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A Pecking Order Theory of Capital Inflows and International Tax Principles

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Abstract

Even though financial markets today show a high degree of integration, the world capital market is still far from the textbook story of high capital mobility. The purpose of this paper is to highlight key sources of market failure in the context of international capital flows and to provide guidelines for efficient tax structure in the presence of capital market imperfections. The analysis distinguishes three types of international capital flows: foreign portfolio debt investment, foreign portfolio equity investment, and foreign direct investment. The paper emphasizes the efficiency of a nonuniform tax treatment of the various vehicles of international capital flows.

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Summary

Even though financial markets today show a high degree of integration, the world capital market is still far from the textbook capital-mobility story. In a perfectly functioning world capital market, the efficient international tax principle is the residence principle. In a less-than-perfect world capital market, this principle may no longer be efficient and the optimal tax structure may require substantial modification.

International capital immobility has been explained not only by capital controls, but also by informational problems associated with international investments. Because of adverse selection and moral hazard problems, real rates of return across countries are not fully equalized. Capital market regulations and better rules of disclosure as applied to the information about the profitability of domestic firms alleviate some of these asymmetric information problems. Transferring managers from the headquarters of multinational firms to their foreign direct-investment establishments in destination countries is a way to monitor the operation of these establishments and thus circumvent some informational problems.

This paper highlights sources of market failure in the context of international capital flows and provides guidelines for an efficient tax structure in the presence of capital market imperfections. The analysis distinguishes among foreign portfolio debt investment, foreign portfolio equity investment, and foreign direct investment.

The paper models the risk in an economy and the asymmetry in information between foreign investors and domestic investors. In the case of foreign portfolio debt investment it emphasizes market failure associated with domestic lenders being better informed than their foreign counterparts about the creditworthiness of domestic borrowers. In the case of foreign portfolio equity investment it emphasizes the asymmetry between domestic investors and foreign investors, the former being better informed about the prospective profitability of domestic firms. It views foreign direct investment as involving the accumulation of both foreign physical capital and managerial skills. Foreign direct investment is not merely an inflow of capital, but an inflow of both capital and managerial inputs that circumvents the asymmetric information problem.

The results emphasize the efficiency gains from a nonuniform treatment of the various vehicles of international capital flows. For the three types of capital inflow to coexist efficiently, their tax treatment cannot be identical.

Introduction

Even though financial markets today show a high degree of integration, with large amounts of capital flowing across international borders to take advantage of rates of return and risk diversification benefits, the world capital market is still far from the textbook story of perfect capital mobility. As an example of the limited degree of capital mobility, Tesar and Werner (1995) find that despite the recent increase in U.S. equity investment abroad (including investments in emerging stock markets), the U.S. portfolio remains strongly biased towards domestic equity. They report that equity portfolio flows to West Europe, as a fraction of the value of U.S. equity markets' capitalization, rose only from 0.3 percent in 1976 to about 2.2 percent in 1990. The share invested in Canada remained fairly constant, at less than 1 percent.

International capital immobility has been explained not only by capital controls, but also by the informational problems associated with international investments. Because of adverse selection and moral hazard problems, real rates of return across countries are not fully equalized. 1/ Capital market regulations and better rules of disclosure as applied to the information about the profitability of domestic firms alleviate some of these asymmetric information problems. The transfer of managers from the headquarters of multinational firms to their foreign direct investment establishments in the destination countries is one way to monitor closely the operation of these establishments, thus circumventing some of these informational problems.

It is well known that, in a perfectly functioning world capital market, the efficient international tax principle is the residence principle. That is, foreign-source and domestic-source incomes of residents are taxed at equal rates, and nonresidents' incomes are fully tax exempt. 2/ In a less-than-perfect world capital market, the residence principle may, however, no longer be efficient, and the optimal tax structure may also require substantial modifications. The purpose of this paper is to highlight some key sources of market failure in the context of international capital flows and to provide guidelines for efficient tax structure in the presence of capital market imperfections.

1/ See Obstfeld and Rogoff (1995, Chapter 6) for a further discussion.

2/ The residence principle means that the home country does not levy additional taxes on incomes of nonresidents over and above what they will have to pay in their country of residence. In case the latter country offers credits for foreign taxes (that is, for the taxes paid by these nonresidents in the home country), then the home country will only levy a tax on nonresidents which is equal to what they will be liable to pay (before the credit) in their country of residence. Therefore, the "zero-tax" reference point for nonresidents would mean "same tax" as the tax levied on nonresidents in the country of residence.

The failure to have a tax scheme in which the rate of returns across countries are equated can result in inefficient capital flows across countries. This comes from the interactions of market failure and the tax system. For an application of the interaction between taxation and inflation see Bayoumi and Gagnon (1996).

Bovenberg and Gordon (1993) developed a useful stylized model of asymmetric information between foreign and domestic investors in order to examine principles of international taxation. They confined their analysis mostly to foreign equity investments. In this paper we attempt to provide a synthesis of various types of capital inflows. We distinguish among three main types of international capital flows: foreign portfolio debt investment (FPDI), foreign portfolio equity investment (FPEI), and foreign direct investment (FDI).

In the case of the FPDI we emphasize market failure associated with domestic lenders being better informed than their foreign counterparts about the creditworthiness of domestic borrowers. Our analysis of FPDI draws on the work of Stiglitz and Weiss (1981), formulated in the context of bank lending. In the case of FPEI we follow Bovenberg and Gordon (1993) in emphasizing asymmetric information between domestic investors and foreign investors, the former being better informed about the prospective profitability of domestic firms. We view foreign direct investment (FDI) as involving accumulation of both foreign physical capital and managerial skills. Our view is that FDI is not merely an inflow of capital, but a tie-in inflow of capital and managerial inputs which circumvents the asymmetric information problem.

According to Claessens (1995), portfolio flows now account for about a third of the net resource flows to developing countries. The breakdown between the various kinds of capital flows is given in Table 1, which shows that although equity flows to developing countries rose fast in recent years, they are still a much smaller fraction of the total portfolio flows than debt instruments (bonds, certificate of deposits, and commercial papers). There is a striking feature in this Table: FDI makes up over half of private flows, followed by debt finance, while equity flows are relatively unimportant. Indeed, our model suggests some reasons associated with asymmetric information as to why this pattern might occur. This ranking of capital inflows is consistent with the pecking order hypothesis of corporate finance. The hypothesis maintains that firms prefer internal finance similarly to the dominance of FDI in Table 1. If also external finance is required then firms issue the safest security (debt) first, and only as a last resort they issue equity. (See Myers (1984)). The advantage of debt over equity issues is also captured in Table 1, when comparing FPDI and FPEI.

Even though the literature has emphasized the efficiency of the residence principle in international taxation (e.g., Frenkel, Razin, and Sadka (1991); Gordon and Varian (1989)), our main conclusion is that it is generally efficient to have a different tax treatment for these three types of international capital flows. First, we show that for both FPDI and FPEI

Table 1. Aggregate Net Long-term Resource Flows to Developing Countries, 1990-95

(In billions of U.S. dollars)

	1990	1991	1992	1993	1994	1995
Aggregate net resource flows	103.5	129.2	159.7	212.8	212.9	233.3
Official development finance	57.2	64.4	55.3	52.5	44.9	71.5
Official grants	28.8	36.9	31.6	28.5	27.6	27.0
Official loans	28.4	27.5	23.7	24.0	17.3	44.5
Bilateral	13.2	12.6	10.9	9.4	7.1	32.6
Multilateral	15.2	15.0	12.8	14.6	10.2	11.9
Total private flows	46.3	64.8	104.4	160.3	168.0	161.8
Private debt flows	16.2	20.5	42.4	45.8	56.1	53.5
Commerical banks	1.1	3.9	14.3	-2.6	15.1	17.0
Bonds	3.1	12.4	12.9	39.9	38.0	33.0
Others	12.0	4.2	15.2	8.5	3.0	3.5
Foreign direct investment	26.3	36.7	47.8	67.6	77.3	86.1
Portfolio equity flows	3.8	7.6	14.2	46.9	34.6	22.2

Source: World Bank, Debtor Reporting System.

there may be deviations from residence-based taxation on efficiency grounds, while efficient taxation of FDI is compatible with the residence principle. Second, while in the case of FPEI it is efficient to subsidize nonresidents on their investments and tax domestic corporate income (as shown by Bovenberg and Gordon (1993)), in the case of FPDI it is still efficient to grant nonresidents a favorable tax treatment over residents, but not necessarily to actually subsidize foreign investment. In the latter case it remains efficient to tax domestic corporate income, and interest income of residents.

The organization of the paper is as follows. Section II develops the analytical methodology employed in this paper. The framework is applied to FPDI. The other kind of portfolio flow, FPEI, analyzed by Bovenberg and Gordon (1993), is recast in the framework of our analytical methodology in Section III. In Section IV we look at FDI and in Section V we provide concluding remarks.

II. Foreign Portfolio Debt Investment (FPDI)

Throughout this paper we assume a small, capital-importing country, referred to as the home country. In this section we assume that capital imports are channelled solely through borrowing by domestic firms from foreign banks and other lenders. The economy is small enough that, in the absence of any government intervention, it faces a perfectly elastic supply of external funds at a given risk-free world rate of interest, r^*. However, as in Stiglitz and Weiss (1981), a firm may choose to default on its debt if its future cash flow falls short of its accumulated debt. Therefore, foreign lenders may charge ex-ante a higher rate of interest for domestic borrowers than for foreign borrowers.

In the planning stage of the first period the firms commit their investment but the actual investment and its funding is delayed to the implementation stage in the first period. 1/ We follow Bovenberg and Gordon (1993) in modelling the risk in this economy and the asymmetry in information between foreign investors and domestic investors. Consider a two-period model with a very large number (N) of <u>ex-ante</u> identical domestic firms. Each firm employs capital input (K) in the first period in order to produce a single composite good in the second period. For the sake of simplicity, we assume that capital depreciates fully at the end of the production process in the second period. Gross output in the second period is equal to $F(K)(1 + \varepsilon)$, where F is a production function exhibiting diminishing marginal productivity of capital and ε is a random productivity factor. The latter has zero mean and is independent across all firms. (ε is bounded from below by -1, so that output is always nonnegative.) Given the very large size of N and the independence of ε across firms, we assume that consumers-investors behave in a risk-neutral way.

1/ This is a simple way to represent asymmetric information for lenders in a general equilibrium model.

We follow Bovenberg and Gordon (1993) in assuming that firms make their investment decisions before the state of the world (that is, ε) is known. Thus, since all firms face the same probability distribution of ε, they all choose the same level of investment (K). They then issue debt, either at home or abroad, to finance the investment. At this stage, domestic lenders are better informed than foreign lenders. There are many ways to specify the degree of this asymmetry in information. However, in order to facilitate the analysis, we simply assume that domestic lending institutions, being "close to the action," observe ε before they make their loan decisions, but foreign lending institutions, being "far away from the action" do not.

Throughout this paper we consider three tax instruments: a tax on capital income of nonresidents (at rate τ^*), a tax on capital income of residents (at rate τ), and a corporate income tax (at rate θ). However, with debt financing a corporate tax is essentially a tax on pure profits (rents) and therefore it does not affect corporate behavior (see Appendix I, (A)). Thus, for notational simplicity, we set θ equal zero in this section; in practice the neutrality of this tax in the presence of debt finance makes it efficient to set it at a high rate.

Competition among the borrowing firms and among the lending institutions, both domestic and foreign, ensures that there will be a unique interest rate charged to all the domestic borrowing firms. Denote this domestic interest rate by r. Given its investment decision (K), a firm will default on its debt if the realization of its random productivity factor is low so that its output $F(K)(1 + \varepsilon)$ is smaller than its accumulated debt $K(1+r)$. Thus, there is a cut-off value of ε_o, such that all firms which realize a value of ε below ε_o default and all other firms (that is, firms with $\varepsilon > \varepsilon_o$) fully repay their debts. This cut-off level of ε is defined by

$$F(K)(1 + \varepsilon_o) = (1 + r)K \quad . \tag{1}$$

Denote the cumulative probability distribution of ε by ϕ. Then, $N\phi(\varepsilon_o)$ firms default on their debt while the other $N[1-\phi(\varepsilon_o)]$ firms remain solvent.

Recall that domestic lenders observe the value of ε before making their loan decisions. Therefore, they will not lend money to a firm that realized a value of ε lower than ε_o. But foreign lenders do not observe ε, so that they will advance loans to all firms, since they all look identical to them. Thus, foreign lenders will give loans to all the $N\phi(\varepsilon_o)$ would-be bankrupt firms and to some fraction (say, β) of the $N[1-\phi(\varepsilon_o)]$ would-be solvent firms. (The other fraction, $1 - \beta$, of the would-be solvent firms is financed by domestic lenders). Foreign lenders therefore receive a total of $\beta N[1-\phi(\varepsilon_o)]K(1 + r)$ from the solvent firms. Each bankrupt firm can pay back only its gross output, that is $F(K)(1+\varepsilon)$. Thus, foreign lenders receive a total of $N\phi(\varepsilon_o)F(K)(1 + e^-)$ from the bankrupt firms, where e^- is the mean value of ε realized by the bankrupt firms:

$$e^- \equiv E(\varepsilon / \ \varepsilon \leq \varepsilon_o), \tag{2}$$

that is, e^- is the conditional expectation of ε, given that $\varepsilon \leq \varepsilon_0$. For later use we also define by e^+ the conditional expectation of ε, given that $\varepsilon \geq \varepsilon_0$:

$$e^+ \equiv E(\varepsilon / \varepsilon \geq \varepsilon_0) \tag{3}$$

and we note that the weighted average of e^- and e^+ must yield the average value of ε that is:

$$\phi(\varepsilon_0)e^- + [1 - \phi(\varepsilon_0)]e^+ = E(\varepsilon) = 0 \quad . \tag{4}$$

The latter equation also implies that $e^- < 0$ while $e^+ > 0$, that is: the expected value of ε for the "bad" ("good") firm is negative (positive). Altogether, foreign lenders receive the sum of

$$A \equiv \beta N[1 - \phi(\varepsilon_0)]K(1 + r) + N\phi(\varepsilon_0)F(K)(1 + e^-) \tag{5}$$

before domestic taxes, on their total loans (Foreign Portfolio Debt Investment-FPDI) of

$$FPDI = \beta N[1 - \phi(\varepsilon_0)]K + N\phi(\varepsilon_0)K, \tag{6}$$

made to domestic firms. They thus accumulate a capital income that equals A - FPDI, which is subject to domestic taxation at the rate of τ^*. Net of tax, their FPDI yields $A - \tau^*(A - FPDI)$. This amount must be equal to $FPDI(1 + r^*)$, as foreign lenders can earn a return of r^* in their home countries. Thus, we conclude that

$$FPDI[1 + r^*/(1 - \tau^*)] = A. \tag{7}$$

The rationale for the latter equality is straightforward: foreign lenders must earn a before-tax rate of return of $r^*/(1 - \tau^*)$ on their FPDI so that their after-tax rate of return remains r^*, the rate of return they can earn in their home countries. Thus, the tax that our small economy imposes on their capital income is fully shifted to domestic borrowers. Substituting for the values of A and FPDI from (5) and (6), equation (7) becomes:

$$\begin{aligned} &\{\beta N[1 - \phi(\varepsilon_0)]K + N\phi(\varepsilon_0)K\}[1 + r^*/(1 - \tau^*)] \\ &= \beta N[1 - \phi(\varepsilon_0)]K(1 + r) + N\phi(\varepsilon_0)F(K)(1 + e^-). \end{aligned} \tag{8}$$

Let us now examine the debt-financed investment decision of a representative firm. This firm invests K in the first period and expects to receive a gross output of $E[F(K)(1 + \varepsilon)] = F(K)$ in the second period. It also knows that if ε turns out to be smaller than ε_0, it will default on its debt. This firm expects then to pay back its accumulated debt, that is $K(1 + r)$, with probability $1 - \phi(\varepsilon_0)$. It expects to default, paying only $F(K)(1 + e^-)$, with probability $\phi(\varepsilon_0)$. Thus, the expected value of its cash receipts in the second period are

$$F(K) - [1 - \phi(\varepsilon_0)]K(1 + r) - \phi(\varepsilon_0)F(K)(1 + e^-) \quad . \tag{9a}$$

Maximizing the latter expression with respect to K yields the following first-order condition:

$$F'(K) = \frac{[1-\phi(\varepsilon_o)](1+r)}{1-\phi(\varepsilon_o)(1+e^-)} \quad . \tag{9}$$

Note that since $1 + e^- < 1$, it follows that

$$F'(K) < 1 + r \quad . \tag{10}$$

Knowing that in "bad" realizations of ε (when $\varepsilon \leq \varepsilon_o$) it will not fully repay its loan, the firm invests beyond the level where the unconditional expected net marginal productivity of capital (namely, $F'(K) -1$) is just equal to the interest rate (namely, r). Note that, unlike with FPEI discussed in the next section, we cannot assert here that $F'>1+ r^*/(1 - \tau^*)$. However, as expected, because of the default possibility, foreign lenders charge an ex-ante interest (namely, r) which is higher than what they will be satisfied with (namely, $r^*/(1 - \tau^*)$), given that the alternative return at home is r^*. This difference is a reflection of the risk premium. 1/

We abstract from income-distributional equity considerations, implicitly assuming that the government can optimally redistribute income via lump-sum transfers à la Samuelson (1956). This means that with no loss of generality we may assume that there is one representative individual-consumer in the economy. She has an initial endowment of I_1 in the first period and I_2 in the second period. She consumes c_1 in the first period and c_2 in the second period. Her saving earns an after-tax rate of return of $(1 - \tau)r$, so that her net discount factor is equal to 2/

$$q \equiv [1 + (1 - \tau)r]^{-1} \text{ or } \tau \equiv (rq - 1 + q)/rq \ . \tag{11}$$

We denote her net wealth (that is the present value of her after-tax life-time income) by W. As we assume that the government can levy lump-sum taxes, it essentially controls W. The consumer budget constraint is given

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1/ More specifically, one can show (by substituting (1) and (8) into (9)) that $[1+r^*/(1-\tau^*)]/(1+r) = \alpha \bullet 1+(1-\alpha) \bullet (1+e^-)(1+\epsilon_o)^{-1}$, where $\alpha = \beta[1-\phi(\epsilon_o)]/\{\phi(\epsilon_o + \beta[1 - \phi(\epsilon_o)]\}$. Thus, $1 + r^*/(1 - \tau^*)](1 + r)$ is a weighted average of 1 and $(1+e^-)/(1 + \epsilon_o)$. Since $(1+e^-)/(1 + \epsilon_o) < 1$, it follows that $1 + r^*/(1 - \tau^*) < 1 + r$. This implies that $r^*/(1 - \tau^*) < r$. For a related analysis of the interactions between optimal taxation of foreign investment and sovereign debt, see Eaton and Gersovitz (1989).

2/ Her saving is either deposited with domestic intermediaries (banks, etc.) that channel it to the firms or in government's bonds that also yield before-tax rate of return of r. Assuming, as we are, that the government can levy lump-sum taxes in each period to balance its budget makes these bonds superfluous.

by $c_1 + qc_2 = W$. The maximization of her utility subject to this constraint gives rise to an indirect utility function, $v(W,q)$, and consumption demand functions, $c_1(W,q)$ and $c_2(W,q)$, in the first and second period, respectively.

In the first period the economy faces a resource constraint, stating that FPDI must suffice to cover the difference between domestic investment (namely, NK) and national savings (namely, $I_1 - c_1(W,q) - G_1$, where G_1 is public consumption):

$$FPDI = NK - [I_1 - c_1(W,q) - G_1]. \tag{12}$$

No matter what taxes are levied by the home country on FPDI, foreigners will be able to extract from the home country an amount of $1+r^*$ units of output in the second period for each unit that they invest in the first period. Therefore, the home country faces the following second-period budget constraint: 1/

$$NF(K) - (1 + r^*)FPDI + I_2 = c_2(W,q) + G_2. \tag{13a}$$

That is, gross national output (namely, $NF(K) - (1 + r^*)FPDI$) and the initial endowment (namely, I_2) must suffice to support private consumption (c_2) and public consumption (G_2). Employing (12), one can rewrite (13a) in present value terms as

$$\begin{gathered} I_1 + I_2/(1+r^*) + NF(K)/(1 + r^*) = \\ c_1(W,q) + c_2(W,q)/(1 + r^*) + G_1 + G_2/(1 + r^*) + NK \end{gathered} \tag{13}$$

We are now in a position to formulate an optimal tax policy for the government. Since we concentrate on tax policy, we may consider the public expenditure variables (namely, G_1 and G_2) as exogenous, with no loss of generality. (This means that our results are valid whether or not the government expenditure policy is optimal.) The aim of our benevolent government is to maximize the utility $v(W,q)$ of the representative individual. There are nine endogenous variables: K, r, ε_0, β, τ^*, τ, q, W, and FPDI. There are also seven constraints that combine real resource constraints (namely, (12) and (13)), market equilibrium constraints (namely, (1), (6), and (8)), an optimizing-agent behavioral constraint (namely, (9)), and a definition of the consumer's discount factor (namely, (11)).

However, it turns out that the optimal policy problem can be simplified a great deal. To accomplish this, notice that the objective function (namely, $v(W,q)$) and the present-value resource constraint (namely, (13)) contain only three endogenous (control) variables--W, q, and K. Thus, we can first choose these three variables so as to maximize the individual utility function, subject to the present-value resource constraint (13).

1/ Note that the expected value of output is $E[NF(K)(1+\epsilon)] = NF(K)$, since $E(\epsilon) = 0$.

The Lagrangian expression for this optimization problem is

$$L = v(W, q) + \lambda[I_1 + I_2/(1 + r^*) + NF(K)/(1 + r^*) - c_1(W,q) - c_2(W,q)/(1 + r^*) - G_1 - G_2/1 + r^*) - NK], \tag{14}$$

where $\lambda \geq 0$ is a Lagranage multiplier. Having solved for the optimal values of W, q and K, we can then employ the remaining six constraints--(1), (6), (8), (9), (11), and (12)--in order to solve for the optimal values of the remaining six control variables - r, ε_0, β, τ^*, τ and FPDI.

There are three main policy conclusions that we wish to emphasize here. First, the optimal level of investment is such that the expected net marginal product of capital (that is, $F'(K) - 1$) is equal to the world rate of interest (that is, r^*):

$$F'(K) = 1 + r^* . \tag{15}$$

(Note that it then follows from (10) that $r>r^*$; that is, the domestic rate of interest stays above the world rate of interest). Equation (15) is essentially a corollary of the familiar aggregate production efficiency theorem of welfare economics: a small open economy should equate all of its marginal rates of transformation to the corresponding world prices. In our case there is only one marginal rate of transformation (namely, the intertemporal rate $F'(K)$), and the corresponding world price is $1 + r^*$. The proof of (15) follows immediately upon differentiating L in (14) with respect to K and setting the derivative equal to zero.

Second, the optimal policy calls for a tax on capital income of residents, that is $\tau > 0$. To prove this, observe that with the availability of lump-sum, nondistortionary taxes, it is optimal to follow the Pareto-efficiency rule of equating the marginal rate of substitution between present and future consumption (namely, q^{-1}) to the gross marginal product of capital (namely, $F'(K) = 1 + r^*$):

$$q^{-1} = 1 + r^* ; \tag{16}$$

see also (Appendix I, (B)), for a formal proof. Substituting $q^{-1} = 1 + r^*$ into equation (11) yields

$$1 + (1 - \tau)r = 1 + r^*$$

which implies that:

$$\tau = 1 - r^*/r > 0 , \tag{17}$$

because $r^* < r$.

Third, the rate of tax on capital income of nonresidents (namely, τ^*) must be lower than the rate of tax on residents' capital income (namely, τ). To prove this, substitute (1) into (8) to get:

$$\{\beta N[1-\phi(\varepsilon_0)]K + N\phi(\varepsilon_0)K\}[1 + r^*/(1 - \tau^*)]$$
$$= \beta N[1 - \phi(\varepsilon_0)]K(1 + r) + N\phi(\varepsilon_0)K(1 + r)(1 + e^-)(1 + \varepsilon_0)^{-1} \quad .$$

Rearranging terms yields

$$\frac{1+r^*/(1-\tau^*)}{1+r} = \frac{\beta[1-\phi(\varepsilon_0)]+\phi(\varepsilon_0)(1+e^-)/(1+\varepsilon_0)}{\beta[1-\phi(\varepsilon_0)] + \phi(\varepsilon_0)} < 1 \quad , \quad .$$

because $e^- < \varepsilon_0$. This implies that

$$\tau^* < 1 - r^*/r = \tau \quad , \tag{18}$$

by (17). In fact, τ^* may even be negative. It is worth emphasizing that the two tax instruments (τ and τ^*) support a first-best allocation.

The rationale for the optimal tax policy (namely, $\tau > 0$, and $\tau^* < \tau$) is quite straightforward. First, given the possibility of default, in which case firms do not fully repay their loans, they tend to overinvest relative to the domestic interest rate that they face: the expected net marginal product of capital (namely, $F'(K) - 1$) is driven below the domestic rate of interest (namely, r); see condition (10). In order to ensure that firms do not drive their expected net marginal product of capital below the world rate of interest (r^*), the government must positively tax domestic interest so as to maintain the domestic rate of interest above the world rate of interest. Second, any tax levied on foreign lenders must be shifted fully to domestic borrowers, by the small country assumption. Therefore, foreign lenders must earn an expected return of $r^*/(1 - \tau^*)$ on their loans. Since in the case of default they are unable to recoup all of the interest, they must initially charge domestic borrowers a higher rate of interest than $r^*/(1 - \tau^*)$. Therefore, the domestic rate of interest (r) which is charged by all lenders, both foreign and domestic ones, must be higher than $r^*/(1 - \tau^*)$, that is $r > r^*/(1 - \tau^*)$, or $r(1 - \tau^*) > r^*$. This means that if the nonresident tax rate (τ^*) were to be applied to residents their net of tax interest rate (namely, $(1 - \tau^*)r$) would have been higher than the world rate of interest (namely, r^*). But, actually Pareto-efficiency requires that the net of tax domestic interest rate (namely, $(1 - \tau)r$) will be equal to the world rate of interest. Therefore, residents must be levied a higher tax rate on their capital income than nonresidents.

III. Foreign Portfolio Equity Investment (FPEI)

In this section we assume that capital flows are channeled solely through portfolio equity investment, FPEI. Officially, foreign portfolio equity investment is defined as buying less than a certain small fraction

(10-20 percent) of shares of a firm. However, from an economic point of view the critical feature of FPEI is the lack of control of the foreign investor over the management of the domestic firm, because of the absence of foreign managerial inputs. Therefore, for our purposes, we shall simply assume that foreign investors buy shares in existing firms without exercising any form of control or applying its own managerial inputs.

This is also why we assume, in complete analogy to the information asymmetry assumed in the model of FPDI, that foreign investors do not observe the actual value of ε when they purchase shares in existing firms. Domestic investors, on the other hand, do observe the value of ε at this stage. As before, we continue to assume that ε is not known to the firm or to anyone else when the capital investments are made.

This is precisely the model which was developed by Bovenberg and Gordon (1993). For the sake of completeness, we employ the analytical apparatus that we developed in the preceding section in order to derive optimal policy prescriptions in this case. These policy prescriptions are different than those obtained in the preceding section, in the case of FPDI.

As before, in the first period all firms choose the same level of K, since ε is unknown to them at this stage. All firms are originally owned by domestic investors who equity-finance their capital investment K. After these capital investments were made, the value of ε is revealed to domestic investors but not to foreign investors. The latter buy shares in the existing firms at a total amount of FPEI. They expect their investment to appreciate in the second period to an amount of FPEI $[1 + r^*/(1-\tau^*)]$, as the capital gains are taxed at the rate of τ^*, and foreign investors must earn a net-of-tax rate of return of r^*, which is the alternative rate of return they can earn when they invest at their home countries.

Being unable to observe ε, foreign investors will offer the same price for all firms reflecting the average productivity for the group of low productivity firms they purchase. On the other hand, domestic investors who do observe ε, will not be willing to sell at this price the firms which experienced high values of ε (or, equivalently, domestic investors will outbid foreign investors for these firms). Therefore, as before, there will be a cutoff level of ε, say ε_0 (possibly different than the one under FPDI), such that all firms which experience a lower value of ε than the cutoff level will be purchased by foreigners; all other firms will be maintained by domestic investors. The cutoff level of ε is then defined by

$$[(1 - \theta)F(K)(1 + e^-)]/[1 + r^*/(1 - \tau^*)]$$
$$= [(1 - \theta)F(K)(1 + \varepsilon_0)]/[1 + (1 - \tau)r] \quad . \tag{19}$$

The value of a firm in the second period is equal to its gross output, minus corporate profit taxes, that is: $(1 - \theta)F(K)(1 + \varepsilon)$. 1/ Because foreign equity investors buy only the firms with $\varepsilon \leq \varepsilon_0$, the expected second-period value of a firm they buy is only $(1 - \theta)F(K)(1 + e^-)$, which they then discount by the factor $1 + r^*/(1 - \tau^*)$ to determine the price they are willing to pay for it in the first period. At equilibrium, this price is equal to the price that a domestic investor is willing to pay for the firm which experiences a value of ε_0 for its productivity factor ε. The cutoff price is equal to the output of the firm, minus corporate profit taxes, discounted at the rate of $(1-\tau)r$, which is the rate that domestic investors can earn on domestic government bonds. 2/ This explains the equilibrium condition (19). Rearranging terms, equation (19) reduces to:

$$(1 + e^-)/[1 + r^*/(1 - \tau^*)] = (1 + \varepsilon_0)/[1 + (1 - \tau)r] \ . \qquad (1')$$

Note that since $1 + e^- < 1 + \varepsilon_0$, it follows that an equilibrium with both foreigners and residents having nonzero holdings in domestic firms requires that the foreigners' net of tax rate of return, namely $r^*/(1 - \tau^*)$, is lower than the residents' net of tax rate of return, namely $r(1 - \tau)$. In some sense this means that foreign investors are overcharged for their purchases of domestic firms. They outbid domestic investors that are willing to pay, <u>on average</u>, only a price of $(1 - \theta)F(K)(1 + e^-)/[1 + (1 - \tau)r]$ for the low productivity firms.

Since there are $\phi(\varepsilon_0)N$ firms purchased by foreign investors, it follows that:

$$FPEI = [\phi(\varepsilon_0)N(1 - \theta)F(K)(1 + e^-)]/[1 + r^*/(1 - \tau^*)] \ . \qquad (6')$$

Consider now the capital investment decision of the firm that is made before ε becomes known. The firm seeks to maximize its market value, net of the original investment (K). Since with a probability $\phi(\varepsilon_0)$ it will be sold to foreign investors, who pay $(1-\theta)F(K)(1 + e^-)/[1 + r^*/(1 - \tau^*)]$, and with a probability $[1-\phi(\varepsilon_0)]$ it will be sold to domestic investors, who pay on average $(1 - \theta)F(K)(1 + e^+)/[1 + (1 - \tau)r]$, the firm's expected market value, net of the original capital investment, is

$$\begin{aligned} &- K + \phi(\varepsilon_0)(1 - \theta)F(K)(1 + e^-)/[1 + r^*/(1 - \tau^*)] \\ &+ [1 - \phi(\varepsilon_0)](1 - \theta)F(K)(1 + e^+)/[1 + (1 - \tau)r] \ . \end{aligned} \qquad (9a')$$

1/ Strictly speaking, the corporate tax rate (θ) applies to profits, F(K) - K, that is output minus depreciation, and not to output, F(K). However, there is a one-to-one relationship between the tax base F(K) - K and the tax base F(K). We therefore follow Bovenberg and Gordon (1993) in levying a tax at a rate θ on output, F(K), which simplifies the notation a great deal.

2/ Here again government bonds are superfluous, but we maintain them in order to establish a possibility for the consumer to lend money and assign some meaningful value for a net-of-tax domestic interest rate, namely $(1 - \tau)r$.

Maximizing this expression with respect to K yields the following necessary and sufficient first-order condition:

$$\phi(\varepsilon_0)(1 - \theta)F'(K)(1 + e^-)/[1 + r^*/(1 - \tau^*)] + [1 - \phi(\varepsilon_0)](1 - \theta)F'(K)(1 + e^+)/[1 + (1 - \tau)r] = 1 . \quad (9')$$

As expected, and as can be immediately seen form equation (9'), the corporate tax in this equity-finance case, unlike the debt-finance case of the preceding section, <u>does</u> affect firm's behavior. Since the firm knows, when making its capital investment decision, that it will be sold to foreign investors at an "overcharged" price in low-productivity events, it tends to overinvest relative to the net of tax rate of return to domestic investors and underinvest relative to the net of tax rate of return to foreign investors:

$$1 + r^*/(1 - \tau^*) < (1 - \theta)F'(K) < 1 + (1 - \tau)r . \quad (10')$$

(A formal proof of these inequalities is provided in Appendix I, (C))

The remaining equations of the FPEI model are essentially similar to those of the FPDI model in the preceding section. Equation (11) which defines the consumer's discount factor stays intact. In equation (12) we have to replace FPDI by FPEI. Accordingly,

$$FPEI = NK - [I_1 - c_1(W,q) - G_1] . \quad (12')$$

Equation (13), the present-value resource constraint remains unchanged.

The public finance objective is again to maximize $v(W,q)$, subject to six constraints: (1'), (6'), (9'), (11), (12'), and (13). There are nine control (endogenous) variables: K, r, ε_0, τ^*, τ, θ, q, W, and FPEI. Note that we have the same number of variables as before, but one fewer constraint. This is not surprising because τ and r cannot be uniquely determined since the only lending/borrowing activity here is carried out between the government and the (homogenous) household sector; therefore it only matters what is the net of tax rate of interest, that is $(1 - \tau)r$, and not τ and r separately. We apply now similar analytical procedure as in the preceding section.

The optimal policy prescriptions are as follows 1/:

First, as in the FPDI case, the expected net (of depreciation) marginal product of capital (namely, $F'(K) - 1$) must be equated to the world rate of interest (namely, r^*):

$$F'(K) = 1 + r^* . \quad (15)$$

1/ These are precisely the policy prescriptions derived by Bovenberg and Gordon(1993).

This means, that capital investment per firm is identical in the two cases (FPDI and FPEI).

Second, the optimal policy calls for a subsidy to foreign investment, that is:

$$\tau^* < 0 . \tag{18'}$$

To see this, observe first that, as in the preceding section, one can show that $1 + (1 - \tau)r = 1 + r^*$ (equation (16)). Substituting this equality into (10') yields $1 + r^*/(1 - \tau^*) < 1 + r^*$, which implies (18').

Third, it is optimal to levy a positive tax on corporate income, that is:

$$\theta > 0 . \tag{20}$$

To see this, substitute (15) and (16) into (10') to get $(1 - \theta)(1 + r^*) < 1 + r^*$, which implies that $\theta > 0$.

Indeed, by using the optimal tax instruments, we obtain again the first-best allocation, as in the preceding section. Thus, the volume of optimal foreign investment is identical in both cases: FPDI = FPEI. The difference is in the mix of policy tools: (i) In the debt-flow case the corporate income tax (θ) is a neutral tax, that could be set at any (arbitrarily high) level. In the equity-flow case we found a well-defined tax $\theta > 0$. (ii) In the debt-flow case, we find that the capital income of residents must be positively taxed (that is $\tau > 0$). In the equity-flow case, τ is irrelevant. (iii) In the debt-flow case, we found that the tax on capital income of nonresidents (τ^*) must be lower than the corresponding tax on residents (τ), that is $\tau^* < \tau$. In the equity-flow case, we find that foreign investment must be actually subsidized, that is $\tau^* < 0$, while τ is irrelevant.

In concluding the discussion of the two indirect flows of capital we emphasize that the real system with fixed corporate, domestic, and foreign investment tax rates fits closely the first-best equilibrium, that is achieved in the full information set up.

IV. Foreign Direct Investment (FDI)

In this section we consider international capital flows in the form of foreign direct investment (FDI). In a formal sense a foreign acquisition of shares in domestic firms is classified as a direct foreign investment when the shares acquired exceed a certain fraction of ownership (10-20 percent). From an economic point of view we look at FDI not just as a purchase of a sizable share in a company but, more importantly, as an actual exercise of control and management. We thus view FDI as a tie-in activity, involving an inflow of both capital and managerial inputs.

This combination of inputs accords foreign investors with the same kind of "home-court" advantage (with respect to, say, business information) that domestic investors have, but foreign portfolio (debt and equity) investors lack. Specifically, foreign direct investors learn about the state of the world (i.e., the realization of the productivity factor ε) at the same stage as domestic investors. The asymmetric information feature of the two preceding sections is thus circumvented by FDI.

A foreign direct investor purchases a domestic company from scratch, at the "greenfield" stage; that is, before any capital investment has been made. In fact, the foreign direct investor makes the capital investment decision herself and imports a bundle of inputs, K^* and M^*, where K^* is capital input and M^* is a managerial input. Gross output in the second period is $(1 + M^*)^\gamma F(K^*)(1 + \varepsilon)$, where $0 < \gamma < 1$. If J firms are purchased by the foreign direct investors, for a price of V per firm, then the total volume of FDI is given by

$$FDI = J(K^* + V) \ . \tag{21}$$

(Recall that foreign direct investors bring to the firm which they purchase their own capital input K^*.)

Gross output of a domestically owned firm, which invests a capital input of K, is still only $F(K)(1 + \varepsilon)$. As foreign investors and domestic investors are equally informed, the expected value of ε is equal for both investors, that is zero.

If a firm is sold to foreign direct investors, its expected second-period cash receipts, net of corporate taxes, is 1/

$$(1 - \theta)[(1 + M^*)^\gamma F(K^*) - M^* w^*_M/(1 - \tau^*_M)]$$

which is worth to the foreign investors only

$$(1 - \theta)[(1 + M^*)^\gamma F(K^*) - M^* w^*_M/(1 - \tau^*_M)]/[1 + r^*/(1 - \tau^*)]$$

in the first period, where w^*_M is the world wage of managerial inputs and τ^*_M is the tax rate levied by the home country on nonresident managers. (Notice that the tax τ^*_M levied by the small home country on nonresident managers is again shifted fully back to itself). Subtracting from the last expression the original capital investment yields:

$$V = - K^* + (1 - \theta)[(1 + M^*)^\gamma F(K) - M^* w^*_M/(1 - \tau^*_M)]/[1 + r^*/(1 - \tau^*)] \ , \tag{22}$$

as the market value of a firm purchased by foreign direct investors.

1/ We continue to ignore depreciation in calculating the corporate tax base with no loss of generality.

Similarly,

$$- K + (1 - \theta)F(K)/[1 + (1 - \tau)r] \tag{23}$$

is the market value of a domestically owned firm. Thus, a firm is sold to foreign direct investors if equations (22) exceeds (23) (when K^*, M^* and K are optimally chosen). At an equilibrium with a positive number of firms owned by both types of investors, we must therefore have equality between equations (22) and (23), that is:

$$\begin{aligned} - K^* + (1 - \theta)[(1 + M^*)^\gamma F(K^*) - M^* w^*_M / \\ (1 - \tau^*_M)]/[1 + r^*/(1-\tau^*)] \\ = - K + (1 - \theta)F(K)/[1 + (1 - \tau)r] . \end{aligned} \tag{1"}$$

Optimizing behavior on the part of all firms (i.e., maximization of equation (22) with respect to K^* and M^* and maximization of equation (23) with respect to K) yields

$$(1 + M^*)^\gamma F'(K^*) = 1 + r^*/(1 - \bar{\tau}^*) , \tag{9"a}$$

$$\gamma(1 + M^*)^\gamma F(K^*) + w^*_M/(1 - \tau^*_M) , \tag{9"b}$$

and

$$(1 - \theta)F'(K) = 1 + (1 - \tau)r, \tag{9"c}$$

where $\bar{\tau}^*$ is the total effective tax rate levied by the home country on capital income of nonresidents at both the corporate and individual levels, and is defined implicitly by:

$$1 + r^*/(1 - \bar{\tau}^*) \equiv [1 + r^*/(1 - \tau^*)]/(1 - \theta) .$$

The optimal fiscal policy conclusions in this case of fully symmetric information are quite straightforward (formal proofs are relegated to Appendix I, (D)).

First, it will be still efficient to follow the aggregate production efficiently rule which requires that

$$(1 + M^*)^\gamma F'(K^*) = 1 + r^* , \tag{15"a}$$

and that

$$\gamma(1 + M^*)^{\gamma-1}F(K^*) = w^*_M . \tag{15"b}$$

Comparing equations (15"a) to (9"a) and (15"b) to (9"b) implies that nonresident's incomes should not be taxed, that is:

$$\bar{\tau}^* = \tau^*_M = 0 . \tag{24}$$

Thus, the residence principle of international taxation should be followed in this case. Foreign direct investment, which circumvents the asymmetric information distortion, restores the efficiency of the residence-based taxation on international flows of factors of production; see Frenkel, Razin, and Sadka (1991). 1/

Note also that aggregate production efficiency requires that the net of depreciation marginal product of capital of the non-FDI domestic firm (namely, $F'(K) - 1$) should be equal to the world rate of interest (namely, r^*) that is

$$F'(K) = 1 + r^* . \tag{15"c}$$

Comparing equations (15"a) to (15"c) implies that due to the foreign advantage afforded by foreign managerial inputs, the firm owned by the foreign direct investor finds it profitable to carry larger capital investments than the domestically-owned firm, that is $K^* > K$. Also, comparing equations (15"c) to (9"c) implies that domestic tax rates must be set in such a way so as to satisfy:

$$[1 + (1 - \tau)r]/(1 - \theta) = 1 + r^* . \tag{25}$$

That is, there should be no tax distortions on corporate profits of non-FDI firms. (Recall from equation (9"c) that the term on the left-hand side of equation (25) is the corporate return factor, net of all taxes, both at the individual level and the corporate level.)

In addition, aggregate production efficiency requires that the number of the firms sold to the foreign direct investors is such that the net economic value of a firm at the hands of foreign direct investors must be equal to the net economic value of a firm remaining with domestic control and management, that is:

$$\frac{(1+M^*)^{\gamma}F(K^*) - w_M^* M^*}{1+r^*} - K^* = F(K)/(1+r^*) - K \quad . \tag{26}$$

Indeed, when the residence principle of international taxation is fulfilled and the domestic tax rates are set as in equation (25), then condition in equation (26) must also be satisfied. This can be seen by substituting the optimal tax rules equations (24) and (25) into (1") and comparing the outcome to equation (26). (Recall also that $1 + r^*/(1 - \bar{\tau}^*) = [1 + r^*/(1 - \tau^*)]/(1 - \theta)$.)

1/ It is worth emphasizing that this strong result of no taxation of nonresidents' income holds whether or not the government can levy lump-sum taxes or transfers, that is whether or not a first-best allocation is attained. Thus, even when the government must resort to distortionary taxation on residents' incomes (namely, $\tau > 0$) in order to meet its revenue needs, it will still be efficient to exempt nonresidents.

V. Conclusion

The main policy conclusions are summarized in Table 2. The table emphasizes the efficiency of a nonuniform treatment of the various vehicles of international capital flows. In order for the three kinds of capital inflows to efficiently co-exist, their tax treatment cannot be identical.

Our model gives predictions in line with the pecking order story of corporate finance. Recall that the finance pecking order is: (1) Firms prefer internal finance (the analogue of FDI). (2) If external finance is required, firms issue the safest sercurity first; that is they start with debt (the analogue of FPDI). (3) Equity issue (the analogue of FPEI) is used as a last resort. Work in finance based on asymmetric information yield propositions roughly consistent with this story (see Myers (1984)).

One issue, which has not been dealt with in the paper is the existence of insured domestic financial intermediaries, as in the case of the central bank (or the government) bailing out troubled commercial banks and savings and loans institutions. If these intermediaries are not excluded from international transactions, there is the possibility that the essentially domestic moral hazard problem will also plague international capital inflows. This problem calls, however, for applying different policy instruments than the ones analyzed in this paper.

Table 2. Tax Treatment of Foreign Investment

Type of Tax	Type of Foreign Investment		
	Foreign Portfolio Debt Investment	Foreign Portfolio Equity Investment	Foreign Direct Investment
Corporate tax (θ)	High	Positive	Depends on government revenue needs
Tax on Capital Income of Residents (τ)	Positive	Irrelevant	Depends on government revenue needs
Tax on Capital Income of Nonresidents (τ^* or $\boldsymbol{\tau}^*$)	Lower than on residents	Negative	Zero

Derivations

A. Expression (9a) describes the expected (second-period) cash receipts of the firm before any corporate taxes. If a corporate tax θ is levied on the firm, and assuming full loss offset, the expected tax liability will be:

$$\theta\{F(K) - K - [1 - \phi(\varepsilon_o)]Kr - \phi(\varepsilon_o)[F(K)(1 + e^-) - K]\} . \tag{A1}$$

The tax is levied on net output (i.e., $F(K) - K$, allowing for depreciation), minus interest expenses which are either Kr with probability $[1 - \phi(\varepsilon_o)]$ in the no-default case or $F(K)(1 + e^-) - K$ with probability $\phi(\varepsilon_o)$ in the default case. Subtracting (A1) from (9a) yields the net-of-tax expected cash receipts of the firms:

$$(1 - \theta)\{F(K) - [1 - \phi(\varepsilon_o)]K(1 + r) - \phi(\varepsilon_o)F(K)(1 + e^-)\} . \tag{A2}$$

Since the after-tax objective function of the firm (namely, (A2)) differs from its pre-tax objective function (namely, (9a)) only by a multiplicative factor (namely, $1 - \theta$), it follows that, with a full loss offset, the tax has no effect on the firm's behavior.

B. Differentiate L (equation (14)) with respect to W and q, to get:

$$v_1 - \lambda c_{11} - \lambda c_{21}/(1 + r^*) = 0 , \tag{A3}$$

and

$$v_2 - \lambda c_{12} - \lambda c_{22}/(1 + r^*) = 0 , \tag{A4}$$

where $v_1 = \partial v/\partial W$, $v_2 = \partial v/\partial q$, $c_{11} = \partial c_1/\partial W$, $c_{12} = \partial c_1/\partial q$, $c_{21} = \partial c_2/\partial W$, and $c_{22} = \partial c_2/\partial q$. Substituting Roy's identity

$$v_2 = -c_2 v_1 \tag{A5}$$

and the Hicks-Slutsky equations

$$c_{i2} = \bar{c}_{i2} - c_2 c_{i1} \qquad i = 1, 2 \tag{A6}$$

where $\bar{c}_{i2}$ is the Hicks-compensated derivative of c_i with respect to q, into (A4) yields

$$-c_2[v_1 - \lambda c_{11} - \lambda c_{21}/(1 + r^*)] - \lambda \bar{c}_{12} - \lambda \bar{c}_{22}/(1 + r^*) = 0 . \tag{A7}$$

Substitute (A3) into (A7) to get

$$\bar{c}_{21} + \bar{c}_{22} /(1 + r^*) = 0 , \tag{A8}$$

where use is made of the symmetry of the Hicks-substitution effects: $\bar{c}_{12} = \bar{c}_{21}$. Substituting the Euler's equation,

$$\bar{c}_{21} + q\bar{c}_{21} = 0 , \tag{A9}$$

into (A8) implies $q^{-1} = 1 + r^*$.

C. Substitute for $(1 + e^-)[1 + r^*/(1 - \tau^*)]$ from (1') into (9') and rearrange terms to get:

$$\begin{aligned}&\phi(\varepsilon_o)(1 - \theta)F'(K)(1 + \varepsilon_o)\\ &+ [1 - \phi(\varepsilon_o)](1 - \theta)F'(K)(1 + e^+) = 1 + (1 - \tau)r .\end{aligned} \tag{A10}$$

Since $1 + \varepsilon_o > 1 + e^-$, it follows from (A10) that

$$\begin{aligned}1 + (1 - \tau)r &> (1 - \theta)F'(K)\{\phi(\varepsilon_o)(1 + e^-) + [1 - \phi(\varepsilon_o)](1 + e^+)\}\\ &= (1 - \theta)F'(K) ,\end{aligned}$$

because the term in the curly brackets is equal to one (see equation (4)). This proves the inequality in the right end of (10'). Substitute for $1 + (1 - \tau)r$ from (1') into (9') and rearrange terms to get:

$$\begin{aligned}&\phi(\varepsilon_o)(1 - \theta)F'(K)(1 + e^-) + [1 - \phi(\varepsilon_o)](1 - \theta)F'(K)\\ &(1 + e^+)(1 + e^-)(1 + \varepsilon_o)^{-1} = 1 + r^*/(1 - \tau^*) .\end{aligned} \tag{A11}$$

Since $(1 + e^-)(1 + \varepsilon_o)^{-1} < 1$, it follows from (A11) that

$$\begin{aligned}1 + r^*/(1 - \tau^*) &< (1 - \theta)F'(K)\{\phi(\varepsilon_o)(1 + e^-) + [1 - \phi(\varepsilon_o)](1 + e^+)\}\\ &= (1 - \theta)F'(K),\end{aligned}$$

which completes the proof of (10')

D. The objective of the government is to choose K, K^*, M^*, q, W, and J so as to maximize v(W,q), subject to the present-value resource constraint:

$$\begin{aligned}&I_1 + I_2/(1 + r^*) + (N - J)F(K)/(1 + r^*)\\ &+ J(1 + M^*)^{\gamma} F(K^*)/(1 + r^*) - Jw^*_M M^*/(1 + r^*)\\ &= c_1(W,q) + c_2(W,q)/(1 + r^*) + G_1\\ &+ G_2/(1 + r^*) + (N - J)K + JK^* .\end{aligned} \tag{13"}$$

Then, the other seven control variables--FDI, V, τ, r, τ^*_M, $\bar{\tau}^*$, θ--are determined by the following constraints: (21), (1"), (9"a), (9"b), (9"c), (11), and the first-period resource constraint:

$$FDI = JK^* + (N - J)K - [I_1 - c_1(W,q) - G_1] . \tag{12"}$$

The Langragian expression is given by

$$L = v(W,q) + \lambda[I_1 + I_2/(1 + r^*) + (N - J)F(K)/(1 + r^*) + J(1 + M^*)^\gamma F(K^*)/(1 + r^*) - Jw^*_M M^*/(1 + r^*) - c_1(W,q) - G_1 - c_2(W,q)/(1 + r^*) - G_2/(1 + r^*) - (N - J)K - JK^*]. \quad (14")$$

The first-order conditions establish the familiar aggregate production efficiency results:

$$(1 + M^*)^\gamma F'(K^*) = 1 + r^* , \quad (15"a)$$

$$\gamma(1 + M^*)^{\gamma-1} F(K^*) = w^*_M , \quad (15"b)$$

and

$$F'(K) + 1 + r^*. \quad (15"c)$$

In addition, differentiating L with respect to J and setting the derivative equal to zero yields

$$(1 + M^*)^\gamma F(K^*) - w^*_M M^* - (1 + r^*)K^* = F(K) - (1 + r^*)K.$$

This proves (25).

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