NBER WORKING PAPERS SERIES

THE INTERNATIONAL TRANSMISSION OF TAX POLICIES IN A DYNAMIC WORLD ECONOMY

Stephen J. Turnovsky

Marcelo Bianconi

Working Paper No. 4086

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
June 1992

This paper is part of NBER's research program in International Trade and Investment. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

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ABSTRACT

This paper analyzes the international transmission of tax shocks in a two-country infinite-horizon representative agent framework. In analyzing such shocks, the viability of the underlying tax regimes, arising from the arbitrage conditions characterizing equilibrium in a perfect world capital market, is emphasized. Conditions for both short-run and long-run viability are derived, and the two polar regimes of source-based and residence-based taxation discussed. In general, we find the former more likely to satisfy the viability conditions, than the latter. With equity financing, the long-run viability of residence-based taxation is likely to require the harmonization of tax and/or dividend policy. The main features of the dynamic adjustment paths following a tax increase are characterized.

Stephen J. Turnovsky
Department of Economics
University of Washington
301 Savery Hall
Seattle, WA 98195
and NBER

Marcelo Bianconi
Department of Economics
Tufts University
305 Braker Hall
Medford, MA 02155

1. Introduction

The macroeconomic aspects of public finance have received increasing attention during the last decade or so. Fiscal policy at the aggregate level has become one of the fundamental issues facing most policy makers at the present time. Parallel to this, the world economy has experienced a substantial increase in international economic integration, not only within specific regions such as Europe or North America, but also across continents such as Asia, North America, and Europe. Macroeconomic interdependence has become apparent and along with it, the interdependence of macroeconomic policies. This paper focuses on the issue of the international transmission of fiscal policies, specifically tax policies, in an environment of integrated world capital markets.

There has been a growing literature that addresses issues pertaining to tax policy in an integrated world economy. Several related matters have been receiving attention, among the most important being the viability of alternative tax regimes. The main issue here is that the arbitrage opportunities provided by an integrated capital market impose restrictions on the tax policies the authorities in different jurisdictions may adopt, leading to questions involving tax harmonization and tax competition (Razin and Sadka 1991a, 1991b, Giovannini 1990, Sinn 1990). Two principles of international capital income taxation represent two polar forms of tax regime, elements of which are found in practice. These are: (i) residence–based taxation, where income is taxed on the basis of the residence of the tax payer; and (ii) source–based taxation, where income is taxed according to its place of origin. Previous authors have shown how these two regimes are generally viable, though they lead to different allocations of the world capital stock. Residence–based taxation, by equating before–tax rates of return leads to an efficient allocation of investment, but not savings. Source–based taxation, by equating after–tax rates of return leads to efficient allocation of savings, but not investment. Moreover, Razin and Sadka (1991b) have shown how the residence–based taxation scheme can emerge as a Nash equilibrium from tax competition, where tax authorities seek to maximize the welfare of their respective representative agents.

Despite the fact that in an interdependent world, tax policy in one country will impact abroad, there has been relatively little analysis of the international transmission of tax shocks. Among the most prominent recent work is that of Frenkel, Razin, and Sadka (1991), which is based primarily on a two period model. Our contribution is to examine the issue of the international transmission of tax policies using an intertemporal optimizing, infinite horizon two–country general equilibrium framework.[1]

In constructing this model, we assume that firms finance investment by issuing equities. Part of the financial decisions faced by firms involve dividend policy. This has implications for the tax arbitrage restrictions, imposing constraints between tax rates and dividend policy, in order for an equilibrium to be viable. In effect, by impinging on the cost of capital facing the firm, we show that dividend policy interacts with tax policy in an important way in a world with integrated capital markets.

The equilibrium we consider emphasizes the viability of the tax regime. In contrast to the previous literature, we distinguish between short–run and long–run viability conditions. The former arise from the usual arbitrage conditions, while the latter stem from the long–run equilibrium relationships between after–tax rates of return on assets and the rates of time preference, which we take to be given. In general, we find that the conditions required for source–based taxation to be viable are less restrictive than those required under residence–based taxation. Thus the adoption of residence–based tax principles is likely to require greater harmonization of tax policies, or of the firms' dividend policies.

One benchmark result of the existing literature is that the residence principle of capital income taxation does not distort production decisions, an international version of the production efficiency theorem of Diamond and Mirrlees (1971). In our model, this result obtains only under very specific restrictions on the firm's dividend policy and the consumer's subjective rate of time preference.

The remainder of the paper is organized as follows. Section 2 presents the two–

country macroeconomic structure. The issue of viability of the tax structure is discussed at some length in Section 3, while the following section sets out the resulting macrodynamic equilibrium. Section 5 discusses the international transmission of tax shocks under the source–based tax regime. The dynamic adjustments in both the domestic and foreign economies are spelled out in detail. Despite the fairly complex nature of the model, the dynamics can be illustrated in a fairly compact way. The welfare implications of the tax shock, as measured by the intertemporal utility of domestic and foreign agents, are also discussed. Section 6 briefly considers the transmission of tax shocks under the residence–based tax system, while our main conclusions are reviewed in Section 7.

2. Two-Country Macroeconomic Structure

Consider a two–country, one–good model of a decentralized world economy inhabited by households, firms, and their respective governments. Both countries accumulate capital gradually over time, with the world market for capital being perfectly integrated. Labor supply in each country is assumed to be fixed inelastically, and to be internationally immobile. The analysis employs the basic infinite horizon perfect foresight representative agent framework, which has become a standard approach to international macroeconomics. The structure is very much in the spirit of the recent two–country model of Devereux and Shi (1991), with three basic differences: our equilibrium is distorted by the presence of tax rates; we consider the firm's financial problem explicitly; and we assume a fixed rate of time preference in each country.[2] In outlining the model we shall focus primarily on the domestic economy. Variables pertaining to the domestic economy are unstarred, while the corresponding foreign economy variables are starred. The superscript d refers to the holdings of domestic residents, while f refers to the holdings of foreign agents.

A. Households

For simplicity the economy is a real one, abstracting from money and other nominal assets. The representative household in the domestic economy chooses his consumption level, c, his holdings of equities issued by domestic firms, E^d, and his holdings of equities issued by foreign firms, E^{*d}, so as to:

$$Max \int_0^\infty U(c)e^{-\beta t}dt \tag{1a}$$

subject to the budget constraint

$$\begin{aligned} c + q\dot{E}^d + q^*\dot{E}^{*d} &= (1-\tau_{y,rd})D^d + (1-\tau^*_{y,nr}-\tau_{y,rf})D^{*d} \\ &- \tau_{c,rd}\dot{q}E^d - (\tau^*_{c,nr}+\tau_{c,rf})\dot{q}^*E^{*d} + w + T \end{aligned} \tag{1b}$$

and given initial equity holdings

$$E^d(0) = E^d_0 > 0; \quad E^{*d}(0) = E^{*d}_0 > 0 \tag{1c}$$

where

β is the domestic rate of time preference, taken to be constant,

q is the real price of domestic equities,

q^* is the real price of foreign equities,

D^d are the dividends paid by the domestic firm to domestic residents,

D^{*d} are the dividends paid by the foreign firm to domestic residents,

w is the real wage income, with labor fixed and normalized to unity,

T is the lump–sum tax rebate.

In addition, agents in both countries face a set of distortionary taxes defined as follows:

(i) $\tau_{i,rd}$ for $i = y, c$ (dividend income and capital gains income, respectively) is the tax rate levied on domestic residents on their domestic source income;

(ii) $\tau_{i,rf}$ is the effective rate of additional tax levied on domestic residents on their foreign source income, over and above the tax paid abroad;

(iii) $\tau_{i,nr}$ is the tax rate levied on nonresidents on their income earned in the other country.

This problem is standard. The utility function $U(c)$ is assumed to have the usual property of positive, but diminishing, marginal utility. The domestic household budget constraint is expressed in real flow terms. It asserts that after–tax dividends and capital gains on holdings of domestic and foreign equities, plus labor income and transfers, are spent on consumption, and on additions to their holdings of domestic and foreign equities. Tax schedules are assumed to be linear, with the returns on foreign asset holdings being taxed possibly by the domestic or foreign government, depending upon the tax regime. Finally, capital gains are assumed to be taxed on accrual.

Assuming that the representative agent treats the dividend yield on his equity holdings, $\frac{D^d}{qE^d}, \frac{D^{*d}}{q^*E^{*d}}$, as given, the first order conditions for an interior optimum are:[3]

$$U_c(c) = \alpha \tag{2a}$$

$$(1 - \tau_{y,rd})D^d/qE^d + (1 - \tau_{c,rd})\dot{q}/q = \theta \tag{2b}$$

$$(1 - \tau_{y,rf} - \tau^*_{y,nr})D^{*d}/q^*E^{*d} + (1 - \tau_{c,rf} - \tau^*_{c,nr})\dot{q}^*/q^* = \theta \tag{2c}$$

$$\theta = \beta - \dot{\alpha}/\alpha \tag{2d}$$

together with the transversality conditions

$$\lim_{t\to\infty} \alpha E^d e^{-\beta t} = 0; \quad \lim_{t\to\infty} \alpha E^{*d} e^{-\beta t} = 0 \tag{2e}$$

where α, the Lagrange multiplier associated with the accumulation equation (1b) is the marginal utility of wealth of the domestic resident. The optimality conditions (2b, 2c) are arbitrage conditions equating the after–tax rates of return on domestic and foreign equities to the rate of return on consumption defined in (2d).

The problem facing the foreign household is symmetric, with the corresponding optimality conditions being:

$$U_c^*(c^*) = \alpha^* \tag{3a}$$

$$(1 - \tau_{y,rd}^*)D^{*f}/q^*E^{*f} + (1 - \tau_{c,rd}^*)\dot{q}^*/q^* = \theta^* \tag{3b}$$

$$(1 - \tau_{y,rf}^* - \tau_{y,nr})D^f/qE^f + (1 - \tau_{c,rf}^* - \tau_{c,nr})\dot{q}/q = \theta^* \tag{3c}$$

$$\theta^* = \beta^* - \dot{\alpha}^*/\alpha^* \tag{3d}$$

and the transversality conditions:

$$\lim_{t\to\infty} \alpha^* E^{*f} e^{-\beta^* t} = 0; \quad \lim_{t\to\infty} \alpha^* E^f e^{-\beta^* t} = 0. \tag{3e}$$

B. Firms

The domestic representative firm employs labor and capital to produce output using a neoclassical production function having the usual properties of positive, but diminishing, marginal physical product and constant returns to scale. We assume that firms finance their capital expenditures either out of retained earning or by issuing new equities.

Gross profit π is defined by:

$$\pi = f(k) - w \tag{4a}$$

where k is the capital stock, and labor is normalized at unity. Domestic corporate profit is taxed domestically at the rate τ_p and the remainder is either paid out as dividends, D, to stockholders or held as retained earnings, RE, to finance further investment:[4]

$$(1 - \tau_p)\pi = D + RE \tag{4b}$$

The financing constraint is specified by

$$I = \dot{k} = q\dot{E} + RE \tag{4c}$$

where E denotes the total number of the firm's equities outstanding. The allocation of these equities and the corresponding dividend payments between domestic and foreign residents are described by:

$$E = E^d + E^f. \tag{4d}$$

$$D = D^d + D^f \tag{4e}$$

The total value of outstanding equities of the domestic firm, V, is defined to be

$$V \equiv qE \tag{5}$$

with the value held by domestic residents and foreigners being $V^d \equiv qE^d$ and $V^f \equiv qE^f$, respectively. Eliminating RE from equations (4b) and (4c), one obtains

$$D = (1 - \tau_p)\pi - \dot{k} + q\dot{E}. \tag{6}$$

Next, taking the time derivative of (5), and using (4d), (4e), and (6), leads to

$$\dot{V} = \dot{q}(E^d + E^f) + D^d + D^f - \gamma \tag{7}$$

where $\gamma \equiv (1-\tau_p)\pi - \dot{k}$ is the domestic firm's net cash flow. Using the optimality condition (2b) of the domestic household, the corresponding condition (3c) of the foreign household, and assuming that the dividend yields received by domestic and foreign residents are equal; i.e., $D^d/V^d = D^f/V^f$, the value of the domestic firm evolves in accordance with the differential equation

$$\dot{V} = \left(\frac{\theta}{1-\tau_{c,rd}}\right) V - \left(\frac{\tau_{y,rd} - \tau_{c,rd}}{1-\tau_{c,rd}}\right) D - \gamma. \tag{8}$$

This equation is identical to that for a closed economy (Brock and Turnovsky 1981). It is interesting to observe that at the interior optimum with a perfect world capital market, the firm is indifferent as to where its equities are held or to the tax rates abroad.

As long as $\tau_{y,rd} \neq \tau_{cr,d}$, dividend policy will impact on the value of the firm and needs to be specified. We shall assume that dividend policy takes the form of paying out a fraction of after–tax profits

$$D = \phi(1-\tau_p)\pi \qquad 0 \leq \phi \leq 1. \tag{9}$$

This rule, originally studied by Lintner (1956), turns out to be convenient for parameterizing dividend policy in the present model.[5] Substituting (9) into (8), yields

$$\dot{V} = \left(\frac{\theta}{1-\tau_{c,rd}}\right) V - \frac{[\phi(1-\tau_{y,rd}) + (1-\phi)(1-\tau_{c,rd})]}{1-\tau_{c,rd}}(1-\tau_p)[f(k) - w] + \dot{k}. \tag{10}$$

The objective of the firm is to choose its capital stock k to maximize the initial value of equity $V(0)$, which from (10) above is

$$V(0)=\int_0^\infty \left\{\left[\frac{\phi(1-\tau_{y,rd})+(1-\phi)(1-\tau_{c,rd})}{1-\tau_{c,rd}}\right](1-\tau_p)[f(k)-w]-\dot{k}\right\}e^{-\int_0^t \frac{\theta(s)}{1-\tau_{c,rd}}ds}dt \tag{11}$$

subject to the given initial capital stock $k(0)=k_0>0$. The optimality condition determining the demand for capital can be expressed as:[6]

$$(1-\tau_p)f_k(k)=\theta/[\phi(1-\tau_{y,rd})+(1-\phi)(1-\tau_{c,rd})]. \tag{12}$$

That is, the after–tax marginal physical product of capital is equal to the required rate of return on capital to consumers. This depends upon dividend policy. It is well known that if $\tau_{c,rd}<\tau_{y,rd}$, as is indeed the case for most economies, the optimal dividend policy is to pay no dividends, i.e., set $\phi=0$. The problem facing the foreign firm is symmetric and the optimality condition determining its capital stock is

$$(1-\tau_p^*)f_k^*(k^*)=\theta^*/[\phi^*(1-\tau_{y,rd}^*)+(1-\phi^*)(1-\tau_{c,rd}^*)]. \tag{13}$$

C. Governments

We assume that all revenues received by the government in each country are rebated to its own residents in a lump–sum fashion,[7] in accordance with the schemes

$$\begin{aligned}T&=\tau_{y,rd}D^d+\tau_{y,rf}D^{*d}+\tau_{y,nr}D^f\\&\quad+\tau_{c,rd}\dot{q}E^d+\tau_{c,rf}\dot{q}^*E^{*d}+\tau_{c,nr}\dot{q}E^f+\tau_p\pi\end{aligned} \tag{14a}$$

$$\begin{aligned}T^*&=\tau_{y,rd}^*D^{*f}+\tau_{y,rf}^*D^f+\tau_{y,nr}^*D^{*d}\\&\quad+\tau_{c,rd}^*\dot{q}^*E^{*f}+\tau_{c,rf}^*\dot{q}E^f+\tau_{c,nr}^*\dot{q}^*E^{*d}+\tau_p^*\pi^*.\end{aligned} \tag{14b}$$

These depend upon the tax regimes and the two schemes, both most widely adopted, and discussed in the literature, and which we shall consider are: (i) source–based taxation, and (ii) residence–based taxation; (Giovannini 1990; Frenkel, Razin, and Sadka 1991).[8] According to the source–based principle, income is taxed according to the origin of the income and is therefore specified by

$$\tau_{i,nr} = \tau_{i,rd} = \tau_i, \quad \tau_{i,rf} = 0; \qquad \tau^*_{i,nr} = \tau^*_{i,rd} = \tau^*_i, \quad \tau^*_{i,rf} = 0 \tag{15}$$

for $i = y, c$, where τ_i, τ^*_i, refer to the tax rates on the type of income i in domestic and foreign countries, respectively. Under residence–based taxation, income is taxed on the basis of the residence of the taxpayer, regardless of the source of income:

$$\tau_{i,rd} = \tau_{i,rf} = \tau_i, \quad \tau_{i,nr} = 0; \qquad \tau^*_{i,rd} = \tau^*_{i,rf} = \tau^*_i, \quad \tau^*_{i,nr} = 0. \tag{16}$$

D. *World Goods Market Equilibrium*

In a single commodity world, goods market equilibrium is described by

$$c + c^* + \dot{k} + \dot{k}^* = f(k) + f^*(k^*). \tag{17}$$

The sum of consumption and investment expenditures in the two economies must equal total world output.

E. *Wealth and Accumulation of Net Foreign Assets*

Aggregate wealth in each country is defined to be[9]

$$W \equiv V^d + V^{*d} = qE^d + q^*E^{*d} = k^d + k^{*d} \tag{18a}$$

$$W^* \equiv V^{*f} + V^f = q^*E^{*f} + qE^f = k^{*f} + k^f \tag{18b}$$

where k^d, k^{*d}, denote the stocks of domestic and foreign physical capital owned by domestic residents, and analogously for k^f, k^{*f} so that[10]

$$W + W^* = qE + q^*E^* = k + k^* \tag{19}$$

where the last equality follows from the equilibrium relationship between the value of the firm and its capital stock; see footnote 6.

The net foreign asset position of the domestic economy, N say, is defined as

$$N = q^*E^{*d} - qE^f = k^{*d} - k^f. \tag{20}$$

Domestic and foreign wealth can thus be expressed as: $W = k + N, \quad W^* = k^* - N$.

Taking the time derivative of (20), and using: (i) the optimality conditions for households; (ii) the equilibrium conditions for firms; (iii) the domestic household constraint; and (iv) the tax rebate scheme (14a), one can derive the following expression for the current account balance

$$\begin{aligned}\dot{N} = f(k) - c - \dot{k} + (1-\tau_p)[\phi(1-\tau_{y,nr}) + (1-\phi)(1-\tau_{c,nr})]f_k(k)N \\ + k^{*d}\{(1-\tau_p^*)[\phi^*(1-\tau_{y,nr}^*) + (1-\phi^*)(1-\tau_{c,nr}^*)]f_k^* \\ - (1-\tau_p)[\phi(1-\tau_{y,nr}) + (1-\phi)(1-\tau_{c,nr})]f_k\}.\end{aligned} \tag{21}$$

This equation asserts that the rate of accumulation of net foreign assets depends upon output less domestic absorption, plus the net international flow of earnings on assets. Observe that for an arbitrary tax structure, the rate of net foreign asset accumulation depends upon the international distribution of the capital stock, as reflected by k^{*d}. In the absence of any taxation, (21) reduces to the familiar relationship

$$\dot{N} = f(k) - c - \dot{k} + f_k(k)N. \tag{21'}$$

3. Viability of Equilibrium

With integrated world capital markets and the arbitrage possibilities they offer, a key issue in any international taxation system concerns its viability.[11] Central to this are the consumers' optimality conditions (2b), (2c), and (3b), (3c) in the two economies. From the homogeneity of the firm's production function, the equilibrium profit of the domestic firm is $\pi = f_k k$, in which case their equilibrium dividends and retained earnings are

$$D = \phi(1-\tau_p)f_k(k)k \tag{22a}$$

$$RE = (1-\phi)(1-\tau_p)f_k(k)k. \tag{22b}$$

Now, using (4c), and the fact that in equilibrium $k = qE$, we see that $\dot{q}E = RE$, so that the rate of price change of domestic equities is

$$\dot{q}/q = (1-\phi)(1-\tau_p)f_k(k).$$

For notational convenience, we define

$$\tau_d \equiv \phi\tau_{y,rd} + (1-\phi)\tau_{c,rd} \tag{23a}$$

$$\tau_f \equiv \phi^*[\tau_{y,rf} + \tau^*_{y,nr}] + (1-\phi^*)[\tau_{c,rf} + \tau^*_{c,nr}] \tag{23b}$$

$$\tau^*_d \equiv \phi^*\tau^*_{y,rd} + (1-\phi^*)\tau^*_{c,rd} \tag{24a}$$

$$\tau^*_f \equiv \phi[\tau^*_{y,rf} + \tau_{y,nr}] + (1-\phi)[\tau^*_{c,rf} + \tau_{c,nr}]. \tag{24b}$$

The rate τ_d describes the average tax rate paid by domestic residents on their domestic source income. It is a weighted average of the tax rate paid on domestic dividend and capital gains income, the weight being the domestic dividend payout rate, ϕ. Similarly, τ_f is the average tax paid by domestic residents on their foreign source income. It is a weighted average of the tax paid on foreign dividend income and on foreign capital gains, the weight being ϕ^*. Analogously, τ_d^*, τ_f^*, apply to the foreign taxpayer.

With this notation, using the above equilibrium relationships for D and $\frac{\dot{q}}{q}$, the optimality conditions (2b), (2c), and (3b), (3c) for consumers simplify to:

$$(1-\tau_d)(1-\tau_p)f_k(k) = \theta \tag{2b'}$$

$$(1-\tau_f)(1-\tau_p^*)f_k^*(k^*) = \theta \tag{2c'}$$

$$(1-\tau_d^*)(1-\tau_p^*)f_k^*(k^*) = \theta^* \tag{3b'}$$

$$(1-\tau_f^*)(1-\tau_p)f_k(k) = \theta^*. \tag{3c'}$$

These conditions equate the net of tax marginal physical products of capital in the two economies, to the respective rates of return θ, θ^*. They describe short-run equilibrium conditions. Dividing (2b′) by (3c′), and (2c′) by (3b′) leads to the relationships

$$(1-\tau_d)/(1-\tau_f^*) = (1-\tau_f)/1-\tau_d^*) = (\theta/\theta^*). \tag{25}$$

The equilibrium conditions will be consistent, and the tax system viable, if and only if the left-hand equality in (25) holds. This is the condition stressed by Frenkel, Razin, and Sadka (1991) and others.[12] Since the arbitrage conditions pertain to the short run, we refer to (25) as being a *short-run viability* condition. In interpreting this condition, we should also recall that the tax rates, $\tau_d, \tau_f, \tau_d^*, \tau_f^*$, are composite rates, as defined in (23), (24).

In the short run, the rates of return θ, θ^*, are endogenously determined, by (2b′) and (3b′) and do not impose any constraints on the equilibrium tax system. However, θ, θ^* evolve over time and, assuming stability, in the long run converge to the exogenously given rates of time preference β and β^*, respectively; see (2d), (3d). Thus in order for the tax regime to be viable in the long run, the following *long-run viability* condition must hold:

$$(1-\tau_d)/(1-\tau_f^*) = (1-\tau_f)/(1-\tau_d^*) = \beta/\beta^*. \tag{25'}$$

A. Source-Based Taxation

In the case where taxation is source-based, equations (15), (23) and (24), imply

$$\tau_f^* = \tau_d; \quad \tau_d^* = \tau_f, \qquad \text{so that } \theta = \theta^*.$$

The short-run viability condition (25) is met. The pairs of optimality conditions (2b′), (2c′), and (3b′), (3c′) thus both imply

$$(1-\tau_d)(1-\tau_p)f_k(k) = (1-\tau_d^*)(1-\tau_p^*)f_k^*(k^*). \tag{26}$$

Hence, equilibrium under source-based taxation requires the marginal physical products of capital, net of both corporate and personal taxes, to be equated. But in order to be viable in the long run, it requires in addition that $\beta^* = \beta$. That is, the representative agents in the two economies must have the same rates of time preference.

B. Residence-Based Taxation

This is more complicated and restrictive. Using (16), (23), and (24), we find:

$$\tau_d = \phi\tau_y + (1-\phi)\tau_c; \qquad \tau_f = \phi^*\tau_y + (1-\phi^*)\tau_c$$

$$\tau_d^* = \phi^*\tau_y^* + (1-\phi^*)\tau_c^*; \qquad \tau_f^* = \phi\tau_y^* + (1-\phi)\tau_c^*$$

so that (25) becomes

$$\frac{\phi(1-\tau_y)+(1-\phi)(1-\tau_c)}{\phi(1-\tau_y^*)+(1-\phi)(1-\tau_c^*)} = \frac{\phi^*(1-\tau_y)+(1-\phi)(1-\tau_c)}{\phi^*(1-\tau_y^*)+(1-\phi^*)(1-\tau_c^*)} = \frac{\theta}{\theta^*}. \tag{27}$$

A necessary and sufficient condition for short-run viability is that:

either: *Tax Harmonization* $(1-\tau_y)/(1-\tau_y^*) = (1-\tau_c)/(1-\tau_c^*)$ (28a)

or: *Dividend Harmonization* $\phi = \phi^*$. (28b)

Thus, in order for residence–based taxation to be viable in the short run, either the relative after–tax returns on the two types of income in the two countries must be proportional, as in (28a), or the dividend payout rate in the two economies must be identical.

In the former case, the marginal physical product conditions must satisfy[13]

$$(1-\tau_d)(1-\tau_p)f_k(k) = (1-\tau_f)(1-\tau_p^*)f_k^*(k^*)$$

which is virtually identical to (26) above. Long–run viability in this case requires, in addition, that the rates of time preference in the two economies also satisfy (28a):

$$(1-\tau_y)/(1-\tau_y^*) = (1-\tau_c)/(1-\tau_c^*) = \beta/\beta^*. \tag{29}$$

The restriction on dividend policy in the alternative case, (28b), is important. It implies that the integration of dividend policy is in general an important element of an integrated tax regime, where governments tax on the basis of residence.[14] Evidence among European Community countries suggests quite divergent dividend payout rates.[15] Yet this is something which needs to be addressed as financial and tax integration occurs. In this case, equilibrium with residence–based taxation implies $\tau_d = \tau_f, \tau_d^* = \tau_f^*$, which in turn leads to the equality between the after–corporate profit tax, but before–personal tax, marginal physical products, namely

$$(1-\tau_p)f_k(k) = (1-\tau_p^*)f_k^*(k^*) \tag{26'}$$

The corresponding condition for the long–run viability of residence–based taxation is

$$\frac{1-\tau_d}{1-\tau_d^*} \equiv \frac{\phi(1-\tau_y)+(1-\phi)(1-\tau_c)}{\phi(1-\tau_y^*)+(1-\phi)(1-\tau_c^*)} = \frac{\beta}{\beta^*}. \tag{29'}$$

This relationship imposes a constraint between domestic and foreign tax rates, the common dividend payout rate, and the rates of time preference. Clearly, tax policy under the residence-based principle involves serious problems of international coordination if it is to be viable in the long run. It is evident that in general, a change in any one of the tax rates will require a compensating adjustment in some other tax rate, or in dividend policy, in order for (29) or (29′) to be maintained.[16]

One less restrictive case in which (29′) will hold is if one defines β' to be a "pure" rate of time preference and assumes that the agents in the two economies, recognizing that they are constrained by an integrated world financial system, adjust their rates of time preference to allow for their respective tax rates, namely

$$\beta = [\phi(1-\tau_y) + (1-\phi)(1-\tau_c)]\beta'; \quad \beta^* = [\phi(1-\tau_y^*) + (1-\phi)(1-\tau_c^*)]\beta'.$$

In this case, the long-run viability condition for residence-based taxation is met. This assumption, is analogous to the standard procedure of setting the discount rate of a small open economy under perfect capital markets to the given world interest rate, which can be viewed as representing the "pure" rate of time preference in the world economy.

The comparison between viability under these two types of tax regimes is interesting. Previous authors, such as Frankel, Razin, and Sadka (1991) have shown how, while both schemes are viable in their framework, they tend to argue in favor of residence-based taxation, from the viewpoint of international efficiency issues. While that may be the case, we find that the restrictions required for both the short-run and long-run viability of residence-based taxation in the present framework are stringent. Two differences in our analysis account for this. First, having two classes of income—dividends, and capital gains—which are taxed at different rates, raises further arbitrage possibilities. Given that dividend payouts tend to be source determined, this imposes constraints on residence-based taxation. Also, the fact that residence-based taxation tends to equate before-personal tax rates of return, while long–run rates of time preference determine required after–tax rates of return, introduces a further wedge into this form of taxation scheme.

4. Macroequilibrium

The macroeconomic equilibrium in the world economy can be characterized as follows:

Domestic Economy

$$U_c(c) = \alpha \qquad i.e.,\ c = c(\alpha) \quad c_\alpha < 0 \tag{30a}$$

$$(1-\tau_d)(1-\tau_p)f_k(k) = \theta \qquad \theta_k < 0 \tag{30b}$$

$$(1-\tau_f)(1-\tau_p^*)f_k^*(k^*) = \theta \qquad \theta_{k^*} < 0 \tag{30c}$$

Foreign Economy

$$U_c^*(c^*) = \alpha \qquad i.e.,\ c^* = c^*(\alpha^*) \quad c_{\alpha^*}^* < 0 \tag{31a}$$

$$(1-\tau_d^*)(1-\tau_p^*)f_k^*(k^*) = \theta^* \qquad \theta_{k^*}^* < 0 \tag{31b}$$

$$(1-\tau_f^*)(1-\tau_p)f_k(k) = \theta^* \qquad \theta_k^* < 0 \tag{31c}$$

where the tax rates $\tau_d, \tau_f, \tau_d^*, \tau_f^*$, satisfy the short and long–run viability conditions discussed in Section III. Equations (30a), (31a) determine consumption in terms of the respective marginal utilities of wealth. The two independent optimality conditions (30b, 30c), (31b, 31c) express the rates of return on consumption in terms of the after–tax marginal physical product of the respective capital stocks.

The dynamic evolution of the world economy may be represented by the following set of equations:[17]

$$\dot{\alpha}/\alpha = \beta - \theta \tag{32a}$$

$$\dot{\alpha}^*/\alpha^* = \beta^* - \theta^* \tag{32b}$$

$$\dot{k} + \dot{k}^* = f(k) + f^*(k^*) - c(\alpha) - c^*(\alpha^*) \tag{32c}$$

$$\dot{N} = f(k) - c(\alpha) - \dot{k} + \theta' N \tag{32d}$$

given k_0, k_0^*, N_0 and the intertemporal solvency condition

$$\lim_{t\to\infty} N e^{-\theta' t} = 0 \tag{32e}$$

where

$$\theta' \equiv (1-\tau_d)(1-\tau_p)f_k(k) \text{ for the source based regime}$$

$$\equiv (1-\tau_p)f_k(k) \text{ for the residence based regime.}$$

Equations (32a) - (32d) just restate (2d), (3d), (17), and (21), respectively, though with the perfectly integrated capital and goods markets, they are not all independent. As apart from possible initial jumps, α mirrors α^*, and likewise for k and k^*. The intertemporal solvency condition (32e) prevents either economy from running up infinite debt.

The relationship between the marginal utilities of wealth in the two economies, obtained by solving the dynamic equations (32a), (32b), depends upon the taxation regime. With source–based taxation, when viability implies $\theta = \theta^*, \beta = \beta^*$, it is straightforward to show that the two marginal utilities, are proportional, being related by[18]

$$\alpha^* = \overline{\mu}\alpha \tag{33a}$$

where $\overline{\mu}$ is constant over time, being determined by steady–state conditions. This equation implies that the ratio of the marginal utilities of consumption in the two economies, and therefore the distributions of consumption, remain fixed over time. With residence–based taxation, α, α^*, are now related by[19]

$$\alpha^* = \overline{\mu}\alpha^{(1-\tau_d^*)/(1-\tau_d)} \tag{33b}$$

In analyzing the dynamics, we assume that at any instant of time the aggregate world capital stock, and therefore wealth, is fixed, namely

$$W_0 + W_0^* = k_0 + k_0^*. \tag{34}$$

Wealth in the two economies are, respectively

$$W_0 = k_0 + N_0, \quad W_0^* = k_0^* - N_0$$

and either country can augment its stock of capital instantaneously by entering the world capital market, in accordance with

$$dk_0^* = -dk_0 = dN_0. \tag{35}$$

Thus the domestic economy can increase its initial stock of capital, k_0, by selling equities abroad, thereby reducing its net foreign asset position, N_0. The reverse occurs abroad.

A. Dynamic Adjustment

The general characteristics of the dynamic adjustment path in the world economy are essentially the same under both forms of tax regime. We shall derive the structure under source-based taxation, as follows. First, under this regime, $\tau_d = \tau_f^*, \tau_f = \tau_d^*$, and the consumer arbitrage conditions reduce to

$$(1-\tau_d)(1-\tau_p)f_k(k) = (1-\tau_d^*)(1-\tau_p^*)f_k^*(k^*) = \theta \tag{36}$$

implying that along the adjustment path

$$(1-\tau_d)(1-\tau_p)f_{kk}\dot{k} = (1-\tau_d^*)(1-\tau_p^*)f_{kk}^*\dot{k}^*. \tag{36'}$$

These two equations express $k^*, \dot{k}^*$ in terms of $k, \dot{k}$, respectively. Note that following any initial jump, the capital stocks in the two economies evolve together. Linearizing the world product market equilibrium condition (32c), together with (32a), and taking account of (36), (36′), the linearized dynamic evolution of the world economy can be represented by

$$\begin{pmatrix} \dot{k} \\ \dot{\alpha} \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & 0 \end{pmatrix} \begin{pmatrix} k-\tilde{k} \\ \alpha-\tilde{\alpha} \end{pmatrix} \tag{37}$$

where

$$a_{11} = \frac{(1-\tau_d^*)(1-\tau_p^*)f_{kk}^*f_k + (1-\tau_d)(1-\tau_p)f_{kk}f_k^*}{(1-\tau_d^*)(1-\tau_p^*)f_{kk}^* + (1-\tau_d)(1-\tau_p)f_{kk}} > 0$$

$$a_{12} = -\frac{(c_\alpha + c_\alpha^*\overline{\mu})(1-\tau_d^*)(1-\tau_p^*)f_{kk}^*}{(1-\tau_d^*)(1-\tau_p^*)f_{kk}^* + (1-\tau_d)(1-\tau_p)f_{kk}} > 0; \quad a_{21} = -\tilde{\alpha}\theta_k > 0 \tag{38}$$

and tildes denote steady-state values.[20]

The dynamics described by (37) are a saddlepoint, with the stable eigenvalue being denoted by $\lambda < 0$. Starting from an initial capital stock k_0, the stable solution is:

$$k(t) = \tilde{k} + (k_0 - \tilde{k})e^{\lambda t} \tag{39a}$$

$$\alpha(t) = \tilde{\alpha} + \frac{a_{21}}{\lambda}(k_0 - \tilde{k})e^{\lambda t}. \tag{39b}$$

These two equations define a negatively sloped stable locus in $k - \alpha$–space.

To determine the accumulation of net foreign assets, we consider (32d), expressed in terms of α, k, as follows:

$$\dot{N} = f(k) - c(\alpha) - \dot{k} + (1 - \tau_d)(1 - \tau_p)f_k(k)N \tag{40}$$

and apply the procedure discussed by Sen and Turnovsky (1990), Turnovsky (1991). This involves linearizing this equation about its steady state, substituting for (39a), (39b), and invoking the intertemporal solvency condition (32e). Thus starting from an initial stock of net foreign assets N_0, the stable adjustment, consistent with intertemporal solvency, is

$$N(t) = \tilde{N} + \frac{\Omega}{\lambda - \beta}(k_0 - \tilde{k})e^{\lambda t} \tag{41a}$$

with

$$N_0 - \tilde{N} = \frac{\Omega}{\lambda - \beta}(k_0 - \tilde{k}) \tag{41b}$$

and where

$$\Omega \equiv f_k - \lambda + c_\alpha \alpha \theta_k / \lambda + \theta_k \tilde{N}.$$

The expression Ω describes the instantaneous effect of an increase in the domestic capital stock on the current account. This operates through two channels. First, the expression

$$f_k - \lambda + c_\alpha \alpha \theta_k / \lambda \equiv \partial(f - \dot{k} - c)/\partial k$$

represents the impact of a change in the domestic capital stock on the trade balance. The increase in output and the decline in investment, as k increases is positive. The accompanying decline in α and the increase in consumption it generates is negative. The second factor, represents the fact that as the capital stock increases, the rate of return declines and this results in a declining current account balance if the country is a creditor nation and an increase otherwise. Note that in the special case that the two economies have identical technologies, tax structures, and preferences, the trade balance effect is zero so that $sgn\ (\Omega) = -sgn\ (\tilde{N})$.[21] That is, if in equilibrium the economy is a net creditor, as it accumulates capital, it acquires foreign assets; the reverse holds for a debtor nation.

The solution (39a), (39b), and (41a) expresses the dynamics from the viewpoint of the domestic economy. However, the solution for the foreign capital stock is readily obtained from (36′) and the foreign marginal utility of wealth from (32b).

B. Steady State

We shall focus on the case where tax is source–based. In this case, the steady–state equilibrium includes the following set of relationships:

$$(1-\tau_d)(1-\tau_p)f_k(\tilde{k}) = \beta \tag{42a}$$

$$(1-\tau_d^*)(1-\tau_p^*)f_k^*(\tilde{k}^*) = \beta \tag{42b}$$

$$f(\tilde{k}) + f^*(\tilde{k}^*) = \tilde{c} + \tilde{c}^* \tag{42c}$$

$$\beta\tilde{N} = \tilde{c} - f(\tilde{k}) = f^*(\tilde{k}^*) - \tilde{c}^* \tag{42d}$$

$$\tilde{N} - N_0 = \frac{\Omega}{\lambda - \beta}(\tilde{k} - k_0). \tag{42e}$$

The first two equations are the steady–state arbitrage conditions, which in the long run involve equating the after–tax rates of return to the (common) given consumer rate of time preference. These equations determine the capital stocks in the two countries, in terms of the tax rates prevailing in that country alone. Having determined the capital stocks, and hence national output, and therefore world output, the steady–state goods market equilibrium condition determines long–run total world consumption. Note that $\tilde{k}, \tilde{k}^*$, and $\tilde{c} + \tilde{c}^*$ are determined by production conditions alone.

Given $\tilde{k}$, equation (42e) determines the steady–state net asset position, $\tilde{N}$, of the domestic (and foreign) economy. Note that this depends upon the initial stocks of the two assets, k_0, N_0. This is a consequence of the integrated world capital market. As discussed elsewhere by Sen and Turnovsky (1991), Turnovsky (1991), in the context of a small open economy, it introduces hysteresis into the system. In this case, temporary tax shocks will have permanent effects on the international distribution of consumption and wealth, though not on the respective world aggregates.[22]. In any event, having determined $\tilde{N}$, the first equality in (42d) determines domestic consumption. It equals domestic output, plus net income (which may be positive or negative) on foreign assets. Foreign consumption is determined similarly. Having determined consumption, the marginal utilities are obtained from (31a) and (31b), respectively, with $\overline{\mu}$ being the ratio between them.

Finally, we may note that the steady state is determined in a generally similar way in the case of residence–based taxation. The main difference is that personal taxes will impact in a somewhat different way.

5. Transmission of Tax Shocks Under Source–Based Regime

Table 1 summarizes the short–run and long–run effects of an unanticipated permanent increase in the domestic corporate tax rate under the source–base system of taxation. Personal and corporate taxes impinge on the economy in identical ways, so that our discussion applies to either form of taxation. For expositional simplicity we shall assume that the economies have: (i) identical tastes; (ii) identical technologies; and that (iii) the initial equilibrium is one of zero taxes. We shall also assume that in the neighborhood of the equilibrium we consider, the domestic economy is a net creditor nation, i.e., $\tilde{N} > 0$.

A. Domestic Tax Increase

Suppose that the world economy is initially in steady-state equilibrium. The introduction of a corporate profit tax in the domestic economy immediately reduces the after-tax marginal physical product of capital in the domestic economy below the required rate of return and the rate of return on capital abroad. As a consequence, there is an instantaneous transfer of capital from the domestic, to the foreign economy. Associated with this shift of the instantaneously given world capital stock, is an increase in the net foreign asset holdings of domestic residents (with a corresponding reduction by foreigners), as they increase their equity holdings of foreign capital. The instantaneous move of capital from the domestic, to the foreign economy, lowers the marginal physical product of capital abroad, and hence the after-tax world rate of return on capital, θ.

In the long run, the after-tax return on capital in the two economies must equal the common, given world rate of time preference. In both economies, the after-tax marginal physical product of capital is therefore restored to its original level. With the tax rate abroad remaining unchanged, the capital stock in the foreign economy returns to its original level. Hence following its initial purchase of capital from the domestic economy, the foreign economy decumulates capital. However, with the required return on capital being restored to its original level, the demand for capital in the domestic economy is reduced further, and capital decumulates over time in the domestic economy, as well. For the case where the economies have identical preferences and production structures, the short-run reduction in the domestic stock of capital is precisely equal to half its eventual steady-state decline. The time paths of the capital stocks in the two economies are illustrated in Figure 1.A.

The long-run net asset position of the domestic economy is unclear. The initial sale of capital abroad raises its initial stock of net foreign assets, N_0. However, being assumed to be a net creditor nation, the subsequent decline in the domestic capital stock is associated with a current account deficit. Foreign assets are decumulated and the net effect on the long-run net asset position depends upon whether the initial increase in foreign assets exceeds the subsequent accumulation of current account deficits.

The response of wealth is as follows. The initial trade of assets leaves wealth unchanged. However, the decrease in the capital stock in the domestic economy over time, with the accompanying reduction in the economy's holdings of net foreign assets, leads to an unambiguous long-run decline in the wealth position of the domestic economy. With the long-run capital stock abroad returning to its original level, the response of wealth abroad depends solely upon $\tilde{N}$. The initial increase in N leads to a reduction in the holdings of foreign assets abroad, but the accumulation by the foreign economy leads to a positive effect, and the net effect on foreign wealth depends upon which dominates. With the net foreign asset position representing a transfer between the economies, aggregate world wealth, $\tilde{k} + \tilde{k}^*$ always declines in the long run.

Moreover, in the absence of initial taxes, the response of consumption mirrors that of wealth. This can be seen by noting from (42d) that

$$d\tilde{c}/d\tau_p - \beta\left(d\tilde{N}/d\tau_p + d\tilde{k}/d\tau_p\right) = \beta d\tilde{W}/d\tau_p; \quad d\tilde{c}^*/d\tau_p = -\beta d\tilde{N}/d\tau_p = \beta d\tilde{W}^*/d\tau_p.$$

Long-run consumption in the domestic economy therefore declines, foreign consumption may fall or rise, while long-run world consumption also falls. These responses in wealth are reflected, as one would expect in the corresponding marginal utilities $\tilde{\alpha}, \tilde{\alpha}^*$. Since wealth is more adversely affected in the domestic economy, the ratio $\overline{\mu}$ rises.

Being a world of forward-looking agents, short-run consumption and marginal utility are driven in part by the perfectly foreseen steady-state responses. The fact that it is known that it is going to become less desirable to accumulate capital in the future, reduces the marginal utility of wealth today. At the same time, the knowledge that the reduction in steady-state wealth will raise the marginal utility of wealth in the long run, tends to raise the short-run marginal utility, as well. Which effect dominates depends upon tastes.

Consider the specific example in which the utility in both countries is represented by a logarithmic function. Then using (42d), we can easily see that an increase in τ_p will lead to a decline in initial marginal utilities at home and abroad, and therefore to increases in the initial consumption levels.[23] With identical tastes, consumption rises less in the domestic economy, if it is a net creditor nation ($\tilde{N} > 0$), than it does abroad. This is because of the expected decline in foreign earnings during the transition. For less restrictive utility functions, initial consumption in the domestic economy may either rise or fall, although it will always rise abroad, as long as $\tilde{N} > 0$. However, initial aggregate consumption in the world economy $c(0) + c^*(0)$ will always rise unambiguously. The time paths for consumption in the two economies are illustrated in Figure 1.B.

A phase diagram representation of these adjustments is illustrated in Figure 2. The first (northeast) quadrant portrays the negatively-sloped equilibrium relationship between the domestic capital stock k, and the domestic marginal utility of wealth α. The second quadrant depicts the corresponding relationship abroad. The lower two quadrants illustrate the relationships between the accumulation of the capital stock and foreign assets in the two economies. On the assumption that the economies are identical and that the domestic economy is a net creditor ($\tilde{N} > 0$), these imply a positive relationship between k and N and a negative relationship between k^* and N.

The dynamics are as follows. The initial world equilibrium is represented by the points A, D, M, and R in the four quadrants. At time 0, say, when the tax τ_p is introduced, the short-run equilibrium jumps to A', D', M', and R', respectively. In the first quadrant, this represents the combination of (i) the initial decline in k_0, accompanied by (ii) the initial decline in α_0. The displacement of k_0^* in the second quadrant equals $-dk_0$, while as we have noted, $\alpha^*(0)$ declines more than $\alpha(0)$, due to the anticipated transfer of wealth abroad. The jumps RR', MM' represent the initial trades $dN_0 = dk_0^* = -dk$. The stable adjustment paths shift as indicated. Following the initial jump, the stocks of capital and foreign assets held by the domestic economy decline steadily, while the net foreign asset position abroad accumulates. These adjustments are represented by the movements $R'S$ and $M'N$ in the third and fourth quadrants. Likewise, the marginal utilities of wealth at home and abroad increase, as the world capital stock declines. At all points, $\alpha^*(t) < \alpha(t)$, reflecting the fact that domestic consumption is more adversely affected by the domestic tax.

B. *World-Wide Tax Increase*

The effects of a uniform world–wide tax increase can be readily obtained from Table 1. The main point to note is that equal tax increases imposed on identical economies leads to no initial trade in capital; i.e., $dk_0 = dk_0^* = dN_0 = 0$. The capital stocks in the two economies evolve gradually from their respective initial levels. In the long run, the fact that the tax increase is levied in both economies, in effect leads to a doubling to the long–run adverse effects on wealth.

C. *Welfare Effects*

The representative agent in each country derives utility from consumption. Thus the effects of a tax increase on his instantaneous level of welfare reflects what happens to consumption. Thus, a tax increase in the domestic economy will tend to raise welfare in the short run, in the two economies, though with a more positive effect abroad than domestically. Over time, however, as consumption declines, the instantaneous level of welfare, declines as well, declining more in the home country, than abroad.

An appropriate summary of welfare is provided by the intertemporal utility functions (1a) of the respective representative agents. In the case of the domestic agent, the instantaneous level of utility at time t, as the economy follows the transitional dynamic adjustment path described in Section 5.A, may be approximated by the linear expression:

$$U(c(t)) \cong U(\tilde{c}) + U_c[c(0) - \tilde{c}]e^{\lambda t}. \tag{43}$$

Substituting this into (1a), the level of welfare of the domestic consumer is approximately

$$Z \equiv U(\tilde{c})/\beta + U_c[c(0) - \tilde{c}]/(\beta - \lambda). \tag{44}$$

This expression approximates the utility of the agent in terms of his instantaneous and steady–state levels of consumption. The first term in (44) represents the agent's welfare if the steady state were attained instantaneously. The second term reflects the adjustment due to the fact that the steady state is reached only gradually alonr the transitional path.

Differentiating (44) with respect to τ_p, yields

$$\frac{dZ}{d\tau_p} = \frac{U_c}{\beta(\beta - \lambda)}\left[\beta\frac{dc(0)}{d\tau_p} - \lambda\frac{d\tilde{c}}{d\tau_p}\right].$$

Substituting for $\frac{dc(0)}{d\tau_p}, \frac{d\tilde{c}}{d\tau_p}$, from Table 1, we see that for identical economies, and in the absence of initial taxes, this expression and the corresponding effect abroad reduce to

$$\frac{dZ}{d\tau_p} = -\frac{1}{2}\beta^2\tilde{N}; \quad \frac{dZ^*}{d\tau_p} = \frac{1}{2}\beta^2\tilde{N}. \tag{45}$$

We thus conclude the following. If the two economies are identical and tax rates are initially zero, the introduction of a positive tax in the domestic economy will deteriorate domestic welfare if and only if the country is a net creditor. It will improve welfare abroad correspondingly, leaving total world welfare unchanged. The reverse applies if the country imposing the tax is a net debtor. The fact that starting from an initial zero tax situation, the imposition of a tax has no first order welfare effect, is well known. The intuition for the international redistribution of welfare that occurs, reflects the fact that the decline in the interest rate during the transition results in a net transfer from the creditor, to the debtor, nation. It is also straightforward to show that if the tax rate is initially positive, then an increase in this rate will lower world welfare unambiguously.

6. Transmission of Tax Shocks Under Residence–Based Regime

As emphasized in Section 3, residence–based taxation imposes severe restrictions on tax and dividend policy, in order to be viable in the long run. Since the general dynamic characteristics are similar under the two tax regimes, we shall restrict our treatment of this case to a brief discussion of two examples.

First, in the case noted in Section 3, where the rates of time preference in the two economies are taken to be tax–adjusted proportions of the "pure" rate of time discount, the steady–state capital stocks in the two economies are determined by

$$(1-\tau_p)f_k^*(\tilde{k}) = (1-\tau_p^*)f_k^*(\tilde{k}^*) = \beta' \tag{46}$$

while the short–run marginal products of capital satisfy (26′). It is straightforward to show that in this case, an increase in the corporate profit tax rate operates both during the short–run transitional phase, and in the long run, just as described in Section 5. By contrast with the source–based regime, however, a change in the personal tax rate has no effect either in the short run or in steady state. All that happens is that the appropriate rate of time preference is adjusted and everything else remains unchanged.

In the absence of corporate taxes, $\tau_p = \tau_p^* = 0$, and (46) denote the open economy version of the production efficiency theorem of Diamond and Mirrlees (1971). In the infinite horizon model this means that the long–run capital stocks satisfy the modified golden rule. However, it is shown here that it obtains only in special conditions, namely: residence–based tax regimes with coordinated dividend policies; tax adjusted country–specific discount rates; and no corporate income taxes. In the two–period model of Frenkel, Razin, and Sadka (1991, Chapter 5) they emphasize the restriction of no corporate taxes, but with the infinite horizon, further restrictions are required.[24]

As a second example, suppose that the rates of time preference β, β^*, are fixed, so that $(1-\tau_d)/(1-\tau_d^*) = \beta/\beta^*$. In this case an increase in the domestic tax rate, τ_d say, will require an increase in the corresponding tax rate abroad. This is essentially similar to the adjustment following a worldwide tax increase noted in the previous section.

7. Conclusions

This paper has analyzed the international transmission of tax shocks in a two–country infinite–horizon representative agent framework. The main features of the transitional dynamic adjustment path following a tax increase have been characterized. A tax increase in, say, the domestic economy, leads to an initial transfer of capital from the domestic to the foreign economy. Thereafter the capital stock in both countries, and therefore in the world economy, steadily declines, with the foreign capital stock ultimately being restored to its original level. The levels of consumption involve a more pronounced intertemporal tradeoff, rising in the short run, and declining over time as the capital stock is depleted.

In considering such tax shocks, the viability of the underlying tax regimes has been emphasized. This issue arises from the arbitrage conditions characterizing equilibrium in a perfect world capital market, a consequence of which is to impose restrictions on the tax rates which the respective tax authorities may feasibly set. Conditions for both short–run and long–run viability have been considered. Whereas the former reflect the familiar short–run arbitrage opportunities, the latter arises from the long–run equality of the after–tax returns and the consumer rate of time preference.

The two polar regimes of source–based taxation and residence–based taxation have been considered. In general, we find that the former is more likely to satisfy the viability conditions, than is the latter. Source–based taxation is always viable in the short–run, while all long–run viability requires is that the agents in the two economies have equal rates of time preference. By contrast, in a world where firms finance using equities, in order for residence–based taxation to be viable in the short run, requires the coordination of dividend policy or of the appropriate tax rates in the two economies. The constraints on the long–run viability of residence–based taxation are even more stringent, in general imposing restrictions on both dividend policy and taxation in the two economies. The fact that the rate of dividend payout tends to be source–determined imposes a constraint on residence–based taxation. It suggests that the coordination of dividend policy is a necessary part of tax harmonization, if residence–based taxation is to be viable in the long run. These considerations need to be weighed against the efficiency advantages associated with residence–based taxation.

To conclude, one important feature of our framework merits comment. The long–run restrictions, applicable particularly to residence–based taxation, stem from a combination of: (i) the long–run equality of after–tax rates of return with the rates of time preference; and (ii) the fact that the latter are taken to be fixed exogenously in the two economies. Since these conditions are both standard characteristics of intertemporal economics, this framework serves as a reasonable starting point. However, it should be acknowledged that the combination of these two conditions could be proving to be overly restrictive and that the conditions for long–run viability may be substantially relaxed.

There are several ways in which this may be accomplished. The first is to relax (ii) through the introduction of variable discount rates as in Nielsen and Sorensen (1991). In this case the long–run rate of time preference becomes determined endogenously, rather than serving as a constraint. Secondly, one can retain (ii), but relax (i), by adopting the overlapping families framework of Weil (1989). Alternatively, (i) can be relaxed in an equilibrium characterized by steady growth. Finally, the introduction of risk in an intertemporal framework as in Grinols and Turnovsky (1991) weakens the arbitrage conditions, thereby further relaxing (i). All of these approaches themselves impose restrictions but are directions in which this analysis can be usefully extended.

TABLE 1

INCREASE IN DOMESTIC TAX τ_p OR τ_d

	A. Short Run		B. Long Run
k_0	$\frac{\beta}{2f_{kk}} < 0$	$\tilde{k}$	$\frac{\beta}{f_{kk}} < 0$
k_0^*	$-\frac{\beta}{2f_{kk}} > 0$	$\tilde{k}^*$	0
N_0	$-\frac{\beta}{2f_{kk}} > 0$	$\tilde{N}$	$\frac{\beta}{2}[-\frac{1}{f_{kk}} + \frac{N}{\lambda - \beta}]$
W_0	0	$\tilde{W}$	$\frac{\beta}{2}[-\frac{1}{f_{kk}} + \frac{\tilde{N}}{\lambda - \beta}]$
W_0^*	0	$\tilde{W}^*$	$-\frac{\beta}{2}[-\frac{1}{f_{kk}} + \frac{\tilde{N}}{\lambda - \beta}]$
$W_0 + W_0$	0	$\tilde{W}+\tilde{W}^*$	$\frac{\beta}{f_{kk}} < 0$
θ_0	$-\frac{\beta}{2}$	$\tilde{\theta}$	0
$c(0)$	$\frac{\beta}{2(\lambda - \beta)}[\frac{U_c}{U_{cc}} + \beta\tilde{N}]$	$\tilde{c}$	$\frac{\beta^2}{2}[\frac{1}{f_{kk}} + \frac{\tilde{N}}{\lambda - \beta}]$
$c^*(0)$	$\frac{\beta}{2(\lambda - \beta)}[\frac{U_c}{U_{cc}} - \beta\tilde{N}]$	$\tilde{c}^*$	$\frac{\beta^2}{2}[\frac{1}{f_{kk}} - \frac{\tilde{N}}{\lambda - \beta}]$
$c(0)+c^*(0)$	$\frac{\beta}{\lambda - \beta}\frac{U_c}{U_{cc}} > 0$	$\tilde{c}+\tilde{c}^*$	$\frac{\beta^2}{f_{kk}} < 0$
$\alpha(0)$	$\frac{\beta U_{cc}}{2(\lambda-\beta)}[\frac{U_c}{U_{cc}} + \beta\tilde{N}]$	$\tilde{\alpha}$	$\frac{\beta^2 U_{cc}}{2}[\frac{1}{f_{kk}} + \frac{\tilde{N}}{\lambda-\beta}]$
$\alpha^*(0)$	$\frac{\beta U_{cc}}{2(\lambda-\beta)}[\frac{U_c}{U_{cc}} - \beta\tilde{N}]$	$\tilde{\alpha}^*$	$\frac{\beta^2 U_{cc}}{2}[\frac{1}{f_{kk}} - \frac{\tilde{N}}{\lambda-\beta}]$

Assume: (i) identical tastes; (ii) identical technologies; (iii) no initial taxes.

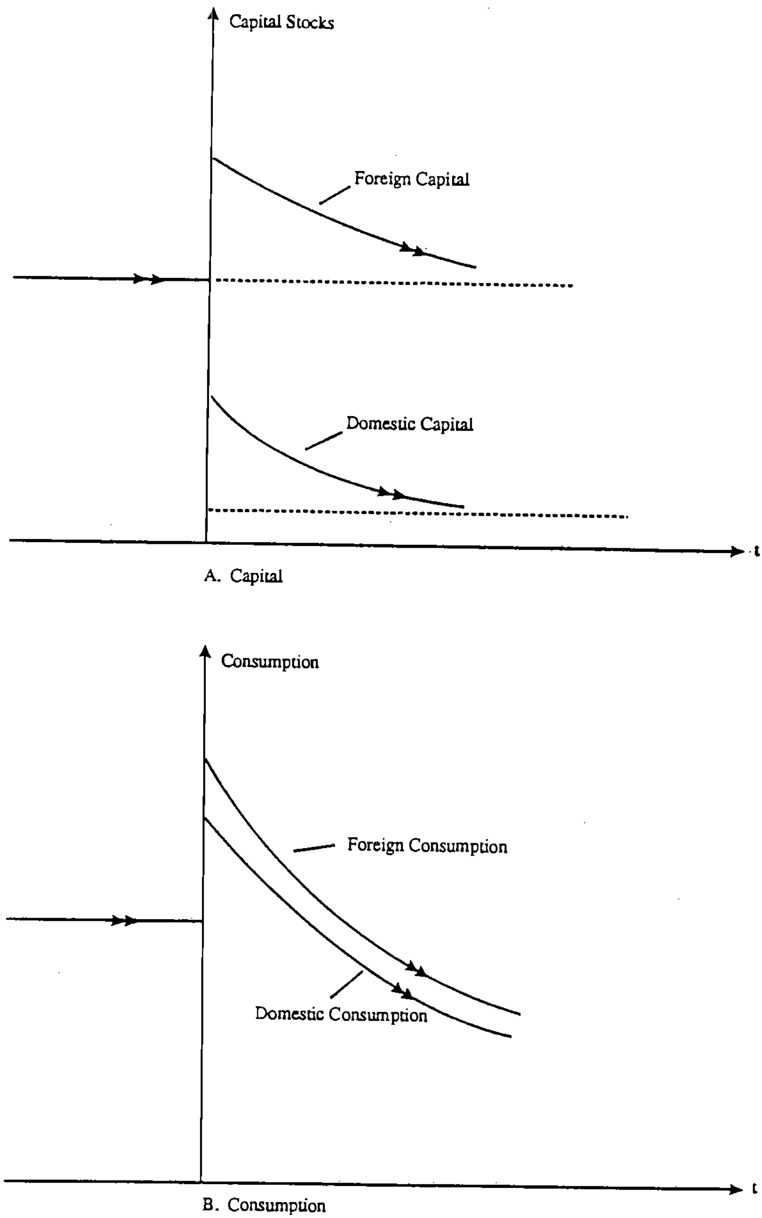

FIGURE 1. ADJUSTMENT TIME PATHS

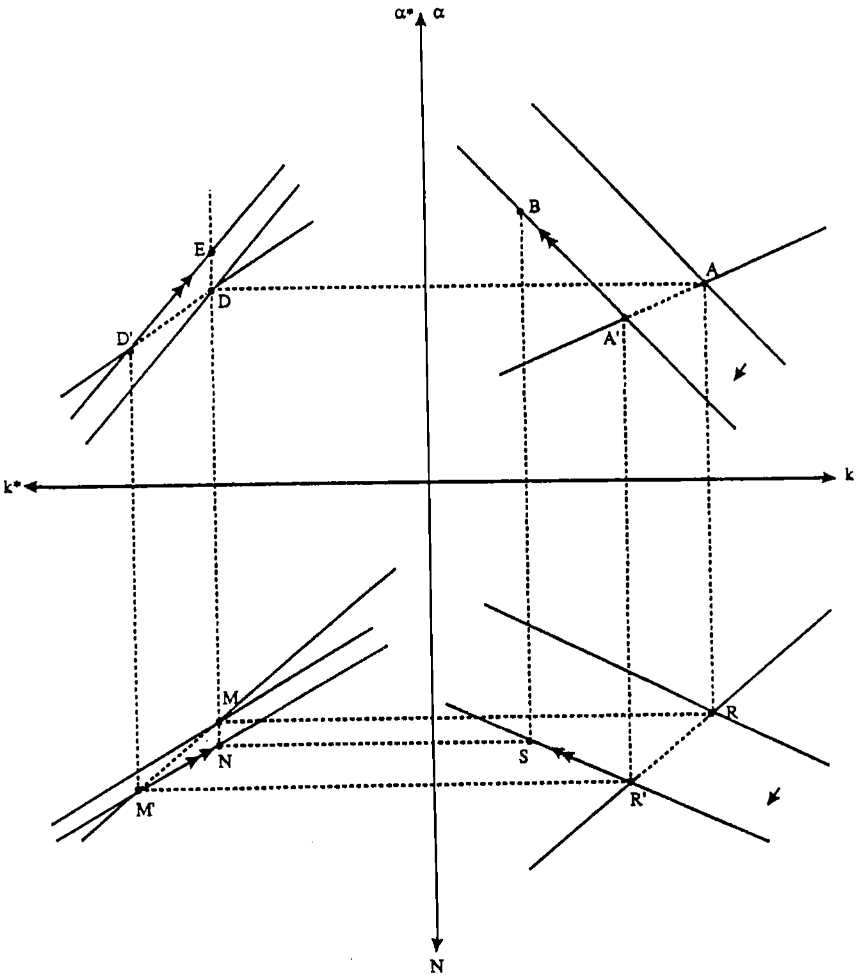

FIGURE 2. PHASE DIAGRAM

FOOTNOTES

*We are grateful to James Hines for helpful comments on an earlier version of this paper.

[1]A recent paper by Ihori (1991) discusses issues of tax reform under alternative tax regimes in a overlapping generations framework; see also Sibert (1990).

[2]In effect we present a two–country version of the Brock–Turnovsky (1981) and Turnovsky (1982) models. Nielsen and Sorensen (1991) use a similar approach to analyze tax shocks in an international setting. They assume a variable discount rate and restrict themselves to a small open economy.

[3]We adopt the following notation. Time derivatives are denoted by dots. Where the meaning is clear, partial derivatives are denoted by lower case letters.

[4]Note that we do not consider bond financed investment by the firm. Frenkel, Razin, and Sadka (1991, Chapter 5) discuss this situation, but assume that the firm can borrow only domestically.

[5]Alternative dividend policies can also be considered. For example, Brock and Turnovsky (1981) assume the dividend yield $\frac{D}{V}$ to be fixed. Other authors, such as Summers (1981) assume that the marginal source of financing is through retained earnings, with dividends being determined residually. These cases can be analyzed, as in this paper.

[6]The optimality condition for the equilibrium real wage is determined by the marginal physical product of the fixed labor supply condition. Substituting this condition, together with (12), into (10) and invoking the homogeneity of the production function leads to the differential equation relating V to k

$$\dot{V} - \dot{k} = [\theta/(1 - \tau_{c,rd})](V - k).$$

The transversality condition for the firm then implies the equality $V(t) = k(t)$.

[7]In general, this assumption implies an international redistribution of tax revenues. An alternative assumption, which is almost identical, is to assume that tax revenues are rebated to the residents of the country which levied the original taxes.

[8]These two regimes represent polar extremes and pure forms are not commonly found in practice. Nevertheless, they can capture the essential features of various more realistic international tax arrangements. For example, foreign tax credits can be accommodated in the following manner. Consider a domestic resident who is taxed abroad on his foreign capital income and can credit the amount paid abroad against his domestic tax liability. As long as the amount paid abroad is less than the domestic tax rate, his effective tax rate is residence–based. On the other hand, if the amount paid abroad exceeds the domestic tax rate, since the domestic tax authorities will generally not refund the difference, the individual's effective tax rate is

source–based. However, note that the distribution of tax revenues across countries is indeed sensitive to the details of such arrangements. Finally, "tax–haven" countries can be considered as operating source–based tax regimes.

[9]Equilibrium valuation of equities implies $V^i = qE^i = k^i; \quad V^{*i} = q^* E^{*i} = k^{*i}; \quad i = d, f$.

[10]It is clear that $k = k^d + k^f; \quad k^* = k^{*d} + k^{*f}$.

[11]Viability of the equilibrium refers to the assurance that the first order optimality conditions hold with equality, so that the equilibrium is an interior one.

[12]See also Gordon (1986) for a discussion of this issue for a small open economy.

[13]In the case of the domestic economy, this relationship follows directly by equating (2b′) and (2c′). For the foreign economy it follows by equating (3b′) and (3c′), and using the fact implied by (28a), $(1-\tau_d)/(1-\tau_f^*) = (1-\tau_f)/(1-\tau_d^*)$.

[14]Note that if $\tau_c < \tau_y, \tau_c^* < \tau_y^*$, and each firm follows the optimal dividend policy, namely $\hat{\phi} = \hat{\phi}^* = 0$, the short–run viability condition (28b) is automatically met. Problems of viability, will arise however, if say, $\tau_c < \tau_y, \tau_y^* < \tau_c^*$, so that optimal dividend policy calls for $\hat{\phi} = 0, \hat{\phi}^* = 1$.

[15]For example in 1991 British firms paid out around 65 percent of their earnings as dividends in contrast to German firms for whom the payout rate was around 30 percent. Moreover the difference in the payout rates has been diverging since the late 1970's when the payout rate for firms in both countries was around 50 percent.

[16]This may be easier to achieve, where one of the two countries is smaller and willing to adapt its tax policy to that of the larger economy, along the lines discussed by Feldstein and Hartman (1979).

[17]To be concrete, the dynamic relationships are applicable to: (i) source–based taxation and (ii) residence–based taxation with dividend harmonization. Other regimes will require the net foreign asset accumulation equation (32d) to be modified in accordance with (21).

[18]Under viable source–based taxation, (32a) and (32b) imply $\dot{\alpha}^*/\alpha^* = \dot{\alpha}/\alpha$ from which (33a) immediately follows.

[19]Under viable residence–based taxation with dividend harmonization, (32a) and (32b) imply $\dot{\alpha}^*/\alpha^* = [(1-\tau_d^*)/(1-\tau_d)]\dot{\alpha}/\alpha$ from which (33b) is obtained.

[20]In the discussion of the transmission of the tax shock we shall assume identical technologies, identical tastes, and identical tax structures, $a_{11} = f_k, -a_{12} = c_\alpha$ and the characteristic equation associated with (37) simplifies to $\lambda^2 - f_k\lambda + \alpha c_\alpha \theta_k = 0$.

[21]Under these conditions, the trade balance effect is precisely the characteristic equation to the dynamic system, namely $f_k - \lambda + c_\alpha \alpha \theta_k/\lambda = 0$.

[22]This is because long-run aggregate consumption and wealth depend upon production conditions alone, whch in steady state are unaffected by temporary tax changes. Temporary tax changes would have a permanent effect on capital stock and therefore on aggregate world consumption, if labor were endogenous.

[23]This can be seen as follows for the logarithmic utility function, *ln c*

$$U_c/U_{cc} + \beta\tilde{N} = -c + \beta\tilde{N} = -f(\tilde{k}) < 0.$$

Thus from Table 1, we see that initial consumption in the domestic economy $c(0) > 0$. Likewise for the identical foreign economy

$$U_c/U_{cc} - \beta\tilde{N} = -\tilde{c}^{*} - \beta\tilde{N} = -f^{*}(\tilde{k}^{*}) < 0$$

implying that $c^{*}(0) > 0$, as well.

[24]See also Razin and Sadka (1991a, 1991b), Giovannini (1990), and the discussion of Gordon (1990) for the case of the small open economy.

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