COMPETITIVE FEDERALISM: A POLITICAL-ECONOMY GENERAL EQUILIBRIUM APPROACH

by

Nicolaas Groenewold

Alfred J. Haggar

and

John R. Madden

ABSTRACT

This paper develops a modelling framework within which questions of fiscal federalism can be handled. Regional computable general equilibrium (CGE) models form one good approach for examining such questions. However, conventional regional CGE models contain little, if any, theory relating to optimal economic decision-making by governments. In this paper we overcome this limitation by analysing a simple two-region GE model to which maximising behaviour by regional governments is added. We call this a regional political-economy general equilibrium (PEGE) model.

We begin by considering a model with only regional governments. We then introduce a rudimentary federal government and consider two cases; in the first the federal government carries out a lump-sum transfer of resources from one regional government to another and in the second it imposes lump-sum income taxes on households and uses this revenue to make transfers to regional governments. We compare the implications of the PEGE model with and without the federal government transfers and conclude that optimising regional governments change their own tax rates to offset the effects on their citizens of the federal government action.

1. Introduction

This paper develops a modelling framework within which questions of fiscal federalism can be handled.

Regional computable general equilibrium (CGE) models form one good approach for examining such questions. There are many examples of studies using regional and multi-regional CGE models to look at fiscal federalism issues. See for example, Jones and Whalley (1989), Dixon, Madden and Peter (1993), Madden (1993), Morgan, Mutti and Rickman (1996) and Nechyba (1997).

However, conventional regional CGE models contain little, if any, theory relating to optimal economic decision-making by governments. This imposes a clear limitation on such models for analysing competitive federalism.

An alternative modelling approach is the one developed by game-theorists who have analysed competitive federalism in terms of a non-cooperative, strategic-form game. Examples of this approach can be found in Mintz and Tulkens (1986), Wildasin (1988), Hoyt (1993) and Laussel and Le Breton (1998).

A way forward in combining the above two approaches was shown by Pant (1997) who analysed tariff determination by means of a "mini" one-region GE model onto which a relationship serving to endogenise tariff decision-making by the government, had been grafted.

We intend to develop this idea in building our modelling framework. In this paper we analyse a simple two-region GE model to which maximising behaviour by regional governments is added. We call this a two-region political-economy GE (PEGE) model.

We begin by considering a model with only regional governments. We explore this model both with and without government optimisation. We then introduce a rudimentary federal government and consider two cases; in the first the federal government carries out a lump-sum transfer of resources from one regional government to another and in the second it imposes lump-sum income taxes on households and uses this revenue to make transfers to regional governments. We compare the implications of the PEGE model with and without the federal government transfers and conclude that optimising regional governments change their own tax rates to offset the effects on their citizens of the federal government action. But this offsetting action is no more than partial since the regional governments have

access only to distorting payroll taxes so that any attempt to offset lump-sum transfers or lump-sum income taxes generates changes in the other endogenous variables of the system such as employment, consumption and government expenditure.

The structure of the paper is as follows. We begin our account by presenting, in section 2, a two-region GE model and go on in section 3 to describe its conversion to a two-region PEGE model by adding optimising government behaviour. In section 4 the model is extended to incorporate a federal government. Conclusions are presented in the final section.

2. The Two-Region GE Model

2.1 The Equations

Our model consists of two regions in each of which there are households, firms and a regional government. We defer the introduction of a federal government until section 4.

The firms produce a single good which is supplied to households for consumption or, after costless transformation, to regional government. The government supplies the transformed good to households free of charge and finances the purchase of the good by a payroll tax levied on firms located in its region.

Output is produced using a single factor, labour, which is supplied by households. We assume that households supply labour only to firms in the region in which they live, thus excluding the possibility that they live in one region and commute to work in the other. We do allow inter-regional migration, however, which we assume to occur in response to inter-regional wage differentials. We assume that the national supply of labour is fixed and that in equilibrium wages clear the national labour market and are equal across regions.

We abstract from other inter-regional effects. In particular, it is assumed that firms supply output only to the households and the government in the region in which they are located so that we exclude inter-regional trade in goods. Further, we assume that each regional government supplies the government good only to households living in its own region, thus abstracting from inter-regional spillover effects in the provision of government goods. Finally, we assume that each firm is owned by households in the region in which it is located.

Both households and firms are optimisers - the representative household chooses its purchases of the good so as to maximize utility subject to an income

constraint, with the product price and income taken as parameters, while the representative firm chooses its purchases of labour services so as to maximise profits subject to a production function constraint, with the product price and the wage rate taken as parameters. Each household has an equal share in the firms in its region and the firms distribute all profits to households.

Consider the representative household in region i in more detail. We assume that there are L_i households in region I and that each maximises utility subject to a budget constraint. Utility depends on the consumption per household of the private good, Ci/Li, and of the government-provided good, G_i/L_i. It is important to note that G_i is not a public good in the sense of its being non-rival in consumption – each household consumes its own share of G_i to the exclusion of other households. The utility function is:

(1) $u_i = u(C_i/L_i, G_i/L_i) \qquad i = 1,2.$

We assume that u(.) has the standard properties: it is quasi-concave with positive marginal utilities and

(2) $\lim_{C/L \to 0} [\partial u/\partial(C/L)] = \infty$ and $\lim_{G/L \to 0} [\partial u/\partial(G/L)] = \infty.$

Utility is maximised subject to a budget constraint which requires consumption to be equal to income which, in turn, consists of wage income and profit income:

(3) $P_iC_i/L_i = M_i/L_i = \pi_i/L_i + W_i, \qquad i = 1,2$

where P_i denotes the price of the consumption good, M_i/L_i denotes income per household, π_i denotes profits and W_i the wage rate, all in region i. The budget constraint incorporates the assumption that each household supplies a single unit of labour so that its labour income is simply the wage rate. It also incorporates the assumption that profits earned by firms in region i are distributed only to households in region I, with each household receiving and equal share. When households migrate from one region to the other they lose the right to profits generated in the region they leave but gain rights to profits in the destination region.

The household takes both W_i/L_i and π_i/L_i (and therefore M_i/L_i) as given. There is, therefore, only one feasible solution to the household's problem:

(4) $C_i/L_i = M_i/(L_i .P_i), \quad$ or $\quad C_i = M_i/P_i \qquad i = 1,2.$

It may be argued that our modelling of households is inconsistent – households are assumed to choose their consumption to maximise a utility function dependent on both C/L and G/L but make their location decision based only on W – in effect on C/L alone. A theoretically preferable alternative would be to assume that households choose their location to maximise the same utility function as is used to motivate their consumption choice. In that case the equilibrium condition for inter-regional migration would be

$$u(C_1/L_1, G_1L_1) = u(C_2/L_2, G_2/L_2),$$

instead of the simpler condition that $W_1 = W_2$. While preferable theoretically, this would greatly complicate the analysis and at this stage we use the simpler assumption of inter-regional wage equality in the interests of tractability.

Consider now the firm's problem. To keep the notation simple, we assume that there is a single firm in each region which behaves competitively in that it takes product and factor prices as given. This representative firm in region i chooses its output to maximise profit, π_i, defined by:

$$(5) \qquad \pi_i = P_i(C_i + G_i) - W_iL_i(1 + T_i), \qquad i = 1,2,$$

where G_i is the amount of the firm's output supplied to region i's government and T_i is the payroll tax rate in that region. Note that we have assumed that the firm sells its output to the government and the private sector at the same price. Since the firm transforms output from C to G costlessly, any difference between the price charged to the government and the price charged to private consumers would be inconsistent with profit maximisation. The firm is assumed to produce output with a single factor, labour, according to the production function:

$$(6) \qquad O_i = L_i^{\alpha}, \qquad 0 < \alpha < 1, \qquad i = 1,2,$$

where O_i is real output given by:

$$(7) \qquad O_i = C_i + G_i, \qquad i = 1,2,$$

and the production process is assumed to be identical in both regions.

A necessary and sufficient condition for profit maximisation is the standard marginal-productivity condition:

$$(8) \qquad \alpha P_iL_i^{\alpha-1} = W_i(1 + T_i), \qquad i = 1,2.$$

This condition determines employment (labour demand) for given P_i, W_i and T_i. Output supplied is then determined via the production function (6).

Equilibrium in the labour market requires equality between the sum of regional labour demands and national labour supply which is assumed to be fixed at $\bar{L}$:

(9) $L_1 + L_2 = \bar{L}$.

The final component of the model relates to the regional governments. It is assumed that each government faces a budget constraint:

(10) $P_iG_i = W_iL_iT_i$, $\quad i = 1,2,$

where the left-hand side measures the value of government expenditure and the right-hand side revenue. The government budget constraint implies that the government cannot treat both T_i and G_i as instruments. We assume that it treats T_i as its policy instrument and adjusts G_i to satisfy (10). G_i is therefore treated as endogenous and T_i as exogenous in our GE model.

Note that the consumption function, (4), and the definitions of household income and profits, (3) and (5), together imply that $P_iG_i = W_iL_iT_i$ which is the government budget constraint for region i, equation (10). Hence, one of the equations for each region is redundant. We remove this redundancy by eliminating the government budget constraints although they reappear later when we combine equations (3), (4) and (5). Finally, we choose units so that $P_1 = P_2 = 1$.

We are therefore left with 13 equations, (3) – (9) which can be reduced to the following eight by substitution:

(11) $G_i = W_iL_iT_i$ $\quad i = 1,2$

(12) $\alpha L_i^{\alpha-1} = W_i(1 + T_i)$ $\quad i = 1,2$

(13) $C_i = L_i^{\alpha} - G_i$ $\quad i = 1,2$

(14) $L_1 + L_2 = \bar{L}$, and

(15) $W_1 = W_2$.

Relationships (11) – (15) constitute our two-region GE model. This is a set of eight relationships in eleven variables: G_i W_i, L_i, C_i, T_i (all for i=1,2) and $\bar{L}$,. We take the labour force ($\bar{L}$) and the two tax rates (T_i, i=1,2) as exogenous and the remaining variables endogenous.

2.2 The Solutions

The solutions given by the model for L_i (i=1,2) can be obtained from (12), (14) and (15). The solution for L_1 is shown in (16).

$$(16) \quad L_1 = \frac{\bar{L}}{1+\left(\frac{1+T_1}{1+T_2}\right)^{-\beta}},$$

where $\beta = 1/(\alpha-1) < 0$. The solution for L_2 can be obtained from (16) by using $L_2 = \bar{L} - L_1$:

$$(17) \quad L_2 = \frac{\bar{L}}{1+\left(\frac{1+T_1}{1+T_2}\right)^{\beta}}$$

Having obtained the solution for L_1, the solution for W_1 (in terms of L_1) can be obtained from (12):

$$(18) \quad W_1 = \frac{\alpha L_1^{\alpha-1}}{1+T_1}$$

From (15) it follows that (18) will also be the solution for W_2.

To obtain the solution for G_1 (again, in terms of L_1) we use (11) and (12) to get:

$$(19) \quad G_1 = \frac{\alpha T_1}{(1+T_1)} L_1^{\alpha}$$

Similarly the solution for G_2 (in terms of L_2) is:

$$(20) \quad G_2 = \frac{\alpha T_2}{(1+T_2)} L_2^{\alpha}$$

Finally, we obtain the solutions for C_1 and C_2 (in terms of L_1 and L_2 respectively). From (11), (13) and (18) we get:

$$(21) \quad C_1 = L_1^{\alpha} - T_1 W_1 L_1 = L_1^{\alpha} - T_1 \frac{\alpha L_1^{\alpha-1}}{1+T_1} L_1 = \left\{\frac{1+(1-\alpha)T_1}{1+T_1}\right\} L_1^{\alpha}$$

Arguing along the same lines we get the solution for C_2:

$$(22) \quad C_2 = \left\{\frac{1+(1-\alpha)T_2}{1+T_2}\right\} L_2^{\alpha}$$

2.3 The Multipliers

While we are not interested in the GE model *per se*, we derive several multipliers at this stage of the analysis since they will be useful in the analysis of the two-region PEGE model to be developed in the next section. Multipliers can be derived for each of the endogenous variables with respect to each of the exogenous variables but, given the nature of our interests, we restrict the derivation to multipliers for the region-1 variables with respect to T_1. Similar results can be derived for the second region.

Consider L_1 first. The multiplier for L_1 with respect to T_1 can be derived by taking the partial derivative of (16) with respect to T_1 to get:

$$(23)\quad \frac{\partial L_1}{\partial T_1} = \frac{\partial\left\{\bar{L}\left[1+\left(\frac{1+T_1}{1+T_2}\right)^{-\beta}\right]^{-1}\right\}}{\partial T_1} = \bar{L}\beta\left[1+\left(\frac{1+T_1}{1+T_2}\right)^{-\beta}\right]^{-2}\left(\frac{1+T_1}{1+T_2}\right)^{-\beta-1}\left(\frac{1}{1+T_2}\right) < 0,$$

where the negative sign follows immediately from the fact that $\beta = 1/(\alpha\text{-}1)$ and the restriction that $0 < \alpha < 1$ so that $\beta < 0$. Since output is monotonically related to employment, a rise in T_1 reduces not only employment in the region but also output.

The multiplier for W_1 with respect to T_1 is given by the following expression for W_1 which uses the equilibrium condition that $W_1 = W_2$:

$$W_1 = W_2 = \frac{\alpha}{1+T_2} L_2^{\alpha-1} = \frac{\alpha}{1+T_2}\left(\bar{L} - L_1\right)^{\alpha-1}$$

so that

$$(24)\quad \frac{\partial W_1}{\partial T_1} = -\frac{\alpha(\alpha-1)}{(1+T_2)}\left(\bar{L} - L_1\right)^{\alpha-2}\frac{\partial L_1}{\partial T_1} < 0$$

where the sign of the multiplier again follows from the restrictions on α (and the sign of the multiplier for L_1). Hence a tax rise in region 1 depresses wages in both regions.

The effect on G_1 of a change in the tax rate in region 1 follows from the multiplier for G_1 with respect to T_1 which is obtained by differentiation of (19) with respect to T_1. It is:

$$(25)\quad \frac{\partial G_1}{\partial T_1} = \frac{\alpha}{(1+T_1)^2} L_1^{\alpha} + \frac{\alpha^2 T_1}{(1+T_1)} L_1^{\alpha-1}\frac{\partial L_1}{\partial T_1}$$

We have already established that $\partial L_1/\partial T_1$ is < 0. From this it follow that the second term in (25) is negative (assuming that T_1 and T_2 are positive). The first term, however, is positive. Consequently, unlike the multipliers of L_1 and W_1 with respect to T_1, the sign of the multiplier of G_1 with respect to T_1 is indeterminate. Experimentation with various plausible parameter values suggests that in almost all cases we will have $\partial G_1/\partial T_1 > 0$ although with a very small value of $L_1/\bar{L}$ (less than 0.01) it is possible to construct a case where $\partial G_1/\partial T_1 < 0$. We assume henceforth that this multiplier is positive.

Finally consider the effects of a tax change on consumption expenditure. From (11), (12) and (13) we have:

$$C_1 = \frac{(1+(1-\alpha)T_1)}{1+T_1} L_1^{\alpha}$$

so that

$$(26) \qquad \frac{\partial C_1}{\partial T_1} = -\frac{\alpha L_1^{\alpha}}{(1+T_1)^2} + \left(\frac{1+(1-\alpha)T_1}{1+T_1}\right)\alpha L_1^{\alpha-1}\frac{\partial L_1}{\partial T_1} < 0$$

where the negative sign follows from the restriction that $0 < \alpha < 1$ and the sign of $\partial L_1/\partial T_1$.

From the above analysis it is clear that a change in payroll tax in region 1 affects variables in both regions in various ways. In the first place, for a given regional distribution of labour, the effect of the tax rise is to redistribute a given quantity of output from C to G. Secondly, a rise in region 1's tax rate initially depresses the wage in region 1, causing labour to migrate to region 2 in search of higher wages. This reduces employment and output in region 1 and increases employment and output in region 2. Hence, once inter-regional migration is accounted for, output falls in region 1, thus exacerbating the effect of the initial fall in C and partially offsetting the effect of the rise in G. The effect in region 1, therefore, is both to reduce output and to redistribute output from C to G. These effects ensure an unambiguous effect on C_1 but produce an ambiguous effect on G_1 although, as argued above, the final effect if most likely to be a rise in G_1.

The effects of the tax rise on the wage and employment are illustrated in Figure 1.

[Figure 1 near here]

The length of the horizontal axis, O_1O_2 represents the fixed national labour supply. Wages are measured up the vertical axes – W_1 along the left-hand axis and W_2 along the right-hand axis. The two curves labelled $MPL_1/(1+T_1)$ and $MPL_2/(1+T_2)$ are the initial marginal product curves adjusted for the presence of the payroll tax. In equilibrium the tax-adjusted MPL must be equal to the wage in each region and inter-regional migration equilibrium requires that wages are equalised across the two regions. Hence the initial equilibrium is represented by the wage $W_1^* = W_2^*$ where national employment is distributed to the two regions as O_1E and EO_2 respectively.

The effect of an increase in the tax rate in region 1 from T_1 to T_1' which shifts its MPL curve down to $MPL/(1+T_1')$. The result is a reduction in the wage rate from W_1^* to $W_1^{*\prime}$ which causes migration of labour to region 2 so that employment in region 1 falls to O_1E' and employment in region 2 increases by the same amount. The fall in the wage is smaller than it would be in the absence of migration in which case the wage in region 1 would have fallen to $W_1^{*\prime\prime}$. Thus, in the two-region model, there are spillover effects on region 2 of a tax rise in region 1 and, while region 2 "gains" in terms of increased employment (and population), it "loses" in terms of a lower wage.

3. The Two-Region PEGE Model

We now extend the model of the previous section to include optimisation on the part of the two regional governments and so move to the two-region PEGE model. We assume that each regional government chooses its own payroll tax rate to maximise the welfare of its own citizens. There are various ways in which the government's objective may be modelled. We assume that it depends on the aggregate counterparts of the variables which determine utility of the representative household – private and government consumption. To keep the algebra manageable, we assume that the welfare function is additively separable with positive but declining marginal welfare effects of increases in its two arguments.

We also assume that each government knows the structure of its regional economy so that, in solving its maximisation problem, it is constrained by the set of relationships which constitute the GE model determining consumption and government expenditure in its own region. Each government is assumed to take the tax rate in the other region as given so that the resulting equilibrium will be a Nash equilibrium.

Our discussion of the relationships defining the regional governments' optimal tax-rates will be conducted throughout in terms of region 1. A parallel discussion holds for region 2.

The government of region 1 chooses T_1 to maximise:

$$(27) \quad I_1 = U(C_1) + V(G_1)$$

where U′ and V′ are both positive and U″ and V″ are both negative. Welfare, I_1, is maximised subject to the solutions for C_1 and G_1 derived from the GE model in section 2 (equations (19) and (21)) with L_1 replaced by the expression in (16) and T_2 and $\bar{L}$ treated as parameters. The first-order condition for this problem is:

$$(28) \quad \frac{\partial I_1}{\partial T_1} = U' \frac{\partial C_1}{\partial T_1} + V' \frac{\partial G_1}{\partial T_1} = 0$$

The terms $\partial C_1/\partial T_1$ and $\partial G_1/\partial T_1$ are simply the relevant multipliers derived from the GE model in the previous section. On substituting these expressions, equations (25) and (26), into equation (28) and simplifying notation by using $W_1=\alpha L_1^{\alpha-1}/(1+T_1)$ and $C_1=L_1^{\alpha}(1+\alpha(1+T_1))/(1+T_1)$, the first-order condition for the government's problem can be written as:

$$(29) \quad U' - V' = \frac{\alpha\left\{U'\dfrac{C_1}{L_1} + V'T_1W_1\right\}}{W_1L_1/(1+T_1)} \bullet \frac{\partial L_1}{\partial T_1}$$

The coefficient of $\partial L_1/\partial T_1$ on the right-hand side of (29) is positive and we have seen in section 2 that $\partial L_1/\partial T_1$ itself is negative so that the right-hand side of the condition for the optimal value of T_1 is negative. Hence at the optimum $U' < V'$.

The requirement that $U' < V'$ at the optimum can be explained by comparing it to the case where inter-regional migration is not permitted in which case U′ and V′ are equal at the optimum.[1] In the case without inter-regional migration each region's labour supply (and, therefore, its output) is fixed so the tax rate determines only the division of a given output between C and G. Hence, an increase in tax increases G and decreases C by the same amount so that at the optimum the welfare benefit of the increase in G (V′) must be exactly offset by the welfare foregone from lost consumption (U′).

[1] Note that if labour is not inter-regionally mobile (i.e., $\partial L_1/\partial T_1 = 0$) condition (29) reduces to $U' = V'$.

Once inter-regional migration is permitted there is an additional effect of a tax change. Now a change in tax affects not only the distribution of given output between C and G but affects the level of output itself. In particular, an increase in T_1 results not only in a shift of output from C_1 to G_1 but also in a reduction in output in region 1. Hence the cost in terms of consumption foregone of a given increase in G is greater than it is in the no-migration case so that at the welfare optimum the welfare effects are balanced only if $U' < V'$.

The complete two-region PEGE model consists of 10 equations: two optimality conditions of the form of (29) and the solution equations for L_i, G_i, C_i and W_i given by equations (16)-(22). The system has 10 endogenous variables (T_i, G_i, C_i, L_i and W_i, i=1,2) with a single exogenous variable, $\bar{L}$.

4. The Two-Region PEGE Model with a Federal Government

The PEGE model developed in the two preceding sections has two optimising regional governments but no federal government. We now introduce a federal government which uses its authority to modify the equilibrium generated by the regional governments' optimising strategy. We consider two possibilities.

The first is that the federal government takes from one regional government some of the output which it has purchased for distribution to households in its region and gives it to the other regional government. The second possibility is that the federal government imposes a lump-sum tax on households in both regions and uses the combined proceeds to purchase outputs of the transformed good from the two regional governments. The output so purchased it then distributes, on a lump-sum basis, directly to households in each of the two regions.

4.1 Lump-sum Inter-governmental Transfers

Denote the output transferred to the government of region 1 by the federal government by TR_1 and the output transferred to the government of region 2 by TR_2. They satisfy:

(31) $\quad TR_1 + TR_2 = 0$

We add this relationship to the relationships of the PEGE model and treat one of TR_i (i=1,2) as exogenous, the other being determined by (31).

The question we now consider is: How will a federal-government intervention of the type now under discussion change the equilibrium generated by the two-region PEGE model of section 3 and, in particular, how are the regional governments likely to react?

We focus on the two regional government optimising conditions of the form of (29). We begin by noting that we need to distinguish between the amount of output purchased by regional government i and that distributed to the households in region i. We continue to use the notation G_i to refer to government purchases so that the amount consumed by citizens of region i is now $G_i + TR_i$. With this interpretation of G_i none of the solution expressions for L_i, W_i, C_i and G_i given by equations (16)-(22) is affected by the introduction of the federal governments transfers. Hence the private sector will respond to the federal government re-distribution only if the regional governments change their tax rates. Whether they do will be governed by their optimising conditions.

Consider the case of region 1. Equation (29) may be written as:

$$(32)\qquad \frac{V'}{U'} = \frac{\dfrac{\alpha L_1^{\alpha}}{(1+T_1)^2} - \alpha\dfrac{C_1}{L_1}\dfrac{\partial L_1}{\partial T_1}}{\dfrac{\alpha L_1^{\alpha}}{(1+T_1)^2} + \alpha T_1 W\dfrac{\partial L_1}{\partial T_1}}$$

The optimising T_1 must satisfy this condition both before and after a federal-government intervention of the type described. Suppose that T_1^* is the tax rate which satisfies the condition before the lump-sum transfer. It will no longer satisfy (32) after the transfer since the argument of V' is now $(G_1 + TR_1)$ and if we assume that the transfer is from region 2 to region 1 so that $TR_1 > 0$, we find that after the transfer V'/U' will be less than the right-hand side of (32) at the original taxes rates. Hence, the optimality condition for region 1's government is violated at unchanged tax rates.

To restore optimality it will need to change its tax rate so as to increase C_1 or reduce G_1 or both. Recall from equation (26) that $\partial C_1/\partial T_1<0$ and from our discussion of equation (25) that it is likely that $\partial G_1/\partial T_1>0$. Hence the required rise in C_1 and fall in G_1 will both be achieved by a reduction in T_1. The opposite is true for region 2 since TR_2 will be negative. Hence the government in region 2 will need to increase the payroll tax rate to restore optimality.

We can conclude, therefore, that the reactions of the regional government to the federal government re-distribution will move in the direction of offsetting the effects of the transfer. Optimising regional governments will therefore undo (at least part of) the actions of the federal government. But the tax cut necessary to achieve the fall in G_1 will also increase C_1, reducing U', so that not all of the adjustment can be in G_1, some of the adjustment necessarily being in C_1.

The above argument contains two omissions which should be noted by way of qualification. In the first place, it ignores the fact that if $TR_1 > 0$, then $TR_2 < 0$ and T_2 will need to rise; the rise in T_2 will work against the fall in T_1 as regards region 1's $\frac{V'}{U'}$ ratio. Likewise, no account is taken of the fact that the fall in T_1 will work against the rise in T_2 as regards region 2's $\frac{V'}{U'}$.

Secondly, no account is taken of the fact that both the fall in T_1 and the rise in T_2 will have effects on the right-hand side of the equality set out in (32) as well as on the left-hand side. This reflects the fact that some of the variables on the right-hand side of (32) are endogenous and will, therefore, themselves be affected by the change in T_1.

4.2 Lump-sum Income Taxes and Transfers

We turn now to the second type of federal government intervention distinguished at the outset. This is where the federal government uses its authority to impose a lump-sum income tax on households in each of the two regions. It then uses the proceeds of the tax to purchase output of the transformed good from the regional governments. Finally it distributes this output directly to regional households on a lump-sum basis.

Denote the lump-sum income tax imposed on households in region i by F_i (i=1,2) and the lump-sum transfers of the transformed good to households in region i, by GF_i (i=1,2). These four variables are linked by the federal government's budget constraint:

(33) $F_1 + F_2 = GF_1 + GF_2$

We continue to denote the output purchased by the regional government by G_i so that the regional government budget constraint remains as before:

$G_i = T_i W_i L_i$

As in the lump-sum-transfer case, the introduction of GF_i does not affect the solutions for C_i, G_i, W_i and L_i at given payroll tax rates. The only change is that the amount of government good consumed by residents of region i is now (G_i+GF_i).

The introduction of the lump-sum income tax does, however, change the consumption of the private good since it reduces the amount of income households have to spend. Private consumption expenditure is now

$$C_i = O_i - G_i - F_i = L_i^{\alpha} - T_i W_i L_i - F_i$$

As in the previous case, condition (32) must hold both before and after the federal government intervention.[2] Suppose, again, that T_i^* is the tax rate which satisfies the condition before the federal government's action. Will it continue to be optimal after the federal government policy? The answer is "No" for two reasons. The first is similar to that given in the simpler case of a transfer – the new argument of V′ is now G_1+GF_1 so that V′ is now "too low" (assuming that both GF_1 and GF_2 are positive). The second reason is that the argument of U′ is now the original C_1 less F_1 so that U′ is "too high" (assuming that F_i is positive). Both of these changes require a fall in T_1 to restore optimality for region 1.

Thus in the tax and transfer case, the federal government not only provides goods to the citizens of region 1 which skews the distribution of output towards the government good (requiring an offsetting action by the regional government) but also raises taxes on the citizens of region 1 which further skews the allocation of output towards the government good, requiring a further shrinking of the regional government to maintain optimality for the citizens of region 1. The federal government essentially does what the regional government also does – transform taxes into the government good – and to maintain a welfare maximum the regional government reduces its operations in response to the federal government's attempt to redistribute output from private consumption to government consumption and from one region to another. As in the simple transfer case, the offsetting action of the regional governments will not be perfect because of the differences in the nature of the instruments available at the two levels of government.

Exactly the same argument holds for region 2. Thus, in the case of the intervention now under discussion both regional governments will need to reduce

their labour tax if they are to remain in an optimal situation. This is in contrast to the case of federal intervention analysed in section 4.1 where one regional tax needs to fall and the other to rise.

It will be recalled that the argument developed in section 4.1 for the lump-sum-transfer case of federal intervention was subject to two qualifications which were noted. Similar qualifications apply here. Once again our argument ignores the effect of the fall in T_2 (T_1) on region 1's (region 2's) situation, though here the effect will be supportive rather than offsetting. Likewise no account is taken in the argument that both the fall in T_1 and the fall in T_2 will have effects on the right-hand side of the two relationships set out in (32), as well as on the left-hand side.

5. Conclusion

In this paper we set out to build a small inter-regional general equilibrium (GE) model and extend it to include optimising behaviour on the part of regional governments. The motivation for the research was the observation that standard regional CGE models assume optimising behaviour on the part of private agents (firms and households) but assume government behaviour to be exogenous. Here we assumed, instead, that regional governments choose their policy instruments so as to maximise a welfare function which depends on the aggregate counterparts to the variables which determine individual household utility.

The economy modelled was assumed to comprise two regions, in which we allowed for inter-regional migration. In this model a change in the rate of payroll tax by one of the regional governments not only shifts output from the private to the government sector but also affects the total amount of output produced as workers migrate in response to inter-regional wage differentials – output falls in the region in which the tax is increased and rises in the other region. The regional government takes both of these effects into account in setting the optimal tax rate.

The final section of the paper introduced a federal government which attempts to change the distribution of resources between the regions by lump-sum tax and transfer mechanisms. We found that the optimising regional governments operate to frustrate the redistributional aims of the federal government but they are only partially

[2] Note that C_1 also appears on the right-hand side of (32). However, in the derivation of (32) this was introduced when $\alpha C_1/L_1$ was substituted for $[(1+T_1(1-\alpha)/(1+T_1)]\alpha L_1^{\alpha-1}$ which is not affected by the federal intervention.

successful in doing so since their taxes have allocational consequences. Hence, federal governments which engage in inter-regional transfers in order to achieve, say, equity objectives, may be seriously mislead as to the efficacy of their transfers if they ignore the likelihood that regional governments systematically pursue goals of their own, goals which are likely to be different to those of the federal government. Our results show that such strategic regional governments are likely to partially thwart the federal government's attempts to transfer resources from one region to another.

Moreover, where there is inter-regional migration of labour, workers may also offset the effects of federal government initiatives by migrating to the region which receives the federal government grant.

How large either of these offsetting effects is likely to be is beyond the ability of the theoretical model to predict and awaits numerical or possible empirical work.

References

Boadway, R. and Keen, M. 1997. Efficiency and the Optimal Direction of Federal-State Transfers in D.E. Wildasin (ed.). *Fiscal Aspects of Evolving Federations*, Cambridge University Press, Cambridge, 41-62.

Dixon, P.B., Madden, J.R. and Peter, M.W., 1993. "The Effects of Reallocating General Revenue Assistance Among the Australian States", *Economic Record* 69(207), 367-381.

Hoyt, W.H, 1993. "Tax Competition, Nash Equilibria, and Residential Mobility", *Journal of Urban Economics* 34(3), 358-79.

Laussel, D. and Le Breton, M., 1998. "Existence of Nash Equilibria in Fiscal Competition Models", *Regional Science and Urban Economics* 28(3), 283-96.

Madden, J.R., 1993. "The Economics of Vertical Fiscal Imbalance: An Applied General Equilibrium Approach", *Australian Tax Forum* 10(1), 75-90.

Morgan, W., Mutti, J. and Rickman, D., 1996. "Tax Exporting, Regional Economic Growth, and Welfare", *Journal of Urban Economics* 39, 131-159.

Nechyba, T., 1997. "Computable General Equilibrium in Local Public Finance and Fiscal Federalism", in D.E. Wildasin (ed.). *Fiscal Aspects of Evolving Federations*, Cambridge University Press, Cambridge, 168-193.

Pant, H.M., 1997. *Tariff Determination in the General Equilibrium of a Political Economy*. Ashgate Aldershot.

Wildasin, D.E., 1988. "Nash Equilibria in Models of Fiscal Competition", *Journal of Public Economics* 35(2), 229-40.

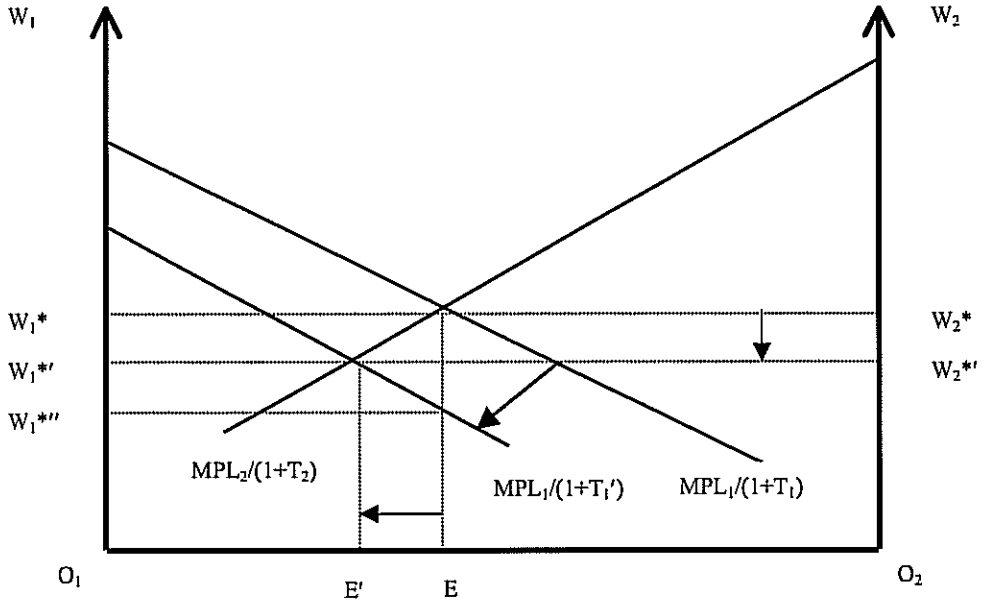

Figure 1: Employment and Wages in the Two-Region GE Model and the Effects of a Payroll-Tax Change