(1-t_j))c_n \geq (1+r_m(1-t_j))c_m$. By simple algebra, these two conditions imply

$$\frac{c_m - c_n}{1-t_i} \geq c_n r_n - c_m r_m \geq \frac{c_m - c_n}{1-t_j}. \tag{3}$$

Since $c_m > c_n$ and $t_j > t_i$ by assumption, however, this leads to a contradiction. ∎

This proposition shows simply that higher tax bracket investors have a comparative advantage in bonds with low taxable coupons.

I now try to characterize relative rates of return in equilibrium. Let $t(k)$ denote the tax rate of some investor who buys bonds of country k, and let $t_x(k)$ and $t_m(k)$ represent the largest and the smallest values that $t(k)$ can take on. Then,

Proposition 4. *In equilibrium, relative interest rates must satisfy the following equation for all i and k such that $i < k$:*

$$\sum_{j=i+1}^{k} \frac{c_{j-1} - c_j}{1 - t_m(j-1)} \geq c_k r_k - c_i r_i \geq \sum_{j=i+1}^{k} \frac{c_{j-1} - c_j}{1 - t_x(j)} \tag{4}$$

Proof. Equation (3) must hold for the tax rate of any investor in bonds of countries $k-1$ and k. In particular, the left-hand inequality must be satisfied for $t_m(k-1)$, so $c_k r_k \leq (c_{k-1} - c_k)/(1 - t_m(k-1)) + c_{k-1} r_{k-1}$. This inequality must hold for all k. Repeated substitution for $c_{k-1} r_{k-1}$ yields one side of equation (4). Starting from the right-hand side of equation (3), using $t_x(k)$, and following the same procedure yields the other side of equation (4). ∎

Corollary. *In equilibrium, relative interest rates must satisfy*

$$\sum_{j=i+1}^{k} \frac{(\pi_k - \pi_{k-1}) t_m(k-1) c_k c_{k-1}}{1 - t_m(k-1)} \geq (r_k - \pi_k) c_k - (r_i - \pi_i) c_i \geq \sum_{j=i+1}^{k} \frac{(\pi_k - \pi_{k-1}) t_x(k) c_k c_{k-1}}{1 - t_x(k)} \quad (5)$$

for all i and k such that $i < k$.

Proof. Given purchasing power parity, $c_k = 1/(1+\pi_k)$. Substituting for c_k in equation (3) gives equation (5) for $k = i+1$. Repeated addition of these equations for higher values of k gives the desired result. ∎

This characterization of relative interest rates in a world with taxes replaces the much studied interest rate parity condition, which argues that real (before-tax) interest rates ought to be equated in different countries. Instead, it shows that the real rate is higher in countries where the inflation rate is higher.[8] The corollary is a straightforward generalization of the commonly cited result that if the real after-tax interest rate, $r(1-t) - \pi$, is to remain constant as inflation changes, then $\partial(r - \pi)/\partial\pi = t/(1-t)$.

Since investors with higher tax rates invest in bonds with lower nominal interest payments, they have as a result smaller taxable income than lower tax rate investors, and could pay less in taxes. However, they still earn a lower after-tax real return, for:

Proposition 5. *In equilibrium, $r_n(1 - t(n)) - \pi_n > r_m(1 - t(m)) - \pi_m$ for all $n > m$.*

Proof. For investors in bonds of country n, $c_n(1 + r_n(1 - t(n))) \geq c_m(1 + r_m(1 - t(n)))$. This implies that $c_n(r_n(1 - t(n)) - \pi_n) \geq c_m(r_m(1 - t(n)) - \pi_m)$. Since $t(m) \geq t(n)$ and $c_m > c_n$, the result follows. ∎

[8] Makin(1984) and Boadway, Bruce, and Mintz(1984) also point out that after-tax real rates, rather than before-tax rates, ought to be equated in equilibrium. They assumed, however, that there is some one tax rate at which all after-tax real rates are equated, contrary to equation (5).

In words, the lower tax rate investor could have purchased the same bond as the higher tax rate investor. If he had, he would have received a higher net-of-tax return. Instead, he does better yet by buying some other bond.

In order to characterize the required return on real capital, it is necessary to determine where (and whether) corporations would choose to borrow. Unlike investors, who look for the highest available after-tax return, given their tax rate, corporations would look for the minimum required after-tax borrowing cost, given their corporate tax rate. It is straightforward to show that

Proposition 6. *In equilibrium, corporate debt policy can be characterized as follows:*
a) *If* $\tau_i < \tau^* = [c_N(1+r_N) - c_i(1+e_i)]/(c_N r_N)$, *then a corporation does not borrow.*
b) *Corporations facing values of* $\tau \geq \tau^*$ *would all borrow in the country with the highest inflation rate.*[9]

Proof. A corporation would be willing to borrow in country N only if the required payment on bonds, net of corporate tax, were less than that required on an additional unit of equity, or if $c_N(1+r_N(1-\tau_i)) \leq c_i(1+e_i)$. This inequality is satisfied except when $\tau_i < \tau^*$.

In order to show that a corporation, if it borrows, borrows in country N rather than in some other country m, let t_m^* be defined so that $c_m(1+r_m(1-t_m^*)) = c_N(1+r_N(1-t_m^*))$. It is easy to show that $t(N) \leq t_m^* \leq t(m)$. It also follows easily that $c_m(1+r_m(1-t_m^*)) \geq c_m(1+r_m(1-t(m)) \geq c_i(1+e_i)$. If $t_m^* \geq \tau_i$, then $c_m(1+r_m(1-\tau_i)) \geq c_i(1+e_i)$, and the corporation would prefer equity finance to borrowing in country m. But if $t_m^* \leq \tau_i$, then $c_N(1+r_N(1-\tau_i)) \leq c_m(1+r_m(1-\tau_i))$, since $c_N r_N \geq c_m r_m$ by proposition 4. Therefore, a corporation would borrow only in country N, if it borrows at all. ∎

This result that all corporations prefer to borrow in the highest inflation rate country clearly contradicts the evidence. Presumably the agency costs of debt are less if the debt is used to finance an investment made in the same country.

In order to characterize the required return on real capital, let $t_m(0)$ represent the minimum tax rate among investors who buy equity. Then

Proposition 7. *In equilibrium, assuming* $\tau_m > \tau^*$, *real investment in each country* m *ought to occur until*

$$\frac{(1-d)(r_1(1-t_m(0)) - \pi_1)c_1}{1-\tau_m} \leq f_{mK}c_m - \frac{d(r_N(1-\tau_m) - \pi_N)c_N}{(1-\tau_m)} \leq \frac{(1-d)(r_1(1-t_x(1)) - \pi_1)c_1}{1-\tau_m}.$$

[9] This result is analagous to a result in Gordon(1982) that corporations in a closed economy would prefer to issue bonds of that maturity which has the highest coupon.

Proof. For the maximum tax rate investor in bonds of country 1, $c_1(1 + r_1(1 - t_x(1)) \geq c_m(1+e_m)$. For the minimum tax rate investor in equity, $c_m(1+e_m)) \geq c_1(1+r_1(1-t_m(0))$. With purchasing power parity, this implies that $(r_1(1 - t_m(0)) - \pi_1)c_1 \leq (e_m - \pi_m)c_m \leq (r_1(1 - t_x(1)) - \pi_1)c_1$. But, given $\tau_m > \tau^*$, $c_m(e_m - \pi_m)(1 - d) = c_m f_{mK}(1 - \tau_m) - dc_N(r_N(1 - \tau_m) - \pi_N)$. The result follows trivially after substitution. ∎

Given international mobility of capital, the required real return on equity is no higher than the minimum after-tax real return earned by any investor in bonds.

In deriving the required rate of return on investment in a country, I did not consider explicitly the possibility of investment by multinationals. All investment in a country, whether by a local company or by a multinational, is subject to local corporate taxes and no personal taxes. If a multinational must pay any additional taxes at repatriation, then it would require a higher marginal product of capital than the local corporation would, and so could not compete. Under U.S. law, repatriation cannot result in a drop in tax payments. Therefore, with this model, at best multinational firms are at no competitive disadvantage relative to local corporations. [10]

Many characteristics of the equilibrium described in the above theorems are portrayed graphically in Figure 1, for a two country world economy. This figure graphs the net of tax real return earned on each financial asset as a function of the tax rate of the investor. Equity is untaxed, so its return does not vary with t. The after tax return on any bond, $c_i(r_i(1 - t) - \pi_i)$, declines with t with a slope equal to $-c_i r_i$. Therefore, the after-tax return line for bonds from the higher inflation country, which by proposition (1) must pay a higher coupon, has a steeper slope. As seen from the graph, investors with t below t_a earn the highest return on the bonds with the larger coupon. Similarly, investors with t greater than t_b prefer equity, while the remaining investors prefer the low coupon bond. In equilibrium, these lines must adjust so that demand for each asset equals the supply of each asset.

The real return on each asset is measured by the height of the return line when $t = 0$. As proven earlier, the high coupon bond earns the highest real return, while equity earns the lowest. Similarly, the after tax return earned by any investor, must lie on the envelope of the various lines, and clearly declines with t. Note that there is no one tax rate at which all after tax returns are equal – explaining differences in real rates is more complicated.

The cost to a corporation of borrowing in each country is the height of each of the return lines at $t = \tau$. A corporation would borrow only if this height is below that of the equity return line. As seen in the graph, corporations would borrow only when $\tau \geq \tau^*$ and only in the highest inflation rate country.

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[10] Taxation of income at repatriation in the U.S. is rather complicated, as described in Hartman(1981). As Hartman argues, a multinational can avoid extra taxes, and so be at no disadvantage, either by indefinitely postponing repatriation or by investing in such a mix of foreign countries that its average tax payment abroad is at least as high as the U.S. tax payment would be.

1.4 Equilibrium in an open economy with no international trade in equity

The model described above has many counterfactual implications. To begin with, investors own very specialized portfolios, and are no more likely to own securities issued in their own country than to own foreign securities. Also, there is no role in the model for multinational firms. Of course, a model with random returns on securities and risk aversion will lead to diversified portfolios, and perhaps to a tendency to concentrate one's portfolio in the securities issued in one's own country. [11] The presence of risky tax revenue and endogenous diversification greatly complicates the analysis, however. In this section, I describe instead a much simpler alternative, but one which still leads to an equilibrium which is somewhat more consistent with the data.

In particular, I assume that investors cannot buy equity in foreign firms. While some international trade in equity exists, volume is small relative to the volume of international loans. Initially, I assume in addition that there are no multinational firms.

The equilibrium in this setting is very similar to that described previously. For simplicity, assume that in each country investors have more than enough wealth to buy all the domestic equity. Each investor will own, in addition to equity, those bonds most appropriate for their tax rate. By the same arguments as before, those with high tax rates will prefer low coupon bonds, and conversely. The analogue to proposition 4 and its corollary, describing relative interest rates, will continue to hold.

The allocation of capital will be very different in this setting, however. Equity in a country must provide the same real rate of return as is earned on the bonds most appropriate for domestic investors, given their tax rate. This required rate of return on equity will vary by country, being higher in countries where investors face lower tax rates, as shown in Proposition 5. Countries with high personal tax rates should therefore be *more* capital intensive, contrary to the standard intuition. This is true regardless of the impact of a country's high personal tax rate on the domestic savings rate.

As a result, however, there would be an important role for multinationals in this model. Firms based in countries where investors face a low tax rate must provide a higher nominal rate of return on equity than firms based elsewhere. Yet all firms investing in a country, by assumption, have the same technology, and, ignoring any surtax at repatriation, pay the same corporate tax rate. Therefore, firms based in countries with high personal tax rates have a competitive advantage when investing abroad. If there were no tax at repatriation, then the equilibrium would be exactly that described in section 1. Investors in the high tax rate countries would own the equity of domestic firms which invest throughout the world, while investors in lower tax rate countries would own bonds of the appropriate type.

Hartman(1981) described various ways by which a firm can reduce any surtax at repatriation. However, if a surtax for firms in a particular country is unavoidable and large enough, then firms in that country will invest only domestically, and individual investors there will end up owning the appropriate bonds, as well as equity.

[11] See, for example, Fraga(1984).

For the same reasons that individual investors may not buy equity abroad, however, multinationals may not have quite the same technological opportunities in foreign countries. Local firms would presumably have much better information about local markets than would a foreign entrant.[12] A model which seriously addressed the implications of differential information should therefore end up with some multinationals, given the tax incentives described above, but not to the point where they control production in all countries with lower personal tax rates.

2. Implications for government policy[13]

2.1 Closed economy

These different models of capital taxation in an open economy have very different implications for optimal tax policy. To show this, I begin by briefly describing the incentives faced by a government in a closed economy. Assume that the government can raise revenue through a tax on labor income, a corporate tax, and a tax on interest income. In addition, assume that the government has control over the country's inflation rate. I will ignore, though, any revenue collected by the inflation tax and focus only on the implications of the inflation rate for market prices and the revenue collected by the other taxes.

In order to describe the welfare effects of tax changes, I need to make more explicit the structure of the economy. I have chosen a very simple one. In particular, I assume that the representative individual lives for two periods. He is born with wealth of Y, and during the first period can either consume these assets or invest them in equity or bonds.

Production takes place only during the second period. During this period, the individual works, receiving labor income of $q_L = wL(1-s)$, where L is his labor supply and s is the proportional tax rate on labor income. His consumption in the second period equals his labor income plus the principal and the net of tax return on his savings.

His indirect utility from private expenditures depends on his income and the various prices that he faces. Let second period consumpton be the numeraire, implying that the value of his initial wealth is $Y(1+r(1-t)-\pi)$. The only other prices are his wage rate and the price of first period consumption. The individual's utility from private goods can therefore be expressed as $V(q_L, q_1, q_1 Y)$, where $q_1 = (1+r(1-t)-\pi)$. Similarly, the individual's optimal labor supply, L, and optimal consumption in each period, denoted C_1 and C_2, can also be expressed as a function of the same variables. Let α denote his marginal utility of income.

The government issues bonds of amount G during the first period to fund government spending. During the second period, it receives revenue from the tax on labor income, the tax on nominal interest, and the corporate income tax. These revenues must be sufficient to cover the cost of repaying the debt. Therefore, the government's budget constraint

[12] However, a foreign entrant would likely have much better information about foreign markets than would an individual investor about foreign equity.

[13] I would like to thank Jay Wilson for helpful advice on this section.

is $swL + tr(G + dK) + \tau(f_K - rd)K = (1 + r - \pi)G$. By Walras' law, satisfying the government's budget constraint is equivalent to satisfying the country's overall resource constraint $C_2 = f(K, L) + K$, where $K = Y - G - C_1$.

I assume that the representative individual receives utility from government expenditures of λG. The government's problem is to set the tax rates t,s, and τ, and the inflation rate, allowing G to adjust implicitly, so as to maximize the utility of the representative individual. Implicitly, however, following the approach used by Diamond-Mirrlees(1971), the government in setting its policy is simply choosing output G, consumer prices q_L and q_1, and the capital stock, K – through its tax policy the government can determine these parameters and given these parameters the equilibrium is entirely determined.

The characteristics of optimal policy in this setting have been explored extensively in the past,[14] and I will not attempt to reproduce them here. In this particular model, however, the government has a surplus of instruments to affect the amount of savings and investment. In particular,

Proposition 8. *The government can choose arbitrary values of t and π, allowing τ to adjust appropriately, and leave the equilibrium entirely unchanged.*

Proof. Denote the optimal values of the policy parameters by a superscript $*$. Then, equation (2) and the definition of q_1 imply that the tax parameters must be chosen so that

$$q_L^* = w(1 - s), \tag{6a}$$

$$q_1^* = 1 + r(1 - t) - \pi, \text{and} \tag{6b}$$

$$f_K(K^*, L^*) = [(1 - d)r(1 - t) + dr(1 - \tau) - \pi]/(1 - \tau), \tag{6c}$$

where L^* is that value chosen by the individual, given q_1^* and q_L^*. Given arbitrary values of t and π, the interest rate r will adjust to produce the desired q_1^*. Given the interest rate, t, and π, the tax rate τ can then be set to satisfy equation (6c). The tax rate s can easily be chosen to ensure equation (6a) is satisfied. ∎

The equilibrium depends on the tax wedge between the individual's return to savings and the marginal product of capital, and there are many sets of tax parameters which imply the same tax wedge.

2.2 Optimal tax policy with international trade in all securities

In an open economy, individual savings need no longer equal government borrowing plus domestic investment – investment flows of capital can offset any difference. As a result, taxation of savings is no longer equivalent to taxation of investment.

In general, characterizing optimal government policy in an open economy is very complicated, since government decisions could well affect world prices, and also induce

[14] See, for example, Feldstein(1978), King(1980), or Bradford(1980).

other governments to change their policies in response.[15] The objective of this paper is not to describe all these general equilibrium complications, but merely to point out various considerations that have been ignored in the existing literature. To make these considerations clear, I make the following simplifying assumptions: 1) Each country is sufficiently small that its policy has a negligible impact on the level of world interest rates, 2) the set of available bonds is sufficiently dense that it can be approximated by a continuum,[16] and (3) each government sets its policy based on world prices, and does not react strategically to decisions of other governments.

Given these assumptions, each country faces a horizontal supply of foreign equity at the real rate of return to equity required in the world securities market, denoted by e_r, and a horizontal supply of foreign loans at the appropriate real interest rate, given the domestic inflation rate. Denote this real rate by $i(\pi)$. Similarly, domestic investors can invest as much as they want in whatever asset is appropriate, given their tax rate. Denote the real (before-tax) return from this asset, including principal repayment, by $p_1(t)$ and the real after-tax return by $q_1(t)$. Also, if investors buy bonds rather than equity, let $r(t)$ denote the nominal coupon on the bonds and $\pi(t)$ the real capital loss on the bonds due to inflation, so that $p_1(t) = 1 + r(t) - \pi(t)$.[17] Similarly, if corporations borrow, let r_N denote the coupon on the bonds they issue in country N, measured in the home currency, and let π_N denote the real capital loss on these bonds.

When setting its tax policy, each government is again assumed to maximize the utility of the representative individual subject to the aggregate resource contraint[18]

$$C_2 + (1 + i(\pi))G + (1 + e_r)M \leq f(M, L) + M + (Y - C_1)p_1(t). \tag{7}$$

Here, M represents the amount of corporate capital invested, by assumption, by foreigners. Individuals invest in those foreign assets most appropriate given their tax rate.[19] Total domestic income is used to repay foreign owners of domestic equity and government bonds, as well as to fund second period consumption.

As before, individual utility and individual behavior depend on the two prices q_L and q_1. The government, in setting its policy, is implicitly choosing values for q_L, t, M, and π, allowing G to adjust to satisfy the resources constraint. These values are under the control of the government, given the available tax instruments, and together determine the equilibrium for the economy.

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[15] For an examination of these complications, see Feldstein and Hartman(1979).

[16] Otherwise, there could be a nondifferential change in investor's portfolios in response to a differential change in tax policy, making differential analysis inappropriate.

[17] This involves a slight change in notation. Under the previous notation, the coupon and the real capital loss would have equaled $c_i r_i$ and $c_i \pi_i$ respectively.

[18] I implicitly assume here that the corporate tax rate is below τ^*, so that corporations do not use debt finance. This assumption is justified in the next proposition.

[19] If domestic investors buy domestic securities, then $p_1(t)$ will simply equal either $i(\pi)$ or e_r, as appropriate.

Since the economy faces a horizontal supply curve for capital, one might expect that the government would not choose to tax corporate investments. Indeed,

Proposition 9. *If in a small open economy a government is choosing optimal rates simultaneously for a labor income tax and a corporate income tax, then it will set the corporate tax rate to zero.*

Proof. The optimal corporate tax rate is zero if, at the optimal value of M, $f_M = e_r$ so that equity holders are paid the entire marginal product of capital. But differentiating utility with respect to M, holding constant the other policy instrument q_L, and setting the derivative equal to zero, immediately implies that $f_K = e_r$. Note, however, that when M changes, in order to hold q_L constant the tax rate s must change to compensate for changes in the domestic wage rate. ∎

Intuitively, labor bears the entire burden of either a labor tax or a corporate income tax when the supply of capital is infinitely elastic, so both lead to a change in labor supply decisions. A corporate tax, however, simultaneously creates an additional distortion reducing capital investment in the economy. A small country should therefore not attempt to tax capital, regardless of the tax policies in other countries.

Unlike in the closed economy, the values of π and t are no longer arbitrary. When a country lowers its inflation rate, it lowers the *real* rate of return that it must pay on government debt, as shown in the corollary to proposition 4. Since inflation plays no other role in the model, a country always has this incentive to lower its inflation rate. Of course, other considerations may also enter into the choice of an inflation rate.

Similarly, in an open economy, the income to investors and the government together from the purchase of a bond is the before-tax real interest rate on the bond. But, the higher the personal tax rate of investors in a country, the lower the real return earned on the asset they choose to buy, creating an incentive for each country to lower its personal tax rate on interest income.

This change in the real interest rate received on savings is only one factor, however, affecting a country's choice of t. In general,

Proposition 10. *In a small open economy, if investors own bonds rather than equity, then the welfare effect of a change in the tax rate on interest income equals*

$$\frac{\partial W}{\partial t} = S\alpha\frac{\partial p_1}{\partial t} + S(\lambda^* - \alpha)(r + t\frac{\partial r}{\partial t}) + \lambda^* sw\frac{\partial L}{\partial t} + \lambda^* tr\frac{\partial S}{\partial t}, \tag{8}$$

where $S = Y - C_1$, *and where* $\lambda^* = \lambda/(1+i)$.

Proof. The representative individual's utility equals $W = V(q_L, q_1, Yq_1) + \lambda G$, where G is determined by the country's resource constraint. Differentiating utility with respect to t, holding the other tax instruments constant, and using Roy's identity implies

$$\frac{\partial W}{\partial t} = \alpha S\frac{\partial q_1}{\partial t} + \lambda^*[f_L\frac{\partial L}{\partial t} + S\frac{\partial p_1}{\partial t} - p_1\frac{\partial C_1}{\partial t} - \frac{\partial C_2}{\partial t}]. \tag{9}$$

The individual's budget constraint is $C_2 = (Y - C_1)q_1 + q_L L$, implying that $\partial C_2/\partial t = q_L(\partial L/\partial t) + (Y - C_1)(\partial q_1/\partial t) - q_1(\partial C_1/\partial t)$. Substituting for $(\partial C_2/\partial t)$ and using the definition that $q_1 = p_1 - rt$ leads to equation (8) after minor algebra. ∎

The proposition shows that for a small country four different considerations enter when choosing t. The first term in equation (9) describes the change in the real interest rate received on savings when the tax rate changes. This change clearly discourages tax increases. The second term describes the change in the government's revenue from the tax on interest income, holding savings constant. If the government collects more revenue when the tax rate rises, this provides some net benefit since alternative sources of revenue are also costly. The last two terms describe the change in labor supply and savings resulting from the drop in the individual's net return to savings. Presumably savings drop while labor supply rises to compensate, leading to an ambiguous effect overall.

If enough other countries have chosen positive values of t, so that some bonds are owned by investors facing positive tax rates, then any small country would find it optimal to make t positive. To show this, all we need to do is demonstrate that $(\partial W/\partial t) > 0$ when evaluated at $t = 0$. Equilibrium pricing requires that the first term in equation (8) equal zero when $t = 0$. The second term is clearly positive at $t = 0$. Given the presumption that $(\partial L/\partial t) > 0$, the entire derivative must therefore be positive.

Similarly, if a country currently has so high a value of t that its investors own some equity, and if some bonds are owned by foreign investors facing positive tax rates, then there is a strong presumption that the country ought to cut its tax rate. Tax revenue would certainly rise if t is cut, the real before-tax return earned by investors would rise, and presumably savings would rise. As long as any fall in labor supply is not too large, there is a welfare gain from cutting t.

We have just shown that if any country's investors own equity, then that country would want to cut its tax rates. But investors in at least the country with the highest tax rate would own equity. Therefore, if all countries are small and have simultaneously chosen optimal values of t, then no bonds would be held by investors facing positive values of t and no country would collect revenue from this tax.[20] This is a somewhat surprising result since the elasticity of the supply of savings in a country is no different if the economy is open. What is different is that in an open economy, investors have unlimited opportunites to avoid tax by buying equity if tax rates get too high.

If any large countries, facing more complicated incentives, choose to tax interest, however, and as a result lead some taxable investors to own bonds, then all small countries would also tax interest income.[21]

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[20] If any set of countries choose negative values for t, then interest rates would adjust so that their investors earn a lower before-tax return on their savings. Given that the subsidy also uses revenue, these countries would face an incentive to raise their tax rates back towards zero.

[21] Similar interactions among the tax policies of different governments have been de-

2.3 Other policy responses in an open economy

If other countries do tax interest income at varying tax rates, perhaps because some countries are large, and if enough do so that some taxable investors own bonds, then the diversity of real returns in equilibrium in the world securities market creates a variety of peculiar incentives for governments. In this section, I describe several of them.

To begin with, while individuals and corporations have been assumed to be unable to engage in arbitrage, given the presence of these different rates of return, governments may not face the same difficulties yet face the same incentives. Each government would wish to borrow at a low real rate and reinvest at a high real rate. For example, a low inflation rate country could issue debt to finance the purchase of a stock of foreign bonds issued by higher inflation rate countries.. Similarly, a high inflation country could borrow in a foreign currency (e.g. debt denominated in dollars), and use the funds to retire any debt issued in its own currency.[22] Within the model, there is no natural limit to these arbitrage opportunities. Presumably such arbitrage is limited by the moral hazard problem of explicit default, or implicit default through unexpected inflation.

Similarly a country borrows at one real rate, while its investors save facing another real rate. When these two rates differ, there is an additional consideration when comparing debt vs. tax finance of government expenditures. If a country has both a low inflation rate and a low value of t, then it faces a strong incentive to use debt finance, since it must pay a low real rate on its debt, whereas its investors, who increase their savings to cover future tax obligations, earn a higher real rate on their extra savings.

In contrast, a country with both a high inflation rate and a high value of t ought to avoid any debt and even try to built up a stock of foreign reserves. Its investors earn a lower real return on their savings than the government must pay on its debt. Such a government might also try to induce its investors to buy domestic bonds rather than foreign bonds. Simply outlawing purchase of foreign assets, however, may lead investors to buy domestic equity rather than domestic debt, and so earn an even lower rate of return. A commonly used alternative is to impose a withholding tax on any interest payments sent to foreign owners. If foreign investors are to continue to find these assets attractive, the coupon net of withholding tax cannot change implying that the stated interest rate must rise by the size of the withholding tax. This increased interest rate is implicitly available only to domestic investors. If the increase is sufficient, i.e. if the withholding tax is large enough, domestic investors will switch to buying domestic bonds rather than foreign bonds.[23]

In contrast, a country should never consider a withholding tax on the return to equity. This tax would raise the required return on capital, a welfare loss by proposition 9, and may induce domestic investors to buy equity rather than higher yielding foreign bonds.

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scribed in the fiscal federalism literature. See, for example, Wilson(1985) or Gordon(1983).

[22] This provides an intriguing explanation for the heavy indebtedness to U.S. banks of a number of developing countries with high domestic inflation rates.

[23] Note that a country should consider a withholding tax on interest payments only if $p_1(t) < i(\pi)$.

Many of the peculiar incentives described above would be eliminated if a country taxed the real return earned on every asset at some given tax rate, as would occur under a comprehensive income tax, rather than the nominal return earned on bonds and none of the return on equity, and similarly allowed corporations to deduct only the real interest rate paid on its debt. When only the real return is taxed, each investor would invest in that asset earning the highest before-tax real rate of return, regardless of the size of the tax rate, and each corporation would borrow at the lowest available real interest rate. Portfolio choice would no longer be distorted, only savings incentives. While a country would still not wish to impose a corporate income tax, the optimal tax rate on the return to savings should be positive, regardless of the tax policies in other countries.[24]

Similar incentives would be created if instead of imposing a comprehensive income tax, the government simply made foreign exchange gains and losses on bonds fully taxable.[25] In this case, taxable income on any investment in bonds is the real return earned on the bond plus the domestic inflation rate. An investor in bonds would still purchase the bond paying the highest before-tax real return. However, since the tax treatment of equity would remain different, the investor may still prefer to invest in equity even if its before-tax rate of return is lower.

One other response a government might take to tax competition driving all tax rates to zero is to negotiate with other governments concerning their joint tax policy. In isolation, each country sets its tax rates such that any small change has no effect on the utility of its representative citizen. However, a small change in one country's tax policy could well have first-order effects on the utility of nonresidents. When it does, there exists the possibility of mutually beneficial tax treaties.[26] Since an examination of the possibility of tax treaties inevitably involves examining decisions by a group of countries which collectively can affect market prices, a problem avoided elsewhere in this paper, I leave this topic to future research.

2.4 Open economy: no international trade in equity

One characteristic of the small open economy analyzed above is that tax rates on individual investors can be varied freely without affecting the required marginal product of corporate investment. This strong separation between the behavior of investors and the capital intensity of corporate production does not exist if there is no international trade in equity and no multinational firms, as in the model described at the end of section 1. Without this separation, additional complications arise when analyzing the effects of tax changes.

In the model with no international trade in equity, individual portfolios consist of both

[24] If real interest is taxed, then the welfare effect of a tax change is still described by equation (8), but the first term now equals zero, as does $(\partial r/\partial t)$. If $(\partial L/\partial t)$ is positive, as assumed above, then this derivative is positive when $t = 0$ and the optimal tax rate is positive.

[25] This tax change was recently proposed by the U.S. Treasury.

[26] See Gordon (1984) for a further discussion in the context of fiscal federalism.

domestic equity and foreign bonds. The required return on equity, and so the amount of investment, now depends directly on the tax treatment of bonds. Whenever the taxes collected on a unit investment in capital differ from those collected on a unit investment in bonds, the portfolio composition of the country is distorted. Under an optimal tax system, this would not occur, for

Proposition 11. *In a small open economy in which domestic capital is owned entirely by domestic investors, optimal taxation of corporations implies that*[27]

a) $f_K = r - \pi$, *and*

b) $\tau = tr/(r-\pi) + d[(r(1-t)-\pi) - (r_N(1-\tau)-\pi_N)]/(r-\pi)$.

Proof. When equity is owned entirely by domestic investors, the country's resource constraint is $(1+i)G = f(K,L) + K + p_1(Y - C_1 - K) - C_2$. Through its choice of τ, the government implicitly chooses K. Differentiating utility with respect to K, holding q_L and t constant, immediately proves part (a) of the proposition.

However, firms will invest until $f_K(1-\tau) = (1-d)[r(1-t)-\pi] + d[r_N(1-\tau)-\pi_N]$. Substituting for f_K and solving for τ yields part (b) of the proposition after simple algebra. ∎

Optimal tax policy still involves investing until the marginal product of capital equals the rate of return available on the world market. However, this is no longer accomplished by setting the corporate tax rate to zero, since imposing a tax on interest income lowers the required rate of return on equity. Instead, the tax system must be designed so that the same amount is collected in tax on an investment in foreign bonds as is collected on an investment in corporate capital. Since the nominal return on bonds is taxable under the personal tax, but only the *real* return on capital is taxable under the corporate tax, this requires a corporate tax rate that is much higher than the personal tax rate. If the corporation gains by using debt finance, then the corporate rate must be higher still.[28] For example, even if the corporation borrows domestically, if $t = .30$, $r = .10$, $\pi = .04$, and $d = .25$, the optimal value of τ would be 0.75. For many plausible parameter values, even a corporate tax rate of virtually 1.0 would not bring the marginal product of capital up to the opportunity cost of funds.

These results on optimal corporate taxation are in sharp contrast to those found in the previous section, where equity was assumed to be tradeable internationally. There, the optimal corporate tax rate was zero, regardless of the value chosen for t, whereas here the optimal corporate tax rate is much higher than the value chosen for t. Optimal corporate tax policy depends critically on which assets are tradeable internationally.

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[27] I have assumed that corporations would choose to borrow, given the optimal τ. If not, then d ought to be set equal to zero in the proposition.

[28] If the corporation chooses to borrow, then the second term in part (b) of the proposition must be positive.

3. Summary

This paper has explored the characteristics of individual portfolio holdings in a world economy with a unified securities market where there are many countries, each with its own tax rates and inflation rate. When nominal interest is taxable but income to equity owners is tax exempt in all countries, I show that the highest tax bracket investors specialize in equity and, among the remaining investors, those with lower tax rates buy bonds of countries with higher inflation rates.

Because of the tax system, countries with a higher inflation rate must pay a higher *real* interest rate on their debt. This is necessary in equilibrium to compensate those who purchase the debt for their higher taxable income, and gives countries an incentive to lower their inflation rate.

Similarly, the income accruing to both investors and the government together in a country on their savings, which is just the real interest rate received on their investments, is higher in countries where the tax rate on investors is lower. This occurs because lower tax rate investors buy bonds of countries with higher inflation rates, and countries with higher inflation rates must pay a higher real interest rate on their debt. Countries where investors, because of their high tax rate, specialize in equity receive the lowest real return on their savings.

I also explore a model where there is a unified world market in bonds, but no international trade in equity. Here, I find a strong tax incentive for firms owned by investors in countries with high personal tax rates to become multinationals and invest abroad. These firms require a low real return on their investments since their equity owners have a low opportunity cost of funds. It remains true, however, that the highest tax rate countries, which generate multinational firms, receive the lowest real return on their savings.

If multinationals are assumed not to play an important role, then investors in a country would own both bonds and domestic equity. In this case, the tax system distorts investors' portfolio choice whenever the total taxes paid on an equivalent investment in equity or foreign bonds differ. This is likely since nominal income on bonds is taxable, but only the real return on corporate capital is taxable. If equity investments are taxed more lightly, then there is an incentive on a government to raise its corporate tax rate, and/or lower its personal tax rate on interest income.

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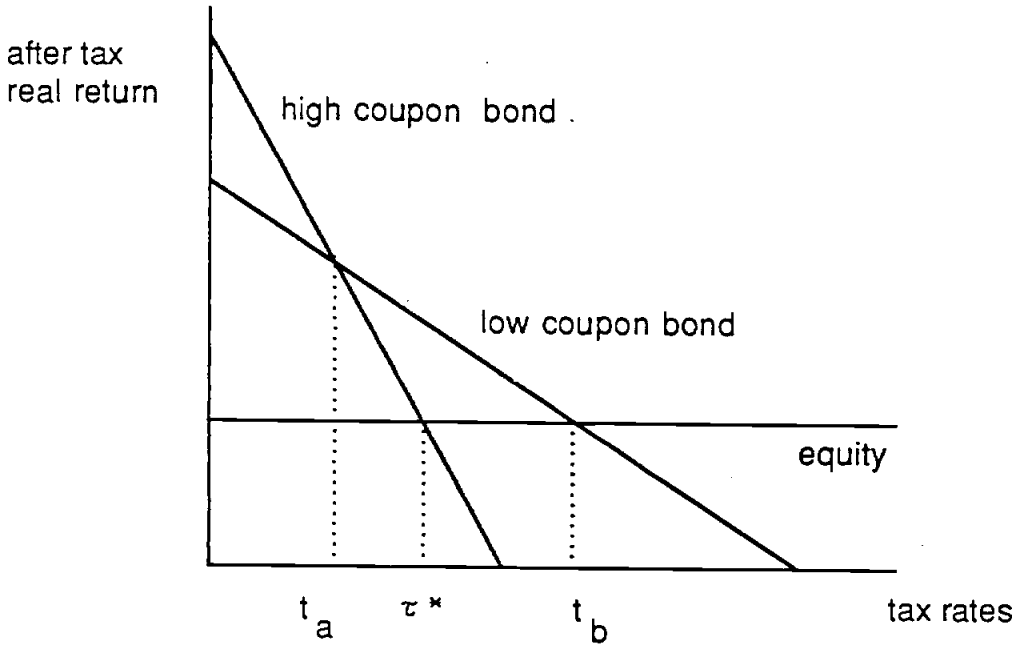
Figure 1


after tax
real return
high coupon bond
low coupon bond
equity
t_a
τ^*
t_b
tax rates