The Origin Principle, Tax Harmonization and Public Goods

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Abstract

This paper verifies that some reasonable conjectures concerning the welfare effects of tax harmonization hold under an origin-based tax system when public goods are present. It is shown that if both countries have the same marginal costs of public funds then the reform generates a potential Pareto improvement when global revenues are conditionally neutral. An actual Pareto improvement can be achieved under more stringent conditions: those of Nash equilibrium taxes and the Samuelson rule of public good provision.

Keywords: Origin-based taxation; commodity tax harmonization; public goods

JEL classification: F15; H21; H41.

1 Introduction

As part of its objective to create an efficient common market, the European Union has long undertaken a legal and political commitment to establish a common system of commodity taxation based on the origin principle (commodities are taxed by - and revenues accrue to - the country that produces them). Central to the proposals of the European Commission was the movement of taxes towards a common average. Keen (1987) shows that a move of destination-based commodity taxes towards an appropriately weighted average would generate a potential Pareto improvement. An actual Pareto improvement is more difficult to establish (Keen (1989)). A limitation of Keen (1987, 1989) is that tax revenues are returned to consumers in a lump-sum fashion so there are no effects through public good expenditure. Delipalla (1997) introduces public goods and shows that, under certain conditions, indirect tax harmonization under the
destination principle leads to a potential Pareto improvement.¹

The parallelism between destination and origin taxation with public goods is not at all obvious,² and consequently it is rather surprising that work on origin-based taxation is limited. Lopez-Garcia (1996), in a model without public goods, establishes that Keen’s reforms are robust under origin taxation. Lucas (2001) considers public goods but in a very restrictive environment. In this paper we provide a unified framework that nests Lopez-Garcia (1996) and Lucas (2001) and asks: Is there a welfare case for tax harmonization when government revenue finances a local public good and commodities are taxed under the origin principle?

2 The Model

The basic framework is a standard general equilibrium model of international trade in which there are two countries labelled ‘home’ and ‘foreign’. Home and foreign country variables are denoted by lower and upper case letters respectively. In each country there is a private sector (with a representative consumer) and a public sector. There are \( N + 1 \) tradeable commodities. Each public sector produces a non-tradeable local public good³ \( g(G) \) financed by tax revenues and provided free of charge. Commodity taxation is origin based. Intergovernmental lump-sum transfers are permitted at some point. The implication of origin based taxation is that in equilibrium the home country consumer price vector \( q \) and the foreign country consumer price vector \( Q \) will be the same but producer prices \( p(P) \) may differ because of the presence of commodity tax vector \( t(T) \).

Consumer preferences in the home country are represented by the expenditure function \( e(q, u, g) \) \( (E(Q, U, G)) \) with \( e_g < 0 \) \( (E_G < 0) \) representing the reduction in expenditure on the private goods as a result of an extra unit of consumption of the public good holding utility constant. The public sector is competitive and characterized by a “restricted” revenue function denoted by \( r(p, g) \) \( (R(P, G)) \), which embeds all the usual properties of technology (see Abe (1992)).

Assuming it exists, an equilibrium for this economy is a set of values for the \( N + 5 \) endogenous variables \( \{q, U, u, g, G\} \) that satisfy market clearing and meet the budget constraints of the two consumers and two governments given the exogenous tax rates \( \{t, T\} \). Conventional normalizations⁴ allows us to write

¹See also Lahiri and Raimondos-Møller (1998) and Lopez-Garcia (1998).
³The case of public inputs is treated in Kotsogiannis and Myles (2003).
⁴We choose the first commodity, commodity 0 to be the numeraire and to be untaxed by both countries and so \( t_0 = T_0 = 0 \) and \( q_0 = 1 = Q_0 \). Walras’ Law then allows us to drop the market-clearing equation for commodity 0. The final system has \( N + 4 \) equation in the same number of variables and is so exact.
the system that characterizes the equilibrium as

\[ e_q(q, u, g) + E_q(q, U, G) - r_p(q - t, g) - R_P(Q - T, G) = 0_N, \]  
(1)

\[ e(q, u, g) - t' r_p(q - t, g) - z = r(q - t, g), \]  
(2)

\[ E(q, U, G) - T' R_P(Q - T, G) + z = R(Q - T, G), \]  
(3)

\[ t' r_p(q - t, g) + z = -g r_g(q - t, g), \]  
(4)

\[ T' R_P(Q - T, G) - z = -G R_G(Q - T, G). \]  
(5)

Equation (1) gives the market clearing conditions for the \( N \) tradeable goods. Denoting by \( z \) the level of transfers between the countries in units of the numeraire, equations (2) and (3) give the home and foreign budget constraints. The government budget constraints for the home and foreign country are given by (4) and (5).

We analyze harmonization by considering perturbations of this system. Throughout we assume that in each country income effects attach only to good 0 and so \( e_{q0} = E_{QU} = 0_{N \times 1} \). To remove two further inessential complications we suppose that public good provision does not affect: (i) the compensated demands for any other good other than the numeraire (Wildasin (1979)) and so \( e_{g0} = E_{gG} = 0_{N \times 1} \), and (ii) supply for any other good other than the numeraire and so \( r_{pg} = R_{PG} = 0_{N \times 1} \).

3 Small-Country Analysis

Although we do not find it a good assumption in the circumstances, Lucas (2001) works with the small country assumption that world prices, \( q = Q \), are fixed. Why we do not find this assumption attractive is that it removes all the interactions between the two countries except that through the lump-sum transfer. Consequently, there are no fiscal externalities so removing one of the motivations for tax harmonization. However, this is the case used by Lucas and it seems necessary to correct his analysis.

Perturbing equations (2) and (4), holding \( q \) constant, we obtain

\[ e_u du = \left[ \frac{s_g}{r_g} r_p' - \frac{e_g}{r_g} r_{pp} \right] dt + \frac{e_g}{r_g} dz, \]  
(6)

where \( s_g = e_g - r_g \) and a similar expression (but having a minus on the \( dz \) term) holds for the foreign country. The lack of fiscal externality is reflected in the fact that \( dT \) does not appear in (6).

The first question to address is whether harmonization can lead an actual Pareto improvement which is a reform that raises home utility \( u \) leaving foreign utility \( U \) unchanged but with no transfers so \( dz = 0 \). Since \( dz \) is zero, what happens to \( T \) becomes entirely irrelevant to the home country. This reinforces our observation that this is not a good case to study. Now define the optimal tax
rate, \( t^* \), by \( \frac{dt}{dt^*} = 0 \). From (6), \( t^* = \frac{2}{t_r^*} r_p \). Lucas considers reforms defined by \( dt = \beta (t^* - t) \), \( dT = \beta (T^* - T) \), with \( \beta > 0 \). But this reform is just uniform convergence to the optimum taxes, so is entirely unconnected with the issue of harmonization. To see this, just assume that the tax vectors satisfy \( t > t^* \), \( T < T^* \) but \( t^* < T^* \). The reform described will reduce \( t \), raise \( T \) but move the two vectors further apart.

What this demonstrates is that in this case, since there is no fiscal externality, the issue of harmonization is of no interest. The reform identified will raise welfare because it is a move towards the optimum and not because of any connection with harmonization.

A potential Pareto improvement is a reform that raises home utility \( u \) but leaves foreign utility \( U \) unchanged under the existence of lump-sum transfers. Setting \( dU = 0 \) in the foreign counterpart of (16) gives \( dz = -(T - T^*)' R_{pp}dT \).

Substituting into (16)

\[
-\frac{r_g}{v_g} e_a du = (t - t^*)' r_{pp} dt + (T - T^*)' R_{pp} dt.
\]

We now consider the tax reforms given by

\[
dt = \beta \psi (H - t), \ dT = \beta \Psi (H - T).
\]

(8)

\( H = \Sigma t + (I - \Sigma)T \) is the common target for the taxes, where \( \Sigma = (\psi r_{pp} + \Psi R_{pp})^{-1} \psi r_{pp} \) and \( I_N \) is the identity matrix of dimension \( N \). It is clear that \( H \) is a weighted average of the two initial tax structures, with the weights being dependent on local supply responses. \( \beta \) is positive and \( \psi, \Psi \) are arbitrary positive numbers. This nests previous work as the special case with \( \psi = \Psi = 1 \). What the inclusion of \( \psi \) and \( \Psi \) allows is a more general interpretation of harmonization.

To see this, note that with \( r_{pp} = R_{PP} \), the target becomes \( H = \delta t + (1 - \delta) T \) with \( \delta = \frac{\psi}{\psi + \Psi} \). Hence, by varying \( \psi \) relative to \( \Psi \), it is possible to vary the target from \( H = t \) to \( H = T \). The special case of \( \psi = \Psi \) gives \( H = \frac{1}{2} (t + T) \).

Calculation shows that all reforms satisfying (8) imply \( r_{pp} dt + R_{PP} dt = 0_N \).

Substitution into (7) then gives

\[
\frac{r_g}{v_g} e_a du = (t - t^*)' S (t - T) - (t^* - T^*)' S (t - T).
\]

(9)

The first term is positive since \( S \equiv \Psi R_{pp} [\psi r_{pp} + \Psi R_{pp}]^{-1} \psi r_{pp} = \left[ \psi r_{pp}^{-1} + \psi R_{pp}^{-1} \right]^{-1} \) is positive definite. This is the usual welfare-enhancing effect associated with tax harmonization in the absence of public goods (Lopez-Garcia (1996)). The second term reflects the existence of public goods and its sign is ambiguous even if \( \psi = \Psi = 1 \).

Given this indeterminacy, it is clear that additional restrictions must be imposed in order to generate definite results on potential Pareto improvements. Assume that both the initial and optimal tax rates are uniform, so that \( t = \tau 1_N, t^* = \tau^* 1_N, T = \Gamma 1_N \) and \( t^* = \Gamma^* 1_N \). With these restrictions (9) becomes

\[
\frac{r_g}{v_g} e_a du = (\tau - \Gamma) \left[ (\tau - \tau^*) - (\Gamma - \Gamma^*) \right] 1_N^t S 1_N, \]

(10)
where $1' S 1_N$ is positive. To interpret this, assume (without any loss of generality) that $\Gamma > \tau$, so the foreign country has higher taxes initially. Then to obtain a potential Pareto improvement it is necessary that $(\Gamma - \Gamma^*) > (\tau - \tau^*)$, so that the divergence between actual and optimal tax rates is greater in the higher tax country at the initial position. This does establish a conclusion, but contrary to the claim in Lucas (2001), it requires both uniformity and a condition on the initial deviation from optimality.

4 Endogenous World Prices

The analysis is considerably more interesting when world prices are endogenized since this introduces a fiscal externality.

Perturbing equations (2) and solving for the level of utility of the home country we obtain

$$e_u du = - (m' - t' r_{pp}) dq - t' r_{pp} dt + (-e_g - (-r_g)) dg + dz, \quad (11)$$

where $e_u > 0$, is the marginal utility of income, $m' = e'_q - r'_p$ is the $N$-row-vector of imports of the non-numeraire goods for the home country.

From (11), welfare in the home country depends on the following terms: the first, $-m'$, is the terms of trade effect (at fixed $-m'$ the higher the world consumer prices the lower the utility of the consumer that is, $-m'dq < 0$ with $dq > 0$). The second, $-t' r_{pp} dq$, and third, $-t' r_{pp} dt$, terms are effects arising from distortions associated with the change in the vector of producer prices, $q - t$, in the home country. The fourth effect, $-e_g - (-r_g)$, arises from the diversion of public good provision from the Samuelson rule, $e_g = r_g$. The final effect is via international compensatory transfers; ceteris paribus, an increase in transfers $z$, increases welfare in the receiving country.

Perturbation of (4) gives

$$dg = r^{-1}_g (-t' r_{pp} dq + (t' r_{pp} - r'_p) dt - dz). \quad (12)$$

To evaluate tax reforms we now need to relate the changes in welfare $du$ and $dU$ directly to changes in $\{dt, dT\}$. Perturbing equation (1) and solving for $dq$ we obtain

$$dq = -\Lambda^{-1} r_{pp} dt - \Lambda^{-1} R_{PP} dT, \quad (13)$$

where $\Lambda = e_{qq} + E_{qq} - r_{pp} - R_{PP}$ gives the derivative of the compensated world excess demands for the non-numeraire goods with respect to the non-numeraire prices. We assume that $\Lambda$ is negative definite (Dixit and Norman (1980)).

Substituting (12) and (13) into (11) we obtain the final expression determining the welfare consequences of changes in the fiscal instruments for the home country.

5 Conditions on the foreign country are similar and typically omitted from the presentation.

6 Since $e_{qq}, E_{qq}$ are $N \times N$ negative semidefinite matrices and $r_{pp}, R_{PP}$ are $N \times N$ positive semidefinite matrices, $\Lambda$ is negative semidefinite.
\[ e_u du = \left[ - (t' r_{pp} - r'_p) \gamma - r'_p + (m' - t' r_{pp} \gamma) \Lambda^{-1} r_{pp} \right] dt \]
\[ + \left[ (m' - t' r_{pp} \gamma) \Lambda^{-1} R_{PP} \right] dT + \gamma dz, \tag{14} \]

where \( \gamma \equiv e_g / r_g > 0 \). Notice that in equilibrium \( e_g / r_g \) is equal to the Marginal Cost of Public Funds (MCPF) that is, the cost to the consumer of home country public good per unit of home country revenue.\(^7\)

The welfare consequence of substituting the reform (8) into (14) is

\[ e_u du = \left[ - (t' r_{pp} - r'_p) \gamma - r'_p \right] dt + \gamma dz. \tag{16} \]

Equation (16) is intuitive; the reform induces producer prices to change in such way that world consumer commodity prices fixed at \( q \). Since equilibrium demand and supply remain unaffected the import vector \( m' \) also remains unaffected. Income changes due to the change in the producer price vector are also offset by the need to maintain some level of public good \( g \). To put it differently, the loss in revenues due to the change in the producer price vector, \( t' r_{pp} \), is offset by the change in the public good supply. What is left, therefore, is the public good effect \(- (t' r_{pp} - r'_p) \gamma dt\), the revenue effect \(- r'_p dt\), and the change in transfers \( \gamma dz \).

To consider potential Pareto improvements set \( dU = 0 \) in the foreign counterpart of (16) solving for the level of transfer \( dz \) and substituting this into (16), we obtain

\[ MCPF_h^{-1} e_u du = \left[ - \left( t' R_{pp} - r'_p \right) dt + \left( T' R_{PP} - R'_P \right) dT \right] \]
\[ - \left( MCPF_h^{-1} r'_p dt + MCPF_f^{-1} R'_p dT \right), \tag{17} \]

where the marginal cost of public funds \( MCPF_h \equiv \frac{e_g}{r_g} \) and \( MCPF_f \equiv \frac{E_g}{R_g} \).

(17) points to instances in which tax harmonization is potentially Pareto improving. Suppose for instance that \( MCPF_h \) in the home country is equal to the foreign country’s \( MCPF_f \equiv \mu > 0 \) and that global tax revenues are conditionally neutral (so that the first bracketed term sums to zero). Conditional revenue neutrality implies that the change in world tax revenues at unchanged behavior, \( r'_p dt + R'_p dT \), evaluated with the reform, is strictly negative and so on this score tax harmonization is potentially welfare improving. This is intuitive; conditional revenue neutrality implies that there is no revenue loss for the home country since there is one to one compensation from the country who gains to the country who loses from this reform. On this score home country’s welfare remains unchanged. A reduction in global revenues in turn implies that there are efficiency gains due to less production distortions (from a reduction in the producer price vector necessary to maintain fixed consumer prices). It is then

\(^7\)Whether, in equilibrium, public goods are over or under supplied depend on the divergence of the actual optimal rule from the Samuelson rule of optimal public good provision, \( e_g = r_g \) (Atkinson and Stern (1974)).
easy to show that equation (17) reduces to
\[ e_u du = \beta(T - t) S(T - t) > 0 , \]  
where the inequality sign follows from \( \beta > 0 \) and the fact that \( S \) is positive definite. Summarizing we have Proposition 1 that generalizes the result in Lopez-Garcia (1996). In this particular instance, the existence of public goods does not affect the possibilities for an improving reform.

**Proposition 1**Assuming that revenues are conditionally neutral and the MCPF in both countries equals \( \mu > 0 \), then starting from an arbitrary tax distorted equilibrium with \( t \neq T \) the reform attains a potential Pareto improvement for any \( \psi, \Psi \).

We now investigate whether the reform is capable of achieving an *actual Pareto improvement* with \( du, dU > 0 \) and \( dz = 0 \). Clearly, this imposes a more stringent requirement on the problem: for in this case there is one degree of freedom less due to the absence of the variable \( z \), and so, in general, one should expect the achievement of an actual Pareto improvement to be highly dependent on the initial tax rates (Keen (1989)). Setting \( dz = 0 \) in (14) and its foreign counterpart we obtain the welfare effects of a change in taxes

\[ e_u du = \beta(T - t) S(T - t) . \]  

A natural step to follow in evaluating (20), and its foreign counterpart, is to assume that both countries follow the Samuelson rule of public good provision. Setting \( e_g = r_g \) in (20) and using (8) one obtains

\[ e_u du = -\beta t^* S(T - t) . \]  

The sign of (22) is, in general, ambiguous: for, given that \( S \) is positive definite, \( t' S t > 0 \) but \( -t' ST \gtrless 0 \). An instance in which this ambiguity is removed is if countries behave as Nash competitors. In this case the Nash equilibrium level of taxes, denoted by \( t^*_n \) for the home country and \( T^*_n \) for the foreign are, respectively

\[ t^*_n = (r_{pp} + \Lambda)^{-1} m , \]  

and

\[ T^*_n = (R_{PP} + \Lambda)^{-1} M . \]  

It then follows that

\[ t^*_n ST^*_n = -m' \Phi m , \]  

where \( \Phi = (c_{qq} + E_{qq} - r_{pp})^{-1} S(c_{qq} + E_{qq} - R_{PP})^{-1} \) and so the sign depends on the matrix \( \Phi = \phi[i, j] \). Following Kotelyanskii’s theorem\(^8\) \( \Psi \) is positive definite if

\(^8\)See Takayama (1985), Chapter 4, p. 385.
The definiteness of matrix $\Phi$ so points to a number of possibilities for which the reform is capable of generating an actual Pareto improvement when starting from the Nash equilibrium. Suppose, for instance that compensated demands are linear in both countries and so $e_{qq} = E_{qq} = 0_{N \times N}$. In this case the matrix $\Phi$ reduces to $\Phi = (r_{pp} + R_{pp})^{-1}$ and is still - being the inverse of a positive definite matrix - positive definite. Another possibility is when there are no cross effects in consumption or production and so $\phi_{i,j} = 0 \; \forall i \neq j$.  

Summarizing:

**Proposition 2** Suppose that international transfers do not exist, both countries follow the Samuelson rule, and

- either (i) the compensated demands in both countries are linear,
- and/or (ii) there are no cross effects in consumption and production.

Then indirect tax harmonization in the sense of the (8), starting at the Nash equilibrium level of taxes, generates an actual Pareto improvement.

It is clear then that the tax harmonizing reform is capable of generating an actual Pareto improvement even if international compensatory transfers are unavailable though the sufficient conditions are stronger than with transfers. The conditions identified though are quite restrictive.

## 5 Conclusion

This paper has taken up the task of verifying that some reasonable conjectures concerning the welfare effects of a particular tax harmonizing commodity reform - that of Keen (1987) - holds under the origin based tax system when public goods are present. In particular, it has been shown that if both countries have the same $MCPF$ then the reform generates a potential Pareto improvements when global revenues are conditional neutral. An actual Pareto improvement can be achieved under more stringent conditions: that of Nash equilibrium level of taxes and the Samuelson rule of public good provision.

## References


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9 This possibility is also recognized in Lopez-Garcia (1996). Here this is established in a more general case with public good provision.


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Appendices

Appendix A

Derivation of equation (19) in text.

We first show that conditional (on $dq = 0_{N \times 1}$) neutrality means

$$- \left[ (t' r_{pp} - r'_p) \ dt + (T' R_{PP} - R'_P) \ dT \right] = 0 . \quad (A.1)$$

To see this denote global tax revenues by $\rho = t' r_{p}(p, g) + T' R_{P}(P, G)$. Upon perturbation, making use of the assumption in text that $r_{pg} = R_{PG} = 0_{N \times 1}$, one obtains

$$d\rho = t' r_{pp} dp + r'_p dt + T' R_{PP} dP + R'_P dT = 0 , \quad (A.2)$$

which, upon using $dp = dq - dt$, becomes

$$d\rho = t' r_{pp} (dq - dt) + r'_p dt + T' R_{PP} (dq - dT) + R'_P dT = 0 . \quad (A.3)$$

Making now use of the consequence of the reform, that $dq = 0_{N \times 1}$, (A.3) reduces to

$$d\rho = - \left[ (t' r_{pp} - r'_p) \ dt + (T' R_{PP} - R'_P) \ dT \right] = 0 . \quad (A.4)$$

Setting $MC_PF_h = MC_PF_f = \mu > 0$ in (17) it remains now to show that

$$-(r'_p dt + R'_P dT) > 0 .$$

Solving (A.4) for $r'_p dt + R'_P dT$, (17) becomes

$$e_a du = -(T' R_{PP} dt + t' r_{pp} dt) . \quad (A.5)$$

Applying the reform to (A.5) then gives (19) in text that is,

$$e_a du = \beta(T - t)' S(T - t) > 0 ,$$

where the inequality sign follows from the fact that $\beta > 0$ and the matrix $S$ is positive definite. \hfill \Box

Appendix B
Derivation of equation (23) and (24) in text.

If each country behaves as a Nash competitor choosing its origin-based commodity taxes to maximize the welfare of the representative citizen, taking the other country’s taxes as given then these taxes are obtained, for the home country, by setting the coefficient of \( dt \) in (20) equal to zero. Setting \( e_g = r_g \) (and \( E_G = R_G \) in the foreign counterpart of (20)) these taxes are then defined by

\[
0'\left[r_{pp} + r_{pp}\Lambda^{-1}r_{pp}\right] - m'\Lambda^{-1}r_{pp} = 0_{1 \times N},
\]

(B.1)

for the home country, and

\[
T'[R_{PP} + R_{PP}\Lambda^{-1}R_{PP}] - M'\Lambda^{-1}R_{PP} = 0_{1 \times N},
\]

(B.2)

for the foreign country.

Post-multiplying (B.1) by \([r_{pp} + r_{pp}\Lambda^{-1}r_{pp}]^{-1}\) and (B.2) by \([R_{PP} + R_{PP}\Lambda^{-1}R_{PP}]^{-1}\), simplifying and taking the transpose of the resulting equations one obtains (23) and (24) in the text. \(\square\)