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Optimal fiscal equalisation and its application to Australia: updated

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Abstract

The first part of this paper develops a theoretical model of fiscal equalisation 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 welfare-maximising role of fiscal equalisation is to support an efficient distribution of different labour types across states. The theoretical model further develops work by Boadway and Flatters and by Albouy with some Australian-oriented extensions. Under optimal equalisation, full equalisation is applied when a state government achieves a fiscal advantage by using source-based taxes to raise revenue from non-residents (e.g. mining royalties) or from spreading its fixed costs over a large population. However, efficiency also dictates that equalisation is limited to fiscal advantages arising from differences in state population composition when applied to revenue raised from residents (e.g. via labour or consumption taxes) or to the variable costs of government. Simplifying assumptions are discussed. The second part of this paper applies the optimal equalisation approach to Australia using, as a base, the Commonwealth Grants Commission (CGC) assessments for 2017/18 and 2018/19. 2016 Census data is used to measure the impact of each state's population composition on its ability to raise revenue from residence-based taxes for use in applying limited equalisation. The gain in consumer welfare of moving from the current Australian full equalisation system to optimal equalisation is estimated. Policy alternatives that are found to be inferior to the current full equalisation system include no equalisation, half-equalisation and the donor relief equalisation schemes recently recommended by the Australian Productivity Commission.

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Optimal fiscal equalisation and its application to Australia: updated[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 Australian 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

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is called for on efficiency grounds is one that fully equalises per capita revenues from both 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 concurs with these earlier studies in finding that full equalisation is optimal for source-based revenues, but differs from them in finding that a specific, limited form of equalisation is optimal for residence-based revenues. After separating equalisation transfers from other central government transfers that target vertical equity, we find that the influence of population composition, but not other factors, should be taken into account in assessing the capacity of states to raise revenue from residence-based taxes.

More generally, optimal fiscal equalisation in this paper establishes an efficient connection *at the margin* between the cost of state government services and the charging of a state's residents for those services through residence-based taxes, such as those on labour income or consumption. This resembles the user pays approach stressed by Albouy (2012) with the important exception of the different interpretation for residence-based taxes. It results in some fiscal advantages being equalised away while others are not.

Full equalisation is optimal for source-based taxes such as those commonly applied to mineral resources and land because these taxes can be used to raise revenue from non-residents. Full equalisation is also optimal for the fixed costs of state government so that these are shared on an equal per capita basis and do not distort locational choices at the margin.

On the other hand, full equalisation is not optimal for the variable costs of government and residence-based taxes such as those on labour income or consumption, as this is not consistent with the efficient provision of state government services. In these cases, equalisation is required for the effects of differences in state population compositions, as highlighted in the work of Boadway and Flatters (1982). However, it should be limited to the effects of population composition and not reflect other state differences in areas such as amenity or productivity.

This paper shows how limited equalisation of residence-based taxes can be designed in principle and implemented in practice. Australian 2016 Census data is used to assess how differences in state population compositions according to age, educational attainment and indigenous status influence personal incomes, and thereby the capacity to raise revenue from residence-based taxes. Equalisation is then applied for differences in states per capita personal

incomes to the extent that they are explained by these differences in state population compositions but not for other sources of differences such as in state productivity levels for the same labour type.

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, until recently Australian work in this area has used multi-regional Computable General Equilibrium (CGE) models. For example, Independent Economics (2015) used such a model to estimate a gain in annual consumer welfare of $521 million in 2015/16 from the Australian equalisation system, compared to a situation in which all equalisation adjustments, except on account of indigeneity, were abandoned. The CGE modelling approach has the advantage of providing estimates for a wide range of economic impacts from fiscal equalisation.

At the same time, Albouy (2012) demonstrates that a theoretical analysis of fiscal equalisation can be more powerful. More general assumptions can be made, so the findings can be more robust. There is also the potential to derive a welfare-maximising equalisation formula for adoption by the authorities. With such an optimal formula, the loss of consumer welfare from departing from it can be quantified using deadweight loss calculations, as illustrated by Albouy (2012) for Canada.

In a preliminary version of this study, Murphy (2017) follows Albouy (2012) in undertaking a theoretical analysis. This theoretical approach makes more general assumptions than the earlier Australian CGE modelling, including allowing for heterogeneous individuals, capital and more types of residence-based and source-based taxes. Murphy (2017) finds in favour of a combination of full and limited equalisation, as outlined above.

This final paper expands the Murphy (2017) study in three main ways. First, it more fully demonstrates how the concept of limited equalisation can be applied to residence-based taxes by using the recently-released complete data from the 2016 Population Census. Second, it models a wider range of equalisation policy options, including those recently recommended by the Productivity Commission (2017) in its draft report on 'Horizontal Fiscal Equalisation'. Third, it updates to use the latest equalisation payments determined by the Commonwealth Grants Commission (2017a, 2018), those for 2017/18 and 2018/19, as its point of reference.

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), adds the Australian-oriented enhancements introduced above and offers fresh insights on optimal fiscal equalisation. This section provides a general explanation of the model and formula, while the full theoretical analysis is presented in the Appendix.

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 illustrated using the CGC equalisation assessment for 2018/19.

Section 4 shows how limited equalisation could be implemented for residence-based taxes and how this differs from full equalisation. This limits equalisation to differences in capacity arising from differences in state population composition. 2016 Census data is used to measure how population compositions vary between states and to identify how personal income, which is used as an indicator of the tax base for residence-based taxes, varies between population types at the national level.

Section 5 estimates the impacts of alternative equalisation policies on consumer welfare and the state distribution of the national population. The existing policy of full equalisation is used as a baseline or reference point. The alternative policies considered fall into three categories: half-equalisation or no equalisation; the donor relief equalisation schemes recently recommended by the Productivity Commission (2017); and optimal equalisation in full or a simplified form.

Section 6 presents the six main qualifications to the analysis.

Section 7 summarises the proposal for optimal equalisation developed in this paper and compares this to the proposals from the Productivity Commission.

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 as illustrated in section 4. 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 (Canada 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 each category 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. 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 change. 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 is appropriate to cross-classify populations using attributes such as age, educational attainment and indigeneity status. Section 4 demonstrates how limited equalisation can be applied in practice using data from the 2016 Census.

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 suppositional 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 logically 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, rather than no 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 supporting an efficient national labour market.

The Australian equalisation system is unusually comprehensive, being applied to both state government revenues and expenditures. For example, in 2016/17 the states raised $133 billion in own-source revenue, and also received from the central government $60 billion in GST revenue and $45 billion in other payments. All of the total revenue of $238 billion was subject to fiscal equalisation. Similarly, total expenses of $250 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.

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 2018/19, 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 follows 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. In practice, equalisation is based on mining production and it has been argued that some states are more willing than other states to exploit their mining capacity. 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, not of working age or has low educational attainment, 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 for residence-based taxes is developed in section 4 using data from the 2016 Census. Section 4 also explains how this differs from 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 population composition 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
government efficiency	none	none

3.2 2018/19 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 2018/19. Table 3A is drawn directly from the CGC (2018) report and shows 18 separate components or drivers that are aggregated to reach the final transfers recommended by the CGC. Those recommended equalisation transfers appear in the final row of the table. By design, they sum to zero when added across states.

Table 3A: Drivers of CGC (full) fiscal equalisation, 2018/19

	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	1 977	2 810	- 658	-4 927	486	178	188	- 54	5 639	source-based
Payrolls paid	- 536	423	478	- 993	466	200	7	- 46	1 575	economic/demog
Property sales (a)	-2 141	- 242	442	793	760	240	38	109	2 383	source-based
Land values	- 449	- 234	406	- 173	266	95	64	25	857	source-based
Other revenue effects	193	124	- 85	- 231	- 46	3	35	6	362	economic/demog
Total revenue raising capacity	- 956	2 882	583	-5 531	1 932	717	332	40	6 487	
Effects of expenditure requirements										
Demographic features										
Remoteness and regional costs (b)	-1 172	- 952	709	373	87	394	- 142	703	2 266	geographic
Indigenous status (c)	9	-1 583	698	198	- 129	107	- 65	765	1 777	demographic
Socio-economic status (d)	98	- 108	81	- 178	404	55	- 230	- 122	638	demographic
Other SDC (e)	- 34	- 751	365	86	147	42	4	141	785	demographic
Wage costs (g)	157	-390	-228	712	-242	-188	100	79	1048	economic
Population growth (h)	-46	674	-79	-297	-172	-86	-29	35	710	demographic
Urban centre size (f)	402	1035	-707	-53	-215	-264	-71	-127	1437	geographic
Administrative scale	-448	-301	-171	46	126	236	243	268	920	fixed costs
Natural disaster relief	-84	-151	273	-7	-28	7	-6	-5	280	geographic
Small communities (i)	-272	-249	88	160	62	22	-17	206	538	geographic
Non-State sector (j)	-162	-122	-52	264	0	57	39	-24	361	demographic
Other expense effects	-535	-1004	228	604	148	17	-42	584	1581	demographic
Total expense and capital effects	-2 088	-3 900	1 206	1 908	187	400	- 216	2 503	6 204	
Effects of Commonwealth payments	22	817	-505	5	69	-58	85	-434	997	
Total	-3021	-201	1284	-3618	2188	1059	200	2109	6840	

Source: CGC (2018), Table S5-6.

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

Table 3B shows the estimated optimal transfers. It can be compared directly with the existing transfers shown in Table 3A. Finally, Table 3C shows a simplified version of the optimal transfers. The simplification is to set transfers to zero in all cases on the revenue side where full equalisation is not optimal, rather than introducing the new feature of limited equalisation.

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.

Table 3B: Drivers of optimal fiscal equalisation

	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	1 977	2 810	- 658	-4 927	486	178	188	- 54	5 639	full equalisation
Payrolls paid	*- 77*	*- 140*	*179*	*24*	*17*	*24*	*- 60*	*32*	*277*	demographic only
Property sales (a)	-2 141	- 242	442	793	760	240	38	109	2 383	full equalisation
Land values	- 449	- 234	406	- 173	266	95	64	25	857	full equalisation
Other revenue effects	*- 53*	*- 96*	*124*	*16*	*12*	*17*	*- 42*	*22*	*191*	demographic only
Other revenue	*- 165*	*- 299*	*384*	*51*	*37*	*52*	*- 129*	*69*	*593*	demographic only
GST: imputed less epc revenue	*1 119*	*- 89*	*- 673*	*76*	*- 398*	*- 163*	*53*	*74*	*1 322*	
GST: equalisation	*- 195*	*- 354*	*455*	*60*	*43*	*61*	*- 153*	*82*	*702*	demographic only
Total revenue raising capacity	17	1 356	659	-4 079	1 222	505	- 41	360	4 120	
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)	9	-1 583	698	198	- 129	107	- 65	765	1 777	demographic
Socio-economic status (d)	98	- 108	81	- 178	404	55	- 230	- 122	638	demographic
Other SDC (e)	- 34	- 751	365	86	147	42	4	141	785	demographic
Wage costs (g)	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	nil equalisation
Population growth (h)	-46	674	-79	-297	-172	-86	-29	35	710	demographic
Urban centre size (f)	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	nil equalisation
Administrative scale	-448	-301	-171	46	126	236	243	268	920	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)	-162	-122	-52	264	0	57	39	-24	361	demographic
Other expense effects	-535	-1004	228	604	148	17	-42	584	1 581	demographic
Total expense and capital effects	-1 118	-3 193	1 070	723	523	429	- 81	1 647	4393	
Effects of Commonwealth payments	22	817	-505	5	69	-58	85	-434	997	
Total	-1079	-1020	1224	-3351	1814	875	-37	1574	5487	

The remaining two categories of revenue are classified to both the "economic" and demographic categories. These revenue sources are payroll tax, which was discussed earlier, and "other revenue effects", which refer to insurance taxes and motor vehicle taxes. These taxes are driven by state incomes, which are influenced by demographic circumstances as well as 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 implicitly assumes that "other revenue" is driven by population size, so no equalisation is needed. Accounting for 37 per cent of own-source revenue, this category includes gambling taxes, user charges and interest and dividends. The bulk of revenue in this category would 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.

Table 3C: Drivers of simplified fiscal equalisation

	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	1 977	2 810	- 658	-4 927	486	178	188	- 54	5 639	full equalisation
Payrolls paid	0	0	0	0	0	0	0	0	0	nil equalisation
Property sales (a)	-2 141	- 242	442	793	760	240	38	109	2 383	full equalisation
Land values	- 449	- 234	406	- 173	266	95	64	25	857	full equalisation
Other revenue effects	0	0	0	0	0	0	0	0	0	nil equalisation
Total revenue raising capacity	- 613	2 334	190	-4 307	1 512	514	290	80	8 879	
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)	9	-1 583	698	198	- 129	107	- 65	765	1 777	demographic
Socio-economic status (d)	98	- 108	81	- 178	404	55	- 230	- 122	638	demographic
Other SDC (e)	- 34	- 751	365	86	147	42	4	141	785	demographic
Wage costs (g)	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	nil equalisation
Population growth (h)	-46	674	-79	-297	-172	-86	-29	35	710	demographic
Urban centre size (f)	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	nil equalisation
Administrative scale	-448	-301	-171	46	126	236	243	268	920	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)	-162	-122	-52	264	0	57	39	-24	361	demographic
Other expense effects	-535	-1004	228	604	148	17	-42	584	1 581	demographic
Total expense and capital effects	-1 118	-3 193	1 070	723	523	429	- 81	1 647	4393	
Effects of Commonwealth payments	22	817	-505	5	69	-58	85	-434	997	
Total	-1709	-42	755	-3579	2104	884	294	1293	5330	

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.

Table 3C shows the simplified version of the optimal transfers. As noted above, this sets transfers to zero in all cases on the revenue side where full equalisation is not optimal. This gives a system that is considerably simpler than both the existing full equalisation system and the proposed optimal equalisation system.

On the revenue side, this means that under the simplified system the source-based taxes on mining, property and land continue to be fully equalised. However, for residence-based taxes, equalisation is abolished instead of introducing the new feature of equalisation that is limited to the influence of population composition.

Equalisation on the expenditure side is the same as under the optimal system. That is, the existing equalisation for wage costs and geographic factors is removed, while equalisation for demographic factors and fixed costs is retained.

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 (2015) also use a multi-regional CGE model but make the more common assumption that State governments do spend in accordance with household preferences. They estimate a gain in annual consumer welfare of $521 million in 2015/16 from the Australian equalisation system, compared to a situation in which all equalisation adjustments, except on account of indigeneity, were abandoned. This welfare gain arises primarily from equalisation of source-based taxes, notably mining royalties. Mining royalties would have been a much less important factor in Dixon et al. because real mineral prices were much lower in 2002 than in 2015.

In a precursor to this paper, Murphy (2017) follows Albouy (2012) in moving from a CGE analysis of alternative equalisation schemes to a theoretical analysis of the optimal scheme. Welfare losses from sub-optimal schemes are then estimated using deadweight loss analysis, as described in section 5.

4 FULL AND LIMITED EQUALISATION IN PRACTICE

This section shows how limited equalisation could be implemented for residence-based taxes and how this differs from full equalisation. Limited equalisation involves isolating differences in revenue-raising capacity that arise from differences in state population compositions. In Australia a similar type of demographic analysis is already conducted on the expenditure side of the budget, so this section concentrates on how it can be extended to the revenue side.

Two main data sources are used. 2016 Census data is used to measure how population compositions vary from state-to-state and to estimate the capacity of each population type to contribute to the tax base. The 2018/19 CGC equalisation assessments provide information on state revenue collections from residence-based taxes.

The optimal equalisation formula presented as equation [27] in section 2 includes full equalisation for source-based taxes and limited equalisation for residence-based taxes. To provide context for how limited equalisation works, it is useful to begin by considering full equalisation as applied to source-based taxes.

Under full equalisation, 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 standard 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-3C 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 outwards interstate migration. Subsidising that underperformance through full equalisation would maintain 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 61 per cent of all state government revenue in 2016-17 ($145 billion of $238 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. The aim was to choose attributes that influence income and stay

with a person. This is distinct from other attributes such as occupation or industry of employment, which may change over a lifetime.

Use of these three attributes resulted in a total of 432 labour types based on 16 age categories by 3 indigenous status categories by 9 educational level categories. In addition, there is a single, final type covering everyone aged under 15 years, who are all recorded in the Census as having no income, giving a final tally of 433 types.

The 16 age categories for the labour types are constructed using 5-year age groups. These groups extend from those aged 15 to 19 to those aged 85-89. The final age-group was constructed by aggregating three age groups in the original data into a single, open-ended age-group aged 90 and above. This aggregation was necessary so that there are sufficient numbers of people in each of the final types to support a statistically meaningful analysis.

The three indigenous status categories are indigenous, non-indigenous and not stated. The indigenous category was obtained by aggregating the three separate categories found in the original data: aboriginal; Torres Strait Islander; and both Aboriginal and Torres Strait Islander. Again, this aggregation was necessary so that there are sufficient numbers of people in each of the final types to support a statistically meaningful analysis.

In the original data there are ten educational categories: Postgraduate Degree Level; Graduate Diploma and Graduate; Bachelor Degree Level; Advanced Diploma and Diploma; Certificate III and IV level; Secondary Education – Years 10 and above; Certificate I and II level; Secondary Education – Years 9 and below; Supplementary Codes; and Not stated. To form the final nine educational categories, the two original categories of Certificate I and II level and Secondary Education – Years 9 and below, were aggregated into a single category, again to allow statistically meaningful analysis.

This cross-classification of the population into these 433 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. The average annual personal income for the 432 income-earning types is $42,800. This falls to $34,800 if the non-income-earning group aged under 15 years is also considered, as shown in Chart 1.

There is considerable variation in income across the 432 income-earning types relative to the average income of $42,800. The top-earning type is people of 50 to 54 years of age, who are non-indigenous and have a Postgraduate Degree. Their average personal income is $111,300. The bottom-earning type is people of 15 to 19 years of age, for whom indigenous status and education are both not stated. Their average personal income is $200. The high variation suggests that the three attributes taken together are informative about how population composition affects personal incomes.

The third step is to determine the influence of state-to-state variation in population composition on state-to-state variation in average personal incomes. 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. With this replacement, variations between states in their predicted incomes per head are due to variations between states in their population composition, rather than variation between states in income received by the same labour type.

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

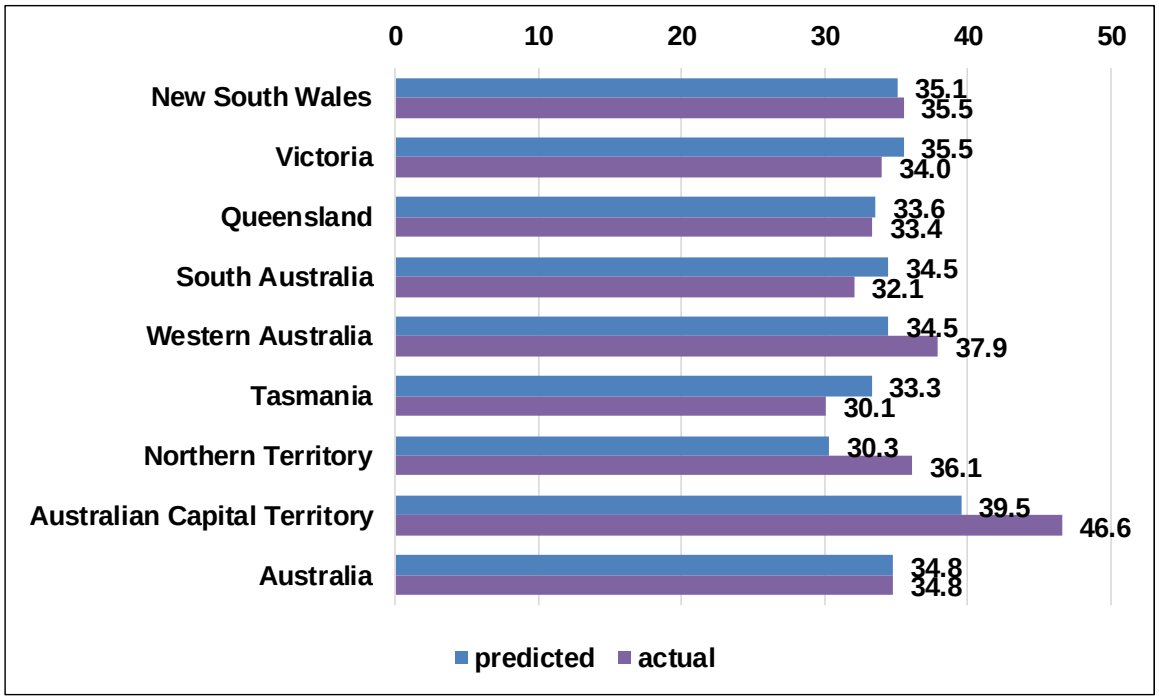


Chart 1 implies that predicted annual personal income per head is within one per cent of the national figure of $34,800 for three states – NSW, SA and WA. This suggests that, in 2016, population composition had a broadly neutral impact on the ability of these three states to raise revenue from state income-based taxes.

The remaining five states show some variation in how population composition affects their ability to raise revenue from state income-based taxes. Victoria has a small advantage of around 2 per cent, while Queensland and Tasmania have small disadvantages of 3 and 4 per cent respectively. The outliers are the territories, with the ACT having an advantage of around 13 per cent and the NT a disadvantage of around the same percentage. 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, based on the 2016 Census.

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 limited equalisation may result in significant locational inefficiencies.

For example, WA achieves actual per capita incomes that are 9 per cent above the national benchmark, despite its population composition predicting that it would be 1 per cent below that benchmark. Under limited equalisation, this 10 per cent outperformance is allowed to act as a market signal for migration to WA. Applying full rather than limited equalisation for residence-based taxes blunts this market signal.

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 could be made. For example, it should be taken into account that, in effect, the general government sector is exempt from payroll tax. This confers a fiscal disadvantage on the ACT in particular, which the CGC already appropriately takes into account.

Table 4: Limited equalisation of residence-based taxes: calculations, 2018/19

	NSW	Vic	Qld	WA	SA	Tas	ACT	NT	AUS
predicted income/head ($,000 per year)	35.1	35.5	33.6	34.5	34.5	33.3	39.5	30.3	34.8
population ('000 persons)	7,480	5,927	4,703	2,474	1,677	510	397	229	23,397
predicted state personal income ($m)	262,612	210,539	157,977	85,325	57,788	16,980	15,714	6,945	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	32.27%	25.87%	19.41%	10.48%	7.10%	2.09%	1.93%	0.85%	
population share less predicted income share	-0.30%	-0.54%	0.69%	0.09%	0.07%	0.09%	-0.23%	0.12%	
national revenue from residence-based taxes ($m)									165,210
limited equalisation for residence-based taxes ($m)	-489	-889	1142	152	109	154	-384	206	0

Table 5: Limited equalisation of residence-based taxes: by tax ($ million), 2018/19

	NSW	Vic	Qld	WA	SA	Tas	ACT	NT
Payrolls paid	-77	-140	179	24	17	24	-60	32
Other revenue effects	-53	-96	124	16	12	17	-42	22
Other revenue	-165	-299	384	51	37	52	-129	69
GST: equalisation	-195	-354	455	60	43	61	-153	82
limited equalisation for residence-based taxes ($m)	-489	-889	1142	152	109	154	-384	206

5 EMPIRICAL ANALYSIS

This section estimates the effects of alternative equalisation policies on consumer welfare. In calculating these welfare effects, one of the policies needs to be chosen as the reference point. The initial calculations use the optimal policy as their reference point, so that the deadweight losses from departing from an optimum can be calculated in the usual way. However, when presenting the results in the report, convention requires that the existing policy of full equalisation is used as the baseline. This is achieved in the final calculation by adjusting the initial calculations of the welfare effects for the gain from moving from the existing policy to the optimal policy.

Relative to this baseline of existing policy, optimal equalisation will result in a welfare gain, while other equalisation policies may result in a smaller welfare gain or a welfare loss. The alternative policies considered fall into three categories: half-equalisation or no equalisation; the donor relief equalisation schemes recently recommended by the Productivity Commission (2017); and optimal equalisation in full or a simplified form.

In the initial calculations, the optimal equalisation transfers, which are taken from the final row of Table 3B, are used in estimating the impact on consumer welfare of the other scenarios, which are all sub-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 (i.e. a subsidy) 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. Because 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.

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.

To perform these calculations, a baseline year needs to be chosen. The latest CGC (2018) assessment of equalisation transfers is for 2018/19, which is the baseline year chosen here. The CGC calculated these transfers in the usual way by assessing state fiscal capacities in the latest three historical years of 2014/15, 2015/16 and 2016/17, and then projecting forward to 2018/19 using forecasts for growth in population and GST revenue.

To provide a sensitivity analysis of the results to this choice of baseline year, the CGC (2017a) transfers for the previous year of 2017/18 are used as an alternative baseline. Thus, in simulating each alternative equalisation policy, two sets of results are provided. These show the simulated effects of the alternative policies in 2017/18 and 2018/19.

With the delayed effect on the equalisation transfers of the fading in the minerals price boom, donor transfers from WA fell significantly from 2017/18 to 2018/19. This can be seen by comparing the "baseline" columns for the two years in Table 6. Because it is efficient to equalise for differences in mineral resource endowments, the falling revenue significance of these endowments means that there are smaller gains from equalisation in 2018/19 than in 2017/18, as we shall see in the results.

The basis for the CGC equalisation transfers in terms of equalisation drivers was shown for 2018/19 in Table 3A. Thus, the final row of Table 3A matches the 2018/19 baseline transfers shown in Table 6.

We now turn to the results for the various policy scenarios in a series of three sub-sections. These cover half-equalisation or no equalisation, donor relief equalisation schemes (as recommended by the Productivity Commission), and optimal equalisation in full or simplified form. As noted above, the economic impacts of each scenario are reported against the existing policy of full equalisation.

5.1 Partial or no equalisation 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 Productivity Commission (2017) identifies an EPC system as one possible alternative to full equalisation. Between these two polar cases is "half-equalisation" in which the equalisation transfers calculated by the CGC are discounted by 50 per cent.

Table 6 compares the equalisation transfers in these three alternative scenarios. It does this for both 2017/18 and 2018/19. It can be see that "half-equalisation" results in transfers that are

midway between the full equalisation transfers of the baseline and the zero equalisation transfers of an EPC system.

When transfers are re-expressed on a per capita basis, WA has the biggest gain and NT the biggest loss in moving to an EPC system or half-equalisation system. This is true in both 2017/18 and 2018/19. 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.

Overall, moving to an EPC system would result in a loss in consumer welfare of $1,052 in 2017/18 or $773 million in 2018/19, as seen in Chart 2. These substantial losses reflect the fact that the optimal equalisation system detailed in Table 3C is much closer to the existing full equalisation system than it is to an EPC system. That is, most of the equalisation under the existing system is justified on economic grounds.

Moving to an EPC system would generate these welfare losses partly because it would confer WA with a fiscal advantage at the expense of other states. Some reduction in the donor transfer from WA is optimal, from the CGC transfer of $3,618 million to the optimal transfer of $3,351 million. This can be seen by comparing Table 3A with Table 3B for 2018/19. However, an EPC system would go much further by completely eliminating such transfers. The resulting $3,351 million fiscal advantage to WA is similar to the amount of revenue that WA is currently projected to raise from payroll tax in the same year of $3,460 million.

Thus, moving to an EPC system would fund the WA to establish a tax haven by abolishing payroll tax. Alternatively, WA could use its new substantial fiscal advantage, achieved from unequalised mining royalties, in some other way to draw economic activity from other states. The resulting inefficient interstate migration is estimated, in the long term, to boost the population of WA by 4.5 per cent at the expense of the other states, as seen in Table 7.

On the other side of this EPC equalisation coin, the NT would incur a substantial fiscal disadvantage. Some reduction in its recipient transfer is optimal, from $2,109 million to $1,574 million in 2018/19. However, the fiscal disadvantage of $1,574 million from completely eliminating the transfer under an EPC system would be a large strain on the NT economy. For example, covering this fiscal disadvantage by raising NT taxes and royalties would involve nearly trebling them from their projected level of $803 million to $2,377 million.

This would take the NT economy close to a tipping point. As equalisation transfers are withdrawn from the NT, the NT's population contracts. This results in its large, fixed fiscal disadvantage from its population composition being spread more thickly over a progressively smaller population. Increasingly this offsets the population elasticity effect, so that a tipping point is reached in which further population reductions no longer succeed in helping per capita consumer welfare to recover, leading to a downward spiral in the population. The EPC scenario takes the NT economy close to this tipping point. The estimated NT population loss is 37.7 per cent.

The effects on consumer welfare of moving to half-equalisation are more complex and operate in opposite directions. For example, half-equalisation works to reduce consumer welfare in areas that would optimally have 100% equalisation, but have it reduced to 50% 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 50% under this proposal e.g. equalisation of government spending for wage costs and geographic circumstances. Overall, there is a net loss in annual consumer welfare. Chart 2 shows a loss of $40 million in 2017/18 and $36 million in 2018/19. The long-run effects on state populations follow a similar pattern to the EPC scenario, but are more muted.

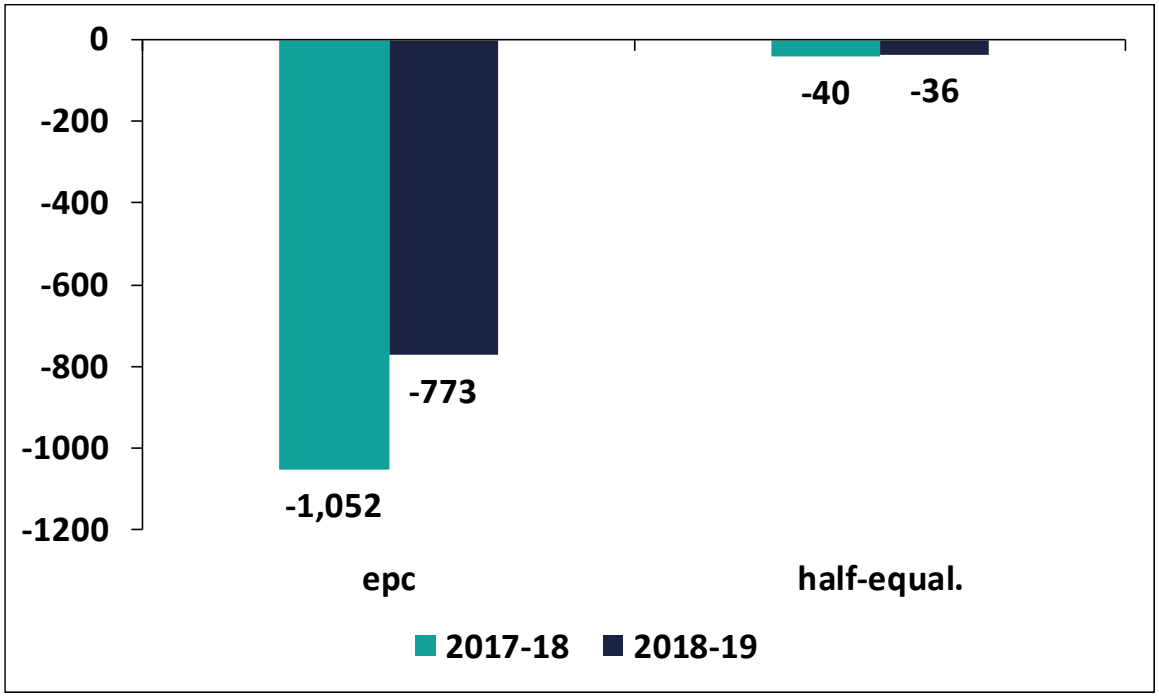
Table 6: Baseline and EPC transfers ($ million)

	2017-18			2018-19		
	baseline	epc	half-equal.	baseline	epc	half-equal.
NSW	-2,431	0	-1,216	-3,021	0	-1,511
Vic	-1,033	0	-516	-201	0	-100
Qld	2,399	0	1,200	1,284	0	642
WA	-4,465	0	-2,233	-3,618	0	-1,809
SA	1,955	0	978	2,188	0	1,094
Tas	1,075	0	537	1,059	0	529
ACT	203	0	102	200	0	100
NT	2,296	0	1,148	2,109	0	1,054
Total	0	0	0	0	0	0

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

	2017-18		2018-19	
	epc	half-equal.	epc	half-equal.
NSW	1.2%	0.5%	1.4%	0.6%
Vic	0.7%	0.3%	0.2%	0.1%
Qld	-1.5%	-0.8%	-0.7%	-0.4%
WA	5.6%	2.8%	4.5%	2.3%
SA	-3.8%	-1.9%	-4.1%	-2.1%
Tas	-7.1%	-3.5%	-6.9%	-3.4%
ACT	-1.5%	-0.8%	-1.4%	-0.8%
NT	-44.7%	-17.1%	-37.7%	-15.2%
Total	0.0%	0.0%	0.0%	0.0%

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



5.2 Donor relief systems

In its draft report on "Horizontal Fiscal Equalisation", the Productivity Commission (2017) recommends two alternative donor relief equalisation systems. These systems reduce the transfers paid by one or more donor states. The resulting funding shortfall is made up by a uniform per capita charge on all states.

In rationalising the two donor relief schemes, the Productivity Commission (PC) departs from the most common practice of considering an equalisation scheme in a single step. Based on standard economic theory, that single step involves neutralising state fiscal advantages and disadvantages relative to a national benchmark through a system of transfers that automatically sum to zero. An example of this was seen when economic principles were used to develop an optimal system of equalisation transfers, presented in equations [27] and [28] of this paper.

Rather than following this usual single step approach, the PC breaks the equalisation process down into three steps. In an accounting sense the end result is the same as under the single step approach. However, the individual steps have no particular economic significance. Consequently, when the PC develops equalisation schemes by modifying the second step, those schemes are left without a strong economic justification. Instead, the PC appeals to the nebulous concept of a "reasonable" level of equalisation.

The two donor relief schemes proposed by the PC share two common traits. First, they begin by reducing the grants paid by one or more donor states. Second, they recover the resulting shortfall in funding by, in effect, imposing a uniform per capita levy on all states. The two

schemes only differ in the method they use in the first step to reduce the grants paid by donor states.

Using its 3-step framework, the PC describes its first donor relief scheme as "equalising to the average fiscal capacity across the states". However, this scheme is more widely known in the literature as a grants equalisation scheme, which is a more informative way of characterising it. Under a grants equalisation scheme, recipient states continue to receive their transfers or grants calculated in the usual way. However, these grants are no longer funded by donor states, who are relieved of this funding obligation. Instead, they are funded by the uniform per capita levy applied to all states. Applying this donor relief system would require a per capita levy of $321 in 2017/18 or $273 in 2018/19.

The per capita levy leaves all recipient states worse off as they are required to partly self-fund their own fiscal disadvantage through the uniform levy. The levy approach also fails to take into account the differences between states in their fiscal advantages, as all states that were formerly donor states are levied at the same rate. This means that the largest donor state in per capita terms will always be better off under a grants system than under full equalisation. Only full equalisation fully recognises the differences between states in their fiscal advantages and disadvantages.

The issues with the levy approach can be illustrated taking the case of WA in 2018/19. Under the existing full equalisation system, it will pay a transfer of $3,618 million based on its assessed fiscal advantage relative to a national benchmark. Under the grants scenario, it instead pays a transfer of only $714 million, as seen in Table 8. This is calculated as the per capita levy applied to all states of $273 times the projected WA population of 2,621,000.

Turning to the second donor relief scheme, the PC describes it as "equalising to the fiscal capacity of the second strongest state". While the grants scheme provides donor relief to all donor states, this scheme differs by only providing donor relief to the state that is the largest donor in per capita terms. Hence, this scheme is more informatively described as a largest donor scheme. Both in 2017/18 and 2018/19, the largest per capita donor was WA.

The largest donor scheme reduces the per capita grant from the largest donor state to match that from the second largest donor state. For example, in 2018/19 the per capita grant from WA of $1,380 is reduced to $376, matching the per capita grant from NSW. This grant reduction results in a funding shortfall of $2,631 million. This is covered by applying a per capita levy of $105 on all states. For 2017/18, the corresponding figures are that the per capita grant from WA is reduced from $1,665 to $307, resulting in a funding shortfall of $3,641 million, which is recovered by applying a per capita levy of $148 on all states.

Thus, relative to full equalisation, the largest donor scheme redistributes revenue to the largest donor state and away from all other states. Hence, Table 8 shows all states other than WA being worse off in the largest donor scenario compared to the baseline scenario in both 2017/18 and 2018/19.

The PC (2017) also considered, but rejected, a third donor relief scheme, which is based on a GST relativity floor. It suggests "a floor is targeting a symptom, and ultimately, prevention is better than cure". However, if a GST relativity floor is only binding on one state, then it is equivalent to a largest donor scheme. In fact, in both 2017/18 and 2018/19, a GST relativity floor of 0.82 would have resulted in the same equalisation transfers as the largest donor scheme recommended by the PC. It is therefore difficult to see the rationale behind the PC recommending in favour of a largest donor scheme but against a relativity floor. In fact, as we shall see, all of these donor relief schemes are inferior to the existing system of full equalisation.

The idea of a GST relativity floor 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 broadly equivalent largest donor scheme proposed by the PC is equally arbitrary.

The effects of the largest donor scheme are considered first because its redistribution of transfer payments is simpler than under the grants scheme, leading to simpler effects. As discussed above, compared to full equalisation, the largest donor scheme simply redistributes revenue to the largest donor state and away from all other states.

The main divergence of the largest donor scheme from the optimal scheme is in its more generous treatment of WA. In 2017/18, it means WA pays $1,220 million compared to its optimal payment of $4,245 million, a shortfall of $3,025 million. In 2018/19 the shortfall from the optimal payment is less at $2,090 million. The effect of the largest donor system in these two years is to greatly reduce the extent to which WA's mining royalties are equalised with other states.

These fiscal advantages for WA from the largest donor scheme are significant compared to the amount of revenue that WA currently raises from payroll tax. For example, the fiscal advantage of $2,090 million conferred in 2018/19 could replace more than one-half of projected WA payroll tax collections of $3,460 million.

Thus, moving to a largest donor system would enable the WA to establish a tax haven based on a very low payroll tax rate, although unlike under an EPC system it would not be able to go as far as abolishing payroll tax. Alternatively, WA could use its new substantial fiscal advantage, achieved in effect from low equalisation of its mining royalties, in some other way to inefficiently draw economic activity from other states. The resulting inefficient interstate migration is estimated, in the long term, to boost the population of WA by 2.9 per cent at the expense of the other states, as seen in Table 9.

Overall, moving to the largest donor scheme would result in a loss in consumer welfare of $92 million in 2017/18 or $43 million in 2018/19, as seen in Chart 3. These losses reflect the fact that the optimal equalisation system detailed in Table 3C is closer to the existing full equalisation system than is the largest donor scheme. This is because the optimal equalisation system, like the full equalisation system, includes full equalisation of mining royalties, rather than the very partial effective equalisation of the largest donor system.

In broad terms, the effects of the grants scheme are similar to the effects of the largest donor scheme. In both cases, the main development is that the largest donor state receives generous relief from grant payments at the expense of some or all other states. In practice this means that the effective equalisation of WA's mining royalties is greatly reduced. This is welfare reducing because it is efficient to fully equalise for differences in mineral endowments.

In fact, the reductions in welfare are similar under both donor relief equalisation schemes, as can be seen from Chart 3. Moving to the grants scheme would result in a loss in consumer welfare of $94 million in 2017/18 or $49 million in 2018/19, similar to the estimates of $92 million and $43 million for the largest donor scheme.

The main difference between the design of the two schemes is that the grants scheme offers donor relief that is deeper and is broadened beyond the largest donor state. In practice this means that in both 2017/18 and 2018/19, WA and NSW do better under the grants scheme than under the largest donor scheme while the other six states all do worse. This has two effects on consumer welfare.

On the one hand, the greater donor relief for WA under the grants scheme is welfare reducing, because WA is already treated over-generously under the largest donor scheme compared to the optimal scheme. On the other hand, the greater donor relief for NSW under the grants scheme is welfare increasing, because NSW is still treated too harshly compared to the optimal scheme. These two effects on consumer welfare are broadly offsetting, leading to the similar welfare outcomes for both schemes.

The even more generous treatment of WA under the grants scheme compared to the largest donor scheme increases its fiscal advantage and associated potential to establish a tax haven. Compared to the optimal scheme, the grants scheme provides WA with a fiscal advantage of $3,383 million in 2017/18 and $2,637 million in 2018/19. Comparing this with projected WA payroll tax collections for 2018/19 of $3,460 million, it can be seen that the grants scheme would give WA the scope to cut payroll tax by around 75 per cent.

Thus, moving to a grants system would enable the WA to establish a tax haven based on a very low payroll tax rate, even more so than under a largest donor scheme. Alternatively, WA could use its new substantial fiscal advantage, achieved in effect from low equalisation of its mining royalties, in some other way to inefficiently draw economic activity from other states. The resulting inefficient interstate migration is estimated, in the long term, to boost the population of WA by 3.6 per cent at the expense of the other states, as seen in Table 9.

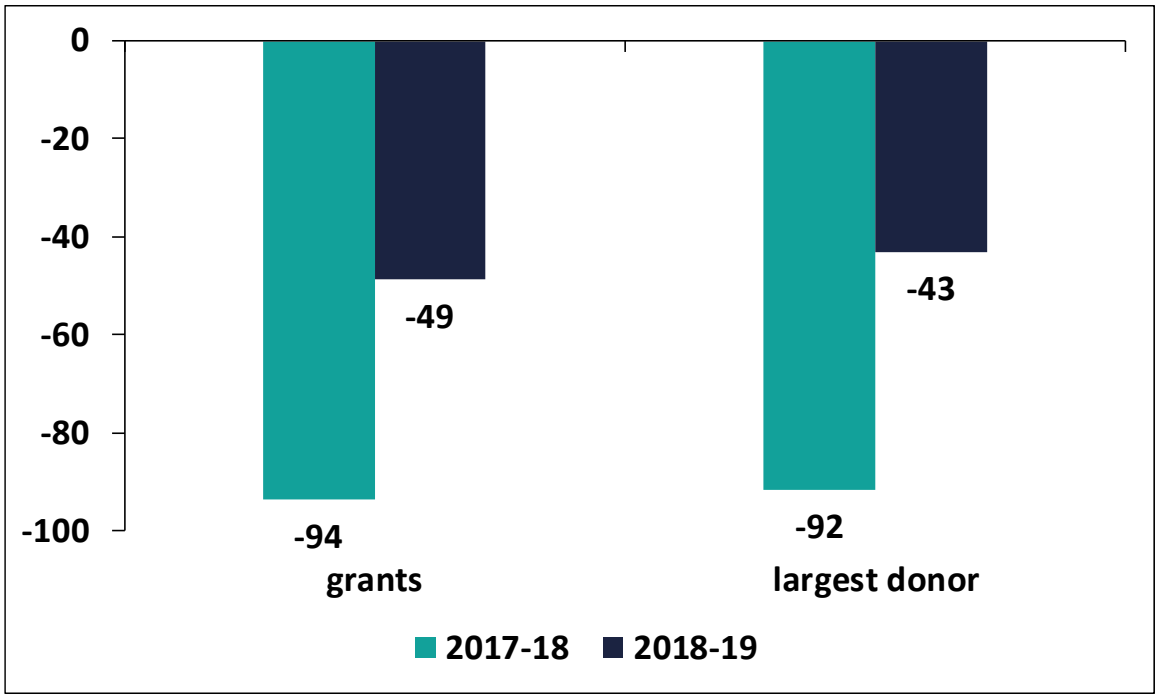
Table 8: Baseline and donor relief system transfers ($ million)

	2017-18			2018-19		
	baseline	grants	largest donor	baseline	grants	largest donor
NSW	-2,431	-2,542	-3,598	-3,021	-2,188	-3,863
Vic	-1,033	-2,005	-1,953	-201	-1,770	-882
Qld	2,399	812	1,670	1,284	-84	757
WA	-4,465	-862	-1,220	-3,618	-714	-1,261
SA	1,955	1,399	1,700	2,188	1,714	2,006
Tas	1,075	907	998	1,059	916	1,004
ACT	203	74	144	200	86	156
NT	2,296	2,217	2,260	2,109	2,042	2,083
Total	0	0	0	0	0	0

Table 9: Population impacts of donor relief systems
(deviations from baseline, per cent)

	2017-18		2018-19	
	grants	largest donor	grants	largest donor
NSW	0.0%	-0.5%	0.4%	-0.3%
Vic	-0.5%	-0.5%	-0.8%	-0.3%
Qld	-1.1%	-0.5%	-0.9%	-0.3%
WA	4.4%	4.0%	3.6%	2.9%
SA	-1.1%	-0.5%	-0.9%	-0.3%
Tas	-1.1%	-0.5%	-0.9%	-0.3%
ACT	-1.1%	-0.5%	-0.9%	-0.3%
NT	-1.0%	-0.5%	-0.9%	-0.3%
Total	0.0%	0.0%	0.0%	0.0%

Chart 3: Welfare impacts of donor relief 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. On the expenditure side of the budget, the optimal equalisation system reduces 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 on the revenue side of the budget by using a global treatment of residence-based taxes, based on limited equalisation. In contrast, the existing equalisation system treats different residence-based taxes in different ways that are difficult to justify. GST is initially distributed on a per capita basis, implying that it is fully equalised. There are separate full equalisation treatments for payroll tax, insurance taxes and motor vehicle taxes. The remaining residence-based taxes are combined under "other revenue", which is not equalised.

The limited equalisation approach developed in section 4 combines all of these residence-based taxes in a single line item, which covers 61 per cent of state government revenue. Further, residence-based taxes are equalised efficiently by equalising for the effects of differences in state population compositions but not for other effects such as differences in state economic productivity for the same labour types, as demonstrated in section 4. To apply this process to GST, it is first allocated between states based on the estimated amount of revenue raised in each state, similar to other taxes, and is then subject to limited equalisation.

To provide an option that involves even further simplification, a "simplified" optimal scheme is modelled. It varies the optimal equalisation policy by eliminating equalisation for residence-based taxes, as shown in Table 3C. The transfers under the "simplified" scenario, like the transfers under the optimal scenario, are presented in Table 10. However, in the following discussion, most emphasis is placed on the optimal equalisation system as this maximises consumer welfare while still offering important simplifications over the current system.

Overall, 'optimal' equalisation involves moderate changes from the existing system of full equalisation, relative to the major changes involved in an EPC system. The changes from optimal equalisation are moderate because most of the equalisation under the current system is optimal, including the full equalisation for source-based taxes, demographic effects and the fixed costs of government. Thus, in 2018/19, a move from full equalisation to optimal equalisation would involve only a moderate reduction from $6,840 million to $5,487 million in the value of transfers from donor states to recipient states, as seen from the final rows of Tables 3A and 3B.

This picture of moderate change is particularly true for the recipient states of Queensland, South Australia, Tasmania, the ACT and the NT. Putting the ACT to one side, for the each of the other four recipient states, a move from the existing system to the optimal system in 2018/19 would have seen transfers being maintained at between 75 and 95 per cent of their existing levels for that year. The ACT is more affected, but this would change to some extent once the optimal system is adjusted to follow the existing system in allowing for the fiscal disadvantage to the ACT from it not being able to apply payroll tax to federal government employment.

The impact on the NT would be more substantial than might appear from this comparison. While the NT would have 75 per cent of its transfer maintained, this is from a high base, with the NT per capita transfer falling from $8,559 to $6,387 or by $2,172. This fall can be attributed to the loss of equalisation for the geographic factor of remoteness and regional costs.

There is more change among the donor states, although they all continue to be donors.

NSW becomes a smaller donor for two reasons. First, it gains from the move from full to limited equalisation of GST revenue. This rewards NSW for the fact that it currently outperforms in raising GST revenue, as judged by its actual share of the tax base, household consumption expenditure, exceeding what would be expected based on the size and composition of its population. Second, NSW gains from the removal of equalisation for the geographic factor of remoteness and regional costs.

Victoria becomes a larger donor as it loses from the move from full to limited equalisation for residence-based taxes. As seen in section 4, according to data from the 2016 Census, Victoria currently underperforms in generating a tax base for residence-based taxes relative to what would be expected from the size and composition of its population. It is inefficient to equalise for this underperformance.

WA becomes a slightly small donor. WA gains from the move to limited equalisation for payroll tax. After controlling for its population size and composition, WA outperforms in raising revenue from payroll tax, which may be associated with the recent expansion in the mining industry. The current practice of equalising for this labour market outperformance is inefficient as this blunts a market signal for interstate migration to WA.

Besides boosting payroll tax collections, higher WA wages also add to its costs of government. Hence, removing equalisation for wage costs results in a budget loss for WA on the expenditure side. However, this loss only partly offsets the gain on the revenue side, so WA makes a small net budget gain when equalisation for wages is removed from both sides of the budget.

The existing equalisation system for mining royalties is not perfectly efficient to the extent that mining production is not serving as a close proxy for mining capacity. Ideally, the equalisation system would control for any differences between state governments in their willingness to convert mining capacity into mining production. Such an adjustment may be challenging, but would be likely to provide some budget net gain to WA.

These changes to the state pattern of transfer payments are reflected in state populations, as seen in Table 11. Because of the fall in their donor payments, NSW and WA make population gains, although those gains are under 1 per cent. The larger donor payment by Victoria, and the smaller grants received by the recipient states, lead to population losses, but these losses are generally small. The exception is the NT with a population loss of 6.8 per cent in response to the significant fall in its per capita grant.

Because of the welfare-maximising nature of the optimal scenario, all of these population shifts are efficient. They result in a gain in consumer welfare of $63 million in 2017/18 and $49 million in 2018/19, as seen in Chart 4. For the same reason, the optimal scenario will result in a higher level of consumer welfare than any other scenario.

The simplified equalisation scheme also results in welfare gains, but these are necessarily more modest than for the optimal scenario. The welfare gains are $49 million in 2017-18 and $27 million in 2018-19.

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.

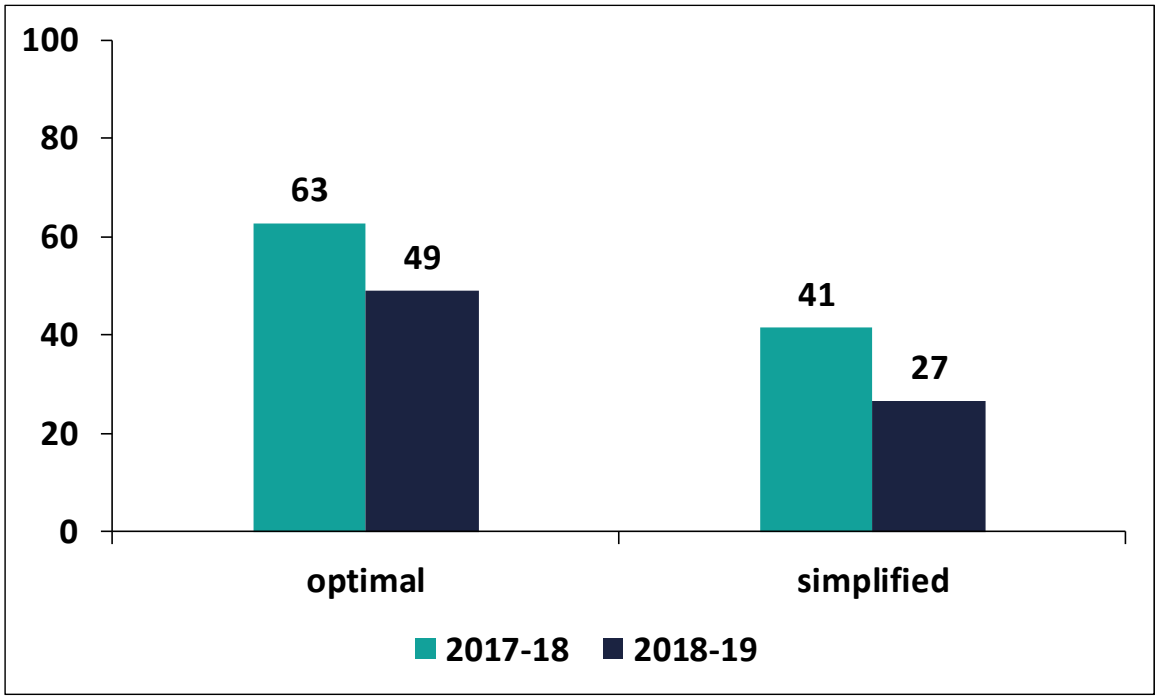
Table 10: Baseline and optimal equalisation transfers ($ million)

	2017-18			2018-19		
	baseline	optimal	simplified	baseline	optimal	simplified
NSW	-2,431	-489	-936	-3,021	-1,079	-1,709
Vic	-1,033	-1,294	-299	-201	-1,020	-42
Qld	2,399	2,015	1,300	1,284	1,224	755
WA	-4,465	-4,245	-4,442	-3,618	-3,351	-3,579
SA	1,955	1,623	1,891	2,188	1,814	2,104
Tas	1,075	785	817	1,059	875	884
ACT	203	-60	245	200	-37	294
NT	2,296	1,665	1,424	2,109	1,574	1,293
Total	0	0	0	0	0	0

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

	2017-18		2018-19	
	optimal	simplified	optimal	simplified
NSW	0.8%	0.6%	0.8%	0.5%
Vic	-0.2%	0.4%	-0.4%	0.1%
Qld	-0.3%	-0.8%	0.0%	-0.4%
WA	0.3%	0.0%	0.3%	0.0%
SA	-0.7%	-0.1%	-0.7%	-0.2%
Tas	-1.9%	-1.7%	-1.1%	-1.1%
ACT	-2.2%	0.3%	-1.8%	0.7%
NT	-8.2%	-11.6%	-6.8%	-10.5%
Total	0.0%	0.0%	0.0%	0.0%

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



6 QUALIFICATIONS

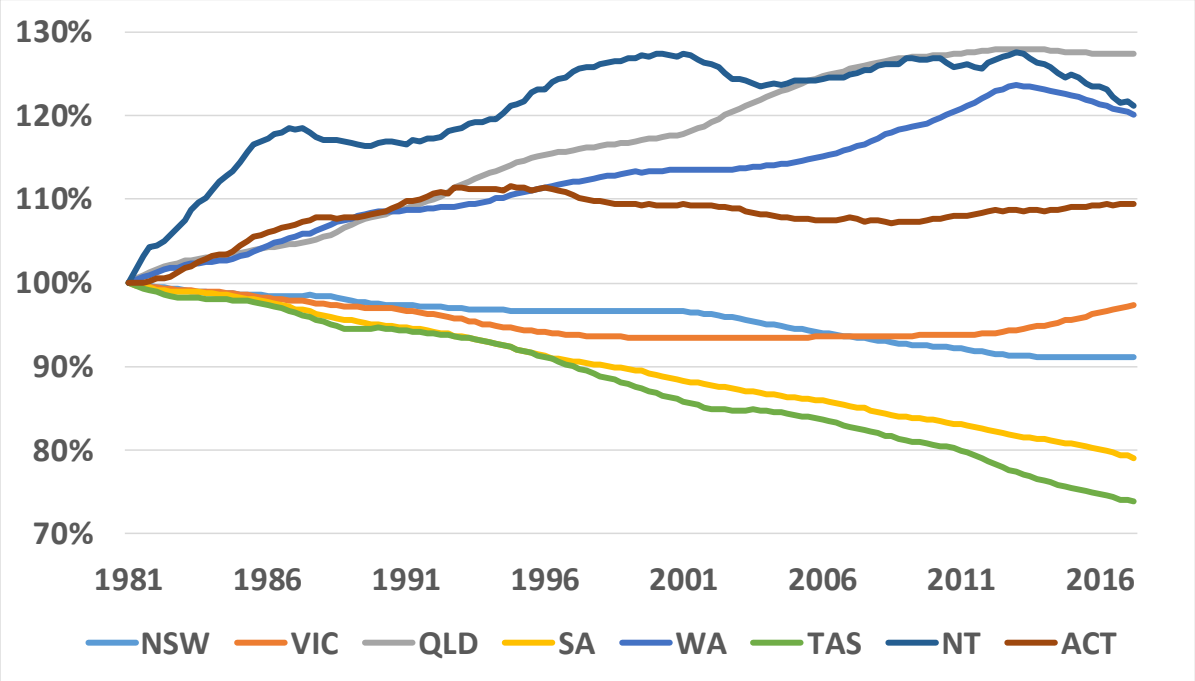
Six qualifications to the theoretical model used here, and therefore the associated empirical analysis, are as follows.

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 congestion policies that are specific to the location of the congestion. Thus, congestion is best viewed as an issue for congestion policy 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 emphasises 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 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, vertical equity objectives continue to be achieved through redistributive policies incorporated in government budgets at both the federal and state levels. The role of fiscal equalisation is to establish an efficient connection *at the margin* between the cost of state government services and the charging of a state's residents for those services through residence-based taxes such as those on labour income or consumption.

Because this system is optimal, compared to other equalisation systems it promotes a more efficient locational distribution of labour, generating higher living standards across all states. This involves full equalisation for the fixed costs of state government and for source-based taxes on natural resources and land. However, equalisation is limited to the influences of the composition and level of the population for the variable costs of state government, residence-based taxes on factor incomes and consumption taxes.

In the Australian context, optimal equalisation represents moderate change from the existing full equalisation system. For example, in 2018/19 a move from full equalisation to optimal equalisation would involve only a modest reduction from $6,840 million to $5,487 million in the value of transfers from donor states to recipient states. This involves varying the existing system of full equalisation in the following ways on the revenue and expenditure sides of state budgets.

7.1 Revenue

1. Optimal equalisation retains full equalisation for source-based taxes, namely mining royalties, stamp duties on conveyances and land tax. Full equalisation is optimal for these source-based taxes because they can be used to raise revenue from non-residents. Without full equalisation, states with greater ability to tax non-residents could establish a tax haven for residents, inefficiently drawing businesses and labour from other states with higher productivity. At the same time, ideally the existing equalisation system based on mining production would be adjusted to control for any differences between state governments in their willingness to convert mining capacity into mining production.

2. Optimal equalisation replaces the initial population-based state distribution of national GST revenue with a household consumption-based state distribution. Because GST is a consumption-based tax, this change brings GST into line with other taxes, where the starting point for equalisation is the amount of revenue raised in each state.

3. Under optimal equalisation, for residence-based taxes including GST, payroll tax and other revenues not in (1), limited equalisation is adopted. This involves isolating differences in revenue-raising capacity that arise from differences in state population compositions and levels, and only equalising for those. This method has been demonstrated in this paper using labour types that are cross-classified by age, indigenous

status and educational attainment. Unlike the existing equalisation system, this method avoids inefficiently equalising for differences between states in the productivity of the same type of labour.

7.2 Spending

1. Optimal equalisation retains full equalisation for administrative scale. This is so the fixed costs of state government are shared nationally on an equal per capita basis. This is to avoid fixed costs becoming a disproportionate burden on the budgets of less populous states and thus distorting state locational choices for labour at the margin.

2. Optimal equalisation retains full equalisation for demographic-based characteristics, such as indigenous status and age. This is so the costs of fiscally-needy groups such as the indigenous are shared nationally, and so again do not distort state locational choices for labour at the margin.

3. Optimal equalisation removes equalisation for geographic circumstances. This supports efficient provision of state government services by exposing state residents to the true cost of providing services in their own states.

4. Optimal equalisation also removes equalisation for wage costs. Differences between states in wages for the same type of labour are a market signal for interstate migration that should not be dulled by equalisation.

The optimal equalisation system significantly simplifies the existing full equalisation system and generates a gain in annual consumer welfare estimated at $63 million in 2017/18 and $49 million in 2018/19. This gain is spread across residents of all states and territories.

To a considerable extent, the role of the optimal equalisation scheme is to compensate for some shortcomings in the design of the Australian Federation. If the Federal Government had the right to raise source based taxes, such as mining royalties and land taxes, offset by a right for state governments to raise a residence-based tax through partial access to personal income tax, per capita revenue raising capacities would be much equal between states. Similarly, if the Federal Government were responsible for indigenous affairs, and state boundaries were re-drawn so that state populations were more equal (reducing the significance of administrative scale as an equalisation factor), per capita expenditure needs would also be more equal.

In these hypothetical circumstances, there would be a much diminished role for optimal fiscal equalisation. In the meantime, optimal equalisation can play the useful role of providing a backstop for some shortcomings in the design of the Australian Federation.

In comparison with this paper, the Productivity Commission (2017) draft report focusses less on the economic validity of the various drivers of the current equalisation system, and more on modifying the outcomes of that system by introducing a donor relief scheme.

The two donor relief schemes recommended by the Productivity Commission both result in welfare losses relative to the existing system. The scheme of "equalising to the average fiscal capacity across the states", better known as a grants scheme, would result in welfare losses of $92 million in 2017/18 and $43 million in 2018/19. The scheme of "equalising to the fiscal capacity of the second strongest state", which amounts to providing relief restricted to the largest per capita donor state, would result in welfare losses of $94 million in 2017/18 and $49 million in 2018/19.

It was shown that either of the donor relief schemes recommended by the PC would fund WA to become a tax haven for its residents. For example, it could offer payroll tax at well under half the rate of other states. This would draw economically-inefficient migration of businesses and people from other states where they are more productive.

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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.