CHAPTER 5

The Theory of International Tax Competition and Coordination

Michael Keen* **and Kai A. Konrad†,‡**

*International Monetary Fund, Fiscal Affairs Department, Washington DC 20431, USA
†Max Planck Institute for Tax Law and Public Finance, Marstallplatz 1, 80539 Munich, Germany
‡Social Science Research Center Berlin, Germany

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1. INTRODUCTION

Awareness that national tax policies can induce economic activity to move across international borders is not new. In 1763 (and there are earlier examples), Catherine the Great gave to ". . . Foreigners that have settled themselves in Russia [to] erect Fabricks or Works, and manufacture there such Merchandizes as have not yet been made in Russia . . ." the right to "sell and export said Merchandizes out of our Empire for 10 years, without paying any inland Tolls, Port Duties or Customs on the Borders . . ."[1] It is over the last two decades or so, however, that increased economic integration has made international considerations a central component of tax policy in economies at all levels of development. Like it or not, national tax policy makers are involved in a game with one another. This class of games is what will be meant here by "international tax competition,"[2] and it is the aim of this chapter to provide a reasonably concise account of what is known of such games, the outcomes they may lead to, and the ways in which they might be beneficially reshaped.

The practical policy agenda on these issues is an active one. The constraints that international considerations place on national tax policies are a commonplace of budget (and campaign) speeches, with the downward trend of statutory corporate tax rates—most often remarked upon for advanced economies, but hardly less marked elsewhere[3] (Figure 1)—the paramount *prima facie* example of international tax competition at work. But there are many others. A partial list would include the widespread demise of inheritance and gift taxation; the reduction in top marginal rates of personal taxation on both labor income (reflecting the mobility of high earners and the tax avoidance opportunities created if that rate strays too far from the falling corporate rate) and capital income; and the limits placed on cigarette and alcohol excises in the European Union and some other regional groups by the prospect of cross-border shopping and smuggling from less heavily taxing neighbors.

Concern at the pressures consequently imposed on national tax bases has led to proposals for, and, to a much lesser extent, action on coordinated measures to restrict downward pressures on tax rates. When it removed tax-related controls from its internal frontiers, for instance, the European Union (EU) adopted minimum excise duties in order to curtail expected downward pressure on rates. In the area of corporate income taxation,

[1] Weightman (2007, p. 33). She was quite successful, it seems; even James Watt was reportedly tempted.

[2] We will not agonize over a precise definition of "tax competition," but stress that its usage does not imply that taxes are necessarily "too low"—indeed we will see examples of the precise opposite.

[3] Arguably it is actually a greater concern in lower income countries, since they are typically more reliant on the corporate tax as a source of revenue.

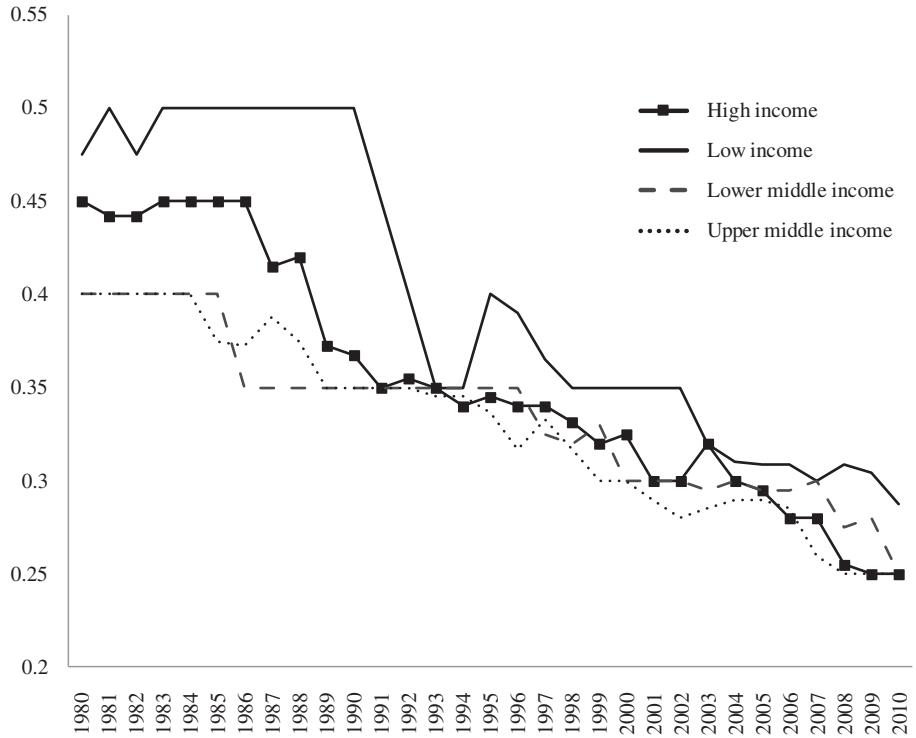

Figure 1 Median statutory corporate tax rates by income group, 1980–2010. *Note*: Tax rates from KPMG tax rates online and IMF compilation. Countries classified by income, at each date, into four equal-sized groups.

the Ruding Committee (1992) proposed for the EU a common minimum tax rate, at the now quaint-looking level of 30%.[4] In the latter 1990s, international efforts focused on identifying forms of "harmful tax competition" (distinguishing this from simply low rates of tax), notably with a landmark report by the OECD (1998) and the adoption by the EU of a Code of Conduct aimed at rolling back and precluding particular forms of tax incentive. The fate of this OECD initiative reflected the difficulty of agreeing on a delineation of harmful tax design, as it came to focus instead on the narrower (but still ambitious) objective of ensuring that countries provide each other with the information needed to enforce their own tax systems. This effort was massively reinforced by leadership from the G20 in the wake of the 2008 crisis. Regional blocs other than the EU—in Central America, Eastern and Southern Africa, and elsewhere—have also sought agreement to limit corporate tax competition among themselves, but, like the EU, have had only limited success. Coordination is more common on commodity taxation and the

[4] Assessments of the Ruding Report are in Devereux (1992) and Vanistendael (1992).

VAT—despite the fact, or perhaps because of it, that the lesser mobility of goods (though perhaps not, and increasingly importantly, of some key services) than capital suggests that this is likely to be less important than action on business taxation.

This increased policy focus on international tax competition has been matched, and even to some degree preceded, by a massive expansion of the public economics literature on these issues. This chapter does not aim to provide an exhaustive review of what has become a large and complex body of work, already the subject of several excellent surveys.[5] Instead it focuses on theoretical aspects of strategic interactions in national tax-setting, and possible policy responses, primarily in relation to the taxation of capital income.

This is the area in which tax competition concerns have had the greatest political salience and on which most academic attention has focused. In relation to corporate taxation, Figure 1 goes a long way to explain why. But such much-used figures also raise, and hide, as many questions as they answer. Is it even obvious, for instance, that tax competition implies downward pressure on rates, rather than upward, and is it necessarily the case that downward pressures on statutory tax rates from international tax competition are undesirable? Who gains, who loses? Might the EU have been wise to adopt the Ruding minimum rates, or would that simply have made it even more vulnerable to undercutting by other countries? What exactly are countries trying to attract in competing through their tax systems—productive investments or paper profits shifted by multinationals through a range of avoidance devices—and what difference does that make to the policy advice that might be offered? The figure also conceals the scope for countries to offer special regimes tailored to particular types of investments. Why do they do that—standard tax policy advice being to charge all businesses at the same rate—and does such targeting make tax competition more or less damaging? Not least, the figure also highlights that tax interactions are not a one-shot game, but evolve as a dynamic process in which different countries choose their tax rates repeatedly. How does that affect the nature of the equilibrium and the impact of possible policy interventions?

These are the kind of issues that the literature on international tax competition and coordination seeks to illuminate, and they are at the heart of this review. The focus here is on theoretical perspectives, and especially on the nature and implications of alternative forms of strategic interaction in the setting of taxes on capital and capital income. In this, the chapter emphasizes analogies between the theory of tax competition and competition models in the theory of industrial organization; analogies made evident in some of early and seminal contributions describing tax competition as an oligopoly game (Wildasin, 1988, 1991a; Wilson, 1986; Bucovetsky, 1991).

Doing justice to these issues means that the chapter refers only in passing to important aspects of the broader literature. It does not review econometric work on tax competition, which generally confirms that countries' fiscal policies are indeed interdependent, with

[5] These include Wilson (1999), Gresik (2001), Zodrow (2003), Wilson and Wildasin (2004), Fuest, Huber and Mintz (2005), Zodrow (2010), Genschel and Schwarz (2011), and Boadway and Tremblay (2012).

many of the findings in line with the main hypotheses derived from the theory reviewed here.[6] Nor does it consider in any detail the rather different issues that arise in relation to commodity tax competition.[7] And it addresses only briefly the nature of tax competition within and between multileveled federal systems.[8] The models used are a highly stripped down version of a reality that is far more complex in terms of both international tax rules and the avoidance devices that multinationals may use, accounts of which may be found elsewhere.[9] The treatment of profit-shifting by multinationals—in essence, the moving of paper profits between countries without changing the location of any real activity—is thus highly stylized.[10]

A word is also needed on the "international" in our title. Many of the issues raised at the outset also arise in relation to competition between states within federations, and localities within states. Indeed much of the literature reviewed here was developed with precisely such applications in mind. Many of the results reviewed here can thus be thought of as applying to any set of horizontally related jurisdictions, including within nations. Indeed the empirical literature often studies fiscal competition within federations, reflecting better data availability and the potential advantages of dealing with a more homogenous set of jurisdictions.[11] This makes it tempting to speak of "jurisdictions" rather than "countries."[12] But there are important differences. In federal systems, an overarching central government adds an additional level of vertical interaction in tax-setting since, explicitly or implicitly, tax bases are likely to overlap between levels of government. Moreover, the fundamental political context is generally quite different, with greater openness in federations to intergovernmental transfers and some forms of

[6] See, notably, Devereux, Lockwood, and Redoano (2008).

[7] There are resonances between the two lines of literature, and the Kanbur-Keen (1993) model discussed in Section 2.1.2, in particular, has applications to both. But tax impacts through final consumption and through factor inputs generally require quite different modeling. Central concerns in the analysis of commodity tax competition, which begins with Mintz and Tulkens (1986), are the characterization of and comparison between non-cooperative equilibria and potential coordination measures under both origin taxation (taxation occurring where commodities are produced) and destination principles (taxation according to where they are consumed). Lockwood (1997) provides an integrated treatment, and a survey (now, however, somewhat outdated) is included in Keen (2001).

[8] See Wilson and Janeba (2005); the survey by Boadway and Tremblay (2012) focuses on fiscal federalism, but includes considerations of tax competition. Zodrow (2010) focuses on the empirical evidence both on the sensitivity of capital flows on taxes and the evidence on the strategic interaction between governments in the context of tax competition.

[9] See Gordon and Hines (2002) on the former and Mintz and Weichenrieder (2010) on the latter. Also relevant here is the literature on double tax agreements, which has been primarily focused on whether these have encouraged capital movements: see for example Blonigen and Davies (2004).

[10] Gresik (2001) covers many of the early contributions on transfer pricing issues. The status of the discussion in the legal and economic literature on transfer pricing and other means of profit-shifting are set out in the collected volume by Schön and Konrad (2012).

[11] An early overview is by Brueckner (2003). More recent empirical contributions are Winner (2005), Carlsen, Langset, and Rattsø (2005), Overesch and Rincke (2009), Parry (2003), Revelli (2003), Boadway and Hayashi (2001), Büttner (2003), Mintz and Smart (2004), Binet (2003), Karkalakos and Kotsogiannis (2007), Gérard, Jayet and Paty (2010), and Jacobs, Ligthart, and Vrijburg (2010). For a recent survey see also Zodrow (2010).

[12] This usage would also have the merit of recognizing that many low tax jurisdictions that are important in practice are not, strictly speaking, independent countries, but overseas territories or dependencies.

coordination by the center. It is the interactions between independent nations, with their distinct powers and objectives, that give rise to the policy concerns above, and which are the primary focus of the chapter; to stress this, we shall speak of "countries" throughout, though other applications will be obvious (and even though many tax havens are dependencies rather than independent nations).

All this leaves a lot of ground to cover. In navigating it, we make extensive use of the two workhorse models that have been most widely used in the literature: those of Zodrow and Mieszkowski (1986) and Wilson (1986)—the "ZMW" model—and that of Kanbur and Keen (1993)—"KK." Both view tax competition as a game between countries played over the choice of a single tax rate, but with different types of interaction in mind: in ZMW (which has been especially prominent), tax differences across countries drive movements in productive capital; in KK (which has been used mainly in relation to commodity taxation, but as will be seen also has application to capital taxation) they affect the country in which tax is paid.

Section 2 starts by setting out and assessing these models, then uses them to explore the features, comparative statics, and welfare properties of noncooperative equilibria. Section 3 considers potential measures of coordination (such as the adoption of minimum tax rates, or coordination among a subset of countries), and Section 4 then takes a broader perspective, addressing a range of issues that are prominent in recent policy debates (including the use of special regimes targeted at particular firms or activities and the impact of tax havens and of the policy responses they might induce) and the political economy of tax competition and coordination. Section 5 concludes.

2. UNCOORDINATED ACTIONS

This section considers the outcomes to which unrestricted international tax competition might lead.

2.1. Workhorse Models

Formal thinking on this, and on many other issues reviewed here, has largely revolved around two, complementary modeling approaches. We start by setting these out.

2.1.1. The Zodrow, Mieszkowski, and Wilson (ZMW) Model

The formal literature on tax competition is largely rooted in an elegant model developed by Zodrow and Mieszkowski (1986) and Wilson (1986), the influence of which pervades the literature and so runs throughout this survey. This "ZMW" model considers a world economy comprised of n "countries," $i = 1, \ldots, n$, each characterized by investment opportunities described by an increasing and strictly concave product-of-capital function $f_i(k_i)$, where k_i denotes the capital-labor ratio, and f_i is to be interpreted as output per

unit of labor. (For the most part, one can equally well interpret k_i as aggregate capital and f_i as aggregate output; the difference is material, however, when as later in this section, differences in country size are analyzed.) Behind the scenes there may be other factors of production, such as labor, intangibles, and publicly provided inputs; where these are in variable supply and untaxed, they can be taken to have been concentrated out of the production function; they shape the function $f_i(k_i)$ but for the purposes here need not be considered in the formal analysis. The downward slope of the marginal product of capital, $f_i'(k_i)$, can be explained by the presence of these hidden factors.[13] For clarity, and except where indicated, they are taken throughout to be fixed in supply and immobile across countries. Labor, specifically, is assumed to be supplied in amount unity by each household, so that the aggregate labor supply in country i is simply its population, denoted h_i.

Taxes are levied on a "source" basis, meaning that each country i chooses the per-unit tax $t_i \in [0, 1]$ levied on each unit of capital that is invested within it, generating tax revenue of $t_i k_i$. Since tax treatment depends only on the location of the investment, and investors (those who supply the capital) can invest wherever they choose, all investors (assumed to be price-takers) must achieve, in equilibrium, the same after-tax rate of return on capital, denoted by ρ. Thus

$$f_i'(k_i) - t_i = \rho \text{ for all } i = 1, \ldots, n. \tag{1}$$

In the basic ZMW framework, the aggregate world capital-labor ratio is fixed at some level $\bar{k}$, implying the market clearing condition

$$\sum_{i=1}^{n} \sigma_i k_i = \sum_{i=1}^{n} \sigma_i \bar{k}_i = \bar{k}, \tag{2}$$

where $\sigma_i \equiv h_i / \sum_{s=1}^{n} h_s$ denotes country i's share of the global population (one indicator of its "size"), $\bar{k}_i \geq 0$ the per capita endowment of capital in country i. Attention is confined here, and throughout, to equilibria in which capital is fully employed. Conditions (1) and (2) then characterize the Walrasian equilibrium outcome in the capital market with perfect competition and perfect capital mobility.

Equations (1) and (2) jointly determine both the capital allocated to each country and the common net rate of return as functions $k_i(t_1, \ldots, t_n)$ and $\rho(t_1, \ldots, t_n)$ of tax rates

[13] The framework is a special case of a more general model in which output is a function $F(K, N, B)$, with N being an input factor such as labor that is paid a competitive market price (and may be supplied elastically or inelastically) and B representing other fixed factors such as, for instance, national public goods that firms do not have to pay for. The benchmark model is obtained from this, for instance, if B is absent, N completely inelastically supplied, and $F(K, N)$ is homogenous of degree 1; note, however, that the representation in the text does not in itself require constant returns.

in all countries. These, it is dull to show,[14] have the properties that

$$\frac{\partial k_i}{\partial t_j} = \begin{cases} \frac{1}{f_i''}\left(\frac{\sum_{s\neq i}^{n}\zeta_s}{\sum_{s=1}^{n}\zeta_s}\right) < 0, \text{ for } i = j \\ -\frac{1}{\sigma_i}\left(\frac{\zeta_i\zeta_j}{\sum_{s=1}^{n}\zeta_s}\right) > 0, \text{ for } i \neq j \end{cases} \tag{3}$$

where $\zeta_j \equiv \sigma_j/f_j'' < 0$, and $\partial\rho/\partial t_i < 0$ for all i.[15] An increase in the tax rate in any country i thus reduces the capital employed there, increases capital employed in all other countries j—capital moving until the increased scarcity of capital in i has increased the gross marginal product of capital there and reduced the marginal product of capital elsewhere by enough to bring the arbitrage condition back into balance—and reduces the common net rate of return. The magnitude of these effects reflects, as one might expect, shapes of marginal product schedule and the significance in the world capital market of the countries concerned.

On the consumption and welfare side of the model, there is in each country a single representative consumer—immobile across countries—with preferences[16] $W_i(x, r) = x + G_i(r)$ defined over private consumption x and the amount r of some publicly provided good, with G_i strictly increasing, strictly concave, and satisfying an Inada condition which ensures that, in the absence of other sources of revenue, all countries will charge a strictly positive tax rate in equilibrium. Private consumption x is financed by the rents to domestic immobile factors, $f_i(k_i) - f_i'(k_i)k_i$ and the net return to domestically owned capital, of $\rho\bar{k}_i$. Public provision is financed entirely by per capita receipts t_ik_i from capital located domestically, and the relative price of the private and publicly provided goods is taken to be fixed and normalized at unity; so $r_i = t_ik_i$.[17] Welfare of the typical consumer in country i can thus be written as

$$W_i = f_i(k_i) - f_i'(k_i)k_i + \rho\bar{k}_i + G_i(t_ik_i). \tag{4}$$

(where taking the argument of G_i to be per capita rather than total revenue is of course immaterial given a fixed population size). Given their action spaces and payoff functions (4), each government maximizes its objective function by a choice of its tax rate, taking

[14] Perturbing the $n-1$ equations corresponding to (2),

$$f_i'(k_i) - t_i = f_n'\left(\bar{k}/\sigma_{n-1} - \sum_{s=1}^{n-1}(\sigma_s/\sigma_n)k_s\right) - t_n,\ i = 1, \ldots, n-1,$$

gives the system $(A + \sigma_n f_n''\iota\alpha')dk = (dt_1 - dt_n, \ldots, dt_{n-1} - dt_n)'$ where A is the diagonal matrix with jjth element f_{jj}'', ι is the column vector of ones and the typical element of α is σ_j/σ_n. Supposing that only one tax rate changes, (3) follows after using a result on a matrix inversion, found, for instance, in Dhrymes (1978, Proposition 33).

[15] Differentiating (1), for any $j \neq i$, gives $\partial\rho/\partial t_j = f_i''\partial k_i/\partial t_j$, and the conclusion follows from (3).

[16] Little of substance is lost by the restriction on the functional form of preferences.

[17] Note that this is, in effect, a model of trade in two goods: a final consumption good and capital. Country i's exports, given by the excess of production $f_i(k_i)$ over its aggregate consumption $x_i + r_i$ are equal, given individual and public budget constraints, to its net payments on imported capital $\rho(k_i - \bar{k}_i)$. The elegance of the ZMW model derives largely from its collapsing a model of intertemporal trade into a single period.

the (equilibrium) tax rate choices of all other countries as given, and anticipating the implications of their choice for the allocation of and net return to capital.

Interpretation and Limitations

There are many embellishments of this basic ZMW structure to be found in the literature. Many of these are considered below, though by no means all. One not considered, for instance, is that in which public expenditure enters the production function rather than individuals' preferences, reflecting public spending on some form of infrastructure. In terms of strategic interactions and efficiency considerations, this leads to much the same conclusions as below. Before putting this model through its paces, however, it is important to see where it inherently does and does not connect with practical policy concerns.

One key issue is the interpretation of "capital," k. This is most naturally thought of as physical productive capital. ZMW is not a model of financial investments, since capital flows are taken to lead directly to changes in production: portfolio investments, or direct investments taking the form of acquisitions, need different handling.[18] The interpretation as physical capital requires, of course, some suspension of disbelief in terms of the ease with which factories and the like can be shifted from one country to another—raising issues of sunk and adjustment costs that are taken up later. More generally of course, "capital" here can be read as a metaphor for anything that is mobile internationally and generates real output where it is applied—the ZMW framework has been fruitfully applied, for instance, to issues of labor mobility [as in Wildasin (1991b)]. Note too that, as a first approximation, "capital" is considered as a non-lumpy and homogenous good, with foreign- and domestically-owned variants indistinguishable.[19]

On the tax side, several important elements of reality are abstracted from by specifying tax paid as simply $t_i k_i$.

First, the corporate income tax is in practice levied not on capital itself k_i but on some combination of the rents that capital earns, $f_i(k_i) - f_i'(k_i)k_i$ and the aggregate return to investment, $f_i'(k_i)k_i$. Allowing for a distinct tax on rents that accrue to the domestic citizen is straightforward: being non-distorting, this could be thought of as a preferred source of revenue, with the tax on capital k_i levied only insofar as additional revenue is needed (or to induce a beneficial change in the worldwide net rate of return, akin to an optimal tariff). Since it does not bear directly on rents, the tax rate t_i is best thought of as an indicator of the "marginal effective tax rate" on capital invested in country i—the additional tax paid on a real investment, reflecting both the statutory tax rate and the base of the tax—rather than the statutory tax rate alone. Even this, however, is not precisely right, because tax in the ZMW framework is levied on capital k_i rather than its earnings $f_i'(k_i)k_i$. The distinction here is similar to that between a specific and an ad valorem tax

[18] See, for one approach, Becker and Fuest (2010a, 2011).
[19] Mintz and Tulkens (1996) is an important exception on the latter point.

in the context of commodity taxation. In that context, and here too, the distinction is immaterial in terms of the decisions of competitive firms. Lockwood (2004) shows, however, that the distinction does matter in terms of strategic tax-setting, with tax competition likely to be more aggressive in the more realistic case in which it is the return to capital that is taxed. Intuitively, if country *i* reduces its tax rate, a larger inflow of capital is caused when it is the return to capital that is taxed because the reduction in the marginal return that inflow induces reduces the tax paid per unit of capital and so leads to an inflow in addition to that which would arise if tax per unit of capital were fixed.

Second, the assumption that tax liability follows mechanically from real investment decisions ignores the ability of firms to use a variety of devices—transfer pricing, financial decisions, and organizational structures—to disassociate the two. These issues, at the heart of much international tax debate, cannot be captured in the basic ZMW setting.

Third, the assumption of taxation only by the source country (where the productive capital is located) is apparently at odds with core features of the international tax architecture. Several countries have applied instead the "residence principle" in taxing foreign direct investment (and almost all do so for portfolio investment), by which, while the source (or "host") country has primary taxing rights, the home country (where the parent company is formally resident) also taxes income arising abroad, with a credit (non-refundable in practice) for taxes paid abroad. This is still, most notably, the system applied by the US. Residence taxation and can have profound implications for the strategic issues with which we are concerned here, and for national welfare, since it means that in some circumstances the tax applied by the host country is entirely irrelevant for the foreign investor. A small but long-standing literature aims to understand the choices countries have made as between the residence or source (also known as "exemption" or "territorial") principles (and other possibilities). One prominent puzzle is that of understanding why large capital exporters have historically chosen to give full credit for taxes paid abroad rather than simply allowing them as a deduction (which, as pointed out by Musgrave (1963), would seem preferable from their own perspective, since from their perspective taxes paid to a foreign government are a cost much like any other incurred in the host country). These issues are addressed in Gordon and Hines (2002) and Fuest et al. (2005), and not pursued here. Indeed it may well be that the ZMW assumption of source taxation is a reasonable characterization of reality even where foreign direct investment is subject, notionally, to residence-based taxation: additional taxes payable in the residence country can generally be deferred, for instance, by delaying repatriation of profits (this being a large part of what tax havens enable companies to do). And in some cases—more at the personal level rather than corporate—residence taxes are liable to outright evasion by simply failing to declare taxable income. There has, moreover, been a trend toward territorial systems, with both the UK and Japan having recently moved in this direction. The strong residence elements in the international tax architecture should not, however,

be forgotten—there are over 2000 double tax treaties that largely serve to clarify and coordinate taxing rights of residence and source countries.

Equilibrium and Social Optimality

Returning to the model itself, the choice by the typical country i of its own tax rate t_i to maximize its welfare, as in (4), taking the tax rates of all other countries as given, gives the first-order conditions

$$\frac{\partial W_i}{\partial t_i} = -f_i''(k_i)k_i\frac{\partial k_i}{\partial t_i} + G_i'(t_i k_i)\left(k_i + t_i\frac{\partial k_i}{\partial t_i}\right) + \frac{\partial \rho}{\partial t_i}\bar{k}_i = 0,\ i = 1, \ldots, n. \tag{5}$$

In considering an increase in its tax rate, each government thus weighs the reduction in rents to immobile factors consequent on the capital outflow this would cause, as well as any increase in revenue, against the reduced net income that it would earn on its capital endowment.

For each country i, (5) defines a best response function (or, more generally, correspondence) $t_i(t_{-i})$ relating its maximizing tax rate(s) to the tax rates t_{-i} set by all others (the subscript $-i$ referring to all countries other than i). Of particular importance, in any tax policy game, to understanding the impact of various policy interventions and country characteristics on equilibrium outcomes, is the sign of the slope of best responses: on whether country i's best response to a higher tax rate in country j is to raise its own tax rate (in which case tax rates are strategic complements) or to lower it (strategic substitutes).[20] For a game generating some reduced form $W_i(t_i, t_{-i})$ relating welfare directly to tax rate choices, strategic complementarity is equivalent to supermodularity[21] of W_i, and in the differentiable case is equivalent (as a consequence of the implicit function theorem) to

$$\frac{\partial^2 W_i}{\partial t_i \partial t_j} > 0, \tag{6}$$

with the reverse inequality corresponding to strategic substitutability. Using (5) to construct this cross-derivative in the ZMW model, it is easy to believe from the complex expression which results that, without further restriction, its sign is uncertain. Intuition might suggest, in particular, that the best response to a reduction in some other country's tax rate will be for i to reduce its own rate too; meaning that tax rates are strategic complements. But this is not, in general, assured (even in the case of symmetric countries). A lower tax rate in some other country j, for instance, moves capital out of country i and so reduces its tax revenue and public spending; whether the best response to this is for i to raise or

[20] Some care is needed here for a country that may deploy more than one instrument, since the slope of the final response of any one instrument to a change elsewhere will depend not only on the derivative in (4) but also on how it adjusts its other instruments.

[21] See, for instance, Amir (2005), who illustrates the power of supermodularity in a range of areas.

lower its tax rate depends, among other things, on how large an increase in the marginal value of public spending this implies (being more likely the greater is that increase).[22]

A solution to the system (5) is an intersection of the best responses $t_i(t_{-i})$, and characterizes an interior Nash equilibrium in pure strategies where it exists. For present purposes, we simply assume the existence of this equilibrium, $(t_1^N, t_2^N, \ldots, t_n^N)$. The assumption is not trivial, and has received more attention in recent years, sufficient conditions being explored, for instance, by Laussel and Le Breton (1998) and Taugourdeau and Ziad (2011).

A central question of interest is whether such an equilibrium has any social optimality properties. Potential inefficiency arises in a game with objective functions $W_i(t_i, t_{-i})$ when one country j's tax choice has some external effect on the welfare of country i, so that $\frac{\partial W_i}{\partial t_j} \neq 0$, with the sign of this term then shaping whether the expectation is of taxes being "too low" in equilibrium or "too high." If it is the case in equilibrium, for instance, that[23]

$$\frac{\partial W_i}{\partial t_j} > 0, \tag{7}$$

then country j, in ignoring the benefit that an increase would confer on country i, sets a tax rate that, from the perspective of the latter, is too low. For the ZMW model, (4) above implies that

$$\frac{\partial W_i}{\partial t_j} = \{f_i''(\bar{k}_i - k_i) + G_i'(t_i k_i)t_i\}\frac{\partial k_i}{\partial t_j}. \tag{8}$$

Before turning to the implications of this, it is also useful for later purposes to consider the case in which all countries raise their tax rates by some common and small amount $dt_i = dt$. From (1), this simply reduces the common net return ρ by the same amount and leaves the allocation of capital unchanged, so that the welfare impact on country i is $dW_i = -k_i dt + G_i' k_i dt$; evaluating this at the Nash equilibrium (noting from (1) that $\partial\rho/\partial t_i = f_i''(\partial k/\partial t_i)) - 1 = f_j''(\partial k_j/\partial t_i)$ i's first-order condition (5) then implies[24]

$$dW_i = [(k_i - \bar{k}_i)f_i'' - G_i'(t_i k_i)t_i]\frac{\partial k_i}{\partial t_i}dt. \tag{9}$$

With all this in mind, it is helpful to consider first the case in which all countries are identical, before turning to that in which they may differ.

Suppose then that all countries are identical in their production opportunities ($f_i(.) \equiv f(.)$, for all i), capital endowment ($\bar{k}_i = \bar{k}$), and preferences ($G_i(.) = G_j(.) \equiv G(.)$). Then

[22] Consistent with this intuition, Rota Graziosi (2013) shows that when the object of policy is simply to maximize tax revenue, log concavity of the production function is sufficient for supermodularity. Vrijburg and de Mooij (2010) argue, however, that it is not hard to find examples of strategic substitutability when the government has a welfarist objective.

[23] More terminology: Eaton (2004) refers to this as the case of plain complementarity and that in which $\frac{\partial W_i}{\partial t_j} < 0$ as plain substitutability.

[24] This can also be seen, more directly but somewhat less instructively, by using (3) in (8).

in the symmetric equilibrium in pure strategies the employment of capital k_i must be the same in all countries, and must equal the endowment of capital in each. Thus $k_i = \bar{k}_i$, and (8) gives

$$dW_i = -G'(t_i k_i) t_i \frac{\partial k_i}{\partial t_i} dt > 0. \tag{10}$$

The Nash equilibrium is thus Pareto inefficient: all countries would benefit from a small, uniform increase in all tax rates. This is the central result in the argument against unconstrained international tax competition.

In this symmetric case, the Nash equilibrium can be very directly compared with the social optimum. With identical countries, the latter is simply the combination of tax rates and transfers between countries that maximizes the sum of all their utilities. A necessary condition for this first-best outcome is the efficient provision of public funds, which, at an interior solution, requires

$$G'(.) = 1 \text{ for all } i = 1, \ldots, n. \tag{11}$$

Since the global capital stock is assumed completely inelastic, taxing its use at the same rate in each country ($t_i = t$ for all $i = 1, \ldots, n$) is entirely non-distorting; production efficiency is maintained, since, recalling (1), this ensures that marginal products of capital are equalized across countries (without which, aggregate output could be increased by reallocating capital between them). From (11), the first-best set of tax rates is given by

$$t_i = \frac{G'^{-1}(1)}{\bar{k}_i}, \text{ for } i = 1, \ldots, n. \tag{12}$$

The Nash equilibrium outcome generically differs from this since, in the symmetric case, the first-order condition (5) implies (substituting for $\partial\rho/\partial t_i$ as before (9))

$$G'(t\bar{k}) = \frac{1}{1 + E_k} < 1, \tag{13}$$

where $E_k \equiv \frac{\partial ln(k_i)}{\partial ln(t_i)} < 0$ denotes the elasticity of capital employed in i with respect to its own tax rate, evaluated at the Nash equilibrium. Relative to the social optimum, there is thus under-provision of the public good, and too low a tax rate, in the Nash equilibrium. The symmetric Nash equilibrium does have production efficiency: all countries charge the same tax rate, so the allocation of capital is first best. But the decentralized tax-setting means that countries fail to properly exploit what is, from the collective perspective, a perfectly inelastic tax base, access to which makes the first best feasible.

The simplicity of the case in which countries are identical, and sharpness of the results to which it leads, has made symmetry a common assumption in the literature. It is, however, highly unrealistic. The implication, for instance, is that there is no capital movement in equilibrium, and no gain from allowing capital to move; indeed there is a

loss, given the inefficient tax-setting from allowing capital to move at all. (If borders were closed, each country would recognize the inelasticity of the tax base and achieve the first best.) The asymmetric case is thus inherently more interesting; but it is also much more complex.

The diversity of national interests that can then arise is evident from (9), which shows that country i gains from a small, collective increase in tax rates if and only if $(k_i - \bar{k}_i) f_i'' - G_i'(t_i k_i) t_i < 0$. This is sure to be the case when $k_i > \bar{k}_i$; that is, for a capital importing country. For a capital exporting country, however, the reduction in after-tax capital income may more than outweigh the value of the increased tax revenue.

Social optimality also becomes more complex in the asymmetric case. Consider, for instance, the characterization of Pareto efficient tax structures: ones, that is, from which no country can be made better off without making any other worse off (and from which a selection might then be made if some social welfare function is available). It follows from results of Keen and Wildasin (2004) that if there are three or more countries, then, in the absence of lump sum international transfers, marginal products of capital may differ across countries at a (constrained) Pareto efficient allocation. Constrained Pareto efficient international tax structures, then, may well involve tax rates that vary across countries.

One implication is that the case for the residence principle, sometimes presented as the preferred international tax regime on the grounds that it eliminates the production inefficiency potentially associated with the source principle,[25] is weaker than often thought: it can lead to Pareto inefficient outcomes. The qualification has some policy importance, given the focus of current initiatives—discussed later—on strengthening the enforcement of residence taxation.

Comparative Statics

For the symmetric case, (13) immediately implies that the equilibrium tax rate is lower the larger (in absolute terms) is the elasticity of each country's tax base with respect to its own tax rate. Probing further, this elasticity can be shown, from (3), to be given by

$$E_k = \left(1 - \frac{1}{n}\right)\left(\frac{t}{\bar{k}_i f''}\right). \tag{14}$$

Substituting this into (13), it is straightforward to show that the equilibrium tax rate t is lower the more countries there are and the flatter is the marginal product of capital (the smaller, that is, is $|f''(\bar{k}_i)|$). This is as intuition would suggest: there is no distortion, of course, if $n = 1$; and a flatter marginal product schedule means that small tax differences induce larger capital flows.

In the asymmetric case, however, general results are hard to find. For that one must look to further restrictions on functional form, as for example, assuming a quadratic production function $f_i(k_i)$, as in Wildasin (1991a) and Bucovetsky (2009), giving a linear

[25] Under source-based taxation, if $t_i \neq t_j$, the arbitrage condition (2) implies $f_i' \neq f_j'$; under residence-based taxation, tax rates (and net returns) vary by the residence of the investor, so that the arbitrage condition, in obvious notation, becomes $f_j' - t_i = \rho_i$ for all i and j, implying $f_i' = f_j'$.

marginal product in each country i

$$f_i'(k_i) = max\{a_i - k_i, 0\};\ a_i > 0, \tag{15}$$

where the constant slope of this relationship is assumed the same in all countries (and normalized to unity), while differing intercepts allow for differing average products. The capital market equilibrium condition (1) then becomes

$$a_i - k_i - t_i = \rho \quad \text{for all } i = 1, \ldots, n. \tag{16}$$

On the consumption side, $G_i(t_i k_i)$ is assumed to be of the form

$$G_i = \begin{cases} (1+\lambda_i)t_i k_i & \text{for } t_i k_i \le \bar{G}, \\ (1+\lambda_i)\bar{G} & \text{for } t_i k_i > \bar{G}. \end{cases} \tag{17}$$

so that the private evaluation of the public good is strictly proportional to the cost of its provision up to some level $\bar{G}$, beyond which further increases have no value. This public expenditure generates some surplus, which can be seen as the shadow price of public funds, to the extent of $\lambda_i > 0$. (The upper limit $\bar{G}$ is assumed to be high enough not to affect the tax-competition equilibrium but not so high as to imply that an autarchic government would wish to confiscate all capital.)

To generate the closed forms this structure allows, note first that, since $\sum_{j=1}^{n} \sigma_j = 1$, (16) implies

$$a - \bar{k} - \sum_{j=1}^{n} \sigma_j t_j = \rho, \tag{18}$$

where $a \equiv \sum_{j=1}^{n} \sigma_j a_j$, and hence

$$\frac{\partial \rho}{\partial t_i} = -\sigma_i. \tag{19}$$

Substituting (18) in (16) gives

$$k_i = a_i - t_i - a + \bar{k} + \sum_{j=1}^{n} \sigma_j t_j \tag{20}$$

and so

$$\frac{\partial k_i}{\partial t_i} = -(1 - \sigma_i). \tag{21}$$

Using (19) and (21), the necessary condition (5) on country i's choice of tax rate gives the best response

$$t_i = \frac{(\lambda_i + \sigma_i)(a_i - a + \bar{k}) - \sigma_i \bar{k}_i}{(1-\sigma_i)(1 + 2\lambda_i + \sigma_i)} + \frac{(\lambda_i + \sigma_i)}{(1-\sigma_i)(1 + 2\lambda_i + \sigma_i)} \left(\sum_{j \neq i}^{n} \sigma_j t_j \right). \tag{22}$$

Nash equilibrium tax rates follow on solving the system of equation (22) for all n countries. It is straightforward to derive closed forms for the Nash equilibrium tax rates from (22); for present purposes, however, it is enough to focus on these best responses themselves. One immediate implication is that in this special case, country i's tax rate t_i depends only on the weighted average of those set elsewhere; each looks in particular to the tax rates set by the largest countries.

For the two country case, a simple graphical tool proves helpful; the same broad picture can of course be used to thinking about the general case too, but without the same confidence in the structure of the relationships drawn. Introducing this, Figure 2 illustrates the present special case when, moreover, the two countries are identical. It shows the Nash equilibrium N with tax rates (t^N, t^N) where the two reply functions intersect, and the iso-welfare curves $W_1(t^N, t^N)$ and $W_2(t^N, t^N)$ at the Nash equilibrium. The iso-welfare curves for country 1 intersect country 1's reply function $t_1(t_2)$ with a slope of zero: by definition, $t_1(t_2)$ gives the optimal choice of t_1 for the given t_2; so a small deviation in t has only a second-order effect for welfare along the curve $t_1(t_2)$. A similar argument explains the slope of $W_2(t^N, t^N)$ along $t_2(t_1)$. The curves $W_1(t^N, t^N)$ and $W_2(t^N, t^N)$ form a lens (the shaded area in Figure 2) that describes the set of tax rate pairs (t_1, t_2) that, if implemented, yield a strict welfare improvement for both countries relative to the Nash equilibrium even in the absence of any transfers between them.

More particularly, (22) implies that tax rates are in this case strategic complements: country i's best response to an increase in any of the tax rates set abroad is to increase its own tax rate—hence the upward sloping reaction functions in Figure 2. As discussed above, this strategic complementarity of single tax rates cannot be taken for granted.

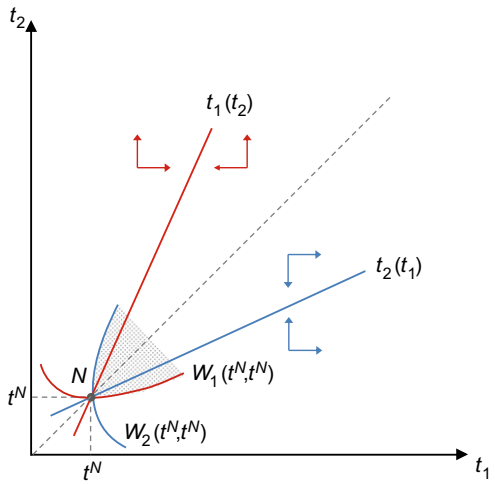

Figure 2 Nash equilibrium as the intersection of best responses in the linear model.

A rich series of comparative statics results follow from (22). Broadly speaking, equilibrium tax rates are lower in countries that are better endowed with capital, have more productive technologies, value public spending less, or are smaller.

To see this, consider first the endowment of capital, per unit of labor, $\bar{k}_i$. From (22), an increase in this endowment affects i's best response only by shifting down the intercept term. This, it is easily seen, leads to a lower equilibrium tax rate. Supposing then that all countries are identical in their shadow price of public goods ($\lambda_i \equiv \lambda$), and local opportunities for production ($a_i = a$), it follows from (22) that country i has a lower tax rate than country j if $\bar{k}_i > \bar{k}_j$. Intuitively, suppose that initially $t_i = t_j$; given identical technologies, (1) implies that capital is allocated so that the capital-labor ratio is the same in all countries. Country i must then be a capital exporter. Increasing its tax rate would reduce the world net rate of return, so that its citizens receive less on their investments both at home and abroad; the former is a matter of indifference, since there is an exactly offsetting increase in domestic revenues—but there is no offset to the loss of private income from investments abroad, which instead manifests itself as increased rents to the foreign citizen. Capital-rich countries will consequently be less aggressive in their tax policies.[26]

Higher productivity, manifested as a higher value of a_i, has an equally straightforward effect: this simply shifts up the intercept in (22), and so—assuming countries to be identical in all other respects—leads to a higher t_i. Intuitively, starting at $t_i = t_j$, (20) implies, given $a_i > a_j$ that $k_i > k_j$, while (21) implies (given equality of size) that $\partial k_i/\partial t_i = \partial k_j/\partial t_j$. The more productive country thus attracts the same amount of capital by lowering its tax rate as does the less productive; but—because it is more productive—this is more than offset by what it loses by taxing less heavily the capital already there.

A stronger taste for public spending over private consumption, corresponding to an increase in λ_i, can be shown (assuming countries to be in all other respects identical) to increase both the intercept in (22) and the slope of the best response function. Both effects point to an unsurprisingly increased tax rate in country i: again taking an initial position in which $t_i = t_j$ and supposing all countries to be otherwise identical, all countries have the same shift from private to public consumption from increasing their tax rate, but country i enjoys a greater benefit than country j.

The effects of country size, parameterized by σ_i, are more complex. Taking the two country case, simply some tedious differentiation and calculation shows (assuming the countries to be otherwise identical, and initially the same size) that both the intercept term and responsiveness to the other country's tax rate are greater in the larger country—the latter perhaps surprising result being a sign of the power of small countries in tax competition games, returned to later. This suggests (and direct calculation of the Nash equilibrium tax rates confirms—in this exercise, both best response functions shift) that the smaller of the two countries will set the lower tax rate in equilibrium. Intuitively, in

[26] More general analyses of tax competition with differences in capital ownership are provided by Wilson (1991) and Peralta and van Ypersele (2006).

considering a tax rate cut, countries must weigh the loss of revenue from their own capital against the benefits of attracting more inward investment; and for a small country, with a narrow domestic capital base and a lot of capital abroad that it might attract, the attractions of a rate cut will be greater. Bucovetsky (2009) further shows, in this same linear case (and assuming it is per capita public spending that matters for welfare, not—as would be the case with a classic Samuelsonian public good—total public spending), that the smaller country is the winner in this tax competition game, in the sense that, in equilibrium, per capita welfare is higher there than in the larger country.

2.1.2. The Kanbur-Keen (KK) Model

As will become abundantly clear, the workhorse ZMW model has proved extremely versatile and informative. In one important respect, however, it is, as noted earlier, inherently limited as an approach to thinking about international tax competition. This is because the tax base over which countries are assumed to compete is mechanically tied to real activity. In practice, both companies and individuals have many ways in which they can rearrange their affairs so as to reduce the total tax they pay with only limited effect on the pre-tax income they receive. Companies can shift paper profits to low tax jurisdictions, for instance, by transfer pricing (that is, manipulating prices charged within the group—for example, by providing highly priced management services to a subsidiary in a high tax country from another located in a low tax country), by financial structuring (such as "thin-capitalization": lending from a subsidiary in a low tax country to subsidiaries in high tax ones, the interest deduction in the latter generating tax savings that exceed additional tax due in the former), or by judicious choice of organizational form (exploiting mismatches in the way different countries view the same entity for tax purposes). Individuals can choose to hold investments through accounts in low tax jurisdictions, and evade or defer taxes due in their home countries. Quantifying these effects is difficult, but there is little doubt that the sums at stake are large.

The aim here is not to review such avoidance or evasion schemes—on the corporate side, an excellent treatment is in Mintz and Weichenrieder (2010)—but rather to consider how profit-shifting activities affect the way in which one should think about strategic aspects of international tax competition. For this, the model of Kanbur and Keen (1993) is a useful start. It was initially exposited as a model of commodity tax competition, and, although that is not the topic of this review, it will be helpful to construct it in the same way and then to reinterpret it as one of profit-shifting.

The framework is a spatial one, with two countries, $i = 1, 2$, each of length unity, located on a line with a border between them in the middle. The population is distributed uniformly in each, but population sizes h_i differ. Consumers buy only one unit of some good, which they can do either where they are located, paying the local tax, or by traveling to the border to buy at the tax-inclusive price of the other country. In the latter case they incur unit transport costs of δ. Suppose then that $t_1 < t_2$, where t_i denotes the unit tax

in country i. Then all consumers in low tax country 1 will simply buy at home. In high tax country 2, a consumer living a distance of s from the border will find it worthwhile to purchase abroad if and only if $t_1 + \delta s < t_2$; in aggregate, a proportion

$$s^* \equiv \frac{t_2 - t_1}{\delta} \tag{23}$$

of country 2 consumers will thus shop abroad. Revenues in the two countries are then:

$$r_1 = t_1\left(h_1 + h_2\left(\frac{t_2 - t_1}{\delta}\right)\right); \quad r_2 = t_2 h_2\left(1 - \left(\frac{t_2 - t_1}{\delta}\right)\right) \tag{24}$$

reflecting the revenue gain to the low tax country from sales to a proportion s^* of the h_2 consumers in country 2, and the corresponding loss to the latter. Each government is assumed to maximize its tax revenue, taking as given the tax set of the other. In the region where $t_1 < t_2$, these best responses are readily calculated to be

$$t_1(t_2) = \frac{1}{2}(\delta\eta + t_2); \quad t_2(t_1) = \frac{1}{2}(\delta + t_1), \tag{25}$$

where $\eta \equiv \frac{h_1}{h_2}$, as shown in Figure 3. What the figure also shows, however, is that viewed over the full space of tax rates there is a discontinuity in the best response of (only) the small country.[27] When the larger country sets a low rate, the smaller would have to set such a very low rate to attract shoppers from across the border that the revenue gained thereby would less than offset the revenue lost from its own consumers; as the rate in the larger country increases, however, there comes a point at which the smaller country finds it optimal to shift discontinuously to a strategy of undercutting. While this discontinuity makes existence problematic, Kanbur and Keen (1993) show that there is a unique Nash equilibrium, and, as at E, it is in the region where $t_1 < t_2$. From (25), the Nash equilibrium tax rates are

$$t_1^N = \delta\left(\left(\frac{2}{3}\right)\eta + \frac{1}{3}\right); \quad t_2^N = \delta\left(\left(\frac{1}{3}\right)\eta + \frac{2}{3}\right). \tag{26}$$

The Kanbur-Keen model thus formulates very sharply the idea that smaller countries will set lower tax rates. More generally, such closed form solutions for equilibrium tax rates are rarely available, and generate a series of useful benchmark results.

Several embellishments of this framework are to be found in the commodity tax literature.[28]

[27] Discontinuities are also a prominent feature of the model of commodity tax competition with transport costs in Mintz and Tulkens (1986).

[28] Nielsen (2001), for instance, shows that essentially the same results hold if countries instead have uniform population densities but differ in length. Ohsawa (1999) extends the analysis to the case of three countries located on a line, showing that (in the absence of size differences) tax rates will be higher in the periphery (because the intermediate

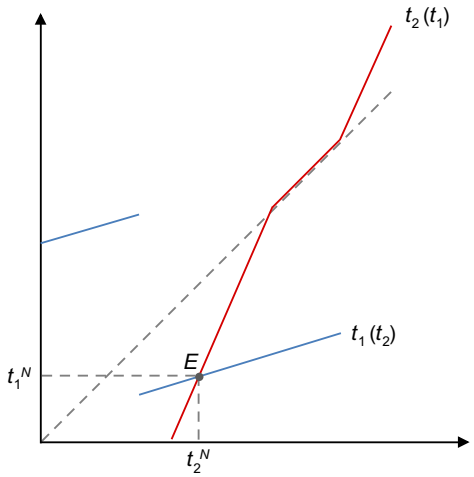

Figure 3 Equilibrium in the Kanbur-Keen model.

To see how a simple model of profit shifting can lead to the same formal structure, consider a multinational that earns "true" profits[29] in each of the two countries of Π_i, $i = 1, 2$. Profit declared in country i, and taxed there at a proportional rate t_i differs from true profit, however, to the extent that the company uses transfer pricing and other devices to shift profit between them. Suppose, as above, that $t_1 < t_2$ so that the incentive is to shift profits into country 1, and denote by s the fraction of real profit in country 2 that is shifted. Such shifting is not costless, however, involving some organizational cost, distortion of activities, or risk of penalty. Assuming this cost to take the form $(1/2)\delta s^2 \Pi_i$ and not to be deductible in either country,[30] the firm's net profit is then

$$\Pi = \Pi_1 + \Pi_2 - t_1(\Pi_1 + s\Pi_2) - t_2(\Pi_2 - s\Pi_2) - \left(\frac{1}{2}\right)\delta s^2 \Pi_2. \qquad (27)$$

country attracts cross-border shoppers from two countries by setting a lower rate, but the others from just one). Agrawal (2012) discusses tax competition if countries can choose regionally differentiated tax rates. With a federal structure in mind, Agrawal (2011) locates states (corresponding to countries in the analysis above) along a circle and allows for tax differentiation across towns within states. Keen (2002) provides an review of this literature.

[29] The concept of "true" profits being allocable to particular countries is problematic in itself. The centerpiece of international taxation practice is the principle of valuing intra-group transactions at "arms-length" prices which would be paid between unrelated parties. Since competitive markets, where such prices can be found, often do not exist (a fact in itself linked with the existence of the multinationals) this is in practice highly contentious. For present purposes, however, a broad distinction between profits associated with real activity in particular and those shifted with the tax-minimizing intention of shifting the distribution rather than the total of group profits is clear enough.

[30] This is for convenience rather than realism. In practice, costs may well be tax-deductible in one country or the other, and the cost may reflect penalties that in turn depend on the applicable tax rate. The extent of profit-shifting may then depend on tax rates through more than just the absolute difference between them.

Maximizing with respect to s, the proportion of profits shifted from country 2 to country 1, s^* is exactly as in (23) above and revenues in the two countries are precisely as in (24), with true profit Π_i replacing population size. Conclusions drawn from the commodity tax form of the model can thus be translated directly into results on profit shifting.

Prominent among these is that it is the country which is "smaller," not necessarily (as in the commodity tax variant) in terms of population or geographical size but in the sense of hosting lower aggregate profits from real activities, which sets the lower tax rate in equilibrium. This is a strong prediction that, as will be seen, resonates closely with some features of reality. The intuition underlying it is straightforward: a country that is small in this sense loses little revenue from its own tax base by cutting its tax rate, but can gain a good deal by attracting taxable profit from the rest of the world.

Many of the other implications drawn from the KK model are also broadly similar to those derived earlier for the ZMW model, with the closed forms available enabling particularly sharp expression. These include the finding that setting a uniform rate anywhere between the rates that emerge in the Nash equilibrium always harms the small, low tax country, whereas imposing a minimum tax anywhere in that range is Pareto-improving. There is, though, one important difference: whereas the tax rates in the ZMW model are, as noted, best interpreted as marginal effective rates, capturing the combined impact of tax rates and tax base on the additional liability associated with investing a little more, the relevant tax rates in considering profit shifting are best thought of as corresponding to statutory rates, since the shifting has no impact, for instance, on depreciation allowances claimed. Thus it is quite possible, for instance, that countries might wish to lower the statutory rate in order to manipulate profit-shifting while expanding tax bases so as to protect revenue from real investments.

With this important difference between them, the confluence of results is nonetheless reassuring, in the sense that the insights into equilibrium outcomes and broad policy responses seem reasonably robust to the mix between real and paper shifting of tax bases. But they also point to the importance of asymmetries and the difficulties these create for coordinating beneficial outcomes. It is a general feature of tax competition models that small countries matter a good deal—a sharp contrast, for example, to the literature on tariff wars, in which it is the large countries that are potential winners from trade wars. This has powerful implications for designing feasible reforms in this area, a point taken up in the next section.

2.2. Sequential Decision Making

There is some evidence that countries' tax reforms do not occur simultaneously. The results of Altshuler and Goodspeed (2002), for instance, suggest that sequential choices between the US and European countries have existed since the 1986 US tax reform, with the USA acting as a Stackelberg leader and European countries acting as followers vis-à-

vis the USA and moving simultaneously vis-à-vis each other.[31] This raises the question of how the possible sequentiality of choices among governments can change the outcome.

This has been addressed in theoretical contributions by Wang (1999) for indirect taxes (in the setting of the KK model discussed in Section 2.1.2 above) and Kempf and Rota Graziosi (2010), who analyze endogenous timing, using the workhorse ZMW model.

Figure 4 illustrates the Stackelberg leadership case, under the assumption that tax rates are strategic complements. It shows the same best reply functions for the linear variant of the workhorse model as in Figure 2, and the Nash equilibrium that emerges from simultaneous tax-rate choices. Suppose now that, for some reason, country 1 has to choose its tax rate t_1 first while country 2 is the follower who observes this choice and chooses t_2 on the basis of that observation. In this case, country 1 anticipates that, whatever t_1 it selects, country 2 will choose a $t_2(t_1)$ in line with its reply curve. Hence, by choosing t_1 and anticipating subgame perfect play, the country can essentially choose from all combinations $(t_1, t_2(t_1))$ that are graphically described by the reply function $t_2(t_1)$. If country 1 optimizes, it chooses the point along $t_2(t_1)$ that maximizes its objective function. Graphically, such a point is found where an iso-payoff curve for country 1 is tangent to $t_2(t_1)$, as it is drawn in Figure 4. It follows that, in a Stackelberg equilibrium, and given strategic complementarity, both countries choose higher taxes than in the Nash equilibrium. Starting from the latter, there would be no advantage to country 1 from raising its tax rate if country 2 continued to choose the Nash equilibrium tax rate—as would happen in the simultaneous game, because country 2 would have no reason to anticipate this deviation from $t_1 = t^N$. However, if country 1 chooses first and country 2 can observe this choice, country 2 re-optimizes and finds that, given $t_1 > t^N$, its optimal tax rate is also higher. By setting $t_1 > t^N$, country 1 induces a higher t_2, and it is this strategic effect that benefits country 1.

It is clear from the figure that country 2 is also better off than at the Nash equilibrium, being on a higher iso-payoff curve. Indeed in the symmetric country case it may well benefit more than the leader, since the latter charges the higher rate: for both then benefit from the increase in both tax rates to the level that the follower sets in the Stackelberg equilibrium, but the follower then benefits in addition (and the leader suffers) from the further increase in the leader's rate.

While sequential choice is in the interest of all countries here, it requires commitment. In the symmetric case in Figure 4 the Stackelberg follower is seemingly at an advantage, and the commitment problem is one of staying flexible and out-waiting the other country. Procedural rules, the timing of government formation, and so on may yield some differences in the timing in different countries. But the cyclic nature of most of these institutional procedures does not clearly answer the question of who would be expected to move first.

[31] Stackelberg leadership of the federal government is also commonly assumed in the literature that discusses tax competition within a federation (see for instance, Hayashi & Boadway, 2001; Janeba & Osterloh, 2012).

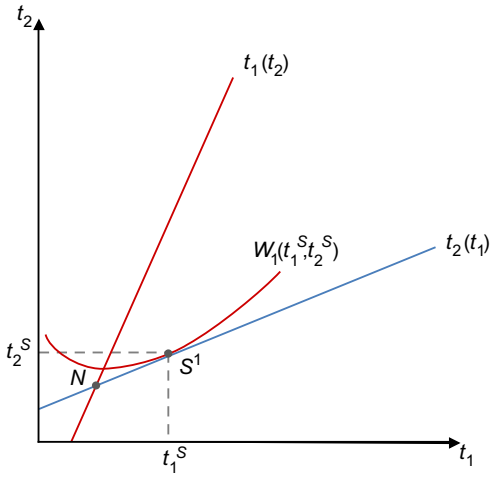

Figure 4 Stackelberg equilibrium.

A solution to this problem comes from the theory of endogenous sequential choices, first developed in the context of duopoly by Hamilton and Slutsky (1990) and applied in the context of tax competition duopolies by Kempf and Rota Graziosi (2010). A Stackelberg leader-follower outcome can typically be obtained as the outcome of a game which is augmented by an earlier stage in which each country first chooses its timing of choice (what Hamilton and Slutsky call "the extended game with observable delay"). Let there be two points of time for tax rate choices: $h \in \{e(arly), l(ate)\}$, with the point $l(ate)$ occurring after the point $e(arly)$ in the time line. First, let each country simultaneously choose whether it would like to choose and fix its tax rate at time e or l. One can then show that there is a subgame perfect equilibrium in which one country, say, country 1, chooses $h_1 = e$ and the other country 2, chooses $h_2 = l$; the Stackelberg game just discussed is the continuation game. To confirm this, we need to show that, assuming subgame perfect play in all possible continuation games, $h_1 = e$ and $h_2 = l$ are mutually optimal replies. Suppose that, for whatever reason, country 1 assumes that country 2 chooses l. Then, country 1 has essentially two options. It can also choose $h_1 = l$. In this case, both countries choose their tax rate at time l and simultaneously. They end up in the Nash equilibrium (t^N, t^N). Alternatively, country 1 can choose $h_1 = e$. In this case they end up in the sequential subgame with country 1 the Stackelberg leader and country 2 the follower, with an equilibrium at S^1 in Figure 5. As just discussed, this outcome is superior to the Nash equilibrium outcome for country 1; hence, $h_1^*(h_2 = l) = e$. Turning now to country 2, it remains to confirm that, given $h_1 = e$, country 2 prefers $h_2 = l$. Supposing that country 2 anticipates $h_1 = e$, it has essentially two options. It can choose $h_2 = e$. This yields simultaneous tax rate choices in the continuation game, and the equilibrium is the Nash equilibrium with tax rates (t^N, t^N). Or country 2 can

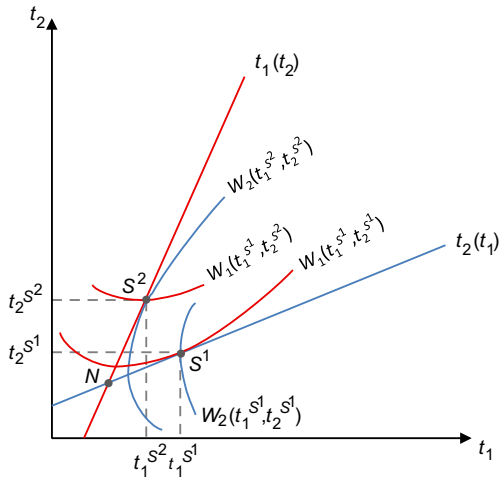

Figure 5 Endogenous sequencing in the tax rate choices.

choose $h_2 = l$ instead. In this case, the subgame is the Stackelberg game discussed above, which country 2 prefers to the Nash equilibrium.

Two difficulties remain with this concept. One is the coordination problem. As was argued in the context of Figure 4 above, both countries prefer the Stackelberg game to the Nash game. But, they typically prefer being in the position of Stackelberg follower (i.e., to be the country that chooses $h = l$) if the other country chooses $h = e$. If the countries cannot coordinate on who becomes follower and who becomes leader, they may randomize independently about their commitment choices. This leads to an equilibrium with mixed strategies at the stage in which they choose timing. In some of the subgames, the mixed strategies result in (e, e) or (l, l), in which case a Nash game follows as the continuation game; in other subgames they manage to end up with (e, l), leading to the Stackelberg equilibrium S^1 or (l, e), leading to the Stackelberg equilibrium S^2 in the continuation game. Kempf and Rota Graziosi (2010) use an equilibrium selection argument (the risk-dominance criterion) to argue that—focusing on country differences in capital productivity—the less productive country is more likely to be the leader. If the countries become sufficiently asymmetric, this order of moves can even become Pareto dominant.[32]

The second problem that remains is to explain what makes the commitment feasible and credible at the stage when countries commit on their timing. In an institutional context in which tax reforms are feasible only in some time windows, within an electoral cycle, for instance, the choice of the timing of elections may induce some sequential ordering of decision making.

[32] For further discussion taking into consideration the role of capital ownership and asymmetries between countries, see also Ogawa (2013) and Kempf and Rota Graziosi (2012).

2.3. Pure Profits and International Portfolio Diversification

If aggregate production is a function of internationally mobile capital and other, internationally immobile, factor inputs, and if some of these inputs can be used costlessly, then the ownership of the production facilities in a country may include entitlements in pure profits. The assumption in the ZMW workhorse model above was that any such rents all accrue to domestic residents and are untaxed. Such rents are of course an attractive target for taxation, being non-distorting insofar as these rents are genuinely location-specific. Allowing for such rent taxes adds little when rents all accrue domestically, simply implying that source-based taxes need to be used only insofar as such taxes cannot raise all the revenue required.[33] Foreign ownership, however, raises more substantial issues.

To address these, we consider a simplified version of the ideas outlined in Huizinga and Nielsen (1997, 2002, 2008) and Fuest (2005). Pure profits, it is assumed, cannot be taxed directly but a source tax on capital can be levied—perhaps because paper profits are easier to conceal, or shift across jurisdictions, than productive capital. Production in each country uses capital as the single variable factor in combination with some unpriced fixed factor, which can be thought of as a natural public good. Then $(f_i(k_i) - f_i'(k_i)k_i)$ is the total pure profits that accrue to the owners of the production facilities in country i. Denote by θ_{ij} the share of the production facilities in country j that is owned by the citizens of country i. Then the national welfare function becomes

$$W_i = \sum_{j=1}^{n} \theta_{ij}(f_j(k_j) - f_j'(k_j)k_j) + \rho\bar{k}_i + G_i(t_i k_i) \tag{28}$$

(with Eq. (4) above being the special case in which $\theta_{ii} = 1$ and $\theta_{ij} = 0$ for $i \neq j$). An assumed interior equilibrium characterized by the first-order conditions can be determined by

$$\frac{\partial W_i}{\partial t_i} = \sum_{j=1}^{n} \theta_{ij}(-f_j''(k_j))k_j \frac{\partial k_j}{\partial t_i} + \frac{\partial \rho}{\partial t_i}\bar{k}_i + G'(t_i k_i)\left(k_i + t_i \frac{\partial k_i}{\partial t_i}\right) = 0, \quad i = 1, \ldots, n. \tag{29}$$

Comparing this with Eq. (5) above, the relocation of capital away from the country induced by an increase in its tax rate t_i has different welfare effects in the presence of international portfolio investment. First, country i bears only the share θ_{ii} of any loss in rents $(f_i(k_i) - f_i'(k_i)k_i)$ on domestically employed capital, since its citizens own only a share $\theta_{ii} < 1$ of these rents. This makes an increase in t_i more attractive than when $\theta_{ii} = 1$. Second, the citizens in i benefit from the increase in production rents that accrue

[33] The strategic role of an internationally diversified ownership of firms for decision making of a government that maximizes national welfare has been highlighted in other areas of public economics as well. These include strategic trade policy (Dick, 1993, Huck & Konrad (2003, 2004)), competition policy (Haufler & Schulte, 2011), international trade policy (Feeney & Hillman, 2001), and privatization policy (Norbäck & Persson, 2005).

in other countries, in proportion to the shares θ_{ij} which they own in these rents. As an increase in t_i increases these production rents, this effect also makes an increase in t_i more attractive than for $\theta_{ij} = 0$. Starting from the values $(t^N, \ldots, t^N)$ that characterize a Nash equilibrium for $\theta_{ii} = 1$ and $\theta_{ij} = 0$ and fully symmetric countries (including in population size), the first-order welfare effect of an increase in i's own tax rate is

$$\frac{\partial W_i}{\partial t_i} = (\theta_{ii} - 1)\left(-f''\left(\bar{k}\right)\right)\bar{k}\frac{\partial k_j}{\partial t_i} + \sum_{j \neq i}\theta_{ij}\left(-f''\left(\bar{k}\right)\right)\bar{k}\frac{\partial k_j}{\partial t_i}. \tag{30}$$

This is unambiguously positive for $\theta_{ii} \in (0, 1)$ and $\theta_{ij} \in (0, 1)$. Again assuming strategic complementarity of tax rates, this implies that international portfolio diversification weakens tax competition and leads to higher equilibrium tax rates than in the benchmark case.[34]

This result—that a high degree of international ownership reduces the incentives for a race to the bottom—in turn suggests a potential strategic relationship between the degree of international firm ownership and the intensity of tax competition. If portfolio investors in a country could coordinate on a joint portfolio policy, and if (as seems plausible) they were less interested in the public good than the policy maker (or the median voter), then those investors would have an incentive to reduce their international investment activities in order to induce lower domestic tax rates. Indigenization—encouraging national ownership in national firms and their profits—is a well-known means to reduce the government's incentive to generate tax revenue from them.[35]

This indigenization effect is well-known from other contexts. For instance, it has been argued that indigenization, or joint ventures with host country citizens reduce the incentives of the national government in the host country to expropriate or nationalize foreign direct investment. Konrad and Lommerud (2001) show that the problem of ex-post opportunistic behavior can also be moderated if the host country government has incomplete information about the true profitability of the FDI project and if a large share of the foreign company is owned by citizens of the host country. Key to their argument is that this incomplete information shields an information rent of the firm from being extracted, even if the host government applies the most sophisticated extortionary means to extract as much revenue as possible. Similarly, it has been argued that a country with sovereign debt should be less inclined to default if its debt is held mainly by its own nationals (Broner, Martin, & Ventura, 2010).

[34] Huizinga and Nicodème (2006) interpret their empirical findings on the relationship between international ownership and corporate taxes as being in line with this finding.

[35] The trade-off between risk diversification and the incentives for tax revenue extraction in the context of international ownership of fixed resources is developed in Wildasin and Wilson (1998).

2.4. Tax Competition with Multiple Instruments

A common feature of both ZMW and KK is that each country deploys only one tax instrument. Many contributions to the literature relax, in one way or another, this unrealistic assumption.

Even allowing for taxes on immobile factors can make an important difference. In ZMW, a country that could also tax rents to the domestic factors generating the concavity of the production function but was unable to affect the common return ρ would optimally choose not to impose a source-based tax on capital: this is the well-known result that small countries should not tax capital.[36] Bucovetsky and Wilson (1991) show that the same applies when labor supply is variable, and wage income can be taxed directly. The intuition is the same in both cases: with the required return on world markets fixed, the real burden of any tax on capital is passed onto labor—and it is then better to tax labor directly than to distort capital intensity. The fundamental inefficiency remains, however, if the global capital stock is fixed, since a common tax on that base is then lump sum.

The case in which distinct instruments bear directly on the allocation of production and tax bases across countries is of obvious direct interest. One such instance—in which different types of mobile capital can be taxed, in ZMW fashion, at differing rates—is discussed at some length in Section 4.2. Here we consider another. For with ZMW attuned to modeling movements of real capital and KK to the shifting of paper profits—and both important in practice—it is natural to combine the two. This is the essence, for example, of the model set out in Devereux et al. (2008), a stripped down version of which suffices here.

Suppose then that there are two countries, each, in the spirit of ZMW, with a fixed endowment of capital that is freely mobile between them. In each there is a single multinational enterprise, which undertakes real production only there but which, in the spirit of KK, can also, at some increasing and strictly convex cost $c_i(s_i)$, shift an amount of taxable profits s_i to the other country (the assumption being that it has unmodeled taxable income arising there to which it can add or subtract). Country i levies both a source-based tax t_i on the real capital located there and a profit tax T_i on output $f_i(k_i)$ net of profits shifted abroad, financing costs ρk_i, and the source-based tax. With all investment-related costs deductible, T_i is effectively a tax on rents, so that this structure[37] captures two core components of the corporate tax discussed in Section 2.1.1. The after-tax profits of the multinational located in 1 are thus

$$\Pi_1 = (1 - T_1)\{f_1(k_1) - \rho k_1 - t_1 k_1\} + (T_1 - T_2)s_1 - c_1(s_1) \tag{31}$$

[36] A result that is sometimes invoked too loosely: such a country should, if it can, impose a residence-based tax on capital, and will wish to impose a source-based tax if full credit for that payment is given in the residence country of foreign investors (a major consideration, in practice, for many developing countries).

[37] The assumptions that the source-based tax is deductible against the profit tax, and the costs of profit-shifting are not are inessential.

with the net return ρ taken as given by the multinationals but determined in equilibrium, as in ZMW, so as to clear the global capital market; and the tax revenue collected in country 1 is

$$r_1 = T_1\{f_1(k_1) - \rho k_1 - s_1\} + (1 - T_1)t_1 k_1 + T_1 s_2, \tag{32}$$

the final term reflecting revenue raised from profits shifted in by the multinational headquartered in country 2.

Maximizing in (31), the multinational headquartered in country 1 shifts an amount of profit such that

$$c_1'(s_1) = T_1 - T_2 \tag{33}$$

and invests to the point at which

$$f_1'(k_1) - t_1 = \rho. \tag{34}$$

In terms of behavioral impact, there is thus a simple dichotomy of effects: the extent of profit-shifting depends only on the difference in rates of rent taxation (reminiscent of (23) in the KK case), while the allocation of capital depends only on the difference in effective rates of source-based taxation.

For policy-making, however, there is no such simplifying decoupling of the two tax instruments. In considering acting on profit-shifting by changing the rate of its rent tax, for instance, a country needs to be mindful that although this does not affect the real capital employed there, it does affect the revenue it collects on the earnings generated by that capital. The interactions between the tax instruments, both within and across countries, become complex, and are not discussed here.[38] One lesson worth noting, however, is that it is no longer the case that a small country with access to a rent tax would not wish to impose a source-based tax: it generally will, to provide some safeguard against the erosion of its ability to tax those rents as a consequence of profit-shifting.

2.5. Vertical Externalities and the Strategic Role of Internal Governance Structure

The analysis so far has abstracted from the complex multiplayer decision-making process generating national tax policy choices, treating these decisions as if they were made by single players acting in the interest of their citizens. In fact, many countries have multilayered governance systems, with each layer of government imposing taxes with (explicitly or implicitly)[39] partially overlapping tax bases and, often, systems of intergovernmental grants. This internal architecture can have significant effects on the tax competition games played both within and between countries.

[38] Devereux et al. (2008) discuss these, and optimal tax rates, in some detail for symmetric countries.

[39] The overlap is obvious when, for example, central and lower level governments both tax corporate income; but can also arise, for example, when the central government imposes a VAT and lower levels some form of wage tax, since in economic terms the bases of the two taxes are very similar.

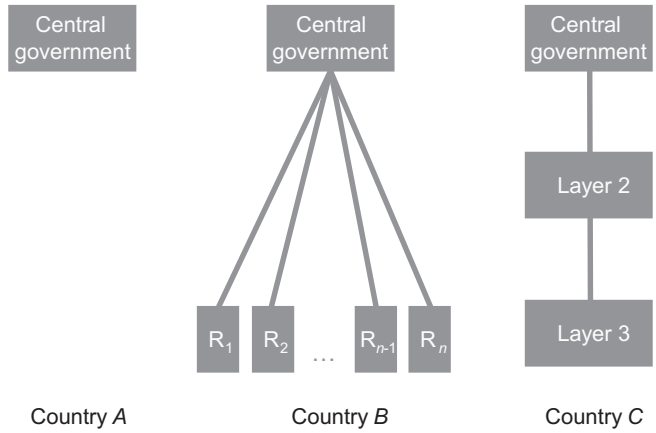

Figure 6 Different prototypes of governance.

To illustrate this, Figure 6 shows three prototype countries with very different federal structures. Country *A* is fully centralized, all choices about tax rates and the tax system being made at the most central level; it resembles most closely the type of player usually considered in the context of tax competition, as elsewhere in this survey. Country *B* has one central government and a considerable number of regional governments R_i, with capital horizontally mobile between them. Country *C* has several vertically related governments, all drawing on the same national tax base, but no horizontal competition between regions inside the country. The "vertical" tax competition induced by these layers of government would generally be expected to lead to inefficiently high tax rates, as more decision makers independently extract tax revenue from the same tax base: in considering an increase in its own tax rate, each level is likely to take account of the consequent contraction of the tax base, but attach relatively little weight to the losses that this also implies for other levels. (The point is especially clear when policy makers at each level are simple revenue-maximizers, in which case, as first noted by Flowers (1988), combined tax rates in the Nash equilibrium may be beyond the peak of the Laffer curve.)

Consider country *B* more carefully. Suppose the central and local governments each independently choose a unit tax on capital at source. The capital that is applied in region *i* will then be taxed by both the central and the local government. In each region, these unit taxes add to the total tax burden on capital in the respective region. The tax rate choice of the central government will presumably be guided by the preferences of the citizens in all regions. The regions, however, are likely to focus more narrowly on the well-being of their own citizens. One aspect of the problem they face is the potential for their tax choices to induce capital to move into, or from, other regions: this "horizontal" tax competition is of essentially the same form as discussed above. But there is another set of constraints arising from the vertical relation between regional and central governments. In making

their rate decisions, while the regional governments presumably anticipate some tax base deterioration or other distortions that will diminish the revenue accruing to the central level, since they do not receive all the benefit of that revenue they will attribute too low a shadow price to it. Also, the double taxation of the same tax base by the different layers of government may cause an aggregate tax burden in country *B* that is too high. These effects of vertical tax competition and their interaction with horizontal tax competition between regions and between nations—especially the question of whether tax rates will ultimately be too low or too high—have been quite extensively analyzed (see Keen & Kotsogiannis, 2002, 2004; Wrede, 1999).

Within federations, particularly if regions have some tax autonomy, there are often systems of interregional or vertical intergovernmental transfer systems in place. An analysis of these transfer arrangements can lead to policy conclusions about the disincentive of tax enforcement they can create in the different regions, and to other negative incentive effects of such systems. It is therefore interesting to note that horizontal and vertical transfer systems inside a federal country can and partially do counterbalance the internal forces of vertical and horizontal tax competition inside this federation and can partially correct for the problems caused by interregional or vertical tax competition (see, for instance, Fenge & Wrede, 2007; Kelders & Koethenbuerger, 2010; Kotsogiannis, 2010).

These aspects of domestic fiscal architecture can have strategic implications for international tax competition too. For instance, due to the presence of vertical externalities and absence of horizontal tax externalities, a country of type *C* with revenue maximizing layers of government has a tendency to choose a higher tax rate on capital than would a country of type *A*, when competing with each other. This remains the case in a framework with international tax competition between countries of types *A* and *C*. The internal governance structure of a country has strategic effects, affecting the tax rate choices in the country. As the internal governance structure of a country affects its tax choices, it can change equilibrium choices in other countries and create further strategic considerations. Wilson and Janeba (2005) and Kessing, Konrad, and Kotsogiannis (2009) highlight this point. Due to this strategic effect, a structure that induces vertical tax competition can be advantageous or disadvantageous. As the choice of governance structure is a long-term decision and cannot be adjusted in the short run as easily as the tax rate, the governance structure could be used as a commitment device by which countries can position themselves in a framework of international tax competition. More independent vertical tiers of governance may lead to higher effective tax rates, the anticipation of which will induce other countries—provided that tax rates are strategic complements—to also choose higher tax rates. This strategic effect is similar to the commitment of a Stackelberg leader and can be a similar source of benefit. However, this advantage becomes small when faced with many competitors, smaller than the negative side effect of deviating from what would have been the tax rate chosen from the perspective of unitary state. Hence, if the

number of competitors of the country is sufficiently large, the overall effect will typically work to the disadvantage of this country in the context of capital taxation at source.

3. COORDINATION

It is clear from the analysis above that the tax rate choice of one country can have several external effects on other countries. First, a higher tax rate in one country typically drives capital into other countries. This "tax base" effect benefits these other countries by broadening their capital tax base and so increasing their tax revenues. Second, the inflow of capital abroad leads to an expansion of production there, which may also be to their benefit. Third, an increase in any country's tax rate reduces the net return on capital, imposing a burden on all capital owners, not just its own citizens but those abroad too. Generically, these different external effects do not cancel each other out, and so the tax competition equilibrium can be expected to be inefficient.

In general, there will be a whole range of tax combinations $(t_1, t_2, \ldots, t_n)$ that are Pareto-superior to the non-cooperative equilibrium. If countries could negotiate a cooperative outcome, they would be expected to arrive at one in the core, which will depend, inter alia, on whether or not international transfers are feasible. More generally, if the decentralized solution suffers from externalities between the players, it generically holds that an appropriately chosen central planner's solution exists that yields strictly higher welfare in every country, relative to the decentralized outcome. But the central planner solution is a Nirvana outcome, demanding more than one can reasonably expect. For instance, it requires the absence of problems of asymmetric information and it typically requires full commitment—that is, the ability to write and implement fully binding contracts on all matters of relevance. It also requires that these contracts be written prior to any possible unilateral action by which a single player can tilt the cooperative outcome in their own favor. In an international context, with sovereign countries being the decision makers, full commitment and its enforcement is probably the most serious hurdle—even treaties can be undermined or abrogated—but information problems can also be an obstacle; and transfers between players, though clearly present in international settings, are hard to envisage in the present context (politicians likely finding it hard to explain, for instance, the case for paying another country to increase its tax rate). The question is whether, and if so exactly how, countries may coordinate their tax policies in order to overcome these inefficiencies.

When countries are identical, and can commit over a full range of instruments and time periods, it is straightforward—in principle at least—to identify Pareto-improving forms of coordination. In both the ZMW (as seen) and KK (as readily shown) models, for example, all countries benefit, relative to the Nash equilibrium from a small, common increase in tax rates. Matters are far more complex, however, when—as is manifestly the most relevant practical case—the preconditions at the start of this paragraph fail.

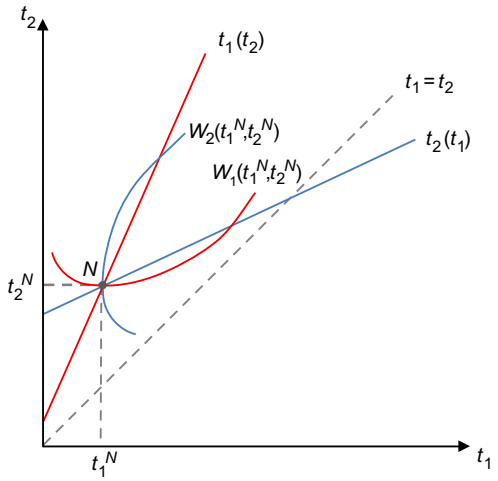

Figure 7 Asymmetries and the dangers of harmonization in the linear model.

3.1. Asymmetries and the Limits of Harmonization

Harmonization, particularly to some average of non-cooperative tax rates, seems to have a natural appeal to policy makers as a response to tax-induced movements of tax base.[40] It is inherently flawed, of course, as a response to problems of tax competition in its neglect of overall levels of taxation: with symmetric countries, tax rates are expected to be spontaneously harmonized, but there are still gains from coordination.

Asymmetries create further difficulties for a strategy of harmonization. Returning to the linear case of the ZMW model in Section 2.1.1 above, for instance, Figure 7 shows the outcome in which country 1 has a higher capital endowment, per unit of labor than country 2, and so sets a lower tax rate in equilibrium. In such a case it may be, as drawn, that there is simply no harmonized tax rate $\tau = t_1 = t_2$ at which both countries are better off than at the Nash equilibrium. The point emerges still more clearly in the KK model. In this case, the smaller country (1, say) is sure to be made worse off by harmonization to any tax rate between those of the Nash equilibrium, because its revenue is then

$$r_1(\tau, \tau) \leq r_1(t_2^N, t_2^N) < r_1(t_1(t_2^N), t_2^N) = r_1(t_1^N, t_2^N), \tag{35}$$

where the first inequality reflects the fixity of the national base and the second the definition of a best response.

3.2. Minimum Tax Rates

As one possible limitation on the amount of cooperation, countries may be unable to harmonize on common tax rates but able to agree on a range within which rates must lie.

[40] Harmonization of this kind (both from Nash equilibria and more generally) has been a particular focus of the literature on commodity tax competition: see, for instance, the review in Keen (2001).

One leading example of such type of limited cooperation is agreement on minimum tax rates; as with, for example, the agreement in the West African Economic and Monetary Union of a minimum corporate tax rate of 25% and on minimum rates of excise duty both there and in the EU. Lower (and/or upper) limits for possible tax rate choices leave countries some flexibility to react to structural or macroeconomic developments, or to changes in their shadow price of public funds, which may be more appealing for the countries' decision makers than a fully rigid system of coordinated taxes that can be changed and adjusted to their needs only by renegotiation (especially when, as in the EU, this requires the unanimous approval of all participating countries).

It might seem that the adoption of such minimum taxes must make those countries that are consequently forced to raise their tax rates worse off. This, however, is not the case: lower (or upper) bounds on tax rates can have surprising consequences for welfare in the resulting tax competition equilibrium.

Starting from an asymmetric Nash equilibrium N with (t_1^N, t_2^N) in the fully uncoordinated situation with $t_1^N < t_2^N$, a common lower bound of $t_i = t_0 < t_1^N$ has no impact given simultaneous rate setting (a less trivial observation than it may appear, as will become clear later). A bound t_0 in the interval (t_1^N, t_2^N) between the two Nash equilibrium rates, generally binds country 1 and typically induces it to choose this lower bound. This is illustrated in Figure 8, where the kink in the new best reply function of the low tax country $t_1(t_2)$ reflects the prohibition on setting a rate below t_0. For the same reason, the best response $t_2(t_1)$ for country 2 also acquires a kink, but in a range that is irrelevant for the equilibrium. The change of t_1 from t_1^N to t_0, taken in isolation, would benefit

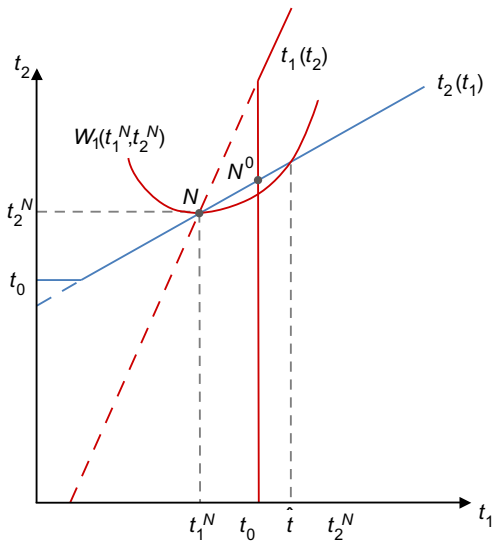

Figure 8 A lower bound on tax rates.

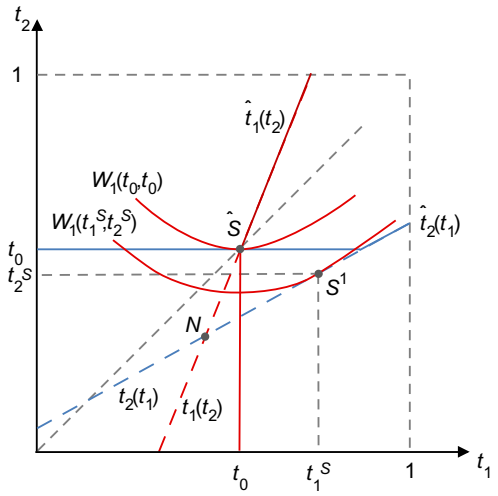

Figure 9 Effects of a binding minimum tax in a Stackelberg equilibrium.

the high tax country 2, but would reduce welfare in the low tax country 1. Country 2, however, will not continue to choose t_2^N in the new equilibrium. Using the Nash equilibrium conjecture $t_1 = t_0$, it will choose its optimal reply $t_2(t_0)$. Assuming strategic complementarity, this means a tax rate higher than t_2^N. This change can be beneficial for both countries. With the new equilibrium at N^0, the overall welfare effect for country 1, compared to the unconstrained Nash equilibrium, is in general unclear.

Consider, though, a marginal increase in t_1 from its level in the unconstrained Nash equilibrium, t_1^N, to the very slightly higher level $t_0 = t_1^N + \varepsilon$. This has a zero first-order effect for the welfare of country 1, as $W_1(t_1^N, t_2^N)$ has a slope of zero at N. But it induces an equilibrium reaction by country 2, which increases its tax rate t_2 by ε times the slope of $t_2(t_1)$. This increase in t_2 does have a first-order marginal effect for country 1's welfare, and it is beneficial. Thus agreement on a minimum tax rate that is above but sufficiently close to the lower of the unconstrained Nash equilibrium rates t_1^N is Pareto improving. In Figure 8, both countries gain if N_0, on the upper right of N, is to the left of the tax rate $\hat{t}$ at which $t_2(t_1)$ and $W_1(t_1^N, t_2^N)$ intersect: any minimum rate $t_0 \in (t_1^N, \hat{t})$ induces an increase in both countries' welfare, whereas lower bounds in the higher range $t_0 \in (\hat{t}, t_2^N)$ make the low tax country 1 worse off.[41]

Matters are quite different when countries choose sequentially. Wang (1999) addresses this case in the KK model, but the same insights can be seen using the linear model illustrated in Figure 9. Focusing on the asymmetric case and taking the larger country 1 to be the Stackelberg leader, the initial equilibrium in the absence of any minimum taxes is at

[41] Peralta and van Ypersele (2006) show, however, that this result need not hold more generally in related models. In their framework with three countries, a minimum tax rate may not make all countries better off, whereas a combination of a lower and an upper bound might.

S^1, the point of tangency between country 1's iso-welfare curve $W_1(t_1^s, t_2^s)$ and country 2's reply function, which has $t_1^s > t_2^s$. Now imposing a minimum tax rate t_0 between the two initial equilibrium rates ($t_1^s > t_0 > t_2^s$) may cause the tax rate of the Stackelberg leader to fall and, for a broad range of parameters and under quite general conditions, lead to higher welfare for the leader and lower welfare for the follower. Figure 9 illustrates. Here a minimum tax t_0 that is slightly higher than t_2^s leads to kinked reply functions $\hat{t}_1(t_2)$ and $\hat{t}_2(t_1)$, just as above. When country 1 chooses its most preferred point (t_1, t_2) along the reply function $\hat{t}_2(t_1)$ of country 2, subject to the constraint $t_1 \geq t_0$, it selects $\hat{S}$. The Stackelberg leader thus chooses a tax rate that is considerably lower than its choice in the initial equilibrium t_1^s, with the effect, as Figure 9 suggests, that the leader is better-off, but the follower may be worse off, than in the unconstrained Stackelberg equilibrium. Setting such a low rate was not attractive to the leader in the absence of the minimum tax rate, because the follower would react to such a choice by an even lower tax. The minimum tax prevents such a reaction, making $t_1 = t_0$ attractive for the Stackelberg leader. Had the Ruding Committee proposal of a 30% minimum tax rate been adopted, for instance, EU members setting a higher rate could have reduced their rate secure in the knowledge that no other country would undercut them by going below 30%.

Konrad (2009) goes one step further and considers a minimum rate $t_0 < t_2^s$: a minimum, that is, below the lower of the two tax rates chosen in the unconstrained equilibrium. One might expect this to have no effect. But, in the Stackelberg case, even such seemingly unconstraining floors change the nature of the equilibrium and may induce all countries to reduce their tax rates. The reason for this can be seen in Figure 10, which is similar to Figure 9. With a lower bound of t_0, the reply functions $\hat{t}_1(t_2)$ and $\hat{t}_2(t_1)$

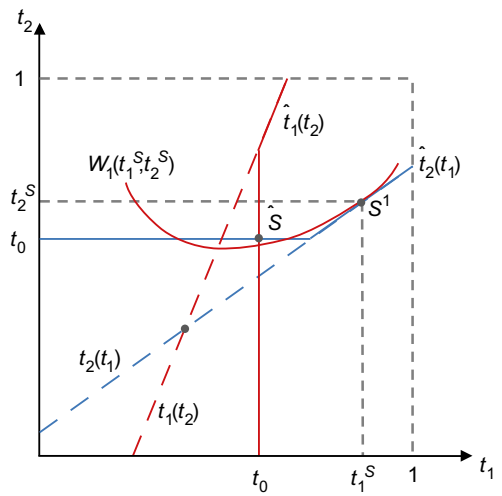

Figure 10 Effects of a minimum tax that is lower than the lowest equilibrium tax rate in the Stackelberg equilibrium.

are drawn as closed lines, kinked as above at this very low minimum. Now $\hat{S}$ is the new equilibrium, yielding an increased payoff for country 1 and a reduced payoff for country 2. Both countries thus switch to setting their rate at the minimum permissible level even though, in the initial equilibrium, both rates were higher than that. The intuition is essentially as above: without a floor, the leader refrains from setting $\hat{t}_1 = t_0$ because this would induce the follower to choose a very low tax rate chosen by country 2 in the unconstrained situation, but the imposition of the minimum cuts off this possibility. What is striking is that the same intuition continues to apply even for non-binding minima.

These are surprising results. But they also call for some caution in drawing policy conclusions, showing that such a straightforward and central policy idea as imposing a minimum rate can (but need not) lead to a Pareto improvement depending on the precise nature of the strategic interaction in tax-setting.

3.3. Coordination Among a Subset of Countries

A simultaneous coordination of all countries is hard to envisage if there is no supra-national agency that could enforce such an agreement. However, supra-national structures such as the European Union may enable their members to commit to joint action. But is it in the interest of subsets of countries to coordinate only among themselves? Non-participating countries' equilibrium tax rates may then well be different from those they set in the fully non-cooperative Nash equilibrium. So even though participating countries can benefit from joint action in the absence of such strategic effects on non-participants (they can at least not do worse), it is not clear whether or not, once those effects come into play, the overall outcome of this coordinated action will be beneficial for them. The issue, it should be stressed, is a very real one for the several regional blocs facing the question of whether some degree of coordination toward higher taxation would be to their advantage or would simply make them more vulnerable to tax competition from non-participating countries.[42]

This problem has been addressed formally by Burbidge et al. (1997) and Konrad and Schjelderup (1999). The latter addressed the general question in a modified version of the reaction curve figure above, now with three countries. Suppose that the symmetric Nash equilibrium in pure strategies exists and denote the uniform equilibrium tax rate $t_1 = t_2 = t_3 = t^N$. Could countries 1 and 2 gain if, rather than maximizing their own welfare individually and finding themselves in this Nash equilibrium, they join forces and credibly and publicly agree on choosing a common tax rate $t_1 = t_2 \equiv t_A$ that maximizes their joint welfare $W_A \equiv W_1 + W_2$, where W_i is as in (4) above?

[42] Related issues emerge in the context of customs unions and in the literature on coalition formation more generally. The members of a customs union can choose their tariffs and compensation payments in order to improve their joint welfare. However, the formation of the customs union affects trade relationships with non-members (see Panagariya (2000) for a survey).

A first question is whether they can increase their welfare by both choosing a slightly higher tax rate, assuming first that country 3 still chooses $t_3 = t^N$. That they can follows on differentiating their aggregate welfare at $(t_1, t_2, t_3)=(t^N, t^N, t^N)$ to find

$$\frac{\partial(W_1 + W_2)}{\partial t_A} = \frac{\partial(W_1 + W_2)}{\partial t_1} + \frac{\partial(W_1 + W_2)}{\partial t_2} = \frac{\partial W_2}{\partial t_1} + \frac{\partial W_1}{\partial t_2} > 0, \qquad (36)$$

where use is made of the first-order conditions $\partial W_i/\partial t_i = 0$. Intuitively, if both countries 1 and 2 slightly increase their tax rate starting at the non-cooperative Nash equilibrium, the direct first-order effect of the increase in their own tax rate on their own welfare is zero because the deviation occurs at the local optimum. However, each country enjoys a first-order gain from the increase in the other's tax rate, due to the tax-base effect. The non-participating country 3 gains even more, since it benefits from the base effect from the increased tax rates in two countries, not just one.

But country 3 is unlikely to continue to set $t_3 = t^N$ given the higher rate set elsewhere. The new equilibrium is obtained as a set of taxes (t_A, t_A, t_3) that fulfills two conditions. First, given country 3's Nash conjecture that countries 1 and 2 both choose t_A, country 3 chooses the t_3 that maximizes $W_3(t_A, t_A, t)$. Second, the joint tax rate t_A is the argument $t \in (0, 1)$ that maximizes the sum of $W_1(t, t, t_3) + W_2(t, t, t_3)$ given the Nash conjecture about t_3. Whether or not the coordinated choice of countries 1 and 2 improves their joint welfare in the new equilibrium will crucially depend on the new equilibrium value of t_3. However, if tax rates are strategic complements, the optimal reply of country 3 to the conjectured $t_1 = t_2 = t_A > t^N$ is a choice of $t_3 > t^N$. This higher tax rate typically benefits countries 1 and 2, so that the overall welfare effect for countries 1 and 2 of their coordinated tax increase is positive in this case. Indeed it is greater with the strategic response of country 3 than it would be without. This analysis can easily be extended to more than three symmetric countries, with a subset of these partially coordinating.

These implications of regional cooperation have a parallel in work on the merger of m firms in an oligopoly with $n > m$ firms and price competition (see Deneckere & Davidson, 1985). Merger of firms in this context means that they maximize their joint profits by a coordinated choice of their prices. If the prices of all firms are strategic complements, the merging firms typically choose higher prices. The strategic effect of this increase on bystanding firms is that they also increase their prices. Overall, the merger increases the profits of all firms.

Aspects of regional tax coordination are explored in several other studies. Conconi, Perroni, and Riezman (2008) essentially analyze coordination by subsets of countries in a context combining downward pressure on tax rates from tax competition and upward pressure due to time consistent confiscatory taxation. Coordination by a suitably chosen subgroup may be used to find the right balance for this trade-off. Haufler and Wooton (2006) apply a related logic in a competition for direct investment. Sørensen (2004a)

explores a similar logic (as do Burbidge et al., 1997), focusing on the amount of redistributive taxation, rather than on the provision of public goods and providing numerical simulations of the welfare effects (compared to fully uncoordinated tax competition) of regional (subgroup) rather than global coordination. These suggest that the beneficial effect of coordination among a subset of all countries is small relative to the benefit for the country that is not part of the coordinating subgroup. Simulation results with a similar flavor which allow for asymmetries between the countries are presented in Parry (2003), Brochner et al. (2007), and Vrijburg and de Mooij (2010) highlight the importance of asymmetries between countries. Strategic complementarity of tax rates cannot be taken for granted in this case, and it is then no longer certain that the alliance partners 1 and 2 benefit from their cooperation.

Burbidge et al. (1997) also address the question of which subgroup of countries may enter into a tax alliance if this choice is endogenous. If there are $n > 2$ symmetric countries, for instance, the formation of a subgroup of 2 typically is a Pareto improvement relative to no group formation at all. But the gains to those in the subgroup are typically smaller than those of outsiders—so which countries, if any, would voluntarily join such a subgroup? Moreover, an enlargement of the participating group from $n - 1$ to n, or what could be called the "grand tax alliance," is typically not a Pareto improvement. Understanding how and which subgroups might form becomes a challenging theoretical question. In the case of Europe and potentially other supra-national entities, the set of candidate countries that may enter into a regional coordination agreement is given exogenously or has been determined by other factors outside the context of the tax competition problem.

3.4. Coordination Across a Subset of Instruments

As stressed earlier, countries generally have more than one tax instrument to deploy. Partial coordination in such contexts can mean that all countries agree on restrictions as regards some but not all of their instruments. Keen and Marchand (1997), for instance, consider coordination of tax rates in a framework in which countries can continue to compete along another dimension, which is their decision about infrastructure investment, and which works like an input subsidy; and Fuest and Huber (1999) consider a framework with multiple tax or subsidy instruments.

The key lessons in such contexts are straightforward. When countries have several policy instruments, some may be redundant, in that coordinated action that fixes the value of one instrument at some level can be undone by changes in the other instruments. And if the instruments available are only imperfect substitutes, coordinated action that constrains the value of one may lead to a substitute instrument being used more aggressively as a tool of competition. In Keen and Marchand (1997), for instance, coordination on higher capital tax rates may lead countries to distort their public spending patterns towards

infrastructure and other items that raise the productivity of, and so tend to attract, mobile capital, and away from items that contribute directly to private welfare. The final effect of such distortions may be a Pareto-worsening relative to the non-cooperative outcome. Cremer and Gavhari (2000), for instance, consider a KK-type setting in which welfare-maximizing governments choose both a statutory rate of tax and the intensity with which it is enforced by auditing firms to detect evasion: a lower audit probability then has effects very similar to a reduction in the statutory rate (a possibility not without echoes in actual practice). Setting a common tax rate may—but need not (this depends on values of parameters and the harmonized tax rate)—lead to such a reduction in enforcement activities that, ultimately, both countries are worse off.

3.5. Dynamic Aspects

Tax competition takes place, in practice, in a dynamic framework. This has several implications. Where there is an unknown, possibly unending series of choices, the theory of infinitely repeated games becomes relevant. A second aspect of these dynamics is that decisions are made sequentially. Some early decisions may generate stock effects that determine the environment in which later decisions take place. Today's capital stock is the result of earlier decisions on savings and consumption, and this may generate time consistency problems for the optimal tax policy that interact with the effects of tax competition. A third aspect is the relationship between stocks and flows and the trade-off between taxing stocks and attracting an inflow of new capital. We consider these three aspects in turn.

3.5.1. Infinitely Repeated Interaction

Tax laws change from time to time, and there is no reason for an end to this process. This makes the folk theorems of infinitely repeated games potentially relevant in thinking about tax competition. One question is whether the benefits of coordination or tax harmonization can be obtained in a fully non-cooperative game due to the infinite repetition. Analyses of this problem are given in Cardarelli, Taugourdeau, and Vidal (2002), Catenaro and Vidal (2006), Kessing, Konrad, and Kotsogiannis (2006), and Kiss (2012). The last of these considers a symmetric setup with n countries and uses simple trigger strategies to generate efficient tax harmonization as a non-cooperative equilibrium outcome. The most striking point that emerges, however, is that in this setting introducing a minimum tax rate that is higher than that in the static Nash equilibrium may destabilize an existing efficient equilibrium.

The following multiperiod version of the workhorse model with two countries illustrates why. Generalizing it to an infinitely repeated game with the static game as a state game, the local strategies of countries in a given period $h = 0, 1, \ldots$ are their tax rate choices t_1^h and t_2^h which may generally be functions of the whole history. Let $W_i(t_1^h, t_2^h)$ be

the period payoff of country i in period h if the tax rates are t_1^h and t_2^h in that period, and let

$$\sum_{h=k}^{\infty} \delta^h W_i(t_1^h, t_2^h) \tag{37}$$

be the discounted present value of payoffs for all periods from period k on that emerge from a series of tax rate choices $(t_1^k, t_2^k), (t_1^{k+1}, t_2^{k+1}), \ldots,$ with δ a discount factor that is invariant over time and the same for both countries. Further, denote by (t^N, t^N) the static symmetric Nash equilibrium tax rates, and by (t^0, t^0) the efficient tax rates that implement the symmetric first-best Pareto optimum. Suppose both countries follow the simple local strategy of choosing t^0 in the first period and then, for all further periods, choosing t^0 if both players chose t^0 in the previous period but t^N if one did not. These strategies constitute an equilibrium with $(t_1^h, t_2^h) = (t^0, t^0)$ for all $h = 0, 1, \ldots,$ if the condition

$$\sum_{h=0}^{\infty} \delta^h W_i(t^0, t^0) \geq W_i(t_i(t^0), t^0) + \sum_{h=1}^{\infty} \delta^h W_i(t^N, t^N) \tag{38}$$

is fulfilled, where $t_i(t^0)$ is the tax rate that maximizes i's period payoff given the choice of t^0 by the other country. The left-hand side of (38) is the present value of the sum of all payoffs of country i if both countries choose the efficient taxes t^0 forever. The right-hand side consists of two terms. The first is the period payoff if country i chooses the optimal deviation tax rate $t_i(t^0)$ that maximizes its period payoff. The second term is the present value of the sum of all payoffs from all future periods, in which both countries choose the tax t^N that characterizes the static non-cooperative Nash equilibrium. So if (38) holds, both countries prefer to stick to t^0 rather than to defect; this will be the case if they are sufficiently patient, in the sense that the discount factor δ is above some critical value. Note that in this equilibrium $t^N < t_i(t^0) < t^0$, which is a consequence of the assumed strategic complementarity of the tax rates.

Suppose now that countries enter into a binding agreement in period 0 which states that none of them will ever set a tax rate lower than some t_{min}, with $t_{min} \in (t^N, t_i(t^0))$. This changes the equilibrium of the static game, since the Nash equilibrium (t^N, t^N) is no longer feasible. Instead, reversion to the static non-cooperative Nash equilibrium will imply that the countries both choose t_{min}. The condition for an equilibrium with sustained cooperation thus becomes

$$\sum_{h=0}^{\infty} \delta^h W_i(t^0, t^0) \geq W_i(t_i(t^0), t^0) + \sum_{h=1}^{\infty} \delta^h W_i(t_{min}, t_{min}). \tag{39}$$

All that has changed, compared to (38), is that reversion to the static Nash equilibrium is now less harmful for the two countries since it yields a present value of the discounted sum of period payoffs $W_i(t_{min}, t_{min}) > W_i(t^N, t^N)$. Accordingly, if a country deviates from

t^0, its immediate gain is the same as without a minimum tax, but the present value of future payoffs does not drop by as much. With the costs of deviating reduced by adoption of the minimum, sustaining the efficient outcome becomes less likely: the critical level of the discount factor above which it can be sustained is increased.

This result is an application of the "topsy-turvy principle" from industrial organization: an institutional change that causes an improvement for the static non-cooperative Nash equilibrium may be harmful for the stabilization of collusive outcomes in infinitely repeated games. This is because such a change reduces the punishment that players experience in future periods if they defect from the collusive path.

3.5.2. Endogenous Savings and Time Consistent Taxation

So far, we have considered the world capital stock to be exogenous. In a dynamic perspective, however, the current capital stock is the outcome of consumption and savings choices made in earlier periods. The implications for international capital taxation have been explored (Gordon, 1986). A simple strategic setting can be used to analyze optimal and time consistent tax choices of symmetric, equally sized countries $i = 1, 2, \ldots, n$ in a dynamic framework with two periods, 0 and 1. This is a natural extension of the workhorse model and a simplified version of the two-period framework analyzed by Huizinga (1995). In each country, a (representative) individual is born in period 0 with an endowment κ and decides how much to save ($\bar{k}_i$, this becoming, as the notation suggests, the endowment of the next period) and how much to consume ($\kappa - \bar{k}_i$) in that period. At the beginning of period 1, the sum of these savings $\sum_i \bar{k}_i$ determines the world capital stock; the period 1 economy is very similar to that in the static workhorse model. International capital market clearing requires

$$\sum_i \bar{k}_i = \sum_i k_i \tag{40}$$

and, as before,

$$\rho = f'(k_i) - t_i \text{ for all } \quad i = 1, \ldots, n. \tag{41}$$

The public good is produced and used only in period 1. Assuming additively separable period utilities with increasing and concave consumption utility $u(\kappa - \bar{k}_i)$ in period 0, the objective function of a welfarist government is

$$W_i = u(\kappa - \bar{k}_i) + f(k_i) - f'(k_i)k_i + \rho\bar{k}_i + G_i(t_i k_i). \tag{42}$$

The first component here is the utility of period 0 consumption of private goods. The second is the utility of private consumption in period 1, the assumed quasi-linearity sterilizing the analysis with respect to income effects. This private consumption is equal to output net of the remuneration of capital used in the country plus citizens' net-of-tax capital income. The third component is $G_i(t_i k_i)$, utility from the public good that is produced from the tax revenue $t_i k_i$; this is assumed to take the same linear form as in (17) above.

Before analyzing the equilibrium outcome for $n > 1$, we discuss two benchmark outcomes for $n = 1$. This reduces the problem to a special case of the analysis of Kydland and Prescott (1980) which they used to show the pitfalls of time consistent capital taxation. Suppose first that the government can commit to the tax rate it will set in period 1. Taking as given the tax rate credibly announced by the government in period 0, the representative individual chooses savings according to

$$u'(\kappa - \bar{k}_1) = f'(\bar{k}_1) - t_1, \tag{43}$$

use being made here of $k_1 = \bar{k}_1$ for $n = 1$. This first-order condition implies that $\bar{k}_1$ is a decreasing function of t_1. The government takes this relationship $\bar{k}_1(t_1)$ into consideration when choosing the t_1 that it will commit to, the first-order condition for which leads to

$$1 + \lambda = \frac{1}{1 + \frac{t_1}{\bar{k}_1}\frac{\partial \bar{k}_1}{\partial t_1}}, \tag{44}$$

an elasticity rule that just balances the benefit of additional public good against the marginal excess burden from the distortion of the consumption-savings decision. Typically, this condition singles out one tax rate that induces the second-best optimal amount of savings.

Difficulty arises, however, if the government cannot commit to the tax rate. For once the individual savings decisions have been made, $\bar{k}_1$ becomes exogenous and fixed, so that the marginal welfare cost of taxing capital is no longer $1 + \lambda$ but is instead unity: taxing the fixed capital as lump sum. A welfare-maximizing government able to set whatever tax rate it likes in period 1 will find, assuming that a unit tax exceeding full expropriation is not feasible, that the welfare optimum is attained either at $t_1 = 1$ if $\bar{k}_1 < \bar{G}$, or at t_1 that solves $t_1\bar{k}_1 = \bar{G}$ if $\bar{k}_1 > \bar{G}$. But this high tax rate will be anticipated by the individuals already in period 0 and its anticipation will generally discourage savings. Even though the ex-post optimal tax does not change the capital stock when it is introduced, its anticipation imposes an excess burden. In particular, in an economy in which aggregate savings are formed by many individuals, there is typically an equilibrium in which $\bar{k}_1 = 0$. Ex-post optimal taxation leads to excessive taxation in the single economy.

Return now to $n > 1$. As has been shown in the benchmark analysis, tax competition has a tendency to drive down tax rate levels. Kehoe (1989) argued that this effect may be desirable when the government cannot credibly commit on a capital tax early on, and suffers from the Kydland and Prescott (1980) time consistency just described. If we open up tax competition between a set of such identical economies of the kind just described, this will drive equilibrium tax rates below these excessive levels. But can tax

competition without commitment lead to the same equilibrium outcome as the optimal ex-ante program of capital taxation with commitment?[43]

The answer is: possibly, but the outcome is generically still inefficient. To see that efficiency may be restored, consider first the downward sloping function $\bar{k}_1(t_1)$. For the solitary economy, denote the ex-ante optimal tax rate with commitment by t^p, and the corresponding savings by $\bar{k}^p$. Now turn to the case of n symmetric, identical countries with tax competition and tax rates chosen at the beginning of period 1. Suppose that the citizens in each of these countries expect the tax rate that will be chosen at the beginning of period 1 will be t^p. Then, there is indeed an equilibrium in which the individually optimal consumption choices in period 0 induce savings in each country equal to $\bar{k}^p$.

But is there a symmetric Nash equilibrium in the tax competition game that really induces t^p as the tax rate? Note that the situation in period 1 is essentially the same as in the static tax competition problem that has been solved in the benchmark case, with capital endowments $\bar{k}_i = \bar{k}^p$ in each of the n countries. For this $\bar{k}^p$ to be induced by optimal ex-post taxation, the elasticity formula (13) (replacing G' by $(1 + \lambda)$) implies that the corresponding tax rate t^N must satisfy

$$1 + \lambda = \frac{1}{1 + \dfrac{t^N}{\bar{k}^p}\left(\dfrac{n-1}{n}\right)\dfrac{1}{f''(\bar{k}^p)}}. \tag{45}$$

This typically has one solution $t^N(\bar{k}^p, n)$. If it so happens that $t^N = t^p$, then the expectations of the individuals that induced their savings of $\bar{k}^p$ were justified and tax competition can indeed implement the ex-ante efficient outcome with t^p and $\bar{k}^p$. For $n = 1$, we return to the case of excessive ex-post efficient taxation for the case of the solitary economy, with $t^N > t^p$. However, $t^N(\bar{k}^p, n)$ is a downward sloping function of n. Assuming away the indivisibility problem for n, and depending on the shape of the production function f, for sufficiently large n the solution to (45) may just be equal to t^p. In this case the forces of tax competition happen to exactly compensate for the ex-post inefficiently high incentives to confiscate capital. In general, however, this will not be so, though it remains the case that the pressure of tax competition allows the country to credibly commit to a tax rate that is lower than the high tax rate on capital that would be the time consistent solution in the solitary economy.

Kehoe's (1989) result is in the tradition of Lipsey and Lancaster (1956): distortions can reinforce or offset each other. It is only fortuitously, however, that a combination of some degree of tax competition and of time consistent capital taxation will lead to fully efficient taxation. Generically, the outcome will be inefficient. If, moreover, countries are asymmetric, it will typically be the case that the degree of tax competition that is just

[43] Ways to moderate this problem, other than tax competition, have also been discussed. Boadway and Keen (1998), for instance, show that commitment to a lax audit policy can reduce the ex-post tax rate that is optimal and can thereby mitigate the time consistency problem.

desirable from the perspective of one country will be suboptimal for other countries. And there is one further problem with the notion that tax competition can ease the time consistency problem in taxing capital income. It relies on the idea that the world capital stock is fixed once savings decisions are made, but this capital remains mobile internationally once it has been formed and can be shifted between the countries as a reaction to the tax rate choices. It is true that single investors can sell their assets in one country and purchase assets in another country. Capital is, hence, mobile at the level of the individual. At the aggregate country level, however, most tangible capital assets are essentially immobile and can be taxed at source.[44] (Even so, it might be argued that profit-shifting devices make taxable profits mobile, especially in relation to intangibles; as seen earlier, this though calls for a different type of analysis).

An analysis that develops a more credible mechanism but remains in the spirit of Kehoe (1989) is that of Janeba (2000), who considers a hold-up problem that essentially resembles the problem of time consistent taxation. A firm faces an exogenously given block demand. It can sell up to m units of a homogenous product for a given unit price (normalized to unity). Any additional output can be sold only at a price of zero. The firm's production technology is characterized by a capacity cost of $\gamma \in (0, 1/2)$ per unit of capacity, and zero variable cost up to the capacity limit. Suppose the firm can invest only in one location, say, country A, and let μ_A be the capacity that it chooses to build up in this country at a cost of $\gamma \mu_A$. The government of A, interested, suppose, only in tax—can levy a unit tax t_A on goods produced inside the country. It has to choose t_A at a time when the capacity investment is made, but prior to the firm's output choice. In this case the following hold-up problem emerges. The firm's quasi-rent (ignoring capacity costs), net of taxes, is $x(1 - t_A)$ for any x up to the block demand m, and $m(1 - t_A)$ at any higher output. Anticipating that the firm will maximize this quasi-rent, the government optimally chooses a t_A that equals, or is just an epsilon below, the selling price, reducing the net producer rent to zero. Anticipating this, however, the firm will not invest in capacity since it will then make a loss equal to its investment cost $\gamma \mu_A$.

Suppose now that this firm can also build up capacity μ_B in country B, also with a marginal capacity cost of γ. Governments in A and B must decide on their tax rates t_A and t_B on each unit produced in their country, and they must do so after the capacity investment is made but before the production decision. Janeba (2000) shows that the firm would then be wise to build capacity of m in both countries, giving it twice the capacity needed to cover the block demand: for then it becomes evident to each government that the firm will produce the whole quantity m in whichever country has the lower tax and nothing in the other. Countries face cutthroat competition from each other, and the

[44] Andersson and Konrad (2003) explore a similar approach in the context of human capital investments, and argue that the international mobility of human capital can cure the problems created by time consistent taxation of human capital that emerged in a closed economy. Unlike physical capital, human capital is mobile ex-post. It is embodied in persons, but the persons are mobile.

equilibrium tax rates they choose are $t_A = t_B = 0$. Tax competition thus removes the hold-up problem—but this does not come for free, as the firm incurs additional costs from the excess capacity it holds. And without excess capacity, the firm's threat of relocating production is empty.

3.5.3. Stock Effects and Agglomeration

In a dynamic framework there is a critical distinction between the stock of capital invested in a country, which is typically embodied in physical capital and very expensive or impossible to relocate, and the flow of additional net investment in a given period. Countries must then distinguish between two effects of raising their tax rate. A higher tax rate will generate potentially considerable revenue from the existing "old" stock of capital. But it may also discourage investors from building up new capital (Wildasin, 2003). Conversely, the choice of a low tax rate makes a country an attractive location for new investment but brings in little tax revenue in the short term.

This is the trade-off faced by a government that would like to generate a large present value of revenue from the taxation of the stock of capital in a sequence of periods. In a strategic environment, a large stock of old capital can be a disadvantage for a country that competes for new capital with other countries: it has a higher opportunity cost from a reduction in its tax rate in the ongoing period than does a country with less old capital (Janeba & Peters, 1999; Marceau, Mongrain, & Wilson, 2010). For this reason, some countries may decide to extract as much as possible from the given stock of capital invested there and leave it to other countries to attract the new investment; this can lead to capital-rich countries with high taxes and a lack of investment dynamics and young emerging countries with low taxes and dynamic investment.

There is an important countervailing force to this divergence in tax rates, however, if a large installed capital base has positive externalities for new investors. Such agglomeration advantages may make it attractive for new investment to locate in the country with the larger capital base, even if the tax rates are higher there. Baldwin and Krugman (2004) analyze the tax competition outcome in a framework with such agglomeration advantages. They show that an optimal tax policy of the country with large agglomeration advantages can be "limit taxation" (in analogy to limit pricing in competition policy): setting a tax rate that puts a strictly positive net fiscal burden on new investors but is sufficiently low such that this burden is smaller than or just equal to the benefits from joining the agglomeration, rather than investing in a competitor country without such agglomeration advantages, even if this competitor country chooses a zero tax. If this equilibrium exists, it can perpetuate agglomeration advantages.

Whether such a perpetuated equilibrium with limit taxation exists, and under which conditions the equilibrium is one with capital-rich high tax countries that exploit their existing capital and suffer from lack of new investment on the one hand and capital-poor low tax countries with strong growth on the other, is analyzed by Konrad and

Kovenock (2009). They show that both outcomes are possible and which emerges in equilibrium depends on the size of the agglomeration benefit for newly attracted capital and on the quantity of newly attracted capital compared to the stock of existing capital that cannot escape taxation. They also consider the case in which existing capital and new capital can be taxed at different rates or in which newly attracted capital receives tax holidays. In this case the agglomeration is more stable, but tax revenue is very low in the long run as there is strong competition for the newly attracted capital. Empirically, asymmetric equilibria in which one country or region chooses a high tax strategy and extracts from the existing immobile capital base while another competes for new investments have been the motivation for the analysis by Cai and Treisman (2005), who study this type of asymmetric equilibrium in Russia.

4. BROADENING THE PERSPECTIVE

The benchmark ZMW model of tax competition considers a tax base "capital" as a continuously divisible quantity that flows between countries, with these flows affecting the marginal product of capital in all of them. It describes changes in capital use at the intensive margin and assumes a perfectly competitive market for capital inside each country. From the perspective of industrial economics, countries operate much like companies that are price setters and compete with each other for aggregate demand, where this demand may be fixed (as in an oligopoly with block demand) or where aggregate demand may also react to the prices offered. From the point of view of formal structure, the main difference is the different objective function of governments which do not simply maximize tax revenue, but rather a more complex notion of national welfare. This does not exhaust all practically relevant models of competition, and some of these alternative concepts also matter in the context of tax competition. What follows discusses several other concepts. Governments may make bids for lumpy investment, trying to attract firms much like in an auction. Governments may apply the concept of "third-order tax discrimination" when they compete for tax bases with different mobility. Information exchange between countries can also be an important element of tax competition and coordination. Also geography, and proximity in particular, may play a role in shaping tax competition. All these concepts play a role in understanding the phenomenon of tax havens, which we address at the end of this section.

4.1. Bidding for Firms

Where countries compete for foreign direct investment, this is often not a competition for additional capital that is then used at the intensive margin, but for individual firms or projects: that is, it is competition at the extensive margin and makes the taxed subjects strategic players.

A number of contributions consider the bidding for firms by governments that stand to benefit from attracting them to their country. Ferrett and Wooton (2010a) provide a simple and fairly general framework of two countries bidding for one firm. They consider two countries A and B who can make bids γ_A and γ_B to attract a firm from the rest of the world. Let π_A and π_B be the gross profits of the firm when locating in A and B, respectively, and $\pi_A - \pi_B \geq 0$ the difference between them. Further, let w_A and w_B be some additional benefits that accrue to countries A and B, respectively, should the firm locate there. This captures the idea, commonplace among policy makers, that inward foreign direct investment conveys external benefits to the wider economy. Possible channels by which this may happen include a reduction in the per-capita cost of provision of public goods or inputs[45], increases in wage income[46], technological spillovers, and other external effects. Denoting by σ_A and σ_B the shares in the firm owned by citizens of country A and B, welfare in country i is then

$$\begin{gathered}\sigma_i(\pi_i + \gamma_i) - \gamma_i + w_i \text{ if the firm locates in } i \text{ and} \\ \sigma_i(\pi_{-i} + \gamma_{-i}) \text{ if it does not.}\end{gathered} \tag{46}$$

Assuming a suitable tie-breaking rule for the case in which a firm is just indifferent, one can characterize the equilibrium (γ_A^*, γ_B^*) as follows: The country i that loses makes a bid such that it is indifferent to losing or winning, which, from (46), is the case if

$$\gamma_i^* = \sigma_i(\pi_i - \pi_j + \gamma_i^* - \gamma_j^*) + w_i. \tag{47}$$

The winning country j makes a bid that is just large enough to win against this bid, and thus bids $\gamma_j^* = \pi_i + \gamma_i^* - \pi_j$. Note that this latter condition implies $\pi_i - \pi_j + \gamma_i^* - \gamma_j^* = 0$ and hence, from (47), $\gamma_i^* = w_i$, whereas $\gamma_j^* = \pi_i - \pi_j + w_i$. This equilibrium has attractive features. First, it can be shown, by way of contradiction, that $\pi_j + w_j \geq \pi_i + w_i$ if country j wins the bid in this equilibrium, so that the firm allocates where it generates the higher social surplus. Second, both the bids and the equilibrium allocation are independent of the ownership shares in the firm. The reason for this is that by making a bid that is just large enough to attract the firm, that is for which $\pi_i - \pi_j + \gamma_i - \gamma_j = 0$, the winning country ensures that the firm's owners are just indifferent to locating the firm in A or B.

Allocative efficiency of the bidding equilibrium can be destroyed, however, by additional considerations. Kessing et al. (2009), for instance, apply a very similar auction framework with two countries making bids for a foreign direct investment. One is a unitary country with a government that has essentially the same objective function as above. The other is a federal union in which several layers of government share the tax revenue that can be collected if the investment occurs in this country. As discussed in Section 2.2, this may create a vertical fiscal externality that may lead to an excessively high tax burden

[45] See, for instance, Black and Hoyt (1989).
[46] Among these contributions is Haaparanta (1996).

and taxation on the downward sloping part of the Laffer curve. In addition, while the governments at the different layers share a common interest in the bidding process, they face a collective good problem when making their contributions to the country's overall bid. Vertical fiscal externalities and free-riding problems within the federal union generate a disadvantage for the federal union in a bidding competition with a unitary country.

Another set of effects derive from the dynamic nature of investments, particularly in a multiperiod framework. The analysis of King, McAfee, and Welling (1993) addresses some of these. First, the location choice of a firm may involve sunk costs and may reduce the firm's mobility, thus exposing it to a host government that may then be tempted to extract from this firm. (This is true not only if the firm becomes fully immobile, but even if some capital investment is made that is immobile or that may lose some of its value if it is relocated.) As a result, and unless there are other means to overcome this hold-up problem, governments may compensate firms for the later extraction of tax revenue by making upfront subsidies. Also, a government may invest in infrastructure in order to increase the profitability of a firm should it locate in this country. If countries cannot coordinate on such investment choices, the result may be a non-cooperative equilibrium with asymmetric investment choices in which one country invests a lot and the other country little.[47]

Bidding for firms occurs in a setup in which foreign direct investment may have a number of externalities. In similar spirit, Haufler and Wooton (1999) analyze the competition between two countries for a foreign owned monopolist and show that a large home market is advantageous if there are trade costs. The role of trade cost and market size is also important in the context of other types of imperfect competition, making this paper the starting point of a large literature exploring these effects.[48]

4.2. Preferential Regimes

In its report on Harmful Tax Competition, the OECD (1998) pays particular attention to practices by which countries may apply different tax rules to different types of business activity, typically setting a lower tax rate for more mobile activities. The presumption in the OECD work was that such "preferential regimes" aggravate the inefficiencies associated with international tax competition. But this may not be right.

To see why, broaden the benchmark two-country ZMW model to allow for two capital tax bases rather than just one. Denote the tax bases that locate in country i as k_i and κ_i, respectively, and let t_i and τ_i be the unit source-based taxes applied to each. Generally, these quantities are functions $k_i(t_i; t_{-i})$ and $\kappa_i(\tau_i; \tau_{-i})$ where, as before, $-i$ denotes the corresponding tax rate in the other country. Tax revenue in country i is thus

$$T_i = t_i k_i(t_i; t_{-i}) + \tau_i \kappa_i(\tau_i; \tau_{-i}). \tag{48}$$

[47] An elegant way to overcome the problem of opportunistic behavior of the host government ex-post is offered by Janeba (2000), as discussed above.

[48] That literature includes Raff (2004), Bjorvatn and Eckel (2006), Ferrett and Wooton (2010b), Becker and Fuest (2010b), and Haufler and Wooton (2010).

A first and straightforward observation is that if the (semi-) elasticities of the two bases differ then, given any fixed tax policy of the other country, it is always possible to strictly increase tax revenue by appropriate rate differentiation. To see this, focusing on situations in which first-order conditions describe optimized choices and there is an interior equilibrium, note that if country i must tax both tax bases at the same uniform rate $t_i = \tau_i = z_i$ then, maximizing in (48), it will choose that rate so that

$$k_i + z_i \frac{\partial k_i}{\partial t_i} + \kappa_i + z_i \frac{\partial \kappa_i}{\partial \tau_i} = 0, \tag{49}$$

where the optimal uniform rate is thus the inverse of a weighted average of the semi-elasticities of the two bases. When the two bases can be taxed differentially, however, the first-order conditions become

$$k_i + t_i \frac{\partial k_i}{\partial t_i} = 0 \text{ and } \kappa_i + \tau_i \frac{\partial \kappa_i}{\partial \tau_i} = 0, \tag{50}$$

and thus the rate on each base will be set to the inverse of its own semi-elasticity. Since the ability to differentiate can never reduce revenue, optimal differentiation strictly increases revenue whenever the semi-elasticities differ. All this, of course, is well known from the theory of third-degree price discrimination in monopolies.

In the context of competition between countries, however, the strategic response of the other country cannot be ignored. How does a world in which all countries may apply a preferential regime differ from one in which they are constrained to apply a uniform regime? Are preferential regimes, in that sense, necessarily a harmful form of tax competition?

When preferential treatment is permitted, (50) implies that equilibrium tax revenues are

$$T_i^P = -k_i^2/(\partial k_i/\partial t_i) - \kappa_i^2/(\partial \kappa_i/\partial \tau_i). \tag{51}$$

If on the other hand both countries apply uniform taxation, maximization of tax revenue in country i, as in (49), yields

$$T_i^U = -(k_i + \kappa_i)^2 / \left(\frac{\partial k_i}{\partial t_i} + \frac{\partial \kappa_i}{\partial \tau_i} \right). \tag{52}$$

Keen (2001) compares the implied equilibrium tax revenues in these two cases when countries are symmetric, assuming also that $k_i(t_i, t_{-i}) = k_i(t_i - t_{-i})$, and $\kappa_i(\tau_i, \tau_{-i}) = \kappa_i(\tau_i - \tau_{-i})$; the base in each country is thus assumed to depend solely on the difference in tax rates between them, essentially removing from the picture any effect of the general tax level on the aggregate tax base. The difference in each country's tax revenues between the Nash equilibrium in which all countries are constrained to applying uniform taxation (T^U) and that in which they may deploy preferential regimes (T^P) is

$$T_i^U - T_i^P = \frac{k_i^2 \kappa_i^2}{k_i' \kappa_i' (k_i' + \kappa_i')} \left(\frac{k_i'}{k_i} - \frac{\kappa_i'}{\kappa_i} \right)^2 \leq 0, \tag{53}$$

with $k_i' \equiv \partial k_i(0)/\partial t_i$ and $\kappa_i' \equiv \partial \kappa_i(0)/\partial \tau_i$. Equality only holds if $k_i'/k_i = \kappa_i'/\kappa_i$, that is, only if there is no difference in elasticities in the two tax bases. In the general case, in which elasticities differ, however, revenue is now unambiguously *higher* when preferential regimes may be deployed. In that sense, preferential regimes actually make tax competition less harmful. The intuitive attraction of imposing uniformity as a coordination measure is in making it more costly for countries to tax mobile capital by ensuring that this implies a revenue loss from less mobile capital. But differentiation, while increasing the scope for competition for mobile capital, protects the revenue from the less mobile base. In the setting of Keen (2001), this latter effect always dominates.

This result, running exactly counter to the commonplace presumption against preferential regimes of various kinds has triggered much further consideration—see, for instance, Bucovetsky and Haufler (2007), Haupt and Peters (2005), Janeba and Peters (1999), and Janeba and Smart (2003)—exploring the robustness of this result. The variant of the benchmark model which yields the largest divergence maintains the assumption of symmetry between countries and two tax bases, but assumes that one of them is completely immobile and inelastic up to a maximum tax rate of $\bar{\tau}$ in each of the countries. Above this rate, the owners of the tax base make use of a disposal option and the tax base vanishes. The other type of capital has a perfectly elastic tax base of $2k$ that floats freely between the two countries and locates in whichever has the lower tax rate, and locates symmetrically between them if they tax it at the same rate. In this case, the equilibrium with preferential taxation is characterized by $t_1 = t_2 = 0$ and $\tau_1 = \tau_2 = \bar{\tau}$: both countries make full use of their monopoly power as regards their immobile tax base, but face cutthroat competition as regards the fully mobile tax base. In case of uniform taxation, an equilibrium in pure strategies typically does not exist. However, an equilibrium in mixed strategies does. For symmetric countries, applying the logic of Narasimhan (1988), this mixed strategy equilibrium is characterized by uniform tax rates z_1 and z_2 that are random draws from a distribution that is defined by a cumulative distribution function $F(z) = 1 + \frac{\kappa}{2k} - \frac{\kappa \bar{\tau}}{2kz}$ and supports $\left[\frac{\kappa \bar{\tau}}{2k+\kappa}, \bar{\tau} \right]$. The expected tax revenue in this equilibrium is equal to $\kappa \bar{\tau}$ for each of the two countries. Accordingly, preferential treatment generates exactly the same tax revenue as uniform taxation in the equilibrium.[49]

[49] The results on preferential tax regimes are reminiscent of those on third-degree price discrimination in interfirm competition. This literature first concentrated on third-degree price discrimination of a monopolist who serves several distinguishable customer groups (see, for instance, Schmalensee, 1981). Here, price discrimination never yields monopoly profits that are lower than with uniform pricing, and as Holmes (1989) discusses, this carries over to collusive duopoly. This structural similarity is noted by Janeba and Smart (2003).

4.3. Information Exchange and Implementation of the Residence Principle

As noted in Section 2.1, it is the residence principle—not the source principle, which most of the formal literature reviewed here presumes—that is the international norm for personal-level taxation of capital income,[50] and which continues to be important at corporate level too. Its implementation, however, can be problematic, for two reasons. One is that residence country taxes are generally not imposed until income is repatriated there, so that the real liability can be reduced by retaining funds abroad. A number of countries seek to address this at corporate level through "controlled foreign corporation" (CFC) legislation, which enables them to tax income remaining abroad—albeit generally only income that is "passive" in the sense of not arising from immediate business activities. Deferral, nonetheless, remains a key instrument of international tax planning (though not the only one, of course). The second difficulty, which arises primarily at the individual level, is simply the risk that taxpayers will not reveal to their home authorities income arising abroad. The most obvious remedy for this is for the tax authorities to provide their counterparts abroad with information on the income arising in their country to residents of others. Fostering such information sharing has been the focus of considerable (indeed unprecedented) action in recent years,[51] as is described in the next subsection, and has attracted some theoretical interest.

Much of the literature on information exchange has focused on the question of whether or not countries might choose to provide such information voluntarily.[52] At first sight, it might seem that those which are net recipients of income undeclared to the investors' home authorities would not, since by providing information they would enable the residence country to levy additional taxation and so make themselves less attractive a location for such funds. Strategic considerations, however, again come into play, a point first stressed by Bacchetta and Espinosa (1995). For if it can commit to providing such information—and double tax treaties and tax information exchange agreements may provide a vehicle for doing so—a low tax country enables the residence country to charge a higher tax rate than would otherwise be the case, which in itself tends to increase the inflow of capital that it receives—an effect that counteracts and may outweigh the directly harmful impact.[53]

[50] There are some exceptions: Capital gains related to real estate, for instance, are generally taxable only where that real estate is located.

[51] The practicalities of information sharing are outlined in Keen and Ligthart (2006), though this predates the recent expansion of information agreements.

[52] Some papers compare information exchange in this setting with the imposition of withholding taxes by the low tax country, following Huizinga and Nielsen (2003). This is motivated largely by particularities of the EU Savings Directive, under which countries may either provide information or impose a withholding tax. In practice, many countries do both (double tax agreements for instance, typically providing for both information exchange and withholding taxes).

[53] Eggert and Kolmar (2002) consider the case in which tax rates and the extent of information sharing are chosen simultaneously, showing that the equilibrium degree of information sharing is then indeterminate.

To see this, consider again a world of just two countries, with $t_2 > t_1 > 0$. In the high tax country 2, there is a fixed amount of savings S that can be invested in either country, in amounts s_1 and s_2; the former incurring expected (non tax-deductible) costs of $C(s_1)$, with C increasing and strictly convex. There are no savings in the low tax country (to avoid the complication of cross-hauling of savings). The authorities in low tax country 1 collect taxes at the rate t_1 on all savings located there, and will provide information to the authorities in country 2 only on some proportion λ of their residents' savings there. These are then liable to additional taxation in country 2 at $t_2 - t_1$ (credit being given for taxes paid abroad). Assuming the gross rate of return to be the same in both countries (and normalizing it to unity), country 2's investors will allocate their savings in order to minimize the sum of taxes paid and transaction costs incurred, which is given by

$$t_2(S - s_1) + (1 - \lambda)t_1 s_1 + \lambda t_2 s_1 + C(s_1), \tag{54}$$

with the first term being the tax paid on savings retained at home, the second that paid on income abroad that is successfully concealed, and the third being total tax paid on income abroad that is reported and so ultimately subject to the full home rate. Maximizing this to trade off the tax advantage of saving abroad against the transactions cost of doing so, savings allocated abroad, $s_1(\lambda, t_1, t_2)$, are an increasing function $h[\beta(\lambda, t_1, t_2)]$ of the tax saved by doing so, per unit of saving, given by $\beta \equiv (1 - \lambda)(t_2 - t_1)$. Thus

$$\frac{\partial s_1}{\partial t_2} = (1 - \lambda)h'(\beta) > 0 \tag{55}$$

so that, as one would expect, the amount saved abroad increases with the tax rate at home. Similarly, it decreases with both the foreign tax rate and (at constant tax rates) the extent of information sharing. For simplicity, assume that revenue rather than welfare is the object of policy-making. In country 1, this is simply

$$r_1 = t_1 s_1(\lambda, t_1, t_2), \tag{56}$$

while in country 2 it is

$$r_2 = t_2 s_2 + \lambda(t_2 - t_1)s_1 = t_2 S - \{\lambda t_1 + (1 - \lambda)t_2\}s_1(\lambda, t_1, t_2). \tag{57}$$

With the degree of information sharing assumed to be determined at the first stage of the game (being more in the nature of a long-term commitment, perhaps embodied in a treaty), each country chooses its tax rate taking as given both λ and the tax rate of the other country. The tax rate chosen in the high tax country, in particular, is thus $t_2(\lambda, t_1)$. Suppose then that the low tax country commits to a small increase in the extent of information sharing λ. From (57), the revenue impact in the high tax country, given that the effect of any induced change in its own tax rate vanishes as an envelope property, is

$$\frac{dr_2}{d\lambda} = (t_2 - t_1)s_1 - \{\lambda t_1 + (1 - \lambda)t_2\}\frac{\partial s_1}{\partial \lambda} \tag{58}$$

and so is unambiguously positive: there is a gain from both the increased taxation of any income invested abroad and the reduction in the extent of such investments. For the low tax country 1, matters are more complex. With revenue being $t_1 s_1[\lambda, t_1, t_2(\lambda, t_1)]$, the effect is given by

$$\frac{dr_1}{d\lambda} = t_1 \left\{ \frac{\partial s_1}{\partial \lambda} + \frac{\partial s_1}{\partial t_2} \frac{\partial t_2}{\partial \lambda} \right\}. \tag{59}$$

Here the first term is the direct, adverse effect on the low tax country: it becomes less attractive as a venue for tax evasion. The second is the strategic effect: to the extent that the fuller information induces the high tax country to increase its tax rate—as is plausible, but not assured without further restriction of functional forms—this leads to more evasion into the low tax country. The overall impact of the low tax country is thus, in principle, unclear.

It is possible, however, that the strategic effect dominates. Indeed, in the simple structure above, this is, under plausible conditions, sure to be the case. To see why, suppose that the high tax country 2 reacts to increased information sharing by raising its own tax rate just enough to leave the tax saved by investing abroad, β, unchanged in the face of the higher λ. This means that the amount of savings allocated abroad is also unchanged, and hence revenue in the low tax country remains as it initially was. Recalling (55), however, the higher λ means that savings invested abroad are now less responsive than they were to the tax set by the high tax country 2, which tips the balance of country 2's considerations towards increasing its tax rate further—pushing savings further in country 1's direction, and implying that it too is ultimately better off.[54]

This, of course, is a strong and quite special result. Fuller treatments allow also for the adjustment of country 1's tax rate and endogenize the choice of tax rates (relating them in particular to country size, with the standard conclusion that rates tend to be lower in smaller countries). They allow too for cross-hauling of savings, and explore the implications of differential tax treatment of residents and non-residents. Importantly, the strategic effect clearly becomes much less powerful when there is more than one low tax country: greater information sharing by one will then be met in part by a shifting of savings to other low tax countries, so that the impact on the tax-setting decisions of the high tax country will be greatly muted. The most robust result is probably the most obvious: there can be a sharp divergence of interests, with high tax countries being much more certain to gain from mutual information exchange than are low tax countries.[55]

[54] The result follows more formally by noting, from (57), that

$$\partial r_2/\partial t_2 = S - (1-\lambda)s_1(\beta) - (1-\lambda)(\beta + t_1)h'(\beta)$$

from which, for given t_1 and β, satisfaction of the necessary condition $\partial r_2/\partial t_2 = 0$ in the initial position implies that $\partial r_2/\partial t_2 > 0$ if country 2 were to hold β unchanged in the face of the increased λ. So long as r_2 is convex in t_2 (as is the case, for example, if the cost function $C(s)$ is quadratic), the higher λ must therefore be associated with a higher choice of t_2.

[55] The last observation perhaps suggests it might be Pareto-improving for the low tax jurisdiction to receive some of the proceeds of the additional revenue raised as a consequence of the information it provides. Keen and Ligthart (2006)

4.4. Tax Havens

Though widely used, the precise meaning of the term "tax haven" is elusive, and even in the practical world of policy there is no agreed definition. A low or zero tax rate on some activities or forms of income is clearly a necessary ingredient, but is not enough to capture common usage: Very resource-rich countries, for example, may simply not need tax rates at the same levels found elsewhere, and have little interest in how that affects capital or other cross-border flows. Beyond low taxation, the term carries the connotations that it is paper rather than real economic activity that is being attracted, and moreover that these are jurisdictions which encourage, or at least do not adequately discourage, tax avoidance or evasion that undermines tax revenues of other countries, perhaps by providing secrecy laws or other restrictions that preclude their sharing of information.[56] Quite what the standard of adequacy should be is, of course, by no means clear. Where the line lies that defines a tax haven remains hazy, but three features seem to capture the essence: low taxation that is not a reflection of high revenue, relative to needs, from other sources; the attraction of profit-shifting and other tax arbitrage activities more than real activity; and imperfect sharing of information.

4.4.1. Which Countries Become Tax Havens?

The theory set out above carries the strong prediction that it is smaller countries which are more likely to become, in this broad sense, tax havens. They are more likely to set low tax rates that encourage profit-shifting and tax arbitrage, as seen in Section 2.1.2, and, by having low tax rates, they are likely, as was seen in the preceding section, to have the least to gain from information sharing.

The empirical evidence broadly matches this prediction. Dharmapala and Hines (2009) identify 41 countries as "tax havens" and compare these with nonhavens. Their descriptive statistics suggest that, relative to nonhavens, tax havens are small as regards population and area, are more likely to be islands, and provide an institutional framework that is characterized, in broad terms, by good governance. These descriptive results are supported by their multivariate analysis, which suggests a strong positive correlation with governance quality, and a negative correlation with population size. These findings are in line with those of Slemrod (2008), who offers an explanation based on the concept of commercialization of a country's sovereignty. Such commercialization for the purpose of tax haven activities has benefits that are not closely related to population size. However, the status as tax haven may have a cost in terms of "integrity" or "reputation," and this

show that this can indeed be the case, if the countries concerned are sufficiently asymmetric, even though such transfers may, perhaps surprisingly, reduce total revenue collected (by increasing the incentive for the low tax country to attract would-be evaders, since they then have less to fear if the evaders are caught).

[56] Dharmapala and Hines (2009), for example, define a tax haven as "a state or a country or territory where certain taxes are levied at a low rate or not at all while offering due process, good governance and a low corruption rate." But many would argue that it is bad governance—in the form of unwillingness to share tax information—that is a hallmark of tax havens.

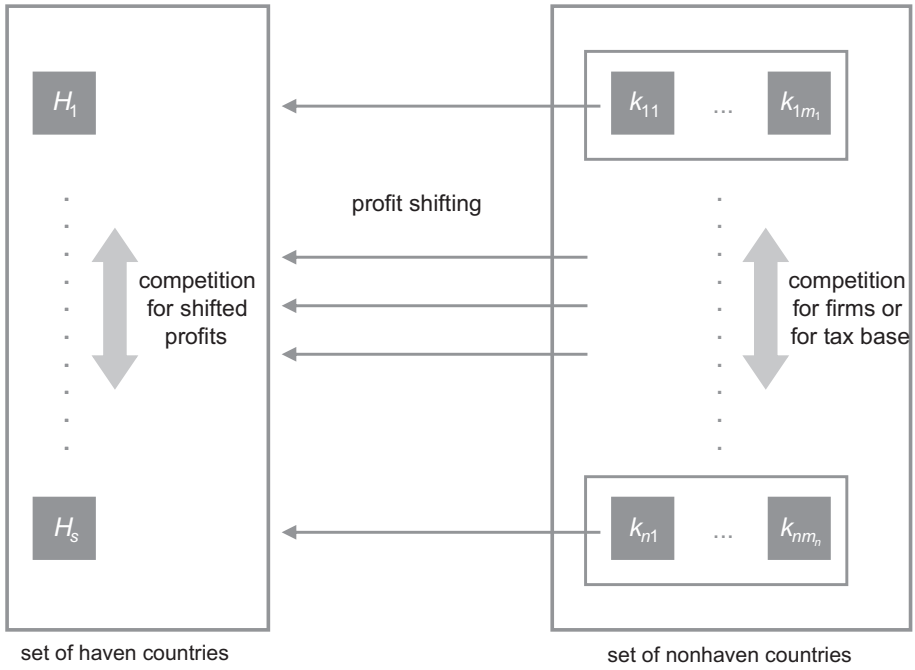

Figure 11 Interactions within and between havens and nonhavens.

may be strongly correlated with population size, or with the size of regular economic activity in the respective country.

4.4.2. Are Tax Havens Good or Bad?

The term "tax haven" has clear pejorative overtones—one reason why policy makers have found an agreed definition so hard to find—but the recent literature has begun to focus on whether their existence and activities might not have beneficial effects. The question is closely related to the wider one of whether tax competition itself can be welfare-improving (political economy aspects of which are taken up in Section 4.6): After all, in any asymmetric equilibrium, some country will have the lowest tax rate and in that sense look like a tax haven. The importance of pure arbitrage activities in the tax haven context does, however, raise distinct issues.[57]

The structure mapped in Figure 11 provides a constructive way of looking at tax havens as specific players in the context of tax competition rather than as especially small but otherwise ordinary countries. This shows a number of "nonhaven" countries on the right-hand side. These provide an environment for real sector activity and host production facilities for firms. Some firms are fully immobile and locate their business

[57] Dharmapala (2008) provides an overview of the theoretical and empirical literature that analyzed the consequences and existence of tax haven countries.

completely in nonhaven countries. Others are mobile and make a location decision, choosing where and how much capital to locate. The right-hand side of the diagram can then be interpreted as corresponding to the benchmark ZMW model. Apart from "real" production decisions, firms may use other means to relocate accounting profits from one country to another. This may also happen between the nonhaven countries, but this is the point where haven countries enter into the picture. As they typically have a real sector that is negligible in comparison to the financial business they host, or have means to separate these two types of activities, they have an interest in firms shifting their taxable profits from nonhaven countries in return for low tax payments or small fees.[58] Tax havens compete with each other regarding the quality of their concealment or profit-shifting services and in how much they charge for them. Some firms in the nonhaven countries—presumably the larger and more international—then have a choice along a second dimension. They must determine how much of their tax base to shift, bearing in mind the various costs potentially associated with this: taxes or "fees" charged by the haven, the cost of setting up the appropriate international firm structure, and potentially some economic cost from adjustments required for the actual business operations. There may also be an indirect cost, given that nonhaven countries may take countermeasures to such shifting activities.[59] It is in this broader framework that work has identified several partial but important effects, some detrimental but others possibly beneficial.

Slemrod and Wilson (2009) adopt this perspective and identify several reasons why the provision of tax reduction services by haven countries can be undesirable. Most obviously, it involves some resource cost: as with tax avoidance activities in a standard tax compliance model that are pursued with the help of tax consultants, tax payers should be willing to expend up to 99 cents to avoid an additional $1 in taxes, meaning social waste of 99 cents at the margin. A further insight of this paper is on the role of the direct shifting cost. An increase of this cost (for instance, due to relaxed competition between tax havens) generally reduces the amount of shifting and may even reduce the total amount of associated cost. Less shifting implies a broadening of the tax base and, thereby, reduces the marginal cost of public funds. An element that adds to the analysis of the relationship between the tax office, tax payers, and a sector of tax consultants in this analysis is the role of competition between "ordinary" countries that may take place along the lines of tax rates or the intensity of enforcement effort.

Hong and Smart (2010) highlight a different effect by which, to the contrary, profit shifting to zero-tax jurisdictions can have beneficial consequences. In their framework, the nonhaven country has a mobile and an immobile sector, with a single tax rate applied

[58] As pointed out in Schön (2005), a tax haven may successfully raise revenue even if the nominal tax rate on profits is zero, through registration fees or levies and charges on the financial service industry that facilitates multinational companies' operations in the tax haven.

[59] This perspective makes tax havens similar or comparable to tax consultancy companies which offer legal means to reduce the tax burden, charge a fee for this service, and compete among themselves.

to taxable profits in each. Profits in the immobile sector are fully taxed. The mobile sector, however, can use debt operations to shift some of its taxable profits to a zero-tax jurisdiction by borrowing from a related company in the latter. A key assumption is that the amount of profit that can be shifted is proportional to the capital invested in the nonhaven country, reflecting such potential constraints as thin-capitalization rules (denying the interest deductibility underlying the arbitrage if debt levels are high relative to assets employed). Firms that can engage in such profit shifting thus face a lower effective tax rate than those that cannot. If the government of the small open economy they consider can perfectly and costlessly control the amount of profit shifting through the severity of its thin-capitalization rules, it has two independent fiscal instruments at its disposal which is very similar to having two independent corporate tax rates, one for mobile and one for immobile capital—as analyzed in Section 4.2 above. Desai, Foley, and Hines (2006a) conclude that the effect of profit shifting in reducing the effective corporate tax rates for firms, and so increasing the net-of-tax marginal return on real investment in nonhaven countries, may dominate other, possibly detrimental effects of tax havens for investment in nonhaven countries. Their companion paper Desai, Foley, and Hines (2006b) shows that there is indeed a positive relationship between firms' international investment activities in nonhaven countries and their activities in haven countries.

Johannesen (2010) explores another way in which the existence of tax havens changes the nature of international tax competition. He starts with an analysis of tax competition between n countries, with a representative multinational firm that can relocate a given amount of physical capital between them and also, at some cost, shift accounting profits. There emerge from these asymmetric equilibria in which some countries charge high taxes and lose some tax base through profit shifting while others set low taxes that attract a considerable amount of shifted profits. Equilibrium tax rates are not zero, however, even in the low-tax countries. Now introduce a set of haven countries defined to be such that they choose zero taxes and do not allow for real production. If these have a sufficient capacity, they absorb all the profit shifting and essentially make the low tax strategy unprofitable for those countries that would otherwise be low tax countries in the asymmetric equilibrium, leading to symmetric behavior among the nonhaven countries. The tax havens deflect competition that took place between nonhaven countries toward competition between nonhaven and haven countries. And this, it turns out, can yield higher equilibrium tax revenue for the nonhaven countries.

4.4.3. Closing Down Tax Havens

Although few drew any strong links between the activities of tax havens and the 2009 financial crisis, at their London summit that year, G20 leaders put substantial new vigor into the OECD work on encouraging widespread information exchange. Much of this effort has focused on encouraging tax havens to sign information exchange agreements (TIEAs), in order to make the concealment of taxable income more difficult, with peer

reviews to ensure both that the legal mechanisms to do this are in place and that these arrangements are implemented in practice. Johannesen and Zucman (2012) survey these events and use data from the Bank of International Settlements on total deposits held by residents from one country at banks in 14 tax havens, to measure the impact of TIEAs on deposit holdings. They find that signing an agreement between a nonhaven and a haven tends to reduce the deposits from the nonhaven in this haven country—but also that these deposits tend to shift to other havens.

Elsayyad and Konrad (2012) study a competition framework in which attempts are made to convince tax havens to close down their operations, for instance, by exchanging information with nonhaven governments. They show that this process may work well, initially, in a framework with a large number of tax havens. In this early stage, what each tax haven can earn from offering these concealment services is low, due to intense competition from the large number of other havens. However, once a large number of tax havens have exited from this business, the rents that accrue to those that remain increase. It then becomes ever more difficult to convince those remaining tax havens to exit. The outcome may be one in which a smaller set of havens is operative, charging higher fees and acquiring a larger share of the accounting profits that are generated from business activities in nonhaven countries. Using Zucman's (2011) estimate for total world financial wealth located in tax havens and applying their static competition model straightforwardly, Elsayyad and Konrad (2012) estimate that the profit losses of the last of the 35 tax havens listed by the OECD (2000) is 17 times as high as for each of the 34 havens that may exit previously. If the process stops short of completion, the outcome can be worse, from a welfare perspective, for the nonhaven countries than it would be in the initial state, with much competitive pressure among haven countries.

4.5. Formula Apportionment

The incentive for companies to use transfer pricing and other devices to shift profits between jurisdictions—and for governments to design their tax systems to affect that incentive—would be removed if, instead of seeking to identify profits earned in particular jurisdictions, taxes were simply levied on the aggregate of a multinational's profits over all jurisdictions.[60] "Formula apportionment" is an alternative to either residence or source principles that goes some way in this direction, by using indicators of the extent of a company's activities in particular countries ("apportionment factors") to attribute to each a share of those aggregate profits, which it may then tax at whatever rate it chooses. This is the norm for state-level corporate taxation in the US and Canada, for instance (generally using as apportionment factors some combination of the shares of sales, payroll,

[60] Nielsen, Raimondos-Møller, and Schjelderup (2003) show, however, that formula apportionment may not eliminate transfer pricing incentives when subsidiaries of a controlling parent compete in oligopolistic markets. An additional motive which may reinforce tax considerations then comes into play: if the subsidiary takes that transfer price as the basis for its decision making, the center may manipulate it as a commitment device to improve product market outcome.

and assets located in each state), and has been proposed by the European Commission, as a "common consolidated corporate tax base" (CCCTB) for the EU.[61]

Consider the simple case in which there is a single apportionment factor, so that with some α_i indicating the extent of a multinational's activity in country i and n countries, the total tax payable on a multinational's groupwide profit of $\pi(\alpha_1, \ldots, \alpha_n)$ is

$$\pi(\alpha_1, \ldots, \alpha_n) \sum_{i=1}^{n} \left(\frac{\alpha_i}{\sum_{h=1}^{n} \alpha_h} \right) t_i. \tag{60}$$

The attraction of this approach is that, for given decisions α there is no gain in simply reallocating paper profits across jurisdictions, even though they may charge different tax rates. There is, however, a potential distortion to those decisions. Assuming Π to be strictly concave in the α_i, these would be chosen in the absence of taxation (or with tax levied directly on aggregate profit) so that $\partial\Pi/\partial\alpha_i = 0$, for all i. Under formula apportionment, however, cross-country differences in tax rates distort these choices, it being straightforward to show that maximization of net profits implies $\partial\Pi/\partial\alpha_i < 0$ if the tax rate in country i is below the α-weighted average and the converse where it is above: broadly speaking, whatever the factor in the apportionment, it will tend to be reallocated from high to low tax countries.[62]

Of particular interest here is that revenue-seeking governments will generally have an incentive to set tax rates with the intention of manipulating the multinational's choice of the α_i.[63] Suppose, for instance, that capital is used as the sole apportionment factor α_i, and consider a multinational with some fixed amount of capital 2κ to allocate between just two identical countries. Then the multinational will maximize after-tax profits

$$[\Pi(k_1) + \Pi(2\kappa - k_1)](1 - T(t_1, t_2, k_1)), \tag{61}$$

where we assume that "true" profits can meaningfully be ascribed to countries (that earned in each depending only on the capital located there), and where the average tax rate

$$T(t_1, t_2, k_1) \equiv \frac{t_1 k_1 + t_2(2\kappa - k_1)}{2\kappa} \tag{62}$$

is endogenous to the investment decision. The solution to the firm's optimization problem leads to an allocation of capital $k_1(t_1, t_2)$ with the property that, where $t_1 = t_2 = t$,

$$\frac{\partial k_1}{\partial t_1} = \frac{\Pi(\kappa)}{(1 - t)2\kappa\Pi''(\kappa)}. \tag{63}$$

[61] Adoption would be optional by country and by company. On the CCCTB debate, see Sørensen (2004b) and Bettendorf et al. (2011).

[62] Gordon and Wilson (1986) provide a detailed analysis of how formula apportionment can affect firm behavior, including through incentives to merge or dissolve. The analysis here follows Keen (1999).

[63] On other aspects of and practical experience with formula apportionment, see Weiner (2005).

Supposing revenue to be the governments' sole concern, that in country 1 (say) then chooses t_1 to maximize $t_1(\Pi(k_1) + \Pi(2\kappa - k_1))k_1$; the necessary condition for which, using (63), implies that in symmetric equilibrium where $k_1 = k_2 = \kappa$,

$$\frac{t^{FA}}{1 - t^{FA}} = -\frac{(2\kappa)^2 \Pi''(\kappa)}{2\Pi(\kappa)} \equiv \Delta^{FA}, \tag{64}$$

where "FA" stands for formula apportionment. This outcome is clearly inefficient, since any higher common tax rate would yield both countries greater revenue.

More striking, however, is the comparison with the non-cooperative outcome under source taxation. In this case, the total tax paid by the multinational is $t_1\Pi(k_1) + t_2\Pi(2\kappa - k_1)$, and, by steps analogous to those leading to (64), the symmetric equilibrium tax rate has a tax rate in each country of

$$\frac{t^{ST}}{1 - t^{ST}} = -\frac{2\Pi(\kappa)\Pi''(\kappa)}{(\Pi'(\kappa))^2}, \tag{65}$$

where "ST" refers to source taxation. Comparing this with (64) gives

$$\frac{t^{FA}}{1 - t^{FA}} - \frac{t^{ST}}{1 - t^{ST}} = \frac{2\Pi''}{(\Pi')^2\Pi}[\Pi(\kappa)^2 - (\Pi'(\kappa))^2\kappa^2] < 0, \tag{66}$$

the inequality being from the strict concavity of Π. Tax competition thus leads to an unambiguously lower equilibrium tax rate under formula apportionment than under source taxation, and so, in that sense, to unambiguously more intense tax competition. To see the intuition for this, suppose that initially both countries charge the same tax rate. Under source taxation, attracting an additional unit of capital raises revenue of $t_1\Pi'(\kappa)$, reflecting the marginal product of that capital; under formula apportionment, however, it raises additional revenue of $t_1\Pi(\kappa)/2\kappa$, reflecting—because the country is taking a share in aggregate profits, wherever earned—the average profit rate $\Pi(\kappa)/\kappa$. So long as the average rate of return exceeds the marginal rate, the incentive to attract capital is thus greater under formula apportionment.

This comparison of regimes is somewhat unnatural in that there is assumed to be no scope for manipulating liability under the source regime other than by relocating real activities: the profit-shifting to which formula apportionment is seen as a possible response is thus absent. What the result does suggest, nonetheless, is that formula apportionment can be preferred only if the distortions to firms' and governments' behavior that profit-shifting leads to are sufficiently large to outweigh what would otherwise be an adverse strategic effect. Introducing the possibility of transfer pricing, at some cost to the multinational, into a framework similar to that above, Nielsen, Raimondos-Møller, and Schjelderup (2010) provide a fuller treatment of the issue, elaborating on the circumstances, which turn on the level of profitability and the ease of transfer pricing, under which profit-shifting concerns dominate and formula apportionment consequently leads to a Pareto-superior non-cooperative outcome.

4.6. Political Economy and Agency Issues

There has long been debate as to whether international tax competition is good or bad from a welfare perspective. In the workhorse model, tax competition is (almost) certainly bad, in the sense that (leaving aside the time consistency issue discussed in Section 3.5.2) a central planner could implement any tax rates that can emerge in a decentralized equilibrium but could also choose the potentially many other tax rate combinations that cannot. Hence, coordinated tax rate choices—complemented as need be with international transfers of tax revenue—are at least as good, in a Pareto sense, as decentralized choices, and, since there are several externalities at work, will generally be Pareto-superior.[64]

But comparing a decentralized tax competition equilibrium outcome with the centrally coordinated solution brought about by a fully benevolent government is not a very satisfying exercise. If there were no more to say, then for the same reason all private market economies should be transformed into centrally planned ones. The aim in this section is to review the implications for tax competition and coordination of richer views of policy-making.

Both centralized and decentralized political decision making suffer from problems other than the possible externalities between decentralized decision makers. One can doubt, in particular, if policy decisions are well described as those of a benevolent dictator who maximizes the utility of a representative citizen. Political decision making reflects distributional conflicts, with the electoral process, perhaps giving the median voter a key role, and special interest groups may lobby for their preferred tax policy.[65] And, perhaps most importantly, power is delegated to governments which generates a number of accountability problems between the government and its constituency. We focus on these problems.

4.6.1. Tax Competition and Leviathan

There is a long-standing tradition in the public choice literature to the effect that tax competition is not, as the analysis and arguments above suggest, a source of inefficiency. On the contrary, when other limits on their actions are weak, tax competition in this view serves a valuable social purpose in constraining leviathans; that is, policy makers who are inherently inclined to raise public revenue to serve their own rather than society's wide interests. To Brennan and Buchanan (1980, p. 186), for instance, "… tax competition

[64] This reasoning is also in line with Sinn's (1997) selection principle, which argues that the government is ideally involved in tasks which are performed poorly in the private sector, and with the financing of public goods as a classical example. With intergovernmental competition, inefficiencies may return, now on the intergovernmental level, and this may suggest centralization of these tasks on the supra-national level.

[65] Lobbying activities by powerful groups can affect the outcome of tax competition. Citizens who own above-average quantities of capital, for instance, may lobby in the political process, trying to shift the reply function "downward" toward lower capital taxes. Chirinko and Wilson (2010) report evidence suggesting that business campaign contributions may indeed affect the tax reaction function and so influence tax policy.

among separate units … is an objective to be sought in its own right." The view that policy makers divert all revenue to their own use is, of course, extreme. So too, however, is the assumption in the preceding sections that they are concerned only with the general social good.

Edwards and Keen (1996) set out a variant of the ZMW model that blends the two views. Everything remains as in the symmetric version of the model analyzed in Section 2.1, except that now policymakers are assumed to maximize some function $V(W, B)$ that reflects both the amount of tax revenue that they are able to divert to their own use, B, and, perhaps through concerns of re-election or revolt, the welfare W of the taxpayer (all non-policy makers being assumed identical, and as described in Section 2.1). The problem of the policy maker in country i can then be broken down into two stages. At the first, B_i is taken as given and the tax rate t_i chosen so as to maximize the citizen's welfare

$$W_i = f_i(k_i) - f_i'(k_i)k_i + \rho\bar{k}_i + G_i(t_i k_i - B_i). \tag{67}$$

The solution to this gives $W(B_i)$, and the second stage of the problem is then that of choosing B_i to maximize the policy maker's welfare $V(W(B_i), B_i)$.

Consider then the effects of a coordinated small increase in the tax rate charged by each country, starting from the Nash equilibrium. This evidently makes the policy makers in each country better off. But what of the citizens? For this, note first that with B_i fixed the first stage of the policy maker's problems is formally the same as that in Section 2.1.1, so that (13) will again hold in the symmetric equilibrium:

$$G'(t\bar{k}) = \frac{1}{1 + E_k} < 1. \tag{13}$$

Along the same lines as before Eq. (9), the welfare impact of this coordinated reform is $dW = -\bar{k}dt + dG$, but now dG is less than $G'\bar{k}dt$ to the extent that part of the additional revenue that this reform yields is spent on B instead. So:

$$dW = (G'(t\bar{k})\bar{k}\left(1 - \frac{dB}{d(t\bar{k})}\right) - \bar{k})dt \tag{68}$$

and hence, using (13) in (68), the citizen's welfare increases if and only if

$$\frac{dB}{d(t\bar{k})} < E_k, \tag{69}$$

meaning that the policy makers' marginal propensity to consume on the item that benefits only themselves is less than the (absolute value of) the elasticity of the tax base with respect to its own tax rate. The former is essentially an aspect of policy makers' preferences, and the latter can be thought of as increasing in the intensity of tax competition. One implication of (69) is, thus, that a coordinated tax increase is more likely to benefit the citizenry, all else equal, the more intense is tax competition.

A limitation of the Edwards-Keen model is that the form of policy makers' preferences and the nature of "wasteful" spending B are left unspecified: one person's waste is another's socially worthwhile spending. The fundamental issue ultimately is one of distributional politics. This aspect is pursued further by Eggert and Sørensen (2008), who take B to be rents paid to public sector workers by politicians anxious to secure their support in a probabilistic voting setting. An appealing feature of this framework is that there is in principle an optimal degree of tax competition: too little and rents are excessive, too much and underprovision of a beneficial public good dominates the gain from rent destruction. Interestingly, their simulations suggest that this optimal degree of tax competition may be fairly low, leading them to conclude that: "… tax competition … seems a badly targeted remedy against political distortions, compared to domestic institutional reform such as restrictions on campaign contributions by lobby groups."[66]

4.6.2. Voters' Choices

Several of the approaches used to describe democratic decision making have been applied to tax rate choices in a framework with tax competition. Persson and Tabellini (1992), Brückner (2001), and Fuest and Huber (2001) consider a median voter framework, while Ihori and Yang (2009) consider a citizen-candidate model. A general insight from these models is that the political process may distort the intrajurisdictional tax rate choice away from that which a benevolent planner would have chosen, and this political distortion has to be compared with those that are introduced through the various fiscal externalities associated with tax competition. To illustrate this in the context of the linearized framework of Section 2.1.1, suppose that voters differ only in their shares in the ownership of capital. Suppose further that, as one would expect, the median voter in each country has less than the mean ownership of capital: $\bar{k}_m < \bar{k}$. Recalling (22), with decision reflecting the capital ownership of the median voter rather than the average in the population, yields $t_i^m(t_j)$ that are obtained from $t_i(t_j)$ by an upward shift, leading to an equilibrium with higher taxes: tax competition becomes less aggressive.

An alternative view of electoral politics, one that also captures the self-interest of policy makers that motivates the Edward-Keen model, is explored by Besley and Smart (2007). They consider a world in which there are two types of politicians—some pure Leviathans, concerned only with the surplus B that they can extract from themselves, and some wholly benevolent—competing for office in a world with a two-period term limit. Voters do not directly observe politicians' types, and while they can observe the taxes they pay and the public services they enjoy, they cannot observe the cost of providing those services or, hence, the surplus that the incumbent policy maker extracts for himself. There are then two broad types of outcome, depending on the parameters of the model. One possibility is a separating equilibrium in which leviathan incumbents "go for broke," extracting as

[66] Eggert and Sørensen (2008, p. 1154).

much revenue as they can when in office, accepting that in doing so they will reveal their identity as leviathans and consequently not be re-elected. The other possibility is a pooling equilibrium in which leviathan incumbents will restrain the amount of revenue they raise so as to mimic the behavior of a benevolent policy maker faced with an adverse cost shock, so improving their chances of being re-elected and extracting as much surplus as they can in a final period of office.

Though it is not cast as a model of international taxation, Besley and Smart (2007) directly address in this framework the question of interest here: might an increase in the efficiency of the tax system—such as a coordinated increase in the tax rate in circumstances of international tax competition—reduce voter welfare (evaluated before the type of the first-period incumbent is known)? They show that it could, if it causes a shift from a separating to a pooling equilibrium. Such an increase in efficiency makes it more attractive for a leviathan to mimic a benevolent policy maker—the latter would now choose a higher level of public good provision, which enables the former to extract more rent by pretending that cost has proved to be high—so that the electoral process becomes less effective at removing leviathans, thereby creating more risk of abuse in the final term of office. This source of loss is greater the more likely it is that a candidate with no record of office would prove to be benevolent, since then the shift to a pooling equilibrium involves a greater loss of electoral effectiveness.[67] For this reason—and counter, perhaps, to simple intuition—a coordinated increase in tax rates is more likely to reduce voter welfare the *fewer* the number of politicians that are potential Leviathans.

5. CONCLUDING REMARKS

Thirty years ago, at the time of the first *Handbook*, there was almost no formal literature on international tax competition and coordination. Its growth since then has been spectacular, and it has produced a range of elegant, and in some cases powerful, results. These suggest, for instance, that agreement on minimum tax rates at levels somewhat above the lowest in the observed outcome is likely to be a more fruitful path to coordinating away from inefficient outcomes than is agreeing on common rates.[68] It would be too much to expect conclusions to be unqualified—we do not expect this in other areas—and they are not: it has also been seen, for instance, that the adoption of a minimum rate has less clear-cut effects in a Stackelberg game and can even undermine "good" equilibria in a repeated game context. The literature does, nonetheless, provide a coherent basis for contributing to and perhaps also shaping policy debates.

The literature does a much better job, however, in explaining why concerted action may be difficult than in suggesting with great precision or confidence which actions might

[67] It is also greater the lower the voter's discount rate is, since then the greater is the present value cost of a future unrestrained leviathan.

[68] Effective or statutory, depending on the context, and assuming agreement on a common base.

be both desirable and feasible. Empirical work can of course help policy navigate through the various possibilities that the theory identifies, and already is—as, for instance, in tending to confirm that strategic complementarity of tax rates across jurisdictions, though not a theoretical necessity, does indeed seem to be the norm. But deeper conceptual issues remain. Perhaps most fundamentally, the literature has not answered the basic question that has loomed over policy debates since OECD (1998): How can one distinguish tax competition that is "harmful" from that which is not? Progress has been made, but not yet enough to confidently determine whether, for instance, the presumption should be against or in favor of preferential regimes.

Further advance may require not only deeper empirical understanding and perhaps more use of calibrated simulations, but less simplistic views of the international tax regime itself. Much of the practical policy debate takes place not at the grand level of the models reviewed here but over details of international taxation of quite extraordinary complexity: relating for instance, to cross-country mismatches in the treatment of corporate forms or financial instruments, and the pricing of intangibles. This disconnect between the theory (and much of the empirics) and the details of practical concerns is perhaps greater in this area of public economics than most, and it may be growing. Models are no more than metaphors, but closer attention to detail might enable both the development of more informative ones—less rooted, for instance, in the view of a now vanishing word in which investment is essentially about large amounts of tangible capital and more rooted in one in which much corporate income is "stateless"[69]—and a more direct contribution on issues where real change seems most possible. While much of the theory in this area predated the greatly increased policy importance of the issues, the risk now is that the world will move more quickly than the theory.

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[69] The apt term is due to Kleinbard (2011).

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