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The Effects of an Inter-Regional Transfer with Empire-Building Regional Governments

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Abstract

This paper is concerned primarily with the economic and welfare consequences of federal redistributive grants to regional governments. We use a model that has two regions, each with households, firms, and a regional government 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 maximize total expenditure – the size of their empire. Labor is free to move between regions in response to utility differences and does so until such differences have been eliminated. Interregional migration and federal government redistribution are the main sources of interconnectedness between the two regions. The model is linearized in log-differences and simulated using Australian state-level data. We find that the welfare effects of intergovernmental transfers are trivial but that all other variables of interest change substantially – consumption, employment, taxes, wages, output, and government expenditure. The welfare effects of a federal transfer are little influenced by the choice of empire-building rather than beneficent regional governments, but the influence on other variables is substantial.

Keywords: *Regional; Transfer; Federalism*

JEL classification: *R13; R50; H77*

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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 that 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 that 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 that 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 rather than optimality include the North American studies of Boadway and Flatters (1982) and Myers (1990) and the Australian studies of 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, Picton, and Rimmer (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 most of them, however, in two important ways. The first relates to the procedure used to develop the modeling framework for the study. The second concerns the way in which the conclusions about economic and welfare effects that the model implies are drawn. In the present study, these conclusions are generated by numerical simulations resembling those that are to be found in studies based on CGE modeling.

In developing our modeling framework, we adopted a two-stage approach. We began with a model from a class that 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 labor. In these models, labor 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 many of the studies focusing 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, 2003).

The mobility model that 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 are treated as exogenous. Labor is free to move between regions in response to utility differences and does so until such differences have been eliminated. Since the model is essentially Walrasian in character, we refer to it as the GE (general equilibrium) component of the modeling framework.

The GE model has two sources of interconnectedness between the regions – the main one is inter-regional migration, and the other is the redistribution carried out by the federal government. 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 and profits are distributed to these households on an equal per capita basis.

The second step in developing our modeling 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 maximize 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). Such an assumption has been particularly appropriate when addressing the question of whether federal government transfers can be welfare-enhancing even if regional governments are welfare-maximizers. 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 maximize total expenditure – the size of their empire. We find this an interesting and plausible alternative. It provides the basis for one of the main contributions of this paper, which is to address the question of whether the effects of the transfer are materially affected by the assumption made about the behavior of the regional governments – in particular, whether they are assumed to exhibit beneficent or empire-building behavior. Besides, many would argue that self-interested governments are more common than those who act solely in the interests of their citizens so that an analysis of the effects of transfers in the face of empire-building regional governments is of interest for its own sake.

Each regional government is therefore assumed to make its fiscal decisions so as to maximize its total expenditure, subject to the constraints imposed by 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 that 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 effects on welfare and other economic variables of federal redistributive grants. We get round this difficulty by using a process of log-differentiation to linearize the model that is then calibrated from Australia data and used to simulate the economic and welfare effects in each of the two regions of a federal government transfer shock.

Six simulations were conducted. In the first, New South Wales was the region to which the transfer was made and the rest of the country the region making the transfer. 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 emerge from these simulations.

The possibility that federal redistributive grants might be welfare-improving, 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.) With the help of our six simulations, we found that Pareto-improvements take place in those cases in which the recipient regions are 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 were able to show that in each of the cases of Pareto-improvement, the welfare gains are trivial and that the same is true of the welfare losses in the remaining cases.

Thirdly, the simulations make it clear that while welfare is unaffected for all practical purposes, all other variables of interest change substantially – consumption, employment, taxes, 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 making citizens significantly better or worse off.

Finally, a comparison to earlier literature shows that the welfare effects of a federal transfer are little influenced by the choice of empire-building rather than beneficent regional governments (since households migrate to equalize welfare across regions), but that the influence on other variables is substantial. Interestingly, earlier work has shown that beneficent regional governments tend to change their expenditure levels so as to offset the effect of the transfer, whereas we find that empire-builders take advantage of

the movement of population to reinforce the effects of the transfer on total government expenditure in the region, an interesting twist on the “flypaper effect.”

The rest of the paper consists of the following. 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 and calibrated; the details are reported in Appendix A. The model is put to work in Section 3. 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

2.1 The Two-Region GE Model

2.1.1 The Representative Household

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

$$(1) \quad U_i = \beta_i C_i^{\gamma_i} G_i^{\delta_i}, \quad i = 1, 2$$

where U_i = utility, region i ;
 C_i = real private consumption per household, region i ;
 G_i = real government-provided consumption per household, region i .
 $\beta_i > 0$
 $0 < \gamma_i < 1$
 $0 < \delta_i < 1$
 $\gamma_i + \delta_i = 1$

There is no saving in the model, so that the constraint facing the household is:

$$(2) \quad P_i C_i = M_i = \pi_i + W_i, \quad i = 1, 2$$

where P_i = price of the (single) consumption good, region i ;
 M_i = nominal income per household, region i ;
 π_i = nominal profit distribution per household, region i ;
 W_i = nominal wage, region i .

Equation (2) incorporates the assumption that each household supplies one unit of labor, so that labor income is W_i . The household takes G_i , π_i , and W_i as given and has only a single choice-variable, C_i . The utility-maximizing level of C_i is:

$$(3) \quad C_i = M_i/P_i = (\pi_i + W_i)/P_i, \quad i = 1, 2$$

We assume that there are L_i households in region i . Since each household supplies one unit of labor, it follows that L_i is also the labor supply in region i . Total private consumption in region i must be $L_i C_i$, and total consumption of the government-provided good, $L_i G_i$.

2.1.2 The Representative Firm

We assume that there are N_i firms in region i . N_i is treated as exogenous. We assume that the production function has a positive and declining marginal product of the single factor, labor. L_i represents employment in region i and, because of the decreasing returns to scale, each firm in region i will be of the same size. Hence output, Y_i , for the representative firm in region i is given by:

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

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

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

subject to the production function (4) with P_i and W_i taken as given. In (5) Π_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 maximizing with respect to L_i , we get the single first-order condition:

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

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

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

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:

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

where GF_i is the amount of output supplied per household to the residents of region i .¹

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

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

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 labor market clears:

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

where $\bar{L}$ is the national labor 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

¹ It is recognized that in practice fiscal equalization (and, indeed, government finance in general) is much more complicated than the straightforward transfer modelled here, but we intentionally abstract from these complications to focus simply on the transfer. We also abstract from the motivation of the federal government and preclude any strategic behaviour on the part of the regional governments as they seek to exploit the equalization formula; see Groenewold (1981) for an example of an algebraic treatment of the complicated Australian equalization formula and Petchey and Levchenkova (2004) for a recent paper on strategic behavior in a theoretical model motivated by the Australia system of fiscal federalism.

levels.² Equilibrium occurs when utility differences have disappeared so that $U_1 = U_2$. Since it seems implausible to assume that households change their preferences when they migrate from one region to the other, we assume that utility functions are the same across regions, apart from the β_i parameter, which we use to allow for regional amenity differences. Thus, the migration equilibrium condition is written:

$$(11) \quad \beta_1 C_1^\gamma G_1^\delta = \beta_2 C_2^\gamma G_2^\delta.$$

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

$$(12) \quad N_i Y_i = L_i (C_i + G R_i) \quad i = 1, 2$$

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:

$$(13) \quad L_i \pi_i = N_i \Pi_i \quad i = 1, 2,$$

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 (3) - (13) comprise the two-region GE model. To move to the two-region PEGE model, we add optimization by the regional governments. There are various ways in which this might be done. Some earlier papers have assumed that governments are beneficent and maximize the utility of their citizens – see, e.g., Petchey (1993); Petchey and Shapiro (2000, 2002); and Groenewold, Hagger, and Madden (2000, 2003). This assumption is particularly attractive if the research objective is to investigate whether federal transfers can have an efficiency role even if regional governments act in a beneficent manner. This is not the focus of the present paper, however, and consequently our approach here differs and is intentionally 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 maximize the size of their total expenditure subject to their budget constraint and the constraints imposed by the structure of the economy. While the assumption of beneficent regional governments has its role as a modeling device, it is surely not the only plausible one. Indeed, popular views of government suggest the opposite, and we choose an

² Thus, e.g., in practice land prices may differ considerably between regions and some of this difference may reflect the capitalized 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).

empire-building objective on the argument that at least it is interesting to ask whether the beneficent-government assumption is in any way central to existing results.

The maximization problem faced by the government of region i is therefore simply $\max(L_i GR_i)$, subject to the constraints imposed by the GE model of region i , including $\{T_i\}$ the regional government budget constraint.

The first order condition for this maximization problem is:

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

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

$\frac{\partial L_i}{\partial T_i} < 0$. 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_1), with the second being determined via its budget constraint, equation (8).³ The PEGE model thus consists of 21 equations in the following 21 endogenous variables:

$$C_i, \pi_i, \Pi_i, W_i, P_i, O_i, L_i, T_i, GR_i, G_i, GF_2 \quad i = 1, 2$$

and the following four exogenous variables:

$$N_i, GF_1, \bar{L} \quad i = 1, 2.$$

We now write the model more compactly. First the endogenous variables are reduced to 19 by setting $P_i = 1$ ($i = 1, 2$), thus treating output in each region as the numeraire.

Next we use (13), (4), and (5) to write (3) as:

$$(15) \quad C_i = (L_i/N_i)^{\alpha_i-1} - W_i T_i \quad i = 1, 2$$

Equations (6), (7), (8), and (10) are reproduced as they stand:

³ 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.

$$(16) \quad \alpha_i \left(\frac{L_i}{N_i} \right)^{\alpha_i - 1} = W_i (1 + T_i) \quad i = 1, 2$$

$$(17) \quad GR_i = T_i W_i \quad i = 1, 2$$

$$(18) \quad L_1 GF_1 + L_2 GF_2 = 0$$

$$(19) \quad L_1 + L_2 = \bar{L}$$

We next use (9) to substitute for G_i in (11) and add (14):

$$(20) \quad \beta_1 C_1^\gamma (GR_1 + GF_1)^\delta = \beta_2 C_2^\gamma (GR_2 + GF_2)^\delta$$

$$(21) \quad L_i \frac{\partial GR_i}{\partial T_i} + GR_i \frac{\partial L_i}{\partial T_i} = 0 \quad i = 1, 2$$

Finally, we use (4) to write the product-market-clearing condition, (12), as:

$$(22) \quad \left(\frac{L_i}{N_i} \right)^{\alpha_i - 1} = C_i + GR_i \quad i = 1, 2$$

This gives a total of 13 equations in 11 endogenous variables: C_i , L_i , W_i , T_i , GR_i , and GF_1 (say). Two of the 13 equations are redundant, however. This can be seen by substituting (17) into (15) to obtain (22). We therefore drop (15) and as our final form of the PEGE model, take the 11 equations, (16)-(22) in the 11 endogenous variables listed above, exogenous variables N_i , $\bar{L}$, and GF_2 and parameters, β_i , γ , δ , and α_i .

The two-region PEGE model set out above 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 empire-builders. We circumvent this problem by deriving a linearized version of the model and then calibrating this linearized version using data for the Australian states.⁴ The details of the linearization and calibration are given in Appendix A.

⁴ It should be noted that calibrating with Australian data does not necessarily make the model useful for analysis of specifically Australian policy issues. This is particularly true given the many abstractions from the complexities of the Australian fiscal system. Rather, the focus is on the numerical analysis of the model as such.

3. 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.

3.1 Determination of Shocks

For each simulation, we shocked GF_1 by choosing a non-zero value for gf_1 and setting the changes in the remaining exogenous variables 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 assumed increase in the per capita transfer to region 1 was set at 10 percent of the average per capita transfer for all regions over the five-year base period. The average per capita transfer was calculated at \$3,226.20 so that gf_1 was shocked by an amount calculated to ensure a rise in GF_1 of \$322.62 in each simulation.

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.

3.2 Results of Simulations with PEGE Model

Results for the six simulations carried out with the PEGE model in its numerical linearized form are shown in Table 1. The initial effect of the increase in GF_1 is to increase the consumption of the government good in region 1 and decrease it in region 2. Both individuals and regional governments react to this shock.

Initially the residents of region 1 find that they are better off and those living in region 2 find that they are worse off. This is clear from the numbers in the row for “initial- u ” in Table 1, which gives the effect of the shock on utility before either the regional governments or individuals themselves have responded. Individuals in region 2, therefore, find that they could improve their welfare by moving to region 1; and inter-regional migration occurs until the equality between utility in the two regions is re-established.

In the process of migration, the labor force expands in region 1 but contracts in region 2. Since the total labor force is fixed, the increase in L_1 is exactly offset by the fall in L_2 , as is evident from the results in Table 1.

TABLE 1

Results of Simulations with gf Shock: Regional Government Expenditure Maximized

Variable	Version											
	1		2		3		4		5		6	
	Reg 1: NSW	Reg 2: ROC	Reg 1: Vic	Reg 2: ROC	Reg 1: Qld	Reg 2: ROC	Reg 1: SA	Reg 2: ROC	Reg 1:WA	Reg 2: ROC	Reg 1: Tas	Reg 2: ROC
c (%)	-1.2109	0.6777	-1.2152	0.4693	1.2988	0.2877	-1.3546	0.1011	-1.4163	0.1525	-1.3197	0.0240
l (%)	2.2475	-1.1796	2.3465	-0.8136	2.2119	-0.5176	2.0986	-0.1823	2.3435	-0.2739	1.7443	-0.0431
L (number)	63,031	-63,031	49,226	-49,226	34,176	-34,176	13,666	-13,666	19,983	-19,983	3,429	-3,429
w (%)	-1.3259	0.7523	-1.3279	0.5203	-1.4607	0.3165	-1.5287	0.1115	-1.5619	0.1685	-1.5442	0.0265
t (%)	3.5734	-1.9318	3.6743	-1.3340	3.6727	-0.8341	3.6273	-0.2938	3.9054	-0.4424	3.2885	-0.0696
gr (%)	2.2475	-1.1796	2.3465	-0.8136	2.2119	-0.5176	2.0986	-0.1823	2.3435	-0.2739	1.7443	-0.0431
GR(\$pc)	161.8000	-79.6800	151.5000	-57.4800	138.3300	-36.5500	158.1300	-12.4900	172.0400	-18.7800	152.8000	-2.9600
g (%)	6.7936	-3.6485	7.7354	-2.3093	7.4349	-1.5791	5.4610	-0.6381	7.1774	-0.7977	4.1696	-0.1781
G(\$pc)	484.4200	-247.7800	474.1200	-165.7600	460.9500	-111.7000	480.7500	-43.0300	494.6600	-55.1200	475.4200	-12.1000
y (%)	-0.6872	0.3878	-0.6997	0.2663	-0.7744	0.1621	-0.7547	0.0577	-0.7603	0.0875	-0.7237	0.0137
ytot (%)	1.5638	-0.7918	1.6468	-0.5473	1.4376	-0.3555	1.3440	-0.1246	1.5832	-0.1865	1.0207	-0.0294
initial-u (%)	0.6841	-0.3881	0.7286	-0.2419	0.7716	-0.1659	0.7227	-0.0684	0.7751	-0.0808	0.6767	-0.0205
u (%)	-0.0006	-0.0006	0.0237	0.0237	-0.0038	-0.0038	-0.0106	-0.0106	0.0066	0.0066	-0.0068	-0.0068

TABLE 2

Effect on National Output of a Positive Shock to GF_1
Regional Government Expenditure Maximized

Simulation	Output Change (%)	MPL ₁ (\$ p.c.)	MPL ₂ (\$p.c.)
NSW as Region 1	0.0661	40,060.83	35,805.07
Vic as Region 1	0.0172	37,764.43	37,098.40
Qld as Region 1	-0.0366	33,463.34	38,160.63
SA as Region 1	-0.0106	35,312.35	37,439.92
WA as Region 1	-0.0119	35,764.51	37,445.83
Tas as Region 1	-0.0039	35,108.85	37,323.31

Output also increases in region 1 and falls in region 2, although output per capita moves in the opposite direction, reflecting the diminishing marginal product of labor in each region, which ensures that average product falls as employment rises.

Since output in region 1 rises and output in region 2 falls, the effect of the federal government transfer on *national* output is of ambiguous sign. The results reported in column 2 of Table 2 show that the percentage change in national output is positive for some simulations and negative for others.

Whether national output falls or rises depends on the relative magnitudes of the regional marginal products of labor, which – in turn, following equation (6) – are the payroll-tax-adjusted real wages. The third and fourth columns of Table 2 show the marginal products implied by the data base and equation (6). It is clear from those two columns that in all cases where national output increases, migration occurs from the low to the high marginal-product region and vice versa.

In all of the six simulations covered by Table 1, gr and t are both negative for the donor region but are both positive for the recipient region. Thus the government of the recipient region reacts to the additional federal government expenditure not by reducing its own expenditure but by increasing its own expenditure, thereby generating a healthy increase in total government expenditure in its region. The increase in g in region 1 ranges from nearly 4 percent when Tasmania is region 1 to just over 8 percent in the Victorian case.

This effect is the opposite of that obtained with beneficent regional governments (which act to largely offset the effect of the transfer; see Groenewold, Hagger, and Madden 2003) and may be explained as follows. In setting its tax rate in order to maximize total expenditure, the regional government faces two conflicting effects of changing taxes. On the one hand, an increase in its tax rate increases employment costs (although this is tempered by a fall in wages), which reduces employment and therefore the number of households in the region. This leads to a fall in total expenditure, *ceteris paribus*. On the other hand, raising its tax rate allows it to increase expenditure per capita, thus increasing total expenditure. At the optimum position it balances the effects

on its total expenditure of these two opposing forces. A positive transfer from the federal government draws population to the region, which disturbs the previous balance between L and GR in favor of L and allows the regional government to increase GR to re-establish the balance.

The reaction of regional government expenditure to the transfer is an interesting twist on the flypaper argument. Rather than the question being how much the federal transfer “sticks” and how much is offset by an opposite change in regional expenditure, the transfer actually *increases* the corresponding regional government’s expenditure.⁵

Another noteworthy feature of the results reported in Table 1 is that in two of the six cases (where the recipient regions are Victoria and Western Australia), the final change in utility is positive in both regions and in the other four it is negative in both regions. In other words, in two cases the federal government transfer is Pareto-improving while in the other four cases the reverse is the case. However, the results of Table 1 show that regardless of whether the federal government transfer is Pareto-improving, its ultimate effects on welfare are trivial.

It is well known (see, e.g., Petchey, 1995) that in the absence of distortions, free inter-regional migration will lead to a Pareto-optimal equilibrium. In that case, small changes to transfers would necessarily have zero welfare effects. In our model there are two distortions, however, which make it unlikely that the initial equilibrium is efficient and therefore imply the likelihood of non-zero welfare effects. First, the transfers themselves are not chosen to maximize welfare (even though the C/G ratio is chosen to maximize individual utility, but more of that later). Second, profits are distributed to residents on an equal per capita basis, which, *ceteris paribus*, will lead to too much population in the high profit region.⁶ Thus a market equilibrium without federal government intervention is unlikely to be Pareto-optimal and, as has been demonstrated in previous literature, the optimal transfer is likely to be non-zero and changes in transfers may be beneficial or not.⁷

A comparison of the results in Tables 1 and 2 shows that a rise in national output is neither necessary nor sufficient for a welfare increase to result from change in the transfer. Marginal products of labor are generally not equal in equilibrium, even though migration ensures that utilities are. There are several reasons for this, all reflecting the

⁵ The flypaper effect is the common observation that more of a federal grant to regional government sticks in the area to which it is allocated than would be expected from standard neoclassical modelling. It has been widely documented and tested. See Brennan and Pincus (1996), Downes (2000), and Gordon (2004) for recent applications and Bailey and Connolly (1998) for a survey.

⁶ It is interesting that in a simpler but similar model in Groenewold, Madden, and Hagger (2003), a condition was derived that the sign of the welfare change depends on the sum of the per capita values of the transfer and profits.

⁷ Given that our model is able to solve only for proportional changes and not the levels in the endogenous variables, it is not possible to compute the set of optimal transfers corresponding to our data base. We can, though, establish whether transfers are welfare improving or the opposite.

fact that utility is more broadly based than just output. In the first place, households respond to net-of-tax wages while marginal products equilibrate at wages adjusted for the payroll tax. Hence if taxes are unequal across regions (as they are in the data base used for calibration), they drive a wedge between the regional marginal products. Second, households respond to total income, including profit distributions, which are in general unequal across regions and can be thought of as representing the returns to an immobile natural resource or capital. Thirdly, utility that drives migration also depends on the amount of the government good provided by the regional governments. Finally, preferences may, in principle, differ across regions although we have assumed them to be common in our specification. Added to these characteristics of the model is, of course, the distortion introduced by the federal transfers themselves.

A question that arises from the small welfare effects is how much of the offsetting of the federal government initiative results from inter-regional migration and how much results from the endogenous policy response of the regional governments. Table 3 throws light on this question. The table has two rows for each variable, the first of which replicates the relevant figures from Table 1 and the second of which shows the corresponding figures for the case when the regional governments are assumed not to react, i.e., when they are treated as exogenous, as in the GE model.

Two variables are seen to be largely unaffected by keeping the regional governments exogenous – the percentage changes in employment and utility. Irrespective of whether regional governments optimize, substantial inter-regional migration follows the federal government shock; and this movement of labor from region 2 to region 1 serves to largely wipe out the welfare effects of the inter-regional transfer. Thus, in our model regional government optimization does not materially affect welfare. On the other hand, the results in the table make clear that the endogenizing of regional governments substantially affects other variables, in particular consumption, the wage rate and total government expenditure. Thus the regional government's maximizing behavior has a strong impact on the allocation of a region's output between consumption and the government-provided good, but the level of output in each region and the welfare of its representative household are largely determined by inter-regional migration.

The question just considered was the extent to which the economic and welfare effects of federal government transfers are governed by whether the regional governments are optimizers. A related question is whether, given that they are optimizers, the effects of federal government transfers are significantly dependent on the *nature* of the optimization.

Light can be thrown on this question by comparing the results presented in Table 1 with those presented in a paper by Groenewold, Hagger, and Madden (2003) in which the economic and welfare effects of federal government transfers were examined by means of a set of six simulations identical with those used in the present paper but in terms of a modeling framework having *welfare*-maximizing, rather than *empire-building*, regional

TABLE 3

Results of Simulations with gf Shock: GE Model

Variable	Version											
	1		2		3		4		5		6	
	Reg 1: NSW	Reg 2: ROC	Reg 1: Vic	Reg 2: ROC	Reg 1: Qld	Reg 2: ROC	Reg 1: SA	Reg 2: ROC	Reg 1: WA	Reg 2: ROC	Reg 1: Tas	Reg 2: ROC
c (%)	-1.2109	0.6777	-1.2152	0.4693	1.2988	0.2877	-1.3546	0.1011	-1.4163	0.1525	-1.3197	0.0240
	-0.6843	0.3881	-0.7047	0.2682	-0.7750	0.1623	-0.7495	0.0573	-0.7636	0.0878	-0.7213	-0.6843
l (%)	2.2475	-1.1796	2.3465	-0.8136	2.2119	-0.5176	2.0986	-0.1823	2.3435	-0.2739	1.7443	-0.0431
	2.2494	-1.1826	2.3632	-0.8194	2.2137	-0.5180	2.0842	-0.1810	2.3538	-0.2751	1.7385	2.2494
L (number)	63,031	-63,031	49,226	-49,226	34,176	-34,176	13,666	-13,666	19,983	-19,983	3,429	-3,429
	63,085	-63,085	49,577	-49,577	34,204	-34,204	13,572	-13,572	20,071	-20,071	3,418	63,085
w (%)	-1.3259	0.7523	-1.3279	0.5203	-1.4607	0.3165	-1.5287	0.1115	-1.5619	0.1685	-1.5442	0.0265
	-0.6843	0.3881	-0.7047	0.2682	-0.7750	0.1623	-0.7495	0.0573	-0.7636	0.0878	-0.7213	-0.6843
g (%)	6.7936	-3.6485	7.7354	-2.3093	7.4349	-1.5791	5.4610	-0.6381	7.1774	-0.7977	4.1696	-0.1781
	3.8336	-2.0891	4.5213	-1.2442	4.4220	-0.9004	3.0232	-0.3944	3.8678	-0.4357	2.2754	3.8336
u (%)	-0.0006	-0.0006	0.0237	0.0237	-0.0038	-0.0038	-0.0106	-0.0106	0.0066	0.0066	-0.0068	-0.0068
	0.0008	0.0008	0.0280	0.0280	-0.0035	-0.0035	-0.0118	-0.0118	0.0075	0.0075	-0.0070	0.0008

governments. Here the assumption was that each regional government chooses its rate of payroll-tax so as to maximize a social-welfare function consisting of a weighted sum of the utility functions of the households in its region. The results of the six simulations carried out in terms of this welfare-maximizing framework are set out in Table 1 of the earlier paper.

The most striking feature of the comparison is the further evidence it provides that migration is the most important force in determining the welfare effects of the transfer. As in the previous comparison between exogenous and empire-building regional governments, the present comparison of beneficent and empire-building governments shows that the migration and utility effects are the same whatever the assumed regional government behavior.

Most other variables differ considerably across the two sets of simulations. An important difference relates to the reaction of regional governments to the transfer. Regional governments that seek to maximize welfare change their tax rates so that the effect on G of the change in GF is largely offset by an opposite change in GR . Thus in a welfare-maximizing framework the government in the recipient region “takes advantage” of the transfer to lower its tax rate and expenditure, while in the present empire-building framework it reacts in the opposite way – the regional governments’ reactions amplify the effects of the federal government’s action.

As explained in more detail in Appendix A, the procedure used to calibrate the parameters of the utility function is based on the assumption that in the initial equilibrium, households choose C and G to maximize their utility. However, this is not strictly implied by the CGE component of our model in which households take G as given and actually choose only C so that the conditions on γ and δ will generally not be satisfied even if the initial solution corresponding to the data base is one in which households maximize utility.

The question to which this gives rise is to what extent the qualitative character of the results presented above would be affected by a change in the values used for γ and δ in the linearized version of our PECGE model. In Table 4 we give the results of a sensitivity analysis of the results in Table 1. The table relates only to the NSW simulation. However this simulation is typical as will be seen from Appendices C and D where the corresponding sensitivity analysis for the other five simulations can be found. In Appendix E we present sensitivity analysis of the effects of the federal government shock on national output, previously reported in Table 2.

Table 4 makes it clear that with one exception, the general character of the results given in Table 1 is not affected by substantial changes in the values used for γ and δ in the simulations. The one exception relates to the u row where a sign change occurs in the “-0.05” column. This reflects the fact that whether the shock is welfare-enhancing depends on the initial equilibrium. Recall that even with $\gamma = C/(C + G)$, which maximizes individual utility, welfare will generally not be at an optimum because of the

TABLE 4

Sensitivity of Table Results to Changes in Values of γ and δ : NSW Simulation

Variable	$\gamma = C/(C + G)$		$\gamma = C/(C + G) - 0.05$		$\gamma = C/(C + G) + 0.05$	
	Region 1	Region 2	Region 1	Region 2	Region 1	Region 2
c (%)	-1.2109	0.6777	-2.1332	1.1939	-0.6540	0.3660
l (%)	2.2475	-1.1796	3.9595	-2.0781	1.2139	-0.6371
L (number)	63,031	-63,031	111,044	-111,044	34,044	-34,044
W (%)	-1.3259	0.7523	-2.3358	1.3253	-0.7161	0.4063
t (%)	0.7828	-0.4492	1.3791	-0.7914	0.4228	-0.2426
Gr (%)	2.2475	-1.1796	3.9595	-2.0781	1.2319	-0.6371
GR (\$pc)	161.8000	-79.6800	285.0500	-140.3800	87.3900	-43.0400
g (%)	6.7936	-3.6484	8.5221	-4.5284	5.7501	-3.1172
G (\$pc)	484.4200	-247.7800	607.6700	-307.5300	410.0100	-211.6900
y (%)	-0.6837	0.3878	-1.2045	0.6832	-0.3693	0.2095
y_{tot} (%)	1.5638	-0.7918	2.7549	-1.3949	0.8446	-0.4277
initial- u (%)	0.6841	-0.3881	0.9103	-0.5089	0.4578	-0.2652
u (%)	-0.0006	-0.0006	0.0106	0.0106	-0.0059	-0.0059

distortions present in the model. The analysis reported in Petchey (1995) and Groenewold, Hagger, and Madden (2003) show that a change in government transfers may be efficiency-enhancing depending on the balance between the size of the transfer and profits (which are also distributed on an equal per-capita basis). This balance is, in turn, affected by the parameters of the utility function: decreasing the weight on C and therefore increasing the weight on G makes it more likely that the initial equilibrium is one where G is too small (from a welfare point of view) so that an increase in G is welfare-enhancing. It remains true, however, that (as before) utility changes are small relative to those in the other variables.

4. CONCLUSION

In this paper we have set out to analyze 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 maximize 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 maximization.

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 large initial effects on utility but that once households are permitted to migrate in response to inter-regional utility differentials, the effect of migration is to substantially remove these welfare effects. We found that the changes in transfers result in significant changes in per capita consumption, government expenditure, wages, and tax rates. The initial increase in welfare in the recipient region leads to an 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 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-maximizing level.

Comparison of results for three different assumptions regarding the behavior of regional governments (exogenous, beneficent, and empire-building) showed that welfare effects differ little across models incorporating these three different modes of behavior. The welfare effects appear instead to be driven largely by inter-regional migration, which is the same across all cases. The effects of the transfer on the other variables are, however, substantially affected by the assumed behavior of the regional governments. In particular, regional government expenditure offsets the effects of the transfer under the assumption of beneficent behavior while it reinforces it in the empire-building case.

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APPENDIX A. THE LINEARIZED NUMERICAL VERSION OF THE TWO-REGION PEGE MODEL

A.1 Linearization of the PEGE Model

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

The linearized form of the PEGE model is:

$$(16') \quad (\alpha_i - 1)l_i - w_i - \sigma_{t_i} t_i = (\alpha_i - 1)n_i \quad i = 1, 2$$

where $x_i \equiv \frac{dX_i}{X_i}$ for all X_i and $\sigma_{t_i} \equiv \frac{T_i}{1 + T_i}$.

$$(17') \quad gr_i = w_i + t_i \quad i = 1, 2$$

$$(18') \quad l_1 + gf_1 = l_2 + gf_2$$

$$(19') \quad \sigma_{\ell 1} l_1 + \sigma_{\ell 2} l_2 = \bar{l}$$

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

$$(20') \quad \gamma c_1 + \delta (\sigma_{gr1}^g gr_1 + \sigma_{gf1}^g gf_1) = \gamma c_2 + \delta (\sigma_{gr2}^g gr_2 + \sigma_{gf2}^g gf_2)$$

where $\sigma_{gri}^g = \frac{GR_i}{GR_i + GF_i} = \frac{GR_i}{G_i}$ and $\sigma_{gfi}^g = \frac{GF_i}{G_i}$

$$(21') \quad \ell_i = gr_i \quad i = 1, 2$$

$$(22') \quad \sigma_{ci}^y c_i + \sigma_{gri}^y gr_i - (\alpha_i - 1)l_i = -(\alpha_i - 1)n_i \quad i = 1, 2$$

where $\sigma_{ci}^y = \frac{C_i}{C_i + GR_i}$ and $\sigma_{gri}^y = \frac{GR_i}{C_i + GR_i}$

Equations (16')-(22') constitute a linear system in the 11 endogenous variables: c_i , l_i , w_i , t_i , gr_i , and gf_2 and the four exogenous variables: n_i , gf_1 , and $\bar{l}$.

A.2 Numerical Version of the Linearized PEGE Model

We now put the linearized PEGE model into numerical form by evaluating the various coefficients that 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), and 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 that have to be evaluated: α_i , γ , δ , σ_{ti} , σ_{li} , σ_{gri}^g , σ_{gfi}^g , σ_{ci}^y , and σ_{gri}^y . These parameters fall into two groups. The first

three appear in model relationships, γ and δ appear in the utility function (1), and α_i in the production function (4). The last six, 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 (16) and (22) we get:

$$\alpha_i = \frac{W_i(1+T_i)}{C_i + GR_i}, \quad i = 1, 2$$

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_i , T_i , C_i , 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 and δ . Here we follow the approach conventionally adopted by GE modelers and calibrate the utility function to ensure that the initial solution is one of utility maximization.⁸ Since the relative price of C and G is unity, utility maximization implies that the ratio γ/δ is equal to C/G . Then, using the restriction that $\gamma + \delta = 1$, we have

$$\gamma = C/(C + G),$$

and

$$\delta = G/(C + G).$$

The linearization parameters can be evaluated directly from their definitions, as presented above, 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_i , and L_i . We use the model constraints to calculate $T_i = GR_i/W_i$ and $G_i = GR_i + GF_i$, thus ensuring that the parameter values are consistent with the constraints. The figures we use for the aggregates that appear in these constraints are the average values for the years 1994-95 to 1998-99.

The data used for parameter evaluation is given for each of the six versions of the linearized model in Appendix B.

⁸ It should be noted that while this parameterization is conventional, it is not strictly implied by our model specification since households maximize utility subject to a given level of G .

APPENDIX B. DATABASE

	Total corresponding to		LW (\$m)	GF (\$m)	W (\$ '000)	L ('000)	Y/L (\$ '000)
	C (\$m)	GR (\$m)					
Region 1 NSW	112,265.4	20,189.8	92,160.8	-192.3	32.8618	2,804.5	47.2295
Region 2 ROC	195,152.8	36,096.6	15,227.8	192.3	29.0498	5,343.5	43.2768
Nation	307,418.2	56,286.4	247,388.6	0.0	30.3619	8,148.0	44.6373
Region 1 Vic	80,040.8	13,545.4	65,680.6	-686.9	31.3078	2,097.9	44.6095
Region 2 ROC	227,377.4	42,741.0	181,708.0	686.9	30.0339	6,050.1	44.6469
Nation	307,418.2	56,286.4	247,388.6	0.0	30.3619	8,148.0	44.6373
Region 1 Qld	55,026.0	9,662.6	42,041.6	-83.3	27.2096	1,545.1	41.8669
Region 2 ROC	252,392.2	46,623.8	205,347.0	83.3	31.0995	6,602.9	45.2856
Nation	307,418.2	56,286.4	247,388.6	0.0	30.3619	8,148.0	44.6373
Region 1 SA	23,339.2	4,906.8	18,088.6	826.0	27.7773	651.2	43.3753
Region 2 ROC	284,079.0	51,379.6	229,300.0	-826.0	30.5864	7,496.8	44.7469
Nation	307,418.2	56,286.4	247,388.6	0.0	30.3619	8,148.0	44.6373
Region 1 WA	29,616.0	6,259.6	24,236.8	-383.0	28.4236	852.7	42.0729
Region 2 ROC	277,802.2	50,026.8	223,151.8	383.0	30.5884	7,295.3	44.9370
Nation	307,418.2	56,286.4	247,388.6	0.0	30.3619	8,148.0	44.6373
Region 1 Tas	7,130.8	1,722.2	5,180.2	519.4	26.3489	196.6	45.0305
Region 2 ROC	300,287.4	54,564.2	242,208.4	-519.4	30.4611	7,951.4	44.6276
Nation	307,418.2	56,286.4	247,388.6	0.0	30.3619	8,148.0	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. 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 is calculated from these figures to ensure that the model constraints hold: $L = L_1 + L_2$, $W_i = W_i L_i / L_i$, $Y_i = GR_i + C_i$, $G_i = GR_i + GF_i$, $T_i = GR_i / W_i L_i$. It should be noted that, as the model excludes investment and net interstate and overseas exports, Y_i will not conform with official figures.

APPENDIX C: RESULTS OF SIMULATIONS WITH $\gamma = (C/C+G) + 0.05$

Variable	Version											
	1		2		3		4		5		6	
	Reg 1: NSW	Reg 2: ROC	Reg 1: Vic	Reg 2: ROC	Reg 1: Qld	Reg 2: ROC	Reg 1: SA	Reg 2: ROC	Reg 1: WA	Reg 2: ROC	Reg 1: Tas	Reg 2: ROC
c (%)	-0.6542	0.3660	-0.6329	0.2444	-0.7026	0.1556	-0.8211	0.0613	-0.7875	0.0848	-0.8683	0.0158
l (%)	1.2139	-0.6371	1.2220	-0.4235	1.1966	-0.2800	1.2721	-0.1105	1.3030	-0.1523	1.1476	-0.0284
L (number)	34,045	-34,045	25,637	-25,637	18,489	-18,489	8,284	-8,284	11,110	-11,110	2,256	-2,256
w (%)	-0.7161	0.4063	-0.6916	0.2710	-0.7902	0.1712	-0.9267	0.0676	-0.8684	0.0937	-1.0159	0.0174
t (%)	1.9301	-1.0434	1.9136	-0.6947	1.9869	-0.4512	2.1988	-0.1781	2.1714	-0.2460	2.1635	-0.0458
gr (%)	1.2139	-0.6371	1.2220	-0.4237	1.1966	-0.2800	1.2721	-0.1105	1.3030	-0.1523	1.1476	-0.0284
GR(\$pc)	87.3900	-43.0400	78.9000	-29.9400	74.8300	-19.7700	95.8600	-7.5700	95.6500	-10.4400	100.5300	-1.9500
g (%)	5.7501	-3.1172	6.5510	-1.9495	6.4108	-1.3441	4.7536	-0.5505	6.0691	-0.6858	3.7112	-0.1573
G(\$pc)	410.0100	-211.7000	401.5200	-139.9400	397.4500	-95.0800	418.4800	-37.1200	418.2700	-47.3900	423.1500	-10.6900
y (%)	-0.3693	0.2095	-0.3644	0.1387	-0.4189	0.0877	-0.4575	0.0350	0.4227	0.0486	-0.4761	0.0090
ytot (%)	0.8446	-0.4277	0.8577	-0.2851	0.7777	-0.1923	0.8147	-0.0755	0.8803	-0.1037	0.6715	-0.0194
initial-u (%)	0.4579	-0.2652	0.4654	-0.1691	0.5114	-0.1130	0.5394	-0.0443	0.5410	-0.0554	0.5353	-0.0132
u (%)	-0.0060	-0.0060	0.0023	0.0023	-0.0036	-0.0036	-0.0006	-0.0006	0.0050	0.0050	-0.0019	-0.0019

APPENDIX D: RESULTS OF SIMULATIONS WITH $\gamma = (C/C+G) - 0.05$

Variable	Version											
	1		2		3		4		5		6	
	Reg 1: NSW	Reg 2: ROC	Reg 1: Vic	Reg 2: ROC	Reg 1: Qld	Reg 2: ROC	Reg 1: SA	Reg 2: ROC	Reg 1: WA	Reg 2: ROC	Reg 1: Tas	Reg 2: ROC
c (%)	-2.1332	1.1939	-2.1872	0.8447	-2.2525	0.4990	-2.1910	0.1635	-2.4673	0.2657	-1.9935	0.0363
l (%)	3.9595	-2.0781	4.2235	-1.4645	3.8363	-0.8977	3.3945	-0.2949	4.0826	-0.4772	2.6348	-0.0651
L (number)	111,045	-111,045	88,604	-88,604	59,273	-59,273	22,105	-22,105	34,812	-34,812	5,180	-5,180
w (%)	-2.3358	1.3253	-2.3901	0.9366	-2.5334	0.5489	-2.4726	0.1803	-2.7210	0.2935	-2.2325	0.0400
t (%)	6.2953	-3.4034	6.6155	-2.4011	6.3697	-1.4466	5.8672	-0.4752	6.8035	-0.7707	4.9673	-0.1052
gr (%)	3.9595	-2.0781	4.2235	-1.4645	3.8363	-0.8977	3.3945	-0.2949	4.0826	-0.4772	2.6348	-0.0651
GR(\$pc)	285.0500	-140.3800	272.6900	-103.4600	239.9100	-63.3900	255.7800	-20.2100	299.7000	-32.7200	230.8100	-4.4700
g (%)	8.5221	-4.5284	9.7127	-2.9099	9.0733	-1.9549	6.5702	-0.7755	9.0298	-0.9846	4.8538	-0.2091
G(\$pc)	607.6700	-307.5300	595.3100	-208.8700	562.5300	-138.2800	578.4000	-52.3000	622.3200	-68.0400	553.4300	-14.2100
y (%)	-1.2045	0.6832	-1.2594	0.4793	-1.3430	0.2812	-1.2207	0.0933	-1.3245	0.1524	-1.0931	0.0207
ytot (%)	2.7550	-1.3950	2.9641	-0.9852	2.4932	-0.6165	2.1739	-0.2016	2.7581	-0.3248	1.5417	-0.0445
initial-u (%)	0.9103	-0.5090	0.9917	-0.3089	1.0318	-0.2183	0.9059	-0.0957	1.0091	-0.1041	0.8082	-0.0290
u (%)	0.0106	0.0106	0.0549	0.0549	-0.0069	-0.0069	-0.0253	-0.0253	0.0112	0.0112	-0.0134	-0.0134

APPENDIX E: EFFECT ON NATIONAL OUTPUT OF A POSITIVE SHOCK TO GF_1 : SENSITIVITY TO THE VALUES OF THE PARAMETERS OF THE UTILITY FUNCTION

Simulation	Output Change		
	$\gamma = \text{share}$	$\gamma = \text{share} - 0.05$	$\gamma = \text{share} + 0.05$
NSW as Region 1	0.0661	0.1164	0.0357
Vic as Region 1	0.0172	0.0310	0.0090
Qld as Region 1	0.0366	-0.0634	-0.0198
SA as Region 1	0.0106	-0.0171	-0.0064
WA as Region 1	-0.0119	-0.0207	-0.0066
Tas as Region 1	-0.0039	-0.0059	-0.0026