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On Noncooperative Capital Income Taxation in Open Economies

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Abstract

This paper discusses the strategic use of capital income taxation and lump-sum fiscal policies for gaining national advantage in an integrated world capital market. Each fiscal authority seeks to maximize a social welfare function defined over the utilities of home country residents incorporating national redistributing objectives. A national optimum policy is to impose a non-discriminatory source-based capital income tax or subsidy along with an optimal lump-sum tax and transfer plan. Residence-based capital income taxes do not augment the set of lump-sum fiscal instruments, although both policies can be used to influence the world interest rate to national advantage, redistributing welfare internationally. When unrestricted lump-sum fiscal policies are unavailable, source-based capital income taxes may be needed to achieve distributional objectives, so that departures from global production efficiency can arise in a cooperative equilibrium.

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Contents   Page

Summary

This paper examines the strategic use of capital income taxation in concert with national lump-sum fiscal policies for gaining advantage in world capital markets. The fiscal authority of each country possesses a social welfare function expressing distributional objectives over the welfare of residents. The paper shows that the optimum policy for a single country is to combine a source-based capital income tax or subsidy with a lump-sum fiscal policy.

In a noncooperative equilibrium, discriminatory taxation by residence of recipients or by location of assets does not increase the planners' sets of fiscal instruments. Residence-based interest income taxes are redundant in the presence of lump-sum fiscal policies (possibly, deficit financed), although both policies allow a country to influence the world rate of interest to its benefit. In this context, residence-based taxes do not lead to departures from allocational efficiency in the global economy, but their strategic use does lead to redistribution of welfare across borders.

The paper also discusses the role of source-based taxation for achieving redistributional goals when unrestricted lump-sum fiscal policies are unavailable. Capital income taxation and departures from global production efficiency can arise when national or international distribution become social welfare objectives.

I. Introduction

The impending removal of internal barriers to commodity trade and factor mobility within the EC combined with the increased possibility of European monetary integration has shifted attention to the coordination of national fiscal policies. With the potential loss of national discretion over seigniorage, national public spending can be financed only through taxes and other current revenues or by national public borrowing. With an integrated capital market and fixed exchange rate regime (or a fortiori with a monetary union and pooled international reserves), interest rates for financial claims offering a common combination of risk and return will be equalized among the members of the EC. The location of physical capital within the community will be determined by factors such as taxes on capital and interest income, as well as regulations, labor costs, and, possibly, public services to capital. The need for coordination of both the tax treatment of capital and of the fiscal financing plans of the public sector has been raised in many quarters.

This paper discusses aspects of two of the issues posed by European economic integration for national fiscal policy making. These are the harmonization of capital income taxation and the coordination of public sector finance of a stream of exhaustive public spending. The emphasis is placed on the distributional questions raised by policy coordination and on the use of national fiscal policies to gain advantage in an integrated international economy.

Independent fiscal policy making in the presence of an integrated world capital market can lead to an inefficient allocation of resources due to the transmission of policies chosen by one country on the opportunity sets of other countries. Adverse spillover effects of national fiscal policies on other countries form a common basis for arguments in favor of international policy coordination. An important distinction must be made between those spillovers that are properly called externalities, leading to reductions in total world surplus as a result of attempts to maximize only national welfare by fiscal authorities, and spillovers that alter the world distribution of wealth and income through changes in prices.

Public sector budget deficits or surpluses for one country affect world interest rates and real exchange rates. However, such spillovers are a feature of general international interdependence and need not necessarily provide an argument for fiscal policy coordination on efficiency grounds. In the absence of preexisting distortions, such as distortionary commodity or capital income taxation, internationally enjoyed public goods (or bads), incomplete markets for risk-sharing, technological externalities, or Keynesian market failures, the impact of one country's budgetary policy on another country's opportunity set is a pecuniary externality. Higher interest rates redistribute income from borrowers to lenders. This occurs both internationally and within the national economy. Interest rate changes distribute income towards

renters and away from labor and the owners of other real resources. Higher interest rates also tend to be associated with intergenerational redistribution from the young to the old. International distributional issues should be an area of legitimate policy concern.

The distinction between international policy interdependence and adverse externalities being imposed on other countries by one country's deficit-financing plan has been discussed by Buiter and Kletzer (1990a, 1990b, and 1990c). The first two of these papers analyze the positive and normative economics of lump-sum fiscal policies in a two-country world lacking Ricardian equivalence, respectively. The scope for the strategic use of lump-sum policy to achieve national welfare objectives is shown to exist even though the resulting equilibrium is efficient. The analysis of distortionary capital income tax policies in this paper is carried out using the framework of Buiter and Kletzer (1990a, b). Lump-sum fiscal policies are allowed in part of this paper where they complement distortionary taxation for achieving national goals. The presence of national redistributional objectives plays a central role in the discussion of adverse national fiscal policy externalities and of the coordination of distortionary capital income taxation for efficient resource allocation with respect to national social policy objectives.

Capital income tax rates and the choice of the tax base can be used strategically by governments to promote national objectives at the expense of other countries' welfares. The decision between the application of the residence or the source principle of capital income taxation will have major effects on the location of economic activity. Much has been made of the argument that capital income taxes should not interfere with the efficient international allocation of capital (for example, Giovannini (1989) and Giovannini and Hines (1989)). International production efficiency requires that the before-tax rates of return to physical capital be equal across borders. This is achieved by a global residence-based system of capital income taxation: an individual's asset income is subject to the same tax rate regardless of where the income is produced. Competition between fiscal authorities for the location of physical capital is easily seen to lead to inefficiently low levels of capital income taxation when taxes serve to distribute the burden of providing given levels of public spending across residents (Gordon (1986). While the Diamond-Mirrlees production efficiency theorem of optimal taxation suggests that the before tax rate of return to capital should be equalized across borders, explicit national and international distributional objectives can conflict with this prescription. The theorem applies to the distribution of the burden of taxation for raising revenue for the provision of public goods in a representative agent framework. The main concern in this paper is the importance of national distributional objectives for international coordination of capital income taxation.

Harmonization of capital tax systems across borders can have multiple meanings. It can mean the adoption by different countries of common definitions of the tax base, or it can go as far as international

agreement on the rates of taxation adopted by countries. International taxation of capital income on a residence-basis requires that countries cooperate to deter tax evasion. Bank secrecy laws and convenient exemptions from taxpayer registration of portfolio investments are adopted by countries to increase their tax bases in the presence of international capital mobility. One aspect of coordination of fiscal policies is the harmonization of income reporting requirements and reaching agreements to exchange information about the nonlabor income of foreign residents.

Agreement not to impose discriminatory taxation of income received by foreign residents from holdings of home country capital or of income received by home country residents from foreign capital may be a rudimentary part of capital income taxation. However, nondiscriminatory taxation or subsidization of capital can provide the same scope for exploiting one's neighbors if the set of fiscal policy tools available for taxing and subsidizing domestic residents is adequate. International agreements to restrict capital income taxation to residence-based systems (even to the extent of setting identical definitions of the tax base) still allow countries to exploit their size in international asset markets. Tax rate harmonization may be necessary to achieve an efficient outcome. However, in a world of restricted tax instruments, residence-based taxes may be insufficient to achieve national, or international, distributional objectives. Source-based capital income taxes and other types of investment incentives may be needed for national governments to achieve desired distribution across their residents. When only distortionary tax instruments are available, distributional objectives for governments can preclude the prescription of a residence-based tax.

The scope of this paper is necessarily narrow. In particular, the role of multinationals and corporate income tax systems are entirely ignored, as is the role of public goods provision. Exhaustive public spending is not considered in favor of focussing on the redistributional aspects of national fiscal policies. Tax evasion is also not considered, so that compliance is assumed. Other questions of tax competition versus harmonization are addressed by Tanzi and Bovenberg (1990), Musgrave (1987), MclLure (1986,1989), Cnossen (1988), Siebert (1989), Deveraux and Pearson (1990), among others.

The use of national tax systems to gain advantage in international asset markets is a major theme in this paper. Under international mobility of financial capital, a country can use capital income taxation to affect the world rate of interest if it is large in world financial markets. A national optimum policy will be to place a tax on capital imports or on capital exports in analogy with the optimum tariff familiar from static trade theory. Such policies are discriminatory in that the tax paid on capital income depends upon the residence of the recipient in one case and on the location of the capital in the other. That is, foreign owners of domestic capital in a capital importing country will pay a different tax on the same earnings as will domestic

owners of similar capital. Domestic residents in a capital exporting
country will pay a different capital income tax according to whether the
source of the income was domestic or foreign capital. Withholding taxes
on the asset income of foreign residents imposed by some countries may
serve such purposes.

A two-country model is used in this paper to discuss the
international spillover effects of national fiscal policies in a one
commodity world. There is a single international price, the real
interest rate. The fiscal authority for each country possesses an
explicit redistributional objective defined over the utilities of
residents only. An overlapping generations model without an operative
gift or bequest motive is presented in Section 2. The scope for lump-
sum fiscal policies alone for maximizing social welfare objectives and
for attaining an efficient allocation of resources globally is discussed
in Section 3. The equivalence of unfunded social security retirement
schemes and deficit-financed intergenerational redistribution through
restricted lump-sum transfers is summarized. Part of the purpose of
this section is to define the solvency constraint faced by the fiscal
authority. In general, restrictions on the age-dependency of the lump-
sum transfer and tax scheme lead to alternating budget deficits and
surpluses. These can grow in per capita terms at the rate of
interest. Therefore, constraints on the ability of the government to
levy lump-sum taxes of arbitrary size turn out to reduce significantly
the ability of the fiscal authority to use nondistortionary policies to
achieve national intergenerational distributional goals.

The strategic use of fiscal policy is examined in Section 4. With
lump-sum tax and transfer instruments available to the national planner,
the national optimum is shown to be a combination of a discriminatory
tax on foreign borrowing or lending with a complementary national lump-
sum fiscal policy. Because a domestic wealth accumulation path is
targeted by the lump-sum fiscal policy and the asset income tax is used
to target international interest rate objectives, a source-based capital
income tax coupled with a different choice of a lump-sum fiscal policy
achieves the same optimum. A net creditor adopts a source-based subsidy
to domestic capital income, while a net debtor country (capital
importer) imposes a positive source-based tax. In this economy, a
Pareto optimum requires that both tax rates be set to zero, so that
noncooperative policy making leads to an inefficiently high tax on
domestic capital in one instance, rather than tax competition leading to
excessively low capital income taxation necessarily.

In the presence of lump-sum fiscal policies, residence-based
capital income taxation does not increase the fiscal arsenal available
to the national social planner. Interest income taxes on residents are
redundant because they target national wealth accumulation, a job
already accomplished more fully by nondistortionary taxation. Both
lump-sum fiscal policies (for example, increases in public sector
deficits or surpluses) and residence-based interest taxes can be used to
pursue national welfare goals at the expense of other countries. The

social planner of a net creditor country will want to reduce national
saving by redistributing resources towards the currently old generation
in each period. This is achieved by increasing the public sector budget
surplus or by imposing a higher rate of interest income taxation holding
fixed the lump-sum intergenerational redistribution plan. The opposite
set of policy choices would be made by a net importer of capital.

Section 5 discusses the use of distortionary taxation of capital
and of wage income in the absence of feasible lump-sum transfers and
taxes. In the presence of an explicit distribution objective for the
fiscal authority over the welfare of residents, source-based capital can
be part of an optimal tax policy in the absence of attempts to influence
the interest rate. The inclusion of source taxes in an optimal tax
policy for global welfare optimization has been discussed by Horst
(1980), Dutton (9182), and Buiter and Kletzer (1990b), among others.

II. The Model

The model economy is a two-country version of the Diamond [1965]
overlapping generations model with capital accumulation following Buiter
[1981]. A country is defined by two characteristics. First, there is a
factor of production (labor) that is immobile between countries.
Second, each country has a fiscal authority whose ability to tax
residents may differ from its ability to tax nonresidents and whose
ability to tax domestic sources of income may differ from its ability to
tax foreign sources of income.

Each generation survives for two periods, and the economy has an
infinite horizon. The populations of the two countries, home and
foreign, are equal in size, growing at the same constant proportional
rate n. Within each country the households are homogeneous, but tastes
and initial wealth differ across borders. A constant returns to scale
technology, which may be country-specific, is available to perfectly
competitive firms producing a single output.

There is a public sector in each country which can effect
intergenerational transfers between members of its own population
(currently alive or yet to be born) and levy distortionary taxes. Each
government is represented by a single player possessing a national
social welfare function which it seeks to maximize observing a suitable
solvency constraint (discussed below). Taxes and subsidies may be
levied on domestic investment, foreign asset income received by domestic
residents or payments to foreign investors. There also can be lump-sum
transfers to and taxes on domestic households that do not represent
immediate direct intergenerational transfers. Any budget deficits or
surpluses are financed by issuing or retiring one-period real government
debt.

The utility function for a representative household of each
generation in both countries is assumed to be intertemporally additively

separable, and, without loss of generality, the single-period felicity functions are assumed identical between periods and generations within a country. The utility for a household in the home country which is young at time t is

$$(1) \qquad U_t(c_t^1, c_t^2) = u(c_t^1) + \beta u(c_t^2) ,$$

where c_t^1 is consumption at the time t of the household when young, c_t^2 is consumption at time t + 1 of the household when old, and the discount rate β is between zero and one. The utility function for the counterpart household in the foreign country is

$$U_t^*(c_t^{*1}, c_t^{*2}) = u^*(c_t^{*1}) + \beta^* u^*(c_t^{*2}) ,$$

where asterisks indicate foreign variables and parameters. The felicity functions $u(c)$ and $u^*(c^*)$ are twice continuously differentiable, increasing and strictly concave. Further, we assume that

$$(2) \qquad \lim_{c \to 0} u'(c) = \infty , \text{ and } \lim_{c \to \infty} u'(c) = 0 ,$$

with corresponding Inada conditions for u^*. The home country production function in intensive form is given by

$$y_t = f(k_t) ,$$

where y and k denote per capita output and capital respectively for the home country. f is twice continuously differentiable, increasing and strictly concave, and the Inada conditions are assumed to hold. The foreign production function, assumed to have the same properties as f, is

$$y_t^* = f^*(k_t^*) .$$

National wealth for the home country is the sum of the domestic capital stock an net claims on foreigners h minus home government debt b. We do not need to distinguish between direct foreign investment and foreign lending because they are perfect substitutes in this model.

At time t, total world output is divided between current consumption and capital stocks for period t + 1. Either country's output can be used to form capital for the next period in either country. However, existing capital stocks cannot be reallocated across borders for producing current outputs.

The budget constraint for a young household at time t in the home country under free capital mobility is

$$(3) \qquad w(k_t) - \tau_t^1 - \frac{\tau_t^2}{1 + r_{t+1}} \geq c_t^1 + \frac{c_t^2}{1 + r_{t+1}} ,$$

where r_{t+1} is the world rate of interest,

$w_t = w(k_t) = f(k_t) - k_t f'(k_t)$ is the wage rate, τ_t^1 is the lump-sum tax paid while young, and τ_t^2 is the lump-sum tax paid while old. The competitive household maximizes (1) with respect to its consumption plan c_t^1 and c_t^2 subject to (3), taking as given w_t, r_{t+1}, τ_t^1 and τ_t^2. Household saving by the young and consumption by the old in the home country are given by

$$(4) \qquad (1 + n)\,(h_{t+1} + b_{t+1} + k_{t+1}) + c_t^1 = w(k_t) - \tau_t^1$$

and

$$(5) \qquad c_t^2 = (1 + n)(1 + r_{t+1})(h_{t+1} + b_{t+1} + k_{t+1}) - \tau_t^2 .$$

The equilibrium conditions for the home private sector are

$$(6) \qquad u'(c_t^1) - (1 + r)\beta u'(c_t^2) = 0$$

and

$$(7) \qquad f'(k_{t+1}) = r_{t+1}$$

in addition to (4) and (5). The equilibrium conditions for the foreign private sector are analogous.

In the presence of home country taxes on borrowing or lending abroad, r must be replaced by the sum of the world interest rate and the tax rate on foreign investment income or payments in both (6) and (7). If fixed capital formation in the home country receives a subsidy, then r must be replaced by the world interest rate minus the subsidy rate in (7) alone. If a residence-based tax on interest income is imposed, then r must be replaced by r minus the tax rate in (6) alone.

$$(8) \qquad (1 + r_t)h_t - x_t = (1 + n)h_{t+1}$$

where x_t is the per capita primary external deficit (or trade deficit) for the home country.

The government imposes lump-sum taxes (transfers when negative) on the young and/or the old, and satisfied its budget identity by borrowing or lending. The home country government budget identity on intensive form is

$$(9) \qquad b_{t+1}\,(1 + n) = (1 + r_t)b_t - \tau_t^1 - \tau_{t-1}^2(1 + n)^{-1} ,$$

and for the foreign country, it is

$$(10) \qquad b_{t+1}^*(1 + n^*) = (1 + r_t^*)b_t^* - \tau_t^* - \tau_{t-1}^{*2}(1 + n^*)^{-1} .$$

The global capital market equilibrium condition is given by:

$$(11) \qquad (b_{t+1} + b^*_{t+1} + k_{t+1} + k^*_{t+1})(1 + n) = w_t - \tau^1_t - c^1_t + w^*_t - \tau^{*1}_t - c^{*1}_t$$

The material balance constraint for the world economy is

$$(12) \qquad f(k_t) + f^*(k^*_t) + k_t + k^*_t \geq (1 + n)(k_{t+1} + k^*_{t+1}) \; .$$

$$+ c^1_t + \frac{c^2_{t-1}}{1 + n} + c^{*1}_t + \frac{c^{*2}_{t-1}}{1 + n} \; .$$

Under the assumptions made a competitive equilibrium for this economy exists given h_0 and positive initial capital stocks k^*_0, and given that all distortionary taxes are linear.

III. Lump-sum Fiscal Policies

In the two-country overlapping generations model, a competitive equilibrium allocation is Pareto optimal unless the equilibrium growth path is dynamically inefficient. Fiscal policy using only non-distortionary instruments can be used to attain a Pareto optimum because a sequence of lump-sum taxes and transfers between generations enable a planner to alter the saving decisions of households so that a dynamically efficient level of capital in the world economy is assured. In Buiter and Kletzer (1990a), it is shown that if arbitrary age-dependent lump-sum taxes and transfers are feasible, then efficiency can be achieved through the use of separate balanced budget fiscal policies in each country. Under free international capital mobility, an unfunded social security retirement scheme in each country can be chosen independently of the scheme adopted by the other country without resulting in any overall efficiency loss. Coordination of lump-sum fiscal policies chosen by national planners is not necessary for allocational efficiency.

When unfunded social security schemes are available, relaxing the constraint that the public sector budget be balanced in every period does not increase the ability of either government to achieve national welfare objectives. However, if there are restrictions on the contemporaneous transfers that can be made between residents, then deficit-financing (or accumulation of surpluses) increases the instruments available to policy makers.

In an unrestricted unfunded social security retirement scheme, the budget constraint for the home country each period is given by

$$(13) \qquad \tau^1_t + \frac{\tau^2_{t-1}}{1+n} = 0 \; .$$

The effect of age-dependent lump-sum transfers is to alter the saving
choice of the currently young, changing the level of national wealth for
the next period. In an open economy, a reduction in aggregate world
saving is required if the equilibrium path is dynamically inefficient
for the laissez-faire competitive economy. This can be achieved by
taxing the young and subsidizing the consumption of the old in at least
one of the countries, possibly in both.

In this paper, we examine the role of distortionary taxation of
asset income for achieving national social welfare objectives. The
fiscal authority for each country possesses an utilitarian preference
ordering over the welfare of the country's residents. Fiscal policies
are chosen to maximize a social welfare function which incorporates
national distributional objectives. The welfare function for the home
country national social planner is given by:

$$(14) \qquad W_t = \sum_{i=0}^{\infty} \left(\frac{1+n}{1+\rho}\right)^i \left(u(c^1_{t+1}) + \beta u(c^2_{t+i})\right) + \left(\frac{1+\rho}{1+n}\right) \beta u(c^2_{t-1}) \, ,$$

where ρ is the social generational discount rate of the planner. This
function is used by Buiter and Kletzer (1990b) and is analogous to the
social welfare objective used by Calvo and Obstfeld (1988) in a closed
economy model.

The foreign planner seeks to maximize

$$(15) \qquad W^*_t = \sum_{i=0}^{\infty} \left(\frac{1+n}{1+\rho^*}\right)^i \left(u^*(c^{*1}_t) + \left(\frac{1+\rho}{1+n}\right) \beta^* u^*(c^{*2}_{t-1})\right)$$

In each of these functions, the felicity of the current old generation
is included and discounted at exactly the same rate as the felicity of
the currently young or unborn when they are old. The utility of a
particular household must be discounted between any two time periods
(before its death) at the same rate regardless of the planning date if
an unrestricted command optimum is to be time consistent. Therefore,
continuing to count the utility of the currently old is necessary for
time consistency of the command optimum (compare with Samuelson (1967
and 1968)). All that is necessary is that the utility of those alive
and yet to be born be discounted exponentially. The constant rate, ρ ,
is adopted for every generation for simplicity.

In Buiter and Kletzer (1990b), it is shown that free international
capital mobility and a separate balanced budget age-dependent transfer
scheme for each country are adequate policy instruments to attain a
Pareto optimum with respect to these planner objective functions.
Because the utility of every currently living and yet to be born
household receives positive weight in one of the national social welfare
criteria, the set of all Pareto efficient plans with respect to planner
preferences is a subset of the set of all Pareto efficient (with respect
to household preferences) growth paths for the economy. Although
noncooperative behavior leads to a Pareto optimum with respect to the
preferences of the individual households, coordination of the separate

fiscal policies is required to achieve an efficient plan with respect to the planners' preferences.

An arbitrary Pareto efficient allocation for the world economy can be found by maximizing a weighted sum of the utilities of all households with respect to their consumption plans from the initial date forward using nonnegative weights. Three lump-sum transfer plans suffice to support any efficient allocation for the global economy. These are a balanced budget age-dependent tax and transfer scheme for each country separately and an international lump-sum transfer plan. In the absence of feasible lump-sum transfers between countries, a proper subset of all Pareto optimum are attainable. A Pareto optimum with respect to the social preferences for the national planners is found by maximizing a weighted sum of (14) and (15), where the relative weight of the social welfare of each country is endogenous. The distribution of welfare between the two countries in an efficient growth path excluding international lump-sum transfers is determined by the initial capital stocks and level of net foreign assets held by the countries. A cooperative equilibrium in unfunded social security schemes, therefore, supports an allocation that depends upon the status quo international distribution of wealth.

The alternative of deficit-financed lump-sum transfers to currently living households or of budget surpluses to finance future transfers to as yet unborn generations adds to the fiscal arsenal of the government if restrictions are placed on the scope of age-dependent transfer plans. In the closed infinite-horizon economy, Calvo and Obstfeld (1988) show that if the transfers made to (or taxes paid by) the two generations living at each date must be equal, then public debt management is capable ensuring that a competitive equilibrium allocation is Pareto optimal. In Buiter and Kletzer (1990a), this proposition is extended to the two-country setting to show that, if there is always a next period (that is, if there is an infinite horizon), then an age-independent lump-sum transfer and tax plan with deficit-finance exists for each national social planner that supports any dynamically efficient growth path under free international capital mobility.

A command optimum for the national planner is attained using lump-sum fiscal policies by creating a sequence of net resource transfer to each generation. Using the budget constraint for the generation born at time t, equation (3), the net resource transfer to this generation is given by

$$z_t = - \tau_t^1 - \frac{\tau_t^2}{1+\tau_{t+1}} \ .$$

Under an unfunded social security scheme, the transfer to any generation when they old can be chosen to effect any feasible net transfer of resources to that generation taking as given the transfer they receive when young. By choosing the transfer that the generation born at time t receives when old, the planner fixes the transfer that the next generation receives when they are young via the balanced budget

constraint. For each generation the planner has one instrument to use for making a net resource transfer to or from that generation, the transfer when they are old. This instrument serves no competing purpose so that an efficient path can be attained. Under the age-independent tax and transfer scheme, the net transfer to the currently young at time t is fixed by the planner's choice of the net transfer to the currently old (these are equal), but the transfer or tax for the next period is available to target only the welfare of the generation born at time t.

Under an age-independent lump-sum fiscal policy, the sign of the transfer to the private sector from the public sector can switch back and forth between periods in an efficient age-independent policy, implying that public debt at each date keeps changing sign over time. Therefore, the sequence of discounted public debt at each date may not converge, so that the solvency constraint for the government must be modified from its usual form.

The appendix demonstrates that any equilibrium path of capital accumulation and consumption plan for households for the two countries that can be attained using an unfunded social security scheme can be achieved using age-independent taxes and transfers. It defines the modified public sector solvency constraint which must be imposed and demonstrates that the public sector budget deficit reverses sign every period and grows without bound, in general. The solution to the problem of defining solvency criteria for the two-period overlapping generations model is to redefine the "fiscal year" to mean two periods in sequence together. While for every period, the public sector debt zigzags explosively, for every second period the public debt is well-behaved. The discounted debt for every second period converges to a nonpositive limit.

If there are no constraints on the ability of the government to make lump-sum transfers between resident households, then a balanced budget lump-sum fiscal policy can be used to achieve a command optimum for the national planner. Restrictions on the ability of the fiscal authority to make age-dependent lump-sum transfers do not restrict the ability of the planner to achieve her command optimal plan if she faces no constraint on the level of one-period public debt she can issue each period, as long as the deficit-financing plan meets the modified solvency constraint. If the governments ability to provide lump-sum transfers and collect lump-sum taxes in each period is also restricted, then a command optimum may not be attainable. In fact, it will not be attainable, in general, if unrestricted age-dependent transfers are unavailable and the lump-sum tax imposed on a household cannot grow at the real rate of interest, without bound.

Lump-sum fiscal policies allow the national social planner to achieve an intergenerational redistribution plan given the country's initial stock of capital and net foreign assets. Separate lump-sum fiscal policies are adequate to achieve a Pareto efficient allocation of resources for the world economy, but, of course, not an arbitrary Pareto

optimum. Because these policies are lump-sum, coordination of fiscal
policies is not required to assure that an efficient growth path for the
global economy is reached. A Nash equilibrium in unfunded social
security retirement schemes or their equivalent will yield an efficient
allocation with respect to household utilities, but cooperation is
needed to assure efficiency with respect to social welfare functions.
If a country's deficit-financed lump-sum intergenerational
redistribution scheme can be used to affect the international
distribution of welfare, then national planners will tend to distort
their fiscal policies to gain national advantage at the expense of
foreign welfare. Strategic use of lump-sum fiscal policies in the
absence of Ricardian equivalence leads to movements along the world
utility possibility frontier, but not to points inside it.

IV. Policies for achieving national welfare objectives

With international transmission of fiscal policies under free
financial capital mobility in the two-country economy, uncoordinated tax
policies can be used to gain national advantage in international
intertemporal trade. A government may be able to select distortionary
taxes on capital to exploit its country's size in the world market. A
country that is a net importer of capital will gain if it can reduce the
net interest payments it makes to foreign owners of claims on domestic
capital by imposing a discriminatory tax on these payments. In analogy
with the optimum tariff argument in static trade theory, a tax imposed
on the earnings of foreign-owned capital or on foreign capital income
received by residents can allow a national policy maker to improve the
country's intertemporal terms of trade. In this Section, the national
optimal behavior of a single national planner who takes the current and
future policy choices of the other national planner as given is
studied. Each national planner has access to unrestricted age-dependent
lump-sum transfer schemes for redistribution between her own citizens in
the first part of the analysis. This assumption is dropped later.

To characterize the optimal policy choices of the national planner,
the other government is assumed to be a passive player. The foreign
planner does not impose any distortionary taxes or subsidies. While it
may adopt an internal lump-sum intergenerational redistribution scheme,
this is assumed not to be chosen strategically in response to the
policies pursued by the active home country policy maker. The behavior
of the home government can be interpreted as noncooperative open-loop
Nash behavior. In an open-loop Nash equilibrium, each planner chooses
her current and future policy path taking the strategy of the other
planner as given. Full characterization of an open-loop Nash
equilibrium requires that both countries choose intergenerational
redistribution schemes and distortionary taxes taking the policy plans
of the other planner as given. Therefore, deriving the optimal policy
response of the active government indicates how distortionary policies
are used in a full equilibrium with noncooperative behavior short of
presenting the algebra of a complete solution. Some of the open-loop

Nash policies characterized below do not support national command optima, so that the time consistency of these policies is not guaranteed, in general. In these cases, credibility of the policy path selected by each national social planner is ensured pro forma by assuming that the governments are compulsively honest (they cannot tell a lie). However, some of the distortionary capital income tax and lump-sum transfer policies derived do support national command optima, so that noncooperative open-loop policies are time consistent for each national planner.

1. Discriminatory capital income taxation

The national planner is first allowed unrestricted access to any distortionary taxes including ones that discriminate between foreign owned domestic capital and domestically owned domestic capital, as well as, between the earnings of domestic investors from domestic capital and foreign capital. In this model, the analog of an optimum tariff is a tax on private foreign lending or borrowing. Such a tax equates the domestic rate of intertemporal product transformation (that is, one plus the home country marginal productivity of capital) with the foreign rate of intertemporal transformation (one plus the rate of return to domestic residents from net claims on foreign capital). The tax raises the foreign rate of interest paid to home country residents by foreigners if the home country is a net creditor, or lowers the rate interest paid by domestic residents to foreigners if the home country is a net debtor.

The optimum policy package for the home planner is easily derived. A natural way of characterizing the optimum problem of the domestic planner maximizing W_0 (given in equation (14)) is by viewing her as able to choose directly for all $t \geq 0$ the domestic consumption streams $\{ (c_t^1, c_{t-1}^2)_{t=0}^{\omega} \}$ and the streams of trade deficits $\{ (\tau_t)_{t=0}^{\omega} \}$ subject to the following constraints:

$$(16) \qquad f(k_t) + k_t - (1 + n)k_{t+1} + x_t - c_t^1 - (1 + n)^{-1}c_{t-1}^2 = 0$$

$$(17) \qquad f^*(k_t^*) + k_t^* - (1 + n)k_{t+1}^* - x_t - c_t^{*1} - (1 + n)^{-1}c_{t-1}^{*2} = 0$$

$$(18) \qquad (1 + r_t^*)h_t - (1 + n)h_{t+1} - x_t = 0$$

$$(19) \qquad u^{*\prime}(c_t^{*1}) - \beta^*(1 + r_{t+1})u^{*\prime}(c_t^{*2}) = 0$$

$$(20) \qquad f^*(k_t^*) - k_t^* f^{*\prime}(k_t^*) - c_t^{*1} - (1+r_{t+1})^{-1}c_t^{*2} = 0$$

(21) $\qquad r_t - f^{*\prime}(k_t^*) = 0$

Equations (16) and (17) are the resource constraints of the home country and the foreign country, respectively. Equation (18) is the net external asset accumulation equation for the home country. Equations (19) and (20) characterize competitive household equilibrium in the foreign country. The world rate of interest r_t equals the foreign marginal product of capital. Since the foreign government is passive we lose no generality by omitting all foreign taxes. The home government has three instruments each period, τ_t^1, τ_{t-1}^2 and the lending or borrowing tax. These are sufficient to allow it to choose as competitive equilibrium values of c_t^1, c_{t-1}^2 and x_t in each period any values of these variables that satisfy the home country resource constraint given k_t. The following conditions are satisfied in equilibrium:

(22a) $\qquad f^\prime(k_t) = f^{*\prime}(k_t^*) + h_t f^{*\prime\prime}(k_t^*)$,

(22b) $\qquad u^\prime(c_t^1) = \beta(1 + f^\prime(k_t))u^\prime(c_t^2)$,

and

(22c) $\qquad u^\prime(c_t^1) = (1 + \rho)^{-1}(1 + f^\prime(k_t))u^\prime(f_{t+1}^1)$.

The optimum fiscal policy for the home government combines a foreign lending or borrowing tax with an efficient unfunded social security scheme. The domestic rate of interest equals the marginal productivity of home capital.

The necessary conditions for a social welfare optimum for the national planner behaving noncooperatively lead to a divergence between the marginal productivities of capital in the two countries. In a noncooperative equilibrium, a Pareto optimal allocation of resources is not attained and there exist efficiency gains from coordination of national fiscal policies. Discriminatory taxation of capital income earned by foreigners or of foreign earnings of domestic residents may be restricted by multilateral agreements. We next examine how nondiscriminatory taxation of the income from domestic capital or of the interest income received by residents can also be used strategically to gain national advantage in world capital markets.

2. Nondiscriminatory source-based taxation of capital income

Consider the imposition by the home country of a proportional tax on the income from domestic capital. The tax is nondiscriminatory in that the same rate, $s < 1$, is applied to the rental income from all physical capital located within the national boundaries regardless of whether it is owned by domestic or by foreign residents. Source-based taxation of capital income allows a government to exercise leverage over the domestic stock of capital and the world rate of interest and to tax foreign residents if they own a portion of the domestic capital stock. With source-based capital income taxation, the aftertax rates of return on capital located in the foreign country and on capital located in the home country are equalized if there is perfect international financial capital mobility. The before tax rates of return will differ unless the same proportional rate is levied in both countries. Even if the two rates are equal, there is still a wedge between the world-wide private rate of return to saving (in the absence of residence-based taxes on interest income) and the social rate of return to capital formation.

In the presence of distortionary taxes and in the absence of lump-sum taxes and transfers, optimal budgetary policy will, in general, involve unbalanced government deficits even in models with "first-order" debt neutrality such as representative agent models. If there is a need for nonzero public sector revenues, tax smoothing considerations may make it desirable to spread the burden of distortionary taxes over time to minimize the total impact on a utilitarian social welfare function. However, since nondistortionary taxes and transfers are still available in the model, any desired smoothing of distortionary taxes can be achieved with continuously balanced national budgets by varying the time paths of lump-sum taxes and transfers.

The optimal policy for one national planner taking as given the distortionary tax policy of the other can again be characterized by assuming that the foreign planner is passive, although she may choose an internal intergenerational redistribution scheme taking as given the fiscal policy of the home country. For simplicity, assume that she also takes the world rate of interest as given when choosing her national lump-sum transfer scheme (strategic use of unfunded social security retirement schemes or their equivalent is raised below). The foreign national intergenerational redistribution scheme is allowed to respond to the policy chosen by the home national planner but only in a "passive" manner. Because a social planner for a country that is a net importer of capital will want to impose a discriminatory tax on the home country income of foreign investors, a source-based capital income tax appears to be an appropriate choice of instrument from a restricted menu for such a planner. A national planner for a net creditor country will want to discourage foreign lending (that is, acquisition of claims on foreign capital by domestic residents) to improve its intertemporal terms of trade. A source-based tax discourages home investment while encouraging foreign investment by residents; a source-based subsidy tends to reduce the world rate of interest by placing a wedge between

the foreign marginal productivity of capital and the return to capital at home.

The national planner seeks to maximize her social welfare function using an unfunded social security scheme and source-based capital income tax. The before-tax marginal productivity of domestic capital must equal the world rate of interest, and domestic residents make their saving decisions using the world rate of interest. The constraints for the home government are equations (16) through (21), and

$$(23) \qquad u'(c_t^1) - \beta(1 + r_{t+1} - s_{t+1})u'(c_t^2) = 0$$

$$(24) \qquad f(k_t) + k_t - (1+n)k_{t+1} + x_t - (c_t^1 + \tau_t^1) - \frac{c_t^2 + \tau_t^2}{1 + r_{t+1} - s_{t+1}} = 0$$

$$(25) \qquad (1 + r_{t+1})u'(c_{t+1}^{*1}) - \beta^* u'^1(c_t^{*2}) = 0$$

$$(26) \qquad \tau_t^1 + \frac{\tau_{t-1}^2}{1 + n} + k_t(f'(k_t) - r_t) + s_t(k_t + n_t) = 0$$

$$(27) \qquad \tau_t^{*1} + \frac{\tau_{t-1}^{2*}}{1 + n} = 0$$

Equations (16) and (17) are the resource constraints for the home country and the foreign country, respectively. Equation (18) is the external asset accumulation equation for the home country. Equations (23) and (24) are the first-order conditions for household optimization by domestic residents. Equations (29), (20), and (25) characterize the equilibrium choice of consumption plan for foreign resident households given that the foreign planner chooses her optimal intergenerational redistribution scheme as a passive player in the world financial market (equality in equation (25) expresses this assumption; see the next subsection). That the foreign planner's choice of source-based capital income tax rate is fixed is expressed in equation (21), where it is assumed that the rate is zero. The foreign marginal product of capital is equal to the world rate of interest. The home public sector budget constraint is given by equation (26).

The necessary conditions for a constrained national optimum include

$$(28) \qquad (\psi_{t+1} + \alpha_{t+1})(f'(k_{t+1}) - r_{t+1}) = -\varepsilon_{t+1} f^{*''}(k_{t+1}^*)$$

$$(29) \qquad u'(c_{t+1}^1) - \beta(1+\rho)u'(c_t^2) = 0$$

or, equivalently,

$$u'(c^1_{t+1}) \; (1+f'(k_{t+1})) = (1+\rho)u'(c^1_t),$$

(30) $\qquad (\mu_{t+1} + \eta_{t+1}) \, h_{t+1} + \epsilon_{t+1} = 0$

Equations (28), (29), and (30) derived from (after some algebraic manipulation) optimization with respect to domestic capital accumulation, foreign capital accumulation and saving, the world rate of interest, and the tax rate on the earnings of domestic capital. The multipliers for equations (24), (26), (18), and (16), μ, α, η, and ψ, , respectively, are all nonnegative. These correspond to nonnegative shadow values of the private and public sector budget constraints, the external asset accumulation equation, and the home country resource constraint. Therefore, the multiplier for equation (21), ϵ is positive if the home country is a net debtor and negative if it is a net creditor. The equilibrium source-based tax rate is given by:

$$f'(k_{t+1}) = f^{*\prime}(k_{t+1}) \, h_{t+1} f^{*\prime\prime}(k_{t+1}).$$

The first two (equations (28) and (29)) are the necessary conditions for optimal domestic private saving. Because national lump-sum taxes and transfers are unrestricted, the social planner selects a plan for intergenerational redistribution that maximizes her objective function given the effect of her optimal choice of capital income tax on the world rate of interest and domestic capital accumulation. This suggests that the planner is able to attain her unrestricted optimal response to the passive country's policy choice. We should not expect to see the same first-order condition for a second-best solution as for the first-best. The reason is that the source-based tax on capital income targets the desired wedge between the domestic rate of return to capital and the foreign rate of return to capital. The tax imposed on the earnings of domestic capital owned by domestic residents left to itself will distort domestic private saving. With a discriminatory tax, the rate of interest faced by domestic households in making their saving decisions is the domestic rate of return to capital. Under the source-based capital income tax, the rate of return to saving is the world rate of interest. However, the lump-sum tax and transfer scheme can be chosen to bring domestic saving back to exactly the level it would be at if the were no wedge between the rate of return to private domestic saving and the domestic marginal productivity of capital. Therefore, the source-based capital income tax rate and the unfunded social security scheme are chosen in concert to achieve exactly the same consumption path and capital accumulation path for the home country as under the national first-best with unrestricted discriminatory taxation of capital earnings. Crucial to this result is the presence of unrestricted national lump-sum transfers or their equivalent with unbalanced public sector budgets (for example, costless age-independent lump-sum transfers).

If national redistribution opportunities exist which do not impose efficiency costs, then a system of source-based capital income taxation can be used to advantage net importers of capital in an integrated world economy. With international interdependence, world-wide efficiency losses result just as they do in the static trade model with noncooperative selection of tariffs. However, the statement that international capital mobility leads in the absence of international coordination of fiscal policies to inefficiently low levels of capital income taxation does not follow. In this model, the efficient level of capital income taxation in the open economy is zero and in the closed economy capital income taxation is redundant. National advantage is gained in international financial capital markets by a debtor country by imposing a source-based tax with complementary intergenerational distribution policy. A creditor country national social planner will impose a source-based capital income subsidy in response in the full open-loop Nash equilibrium. It should be noted that both policies achieve command optima for each national social planner, so that credibility of the policy need not be assumed, as in the case of discriminatory taxation of foreign borrowing or lending. The adoption of noncooperative source-based capital income tax or subsidy and lump-sum tax and transfer plans by nationalistic utilitarian planners is time-consistent.

In the overlapping generations model, the nondiscriminatory source-based taxation of domestic capital income reduces the world rate of interest, leading to a decline in the level of the domestic capital stock and expansion in foreign capital stocks. In the national social welfare optimal response to the passive trading partner, domestic savings rises and foreign savings falls. The possibility exists that a capital income tax not only raises the pre-tax rate of return to capital, but leads to an increase in the post-tax return, as well. The well-known paradox due to Diamond (1970) can occur in the two-country model, but it does not arise in our equilibrium because the national social planner selects an unfunded social security scheme along with the distortionary tax.

3. Nondiscriminatory residence-based taxation of capital income

The opposite of nondiscriminatory source-based taxation of capital income is the application by a nation of an equal proportional tax rate to all nonwage income earned by its residents without regard to whether the assets that are the source of the income are located at home or abroad. Much of the discussion on tax harmonization centers on the importance of cooperation for assuring compliance by home country residents under residence-based taxation. International competition for investment has led many countries to facilitate the avoidance and evasion of residence-based taxes. We assume away compliance issues, implicitly presuming that the two countries do cooperate to this extent.

With residence-based taxation of capital income in both countries, perfect international capital mobility implies that the pre-tax rates of

return to capital in both countries are equal. The tax rates need not be equal for the marginal productivities of capital located in each country to be equal. Residence-based taxes are imposed on the saving of the private sector in each country. They can affect the other country through their impact on the world rate of interest. While there is no distortion in the global allocation of physical capital between countries, there can be distortions both between home country and foreign private saving, and in global saving and investment.

To characterize noncooperative equilibrium fiscal policies when nondiscriminatory residence-based taxation of capital income is possible, we assume that the social planner of the home country maximizes her social welfare function W_0 taking as given the policy path adopted by the foreign planner. Assume that the foreign planner imposes a nondiscriminatory residence-based tax and chooses her intergenerational redistribution plan optimally taking the world rate of interest as given. The set of instruments available to the home planner is restricted to the use of lump-sum fiscal policy and imposition of a residence-based tax or subsidy on nonwage income.

The home planner chooses the sequence of lump-sum taxes and transfers $\{(\tau_t^1, \tau_t^2)_{t=0}^\omega \}$ and the path of linear residence-based capital income taxes $\{ (S_t)_{t=0}^\omega \}$ to maximize W_0 subject to equations (16) through (25) and the following additional constraints:

$$(31) \qquad f'(k_{t+1}) - r_{t+1} = 0$$

$$(32) \qquad r_{t+1} - f'(k^*(k^*_{t+1}) = 0$$

$$(33) \qquad \tau_t^1 + \frac{\tau_{t-1}^2}{1 + n} + (k_t + h_t)s_t = 0$$

$$(34) \qquad \tau_t^{*1} + \frac{\tau_{t-1}^{*2}}{1 + n} = 0$$

Equations (23), (24), (19) and (20) are necessary conditions for privately optimal household consumption and saving decisions in both countries, and (25) is the necessary condition for the foreign planner's efficient choice of intergenerational redistribution policy when she behaves passively. By writing (25), we are not directly characterizing the Nash equilibrium in fiscal policies. Instead, we use it to show that the necessary condition for a national social welfare optimal intergenerational distribution plan for a cooperative equilibrium is not satisfied by the home country's fiscal policy when the respective first-order condition is fulfilled by the foreign planner. Therefore, in a noncooperative equilibrium, neither government will choose an efficient intergenerational transfer scheme taking as given the world rate of interest. This contrasts with the case for source-based capital income taxation.

After much algebra, the necessary conditions for the national optimum include

$$(35) \quad \left(\frac{1+n}{1+\rho}\right)^{t-1}\left\{ \frac{u'(c_t^1)}{1+\rho} - \frac{u'(c_{t-1}^1)}{1+r_t} \right\}$$

$$= -\lambda_t \frac{u''(c_t^1)}{1+n} - \lambda_{t-1}\beta(1+r_t)u''(c_{t-1}^2)$$

$$(36) \quad \left(\lambda_{t-1}^* - \gamma_{t-1}\right)(u^{*''}(c_t^{*1}))$$

$$+ \left[\lambda_{t-1}^*(1+r_t) - \gamma_{t-1}(1+\rho^*)\right](1+n)\beta^* u^{*''}(c_{t-1}^{*2}) = 0$$

$$(37) \quad \lambda_t \beta u'(c_t^2) + \lambda_t^* \beta^* u^{*'}(c_t^{*2})$$

$$+ \quad \lambda_t(1+n)\left[u''(c_t^1) + \beta(1+r_{t+1})^2 u''(c_{t+1}^2)\right] \frac{f''(k_{t+1}) + f^{*''}(k_{t+1}^*)}{f''(k_{t+1})f^{*''}(k_{t+1}^*)}$$

$$= (\mu_{t+1} - \mu_{t+1}^* + \eta_{t+1})h_{t+1}$$

$$= \left[\left(\frac{1+n}{1+\rho}\right)^t u'(c_{t+1}^1) + \gamma_{t+1}u''(c_{t+1}^1) - (\mu_{t+1}^* - \gamma_t)u''(c_{t+1}^{*1})\right]h_{t+1}$$

where λ, λ^*, γ, μ, μ^*, and η are the multipliers for the constraints (23), (19), (25), (24), (20), and (21), respectively. The two countries' household budget constraints are written so that at the optimum $(\mu_t - \mu_t^*)$ is nonnegative: a small redistribution of resources from foreign households to the home country households does not reduce home country social welfare. The external asset accumulation constraint is written so that η_t is nonnegative. Optimization with respect to the residence-based tax rate yields a first-order condition that is redundant (the other necessary conditions imply that it is fulfilled), so that no tax or subsidy on home country private saving is needed.

The solution implies that

$$(38a) \quad u'(c_{t+1}^1) - (1+\rho)(1+r_{t+1})^{-1}u'(c_t^1) > 0, \text{ if } h_{t+1} \geq 0,$$

and

$$(38b) \quad u'(c_{t+1}^1) - (1+\rho)(1+r_{t+1}) < 0, \text{ if } h_{t+1} < 0.$$

That is, if $h_{t+1} > 0$, then the noncooperative national optimum lump-sum fiscal policy for the home country reduces national saving by redistributing from the young to the old and the residence-based capital income tax rate is zero. Alternatively, if $h_{t+1} < 0$, then the home country optimum lump-sum fiscal policy redistributes from the old to the young raising national saving. Again, no residence-based nonwage income tax is needed. In the noncooperative equilibrium, a residence-based tax is redundant because it affects national saving, a task already addressed by the lump-sum fiscal policies of the two countries.

As an alternative, the set of tax instruments available to the planner could be restricted to a labor income tax or subsidy and a nondiscriminatory interest income tax. If labor supply remains perfectly inelastic and public sector budget deficits or surpluses are allowed subject to a suitable solvency constraint, then residence-based taxation is again redundant. The single lump-sum tax and transfer instrument along with deficit finance is adequate to achieve the command optimum for a small country. The addition of an interest tax or subsidy does not increase the ability of the government to change the timing of national consumption and to exploit the country's size in world financial markets. These conclusions can be demonstrated by maximizing the planner's objective W with respect to the sequence of wages $\{ (w_t)_{t=0}^{\omega} \}$ and interest taxes $\{ (s_t)_{t=1}^{\omega} \}$ subject to equations (16) through (21) and the following additional constraints:

$$(23) \qquad u'(c_t^1) - \beta (1 + r_{t+1} - s_{t+1})u'(c) = 0$$

$$(39) \qquad W_t = c_t^1 + \frac{c_t^2}{1 + r_{t+1} - s_{t+1}}$$

$$(40) \qquad \left[f(k_t) - k_t f'(k_t) - w_t \right] + s_t (k_t + h_t) + k_t (f'_t(k_t) - r_t) = 0$$

The solution implies that the first-order condition for the interest tax at each date is redundant, so that this instrument is not needed. The command optimum for the national social planner can be achieved if a nondiscriminatory source-based tax is used in concert with the lump-sum wage tax.

The implication of this subsection is that a combination of residence-based capital income taxes and lump-sum fiscal policies provides the same set of opportunities to the planner as lump-sum policies alone. If restrictions are placed on the public sector's ability to select age-dependent lump-sum transfers and finance a sequence of primary deficits, then residence-based taxes or subsidies would contribute to the constrained planner's arsenal of fiscal instruments for redistributing welfare nationally and gaining advantage in world capital markets.

4. Strategic use of lump-sum tax and transfer policies

Even if multilateral agreements restrict the strategic use of discriminatory and source-based taxation of capital income, the absence of Ricardian equivalence implies that lump-sum transfers between households within each country can be used strategically to alter global saving and investment. Suppose that all taxes on capital income by source (imposed by either the receiving or the originating country), investment subsidies, taxes on international borrowing or lending and all similar tax incentives are eliminated by international agreements. Lump-sum taxes and transfers can be used to create intertemporal expenditure switching by the home government to raise national welfare at the expense of the foreign government's welfare objectives.

This possibility is demonstrated by Buiter and Kletzer (1990b). The analysis of the optimum residence-based tax along with lump-sum fiscal policy above implies that noncooperative behavior by each of the national social planners leads to the active use of lump-sum policies alone by both governments. Equations (38a and b) imply that the net importer of capital will choose to bias the distribution of income toward the young more than would be optimal taking the world interest rate as given. The open-loop Nash equilibrium in lump-sum fiscal policies is characterized by equations (35), (36), and (37) if we let the source-based tax rate imposed by the foreign country equal zero.

For example, suppose that the initial capital stock is the same in the two countries, that $u = u^*$ and $f = f^*$, but that the private discount rates differ. Let the national social planner intergenerational rates of discount coincide with the respective private rates of time preference. In a Nash equilibrium (either closed-loop or open-loop), the more patient country's fiscal authority raises social security retirement payments (hence, taxes on the young), while the less patient country's government reduces social security, relative to their respective cooperative equilibrium policies. The government of the (patient) creditor country attempts to raise the world rate of interest by reducing its national savings relative to the cooperative level while the government of the (impatient) debtor country tries to lower the world rate of interest by increasing its national savings. In this case, the net result would be no net change in the world rate of interest in the Nash equilibrium relative to the cooperative equilibrium. The frustrated attempts to achieve international redistribution through changes in the world rate of interest, reflected in values of τ_{t+i}^1 that are higher and values of τ_{t+i}^{*1} that are lower than the cooperative value, result in inferior domestic intergenerational distributions in the two countries.

Noncooperative selection of fiscal policies when distortionary tax instruments are unavailable creates no loss in total world surplus for households: we stay on the world contract curve (defined with respect to household preferences). However, noncooperative fiscal management

leads to movements along this world contract curve. Starting from a national social welfare Pareto optimum, the home country will choose to deviate from the unfunded social security scheme necessary to support this plan in an attempt to raise national welfare unilaterally. This increase in utilities for home resident households is at the expense of foreign residents. No overall distortion (in the individual Pareto sense) is created; the effect of noncooperative policy selection with binding constraints on theuse of all distortionary taxes and subsidies is to redistribute welfare internationally.

Because any unfunded social security scheme can be duplicated using age-independent lump-sum transfers observing the modified public sector solvency constraint, public sector debt management can be used to pursue national gain in international exchange if arbitrary age-dependent lump-sum transfers are restricted. Social security transfer programs and deficit-financing of lump-sum fiscal policies can be used strategically to promote national welfare objectives if Ricardian equivalence fails and first-best (for the individual country) distortionary policy instruments are restricted.

5. Distortionary taxation and distributional objectives without lump-sum taxes and transfers

When costless lump-sum transfers are unavailable to the national planner, capital income taxes play a role in redistributing welfare intergenerationally in addition to serving as instruments of strategic fiscal policy in the open economy. The planner seeks to minimize the social costs of attempting to meet her national distributional and international trade objectives using distortionary tax instruments only. There is a trade-off between attaining the desired distribution of welfare across households and the deadweight loss created by the use of the tax system to effect such redistributions. The optimal tax program for a national social planner will equate the benefits of further redistribution with the costs at the margin. In this case, we should anticipate that source-based capital income taxation may be included in an optimal redistribution scheme even in the absence of attempts to exploit advantage in international financial markets. An explicit redistributional objective for the planner over the welfare of heterogeneous households can lead to departures from production efficiency under the optimal tax policy.

The use of source-based taxes for national distributional objectives in the absence of access to lump-sum transfers is derived first for a small open economy with an inelastic labor supply. Wage income taxes are excluded, and the menu of taxes is restricted to nondiscriminatory proportionate residence-based and source-based capital income taxes. By assuming that the country takes the rate of interest as given, we consider only the role of production-side distortions for redistributing welfare between generations. Because lump-sum taxes and transfers are ruled out, balanced budget policies no longer suffice to attain a (constrained) command optimum in most cases. The public sector

is allowed to incur budget deficits or surpluses subject to meeting the suitable solvency constraint.

Because the command optimum for the planner constrained to use only distortionary taxes on residents' interest income and domestic capital income will not be time consistent, in general, we assume that the planner chooses a source-based tax rate and a residence-based tax rate for each period during the previous period and is compulsively honest. The planner seeks to maximize W_0 with respect to the sequence of residence-based interest income taxes $\{(s_t)_{t=1}^\infty\}$ and of source-based capital income taxes $\{(f'(k_t) - r_t)_{t=1}^\infty\}$ subject to the following set of constraints:

$$(41) \qquad f(k_t) + k_t - (1tn)k_{t+1} + x_t - c_t^1 - \frac{c_{t-1}^2}{1+n} = 0$$

$$(42) \qquad (1 + r_t)h_t - (1+n)h_{t+1} - x_t = 0$$

$$(43) \qquad u'(c_t^1) - \beta(1 + r_{t+1} - s_{t+1})u'(c_t^2) = 0$$

$$(44) \qquad f(k_t) - k_t f'(k_t) = c_t^1 + \frac{c_t^2}{1 + r_{t+1} - s_{t+1}}$$

$$(45) \qquad -(1 + r_t)b_t + (1 + n)b_{t+1} + s_t(k_t + h_t + b_t) + k_t(f'(k_t) - r_t) = 0$$

Equation (45) is the public sector budget identity, where b_t is outstanding public sector debt at time t. The necessary conditions for an optimum include

$$(46) \qquad \psi_{t+1}\left[1 + f'(k_{t+1})\right] - \psi_t(1+n) = (\mu_{t+1} - \gamma_{t+1})k_{t+1}f''(k_{t+1})$$
$$- \gamma_{t+1}\left(s_{t+1} - r_{t+1} + f'(k_{t+1})\right).$$

$$(47) \qquad \gamma_{t+1}(1 + r_{t+1} - s_{t+1}) - \gamma_t(t+n) = 0$$

$$(48) \qquad \eta_{t+1}(1 + \tau_{t+1}) - \eta_t(1 + n) + s_{t+1}\gamma_{t+1} = 0$$

$$(49) \qquad \psi_{t+1}(1 + r_{t+1} - s_{t+1}) - \psi_t(1 + n) =$$
$$- \lambda_t(1 + n)\left[u''(c_t^1) - \beta(1 + r_{t+1} - s_{t+1})u''(c_t^2)\right]$$

(50) $\qquad \lambda_t \beta u'(c_t^2) = \mu \dfrac{(1+n)(k_{t+1} + h_{t+1} + b_{t+1})}{(1 + r_{t+1} - s_{t+1})}$

$\qquad\qquad\qquad\qquad - \gamma_{t+1}(k_{t+1} + h_{t+1} + b_{t+1})$

(51) $\qquad\qquad\qquad \mu_{t+1} = \psi_{t+1}$,

where ψ_t, η_t, λ_t, μ_t, and γ_t are the multipliers for constraints (41), (42), (43), (44), and (45), respectively.

The multiplier for the first-order condition for household saving, λ_t, need not be zero in the solution in the absence of any lump-sum tax instrument. Unless this multiplier equals zero, intergenerational redistribution does not satisfy the necessary condition for a first-best for the social planner:

$$u'(c_t^1)(1 + \rho) = u'(c_{t+1}^1)\left[1 + f'(k_{t+1})\right].$$

With lump-sum fiscal policies, the planner is able to choose any stream of net transfers of wealth to each generation. At each date, the lump-sum transfer to be made to the currently young when they are old targets only the welfare of that generation; it serves one and only one purpose. Without any lump-sum taxes or transfers, a residence-based tax finances a subsidy to capital, which in turn raises the wage rate of the young in a distortionary manner. Unlike the case of lump-sum fiscal policy, raising revenue in this fashion to provide a net increase in the welfare of the young distorts the consumption plan of the individual household. Saving decisions are made using an interest rate other than the world rate of interest. A transfer is made to the currently young by increasing wages using a source-based capital income subsidy, and transfers are made to the currently old through a subsidy to saving. Balanced budget fiscal policies using only nondiscriminatory capital income taxes and subsidies distort the timing of household consumption. Therefore, public sector budget surpluses or deficits help to redistribute welfare between generations currently alive and those yet to be born.

Using equations (46) through (50), we obtain

(52) $\qquad (\psi_{t+1} + \gamma_{t+1})\left(f'(k_{t+1})- r_{t+1}\right] = (\mu_{t+1} - \gamma_{t+1}) k_{t+1} f''(k_{t+1})$

(53) $\qquad -s_{t+1}(\gamma_{t+1} + \psi_{t+1}) = -\lambda_t(1+n)(u''(c_t^1) + \beta(1+r_{t+1}-s_{t+1}) u''(c_t^2)$

$$(54) \qquad \lambda_t \beta u^1(c_t^2) = (\mu_t - \gamma_t) \left(\frac{(1 + n)(k_{t+1} + h_{t+1} + b_{t+1})}{1 + r_{t+1} - s_{t+1}} \right)$$

There are three cases, corresponding to λ_t being positive, negative, or zero. If λ_t is zero, then the only solution is to set both tax rates at zero.

If λ_t is positive, then equation (53) implies that a subsidy to interest received by domestic residents is paid. Equations (52) and (54) then imply that a source-based subsidy to capital is adopted, so that the capital intensity of production rises and the wage received by the young increases. In this case, the public sector runs a primary budget deficit.

If λ_t is negative, then equation (53) implies that a positive residence-based tax is imposed, and equations (52) and (54) imply that the planner may adopt either a source-based tax on or subsidy to domestic capital, depending upon the difference between the shadow value of the public sector budget constraint and the shadow value of the budget constraint of the current generation. If a source-based tax is used, then the public sector runs a primary surplus so that transfers are effected between both currently alive generations and those yet to be born. With a subsidy to domestic capital, either deficits or surpluses are possible along with the redistribution from the currently old to the currently young.

If the multiplier λ_t is initially positive, then it must eventually become negative so that the public sector solvency constraint is met. The converse does not necessarily hold.

The necessary conditions for a constrained command optimum imply that a tax on domestic capital is only imposed in the presence of a tax on domestic saving. While an interest tax may be used to finance a capital income subsidy, a source-based tax on domestic capital is never used to help finance a subsidy to current wealth holders. Both an interest subsidy and a capital income subsidy can be deficit financed. The purpose of a tax on domestic capital is to reduce the impact of the savings distortion created when the government provides a stream of past or future subsidies in an unusual case (γ_t exceeds μ_t). The primary purpose of driving a wedge between the world interest rate and the domestic marginal productivity of capital is to provide a transfer through the wage rate to the currently young. The social cost of making this transfer is the net loss in domestic income (($f'(k_t) - r_t$) integrated over the reduction in the capital stock).

In this example, a production-side distortion is introduced by the social planner, constrained in her set of available fiscal instruments, to achieve a distributional objective. The Diamond-Mirrlees production-efficiency theorem for optimal taxation does not go through in this case because the level of the domestic capital stock affects the distribution of income between heterogeneous households. Except in a special case,

revenue is raised only through a tax on saving and not a tax on capital formation. The subsidy to capital serves as a distortionary subsidy to wage earners. Taxation of domestic capital is used in addition to taxation of savings when the shadow value of public sector income exceeds the shadow value of private sector income. That is, if the consumption of future generations weighs more heavily in social welfare than the consumption of the currently young in equilibrium.

A natural extension of this model is to allow the domestic supply of labor to be endogenous. Assuming that generations only earn labor income while young and that the young consume both leisure and the single consumption good, a labor income tax ceases to be a lump-sum tax. Changes in the rate of taxation of wages alters the equilibrium level of capital in the economy; for the small open economy in a world of perfect international capital mobility, an anticipated increase in the labor income tax leads to a reduction in the per capita level of domestic capital. If lower labor income taxes increase labor supply, then they lead to an increase in investment at home. That is, wage taxes affect the world demand for capital in open economies.

Suppose that the model is modified so that the household utility function is now given by:

$$u(c_t^1, 1-\ell_t) + \rho_t c_t^1 + \beta \, v \, (c_t^2)$$

where $(1 - \ell_t)$ is the household's consumption of leisure while young. The budget constraint for the household is

$$w_t = w_t(1 - \ell_t) + p_t c_t^1 + \frac{p_{t+1} c_t^2}{1 + \tau_{t+1}}$$

The possibility of a consumption tax in each period has been added by allowing the domestic consumer price of the single good, p_t, to differ from the international price, unity.

Optimal tax policies for the utilitarian distributional objective possibly include a wage tax, consumption (commodity) tax, interest tax, and source-based capital income tax, restricting attention to nondiscriminatory taxation. The household budget constraint indicates that allowing time-varying consumption taxes renders a residence-based tax redundant. The wage tax and the consumption tax will be chosen taking account of the elasticities of consumption and the distributional weights for the planner, according to a generalized Ramsey rule (as in Atkinson and Stiglitz (1976)). The tax on consumption and wage tax imposed on the young in any period will be set both to reduce the burden of raising revenue to provide net transfers to past or future generations and to redistribute welfare between those currently alive. For the small open economy, maximization of the social planner's objective if she has access to a wage income tax eliminates the use of a source-based capital income tax. The wage income tax is a superior instrument to the capital income tax for effecting distributions from the young.

In the two country economy, source-based capital income taxes and subsidies are used only to gain national advantage in world capital markets if labor income and interest income (or the equivalent) are available. However, in the absence of the unrestricted availability of source-based taxes, labor income taxes complement the use of residence-based capital income taxes for influencing a country's intertemporal terms of trade.

The use of source-based capital income taxation for international redistributional objectives is considered by Buiter and Kletzer (1990b). They assume that each national planner has access to lump-sum fiscal policies for redistributing welfare across resident households but that international lump-sum transfers are infeasible. Taxation of capital income at source has two effects. If there is net cross border asset ownership in equilibrium, then the rate of interest can be changed causing redistribution between creditors and debtors. With gross cross ownership of claims on physical capital (but not necessarily on net), source-based taxes and subsidies effect direct transfers by levying taxes on or providing transfers to foreigners. They also alter the return to immobile factors of production, in this model, labor. Buiter and Kletzer assume away direct redistribution through foreign ownership by requiring that all tax revenue collected from or subsidies paid to residents of either country be returned or financed through lump-sum transfers to that country. Assuming that a global social welfare objective is maximized, they show that a source-based tax is imposed in one country and a source-based subsidy is adopted in the other if there are gross cross claims on physical capital. Redistribution occurs through both the interest rate and through wages. Production in the world economy is distorted by this restricted optimal policy because a distributional objective over the welfare of heterogeneous households is again being maximized. The lump-sum fiscal policies for each country are coordinated in the solution.

International distributional objectives will call for production-side distortions, in general, in the absence of feasible international lump-sum transfers. Residence-based capital income taxation and tax-sparing credits can used to effect a transfer from one country to another through both the possible impact of a low source-based tax rate (or positive subsidy) on the world rate of interest if the recipient is a debtor and through an increase in the recipient country's wage rate via an increase in her capital stock.

V. Conclusions

Adoption of a common system of capital income taxation allowing national autonomy over rate setting does not rule out the use of fiscal policies for pursuing national goals at the expense of trading partners and the possible exacerbation of inefficient global resource allocation. Unification to a system of residence-based taxation still leaves countries with the ability to alter national patterns of wealth

accumulation. So does autonomy over the ability to produce public sector budget deficits and surpluses. In the case of consumption taxes, the choice between the destination and the origin principle will have major effects on competitiveness and the location of economic activity (see, for example, Bourguignon and Chiappori (1989), Dixit (1985), Slemrod (1988), Feldstein and Krugman (1989), and Sinn (1990b)). Similarly, the choice between source-based and residence-based capital income taxation has implication for both efficiency and distribution between countries and within countries. A source-based tax in the presence of a robust set of feasible lump-sum taxes and transfers allows a national planner to attempt to exploit her country's size in world capital markets to the greatest extent. This results in an overall efficiency cost.

The main purpose of this paper is to discuss the implications of distributional objectives for national fiscal authorities for the efficient taxation of capital income in an integrated economy. Arguments in favor of production efficiency in the literature on tax coordination (for example, Giovannini (1989), Giovannini and Hines (1989), Sadka and Razin (1989) and Sinn (1990a)) do not consider the use of national tax systems for intranational distributional objectives. With lump-sum fiscal policies available, a source-based capital income tax creates adverse externalities. Restrictions on the scope for lump-sum transfers also implies that source-based taxes may be part of an optimal tax program in the absence of attempts to exploit national advantage in a second-best world.

Appendix

To show that any equilibrium growth path that can be supported using unrestricted national age-dependent lump-sum tax and transfer schemes can also be attained using restricted lump-sum transfer policies with deficit-finance, let a particular path for the capital stock of each country and consumption of every household be supported by the unfunded social security schemes, $\{ (\tau_t^1, \tau_t^2)_{t=0}^{\infty} \}$ and $\{ (\tau_t^{*1}, \tau_t^{*2})_{t=0}^{\infty} \}$. Each public sector budget is balanced in every period under these policies, so that

$$\tau_t^1 + \frac{\tau_{t-1}^2}{1+n} = 0 \text{ and } \tau_t^{*1} + \frac{\tau_{t-1}^{*2}}{1+n} = 0$$

for all $t \geq 1$. Let overbars indicate the transfers and public debt for an age-independent lump-sum fiscal policy for each country. Note that $\bar{\tau}_t^1 = \bar{\tau}_{t-1}^2$ and $\bar{\tau}_t^{*1} = \bar{\tau}_{t-1}^{*2}$ for all $t \geq 1$. From the two government budget identities, equations (9) and (10), it follows that

(A1) $$\bar{b}_{t+1} + \bar{b}_{t+1}^* = -(1+r_t) (\bar{b}_t + \bar{b}_t^*) + (\frac{2+n}{1+n}) (\tau_t^1 + \tau_t^{*1}).$$

Equation (A1) must hold for all b_t, b_t^* τ_t^1, and τ_t^{*1}, for all periods. This can only be true if equation (A1) holds country by country; that is,

(A1a) $$\bar{b}_{t+1} = -(1 + r_t) \bar{b}_t + (\frac{2+n}{1+n}) \tau_t^1 ,$$

and

(A1b) $$\bar{b}_{t+1}^* = -(1 + r_t) \bar{b}_t^* + (\frac{2+n}{1+n}) \tau_t^{*1} .$$

Note that b_t and b_t^* are per capita public debt stocks and that r_t is the real interest rate, not the real interest rate net of population growth. Per capita public debt can zigzag from a positive value in one period to a negative value in the next. If $(\tau_t^1 + \tau_t^1)$ is constant over time, then the sawtooth pattern of public debt is readily apparent. It is explosive if the real interest rate is positive.

To assure that the same path for capital accumulation and consumption of households is followed, the budget set for every generation in each country must be unchanged. This requires that

(A2a) $$(\frac{1}{1 + r_{t+1}}) \ \bar{\tau}^1_{t+1} = -(\bar{\tau}^1_{t+1} + \tau^1_t) - (\frac{1 + n}{1 + r_{t+1}}) \ \tau^1_t + 1,$$

and

(A2b) $$(\frac{1}{1 + r_{t+1}}) \ \bar{\tau}^{*1}_{t+1} = - (\bar{\tau}^{*1}_t + \tau^{*1}_t) - (\frac{1 + n}{1 + r_{t+1}}) \ \tau^{*1}_{t+1} \ .$$

In the home country, the unfunded social security scheme increases the present value of lifetime resources of the generation born at time t by $-\tau^1_t + (\frac{1 + n}{1 + r_{t+1}}) \ \tau^1_{t+1}$. To achieve the *same* change in lifetime resources for this generation under the age-independent scheme equation (A2a) must hold. If the tax paid by this generation when it is young is positive, then the transfer received when old must be positive. That is, the transfer received by the young and old alike in period t+1 must be equal in present value to the tax paid by generation t while young plus $- \tau^1_t + (\frac{1+n}{1+r_{t+1}}) \ \tau^1_{t+1}$. The homogenous part of the tax equation changes sign each period and grows at a proportionate rate $1 + r_t$ in absolute value.

From the home country public sector budget identity, we have

(A3) $$(1 + n) \ \bar{b}_{t+1} = (1 + r_t) \bar{b}_t - (\frac{2 + n}{1 + n}) \ \bar{\tau}^1_t \ .$$

Adding this to its foreign counterpart and using equations (A2a), (A2b), and (11), it is apparent that the sawtooth pattern in each country's public debt is reflected in a similar pattern in the world stock of public debt. This raises the important question of how to formulate the proper solvency constraint for the government.

We first solve each country's budget identity (equations (9) and (10)) forward in time to obtain, for the home country

$$\bar{b}_o = \sum_{i=o}^{T-1} \ [\frac{\bar{\tau}^1_i}{1 + n} + (\frac{1}{1 + n})^{2-2} \tau^1_{i-1}] \ \delta_i + \delta_{t-1} \bar{b}_t$$

where $\delta_i = \prod\limits_{j = 1}^{i} (\frac{1}{1 + r_j}) \ .$

The conventional solvency constraint is the requirement the discounted public debt, $\delta_{T-1} \bar{b}_T$, converge to a nonpositive limit as T goes to infinity. This condition will not be satisfied, in general, under the age-independent transfer scheme. While the per capita stock of public

debt will zigzag explosively from period to period, per capita debt over a two period interval will tend to be well-behaved whenever the net intergenerational transfer under the balanced budget unfunded social security scheme is well-behaved. Using the home country budget identity for the age-independent lump-sum tax and transfer scheme in equation (A3), it follows that

$$\bar{b}_{t+2} = \frac{(1 + r_{t+1})(1 + r_t)}{(1 + n)^2} \, \bar{b}_t - \left(\frac{2 + n}{(1 + n)^2}\right) \left(\bar{\tau}^1_{t+1} + (1 + r_{t+1}) \, \bar{\tau}^1_t\right).$$

This can be rewritten using equation (A2a) as

$$\bar{b}_{t+2} = \frac{(1 + r_{t+1})(1 + r_t)}{(1 + n)^2} \, \bar{b}_t + \left(\frac{2 + n}{(1 + n)^2}\right) z_t$$

where $z_t = (1+n)\bar{\tau}^1_t - (1+r_{t+1})\bar{\tau}^1_t$ is the value of the net lifetime resource transfer made to the generation born at time t under either lump-sum policy. Solving this forward yields

$$\bar{b}_t = \frac{-(2 + n)}{(1 + n)^2} \, \sum_{i=0}^{T} \left(\delta_{t+1+2i} \, z_{t+2i}\right) + \delta_{t+2T+1} \, \bar{b}_{t+2T+2}$$

The natural solvency condition for the home country government now is that the limit of the sequence of discounted public debt every two periods, $\delta_{t+2T+1} \, \bar{b}_{t+2T+2}$, be nonpositive.

Buiter and Kletzer (1990a) propose the following modification to the usual formulation of the public sector solvency constraint: the sequence of discounted public sector debt need not converge if it possesses a convergent subsequence that converges to a limit less than or equal to zero.

What this means is that public sector debt may have to zigzag explosively if a restricted lump-sum transfer scheme is to achieve a national social welfare command optimum or support a Pareto efficient growth path. The public sector will be solvent under such a tax and transfer plan financed by a sequence of deficits and surpluses ever growing in absolute value if the length of each "fiscal year" can be chosen. That is, periods (in sequence) can be grouped together, so that the budget for each string of periods discounted remains bounded as the horizon goes to infinity.

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