PARETO-IMPROVING INDIRECT TAX COORDINATION: VIVA TAX DIVERSITY

by

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Abstract: This paper—within a perfectly competitive general equilibrium framework of international trade where inefficiencies in global public good provision linger—analyzes simple and easily implementable tax-coordinating reforms which deliver potential (and actual) Pareto improvements. It establishes that while early practical proposals have been driven primarily by some notion of tax-harmonization (and tax uniformity), there is a strong conceptual case for multilateral tax coordination that preserves *tax diversity* even from a global efficiency perspective.

Keywords: Indirect tax coordination; reform of commodity taxes; global public goods.

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1 Introduction

A key concern in countries designing their commodity tax system—and one that has become still more prominent since the crisis, as they struggle to restore growth—is the fear that their tax base will shift elsewhere if commodity taxes are domestically higher than elsewhere, a concern that is reflected in tax legislation in the EU, and elsewhere (as in Australia and Canada), of provision for tax coordination and tax harmonization. Whatever their precise form (considered more closely shortly below) it is the existence of such spillovers that create a *prima facie* case for central coordination of tax matters across countries, since lack of it will result in outcomes that are inefficient from a global perspective. In the EU, for example, Directive 2006/112/EC—a recast of the Sixth VAT Directive of 1977—has achieved some degree of tax harmonisation with the common bands of VAT, which require a minimum VAT rate of 15% on all products (apart from exemptions and special authorisations).[1]

Unsurprisingly, the appropriate form of tax harmonization has been the focus of the academic literature, and policy discussions, in the last two decades.[2] One of the results in this literature is that, in the absence of public revenue effects, a move towards more tax uniformity can generate potential Pareto improvements, in the sense that at least one of the tax-harmonizing countries will strictly gain and none lose as a consequence of tax harmonization.[3,4] The intuition behind this relies on the fact that the reform, by keeping the producer price-vector fixed, results in an improvement of exchange efficiency by taking, appropriately, into account the demand responses of the tax-harmonizing countries. The desirability of tax-harmonizing reforms diminishes if one accounts for the allocation of tax revenues in the form of either local or global public goods. In this case additional restrictions are required (either on the effects of the reforms on tax revenues

[1]Excise duties are also subject to minimum rates, based on Articles 191-192 of the Treaty on the Functioning of the European Union. There are, of course, forms of harmonization: one possibility is the harmonization of some policy parameters (rate and base), whereas another one is when countries set tax policy parameters independently, and rely primarily on exchange of information to resolve issues related to the taxation of intra-community trade. The analysis here focuses on the former.

[2]Early contributions are Keen (1987, 1988) and Turunen-Red and Woodland (1990). In the EU context, the Single European Act, by requiring unanimity in tax matters, has endowed Member States with a veto power which ensures that only Pareto-improving tax reforms will be adopted (assuming that Member States do not vote strategically).

[3]An actual Pareto improvement—where all participating countries strictly gain in welfare—is more difficult to establish. On this see Keen (1989) for destination-based indirect taxes, and Lopez-Garcia (1996) for origin-based taxes. The market structure also matters, Keen, Lahiri and Raimondos-Møller (2002).

[4]This conclusion is general enough to encompass the origin-based principle of indirect taxes (commodities are taxed by, and revenues accrue to, the country that produces them)—with the supply responses being the critical factor.

and/or availability of unrequited transfers).[5]

While this perspective is clearly an important one, an understanding of the requirements of a tax-coordinating policy that maintains tax diversity is also valuable. This resonates very strongly in the view that tax diversity allows '... member states maximum flexibility in arranging their tax system without, of course, interfering with the establishment of an internal market,' Cnossen (1990), p.473. The issue then is not one of harmonizing taxes but '... how much *tax diversity*[6] can be permitted without interfering with the establishment of a common market ...', Cnossen (1990), p.473. This is also the perspective taken by the EU, and expressed in the European Commission's tax policy strategy (COM (2001) 260), which emphasizes that there is no need for an across the board harmonisation of EU Member States' tax systems: Member States are free to choose the tax systems that they consider most appropriate and according to their preferences. But while it is easy to find statements of the importance of *tax diversity* for tax design and implementation, the technical literature has neglected the issue.

The aim in this paper is therefore to explore the welfare implications of (rather simple and easily implementable) tax-coordinating reforms that maintain and can even foster tax diversity. It does so by characterizing Pareto-improving allocations within a standard general equilibrium model of competitive trade in many goods in which the policy instruments are destination-based commodity taxes and tax revenues finance global public goods (a particularly important class of public goods). The analytics identify cases in which tax coordination, that takes the simple and implementable form of a non-uniform proportional movement of actual taxes towards appropriately designed *country-specific* targets—and in the absence of terms-of-trade-effects (and unrequited transfers)—is conducive to a potential Pareto improvement. This is achieved while countries maintain *tax diversity*, which is desirable even from a global efficiency perspective.

The paper also elaborates on the condition required for a tax reform that approaches optimal taxes to generate a potential Pareto improvement. Interestingly, and against what appears to be a commonly held view, such a tax reform *does not always* generate Pareto improvements: it does so if the initial tax structures are *close enough* (in a way clarified more formally in Proposition 2) to the optimum itself. A potential Pareto

[5]There is a simple reason for this: tax-harmonization is not capable—by way of design—to deal with 'two margins', one arising from the intensity of preferences for public goods, and one arising from inefficiencies in either consumption or production. See, for instance, Delipalla (1997), Lockwood (1997), Lahiri and Raimondos-Møller (1998), Lopez-Garcia (1998), Kotsogiannis and Lopez-Garcia (2007) for the case of local public goods, and Karakosta, Kotsogiannis and Lopez-Garcia (2014) for the case of global public goods.

[6]Emphasis added.

improvement can be, however, achieved when initial taxes approach certain *target vectors* that, interestingly and potentially more policy-relevant, are obtained using the optimal tax formulae—but with evaluation taking place at *actual* taxes (Proposition 3). There also exist coordinating reforms where initial tax structures approach a second family of country-specific *targets* (and ones that relate—in addition to the point of evaluation—to the divergence between worldwide marginal valuations and marginal cost in the provision of global public goods), which give rise to an actual Pareto improvement (Proposition 4).

The organization of the paper is the following. Section 2 provides the background against which the analysis is developed. Section 3 considers Pareto-efficient commodity tax policies, whereas Section 4 shows that there is a simple tax-coordinating reform that generates potential Pareto improvements, while maintaining tax diversity. Section 5, focuses on an actual Pareto-improving reform. Section 6 summarizes the results, discusses also how they can be applied to the case of local public goods, and provides some further remarks.

2 The model

To formalize ideas, use is made of a standard general equilibrium two-country competitive trade model where governments levy destination-based taxes and provide global public goods. The two countries are labeled 'home' and 'foreign', and variables pertaining to the home and foreign country are denoted, respectively, by lower- and upper case letters. In each country there is a private sector which produces $N+1$ tradeable commodities and a public one which produces a non-tradeable public good g (G). This public good is global in the sense that the enjoyment of the good by the home (foreign) country resident does not diminish its availability for the citizen in the foreign (home) country.[7] Commodity taxation is destination-based in the sense that commodities are taxed by—and revenues accrue to—the country where final consumption takes place. Unrequited transfers between governments are not available.

In the home (foreign) country there is a single representative consumer with preferences described by an expenditure function

$$e(u,q,g,G) \equiv \min_{x}\{q'x|\hat{u}(x,g,G)\geq u\} \ \left(E(U,Q,g,G) \equiv \min_{X}\{Q'X|\hat{U}(X,g,G)\geq U\}\right), \tag{1}$$

[7]Examples of global public goods abound: clean up environmental activities, global security and global protection of communicable diseases, to name a few.

where x (X) is the vector of consumption of the $N+1$ private goods, u (U) is the utility of the consumer, and q (Q) is the $N+1$-vector of consumer prices.[8] The vector of compensated demands in the home (foreign) country is given by e_q (E_Q) and $-e_g > 0$ $(-E_g > 0)$ gives the marginal willingness to pay for g by the home (foreign) consumer respectively, or, equivalently, the marginal rates of substitution between g and the numeraire good, denoted by mrs_g (MRS_g). Notice that the utility specification does not place any restrictions on the relationship between the two public goods, g and G.

The private sector is competitive and characterized by a restricted revenue function denoted by $r(p,g)$ $(R(P,G))$ for the home (foreign) country. The vector of supplies in the home (foreign) country is given by r_p (R_p), and $r_g < 0$ $(R_G < 0)$ gives the reduction in the home (foreign) country's production of the tradeable goods—and so revenues $r(p,g)$ $(R\,(p,G))$—as a consequence of an increase in the production of the global public good. The global public goods g and G are produced with technology that exhibits constant returns to scale, implying that the marginal cost of production (the marginal rate of transformation between the domestically supplied global public good g (G) and the numeraire in the home (foreign) country, denoted by mrt_g (MRT_g)), is given by $-r_g > 0$ $(-R_G > 0)$.[9]

To focus on issues arising from the global nature of the public goods, rather than the well-known tax-setting incentives of countries arising through terms-of-trade, the analysis will pay attention to the case in which both countries are small open economies thereby trading at a fixed international commodity producer-price vector, denoted by p. This, as will be emphasized shortly below, does not mean that there are no externalities lingering between the two countries thereby rendering tax-coordination an inefficient international policy. Externalities do exist but they come through the global nature of the public good.

Denoting the destination-based commodity tax-vector in the home country by t and in the foreign one by T, the consumer price-vector is given by $q = p+t$ for the home country and $Q = p+T$ for the foreign one. The homogeneity properties of the functions in the variables q, Q and p, imply that, without loss of generality, we can take the first tradeable commodity, good 0, to be the numeraire and also to be the untaxed commodity in both countries, so that $p_0 = q_0 = Q_0$.

An equilibrium for this economy—assuming it exists[10]—is a set of values for the en-

[8] All vectors are column vectors, with a prime indicating transposition. A subscript denotes differentiation.

[9] The restricted revenue function embeds all the usual properties of technology. On this see Abe (1992).

[10] Standard arguments apply. See Dixit and Norman (1980) and Woodland (1982).

dogenous variables $\{u, U, g, G\}$ that satisfy the budget constraints of the consumers and governments, given the vector of exogenous tax rates t, T. The system of equations that characterizes the equilibrium is given by

$$e(u, q, g, G) = r(p, g) + t' e_q(u, q, g, G), \tag{2}$$

$$E(U, Q, G, g) = R(p, G) + T' E_Q(U, Q, G, g), \tag{3}$$

$$t' e_q(u, q, g, G) = -g r_g(p, g), \tag{4}$$

$$T' E_Q(U, Q, G, g) = -G R_G(p, G). \tag{5}$$

Equations (2) and (3) give, respectively, the home and foreign country consumer's budget constraint.[11] The home and foreign government budget constraints are given by, respectively, equations (4) and (5).

The issues addressed will be analyzed, as it is typically the case, by considering perturbations of the system (2)-(5). In doing so, it will be assumed that $e_{qu} = E_{qU} = 0_{N\times 1}$ meaning that in each country income effects attach only to the untaxed numeraire commodity, good 0. To remove a further inessential complication, it will be also assumed that global public good provision does not affect the compensated demands for, and the supply of, any good other than the numeraire,[12] and so $e_{qg} = E_{qG} = 0_{N\times 1}$. Standard properties of the expenditure function $e(\cdot)$ (and $E(\cdot)$) imply that the $(N+1)\times(N+1)$ matrix of substitution effects (including the untaxed numeraire good) is negative semi-definite. It will further be assumed that there is enough substitutability between the numeraire good and all other goods, so that the $N \times N$ matrices e_{qq} and E_{QQ} are negative definite.[13]

3 Pareto-efficient indirect taxes

Perturbing equations (2) and (4), and making use of the fact that $dp = 0_{N\times 1}$, one obtains the welfare consequences of changes in the fiscal instruments for the home country, given by

$$e_u\, du = \left[\frac{e_g - r_g}{r_g}\left(e_q' + t' e_{qq}\right) + t' e_{qq}\right] dt + \frac{e_G}{R_G}\left(E_Q' + T' E_{QQ}\right) dT, \tag{6}$$

[11] Equation (2) simply states that, in equilibrium, the minimum expenditure of the home consumer to achieve utility u is equal to the sum of the revenues generated by the production of the tradeable goods, $r(p, g)$, and the revenues generated by taxing own demand, given by $t' e_q$. A similar interpretation applies to the budget constraint of the foreign consumer in equation (3).

[12] On this see also Wildasin (1979) and Keen and Wildasin (2004).

[13] See Dixit and Norman (1980), p. 130.

where $e_u > 0$ is the reciprocal of the marginal utility of income of the consumer residing there. Equation (6) shows that home country's welfare—as a consequence of an arbitrary reform $\{dt, dT\}$—is affected by two effects. The first one, given by the terms in the square brackets—$\left[\left(\left(e_g - r_g\right)/r_g\right)\left(e'_q + t'e_{qq}\right) + t'e_{qq}\right]$—reflects the home country's welfare impact of a change in its own tax rate, capturing the utility variations associated with, on the one hand, the induced change in its private consumption and, on the other, both the cost and the benefit of its public good provision. The second effect—given by $\left(e_G/R_G\right)\left(E'_Q + T'E_{QQ}\right)$—relates to the home country's welfare implication arising from changes in the foreign country global public good provision implied by its tax change. Notice, for later use, that the analogous expression for the foreign country is given by

$$E_U\, dU = \left[\frac{E_G - R_G}{R_G}\left(E'_Q + T'E_{QQ}\right) + T'E_{QQ}\right] dT + \frac{E_g}{r_g}\left(e'_q + t'e_{qq}\right) dt, \tag{7}$$

where $E_U > 0$ denotes the reciprocal of the marginal utility of income of the foreign country consumer.

Intuition suggests that the maximization of global welfare—denoted by W and defined as a weighted average of the utility levels u and U enjoyed in the two countries—requires that destination-based taxes will be set in accordance with the Ramsey commodity (international) tax rule that reflects preferences for the global public good.[14] To see this, notice that perturbing W with the appropriate choice of both tax structures, t and T, gives the sum of (6) and (7), which, upon setting $\partial W/\partial t = 0$ and $\partial W/\partial T = 0$ and solving simultaneously, gives

$$t^{*\prime} = \lambda^* e^{*\prime}_q \left[e^*_{qq}\right]^{-1} \quad ; \quad T^{*\prime} = \Lambda^* E^{*\prime}_Q \left[E^*_{QQ}\right]^{-1}, \tag{8}$$

where

$$\lambda^* \equiv -\frac{e^*_g + E^*_g - r^*_g}{e^*_g + E^*_g} \quad ; \quad \Lambda^* \equiv -\frac{E^*_G + e^*_G - R^*_G}{E^*_G + e^*_G}, \tag{9}$$

and all the relevant variables have been evaluated at the global optimum, denoted by an $(*)$. It will be proved convenient later on to note that the Ramsey taxes in (8) are implicitly characterized as the solutions of the following system of equations

$$t^{*\prime} = \psi'\left(t^*, T^*\right) \quad ; \quad T^{*\prime} = \Psi'\left(T^*, t^*\right). \tag{10}$$

Equations (8) and (9) characterize the Ramsey commodity taxes, t^* and T^*, in the home and the foreign country, respectively. The numerator of λ^* in (9)—given by $-(e^*_g + E^*_g - r^*_g)$, (and that of Λ^* given by $-(E^*_G + e^*_G - R^*_G)$)—reflects the extent of the

[14] See also Sandmo (2006).

underprovision of the global public good relative to the Samuelson rule. It is precisely, as noted earlier, the existence of E_g^* (e_G^*) in (9) that will give rise to the externalities (in the absence of terms-of-trade effects) and so the need for some tax coordination in the present framework.

It is also interesting to note that at the level of Ramsey taxes global public goods are underprovided relative to the Samuelson rule. To see this in a clear way, post-multiply the expression in (8) by t^* and T^*, respectively, to obtain, in obvious notation

$$mrs_g^* + MRS_g^* = \frac{\alpha}{\mu} mrt_g^*, \tag{11}$$

where $\alpha \equiv t^{*\prime} e_q^*$ and $\mu \equiv t^{*\prime} e_q^* + t^{*\prime} e_{qq}^* t^*$. With $t^{*\prime} e_q^*$ and $t^{*\prime} e_{qq} t^*$ being scalars (the former being positive from the budget constraint (4) and the latter strictly negative following that e_{qq} is a negative definite matrix) it follows that $\alpha/\mu > 1$ and, thus, in the presence of second-best optimal commodity destination-based taxes global public goods are underprovided[15] relative to the Samuelson first-best rule.[16] Summarizing the preceding discussion:

Proposition 1 *(i) Pareto efficiency requires that commodity taxes are set according to the Ramsey commodity tax rule, and (ii) global public goods are underprovided relative to the Samuelson rule.*

Proposition 1 serves as a useful benchmark case since it characterizes the globally optimal tax policy. But it is precisely the departure of the actual level of taxation in the two countries from the Ramsey commodity tax rule that gives rise to the need for tax-coordinating reforms (or, to put it differently and in a way that we qualify further below, the move towards those Ramsey taxes).[17] This is to what we turn to in the following two sections, taking up the issue of multilateral tax reforms that generate a potential Pareto improvement in Section 4, and of multilateral tax reforms that generate an actual Pareto improvement in Section 5.

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[15]Equation (11) is the so-called modified Samuelson rule, characterizing the optimal provision of (here extended to) home country global public good under the conditions that there are no income effects and demand and supply of the taxed goods are independent of global public good provision. On this see Atkinson and Stern (1974).

[16]Strictly speaking, this statement cannot be taken to imply that the amounts of the global public good are lower than those that would be provided in the first-best situation where lump-sum taxes are available. Underprovision is simply taken to be that, for the home country, $mrs_g^* + MRS_g^* > mrt_g^*$ (and $mrs_G^* + MRS_G^* > MRT_G^*$ for the foreign).

[17]Proposition 1 applies whether or not international transfers between governments can be deployed. If they can be then, of course, Pareto-efficiency requires equalizing λ^* and Λ^* in (9). For brevity, it will be assumed throughout that such transfers cannot be deployed.

4 *Tax diversity* as a potential Pareto-improving indirect tax reform

The analysis now seeks tax reforms $\{dt, dT\}$ which generate a Pareto improvement in the weak sense that $dW = e_u du + E_U dU > 0$. To explore this notice, first, that the $\psi(\cdot)$ and $\Psi(\cdot)$ functions in (10), whose fixed points implicitly characterize the optimal Ramsey taxes t^* and T^*, can be evaluated for *any arbitrary* tax structures of both countries, t and T, that is[18]

$$\psi'(t,T) \equiv \lambda e_q' \left[e_{qq}\right]^{-1} \quad ; \quad \Psi'(T,t) \equiv \Lambda E_Q' \left[E_{QQ}\right]^{-1}. \tag{12}$$

The obtain some intuition for the functions in (12) it is instructive to consider the case in which compensated demands are independent and so e_{qq} and E_{QQ} are diagonal matrices. In this case the specific tax rate ψ_i on commodity i is $\psi_i = \lambda e_i / e_{ii}$, where e_i and e_{ii} are, respectively, the compensated demand for good i and its local response in the home country. The ad-valorem tax rate on good i is then $\psi_i / q_i = \lambda / \epsilon_{ii}$, where ϵ_{ii} is the compensated own-price elasticity of commodity i. If these elasticities are constant, one can straightforwardly compare the components of $\psi(\cdot)$ and $\Psi(\cdot)$ in (12) with their counterparts in t^* and T^* in (8). The latter will be the ones associated with the familiar inverse elasticity rule that is, $t_i^*/q_i = \lambda^*/\epsilon_{ii}$. It is then apparent that ψ_i/q_i and t_i^*/q_i will be different as a consequence of the divergence between λ and λ^*. If, furthermore, ϵ_{ii} is constant for all i, t_i^*/q_i would reflect a uniform tax structure of ad-valorem tax rates, as would ψ_i/q_i.

Adding (6) and (7) and making use of (12), the change in global welfare following an arbitrary multilateral tax reform is given by

$$dW = \frac{e_g + E_g}{r_g}\big(t - \psi(t,T)\big)' e_{qq} dt + \frac{E_G + e_G}{R_G}\big(T - \Psi(T,t)\big)' E_{QQ} dT. \tag{13}$$

What matters then for global welfare are:

- The ratio between worldwide marginal valuations and marginal costs of the global public goods in both countries, given by $(e_g + E_g)/r_g$ for the home country and $(E_G + e_G)/R_G$ for the foreign one;
- The two countries' compensated demand responses, e_{qq} and E_{QQ};
- The deviation of the home (foreign) country's actual taxes from $\psi(t,T)$ ($\Psi(T,t)$).

[18] This parallels Neary's (1993) discussion in a framework where public goods are assumed away and tax revenues are returned to consumers in a lump-sum fashion.

A reasonable conjecture of a reform that delivers a potential Pareto improvement (and one that has featured very prominently in the technical literature and policy discussions) is one in which either of the two countries (or both) change their initial taxes towards their (globally) optimal Ramsey tax structures. That is,

$$\left[\begin{array}{c} dt \\ dT \end{array}\right] = \left[\begin{array}{c} \alpha\left(t^{*}-t\right) \\ A\left(T^{*}-T\right) \end{array}\right], \tag{14}$$

where $\alpha, A \geq 0$ denotes the speed with which the home and foreign country, respectively, approach their optimal tax structures, and the possibility of α (A) being zero allows for the case where one of the two countries keeps its tax structure unchanged. This reform is fully consistent with tax diversity, and it is also a coordinating one: for, in the presence of global public goods, the optimal tax structure in any country depends on the marginal valuations of these goods in *both* countries and, therefore, any movement in a country's tax rates towards the optimal ones accounts not only for this country's preferences but also for the other's.

But there is a subtle point behind (14)—and a much neglected aspect in the literature—which needs to be elaborated on: the initial tax-distorting equilibrium structure matters, and, perhaps more importantly, it has to be *close* (to be qualified shortly) to the optimum.

Equation (13) can now be written, adding and subtracting the optimal tax rates in (10), as

$$\begin{aligned} dW &= \frac{e_g + E_g}{r_g}\left[\left(t-t^{*}\right)+\left(\psi\left(t^{*},T^{*}\right)-\psi\left(t,T\right)\right)\right]' e_{qq} dt \\ &+ \frac{E_G + e_G}{R_G}\left[\left(T-T^{*}\right)+\left(\Psi\left(T^{*},t^{*}\right)-\Psi\left(T,t\right)\right)\right]' E_{QQ} dt. \end{aligned} \tag{15}$$

The change in global welfare thus depends on deviation of the Ramsey taxes from the initial ones and deviation (which, loosely speaking, is a measure of how far the actual taxes are from the optimal ones) of $\psi(t^{*},T^{*})$ from $\psi(t,T)$ and $\Psi(T^{*},t^{*})$ from $\Psi(T,t)$.

Clearly, if the latter deviations are zero (an admittedly stringent requirement) equation (15) reduces to

$$dW = -\alpha\frac{e_g + E_g}{r_g}\left(t-t^{*}\right)' e_{qq}\left(t-t^{*}\right) - A\frac{E_G + e_G}{R_G}\left(T-T^{*}\right)' E_{QQ}\left(T-T^{*}\right) > 0, \tag{16}$$

where the inequality sign follows from the fact that e_{qq} and E_{QQ} are negative definite. It is thus the case that the movement of the destination-based tax structures, t and

T, towards their optimal values, t^* and T^*, delivers a potential Pareto improvement. Summarizing:

Proposition 2 *Starting from an arbitrary tax-distorted equilibrium with $t \neq T$, a potential Pareto improvement following a non-uniform proportional reduction of the gap between t (T) and t^* (T^*) by at least one of the countries is guaranteed if the terms $(\psi(t^*, T^*) - \psi(t, T))$ ($\Psi(T^*, t^*) - \Psi(T, t)$) can be ignored.*

What Proposition 2 simply says is that if the starting point is *close enough* to the optimum then there will always be a tax reform that maintains tax diversity and delivers a global welfare gain. Though insightful, Proposition 2 is also, in a very real sense and as a practical matter, quite restrictive since it requires that the arbitrary initial tax equilibrium is in the neighbourhood of the global optimum: if they are further apart—in the sense of Proposition 1—then the sign of (14) is indeterminate.

Returning to (14) one sharp result, however, emerges quite quickly. Consider the tax-coordinating reform which consists of a non-uniform proportional movement of both countries' tax structures towards the country-specific targets, given in (12), where the vectors and matrices are evaluated at any *arbitrary* initial values of t and T, that is

$$\begin{bmatrix} dt \\ dT \end{bmatrix} = \begin{bmatrix} \gamma\left(\psi\left(t,T\right)-t\right) \\ \Gamma\left(\Psi\left(T,t\right)-T\right) \end{bmatrix}, \tag{17}$$

and where $\gamma, \Gamma \geq 0$. To put it differently: this coordinating-tax reform implies a non-uniform proportional convergence of the tax structures of at least one country towards a country-specific target, where the target results from determining the functional forms of the *optimal* tax formulas using *actual* instead of optimal taxes. Substitution of (17) into (13) gives

$$\begin{aligned} dW = \; & - \; \gamma \frac{e_g + E_g}{r_g} \big(t - \psi\left(t,T\right)\big)' e_{qq} \left(t - \psi\left(T,t\right)\right) \\ & - \; \Gamma \frac{E_G + e_G}{R_G} \big(T - \Psi\left(T,t\right)\big)' E_{QQ} \Gamma \left(T - \Psi(T,t)\right) > 0, \end{aligned} \tag{18}$$

with the inequality sign follows from the fact that e_{qq} and E_{QQ} are both negative definite matrices. It is thus the case:

Proposition 3 *Starting from an arbitrary tax-distorting equilibrium with $t \neq T$, tax coordination in the sense of (17), and thus a non-uniform reduction in at least one country of the gap between t (T) and $\psi\left(t,T\right)$ ($\Psi\left(T,t\right)$), generates a potential Pareto improvement.*

Proposition 3 is valid for any arbitrary tax-distorting equilibrium. Here is, therefore, a reform that preserves tax (and global public goods) diversity (and one that does not require the availability of unrequited transfers across governments) that reflects the countries' preferences for the global public goods, as reflected in the tax structures taken as a starting point.

Thus far it has been shown that that there are coordinating tax reforms that respect tax diversity and are potentially Pareto-improving. Naturally, the question that now arises is whether there exist tax reforms $\{dt, dT\}$ which generate a Pareto improvement in the strict sense and thus $e_u du > 0$ and $E_U dU > 0$. This is to what we next turn to.

5 *Tax diversity* as an actual Pareto-improving indirect tax reform

For an actual Pareto improvement, a natural, and common, approach is to start the reform from those taxes characterized at the Nash equilibrium. At a Nash equilibrium each country's tax structure maximizes its own welfare taking all other taxes as given, which for the home (foreign) country amounts to setting $dT = 0_N$ ($dt = 0_N$) in (6) ((7)). Denoting the Nash equilibrium taxes by t^N and T^N one obtains

$$t^{N\prime} = \pi^N e_q^{N\prime} \left[e_{qq}^N\right]^{-1} \quad ; \quad T^{N\prime} = \Pi^N E_Q^{N\prime} \left[E_{QQ}^N\right]^{-1}, \tag{19}$$

where

$$\pi^N \equiv -\frac{(e_g^N - r_g^N)}{e_g^N} \quad ; \quad \Pi^N \equiv -\frac{\left(E_G^N - R_G^N\right)}{E_G^N}, \tag{20}$$

and all the relevant variables are evaluated at the non-cooperative equilibrium. Notice that, as one would expect, at the Nash equilibrium global public goods are underprovided relative to the Samuelson rule. To see this rewrite the first expression in (19) as $t^{N\prime} e_{qq}^N = \lambda^N e_q^{N\prime}$, post-multiply by t^N and rearrange to find, again in obvious notation,

$$mrs_g^N = \frac{\delta}{\theta} mrt_g^N, \tag{21}$$

where $\delta \equiv t^{N\prime} e_q^N$ and $\theta \equiv t^{N\prime} e_q^N + t^{N\prime} e_{qq}^N t^N$. Since $t^{N\prime} e_q^N > 0$ and $t^{N\prime} e_{qq}^N t^N < 0$, $\delta/\theta > 1$ implying that $mrs_g^N > mrt_g^N$. As a consequence, the numerator of π^N (and that of Π^N) in (20)), reflects the divergence between these marginal rates of substitution and of transformation at the non-cooperative equilibrium. As $mrs_g^N + MRS_g^N > mrs_g^N > mrt_g^N$, it follows that global public goods are underprovided relative to the Samuelson first-best rule.

As an envelope property, evaluating (6) and (7) at the Nash equilibrium gives

$$e_u\, du = \frac{e_G^N}{R_G^N}\left(E_Q^{N\,\prime} + T^{N\,\prime} E_{QQ}^N\right) dT \quad ; \quad E_U\, dU = \frac{E_g^N}{r_g^N}\left(e_q^{N\,\prime} + t^{N\,\prime} e_{qq}^N\right) dt \tag{22}$$

Now use the functions $\psi(\cdot)$ and $\Psi(\cdot)$ in (12) to define the following country-specific targets

$$\omega'\left(t^N, T^N\right) = \mu^N \psi'\left({}^N, T^N\right) \quad ; \quad \Omega'\left(T^N, t^N\right) = M^N \Psi'\left(T^N, t^N\right), \tag{23}$$

where

$$\mu^N \equiv \frac{e_g^N + E_g^N}{e_g^N + E_g^N - r_g^N} \quad ; \quad M^N \equiv \frac{E_G^N + e_G^N}{E_G^N + e_G^N - R_G^N}, \tag{24}$$

and μ^N and M^N reflect the divergence between the worldwide marginal valuations and marginal cost in the provision of global public goods at the non-cooperative equilibrium.

Clearly, the new vectors $\omega(\cdot)$ and $\Omega(\cdot)$ in (23) are obtained by multiplying those in (12) with their respective values in (24), and they are all evaluated at the *non-cooperative* equilibrium.[19] Using (23), the welfare effects in (22) can be written as

$$e_u\, du = \frac{e_G^N}{R_G^N}\left[T^N - \Omega\left(T^N, t^N\right)\right]' E_{QQ} dT \quad ; \quad E_U\, dU = \frac{E_g^N}{r_g^N}\left[t^N - \omega\left(t^N, T^N\right)\right]' e_{qq} dt. \tag{25}$$

Consider now a reform that consists of a non-uniform proportional movement of both countries' non-cooperative tax structures towards the target vectors in (23) that is,

$$\begin{bmatrix} dT^N \\ dT^N \end{bmatrix} = \begin{bmatrix} \eta\left(\omega\left(t^N, T^N\right) - t^N\right) \\ H\left(\Omega(T^N, t^N) - T^N\right) \end{bmatrix}, \tag{26}$$

where $\eta, H \geq 0$. The utility implications for this for the home country is then (with a similar expression applying to the foreign country)

$$e_u du = -H \frac{e_G^N}{R_G^N}\left(T^N - \Omega^N\right)' E_{QQ}\left(T^N - \Omega^N\right) > 0, \tag{27}$$

where $\Omega^N = \Omega(T^N, t^N)$ is the above-mentioned target for the foreign country, and the inequality follows from the fact that $e_G, R_G < 0$ and E_{QQ} is a negative definite matrix. We thus arrive at:

Proposition 4 *Taking as a starting point the non-cooperative equilibrium taxes t^N and*

[19] Notice that $-(e_g^N - r_g^N) > 0$ from (21), so that $-(e_g^N + E_g^N - r_g^N)$ will also be positive in (24). This ensures that μ^N (and also M^N) is positive.

T^N, a multilateral tax-coordinating reform in the sense of (26), generates an actual Pareto improvement.

The non-cooperative tax-setting implied by the presence of public goods externalities is liable to result in outcomes that are inefficient relative to the range of instruments available. The implication is that cooperation, in the form of a multilateral tax reform, is to the advantage of both countries.

Here then is a case in which tax coordination that takes the simple form of a non-uniform movement of actual taxes towards an appropriately designed country-specific target vector —and in the absence of terms-of-trade-effects (and unrequited transfers being unavailable)—is conducive to an actual Pareto improvement. Proposition 4, in conjunction with Proposition 2, then imply that, conceptually at least, it is possible to achieve welfare gains, both from a global and domestic perspective, that are consistent with *tax diversity*.

6 Conclusion and further remarks

This paper has introduced global public goods in a perfectly competitive general equilibrium framework and has shown that simple destination-based tax-coordinating reforms that maintain and even reinforce tax diversity can generate welfare gains. Importantly, (and against a commonly held view) it has shown that a multilateral reform by which countries approach their optimal (Ramsey) taxes need not be desirable from a global welfare perspective: it can only be this if the initial tax structures are *close* to the optimal ones (Proposition 2). It has also shown that a non-uniform convergence of the tax structure of at least one country towards a country-specific target, where the target results from computing the functional forms of the *optimal* tax formulae using *actual* instead of optimal taxes, is potentially Pareto-improving (Proposition 3). When the initial position of the tax structures is the Nash equilibrium, one can design tax-coordinating reforms that lead to an actual Pareto improvement, so that both countries are better off. These reforms are qualitatively identical to the ones leading to a potential welfare gains, the only difference being that the country-specific vectors towards which taxes converge take into account the divergence between worldwide marginal valuations and marginal cost in the provision of global public goods (Proposition 4).

The discussion has focused on the case in which governments provide global public goods. The framework, however, is general enough to consider also local public goods, in the sense that the home (foreign) country consumer derives utility only from the production of the home public good g (G). What this implies in modeling terms is that $e_G =$

$E_g = 0$ in (2)-(5).[20] With no externalities through public goods present, the Ramsey optimal taxes, following equations (6) and (7), are defined by $t^{*\prime} = \psi'(t^*, 0)$ and $T^{*\prime} = \Psi'(T^*, 0)$.[21] Thus the essence of Proposition 1 (but now the optimal taxes expressed in terms of local public goods) remains unchanged. So do, interestingly, Propositions 2 and 3, with the consequence that the multilateral tax-coordinating reform (17)—a non-uniform reduction by a least one country of the gap between t (T) and $\psi(t, 0)$ ($\Psi(T, 0)$)—too entails a potential Pareto improvement. When public goods are local the optimal Ramsey commodity taxes in (8) will coincide with the non-cooperative ones in (19) that is, $t^* = t^N$ and $T^* = T^N$. As a consequence there is no counterpart of Proposition 4 when governments provide local public goods.

The analysis here is of course limited in several respects. The market structure has been perfectly competitive and other instruments have been assumed away (for example, trade taxes). What the analysis here does establish, however, is that while practical proposals have been recently driven primarily by some notion of tax-harmonization (and tax uniformity), there is a strong conceptual case for tax coordination and tax diversity. There remains much scope for the analysis of tax coordination and tax diversity in richer analytical models. We hope to have shown that the task is worthwhile and that the conclusions can be instructive.

[20]This is the framework used by Lahiri and Raimondos-Møller (1998) to discuss the welfare effects of indirect tax harmonization in the particular case where the commodity tax rates (for the non-numeraire goods) are uniform.

[21]That t^* does not depend on T^* when public goods are local in nature follows from (6) when $e_G = 0$. Similar considerations apply to T^* and t^*.

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