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Optimal fiscal equalisation and its application to Australia

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Abstract: The first part of this paper develops a theoretical model of fiscal equalisation and uses the model to derive an optimal equalisation formula that has general applicability for federations. If vertical equity is achieved by the central government and horizontal equity by interstate migration, the role of fiscal equalisation is to support an efficient distribution of different labour types across states. The theoretical model draws on Boadway and Flatters (1982) and Albouy (2012), with some Australian-oriented extensions. The resulting optimal formula implies that full equalisation should be applied for the fixed costs of state government and for source-based taxes on natural resources, land and capital. However, equalisation should only correct for difference in fiscal capacities arising from state demographic mixes when applied to the variable costs of state government, residence-based taxes on labour and consumption taxes. Simplifying assumptions of the model are discussed. The second part of this paper applies the optimal equalisation approach to Australia, using the Commonwealth Grants Commission (CGC) assessment for 2017/18 as a base. The effects on consumer welfare of moving from the current Australian full equalisation system to optimal equalisation, partial equalisation or no equalisation are estimated, along with the associated impacts on state populations.

Key words: fiscal equalisation, Federalism, Intergovernmental relations, Australia

JEL Codes: D61, H77, J61

Optimal fiscal equalisation and its application to Australia[1]

1 INTRODUCTION

Most federations use a system of fiscal equalisation to address concerns that states have different fiscal capacities. This is consistent with Buchanan (1950) who was concerned that economic forces had "tended to concentrate high income earners in specific geographic areas" leading to "inter-regional disparities in fiscal capacity". He proposed the principle that fiscal equalisation be used to "allow state units originally unequal in fiscal capacity to provide equal services at equal rates of taxation".

Australia has closely followed Buchanan's principle in developing what Spahn (2007, p.93) has identified as the world's most comprehensive system of fiscal equalisation.

> Despite shortcomings such as a high degree of complexity, the Australia system has become *the* model for an ideal equalisation system. The basic approach is sound, complete, feasible, and reasonably transparent…the unique benchmark against which all equalisation mechanisms have to be compared in terms of their vulnerability to manipulation and perverse incentives.

This paper has two aims. First, it develops a theoretical model of fiscal equalisation and uses that model to derive an optimal fiscal equalisation formula that has general applicability for federations. Second, the optimal formula is used as a benchmark in estimating the impacts on consumer welfare in Australia of alternative equalisation policies. The comprehensive nature of the existing Australian equalisation system provides a natural platform for investigating the merits of equalisation in the real world.

The theoretical grounds for fiscal equalisation have shifted. Originally, Buchanan proposed his equalisation principle on the horizontal equity grounds of "equal treatment for equals" (Buchanan, 1950, p. 587). However, the free movement of labour between the states of a federation offers a way of achieving horizontal equity in which individuals can allow for all factors that influence their welfare, not just net fiscal benefits.

Later, Buchanan (1952) demonstrated that the principle of "equal treatment for equals" could promote locational efficiency of labour. Indeed, Boadway and Flatters (1982) developed a theoretical model with heterogeneous individuals and found that "the equalisation program that is called for on efficiency grounds is one that fully equalises per capita revenues from both

[1] The author would like to thank participants at a seminar at the Arndt-Corden Department of Economics, ANU, and at the Federal Relations Tax Reform Workshop, University of Adelaide, for helpful comments on earlier versions of this paper.

source-based and residence-based taxes". Full equalisation of the capacity to raise revenue was needed so that location decisions for each type of labour were driven by marginal productivity rather than net fiscal benefits.

Albouy (2012), using an extended version of the Boadway and Flatters (1982) model that allows for interstate differences in productivity and consumer amenity, calls this finding into question. "Unlike influential work by Buchanan (1950) and Boadway and Flatters (1982), I argue that, when properly interpreted, this same framework actually only supports the equalisation of source, and not residence-based revenues."

This study also supports equalisation of source-based revenues, but obtains more precise findings than Albouy (2012) for equalisation of residence-based revenues. After separating equalisation transfers from other central government transfers that target vertical equity, it finds that a form of limited equalisation is optimal for residence-based taxes. Limited equalisation takes into account demographic factors, but not other factors, in assessing the capacity of states to raise revenue from residence-based taxes.

While the literature on fiscal equalisation has focussed more on state government revenues than their expenditures, the Australian fiscal equalisation system covers both sides of state budgets. Consequently, the theoretical modelling in this paper features an enhanced treatment of government expenditures. This treatment allows demands for government services to vary across types of individuals and it makes a distinction between the fixed and variable costs of providing government services. The Goods and Services Tax (GST) plays a central role in the Australian equalisation system, so this paper also introduces a consumption tax into the theoretical model.

Turning to the second aim of this paper of assessing alternative equalisation policies in Australia, until recently work in this area has used multi-regional Computable General Equilibrium (CGE) models. For example, Independent Economics (2012) used such a model to estimate a gain in annual consumer welfare benefit of $295 million from the Australian equalisation system, compared to a situation in which all equalisation adjustments, except on account of indigeneity, were abandoned.

While such CGE modelling can provide estimates of a wide range of economic impacts from fiscal equalisation, Albouy (2012) demonstrates the potential advantages of instead undertaking a theoretical analysis, beyond the ability to make more general assumptions. If an optimal policy rule can be derived, that rule can have direct importance for policy makers. Furthermore, with an optimal rule, the effects on consumer welfare of departing from that rule can be quantified using deadweight loss calculations, as illustrated by Albouy (2012) for Canada.

In a precursor to this study, Murphy (2015) follows Albouy (2012) in undertaking a theoretical analysis, but applies the findings to Australia rather than Canada. This theoretical approach

makes more general assumptions than the earlier Australian CGE modelling, including allowing for heterogeneous individuals, capital and different types of residence-based and source-based taxes.

This paper further develops the precursor study of Murphy (2015) in four main ways. First, it develops the design of an optimal equalisation system in greater detail. Second, it provides a practical example of how the concept of limiting equalisation to demographic drivers can be implemented. Third, it considers a wider range of equalisation policy options. Fourth, it updates by using the 2017/18 equalisation payments in place of the 2015/16 payments.

Section 2 of this paper pursues the first aim of this paper. That is, it develops a model of fiscal equalisation and uses that model to derive an optimal fiscal equalisation formula. The model synthesises Boadway and Flatters (1982) with Albouy (2012) and adds the Australian-oriented enhancements introduced above. This section provides a general explanation of the model and formula, while the full theoretical analysis is presented in the Appendix.

Under the optimal formula, there is full equalisation for the fixed costs of state government and for source-based taxes on natural resources, land and capital. However, equalisation limited to demographic factors is applied for the variable costs of state government, residence-based taxes on factor incomes and consumption taxes (e.g. GST).

The remaining sections pursue the second aim of this paper. That is, they use the optimal equalisation formula derived here to estimate the impacts on consumer welfare of alternative equalisation policies in Australia.

Section 3 summarises the existing Australian system of fiscal equalisation, which is managed by the Commonwealth Grants Commission (CGC). It identifies the similarities and differences between the Australian system and the welfare-maximising system. These differences are quantified by comparing the CGC equalisation transfers for 2017/18 with the optimal transfers.

Section 4 explains how limited equalisation could be implemented and how it differs from full equalisation. This is demonstrated using the 2017/18 CGC equalisation assessments as a reference point.

Section 5 estimates the impacts of alternative equalisation policies on consumer welfare and the state distribution of the national population. The policies considered include no equalisation, partial equalisation and optimal equalisation.

Section 6 presents the main qualifications to the analysis.

Section 7 summarises the proposal for optimal equalisation developed in this paper.

2 EQUALISATION MODEL

The first aim of this paper is to develop a theoretical model of fiscal equalisation and use that model to derive an optimal fiscal equalisation formula that has general applicability for federations. This section provides a general explanation of the model and associated formula, while the Appendix provides the full theoretical analysis.

2.1 Model

The model used here draws on Boadway and Flatters (1982) and Albouy (2012). While Boadway and Flatters (2012) present a range of models, this paper refers to the final model, which features heterogeneous individuals and capital. Table 1 summarises the main features of the model used here compared to the models of Boadway and Flatters (1982) and Albouy (2012).

As can be seen from Table 1, the model used here contains three main enhancements, all of which are designed to make it more useful in the Australia setting. First, the model introduces a consumption tax, as the Goods and Services Tax (GST) plays a central role in fiscal equalisation in Australia. Second, the model allows for the fixed costs of state government, as these feature in Australia's fiscal equalisation arrangements. Third, the model takes into account that state governments provide different levels of services to different individuals, as differences in individual needs also play an important role in Australian equalisation.

In the model, the national population is classified into different labour market types. In practice, likely ways of distinguishing between these types include age, educational attainment and indigeneity status. The national supply of each type is assumed to be fixed.

Labour is assumed to be mobile between states. Consequently, a given labour type will migrate between states until its welfare level is equalised across states. In this way, migration ensures that there is full horizontal equity. This removes horizontal equity as a motive for fiscal equalisation.

At the same time, the central government pursues vertical equity using the tax-transfer system. This is represented as a set of net transfers between labour types that sum to zero. Thus, the central government achieves vertical equity through the tax-transfer system, removing vertical equity as a motive for fiscal equalisation.

This leaves only one role for the fiscal equalisation transfers, which are also made by the central government. That role is to ensure that differences in fiscal capacities between states do not distort the locational decisions of each type of labour. This is part of ensuring that the national labour market for each labour type operates efficiently.

Table 1: Comparison of Main Assumptions

	Boadway and Flatters (1982)	*Albouy (2012)*	*this paper*
No. of states	2	any	any
State Residence-based taxes	labour, property	labour, interest, rent	labour, interest, rent, consumption
State Source-based taxes	capital, fixed factor	capital, fixed factor	capital, fixed factor
Central Govt taxes	none	residence-based taxes	none
Central Govt transfers	differentiated by state	differentiated by state by labour type	differentiated by state by labour type
Individuals	heterogeneous	heterogeneous	heterogeneous
Asset holdings (state/national)	national	national	national
Key differences between states	Skill-mix of individuals	Skill-mix of individuals; economic rents; productivity; consumer amenity	Skill-mix of individuals; economic rents; productivity; consumer amenity
State government good	Private; equal provision across individuals	Private/public; equal provision across individuals	Private; provision can vary across individuals; fixed and variable production costs
State government view of equalisation payments	taken as given	taken as given	taken as given
Labour and capital supplies	Fixed nationally; fully mobile between states	Fixed nationally; fully mobile between states	Fixed nationally; fully mobile between states

The motivation for fiscal equalisation arises from economic differences between states. In the model, the structure of state economies can differ in three ways.

First, states can vary in their amenity to consumers. A state with higher amenity to likely to attract more labour, until the benefit of the higher amenity is balanced by the cost of lower wages. Thus, in labour market equilibrium, there may be higher amenity-lower wage states, and lower amenity-higher wage states.

Second, states can vary in their underlying productivity. State differences in productivity can arise from factors such as remoteness or inefficient delivery of government services. Higher productivity states can attract more labour, until real wages are equated between states, for a given level of amenity and labour type.

Third, states can vary in their natural endowments, leading to different levels of economic rents from fixed factors of production such as land and mineral resources. The model assumes that individuals hold portfolios of national assets rather than state assets, so that property income is independent of state of residence. This removes state differences in property income as a direct distortion to labour location decisions in the model. At the same time, labour location decisions are influenced by the effects of the availability of fixed factors of production on the marginal productivity of labour, as required for efficiency.

All three structural state differences – amenity, productivity and natural endowments – can influence labour location decisions both directly and indirectly via state budgets. Further, these influences may be different for different types of labour. Hence, states may differ in a fourth way, namely in their mix of labour types or population composition.

Like each type of labour, the supply of capital is assumed to be fixed at the national level but mobile between states. While it would be inappropriate to assume a fixed national supply of capital in a study of corporate tax, it is a more innocuous assumption in the current context of analysing labour locations decisions.

For capital to be efficiently allocated across states, its marginal product must be uniform across states. Otherwise, returns to the stock of national capital could be increased by re-allocating capital from states where its marginal product is lower to states where it is higher. The marginal product of capital will be uniform across states provided its rental price is also uniform.

On the supply side of the capital market, capital owners will arbitrage between states until the returns they receive exclusive of each state's source-based capital tax are the same. For capital returns to be uniform across states both before this tax (the efficiency condition) and after this tax (the arbitrage condition), each state must apply the same tax rate.

It follows that if states can levy a source-based capital tax such as a corporate tax, as they can in some countries (but not Australia), a Pareto optimum requires that all states apply corporate tax at the same rate, as found by Boadway and Flatters (1982) and confirmed by Albouy (2012).

Like the models of Albouy (2012) and Boadway and Flatters (1982), the model here allows for a second state source-based tax, namely a tax on a state's fixed factor. Land and mining-based taxes fall in this category. Because the supply of the fixed factor is fixed at the state level, the issue of locational efficiency does not arise.

Turning to residence-based taxes, the model here follows Albouy (2012) in allowing for taxes on labour, interest (i.e. income from capital) and rents (i.e. income from the fixed factor). State income tax (which is not applied in Australia) and state payroll tax fall in this category. In addition, the model extends the previous modelling by allowing for a tax on private consumption, such as the Australian GST.

State governments also provide a good, which is assumed to be private rather than public in nature. Typical examples are education and health services. While the previous modelling assumes that each individual in a state consumes the same amount of this government good, the model here allows consumption of the government good to vary between labour types. This takes into account that consumption of some state government services varies between individuals with attributes such as age and indigenous status. The model here also develops the modelling of Boadway and Flatters (1982) and Albouy (2012) by allowing for the fixed costs of a state government administration.

In the model, government policy decisions are assumed to be made by a benevolent planner. This benevolent planner has four main tasks. First, the planner needs to ensure that it makes the optimal supply of the state government good to each labour type in each state. Second, the planner needs to achieve vertical equity in making redistributive transfers between labour types. Third, the planner needs to support an efficient locational distribution of labour through fiscal equalisation between states. Fourth, as already noted, the planner needs to support an efficient locational distribution of capital by setting a uniform rate of source-based capital tax across all states.

As shown rigorously in the Appendix, the condition for an efficient locational distribution of labour is that, for a given type of labour, every state offers the same non-labour income. This is so location decisions for each labour type are driven by the marginal product of labour and are not distorted by signals from non-labour income. Determining whether this condition for uniform non-labour income is met involves considering each of the three categories of non-labour income to see if it is the same level in all states, for a given type of labour.

The first category of non-labour income is the central government transfers (positive and negative) designed to achieve vertical equity. These transfers are assumed to vary only according to labour type, not according to state, and so they satisfy the uniformity requirement.

In any case, with mobile labour, these transfers do not need to vary by labour type to achieve vertical equity. Furthermore, central government transfers that differentiate simultaneously between labour type and state of residence can be unconstitutional in some federations, including in the Australian federation.

The second category of non-labour income is property income, including rental income from both capital and land. In the model, property income for a given labour type is independent of state of residence, so property income also meets the uniformity requirement. This follows from the assumption that individuals of a given type own the same portfolio of national assets irrespective of their state of residence.

While this assumption follows some previous literature, including Albouy (2012) and the final model of Boadway and Flatters (1982), there is also a literature that assumes that individuals own a share of assets in the state in which they live, including in one of the earlier models considered by Boadway and Flatters (1982). If individuals only hold assets of their own state, their location decisions can be influenced by state differences in property income. However, in reality private wealth does not change merely as a result of moving from one state to another, even though portfolio compositions may. So to remove this doubtful influence on location decisions, this paper assumes that individuals own a share of national assets, rather than a share of state assets. This means that property income does not influence location decisions.

The third category of non-labour income is the net fiscal benefit offered by each state to an individual of a given labour type. This net fiscal benefit is equal to the value of state government services received by that individual net of the value of the state residence-based taxes that the individual is required to pay. In general, in the absence of fiscal equalisation, net fiscal benefits will not be uniform across states for the same type of individual.

In the model, there are three main reasons that some states will offer higher net fiscal benefits than other states if there is no fiscal equalisation. First, states with larger populations are able to spread the fixed costs of their government administrations more thinly across their populations. Second, states richer in land and minerals are likely to have a fiscal advantage in raising revenue from source-based taxes. Such taxes can be used to fund services to the residents of a state, but are partly collected from non-residents. Third, states with higher-skilled labour more heavily represented in their populations are likely to raise more revenue from residence-based taxes, leaving them better funded to provide services to all labour types.

In each of these cases of fiscal advantage, the advantaged state is able to offer labour of a given type a higher net fiscal benefit. In general, this can take the form of higher government services and/or low tax rates for residence-based taxes. This will lead to interstate migration driven inefficiently by state differences in net fiscal benefits, rather than driven efficiently by state differences in real wages adjusted for state amenity. However, equalisation transfers can be used to remove this locational inefficiency, as originally emphasised by Buchanan (1952).

2.2 Optimal Fiscal Equalisation Formula

The Appendix formally derives the optimal fiscal equalisation formula, which is obtained at its equations [27] and [28]. The formula is reproduced below. Under this formula, each state is funded to offer the same labour type *e* the same net fiscal benefit, res_e, as required for efficient labour location.

$$fe^j = \left[GF^j/N^j - \sum_j GF^j/N\right] - \left[tL^j r^j L^j/N^j - \sum_j tL^j r^j L^j/N\right] - \left[tK^j i^j K^j/N^j - \sum_j tK^j i^j K^j/N\right] + \sum_e \left(N_e^j/N^j - N_e^{TOT}/N\right) res_e \quad [27]$$

$$res_e = \frac{1}{N_e^{TOT}} \left\{ \begin{array}{c} \sum_j PG^j N_e^j g_e^j - \sum_j tc^j PC^j N_e^j c_e^j - \sum_j tw^j N_e^j w_e^j \\ -\theta_e \sum_j \frac{N_e^j tI^j}{N_e^{TOT}} \sum_k (1 - tK^k) i^k K^k - \theta_e \sum_j \frac{N_e^j tR^j}{N_e^{TOT}} \sum_k (1 - tL^k) r^k L^k \end{array} \right\} \quad [28]$$

Equation [27] shows the optimal fiscal equalisation transfer per capita to state *j* of fe^j. The right hand side of equation [27] conveniently decomposes the components of the state budget into those that should be fully equalised and those that should be subject to limited equalisation. The first three terms involve full equalisation and are now considered in turn.

The first term implies that the fixed costs of each state government (GF^j) should be fully equalised. A state government receives from the equalisation pool its state fixed costs and pays into the pool its per capita share of the fixed costs for all states. In that way, each state faces the same per capita fixed costs. This removes the fiscal advantage that larger states enjoy over smaller states from spreading fixed costs over a larger population base. It is efficient to equalise for fixed costs because labour location decisions should be based on marginal costs, not fixed costs. In Australia there is full equalisation for the fixed costs of government in what is known as equalisation for administrative scale.

The second and third terms imply that source-based taxes on productive assets such as land or natural resources (*L*) and capital (*K*) should also be fully equalised. In the model, individuals own shares of national assets, so the ability to tax asset income at its source enables a state government to tax asset holders nationwide. For example, mining royalties allow a state government to tax shareholders in all states (and, in practice, internationally). Because of this national incidence, it is efficient to share the proceeds nationally. To do otherwise creates fiscal advantages for states with more ready access to source-based tax revenue, leading to inefficient fiscally-induced migration. In Australia, the main state source-based taxes are fully equalised. This includes full equalisation of mining royalties, stamp duty on conveyances and land tax.

The final term involves only limited equalisation of the net fiscal benefit (res_e). This limited equalisation only takes into consideration state differences in fiscal capacity that arise from state differences in population compositions. In particular, if the share of a labour type in a state population (N_e^j/N^j) is higher than in the national population (N_e^{TOT}/N), the state is

funded to provide the national net fiscal benefit to its excess population of that labour type. This limited equalisation eliminates inefficient migration driven by fiscal advantages and disadvantages arising from differences between states in their population compositions. Limited equalisation does not equalise for factors other than population composition, including state amenity and state productivity, for reasons discussed below.

To apply limited equalisation, it is necessary to analyse state fiscal advantages and disadvantages resulting from differences in population compositions. For this purpose, it would be appropriate to cross-classify populations using attributes such as age, educational attainment and indigeneity status. Section 4 demonstrates how limited equalisation could be applied in practice using this approach.

The case for limited rather than full equalisation only applies to the net fiscal benefit. However, the net fiscal benefit defined in equation [28] accounts for a large part of state budgets. That equation constructs the net fiscal benefit for a given labour type at the national level, as it is uniform across states under optimal fiscal equalisation. The net fiscal benefit covers all of government spending other than the fixed costs and is net of consumption taxes such as GST, labour income tax such as payroll tax, and residence-based taxes on asset incomes. Australia currently practices full equalisation of government spending, GST and payroll tax, so replacing this with limited equalisation is a notable reform.

Limited equalisation, rather than full equalisation, of the net fiscal benefit is consistent with applying a user pays approach to providing state government services, where users pay through state residence-based taxes. For this to work efficiently, price signals need to be transmitted from expenditures to revenue raising, without any offset from equalisation. For example, if providing government services in a state is expensive because of remoteness or an inefficient state government, it is important this price signal is transmitted to residents of that state through higher residence-based taxes. In contrast, under full equalisation, a higher net fiscal benefit would be inappropriately paid to subsidise the higher cost of service provision.

Similarly, if a state has higher amenity leading more individuals to choose to live there in a trade-off with lower productivity and wages, it is important that the full impact of lower wages is felt so that the trade-off is made efficiently. This trade-off will be made inefficiently if full equalisation is used to compensate higher amenity states for the lower revenue base resulting from lower wages.

Finally, it is important to confirm that locational efficiency thorough fiscal equalisation transfers, and vertical equity through redistributive transfers, can be achieved at the same time. To fully pursue vertical equity, the central government must control total redistributive transfers (F_e) between labour types. This involves setting its own redistributive transfers (tr_e), after taking into account the amount of vertical redistribution already achieved in state government budgets through the dependence of state net fiscal benefits on labour type ($res_e - \overline{res}$).

$$F_e = tr_e + res_e - \overline{res} \quad [29]$$

This assumes that state governments all follow the same redistribution policy in determining the net fiscal benefit that they offer to each labour type. With each state operating the same redistribution policy, the central government can exercise control over the total extent of the vertical redistribution across labour types.

Another reason that redistribution policies need to be synchronised across states is so fiscal equalisation can achieve locational efficiency. If one state chooses to pursue greater vertical redistribution that other states, it is likely to result in inefficient migration involving an outflow of higher-skilled labour and an inflow of lower-skilled labour.

This raises the issue of whether it is likely that state redistribution policies will be synchronised. Boadway and Flatters (1982) make the following assumption about the progressivity of provincial government budgets in Canada.

> Residence-based taxes in each province are proportional to each individual's income, while public services, assumed to be of a quasi-private nature, are distributed on an equal per capita basis. The net effect of the provincial fiscal structures is therefore progressive.

Similar assumptions are reasonable for state government budgets in Australia and are also consistent with the models used in Albouy (2012) and here. Thus, government budgets in each state are likely to achieve some progressive, vertical redistribution between labour types.

At the same time, there are likely to be some small differences in state budgets arising from state differences in productivity and amenity. This could lead to some minor variation between states in the amount of vertical redistribution generated by their budgets. In the theoretical model in the Appendix, this minor variation is eliminated using state government redistributive transfers. That is, these transfers play the fine tuning role of synchronising vertical redistribution across state budgets. They do not change the overall vertical redistribution achieved by state budgets when viewed from a national level.

2.3 Relationship to previous studies

As already noted, Buchanan (1952) and Boadway and Flatters (1982) call for full equalisation of both residence-based and source-based taxes. However, their findings for residence-based taxes stem from the assumption that states only differ in their population compositions. Had they also considered differences between states in productivity or consumer amenity and applied the same theoretical approach, they would have found in favour of the limited equalisation proposed here that is based on population compositions only.

This analysis is also consistent with the model of Albouy (2012). This may appear surprising given Albouy's conclusion: "unlike influential work by Buchanan (1950) and Boadway and

Flatters (1982), I argue that, when properly interpreted, this same framework actually only supports the equalisation of source, and not residence-based revenues".

This may appear to differ from our finding that there should be limited equalisation of residence-based revenues. However, the two studies can be reconciled. The first step is to re-write the optimal fiscal equalisation formula of equation [27] more simply as follows.

$$fe^j = X^j + \overline{res_j} - \overline{res} \qquad [30]$$

Here X^j covers the terms involving full equalisation. The remaining term shows that limited equalisation involves a per capita transfer equal to the difference between the average net fiscal benefit for a state and the corresponding national average. Such differences arise from the differences between states in their population compositions.

Because low income earners receive high net fiscal benefits and high income earners receive low net fiscal benefits, our formula involves fiscal equalisation transfers in the expected direction, from high income states to low income states. This represents the equalisation advocated by Buchanan (1952) for the differences in fiscal capacities arising from differences in population composition.

Albouy (2012) presents his results in a different form. Rather than isolate fiscal equalisation transfers as in equation [30], he provides results for an omnibus government transfer that combines the transfers for fiscal equalisation and vertical redistribution. Thus, this government transfer $\left(F_e^j\right)$ varies by both state and labour type. It is also paid directly to individuals.

To put our results in the same form as Albouy (2012), we first construct a comparable omnibus government transfer. This omnibus transfer adds together our fiscal equalisation transfer given by equation [30] and our vertical redistribution transfer, tr_e.

$$F_e^j = \left(X^j + \overline{res_j} - \overline{res}\right) + tr_e \qquad [31]$$

As explained in the discussion of equation [29], the role of the vertical redistribution transfer (tr_e) is to achieve a target level of vertical redistribution (F_e) after taking into account the vertical redistribution already achieved through net fiscal benefits. Using equation [29] to eliminate tr_e in equation [31] puts our results in the same form used by Albouy (2012).

$$F_e^j = X^j + \overline{res_j} - res_e + F_e \qquad [32]$$

This equation includes an equalisation term for the difference between the average net fiscal benefit for a state and the net fiscal benefit for a type. Since high income earners receive low net fiscal benefits this appears to involve transfers in the opposite direction to before, from low income earners to high income earners. Albouy (2012) explains this as follows: "households paying more than the average (i.e. high income earners) should have excess taxes refunded to them by the federal government, insuring that local taxes operate as user fees".

The conclusion of Albouy (2012) is appropriate when referring to an omnibus government transfer. However, our conclusions are appropriate when referring more specifically to fiscal equalisation transfers.

Our optimal fiscal equalisation formula provided in full in equations [27] and [28] and in abbreviated form in equation [30] features limited equalisation for residence-based taxes. This limited equalisation captures Buchanan's concern of equalising for differences in fiscal capacities arising from differences in population compositions.

Our theoretical framework also provides some insights into the equalisation of state government expenditure. Boadway and Flatters (1982) and Albouy (2012) do not model this as they assume that government services are demanded and provided at the same level to everyone. This means that no state enjoys a population composition-related fiscal advantage or disadvantage in meeting expenditure needs.

In practice, the Australian experience with equalisation shows important differences in the expenditure needs of different population groups. For example, the indigenous population has high government expenditure needs and is highly represented in the Northern Territory. This paper confirms that such differences in expenditure needs based on population compositions should be fully equalised, as Albouy (2012) surmises. As also noted above, this paper also finds that the fixed costs of government should be fully equalised. Australia practices both forms of equalisation. However, Australia goes further by equalising for differences in costs and prices affecting government expenditures. This step away from pricing state government services through the state tax system reduces efficiency.

3 THE AUSTRALIAN AND OPTIMAL FISCAL EQUALISATION SYSTEMS

In Australia, as in most other federations, a system of fiscal equalisation is used to address concerns that states have different fiscal capacities. Historically, the system has been motivated by a desire of governments to achieve horizontal equity. As a result, it differs in some respects from the approach developed in section 2, which is based on locational efficiency.

The Australian equalisation system is unusually comprehensive, being applied to both state government revenues and expenditures. For example, in 2015/16 the states raised $125 billion in own-source revenue, and also received from the central government $57 billion in GST revenue and $42 billion in other payments. All of the total revenue of $224 billion was subject to fiscal equalisation. Similarly, total expenses of $232 billion were also subject to fiscal equalisation.

The method of delivering equalisation varies between jurisdictions. In Australia it involves adjustments to the general purpose grants that states receive from the pool of GST revenue. The initial division of the GST pool is according to each state's share of the national population. Equalisation transfers are then made from states with assessed net fiscal advantages to states with assessed net fiscal disadvantages to arrive at a new division of the GST pool. The aim of the transfers is to leave each state with the same assessed capacity to provide government services.

In recent years the amount of equalisation transfers has increased. This is because, with its high endowment of mineral resources, the fiscal capacity of Western Australia has strengthened with the lift in mining royalties from the mining boom. The resulting larger downward adjustments to WA's share of GST revenue has led to proposals from the WA Government to modify the HFE system.

This section analyses the general factors used by the CGC in formulating its equalisation recommendations, against the optimal equalisation approach developed in section 2. It then examines in greater detail the CGC's latest recommendations, which are for the state distribution of GST revenue in 2017/18, and how this would change under the optimal approach.

3.1 General approach

The general equalisation principle used by the CGC (2015) is as follows.

> State governments should receive funding from the pool of goods and services tax such that, after allowing for material factors affecting revenues and expenditures, each would have the fiscal capacity to provide services and the associated infrastructure at the same standard, if each made the same effort to raise revenue from its own sources and operated at the same level of efficiency.

This is similar to the original equity-based equalisation principle advocated by Buchanan (1950) to "allow state units originally unequal in fiscal capacity to provide equal services at equal rates of taxation".

This is consistent with the traditional view of governments in Australia that the role of fiscal equalisation is to achieve horizontal equity. The CGC does a professional job in following this equity-based policy approach required of it by government. One aim of this paper is to examine the benefits to the community of a change in government policy to an efficiency-based approach to equalisation.

The CGC (2015) lists the broad range of factors it uses in assessing fiscal capacity.

> The fiscal positions of the States differ because of differences in their natural endowments, their economic, demographic and geographic circumstances and the policy choices they make. The Commission calculates what the fiscal capacities of the States would be if the policy differences were removed. We call these the assessed fiscal capacities of States and they are central to our recommended GST distribution. This distribution is designed to equalise the assessed fiscal capacities of the States.

Thus, the equalisation transfers between states recommended by the CGC are driven by four factors:

- natural endowments;
- demographic circumstances;
- geographic circumstances; and
- economic circumstances.

These four factors are now considered in turn against the efficiency-based approach to equalisation developed in section 2.

Natural endowments

Higher natural endowments of minerals and prime land provide a state with a fiscal advantage in collecting mining royalties, land tax and conveyancing duties, which can be seen as source-based taxes. Thus, the analysis set out in section 2 implies they should be fully equalised, which they are. This promotes efficiency by eliminating fiscally-induced migration caused by differences in state capacities to raise source-based taxes from the national population.

Mining royalties are currently the largest driver of equalisation transfers in Australia. In fully equalising for the capacity to raise mining royalties, there are two design considerations. First, to the extent practical, equalisation should be based on mining capacity rather than mining production. Second, to the extent that state government revenue raising from mining royalties involves expenditure costs such as costs incurred in project approval processes, these should be offset against the revenue gains.

Demographic circumstances

As originally argued by Buchanan (1950), demographic circumstances can significantly affect a state's fiscal capacity. If a relatively high proportion of a state's population is indigenous or elderly, revenue-raising capacity will be lower and expenditure needs higher. The Australian practice of fully equalising for this fiscal disadvantage can be expected to promote efficiency, as established in section 2. It promotes efficiency by eliminating fiscally-induced migration caused by state differences in population compositions.

Geographic circumstances

Geographic circumstances can also affect a state's fiscal capacity. The CGC equalises for geographic factors, including the higher costs associated with remoteness and large urban centres. Notwithstanding its statement above, in practice the CGC partially equalises, rather than fully equalises, for geographic factors. Boadway (2007) explains the partial equalisation process as follows.

> Rural and urban areas have different levels of health care and roads because it costs more to provide such services in rural areas. Equalisation systems typically do not try to fully equalise differences in costs. One way of dealing with the problem is to take as given differences in levels of public services in different geographic locations and to equalise the costs of providing those services for like areas across regions. This is the approach taken in Australia.

However, as established in section 2, from an efficiency perspective, these higher cost areas should not be subsidised. Rather, the additional costs should be funded on a user pays basis through taxes levied on state residents, not funded nationally through equalisation payments. Thus, the efficiency of the Australian equalisation system would be improved by moving from partial equalisation to no equalisation for geographic circumstances.

Economic circumstances

The CGC also equalises for the effects of economic circumstances on several areas of a state's budget. However, under the efficiency analysis of section 2, these are all areas in which only limited equalisation (i.e. for demographic circumstances) should apply. Thus, for maximum efficiency, the existing equalisation for economic circumstances should be replaced with narrower equalisation for demographic circumstances. The two main areas of equalisation for economic circumstances are the CGC assessments for payroll tax revenue and the wage costs of expenditures. These two areas are now considered in turn.

The CGC assesses a state's relative capacity to raise payroll tax revenue from a state's labour income. However, that labour income is affected by both demographic and economic circumstances. It is efficient to equalise for the contribution of demographic circumstances (i.e. mix of labour types) to payroll tax revenue. However, it is not efficient to equalise payroll

tax revenue for differences between states in labour market outcomes for the same labour types. In the model of section 2, such differences arise from differences between states in productivity and consumer amenity. These differences act as a market signal for economic migration in an efficiently operating national labour market.

In this report, we simulate the replacement of equalisation for economic circumstances with the more appropriate and narrower equalisation for demographic circumstances. This narrower equalisation was described as limited equalisation in section 2. Under limited equalisation, the population is classified into different types, which may distinguish personal attributes such as age, educational attainment and indigenous status. A national assessment is then made of the average contribution of members of each type to the relevant tax or spending base. These national average member contributions are then applied to each state's population mix in assessing each state's revenue capacity or expenditure needs.

In this way, the contribution of population composition, but not other economic circumstances, is taken into account in assessing the fiscal advantages and disadvantages of each state. The implementation of this limited equalisation is illustrated with a practical example in section 4, where it is also compared with full equalisation.

Turning to the equalisation of expenditures for wage costs, the CGC appropriately seeks to obtain a pure measure of wage costs by controlling for a wide range of demographic and other factors that lead to differences in average wage rates between states. However, if the aim is to promote efficiency, any equalisation for differences in wage costs would be removed, as shown in section 2.

The above analysis is summarised in Table 2. It shows, for each of the four factors, whether the CGC applies full equalisation. It compares this with the optimal approach to equalisation developed in section 2. In addition, under a fully efficient approach, the equalisation process would be widened to cover more taxes as explained below.

Table 2: Equalisation

Factor	CGC	fully-efficient
natural endowments	full	full
demographic circumstances	full	full
geographic circumstances	partial	none
economic circumstances	full	limited

3.2 2017/18 assessment

In practice, the equalisation process used by the CGC is more complex than it may appear from the four factors listed in Table 2. This is seen in the latest CGC assessment, which relates to the distribution of GST revenue in 2017/18. Table 3A is drawn directly from the CGC (2017a) report and shows 18 separate components or drivers that are aggregated to reach the final recommended transfers. Those recommended equalisation transfers appear in the final row of the table. By design, they sum to zero when added across states.

Table 3A: CGC Drivers of fiscal equalisation

Table S5-6 Drivers of illustrative difference from EPC distribution of GST, 2017-18 ($ million)										
	NSW	Vic	Qld	WA	SA	Tas	ACT	NT	Redist	category
	$m	$m	$m	$m	$m	$m	$m	$m	$m	
Effects of revenue raising capacity										
Mining production	2 165	2 770	- 176	-5 530	446	191	186	- 52	5 758	source-based
Payrolls paid	- 389	510	397	-1 128	369	217	57	- 33	1 550	economic/demog
Property sales (a)	-1 817	- 112	483	386	698	236	47	77	1 929	source-based
Land values	- 219	- 202	273	- 246	229	87	55	24	668	source-based
Other revenue effects	250	65	- 98	- 222	- 49	10	34	9	368	economic/demog
Total revenue raising capacity	- 10	3 031	879	-6 740	1 694	740	381	25	6 750	
Effects of expenditure requirements										
Demographic features										
Remoteness and regional costs (b)	-1 098	- 916	692	337	73	379	- 136	669	2 150	geographic
Indigenous status (c)	- 110	-1 440	679	187	- 119	101	- 60	762	1 729	demographic
Socio-economic status (d)	386	- 74	- 67	- 312	339	39	- 225	- 86	764	demographic
Other SDC (e)	- 68	- 522	387	- 99	129	32	14	126	689	demographic
Wage costs (f)	228	-509	-312	828	-235	-165	79	86	1221	economic
Population growth (h)	-146	231	23	113	-137	-94	-42	52	419	demographic
Urban centre size (g)	243	612	-461	39	-92	-196	-45	-100	894	geographic
Administrative scale	-443	-285	-170	40	123	232	238	265	898	fixed costs
Natural disaster relief	-428	-228	782	-57	-66	-9	-12	18	800	geographic
Small communities (i)	-301	-269	99	179	65	22	-19	224	588	geographic
Non-State sector (j)	42	-204	136	39	-36	42	-48	29	288	demographic
Other expense effects	-829	-732	-26	964	72	-25	15	561	1613	demographic
Total expense and capital effects	-2 524	-4 335	1 762	2 258	115	359	- 240	2 605	7 099	
Effects of Commonwealth payments	103	272	-242	17	146	-24	62	-335	601	
Total	-2432	-1032	2399	-4464	1955	1075	203	2296	7928	

Note: The redistribution is the total difference from the EPC distribution. It is the sum of positive (or negative) items in each row.

(a) Stamp duty on conveyances only. Excludes stamp duty on motor vehicles.

(b) The effects of remotenesss on the use and cost of services.

(c) The effects of Indigenous status on the use and cost of services. It does not include the effects of socio-economic status a

(d) The effects of socio-economic status on the use and cost of services. In most catgeories, we have used area based measu

(e) It includes the effects of interstate differences in age structure (including number of students in the Schools assessment), e

(f) The effect of differences between States in wage costs on the cost of providing services across States.

(g) The effects of urban centre size on urban transport net expenses. It excludes the impact of population growth.

(h) The effects of population growth on State investment in infrastructure including urban public transport, net borrowing and

(i) The effects of concentrations of people living in small, remote and very remote communities on utility sudsidies.

(j) The effect of the provision of services by the non-State sector on the demand for State education and health services.

For modelling purposes, these drivers are aggregated to the four broader categories shown in Table 2. A final column has been added to Table 3A showing, for each driver, the broader category (or categories) into which it has been classified.

Table 3B shows the estimated optimal transfers and can be compared directly with the existing transfers shown in Table 3A. The revenue and expenditure sides of both tables are now considered in turn.

Table 3B: Optimal Drivers of fiscal equalisation

Table S5-6 Drivers of illustrative difference from EPC distribution of GST, 2017-18 ($ million)										
	NSW	Vic	Qld	WA	SA	Tas	ACT	NT	Redist	category
	$m	$m	$m	$m	$m	$m	$m	$m	$m	
Effects of revenue raising capacity										
Mining production	2 165	2 770	- 176	-5 530	446	191	186	- 52	5 758	full equalisation
Payrolls paid	*6*	*- 121*	*114*	*- 5*	*- 16*	*27*	*- 37*	*32*	*179*	demographic only
Property sales (a)	-1 817	- 112	483	386	698	236	47	77	1 929	full equalisation
Land values	- 219	- 202	273	- 246	229	87	55	24	668	full equalisation
Other revenue effects	*4*	*- 81*	*77*	*- 3*	*- 11*	*18*	*- 25*	*21*	*120*	demographic only
Other revenue	*12*	*- 257*	*244*	*- 11*	*- 34*	*57*	*- 78*	*67*	*381*	demographic only
GST: imputed less epc revenue	*920*	*- 137*	*- 387*	*50*	*- 373*	*- 181*	*66*	*42*	*1 078*	
GST: equalisation	*14*	*- 298*	*282*	*- 13*	*- 39*	*66*	*- 91*	*78*	*440*	demographic only
Total revenue raising capacity	1 084	1 562	910	-5 372	901	502	124	289	5 372	
Effects of expenditure requirements										
Demographic features										
Remoteness and regional costs (b)	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	nil equalisation
Indigenous status (c)	- 110	-1 440	679	187	- 119	101	- 60	762	1 729	demographic
Socio-economic status (d)	386	- 74	- 67	- 312	339	39	- 225	- 86	764	demographic
Other SDC (e)	- 68	- 522	387	- 99	129	32	14	126	689	demographic
Wage costs (f)	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	nil equalisation
Population growth (h)	-146	231	23	113	-137	-94	-42	52	419	demographic
Urban centre size (g)	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	nil equalisation
Administrative scale	-443	-285	-170	40	123	232	238	265	898	fixed costs
Natural disaster relief	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	nil equalisation
Small communities (i)	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	nil equalisation
Non-State sector (j)	42	-204	136	39	-36	42	-48	29	288	demographic
Other expense effects	-829	-732	-26	964	72	-25	15	561	1 613	demographic
Total expense and capital effects	-1 168	-3 026	962	931	371	327	- 107	1 709	4301	
Effects of Commonwealth payments	103	272	-242	17	146	-24	62	-335	601	
Total	19	-1193	1630	-4424	1419	805	80	1664	5616	

On the revenue side, there are five drivers in Table 3A. Three of these are classified to the "source-based" revenue category: mining production (mining royalties), property sales (conveyancing duty) and land values (land tax). Such source-based revenue should continue to be fully equalised, as established in section 2 and reflected in Table 3B.

The remaining two categories of revenue are classified to both the "economic" and demographic categories. These revenue sources are payroll tax, which has been discussed earlier, and "other revenue effects", which refer to insurance taxes and motor vehicle taxes. These other revenue effects are driven by state incomes, which are influenced by demographic circumstances such as the proportion of the population of prime working age, and economic circumstances. Under the analysis of section 2, the equalisation process for these two revenue items should be narrowed so that it is limited to demographic circumstances. That approach is followed under the optimal approach of Table 3B.

There is also a final category of revenue, "other revenue" (not to be confused with "other revenue effects") which is not shown in Table 3A because there is no equalisation for it. The CGC therefore implicitly assumes that "other revenue" is driven by population size so no

equalisation is needed. Accounting for about 38 per cent of state government revenues, this category includes gambling taxes, user charges and interest and dividends. It seems likely that the bulk of revenue in this category is also be driven by state incomes and therefore will be affected by both demographic and economic circumstances. Under the analysis of section 2, equalisation for "other revenue" should be introduced but limited to demographic circumstances only. This is done in Table 3B.

While the GST itself is not explicitly included in the CGC table, it does have its own implicit equalisation treatment. The starting point for the equalisation is unclear, because there is no data on how much GST revenue is actually collected in each state. This is because the GST is collected by the central government, which imposes a uniform national rate of 10 per cent. However, the finishing point for this equalisation is clear. In particular, as noted earlier, the initial division of the GST pool is according to each state's share of the national population, which corresponds to the outcome under full equalisation. Thus, GST revenue itself is fully equalised between states, but from an unspecified starting point.

Under the optimal approach of Table 3B, the GST should be subject to limited equalisation, rather than full equalisation, because it is a residence-based tax. To put GST equalisation on the same footing as equalisation of other residence-based taxes, it is necessary to use the same starting point, namely the amount of revenue raised in each state. Because GST is a consumption tax, we impute the amount of GST revenue raised in a state by applying a state's share of national household final consumption expenditure to national GST collections. These imputed GST collections are then subject to limited equalisation. These two steps are shown as separate lines in Table 3B.

Turning to the expenditure side of the budget, many of the drivers, such as indigenous status, are demographic-related. If a state has a high concentration of people from a demographic group that requires a high level of government services, it is important to equalise for this, in line with the analysis of optimal equalisation in section 2. Otherwise, the resulting high state tax burden will lead to inefficient, fiscally induced outward migration.

Four of the drivers are geographic, the most important being remoteness and regional costs. As noted above, the CGC does not fully equalise for geographic circumstances but rather partially equalises by funding like services in like areas. As discussed earlier, cost factors such as geographic circumstances ought not to be equalised from an efficiency perspective. This is reflected in Table 3B where equalisation for geographic circumstances is removed.

The next expenditure driver is administrative scale. This refers to the fixed costs of providing state government services. The division of Australia into eight states and territories with eight sets of fixed costs is a given or "natural" feature of the political environment in which equalisation is designed to operate. The analysis in section 2 found that such fixed costs should be fully equalised, so that location decisions can be based efficiently on marginal costs and benefits.

The final expenditure driver of wage costs is clearly part of the "economic circumstances" of each state. As discussed above, it ought not to be equalised for from an efficiency perspective. Hence there is no equalisation for wage costs under the optimal approach of Table 3B.

3.3 Previous Australian estimates of gains from HFE

This section considers previous estimates for Australia of the efficiency effects of the existing equalisation system.

Dixon et al. (2002) use a "general equilibrium model that was tailor-made for examining the welfare effects of variations in the Commonwealth/State funding arrangements". They simulate repealing the current equalisation system and distributing the GST on a purely equal per capita (EPC) basis. They estimate this would results in a welfare *gain* of $169 million in 2000/01 terms. They suggest that "the major source of gain from reducing subsidisation in the allocation of Commonwealth grants is that it will take money away from State governments that do not spend it in accordance with household preferences" (Dixon et al. 2002, p19).

Independent Economics (2012) approximately reproduce the Dixon et al. general equilibrium modelling. They find that the unexpected direction of the Dixon et al. result is due to the inconsistent way that they estimate welfare. In modelling interstate migration decisions, Dixon et al. include an amenity effect under which consumer welfare is reduced by an increase in a state's population. However, when calculating the change in consumer welfare resulting from that interstate migration, they include no such amenity effect. This leads them to report a welfare gain from abolishing HFE. If instead they had consistently applied the same measure of consumer welfare throughout, with the amenity effect included, the approximate replication of their modelling shows that they would have found a significant welfare loss, not a welfare gain, from repealing fiscal equalisation.

Independent Economics (2012) also use their general equilibrium modelling to provide their own estimate of the welfare effect from repealing fiscal equalisation. Their estimate was a welfare loss of $295 million in 2009/10 terms. This is broadly comparable with Dixon et al. (2012) after their modelling is corrected to use the same measure of welfare throughout.

Updated estimates using more refined modelling are presented in Independent Economics (2015). That report estimated a welfare loss of $521 million. The increase from the earlier estimate was mainly due to two factors. First, the estimate in the 2012 report was on a 2009/10 basis while the estimate in the 2015 report was on a 2015/16 basis. Second, equalisation had become more significant because the mining boom had added to equalisation transfers.

4 FULL AND LIMITED EQUALISATION IN PRACTICE

This section explains how limited equalisation could be implemented and how it differs from full equalisation. This is demonstrated using the 2017/18 CGC equalisation assessments as a reference point.

The optimal equalisation formula presented as equation [27] in section 2 contained full equalisation of some budget items and limited equalisation of other budget items. Source-based taxes are subject to full equalisation and are considered first. Drawing from equation [27] and after some manipulation, the transfer payment to a state (*transfer*^{j}) for a source-based tax can be written as follows, using simplified notation.

$$transfer^j = national\ revenue.\left[popshare^j - revenueshare^j\right]$$

This formula indicates that a state receives an equalisation transfer from other states if there is a shortfall of its revenue share from its population share. The problem with this form of equalisation is that it is not policy-neutral. In particular, if a state raises its tax rate in an attempt to raise more revenue, there is a broadly offsetting reduction in its equalisation transfer because its revenue share rises.

For a more policy-neutral approach, it is common to adjust the equalisation formula by replacing a state's revenue share with its tax base share.

$$transfer^j = national\ revenue.\left[popshare^j - baseshare^j\right]$$

Under this formula, a state is assessed to have a fiscal disadvantage if its share of the national tax base is less than its share of the national population. It receives a transfer equal to this share difference multiplied by the national revenue from the tax. Because share differences always sum to zero, the transfers in each row of Tables 3A and 3B always sum across states to zero.

Under this formula for full equalisation, states are always be compensated if their share of a tax base is less than their share of the population, irrespective of the reasons for that shortfall. The analysis of section 2 found that this approach of full equalisation is optimal for source-based taxes. However, limited equalisation is optimal for residence-based taxes.

For a residence-based tax, the transfer to a state under limited equalisation is given by the following formula. Again, the formula is derived starting from the relevant term in equation [27] and shares of revenue are replaced with shares of the tax base.

$$transfer^j = national\ revenue.\left[popshare^j - \sum_e \frac{N_e^j\ \overline{base_e}}{base}\right]$$

Compared to the previous formula for full equalisation, this formula for limited equalisation replaces a state's actual share of the tax base, with the share predicted from its population

composition. In particular, a state's tax base is re-calculated by replacing the average tax base generated by state members of each labour type with that generated by national members of the same labour type. Thus, under limited equalisation, a state is compensated for a shortfall in its share of the tax base (compared to its share of the population) to the extent that shortfall arises because of the state's population composition. Conversely, it is not compensated to the extent that the shortfall arises because state members of a type are underperforming national members of the same type in generating a tax base.

Thus, compared to full equalisation, limited equalisation avoids compensating states for underperforming relative to a national benchmark with respect to a person of a given labour type. Such underperformance is a market signal for efficient interstate migration. Subsidising that underperformance through full equalisation would lead to an inefficient locational distribution of labour.

The CGC already uses limited equalisation, but this use is on the expenditure side rather than the revenue side of state budgets. Table 3A shows these six cases of limited/demographic equalisation on the expenditure side. In dollar terms, the most important example is equalisation for indigenous status.

On the revenue side of the budget, Table 3B indicates that it is optimal to apply limited (or demographic) equalisation to four revenue categories. Those categories are GST, "other revenue" (gambling taxes, user charges and interest & dividends), payroll tax and "other revenue effects" (insurances taxes and motor vehicle taxes). Together these revenue categories account for 63 per cent of all state government revenue in 2016-17 ($141 billion of $224 billion).

Revenue from these "residence-based taxes" is driven by a state's income. Hence, such taxes can be viewed as a user charge for state government services. Limited equalisation for these residence-based taxes is undertaken in four steps.

The first step is to cross-classify the population into labour types. For this paper, a detailed and up-to-date population cross-classification was generated from the 2016 Population Census database. The population was cross-classified based on the three attributes of age, indigenous status and education level. This resulted in a total of 840 types based on 21 age categories by 5 indigenous status categories by 8 educational level categories.

The aim was to select attributes that stay with a person, rather than variables that are subject to change with economic circumstances (such as occupation or industry of employment). At the time of writing, education level was only available in terms of the highest year of schooling, but data for a more detailed enumeration based on highest level of educational attainment will become available in November 2017. The cross-classification of the population into these 840 types was performed both at the national level and for each state and territory separately.

The second step is to analyse the tax base at the national level against the labour types. The best measure available from the 2016 Census of the base for residence-based taxes is personal income. Personal income per capita at the national level was $34,800. However, there is considerable variation between types. Putting aside three types with very few members, the top-earning type is people of 45 to 49 years of age, who are non-indigenous and have completed the highest year of schooling. Their average personal income is $74,500, more than double that of the average person. Personal income is lower for younger and older age groups, for indigenous and for those who did not complete high school.

The third step is to determine the influence of population composition on average personal incomes in each state. Based on population composition, the predicted average personal income of a state is calculated according to the predicted tax base formula given above. That is, average state incomes are calculated after replacing state average incomes for each type with national average incomes for the same type. This gives predicted state personal income per head, as shown in Chart 1. This replacement means that variations between states in their predicted incomes per head are entirely due to variations between states in the population mix of types.

Chart 1: Predicted and Actual Personal Income Per Head by State and Territory ($'000 per year)

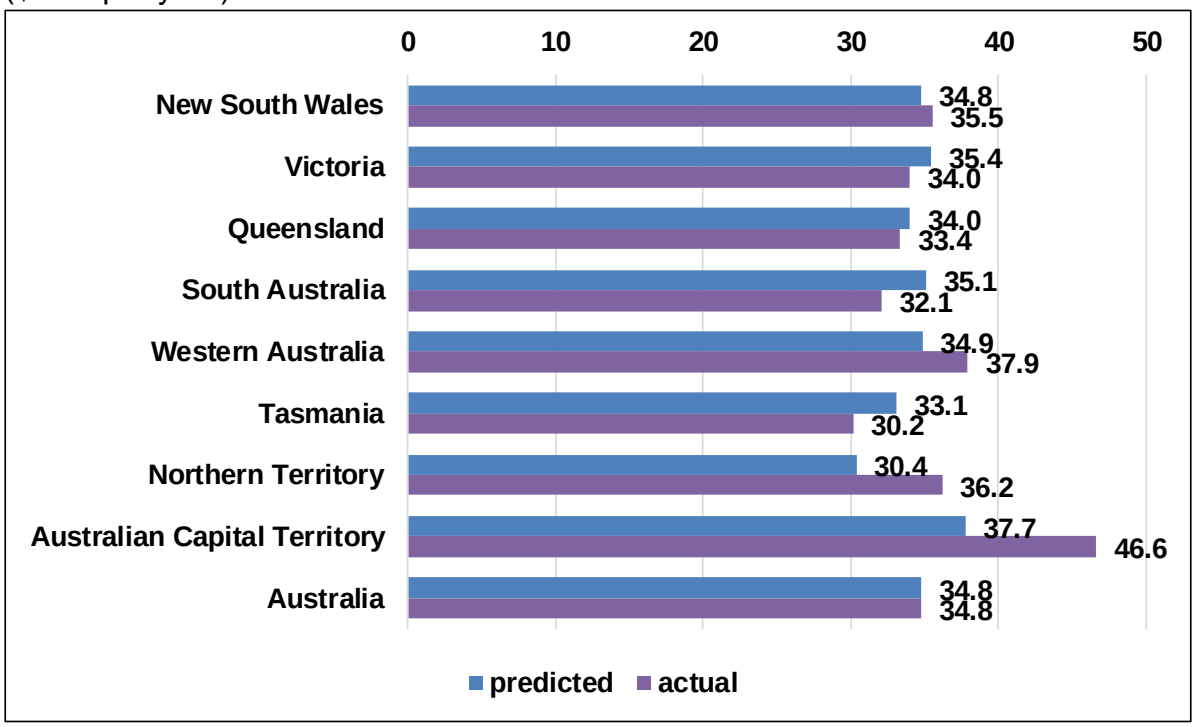


Chart 1 shows that predicted annual personal income per head in the largest state of NSW is $34,800, matching the national figure. Thus, the population composition of NSW, compared to the population composition of Australia, does not confer NSW with either a significant fiscal advantage or fiscal disadvantage in raising residence-based taxes. Population composition confers the largest fiscal advantage on the ACT, which has a predicted average personal income

per head of $37,700. It confers the largest fiscal disadvantage on the NT, which has a predicted average personal income per head of $30,400. Thus, limited equalisation applied to residence-based taxes would result, in part, in a positive transfer for the NT and a negative transfer for the ACT. It should be noted that these estimates will change to some extent once more detailed data is available for educational level.

As noted above, full equalisation differs from limited equalisation by using actual state tax bases, rather than state tax bases predicted from population composition alone. This means it subsidises states that systematically underperform in generating tax bases/incomes for the same labour types. Chart 1 shows noticeable differences for some states and territories between their predicted and actual per capita incomes, indicating that applying full equalisation rather than partial equalisation may result in significant locational inefficiencies.

The fourth and final step calculates the limited equalisation transfers, as shown in the rows of Table 4. For each state, the predicted personal income per head from Chart 1 is multiplied by population to estimate the state's predicted tax base (i.e. the first row of the body of the table is multiplied by the second row to obtain the third row). This predicted tax base is then calculated as a share of the national tax base in the fifth row of the table. In line with the formula above, the gap between a state's share of the population (shown in fourth row of the table) and its predicted share of the tax base is then applied to national revenue to obtain the state's equalisation payment for residence-based taxes in the final row of Table 4.

The same final outcome for limited equalisation of residence-based taxes is also obtained when it is applied to each of the four revenue categories separately, rather than in aggregate. This is shown in Table 5, which reproduces the equalisation estimates for the four categories from Table 3B.

Table 4 provides a good start in calculating limited equalisation for residence-based taxes, but some further refinements are desirable. For example, as noted above, more detailed Census data for educational level could be used once it becomes available in November 2017. Further, some further adjustments that are already made by the CGC could be incorporated. For example, in effect, the general government sector is exempt from payroll tax, which confers a fiscal disadvantage on the ACT in particular, which could be taken into account.

Table 4: Limited equalisation of residence-based taxes: calculations

	NSW	Vic	Qld	WA	SA	Tas	ACT	NT	AUS
predicted income/head ($,000 per year)	34.8	35.4	34.0	34.9	35.1	33.1	37.7	30.4	34.8
population ('000 persons)	7,480	5,927	4,703	2,474	1,677	510	397	229	23,397
predicted state personal income ($m)	260,022	210,021	159,941	86,237	58,830	16,879	15,000	6,950	813,880
share of population	31.97%	25.33%	20.10%	10.58%	7.17%	2.18%	1.70%	0.98%	
share of predicted income	31.95%	25.80%	19.65%	10.60%	7.23%	2.07%	1.84%	0.85%	
population share less predicted income share	0.02%	-0.47%	0.45%	-0.02%	-0.06%	0.11%	-0.14%	0.12%	
national revenue from residence-based taxes ($m)									159,486
limited equalisation for residence-based taxes ($m)	35	-757	717	-32	-99	169	-231	198	0

Table 5: Limited equalisation of residence-based taxes: by tax ($ million)

	NSW	Vic	Qld	WA	SA	Tas	ACT	NT
Payrolls paid	6	-121	114	-5	-16	27	-37	32
Other revenue effects	4	-81	77	-3	-11	18	-25	21
Other revenue	12	-257	244	-11	-34	57	-78	67
GST: equalisation	14	-298	282	-13	-39	66	-91	78
limited equalisation for residence-based taxes	35	-757	717	-32	-99	169	-231	198

5 EMPIRICAL ANALYSIS

This section estimates the impacts of alternative equalisation policies on consumer welfare and the locational distribution of the population. The policies alternatives considered cover no equalisation, partial equalisation and optimal equalisation.

The baseline scenario is based on the existing system of full equalisation as implemented for 2017/18 in CGC (2017a). The CGC calculated these transfers by assessing state fiscal capacities in the three years of 2013/14, 20014/15 and 2015/16, and then projecting forward to 2017/18 using forecasts for growth in population and GST revenue. These baseline transfers, which were presented earlier in the final row of Table 3A, are reproduced in the "baseline" column of Table 6.

The optimal scenario, which is taken from the final row of Table 3B, is used in estimating the impact on consumer welfare of the other scenarios, which are all non-optimal. By varying the pattern of interstate transfers from the optimal pattern, the other scenarios distort locational decisions for labour. The resulting welfare losses can be estimated using the following deadweight loss (DWL) formula (Albouy, 2012).

$$DWL = -\frac{1}{2}\,\epsilon \sum_{j} \left(t^{j}\right)^{2} Y^{j}$$

The DWL generated in each state depends, in part, on the difference between the optimal transfer for a state and the transfer that it receives, expressed as a share of state income. This implicit tax rate t^j on state income will be positive for some states and negative for other states.

The DWL also depends on ϵ, the long-run elasticity of a state's population with respect to changes in its income per capita resulting from changes in its net fiscal benefit. Albouy (2012) uses a population elasticity estimate from Wilson (2003) for Canada of -3.23. This paper rounds this to -3 and applies it to Australia. However, as the DWL is proportional to this parameter, the sensitivity of the DWL estimates to alternative values for this parameter can be readily assessed by re-scaling the DWL estimates. Long-run population adjustments could take around a decade to fully develop through a gradual process of interstate migration and state selection of settlement by incoming migrants.

Finally, the DWL estimate also depends on each state's income, Y^j. The income for each state in 2017/18 has been forecast by applying Australian Treasury economic forecasts for general economic growth to historical data for each state's income.

In referring to the use of the population elasticity in the DWL formula, Albouy (2012) observes that: "employment and deadweight loss predictions are robust to many assumptions of the model, since they are simulated from a reduced-form parameter, which may include many un-modelled effects" (Albouy, 2012). Further, a by-product of these DWL calculations is estimates of percentage impacts on state populations, which are also presented.

We now turn to the results for the various policy scenarios. Scenarios involving no equalisation, partial equalisation and optimal equalisation are considered in turn. The economic impacts of each scenario are reported against the existing policy of full equalisation.

5.1 No equalisation: Equal Per Capita (EPC) systems

If the existing equalisation system were abolished, GST revenue would be distributed between the states on an equal per capita (EPC) basis, without any adjustments for equalisation transfers. The CGC (2017b) identifies an EPC system as one possible alternative to full equalisation.

Table 6 compares the state transfers currently made under full equalisation with the zero transfers that would be made under an EPC system. It also shows the transfers that would be made under a modified EPC system considered by Independent Economics (2012, 2015). The modification is that equalisation is retained for indigenous status. Hence, the transfers shown for the modified EPC system in Table 6 match those for indigenous status that were reported in Table 3A. The rationale for the modified EPC system is that it may be unrealistic to simulate a situation in which the additional government expenditure needs of states with relatively high indigenous populations are not funded at a national level.

When transfers are expressed on a per capita basis, WA has the biggest gain and NT the biggest loss in moving to an EPC system in either standard or modified form. WA gains mainly from removing the economically efficient equalisation of mining royalties. NT loses both from removing the economically efficient equalisation for demographic factors and from removing the economically-inefficient equalisation for geographic circumstances.

Table 7 shows that this pattern of gain and loss in transfers leads to percentage population movements in the expected directions. WA has a significant and inefficient population gain while NT has a very large population loss, which is partly efficient and partly inefficient.

Because these population movements mainly represent inefficient fiscally-induced migration, there are significant losses in economic welfare. For moves to modified or standard EPC systems, the annual losses are estimated at $330 million and $1,038 million as seen in Chart 2. The larger welfare loss in moving to the standard, rather than the modified, EPC system reflects the inefficiencies from removing equalisation for indigeneity. It is efficient to equalise for demographic factors such as indigeneity, as explained in section 3.

At the same time, the large magnitude of the difference in welfare losses between the two EPC scenarios has a particular explanation. As equalisation transfers are withdrawn from the NT, the NT's population contracts so that its large, fixed fiscal disadvantages are spread more thickly over a progressively smaller population. Increasingly this offsets the population elasticity effect, so that a tipping point will be reached in which further population reductions no longer succeed in raising consumer welfare, leading to a downward spiral in the population. The standard EPC scenario takes the NT economy close to this tipping point because a small state economy with large fixed fiscal disadvantages faces a large income loss.

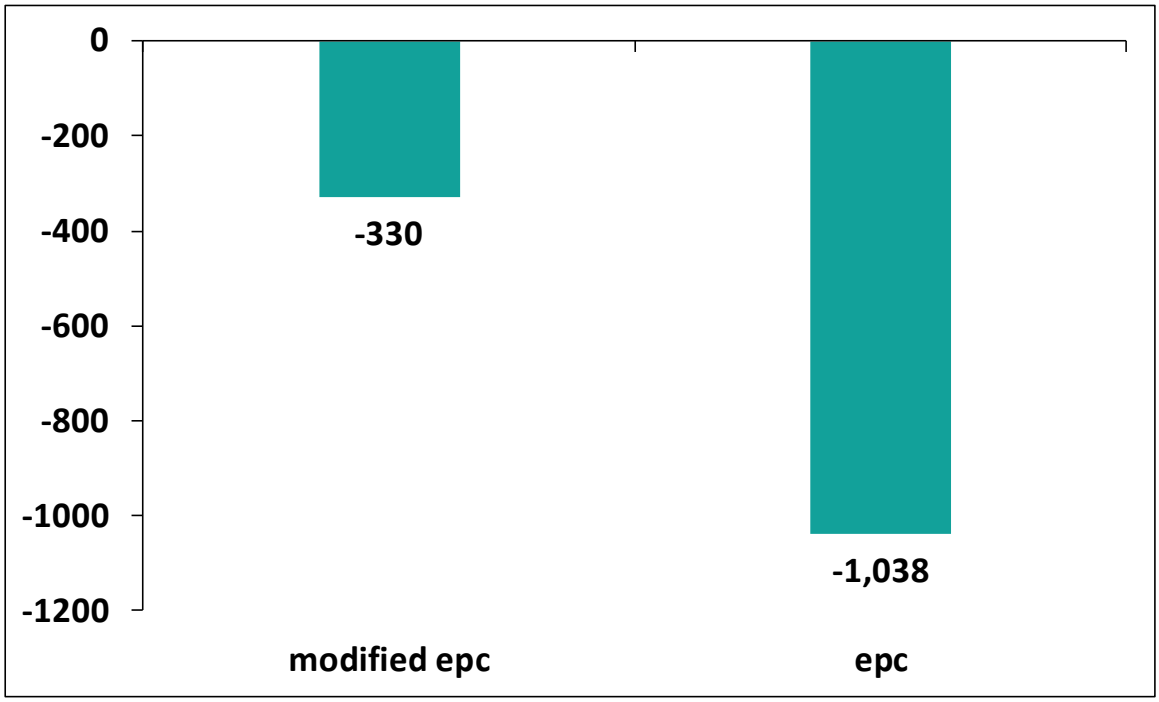
Table 6: Baseline and EPC transfers ($ million)

	baseline	modified epc	epc
NSW	-2,431	-110	0
Vic	-1,033	-1,440	0
Qld	2,399	679	0
WA	-4,465	187	0
SA	1,955	-119	0
Tas	1,075	101	0
ACT	203	-60	0
NT	2,296	762	0
Total	0	0	0

Table 7: Population impacts of EPC systems
(deviations from baseline, per cent)

	modified epc	epc
NSW	1.1%	1.2%
Vic	-0.2%	0.7%
Qld	-1.1%	-1.5%
WA	5.7%	5.6%
SA	-4.1%	-3.7%
Tas	-6.5%	-7.1%
ACT	-2.1%	-1.5%
NT	-23.6%	-44.6%
Total	0.0%	0.0%

Chart 2: Welfare impacts of EPC systems
(deviations from baseline, $m per year)



5.2 Partial equalisation: grant, floor and discount systems

Three alternative policy scenarios involving partial equalisation are simulated. These scenarios achieve partial equalisation through either grants, a floor or a discount.

In the grants scenario, transfers to the recipient states are made by the central government instead of by the donor states. The motivation for the grants scenario may be that it would make donor states better off, because they no longer make equalisation payments, while the recipient states would be no worse off, because there would still receive their equalisation payments.

Such a view of the "grants" scenario is superficial because it ignores the fact that the grants would need to be funded. In modelling this scenario, it is assumed that grants are funded from the GST pool, thus reducing the amount that each state receives in the initial division of the GST pool on an EPC basis. Other ways of funding the grants are likely to have a broadly similar ultimate impact. The CGC (2017b) identifies the grants scenario as one of the possible alternatives to full equalisation and describes is as a partial EPC system.

The "75c floor" scenario is an alternative form of partial equalisation that has been proposed by the Government of Western Australia (2017). It sets a floor of 75 cents on each state's GST grants pool relativity. WA is the only state that was under this floor in the 2017/18 CGC assessment. With a fixed pool of GST revenue, raising the GST grants pool relativity of WA from the assessed value of 0.34 to 0.75 would require reducing the GST grants pool relativities of other states. This scenario assumes this is achieved by the other seven states contributing on an equal per capita basis to the additional funding for WA. This reduces each of their GST grants pool relativities.

The "75c floor" scenario', like the "grants" scenario, reflects an apparently superficial view of equalisation. Its focus on GST relativities ties equalisation transfers to GST revenue. In fact, equalisation transfers could be completely separated from GST revenue with no difference in final outcomes. Donor states would then contribute to a special pool and recipient states would draw from the same pool. GST distributions would be made separately on an EPC basis. This separated system would lead to exactly the same outcome for each state as the existing system. Thus, focussing on GST grants pool relativities confuses the fiscal equalisation policy with its current delivery mechanism. This highlights the arbitrary nature of setting a floor on grants pool relativities.

The "25% discount" scenario is another form of partial equalisation, which has also been proposed by the Government of Western Australia (2017). Under this proposal, equalisation transfers are discounted by 25 per cent.

The equalisation transfers under these three alternative forms of partial equalisation are shown in Table 8. The transfers under the "grants" scenario closely match the CGC (2017b) calculations for its equivalent "partial EPC" scenario. Under both the "grants" scenario and

the "75c floor" scenario, WA receives a higher transfer than under the full equalisation of the baseline scenario, while the other states and territories all receive lower transfers. In contrast, the "25% discount" scenario reduces all transfers, both positive and negative, by a uniform 25 per cent.

Table 9 shows the percentage impacts on state populations of these three alternative partial equalisation scenarios. With WA the only state to receive a higher transfer under either the "grants" or "75c floor" scenarios, it is also the only state to experience a population gain under either scenario. It obtains the bigger gain from the "grants" scenario.

As will become clear when the optimal scenario is considered, the equalisation transfer that WA currently pays is close to the optimal level. This mainly reflects the fact that it is optimal to fully equalise for mining royalties. Hence, scenarios which are characterised by WA becoming a smaller donor, such as the "grants" and "75c floor" scenarios, result in a loss in consumer welfare. Thus, Chart 3 shows a loss in annual consumer welfare of $100 million for the "grants" scenario and $71 million for the "75c floor" scenario, compared to the existing full equalisation policy. The larger loss in the "grants" scenario is consistent with the larger reduction in WA's donor payment.

Returning to the "25% discount" scenario, because it reduces all transfers by 25 per cent, donor states pays less and recipient states receive less. This induces migration from recipient states to donor states, as can be seen from the population impacts in Table 9.

This scenario, which can alternatively be described as "75% equalisation", has effects on consumer welfare that operate in opposite directions. For example, it works to reduce consumer welfare in areas that would optimally have 100% equalisation, but have it reduced to 75% equalisation under this scenario e.g. mining royalties. On the other hand, it works to increase consumer welfare in areas that would optimally have no equalisation, but have it reduced from 100% to 75% under this proposal e.g. equalisation of government spending for wage costs and geographic circumstances. Overall, there is a net gain in annual consumer welfare of $48 million, as seen in Chart 3.

Thus, the only form of partial equalisation that provides a welfare gain relative to the existing system of full equalisation is "75% equalisation". In fact, if one optimises on the equalisation percentage, the highest welfare gain is obtained under "77% equalisation".

At the same time, while the modelling results indicate that the "25% discount" scenario provides a welfare gain over the current equalisation system, that is in the context of the state pattern of fiscal advantages and disadvantages of 2017-18. There is no guarantee that it will outperform the current system in other years. This is in contrast to the optimal equalisation system, which by design will outperform all other systems, including the "25% discount" scenario and the current system, in all years, thus providing a robust solution. This paper now turns to the optimal system.

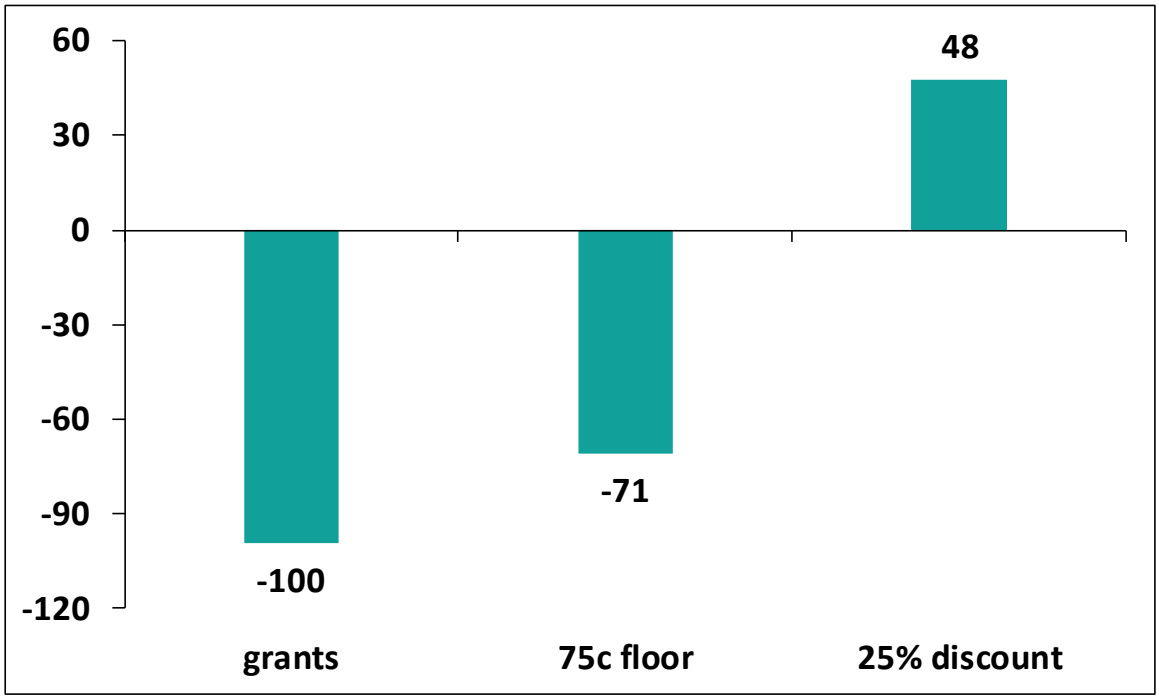
Table 8: Baseline and partial equalisation transfers ($ million)

	baseline	grants	75c floor	25% discount
NSW	-2,431	-2,542	-3,394	-1,823
Vic	-1,033	-2,005	-1,792	-775
Qld	2,399	812	1,798	1,800
WA	-4,465	-862	-1,787	-3,349
SA	1,955	1,399	1,744	1,466
Tas	1,075	907	1,011	806
ACT	203	74	154	153
NT	2,296	2,217	2,266	1,722
Total	0	0	0	0

Table 9: Population impacts of partial equalisation systems (deviations from baseline, per cent)

	grants	75c floor	25% discount
NSW	0.0%	-0.4%	0.3%
Vic	-0.5%	-0.4%	0.1%
Qld	-1.1%	-0.4%	-0.4%
WA	4.4%	3.3%	1.4%
SA	-1.1%	-0.4%	-1.0%
Tas	-1.1%	-0.4%	-1.8%
ACT	-1.1%	-0.4%	-0.4%
NT	-1.0%	-0.4%	-8.0%
Total	0.0%	0.0%	0.0%

Chart 3: Welfare impacts of partial equalisation systems (deviations from baseline, $m per year)



5.3 Optimal equalisation: complete and simplified systems

The optimal equalisation scenario is constructed using the optimal equalisation formula developed in this paper in section 2 and the Appendix. The implementation of the formula was explained in sections 3 and 4. The resulting equalisation transfers were shown in the final row of Table 3B and are reproduced in Table 10.

Spahn (2007) suggests that the existing Australian full equalisation system is too complex. The optimal equalisation system goes some way to reducing this complexity by eliminating equalisation of government spending for four geographic drivers and wage costs, as can be seen by comparing Table 3B with Table 3A. The optimal system also simplifies by using a global treatment of residence-based taxes, based on limited equalisation. This is in place of the existing separate treatments for payroll tax, insurance taxes and motor vehicle taxes and the omission of "other revenue" covering 38 per cent of own-sourced state revenues.

To provide an option that involves even further simplification, a "simplified" scenario is presented. It varies the optimal equalisation policy by eliminating equalisation for residence-based taxes. This is on the basis that the preliminary calculations presented in section 4 indicate that the transfers resulting from this category of equalisation are relatively small. The transfers under the "simplified" scenario are presented in Table 10. These transfers are obtained by deducting the transfers shown for limited equalisation of residence-based taxes (Table 4 or 5) from the optimal transfers.

Both the "optimal" and "simplified" scenarios involve state transfers that have some noticeable differences from the baseline scenario.

NSW changes from being a donor state to being in a broadly neutral position because of two main factors. First, these two scenarios take into account that it is inefficient to equalise for geographic factors, removing a significant supposed fiscal advantage for NSW. Second, these scenarios recognise that more GST revenue is raised in NSW than is taken into account under the existing per capita allocations.

Four recipient states receive noticeably smaller transfers because of the same two factors, working in the opposite direction. Those states are Queensland, the NT, Tasmania and SA. There are relatively small impacts on the transfers received by the three remaining states of Victoria, WA and the ACT.

These changes to the state pattern of transfer payments are reflected in state populations. While these two scenarios virtually eliminate the existing donor transfer from NSW of $2.4 billion, the resulting increase in NSW state income is small in percentage terms, NSW being the largest state economy. Thus, the population gain for NSW is only around 1 per cent.

Similarly, the four recipient states receiving noticeably smaller transfers experience population losses. However, in percentage terms the population loss for the NT easily outstrips the losses of Queensland, Tasmania and SA. This is because the transfer loss for the NT is large relative

to state income, NT being the smallest state economy, even though Queensland experiences a larger transfer loss in dollar terms. Because of the welfare-maximising nature of the optimal scenario, all of these population shifts are efficient.

For the same reason, the optimal scenario will result in a higher level of consumer welfare than any other scenario. Compared to the baseline scenario of full equalisation, Chart 4 shows a gain in annual consumer welfare of $71 million. This compares to a gain of $56 million under the simplified scenario, which is a superior outcome to all scenarios other than the optimal scenario.

While the welfare gain from the simplified scenario may appear close to the welfare gain from the optimal scenario, there are two qualifications to this. First, this result is based on the state pattern of fiscal advantages and disadvantages of 2017-18. The simplified scenario may perform less well in other years. Second, the more detailed enumeration of educational attainment for the 2016 Census that will become available in November 2017 is likely to have some effect on these results. In particular, it is likely to widen the estimated gap between the welfare gain from the optimal scenario and the welfare gain from the simplified scenario.

The gains in consumer welfare under the optimal scenario are likely to be shared widely. The optimal scenario results in each labour type being located efficiently, which has the potential to raise the living standards of all labour types. Furthermore, the gain in living standards for a labour type is experienced across all states. This is because, over time, the free movement of labour can be expected to achieve horizontal equity by equating living standards of any given labour type across all states.

Thus, some states may lose residents and others may gain residents, but in the long term the residents of all states will share in the boost to living standards.

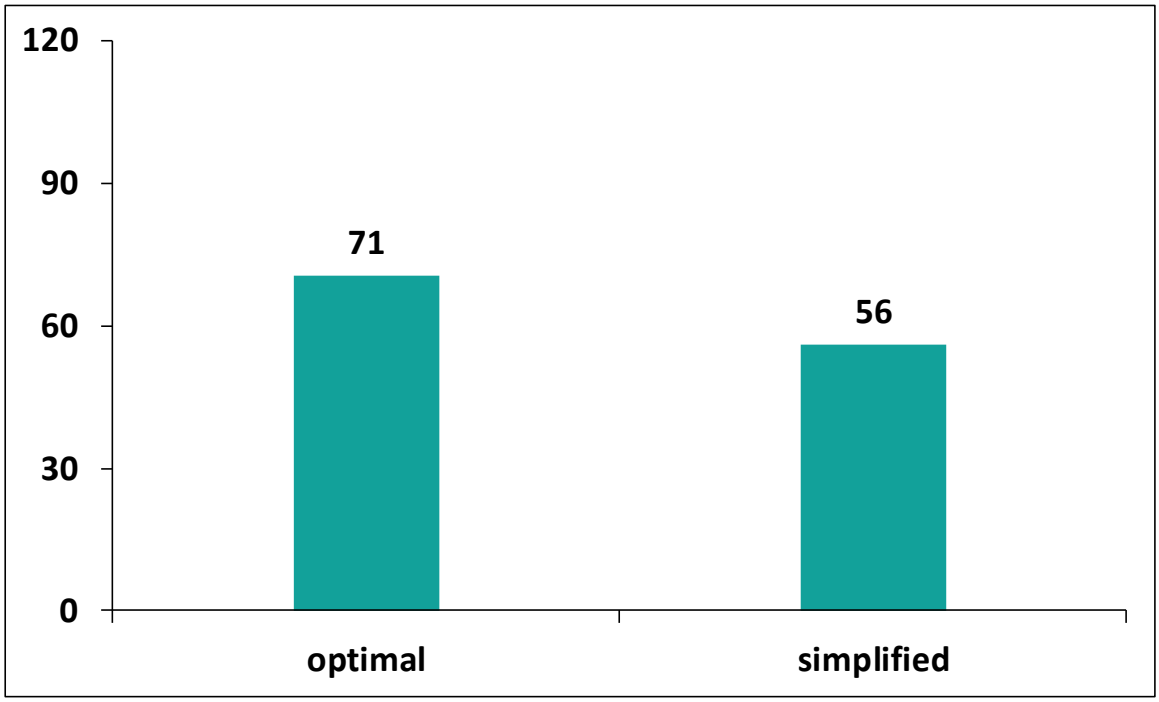
Table 10: Baseline and optimal equalisation transfers ($ million)

	baseline	optimal	simplified
NSW	-2,431	19	-17
Vic	-1,033	-1,193	-436
Qld	2,399	1,630	913
WA	-4,465	-4,424	-4,391
SA	1,955	1,419	1,518
Tas	1,075	805	636
ACT	203	80	310
NT	2,296	1,664	1,466
Total	0	0	0

Table 11: Population impacts of optimal equalisation system (deviations from baseline, per cent)

	optimal	simplified
NSW	1.1%	1.0%
Vic	-0.1%	0.3%
Qld	-0.5%	-1.0%
WA	0.0%	0.1%
SA	-1.1%	-0.9%
Tas	-1.7%	-2.9%
ACT	-1.0%	0.9%
NT	-8.2%	-11.0%
Total	0.0%	0.0%

Chart 4: Welfare impacts of optimal equalisation systems (deviations from baseline, $m per year)



6 QUALIFICATIONS

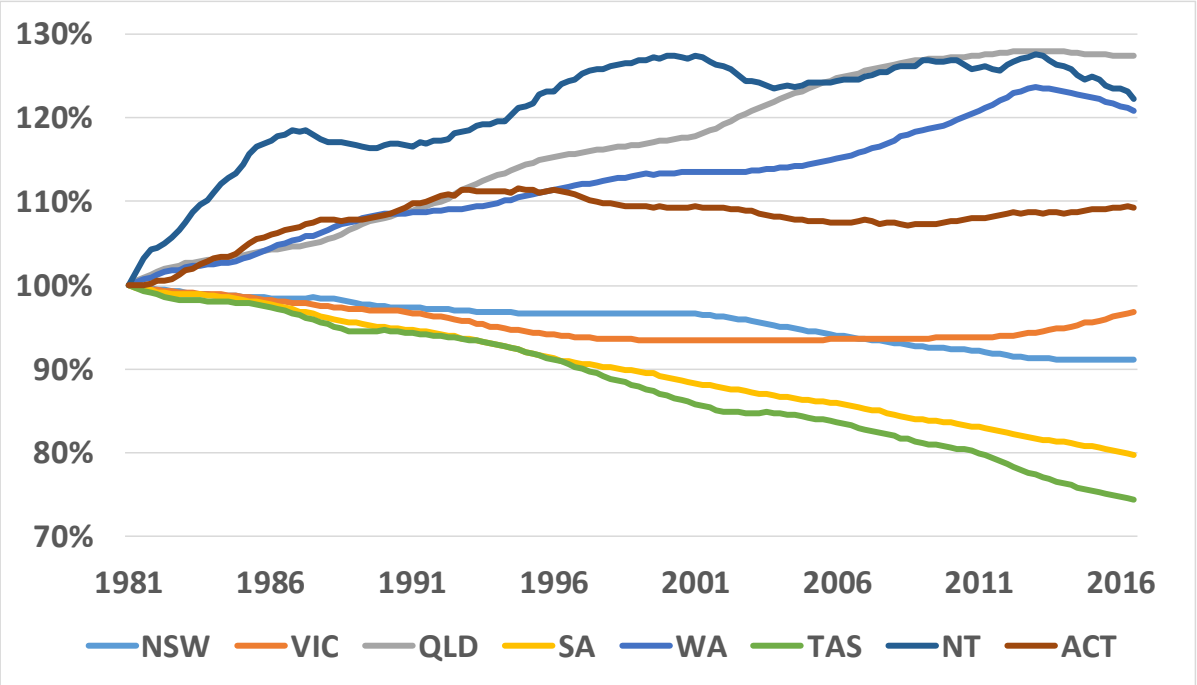
Six qualifications to the theoretical model used here, and therefore the associated empirical analysis, are as follows.

First, following Boadway and Flatters (1982) and Albouy (2012), the modelling treats the national supplies of each type of labour and capital as fixed. This would not be reasonable in an analysis of the efficiency of taxes applied to these factors of production. However, this paper focusses on the specific issue of fiscal equalisation, where the key issue is achieving locational neutrality for labour decisions rather than efficiency in the total supply.

Second, we also assume that labour is perfectly mobile between states. Albouy (2012) points out that "mobility makes the most sense in a long run setting: when mobility costs are amortised over longer periods, they become small relative to the potential gains of moving". He adds: "the conclusions below may hold even when some households are immobile, so long as there is a sufficiently large number of mobile households of each type".

Consistent with this, the historical evidence suggests that in Australia a high degree of labour mobility between states has been achieved over time. This mobility has involved a combination of interstate migration and state selection of settlement by arriving immigrants. Thus, compared to a scenario in which state shares of the national population had remained fixed, Chart 5 shows that since 1981 the population of Queensland, Western Australia and the Northern Territory have all risen by more than 20 per cent, while the populations of South Australia and Tasmania have both fallen by over 20 per cent. By comparison, the modelled population movements shown in Table 11 for the optimal equalisation scenario are relatively small, and might plausibly be achieved in around a decade.

Chart 5: State population relativities (1981=100%)



Third, again following Boadway and Flatters (1982) and Albouy (2012), the modelling implicitly assumes that state governments take their equalisation grants as given. However, the spending and tax behaviour of a state government does have some impact on the equalisation grant that it receives in Australia, as emphasised by Petchey (2011). For example, when a state government unilaterally raises a tax, for each additional dollar of revenue that it receives directly, its equalisation grant is adjusted by a fraction of a dollar. As shown by the full equalisation formula presented in section 4, that fraction is equal to the difference between the state's share of the population and its share of the tax base. That fraction can be positive or negative and generally, although not always, is rather small. Further, there is a lack of empirical evidence that its existence influences state government behaviour.

Fourth, this paper assumes that state government services are private in nature, meaning that there is no fiscal externality from the provision of public goods. This is consistent with the literature assessments of both Boadway and Flatters (1982) and Albouy (2012) that state government services are private to a close approximation. This reflects the private nature of the major state government services such as school education and hospital care as distinct from the public nature of central government services such as defence.

Fifth, congestion is not taken into account, even though it may be affected by interstate population shifts. However, fiscal equalisation is not an efficient method of addressing negative externalities from congestion. An individual moving from Adelaide in SA to Sydney in NSW may increase congestion, but the same individual moving to Bourke in NSW would not. These two cases cannot be distinguished if congestion is addressed in a crude way through adjustments to equalisation payments. The efficient way of addressing congestion is through a congestion tax or related measures (e.g. tolls) that are specific to the location of the congestion. Thus, congestion is viewed as an issue for a congestion tax rather than an issue for fiscal equalisation.

Sixth, in analysing fiscal equalisation, this paper models locational distortions caused by state government budgets, including those generated by central government grants to the states, both general purpose and special purpose. Albouy (2012) also brings in locational distortions generated within central government budgets. However, it can be argued that locational distortions generated within central government budgets are better addressed there, rather than through fiscal equalisation between states. Perhaps for that reason, the equalisation literature generally focusses mainly on state government budgets.

7 PROPOSAL

This paper develops a proposal for an optimal equalisation system, which has general applicability for federations. Under this approach, there is full equalisation for the fixed costs of state government and for source-based taxes on natural resources, land and capital. However, equalisation limited to demographic factors is applied for the variable costs of state government, residence-based taxes on factor incomes and consumption taxes.

Compared to other equalisation systems, this system promotes a more efficient locational distribution of labour, generating higher living standards across all states.

In the Australian context, optimal equalisation varies the existing system of full equalisation in the following ways on the revenue and expenditure sides of state budgets.

7.1 Revenue

1. It retains full equalisation for source-based taxes, namely mining royalties, stamp duties on conveyances and land tax.

2. It replaces the population-based state distribution of national GST with a household consumption-based distribution.

3. For residence-based taxes including GST and other revenues not in (1), it uses limited equalisation where revenue-raising capacity is assessed from state demography, not actual state tax bases. This method has been demonstrated in this paper using labour types that are cross-classified by age, indigenous status and educational attainment.

7.2 Spending

1. It retains full equalisation for administrative scale.

2. It retains full equalisation for demographic-based characteristics.

3. It removes equalisation for geographic circumstances.

4. It removes equalisation for wage costs.

The optimal equalisation system significantly simplifies the existing full equalisation system and generates a gain in annual consumer welfare estimated at $71 million and spread across residents of all states and territories.

In contrast, dismantling fiscal equalisation by switching to a modified EPC system that only retained equalisation for indigeneity would generate a loss in annual consumer welfare estimated at $330 million.

8 REFERENCES

Albouy, David (2012), 'Evaluating the efficiency and equity of federal fiscal equalisation', *Journal of Public Economics*, Vol. 96, pp 824-839.

Boadway, Robin; Flatters, Frank (1982), 'Efficiency and equalisation payments in a federal system of government: a synthesis and extension of recent results', *Canadian Journal of Economics*, Vol. 15, No. 4 (Nov 1982), pp. 613-633.

Boadway, Robin (2003), 'The Theory and Practice of Equalisation', Queens Economic Department Working Paper No. 1016, Department of Economics, Queens University, Ontario.

Boadway, Robin (2007), 'Grants in a Federal Economy: A Conceptual Perspective', Chapter 2 in *Intergovernmental Fiscal Transfers: Principles and Practice*, Boadway, Robin and Shah Anwar (eds.), The World Bank.

Buchanan, James M. (1950), 'Federalism and Fiscal Equity', *The American Economic Review*, Vol. 40, No. 4 (Sep 1950), pp. 583-599.

Buchanan, James M. (1952), 'Federal Grants and Resource Allocation', *Journal of Political Economy*, Vol. 60, No. 3, (June 1952), pp. 208-217.

Commonwealth Grants Commission (2015), 'Report on GST Revenue Sharing Relativities – 2015 Review', Commonwealth of Australia.

Commonwealth Grants Commission (2017a), 'Report on GST Revenue Sharing Relativities, 2017 Update', Commonwealth of Australia.

Commonwealth Grants Commission (2017b), 'Achieving HFE – Other Approaches to Distributing the GST', CGE Staff Research Paper, 2017-03-S.

Dixon, Peter B., Picton, Mark R., Rimmer, Maureen T. (2002) 'Effects of changes in Commonwealth grants to the States: an applied general equilibrium analysis', Centre of Policy Studies, Monash University, March 2002.

Government of Western Australia (2017), 'Western Australia's Submission to the Productivity Commission's Inquiry into Horizontal Fiscal Equalisation', June 2017.

GST Distribution Review (2012), 'Final Report', Commonwealth of Australia, October.

Independent Economics (2012), 'Horizontal Fiscal Equalisation: Modelling the welfare and efficiency effects', for the South Australian Department of Treasury and Finance, 16 February.

Independent Economics (2015), 'Horizontal Fiscal Equalisation: Modelling update and scenarios', for the South Australian Department of the Premier and Cabinet, 19 May.

Murphy, Chris (2015), 'Fiscal equalisation of Australian states and territories: policy options and welfare maximisation', ANU Arndt-Corden Department of Economics seminar paper, 11 August.

Petchey, Jeffrey (2011), 'Fiscal capacity equalisation of the Australian states', *The Australian Economic Review,* vol. 44, no. 2, pp. 207–14.

Spahn, Paul Bernd (2007), 'Equity and Efficiency Aspects of Interagency Transfers in a Multigovernment Framework', Chapter 3 in *Intergovernmental Fiscal Transfers: Principles and Practice*, Boadway, Robin and Shah, Anwar (eds.), The World Bank.

Wilson, L. S. (2003), 'Equalisation, Efficiency and Migration: Watson Revisited', *Canadian Public Policy*, Vol. 29, No. 4 (Dec, 2003), pp. 385-396.

APPENDIX. THEORETICAL DERIVATION

The first aim of this paper is to develop a theoretical model of fiscal equalisation and use that model to derive an optimal fiscal equalisation formula that has general applicability for federations. Section 2 provides a general explanation of the model and associated formula, while this Appendix provides the full theoretical analysis.

A.1 Model

The model set out here draws on Albouy (2012) and the final model of Boadway and Flatters (1982).

An individual with labour of type *e* lives in state *j* and consumes a private consumption good *c* and state government services *g*, which are assumed to be publicly-provided, private goods. Both of these consumption goods are produced from an intermediate good, *y*, which serves as the numeraire. Productivity in transforming the intermediate good into the two consumption goods can differ between states so the prices of *c* and *g* may also differ between states. The individual's income measured in units of the intermediate good is allocated to the private and government goods.

$$y_e^j = PC^j c_e^j + PG^j g_e^j \quad [1]$$

The individual's indirect utility depends on prices of the two consumption goods (*PC*, *PG*), income (*y*) and the consumer amenity (*Q*) of the state in which they live. Hence the indirect utility function, *V*, takes the following form.

$$V_e = V_e(PC^j, PG^j, y_e^j, Q_e^j) \quad [2]$$

Under the long-run assumption of perfect mobility of each labour type, utility is the same in whichever state they live, so indirect utility only varies between labour types.

In each state, capital *K*, land *L* (which can also refer to natural resources) and each type of labour $\boldsymbol{N}$ are combined to produce the intermediate good. Part of this output is used to cover the fixed costs of the state government, *GF*, while the remainder is available for satisfying consumer wants. In the national income constraint, the available income for allocating across all labour types in all states is equal to the total across states of the production of the intermediate good net of the fixed cost of providing the government good.

$$\sum_j \sum_e N_e^j y_e^j = \sum_j \left\{ F^j\left(K^j, L^j, \boldsymbol{N}^j\right) - GF^j \right\} \quad [3]$$

The supply of land in each state is taken as given. The supplies of capital and each type of labour are taken as given at the national level, but these factors are both perfectly mobile between states, leading to the following constraints.

$$K^{TOT} = \sum_j K^j \quad [4]$$

$$\boldsymbol{N}^{TOT} = \sum_j \boldsymbol{N}^j \quad [5]$$

A benevolent planner aims to maximise social welfare. This includes achieving a Pareto optimum. For that purpose, a Lagrangian is formed in which the utility of one type of individual, that of type 1, is maximised while holding the utility of all other types fixed and taking into account the constraints of equations [2], [3], [4] and [5].

$$\mathcal{L}() = V_1 + \sum_j \sum_e \eta_e^j \left[V_e - V_e\left(PC^j, PG^j, y_e^j, Q_e^j\right)\right] + \pi\left[\sum_j \sum_e N_e^j y_e^j - \sum_j\left\{F^j\left(K^j, L^j, \boldsymbol{N}^j\right) - GF^j\right\}\right] + \kappa\left[K^{TOT} - \sum_j K^j\right] + \sum_e \nu_e \left[N_e^{TOT} - \sum_j N_e^j\right] \quad [6]$$

Putting aside the constraints themselves, there are four sets of first order conditions.

$$\frac{\partial \mathcal{L}}{\partial V_1} = 0 \quad [7]$$

$$\frac{\partial \mathcal{L}}{\partial y_e^j} = 0 \quad [8]$$

$$\frac{\partial \mathcal{L}}{\partial N_e^j} = 0 \quad [9]$$

$$\frac{\partial \mathcal{L}}{\partial K^j} = 0 \quad [10]$$

Evaluating these derivatives and re-arranging gives the following conditions.

$$\sum_j \eta_1^j = -1 \quad [11]$$

$$\pi = \frac{\eta_e^j \frac{\partial V_e}{\partial y_e^j}}{N_e^j} \quad [12]$$

$$\nu_e = \pi\left(y_e^j - w_e^j\right) \quad [13]$$

$$\kappa = -\pi i^j \quad [14]$$

The two important first order conditions for present purposes are those associated with the optimal state distributions of capital (equation [14]) and each type of labour (equation [13]). These equations use the result that a profit-maximising producer operating under perfect competition will equate the marginal product of each factor with its tax-inclusive price. These tax-inclusive factor prices are represented by the wage *w*, and the rental price of capital *i*.

Equation [14] implies that, for capital to be optimally allocated across states, its rental price or marginal product must be uniform across states. On the supply side of the capital market, capital owners will arbitrage between states until the returns they receive exclusive of each state's source-based tax on capital are the same. For returns to be equated across states both before and after the source-based tax, each state must apply the same tax rate. Hence, if states can levy a source-based corporate tax, a Pareto optimum requires that they all tax at the same rate.

Turning to equation [13], it implies that for each type of labour to be optimally allocated across states, the non-labour income (*y*-*w*) offered by each state for a given type of individual must be the same. This is so location decisions for each labour type are driven by the marginal product of labour and are not distorted by signals from non-labour income.

Putting this another way, equation [13] can be manipulated to state that, for an individual of a given type, non-labour income in any state is equal to the national average.

$$y_e^j - w_e^j = \frac{\sum_j N_e^j y_e^j}{N_e^{TOT}} - \frac{\sum_j N_e^j w_e^j}{N_e^{TOT}} \qquad [15]$$

This condition for the optimal allocation of each type of labour across states is at the core of deriving the welfare-maximising formula for fiscal equalisation. The next step is to identify the components of non-labour income both for the individual in a particular state and for the national average for that type of individual. This involves considering the central government and state government budget constraints.

The treatment of the central government is rudimentary because the focus of the model is equalisation policy for state budgets. In the model, the central government budget is made up of two types of transfers. The first is redistributive transfers between different types of individuals aimed at achieving vertical equity. These transfers are according to the type of individual.

$$\sum_e N_e^{TOT}\, tr_e = 0 \qquad [16]$$

The second is fiscal equalisation transfers. These transfers are according to state and are paid to state governments.

$$\sum_j fe^j \sum_e N_e^j = 0 \qquad [17]$$

Distinguishing between these two types of central government transfers assists in reconciling the equalisation findings of Albouy (2012) and this paper.

The central government is not assumed to make transfers that differentiate simultaneously between labour type and state of residence. Such transfers are unconstitutional in some

Federations, including in the Australian Federation. However, such differentiation can be achieved by state governments undertaking their own redistributive transfers within their own states.

The modelling of state government budgets is more involved than the modelling of the central government budget.

$$PG^j \sum_e N_e^j \, g_e^j + GF^j + str_e^j = fe^j \sum_e N_e^j + tc^j \, PC^j \sum_e N_e^j \, c_e^j + tL^j r^j L^j + tK^j i^j K^j + tw^j \sum_e w_e^j \, N_e^j + tI^j \sum_e \frac{N_e^j}{N_e^{TOT}} \theta_e \sum_j \left(1 - tK^j\right) i^j K^j + tR^j \sum_e \frac{N_e^j}{N_e^{TOT}} \theta_e \sum_j \left(1 - tL^j\right) r^j L^j \quad [18]$$

The left hand side shows state government expenditures. As stated earlier, a distinction is made between the variable expenditures and fixed expenditures (*GF*) of state governments. Fixed expenditures take into account that any state government will incur some minimum level of costs, independent of the size of the state population, in establishing and maintaining an administrative structure.

State government expenditures also include provision for redistributive transfers within each state (*str*). These state transfers, when averaged across state budgets, do not change the vertical redistribution achieved by those budgets. Rather, they play the fine tuning role of synchronising vertical redistribution across state budgets, as explained later.

$$str_e = \frac{1}{N_e^{TOT}} \sum_j N_e^j str_e^j = 0 \quad [19]$$

The right hand side of equation [18] shows state government revenues. The first term is the fiscal equalisation transfer from the central government that was introduced above. The second term extends Albouy (2012) with the inclusion of a state consumption tax at the rate *tc*. The remaining terms follow Albouy (2012) by allowing for source-based taxes on land and capital at the rates *tl* and *tK*, and residence-based taxes on labour, capital and land incomes at the rates *tw*, *tI* and *tR* respectively.

Because individuals are assumed to own a share of national assets, the nature of the tax base for residence-based taxes on land and capital is the same for each state. Each group of individuals is assumed to own a fixed share θ_e of the national stocks of capital and land, with these shares summing to unity.

Having established the national, central government and state government budget constraints, the budget constraint facing each individual can be inferred.

$$y_e^j = tr_e + w_e^j + \frac{\theta_e}{N_e^{TOT}} \sum_j \left(1 - tK^j\right) i^j K^j + \frac{\theta_e}{N_e^{TOT}} \sum_j \left(1 - tL^j\right) r^j L^j + res_e^j \quad [20]$$

On the left-hand side of equation [20] is the full income of the individual, *y*. Once it is determined, it is available to be spent on *c* and *g* according to equation [1]. The state government is assumed to optimally choose the level of *g* leaving the individual to consume *c* from the remaining income. The level of *g* that is chosen by the state government is assumed to be that which leaves each individual with the utility maximising combination of *c* and *g*, given *y*.

On the right-had side of equation [20] is the sources of the individual's full income. These include its transfer from the central government, its labour income, and its capital and land income, net of taxes that have been deducted at the source. It also includes a net fiscal benefit from the state government or fiscal residuum of *res*, which is defined in equation [21].

$$res_e^j = str_e^j + PG^j g_e^j - tc^j PC^j c_e^j - tw^j w_e^j - tI^j \frac{\theta_e}{N_e^{TOT}} \sum_j \left(1 - tK^j\right) i^j K^j - tR^j \frac{\theta_e}{N_e^{TOT}} \sum_j \left(1 - tL^j\right) r^j L^j \quad [21]$$

The net fiscal benefit from the state government consists of the value of government transfers and government services, net of payments of each of the state residence-based taxes.

We can now return to equation [15], the key condition for obtaining an optimal allocation of labour across states. The left hand-side refers to an individual's non-labour income. The components of this can now be identified by re-arranging equation [20].

$$y_e^j - w_e^j = tr_e + \frac{\theta_e}{N_e^{TOT}} \sum_j \left(1 - tK^j\right) i^j K^j + \frac{\theta_e}{N_e^{TOT}} \sum_j \left(1 - tL^j\right) r^j L^j + res_e^j \quad [22]$$

The right-hand side of equation [15] refers to the national average non-labour income for the same type of individual. This can be obtained by multiplying equation [22] by the number of individuals of that type in that state, aggregating over states and then dividing by the number of individuals of that type. This gives equation [23].

$$\frac{\sum_j N_e^j y_e^j}{N_e^{TOT}} - \frac{\sum_j N_e^j w_e^j}{N_e^{TOT}} = tr_e + \frac{\theta_e}{N_e^{TOT}} \sum_j \left(1 - tK^j\right) i^j K^j + \frac{\theta_e}{N_e^{TOT}} \sum_j \left(1 - tL^j\right) r^j L^j + \frac{1}{N_e^{TOT}} \sum_j N_e^j res_e^j \quad [23]$$

The optimal allocation of labour depends on equality between the components of the individual's non-labour income shown on the right-hand side of equation [22] with the corresponding components for the national average for that type of individual shown on the right hand side of equation [23]. As seen in equation [23], there are three components of non-labour income in the model, any of which could potentially led to distortions in the allocation of labour between states.

The first component is central government transfers (positive and negative) designed to achieve vertical equity. These match in the two equations. As noted above, the amount of central government redistributive transfers, tr_e, depends only on the type of individual, not their location. Thus, the central government's transfer payments do not distort the location of any type of individual.

The second component is property income, including rental income from both capital and land. These components also match because individuals of a given type are assumed to own the same portfolio of national assets irrespective of their state of residence.

The third component is the net fiscal benefit. Comparing the two equations, the condition required for an optimal allocation of labour across states is as follows.

$$res_e^j = \frac{1}{N_e^{TOT}} \sum_j N_e^j \, res_e^j = res_e \qquad [24]$$

This is the optimality requirement for locational efficiency in which each state offers the same type of individual the same net fiscal benefit. The fiscal equalisation rule derived below provides each state with the funding needed to achieve that outcome.

For this funding to translate into each state providing the same pattern of net fiscal benefits across labour types, states need to synchronise their vertical redistribution policies. Such synchronisation is also necessary to dovetail with the vertical redistribution policy of the central government. In the model, states can synchronise their vertical redistribution policies using the state redistributive transfers introduced earlier.

A.2 Optimal Equalisation Formula

The first step in deriving the equalisation formula is to re-express the state government budget constraint of equation [18] by substituting in for the net fiscal benefit given by equation [21] and the optimality condition for the net fiscal benefit given by equation [24].

$$\sum_e N_e^j \, res_e + GF^j = fe^j \sum_e N_e^j + tL^j r^j L^j + tK^j i^j K^j \qquad [25]$$

The above state government budget constraint can be aggregated over states to obtain the all states budget constraint in equation [26]. This aggregation uses the fact that the fiscal equalisation transfers sum to zero, as required by equation [17].

$$\sum_e N_e^{TOT} \, res_e + \sum_j GF^j = \sum_j tL^j r^j L^j + \sum_j tK^j i^j K^j \qquad [26]$$

Expressing both the state and all states budget constraints in per capita form, subtracting the all states constraint from the states constraint, and re-arranging gives the solution for the optimal fiscal equalisation transfers expressed on a per capita basis.

$$fe^j = \left[GF^j/N^j - \sum_j GF^j/N\right] - \left[tL^j r^j L^j/N^j - \sum_j tL^j r^j L^j/N\right] - \left[tK^j i^j K^j/N^j - \sum_j tK^j i^j K^j/N\right] + \sum_e \left(N_e^j/N^j - N_e^{TOT}/N\right) res_e \quad [27]$$

The above equalisation formula involves the national average for the net fiscal benefit of a type *e* individual (res_e). This national average is constructed in equation [28] using equation [21]. In this process, equation [19] is used to set the national average for state redistributive transfers to zero.

$$res_e = \frac{1}{N_e^{TOT}} \left\{ \begin{array}{c} \sum_j PG^j N_e^j g_e^j - \sum_j tc^j PC^j N_e^j c_e^j - \sum_j tw^j N_e^j w_e^j \\ -\theta_e \sum_j \frac{N_e^j tI^j}{N_e^{TOT}} \sum_k (1 - tK^k) i^k K^k - \theta_e \sum_j \frac{N_e^j tR^j}{N_e^{TOT}} \sum_k (1 - tL^k) r^k L^k \end{array} \right\} \quad [28]$$

The optimal equalisation scheme given by equations [27] and [28] is interpreted in section 2.

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