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# The National and Regional Consequences of Australia's Goods and Services Tax

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*The major political parties support the tenet of the original GST agreement that GST change requires unanimous state approval. However, GST change could differentially affect state economies, and thus influence support from individual states. We investigate the potential for GST change to differentially affect state economies. We do this by developing a multi-regional model of the Australian economy that contains details of the legislated features of the GST. In this model, when we change any element of the GST, the economic effects are informed by regional differences in economic structure and their interactions with the details of our GST theory.*

## *I Introduction*

Goods and services tax (GST) reform options have recently returned to prominence in tax policy debate, particularly since the release of the Commonwealth Government's Tax Discussion Paper (Australian Government 2015). This is after a long period in which GST reform was off the political agenda (Freebairn, 2011). Subsequent calls to raise the GST rate have been made by a number of state premiers (Australian Broadcasting Corporation, 2016) and the Australian Institute of Company Directors (Proust, 2017).

While there is no constitutional impediment to the federal government unilaterally changing the GST, the major political parties support the principle that GST change needs the unanimous support of state and territory governments (Boccabella & Bain, 2015). One potential impediment to securing unanimous support is well known, namely, concerns among policy-makers in some states, such as Western Australia, over the way GST revenue is distributed (Freebairn, 2015). These concerns relate to the differential impacts

across states of GST revenue distribution under the horizontal fiscal equalisation (HFE) system.

In this paper, we are concerned with a different, but related, inter-jurisdictional question: how does raising a given amount of GST revenue affect the distribution of economic activity across Australia's states and territories? This is important, because perceptions that the GST affects individual states in different ways could frustrate the achievement of unanimous support for GST reform. To examine this, we introduce a multi-regional model of the Australian economy detailed modelling of the implemented features of the GST system. This includes modelling of the many departures of Australia's GST from an 'ideal' system.<sup>1</sup> Broadly, Australia's GST departs from an ideal system in five ways: (i) some commodities are GST-free<sup>2</sup>; (ii) some commodities are input-taxed, or in terms of the

<sup>1</sup> An ideal GST system (i.e., one imposing the lowest allocative efficiency and compliance costs) has a single rate on all domestic sales, reclamation of GST paid on inputs to production and investment, a zero rate on exports, and no exemptions. A GST with these attributes acts like a pure consumption tax (Ebrill *et al.*, 2001).

<sup>2</sup> Examples include: basic foods, educational courses, health services, health insurance, medical aids, water services, sewerage and drainage services, and transport of passengers to and from Australia.

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international value added tax (VAT) terminology, they are 'GST exempt'<sup>3</sup>; (iii) GST registration is optional for low-turnover firms<sup>4</sup>; (iv) some imports are GST exempt<sup>5</sup>; and (v) some exports (namely, on-shore sales to non-residents, such as foreign tourists) are not zero-rated.<sup>6</sup> As we discuss below, while previous economy-wide VAT modelling exercises have addressed selected elements of these departures from an ideal system, to our knowledge, ours is the first paper to model all these elements, and to do so within a detailed multi-regional framework. As we shall see, regional differences in economic structure are consequential for the measured effects of GST policy change when we model the implemented details of the GST system.

The earliest economy-wide modelling of Australia's GST is Dixon and Rimmer (1999). They used publicly available price results from the Treasury's price input-output model to infer the Treasury's undisclosed assumptions about net movements in indirect tax rates implied by the replacement of wholesale sales tax by the GST. Hence, Dixon and Rimmer carried assumptions

about implicit changes in indirect tax rates on production, investment, and exports. This was a departure from traditional CGE modelling of GST based on the ideal system. However, Dixon and Rimmer did not explicitly model details of Australia's GST system.

Outside Australia, there have been some efforts to explicitly model details of actual VAT systems in computable general equilibrium (CGE) models, albeit at varying levels of detail. For example, recognition of different VAT rates and exemptions can be found in studies by Gottfried and Wiegard (1991), Marks (2005), and Toh and Lin (2005), although each sector is assumed to be either fully taxed or fully exempt. Paz (2015) takes into account VAT on intermediate inputs and VAT thresholds. de Quatrebarbes *et al.* (2016) allow for partial exemptions. Giesecke and Tran (2010) account for multi-production, differentiated degrees of exemption by commodity and user, and industry-specific differences in capacities to reclaim VAT paid on production inputs. Giesecke and Tran (2012) developed this system further, including differentiated VAT registration rates, undeclared imports, unclaimed tax on tourist spending, and general and transaction-specific compliance rates. Giesecke and Tran (2012) used their model to examine VAT compliance rates, but outside a wider CGE system.

In this paper, we extend the Giesecke and Tran (2012) system by adding regional detail. We then embed the system within a multi-regional CGE model of Australia. This allows us to examine the consequences for Australia and its regions of the full details of the GST system as legislated. To our knowledge, the only previous general equilibrium study of VAT at the regional level is Zhai and He (2008), which modelled VAT in a two-region, four-sector model with multiple VAT rates and multiple VAT deduction (i.e. refund) rates.<sup>7</sup>

An important methodological contribution of our paper is that it sets out a GST modelling framework, suitable for embedding in a large-scale CGE model, that carries details of VAT systems as actually implemented by tax authorities. A detailed GST framework is important in CGE analysis of GST issues for three reasons. First, it allows GST payments to be correctly

<sup>7</sup> However, Zhai and He do not discuss how they model deduction rates, and do not model many other features of VAT.

<sup>3</sup> See Division 40 (Input taxed supplies) of A New Tax System (Goods and Services Tax) Act 1999 (GST Act). Subdivisions 40A–40G describe specific input taxed transactions. The most economically significant are Subdivisions 40A–40C (financial supplies, residential rent and residential premises). For such services, producers charge no GST, and cannot reclaim GST on inputs. GST on inputs to production of exempt goods passes into the cost stream for these goods, and is passed on as higher prices to users of the goods, irrespective of whether they are consumers, industries or foreigners. This creates tax cascading, with positive effective GST rates faced by all producers and foreigners purchasing the exempt goods.

<sup>4</sup> GST registration is optional for firms with turnover of \$75,000 or less. Unregistered firms do not charge GST, and cannot reclaim GST on inputs. This creates an additional source of input-taxed sales. Because unregistered firms can exist in any industry, sales of all products have the potential to be input-taxed to some degree.

<sup>5</sup> These include imports falling below the low value threshold of \$1,000, and a number of goods with import-duty-free status. GST will be imposed on low-value imports from 1 July 2018 (Australian Taxation Office, 2017).

<sup>6</sup> A refund for GST under the Tourist Refund Scheme can only be claimed for a small subset of goods purchased locally by non-residents (Department of Immigration and Border Protection, 2017), and many visitors who can reclaim GST do not do so.

represented in the model's database, which is important for accurate calculation of the allocative efficiency impacts, and thus also the welfare impacts, of policy change.<sup>8</sup> Second, the detailed GST theory allows effective GST rates to be influenced by endogenous changes in economic structure, and changes in legislated GST rates, exemptions and refund rates.<sup>9</sup> This improves modelling of the relative price consequences of GST reforms, whether these be changes in rates, exemptions, registration rates, or other factors. Finally, and as emphasised in this paper, it facilitates investigation of the regional consequences of GST reform. Although the GST is a national tax, as we discuss in Section II, the operations of the GST are influenced by regional differences in: shares of taxable and input-taxed supplies in regional economic activity; the proportion of regional exports explained by sales to foreign visitors; GST registration rates across industries; and propensities to import low-value items.

The remainder of this paper is structured as follows. Section II describes the model. We begin with a brief overview of the Victoria University Regional Model (VURM) in Section II(i). VURM is the multi-regional CGE model into which we build our GST equation system. This system is presented in Section II(ii). Section III presents the results of a simulation in which we raise the standard GST rate from 10 per cent to 11 per cent. Section IV concludes.

<sup>8</sup> For a clear exposition of how the distribution of indirect taxes influences measured allocative efficiency effects of policy change, see equation (C.3) in Mariano and Giesecke (2014). The allocative efficiency effects of GST change will be miscalculated if GST is distributed across the wrong bases in the model's database. There is evidence of this in the input–output data supplied by the Australian Bureau of Statistics (Australian Bureau of Statistics, 2016a), which show no GST on intermediate inputs to any industries other than finance and dwellings. This implies 100 per cent GST registration rates across all industries and no informal activity. This effectively narrows the GST base. As a result, the ABS data contain implied GST rates exceeding the legislated 10 per cent for a number of transactions.

<sup>9</sup> Without theory describing the full detail of the GST, modellers must calculate changes in effective tax rates outside the model. This may not be accurate over time if there are changes in the division of a sector's activity across production of exempt and non-exempt commodities (see variable  $SO_{c,i,s}$  in Equation 7a).

## II The Model

### (i) The Victoria University Regional Model

The starting point for the modelling reported in this paper is VURM, a dynamic multi-regional CGE model of the Australian economy.<sup>10</sup> The standard version of VURM does not contain detailed GST theory. We provide a brief overview of VURM, before discussing the detailed GST theory developed for VURM for this paper.

VURM models the behaviour of economic agents within each of Australia's states and territories and identifies a large number of industries and commodities.<sup>11</sup> Neoclassical assumptions govern the behaviour of the model's economic agents. Each representative industry operating within each region is assumed to minimise costs subject to a constant-returns-to-scale production technology and given input prices. A representative utility-maximising household resides in each region. Investors allocate new capital to industries on the basis of expected rates of return. Units of new capital are assumed to be cost-minimising combinations of inputs sourced from each of the model's sources of supply (the domestic regions plus imports). Imperfect substitutability between the imported and domestic sources of supply for each commodity is modelled using the constant elasticity (CES) assumption of Armington. In general, markets are assumed to clear and to be competitive. Purchasers' prices differ from basic prices by the value of indirect taxes and margin services. Taxes and margins can differ across commodity, user, region of source and region of destination. Foreign demand for each commodity from each domestic region is modelled as inversely related to its foreign currency price. The model includes details of the taxing, spending and transfer activities of two levels of government: a regional government operating within each region, and a federal government operating Australia-wide. Dynamic equations describe stock–flow relationships, such as those between regional industry capital stocks and regional industry investment. Dynamic adjustment equations allow for the gradual movement of a number of variables

<sup>10</sup> VURM's database is calibrated to reflect ABS national accounts data and government financial statistics for 2015–16. For a detailed description of VURM, see Adams *et al.* (2015).

<sup>11</sup> The model contains 76 region-specific industries producing 78 commodities.

towards their long-run values. In this regard, we allow region-specific employment rates to temporarily depart from baseline values under an assumption of short-run wage stickiness. Over time, regional wage adjustment gradually returns region-specific employment rates to baseline. Similarly, we allow regional per-capita real disposable income relativities to temporarily depart from baseline, under an assumption of short-run stickiness in rates of inter-regional migration. Over time, gradual adjustment of rates of inter-regional migration returns inter-regional per-capita real disposable income relativities back to baseline.<sup>12</sup> Regional economic linkages arise from inter-regional trade, factor mobility, the taxing and spending activities of federal and state governments, and long-run economy-wide employment and balance-of-trade (BOT) constraints. The model evaluates a full set of national and regional income accounts, and associated deflators. In solving the model, we undertake two parallel model runs: a baseline simulation, and a policy simulation (as discussed in Section IV(i), we also undertake a number of decomposition simulations of the policy simulation).<sup>13</sup> The baseline simulation is a business-as-usual forecast for 2017–30. The policy simulation is identical to the baseline simulation in all respects other than the addition of the exogenous shocks describing the policy under investigation. We report model results as percentage (and in some cases, monetary) deviations in the values of variables in each year of the policy simulation away from their baseline values.<sup>14</sup>

### (ii) *The GST Equation System*

Building on Giesecke and Tran (2010, 2012), our GST system models: multiple legislated tax rates across commodities; different legislated GST exemption statuses across commodities; different legislated capacities to reclaim GST on inputs to production and investment; different rates of registration for GST purposes; export taxation via application of GST on domestic purchases by non-residents; and potential for

incomplete GST collections due to non-compliance. We also require the GST system to carry sufficient detail to be embedded in a multi-regional model. Hence, we require the model to describe details of the legislated GST system as it relates to all commodities, from all sources, used by all agents in all regions. The agents comprise industries, investors, and final users. The regions comprise the eight states and territories. The sources comprise the eight domestic regions plus imports. We expand below.

Tables 1–3 present the GST system we add to VURM. We now briefly describe this system.<sup>15</sup>

Equation (1) calculates GST revenue collected on individual commodity transactions as the product of an effective tax rate and the relevant GST transaction base as calculated by Equation (2). Equation (3a) calculates the effective GST rate on supplies to domestic users on the basis of the relevant GST rate, the extent to which the transaction is GST exempt, and the extent to which the purchaser can reclaim GST. Equation (3b) calculates the effective GST rate on exports as the share-weighted average of the effective GST rates on onshore sales to foreign visitors and offshore sales to foreign customers. Effective rates on offshore sales are 0, because the legislated rate ( $LR_{c,s,export}$ ) is 0. Onshore sales to foreign visitors (such as tourists) attract the same GST rates as sales to Australian households (i.e.  $LR_{c,s,household} \geq 0$ ).  $REFEXP_{c,s}$  provides for some GST refund for departing tourists. Equation (4) determines the effective exemption rate as a function of the legally mandated exemption rate and what we term the de facto exemption rate. In calculating the de facto exemption rate we distinguish between domestically produced commodities (via Equation 5a) and imports (via Equation 5b). Equation (5a) recognises that GST is not charged on commodities sold by businesses that are not registered for GST purposes. Hence, the de facto exemption rate depends on the proportion of activity within each industry that is undertaken by unregistered firms. For imported commodities, Equation (5b) sets the de facto exemption rate equal to the share of imports that are undeclared for GST purposes. Equation (6) calculates the share of business

<sup>12</sup> See Giesecke and Madden (2013) for a description of the model's regional labour market and migration theory.

<sup>13</sup> The model is solved using the GEMPACK modelling software package (Harrison & Pearson, 1996).

<sup>14</sup> See Dixon and Rimmer (2002) for a thorough review of the construction of baseline and policy simulations.

<sup>15</sup> A more detailed discussion of the GST system is in a supplementary information file available online or from the authors on request. This file also contains a discussion of the system's operations using a number of transaction examples.

TABLE 1  
Sets of the GST Equation System

Name	Set elements	Set description
COM	$(c = 1, \dots, 78)$	All commodities
REG	$(r = 1, \dots, 8)$	All domestic regions
SRC	$(s = 1, \dots, 8, \text{foreign})$	Union of the set of domestic sources (REG) and the single foreign source (foreign)
IND	$(i = 1, \dots, 76)$	All industries
INV	$(k = 1, \dots, 76)$	All industry-specific capital creators
GOV	{state and local, federal}	Two government levels: state and local, and federal
MAR	$(m = 1, \dots, 10)$	Margin commodities
DOM	IND $\cup$ INV $\cup$ GOV $\cup$ {household}	All domestic users of commodities
REGU	DOM $\times$ REG	All domestic region-specific users of commodities
ALLU	REGU $\cup$ {Export}	Union of the set of domestic region-specific users (REGU) and the single export user

activity that is registered for GST purposes on the basis of two possible types of non-registration: businesses permitted to be unregistered under GST law, and businesses operating informally. Equations (7a)–(7d) calculate GST refund rates by purchaser type. Equation (7a) calculates the share of GST paid on intermediate inputs that is refundable. It recognises that the GST Act allows only registered firms to claim GST refunds, and only to the extent that the firms are producing commodities that are not GST exempt. Equation (7b) recognises that refunds on inputs to capital creation are the same as those on inputs to current production by the same industry. Equations (7c) and (7d) recognise that households cannot claim GST refunds, while government can.

### III Simulation

#### (i) Simulation Design

As discussed in Section II, the full VURM database recognises eight states and territories. In this paper, for expository purposes we aggregate VURM's regions into two: Australia's most populous state, New South Wales (NSW), and the rest of Australia (RoA). Our aim is to explore the relative regional effects of raising additional revenue via a higher GST rate. To do so, we raise the standard rate from 10 per cent to 11 per cent (i.e. we raise by 0.01 the elements of  $LR_{c,s,u}$  in Equations (3a) and (3b) that have an initial value of 0.10). We do this under a model closure in which:

- 1 Regional labour markets are characterised by short-run stickiness of the real wage with endogenous regional unemployment rates, transitioning to a long-run environment in which regional real wages are endogenous and regional unemployment rates return to baseline. In formulating short-run wage demands, we assume workers understand they will be compensated for changes in the GST via lump sum transfer (see points 4 and 5 below). Hence the real wage measure that is sticky in the short-run is defined as the nominal wage deflated by the Consumer Price Index (CPI) evaluated at prices excluding GST.<sup>16</sup>
- 2 Inter-regional migration rates are sticky in the short run, but adjust gradually to ensure that inter-regional relativities in regional per-capita real disposable income return to baseline.
- 3 Capital and investment are specific to each regional industry. Capital stocks are sticky in the short run, but adjust gradually in response to changes in investment. Annual investment in each regional industry is positively related to the ratio of actual to required rates of return. A policy shock can cause these ratios to temporarily depart from their baseline values in the short run, but they are gradually returned to baseline values via changes in capital stocks.

<sup>16</sup> This is similar to the Dixon and Rimmer (1999) central scenario, in which they assume the real after-tax wage is sticky in the short run.

TABLE 2  
The GST Equation System

Equation	Range
$\text{GST}_{c,s,u} = \text{ER}_{c,s,u} \times \text{TRBASE}_{c,s,u} \quad (1)$	$(c \in \text{COM}; s \in \text{SRC}; u \in \text{ALLU})$
$\text{TRBASE}_{c,s,u} = \text{VBAS}_{c,s,u} + \text{VTAX}_{c,s,u} + \sum_{m \in \text{MAR}} \text{VMAR}_{c,s,u,m} \quad (2)$	$(c \in \text{COM}; s \in \text{SRC}; u \in \text{ALLU})$
$\text{ER}_{c,s,u} = \text{LR}_{c,s,u} \times [1 - \text{EEX}_{c,s,u}] \times [1 - \text{REF}_u] \times \text{CR}_{c,s,u} \quad (3a)$	$(c \in \text{COM}; s \in \text{SRC}; u \in \text{REGU})$
$\begin{aligned} \text{ER}_{c,s,\text{export}} &= \text{CR}_{c,s,\text{export}} \times \{[\text{LR}_{c,s,\text{household}} \times \text{SHNRES}_{c,s} \\ &\times (1 - \text{EEX}_{c,s,\text{household}}) \times (1 - \text{REFEXP}_{c,s})] \\ &+ [\text{LR}_{c,s,\text{export}} \\ &\times (1 - \text{SHNRES}_{c,s}) \times (1 - \text{EEX}_{c,s,\text{export}})]\} \end{aligned} \quad (3b)$	$(c \in \text{COM}; s \in \text{REG})$
$\text{EEX}_{c,s,u} = \text{LEX}_{c,s,u} + (1 - \text{LEX}_{c,s,u}) \cdot \text{DEX}_{c,s,u} \quad (4)$	$(c \in \text{COM}; s \in \text{SRC}; u \in \text{ALLU})$
$\text{DEX}_{c,s,u} = 1 - \sum_{i \in \text{IND}} \text{SJ}_{c,s,i} \times \text{REGIST}_{i,s} \quad (5a)$	$(c \in \text{COM}; s \in \text{REG}; u \in \text{ALLU})$
$\text{DEX}_{c,\text{foreign},u} = \text{ILM}_{c,u} \quad (5b)$	$(c \in \text{COM}; u \in \text{REGU})^*$
$\text{REGIST}_{i,s} = (1 - \text{NRL}_{i,s})(1 - \text{NRI}_{i,s}) \quad (6)$	$(i \in \text{IND}; s \in \text{REG})$
$\text{REF}_{i,s} = \text{REGIST}_{i,s} \times \sum_{c \in \text{COM}} \text{SO}_{c,i,s} \sum_{u \in \text{ALL}} \sum_{r \in \text{REG}} \text{SS}_{c,s,u,r} [1 - \text{LEX}_{c,s,u,r}] \quad (7a)$	$(i \in \text{IND}; s \in \text{REG})$
$\text{REF}_{k,r} = \sum_{i \in \text{IND}} \delta_{k,i} \text{REF}_{i,r} \quad (7b)$	$(k \in \text{INV}; r \in \text{REG})$
$\text{REF}_{\text{Households},r} = 0 \quad (7c)$	$(r \in \text{REG})$
$\text{REF}_{g,r} = 1 \quad (7d)$	$(g \in \text{GOV}; r \in \text{REG})$

Note: \*There is no re-exporting of imports in our model.

4 The federal public sector borrowing requirement (PSBR) follows its baseline path, via endogenous adjustment of a national lump-sum household tax.

5 State-specific PSBRs are exogenously held on their baseline paths, via endogenous adjustment of lump-sum taxes on households within each state.

- 6 The federal government allocates the additional GST revenue to state governments on the basis of population shares.<sup>17</sup>
- 7 The ratio of the BOT to gross domestic product (GDP) is exogenously held on its baseline path via movements in the economy-wide average propensity to consume.
- 8 Subject to the movements in the economy-wide average propensity to consume given by point 6 above, region-specific household consumption spending is determined as a fixed proportion of region-specific household disposable income.
- 9 Values for real public consumption spending by federal and state governments are exogenously held on their baseline paths over the simulation period.

As described by points 1–9, it is clear the simulation involves a number of endogenous policy adjustments (e.g. changes in grants and transfers) in addition to the GST rate rise. To distinguish the effects of the rate rise from the effects of the parallel policy adjustments, we undertake a decomposition simulation. The decomposition simulation divides the total impact of the GST rate rise into six components, namely the effects of: (1) raising the GST rate; (2) returning GST to each state on a collections basis (i.e., each state receives the GST collected within its borders); (3) an adjustment to this hypothetical collections-basis distribution to reflect the true equal per-capita basis for distributing GST revenue in excess of HFE needs; (4) the adjustments to state government transfers to households required to keep state government PSBRs on baseline; (5) the adjustment of federal grants to households required to hold the federal PSBR on baseline; and (6) the adjustment of the economy-wide household savings rate required to ensure the ratio of the BOT to GDP remains on baseline. These effects are labelled ‘Decomp 1–6’ respectively in the decomposition figures.<sup>18</sup>

<sup>17</sup> As outlined in Productivity Commission (2017, p. 7), GST revenue remaining after applying Commonwealth Grants Commission (CGC) HFE formulae is distributed on an equal per-capita basis.

<sup>18</sup> A detailed discussion of the decomposition simulation is contained in the online supplementary information.

## (ii) Results

### *A back-of-the-envelope model*

Figure 1 reports the full simulation results for the deviations in national employment, capital, real GDP, and the real wage. Figure 2 decomposes the GDP deviation into the individual contributions of the six factors discussed in Section IV(i). This figure shows that, of the six factors, it is the GST rate rise that is the dominant influence on the macroeconomy. Hence, we begin our discussion with this factor. We follow Dixon and Rimmer (1999) in their use of a back-of-the-envelope (BOTE) model to guide our macro results discussion. We reproduce key elements of their BOTE model below.

Assume the economy produces one good and imports one good. Production of the domestic good is a Cobb–Douglas (CD) function of labour (L) and capital (K). Units of consumption and investment are produced via CD functions of inputs of the domestic good and the foreign good.<sup>19</sup> Under zero pure profit and cost-minimising assumptions in the production and distribution of the domestic good, the consumption good, and the investment good, we have:

$$P_C = P_D^{\alpha_D^C} \cdot P_M^{\alpha_M^C} \cdot T_C \quad (8)$$

$$MP_K(K/L) = T_D \cdot (Q/P_D) \quad (9)$$

$$P_I = P_D^{\alpha_D^I} \cdot P_M^{\alpha_M^I} \cdot T_I \quad (10)$$

$$\rho = Q/P_I \quad (11)$$

$$MP_L(K/L) = T_D \cdot (W/P_D) \quad (12)$$

$$W_R = W \cdot T_C/P_C \quad (13)$$

where  $P_D$  and  $P_M$  are the basic price of the domestic good and the c.i.f. price of the imported good;  $P_C$  and  $P_I$  are the purchaser price of a unit of consumption and investment;  $T_C$ ,  $T_I$ , and  $T_D$  are the powers (1 plus the rates) of tax on consumption, investment and production;  $W_R$  is the nominal wage deflated by the GST-exclusive consumption deflator;  $Q$  is the rental price of

<sup>19</sup> VURM’s production theory is based on nested constant-returns-to-scale Leontief and CES production functions. In constructing the BOTE model, CD is an effective simplification of this structure.



TABLE 3  
Variables of the GST Equation System (in Alphabetical Order)

Variable	Range	Description and data sources*	Closure
$CR_{c,s,u}$	$(c \in \text{COM}; s \in \text{SRC for } u \in \text{REGU}; s \in \text{REG for } u \in \{\text{Export}\}; u \in \{\text{ALLU}\})$	The GST compliance rate for all users with respect to purchases of commodity $c$ from source $s$ . Source: initial data calibration <sup>†</sup>	Ex.
$\delta_{k,i}$	$(k \in \text{INV}; i \in \text{IND})$	Kronecker's delta (1 for $i = k$ , 0 otherwise)	Ex.
$DEX_{c,s,u}$	$(c \in \text{COM}; s \in \text{SRC for } u \in \text{REGU}; s \in \text{REG for } u \in \{\text{Export}\}; u \in \{\text{ALLU}\})$	The de facto exemption rate, arising from unregistered businesses, underground activity, household own-use production, and undeclared high-value imports	En.
$EEX_{c,s,u}$	$(c \in \text{COM}; s \in \text{SRC for } u \in \text{REGU}; s \in \text{REG for } u \in \{\text{Export}\}; u \in \{\text{ALLU}\})$	The proportion of sales of commodity $c$ from source $s$ to user $u$ that is effectively GST exempt	En.
$ER_{c,s,u}$	$(c \in \text{COM}; s \in \text{SRC for } u \in \text{REGU}; s \in \text{REG for } u \in \{\text{Export}\}; u \in \{\text{ALLU}\})$	The effective rate of GST paid on purchases of commodity $c$ from source $s$ by user $u$	En.
$GST_{c,s,u}$	$(c \in \text{COM}; s \in \text{SRC for } u \in \text{REGU}; s \in \text{REG for } u \in \{\text{Export}\}; u \in \{\text{ALLU}\})$	GST revenue from sales of good $c$ from source $s$ to user $u$	En.
$ILM_{c,u}$	$(c \in \text{COM}; u \in \text{REGU})$	The proportion of imports of commodity $c$ by domestic user $u$ that are undeclared high-value imports (i.e. over \$1,000)	Ex.
$LEX_{c,s,u}$	$(c \in \text{COM}; s \in \text{SRC for } u \in \text{REGU}; s \in \text{REG for } u \in \{\text{Export}\}; u \in \{\text{ALLU}\})$	Legal exemption rate, i.e., the share of sales of commodity $c$ from source $s$ to user $u$ in region $r$ that are GST exempt by law. Source: Australian Legal Information Institute (ALII) (2000), Australian Taxation Office (ATO) (2016a, 2017), Productivity Commission (2011)	Ex.
$LR_{c,s,u}$	$(c \in \text{COM}; s \in \text{SRC for } u \in \text{REGU}; s \in \text{REG for } u \in \{\text{Export}\}; u \in \{\text{ALLU}\})$	The legislated GST rate on purchases of commodity $c$ from source $s$ by user $u$ . Source: ALII (2000), ATO (2016a)	Ex.
$NRI_{i,s}$	$(i \in \text{IND}; s \in \text{REG})$	The share of activity in industry $i$ in region $s$ generated by firms legally required to register for GST but who operate informally and are thus unregistered. Source: Australian Bureau of Statistics (2013)	Ex.
$NRL_{i,s}$	$(i \in \text{IND}; s \in \text{REG})$	The share of the output of industry $i$ in region $s$ that is produced by firms legally permitted not to register for GST. Source: Australian Bureau of Statistics (2015)	Ex.
$REF_{r,r}$	$(u \in \text{REGU})$	The proportion of GST paid on purchases by domestic user $u$ that is refundable	En.
$REFEXP_{c,s}$	$(c \in \text{COM}; s \in \text{REG})$	The proportion of GST collected on domestic sales of commodity $c$ to non-residents in region $s$ that is refunded under the Tourist Refund Scheme. Source: Department of Immigration and Border Protection (2017)	Ex.
$REGIST_{i,s}$	$(i \in \text{IND}; s \in \text{REG})$	The proportion of the output of industry $i$ in region $s$ produced by businesses that are registered for GST purposes	En.
$SHNRES_{c,s}$	$(c \in \text{COM}; s \in \text{REG})$	The share of total exports of commodity $c$ from source $s$ represented by on-shore sales to non-residents (e.g. tourists). Source: Australian Bureau of Statistics (2016b), Tourism Research Australia (2017)	Ex.
$SI_{c,s,i}$	$(c \in \text{COM}, s \in \text{REG } i \in \text{IND})$	The share of the output of commodity $c$ from domestic source $s$ produced by industry $i$ in region $s$	En*
$SO_{c,i,s}$	$(c \in \text{COM}; i \in \text{IND}; s \in \text{REG})$	The share of regional industry $i,s$ 's output accounted for by production of good $c$	En*
$SS_{c,s,u}$	$(c \in \text{COM}; s \in \text{REG}; u \in \{\text{ALLU}\})$	The share of sales to user $u$ in total sales of domestic commodity $c$ produced in region $s$	En*
$TRBASE_{c,s,u}$		The value of the sales transaction base on which GST is levied	En.

TABLE 3  
(continued)

Variable	Range	Description and data sources*	Closure
VBAS <sub>c,s,u</sub>	(c ∈ COM; s ∈ SRC for u ∈ REGU; s ∈ REG for u ∈ {Export}; u ∈ ALLU)	The basic value of commodity c from source s purchased by user u. Source: Australian Bureau of Statistics (2016c, 2017)	En*
VMAR <sub>c,s,u,m</sub>	(c ∈ COM; s ∈ SRC for u ∈ REGU; s ∈ REG for u ∈ {Export}; u ∈ ALLU; m ∈ MAR)	The value of margin service m used to facilitate purchases of (c,s) by user u. Source: Australian Bureau of Statistics (2016c, 2017)	En*
VTAX <sub>c,s,u</sub>	(c ∈ COM; s ∈ SRC for u ∈ REGU; s ∈ REG for u ∈ {Export}; u ∈ ALLU)	The value of non-GST indirect taxes paid on purchases of (c,s) by user u. Source: Australian Bureau of Statistics (2016c, 2017)	En*

Notes: \*Full details of our data sources and methods are in a supplementary information file available online (**address**) of from the authors on request.

<sup>†</sup>Australian Taxation Office (2016b) reports GST collections for the period 2001/02 to 2014/15. When brought together with the VURM database and VURM GST theory, this GST collections data is used to calculate the economy-wide GST compliance rate. This rate comes out at 0.98. One interpretation of this figure is that our GST theory, when evaluated using the aforementioned data sources and integrated within VURM and its database, does a remarkably good job of predicting actual ATO GST collections.

<sup>‡</sup>‘Ex’ denotes exogenous. ‘En’ denotes endogenous. ‘En\*’ denotes endogenous, but largely determined in the CGE core and thus largely given to the GST system. That is, if Equations (1)–(7) were not integrated with the wider CGE model, ‘En\*’ variables would be exogenous.

capital;  $\rho$  is the rate of return on capital;  $\alpha_D^C$  and  $\alpha_M^C$  are the cost shares of domestic and imported goods in a unit of consumption (with  $\alpha_D^C + \alpha_M^C = 1$ ); and  $\alpha_D^I$  and  $\alpha_M^I$  are the cost shares of domestic and imported goods in a unit of investment (with  $\alpha_D^I + \alpha_M^I = 1$ ). Equations (8) and (10) are CD unit cost functions. Equations (9) and (12) describe optimising demands for  $L$  and  $K$ . Equation (11) defines the rate of return. Equation (13) defines the real wage. Via Equations (8)–(13) we have:

$$MP_L(K/L) = T_D \cdot W_R \cdot (P_M/P_D)^{\alpha_M^C} \quad (14)$$

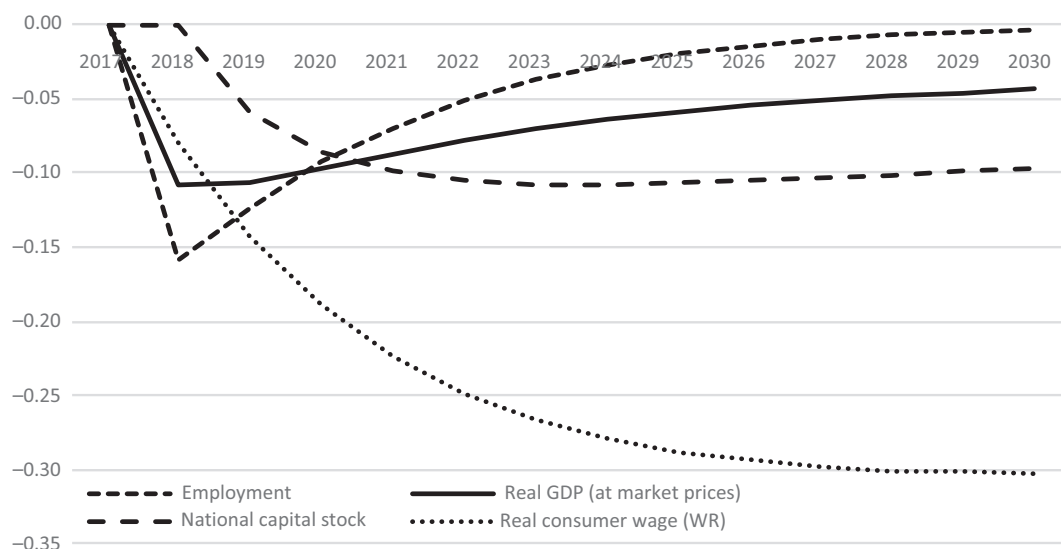
$$MP_K(K/L) = \rho \cdot T_D \cdot T_I \cdot (P_M/P_D)^{\alpha_M^I} \quad (15)$$

When we raise the GST in VURM to 11 per cent, this can be viewed in the BOTE model as increases in  $T_C$ ,  $T_D$  and  $T_I$ . The explanation for the rise in  $T_C$  is straightforward: in Equation (3a), for the household, values for EEX tend to be low, REF is 0, and values for CR are close to 1. Hence, the rise in LR translates strongly into a rise in the effective rate of tax on consumption. This is clear in Figure 3, which reports the deviation in the ratio of: (i) the national consumption deflator as normally defined; and (ii) a measure of the consumption deflator that excludes the GST.

The rise in  $T_D$  arises from non-unitary values for  $REF_{u,r}$ . In a theoretically ideal system,  $REF_{u,r} = 1$ , for all  $u \in IND$ ,  $\forall r \in REG$ . But Equation (7a) reminds us that producers can only reclaim GST paid on inputs to the extent that they produce goods that are not GST exempt, and register for GST. The exempt status of banking, finance and some insurance render producers of these commodities input-taxed. We represent this by low  $REF_{i,s}$  values for industries producing these commodities. We account for industry-specific non-registration rates by informing values for  $NRI_{i,r}$  and  $NRL_{i,r}$  with ABS data on business counts and informal activity (Australian Bureau of Statistics, 2013, 2015). Values for  $NRL_{i,r}$  are low, and often 0, with an average value around 0.005. Values for  $NRI_{i,r}$  are also low (around 0.004 on average).<sup>20</sup> Hence, in terms of Equation (7a), typical values for REGIST are a little below 1,

<sup>20</sup> NRI values range from 0 for sectors dominated by large regulated enterprises, to around 2 per cent for a handful of sectors where ABS data suggest higher informality rates (e.g. construction, construction services and accommodation services).

FIGURE 1  
National Employment, Capital Stock, Real GDP, and Wage Deflated by GST-Exclusive Consumption Deflator,  
 $W_R$  (% Deviation from Baseline)



thus values for  $REF_{i,s}$  are less than 1 for many industries. Via Equation (3a), this introduces low levels of input taxation to many industries. Via these two routes, production of exempt commodities and non-registration, an increase in the GST has the effect of raising taxes on production. In the BOTE model, this is represented by a rise in  $T_D$ . In the VURM simulation, this is apparent in the positive deviation in the ratio of (i) an intermediate input cost index at purchasers' prices as normally defined, and (ii) an intermediate input cost index excluding GST but otherwise at purchasers' prices (Figure 3).

A number of elements of the GST result in investment taxation (a rise in  $T_I$  in BOTE). Under a pure GST system  $REF_{u,r} = 1$  for all  $u \in INV$ , for all  $r \in REG$ . But as already discussed, firms cannot reclaim GST on inputs to the extent that they produce exempt goods or are unregistered. Equations (7a), (7b) and (3a) introduce low levels of investment taxation to many industries via non-registration, and high levels of investment taxation for banking, finance, insurance and dwellings via the exempt status of many of the products these sectors produce. For the macro-economy,

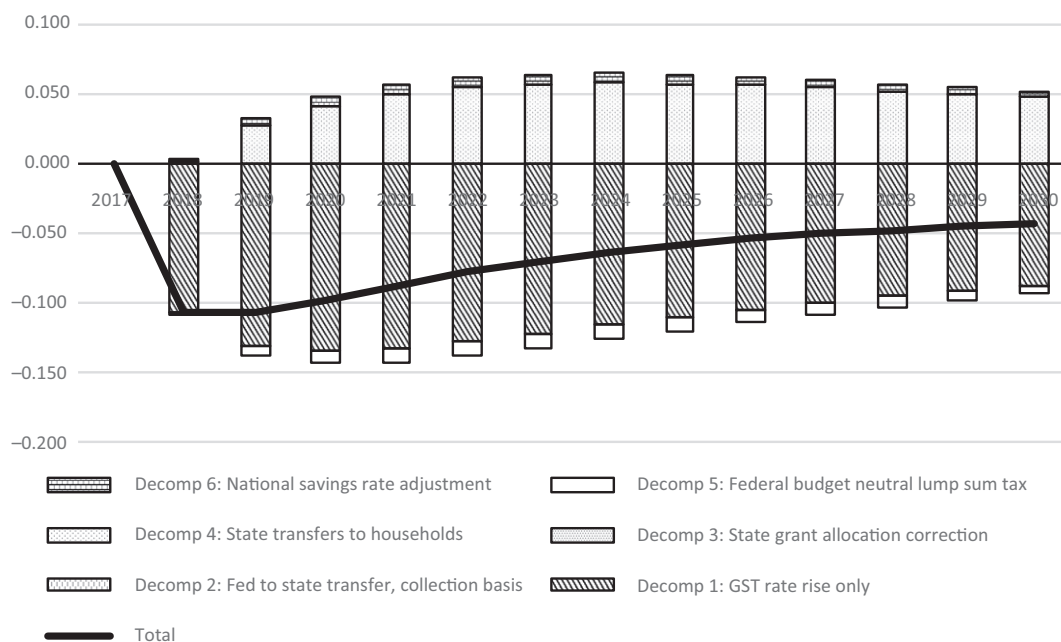
this is reflected in the positive deviation in the ratio of (i) the investment price deflator as normally defined, and (ii) the investment price deflator excluding GST (Figure 3).

#### National results

We use Equations (14) and (15) to explain the short-run and long-run results in Figure 1. In the short run, with the real wage ( $W_R$ ) and the capital stock ( $K$ ) sticky, the rise in production taxes ( $T_D$ ) causes the marginal product of labour ( $MP_L$ ) to rise.<sup>21</sup> With  $K$  sticky, this requires  $L$  to fall. This accounts for the short-run negative deviation in employment, which in turn, accounts for the short run negative deviation in real GDP (Figure 1).

<sup>21</sup> In Equations (14) and (15), the ratio  $P_M/P_D$  is a function of the terms of trade. Movements in this ratio can be understood as second round outcomes arising from the first round impacts on  $K$  and  $L$  of movements in  $T_C$ ,  $T_D$  and  $T_I$ . For this reason, together with our assumption in VURM that foreign currency import prices are exogenous and export demands are highly elastic, it is appropriate to treat  $P_M/P_D$  as given in our BOTE explanation.

FIGURE 2  
National Real GDP Deviation: Decomposition into Contributing Factors (% Deviation from Baseline)



Turning to Equation (15), the short-run negative deviation in  $L$  causes a short-run negative deviation in the marginal product of capital ( $MP_K$ ). Ceteris paribus, this causes the rate of return on capital ( $\rho$ ) to fall relative to baseline. The downward pressure on  $\rho$  via the negative deviation in  $MP_K$  is reinforced by the rise in indirect taxation of investment and production ( $T_I$  and  $T_D$ ). This accounts for the sharp negative deviation in real investment in the short-run (Figure 4).

As discussed in Section IV(i), VURM's capital and labour markets transition in the long run to an environment in which capital adjustment returns values for actual rates of return to required rates of return, and real wage adjustment returns regional unemployment rates to baseline values. In Equations (14) and (15), these long-run outcomes can be described by the exogenous status of  $L$  and  $\rho$  and the endogenous status of  $W_R$  and  $K$ . In Equation (15), with  $L$  and  $\rho$  exogenous, the rise in taxation of investment and production ( $T_I$  and  $T_D$ ) causes the required  $MP_K$  to rise. With  $L$  given in the long-run, the rise in  $MP_K$  requires  $K$

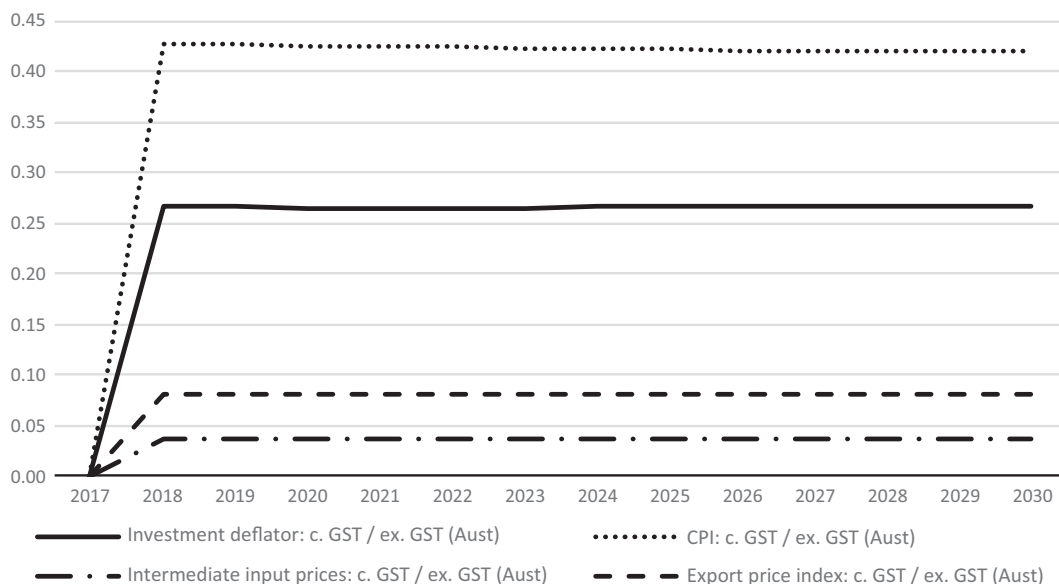
to fall. This accounts for the long-run negative deviation in capital reported in Figure 1. With the long-run capital stock below baseline, and employment returning to baseline, real GDP must be below baseline in the long run (Figure 1).

Turning to Equation (14), with  $K$  below baseline in the long run, and  $L$  returning to baseline, the long run  $MP_L$  deviation must be negative. Ceteris paribus, this dampens the deviation in the long run real wage ( $W_R$ ). This pressure for negative deviation in  $W_R$  arising from the long run negative  $K$  deviation is reinforced by the rise in taxation of intermediate input use.

Figure 4 reports deviations in the expenditure side components of real GDP. As discussed with reference to Equation (15), rates of return on capital fall in the short run. This explains the short-run negative investment deviation. Investment is relatively import intensive. Also, the rise in the GST on export tourism depresses trade relative to GDP. Both factors account for the negative import volume deviation in the simulation's first year. With the BOT to GDP ratio

FIGURE 3

*Ratios of Four Deflators with and without GST (Private Consumption, Intermediate Input Costs, Investment, and Exports). In Each Case: Ratio of the Deflator as Normally Defined (i.e. Inclusive of GST) to the Deflator Excluding GST (but Otherwise as Normally Defined) (% Deviation from Baseline)*



Note(s): 'c' stands for 'including', as opposed to 'ex.' for 'excluding'.

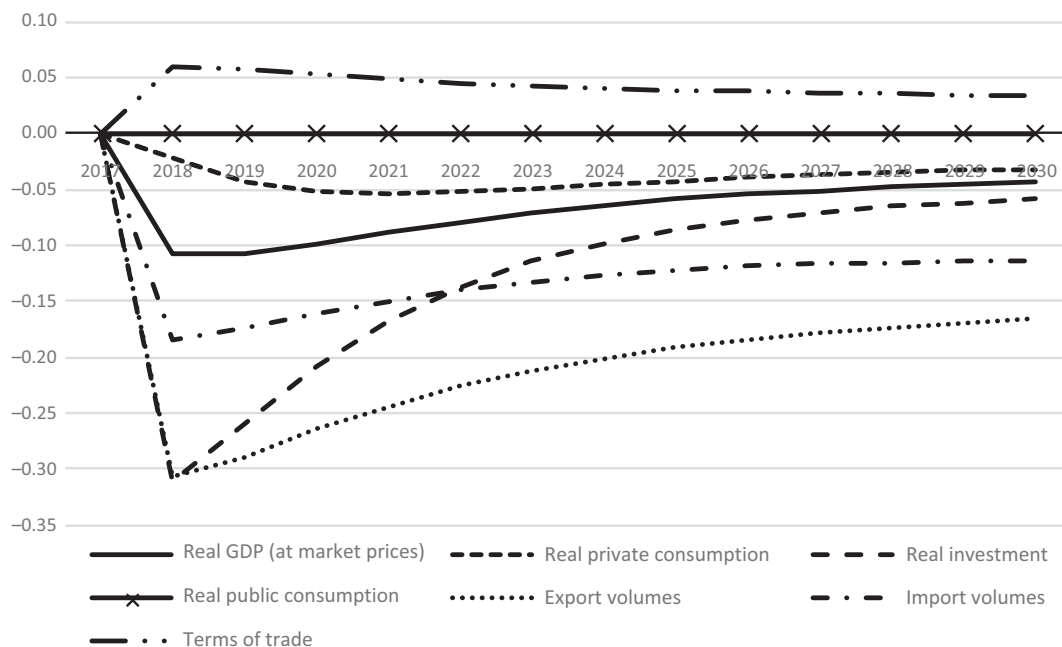
exogenous, the negative import deviation requires a simultaneous negative export deviation. The negative export deviation causes a positive deviation in the terms of trade.<sup>22</sup> The positive deviation in the terms of trade lifts national income relative to GDP. This explains why the real private consumption deviation lies above the real GDP deviation.

In the long run, as discussed with reference to Equation (15), capital adjustment gradually returns rates of return towards baseline. This accounts for the gradual attenuation of the negative investment deviation in Figure 4. Nevertheless, the long-run investment deviation remains negative, because the long-run capital deviation is negative (Figure 1). Investment is relatively import intensive, hence the long-run attenuation of the negative investment deviation causes a long-run attenuation of the negative import

deviation. Via the closure assumption that the BOT to GDP ratio remains on baseline, the long-run negative deviation in imports requires that there be a long-run negative deviation in exports. The negative export deviation lies below the negative import deviation because the terms-of-trade deviation is positive, and the baseline level of the BOT is in deficit. Despite the long-run convergence of the investment and GDP deviations, the import deviation remains below the GDP deviation in the long run. This reflects taxation of export tourism, which damps trade relative to GDP. The long-run negative export deviation causes a small positive terms-of-trade deviation. However, the attenuation in the export deviation over the medium to long run causes the terms-of-trade deviation to attenuate over the longer run. This accounts for the attenuation of the gap between the deviations in private consumption and GDP. This effect is reinforced by the fixity of public consumption at baseline, which leaves private consumption alone to adjust to movements in national income.

<sup>22</sup> In VURM, commodity-specific export volumes are negatively related to commodity-specific export prices.

FIGURE 4  
The Expenditure-Side Components of Real GDP (% Deviation from Baseline)



### Industry results

For reporting, we aggregate the results for production volumes for VURM's 76 industries to outcomes for 17 broad sectors. Figures 5–7 report output deviations for the top six, middle five, and bottom six industries as ranked by 2030 outcomes.

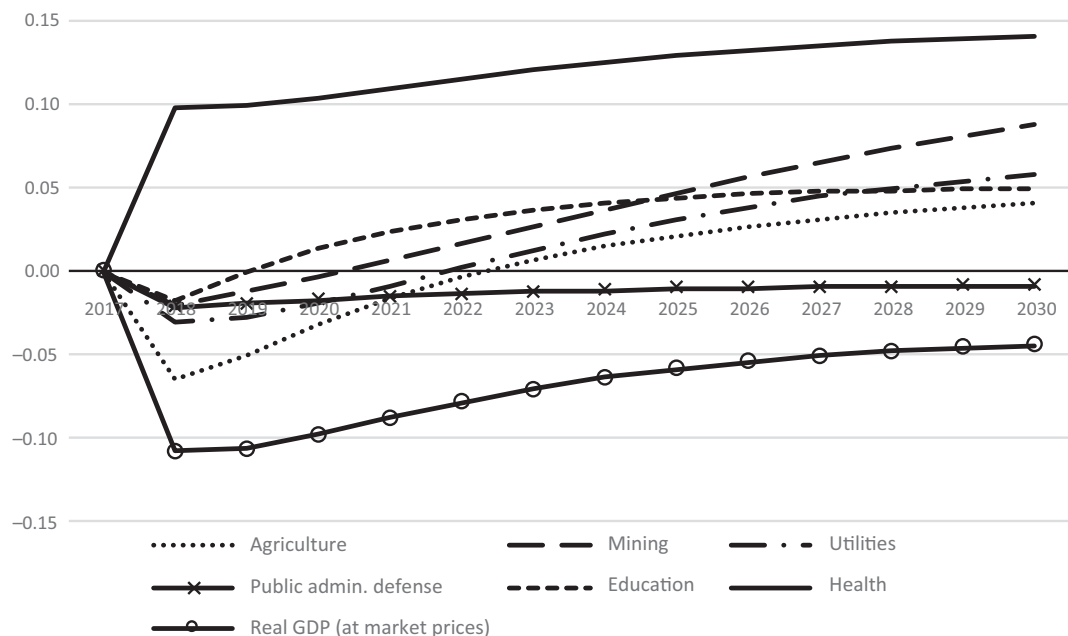
Health and education are the two top-ranked sectors in the long-run (Figure 5). Sales to public consumption represent high shares of the output of both sectors. As discussed in Section IV(i), we assume that public consumption remains on baseline. This supports the output of health and education. It also accounts for the presence of public administration and defence among the top-ranked sectors in Figure 5. A second factor supporting health and education output is their GST status. Outputs of both sectors are zero-rated. Hence, when the GST rate is raised, the relative consumer price of zero rated education and health is lowered, inducing substitution towards these commodities. Similarly, the presence of utilities among the top-ranked sectors is due to the zero rating of water and drainage. The remaining two sectors in Figure 5 are mining and agriculture. As

discussed earlier, the GST rise affects export tourism. For any given level of aggregate exports, taxation of export tourism crowds out tourism exports and crowds in traditional zero-rated exports such as mining and agriculture. The output deviations of mining and agriculture are also constrained by the fixity of natural resource endowments in both sectors.

Figure 6 reports output deviations for the five middle-ranked sectors. These sectors subsume industries that: (i) do not have concentrated sales to any one final demand category (finance and insurance, manufacturing, other services); (ii) are important as intermediate inputs (manufacturing, other business services); and (iii) are important as margin services across many sectors and final demand categories (wholesale trade). In this simulation, these attributes make the output of these sectors correlated with a summary measure of aggregate activity, like GDP. This renders them middle-ranked when their output results are compared with the GDP result.

Figure 7 reports output deviations for the six bottom-ranked sectors. The two sectors with the

FIGURE 5  
Sectoral Output Deviations, Top Six Ranked by 2030 Deviation (% Deviation from Baseline)



largest negative deviations (accommodation and food, and transport) are important providers of services to foreign tourists. When making on-shore purchases of commodities such as hotel stays and restaurant meals, tourists pay GST and cannot claim a refund on departure. In VURM, export demands are modelled as particularly price sensitive. Hence the effective export taxation of tourism-related sales generates comparatively large output contraction for sectors such as accommodation and transport. This is also a factor in the negative output deviations for retail trade and communications.<sup>23</sup> The construction services sector is a key input to investment. Hence, its output deviation is correlated with the deviation in

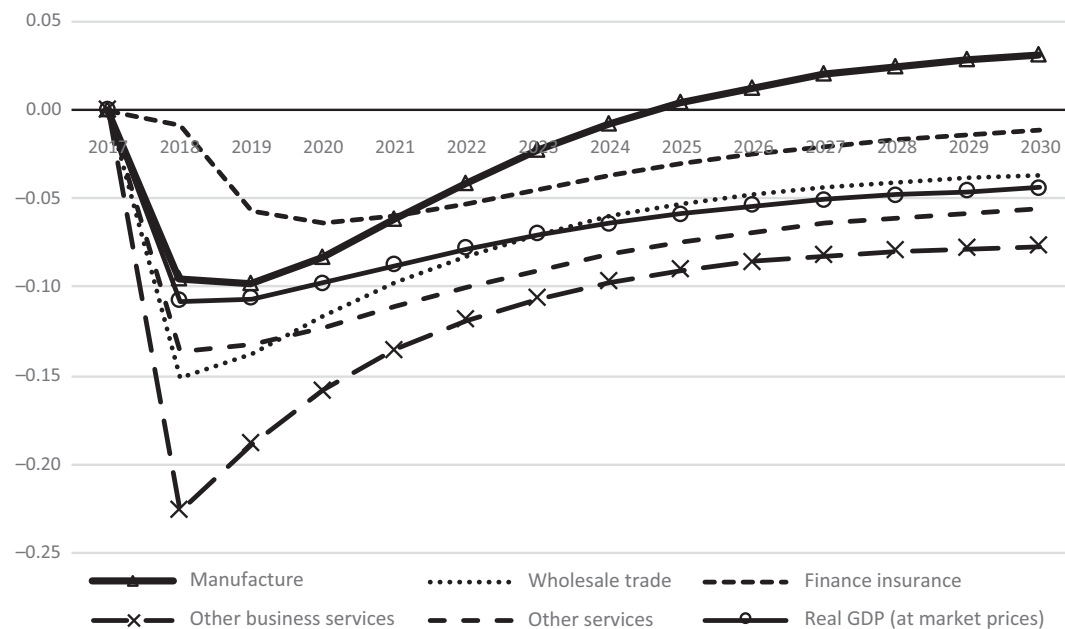
<sup>23</sup> Both sectors also have some exposure to export tourism. Retail margins facilitate tourism-related sales of food, beverages, and other items that are subject to GST because the purchases are made on-shore. About 8 per cent of communications are exported, and of these, about 2.4 per cent are onshore sales to non-residents, and thus subject to GST. Further details on how we calculate onshore non-resident sales shares are available in the supplementary information.

aggregate investment. This accounts for the path of the construction output deviation, which exhibits a sharp negative deviation in the short run, followed by gradual attenuation in the long run. The deviation in dwellings output is small in the short run, consistent with the capital intensity of this sector. Over the medium to long run, the dwellings output deviation is negative and lies slightly below the GDP deviation. This reflects the relatively high expenditure elasticity for dwellings. With the long-run consumption deviation being approximately the same as the long-run GDP deviation (Figure 4), the relatively high household expenditure elasticity for dwellings services causes the dwellings output deviation to lie below the GDP deviation.

#### Regional results

Figure 8 reports GDP deviations for NSW, RoA and Australia as a whole. Relative to Australia as a whole, NSW is adversely affected by the rate rise. To understand why, we begin by examining purchasers' prices in NSW relative to the rest of the country. Figure 9 reports the deviations in 2030 of the ratios of certain national and regional

FIGURE 6  
Sectoral Output Deviations, Middle Five Ranked by 2030 Deviation (% Deviation from Baseline)



deflators (private consumption, investment, exports and intermediate input costs) calculated with and without GST.<sup>24</sup> The results for NSW, RoA and Australian outcomes for the ratio of the CPI as normally defined (i.e. inclusive of GST) to a measure of the CPI excluding GST are similar. This suggests that differences between NSW and RoA in the GST load on consumption are not an important factor in explaining the difference between the NSW and RoA outcomes for real GDP.

This is not the case for the remaining deflators, which show sizeable differences between NSW and RoA in the direct effect of GST on prices for investment, intermediate inputs and exports. The gap between the NSW and RoA outcomes for the direct contribution of the GST to the investment deflator deviations is approximately 0.1

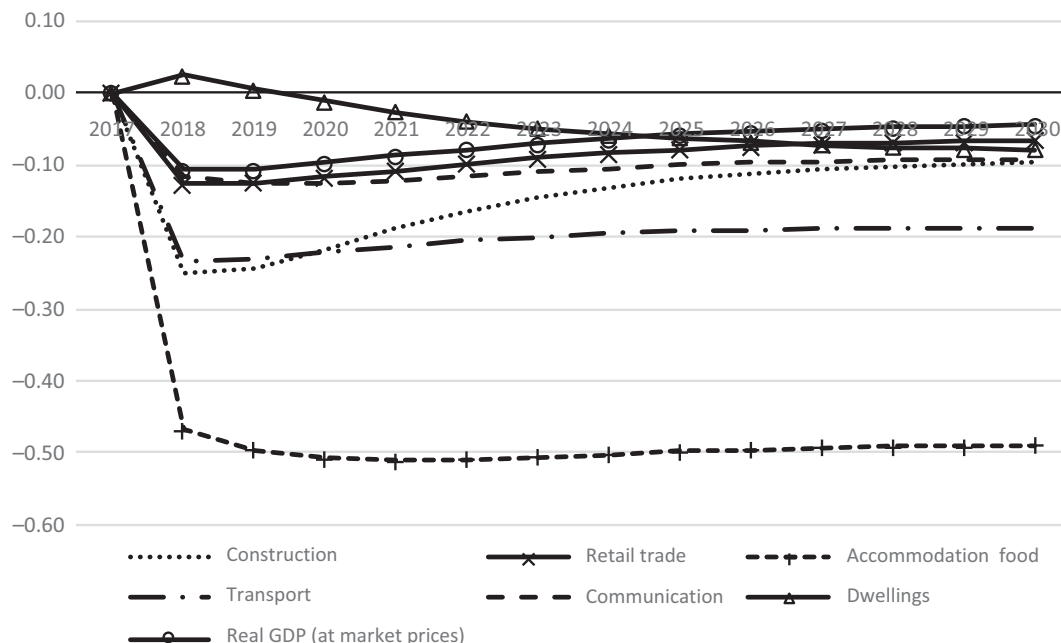
<sup>24</sup> Like results for their national counterparts reported in Figure 3, the deviations in the regional deflator ratios are steady throughout the simulation period. Hence no information is lost by reporting only 2030 results.

percentage points. We can trace this to the higher proportion of activity in NSW in input-taxed industries, in particular banking, finance, insurance and dwellings. Approximately 4.3 per cent of NSW investment is in banking, finance and insurance, while the corresponding number for the RoA is 2.7 per cent. This reflects the status of NSW as a financial centre. Approximately 30.7 per cent of NSW investment is in dwellings construction, while the corresponding number for the RoA is 22 per cent. Much of banking, finance, insurance and dwellings is GST exempt, rendering the industries producing these commodities input-taxed. Because NSW has a higher share of its investment activity in industries producing GST-exempt commodities, when we raise the GST, this has a larger direct effect on the investment price deflator in NSW relative to the RoA.

Production of GST-exempt goods also contributes to the gap between NSW and RoA outcomes for the contribution of the GST to intermediate input costs. GST on intermediate inputs to insurance, banking and finance explains about half the gap between the NSW and RoA



FIGURE 7  
Sectoral Output Deviations, Bottom Six Ranked by 2030 Deviation (% Deviation from Baseline)



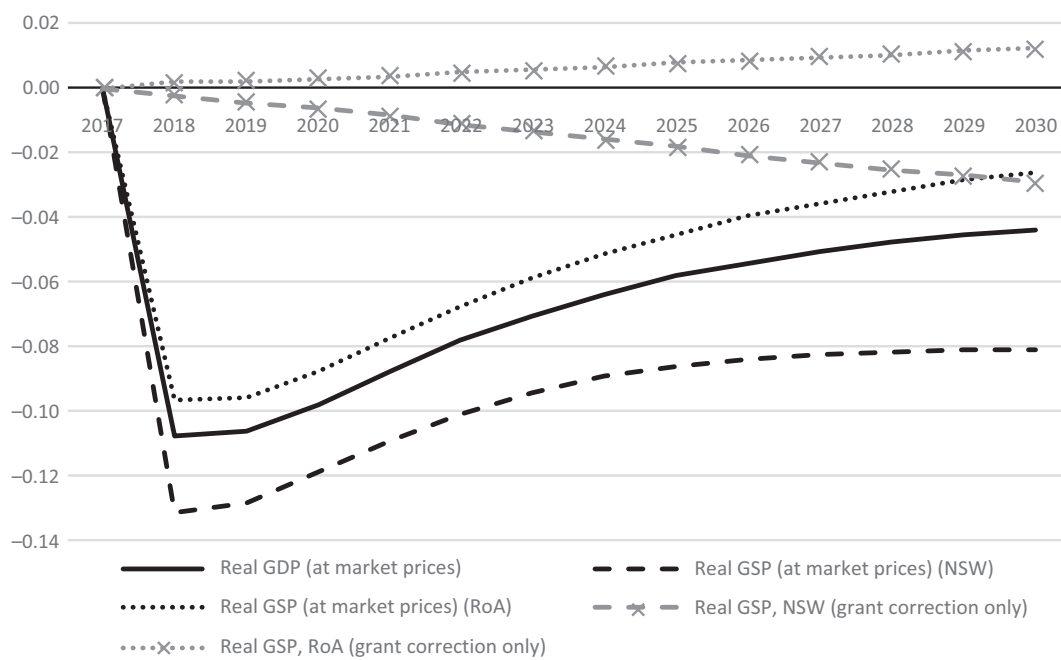
results reported in Figure 9. The remainder is due to GST on intermediate inputs to current production of dwelling services. Insurance, banking and finance are themselves important intermediate inputs in current production, and the input-taxation of production of these commodities leads to some indirect tax cascading. This is more important in NSW than RoA, where inputs of banking, finance and insurance are a higher share of production costs (5.8 per cent versus 4.5 per cent).

The direct effect of the GST on regional export prices accounts for 0.1 percentage points of the gap between the export price deviations for NSW and RoA (Figure 9). We trace this to the greater importance of export tourism to NSW relative to RoA. A rise in the GST translates to a rise in export taxation to the extent that it falls upon commodities purchased on-shore by non-residents, and to the extent that such GST collections are not refunded on departure. Relative to RoA, the VURM database

shows a heavier weighting of NSW exports towards commodities with these characteristics.

We conclude with a discussion of fiscal impacts, a final source of additional damage to the NSW economy relative to that experienced by RoA. Figure 10 reports PSBR outcomes for NSW, decomposed into the individual contributions of our six factors. For the purposes of our decomposition analysis, we divide the federal return of GST revenue to the states into two components: (i) an allocation equal to the amount of GST collected within the state; and (ii) a correction sufficient to bring the net grant in line with CGC allocations of additional revenue on a per-capita basis. Consistent with our assumption of no change in state PSBRs relative to baseline, in Figure 10 the net impact of the six decomposition factors on the NSW PSBR deviation is zero throughout the simulation. There are two sources of positive contribution to the NSW PSBR deviation: federal GST grants calculated on a collection basis, and the effects of the GST rate

FIGURE 8  
*Real National GDP and Regional GSP at Market Prices, and Comparison of Total GSP Impacts with CGC per-capita Correction GSP Impacts Only (% Deviation from Baseline)*



rise itself.<sup>25</sup> Two factors return the NSW PSBR position to zero deviation: (i) a correction to the collection-basis allocation of GST revenue, sufficient to bring the net grant of additional GST revenue in line with that determined by population shares; and (ii) state government transfers to households. For NSW, the population share correction to the collection basis for grant allocation is negative (Figure 10). It is positive by the

<sup>25</sup> Taken on its own, the GST rise generates two sources of positive contribution to the NSW net lending outcome. First, the negative deviation in NSW activity lowers NSW investment. In VURM, this affects both private and public investment. The negative deviation in NSW public investment reduces net acquisitions of non-financial assets by the NSW government, moving the NSW PSBR towards surplus. Second, we hold real NSW public consumption on baseline throughout the simulation. However, the unit cost of public expenditure falls relative to baseline, due to the fall in wages (Figure 1). Both factors move the NSW PSBR towards surplus.

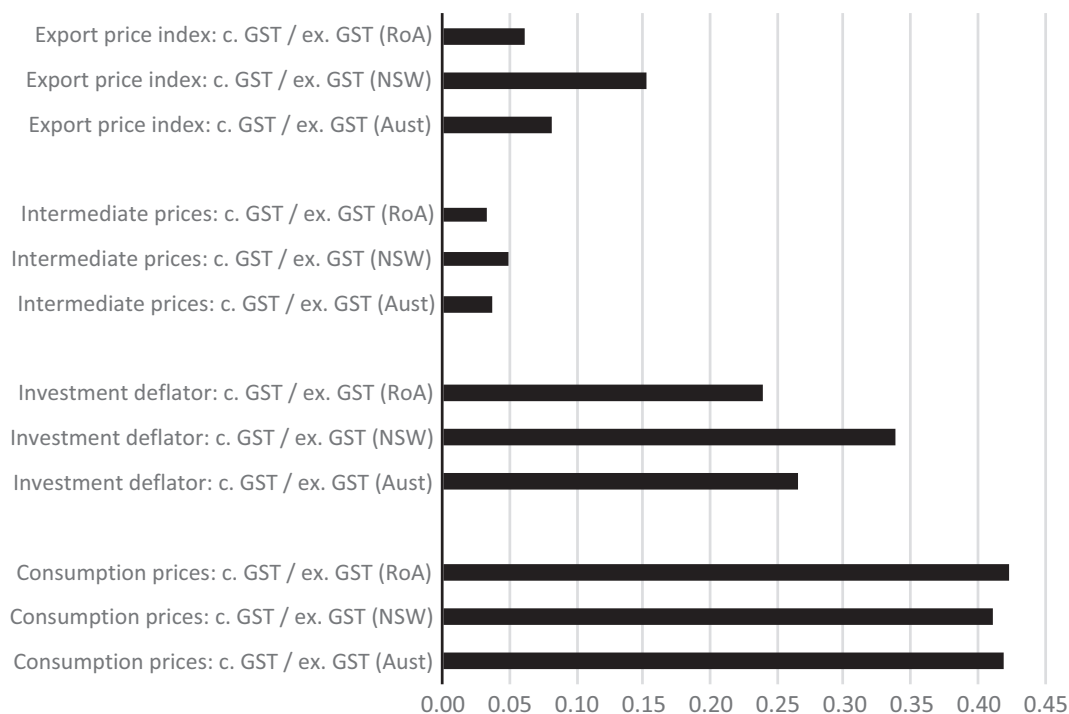
same dollar amount for RoA.<sup>26</sup> The grant correction thus reduces the grant allocation relative to the amount of GST collected from NSW, while for RoA the reverse is the case, with RoA receiving more in GST grants than GST collected within the region. Figure 8 reports the effects on NSW and RoA real Gross State Product (GSP) of the grant correction in isolation from all other shocks, under an assumption that state governments pass on the grant corrections to households via lump-sum taxes/transfers.<sup>27</sup>

Figure 8 makes clear that, relative to a collections basis for distributing additional GST revenue, the CGC per capita correction damps the

<sup>26</sup> To conserve space, we do not report the RoA fiscal outcomes.

<sup>27</sup> This decomposition is conducted under a closure slightly different than that for the decompositions reported in Figure 10 so as to isolate the GSP impacts of the GST grant correction. Closure details can be found in Section III of the online supplementary material.

FIGURE 9  
*Ratios of Selected Macro Deflators Inclusive of GST and Exclusive of GST, Australia, NSW and RoA (2030 % Deviation from Baseline)*

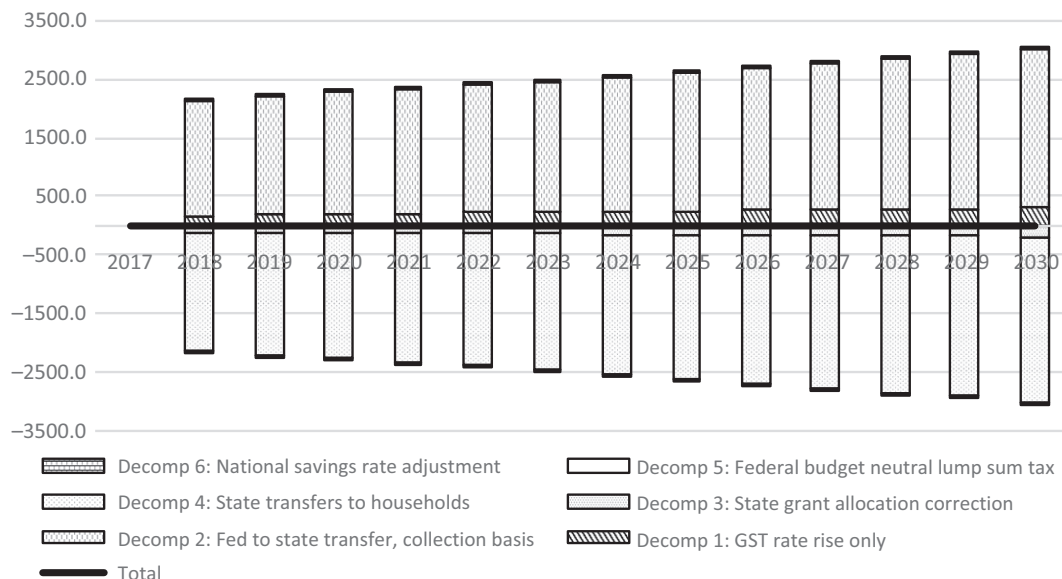


NSW GSP deviation relative to that for RoA. The contribution made by the grant correction to the difference between NSW and RoA GSP outcomes grows over time because the correction affects GSP largely via inter-regional migration. In the short run, inter-regional migration is sticky. But over time it gradually adjusts to the differential in inter-regional post-tax incomes created by the grant correction. By the simulation's final year, the gap between the full simulation outcomes for NSW and RoA GSP deviations is  $-0.055$  ( $=-0.081$  to  $-0.026$ ) per cent. The gap between the GSP deviations attributable to the CGC correction shock alone is  $-0.041$  ( $=-0.029$  to  $0.012$ ) per cent. Hence, relative to a situation in which the additional GST revenue is returned to the states on the basis of GST collections by state, the per capita adjustment explains about three quarters ( $-0.041/-0.055$ ) of the gap between the NSW and RoA real GSP deviations in the simulation's final year.

#### IV Concluding Remarks

Debate over GST reform possibilities has grown in recent years. However, a difficulty for GST change is that, under current conventions governing the GST, unanimous state and territory agreement is required. The support that policy-makers in a given jurisdiction might lend to a given GST proposal will be influenced by perceptions of how the proposal affects their jurisdiction. As such, to inform GST policy deliberations, insights into the regional consequences of GST change are important. The generation of such insights requires a model in which: (i) individual states and territories are modelled in a 'bottom-up' way (i.e. as separate economies in their own right); and (ii) legislated details of the GST are modelled in full. Our model, VURM, is bottom-up multi-regional, explicitly modelling the details of economic activity within each region. An innovation of the paper is the integration of a detailed GST

FIGURE 10  
Public Sector Net Lending/(Borrowing) Requirement - NSW (\$m. Deviation from Baseline)



model within a regional CGE model. The GST model describes the legislated complexity of the GST as it relates to differentiated tax rates, legal exemptions, refund rates, registration rates, export taxation and the low-value import threshold. We implement a two-region (NSW and RoA) version of VURM. When we raise the GST rate and distribute the new revenue to regional governments, our model quantifies a well-known dimension of the regional economic effects of the GST: under current CGC arrangements, a donor state (like NSW) is, relative to other states, adversely affected by a GST rate rise. However, our regional model with GST detail identifies other factors that affect the size of the NSW economy. In particular, we identify the relative importance to NSW of input-taxed activities (such as banking) and export tourism as factors that cause a rise in the GST rate to damp economic activity in NSW relative to the RoA. Hence, a small straightforward change in the GST rate has consequences for the distribution of economic activity across Australia's states and territories. More complex changes, involving broadening the base, are also likely to have differing impacts across states and territories.

Under the current requirement for unanimous support for GST change, consideration of such impacts will need to inform inter-governmental deliberations on GST reform proposals.

We anticipate a number of avenues via which future work with our model can inform GST policy analysis. First, for expository purposes, our paper has focused on economic consequences for Australia's largest state, New South Wales, and the rest of Australia. In future work, we plan to analyse results using the fully disaggregated VURM model with eight states and territories. Second, we plan to investigate a range of base-broadening reform options. We expect this analysis to reveal further insights into how the legislated details of the GST, together with features of region-specific economic activity, interact to generate regionally differentiated impacts from various GST reform options. Third, the analysis can be extended to investigate the economic consequences of the state and territory compensation packages that might be required to achieve unanimous support for GST reform. An interesting policy question, which can be quantified with our GST-augmented VURM model, is the degree to which the efficiency losses

generated by such compensation packages offset the efficiency gains that might otherwise be generated by various tax mix change policy proposals in which GST reform figures prominently. Finally, we note that, while our model is implemented for Australia, it is sufficiently flexible to be generalisable to any country with a fiscal federal system. This would include India, which has recently introduced a nation-wide GST system in the presence of multiple state-specific indirect tax systems, and the USA, where there are periodic calls for a federal VAT.

### Supporting Information

Additional Supporting Information may be found in the online version of this article:

**Appendix S1** Online Supplementary Information

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