An Analysis of the Effects of Fiscal Equalisation in a Two-Region Simulation Model

by

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Abstract

This paper is concerned primarily with the economic and welfare consequences of federal redistributive grants. We use a model which has two regions, each with households, firms and regional governments as well as a federal government. The households, firms and regional governments are all optimizers – households maximize utility, firms maximize profits and we assume that regional governments are empire-builders in that they choose their expenditure and tax levels so as to maximise total expenditure – the size of their empire. Labour is free to move between regions in response to utility differences and does so until such differences have been eliminated. Inter-regional migration, inter-regional trade flows and federal government redistribution are the main sources of interconnectedness between the two regions. The model is linearised in log-differences and simulated using a calibration based on Australian state-level data. We find that the welfare effect of intergovernmental transfers is trivial but that all other variables of interest change substantially – consumption, employment, prices, taxes, wages, output and government expenditure. Finally, the signs of the effects of a federal transfer are not affected by the empire-building behaviour of regional governments although the magnitude of the effects is generally dampened.

1. Introduction

A common feature of the older federal systems such as the United States, Canada and Australia is that the federal government adopts an inter-regional redistributive role. In the case of the Australian federation, for example, the federal government taxes the six states (the members of the federation) uniformly. From its tax collections it then makes an annual grant to each of the six state governments. These annual grants, however, are *not* uniform; the states which suffer most from revenue-raising and cost disabilities get the largest grants in per capita terms. The federal government's system of annual grants is, therefore, redistributive in its effect as between the six states.

Of the economic questions which arise in connection with such federal redistributive grants possibly the most prominent are questions relating to the way in which the size of the grants should be fixed and questions concerned with their economic and welfare consequences. Both types of question have been widely discussed in the fiscal-federalism literature.

Studies which examine questions of the first type include Boadway and Keen (1997) and Petchey (1995) in both of which the issue is how the federal government should proceed if it wishes to determine the grants optimally. Studies in which the focus is on effects include the North American studies of Boadway and Flatters (1982), Boadway (1985), Cornes and Sandler (1986), Myers (1990) and Winer and Gauthier (1982) and the Australian studies of Petchey (1992), Swan and Garvey (1992), Petchey (1993), Petchey and Walsh (1993), Petchey (1995), Petchey and Shapiro (2000, 2002), Groenewold, Hagger and Madden (2000, 2003) and Dixon *et al.* (2002).

The present study belongs with the second group to the extent that it, too, is concerned primarily with the economic and welfare consequences of federal redistributive grants. It differs from them, however, in two important ways. The first relates to the procedure used to develop the modelling framework for the study. The second concerns the way in which the conclusions about economic and welfare effects which the model implies are drawn. In the present study these conclusions are generated by numerical simulations resembling those which are to be found in studies based on CGE modelling.

In developing our modelling framework we adopted a two-stage approach. We began with a model from a class which has played an important part in the fiscal-federalism literature generally and in studies concerned with the effects of redistributive federal grants, in particular. We refer to models of multi-regional federations with a given freely-mobile supply of labour. In these models labour is allowed to migrate costlessly between regions in search of maximum welfare and they typically impose, as an equilibrium condition, that the utility of the representative household be the same in all regions. A mobility model of this type is to be found in several of the studies focussing on the effects of redistributive grants just referred to - those of Boadway and Flatters (1982), Myers (1990), Petchey (1995), Petchey and Shapiro (2000) and Groenewold, Hagger and Madden (2000).

The model which formed our starting point has two regions, each with households, firms and governments. The households and firms are optimizers but the governments are not; the fiscal decisions of the regional governments and the federal government are treated as exogenous, although subject to a budget constraint. Since the model is essentially Walrasian in character we refer to it as the GE (general equilibrium) component of the modelling framework.

The GE model has two sources of interconnectedness between the regions apart from inter-regional migration. The first is the redistribution carried out by the federal government. The second is inter-regional trade in goods. It is assumed that he firms in each region supply output not only to households and government in their own region but also to households in the other region.

We abstract from all other inter-regional effects. For example, we exclude spillover effects in the provision of government goods; we assume that each regional government supplies the government good only to households living in its own region. Again, we assume that each firm in region 1 is owned only by households of region 1 and similarly for region 2.

The second step in developing our modelling framework was to extend the GE model by making the two regional governments behave in an optimizing way. There are various ways in which this may be achieved. The most common is to assume that regional

governments are beneficent in that they choose their tax and expenditure levels so as to maximise the utility of their citizens subject to the constraints imposed by the structure of the economy. Such an approach has been used in, e.g. Petchey (1993), Petchey and Shapiro (2000, 2002) and Groenewold, Hagger and Madden (2000, 2003). An alternative which we follow in this paper is to assume that regional governments are empire-builders in that they choose their expenditure and tax levels so as to maximise total expenditure – the size of their empire. We find this an interesting and plausible alternative – many would argue that it is more plausible than the beneficent alternative. Each regional government is therefore assumed to make its fiscal decisions so as to maximize its total expenditure, subject to the constraints imposed by its budget constraint and the structure of its economy, as depicted in the GE model. In carrying out its maximization process each regional government takes the fiscal decisions of the other as given. In effect, therefore, the two governments are engaged in a non-cooperative strategic game with a Nash equilibrium as the outcome.

We refer to the model which finally emerged from this two-stage procedure as the PEGE (political-economy GE) model. The PEGE model is highly non-linear. For this reason it cannot be solved analytically and so cannot be used, as it stands, to address the question with which the paper is concerned - the economic and welfare effects of federal redistributive grants. We get round this difficulty by using a process of log-differentiation to linearise the model which is then calibrated from Australia data and used to simulate the effects on a range of variables in each of the two regions of a federal government transfer shock.

Numerical simulations are open to the justified criticism that the results depend on the calibration used and we counter this by conducting a number of simulations; in particular, six simulations were conducted. In the first simulation New South Wales was region 1, the region to which the transfer is made and the rest of the country region 2, the region from which the transfer is made. In the second simulation Victoria was the recipient region and the rest of the country the donor region; and so on for each of the other four states (Queensland, South Australia, Western Australia and Tasmania).

Several important conclusions on the efficiency question emerge from these simulations.

The possibility that federal redistributive grants might be efficient, Pareto-wise or in some other sense, was recognized in North American studies in the early 1990s. (A survey of this literature is given in Petchey and Walsh, 1993). But not until Petchey (1995) was the efficiency question systematically examined in an Australian setting. Using a two-region model of the labour-mobility type (a model without regional governments) he confirmed the efficiency possibility and pointed to the conditions under which it might be realized.

With the help of our six simulations we have been able to take the matter a good deal further. In the first place the cases in which a transfer is Pareto-improving and those in which it is not, have been identified. The Pareto-improving cases are those in which the recipient regions are New South Wales, Victoria and Western Australia. Here households are better-off in *both* regions because of the transfer. In the remaining cases households are worse-off in both regions.

Secondly, we have been able to show that in all of the three cases of Pareto-improvement the welfare gains are trivial and that the same is true of the welfare losses in the remaining cases.

Finally, the simulations make it clear that, while welfare is unaffected for all practical purposes, all other variable of interest change substantially – consumption, employment, taxes, prices, wages, output and government expenditure. Households manage to offset the effects of these changes on welfare, however, by migrating from one region to the other. Thus, the federal government transfers effect substantial changes in regional economies but without changing welfare. A comparison of PEGE and GE versions of the model shows that the effect of empire-building regional governments in the process of adjustment to a federal transfer is to dampen the magnitude of the changes resulting from the transfer but to leave the direction of these changes largely unaffected.

The rest of the paper consists of five main sections. In section 2 we begin by building the small two-region GE model. As mentioned already this model has optimizing private agents but not optimizing governments; government fiscal decisions are simply treated as exogenous. We then extend this two-region GE model by making the two regional governments behave in an empire-building way. The result is the PEGE model. This model is linearized in section 3, calibrated in section 4 and put to work in section 5. We

simulate the model by introducing a federal-government transfer shock. We do this for each of the six states in turn, in each case treating the rest of the country as the second region. The results of these simulations are then used to generate conclusions about the effects (both direct and indirect) of inter-regional federal transfers in a regime of optimizing regional governments. In the final section of the paper the major conclusions are dealt with in detail.

2. The Two-Region PEGE Model

We begin by setting out the two-region GE model which forms the core of the PEGE model.

2.1 The Two-Region GE Model

Each region consists of households, firms and a regional government. In addition there is a single federal government. We describe the behaviour of each of these agents in turn before specifying the equilibrium conditions.

2.1.1 The Representative Household

There are two goods in the model, one produced in region 1 and the other in region 2. We assume that the households in each region consumer both of the goods.

We use the following explicit utility function for the representative household in region i:

(1) $\qquad U_i = \beta_i C_{1i}^{\gamma_{1i}} C_{2i}^{\gamma_{2i}} G_i^{\delta_i}, \qquad\qquad i = 1, 2$

where $\quad U_i \quad = \quad$ utility, region i,

$\qquad\quad C_{1i} \quad = \quad$ real private consumption of good 1 per household, region i,

$\qquad\quad C_{2i} \quad = \quad$ real private consumption of good 2 per household, region i,

$\qquad\quad G_i \quad = \quad$ real government-provided consumption per household, region i.

$\qquad\quad \beta_i > 0$

$\qquad\quad 0 < \gamma_{1i} < 1$

$\qquad\quad 0 < \gamma_{2i} < 1$

$\qquad\quad 0 < \delta_i < 1$

$\qquad\quad \gamma_{1i} + \gamma_{2i} + \delta_i = 1$

We assume that inter-regional trade is free and costless and, therefore, that the single good produced in region 1 sells at the same price in both regions and that the price of the good produced in region 2 sells at the same price in both regions. On this assumption and the further assumption that there is no saving in the model, the representative household in region i has a budget constraint of the form:

$$P_1 C_{1i} + P_2 C_{2i} = M_i, \quad i = 1,2$$

where P_i = price of the consumption good i produced in region i,

M_i = nominal income per household, region i.

On the assumption that each household supplies one unit of labour so that labour income per household is equal to the wage rate, M_i is given by:

(2) $\quad M_i = \Pi H_i + W_i, \quad i = 1,2$

where ΠH_i = nominal profit distribution per household, region i,

W_i = nominal wage, region i.

The representative household in region i is assumed to choose C_{1i} and C_{2i} (while taking G_i, ΠH_i, and W_i as given) so as to maximise (1) subject to its budget constraint. This implies demand functions of the form:

(3) $\quad C_{ji} = (\gamma_{ji}/(1-\delta_i))(M_i/P_j), \quad i,j = 1,2$

2.1.2 The Representative Firm

We assume that there are L_i households in region i. Since we have already assumed that each household supplies one unit of labour, L_i is also the labour supply of region i. Further, if full employment is assumed, L_i will also be employment in region i.

We assume that there are N_i firms in region i. N_i is treated as exogenous. We assume that each firm in region i operates with a production function which has a positive but declining marginal product of the single factor, labour. This means that all firms in region i will be of the same size and hence that output, Y_i, for the representative firm in region i is given by:

(4) $\quad Y_i = \left(\dfrac{L_i}{N_i}\right)^{\alpha_i} \qquad i = 1,2 \qquad 0 < \alpha_i < 1$

The representative firm is assumed to operate in perfectly competitive output and labour markets and accordingly chooses employment to maximise profit:

(5) $$\Pi F_i = P_i Y_i - W_i \left(\frac{L_i}{N_i}\right)(1 + T_i) \qquad\qquad i = 1,2$$

subject to the production function (4) with P_i and W_i taken as given. In (5) ΠF_i denotes profit per firm in region i and T_i the payroll tax rate imposed by region i's government. Substituting (4) into (5) and maximising with respect to L_i we get the single first-order condition:

(6) $$\alpha_i \left(\frac{L_i}{N_i}\right)^{\alpha_i - 1} = \frac{W_i}{P_i}(1 + T_i) \qquad\qquad i = 1,2$$

This is the standard marginal productivity condition adjusted for the presence of the payroll tax.

2.1.3 The Regional Government

The government of region i purchases output from firms in region i and receives revenue from the payroll tax levied in region i. The amount of output purchased is GR_i per household or a total of $L_i GR_i$. Total tax revenue is $T_i W_i L_i$. We assume that the government of region i balances its budget so that:

$$L_i GR_i = T_i W_i L_i$$

or

(7) $$GR_i = T_i W_i \qquad\qquad i = 1,2$$

2.1.4 The Federal Government

The federal government engages only in inter-regional transfers. In particular, it acquires part of the output purchased by the government of one region and supplies it to the households of the other region. It, too, balances its budget so that:

(8) $$L_1 GF_1 + L_2 GF_2 = 0$$

where GF_i is the amount of output supplied per household to the residents of region i.

The amount of the government good consumed per household in region i, G_i (the variable which appears in the utility function), is given by:

(9) $$G_i = GR_i + GF_i \qquad\qquad i = 1,2$$

where $GR_i \geq 0$, GF_i may have either sign but G_i is assumed to be > 0.

2.1.5 Equilibrium

There are three equilibrium conditions. The first is that the national labour market clears:

(10) $L_1 + L_2 = \overline{L}$

where $\overline{L}$ is the national labour supply, treated as exogenous.

The second governs inter-regional migration. It is assumed that households move in response to inter-regional differences in utility and that such migration is costless. This is a common assumption in models of this type but clearly abstracts from a range of issues, some of them directly related to the differences in regional government expenditure levels.[1] Equilibrium occurs when utility differences have disappeared so that:

$U_1 = U_2$.

using equations (1), this may be written as:

(11) $\beta_1 C_{11}^{\gamma_{11}} C_{21}^{\gamma_{21}} G_1^{\delta_1} = \beta_2 C_{12}^{\gamma_{12}} C_{22}^{\gamma_{22}} G_2^{\delta_2}$

Thirdly, we assume that the goods market clears in each region:

(12) $N_i Y_i = L_1 C_{i1} + L_2 C_{i2} + L_i GR_i$ $i = 1, 2$

Note that only regional governments purchase output and that the federal government simply transfers part of this from households in one region to households in the other.

The last equation of the GE model is:

(13) $L_i \Pi H_i = N_i \Pi F_i$ $i = 1, 2$

which states that firms in region i distribute all of their profits to households in region i.

2.2 The Two-Region PEGE Model

Relationships (1) - (13) comprise the two-region GE model. To move to the two-region PEGE model we add optimisation by the regional governments. There are various ways in which this might be done. Some earlier papers have assumed that governments are beneficent and maximise the utility of their citizens – see, e.g., Petchey (1993), Petchey and Shapiro (2000, 2002) and Groenewold, Hagger and Madden (2000, 2003). Our

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approach here differs and is undertaken by way of contrast – we assume that regional governments are empire-builders (a common popular view of bureaucracies) and specifically that they choose their expenditure/tax combination so as to maximise the size of their total expenditure subject to their budget constraint and the constraints imposed by the structure of the economy. We choose this objective on the argument that there is at least as much anecdotal evidence that regional governments behave in this way as there is for their beneficent behaviour.

The maximization problem faced by the government of region i is therefore simply:

$$\max_{\{T_i\}} \left(L_i GR_i \right)$$

subject to the constraints imposed by the GE model of region i, including the regional government budget constraint.

The first order condition for this maximization problem is:

$$(14) \qquad L_i \frac{\partial GR_i}{\partial T_i} + GR_i \frac{\partial L_i}{\partial T_i} = 0, \qquad\qquad i=1,2$$

For this condition to be satisfied for positive L_i and GR_i we must have $\dfrac{\partial GR_i}{\partial T_i} > 0$ and

$\dfrac{\partial L_i}{\partial T_i} < 0$. We assume this to be the case.

The PEGE model is obtained by adding (14) to the GE model and making T_i endogenous. The federal government is assumed to choose one of the GF_i values (say GF_2) with the second being determined *via* its budget constraint, equation (8). The PEGE model thus consists of 27 equations, (1) to (14), in the following 27 endogenous variables:

$$U_i, C_{1i}, C_{2i}, G_i, P_i, M_i, \Pi H_i, \Pi F_i, W_i, L_i, Y_i, T_i, GR_i, GF_1, \quad i=1,2$$

and the following four exogenous variables:

$$N_i, GF_2, \overline{L} \qquad\qquad\qquad i = 1,2$$

We now proceed to linearise this model.

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[1] Thus, e.g., in practice land prices may differ considerably between regions and some of this difference may reflect the capitalised value of higher regional government expenditure. See, e.g., Epple, Filimon and Romer (1984), Epple and Sieg (1999), Haughwout and Inman (2001) and Haughwout (2002).

3. The Linearized Numerical Version of the Two-Region PEGE Model

The two-region PEGE model set out in the previous section is non-linear in the levels of the variables. For this reason it cannot be easily used to conduct comparative-static exercises which will throw light on the topic of the present paper - the regional effects of inter-regional federal transfers when regional governments behave as optimising agents. We circumvent this problem by deriving a linearized version of the model and then calibrating this linearized version.

3.1 Linearization of the PEGE Model

To linearize the PEGE model of section 2 we use a process of log differentiation. By this means the model is converted from one which is non-linear in the variables of the model to one which is linear in the proportional rates of change of the variables.

The linearized form of the PEGE model is:

(1') $u_i = \gamma_{1i}c_{1i} + \gamma_{2i}c_{2i} + \delta_i g_i$ $\qquad$ $i = 1,2$

where lower-case letters represent the proportional changes (log differentials) of their upper-case counterparts.

(2') $m_i = \sigma_{m\pi hi}\pi h_i + \sigma_{mwi}w_i$, $\qquad$ $i = 1,2$

where $\sigma_{m\pi hi} = \Pi H_i / M_i$ and $\sigma_{mwi} = W_i / M_i$.

(3') $c_{ji} = m_i - p_j$ $\qquad$ $i,j = 1,2$

(4') $y_i = \alpha_i(l_i - n_i)$, $\qquad$ $i = 1,2$

(5') $\pi f_i = \sigma_{\pi fyi}(p_i + y_i) - \sigma_{\pi fwi}(w_i + l_i - n_i + \sigma_{ti}t_i)$ $\qquad$ $i = 1,2$

where $\sigma_{\pi fyi} = P_i Y_i / \Pi F_i$, $\sigma_{\pi fwi} = [W_i(L_i/N_i)(1+T_i)] / \Pi Fi$, $\sigma_{ti} = T_i / (1+T_i)$

(6') $(\alpha_i - 1)l_i - w_i + p_i - \sigma_{t_i}t_i = (\alpha_i - 1)n_i$ $\qquad$ $i = 1,2$

(7') $gr_i = w_i + t_i - p_i$ $\qquad$ $i = 1,2$

(8') $l_1 + gf_1 = l_2 + gf_2$

(9') $g_i = \sigma_{ggri}gr_i + \sigma_{ggfi}gf_i$ $\qquad$ $i = 1,2$

where $\sigma_{ggri} = GR_i/G_i$, $\sigma_{ggfi} = GF_i/G_i$.

(10') $\sigma_{\ell 1}l_1 + \sigma_{\ell 2}l_2 = \bar{l}$

where $\sigma_{\ell i} \equiv L_i/\bar{L} = L_i/(L_1 + L_2)$

(11') $u_1 = u_2$

(12') $n_i + y_i = \sigma_{yci1}(l_1 + c_{i1}) + \sigma_{yci2}(l_2 + c_{i2}) + \sigma_{ygri}(l_i + gr_i)$, i = 1,2

where $\sigma_{ycij}=L_jC_{ij}/N_iY_i$, $\sigma_{ygri}=L_iGR_i/N_iY_i$

(13') $l_i + \pi h_i = n_i + \pi f_i$,   i = 1,2

(14') $l_i = gr_i$ i = 1,2

Equations (1´)-(14´) constitute a linear system in the 27 endogenous variables: u_i, c_{ij}, g_i, m_i, πh_i, l_i, w_i, p_i, πf_i, y_i, t_i, gr_i and gf_2 and the 4 exogenous variables: n_i, gf_1 and $\bar{l}$.

3.2 Numerical Version of the Linearized PEGE Model

We now put the linearized PEGE model of section 2 into numerical form by evaluating the various coefficients which appear there.

Six numerical versions are constructed. Australia has six states. The states are New South Wales (NSW), Victoria (Vic), Queensland (Qld), South Australia (SA), Western Australia (WA), Tasmania (Tas). One of the six numerical versions has NSW as region 1 and the rest of the country (ROC) as region 2, a second has Vic as region 1 and ROC as region 2 and so on for each of the other four states.

The linearized model contains a number of parameters which have to be evaluated: α_i, γ_{ij}, δ_i, $\sigma_{m\pi hi}$, σ_{mwi}, $\sigma_{\pi fyi}$, $\sigma_{\pi fwi}$, σ_{ti}, σ_{ggri}, σ_{ggfi}, σ_{ycij}, σ_{ygri} and σ_{li}. These parameters fall into two groups. The first three appear in model relationships; γ_{ij} and δ_i appear in the utility function (1) and α_i in the production function (4). The remainder, on the other hand, are linearization parameters.

The model parameters can be evaluated with the help of model restrictions and appropriate past information on model aggregates. Start with α_i. Using the firm's first-order condition for profit-maximisation and the product-market clearing condition, (6) and (12) we can write α_i as:

$$\alpha_i = \frac{(W_i/P_i)L_i(1+T_i)}{L_1C_{i1} + L_2C_{i2} + L_iGR_i}, \qquad\qquad i = 1,2$$

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This expression can be used to evaluate α_i for NSW as region 1 and ROC as region 2 given a figure for each W_iL_i/P_i, T_i, L_i, C_{ij} and GR_i for NSW and each of the other five states, i.e. given these figures for all six states; and similarly for the other five versions.

Turn now to γ_{ij} and δ_i. Here we follow the approach conventionally adopted by CGE modellers and calibrate the utility function to ensure that the initial solution is one of utility maximisation.[2] Since the relative price of C and G is unity, utility maximisation and the restriction that $\gamma_{1i} + \gamma_{2i} + \delta_i = 1$ implies that:

$$\gamma_{ji} = C_{ji}/(C_{1i} + C_{2i} + G_i) , \qquad\qquad\qquad i,j = 1,2$$

and

$$\delta_i = G_i/(C_{1i} + C_{2i} + G_i), \qquad\qquad\qquad i = 1,2$$

The linearization parameters can be evaluated directly from their definitions, as presented in section 3, given values for the model aggregates involved for each of the six states. To evaluate the linearization parameters we need values for T_i, GR_i, GF_i, G_i, C_{ij}, W_i, Y_i, ΠF_i, ΠF_i, M_i and L_i. We assume that P_i and N_i are unity for the base period, use data for C_{ji}, GR_i, GF_i, W_i and L_i and the model constraints to calculate T_i, G_i, Y_i, ΠF_i, ΠH_i and M_i, thus ensuring that the parameter values are consistent with the constraints. The figures we use for the aggregates which appear in these constraints are the average values for the years 1994-95 to 1998-99 and are set out in Appendix A.

4. Simulations with Numerical Versions of the Linearized PEGE Model

In this section we discuss six comparative-static simulations with the PEGE model in its numerical linearized form. In each simulation we choose one of the six states to be region 1 and the rest of the country to be region 2 and examine the effects of an increase in the federal government's transfer from the rest of the country to region 1. In this way we throw light on the topic of the present paper - the regional effects of inter-regional federal transfers when regional governments behave as optimizing agents.

4.1 Determination of the Shock

For each simulation we shocked GF_2 by choosing a non-zero value for gf_2 (the proportional change in GF_2) and setting the changes in the remaining exogenous variables

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[2] It should be noted that, while this parameterisation is conventional, it is not strictly implied by our model specification since there households maximise utility subject to a given level of G.

at zero. In each case we chose a shock large enough to ensure perceptible results but not so large as to be implausible from an historical perspective. The size of gf_2 was chosen so that the resulting increase in the per capita transfer to region 1 amounted to 10% of the average absolute per capita transfer for all regions over the five-year base period.[3] The average per capita transfer was calculated at $3226.20 so that the percentage change in GF_2 was set to ensure a rise in GF_1 of $322.62 in each simulation. Given that the net transfer per capita varies considerably across states (some being positive and some negative since the population-weighted transfers sum to zero), the percentage changes in gf_2 vary in both sign and magnitude across states.

We assume that, for whatever reason, the federal government undertakes this policy in order to improve the welfare of the residents of region 1, if necessary at the expense of the welfare of those living in region 2.[4]

4.2 Results of Simulations with the PEGE Model
Results for the six simulations carried out with the PEGE model in its numerical linearised form are shown in Table 1.

[Table 1 about here]

4.2.1 Utility
From the standpoint of the present paper, the most important result shown in Table 1 is that in three of the six cases (where the recipient regions are NSW, Vic and WA) the final change in utility is positive in both regions and in the other three negative in both regions. In other words, in three simulations the federal-government transfer is Pareto-improving while in the other three the reverse is the case. This result confirms the conclusion

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[3] It is recognised that a 10% change may be considered a "large" change which violates the small change assumption on which the linearisation is often considered to be based. It should be noted, though, that it is 10% of a *net* transfer which is itself relatively small – thus $322.62 is less than 5% of average per capita regional government expenditure and less than 1% of average per capita consumption expenditure. Moreover and more importantly, in the present context, the size of the shock is not a matter of concern – the purpose of the present exercise is not to evaluate a particular policy proposal which involves a 10% shock but simply to explore the properties of the model. If the reader prefers a 1% shock, the results can simply be divided by 10 and similarly for smaller changes than 1%.

[4] Note that while the regional governments are assumed to behave in a purposeful fashion, the behaviour of the federal government is not explicitly modelled. While this is clearly unsatisfactory, it seems a reasonable first step. Alternatives, however, are possible – see an interesting recent paper by Borck and Owings (2003) where intergovernmental grants are the outcome of inter-governmental lobbying activity.

reached in Petchey (1995) from a two-region analytical model that efficiency-enhancing federal-government redistributive transfers are a definite possibility.

A second noteworthy result shown in Table 1 is that, whether or not the federal-government transfer is Pareto-efficient, the ultimate effect of the transfer on utility is trivial – a transfer which induces a 5% change in per capita government expenditure results in a final change in utility of no more than one fiftieth of 1% and in most cases considerably less. This is not because the shock is trivial – the change in initial utility (before any of the endogenous variables have had a chance to react) in about 0.75% – but because of the offsetting effects of the subsequent changes in endogenous variables. Indeed, while the while the results set out in Table 1 suggest that federal-government redistributive transfers have only a small effect on welfare, they also suggest that the effect on other variables of interest is considerable and we now turn to these effects.

4.2.2 Government Expenditure and the Rate of Payroll Tax

It will be seen from Table 1 that in all six simulations both per capita government expenditure and the rate of payroll tax fall substantially in the donor region in response to the change in the federal government grant. On the other hand, both rise substantially in the recipient region. The rise in per capita government expenditure ranges from just over 3% when Tasmania is the recipient region to nearly 1.5% in the Victorian case. As for the rate of payroll tax, the rise ranges from nearly 1.2 percent when NSW is the recipient region to close to 2% in the WA case.

This somewhat surprising result may be explained as follows. Recall that each regional government sets its rate of payroll tax so as to maximise its total expenditures. Proceeding in this way, it faces two conflicting effects of a tax-rate increase. On the one hand, by increasing the tax rate it will increase employment costs and so reduce employment and the number of households in the region. Given expenditure per capita, this will mean a lower total expenditure. On the other hand, by increasing its tax rate it will loosen its budget constraint and so be able to increase expenditure per capita which will increase total expenditure for a given number of households. At the optimal position the regional government be setting its tax rate so that the effects on its total expenditure of these two opposing effects of a higher tax rate are in balance.

This will be the situation in the recipient region prior to the federal-government transfer to the region. When the transfer occurs utility is now higher in the recipient region with the result that population is drawn into the recipient region. This upsets the balance between GR and L in favour of L and allows the regional government to increase T and so GR until optimality is restored.

4.2.3 Employment and Output

The immediate effect of the federal-government redistributive transfer is an increase in the consumption of the government good in the recipient region and a decrease in the donor region. Hence the immediate effect is to increase utility in the recipient region and to decrease it in the donor region as shown by the figures in the "initial-u" rows of Tables 1. However, the utilities were equal in the two regions before the transfer occurred. It follows, therefore, that the immediate effect of the transfer is that individuals in the donor region find that they can improve welfare by migrating to the recipient region.

The inter-regional migration process thus begun continues until equality between utility in the two regions is re-established and has the result of expanding the labour force (equals employment) in the recipient region and reducing the labour force in the donor region. Since the national labour force is exogenous and is held fixed the increase in the labour force of the recipient region is numerically the same as the decrease in the labour force in the donor region.

The results for output shown in Table 1 are also of interest. As expected from the results for labour, the results for output show that, for all the simulations, output increases in region 1 and falls in region 2. However, the percentage increase in region 1 is, in all cases, smaller for output than it is for employment while the percentage decrease for region 2 is, in all cases, larger for output than it is for employment.

Given the results for labour and output, consistency requires that the results for output per capita show output per capita falling for region 1 and rising in region 2 in response to the federal-government redistributive transfer. This the results do, in fact, show for all six simulations in the "ypc_i" rows. It should be noted that results for output and output per capita simply reflect the assumption that marginal product of labour is positive but declining so that average product also declines as employment increases.

A final point regarding the output results is that given the output changes for the individual regions the sign of the change in output for the country as a whole is ambiguous – it is positive for two cases and negative for the remaining four as shown in the "y" row of Table 1.   Since inter-regional migration results in the re-allocation of labour from region 1 to region 2 in all simulations, the effect of the transfer on national output depends simply on the relative marginal products of labour in the initial equilibrium.   In our model the initial marginal product of labour is equal to real unit labour cost (including the payroll tax).   In the case where NSW is region 1, region 1's marginal product of labour (MPL_1) is \$40,061 while MPL_2 is \$35, 805 so that a shift of employment from region 2 to region 1 increases national output as shown while for the case where Qld is region 1, for example, MPL_1 is \$33,463 while MPL_2 is \$38,161 so that the migration of labour from region 1 to region 2 induced by the transfer reduces national output.

4.2.4 Prices and Inter-Regional Trade
The results shown in Table 1 indicate that substantial price changes are also likely to result from a federal-government redistributive transfer.   In all six simulations the recipient region enjoys a substantial price fall of between 1 and 2 percent while the donor region suffers a price rise of less than 1 percent. Table 1 shows that associated with these price changes are substantial changes in inter-regional trade. By adding the entries in the rows for c_{21} and l_1 we get the percentage change in total imports by the recipient region from the donor region consequent on the transfer. Similarly, by adding the entries for c_{12} and l_2 we get the percentage change in total exports of the recipient region to the donor region.   Since the model is calibrated so as to ensure balance of trade in the initial equilibrium, the difference between the percentage change in exports and imports gives the sign of the change in the balance of trade.

Proceeding in this way, we find from Table 1 that when NSW is the recipient region total exports rise by 1.7% while total imports fall by 1.6% resulting in a substantial improvement in the inter-regional balance of trade from the perspective of region 1 and a deterioration from region 2's perspective. Much the same effects is generated in the case of the other five simulations.

These effects may be rationalised as follows. The fall in output per capita in the recipient region described in sub-section 4.2.3 results in a fall in wages and per capita profit distributions and so in real income for the representative household in region 1. Given the demand function, this results in a fall in consumption per capita in region 1 of both goods. Similarly, there is a rise in consumption per household in region 2. Thus, from the perspective of region 1, imports fall and exports rise and *vice versa* for region 2. The decrease in demand for good 1 and the increase in the supply of good 1 results in excess supply and thus a price fall while the opposite is the case for good 2 – excess demand drives the price up.

4.2.5 The Effect of Regional-Government Optimisation

The PEGE model used to carry out the six simulation whose results are reported in Table 1 assumed that regional governments choose their rate of payroll tax so as to maximise their total expenditure. Thus the governments are assumed to be empire-building optimisers. An important question is whether the results in Table 1 are significantly dependent in this assumption. Light can be thrown on this question by comparing the results in Table 1 with those obtained from a simulation in which regional government behaviour is assumed exogenous. This simulation is based on a model identical to the one underlying the results in Table 1 but with equation (14') replaced by

(14") $gr_i = 0$

so that the GR_i is effectively exogenous and T_i is determined to satisfy the regional government budget constraint. The results of such a simulation for the case where NSW is region 1 are reported in the GE columns of Table 2, with the results for the PEGE model (taken from Table 1) reported in the PEGE columns to facilitate comparison.[5]

[Table 2 about here]

The results reported in Table 2 have several interesting features. In the first place, none of the signs are different between the two cases. In this sense the results resorted in Table 1 are not crucially dependent on the assumption of empire-building regional governments.

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[5] Given the similarity of the results for the six different simulations in Table 1, we report only the results for one simulation in Table 2.

The second is that welfare effects of the federal transfer are larger when regional governments do not react – in this particular simulation the empire-building activities of regional governments actually make their citizens worse-off.

Third, generally the absolute values of the effects of the federal-government transfer are larger when regional governments do not react. Thus, in general, the regional governments' actions in the PEGE model do not affect the sign but tend to dampen the magnitude of the effects of the federal transfer. In this simulation, national output expands by less and welfare increases by less as a result of the regional governments' actions and in this sense the regional governments' behaviour is not in their citizens' interest. However, in a case where welfare falls as a results of the federal transfer, such as when Qld is region 1, the empire-building activities of the regional government dampens the welfare loss and thus can be said to benefit the citizens of both regions.

5. Conclusion

In this paper we have set out to analyse the effects of inter-regional transfers made by a federal government. We have done so with the help of a model in which each regional government determines its tax policy so as to maximise the level of its expenditure in the region subject to the constraints imposed by the economic structure of its region. Each regional government is assumed to take the other regional government's tax policy as given in carrying out its maximisation.

We conducted a series of six simulations with a linearized version of the model after calibration using Australian data. The shock was an increase in the federal government's grant to region 1 matched by a decrease to its grant to region 2. In each simulation one of the six Australian states was taken as region 1 and the rest of the country as region 2.

We found that substantial changes in the amount transferred by the federal government from one region to the other have significant initial effects on utility but that once households are permitted to adjust their consumption patterns and to migrate from one region to another in response to inter-regional utility differentials, the result is to substantially remove these welfare effects. We found that the changes in transfers result in significant changes in per capita consumption, output, prices, government expenditure, wages and tax rates. The initial increase in welfare in the recipient region leads to an

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influx of people from the other region, increasing output but reducing productivity and wages. The regional government in the recipient region responds to the increase in population by increasing both its tax rate and expenditure level so that in the new equilibrium employment, taxes, output and government expenditure are all higher but prices, wages, consumption and output per capita are all lower. Welfare may be higher or lower depending on whether the initial level of government expenditure was above or below the welfare-maximising level.

The empire-building activity of regional governments was seen to dampen the magnitude of changes resulting from the federal-government transfer but not to alter the sign of the effects either on welfare or any of the other variables of interest.

Table 1
Results of Simulations with a Shock to GF_2

Variable	NSW as region 1		Vic as region 1		Qld as region 1		SA as region 1		WA as region 1		Tas as region 1	
	%	$p.c.	%	$p.c.	%	$p.c.	%	$p.c.	%	$p.c.	%	$p.c.
m_1	-1.8103	-724.68	-2.1393	-816.21	-2.2430	-798.82	-1.9739	-707.44	-2.7967	-971.34	-1.6425	-595.72
m_2	0.9420	344.03	0.7435	279.44	0.5258	201.00	0.1710	64.78	0.3284	125.03	0.0403	15.23
p_1	-1.2147	NA	-1.4849	NA	-1.5216	NA	-1.3520	NA	-1.9577	NA	-1.0789	NA
p_2	0.6010	NA	0.5013	NA	0.3715	NA	0.1228	NA	0.2362	NA	0.0291	NA
t_1	1.1759	NA	1.3663	NA	1.5031	NA	1.3348	NA	1.8254	NA	1.1900	NA
t_2	-0.6353	NA	-0.4917	NA	-0.3383	NA	-0.1095	NA	-0.2106	NA	-0.0258	NA
w_1	-1.5531	-510.38	-1.8692	-585.19	-2.0068	-546.03	-1.8014	-500.39	-2.5215	-716.71	-1.5371	-405.01
w_2	0.7968	231.46	0.6525	195.97	0.4715	146.65	0.1554	47.53	0.2994	91.56	0.0368	11.21
y_1	0.7104	940.90	0.8313	778.00	0.8136	526.28	0.7208	203.60	1.0724	384.73	0.5706	50.51
y_2	-0.3637	-840.95	-0.2829	-764.28	-0.2007	-600.16	-0.0644	-215.87	-0.1229	-402.81	-0.0151	-53.70
c_{11}	-0.5957	-190.75	-0.6544	-199.75	-0.7215	-205.56	-0.6218	-178.29	-0.8390	-233.12	-0.5635	-163.51
c_{21}	-2.4114	-193.06	-2.6406	-201.49	-2.6145	-186.22	-2.0967	-150.29	-3.0329	-210.68	-1.6716	-121.26
c_{12}	2.1567	90.62	2.2284	58.96	2.0474	34.12	1.5230	9.48	2.2860	18.56	1.1193	2.01
c_{22}	0.3410	110.20	0.2423	84.64	0.1544	56.43	0.0482	17.95	0.0922	34.34	0.0112	4.22
gr_1	0.8375	60.29	0.9820	63.40	1.0179	63.65	0.8854	66.71	1.2615	92.61	0.7318	64.11
gr_2	-0.4395	-29.69	-0.3405	-24.06	-0.2382	-16.82	-0.0769	-5.27	-0.1475	-10.11	-0.0181	-1.24
initial-u_1	0.6841	NA	0.7286	NA	0.7716	NA	0.7227	NA	0.7751	NA	0.6767	NA
initial-u_2	-0.3881	NA	-0.2419	NA	-0.1659	NA	-0.0684	NA	-0.0808	NA	-0.0205	NA
u_1	0.0070	NA	0.0221	NA	-0.0035	NA	-0.0142	NA	0.0122	NA	-0.0069	NA
u_2	0.0070	NA	0.0221	NA	-0.0035	NA	-0.0142	NA	0.0122	NA	-0.0069	NA
l_1	0.8375	23487	0.9820	20601	1.0179	15727	0.8854	5766	1.2615	10757	0.7318	1439
l_2	-0.4395	-23487	-0.3405	-20601	-0.2382	-15727	-0.0769	-5766	-0.1475	-10757	-0.0181	-1439
gf_1	NA	323.15	NA	326.84	NA	323.29	NA	309.97	NA	328.83	NA	302.50
gf_2	NA	-169.14	NA	-111.83	NA	-75.49	NA	-27.99	NA	-37.69	NA	-7.97
g_1	5.3774	383.44	6.3670	390.25	6.2412	386.94	4.2789	376.69	6.1151	421.44	3.2154	366.61
g_2	-2.9278	-198.83	-1.8931	-135.89	-1.3050	-92.31	-0.4932	-33.26	-0.6919	-47.81	-0.1355	-9.21
y	0.0275	12.27	0.0038	1.68	-0.0203	-9.07	-0.0034	-1.51	-0.0050	-2.22	-0.0009	-0.39
ypc_1	-0.1271	-60.04	-0.1507	-67.22	-0.2043	-85.54	-0.1646	-71.39	-0.1892	-79.58	-0.1613	-72.61
ypc_2	0.0759	32.84	0.0576	25.70	0.0375	16.97	0.0126	5.62	0.0246	11.05	0.0030	1.32

Notes:

1. Variables are defined as follows:

m_i = proportional change in per capita nominal income region i,

p_i = proportional change in the price of output produced in region i,

t_i = payroll tax rate in region i,

w_i = proportional change in the nominal wage rate in region i,

y_i = proportional change in out put region i; the $ per capita figure in the second column is simply the proportional change applied to base value of output per capita, and so is not the change in per capita output (which is given later in the table as ypci),

c_{ij} = proportional change in per capita real consumption of good i (produced in region i) by residents of region j,

gr_i = proportional change in real per capita expenditure by regional government i,

initial-u_i = the effect on U_i of the change to GF_i with all other variables held constant,

u_i = proportional change in utility of the representative household in region i,

l_i = proportional change in employment (= labour force = population) region i,

gf_i = proportional change in per capita provision of federal government goods, region i,

g_i = proportional change in per capita real government goods provided to residents of region i,

y = proportional change in real output for the economy as a whole (both total and per capita since economy-wide population is fixed), and

ypc_i = proportional change in real output per capita, region i.

2. All the figures in the $p.c. columns are $ per capita (some real and some nominal; see definitions of the variables) except for l which is persons and y which is $ millions.

3. The "NA" in the $pc columns for p_i, t_i and u_i imply that these are not applicable for these variables since none of them is measured in $ per capita. The "NA" in the $pc column for gf_i reflects the fact that the gf shock was chosen such as to ensure that the initial change in GF_1 was $232.62; the corresponding % figures vary widely in sign and magnitude reflecting the variation in the base values and have no meaning in themselves.

Table 2: The Effects of Regional Government Optimisation

(NSW as region 1)

Variable	PEGE		GE	
	%	$p.c.	%	$p.c.
m_1	-1.8103	-724.68	-1.8288	-732.06
m_2	0.9420	344.03	0.9754	356.24
p_1	-1.2147	NA	-1.4678	NA
p_2	0.6010	NA	0.7609	NA
t_1	1.1759	NA	0.2937	NA
t_2	-0.6353	NA	-0.1773	NA
w_1	-1.5531	-510.38	-1.7615	-578.85
w_2	0.7968	231.46	0.9381	272.53
y_1	0.7104	940.90	1.3465	1783.48
y_2	-0.3637	-840.95	-0.6893	-1594.02
c_{11}	-0.5957	-190.75	-0.3610	-115.61
c_{21}	-2.4114	-193.06	-2.5896	-207.33
c_{12}	2.1567	90.62	2.4432	102.66
c_{22}	0.3410	110.20	0.2146	69.35
gr_1	0.8375	60.29	0.0000	0.00
gr_2	-0.4395	-29.69	0.0000	0.00
initial-u_1	0.6841	NA	0.6841	NA
initial-u_2	-0.3881	NA	-0.3881	NA
u_1	0.0070	NA	0.0087	NA
u_2	0.0070	NA	0.0087	NA
l_1	0.8375	23487	1.5874	44519.38
l_2	-0.4395	-23487	-0.8332	-44519.38
gf_1	NA	323.15	NA	323.93
gf_2	NA	-169.14	NA	-169.14
g_1	5.3774	383.44	4.5429	323.93
g_2	-2.9278	-198.83	-2.4906	-169.14
y	0.0275	12.27	0.0521	23.25
ypc_1	-0.1271	-60.04	-0.2410	-113.80
ypc_2	0.0759	32.84	0.1438	62.25

Notes: variables definitions: see notes to Table 1. PEGE refers to the model with optimising regional governments and GE refers to the model with exogenous regional governments.

Appendix A

Data-Base

	Total corresponding to						
	C ($m)	GR ($m)	LW ($m)	GF ($m)	W ($'000)	L ('000)	Y/L ($'000)
Region 1 NSW	112265.4	20189.8	92160.8	-192.3	32.8618	2804.5	47.2295
Region 2 ROC	195152.8	36096.6	15227.8	192.3	29.0498	5343.5	43.2768
Nation	307418.2	56286.4	247388.6	0.0	30.3619	8148	44.6373
Region 1 Vic	80040.8	13545.4	65680.6	-686.9	31.3078	2097.9	44.6095
Region 2 ROC	227377.4	42741	181708	686.9	30.0339	6050.1	44.6469
Nation	307418.2	56286.4	247388.6	0.0	30.3619	8148	44.6373
Region 1 Qld	55026	9662.6	42041.6	-83.3	27.2096	1545.1	41.8669
Region 2 ROC	252392.2	46623.8	205347	83.3	31.0995	6602.9	45.2856
Nation	307418.2	56286.4	247388.6	0.0	30.3619	8148	44.6373
Region 1 SA	23339.2	4906.8	18088.6	826.0	27.7773	651.2	43.3753
Region 2 ROC	284079	51379.6	229300	-826.0	30.5864	7496.8	44.7469
Nation	307418.2	56286.4	247388.6	0.0	30.3619	8148	44.6373
Region 1 WA	29616	6259.6	24236.8	-383.0	28.4236	852.7	42.0729
Region 2 ROC	277802.2	50026.8	223151.8	383.0	30.5884	7295.3	44.9370
Nation	307418.2	56286.4	247388.6	0.0	30.3619	8148	44.6373
Region 1 Tas	7130.8	1722.2	5180.2	519.4	26.3489	196.6	45.0305
Region 2 ROC	300287.4	54564.2	242208.4	-519.4	30.4611	7951.4	44.6276
Nation	307418.2	56286.4	247388.6	0.0	30.3619	8148	44.6373

Sources: C_i, L_i, LW_i and GR_i are from ABS times series averaged over the period 1994/95 - 1998/99. Time-series data on interstate imports are not reported by the ABS so that in each case C_{11} was set at 80% of C_1 and C_{21} at 20% of C_1. C_{12} was then chosen to ensure a zero balance of trade in the initial equilibrium and C_{22} was chosen as $C_2 - C_{12}$. GF_i is computed as $L_i (MGF_i/L_i - MGF/L)$ where MGF_i is final consumption expenditure by the federal government plus grants to state i. All other data are calculated from these figures to ensure that the model constraints hold: $L = L_1 + L_2$, $W_i = W_iL_i/L_i$, $Y_i = GR_i + C_i$, $G_i = GR_i+GF_i$, $T_i = GR_i/W_iL_i$. It should be noted that, as the model excludes investment and net overseas exports, Y_i will not conform with official figures. P_i was set at 1 for each i in the initial equilibrium.

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