Submission
No 38

INQUIRY INTO LAND TRANSFER DUTY FEES

Name: Joint Submission

Date Received: 14 March 2023

Co-authored by Associate Professor Jason Nassios and James Giesecke (Centre of Policy Studies, Victoria University).

Submission to the Inquiry into Land Transfer Duty Fees in Victoria

Jason Nassios[1] and James Giesecke[2]

Centre of Policy Studies

Victoria University

14 April 2023

Summary

The Parliament of Victoria Economy and Infrastructure Committee is investigating issues around land transfer duty fees and its instruments within the *Duties Act 2000* in Victoria, Australia. The Committee is required to inquire into, consider and report on (1) The current situation regarding land transfer duty, specifically impacts on factor mobility, revenue predictability, efficiency of resource allocation, effects on housing supply, and overall tax efficiency; and, (2) potential alternatives to land transfer duty.

The Centre of Policy Studies (CoPS), an economic modelling research centre at Victoria University, has undertaken a number of tax policy studies that consider issues raised by the inquiry. This submission summarizes findings from those studies. Extended comments are followed by a short summary addressing the terms of reference on which the Committee is basing its inquiry. References follow thereafter.

Extended comments

Stamp duties originated as a form of taxation in the Netherlands in 1624 [Dagnall (1994)], and were later introduced in England under the *Stamp Act 1694*, in part to finance the Nine Years War with France. English stamp duties were levied on a variety of goods, including university degrees, probates, the conveyances of property, newspapers, and playing dice. These early forms of stamp duty were specific taxes, with the tax base being the vellum, parchment or paper used to prepare either legal documentation or print media.

In Australia, the first stamp duty on the transfer of property (hereafter, transfer duty, or TD) was collected on 1 July 1865 by the colony of NSW, in accord with the *Stamp Duties Act 1865 (NSW)*. After a brief hiatus from 1874 to 1880, TD in NSW was reintroduced with the *Stamp Duties Act 1880 (NSW)*, following its introduction in the colony of Victoria with the *Stamp Duties Act 1879 (Vic)*. These ad valorem stamp duties differed from their early English counterparts, in that the dutiable tax base was the value of the property transferred. TDs of this form have remained in place throughout Australia's eight states and territories since, and are active across many other countries today, e.g., the United Kingdom (where it is referred to as Stamp Duty Land Tax), Germany, the Netherlands, the United States of America (where Real Property Transfer Tax is levied in all but five states, namely Mississippi, Missouri, New Mexico, North Dakota and Wyoming), Poland, and Ukraine [see also Bird and Slack (2004)].

While the system of TD in place throughout Australia differs in regional detail, in general a purchaser of an Australian property is liable to pay TD when housing (of either owner-occupied or rented

---

[1] Associate Professor, Centre of Policy Studies, Victoria University, Jason.Nassios@vu.edu.au.

[2] Director and Professor, Centre of Policy Studies, Victoria University, James.Giesecke@vu.edu.au.

tenure) or non-residential properties are transacted, with very few exemptions. Jurisdiction-specific progressive rate schedules apply, with the revenue accruing to Australian state and territory governments.

In line with TDs introduced by the Australian colonies prior to Federation, the dutiable tax base across all regions and for all property types remains the value of the property transacted, i.e., the market value of the capital/land bundle transacted [NSW Treasury (2018); Freebairn (2020)]. The applicable TD rates and thresholds differ by jurisdiction, with top-tier duty rates ranging from 4.5 percent of the property value above A$725 000 in Tasmania, to 7.0% for housing valued above A$3 million in NSW in 2017/18 [NSW Treasury (2018)]. From July 2019, Victoria also imposed an additional duty 8% of the transaction price on foreign purchasers of residential property. Similar foreign purchaser duties have been imposed by other Australian states.

While the tax base for TD is the value of the property, the economic incidence can be viewed as falling on the process of property transfer. Since the 1980's, concern regarding this system of taxation has grown in response to sharp appreciation in Australian housing prices relative to household incomes [Fox and Finlay (2012); Thomas and Hall (2016)]. This upward trend in price-to-income has in turn put upward pressure on the value of TD relative to property ownership transfer costs, the value of which are usually only a fraction of the property price. This appreciation has been particularly pronounced following the Global Financial Crisis, as shown in Figure 1 where we plot the ratio of gross (stamp duty) ownership transfer costs[3] to aggregate TD revenue[4]. The upward trajectory in the ad valorem equivalent stamp duty rate on ownership transfer costs is a reflection of the upward trend in the housing price-to-income ratio over the last decade.

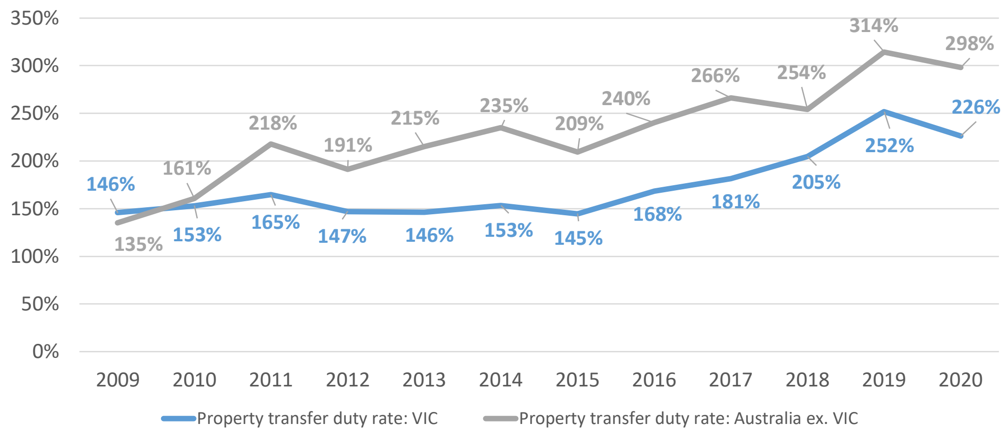


Figure 1: Ad valorem equivalent of conveyancing duty taxes on ownership transfer costs in VIC, and the rest of Australia excluding VIC.

This has stimulated debate about the economic efficiency of Australian TDs, particularly with regard to the role they play in inhibiting the efficient allocation of the nation's housing stock and impeding household mobility. With regard to the latter of these two points, Davidoff and Leigh (2013)

---

[3] See ABS Cat. No. 5220.0 Tables 2 –9. To derive gross ownership transfer costs from ABS 5220.0, we subtract TDs sourced from ABS 5506.0 Tables 2 –9.

[4] See ABS Cat. No. 5506.0 Tables 2 – 9.

quantified the impact of TDs in Australia on housing turnover, and showed that a 10% increase in TD is associated with a 3% fall in housing turnover over one year. If the 10% rise in TD is sustained for 3 years, the reduction in transaction volumes is 6%. The ratio of the transaction volume reduction to the TD increase suggests an elasticity of transactions with respect to tax of -0.6, which was independently established in later work by Adams *et al.* (2020), who studied TD rate reductions and housing transfers associated with the ACT tax reform package [ACT Treasury (2012)]. For international comparisons, we refer readers to Malakellis and Warlters (2020).

Recent reviews of Australia's tax system by Henry *et al.* (2010), the Productivity Commission (2017), and Thodey *et al.* (2020) have each described how TD removal could improve the Australian tax system's resilience and efficiency. Of the suite of taxes levied by state governments in Australia, TD imposes the largest deadweight cost of taxation. Assessments of the relative efficiency of the different elements of the tax system rely on simulation-based assessments that utilize computable general equilibrium (CGE) models of the Australian economy, e.g., see Cao et al. (2015) for work by the Federal Treasury, and region-specific analyses using the Victoria University Regional Model with Tax detail (VURMTAX) by Nassios et al. (2019a) and Nassios and Giesecke (2022a). The quantum of the distortion caused by TD was most recently calculated and reported by Nassios and Giesecke (2022a) for NSW, while Nassios and Giesecke (2022b) study TD across Australia. They found that TD have a marginal excess burden (a measure of the economic damage caused by a tax, expressed as cents of damage per dollar of tax revenue raised) of 76 cents per dollar. When ranked alongside other state and federal taxes, they found that housing TDs cause the largest deadweight cost per dollar of revenue raised, and in the context of Figure 1 it is not difficult to understand why.

In contrast, broad-based taxes on unimproved land values [a tax on unimproved land values with few exemptions and a generally flat rate, see Nassios et al. (2019b)] were shown to carry small negative deadweight costs, due in large part to foreign landowner taxation. The highly distortionary nature of TDs relative to land taxes was also emphasised in Australia's most recent review of the national tax system by Henry *et al.* (2010), which recommended the revenue-neutral replacement of TD with new broad-based land taxes. Of Australia's eight states and territories, only the Australian Capital Territory (ACT) has thus far embarked on a wholesale exchange of TD for broad-based landowner taxation, via the ACT tax reform package [ACT Treasury (2012)]. Adams *et al.* (2020) from Victoria University's Centre of Policy Studies studied the ACT Reforms over 2012/13 – 2017/18 and found that, while the benefit due to the removal of property transfer duty accounted for around 80 percent of the increase in economic activity in the ACT over the time period studied, the imposition of a land tax also carried with it economic benefits.

Among the other Australian states and territories, NSW introduced a First Home Buyer Choice[5] scheme, offering first home buyers the option of paying TD on purchases, or an annual land tax. This partial replacement of TD with a land tax might end later in 2023, following the election of the Minns Labor government in NSW.[6]

With regard to property tax reforms, Nassios and Giesecke (2022a) show that a swap of TD with a broad-based land tax outranks eight other property tax reforms options, when all options are ranked solely in terms of their economic efficiency consequences. They find that the argument in support of

---

[5] For details see https://www.nsw.gov.au/housing-and-construction/first-home-buyer-choice

[6] See https://www.chrisminns.com.au/stampduty and https://www.abc.net.au/news/2023-01-09/nsw-labor-stamp-duty-policy-for-2023-election/101835720

swapping TD with a broad-based land tax is strengthened when the evaluation criteria is broadened to include potential housing price impacts; see Figure 2.

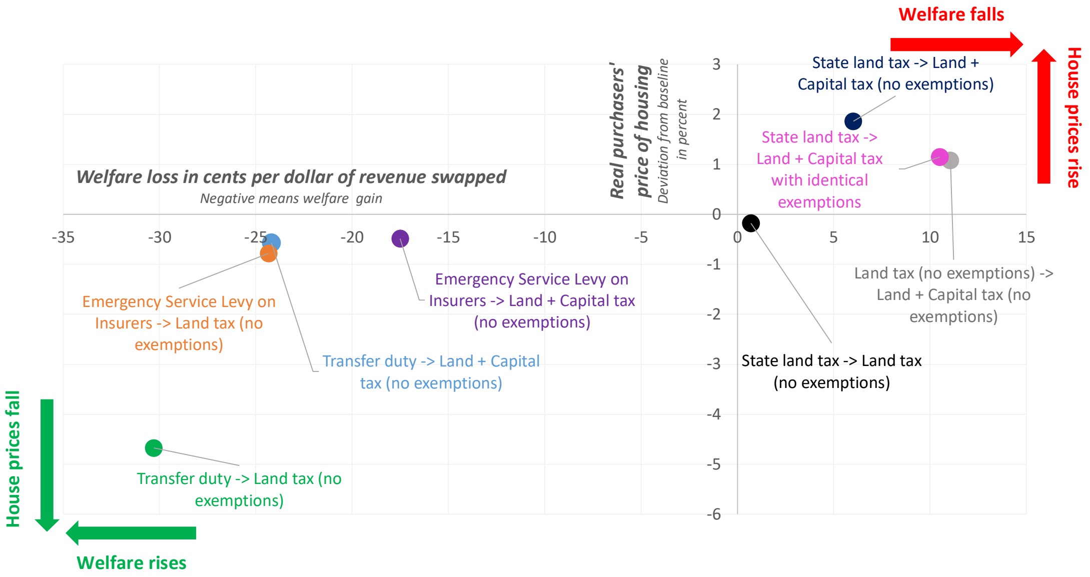


Figure 2: Scatterplot of the welfare loss (x-axis) and real average housing price response (y-axis) for eight pairwise changes in the property tax mix derived using VURMTAX. Mix swaps that simultaneously improve welfare and reduce housing prices inhabit the bottom left quadrant. Source: Nassios and Giesecke (2022a).

That is, they show that swapping TD with land tax not only generates a significant gain in economic efficiency, it also generates a material reduction in the average price of housing, including transfer duties payable upon purchase. While housing prices fall on average, important compositional effects are evident in the relative response between high- and low-density housing prices. Because high-density housing typically has much shorter holding periods than low-density housing, removing TD causes high-density housing prices to rise relative to low-density prices. This high-density housing price rise is not entirely offset by the land tax introduced in Nassios and Giesecke (2022a), because: (i) the tax introduced is imposed at a rate that is uniform across all housing types; and, (ii) high-density housing carries a lower land value share than low-density housing. It would be possible to lessen this upward pressure on apartment prices by imposing higher land taxes on higher density housing, an idea canvassed by Henry *et al.* (2010). Planning and zoning rules could also play a role.

Concluding remarks

To conclude, we make the following comments with regard to the terms of reference on which the Committee is basing its inquiry:

Impacts on labour and capital mobility: TD impedes labour mobility by imposing a significant tax on the process of transacting both existing and new property. As noted in Figure 1, in Victoria these taxes are levied at effective rates in excess of 200%. Regarding capital mobility, TDs on the purchase of new housing or non-residential property damp real investment activity, and thus carry deadweight costs. These costs are reflected in modelling by Nassios and Giesecke (2022a, b).

Revenue predictability: While CoPS modelling cited herein has not discussed this issue specifically, revenue predictability is best debated in relative terms, i.e., how predictable are revenues from TD relative to other potential sources of tax revenue? From Figure 2, of the property tax reforms studied by Nassios and Giesecke (2022a), replacement of TDs with broad-based land taxes drive the strongest welfare gains and real housing price reductions. Relative to broad-based land taxes, TD revenues are potentially more volatile because TD revenues are a function of two variables: market prices and transaction volumes. Land taxes, in contrast, are a function of land values that are only periodically revalued, rather than marked-to-market, and legislated land tax rates, both of which are largely insensitive to market conditions in the short-run.

Efficiency of resource allocation: The standard measure of tax efficiency is the marginal excess burden of taxation. As discussed by Nassios and Giesecke (2002b), at 76 cents per dollar of revenue raised, TDs are the least efficient of the taxes levied in Australia. Alternatives such as broad-based land taxes carry very low deadweight costs.

Effects on housing supply and development: While some new housing purchasers are exempt from paying TD (e.g., first home buyers that qualify for a first home buyer duty exemption or concession (FHBDECs) in Victoria do not pay the tax or pay a reduced rate) not all new housing transactions are exempt. The tax is therefore incident in part on new housing investment activity, and thus bears on housing supply.

Overall tax efficiency: As discussed, with a marginal excess burden of 76 cents per dollar of revenue raised, TD is the most distortionary of the state taxes. Nassios and Giesecke (2022b) consider whether the marginal excess burden of TD becomes comparable to other broad based national taxes, such as the Goods and Services Tax (GST) and personal income tax (PIT), if its rate is reduced to lower levels. The modelling examined a scenario of reducing TDs to one hundredth of their current rates – or from an average level of 4.5% to 0.045% – finding the economic cost was still 39 cents on the dollar. This remains much higher than the 25 cents in economic costs attributable to both the GST and PIT.

Potential alternatives to land transfer duty: Figure 2 is reproduced from Nassios and Giesecke (2002a), and outlines the welfare and real housing price implications for a series of property tax mix swaps. Swaps that simultaneously increase welfare and damp real housing prices inhabit the bottom left quadrant. From Figure 2, replacement of TD with a broad-based land tax drives both the largest welfare gain of approximately 31 cents per dollar of revenue swapped, and places the strongest downward pressure on average real housing prices. Within Australia, the ACT is the only jurisdiction to attempt a tax mix swap of this kind. Adams *et al.* (2020) quantified the economic consequences of this reform for the ACT between 2012 and 2018, and showed that benefits have materialised from both TD rate reductions and increases in land tax collections. In 2023, NSW implemented the First Home Buyer Choice scheme, which offered eligible first home buyers the option of paying TD or an annual land tax.

References

ACT Treasury (2012). *2012-12 Taxation Reform: 2012-13 Budget Paper No. 3.* Available at http://www.treasury.act.gov.au/budget/budget_2012/files/budgetpaper3/03_2taxationreform.pdf

Adams, P. D., J. Nassios and N. Sheard (2020). *The economic and efficiency impacts of altering elements of the ACT's tax mix*. Report to ACT Treasury, available at https://apps.treasury.act.gov.au/__data/assets/pdf_file/0009/1618407/cops-final-report.pdf

Bird, R. M., and E. Slack (2004). *International handbook of Land and Property Taxation*. Edward Elgar Publishing.

Cao, L., A. Hosking, M. Kouparitsas, D. Mullaly, X. Rimmer, Q. Shi, W. Stark and S. Wende (2015). *Understanding the economy-wide efficiency and incidence of major Australia taxes*. Treasury

Working Paper 2015-01. See https://treasury.gov.au/publication/understanding-the-economy-wide-efficiency-and-incidence-of-major-australian-taxes

Dagnall, H. (1994). *Creating a Good Impression: Three Hundred Years of the Stamp Office and Stamp Duties*. H. M. Stationary Office.

Davidoff, I., and A. Leigh (2013). *How do stamp duties affect the housing market?* Economic Record 89 (**286**), pp. 396–410. See

Fox, R., and R. Finlay (2012). *Dwelling prices and household income.* Reserve Bank of Australia Bulletin 2012 (**4**), pp. 13 – 22.

Freebairn, J. W. (2020). *Reform state taxes to Increase Productivity.* The Australian Economic Review 53(**4**), pp. 577 - 585. See https://onlinelibrary.wiley.com/doi/pdf/10.1111/1467-8462.12399

Henry K., J. Harmer, J. Piggott, H. Ridout and G. Smith (2010). *Australia's future tax system: Final Report.* May 2010 (Henry Tax Review), prepared for the Treasurer of the Commonwealth of Australia.

Malakellis, M. and M. Warlters (2020). *The economic costs of transfer duty: a literature review.* Treasury Technical Research Paper Series TTRP 21-08. Available at https://www.treasury.nsw.gov.au/sites/default/files/2021-06/the_economic_costs_of_transfer_duty_a_literature_review.pdf

Nassios, J., J. R. Madden, J. A. Giesecke, J. M. Dixon, N. H. Tran, P. B. Dixon, M. T. Rimmer, P. D. Adams, and J. W. Freebairn (2019a). *The economic impact and efficiency of state and federal taxes in Australia*. CoPS/IMPACT Working Paper no. G-289. Available at https://www.copsmodels.com/elecpapr/g-289.htm

Nassios, J., J. A. Giesecke, P. B. Dixon, and M. T. Rimmer (2019b). *Modelling the allocative efficiency of landowner taxation*. Economic Modelling 81, pp. 111 – 123. See https://doi.org/10.1016/j.econmod.2018.12.007

Nassios, J., and J. A. Giesecke (2022a). *Property Tax Reform: Implications for Housing Prices and Economic Productivity*. CoPS Working paper G-330. Available at https://www.copsmodels.com/ftp/workpapr/g-330.pdf

Nassios, J., and J. A. Giesecke (2022b). *Inefficient at Any Level: A Comparative Efficiency Argument for Complete Elimination of Property Transfer Duties and Insurance Taxes*. CoPS Working paper G-337. Available at https://www.copsmodels.com/ftp/workpapr/g-337.pdf

NSW Treasury (2018). *Interstate comparison of taxes 2017-18.* Available at https://www.treasury.nsw.gov.au/sites/default/files/2018-04/TRP18-01%20Interstate%20Comparison%20of%20Taxes%202017-18.pdf

Productivity Commission (2017). *Shifting the Dial: 5 Year Productivity Review.* Inquiry Report No. 84, report for the Australian Commonwealth Government. Available at https://www.pc.gov.au/inquiries/completed/productivity-review/report/productivity-review.pdf

Thodey, D., B. English, J. Anderson, A. Twomey, J. W. Freebairn, and J. Halton (2020). *NSW Review of Federal Financial Relations*. Final report, August. See https://www.treasury.nsw.gov.au/four-pillars/federal-financial-relations-review/federal-financial-relations-review-final-report

Thomas, M. and A. Hall (2016). *Housing affordability in Australia.* Parliamentary Library Briefing Book – 45th Parliament. August 2016. Available at https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/BriefingBook45p/HousingAffordability

Inefficient at Any Level: A Comparative Efficiency Argument for Complete Elimination of Property Transfer Duties and Insurance Taxes

CoPS Working Paper No. G-337, October 2022

Jason Nassios
And
James Giesecke
Centre of Policy Studies,
Victoria University

ISSN 1 921654 02 3

ISBN 978-1-921654-45-9

The Centre of Policy Studies (CoPS), incorporating the IMPACT project, is a research centre at Victoria University devoted to quantitative analysis of issues relevant to economic policy.
Address: Centre of Policy Studies, Victoria University, PO Box 14428, Melbourne, Victoria, 8001
home page: www.vu.edu.au/CoPS/ email: copsinfo@vu.edu.au Telephone +61 3 9919 1877

About us

Researchers at the Centre of Policy Studies have a 45-year history of continuous achievement in the development, application and dissemination of large-scale economic models. Our models and software are used around the world to analyse a diverse range of economic issues. CoPS' funders include: Australian federal and state government departments; private firms and universities in many parts of the world; central government agencies such as finance and trade ministries in many countries; and international development organisations. The Centre's GEMPACK software, used for solving large economic models, is used at more than 700 sites in over 95 countries.

Citation

Nassios, Jason and James Giesecke, (2022), “Inefficient at any level: A comparative efficiency argument for complete elimination of property transfer duties and insurance taxes” Centre of Policy Studies Working Paper No. G-337, Victoria University, October 2022.

Inefficient at any level: A comparative efficiency argument for complete elimination of property transfer duties and insurance taxes

Jason Nassios[1], James Giesecke[2]

Centre of Policy Studies

Victoria University

Abstract

Harberger (1962) coined the term excess burden to emphasise that taxes impose costs in addition to the revenue they collect. Reviews of Australia's tax system have used point estimates of the excess burden for a series of Australian taxes, among other measures, to motivate and prioritise the nation's reform agenda. In this paper we commence the work needed to elucidate what the optimal tax mix in Australia might look like under alternative revenue raising efforts, by studying how the excess burden of four Australian taxes change as we alter their tax-specific revenue-to-GDP ratios. This is achieved via simulation with a large-scale CGE model with high levels of tax-specific detail. We show that property transfer duties and insurance taxes are highly inefficient even at low levels, strengthening the case for their complete replacement with more efficient taxes.

JEL Codes: C68; E62; H2; H71; R38

Keywords: CGE modelling; Immovable property tax; Recurrent property tax; Insurance tax; Value added tax; Personal income tax; Excess burden

---

[1] Associate Professor, Centre of Policy Studies (Victoria University) and corresponding author. Email: Jason.Nassios@vu.edu.au

[2] Director and Professor, Centre of Policy Studies (Victoria University).

Contents

1. Introduction

Australia's Future Tax System Review [Henry *et al.* (2010)], commissioned in 2008 and published in 2010, set out 138 specific tax reform recommendations. At a high level, these emphasised concentration of revenue-raising across a series of efficient tax bases (personal income, business income, private consumption and economic rents), and the removal of other taxes that do not fall under these categories. Most of the taxes currently relied upon by Australia's states and territories as funding sources do not fall under either of the four efficient tax bases listed by Henry *et al.* (2010).

Previous studies of the relative efficiency costs of Australia's taxes have calculated point estimates of the marginal excess burden for each tax, i.e., marginal excess burden estimated at the tax's current revenue raising effort [Cao *et al.* (2015); Nassios *et al.* (2019a,b)] . However, comprehensive tax reform, and/or large changes in the overall revenue raising effort of the state and federal tax systems, could involve large changes in tax rates for particular taxes. To understand what a comprehensively efficient tax system might look like, and to understand which taxes should best take up additional revenue raising load as inefficient taxes are cut, we require estimates of marginal excess burden for each tax across wide potential revenue raising loads, not just point estimates. This would allow us to answer questions like: What is the systemically-efficient distribution of revenue raising effort across all tax types? Should some inefficient taxes be retained, but at much lower rates?

Both these questions require an understanding of how the excess burden, or welfare cost for a given tax, vary as tax rates/thresholds vary. However, Australia's tax system is complex: Henry *et al.* (2010) for example identified 125 distinct taxes levied across all levels of government in Australia. While deriving welfare cost curves for each of these 125 taxes is beyond the scope of this paper, we illustrate how tax-specific relationships between marginal excess burden and revenue raising effort can be derived using a bottom-up, multi-regional model of Australia's state and territory economies. Our focus is on four taxes in particular: (1) Personal income tax (PIT); (2) The Goods and Services Tax (GST); (3) Property transfer duties (TDs); and (4) Insurance duties (IDs). There are three reasons for studying these four tax instruments. First, personal income tax and the GST are broad-based, efficient taxes, which are often advanced as candidates for replacing narrow-based, inefficient state taxes [Henry *et al.* (2010)]. Point estimates of the marginal excess burden for these two taxes are typically in the range of 20c – 30c per dollar of revenue raised. Second, property transfer duties and insurance duties are often identified as good candidates for reform [Freebairn (2017; 2020a, b)]. They are narrow-based and point estimates of their excess burdens are typically high. Third, a popular reform proposal is for the federal government to assist the states in reducing their reliance on inefficient tax bases. One possibility would be to raise the personal income tax and/or the legislated GST rate, and increase grant payments to the states and territories to fund removal of inefficient state taxes.

For each of the four taxes, we study how its welfare cost, or marginal excess burden, changes as its tax rate varies. The model and process we use to derive these tax-specific marginal excess burden distribution functions is described in section 2. In section 3, we study the marginal excess burden distribution functions for the personal income tax, GST, property transfer duties and insurance duties. Using OLS, we fit polynomial functions to these curves; these functions enable readers to readily estimate the welfare cost (benefit) of increases (decreases) in tax-specific revenues, under an assumption of revenue neutrality. We use the curves to estimate the welfare gain from funding the elimination of two high-cost state taxes using two low-cost federal taxes. In section 4, we present concluding remarks.

2. Model and method

2.1. Model

The Victoria University Regional Model with Tax detail (VURMTAX) is an extension of the VURM computable general equilibrium (CGE) model described in Adams *et al.* (2015), carrying detailed modelling of local, state and federal taxes that distinguishes it from VURM. Herein, we use a two-region (NSW and the Rest of Australia), 86-industry aggregation of the core VURMTAX database. Investment in each regional industry is assumed to be positively related to expected rates of return on capital in each regional industry. VURMTAX recognises two investor classes: local investors (i.e. domestic households and government) and foreign investors. Effective tax rates on each investor class differ, with foreign investors not liable to pay Australian personal income tax on their capital income, while they are also unable to claim back Australian franking credits. Capital creators assemble, in a cost-minimizing manner, units of industry-specific capital for each regional industry. Each region has a single representative household and a state government. The federal government operates in each region. The foreign sector is described by export demand curves for the products of each region, and by supply curves for international imports to each region. Supply and demand for each regionally produced commodity is the outcome of optimising behaviour. Regional industries are assumed to use intermediate inputs, labour, capital and land in a cost-minimising way, while operating in competitive markets. Region-specific representative households purchase utility-maximising bundles of goods, subject to given prices and disposable income. Regions are linked via interregional trade, interregional migration and capital movements, and governments operate within a fiscal federal framework.

VURMTAX provides results for economic variables on a year-on-year basis. The results for a particular year are used to update the database for the commencement of the next year. More specifically, the model contains a series of equations that connect capital stocks to past-year capital stocks and net investment; see Dixon and Rimmer (2002). Similarly, debt is linked to past and present borrowing/saving, and the regional population is related to natural growth and international and interstate migration. The model is solved with the GEMPACK economic modelling software [Horridge *et al.* (2018)].

In sections 2.2 – 2.5, we briefly describe how each of the four taxes we study herein are modelled in VURMTAX. The marginal excess burden is then defined in section 2.6, where we also outline the process used to derive tax-specific marginal excess burden distribution functions.

2.2. Personal income tax (PIT)

While traditional CGE models distinguish federal taxes as indirect taxes and tariffs, or factor income taxes, e.g., capital taxes or labour taxes, VURMTAX models personal income tax (PIT) as a direct tax on labour, capital and land income that accrues to local residents. While we recognise that Australia's personal income tax system is progressive, in this paper we take VURMTAX's assumption of a representative household and model the personal income tax as a flat-rate tax on taxable household income. We do not capture impacts such as heterogeneous labour supply responses, e.g., due to differing labour supply elasticities across the income spectrum and by gender, interactions with the personal benefits system, or the progressive nature of the income tax rate scale. The marginal excess burden we derive herein is best described as a personal income levy, where the effective rate on all labour, capital and land income rises in a homogeneous way.

In section 2.2.1, we outline the tax base and means by which franking credits are accounted for in our modelling, before summarising the data, equation system and assumptions used to model Australia's personal income tax system in VURMTAX.

2.2.1. Modelling Australia's franking credit system

Australia's franking credit system was implemented in July 1987 to avoid double taxation of company profits paid out as dividends to Australian-resident investors in Australian-listed companies [Peirson *et al.* (2009)]. When resident shareholders receive a franked dividend from an Australian company, they are provided a tax credit by this company in addition to the dollar value of the dividend they receive. This credit reflects the fact that the company has already paid tax (at the company tax rate) on the profits from which the dividend has been paid, i.e., the dividend is paid out of post-Australian-company-tax profits. In receiving a fully-franked dividend, capital income received by Australian residents is effectively taxed at the personal income tax rate.

As discussed by Dixon and Nassios (2018a), dividend imputation systems are rare internationally: Australia, New Zealand, Chile and Mexico are the only OECD countries to operate a dividend imputation system. To model this system, we follow the approach in Dixon and Nassios (2018a), where capital ownership is distinguished along two dimensions:

1. By investor type: The domestic capital stock is either foreign-owned or locally-owned, with the industry-*i* and region-*q* capital stock's foreign ownership share defined as FORSHR(*i*,*q*). Income from locally-owned capital accrues to households. Where that capital is not personal income tax exempt, e.g., as is the case for owner-occupied dwellings, the income is subject to personal income tax.
2. By income type: Capital income is either franked or unfranked, with the share of franked dividends received by capital owner type $o \in \{Loc, Fgn\}$ defined as FSHARE(*o*). While FSHARE(*Fgn*) is non-zero (because foreign investors do own some shares that pay franked dividends), they are not permitted to claim back those franking credits in VURMTAX. This is accounted for via the parameter FCLAIM(*o*), which is zero for foreign investors. FCLAIM(*Loc*) and FSHARE(*o*) are then calibrated such that the ratio of franked dividends claimed by households relative to aggregate company tax collected is equal to 33 per cent, matching the average claim ratio in Australian Taxation Office statistics for over 2010-11 to 2013-14.

To permit franking credits attached to franked dividends paid by companies to local capital owners to be claimed by those owners, we apply the framework developed in Dixon and Nassios (2018a). This yields the following expression for personal income tax collections (PITTAX) in VURMTAX, in terms of the flat-rate personal income tax rate T_PIT:

$$\mathrm{PITTAX} = \mathrm{T\_PIT} \cdot \mathrm{PITBASE} - \mathrm{PI} \cdot \mathrm{FCRED}, \tag{1}$$

with the personal income tax base defined as PITBASE taking the following form:

$$\mathrm{PITBASE} = \mathrm{DEDPIT} \cdot \left(\mathrm{LABINC} + \mathrm{NOT\_RET} \cdot \mathrm{CAPINC} \cdot \left[1 - \mathrm{T\_CAP} \cdot \mathrm{DEDCIT} \right] + \mathrm{PI} \cdot \mathrm{FCRED} \right), \tag{2}$$

where FCRED is the aggregate dollar-value of franking credits claimed by households in their tax returns, defined as:

$$\mathrm{FCRED} = \mathrm{FCLAIM} \cdot \mathrm{FSHARE} \cdot \mathrm{T\_CAP} \cdot \mathrm{DEDCIT} \cdot \mathrm{CAPINC}, \tag{3}$$

and:

LABINC is labour income earned by households.

CAPINC	is personal income tax liable capital income earned by households. This includes, for example, income earned from rented low- and high-density housing, but excludes imputed owner-occupied housing rents. The public sector is also assumed to be personal income tax exempt.
T_CAP	is the effective tax rate on corporate income in Australia, i.e., the legal rate less allowable deductions;
PI	is the degree to which franking credits paid to households can be claimed back to offset personal income tax liabilities. This variable takes the default value of 1.
DEDPIT	is the impact of tax-free thresholds and tax deductions on the personal income tax base, calibrated to ensure the average tax rate T_PIT in the base-year (2016/17) equals the Australian average personal income tax rate set out in the Parliamentary Budget Office (2017) report of 23.9 per cent. This yields a value for DEDPIT of 82.7 per cent. Over the baseline forecast, we align T_PIT to forecasts provided by the Parliamentary Budget Office (2022) to 2033, with annual increases in T_PIT thereafter calibrated to match the average annual rate implied in the 2022 – 2033 forecast by Parliamentary Budget Office (2022).
DEDCIT	is the impact of interest expense deductibility on Australia's corporate income tax base. We calibrate the share of interest expense deductions claimed by industries in VURMTAX to the share Australian corporates claimed in ATO Taxation statistics, relative to corporate earnings before interest and tax (EBIT). This reduces the corporate income tax base in VURMTAX, relative to a base equal to aggregate capital income, by 36.6 per cent. Reflecting this, we set the value of DEDCIT to 0.634, which yields an economy-wide average company tax rate of 18.2 per cent that is of similar order to the US Congressional Budget Office (2017) estimate for Australia of 17.0 per cent.
NOT_RET	is the impact of retained corporate profits, which reduces personal income tax liabilities on corporate income earned by households. In VURMTAX, the share of retained profit is set to 20 per cent by setting NOT_RET equal to 0.8, which yields a payout ratio of 80 per cent that is similar to the economy-wide payout ratio in Australia in 2015 [Bergmann (2016)].

In this framework, pre-tax rates of return on capital in Australia are industry- and region-specific, but do not differ across capital owners, i.e., foreign investors and local investors own the same type of industry- and region-specific capital. Post-tax rates of return differ however: for local investors, the tax rate on capital income is set by the average personal income tax rate, after allowances are made for allowable deductions such as interest payments, and retained earnings (which are not taxed at the personal income tax rate herein). Foreign investors generally pay the corporate tax rate, less allowances for deductions and double taxation treaty concessions.

Together with VURMTAX's labour supply specification that follows the labour / leisure choice mechanism outlined in Giesecke *et al.* (2021), the equation system herein provides sufficient detail to study the impact of: (i) adjustment in the average rate of personal income tax in Australia, e.g., a proportional change in all marginal tax rates; (ii) changes in corporate interest deductibility; (iii) changes in foreign taxation treaty agreements; (iv) long-run trends in dividend payout ratios; and (v) partial (or complete) scale back in Australia's dividend imputation system, e.g., see Dixon and Nassios (2018b). The marginal excess burdens derived herein are effectively personal income levies; see point (i) above.

2.3. The Goods and Services Tax (GST)

Following Giesecke and Tran (2018) and Giesecke *et al.* (2021), our detailed VURMTAX GST model recognises: differentiated legislated tax rates across commodities; differentiated legislated GST exemption statuses across commodities; differentiated legislated capacities to reclaim GST paid on inputs to production and investment; differentiated rates of registration for GST purposes across industries; effective taxation of exports via application of GST on domestic purchases by non-residents; and, the potential for incomplete GST collections due to non-compliance. Because the GST model is embedded within the multi-regional framework of VURMTAX, it must also describe details of the legislated GST system as it relates to all commodities, from all sources, used by all agents in all regions. Consistent with the structure of VURMTAX, the agents in the GST theory comprise industries, capital creators, and final demanders. The regions comprise the eight states and territories. The sources comprise the eight domestic regions plus imports. For full details and a description of the equation system, see Giesecke and Tran (2018).

2.4. Insurance duties (IDs)

VURMTAX recognises five distinct levies/duties on contracts of insurance:

1. *General insurance duties.* The tax base is the insurance premium paid for each contract issued, and the tax rate is ad valorem. Life and health insurance contracts are general insurance duty exempt, while duties on compulsory third party insurance are carved out from general insurance duties and modelled distinctly (see below). General insurance duties are GST exempt, and hence fall outside the GST tax base.

2. *Life insurance levies.* The tax base is defined as the life insurance benefit payable per contract raised, and the tax rate is ad valorem. This differs from the approach for general insurance, where the tax base is the premium paid.

3. *The health insurance levy.* Most Australian jurisdictions treat health insurance as duty-exempt. However, in some states, e.g., NSW, a specific tax is levied as a fixed charge per customer, paid by any organisation that provides health insurance benefits.

4. *The Emergency Service Levy (ESL).* Two Australian states collect a levy on certain types of insurance contracts, in addition to the duties collected from general, life and health insurance. Notionally, this ESL is used to partially fund emergency service provision. The tax base is the insurance premium paid on various types of general property insurance, and the levy is GST-liable.

5. *Compulsory third party (CTP) insurance duties:* CTP motor vehicle insurance is mandatory in Australia, with premiums used to cover liabilities of all drivers for injury caused to passengers and other road users in an at-fault motor vehicle accident. While CTP insurance is compulsory, duties are also collected on CTP insurance premiums. Throughout Australia, CTP premiums and insurance duties are typically paid by road users with their annual motor vehicle registration charges. The duties are essentially lump sum taxes charged per vehicle. The resulting distortions to decision making are therefore similar to those caused by motor vehicle registration and weight taxes; see Nassios *et al.* (2019a) for a detailed description. Herein, we model CTP insurance duties as production taxes, largely collected from the private transport industry. In VURMTAX, the private transport industry uses inputs of capital [motor vehicles], motor vehicle repair services, fuel, and some motor vehicle parts, and sells its output (private transport service) exclusively to households. Some CTP tax load is also borne by industries intensive in road transport service delivery, i.e., it is levied upon trucks used by the road freight industry, and other industries maintaining commercial vehicle fleets.

To accommodate this diversity of insurance taxes, we model the demand for insurance in identical fashion to Nassios and Giesecke (2022). To summarise, we account for three types of insurance commodity, produced by a single insurance industry operating in each region. These three commodities are (i) health insurance; (ii) life insurance; and (iii) general insurance. Each commodity is differentiated by its sales structure, price elasticity of demand, and any incident duties/taxes. In calibrating VURMTAX, significant effort was made to ensure sales tax rates reflect APRA Quarterly Performance Statistics for General, Life and Health Insurers, and that price elasticities of demand conform to academic assessments of insurance demand elasticities.[3] For a full discussion of this parameterisation, we refer the reader to Nassios *et al.* (2019a).

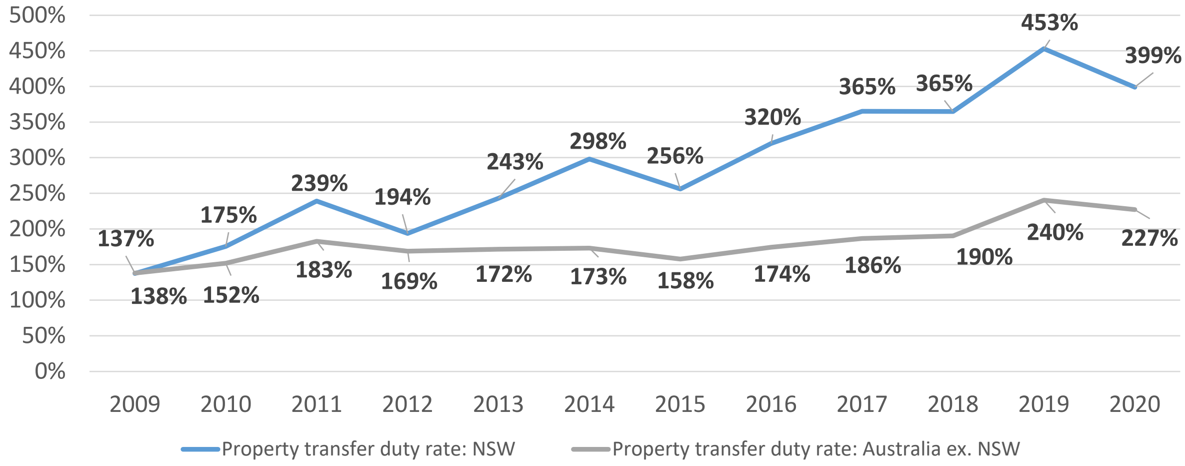
---

[3] In order to set the elasticity of demand for insurance, we reviewed a survey by Hao *et al.* (2018). For Health insurance, the household expenditure elasticity in VURMTAX is calibrated to yield a price of demand equal to

2.5. Property transfer duties (TDs)

Stamp duty on property conveyancing applies to the transfer of ownership of most properties, with the duty base being the value of the property purchased. In all Australian states, a progressive rate schedule is employed. While the tax base for conveyancing duty is the value of the property, the economic incidence falls on the process of property transfer. The value of the resources used in transferring property ownership is usually only a fraction of the property price. This is highlighted in Figure 1, which plots ABS cat. no. 5220 data on ownership transfer costs (before taxes) relative to property transfer duty collections from ABS cat. no. 5506 in NSW and the rest of Australia. The sharp rise in conveyancing duty rates in NSW relative to the RoA depicted in Figure 1 is reflective of the sharp rise in NSW property prices, relative to the price of the goods households and industries consume to transfer their properties.

Figure 1: Ad valorem equivalent of transfer duty taxes on ownership transfer costs in NSW and the rest of Australia (RoA).



---

the mid-point of the range outlined by Butler (1999) for the Australian health insurance market. For life insurance, we use a similar approach and rely on estimates of the price elasticity of demand for term life insurance by Viswanathan *et al.* (2006). For emergency service levy liable general insurance, e.g., house and contents insurance for households, we calibrate the price elasticity of demand in VURMTAX using the elasticity with respect to (w.r.t) tax of -1.34 estimated by Tooth (2015) for Australia. In order to convert the elasticity w.r.t tax to a price elasticity of demand, we first calculate the pre- and post-tax loading for Type A general insurance in NSW using the approach in Nassios *et al.* (2019a). On a pre-tax basis, the loading is equal to 1 / 0.586 – 1 = 70.65%, i.e., the pre-tax cost of Type A general insurance in NSW was 70.65% higher than expected claims in 2015/16. On a post-tax basis, this becomes 1.09 / 0.586 – 1 = 86.01%, which is an increase of 21.7% from a tax on premiums of 9% (roughly 2.4 times the size of the tax). The price elasticity of demand can be related to the elasticity w.r.t tax by -1.34 / 2.4 = -0.56, which is the calibrated price elasticity of demand for ESL-liable general insurance demanded by households in VURMTAX. While some ESL load falls on industries, we retain the usual Leontief demand structure by industries for intermediate inputs to production that underpins VURM and VURMTAX [see Adams *et al.* (2015)].

Herein, we model property transfer duty using the approach described by Nassios and Giesecke (2022), identifying four channels via which transfer duties affect the real economy:

1. *Transfer duties on existing housing*. These duties fall on household purchases of services that facilitate the transfer of ownership of housing (viz. building inspection services, real estate agent services, legal conveyancing services, and public administration). The resulting indirect tax rates are large, as denoted in Figure 1 herein.
2. *Transfer duties on new housing*. These duties fall on investors installing new units of housing capital. In VURMTAX, these duties are paid by households, with the housing sector overwhelmingly domestically-owned.
3. *Transfer duties on existing commercial, industrial and agricultural properties*. Similar to channel 1 above, duties are liable when transferring ownership of non-residential property. Herein, these duties are incident on the services purchased to facilitate the transfer of ownership.
4. *Transfer duties on new commercial, industrial and agricultural properties*. These duties fall on local and foreign investors installing new units of non-residential capital.

In order to model channel 1, four new commodities are introduced to the model. These commodities reflect the real estate, legal (conveyancing), public administration and property inspection/engineering services households and industries purchase in order to facilitate the transfer of property. We then introduce a service bundle in the linear expenditure system governing the households' consumption decisions in VURMTAX, called *Moving services*. *Moving services* is a Leontief aggregate of the four aforementioned commodities. Sales taxes on this bundle of goods are linked to property transfer duty revenue from existing residential property sales, which are set according to a progressive rate schedule using the approach in Nassios and Giesecke (2022). Channel 2 is modelled via the introduction of production taxes on the formation of new units of dwelling capital.

To account for channel 3, we introduce the *Moving services* Leontief bundle into the intermediate input mix of industries in VURMTAX. Demand for this bundle is proportional to industry output levels. In VURMTAX, changes in conveyancing duty on non-residential property thus enter into industry production costs, which has general equilibrium consequences for regional employment, investment, GSP and so forth. Finally, channel 4 is modelled in a similar way to channel 2, with production taxes imposed on new non-residential capital investment.

In this paper, the marginal excess burdens for transfer duties we report are derived from simulations where the duty rates for each of channels 1 – 4 are adjusted by uniform percentage amounts, in each region the duties are collected.

2.6. Deriving marginal excess burdens in VURMTAX

In this paper, we follow the approach by Nassios *et al.* (2019a; 2019b), Adams et al. (2020) and Nassios and Giesecke (2022), by deriving tax-specific marginal excess burdens (MEBs) using VURMTAX. Because VURMTAX is dynamic, it can calculate year-on-year marginal excess burden measures. More specifically, we evaluate the efficiency loss caused by an adjustment to tax instrument *k*, where $k \in \left[\mathrm{PIT}, \mathrm{GST}, \mathrm{TD}, \mathrm{ID}\right]$, at time-period *t* at the national (Australia-wide) level (denoted $\mathrm{MEB}_{\mathrm{k}}^{\mathrm{t}}$) according to:

$$\mathrm{MEB}_{\mathrm{k}}^{\mathrm{t}} = -100\left[\frac{\Delta \mathrm{GNI}^{\mathrm{t}} + \sum_{\mathrm{q}} \mathrm{VLEIS}_{\mathrm{q}}^{\mathrm{t}}}{\sum_{\mathrm{g}} \Delta \mathrm{LST}_{\mathrm{g}}^{\mathrm{t}}}\right], \tag{4}$$

where:

$\Delta \mathrm{GNI}^{\mathrm{t}}$ is the deviation between the year *t* counterfactual and BAU forecast value of real gross national income (deflated by a gross national expenditure (GNE) divisia price index and measured in A$m);

$\Delta \mathrm{VLEIS}_{\mathrm{q}}^{\mathrm{t}}$ is the deviation in the value of leisure time consumed by residents in region *q* in year *t*, valued at the BAU forecast real consumer wage rate [see Nassios et al. (2019a; 2019b) for a description];

$\Delta \mathrm{LST}_{\mathrm{g}}^{\mathrm{t}}$ is the value of budget-balance neutralising lump sum payments to households by government agent *g*, i.e., the NSW and RoA state/local government agent, or the Federal government.

With underlying databases reflective of current tax loads by user, and parameter specifications that accurately capture decision making sensitivities to tax policy changes, CGE models are well-suited to deriving MEBs for the current tax system. This is demonstrated by Nassios *et al.* (2019a; 2019b), Adams *et al.* (2020), Giesecke *et al.* (2021), and Nassios and Giesecke (2022), in which MEBs for thirty-seven Australian taxes are derived via equation (4) using counterfactual scenarios where small reductions or increases in tax-specific revenue typically worth A$100m are simulated, under the assumption of a balanced government budget. The resulting MEB yields a point estimate of the deadweight cost of a marginal adjustment in tax-specific revenue, at the current tax-specific revenue-to-GDP ratio.

As discussed by Harberger (1962) and more recently by Creedy (2003) however, the MEB of a tax is an increasing function of its tax rate. When studying revenue-neutral adjustments to a given tax mix, i.e., swapping revenue of one tax for that of another, the aim is to propose a redesigned tax mix that is less distortionary than the current one, i.e., one that carries a lower excess burden. This requires an understanding not only of the current MEBs of all taxes, but also how sensitive each of these MEBs are to changes in tax rates or a relevant proxy (such as tax-specific revenue-to-GDP ratios).

In this paper, we define the relationship between the MEB of a given tax and its revenue-to-GDP ratio as the MEB distribution function. We use VURMTAX to illustrate how a series of counterfactual scenarios simulated using a CGE model can be used to derive MEB distribution functions. Our computationally-intensive approach is presented via example for four Australian taxes. For each tax, we perform a series of twenty-three counterfactual simulations where we derive results for $\Delta\mathrm{GNI}^{2040}$, $\Delta\mathrm{VLEIS}_{\mathrm{q}}^{2040}$ and $\Delta\mathrm{LST}_{\mathrm{g}}^{\mathrm{t}}$ for all $q \in [\mathrm{NSW},\mathrm{RoA}]$ and $g \in [\mathrm{NSW},\mathrm{RoA},\mathrm{Federal}]$, across the four taxes *k* we described in section 2.2 – 2.5, i.e., $k \in [\mathrm{PIT},\mathrm{GST},\mathrm{TD},\mathrm{ID}]$. For each *k,* the twenty-three simulations allow us to study how $\Delta\mathrm{GNI}^{2040}$, $\Delta\mathrm{VLEIS}_{\mathrm{q}}^{2040}$, and $\Delta\mathrm{LST}_{\mathrm{g}}^{\mathrm{t}}$ vary across the range $\left[0.01T_{\mathrm{k}}^{\mathrm{base}}, T_{\mathrm{k}}^{\mathrm{base}}, 1.99T_{\mathrm{k}}^{\mathrm{base}}\right]$, where $T_{\mathrm{k}}^{\mathrm{base}}$ is the baseline forecast level of the tax rate for tax type *k*. We can define the sample range more simply as:

$$a_{\mathrm{i}} \cdot T_{\mathrm{k}}^{\mathrm{initial}}, \qquad \text{where } i \in \{1,2,3,\ldots,23\},\ a_1 = 0.01, \text{ and } a_{\mathrm{n}+1} = a_{\mathrm{n}} + 0.09. \qquad \mathbf{(5)}$$

The MEB distribution function $\mathrm{MEB}_{\mathrm{k}}^{\mathrm{t}}\left(a_{\mathrm{i}} \cdot T_{\mathrm{k}}^{\mathrm{initial}}\right)$, is then defined as:

$$\mathrm{MEB}_{\mathrm{k}}^{\mathrm{t}}\left(a_{\mathrm{i}}\cdot T_{\mathrm{k}}^{\mathrm{initial}}\right)=-100\begin{cases}\left[\dfrac{\left(\Delta\mathrm{GNI}_{\mathrm{i}}^{\mathrm{t}}-\Delta\mathrm{GNI}_{\mathrm{i+1}}^{\mathrm{t}}\right)+\sum\limits_{\mathrm{q}}\left(\mathrm{VLEIS}_{\mathrm{q,i}}^{\mathrm{t}}-\mathrm{VLEIS}_{\mathrm{q,i+1}}^{\mathrm{t}}\right)}{\sum\limits_{\mathrm{g}}\left(\Delta\mathrm{LST}_{\mathrm{g,i}}^{\mathrm{t}}-\Delta\mathrm{LST}_{\mathrm{g,i+1}}^{\mathrm{t}}\right)}\right] & \mathrm{a}_{\mathrm{i}}<1\\ \left[\dfrac{\Delta\mathrm{GNI}_{\mathrm{i}}^{\mathrm{t}}+\sum\limits_{\mathrm{q}}\mathrm{VLEIS}_{\mathrm{q,i}}^{\mathrm{t}}}{\sum\limits_{\mathrm{g}}\Delta\mathrm{LST}_{\mathrm{g,i}}^{\mathrm{t}}}\right] & \mathrm{a}_{\mathrm{i}}=1\ .\\ \left[\dfrac{\left(\Delta\mathrm{GNI}_{\mathrm{i+1}}^{\mathrm{t}}-\Delta\mathrm{GNI}_{\mathrm{i}}^{\mathrm{t}}\right)+\sum\limits_{\mathrm{q}}\left(\mathrm{VLEIS}_{\mathrm{q,i+1}}^{\mathrm{t}}-\mathrm{VLEIS}_{\mathrm{q,i}}^{\mathrm{t}}\right)}{\sum\limits_{\mathrm{g}}\left(\Delta\mathrm{LST}_{\mathrm{g,i+1}}^{\mathrm{t}}-\Delta\mathrm{LST}_{\mathrm{g,i}}^{\mathrm{t}}\right)}\right] & \mathrm{a}_{\mathrm{i}}>1\end{cases}\qquad\textbf{(6)}$$

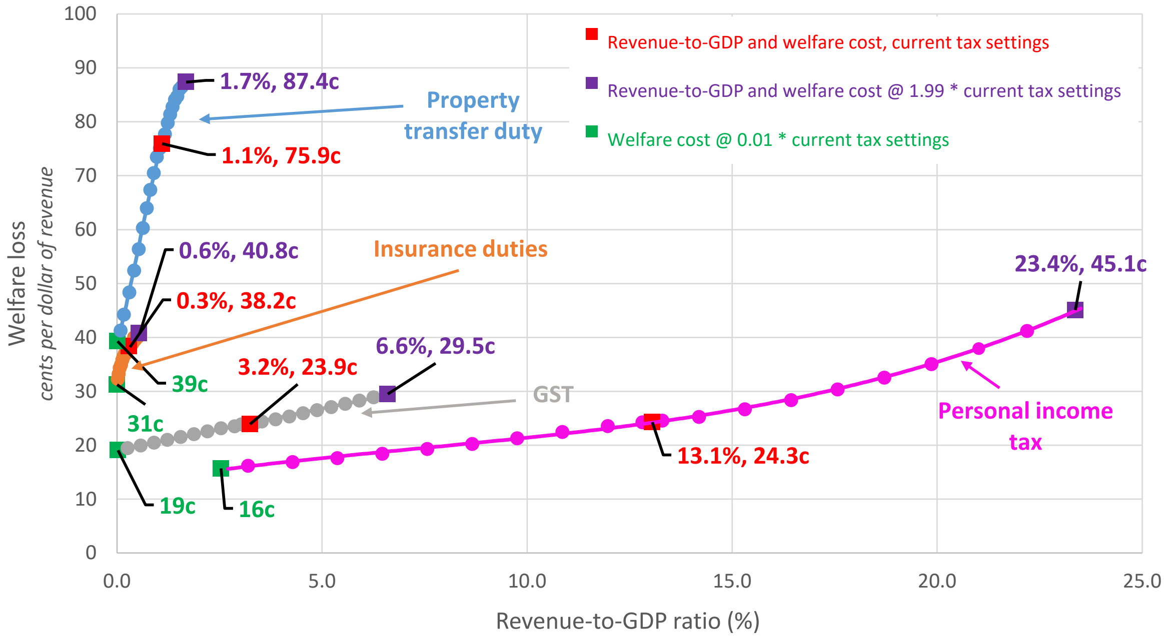
Because the tax bases for each tax we study differ significantly, plotting the MEB distribution functions against tax rates is inappropriate. Instead, plotting MEBs against tax-specific revenue-to-GDP ratios for each tax allow us to compare MEB distribution functions across taxes. At each $a_{\mathrm{i}}\cdot T_{\mathrm{k}}^{\mathrm{initial}}$ for $i\in\{1,2,3,\ldots,23\}$ and each $k\in[\mathrm{PIT},\mathrm{GST},\mathrm{TD},\mathrm{ID}]$, we therefore also report the tax-specific revenue-to-GDP ratio from VURMTAX. Reporting results in this way also facilitates use of the curves for tax-mix swap analysis.

3. Results

The results of the ninety-two simulations we perform yield the MEB distribution functions $\mathrm{MEB}_{\mathrm{k}}^{2040}\left(a_{\mathrm{i}}\cdot T_{\mathrm{k}}^{\mathrm{initial}}\right)$ in Figure 2. Along the vertical axis in Figure 2, we plot $\mathrm{MEB}_{\mathrm{k}}^{2040}\left(a_{\mathrm{i}}\cdot T_{\mathrm{k}}^{\mathrm{initial}}\right)$ for all $i\in\{1,2,3,\ldots,23\}$, measured in cents per dollar of revenue raised.

In the upper left of Figure 2, the blue and orange lines sketch the MEB distribution functions for property transfer and insurance duties, respectively. The narrow-base of each tax is evident in the high and steep MEB gradients exhibited in Figure 2, certainly relative to the broader-based GST (grey circles) and personal income tax (magenta circles). The current MEB and revenue-to-GDP ratio for each tax are highlighted in red squares and text in Figure 2, with property transfer duties carrying the largest current MEB (75.9 cents per dollar). Interestingly, despite different ratios of revenue-to-GDP, the GST and personal income tax exhibit similar MEBs of approximately 24 cents per dollar, indicating that policy makers have arrived at about the right mix of GST (3.2% revenue-to-GDP) and personal income tax (13.1% revenue-to-GDP) in Australia. The green squares marked on the TD (39 cents per dollar) and ID (31 cents per dollar) curves are the MEBs for each tax at very low revenue raising capacity, i.e., when each tax is levied at a rate that is 1 percent of its current rate. Despite very low revenue raising capacity at these tax rates, the MEBs exceed the current MEBs (red squares) for both the GST and PIT. In order to justify raising small amounts of ID revenue, the revenue-to-GDP ratio of the GST would have to be twice as large (see the purple squares in Figure 2 which, for the GST, show its MEB to be 29.5 cents at 6.6 percent revenue-to-GDP, a level that nevertheless still lies below the lower bound MEB for ID of 31 cents), while PIT revenue shares would also need to increase by at least 3 percentage points of GDP, from 13.1 percent to about 16 percent. The case for raising even small amounts of TD revenue are weaker still: the GST revenue share would need to be well in excess of 10 percent of GDP, while the PIT revenue share would need to be about 21 percent of GDP. TDs and IDs could therefore only be justified in Australia's tax mix under public finance scenarios in which the aggregate tax take represented a much higher share of GDP than at present.

Figure 2: Marginal excess burdens at different revenue raising efforts



Notes: Marginal excess burden (y-axis) relative to the ratio of revenue-to-GDP (x-axis) for insurance duties (orange circles), property transfer duties (blue circles), the GST (grey circles) and personal income tax (magenta circles) in Australia, derived using VURMTAX. Lines represent the plots of the functions in equation (7) and are colour-coded to match the aforementioned tax instruments.

With the data points underpinning the plots in Figure 2 in hand, we use Ordinary Least Squares (OLS) to derive lines of best fit for each $k \in [\text{PIT}, \text{GST}, \text{TD}, \text{ID}]$.[4] We assessed a variety of polynomial functional relationships between $\text{MEB}_{\text{k}}^{2040}\left(a_{\text{i}} \cdot T_{\text{k}}^{\text{initial}}\right)$ and the revenue-to-GDP ratio (R2GDP henceforth) for each $k \in [\text{PIT}, \text{GST}, \text{TD}, \text{ID}]$. In each case, we perform a series of F-tests of overall

---

[4] An alternative approach would be to interpolate the data points derived from VURMTAX simulations, e.g., using cubic splines. Our OLS regressions exhibit small standard errors, adjusted R-squared coefficients close to 1, and F-test *p*-values very close to zero. The resulting formulae are also more readily applied by readers. We therefore felt the use of cubic spline interpolation was not necessary.

significance and report results for the model that exhibited the smallest *p*-value for each tax *k* in equation (7):

$$\mathrm{MEB}_{\mathrm{GST}}^{2040}\left(\mathrm{R2GDP}\right)=19.1^{***}+1.55^{***}\,\mathrm{R2GDP}, \tag{7a}$$

$$\mathrm{MEB}_{\mathrm{PIT}}^{2040}\left(\mathrm{R2GDP}\right)=12.6^{***}+1.30^{***}\,\mathrm{R2GDP}-0.076^{***}\,\mathrm{R2GDP}^{2}+0.0034^{***}\,\mathrm{R2GDP}^{3}, \tag{7b}$$

$$\mathrm{MEB}_{\mathrm{ID}}^{2040}\left(\mathrm{R2GDP}\right)=31.5^{***}+43.6^{***}\,\mathrm{R2GDP}-91.7^{***}\,\mathrm{R2GDP}^{2}+78.6^{***}\,\mathrm{R2GDP}^{3}, \tag{7c}$$

$$\mathrm{MEB}_{\mathrm{TD}}^{2040}\left(\mathrm{R2GDP}\right)=38.7^{***}+29.6^{***}\,\mathrm{R2GDP}+13.1^{***}\,\mathrm{R2GDP}^{2}-8.05^{***}\,\mathrm{R2GDP}^{3}. \tag{7d}$$

Every coefficient reported in equation (7) was significant at the 99% confidence level (as denoted by the superscript asterisks "***"), while each model in equation (7) exhibited an adjusted-R^2 in excess of 99 percent. We plot each model in equation (7) in Figure 2 as coloured lines, to facilitate a direct comparison of equation (7) and the simulated outputs from VURMTAX. For example, equation (7b) is represented in Figure 2 by the magenta line. This line clearly demonstrates excellent agreement with each of the magenta circles that represent the CGE-simulated personal income tax MEB distribution function, providing a visual cue that (7b) is a good fit. The plots for equations (7a) [GST, grey line], (7c) [ID, orange line] and (7d) [TD, blue line] demonstrate similarly good agreement with VURMTAX outputs in Figure 2.

While implicitly based on CGE model simulation outputs, the formulae in equation (7) facilitate rapid assessment of the welfare implications of revenue-neutral tax-mix changes, as we now demonstrate. First, evaluating equations (7c) and (7d) at R2GDP =0, we see that the MEBs for insurance duties (31 cents per dollar) and property transfer duties (39 cents per dollar) exceed the current MEBs for both the GST and personal income tax (24 cents per dollar, red squares in Figure 2). This does not directly imply replacement of either (or both) state tax with an increase in GST or PIT collections to be optimal, however, because lifting the rate of the GST and PIT will increase their MEBs. Using equation (7a), we can assess the degree to which the MEB of the GST will increase if it is used to replace both state taxes, whose collections are worth about 1.4 percent of GDP annually by 2040. The target revenue-to-GDP ratio for the GST in 2040 under full replacement, i.e., TD and ID -> GST, is R2GDP = 3.2+1.4 = 4.6 percent; substituting this into the right-hand-side of equation (7a) yields $\mathrm{MEB}_{\mathrm{GST}}^{2040}=26.2$ cents per dollar, a rise relative to the current MEB of about 2.3 cents per dollar. Importantly, this remains well below the zero-rate MEBs for both insurance duties (31 cents per dollar) and transfer duties (39 cents per dollar). Property transfer and insurance duties are thus inefficient at any level, relative to a system where the GST rate is raised by a sufficient amount to leave economy-wide tax revenues unchanged. Welfare can be improved if both are eliminated entirely and replaced via a rise in the GST rate.

Can the welfare improvement be amplified if revenue is replaced with a rise in the average personal income tax rate, instead of a rise in the GST rate? To assess this, we follow a similar process only using equation (7b). The target level for revenue-to-GDP for the personal income tax under full replacement is R2GDP = 13.1+1.4 = 14.5 percent, and substituting this into the right-hand-side of equation (6b) yields $\mathrm{MEB}_{\mathrm{PIT}}^{2040} = 25.7$ cents per dollar, a rise of 1.4 cents per dollar relative to the current level. This 1.4 cent per dollar rise in $\mathrm{MEB}_{\mathrm{PIT}}^{2040}$ is smaller than the 2.3 cent per dollar rise in $\mathrm{MEB}_{\mathrm{GST}}^{2040}$ calculated from an identical 1.4 percent rise in revenue-to-GDP. On economic efficiency grounds, replacement of property transfer and insurance duties with a rise in the average personal income tax rate yields a greater uplift in welfare than replacement of both state taxes with a rise in the GST rate.

Because the PIT and GST currently exhibit similar MEBs, at around 24 cents, a rise in revenue-to-GDP of one of these taxes will push its MEB above that of the other tax. For example, if both state taxes are replaced by the PIT, its MEB will rise to 25.7 cents per dollar, which would then exceed that of the GST. We can thus go one step further, and use equation (7) to determine a reform package where the 1.4 percent of additional revenue-to-GDP required to fully replace both state taxes is distributed across the GST and PIT in such a way that the final MEBs of each tax are equal. In what follows, we illustrate how equations (7a) and (7b) can be solved for these shares. Let *A* be the increase in revenue-to-GDP for the GST, with *B* the corresponding uplift in PIT revenue-to-GDP. The sum of these quantities is equal to 1.4, which is the revenue-to-GDP ratio for both state taxes we seek to replace:

$$1.4 = A + B. \qquad \textbf{(8)}$$

To solve for *A* and *B* we set R2GDP for the PIT in equation (7b) to 13.1+*B,* and R2GDP for the GST in equation (7a) equal to 3.2+*A*. Because we seek solutions for *A* and *B* that yield $\mathrm{MEB}_{\mathrm{PIT}}^{2040} = \mathrm{MEB}_{\mathrm{GST}}^{2040}$, we set equations (7a) and (7b) equal to one another and solve them simultaneously under the constraint in equation (8). We find the $\mathrm{MEB}_{\mathrm{PIT}}^{2040} = 25 = \mathrm{MEB}_{\mathrm{GST}}^{2040}$ when $A = 0.65$ and $B = 0.72$, i.e., the MEBs are equal under the reform package when 48% (=0.65/1.4) of the foregone state tax revenue is replaced via a rise in the GST rate, and the remaining 52% is replaced via an increase in the average PIT rate.

With equation (7) in place, we have the capacity to explore changes to the tax system that equalise MEBs across a suite of taxes. However, as we now demonstrate, a change in the independent variable can enhance the efficacy of our approach. In place of R2GDP, i.e., the ratio of tax-specific revenue to GDP in 2040, as the independent variable, in what follows we set the independent variable in all regressions to the denominator in the $\mathrm{MEB}_{\mathrm{k}}^{2040}\left(a_{\mathrm{i}}\cdot T_{\mathrm{k}}^{\mathrm{initial}}\right)$ from equation (6), which is the deviation in the real national budget-neutralising lump sum tax on households in A$m. Why? Doing so allows us to calculate definite integrals of our regression equations, and interpret the results of those definite integrals as real welfare (in A$m in 2040) responses to tax policy changes. With the dependent variable remaining unchanged, i.e., $\mathrm{MEB}_{\mathrm{k}}^{2040}\left(a_{\mathrm{i}}\cdot T_{\mathrm{k}}^{\mathrm{initial}}\right)$ is the dependent variable, we re-run our OLS regressions, yielding the following set of OLS outputs:

$$\mathrm{MEB}_{\mathrm{GST}}^{2040}\left(\mathrm{LST}\right)=24.1^{***}+4.34\times10^{-5\,***}\,\mathrm{LST}+4.37\times10^{-16\,***}\,\mathrm{LST}^{2}, \tag{9a}$$

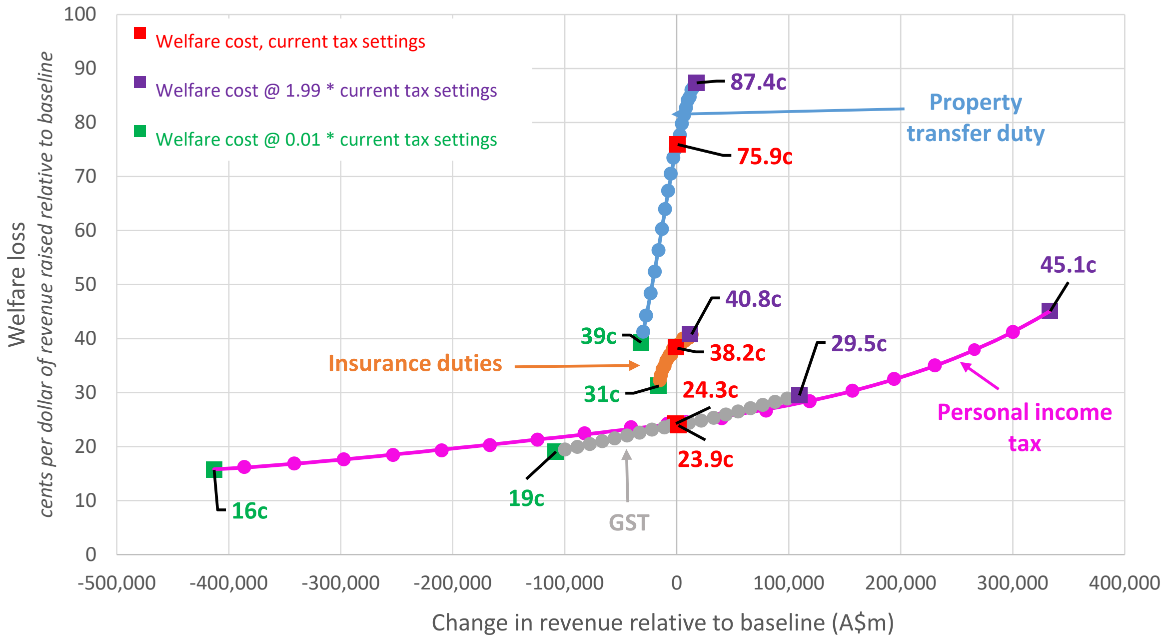
$$\mathrm{MEB}_{\mathrm{PIT}}^{2040}\left(\mathrm{LST}\right)=24.3^{***}+2.78\times10^{-5\,***}\,\mathrm{LST}+4.04\times10^{-11\,***}\,\mathrm{LST}^{2}+1.3\times10^{-16\,***}\,\mathrm{LST}^{3}+1.78\times10^{-22\,***}\,\mathrm{LST}^{4}, \tag{9b}$$

$$\mathrm{MEB}_{\mathrm{ID}}^{2040}\left(\mathrm{LST}\right)=31.5^{***}+1.85\times10^{-4\,***}\,\mathrm{LST}-7.2\times10^{-9\,***}\,\mathrm{LST}^{2}+5.35\times10^{-13\,***}\,\mathrm{LST}^{3}, \tag{9c}$$

$$\mathrm{MEB}_{\mathrm{TD}}^{2040}\left(\mathrm{LST}\right)=75.6^{***}+1.02\times10^{-3\,***}\,\mathrm{LST}-1.4\times10^{-8\,***}\,\mathrm{LST}^{2}-3.3\times10^{-13\,***}\,\mathrm{LST}^{3}. \tag{9d}$$

Equation (9) is similar to equation (7), however the intercept is now $\mathrm{MEB}_{\mathrm{k}}^{2040}\left(T_{\mathrm{k}}^{\mathrm{initial}}\right)$ whereas in equation (7), the intercept was equal to $\mathrm{MEB}_{\mathrm{k}}^{2040}\left(0.01\cdot T_{\mathrm{k}}^{\mathrm{initial}}\right)$. The coefficients in equation (9) are also several orders of magnitude smaller than those in equation (7), because the independent variable is measured in A$m rather than per cent. Nevertheless, the plots of equation (9) show similarly good agreement with modelled results from VURMTAX; see Figure 3, where we plot simulated outputs and equation (9).

Figure 3: Marginal excess burdens at different levels of budget-neutralising lump sum transfer levels



Notes: Marginal excess burden (y-axis) relative to the denominator in the marginal excess burden formula, the A$m deviation in the national public sector budget position from the baseline (x-axis). We include plots for insurance duties (orange circles), property transfer duties (blue circles), the GST (grey circles) and personal income tax (magenta circles) in Australia, derived using VURMTAX. Lines represent plots of the functions in equation (9) and are colour-coded to match the aforementioned tax instruments.

Like we showed for equation (7), equation (9) can also be solved for the GST and PIT tax mix that equalises the two tax-specific MEBs, and raises enough revenue to replace both IDs and TDs. Doing so yields revenue shares that match those derived from equation (7), i.e., 48% GST and 52% PIT. For brevity, we do not repeat this process here. Because the explanatory variable is equal to the denominator of the dependent variable in equation (9), we can calculate $\Delta\mathrm{WELF}_{\mathrm{k}}^{2040}$, the change in real welfare in 2040 (in A$m) caused by a change in the rate of tax instrument $k \in [\mathrm{PIT}, \mathrm{GST}, \mathrm{TD}, \mathrm{ID}]$, by evaluating the definite integral of equation (9). The integration interval is $\left[0, \mathrm{LST}_{\mathrm{k}}^{\mathrm{TARG},2040}\right]$, where $\mathrm{LST}_{\mathrm{k}}^{\mathrm{TARG},2040}$ is the change in the national public sector budget position relative to baseline, when the rate of a tax instrument $k \in [\mathrm{PIT}, \mathrm{GST}, \mathrm{TD}, \mathrm{ID}]$ is altered relative to its BAU forecast level. See equation (10), where we define $\Delta\mathrm{WELF}_{\mathrm{k}}^{2040}$ algebraically:

$$\Delta\mathrm{WELF}_{\mathrm{k}}^{2040}\left(\mathrm{LST}_{\mathrm{k}}^{\mathrm{TARG},2040}\right) = \frac{1}{100} \cdot \int_{\mathrm{LST}_{\mathrm{k}}^{\mathrm{TARG},2040}}^{0} \mathrm{MEB}_{\mathrm{k}}^{2040}\left(\mathrm{LST}\right) \; d\mathrm{LST}, \qquad \mathbf{(10)}$$

where the factor of 1/100 in equation (10) accounts for the units of the MEB (cents per dollar of LST). Substituting equation (9) into (10) then yields the set of welfare functions reported in equation (11):

$$\Delta \mathrm{WELF}_{\mathrm{GST}}^{2040}\left(\mathrm{LST}_{\mathrm{GST}}^{\mathrm{TARG},2040}\right)=24.1\left(\mathrm{LST}_{\mathrm{GST}}^{\mathrm{TARG},2040}\right)+\frac{4.34\times10^{-5}}{2}\left(\mathrm{LST}_{\mathrm{GST}}^{\mathrm{TARG},2040}\right)^{2}+\frac{4.37\times10^{-16}}{3}\left(\mathrm{LST}_{\mathrm{GST}}^{\mathrm{TARG},2040}\right)^{3}, \quad \textbf{(11a)}$$

$$\Delta \mathrm{WELF}_{\mathrm{PIT}}^{2040}\left(\mathrm{LST}_{\mathrm{PIT}}^{\mathrm{TARG},2040}\right)=24.3\left(\mathrm{LST}_{\mathrm{PIT}}^{\mathrm{TARG},2040}\right)+\frac{2.78\times10^{-5}}{2}\left(\mathrm{LST}_{\mathrm{PIT}}^{\mathrm{TARG},2040}\right)^{2}+\frac{4.04\times10^{-11}}{3}\left(\mathrm{LST}_{\mathrm{PIT}}^{\mathrm{TARG},2040}\right)^{3}$$

$$+\frac{1.3\times10^{-16}}{4}\left(\mathrm{LST}_{\mathrm{PIT}}^{\mathrm{TARG},2040}\right)^{4}+\frac{1.78\times10^{-22}}{5}\left(\mathrm{LST}_{\mathrm{PIT}}^{\mathrm{TARG},2040}\right)^{5}, \quad \textbf{(11b)}$$

$$\Delta \mathrm{WELF}_{\mathrm{ID}}^{2040}\left(\mathrm{LST}_{\mathrm{ID}}^{\mathrm{TARG},2040}\right)=31.5\left(\mathrm{LST}_{\mathrm{ID}}^{\mathrm{TARG},2040}\right)+\frac{1.85\times10^{-4}}{2}\left(\mathrm{LST}_{\mathrm{ID}}^{\mathrm{TARG},2040}\right)^{2}-\frac{7.2\times10^{-9}}{3}\left(\mathrm{LST}_{\mathrm{ID}}^{\mathrm{TARG},2040}\right)^{3}$$

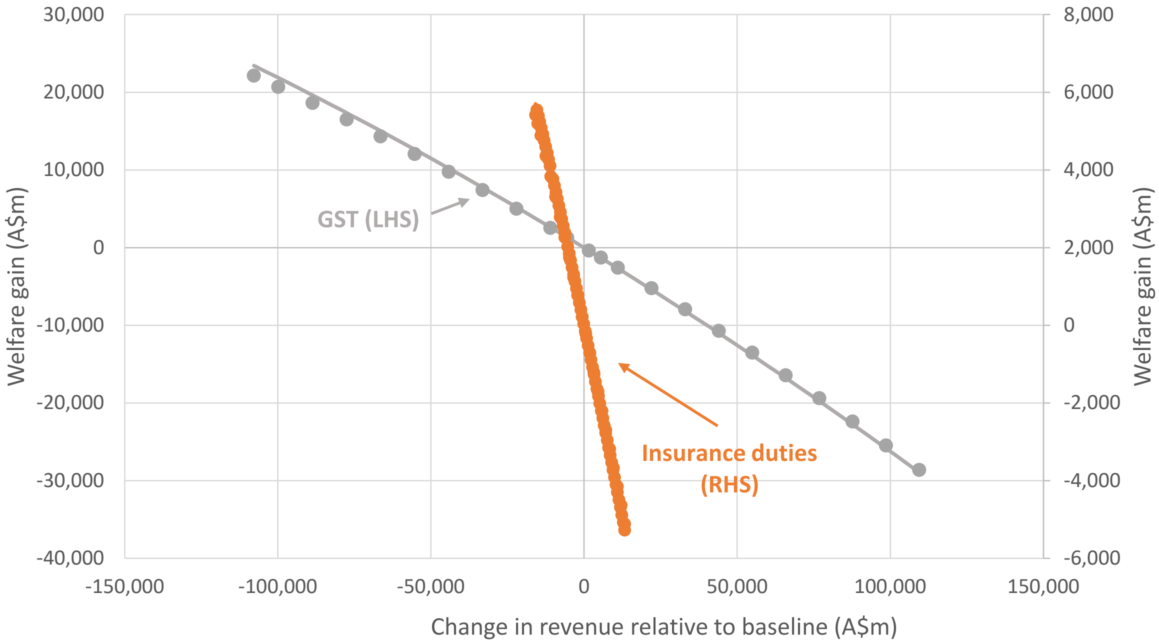
$$+\frac{5.35\times10^{-13}}{4}\left(\mathrm{LST}_{\mathrm{ID}}^{\mathrm{TARG},2040}\right)^{4}, \quad \textbf{(11c)}$$

$$\Delta \mathrm{WELF}_{\mathrm{TD}}^{2040}\left(\mathrm{LST}_{\mathrm{TD}}^{\mathrm{TARG},2040}\right)=75.6\left(\mathrm{LST}_{\mathrm{TD}}^{\mathrm{TARG},2040}\right)+\frac{1.02\times10^{-3}}{2}\left(\mathrm{LST}_{\mathrm{TD}}^{\mathrm{TARG},2040}\right)^{2}-\frac{1.4\times10^{-8}}{3}\left(\mathrm{LST}_{\mathrm{TD}}^{\mathrm{TARG},2040}\right)^{3}$$

$$-\frac{3.3\times10^{-13}}{4}\left(\mathrm{LST}_{\mathrm{TD}}^{\mathrm{TARG},2040}\right)^{4}. \quad \textbf{(11d)}$$

Because these equations are integrals of OLS estimates, they carry greater error than the original OLS estimates of the MEB distribution functions themselves, which showed excellent agreement with our VURMTAX simulation outputs; see Figures 2 and 3. The relative error in the welfare change estimates is generally 5% or less, if the associated MEB distribution functions from equation (9) were relatively smooth. This is true for both IDs, and the GST; see Figure 4, where we plot equations (11a) and (11c) as solid grey and orange lines, respectively, against our simulated welfare responses for the GST (grey circles) and ID (orange circles).

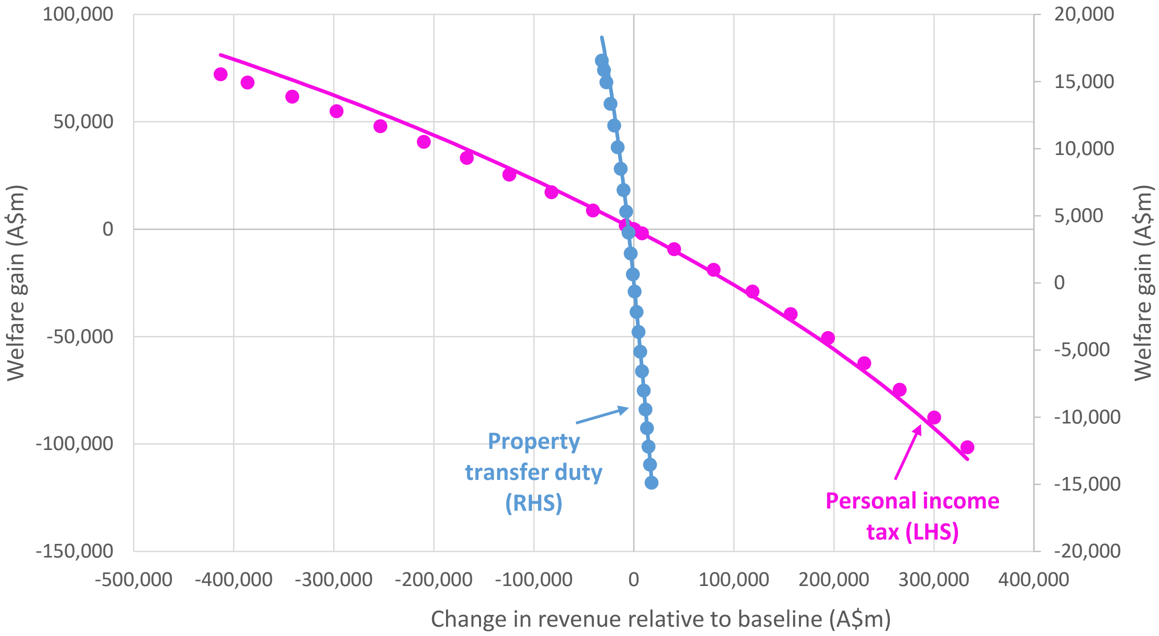
Figure 4: Welfare change at different levels of budget-neutralising lump sum transfer levels: GST and ID



Notes: Welfare change in A$m (y-axis), relative to the A$m deviation in the national public sector budget position from the baseline (x-axis) for the GST (grey circles) and insurance duties (orange circles) in Australia, derived using VURMTAX. Lines represent the plots of the functions in equation (11a) and (11c), and are colour-coded to match the aforementioned tax instruments. Relative errors between the solid lines and simulation outputs/coloured dots are no larger than 5%.

For the PIT and TDs, the relative errors are larger (12 percent or lower); they are largest when the associated MEB distribution functions exhibit greater convexity. See Figure 5, where we plot equations (11b) and (11d) as solid magenta and blue lines, respectively, against our simulated welfare responses for PIT (magenta circles) and TD (blue circles). The largest relative errors in the welfare estimates materialise for large increases (decreases) in revenue, or when tax rates are being heavily increased (reduced). In future work, we plan to increase the granularity of VURMTAX simulations for MEB distribution functions in these regions, e.g., by altering the step size in equation (5) from 0.09 in these regions to something smaller like 0.045. An alternative would be to apply a curve fitting algorithm, e.g., piecewise polynomials like cubic splines. The disadvantage of this approach is that the outputs cannot be written succinctly, because many polynomials will be derived to fit curves using adjacent blue, grey, orange and magenta dots, for each of the MEB distribution functions in Figures 2 and 3.

Figure 5: Welfare change at different levels of budget-neutralising lump sum transfer levels: PIT and TD



Notes: Welfare change in A$m (y-axis), relative to the A$m deviation in the national public sector budget position from the baseline (x-axis) for personal income tax (magenta circles) and property transfer duties (blue circles) in Australia, derived using VURMTAX. Lines represent the plots of the functions in equation (11b) and (11d), and are colour-coded to match the aforementioned tax instruments. Note that deviations between the solid lines and VURMTAX simulated results materialise where the associated MEB distribution functions in Figure 3 also exhibit convexity.

With equation (11) in place users can augment their analysis of tax mix swaps with other variables of interest to policy makers, such as estimates of real welfare responses. For example, if TD and ID are forecast to collectively yield A$48b in real revenues by 2040, from equation (11a) we see that raising the GST rate in order to generate this amount of real revenue will reduce welfare by approximately A$12b, while generating the same amount of real revenue via a PIT rate rise will reduce welfare by A$11.98b. As expected, the GST rate rise carries a larger cost than the average PIT rate rise, although the differences are small. Note that neither of these estimates account for the rise in welfare generated from removal of the inefficient state taxes; from equations (11c) and (11d), this is expected to increase welfare by A$5.7b and A$18.3b, respectively, exceeding the costs associated with the increase in either GST or PIT collections by approximately A$12b (=5.7+18.3-12). Using central estimates from the ABS Household and Family Projections, this equates to approximately $935 per household in 2040.[5]

---

[5] See https://www.abs.gov.au/statistics/people/population/household-and-family-projections-australia/2016-2041. The figures presented by the ABS are forecasts to 2041.The implied annual growth rate in households in the forecasts is 1.4%. We adjust the ABS central estimates (series 2) to remove one years' worth of growth and align the forecasts with the final year of the modelling presented herein, which is 2040. This leaves us with a household count of 12.84m.

4. Concluding remarks and future work

In this paper, we have used a multi-region, multi-industry CGE model of the Australian economy with tax detail to derive functional relationships between the marginal excess burden (MEB) of four Australian taxes, and their tax-specific revenue-to-GDP ratios. For each of the resulting four MEB distribution functions, OLS is applied to yield polynomial expressions between the tax-specific MEB and its revenue-to-GDP ratio. As we demonstrate, the resulting formulae expedite the analysis of revenue-neutral tax reform scenarios. For example, two of the four taxes we study (insurance and property transfer duties) exhibit very high MEBs at their current revenue-to-GDP ratios. Assuming revenue neutrality, we used the MEB distribution functions derived herein to understand whether (i) there was any level of revenue-to-GDP where these inefficient taxes exhibit similar MEBs to broader-based taxes like the GST and personal income tax; and (ii) replacement of both inefficient taxes via increases in the GST rate or the average personal income tax rate was preferable when seeking to maximise the welfare gain. By evaluating equations (7c) and (7d) herein at revenue-to-GDP ratios of zero, we show that both narrow-based taxes cause deadweight losses that exceed those caused by the GST and personal income tax, even at infinitesimally small levels of revenue. This suggests both of the two narrow-based state taxes we study are inefficient at any tax rate and should be eliminated. As we argue, only at very large aggregate revenue-to-GDP ratios could either of the state taxes we study be justified.

By studying how the MEB of the GST and personal income tax change as we increase their revenue-to-GDP ratios, we show that from an economic efficiency perspective, if we can choose only one replacement tax, then an increase in the average personal income tax rate is the preferred tool. But if policy makers can increase both the GST and the personal income tax rate, then an approximate 48%/52% split in the revenue raising effort across the two taxes is more efficient. As we showed, the utility of our approach can be expanded to facilitate a study of the impact of tax mix swaps on real welfare, by altering the explanatory variable in our OLS regressions. Our application of the welfare equations derived herein suggest that removal of the two inefficient taxes we study, funded via a 48/52 GST/PIT revenue increase, could improve welfare by approximately A$935 per household in real terms by 2040. In future work, we plan to improve the accuracy of our welfare functions, by increasing the density of our sampling frequency when tax rates are rising or falling significantly.

In addition, we plan to expand the range of taxes for which we estimate the MEB distribution functions reported in Figures 2 and 3 and equations (7) and (9). This will allow us to compare Australia’s current tax mix to a range of alternatives. These alternatives could span a wide range of possibilities. At the politically-ambitious end of this range, we can investigate the properties of a system-wide optimum, in which marginal excess burdens are equalised across all tax instruments under a given aggregate revenue-to-GDP target. More practically, the system can be used to inform policy makers on a variety of more circumscribed tax swap packages that nevertheless aim to maximise welfare gains but within the constraints of what might be politically feasible.

References

Adams, P. D., J. M. Dixon and J. M. Horridge (2015). *The Victoria University Regional Model (VURM): Technical Documentation, Version 1.0*. CoPS/IMPACT Working Paper no. G-254. Available at https://www.copsmodels.com/elecpapr/g-254.htm

Australian Government (2015). *Re:think Tax discussion Paper*. Commonwealth of Australia. Available at http://bettertax.gov.au/publications/discussion-paper/

Bergmann, M. (2016). *The Rise in Dividend Payments*. RBA Bulletin, March 2016. Available at https://www.rba.gov.au/publications/bulletin/2016/mar/pdf/bu-0316-6.pdf

Butler, J. R. (1999). *Estimating elasticity of demand for private health insurance in Australia*. Working Paper No. 43. National Centre for Epidemiology and Population Health, ANU.

Cao, L., A. Hosking, M. Kouparitsas, D. Mullaly, X. Rimmer, Q. Shi, W. Stark and S. Wende (2015). *Understanding the economy-wide efficiency and incidence of major Australia taxes.* Treasury Working Paper 2015-01.

Creedy, J. (2003). *The excess burden of taxation and why it (approximately) quadruples when the tax rate doubles.* New Zealand Treasury Working Paper 03/29. Available at https://www.treasury.govt.nz/sites/default/files/2007-10/twp03-29.pdf

Dixon J. M., and J. Nassios (2018a). *A dynamic economy-wide modelling analysis of company tax cuts in Australia.* CoPS Working Paper No. G-287. Available at https://www.copsmodels.com/elecpapr/g-287.htm

Dixon J. M., and J. Nassios (2018b). *The effectiveness of investment stimulus policies in Australia.* CoPS Working Paper No. G-282. Available at https://www.copsmodels.com/elecpapr/g-282.htm

Dixon, P.B. and M.T. Rimmer (2002). *Dynamic general equilibrium modelling for forecasting and policy.* Contributions to Economic Analysis No. 256, North-Holland, Amsterdam.

Freebairn, J. W. (2017). *Reform options for state property taxes.* Melbourne Institute Policy Brief No. 2/17.

Freebairn, J. W. (2020a). *Reforming state taxes on property.* Tax and Transfer Policy Institute Working Paper 6/2020. Available at https://taxpolicy.crawford.anu.edu.au/sites/default/files/publication/taxstudies_crawford_anu_edu_au/2020-06/complete_working_paper_6_2020_j_freebairn.pdf

Freebairn, J. W. (2020b). *Reform state taxes to Increase Productivity.* Melbourne Institute Policy Brief No. 2/17.

Giesecke, J.A., and N. H. Tran (2018). T*he National and Regional Consequences of Australia's Goods and Services Tax*. The Economic Record 94 (**306**), pp. 255 – 275.

Giesecke, J. A., C. King, J. Nassios and N. H. Tran (2021). *The impact of GST reform on Australia's state and territory economies.* Applied Economics 53 (**51**), pp. 5929 – 5947.

Henry K., J. Harmer, J. Piggott, H. Ridout and G. Smith (2010). *Australia's future tax system: Final Report.* May 2010 (Henry Tax Review), prepared for the Treasurer of the Commonwealth of Australia.

Hao, M., A. S. Macdonald, P. Tapadar, and R. G. Thomas (2018). *Insurance loss coverage and demand elasticities*. Insurance: Mathematics and Economics 79, pp. 15–25.

Harberger, A. C. (1962). *The incidence of the corporation income tax*. Journal of Political Economy. Volume LXX (3).

Horridge J. M., M. Jerie, D. Mustakinov, and F. Schiffmann (2018). *GEMPACK manual*. GEMPACK Software, Centre of Policy Studies, Victoria University, Melbourne, ISBN 978-1-921654-34-3.

Nassios, J., J. R. Madden, J. A. Giesecke, J. M. Dixon, N. H. Tran, P. B. Dixon, M. T. Rimmer, P. D. Adams and J. W. Freebairn (2019a). *The economic impact and efficiency of state and federal taxes in Australia*. CoPS/IMPACT Working Paper no. G-289. Available at https://www.copsmodels.com/elecpapr/g-289.htm

Nassios, J., J. A. Giesecke, P. B. Dixon and M. T. Rimmer (2019b). *Modelling the allocative efficiency of landowner taxation*. Economic Modelling 81, pp. 111 - 123.

Parliamentary Budget Office (2017). *Changes in average personal income tax rates: distributional impacts*. Report no. 03/2017. Available at https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Budget_Office/Publications/Research_reports/Report_03_2017

Parliamentary Budget Office (2021). *Bracket creep and its fiscal impact.* Budget explainer no. 1, 29 September 2021. Available at https://www.aph.gov.au/-/media/05_About_Parliament/54_Parliamentary_Depts/548_Parliamentary_Budget_Office/Reports/2021-22/Bracket_creep/Bracket_creep_and_its_fiscal_impact_PDF.pdf?la=en&hash=9EDB8FE4CB95E7FF1FFFA6CC2A34B8B7524FA68F

Peirson, G., Brown, R., Easton, S., Howard, P., & Pinder, S. (2009). *Business Finance*, 10th Edition. McGraw-Hill.

The Senate Economics References Committee. (2015). *Corporate tax avoidance*. Commonwealth of Australia. Available at: http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Economics/Corporate_Tax_Avoidance/Report%20part%201/c02.

Tooth, R. (2015). *Analysis of demand for home and contents insurance*. Report for the Insurance Council of Australia by Sapere Research Group. Available at https://www.insurancecouncil.com.au/assets/report/27082015%20-%20Analysis_of_demand_for_home_and_contents%20(1).pdf .

U.S. Congressional Budget Office (2017). *International Comparisons of Corporate Income Tax Rates*. Report prepared at the request of the Ranking Member of the Senate Finance Committee, March 2017. Available at https://www.cbo.gov/system/files/115th-congress-2017-2018/reports/52419-internationaltaxratecomp.pdf

Viswanathan, K. S., J. Lemaire, K. K. Withers, K. Armstrong, A. Baumritter, J. Hershey, M. Pauly, and D. A. Asch (2007). *Adverse selection in term life insurance purchasing due to the BRCA ½ Genetic Test and elastic demand*. Journal of Risk and Insurance 74 (**1**), pp. 65–86.

Property Tax Reform: Implications for Housing Prices and Economic Productivity

CoPS Working Paper No. G-330, June 2022

Jason Nassios
And
James Giesecke
Centre of Policy Studies,
Victoria University

ISSN 1 921654 02 3

ISBN 978-1-921654-38-1

The Centre of Policy Studies (CoPS), incorporating the IMPACT project, is a research centre at Victoria University devoted to quantitative analysis of issues relevant to economic policy.
Address: Centre of Policy Studies, Victoria University, PO Box 14428, Melbourne, Victoria, 8001
home page: www.vu.edu.au/CoPS/ email: copsinfo@vu.edu.au Telephone +61 3 9919 1877

Citation

Nassios, J and J.A. Giesecke (2022), "Property Tax Reform: Implications for Housing Prices and Economic Productivity", Centre of Policy Studies Working Paper No. G-330, Victoria University, June 2022.

Property Tax Reform: Implications for Housing Prices and Economic Productivity

Jason Nassios[1], James Giesecke[2, 3]

Centre of Policy Studies

Victoria University

Abstract

Australia has high housing prices by world standards. Australian state and local governments also have a high reliance on a variety of property taxes. This has generated calls for state tax reform. However, with property prices high, a concern of policy makers is that property tax reform might push house prices higher still. We investigate the effects of seventeen property tax reform options, with a particular focus on potential trade-offs between efficiency benefits and house price impacts.

JEL Codes: C68; E62; H2; H71; R38

Keywords: CGE modelling; Immovable property tax; Recurrent property tax; Housing prices; Excess burden

---

[1] Associate Professor, Centre of Policy Studies (Victoria University) and corresponding author. Email: Jason.Nassios@vu.edu.au

[2] Director and Professor, Centre of Policy Studies (Victoria University).

[3] The authors extend their thanks to Prof. Philip Adams, A. Prof. Janine Dixon, Dr Nicholas Sheard and Dr Locky Liu from the Centre of Policy Studies (Victoria University) for their helpful comments and suggestions.

Contents

Key points

- We study a wide range of property tax reform options using a detailed large-scale economic model of Australia's state and territory economies. We report the implications of property tax reform for housing prices and economic efficiency.

- We measure the economic efficiency implications of tax reform by evaluating the economic cost of raising a given amount of additional revenue from each property tax (i.e. we evaluate the "excess burden" of each tax). We evaluate property price effects in terms of impacts on pre- and post-tax prices for low- and high-density residential dwellings.

- Our modelling builds on previous work via: (a) extensive benchmarking of the model's property value and tax data to official sources; (b) endogenous modelling of tax rate scales; (c) endogenous modelling of property transaction frequency; (d) updated baseline detail including the recent COVID-19 downturn and recovery; (e) modelling of housing prices.

- A focus of our study is housing prices. Hence, our study builds on previous work that has focused on the economic efficiency consequences of property tax reform, but given comparatively little attention to potential consequences for housing prices.

- We find that the impacts of property tax reform on housing prices depend on a number of key metrics for each housing type, in particular: (a) the ratio of land value to structure value; (b) the proportions of occupancy represented by owners and renters; (c) the average duration over which owners hold property before selling to new owners; and (d) the discount rate. Estimates for these inputs are derived and reported herein using publicly-available data.

- A swap of property transfer duty (or stamp duty) with land tax has long been advocated on efficiency grounds. Of the seventeen tax mix swaps that we study, we find that this remains by far the best policy option, when options are ranked solely in terms of their economic efficiency consequences. By extending our model to include endogenous transaction volume response, housing prices, and transfer duty tax rate scales, our estimates of the efficiency cost of transfer duty build significantly on past work.

- We find that the argument in support of swapping property transfer duty with land tax is strengthened when we broaden the evaluation criteria to include potential housing price impacts. That is, we find that swapping property transfer duty with land tax not only generates a significant gain in economic efficiency, it also generates a material reduction in the average price of housing, including transfer duties payable upon purchase.
- While we find that housing prices fall on average, important compositional effects are evident in the relative response between high- and low-density housing prices. Because high-density housing has much shorter holding periods than low-density housing, removing property transfer duty causes high-density housing prices to rise relative to low-density prices. This high-density housing price rise is not entirely offset by the offsetting hypothetical land tax we introduce because: (i) this hypothetical tax is imposed at a rate that is uniform across all housing types; and, (ii) high-density housing carries a lower land value share than low-density housing.

Executive Summary

A recurring theme in discussions of Australia's policy reform options is the overreliance by state and territory governments on property transfer duty. Why is this tax so often emphasised as a prime candidate for reform? Moving house is costly even before considering transfer duty. The decision to purchase a property sets in motion a chain of other transactions: legal experts must be engaged to navigate the transfer process, real estate agents are required to manage the sale of the property, property inspectors are hired to check for defects, and removalists paid to pack and transport possessions. Transfer duties compound matters, by adding a tax on top of the underlying resource cost of moving house. In NSW in 2020, transfer duty accounted for almost 80 percent of the average cost of moving house. Because households are sensitive to price signals, transfer duties reduce the propensity to relocate to more suitable locations when changes in personal or professional circumstances would otherwise make this the best choice. The cost of this tax is therefore significant.

The economic costs of many property and other taxes have been quantified by economists, using a variety of techniques. Studies for Australia by economists at the Commonwealth Treasury (Cao *et al.* 2015), and more recently by economists from Victoria University's Centre of Policy Studies and The University of Melbourne (e.g. Nassios *et al.* 2019a) have shown that, when measured relative to the revenue they raise, the economic cost of property transfer duty exceeds that of any other Australian tax. In contrast, another property tax, land tax, is ranked among the least costly of the many taxes levied in Australia. As such, many policy economists advocate funding a reduction in transfer duties via higher land taxes, as this holds out the possibility of raising a given amount of tax revenue for a lower overall cost compared with current tax arrangements.

Despite the apparent attractiveness of such a property tax swap, only one Australian jurisdiction has embarked on such a reform, the ACT. The ACT's path to property tax reform commenced in 2012, with a key element of the ACT Tax Reform Package involving the phasing out of property transfer duty over a 20-year time horizon, with the revenue replaced by a gradual increase in ACT General Rates. Each year, the General Rates revenue target is achieved by calculating the value of land parcels in the ACT. Households then pay a share of the annual target, which is proportional to the value of their residential land plot relative to the value of the total land stock in the ACT.

Adams *et al.* (2020) from Victoria University's Centre of Policy Studies studied the ACT Reforms over 2012/13 – 2017/18 and found that, while the benefit due to the removal of property transfer duty accounted for around 80 percent of the increase in economic activity, the imposition of a land tax also carried with it economic benefits. Land taxes are attractive in part because taxation of existing foreign landowners means that each dollar of additional land tax costs the economy less than one dollar. Property transaction volumes also rose as a consequence of the reform. The extent of the increase in sales volumes was quantified by studying transaction data from the ACT. This showed a 10 per cent reduction in the stamp duty liable on any given transaction could be associated with a 6 percent rise in property transaction volumes.

To date, a limitation of the property tax reform debate has been a lack of attention to possible impacts on house prices. This is important given the current economic environment facing Australian households and policy makers, one in which housing prices are high, both relative to income and relative to other developed countries. Amplifying prices relative to incomes also carries other risks, in that it has potential implications for macroeconomic stability and the tax and transfer system more broadly.

The core focus of this paper is to address this shortcoming in an active area of Australia's public policy debate. To this end, we develop new theory to embed regional housing price responses into a multi-regional computable general equilibrium (CGE) economic model of Australia's state and territory economies, called the Victoria University Regional Model with Taxation Detail (VURMTAX). The resulting housing price module, embedded within VURMTAX, allows us to study in detail how property tax reforms affect both economic welfare, and housing prices. We do this in two parts:

1. First, we simulate small changes in the rates of seven property taxes that each cost A$100m in tax-specific revenue. These simulations allow us to rank these taxes based on their impacts on economic welfare, and to study how this ranking compares with impacts on real housing prices;
2. Second, we provide a simulation-based assessment of seventeen hypothetical alterations to the property tax mix, reporting the impacts on economic welfare and real housing prices of each reform package.

The seven taxes we study can be broken into two groups. Four are existing taxes: (1) property transfer duty (TD); (2) state land tax (SLT); (3) local council rates (LCR), specifically the NSW system under which the tax is levied on an unimproved land value basis; and (4) The emergency service levy (ESL), with particular emphasis on the current NSW system under which the tax is levied on general insurance. Three are hypothetical taxes: (5) A hypothetical tax whose rate is uniform and whose tax base is unimproved land values (BBUIV); (6) A hypothetical tax whose rate is uniform and whose tax base is capital-improved land value (BBCIV); and, (7) A hypothetical tax whose tax base is narrow, in that it excludes owner-occupied housing and primary producers like SLT, but is otherwise levied at a uniform rate across capital-improved land value (NBUIV). Our seventeen property tax mix swaps involve removing one or more of the four existing taxes, and replacing them with one or more of the three hypothetical taxes. Of the seventeen combination swaps we study, eight focus on pairwise replacement, i.e., we swap one of the current four taxes with one of the three hypothetical taxes. The remaining nine scenarios are combinations of the eight pairwise swaps.

Our results from the first part of this study are summarised in Table E1. Our analysis highlighted that the impact of TD on welfare and efficiency was dependent on the type of property transfer it was collected from, i.e., housing versus non-residential property, and whether it was an existing or new property. For this reason, when reporting TD results in Table E1 we divide its incidence according to property type, i.e., housing versus non-residential property, and study two vintages, i.e., existing or new. For example, row (1) in Table E1 summarises the overall impact of TD, on all property types and vintages. Subsequent rows then isolate individual channels of effect. Row (1.1) isolates the effects of a small reduction in the rate of TD on housing transfers across new and existing vintages, while holding non-residential TD rates fixed. Row (1.2) isolates the effect of a small reduction in the TD rate on transfers of non-residential property of both new and existing vintage, while holding housing TD rates fixed. In rows (1.1.1) and (1.1.2), we further decompose housing TD impacts into the effects of transfers of existing housing (1.1.1), and new housing (1.1.2). Table E1 summarises results reported in more detail in Table 1 in the body of this study, and Column [1] and the row label convention we apply here provides references to the relevant rows of Table 1. Column [2] lists the taxes studied in a given row. In column [3], we report the welfare benefit in cents per dollar of revenue swapped, when we reduce the rate of the tax listed in column [2] and replace foregone revenue with a non-distorting lump sum tax on households.

The results in column [3] of Table E1 allow us to rank the taxes studied according to the welfare benefits that arise from small tax rate reductions. In Table E1, we rank our taxes from the most distortionary tax, which generates the largest benefit when its rate is reduced (shaded red), through to the least distortionary tax (shaded green). From Table E1, we see that a permanent reduction, implemented today, in the rate of TD on transfers of existing houses would improve welfare by 132 cents per dollar of revenue foregone by 2040. This is the largest benefit generated of all the taxes we study. In column [4] of Table E1, we use similar shading to draw attention to the taxes for which rate reduction puts the strongest upward pressure on real housing prices (shaded red), with graded shading for those taxes that cause the smallest price increases or reduce prices (shaded yellow through to green). TD on existing houses also ranks as the most distortionary of the taxes studied on the purchasers' price of housing. In row (1.1.2) of Table E1 we see that removal of TD on new housing damps purchasers' price responses; however, this effect is dominated by the impact of TD on existing transfers because much more TD is collected from existing than new housing in any given year. The corollary of these findings is that removing TD and *not* replacing the revenue with another property tax will generate welfare benefits, but at the cost of real housing price appreciation. We expand on this point in Table 2 of the body of this study, where we show that complete replacement of stamp duty with a lump sum tax raises real house prices, i.e., housing prices relative to the CPI, by approximately 11.7% (before duty) and 7.1% (after duty).

Table E1: Heat map ranking of state and local government property taxes according to their impacts on welfare (column 3), and their impact on state-wide real housing prices (column 4), in response to A$100m in tax cuts.

Relevant row in Table 1*	**Tax**	**Welfare benefit in 2040 *in cents per dollar*** *Largest benefit when rates are reduced (red) to largest cost (green)*	**Real average housing purchasers' price** *deviation from baseline in %*** *Largest rise (red) to largest fall (green)*
Column [1]	Column [2]	Column [3]	Column [4]
(1.1.1)	Transfer duty (TD): transfers of existing houses***	132	0.138
(1.1)	TD: all house transfers***	112	0.104
(1)	TD: all property transfers***	82	0.077
(1.1.2)	TD: transfers of new houses***	43	-0.149
(4)	Emergency Service Levy (ESL)	42	0.013
(1.2)	TD: non-residential transfers***	40	0.000
(7)	Narrow-based capital-improved value tax (NBCIV)	14	0.074
(6)	Broad-based capital-improved value tax (BBCIV)	3	0.072
(5)	Broad-based unimproved value tax (BBUIV)	-8	0.116
(3)	Local council rates (LCR)	-11	0.094
(2)	State land tax (SLT)	-15	0.077

** Table E1 summarises results reported in Table 1 of the main body of this study.*

***Real average housing purchasers' price responses reported here are derived by taking the difference between columns [6ii] and [7] in Table 1 from the body of this study.*

**** For transfer duty, we study its impact across two different property types (housing and non-residential property) and two different vintages (existing and new), because each of these four channels have unique implications for welfare and real housing prices. In row (1.1.1) we study the impact of small TD rate reductions on existing housing transfers, while row (1.1.2) reports our findings when the TD rate on new housing is reduced. We aggregate these results in row (1.1) to report the impact of TD on housing in totality, while in row (1.2) we report the results for non-residential TD. Finally, row (1) aggregates the results in rows (1.1) and (1.2).*

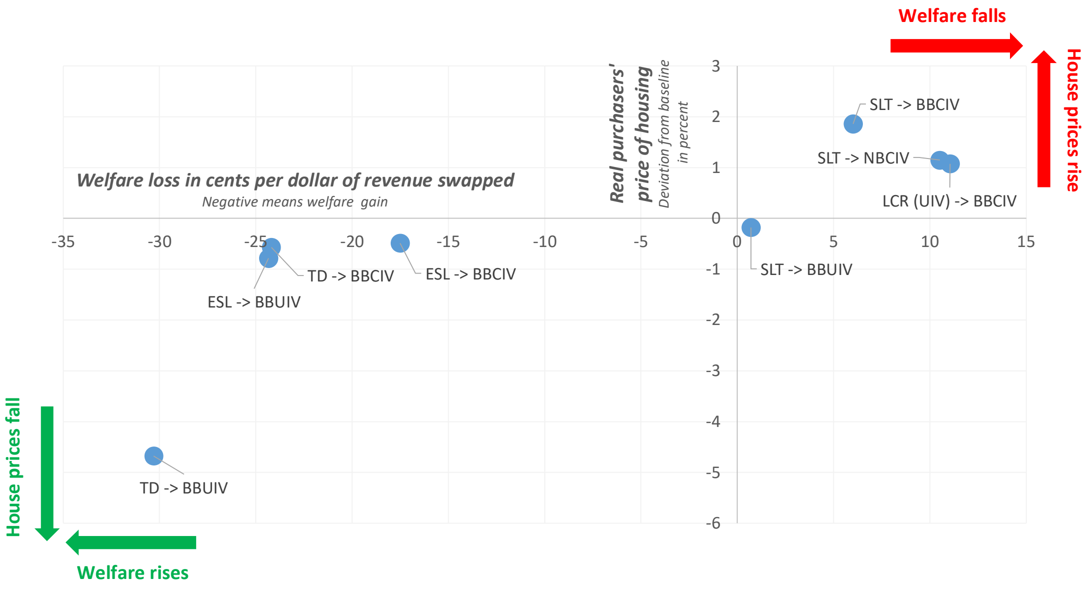
With regard to welfare impacts, land taxes rank as the most efficient in column [3]; reducing land tax collections actually reduces welfare (a negative welfare benefit is reported in row (5), column [3] of Table E1) because of taxation of existing foreign owners of land. Land taxes are thus attractive from an economic welfare perspective. Notably, their housing price impacts are also similar to TDs, as shown in column [4]. This makes land tax attractive as a candidate for direct replacement of transfer duty: welfare benefits can be unlocked, while leaving house prices largely unaffected.

As discussed, in part two of our study, we apply the framework that gives rise to the results in Table E1 to study unilateral, i.e., implemented in one state only, property tax reform. In the body of this study, we report results for seventeen reform scenarios. Eight of the scenarios we investigate involve pairwise swaps of one of taxes (1) – (4) from Table E1 with one of taxes (5) – (7) in Table E1. The relative impact of these eight pairwise swaps on welfare and housing prices, can be studied with the aid of the scatterplot in Figure E1, which helps us identify tax swaps that:

(i) both reduce the purchasers' price of housing and improve welfare (see the bottom, left-hand quadrant of Figure E1); and,

(ii) both increase housing prices and reduce welfare (see the top, right-hand quadrant in Figure E1).

Figure E1: Scatterplot of the welfare loss (x-axis) and real average housing price response (y-axis) for eight pairwise changes in the property tax mix derived using VURMTAX. Mix swaps that simultaneously improve welfare and reduce housing prices inhabit the bottom left quadrant.



One swap (state land tax for a broad-based unimproved value land tax [SLT -> BBUIV]) is broadly neutral on both efficiency and price measures, and thus lies close to the origin in Figure E1.

Based on Figure E1, there are four pairwise swaps that rank highly from an efficiency and housing price standpoint, with the two highest priorities being (1) swapping TD for a BBUIV; and, (2) replacing the ESL on insurance with a BBUIV. We find that other policy options, such as changing the LCR tax base from land to capital-improved value or allowing SLT to be levied on a capital-improved basis, cause housing prices to rise and reduce welfare.

In future work, we aim to apply this framework more broadly, to study how value-added taxes, e.g., Australia's Goods and Services tax (GST), impact both welfare and efficiency. When discussing removal of property transfer duty, the GST is often put forward as an alternative tax-mix swap candidate to broad-based land taxes. Based on previous studies by Nassios *et al.* (2019a), the welfare costs of GST rate rises are smaller than TD, but larger than land taxes. The TD-GST swap would thus rank lower than the TD-BBUIV tax mix swap from a welfare perspective. An interesting follow-up to our work herein would be to explore the impact of a national TD-GST swap using VURMTAX, with particular emphasis on regional housing prices and economic welfare.

1. Introduction

For many years, computable general equilibrium (CGE) models have been applied across multiple jurisdictions to study the implications of tax policy changes [Ballard *et al.* (1987); Kehoe *et al.* (1988); Fehr et al. (1995); Dixon and Rimmer (1999); Copenhagen Economics (2007); Giesecke and Tran (2010; 2012; 2018); Gesualdo *et al.* (2019)]. Within Australia in particular, a number of recent studies have used CGE models to explore the economic efficiency of region-specific and federally-imposed taxes, with a particular emphasis on ranking tax instruments thereon [Henry *et al.* (2010); Cao *et al.* (2015); Nassios *et al.* (2019a)]. These analyses have not investigated the effects of the tax system on housing prices.[4] In part, this is because CGE models typically do not contain variables describing housing prices. They do however contain variables relevant to the determination of housing prices, like rental rates on housing capital and land, and the prices of new units of housing capital.

Australia's high cost of housing relative to income, and the potential housing price effects of state and federal tax systems, are however topics of ongoing debate in Australian policy circles [Thomas and Hall (2016)]. In this paper, we demonstrate how natural CGE model outputs can be used to operationalise a housing price module within a large-scale, multi-regional CGE model with tax detail. We use this new framework to explore the property price and economic efficiency effects of property tax reform in one representative Australian state. We choose New South Wales (NSW) for four reasons: (i) the property value and property tax detail necessary to operationalise our model is publicly available via a number of sources, as cited herein; (ii) it has the nation's most diverse set of property taxes, thus providing an opportunity to study a wide range of tax mix scenarios; (iii) it has the nation's highest residential property prices, making it a fitting case study for our purposes; and (iv) it has a particularly open and active property tax reform debate, as discussed further below.

Over the past decade, a number of NSW property tax reform proposals have been put forward. For example, the NSW Treasury (2012) proposed replacing the Emergency Service Levy (ESL) on insurance with a new broad-based land tax, called the fire and emergency services levy (FESL) [NSW

---

[4] See for example Nassios et al. (2019a; 2019b); Dixon and Nassios (2018); Giesecke and Tran (2018).

Government (2017)]. More recently, the NSW Treasury (2020) proposed replacing property transfer duty and state land tax with a new broad-based land tax, called the NSW property tax [NSW Treasury (2020)]. In addition to these proposed reforms, the NSW Independent Pricing and Regulatory Tribunal (IPART) supported recommendations by the Independent Local Government Review Panel (2012) to allow some local councils to levy council rates on capital-improved land value [IPART (2016)]. In a similar way to their Victorian counterparts, NSW councils could then choose to raise council rate revenue from landowners according to either the unimproved value of their landholdings (i.e., excluding the value of any structures, buildings and property improvements) or the capital-improved property value.

As we shall discuss, the integration of a housing price module within our multi-regional CGE model of Australia's state and territory economies (VURMTAX) enlarges the range of policy-relevant variables generated by the model, enriching the insights that can be provided to policy makers.[5] Motivated by the aforementioned set of tax reform proposals, we perform seventeen unilateral alterations to the NSW state and local government tax system and study their efficiency and housing market implications. Our simulations focus on the revenue-neutral replacement of four current taxes with a combination of three hypothetical new taxes. Our paper therefore focuses on seven taxes in total:

(i) property transfer duty (hereafter referred to as TD);

(ii) state land tax (hereafter referred to as SLT);

(iii) local council rates on unimproved land values (hereafter referred to as LCR);

(iv) the emergency service levy on insurance (hereafter referred to as the ESL);

(v) a hypothetical broad-based unimproved land value tax (hereafter referred to as the BBUIV tax);

(vi) a hypothetical broad-based capital improved land value tax (hereafter referred to as the BBCIV tax); and,

---

[5] For a broad discussion of the theoretical structure of VURMTAX, see section 2 herein.

(vii) a hypothetical narrow-based capital improved value tax (hereafter referred to as NBCIV taxes).

We describe the four existing and three hypothetical taxes in sections 2.2 and 2.3. Item (vii) is a hypothetical construct. No Australian jurisdiction levies such a tax and we are not aware of any proposal to introduce it in any state. NBCIV nevertheless makes an interesting case study, as it carries properties of both BBCIV (the capital improved base) and SLT (the principal place of residence and primary producer exemptions). In section 4, we compare our findings to previous research, particularly with regard to the impact of TD removal and direct replacement with a land tax.

Our paper is structured as follows. In section 2.1, we described the CGE model that underpins our analysis. Section 2.2 outlines the system of TD collection in Australia, while section 2.3 expands on this by outlining how we embed detail of this and other taxes in our multi-regional CGE model. We introduce our housing price module in section 2.4. To study the efficiency of the taxes we consider, we calculate tax specific excess burden measures, which are described in section 2.5. Section 3 is devoted to a discussion of our results. To begin, we perform twenty-two simulations to study the effects of: (i) A$100m reductions in collections from existing NSW state and local government property taxes; and (ii) A$100m increases in collections from the new hypothetical property taxes we introduce to the NSW tax mix. As we discuss in section 2.3.1, while we study seven taxes, for some of these, e.g., TD, the economic incidence can fall on many different agents. Disentangling the efficiency and housing price effects from changes in the rate of one tax can therefore be difficult. To facilitate a comprehensive assessment of the seventeen tax mix changes, we begin by studying the individual efficiency and housing price responses of each of the seven taxes in detail in section 3.1. We introduce and discuss the seventeen tax mix swaps in section 3.2. We compare our housing price responses with findings from previous work in section 4, and we conclude in section 5.

2. Background

2.1. The Victoria University Regional Model with Tax Detail (VURMTAX)

VURMTAX is an 86-industry computable general equilibrium model of Australia based on the Victoria University Regional Model (VURM) [Adams et al. (2015)]. The model is designed for detailed taxation analysis and is described in Nassios et al. (2019a). Applications of VURMTAX include analyses of the GST [Giesecke and Tran (2018); Giesecke *et al.* (2021)], company tax [Dixon and Nassios (2018)], the efficiency of the NSW tax system [Nassios *et al.* (2019a)], SLT and LCR [Nassios et al. (2019b)], and a historical decomposition of the effects of the ACT Tax Reform Package [Adams et al. (2020)].

Consistent with our choice of NSW as case study, we use a two-region (NSW and the Rest of Australia) aggregation of the core eight-region database. In order to parameterise VURMTAX, we rely on data from a variety of sources, including Australian Bureau of Statistics (ABS) Census data, Agricultural Census data, State accounts data, government financial statistics data, and international trade data. The core VURMTAX database developed and applied herein is based upon the ABS 2016/17 national and state accounts data.

Each region in VURMTAX has a single representative household and a state and local government. The federal government operates in each region. The foreign sector is described by commodity and region-specific export demand curves, and by commodity-specific supply curves for international imports to each region. Prices and quantities for each regionally produced commodity is the outcome of optimising behaviour. Regional industries are assumed to use intermediate inputs, labour, capital and land in a cost-minimising way, while operating in competitive markets. Region-specific representative households purchase utility-maximising bundles of goods, subject to given prices and disposable income. Regions are linked via interregional trade, interregional migration and capital movements, and governments operate within a fiscal federal framework.

Investment in each regional industry is positively related to expected rates of return on capital in each regional industry. VURMTAX recognises two investor classes: local investors (i.e. domestic households and government) and foreign investors. Capital creators assemble, in a cost-minimizing manner, units of industry-specific physical capital for each regional industry.[6]

VURMTAX provides results for economic variables on a year-on-year basis. The results for a particular year are used to update the database for the commencement of the next year. More

---

[6] For more detail, see Dixon and Nassios (2018).

specifically, the model contains a series of equations that connect capital stocks to past-year capital stocks and net investment. Similarly, debt is linked to past and present borrowing/saving, and regional populations are related to natural growth and international and interstate migration [Giesecke and Madden (2013)]. Region-specific labour supply effects, in addition to being affected by interregional mobility, adjust in response to movements in region-specific wages and household incomes [Giesecke *et al.* (2021)]. The model is solved with the GEMPACK economic modelling software [Harrison and Pearson (1996); Horridge et al. (2018)].

In solving VURMTAX, we undertake two parallel model runs: a baseline simulation and a policy simulation. The baseline simulation is a forecast for the period of interest (in this study, from 2016/17 to 2039/40). Our baseline simulation is comprised of two parts: for 2016/17 to 2019/20, we rely on realised movements in national macroeconomic variables reported by the ABS, and we thus account for the economic effects of COVID-19 in Australia.[7] From 2020/21 to 2022-23, we adopt Federal Treasury forward estimates from the Australian Federal Budget (2021) for key macroeconomic variables, and thereafter we return to a standard forecast scenario for the Australian economy.[8] The policy simulation is identical to the baseline simulation in all respects, other than the addition of shocks describing the tax policy reform under investigation. We report results as cumulative deviations (either percentage or absolute) away from base case in the levels of variables in each year of the policy simulation.

Natural outputs from a tax policy simulation in VURMTAX include, for example, the year t percentage change in pre-tax rentals for land used by industry i in region q (defined henceforth as $QL_{i,q,t}$), an identical level of granularity in the percentage change in pre-tax capital rental rates (

---

[7] This has been facilitated by the inclusion of explicit consumption bundles to account for the economic impact of changes in the demand for Australian domestic tourism, foreign tourism, and education exports via changes in foreign student patronage at Australian universities. This extension to the core VURMTAX model relies on data from the ABS Tourism Satellite Accounts; see https://www.abs.gov.au/statistics/economy/national-accounts/australian-national-accounts-tourism-satellite-account/latest-release.

[8] More specifically, we hold the national terms of trade and savings rates exogenous and unshocked; assume two percent year-on-year growth in the national CPI; hold the national unemployment rate fixed at 4.75 per cent; assume 1.1 per cent natural growth in the Australian population; and accommodate 2.4 percent annual real GDP growth via the endogenous determination of national labour augmenting technological change. At the industry level, we make allowance for a transition towards renewable energy production, and a reduction in long-run coal exports.

$QC_{i,q,t}$), as well as deviations in over twenty-five distinct tax revenue lines for each Australian state/territory government, and the Australian federal government.

2.2. A brief history of transfer duties (TDs) and their application in Australia

Stamp duties originated as a form of taxation in the Netherlands in 1624 [Dagnall (1994)], and were later introduced in England under the *Stamp Act* (1694), in part to finance the Nine Years War with France. English stamp duties were levied on a variety of goods, including university degrees, probates, the conveyances of property, newspapers, and playing dice. These early forms of stamp duty were specific taxes, with the tax base being the vellum, parchment or paper used to prepare either legal documentation or print media.

In Australia, the first stamp duty on the transfer of property was collected on 1 July 1865 by the colony of NSW, in accord with the *Stamp Duties Act 1865* (NSW).[9] After a brief hiatus from 1874 to 1880, TD in NSW was reintroduced with the *Stamp Duties Act 1880* (NSW), following its introduction in the colony of Victoria with the *Stamp Duties Act 1879* (Vic). These ad valorem stamp duties differed from their early English counterparts, in that the dutiable tax base was the value of the property transferred. Stamp or TDs of this form have remained in place throughout Australia's eight states and territories since, and are active across many other countries today, e.g., the United Kingdom (where it is referred to as Stamp Duty Land Tax), Germany, the Netherlands, the United States of America (where Real Property Transfer Tax is levied in all but five states, namely Mississippi, Missouri, New Mexico, North Dakota and Wyoming), Poland, and Ukraine [see also Bird and Slack (2004)].

While the system of TD in place throughout Australia differs in regional detail, in general, a purchaser of an Australian property is liable to pay TD when housing (of either owner-occupied or rented tenure) or non-residential properties are transacted, with very few exemptions.[10] Jurisdiction-specific progressive rate schedules apply, with the revenue accruing to Australian state and territory

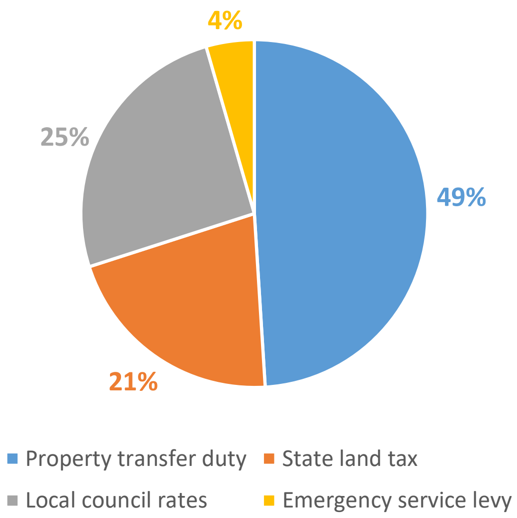
---

[9] See https://researchdata.edu.au/stamp-duties-office-1983-88/165634 for a brief history of NSW stamp duty.

[10] As discussed by Freebairn (2020b), there are exemptions for purchases by charities and other exempt entities, e.g., health and education providers, the Commonwealth government, etc.

governments. State and territory governments across Australia are particularly reliant on TD revenue. Of the four taxes studied herein (TD, SLT, LCR and the ESL) the NSW state/local government relies most heavily on TD, as show in Figure 1 where we summarise tax collection shares in NSW in 2017/18 for TD, SLT, LCR and the ESL.

Figure 1: Selected tax collection shares in NSW in 2017/18.



In line with TDs introduced by the Australian colonies prior to Federation, the dutiable tax base across all regions and for all property types remains the value of the property transacted, i.e., the market value of the capital/land bundle transacted [NSW Treasury (2018); Freebairn (2020b)]. The applicable TD rates and thresholds differ by jurisdiction, with top-tier duty rates ranging from 4.5 percent of the property value above A$725 000 in Tasmania, to 7.0% for housing valued above A$3 million in NSW in 2017/18 [NSW Treasury (2018)].[11] Using data from Domain[12], we found that the average price of a detached house for Sydney in June 2017 was A$1.178m. Applying the general TD rate schedule published by the NSW Treasury (2018), the purchaser of an average Sydney property in 2017-18 would be liable for A$50 280 in TD, or approximately 4.27 percent of the property value.[13]

---

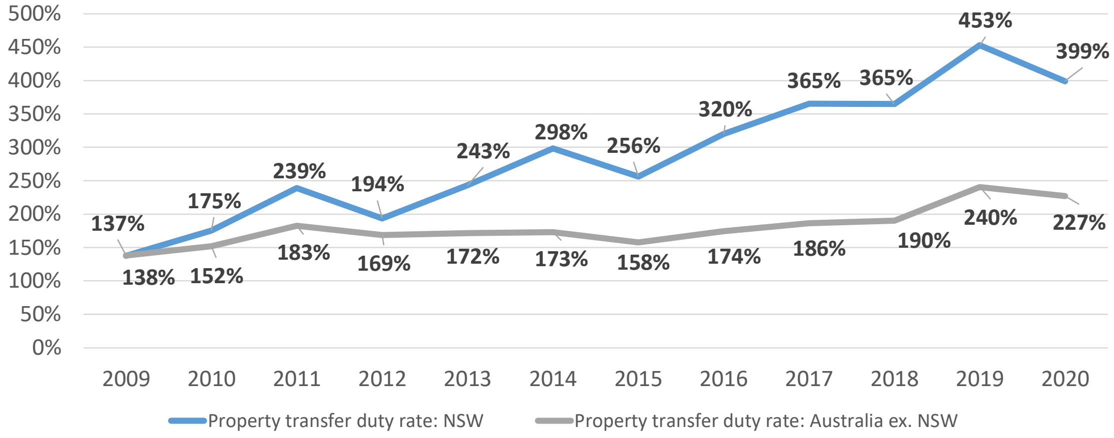
[11] Foreign purchasers attract additional surcharges in NSW, Victoria, Queensland and South Australia.

[12] See the reported House Prices for June 2016 at https://www.domain.com.au/research/house-price-report/june-2017/.

[13] From NSW Treasury (2018), the purchaser of a property whose value exceeds A$1m in NSW is liable to pay A$40 490 plus a marginal rate of 5.5 percent of property value exceeding A$1m.

While the tax base for TD is the value of the property, the economic incidence falls on the process of property transfer. Since the 1980's, concern regarding this system of taxation has grown in response to sharp appreciation in Australian housing prices relative to household incomes [Fox and Finlay (2012); Thomas and Hall (2016)]. This upward trend in price-to-income in turn put upward pressure on the value of TD relative to property ownership transfer costs, the value of which are usually only a fraction of the property price. This appreciation has been particularly pronounced following the Global Financial Crisis, as shown in Figure 2 where we plot the ratio of gross (of stamp duty) ownership transfer costs[14] to aggregate TD revenue[15]. The upward trajectory in the ad valorem equivalent stamp duty rate on ownership transfer costs is a reflection of the upward trend in the housing price-to-income ratio, particularly in regions of NSW.

Figure 2: Ad valorem equivalent of conveyancing duty taxes on ownership transfer costs in NSW and the rest of Australia excluding NSW.



This has stimulated debate about the economic efficiency of Australian TDs, particularly with regard to the role they play in inhibiting the efficient allocation of the nation's housing stock and impeding household mobility. Of the suite of taxes levied by the NSW state government in 2016/17, TD imposed the largest deadweight cost of taxation. The quantum of this distortion was reported by Nassios *et al.* (2019a), who calculated the marginal and average excess burdens of housing TD, non-residential TD, and twelve other NSW state/local government taxes. When ranked alongside these

---

[14] See ABS Cat. No. 5220.0 Tables 2 –9. To derive gross ownership transfer costs from ABS 5220.0, we subtract TDs sourced from ABS 5506.0 Tables 2 –9.
[15] See ABS Cat. No. 5506.0 Tables 2 – 9.

other NSW taxes, housing TD was found to cause the largest deadweight cost per additional dollar of revenue raised, and in the context of Figure 2 it is not difficult to understand why. In contrast, NSW LCR [a tax on unimproved land values with few exemptions and a generally flat rate, see Nassios *et al.* (2019b)] delivered negative deadweight costs, i.e., carried economic benefits, due in large part to foreign landowner taxation.

The highly distortionary nature of TDs relative to land taxes was also emphasised in Australia's most recent review of the national tax system by Henry *et al.* (2010), who put forward a series of reform options to improve the efficiency of the Australian tax system. Among the recommendations suggested were a five percent reduction in the company tax rate, abolition of state royalties on minerals and resources, the introduction of a uniform resource rent tax, and the revenue-neutral replacement of TD with new broad-based land taxes [Wood *et al.* (2012); Freebairn (2015; 2017; 2020a); Coates and Nolan (2019); AHURI (2020); NSW Treasury (2020)]. Of Australia's eight states and territories, only the Australian Capital Territory (ACT) has thus far embarked on an exchange of stamp duty for broad-based landowner taxation, via the ACT tax reform package [ACT Treasury (2012); Adams *et al.* (2020)]. This package will see broad-based land taxes replace TD throughout the ACT by 2032.

The core focus of this paper is to study the effects of a variety of property tax mix changes on regional housing prices in Australia. Some of the tax mix changes we study include the replacement of TDs with broad-based land taxes. In contrast to the national reform recommended by Henry *et al.* (2010), the experiments discussed herein alter the tax system in a single region of Australia. As discussed earlier, we choose NSW to be the reforming region, and treat as exogenous the taxation settings in all other Australian states and territories, and at the federal level. In total, we investigate the effects of seventeen hypothetical tax policy scenarios in NSW on the average prices of NSW low- and high-density housing. These simulations involve combinations of four existing taxes and three hypothetical taxes. The four existing taxes are: property transfer duty (TD), state land tax (SLT), local council rates (LCR) and the emergency service levy on insurance (the ESL). Combinations of these taxes are replaced with combinations of three new taxes: broad-based taxes on unimproved land values

(BBUIV), broad-based taxes on capital-improved land values (BBCIV), and narrow-based taxes on capital-improved land values (NBCIV).[16] In section 2.3, we describe how we model each of these seven taxes in VURMTAX. Section 2.4 outlines how we model the impact of tax policy changes on housing prices.

2.3. Embedding taxation detail in VURMTAX

In this section, we describe how we model four existing states taxes: TD, SLT, LCR and the ESL. We also summarise the tax base and theory required to include three hypothetical taxes into the state tax mix. These taxes are BBUIV, BBCIV and NBCIV taxes.

2.3.1. Modelling property transfer duty (TD)

TDs can be incurred on transfers of new or existing houses or non-residential properties. This creates four channels via which TDs affect the economy:

1. *TDs on existing housing*. We model these duties as falling upon household purchases of services that facilitate the transfer of ownership of property (viz. building inspection services, real estate agent services, legal conveyancing services, and public administration). The resulting indirect tax rates are large, as denoted in Figure 2 herein.
2. *TDs on new housing*. We model these duties as production taxes on the installation of new units of housing capital.
3. *TDs on existing commercial, industrial and agricultural property*. Similar to point 1 above, we model these duties as indirect taxes on the demand for services that facilitate the transfer by businesses of ownership of commercial and agricultural property. As such, we model these duties as indirect taxes on intermediate inputs of various property transfer services to production by industries.
4. *TDs on new commercial, industrial and agricultural property*. We model these duties as production taxes on the installation of new units of non-residential capital.

---

[16] By narrow-based, we mean that the tax includes the same set of exemptions as the current NSW SLT, i.e., the primary producer land and principal place of residence exemptions.

To allocate total NSW TD revenues as recorded in ABS Cat. No. 5506.0, across each of the above four channels, we first determine the residential versus non-residential tax load using data from Revenue NSW. This yields a 75.1 / 24.9 split of total stamp duty collections between residential and non-residential property transfers.[17]

Next, using NSW Valuer General bulk property sales by property type[18], we apportion the 75.1 per cent of total TD revenue that falls on housing into:

(i) a share that falls on new property development (assumed equal to the value-ratio of vacant land transfers to total residential land transfers), amounting to 8.6 per cent of total TD collected in NSW[19]; and,

(ii) a share collected from existing property transfers, which amounts to 66.5 per cent of total TD collected in NSW.

This latter share is further disaggregated into collections from the transfer of existing high-density housing, and existing low-density housing. This share is calculated by studying NSW Valuer General bulk sales data, to determine the total value of strata housing transfers relative to total non-vacant housing transfers. In 2017, this value share was 34.6 percent.

---

[17] Year-on-year estimates of the raw residential/non-residential tax load are variable from Revenue NSW at https://www.revenue.nsw.gov.au/help-centre/resources-library/statistics. We utilised 2016/17 tax year data, which matches the base year of the model database we apply herein. We compared our NSW split with national estimates by studying Table 22 from the ABS National Accounts Input-Output tables for Australia. In Table 22, the tax load on residential and non-residential construction activity represent the residential/non-residential transfer duty split in Australia. From Table 22, we find ABS estimates imply a 77/23 residential/non-residential split as being reflective of the Australia-wide breakdown. For the Revenue NSW and ABS data to be consistent, we expect to see the residential shares in other states and territories of Australia to be broadly similar. In work for the ACT Treasury, Adams *et al.* (2020) showed that this is not true for ACT property transfer duty, by examining ACT government budget papers. Their study determined a 66/34 residential/non-residential transfer duty split is representative of the ACT tax load 2015/16. Nor does this hold in Victoria, where property sales statistics from the Victorian Valuer-General (https://www.land.vic.gov.au/valuations/resources-and-reports/property-sales-statistics) show the split to be 83.6/16.4 for 2019.

[18] The unprocessed NSW property sales information data from 1990 is freely available at https://valuation.property.nsw.gov.au/embed/propertySalesInformation.

[19] Using NSW Valuer-General data, we find that the number of vacant residential land transfers in 2017 accounted for 16.2 percent of the total number residential transfers. This ratio weights each existing transfer in the same way as the transfer of a vacant residential allotment, however. To split residential transfer duty collections between existing and new housing loads herein, we calculate a value-weighted share. This is more appropriate as a means to split transfer duty revenue collected from new and existing housing because the transfer duty base is the dutiable value of the land transferred. Using a value weight yields a vacant transfer share of 11.46 percent in 2017. This value-weight share was broadly in line with Victorian data for 2016/17.

To split aggregate non-residential TDs (which are equal to 100 – 75.1 = 24.9 per cent of total collections in NSW) into collections from existing and new non-residential property transactions, we use a similar approach to Adams *et al.* (2020). Our analysis of NSW Valuer General bulk property sales data by property type shows that the average turnover rate for commercial and industrial property in 2016 was 4.9 per cent, whereas for housing it was 5.2 per cent. Lower turnover rates imply longer holding periods, and larger TD collections from new property sales. Consequently, we scale the share of residential stamp duty that is collected from new housing investment (8.6 / 75.1 = 11.46 per cent of total housing TD revenue) using the difference in derived turnover rates, in order to approximate the share of non-residential TD earned from sales of new commercial and industrial property. This suggests that 12.3 per cent of total non-residential NSW TD revenue is derived from purchases of new non-residential properties. This proportion of total non-residential TD is modelled as production taxes on new non-residential capital investment.

To model the demand for ownership transfer services in VURMTAX, we introduce four new commodities to the model. These commodities reflect the real estate, legal (conveyancing), public administration and property inspection/engineering services that households and industries purchase in order to facilitate property transfers. To model residential conveyancing duty collections from existing property transfers, we modify the linear expenditure system (LES) governing the consumption decisions of regional households in VURMTAX, by introducing a new aggregate commodity called *Moving services*. At the same time, we create a new dummy industry to create this commodity, *Moving services*. This industry produces *Moving services* by combining the four commodities in fixed proportions.[20] GST-exempt sales taxes on this bundle of goods are collected

---

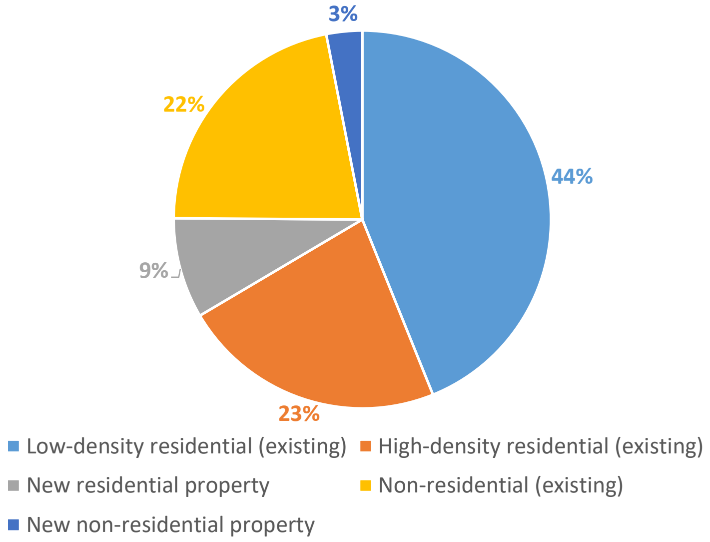
[20] We set the expenditure elasticity for the *Moving services* bundle of goods by households in VURMTAX as a value-weighted average of the expenditure elasticities for the underlying commodities within the bundle. This yields a price elasticity of demand for *Moving Services* by households in NSW of -0.62. This produces an elasticity with respect to tax (in this case, TDs) that is broadly consistent with the three-year turnover elasticity with respect to tax of 0.6 estimated by Davidoff and Leigh (2013). Independent econometric estimates of this elasticity with respect to tax for the ACT were performed by Adams *et al.* (2020) using: (i) property transaction data from 2008-09 to 2016-17 for the ACT, (ii) property market data from the NSW Valuer General, and (iii) data from the ABS. This yielded a statistically significant estimate of 0.6. For a detailed account of transaction elasticity estimates, we refer the reader to Malakellis and Warlters (2020).

and linked to TD revenue from existing housing sales. As discussed, new housing TDs are modelled as production taxes on the formation of new units of housing capital.

In VURMTAX, intermediate inputs, including *Moving services*, are used by industry in fixed proportions. As such, industry demand for *Moving services* is proportional to industry output levels. This renders industry demand for *Moving services* price inelastic, because changes in TD on non-residential property affect industry demand for Moving services indirectly, via its effect on industry production costs.

Putting the shares outlined here together yields the breakdown for stamp duty revenues for 2017 in NSW provided in Figure 3.

Figure 3: Land-related TD collections by source for NSW in 2017 (authors calculations, using ABS and NSW Valuer General data).



2.3.2. Modelling the emergency service levy on insurance (the ESL)

The NSW Government imposes four distinct levies/duties on contracts of insurance:

1. *General insurance duties.* The tax base is the insurance premium paid for each contract issued, and the tax rate is ad valorem. Life and health insurance contracts are general

insurance duty exempt. General insurance duties are defined as GST exempt, and hence fall outside the GST tax base.[21]

2. *Life insurance levies.* The tax base is defined as the life insurance benefit payable per contract raised, and the tax rate is ad valorem. This differs from the approach for general insurance, where the tax base is the premium paid.
3. *The health insurance levy.* This is a specific tax, levied as a fixed charge per customer, paid by any organisation that provides health insurance benefits in NSW.
4. *The ESL.* The tax base is the insurance premium paid on various types of general property insurance. The ESL finances 73.7 percent of the annual costs of funding the NSW rural fire services, the State Emergency Service, and Fire and Rescue NSW via a levy on insurers of specified classes of property located in NSW.

To accommodate this diversity of insurance taxes, we model the demand for three types of insurance commodity in VURMTAX, each produced by a single insurance industry operating in each region (in this case, NSW and the rest-of-Australia). These three commodities are (i) health insurance; (ii) life insurance; and (iii) general insurance. Each commodity is differentiated by its sales structure, price elasticity of demand, and any incident sales taxes. Because all of health, life and general insurance are produced by a single insurance industry in each region, our analysis implicitly assumes that homogenous production technology and input mixes exists across Australian general, life and health insurers. In calibrating VURMTAX along these lines, significant effort was made to ensure sales tax rates are properly calibrated to reflect APRA Quarterly Performance Statistics for General, Life and Health Insurers, and that price elasticities of demand conform to academic assessments of insurance

---

[21] As discussed in Nassios et al. (2019a), there are effectively three distinct classes of general insurance duties collected in NSW, because the tax rate imposed on the insurance premium depends on the type of general insurance purchased. For example, concessional tax rates are levied on crop and livestock insurance (2.5 percent of the premium), compared with tax rates levied on motor vehicle insurance (5 per cent) and house and contents insurance (9 per cent).

demand elasticities.[22] For a full discussion of this procedure, we refer the reader to Nassios *et al.* (2019a).

In this framework, both general insurance duties and the ESL are modelled as sales taxes on general insurance consumption by industries and households. The two taxes are distinguished in VURMTAX according to whether they fall within the GST tax base or not. That is, GST is levied on the ESL while general insurance duties are GST exempt.

2.3.3. *Modelling state land tax (SLT)*

SLTs are levied on the unimproved values of residential and commercial properties, but with three exemptions: primary producer land, principal place of residence (or owner-occupied housing), and land used in selected charity, social service and public sector activities. As discussed in Nassios *et al.* (2019b), in VURMTAX this is represented by differential land tax rates across sectors (reflecting sectoral differences in shares of land use that is tax exempt), and in the case of housing, across tenure (owner occupied and rented). Herein, we model the SLT system following the approach detailed in Nassios *et al.* (2019b). Land values for NSW in the VURMTAX base year are calibrated to NSW Valuer General data for the state-wide value of land on 1 July 2017 [see NSW Valuer General (2017)].

To split aggregate SLT revenue across land use types, we rely on land portfolio holding data from Revenue NSW.[23] This data aggregates land holdings according to the residential postcode of the

---

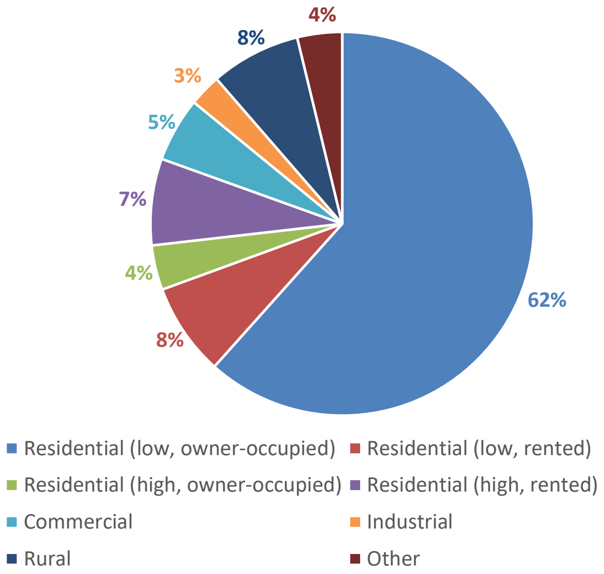
[22] In order to set the elasticity of demand for insurance, we reviewed a survey by Hao *et al.* (2018). For Health insurance, the household expenditure elasticity in VURMTAX is calibrated to yield a price of demand equal to the mid-point of the range outlined by Butler (1999) for the Australian health insurance market. For life insurance, we use a similar approach and rely on estimates of the price elasticity of demand for term life insurance by Viswanathan *et al.* (2006). For fire-service-levy-liable general insurance, e.g., house and contents insurance for households, we calibrate the price elasticity of demand in VURMTAX using the elasticity with respect to (w.r.t) tax of -1.34 estimated by Tooth (2015) for Australia. In order to convert the elasticity w.r.t tax to a price elasticity of demand, we first calculate the pre- and post-tax loading for Type A general insurance in NSW using the approach in Nassios *et al.* (2019a). On a pre-tax basis, the loading is equal to 1 / 0.586 – 1 = 70.65%, i.e., the pre-tax cost of Type A general insurance in NSW was 70.65% higher than expected claims in 2015/16. On a post-tax basis, this becomes 1.09 / 0.586 – 1 = 86.01%, which is an increase of 21.7% from a tax on premiums of 9% (roughly 2.4 times the size of the tax). The price elasticity of demand can be related to the elasticity w.r.t tax by -1.34 / 2.4 = -0.56, which is the calibrated price elasticity of demand for ESL-liable general insurance demanded by households in VURMTAX. While some ESL load falls on industries, we retain the usual Leontief demand structure by industries for intermediate inputs to production that underpins VURM and VURMTAX [see Adams *et al*. (2015)].

[23] See https://www.revenue.nsw.gov.au/help-centre/resources-library/statistics.

registered land owner, and disaggregates the portfolios by land use type. Both the taxable value and land tax payable for all portfolio holdings are reported. To split tax collected across land use type, we disaggregate NSW Valuer General (2017) residential land values into two density types (low- and high-density) and two tenure types (owner-occupied and rented varieties). This split relies on Australian Census data on the number of residential properties in NSW, and their tenure and density split, as well as data from Planning NSW on the size of low- and high-density housing land plots.[24] Using this data, we arrive at the land value distribution for NSW summarised in Figure 4.

Having split owner-occupied from rented housing land on a value basis, we use Revenue NSW parcel land parcel holdings data and a bi-proportional scaling algorithm to determine the land tax collected from residential, agricultural, commercial, industrial and other, i.e., public use and mining, land. Our summary collection shares are presented in Figure 5.

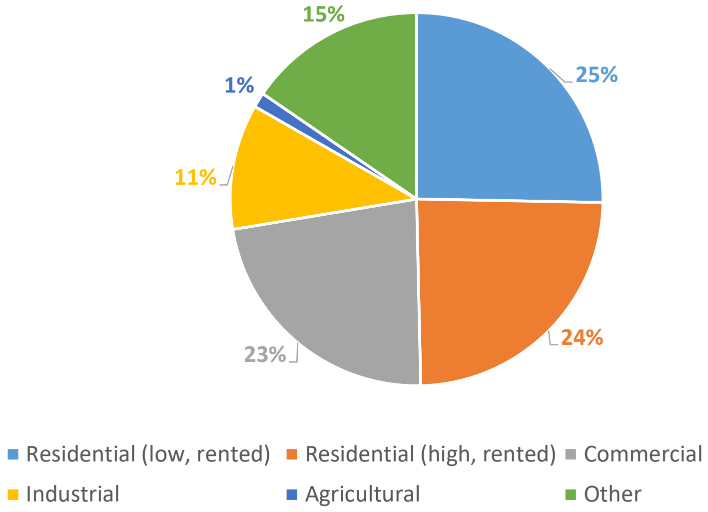
Figure 4: Land value shares for NSW land in 2017 (authors calculations, using Australian Census, ABS and NSW Valuer General data).



---

[24] See https://www.planning.nsw.gov.au/-/media/Files/DPE/Reports/finalisation-report-housing-diversity-2015-06-24.ashx

Figure 5: SLT collection shares for NSW land in 2017 (authors calculations).



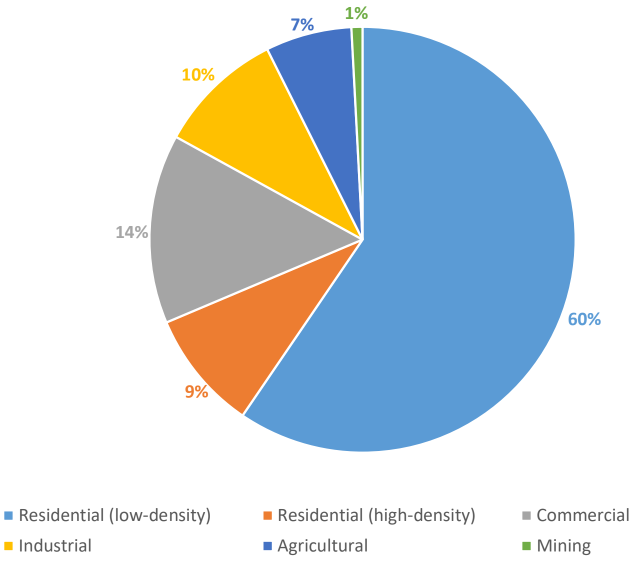
2.3.4. *Modelling local council rates (LCR)*

As discussed by Nassios *et al.* (2019b), LCR in NSW are levied on unimproved land values (UIV), which values properties excluding any buildings, structures and other capital improvements [IPART (2016)]. While the applicable ad valorem rate differs depending on the land zone type, LCR carry few exemptions. This distinguishes LCR in NSW from NSW SLT, which exempts the principal place of residence, primary producer land, and charity, social service and public sector land. Herein, we use data from ABS Cat. No. 5512.0 to calibrate aggregate LCR collections in the base year of the VURMTAX database. We distribute this across VURMTAX industries using data from Your Council NSW[25], with approximately 68.6 percent of total rates revenue collected from housing and the remainder collected from agricultural (6.4 percent), Commercial and Industrial (24.2 percent), and Mining land (0.73 percent). This breakdown across land use type is summarised in Figure 6.

---

[25] See https://www.yourcouncil.nsw.gov.au/nsw-overview/finances/ for 2016/17.

Figure 6: LCR collection shares for NSW land in 2017 (authors calculations using Your Council NSW and NSW Valuer General data).



To determine aggregate revenue growth over time, we rely on ABS Taxation Statistics data up to 2019/20. For 2021, 2022 and subsequent years, we impose NSW Independent Pricing and Regulatory Tribunal (IPART) rate growth targets of 2.6 percent, 2.0 percent, and 2.5 percent as the annual growth rate in collections for our baseline forecast.[26]

2.3.5. Introducing broad-based taxes on unimproved land values (BBUIV)

As outlined in section 2.2, this paper considers the housing price impact of replacing combinations of the aforementioned four existing state taxes with combinations of three hypothetical new taxes. The most economically efficient of the three new taxes are broad-based taxes on unimproved land values. These new indirect taxes are modelled in a similar way to LCR, although collections by land type, i.e., housing, agricultural and business land, differ because the rate of the hypothetical land tax introduced, per dollar of unimproved land value, is uniform across land types. This means that, for each dollar of additional revenue, collection shares more closely resemble those in Figure 4 than those for LCR in Figure 6.

---

[26] See the IPART NSW targets at https://www.ipart.nsw.gov.au/Home/Industries/Local-Government/For-Ratepayers/The-rate-peg.

2.3.6. Introducing broad-based taxes on capital-improved land values (BBCIV)

The IPART (2016) review into the NSW local government rating system suggested that moving to a capital-improved value (CIV) tax base for LCR would be preferable in selected local government areas, or for a new multi-unit housing rating class. Herein, we investigate the effect of replacing some existing NSW taxes with hypothetical broad-based taxes on CIV. This system of taxation is already accounted for in VURMTAX however is inactive in NSW. It applies as the means by which Victoria, South Australia, Tasmania and parts of Western Australia raise their LCR revenues [Passant and Mclaren (2011); IPART (2016); Local Government Rating Review Ministerial Panel (2019)]. In introducing this system of taxation in NSW, we assume that the capital component of a structures' value is determined according to its replacement cost. In section 3.1.6, we will see that because the replacement cost in year *t* is a function of capital investment that occurred in previous time periods, capital-improved value taxes can be evaded by under-investment, i.e., UIV is a more efficient tax base because it does not alter investor decision making.

2.3.7. Introducing narrow-based taxes on capital-improved land values (NBCIV)

Finally, we also consider the impact of introducing a new, narrow-based tax levied on a CIV basis in NSW, i.e., a CIV tax that carries the same principal place of residence (PPR) and primary producer land (PPL) exemptions as the current NSW SLT. To model the hypothetical NBCIV, we embed new theory in VURMTAX that relies on the framework used by Nassios *et al.* (2019b) to model the PPR and PPL exemptions from NSW SLT. This new theory generalises the existing NB-UIV framework that applies for SLT in all jurisdictions except the Northern Territory of Australia (NT), to allow for an alteration of the tax base from UIV to CIV.

2.4. Property taxes and housing prices in a multiregional model of Australia

This section begins with an outline of the equations underlying the VURMTAX housing price module. We also describe how this module is linked to the core CGE model. In section 2.4.2, we describe how short-run deviations in housing prices from housing construction costs can drive real investment activity in VURMTAX. Sections 2.4.3 – 2.4.9 describe the direct and indirect channels via which property tax reform can influence housing prices, with reference to the equation system we present in section 2.4.1.

2.4.1. Modelling housing prices in VURMTAX

We require equations for the market price of housing capital and land for two housing types (low-density housing and high-density housing), $i \in \{\mathrm{DwellingLow}, \mathrm{DwellingHigh}\}$, in region *q* at time *t*.[27] Herein, we write the present value of a housing structure $\mathrm{PVS}_{i,q,t}$ as a sum of two components, being the present value of the capital representing the building structure ($\mathrm{PVC}_{i,q,t}$), and the present value of the land upon which the structure is located ($\mathrm{PVL}_{i,q,t}$). $\mathrm{PVC}_{i,q,t}$ and $\mathrm{PVL}_{i,q,t}$ will depend on:

(a) transaction taxes (e.g., property transfer duty levied at a rate $\mathrm{RTD}_{i,q,t}$ on the taxable base; more on this shortly);

(b) the present value of future income from these assets (defined as $\mathrm{PV\_CAPINC}_{i,q,t}$ for post-tax capital income, and $\mathrm{PV\_LNDINC}_{i,q,t}$ for post-tax land income, respectively); and

(c) the discounted income receivable upon sale of the asset at some future date ($\mathrm{PV@SALE\_C}_{i,q,t}$ and $\mathrm{PV@SALE\_L}_{i,q,t}$ for housing capital and housing land respectively).

Suitable general forms for $\mathrm{PVC}_{i,q,t}$ and $\mathrm{PVL}_{i,q,t}$ are thus:

$$\mathrm{PVC}_{i,q,t} = -\frac{\mathrm{RTD}_{i,q,t}}{2} \cdot \mathrm{PVC}_{i,q,t} + \mathrm{PV\_CAPINC}_{i,q,t} + \mathrm{PV@SALE\_C}_{i,q,t}, \qquad \mathbf{(1)}$$

$$\mathrm{PVL}_{i,q,t} = -\frac{\mathrm{RTD}_{i,q,t}}{2} \cdot \mathrm{PVL}_{i,q,t} + \mathrm{PV\_LNDINC}_{i,q,t} + \mathrm{PV@SALE\_L}_{i,q,t}, \qquad \mathbf{(2)}$$

Note that in (1) and (2) we assume that half the TD is borne by the buyer, and the other half by the seller. The half borne by the buyer appears explicitly as RTD/2 in both equations. The half that is borne by the seller is embedded in the two PV@SALE terms (see equations 20 and 21 below).

Henceforth, we constrain our discussion of the parameterisation of this model to one region of Australia, *q* = NSW. In line with TDs introduced by the Australian colonies prior to Federation, the

---

[27] Low-density housing comprise detached and semi-detached housing, while high-density housing comprise apartments.

dutiable tax base across all regions and for all property types remains the value of the property transacted, i.e., the market value of the capital/land bundle transacted or:

$$PVS_{i,q,t} = PVC_{i,q,t} + PVL_{i,q,t} \ . \quad \textbf{(3)}$$

The applicable TD rates and thresholds differ by jurisdiction, with top-tier duty rates ranging from 4.5 percent of the property value above A$725 000 in Tasmania, to 7.0% for housing valued above A$3 million in NSW in 2017/18 [NSW Treasury (2018)]. The initial housing price ($PVS_{i,NSW,2017}$) and the initial level of the TD rate on housing in NSW (denoted $RTD_{i,NSW,2017}$ henceforth) are important inputs to our housing price module. To parameterise $PVS_{i,NSW,2017}$, we rely initially on high- and low-density housing price data from Domain, and re-weighted these prices to align the total value of the housing stock to match the value for June 2017 of $2.428 trillion from the ABS residential property price index series data.[28] For $RTD_{i,NSW,2017}$, we use $PVS_{i,NSW,2017}$, TD revenue statistics for 2016/17 from Revenue NSW, and housing sales data from the NSW Valuer General to determine the average TD rate on low- and high-density existing housing sales. This approach yields $RTD_{DwellingLow,NSW,2017} = 4.49\%$ and $RTD_{DwellingHigh,NSW,2017} = 4.11\%$. Given the initial housing price level, $PVS_{i,q,2017}$ and initial TD rates $RTD_{i,q,2017}$, we model progressivity in $RTD_{i,q,t}$ according to:

$$\begin{aligned} RTD_{i,q,t} &= \frac{RTD_{i,q,2017} \cdot PVS_{i,q,2017} + RATE\_BRACK_{i,q,t} \cdot \left(PVS_{i,q,t} - PVS_{i,q,2017}\right)}{PVS_{i,q,t}} \\ &= RATE\_BRACK_{i,q,t} - \frac{PVS_{i,q,2017}}{PVS_{i,q,t}} \cdot \left(RATE\_BRACK_{i,q,t} - RTD_{i,q,2017}\right), \end{aligned} \quad \textbf{(4)}$$

where $RATE\_BRACK_{DwellingLow,NSW,2017} = 5.5\%$ and $RATE\_BRACK_{DwellingHigh,NSW,2017} = 4.5\%$ for all *t*.

Having defined the TD rate schedule $RTD_{i,q,t}$, we can continue to unpack the expressions in equations (1) and (2). First, we define the annual post-tax capital and land income earned for each house of type *i* in period *t* by a housing property owner as:

$$UNITINC\_C_{i,q,t} = \left(QC_{i,q,t} - D_{i,q} \cdot CON\_COST_{i,q,t}\right)\left(1 - \sum_{l} TC_{l,i,q,t}\right) \cdot \left(1 - T_{FEDERAL,i,q,t}\right), \quad \textbf{(5)}$$

$$UNITINC\_L_{i,q,t} = QL_{i,q,t} \cdot \left(1 - \sum_{l} TL_{l,i,q,t}\right) \cdot \left(1 - T_{FEDERAL,i,q,t}\right). \quad \textbf{(6)}$$

---

[28] This yields average prices of A$984.966K for low-density housing, and A$564.54K for high-density housing, respectively.

where

$UNITINC\_C_{i,q,t}$	is the post-tax capital income in A$m at time *t* derived from a unit of housing capital of density type *i* in region *q;*
$UNITINC\_L_{i,q,t}$	is the post-tax land income in A$m at time *t* derived from a unit of housing land of density type *i* in region *q;*
$QC_{i,q,t}$	is the return in year *t* on a unit of new housing capital installed in housing industry *i* in region *q*;
$QL_{i,q,t}$	is the pre-tax return in year *t* on a unit of land employed in housing industry *i* in region *q*;
$D_{i,q}$	is the depreciation rate on a unit of housing capital installed in housing industry *i* in region *q*;
$CON\_COST_{i,q,t}$	is the book value or replacement cost of a new unit of physical capital installed in housing industry *i* in region *q* in year *t*. This also includes an element of property TD, namely duty paid on purchases of new housing (note that RTD relates to transfers of existing properties);
$TL_{l,i,q,t}$	is the direct tax rate on the rent earned on a unit of land employed in housing industry *i* in region *q* in year *t*, from tax line $l \in$ (*SLT, LCR*, *BBUIV*, *BBCIV*, *NBCIV*), e.g., state land tax (SLT), local council rates (LCR) or hypothecated property taxes (BBUIV, BBCIV and NBCIV) paid on land used to produce output by industry *i* operating in region *q* in year *t*; and
$TC_{l,i,q,t}$	is the direct tax rate on the rent earned on a unit of physical capital installed in housing industry *i* in region *q* in year *t*, from tax line *l*, e.g., the portion of capital-improved taxes incident on the buildings, structures or home improvements use by industry *i* in region *q* in year *t*;

In writing equations (5) and (6), we allow for federal taxes levied at the rate $T_{FEDERAL,i,q,t}$. Why is this necessary when owner-occupied housing is tax exempt? Because rented housing income is not personal income tax exempt in general, and this depends on the share of rented tenure housing, which in turn differs across low- and high-density housing. Other variables in equations (5) and (6) adopt their earlier definitions, and are natural outputs of a CGE simulation in VURMTAX.

We would like to use these and other natural outputs from VURMTAX to derive expressions for the average market price of a house of density type $i \in \{\text{DwellingLow}, \text{DwellingHigh}\}$ in region *q* at time *t*. To this end, we define the expected value of the annual capital and land income streams in equations (3) and (4) that are earned over the expected holding period $H_{i,q,t}$ of the property as:

$$PV\_CAPINC_{i,q,t} = \int_0^{H_{i,q,t}} \frac{UNITINC\_C_{i,q,T}}{\left(1+NR_{i,q,T}\right)^T} dT, \qquad \textbf{(7)}$$

$$PV\_LNDINC_{i,q,t} = \int_0^{H_{i,q,t}} \frac{UNITINC\_L_{i,q,T}}{\left(1+NR_{i,q,T}\right)^T} dT, \qquad \textbf{(8)}$$

where all previously defined quantities take their expected values over the expected holding period of the property, and we define the expected nominal discount rate for income derived from an investment in industry *i* in region *q* at time *t* as $NR_{i,q,t}$. The initial level of the nominal cost of funds is set uniformly across *i* and *q*, i.e., $NR_{i,q,2017} = NR_{2017}$, and aligned to the average mortgage rate in Australia for 2017. Using the Reserve Bank of Australia (RBA) data series on historical mortgage rates, this was set to 3.5 percent.[29] To complete the parameterisation of equations (7) and (8), we set the initial level of the holding period $H_{i,q,t}$ for $i \in \{\text{DwellingLow}, \text{DwellingHigh}\}$ housing in *q* = NSW to $H_{DwellingLow,NSW,2017}$=24.6 and $H_{DwellingHigh,NSW,2017}$=9.2 years, respectively. These figures are derived in the following way:

(a) To begin, we source data on NSW housing transactions by house type for 2017, $TRANSACTION_{i,NSW,2017}$, from the NSW Valuer General;

(b) Next, we take low- and high-density housing counts $QHOU_{i,NSW,2017}$ from the Australian Bureau of Statistics (ABS);

(c) We calculate density-specific turnover rates by taking the ratio of (a) and (b):

---

[29] In our baseline forecast, we exogenously impose a time-path for $NR_{i,q,t}$ that is consistent with a long-run real discount rate, i.e., $1/RDISC_{A,i,NSW,2040} - 1$, of 3 percent for $i \in \{\text{DwellingLow}, \text{DwellingHigh}\}$.

$$\mathrm{TURNOVER}_{i,q,t} = \frac{\mathrm{TRANSACTION}_{i,q,t}}{\mathrm{QHOU}_{i,q,t}}, \tag{9}$$

(d) Finally, the holding periods $\mathrm{H}_{i,q,t}$ we reported are calculated as the reciprocal of the turnover rates in equation (10):

$$\mathrm{H}_{i,q,t} = \frac{1}{\mathrm{TURNOVER}_{i,q,t}}. \tag{10}$$

The level of the holding period at time *t* differs from that at time *t*-1 in general throughout a VURMTAX simulation, with percentage changes in $\mathrm{H}_{i,q,t}$, defined as $\mathrm{p\_H}_{i,q,t}$, endogenously determined in terms of variations in other naturally endogenous variables. To elaborate, we first link the percentage changes in the level of transaction volumes $\mathrm{TRANSACTION}_{i,q,t}$ (which we define as $\mathrm{p\_transaction}_{i,q,t}$), to percentage changes in real demand for moving services by households[30] in region *q* at time *t* (denoted $\mathrm{p\_moveres}_{q,t}$) in the core CGE model:

$$\mathrm{p\_transaction}_{i,q,t} = \mathrm{p\_moveres}_{q,t}. \tag{11}$$

Next, the percentage change in the number of housing structures $\mathrm{QHOU}_{i,q,t}$ (denoted $\mathrm{p\_qhou}_{i,q,t}$ herein) is linked to:

(a) cumulative percentage changes in $\mathrm{QCAP}_{i,q,t}$, the size of the stock of housing capital of density type *i* in region *q* at time *t* (denoted $\mathrm{x1cap}_{i,q,t}$); and,

(b) cumulative percentage changes in $\mathrm{QLND}_{i,q,t}$, the quantity of high- and low-density housing land releases (denoted $\mathrm{x1\ln d}_{i,q,t}$).

Putting this together yields the expression for $\mathrm{p\_qhou}_{i,q,t}$ in equation (12):

$$\mathrm{p\_qhou}_{i,q,t} = \frac{\mathrm{QCAP}_{i,q,t} \cdot \mathrm{x1cap}_{i,q,t} + \mathrm{QLND}_{i,q,t} \cdot \mathrm{x1\ln d}_{i,q,t}}{\mathrm{QCAP}_{i,q,t} + \mathrm{QLND}_{i,q,t}}. \tag{12}$$

With equations (11) and (12) in place, we take the total derivative of equation (10) and arrive at an expression for $\mathrm{p\_H}_{i,q,t}$:

$$\begin{aligned} \mathrm{p\_H}_{i,q,t} &= -\left(\mathrm{p\_transaction}_{i,q,t} - \mathrm{p\_qhou}_{i,q,t}\right), \\ &= \mathrm{p\_qhou}_{i,q,t} - \mathrm{p\_moveres}_{q,t}. \end{aligned} \tag{13}$$

---

[30] The price elasticity for this bundle of goods is calibrated to match the elasticity with respect to tax of 0.6 estimated by Davidoff and Leigh (2013) and Adams *et al.* (2020).

With the initial level of $\mathrm{H}_{\mathrm{i,q,t}}$ defined and equations derived to endogenously evaluate $\mathrm{p\_H}_{\mathrm{i,q,t}}$, we can reduce equations (7) and (8) to simpler forms by making three assumptions:

(a) We assume that the year-*T* post-tax income from factor $A \in \{\mathrm{CAP, LND}\}$, $\mathrm{UNITINC\_A}_{\mathrm{i,q,T}}$, accrues to the property owner at a uniform rate over the course of a year *T*;

(b) We assume $\mathrm{UNITINC\_A}_{\mathrm{i,q,T}}$ is related to the current period (defined throughout as time period *t*) unit income $\mathrm{UNITINC\_A}_{\mathrm{i,q,t}}$, by the relationship:

$$\mathrm{UNITINC\_A}_{\mathrm{i,q,T}} = \mathrm{UNITINC\_A}_{\mathrm{i,q,t}} \cdot \Pi_{\tau=0}^{\mathrm{T}} \left(1 + \mathrm{G}_{\mathrm{A,i,q,}\tau}\right), \tag{14}$$

where the expected nominal growth rate in income from factor *A*, denoted $\mathrm{G}_{\mathrm{A,i,q,}\tau}$, is initially homogenous for $A \in \{\mathrm{CAP, LND}\}$. Given $\mathrm{G}_{\mathrm{A,i,q,}\tau}$ and NR_{τ}, we define the expected real discount factor $\mathrm{RDISC}_{\mathrm{A,i,q,T}}$ at time *T* as:

$$\mathrm{RDISC}_{\mathrm{A,i,q,T}} = \frac{\left(1 + \mathrm{G}_{\mathrm{A,i,q,T}}\right)}{\left(1 + \mathrm{NR}_{\mathrm{T}}\right)}. \tag{15}$$

Substituting (15) into (7) and (8) yields:

$$\mathrm{PV\_CAPINC}_{\mathrm{i,q,t}} = \mathrm{UNITINC\_C}_{\mathrm{i,q,t}} \int_{0}^{\mathrm{H}_{\mathrm{i,q,t}}} \Pi_{\tau=0}^{\mathrm{T}} \left(\mathrm{RDISC}_{\mathrm{CAP,i,q,}\tau}\right) \mathrm{dT}, \tag{16}$$

$$\mathrm{PV\_LNDINC}_{\mathrm{i,q,t}} = \mathrm{UNITINC\_L}_{\mathrm{i,q,t}} \int_{0}^{\mathrm{H}_{\mathrm{i,q,t}}} \Pi_{\tau=0}^{\mathrm{T}} \left(\mathrm{RDISC}_{\mathrm{LND,i,q,}\tau}\right) \mathrm{dT}, \tag{17}$$

where $\mathrm{RDISC}_{\mathrm{A,i,q,T}}$ for $0 < \mathrm{T} < \mathrm{H}_{\mathrm{i,q,t}}$ is the expected real discount factor at time *t+T,* as determined by investors who are assessing the market price of a housing structure at time *t*.

(c) Evaluating equations (16) and (17) thus reduces to the problem of evaluating the integral of the expected real discount factor $\mathrm{RDISC}_{\mathrm{A,i,q,T}}$ over the expected holding period for a house of type *i* in region *q*. A common assumption in evaluating the integrals of the form of those in equations (16) and (17) is to assume $\mathrm{RDISC}_{\mathrm{A,i,q,}\tau} = \mathrm{RDISC}_{\mathrm{A,i,q,t}}$, i.e., investors expect the real discount factor to remain constant and equal to the discount rate calculated using known base period *t* nominal mortgage rates and income growth rates, across the holding period of the property. Under this assumption, the integrals in equations (16) and (17) become geometric progressions and take simple forms that can be readily evaluated:

$$\int_{0}^{\mathrm{H}_{\mathrm{i,q,t}}} \left(\mathrm{RDISC}_{\mathrm{A,i,q,t}}\right)^{\mathrm{T}} \mathrm{dT} = \frac{\left(\mathrm{RDISC}_{\mathrm{A,i,q,t}}\right)^{\mathrm{H}_{\mathrm{i,q,t}}} - 1}{\log\left(\mathrm{RDISC}_{\mathrm{A,i,q,t}}\right)}. \tag{18}$$

Herein we relax this assumption and allow for time-dependent real discount factors $\mathrm{RDISC}_{\mathrm{A,i,q,t}}$ of the following form:

$$\mathrm{RDISC}_{\mathrm{A,i,q},\tau} = \mathrm{RDISC}_{\mathrm{A,i,q,t}} \cdot \exp\left(-\frac{\tau}{\mathrm{S}_{\mathrm{i,q,t}}}\right), \tag{19}$$

where $\mathrm{RDISC}_{\mathrm{A,i,q,t}}$ is the current real discount rate for housing, and $\mathrm{S}_{\mathrm{i,q,t}}$ is a dimensionless parameter that is chosen to yield reasonable values for $\mathrm{RDISC}_{\mathrm{A,i,q,h}_{\mathrm{i,q,t}}}$, i.e., we calibrate $\mathrm{S}_{\mathrm{i,q,t}}$ so long-run real discount factors are between 2.5 and 3 percent. This is important in the current economic climate, because Australian real discount factors in the housing market are very close to 1. The implication from this is that real discount rates in the housing sector are close to zero. The scale parameter can be exogenously adjusted to ensure these expectations remain consistent over a simulation period, i.e., as the base period real discount rate $\mathrm{RDISC}_{\mathrm{A,i,q,t}}$ approaches a value between 2.5 and 3 percent we can increase the level of $\mathrm{S}_{\mathrm{i,q,t}}$ to flatten the expected discount rate curve implied by equation (16). With equation (19) in place, we define the integrals that appear in equations (16) and (17) as the all-time discount factor $\mathrm{ATDFACT}_{\mathrm{A,i,q,t}}$, which can be manipulated to yield the functional form in equation (20):

$$\begin{aligned}
\mathrm{ATDFACT}_{\mathrm{A,i,q,t}} &= \int_{0}^{\mathrm{H}_{\mathrm{i,q,t}}} \Pi_{\tau=0}^{\mathrm{T}}\left(\mathrm{RDISC}_{\mathrm{A,i,q},\tau}\right)\mathrm{dT} \\
&= \mathrm{RDISC}_{\mathrm{A,i,q,t}} \int_{0}^{\mathrm{H}_{\mathrm{i,q,t}}} \mathrm{RDISC}_{\mathrm{A,i,q,t}}^{\mathrm{T}} \cdot \exp\left(-\frac{\mathrm{T}\cdot(\mathrm{T}+1)}{2\mathrm{S}_{\mathrm{i,q,t}}}\right)\mathrm{dT} \\
&= \sqrt{\frac{\pi \cdot \mathrm{RDISC}_{\mathrm{A,i,q,t}} \cdot \mathrm{S}_{\mathrm{i,q,t}}}{2}} \cdot \exp\left(\frac{\mathrm{S}_{\mathrm{i,q,t}} \cdot \log^{2}\left[\mathrm{RDISC}_{\mathrm{A,i,q,t}}\right]}{2} + \frac{1}{8\mathrm{S}_{\mathrm{i,q,t}}}\right) \\
&\quad \cdot \left[\mathrm{erf}\left(\frac{2\mathrm{S}_{\mathrm{i,q,t}} \cdot \log\left(\mathrm{RDISC}_{\mathrm{A,i,q,t}}\right) - 1}{2\sqrt{2\mathrm{S}_{\mathrm{i,q,t}}}}\right)\right. \\
&\quad \left. -\mathrm{erf}\left(\frac{-2\mathrm{H}_{\mathrm{i,q,t}} + 2\mathrm{S}_{\mathrm{i,q,t}} \cdot \log\left(\mathrm{RDISC}_{\mathrm{A,i,q,t}}\right) - 1}{2\sqrt{2\mathrm{S}_{\mathrm{i,q,t}}}}\right)\right],
\end{aligned} \tag{20}$$

where the error function is defined in the usual way as $\mathrm{erf}(z) = 2/\sqrt{\pi}\int_{0}^{z} e^{-t^{2}}dt$. With $\mathrm{ATDFACT}_{\mathrm{A,i,q,t}}$ so defined, equations (16) and (17) reduce to:

$$PV\_CAPINC_{i,q,t} = UNITINC\_C_{i,q,t} \cdot ATDFACT_{CAP,i,q,t}, \quad \textbf{(21)}$$

$$PV\_LNDINC_{i,q,t} = UNITINC\_L_{i,q,t} \cdot ATDFACT_{LND,i,q,t}. \quad \textbf{(22)}$$

Having defined $RTD_{i,q,t}$, $ATDFACT_{A,i,q,t}$ and $H_{i,q,t}$, we are left to derive expressions for the present value of the housing capital and land at the end of the expected holding period, $PV@SALE\_C_{i,q,t}$ and $PV@SALE\_L_{i,q,t}$ respectively, first introduced in equations (1) and (2). To this end, we make two additional assumptions:

(i.) As discussed by Freebairn (2017), the economic incidence of stamp duty is a function of both the price elasticity of buyers, and the price elasticity of sellers. Herein, we adopt a similar assumption to Freebairn (2017) and model the economic incidence of the tax as falling proportionately on both;

(ii.) Assuming static expectations and that the economic incidence of stamp duty is as outlined in (i) above, $PV@SALE\_C_{i,q,t}$ and $PV@SALE\_L_{i,q,t}$ can be written in terms of the current replacement cost of capital $CON\_COST_{i,q,t}$, the present value of land $PVL_{i,q,t}$, the current rate of transfer duty $RTD_{i,q,t}$ and the holding period $H_{i,q,t}$:

$$PV@SALE\_C_{i,q,t} = \left(1 - \frac{RTD_{i,q,t}}{2}\right) \cdot LRDFACT_{CAP,i,q,t} \cdot CON\_COST_{i,q,t}, \quad \textbf{(23)}$$

$$PV@SALE\_L_{i,q,t} = \left(1 - \frac{RTD_{i,q,t}}{2}\right) \cdot LRDFACT_{LND,i,q,t} \cdot PVL_{i,q,t}. \quad \textbf{(24)}$$

where we have defined the long-run discount factor $LRDFACT_{A,i,q,t}$ as:

$$\begin{aligned} LRDFACT_{A,i,q,t} &= \Pi_{T}^{H_{i,q,t}}\left(RDISC_{A,i,q,T}\right) \\ &= RDISC_{A,i,q,t}^{H_{i,q,t}} \cdot \exp\left(-\frac{H_{i,q,t}\left[H_{i,q,t}+1\right]}{2S_{i,q,t}}\right), \end{aligned} \quad \textbf{(25)}$$

With the present value of the income stream from housing land and capital defined by equations (21) and (22), and the present value of the realisable future income on sale from housing capital and land defined by equations (23) and (24), we can substitute these expressions into equations (1) and (2) to yield the following equations for $PVC_{i,q,t}$ and $PVL_{i,q,t}$:

$$\begin{aligned}\left(1+\frac{\mathrm{RTD}_{i,q,t}}{2}\right)\cdot \mathrm{PVC}_{i,q,t} &= \mathrm{ATDFACT}_{\mathrm{CAP},i,q,t}\cdot\left(\mathrm{QC}_{i,q,t}-\mathrm{D}_{i,q}\cdot \mathrm{CON\_COST}_{i,q,t}\right)\\ &\quad\cdot\left(1-\sum_{l}\mathrm{TC}_{l,i,q,t}\right)\cdot\left(1-\mathrm{T}_{\mathrm{FEDERAL},i,q,t}\right)\\ &\quad+\left(1-\frac{\mathrm{RTD}_{i,q,t}}{2}\right)\cdot \mathrm{LRDFACT}_{\mathrm{CAP},i,q,t}\cdot \mathrm{CON\_COST}_{i,q,t},\end{aligned} \qquad \textbf{(26)}$$

$$\begin{aligned}\mathrm{PVL}_{i,q,t} &= -\frac{\mathrm{RTD}_{i,q,t}}{2}\cdot \mathrm{PVL}_{i,q,t}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{LND},i,q,t}\right)\\ &\quad+\mathrm{ATDFACT}_{\mathrm{LND},i,q,t}\cdot \mathrm{QL}_{i,q,t}\cdot\left(1-\sum_{l}\mathrm{TL}_{l,i,q,t}\right)\cdot\left(1-\mathrm{T}_{\mathrm{FEDERAL},i,q,t}\right)\\ &\quad+\mathrm{LRDFACT}_{\mathrm{LND},i,q,t}\cdot \mathrm{PVL}_{i,q,t}.\end{aligned} \qquad \textbf{(27)}$$

Equations (26) and (27) determine $\mathrm{PVC}_{i,q,t}$ and $\mathrm{PVL}_{i,q,t}$. Substituting equations (4), (26) and (27) into equation (3), yields an expression for the value of a housing structure $\mathrm{PVS}_{i,q,t}$ of type *i* in region *q* at time *t*.

With regard to the initial values for $\mathrm{PVS}_{i,q,2017}$, we target aggregate values of the housing stock for density type *i* across each of Australia's states and territories *q* that align with ABS and Domain housing price data, via endogenous determination of the initial income inflation rates from equation (14), $\mathrm{G}_{\mathrm{CAP},i,q,2017}=\mathrm{G}_{\mathrm{LND},i,q,2017}$.[31,32]

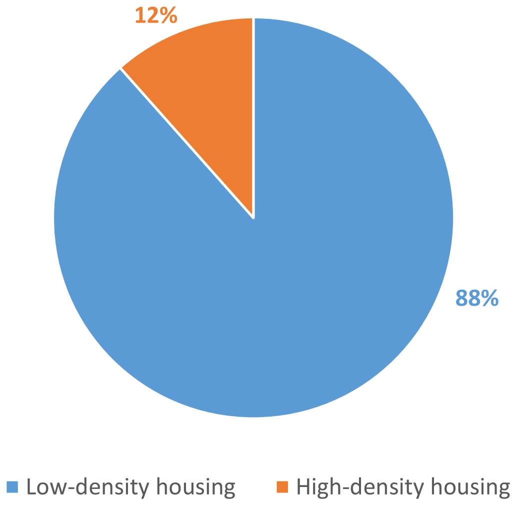
The assumptions and equation system outlined herein yield initial capital value shares for NSW housing of $\mathrm{PVC}_{\mathrm{DwellingLow,NSW,2017}}/\mathrm{PVS}_{\mathrm{DwellingLow,NSW,2017}}=0.38$ and $\mathrm{PVC}_{\mathrm{DwellingHigh,NSW,2017}}/\mathrm{PVS}_{\mathrm{DwellingHigh,NSW,2017}}=0.63$, respectively, with low-density housing making up 88 percent of the NSW housing stock, on a value-weighted basis; see the summary in Figure 7.

---

[31] When we set *q*=NSW, this calibration process yields $G_{\mathrm{A,DwellingLow,NSW,2017}}$ =0.031675 and $G_{\mathrm{A,DwellingLow,NSW,2017}}$ =0.0299.

[32] We set the total number of NSW housing in line with ABS residential property price index series for June 2017. To split the total number of houses in NSW between high- and low-density housing, we took the count of apartments in NSW from Census data for 2016, which shows there were 1.214 million occupied apartments in Australia, 47 percent of which were located in NSW. Finally, we took average apartment and detached house prices in NSW from the Domain House Price report (see https://www.domain.com.au/research/house-price-report/june-2017/), and re-weighted these prices to align the total value of the housing stock to match the value for June 2017 of $2.428 trillion from the ABS residential property price index series data. The present value of low- and high-density housing, $PVS_{i,q,2017}$, in VURMTAX is thus specified by equations (1) and (7) – (9). To ensure these values align with the ABS residential property price index data is achieved by calibrating the inflation rate $G_{i,q}$. When we set *q*=NSW, this calibration process yields $G_{\mathrm{A,DwellingLow,NSW}}$ =0.0260 and $G_{\mathrm{A,DwellingHigh,NSW}}$ =0.0226.

Figure 7: The value-weighted share of low- and high-density housing structures in VURMTAX.



Next, we briefly summarise how each of the seven taxes studied in this paper affect housing prices via the system of equations presented in this section.

2.4.2. The role of asset price valuations in investment

To link short-run deviations in the market price of housing capital $PVC_{i,q,t}$ to investment in housing, we begin with the inverse logistic investment behaviour described by Dixon and Rimmer (2002) for the MONASH model of Australia. The key features of the investment theory by Dixon and Rimmer (2002) are:

i. every industry has its own variety of capital, which is updated annually according to a perpetual inventory calculation;

ii. every industry undertakes investment according to an industry-specific expenditure profile;

iii. industry investment is a positive function of the industry's expected equilibrium post-tax rate of return, given by the inverse logistic function described in Dixon and Rimmer (2002) and calibrated to a trend rate of capital growth and an industry-specific "normal" rate of return;

iv. the disequilibrium component of the expected rate of return is eliminated gradually over several time periods in the simulation, so that rates of return and the capital growth rate converge to long-run normal or trend settings;

v. expectations are adaptive, i.e., in year *t* the expected rate of return on capital in year *t* + 1 is equal to the actual rate of return on capital in year *t*.

The Dixon and Rimmer (2002) derivation begins with a derivation of the present value $\mathrm{PV}_{i,q,t}$ of a unit of physical capital in industry *i*, purchased in period *t*:

$$\mathrm{PV}_{i,q,t} = -\mathrm{CON\_COST}_{i,q,t} + \mathrm{RDISC}_t \cdot \left[\mathrm{UNITINC\_C}_{i,q,t+1} + \mathrm{CON\_COST}_{i,q,t+1}\right]. \qquad \textbf{(28)}$$

Dividing through by the base period construction/replacement cost for a unit of capital $\mathrm{CON\_COST}_{i,q,t+1}$ yields a formula for the industry- and region-specific expected rate of return per unit capital, $\mathrm{ROR}_{i,q,t}$:

$$\begin{aligned}\mathrm{ROR}_{i,q,t} &= \frac{\mathrm{PV}_{i,q,t}}{\mathrm{CON\_COST}_{i,q,t}} \\ &= -1 + \mathrm{RDISC}_t \cdot \left[\frac{\mathrm{UNITINC\_C}_{i,q,t+1}}{\mathrm{CON\_COST}_{i,q,t}} + \frac{\mathrm{CON\_COST}_{i,q,t+1}}{\mathrm{CON\_COST}_{i,q,t}}\right].\end{aligned} \qquad \textbf{(29)}$$

Intuitively, equation (29) defines the period-*t* expected rate of return from an investment of $\mathrm{CON\_COST}_{i,q,t+1}$ that takes one period to construct, as being a function of the discount factor RDISC_t, the expected post-tax income earned in period *t*+1, $\mathrm{UNITINC\_C}_{i,q,t+1}$, and the period *t*+1 replacement cost of the capital, $\mathrm{CON\_COST}_{i,q,t+1}$. In Dixon and Rimmer (2002), expectations are adaptive and all *t*+1 quantities on the RHS are replaced by their period *t* analogues.

In VURMTAX we generalise two elements of the standard investor specifications by Dixon and Rimmer (2002):

(i) As described by Dixon and Nassios (2018), we introduce differential tax treatments for local and foreign investors, allowing us to model, for example, Australia's system of dividend imputation.

(ii) We allow for short-run deviations in the market price of capital, $\mathrm{PVC}_{i,q,t}$, from its construction cost $\mathrm{CON\_COST}_{i,q,t}$. The period-*t* expected rate of return in VURMTAX under adaptive expectations then becomes:

$$\mathrm{ROR}_{i,q,t} = -1 + \mathrm{RDISC}_{t} \cdot \left[\frac{\mathrm{UNITINC\_C}_{i,q,t}}{\mathrm{CON\_COST}_{i,q,t}} + \mathrm{Q}_{i,q,t} \right], \qquad \textbf{(30)}$$

where we have introduced Tobin's Q, $\mathrm{Q}_{i,q,t} = \mathrm{PVC}_{i,q,t} / \mathrm{CON\_COST}_{i,q,t}$, or the ratio of the physical asset's market value relative to its replacement cost in period *t* [Kaldor (1966); Tobin and Brainard (1977)].

Typically, the investment sensitivity is calibrated using canonical simulations with macro econometric models [Dixon and Rimmer (2002)]. Herein, we rely on simulated shocks to the Australian cash rate using the MARTIN model described by Ballantyne *et al.* (2020), and the resulting impact of this shock on housing and non-residential investment.[33]

2.4.3. *Direct and indirect impact of property TD on housing prices*

As discussed in section 2.2, TDs in Australia are levied at the time of sale according to a progressive rates scale, where the taxable base is the value of the transferred property. These duties potentially apply to both existing properties, new house and land sales, and residential, commercial, industrial and agricultural properties. TDs on existing residential properties directly affect housing property prices and appear in equations (26) and (27) as an industry- and region-specific rate ($\mathrm{RTD}_{i,q,t}$). TDs

---

[33] Saunders and Tulip (2020) study a similar problem and using a model of the housing market, and compare their findings to the results of simulation using MARTIN.

on new housing affect housing replacement costs and are embedded in $\text{CON\_COST}_{i,q,t}$, which was defined in section 2.4. To make this explicit, we define $\text{CON\_COST}_{i,q,t}$ algebraically as:

$$\text{CON\_COST}_{i,q,t} = \text{P0}_{i,q,t} \cdot \left(1 + \text{RTDN}_{i,q,t}\right), \tag{31}$$

where:

$\text{RTDN}_{i,q,t}$ is the rate of TD on new units of housing in housing industry *i* in region *q*.

$\text{P0}_{i,q,t}$ is the average price of a new unit of housing capital, inclusive of all input costs and indirect taxes except residential TD on new housing (which adds $\text{P0}_{i,q,t} \cdot \text{RTDN}_{i,q,t}$ to the average cost of a new unit of housing).

TDs on commercial properties do not directly affect housing prices, and so they do not appear in the housing price equations. They can, however, exert small indirect effects on house prices, e.g., by competing for scarce labour resources with residential construction service industries. We identify this effect in the simulations reported in section 3.1.1.

2.4.4. Direct and indirect impact of SLT on housing prices

SLT exerts a direct effect on residential housing prices and is represented by $\text{TL}_{\text{SLT,DwellingLow,NSW},t}$, $\text{TL}_{\text{SLT,DwellingHigh,NSW},t}$ in equation (27). From the sign of $\text{TL}_{1,i,q,t}$ in equation (27), we see that the leading-order effect of increases (decreases) in the SLT rate is a decrease (increase) in state housing prices. SLT on non-residential land does not appear in either equation (26) or (27), and hence exerts only indirect effects, e.g., via their effect on interregional migration propensities. We study some of these effects in section 3.1.2.

2.4.5. Direct and indirect impact of LCR on housing prices

LCR on housing affect housing prices directly, via identical channels to those identified above for SLT. In equation (27), LCR on low-density housing are represented by $\text{TL}_{\text{LCR,DwellingLow,NSW},t}$ and

$\mathrm{TL}_{\mathrm{LCR,DwellingHigh,NSW,t}}$. While LCR levied on non-residential land do not appear explicitly in equations (26) and (27), they nevertheless exert an indirect effect on housing prices through general equilibrium effects; see section 3.1.3.

2.4.6. Direct and indirect impact of the ESL on housing prices

The ESL does not appear in either equation (26) or (27), and thus exerts only indirect effects on NSW housing prices. Because a large share of the ESL is collected from home and contents insurance policies, the ESL feeds into real consumer wage rates in NSW. This affects regional migration propensities, which feed into equations (26) and (27) via changes in housing construction costs, and land and capital rentals; see section 3.1.4.

2.4.7. Direct and indirect impact of a BBUIV tax on housing prices

A BBUIV tax on residential and non-residential property would affect housing prices in a similar way to LCR. Specifically, BBUIV taxes on housing are represented by $\mathrm{TL}_{\mathrm{BBUIV,DwellingLow,NSW,t}}$ $\mathrm{TL}_{\mathrm{BBUIV,DwellingHigh,NSW,t}}$ in equation (27) and thus directly affect housing prices. BBUIV taxes levied on non-residential land do not appear explicitly in equations (26) – (27) but nevertheless exert indirect effects on housing prices through general equilibrium effects; see section 3.1.5.

2.4.8. Direct and indirect impact of a BBCIV tax on housing prices

A BBCIV tax on residential properties would impart direct effects on the price of both residential land and capital, via both $\mathrm{TC}_{\mathrm{BBCIV,i,NSW,t}}$ and $\mathrm{TL}_{\mathrm{BBCIV,i,NSW,t}}$, i,e., BBCIV taxes would fall partially on land and capital owners. BBCIV taxes on residential properties would therefore directly affect the value of housing structures and other home improvements because $\mathrm{TC}_{\mathrm{BBCIV,DwellingLow,NSW,t}}$ and $\mathrm{TC}_{\mathrm{BBCIV,DwellingHigh,NSW,t}}$ appear in equation (26), while residential land values are affected because $\mathrm{TL}_{\mathrm{BBCIV,DwellingLow,NSW,t}}$ and $\mathrm{TL}_{\mathrm{BBCIV,DwellingHigh,NSW,t}}$ appear in equation (27). From the sign of $\mathrm{TC}_{\mathrm{l,i,NSW,t}}$ and $\mathrm{TL}_{\mathrm{l,i,NSW,t}}$ in equations (26) and (27), we see that the leading-order effect of increases (decreases) in BBCIV tax rates arise from decreases (increases) in the post-tax rental returns from housing structures and home improvements, and residential land. BBCIV taxes on non-residential properties do not appear in equations (26) and (27), and hence exert only indirect effects. We study some of these effects in section 3.1.6.

2.4.9. Direct and indirect impact of a NBCIV tax on housing prices

As discussed in section 2.3, NBCIV taxes are similar to BBCIV taxes in that the taxable base is the value of land *plus* the replacement value of structure, buildings and improvements, however NBCIV taxes carry the same principal place of residence (PPR) and primary producer land (PPL) exemptions as the current SLT system. Hence, an NBCIV tax on residential properties would fall largely on rented varieties of low- and high-density housing, and affect housing prices via direct effects on residential land prices [$\mathrm{TL}_{\mathrm{NBCIV,i,NSW,t}}$ in equation (26)], and housing structures [via $\mathrm{TC}_{\mathrm{NBCIV,i,NSW,t}}$ in equation (10)]. NBCIV taxes on non-residential property exert indirect effects on housing prices because they do not appear in equations (26) and (27).

2.5. Measuring the economic efficiency of taxation in VURMTAX

The efficiency of a tax instrument can be measured by studying how changes in the rate of the tax or the level of a tax threshold alter the price-sensitive decision making of economic agents like firms, investors and households. These changes in decision making alter the welfare-maximising allocation of finite resources, diminishing real incomes. As discussed in section 2.1, VURMTAX carries the industry, regional and taxation detail required to assess the economic efficiency of elements of the Australian tax system [Nassios *et al.* (2019a; 2019b); Giesecke *et al.* (2021)]. In this paper, we follow the approach by Nassios *et al.* (2019a; 2019b) and Adams *et al.* (2020) and study the economic efficiency of four existing taxes and three hypothetical taxes, by calculating their marginal excess burdens (MEBs) using VURMTAX.

Because VURMTAX is dynamic, it can calculate year-on-year marginal excess burden measures. More specifically, the efficiency loss caused by a tax policy package in time-period *t* at the national (Australia-wide) level (MEB^{t}) is evaluated according to:

$$\mathrm{MEB}^{t} = -100\left[\frac{\Delta \mathrm{GNI}^{t} + \sum_{q} \mathrm{VLEIS}_{q}^{t}}{\sum_{g} \Delta \mathrm{LST}_{g}^{t}}\right], \quad \textbf{(32)}$$

where:

$\Delta \mathrm{GNI}^{t}$	is the deviation between the year *t* counterfactual and BAU forecast value of real gross national income (deflated by a gross national expenditure (GNE) Divisia price index and measured in A$m).
$\Delta \mathrm{VLEIS}_{q}^{t}$	is the deviation in the value of leisure time consumed by residents in region *q* in year *t*, valued at the BAU forecast real consumer wage rate [see Nassios *et al.* (2019a; 2019b) for a description];
$\Delta \mathrm{LST}_{g}^{t}$	is the value of budget-balance neutralising lump sum payments to households by government agent *g*, i.e., NSW and RoA state/local government agent, or the Federal government.

Equation (32) is a measure of the change in real national income, adjusted for changes in the value of leisure, caused by a change to state or federal tax policy that results in a change in the government's capacity to make a budget-neutral transfer to Australian households of $\sum_{g} \Delta \mathrm{LST}_{g}^{t}$. By using the value of aggregate lump sum payments to households in the denominator (rather than, say, revenue raised from the particular tax in question), we take account of general equilibrium effects, including induced changes in revenue raised from other tax bases.

To derive MEBs, we simulate a small reduction or increase in instrument-specific taxation revenue, under the assumption of a balanced government budget. In this paper, we reduce the rate of existing NSW taxes like housing TD by an amount sufficient to cost A$100m in tax-specific revenue in 2022. In contrast, the MEBs of hypothetical (new) taxes are assessed by raising their rate from zero to a level sufficient to raise A$100m in tax-specific revenue, also in 2022. Budget balance is maintained via the endogenous determination of non-distorting lump sum transfers to households that appear in the denominator of equation (32). By calculating the MEB under this assumption, we can rank taxes based on the economic costs generated by the relative price distortions they cause. In section 3.1, we use equation (32) to calculate MEBs for each of the four existing taxes we study herein: specifically, TD, SLT, LCR, and the ESL. We also calculate MEBs for the three hypothetical (new) taxes we study herein: specifically, BBUIV, BBCIV, and NBCIV taxes.

When assessing the economic efficiency consequences of revenue-neutral alterations to the tax mix, i.e., the dollar-for-dollar swap of one tax revenue line for another, equation (32) becomes unsuitable because the denominator is zero. In this case, we calculate the net excess burden (NEB^t) of the tax mix swap using equation (33):

$$\mathrm{NEB}^t = -100\left[\frac{\Delta\mathrm{GNI}^t + \sum_q \mathrm{VLEIS}_q^t}{\sum_g \Delta\mathrm{SR}_g^t}\right], \qquad \textbf{(33)}$$

where $\Delta\mathrm{GNI}^t$ and $\Delta\mathrm{VLEIS}_q^t$ are as defined, and:

$\Delta\mathrm{SR}_g^t$ is the value of swapped tax revenue across levels of government (including any budget-balance preserving lump sum transfers to households).

Equation (33) provides a measure of the loss in national economic welfare per dollar of tax revenue swapped. Negative NEBs therefore represent tax mix alterations that improve welfare. In section 3.2, we use equation (33) to study the efficiency of changes in the property tax mix and contrast the efficiency implications of compositional changes in tax revenue streams with housing price impacts.

3. Results

In this section we discuss VURMTAX results in two stages. First, we discuss the results for MEBs and house prices of changes in each of seven taxes, considered in isolation of changes in other taxes. This provides the background for our second stage, in which we discuss the results for MEBs and house prices of various revenue neutral swaps among our seven taxes.

3.1. Housing price and efficiency impacts of existing and hypothetical taxes

In this section, we study the housing price effects and economic efficiency of the four existing taxes (TD, SLT, LCR and the ESL), and three hypothetical property taxes (BBUIV, BBCIV, and NBCIV). Results are reported in Table 1. The results for tax reductions that forego A$100m in tax-specific revenue in 2022 from the four existing taxes of interest are reported in rows 1 – 4. The results for tax increases that raise A$100m in tax-specific revenue in 2022 from each of the three hypothetical taxes are reported in rows 5 – 7.

The marginal excess burdens (MEBs) calculated using equation (32) for each tax are reported in column [3], while low-density, high-density, and value-weighted (average) housing price deviations are given in columns [4] – [6] respectively. Two sets of results are reported in columns [4] to [6]. In columns [4i], [5i] and [6i], we report the deviation from baseline of the market price, i.e., the price paid at auction from equation (3), for low-density, high-density and average housing prices in NSW. In columns [4ii], [5ii] and [6ii], we report the deviation from baseline of the purchasers price i.e., the market price plus transaction taxes, for low-density, high-density and average housing prices in NSW.

Column [2] is to assist readers with linking each simulation with the underlying exogenous variables that are relevant to implementing each simulation. For any given simulation whose results are reported in a row in Table 1, column [2] summarises any variables that meet two conditions: (i) they appear in equation (26) or equation (27); and, (ii) they were shocked to perform the given simulation. Shocked variables that appear in equations (26) and (27) directly affect housing prices, and column (2) serves to aid readers in linking our simulations (and the reported housing price responses) to the equations that support the VURMTAX housing price module. Finally, we report the deviation from baseline for the NSW CPI in each simulation in column [7].

As discussed in sections 2.3 and 2.4, some of the existing taxes effect economic efficiency and housing prices along more than one channel of economic incidence. This is particularly true for TDs, which simultaneously affect price-sensitive decision making by households (specifically, their demand for moving services), industries, and new housing and non-residential property construction costs (see discussion in section 2.4.1). To understand the underlying drivers of the results for the seven taxes, we performed an additional fifteen VURMTAX simulations. For TDs, this allows us to understand the relative impact on the overall result in row 1 due to:

(a) TD on housing (see the results in row 1.1, where we hold TDs on non-residential property fixed and reduce the rate of TD on housing by an amount sufficient to reduce housing TD revenue by A$100m in 2022), and

(b) TD on non-residential property (see the results in row 1.2, where we hold TDs on housing fixed and reduce the rate of TD on non-residential property by an amount sufficient to reduce non-residential TD revenue by A$100m in 2022).

The simulation output in row 1 can be thought of as a suitably weighted sum of the results in rows 1.1 and 1.2.

But we go further in our decomposition of results. To understand how the effects of TD on existing and new housing differ, we simulate A$100m reductions in revenue from each of these two lines of TD revenue (see rows 1.1.1 and 1.1.2). Row 1.1 is thus a suitably weighted sum of the results in rows 1.1.1 and 1.1.2. Similarly, we separately study existing versus new non-residential TDs, and report our results in rows 1.2.1 and 1.2.2, allowing us to decompose the results in row 1.2. We also decompose our aggregate results for SLT (row 2) and LCR (row 3), by exploring the impact of reducing revenue from housing (row 2.1 for SLT, row 3.1 for LCR) separately from non-residential property (row 2.2 for SLT, row 3.2 for LCR). In similar fashion, for housing we separately identify the differential impact of low-density housing tax reductions (row 2.1.1 for SLT, row 3.1.1 for LCR) and high-density housing tax reductions (row 2.1.2 for SLT, row 3.1.2 for LCR).

In what follows, we describe the results in rows 1 to 7 of Table 1, using the additional simulations to identify the economic channels that drive tax efficiency and housing price responses.

3.1.1. *Property transfer duty (TD)*

Row 1 in Table 1 summarises the marginal excess burden (MEB) and housing price effects of reducing tax collections from TD in NSW. As outlined in section 2.3.1, TDs affect the economy via levies on transfers of: (i) existing houses, (ii) new houses, (iii) existing non-residential properties, and (iv) new non-residential properties. The impacts of each of these four channels on economic efficiency and housing prices are reported in rows 1.1.1, 1.1.2, 1.2.1, and 1.2.2. We begin by considering the results for housing TDs, before studying the effects of non-residential transfer duties. We conclude by using our findings for the four individual channels to study the aggregate impact of TDs on economic efficiency and housing prices.

TD on housing transfers

To begin, consider the results for the transfer of existing housing in row 1.1.1. This channel was studied by Nassios *et al.* (2019a), who reported a marginal excess burden of 107 cents per dollar, which is lower than the value of 132 cents per dollar reported in row 1.1.1 of column [3]. In Nassios *et al.* (2019a), transfer duties represented an effective tax rate on moving services of 300 percent. In comparison, when calibrated to the later ABS data the effective tax rate in the present paper is approximately 20 percent higher, at 365 percent. This explains the higher MEB magnitudes reported herein relative to Nassios *et al*. (2019a).

Nassios *et al.* (2019a) focussed on the economic efficiency impacts of tax reform, not house prices impacts. In row 1.1.1, we see that under an assumption of revenue neutrality (achieved by replacing foregone TD revenue via a non-distortionary lump sum tax), the reduction in TD collections on sales of existing houses causes a 0.232% increase in the average long-run market price of NSW housing (see column [6i]). After allowing for the reduction in transaction taxes (see column [6ii]), the average purchasers' price (i.e. the market price *plus* TDs) of housing rises relative to baseline, by 0.104

percent. Why? Herein, property prices are evaluated as the discounted present value of the income earned from holding the property, less the discounted present value of all taxes and transfer fees payable. Reductions in $RTD_{i,NSW,2022}$ therefore place direct, upward pressure on the present value of both housing structures and land ($PVC_{i,NSW,2040}$ and $PVL_{i,NSW,2040}$), by reducing the duty falling on the immediate transfer of a property [see equations (1) and (2)]. If this is where the impact stopped (as might happen, for example, if the TD rate changes were delivered as a TD holiday, and thus expected to be only temporary), then our model would predict little change in the purchasers' price of housing. However, this is not the case. While long-run expectations regarding housing structure values are tied down in equation (26) by construction costs ($CON\_COST_{i,q,t}$), land on the other hand is long-lived, non-depreciable and in fixed supply in our counterfactual scenario. The effect of TD removal is therefore amplified by the impact that permanent reductions in TDs have on expected future land prices. This is clear from the presence of $PVL_{i,q,t}$ on the right-hand side of equation (24). Because TD is payable each time a unit of land is transferred, which herein occurs on average every $H_{i,q,t}$ years, we see a long-run positive deviation in the purchasers' prices of housing when TD is reduced in columns [4ii], [5ii] and [6ii] of row 1.1.1. The magnitudes are all broadly consistent with the discounted present-value of forgone TD payments on the land value component of the overall property value.

The larger, positive deviation in high-density prices relative to low-density prices are due to the shorter holding periods of the high-density structures: while land is less important in the production of high-density housing, this is offset by much shorter holding periods. With more transactions over the lifetime of a high-density zoned land parcel, we see stronger price rises for a unit of high-density housing than their low-density counterparts.

Row 1.1.2 reports MEB and housing price impacts of TD on new housing transfers. Recall that, as discussed in Section 2.3.1, stamp duty on transfers of new houses is modelled as a production tax on new units of housing capital. As is clear from row 1.1.2, we find the MEB of TDs levied on transfers of new houses are low compared with existing transfers. This is because the tax base for duties on new houses (the value of new housing investment in NSW) is much larger than the tax base for duties on existing houses (the value of moving services consumed by NSW households). The effective rate of the tax (i.e. the tax revenue divided by the effective base) is therefore significantly lower.

As is clear from columns [4]-[6] of row 1.1.2, prices for both low- and high-density dwellings are positively related to the TD rate on new dwelling transfers, i.e., reductions in this rate reduce dwelling prices.[34] In the short-run, a reduction in transfer duties on new housing reduces the post-tax replacement cost of housing, $CON\_COST_{i,q,t}$. Put another way, existing housing capital becomes less valuable than it was because it becomes comparatively cheaper to now purchase vacant land and build new housing. This places downward pressure on housing capital rentals [see $QC_{i,q,t}$ in equation (26)], which reduces housing prices via the present value relationships embodied in equations (1), (3), (5) and (7).

Having calculated the impacts on efficiency and house prices of duties levied on transfers of new and existing housing, we can share-weight the results in rows 1.1.1 and 1.1.2 of columns [4] – [6] to yield results close to the simulation result for the joint effect of removing transfer duties on both new and existing dwellings reported in row 1.1.[35] An appropriate set of weights to apply in aggregating the transfer duty results for existing and new housing are the shares used to calibrate the initial model database; see section 2.3.1.[36] From section 2.3.1, we see that 11.46 percent of housing transfer duty is collected from new housing sales. Weighting the results in row 1.1.2 by this amount and adding to them the weighted (1-0.1146) results from row 1.1.1, yields a calculated low-density housing market price deviation for housing transfer duties of 0.174 percent: very close to the modelled result of 0.171 percent in column [4i] of row 1.1. In similar fashion, we can approximate the remaining results in row 1.1 as the weighted average of the results in rows 1.1.1 and 1.1.2. This analysis shows that the two housing TD channels (i.e. transfers of existing and new dwellings) drive countervailing housing price

---

[34] While the rate of TD on existing transfers is a function of the value of the house transacted herein, this effect has little impact in the results presented in rows 1.1.2, 1.2.1 and 1.2.2 in Table 1. Hence, column [4i]. [5i] and [6i] are identical to [4ii], [5ii] and [6ii] to three decimal places.

[35] In general, the equations underlying VURMTAX are nonlinear and interaction terms are non-zero. Share-weighted aggregates therefore differ in from the simulated results they approximate.

[36] In general, these shares are not static over the course of a simulation in VURMTAX.

responses, but overall, the impact of transfer duties on existing housing dominates, driving housing prices higher when transfer duties on housing are replaced by lump-sum taxes on households.

TD on non-residential property transfers

Rows 1.2.1 and 1.2.2 identify the long-run MEB (column [3]) and housing price impacts (columns [4], [5] and [6]) of duties levied separately on transfers of existing (row 1.2.1) and new (row 1.2.2) non-residential properties. Row 1.2 identifies the joint MEB of these levies and their joint effect on house prices. As is clear from rows 1.2, 1.2.1 and 1.2.2, the effect on house prices of duties on transfers of non-residential properties is small, and positive. The effect is small, because the relationship between house prices and duties on transfers of non-residential property is highly indirect. The effect is positive (in the sense that a reduction in non-residential property transfer taxes causes a reduction in house prices) because of two factors: (i) the replacement tax, and (ii) housing construction costs. Recall that the $100m of revenue foregone via the reduction in non-residential property transfer duty is replaced via a lump-sum tax on NSW households. This has the effect of reducing demand for NSW housing, and with it, rental rates on housing capital [see $QC_{i,q,t}$ in equation (26)]. Via the present value equations (1), (3), (5) and (7), this reduces both high- and low-density dwelling prices. Housing construction costs fall slightly because removal of the transfer duties on non-residential property transfers acts as a reduction in indirect taxes on NSW businesses, which feeds through, to a small degree, into lower residential housing construction costs.

The MEB of duties on non-residential property transfers is lower than that on transfers of residential property because the industrial demand for moving services in VURMTAX is less price elastic than the residential demand for moving services. As discussed in section 2.3.1, in VURMTAX we model duties on transfers of existing non-residential property as sales taxes on moving service demand by industries. Because we retain the usual Leontief production function specification for industries in VURMTAX, the elasticity of demand for moving services by industries is largely determined by the elasticity of demand for industry output. The realisation of the sales structures and demand elasticities of VURMTAX industries (which are based on 2016-17 input-output accounts for Australia from the Australian Bureau of Statistics) yields a NSW economy-wide elasticity of demand on the part of industry for moving services of 0.26. This is lower than the demand elasticity for moving services by households of 0.6, which is calibrated to match independent econometric estimates by Davidoff and Leigh (2013) and Adams *et al.* (2020).

To reconcile the aggregate impact of non-residential transfer duties on efficiency and housing prices (row 1.2) with the impacts of transfer duties on existing (row 1.2.1) and new (row 1.2.2) non-residential properties, we can share-weight the results in rows 1.2.1 and 1.2.2 of columns [4] – [6] to yield results close to those in row 1.2. From section 2.3.1, we see that 12.3 percent of non-residential transfer duty is collected from new property sales. Weighting the results in row 1.2.2 by this amount and adding to them the weighted (1-0.123) results from row 1.2.1, yields results that are very close to the simulated joint outcome reported in row 1.2.

Aggregate impact

Weighting the housing price responses in columns [4] – [6] in row 1.1 by the share of housing TD (75.1 percent), and adding these to the weighted (1-0.751) results in the corresponding columns of row 1.2 for non-residential property, yield approximations to the aggregate results in row 1 that are very close to the simulated results.[37] Our analysis establishes that while TDs on non-residential

---

[37] Estimated results for row 1 calculated by as the weighted average of rows 1.1 and 1.2 are 0.126, 0.158 and 0.136 for columns [4i], [5i] and [6i] respectively, compared with simulated results for these rows of 0.124, 0.155 and 0.133.

property have some impact on NSW housing prices, these effects are several orders of magnitude smaller than the impact of TDs on transfers of existing and new houses.

3.1.2. State land tax (SLT) and local council rates (LCR)

The MEB and housing price effects of reducing tax collections from SLT and LCR are summarised in rows 2 and 3 of Table 1. As discussed in Nassios *et al.* (2019b) and summarised in section 2.3.3 herein, the SLT differs markedly from the LCR. The latter is very similar in structure to a BBUIV, in that it carries few exemptions, with similar tax rates applying across different land types. This means tax collection shares for LCR in Figure 6 are closely aligned to the land value shares in Figure 4. In contrast, the SLT exempts large portions of the land tax base (e.g., owner occupied housing and primary producer land). This biases tax collections away from housing with high levels of owner-occupation (like low-density housing), and towards: (i) housing types with high rented tenure shares (like high-density housing); and, (ii) non-residential and non-agricultural land. These features are evident in the collection shares for SLT in Figure 5, where we see overrepresentation of high-density housing (24 percent of total collections) compared to its land value share (11 percent), and the opposite for low-density housing (25 percent SLT revenue share versus a 70 percent land value share).

To assess the impact of these features of SLT and LCR on housing prices and efficiency, we decompose the results in rows 2 and 3 into three parts. In rows 2.1.1 and 2.1.2, we report the effects of reductions in the SLT rate on (i) low-density; and, (ii) high-density housing. Rows 3.1.1 and 3.1.2 summarise the corresponding findings for reductions in LCR rates on low- and high-density housing. In rows 2.1 and 3.1, we simulate A$100m reductions in SLT and LCR revenues from all housing, holding fixed the SLT and LCR rates on non-residential property. Using appropriate weights to aggregate 2.1.1 and 2.1.2, we can recover 2.1. This is also true for the results in rows 3.1.1, 3.1.2 and 3.1.

Rows 2.2 and 3.2 summarise the impact of a fall in the non-residential property SLT and LCR rate, respectively, holding fixed the SLT and LCR rates on housing. Once again, the simulated results in row 2 can be approximated by an appropriately weighted sum of the results in rows 2.1 and 2.2, with the same being true of the results in rows 3, 3.1 and 3.2.

There are several differences between the SLT results in rows 2 – 2.2, and the LCR results in rows 3 – 3.2, which we discuss here. We divide our discussion into three parts. First, we consider differences in MEBs across the two existing land taxes. We then consider SLT housing price responses, before contrasting these with LCR housing price responses.

Excess burdens of SLT and LCR

The MEBs for SLT (see column [3], rows 2.1, 2.1.1 and 2.1.2) are consistently higher than their LCR counterparts (see column [3], rows 3.1, 3.1.1 and 3.1.2). As discussed in Nassios *et al.* (2019b), this is due to the tenure choice distortions caused by the SLT. The tenure choice distortion also drives the large difference between the MEB for SLT on low- and high-density housing (see column [3], rows 2.1.1 and 2.1.2). Because low-density housing carries a greater degree of owner-occupation, the tenure choice distortion caused by the SLT is larger, and hence so too is the MEB for low-density housing (7 cents per dollar of SLT revenue collected) compared to the MEB for high-density housing (-3 cents per dollar of SLT revenue collected). Because there is no owner-occupied housing exemption from LCR, the MEBs for LCR on low- and high-density housing (rows 3.1.1 and 3.1.2 in column [3] of Table 1) lie below their SLT counterparts. Because the dwelling stock is overwhelmingly domestically owned and dwelling land is not substitutable across other land uses, foreign landowner taxation does not affect the housing MEBs for SLT and LCRs that are clustered about zero. We can use the results in 2.1.1 and 2.1.2 to reproduce the MEB in column [3] of row 2.1, using a suitable set of weights. These weights are the SLT housing revenue shares in Figure 5.

Weighting the results in row 2.1.1 by 0.25 / 0.49, and the results in row 2.1.2 by 0.24/0.49, we arrive at an approximate housing MEB of 2.1 cents per dollar, which is close to the modelled result of 3 cents per dollar. A similar approach for LCR using housing revenue share weights from Figure 6 yields an estimate of -5.8 cents per dollar, close to the modelled result of -5.

The non-residential MEBs for SLT and LCR also differ slightly relative to each other (see rows 2.2 and 3.2, column [3]). Specifically, the SLT carries a lower MEB than the LCR, i.e., the result in row 3.2 is smaller in magnitude than row 2.2. Why? Herein, large magnitude and negatively signed MEBs arise due to taxation of existing foreign land holdings. The greatest concentration of foreign capital and land ownership in Australia lies in the mining industry, which is overwhelmingly foreign-owned. For LCR, the mining revenue share is 1 percent (see section 2.3.4 and Figure 6). This revenue share is much lower than the land value share for mining land in NSW (4 percent), which lies within the *"Other"* land category in Figure 4 herein. In contrast, SLT collections from "*Other"* land are 15 percent, well in excess of both LCR collections and land value shares (see Figure 5). With lower levels of foreign landowner taxation than the SLT, the LCR on non-residential land carries a smaller (less negative) MEB.

The MEBs for SLT and LCR collected from non-residential property are also more negative than SLT and LCR collected from housing. Specifically, the results in column [3] of rows 2.2 and 3.2 are larger in magnitude and negatively signed, compared to the results in rows 2.1 and 3.1, respectively Why? Once more, this is due to foreign ownership. In VURMTAX, housing is overwhelmingly domestically owned, and as such the MEBs are concentrated around zero. In comparison, a higher proportion of non-residential land is owned by foreign investors, and as such, the MEBs are comparatively more negative relative to those on residential property, reflecting the higher share of the revenue consequences of any tax change that must be borne by existing foreign owners of non-residential land.

Dixon and Nassios (2018) also reported negative MEBs for Australian corporate income tax (CIT), equal to -22 cents per dollar by 2040. As a dividend imputation system, Australia's corporate tax is largely paid by foreign capital owners, with corporate income tax paid on domestically-owned capital passed on as a credit to offset local owners' personal income tax liabilities. Given this structure, the distribution of CIT load is closer to SLT than LCR, which is biased away from mining land. Here, we find the SLT MEB to be -33 cents per dollar by 2040. This lies below the CIT MEB, because when the CIT rate is reduced, an impediment to new foreign investment is reduced. Non-residential land taxation therefore carries greater benefits, i.e., the MEB is more negative than CIT, because the tax does not distort the investment decisions of foreign capital owners.

Finally, we can apply the housing and non-residential revenue shares in Figures 5 and 6 to approximate the MEB results in rows 2 and 3 using the simulated results in rows 2.1 and 2.2, and rows 3.1 and 3.2, respectively. For example, in Figure 6 we see LCR revenue from housing accounts for 69 percent of total collections. Weighting the MEB in column [3] of row 3.1 by this figure, and MEB in column [3] of row 2.2 by (1-0.69), we arrive at approximate LCR MEB -11.5 cents per dollar, once more in close agreement with the simulated result of 11 cents (see row 3, column [3]).

Housing price response to SLT reductions

As is clear from equation (27), to calculate the impact on housing prices of changes in SLTs and LCRs, we must understand how shocks to taxes levied on land values affect post-tax land rental incomes. In a mechanical sense, the translation can be thought of as a function of several ratios. First, consider SLT. Define the SLT tax base as $\mathrm{SLT\_B}_{i,q,t}$. For low- and high-density housing, this can be written in terms of the rented tenure share $\mathrm{RS}_{i,q,t}$ of the unimproved land value $\mathrm{UILV}_{i,q,t}$:

$$\mathrm{SLT\_B}_{i,q,t} = \mathrm{RS}_{i,q,t} \cdot \mathrm{UILV}_{i,q,t}. \tag{34}$$

The base-year rented tenure share can be calculated from Figure 4; for low-density housing, it is equal to 11 percent (=100* 8 / (62+8)), while for high-density housing the figure is around 63 percent (=100

* 7 / (7+4)). For a given change in SLT revenue, $\mathrm{d\_SLT\_C}_{i,q,t}$, the leading-order approximation to the required shock to the SLT rate, $\mathrm{d\_SLT\_R}_{i,q,t}$, is:

$$\mathrm{d\_SLT\_R}_{i,q,t} = \frac{\mathrm{d\_SLT\_C}_{i,q,t}}{\mathrm{RS}_{i,q,t} \cdot \mathrm{UILV}_{i,q,t}}. \tag{35}$$

We require an expression linking $\mathrm{d\_SLT\_R}_{i,q,t}$ to $\mathrm{d\_TL}_{SLT,i,q,t}$ in equation (27). Equation (35) can be re-written straightforwardly as:

$$\mathrm{d\_SLT\_R}_{i,q,t} = \frac{1}{\mathrm{RS}_{i,q,t}} \cdot \frac{\mathrm{d\_SLT\_C}_{i,q,t}}{\mathrm{UILV}_{i,q,t}}. \tag{36}$$

Translating the tax base from land value to land income then yields:

$$\mathrm{d\_SLT\_R}_{i,q,t} = \frac{1}{\mathrm{RS}_{i,q,t}} \cdot \frac{\mathrm{QL}_{i,q,t}}{\mathrm{UILV}_{i,q,t}} \cdot \frac{\mathrm{d\_SLT\_C}_{i,q,t}}{\mathrm{QL}_{i,q,t}}, \tag{37}$$

where $\mathrm{QL}_{i,q,t} / \mathrm{UILV}_{i,q,t}$ is the average gross rental yield for housing type *i* in region *q* at time *t*. The final of the three ratios on the RHS of equation (37) is our desired expression for $\mathrm{d\_TL}_{SLT,i,q,t}$, the change in the level of the SLT rate $\mathrm{TL}_{\mathrm{SLT},i,q,t}$ defined in equation (27). Transposing equation (37) gives us an expression for $\mathrm{d\_TL}_{\mathrm{SLT},i,q,t}$:

$$\mathrm{d\_TL}_{\mathrm{SLT},i,q,t} = \mathrm{RS}_{i,q,t} \cdot \left(\frac{\mathrm{QL}_{i,q,t}}{\mathrm{UILV}_{i,q,t}} \right)^{-1} \cdot \mathrm{d\_SLT\_R}_{i,q,t}. \tag{38}$$

Assuming that the land tax shock is permanent, the approximate impact of the SLT rate shock on land prices can be modelled as a perpetuity and takes the form:

$$\begin{aligned} \mathrm{d\_PVL}_{i,q,t} &= \frac{-\mathrm{QL}_{i,q,t} \cdot \mathrm{d\_TL}_{\mathrm{SLT},i,q,t}}{1-\mathrm{RDISC}_{\mathrm{LND},i,q,t}} \\ &= -\frac{1}{1-\mathrm{RDISC}_{\mathrm{LND},i,q,t}} \cdot \mathrm{RS}_{i,q,t} \cdot \left(\frac{1}{\mathrm{UILV}_{i,q,t}} \right)^{-1} \cdot \mathrm{d\_SLT\_R}_{i,q,t}. \end{aligned} \tag{39}$$

Finally, assuming no direct impact on the replacement cost of the housing structure, we arrive at a leading-order approximation to the true modelled percentage change in the housing price (defined $\mathrm{p\_PVS}_{i,q,t}$) caused by a $100 \cdot \mathrm{d\_SLT\_R}_{i,q,t}$ percentage-point change in the SLT rate:

$$\mathrm{p\_PVS}_{i,q,t} \approx -\frac{\mathrm{UILV}_{i,q,t}}{\mathrm{PVS}_{i,q,t}} \cdot \left[\frac{1}{1-\mathrm{RDISC}_{\mathrm{LND},i,q,t}} \cdot \mathrm{RS}_{i,q,t} \cdot \left(100 \cdot \mathrm{d\_SLT\_R}_{i,q,t} \right) \right], \tag{40}$$

where $\mathrm{UILV}_{i,q,t} / \mathrm{PVS}_{i,q,t}$ is the ratio of unimproved land value to the market price of a property of type *i* in region *q* at time *t*. How accurate is this formula in predicting the price responses in rows 2.1.1 and 2.1.2 of Table 1? Consider the market price response for low-density housing, which is 0.163 percent (see row 2.1.1, column [4i]). Herein, our SLT shock translates to a cut of approximately 5 basis points in the SLT rate on low-density housing. This is like taking the average SLT rate on low-density housing from 0.74 to 0.69 percent, i.e., we set $100 \cdot \mathrm{d\_SLT\_R}_{\mathrm{DwellingLow},\mathrm{NSW},2022} = -0.05$ in (40). As previously discussed, $\mathrm{RS}_{\mathrm{DwellingLow},\mathrm{NSW},2017} = 0.11$.[38] Also, while in our VURMTAX sim

---

[38] When SLT rates are adjusted, rental shares also respond due to changes in the size of the tenure choice distortion caused by the owner-occupied housing exemption. Nevertheless, in applying (40) to approximate the low-density housing price response, we treat this as exogenous.

$\mathrm{RDISC}_{\mathrm{LND},i,q,t}$ transitions from very low levels in the short-run to around 0.9775 percent in the long-run, for the purpose of this discussion we use the long-run target of 0.9775. Finally, we approximate the UIV land value share using the base year (2017) level of $\mathrm{PVL}_{\mathrm{DwellingLow,NSW},2017}/\mathrm{PVS}_{\mathrm{DwellingLow,NSW},2017}=0.62$. Substituting these values into (40) yields an approximate result of +0.152 percent – close to the VURMTAX result of +0.163 per cent.

Equation (40) is also helpful in understanding why a change in SLT has markedly different impacts on prices for low- and high-density housing. In Table 1, we see that a \$100 m. cut to SLT levied on low-density housing raises low-density house prices by 0.16 per cent, while the same cut to SLT levied on high-density housing raises high-density house prices by 0.80 per cent (see rows 2.1.1 and 2.1.2, columns [4i] and [5i], Table 1). From Figure 4, the ratio of rented low-density and high-density housing land is approximately equal to 1 ($\approx 8/7$). Hence the denominator of equation (35) is similar in magnitude across the two housing types. In simulations 2.1.1 and 2.1.2, where we raise an additional A\$100m of SLT from low- and high-density housing respectively, it is reasonable to assume $\mathrm{d\_SLT\_R}_{\mathrm{DwellingLow,NSW},2022}$ in row 2.1.1 and $\mathrm{d\_SLT\_R}_{\mathrm{DwellingHigh,NSW},2022}$ in row 2.1.2 are identical. In this case, the ratio of the low-density housing price response in column [4i] in row 2.1.1, and the high-density response in column [5i] in row 2.1.2, can be approximated as:

$$\frac{\mathrm{p\_PVS}_{\mathrm{DwellingHigh,NSW},t}}{\mathrm{p\_PVS}_{\mathrm{DwellingLow,NSW},t}} \approx \frac{\dfrac{\mathrm{UILV}_{\mathrm{DwellingHigh,NSW},t}}{\mathrm{PVS}_{\mathrm{DwellingHigh,NSW},t}}}{\dfrac{\mathrm{UILV}_{\mathrm{DwellingLow,NSW},t}}{\mathrm{PVS}_{\mathrm{DwellingLow,NSW},t}}} \frac{\mathrm{RS}_{\mathrm{DwellingHigh,NSW},t}}{\mathrm{RS}_{\mathrm{DwellingLow,NSW},t}}, \qquad \textbf{(41)}$$

where we have also assumed the discount rates across the two housing types to be broadly in line with one another in the long-run. Differences in the relative price response to a permanent SLT rate shock between the two housing types will therefore materialise if there are marked differences in either their land value shares, or their rental shares. In the base-year data (2016/17), the rental share ratio of the right-hand side of (41) is roughly equal to 6 while the land value ratio is approximately equal to 0.6.[39]

---

[39] These ratios are endogenous and therefore respond over the course of our simulation to changes in the broader state of the NSW economy and tax system.

From equation (41), *ceteris paribus* we expect the high-density dwelling price response to be 0.6*6 = 3.6 times as large as the low-density dwelling price response. From Table 1, we find that the high-density price rise is 4.9 times as large as the low-density price response. The difference is explicable in terms of changes in the land value ratio and the rental shares over the simulation period, and small differences in the modelled shocks to $d\_SLT\_R_{DwellingHigh,NSW,2022}$ and $d\_SLT\_R_{DwellingLow,NSW,2022}$.

The simulated housing price results in row 2.1 can once more be derived by share-weighting the results in rows 2.1.1 and 2.1.2, using the housing revenue shares for SLT in Figure 5. Doing so yields highly accurate approximations to the true modelled result.[40] The ratio of the high-density and low-density housing price responses in row 2.1, where we calculate the MEB and housing price responses caused by uniform adjustments in the SLT rate on low- and high-density housing, is equal to 4.8 and can thus once more be understood via equation (41).

Finally, we note that the impact on housing prices of reductions in SLT on non-residential land is small (see row 2.2, columns [4i] and [5i]). Once more, this is because the relationship between house prices and SLTs on non-residential property is indirect. The effect is positive (in the sense that a reduction in non-residential SLT causes a reduction in house prices) because of the replacement tax. Recall that the $100m of revenue foregone via the reduction in non-residential SLT is replaced via a lump-sum tax on NSW households. This has the effect of reducing demand for NSW housing, and with it, rental rates on housing capital [see in equation (26)]. Via the present value equations (1), (3), (5) and (7), this reduces both high- and low-density dwelling prices.

Comparing the response of housing prices to LCR and SLT rate reductions

We begin by benchmarking the housing price responses in column [4i] and [5i] of rows 3.1.1 and 3.1.2. Our approach is similar to the process used to derive equation (40) in order to study the

---

[40] For example, our approximated market price response for low-density housing in column [4i] of row 2.1.1 is 0.083 percent, which compares favourably to the modelled outcome of 0.082 percent.

response of housing prices to SLT rate reductions. For a given change in LCR revenue, $\mathrm{d\_LCR\_C}_{i,q,t}$ the leading-order approximation to the required shock to the LCR rate, $\mathrm{d\_LCR\_R}_{i,q,t}$, is:

$$\mathrm{d\_LCR\_R}_{i,q,t} = \frac{\mathrm{d\_LCR\_C}_{i,q,t}}{\mathrm{UILV}_{i,q,t}}. \tag{42}$$

This equation carries a virtually identical form to (35), only with the rental share of housing removed from the denominator. Following a similar process to that which yielded equation (40) from equation (35), we arrive at the following expression for the estimated percentage-change in the price of housing, $\mathrm{p\_PVS}_{i,q,t}$, due to a $100 \cdot \mathrm{d\_LCR\_R}_{i,q,t}$ percentage-point change in the LCR rate on housing:

$$\mathrm{p\_PVS}_{i,q,t} \approx -\frac{\mathrm{UILV}_{i,q,t}}{\mathrm{PVS}_{i,q,t}} \cdot \frac{1}{1-\mathrm{RDISC}_{\mathrm{LND},i,q,t}} \cdot \left(100 \cdot \mathrm{d\_LCR\_R}_{i,q,t}\right). \tag{43}$$

As we did in studying the SLT response, we begin by considering the market price response to an LCR reduction for low-density housing, which is 0.197 percent (see column [4i] of row 3.1.1). Herein, our MEB shock translates to a cut of approximately 0.7 basis points in the LCR rate on low-density housing. This is like taking the average LCR rate on low-density housing from 0.22 percent to 0.213 percent, i.e., we set $100 \cdot \mathrm{d\_LCR\_R}_{\mathrm{DwellingLow,NSW,2022}} = -0.007$ in (43). As before, $\mathrm{RDISC}_{\mathrm{LND},i,q,t} = 0.9775$ and $\mathrm{PVL}_{\mathrm{DwellingLow,NSW,2017}} / \mathrm{PVS}_{\mathrm{DwellingLow,NSW,2017}} = 0.62$. Substituting these data items into (43) yields an approximate result of +0.193 percent, which is within 5 percent of the VURMTAX result in column [4i] of row 3.1.1 in Table 1. This figure is also very similar in magnitude to the low-density housing price response when we cut SLT collections from low-density housing by A$100m (see column [4i] in row 2.1.1 in Table 1). This is because the magnitude of the revenue cut is similar in each case.

In the case of the SLT, we saw via equation (41) that ratio of the high-density housing price response in column [5i] of row 2.1.2 in Table 1, and the low-density price response in column [4i] of row 2.1.1 in Table 1, could be related to the ratio of land in total structure value, and the rented housing shares.

That relationship assumed $d\_SLT\_R_{DwellingHigh,NSW,2022}$ and $d\_SLT\_R_{DwellingLow,NSW,2022}$ were identical. This was justified with reference to Figure 5, which showed similar SLT revenue from low- and high-density housing to be similar. When comparing the results in columns [4i] and [5i] of rows 3.1.1 and 3.1.2, respectively, Figure 7 highlights that LCR revenues across low- and high-density housing are very different. To relate low- and high-density housing responses in this case, we assume $d\_LCR\_C_{DwellingHigh,NSW,2022} = d\_LCR\_C_{DwellingLow,NSW,2022}$, i.e., our rate shocks are calibrated to raise identical revenues in the shock-year. Because the rate reduction applies to all rated housing land in this case, the rate reduction for low-density housing will be lower than the rate reduction for high-density housing, by a factor that is related to the unimproved land value share, i.e.,

$$\frac{d\_LCR\_R_{DwellingHigh,NSW,2022}}{d\_LCR\_R_{DwellingLow,NSW,2022}} = \frac{UILV_{DwellingHigh,NSW,2022}}{UILV_{DwellingLow,NSW,2022}}. \quad \textbf{(44)}$$

The right-hand-side of equation (44) can be approximated using the base period share in Figure 4, which gives us $d\_LCR\_R_{DwellingHigh,NSW,2022} / d\_LCR\_R_{DwellingLow,NSW,2022} \approx 70/11 = 6.4$. Given this, taking the ratio of equation (43) for high-density and low-density housing yields:

$$\frac{p\_PVS_{DwellingHigh,NSW,t}}{p\_PVS_{DwellingLow,NSW,t}} \approx 6.4 \cdot \frac{\dfrac{UILV_{DwellingHigh,NSW,t}}{PVS_{DwellingHigh,NSW,t}}}{\dfrac{UILV_{DwellingLow,NSW,t}}{PVS_{DwellingLow,NSW,t}}}. \quad \textbf{(45)}$$

This yields a very similar relationship between high- and low-density housing price responses to the one uncovered for the SLT, i.e., we expect high-density housing prices to rise by approximately 3.8 times low-density housing prices when rates revenue collected from each falls by an equivalent amount. The modelled result from Table 1 is approximately 3.6 times, which is very close to the approximated result after allowing for changes in relative land value shares over the simulation time horizon.

Interestingly, when we compare the housing price relativities in columns [4i] and [5i] of row 3.1 in Table 1, we find that the percentage-change in low-density housing prices is about two times as large as the high-density response when we reduce the LCR on housing uniformly. This contrasts markedly with the SLT in row 2.1, where high- and low-density price responses were related by equation (41). Why? Consider again equation (43); we can study the expected responses in row 3.1 by setting $d\_LCR\_R_{DwellingHigh,NSW,2022} = d\_LCR\_R_{DwellingLow,NSW,2022}$ in equation (43) and taking the ratio of the high- to low-density housing price relativities. In this case, the ratio reduces simply to:

$$\frac{p\_PVS_{DwellingHigh,NSW,t}}{p\_PVS_{DwellingLow,NSW,t}} \approx \frac{\dfrac{UILV_{DwellingHigh,NSW,t}}{PVS_{DwellingHigh,NSW,t}}}{\dfrac{UILV_{DwellingLow,NSW,t}}{PVS_{DwellingLow,NSW,t}}}. \tag{45}$$

As previously discussed, the right-hand-side is the land value ratio, and in 2017 this is equal to 0.6. This is broadly in line with the ratio of the high-density and low-density housing price responses from columns [5i] and [4i] in row 3.1.

Next, studying the impact of reductions in LCR on non-residential property in row 3.2, we find small, negative housing price responses that are similar in magnitude to the results in row 2.2, where we studied reductions in the SLT across non-residential property. We refer the reader to that discussion for the rationale, which is similar in this case.

Once more, the housing price responses in columns [4i] – [6ii] in rows 3.1 and 3.2 can be appropriately weighted to yield the simulated results in row 3, when we apply an equivalent basis point reduction in the LCR on housing and non-residential property in 2022. Approximate weights in this instance are revenue weights from Figure 6, where we find 69 percent of NSW LCR is derived from housing. Weighting the housing price responses in row 3.1 by 0.69, and the responses in row 3.2 by 0.31, yields housing price responses very similar to the simulated responses in row 3, e.g., the approximation to the result in column [4i] for low density housing is 0.109 percent while the VURMTAX result is 0.108 percent.

3.1.3. The emergency service levy on insurance (The ESL)

Consider the MEB for the ESL on general insurance in row 4. The MEB of 42 cents per dollar is broadly in line with previous estimates by Nassios *et al.* (2019a), which is much lower than existing housing transfer duty; see the results in column [3] of rows 1.1.1 and 3. While the elasticity of demand for both general insurance and moving services are similar, the ESL tax rate is much lower than the effective TD rate on moving services, driving a much lower MEB.

Because the current ESL is collected from general insurance purchased by households and some industries, reductions in its rate have no direct impact on housing prices. Hence, housing price responses are small and positive. The effect is positive (in the sense that a reduction in the ESL causes a reduction in house prices) because of two factors: (i) the replacement tax, and (ii) housing construction costs. Recall that the \$100m of revenue foregone via the reduction in ESL revenue is replaced via a lump-sum tax on NSW households. This has the effect of reducing demand for NSW housing, and with it, rental rates on housing capital [see $QC_{i,q,t}$ in equation (26)]. This reduces both high- and low-density dwelling prices via equations (1), (3), (5) and (7). Housing construction costs fall slightly because removal of the ESL acts in part as a reduction in indirect taxes on NSW businesses, which feeds through, to a small degree, into lower residential housing construction costs.

3.1.4. Broad-based taxes on unimproved land values (BBUIV)

Next, we study the suite of hypothetical taxes introduced herein. The first hypothetical tax is the BBUIV tax, which is modelled as a uniform-rate land tax. The results for increases in revenue of A\$100m in 2022 from this tax in NSW are reported in row 5. A priori, our expectations are that the results in rows 3 and 5 would be very similar, given the NSW LCR functions in many ways as a BBUIV. Indeed we find this is the case (after making allowance for sign differences in the house price outcomes, given that row 3 involves reducing collections by \$A 100 m., while row 5 involves increasing collections by \$A 100 m.). Comparing the MEBs in column [3] of rows 3 and 5, we see that the result in row 5 is slightly smaller in magnitude (-8 cents per dollar) than the result in row 3 (-11 cents per dollar). This is because the LCR revenue shares in Figure 6 are weighted towards non-residential property; in contrast, *ceteris paribus* the BBUIV will exhibit revenue shares similar to the land value shares in Figure 4. We can use land value weights to approximate the result in column [3] of row 5 from the results in column [3] of rows 3.1 and 3.2 of Table 1; applying a weight of 0.8 to the result in column [3] of row 3.1 and a weight of (1-0.8) to the results in column [3] of row 3.2, we arrive at an approximate result of -9 cents per dollar, which is very close to the modelled result of -8 cents per dollar. For a detailed discussion of the mechanisms underlying the housing price results in row 5, we refer the reader to section 3.1.2.

3.1.5. Broad-based taxes on capital-improved land values (BBCIV)

In row 6 of Table 1, we summarise the MEB and housing price responses when we generate A$100m in revenue from a hypothetical tax on BBCIV in NSW, and return the revenue to NSW households via a lump sum transfer. Row 6.1 in Table 1 provides a summary of a related simulation, where we generate A$100m in revenue from a hypothetical tax on the NSW capital stock, i.e., we introduce a tax on the value of a building on a given parcel of land but not on the land itself.

The results in row 6 can be thought of as a weighted sum of the result in row 5 for the BBUIV tax, and row 6.1. This is why the MEB in row 6 is equal to 3 cents per dollar, which lies between the MEB for the BBUIV tax of -8 cents per dollar in column [3] of row 5 in Table 1, and the broad-based capital tax MEB of 15 cents per dollar in column [3] of row 6.1. The appropriate weights are the land and capital value shares in NSW in VURMTAX; because the MEB in column [3] of row 6 in Table 1 lies approximately halfway between the MEBs in rows 5 and 6.1, we see these value shares are approximately 0.5 herein.[41]

Because the housing price effects of a BBUIV were described in section 3.1.4, we are left to explain the housing price effects of the broad-based capital tax. As highlighted in row 6.1, the impact on long-run housing prices of the broad-based capital tax is small, and slightly negative. Why? There are two

---

[41] Our analysis herein allows for exclusions from the capital tax base, such as for motor vehicles used for private transport, road passenger and road freight transport

countervailing effects at play. Firstly, investment in housing is rate of return sensitive in VURMTAX. In the short-run, a new tax on capital [or a positive shock to $TC_{BBCIV,i,NSW,2022}$ in equation (26)], causes the post-tax capital income accruing to capital owners in NSW to fall relative to the baseline. Via equation (30), the post-tax rate of return on capital, $ROR_{i,NSW,2022}$, falls and with it, so too does NSW investment activity. As investment falls relative to baseline, so too does the size of the NSW capital stock. With a lower capital stock relative to baseline, pre-tax capital rentals $QC_{i,NSW,t}$ begin to rise and over time, this process drives post-tax rates of return on capital back to their baseline forecast level. NSW is left with higher pre-tax rentals, similar post-tax rates of return on capital, and a smaller capital stock. Post-tax capital income remains slightly below the baseline however, and via equation (26), this places downward pressure on housing prices. Interestingly, comparing columns [4i] and [5i] in row 6.1 of Table 1, we see the high-density housing price response is approximately one half the magnitude of the low-density response. Why? An analogue of equation (45), which was used to understand the relative response of high- and low-density housing prices to a uniform change in LCR rates in NSW, would be inappropriate in this case. This is because equation (45) was derived under an assumption that land taxes impact housing prices in perpetuity; see for example the discount factor in the denominator of equation (43). For capital taxes, this is not true because the expected sale price of a unit of existing housing capital are tied down by expected replacement costs.[42] This is clear from equation (23), and the final term in equation (26). To derive a form of equation (45) suitable for broad-based capital taxes, we begin with an analogue of equation (42):

$$d\_BBC\_R_{i,q,t} = \frac{d\_BBC\_C_{i,q,t}}{CAPV_{i,q,t}}, \tag{46}$$

where our shock in the broad-based capital tax rate is $d\_BBC\_R_{i,q,t}$, and this shock is calibrated to raise $d\_BBC\_C_{i,q,t}$ in capital tax revenue from housing capital of type *i* in region *q* at time *t*, from a

---

[42] This is akin to saying that $CON\_COST_{i,q,t}$ for housing type *i* responds indirectly related to changes in the level of capital taxes levied on housing, or shocks to $d\_TC_{BBCIV,i,q,t}$.

tax base that is equal to the value of housing capital $\mathrm{CAPV}_{i,q,t}$. Because equation (26) is written assuming that the tax base for the rate shock ($\mathrm{d\_TC}_{\mathrm{BBCIV},i,q,t}$) is capital rentals and not capital values, we rearrange (46) to yield:

$$\mathrm{d\_BBC\_R}_{i,q,t} = \frac{\mathrm{QC}_{i,q,t}}{\mathrm{CAPV}_{i,q,t}} \cdot \frac{\mathrm{d\_BBC\_C}_{i,q,t}}{\mathrm{QC}_{i,q,t}}, \tag{47}$$

where $\mathrm{QC}_{i,q,t}/\mathrm{CAPV}_{i,q,t}$ is the average gross capital rental yield for housing type *i* in region *q* at time *t*. The final of the three ratios on the RHS of equation (47) is our desired expression for $\mathrm{d\_TC}_{\mathrm{BBCIV},i,q,t}$, the change in the level of the broad-based capital tax rate $\mathrm{TC}_{\mathrm{BBCIV},i,q,t}$ defined in equation (26). Transposing equation (47) gives us an expression for $\mathrm{d\_TC}_{\mathrm{BBCIV},i,q,t}$:

$$\mathrm{d\_TC}_{\mathrm{BBCIV},i,q,t} = \left(\frac{\mathrm{QC}_{i,q,t}}{\mathrm{CAPV}_{i,q,t}}\right)^{-1} \cdot \mathrm{d\_BBC\_R}_{i,q,t}. \tag{48}$$

Next, we assume $\mathrm{d\_TC}_{\mathrm{BBCIV},i,q,t}$ has no direct effect on the long-run realisable value at sale for a unit of housing capital. The approximate impact of the broad-based capital rate shock on the market price of a unit of housing capital can be modelled as an annuity in this case, where the discount period is equal to the expected holding period of the house $\mathrm{H}_{\mathrm{i,q,t}}$:

$$\begin{aligned}\mathrm{d\_PVC}_{\mathrm{i,q,t}} &= -\mathrm{QC}_{\mathrm{i,q,t}} \cdot \mathrm{d\_TC}_{\mathrm{BBCIV,i,q,t}} \cdot \frac{1-\left(2-\mathrm{RDISC}_{\mathrm{CAP,i,q,t}}\right)^{-\mathrm{H}_{\mathrm{i,q,t}}}}{1-\mathrm{RDISC}_{\mathrm{CAP,i,q,t}}} \\ &= -\frac{1-\left(2-\mathrm{RDISC}_{\mathrm{CAP,i,q,t}}\right)^{-\mathrm{H}_{\mathrm{i,q,t}}}}{1-\mathrm{RDISC}_{\mathrm{CAP,i,q,t}}} \cdot \left(\frac{1}{\mathrm{CAPV}_{\mathrm{i,q,t}}}\right)^{-1} \cdot \mathrm{d\_BBC\_R}_{\mathrm{i,q,t}}.\end{aligned} \tag{49}$$

Finally, assuming no direct impact on the replacement cost of the housing structure, we arrive at a leading-order approximation to the true modelled percentage change in the housing price $\mathrm{p\_PVS}_{\mathrm{i,q,t}}$ caused by a $100 \cdot \mathrm{d\_BBC\_R}_{\mathrm{i,q,t}}$ percentage-point change in the broad-based capital tax rate:

$$\mathrm{p\_PVS}_{\mathrm{i,q,t}} \approx -\frac{\mathrm{CAPV}_{\mathrm{i,q,t}}}{\mathrm{PVS}_{\mathrm{i,q,t}}} \cdot \left[\frac{1-\left(2-\mathrm{RDISC}_{\mathrm{CAP,i,q,t}}\right)^{-\mathrm{H}_{\mathrm{i,q,t}}}}{1-\mathrm{RDISC}_{\mathrm{CAP,i,q,t}}} \cdot \left(100 \cdot \mathrm{d\_BBC\_R}_{\mathrm{i,q,t}}\right)\right], \tag{50}$$

where $\mathrm{CAPV}_{\mathrm{i,q,t}}/\mathrm{PVS}_{\mathrm{i,q,t}}$ is the capital value share of a property of type *i* in region *q* at time *t*. This equation differs markedly from land tax analogues; by assuming the tax has no direct impact on long-run capital replacement costs and market prices of capital, capital taxes must be modelled as annuities and thus the housing price response becomes a function of the anticipated holding period of the property. Equation (50) is an increasing function of the expected holding period, $\mathrm{H}_{\mathrm{i,q,t}}$, which differs markedly for low-density and high-density housing. Taking the ratio of equation (50) for high- and low-density housing and assuming $d\_BBC\_R_{DwellingHigh,q,t} = d\_BBC\_R_{DwellingLow,q,t}$, we arrive at an analogue of (45) for capital taxes that can be used to study the relative responses in row 6.1:

$$\frac{p\_PVS_{DwellingHigh,NSW,t}}{p\_PVS_{DwellingLow,NSW,t}} \approx \frac{\dfrac{CAPV_{DwellingHigh,NSW,t}}{PVS_{DwellingHigh,NSW,t}}}{\dfrac{CAPV_{DwellingLow,NSW,t}}{PVS_{DwellingLow,NSW,t}}} \cdot \frac{1-\left(2-RDISC_{CAP,i,q,t}\right)^{-H_{DwellingHigh,NSW,t}}}{1-\left(2-RDISC_{CAP,i,q,t}\right)^{-H_{DwellingLow,NSW,t}}}. \qquad \textbf{(51)}$$

This is close to our observed relative response of 0.5. One factor that impacts the relative response is the fact that this tax is also levied on other industries. Some of these industries supply their output to housing and non-residential investors. As pre-tax capital rentals rise in response to the new capital tax faced by these industries, their production costs also rise. To a small degree, this passes into housing construction costs, which rise slightly relative to baseline. Higher long-run replacement costs for housing places upward pressure on housing prices, because the long-run value of an existing house is now elevated slightly relative to the baseline; see the final term in equation (26) that involves $CON\_COST_{i,q,t}$.

Having described the relative housing price responses to broad-based capital taxation reported in row 6.1 of Table 1, the BBCIV responses in row 6 are weighted sums of the responses in rows 5 (BBUIV tax responses) and row 6.1 (broad-based capital tax responses). Suitable weights are the land- and capital-value shares, respectively. For low-density housing, these are initially equal to 0.62 and 0.38 respectively, while for high-density housing they are 0.37 and 0.63. Using these weights, the approximate result for column [4i] in row 6 is 0.086, which is identical to the VURMTAX result reported in Table 1.

3.1.6. Narrow-based taxes on capital-improved land values (NBCIV)

Having discussed how BBCIV's can be studied relative to BBUIV's in section 3.1.5, we provide brief commentary here regarding the MEB and housing price responses to a rise of A$100m in collections from a hypothetical NBCIV. This tax is narrow based, in the sense it excludes owner-occupied housing and primary producer capital and land from its tax base. Readers can apply a similar approach to that in section 3.1.2, where we studied state land tax (which carries similar exemptions), and section 3.1.5, where we described how BBCIV's can be understood by studying both BBUIV's, and broad-based capital taxes. This allows one to relate the housing price responses in row 7 to those for SLT in row 2.

- The MEB for NBCIV taxes is 14 cents per dollar (see column [3], row 7). This is much higher than the corresponding MEB for SLT in row 2, which is similar in magnitude but negative. This is because under a NBCIV, approximately 50 percent of capital taxes are collected from non-residential capital. This feeds into production costs and international competitiveness, driving much higher MEB estimates.
- Whereas in studying SLT we found high-density housing prices exhibited stronger responses, for NBCIV's we find the opposite is true. This reversal in relative price response is caused by capital taxation. In section 3.1.5, we showed how the housing price responses to broad-based capital taxes are increasing functions of the expected holding period of the house. A similar effect arises here for NBCIV's. With shorter holding periods and larger capital value shares, this effect dominates for high-density housing prices when NBCIV's are introduced.

3.2. Simulating the housing price impacts of changes in the property tax mix

In this section, we build on the tax-specific simulations discussed in section 3.1 by simulating a series of property tax mix swaps. Our results are reported in Table 2. In general, these results can be thought of as combinations of one or more of the results in rows 1 - 4 from Table 1 (which focus on TD, SLT, LCR and the ESL, respectively), with one or more of the results reported in rows 5 - 7 of Table 1 (BBUIV, BBCIV, and NBCIV, respectively), scaled up in each case because the revenue swapped in Table 2 is much larger than the marginal swaps studied in Table 1. Table 2 is broken into two main parts. Rows A to H report the results of eight core tax mix swap scenarios, where one of the taxes in rows 1, 2, 3 and 4 of Table 1 are swapped with one of the taxes in rows 5, 6 and 7 of Table 1. In rows I to Q of Table 2, we combine one or more of the tax swaps in rows A to H. All mix swaps are revenue neutral, with foregone revenue from existing taxes replaced dollar-for-dollar with new taxes, and variations in all other tax revenue lines replaced via a direct tax on households. All tax mix swaps are implemented in 2022. This means the existing set of taxes are eliminated in 2022 and fully replaced by one (or a combination of) the new hypothetical taxes on a dollar-for-dollar basis. We report results for all variables we consider in simulation year 2040, eighteen years after the mix swaps are implemented.

The net excess burdens (NEBs) we report are calculated using equation (33) and are reported in column [3] of Table 2. Recall from section 2.5 that negative NEBs indicate that the simulated tax mix swap has increased national welfare, after accounting for changes in labour supply and leisure value. We also report low-density, high-density, and value-weighted (average) housing price deviations in columns [4] – [6] respectively. As in Table 1, two sets of results are reported in columns [4] to [6] of Table 2. In columns [4i], [5i] and [6i], we report the deviation from baseline of the market price, i.e., the price paid at auction from equation (3), for low-density, high-density and average housing prices. In columns [4ii], [5ii] and [6ii], we report the deviation from baseline of the purchasers' price i.e., the market price plus transaction taxes, for low-density, high-density and average housing prices. For any given simulation whose results are reported in a row in Table 2, column [2] summarises any variables that meet two conditions:

(i) they appear in equation (26) or equation (27); and,

(ii) they were shocked to perform the given simulation.

Shocked variables that appear in equations (26) and (27) directly affect housing prices, and as before, column (2) serves to aid readers in linking our simulations (and the reported housing price responses) to the equations that support the VURMTAX housing price module. Finally, we report the deviation from baseline for the state CPI in column [7] for each simulation.

As discussed, the scenarios studied in each row of Table 2 can be related to two or more of the taxes studied in Table 1. For example, in row A of Table 2, we report simulated results for the complete removal of TD (row 1 of Table 1), with revenue replaced via a new BBUIV (row 5 of Table 1). This simulation is the focus of section 3.2.2. Because the results in row A of Table 2 assume that the land tax introduced to replace TD is uniformly rated across all land, i.e., it is homogenous and independent of land zoning, the policy differs from the proposal by Henry *et al.* (2010), which argued in favour of higher rates for inner-city (or high-density) housing. To aid our discussion, we break this simulation up into two parts: (i) in row A.1, we simulate the replacement of TD with a non-distorting lump sum tax (LST); and, (ii) in row A.2, we hold the TD rate schedule at its baseline level but raise enough revenue to replace TD on a dollar-for-dollar basis via a new BBUIV tax, with the revenue raised returned to households via a non-distorting lump sum transfer. The results in row A.1 of Table 2 are directly related to the results in row 1 of Table 1, while the results in row A.2 in Table 2 are directly related to row 5 in Table 1.

Of the other core scenarios considered, in row B of Table 2, we once more remove TD and replace the revenue with a BBCIV instead. In row C we study replacing LCRs, which are unimproved value land taxes, with a new BBCIV tax. From column [3] in Table 2, the positive NEB indicates that the proposal would have diminished national welfare (with an 11c welfare loss per $1 of revenue swapped), while rows [4] – [6] highlight that house prices would also have risen relative to state CPI in column [7]. Row's D , E, and F focus on SLT. In row D, we simulate replacement of SLT with a capital improved value tax that carries the same owner-occupied housing and primary production exemptions as the existing SLT, i.e., a NBCIV tax. Row E is like row D, however owner-occupied housing and primary producers are no longer exempt from the replacement tax, which is broad-based and levied on a capital-improved value basis. Finally, in row F we simulate removal of the SLT principal place of residence and primary producer land exemptions, by replacing SLT with a BBUIV tax. In row G, we report the impact of replacing ESL replaced by a BBUIV. Our results show that a swap of ESL for BBUIV would have reduced house prices relative to the baseline (columns [4] – [6]), and relative to state CPI (column [7]), while national welfare would have improved by 24 cents per dollar of revenue swapped (see the negative NEB in column [3]). In row H, we consider the impact of replacing the ESL with a new BBCIV. As we highlight in section 3.2.2, interaction effects between tax mix swaps can mean true modelled results, i.e., combination experiments in rows I – Q of Table 2, can deviate from the sum of their parts. This means linear combinations of rows A – H in Table 2 will not necessarily add to the results in rows I – Q. For this reason, we perform nine combination experiments and report the results in Table 2 for the readers convenience.

In what follows, section 3.2.1 describes our land price attribution model. This model was developed to isolate the key channels driving land price responses in VURMTAX, and to aid result interpretation. In section 3.2.2, we apply this model to study the results in rows A, A.1 and A.2 in section 3.2.2.

3.2.1. Explaining VURMTAX land price responses via back-of-the-envelope equations

VURMTAX, like many CGE models, is large and complex. Nevertheless, as Dixon and Rimmer (2013) explain, among the many ways that CGE modellers can validate and communicate the results from such models is via back-of-the-envelope representations of the model's key equations and data. In this section, we derive and implement back-of-the-envelope equations to describe VURMTAX's land price results. Much of the price effects caused by property tax reform herein manifest through changes in long-run land values. Those land value changes can however arise for a variety of reasons, as highlighted by equation (27), which is a function of post-tax land incomes, transfer duty tax rates, and expected holding periods. To yield a functional form for $\mathrm{PVL}_{i,q,t}$ that can be used to study land price (and thus housing price) responses in general, equation (27) can be further manipulated by repeatedly substituting $\mathrm{PVL}_{i,q,t}$ into term 3 on its right-hand side. This manipulation unpacks term 3 as a function of income earned beyond the expected holding period $\mathrm{H}_{i,q,t}$ of the current land parcel owner, as well as future expected tax liabilities; see equation (52).

$$\begin{aligned}\mathrm{PVL}_{i,q,t} = \Bigg[& -\frac{\mathrm{RTD}_{i,q,t}}{2}\cdot \mathrm{PVL}_{i,q,t}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{LND},i,q,t}\right) \\ & +\mathrm{ATDFACT}_{\mathrm{LND},i,q,t}\cdot \mathrm{UNITINC\_L}_{i,q,t}\Bigg]\cdot\Big(1+\mathrm{LRDFACT}_{\mathrm{LND},i,q,t} \\ & +\mathrm{LRDFACT}^{2}_{\mathrm{LND},i,q,t}+\ldots\Big).\end{aligned} \qquad \textbf{(52)}$$

The series involving $\mathrm{LRDFACT}_{\mathrm{LND},i,q,t}$ evaluated at time *t* is a geometric progression and can be written as:

$$\begin{aligned}\sum_{T=1}^{\infty}\mathrm{LRDFACT}_{\mathrm{LND,i,q,t}}^{\mathrm{T}} &= 1+\sum_{T=1}^{\infty}\mathrm{LRDFACT}_{\mathrm{LND,i,q,t}}^{\mathrm{T}} \\ &= 1+\frac{\mathrm{LRDFACT}_{\mathrm{LND,i,q,t}}}{1-\mathrm{LRDFACT}_{\mathrm{LND,i,q,t}}}.\end{aligned} \tag{53}$$

Substituting (53) into (52) and simplifying yields:

$$\begin{aligned}\mathrm{PVL}_{\mathrm{i,q,t}} =& -\frac{\mathrm{RTD}_{\mathrm{i,q,t}}}{2}\cdot\mathrm{PVL}_{\mathrm{i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{LND,i,q,t}}\right) \\ & +\mathrm{ATDFACT}_{\mathrm{LND,i,q,t}}\cdot\mathrm{UNITINC\_L}_{\mathrm{i,q,t}} \\ & +\frac{\mathrm{LRDFACT}_{\mathrm{LND,i,q,t}}}{1-\mathrm{LRDFACT}_{\mathrm{LND,i,q,t}}}\cdot\left[-\frac{\mathrm{RTD}_{\mathrm{i,q,t}}}{2}\cdot\mathrm{PVL}_{\mathrm{i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{LND,i,q,t}}\right)\right. \\ & \left.+\mathrm{ATDFACT}_{\mathrm{LND,i,q,t}}\cdot\mathrm{UNITINC\_L}_{\mathrm{i,q,t}}\right],\end{aligned} \tag{54}$$

where the first two expressions are equivalent to the first two terms in equation (27), and term 3 in (54) is equal to term 3 in equation (27).

We can use equation (54) to decompose the overall land price response in any counterfactual simulation, denoted $\mathrm{PVL}_{\mathrm{P|i,q,t}}$ from henceforth, into three distinct channels. This is achieved by creating a series of land value indices based on the terms in equation (54). As we shall discuss, these land price indices are identical in all respects to the baseline forecast land value index, except for one difference, e.g., we allow the TD rate on property transactions $\mathrm{RTD}_{\mathrm{i,q,t}}$ to adopt its counterfactual value $\mathrm{RTD}_{\mathrm{P|i,q,t}}$, rather than the value under the baseline forecast $\mathrm{RTD}_{\mathrm{B|i,q,t}}$. By measuring deviations between the resulting set of indices and the baseline forecast land value index $\mathrm{PVL}_{\mathrm{B|i,q,t}}$ defined in equation (55),

$$\begin{aligned}\mathrm{PVL}_{\mathrm{B|i,q,t}} =& -\frac{\mathrm{RTD}_{\mathrm{B|i,q,t}}}{2}\cdot\mathrm{PVL}_{\mathrm{B|i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}\right) \\ & +\mathrm{ATDFACT}_{\mathrm{B|LND,i,q,t}}\cdot\mathrm{UNITINC\_L}_{\mathrm{B|i,q,t}} \\ & +\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}\cdot\mathrm{PVL}_{\mathrm{B|i,q,t}},\end{aligned} \tag{55}$$

we can measure the impact of each of the channels we identify on the total deviation in land prices in the counterfactual simulation $\mathrm{PVL}_{\mathrm{P|i,q,t}}$, defined in equation (56) below, from the baseline forecast level in equation (55):

$$\begin{aligned}\mathrm{PVL}_{\mathrm{P|i,q,t}} = &-\frac{\mathrm{RTD}_{\mathrm{P|i,q,t}}}{2}\cdot \mathrm{PVL}_{\mathrm{P|i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{P|LND,i,q,t}}\right)\\ &+\mathrm{ATDFACT}_{\mathrm{P|LND,i,q,t}}\cdot \mathrm{UNITINC\_L}_{\mathrm{P|i,q,t}}\\ &+\mathrm{LRDFACT}_{\mathrm{P|LND,i,q,t}}\cdot \mathrm{PVL}_{\mathrm{P|i,q,t}}.\end{aligned} \tag{56}$$

In what follows, we define and describe each of our land price indices, before applying them via an example.

1. **Transfer duty effects:** Transfer duty effects capture the impact on land prices of changes in the rate of property transfer duty from $\mathrm{RTD}_{\mathrm{B|i,q,t}}$ to $\mathrm{RTD}_{\mathrm{P|i,q,t}}$. We define two types of transfer duty effects: *direct* and *indirect* effects. The direct transfer duty (TD) effect focuses on the first term in (54), which aligns with the first term in (27), i.e., it captures the impact on land prices when the transfer duty rate changes from $\mathrm{RTD}_{\mathrm{B|i,q,t}}$ $\mathrm{RTD}_{\mathrm{P|i,q,t}}$ for transfers occurring over the expected holding period of the property. The *indirect* TD effect focuses on the third term in equation (54), and captures the impact of changes in expected long-run TD rates, i.e., on transfers beyond the expected holding period of the property. The aggregate, or combined impact of direct and indirect TD effects, yield the price index in equation (57):

$$\begin{aligned}\mathrm{PVL}_{\mathrm{TD\_E|i,q,t}} = &-\frac{\mathrm{RTD}_{\mathrm{P|i,q,t}}}{2}\cdot \mathrm{PVL}_{\mathrm{B|i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}\right)\\ &+\mathrm{ATDFACT}_{\mathrm{B|LND,i,q,t}}\cdot \mathrm{UNITINC\_L}_{\mathrm{B|i,q,t}}\\ &+\frac{\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}}{1-\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}}\cdot\left[-\frac{\mathrm{RTD}_{\mathrm{P|i,q,t}}}{2}\cdot \mathrm{PVL}_{\mathrm{B|i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}\right)\right.\\ &\left.+\mathrm{ATDFACT}_{\mathrm{B|LND,i,q,t}}\cdot \mathrm{UNITINC\_L}_{\mathrm{B|i,q,t}}\right].\end{aligned} \tag{57}$$

To study direct and indirect effects independently, we split (57) into two TD effect land price indices: (i) the direct TD effect index $\mathrm{PVL}_{\mathrm{D\_TD\_E|i,q,t}}$, defined in equation (58); and, (ii) the indirect TD effect index $\mathrm{PVL}_{\mathrm{I\_TD\_E|i,q,t}}$ defined in equation (59). We measure each effect by calculating how the direct and indirect TD effect indices move relative to the baseline forecast land value index $\mathrm{PVL}_{\mathrm{B|i,q,t}}$ from equation (55).

$$\begin{aligned}\mathrm{PVL}_{\mathrm{D\_TD\_E|i,q,t}} = & -\frac{\mathrm{RTD}_{\mathrm{P|i,q,t}}}{2}\cdot \mathrm{PVL}_{\mathrm{B|i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}\right)\\ & +\mathrm{ATDFACT}_{\mathrm{B|LND,i,q,t}}\cdot \mathrm{UNITINC\_L}_{\mathrm{B|i,q,t}}\\ & +\frac{\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}}{1-\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}}\cdot\left[-\frac{\mathrm{RTD}_{\mathrm{B|i,q,t}}}{2}\cdot \mathrm{PVL}_{\mathrm{B|i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}\right)\right.\\ & \left.+\mathrm{ATDFACT}_{\mathrm{B|LND,i,q,t}}\cdot \mathrm{UNITINC\_L}_{\mathrm{B|i,q,t}}\right],\end{aligned} \tag{58}$$

$$\begin{aligned}\mathrm{PVL}_{\mathrm{I\_TD\_E|i,q,t}} = & -\frac{\mathrm{RTD}_{\mathrm{B|i,q,t}}}{2}\cdot \mathrm{PVL}_{\mathrm{B|i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}\right)\\ & +\mathrm{ATDFACT}_{\mathrm{B|LND,i,q,t}}\cdot \mathrm{UNITINC\_L}_{\mathrm{B|i,q,t}}\\ & +\frac{\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}}{1-\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}}\cdot\left[-\frac{\mathrm{RTD}_{\mathrm{B|i,q,t}}}{2}\cdot \mathrm{PVL}_{\mathrm{B|i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}\right)\right.\\ & \left.+\mathrm{ATDFACT}_{\mathrm{B|LND,i,q,t}}\cdot \mathrm{UNITINC\_L}_{\mathrm{B|i,q,t}}\right].\end{aligned} \tag{59}$$

2. **Income effect:** The aggregate income effect focuses on the second term in (54), which is identical to the second term in (27), and the fourth term in (54), which is derived by expanding the third term in (27). These two terms capture the impact on prices of altering expected annual post-tax land rents (after deducting all state and local government land taxes, and all federal government income taxes) from their baseline forecast level $\mathrm{UNITINC\_L}_{\mathrm{B|i,q,t}}$ to their counterfactual level $\mathrm{UNITINC\_L}_{\mathrm{P|i,q,t}}$, holding all else in (54) at its baseline forecast level. The price index for the aggregate income effect is equal to:

$$\begin{aligned}\mathrm{PVL}_{\mathrm{INC\_E|i,q,t}} = & -\frac{\mathrm{RTD}_{\mathrm{B|i,q,t}}}{2}\cdot \mathrm{PVL}_{\mathrm{B|i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}\right)\\ & +\mathrm{ATDFACT}_{\mathrm{B|LND,i,q,t}}\cdot \mathrm{UNITINC\_L}_{\mathrm{P|i,q,t}}\\ & +\frac{\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}}{1-\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}}\cdot\left[-\frac{\mathrm{RTD}_{\mathrm{B|i,q,t}}}{2}\cdot \mathrm{PVL}_{\mathrm{B|i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}\right)\right.\\ & \left.+\mathrm{ATDFACT}_{\mathrm{B|LND,i,q,t}}\cdot \mathrm{UNITINC\_L}_{\mathrm{P|i,q,t}}\right],\end{aligned} \tag{60}$$

The second term in (60) above is the impact of changes in income earned by the purchaser within their expected holding period. We call this the *direct* income effect. The fourth term is the discounted present value of the expected income earned over the lifetime of the land parcel, excluding income earned over the expected holding period of the owner at time *t*. We define the impact of changes in this term on land price as the *indirect* income effect. Once again, to study the impact of each of these two terms independently, we form two income effect price indices, the direct and indirect income effect indices [$\mathrm{PVL}_{\mathrm{D\_INC\_E}|i,q,t}$ in equation (61) and $\mathrm{PVL}_{\mathrm{I\_INC\_E}|i,q,t}$ in equation (62) respectively] and study how these indices move relative to the baseline forecast land value index $\mathrm{PVL}_{\mathrm{B}|i,q,t}$ from equation (55).

$$\begin{aligned}\mathrm{PVL}_{\mathrm{D\_INC\_E}|i,q,t} = & -\frac{\mathrm{RTD}_{\mathrm{B}|i,q,t}}{2}\cdot \mathrm{PVL}_{\mathrm{B}|i,q,t}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{B|LND},i,q,t}\right) \\ & +\mathrm{ATDFACT}_{\mathrm{B|LND},i,q,t}\cdot \mathrm{UNITINC\_L}_{\mathrm{P}|i,q,t} \\ & +\frac{\mathrm{LRDFACT}_{\mathrm{B|LND},i,q,t}}{1-\mathrm{LRDFACT}_{\mathrm{B|LND},i,q,t}}\cdot\left[-\frac{\mathrm{RTD}_{\mathrm{B}|i,q,t}}{2}\cdot \mathrm{PVL}_{\mathrm{B}|i,q,t}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{B|LND},i,q,t}\right)\right. \\ & \left.+\mathrm{ATDFACT}_{\mathrm{B|LND},i,q,t}\cdot \mathrm{UNITINC\_L}_{\mathrm{B}|i,q,t}\right],\end{aligned} \quad \mathbf{(61)}$$

$$\begin{aligned}\mathrm{PVL}_{\mathrm{I\_INC\_E}|i,q,t} = & -\frac{\mathrm{RTD}_{\mathrm{B}|i,q,t}}{2}\cdot \mathrm{PVL}_{\mathrm{B}|i,q,t}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{B|LND},i,q,t}\right) \\ & +\mathrm{ATDFACT}_{\mathrm{B|LND},i,q,t}\cdot \mathrm{UNITINC\_L}_{\mathrm{B}|i,q,t} \\ & +\frac{\mathrm{LRDFACT}_{\mathrm{B|LND},i,q,t}}{1-\mathrm{LRDFACT}_{\mathrm{B|LND},i,q,t}}\cdot\left[-\frac{\mathrm{RTD}_{\mathrm{B}|i,q,t}}{2}\cdot \mathrm{PVL}_{\mathrm{B}|i,q,t}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{B|LND},i,q,t}\right)\right. \\ & \left.+\mathrm{ATDFACT}_{\mathrm{B|LND},i,q,t}\cdot \mathrm{UNITINC\_L}_{\mathrm{P}|i,q,t}\right].\end{aligned} \quad \mathbf{(62)}$$

3. **Holding period and discount rate effect:** The holding period and discount rate effect impacts elements of all four terms in (54), and captures the impact on land prices of: (i) altering the expected holding period of the land parcel from $\mathrm{H}_{\mathrm{B}|i,q,t}$ to the counterfactual level $\mathrm{H}_{\mathrm{P}|i,q,t}$, holding all else in (54) at its baseline forecast level; (ii) altering the real discount rate from $\mathrm{RDISC}_{\mathrm{B|LND},i,q,t}$ to $\mathrm{RDISC}_{\mathrm{P|LND},i,q,t}$, holding all else constant; and, (iii) altering the shape parameter introduced in equation (19) for the path of expected future discount rates from $\mathrm{S}_{\mathrm{B}|i,q,t}$ to $\mathrm{S}_{\mathrm{P}|i,q,t}$, holding all else constant. This effect is most pronounced when altering transfer duty on existing properties,

expectations surrounding growth rates in future incomes, or the cost of borrowing. This term can once more be broken into *direct* effects and *indirect* effects, which have the following forms:

$$\begin{aligned}\mathrm{PVL}_{\mathrm{D\_HLD\_E}|\mathrm{i,q,t}} = &-\frac{\mathrm{RTD}_{\mathrm{B}|\mathrm{i,q,t}}}{2}\cdot \mathrm{PVL}_{\mathrm{B}|\mathrm{i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{P}|\mathrm{LND,i,q,t}}\right)\\ &+\mathrm{ATDFACT}_{\mathrm{P}|\mathrm{LND,i,q,t}}\cdot \mathrm{UNITINC\_L}_{\mathrm{B}|\mathrm{i,q,t}}\\ &+\frac{\mathrm{LRDFACT}_{\mathrm{B}|\mathrm{LND,i,q,t}}}{1-\mathrm{LRDFACT}_{\mathrm{B}|\mathrm{LND,i,q,t}}}\cdot\Bigg[-\frac{\mathrm{RTD}_{\mathrm{B}|\mathrm{i,q,t}}}{2}\cdot \mathrm{PVL}_{\mathrm{B}|\mathrm{i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{B}|\mathrm{LND,i,q,t}}\right)\\ &+\mathrm{ATDFACT}_{\mathrm{B}|\mathrm{LND,i,q,t}}\cdot \mathrm{UNITINC\_L}_{\mathrm{B}|\mathrm{i,q,t}}\Bigg],\end{aligned} \quad \textbf{(63)}$$

$$\begin{aligned}\mathrm{PVL}_{\mathrm{I\_HLD\_E}|\mathrm{i,q,t}} = &-\frac{\mathrm{RTD}_{\mathrm{B}|\mathrm{i,q,t}}}{2}\cdot \mathrm{PVL}_{\mathrm{B}|\mathrm{i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{B}|\mathrm{LND,i,q,t}}\right)\\ &+\mathrm{ATDFACT}_{\mathrm{B}|\mathrm{LND,i,q,t}}\cdot \mathrm{UNITINC\_L}_{\mathrm{B}|\mathrm{i,q,t}}\\ &+\frac{\mathrm{LRDFACT}_{\mathrm{P}|\mathrm{LND,i,q,t}}}{1-\mathrm{LRDFACT}_{\mathrm{P}|\mathrm{LND,i,q,t}}}\cdot\Bigg[-\frac{\mathrm{RTD}_{\mathrm{B}|\mathrm{i,q,t}}}{2}\cdot \mathrm{PVL}_{\mathrm{B}|\mathrm{i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{P}|\mathrm{LND,i,q,t}}\right)\\ &+\mathrm{ATDFACT}_{\mathrm{P}|\mathrm{LND,i,q,t}}\cdot \mathrm{UNITINC\_L}_{\mathrm{B}|\mathrm{i,q,t}}\Bigg].\end{aligned} \quad \textbf{(64)}$$

4. Interaction effects: Each of the three direct channels defined thus far, along with each of the three indirect channels described, also interact with one another. This gives rise to two additional effects, called the *direct* and *indirect* interaction effects, defined as $\mathrm{PVL}_{\mathrm{D\_INT\_E}|\mathrm{i,q,t}}$ and $\mathrm{PVL}_{\mathrm{I\_INT\_E}|\mathrm{i,q,t}}$ respectively; see their mathematical definition in equations (65) and (66).

$$\begin{aligned}\mathrm{PVL}_{\mathrm{D\_INT\_E}|\mathrm{i,q,t}} = &-\frac{\mathrm{RTD}_{\mathrm{P}|\mathrm{i,q,t}}}{2}\cdot \mathrm{PVL}_{\mathrm{P}|\mathrm{i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{P}|\mathrm{LND,i,q,t}}\right)\\ &+\mathrm{ATDFACT}_{\mathrm{P}|\mathrm{LND,i,q,t}}\cdot \mathrm{UNITINC\_L}_{\mathrm{P}|\mathrm{i,q,t}}\\ &+\frac{\mathrm{LRDFACT}_{\mathrm{B}|\mathrm{LND,i,q,t}}}{1-\mathrm{LRDFACT}_{\mathrm{B}|\mathrm{LND,i,q,t}}}\cdot\Bigg[-\frac{\mathrm{RTD}_{\mathrm{B}|\mathrm{i,q,t}}}{2}\cdot \mathrm{PVL}_{\mathrm{B}|\mathrm{i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{B}|\mathrm{LND,i,q,t}}\right)\\ &+\mathrm{ATDFACT}_{\mathrm{B}|\mathrm{LND,i,q,t}}\cdot \mathrm{UNITINC\_L}_{\mathrm{B}|\mathrm{i,q,t}}\Bigg],\end{aligned} \quad \textbf{(65)}$$

$$\begin{aligned}\mathrm{PVL}_{\mathrm{I\_INT\_E}|\mathrm{i,q,t}} = &-\frac{\mathrm{RTD}_{\mathrm{B}|\mathrm{i,q,t}}}{2}\cdot \mathrm{PVL}_{\mathrm{B}|\mathrm{i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{B}|\mathrm{LND,i,q,t}}\right)\\ &+\mathrm{ATDFACT}_{\mathrm{B}|\mathrm{LND,i,q,t}}\cdot \mathrm{UNITINC\_L}_{\mathrm{B}|\mathrm{i,q,t}}\\ &+\frac{\mathrm{LRDFACT}_{\mathrm{P}|\mathrm{LND,i,q,t}}}{1-\mathrm{LRDFACT}_{\mathrm{P}|\mathrm{LND,i,q,t}}}\cdot\Bigg[-\frac{\mathrm{RTD}_{\mathrm{P}|\mathrm{i,q,t}}}{2}\cdot \mathrm{PVL}_{\mathrm{P}|\mathrm{i,q,t}}\cdot\left(1+\mathrm{LRDFACT}_{\mathrm{P}|\mathrm{LND,i,q,t}}\right)\\ &+\mathrm{ATDFACT}_{\mathrm{P}|\mathrm{LND,i,q,t}}\cdot \mathrm{UNITINC\_L}_{\mathrm{P}|\mathrm{i,q,t}}\Bigg].\end{aligned} \quad \textbf{(66)}$$

Why are interaction effects present? Consider a policy experiment that decreases the TD rate, and decreases post-tax annual land rentals. While each of these effects are expected to drive land values higher independently, they would also be expected to interact with one another. Why? Because the second of the two effects (lower post-tax rentals) decrease land values, which will impact TD payable for any given non-zero TD rate. In other words, their aggregate impact on $PVL_{P|i,q,t}$ will likely differ from the sum of their parts.

The attribution formulae in equations (58), (59), and (61) – (66) are used in the following subsection to study how land prices respond to tax mix changes. As we shall see, much of the price response in the long-run is driven by permanent shifts in land prices, because long-run housing capital values are tied down by construction costs. To build land price decompositions, we measure the cumulative percentage deviation of each land price index from the baseline forecast land price, i.e., $PVL_{P|i,q,t}$ - $PVL_{B|i,q,t}$. This yields a total of eight direct and indirect price effect channels, i.e., direct and indirect TD effects, direct and indirect income effects, direct and indirect holding period effects, and direct and indirect interaction effects. To recap, these effects describe the following economic phenomena:

1. The direct TD effect. This measures the impact on the current land price arising from expected transfer duty liabilities over the current purchaser's expected holding period of the property. This effect will be smaller than the rate of TD, because we assume the tax to be proportionately borne by buyers and sellers.
2. The indirect TD effect. This measures the impact on the current land price arising from expected transfer duty liabilities beyond the current purchaser's expected holding period. This effect arises because the current property purchaser will eventually be a seller of the property, and embedded within the sale price are the impacts of TD beyond the current owners holding period.
3. The direct income effect. This measures the impact on the current land price arising from tax-induced changes in post-tax land rental prices over the current purchaser's expected holding period.

4. The indirect income effect. This measures the impact on the current land price arising from tax-induced changes in post-tax land rental prices beyond the expected holding period of the current landowner.

5. The direct holding period effect. This measures the impact on the current land price arising from changes in the property holding period for the current owner. This effect arises because the holding period of the property responds inelastically to the tax-inclusive cost of transacting property.

6. The indirect holding period effect. This measures the impact on the current land price arising from changes in the property holding period for future owners of the property. This effect arises because changes in the property holding period determine the expected frequency of future property turnover, and thus the expected frequency with which future TD liabilities will be incurred.

7. The direct interaction effect. This measures the degree to which the three direct effects interact with one another to impact the current land price. This effect arises because our model is inherently non-linear. As an example, consider the impact of a temporary TD rate reduction and a temporary land tax increase, expected to last one holding period. This policy would be expected to drive positive direct TD effects (in response to the fall in the TD rate) and negative direct income effects (in response to the rise in land taxes). The latter of these will also be capitalized into the land price, which is the tax base for TDs. This (lower) land price will reinforce the direct TD effect, and appear as a small, direct interaction effect.

8. The indirect interaction effect. This measures the degree to which the three indirect effects interact with one another to impact the current land price, and materializes once more due to the inherent nonlinearity in our model.

We include one final *other effect* category, to capture any other impacts on land prices. As we show, this effect is infinitesimally small, implying our eight land price indices capture at least 99.9 percent of the total simulated land price variation.

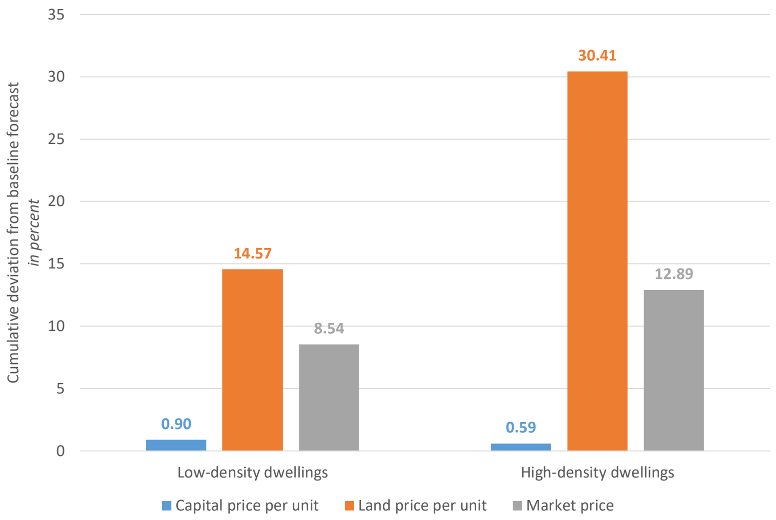
3.2.2. *Studying replacement of TD with a new BBUIV tax*

In this section, we study the results in row A of Table 2, where we simulate the replacement of TD with a broad-based, uniform rate tax on unimproved land value. This analysis is broken into three parts. First, we examine the results in row A.1, to understand the impact of removing TD and replacing the revenue with a non-distortionary lump sum tax levied on households. Next, we study the results in row A.2, where we levy a BBUIV and return the revenue via a lump sum transfer to households. Finally, we put the two simulations together and study row A.

The response of housing prices to revenue-neutral removal of TDs

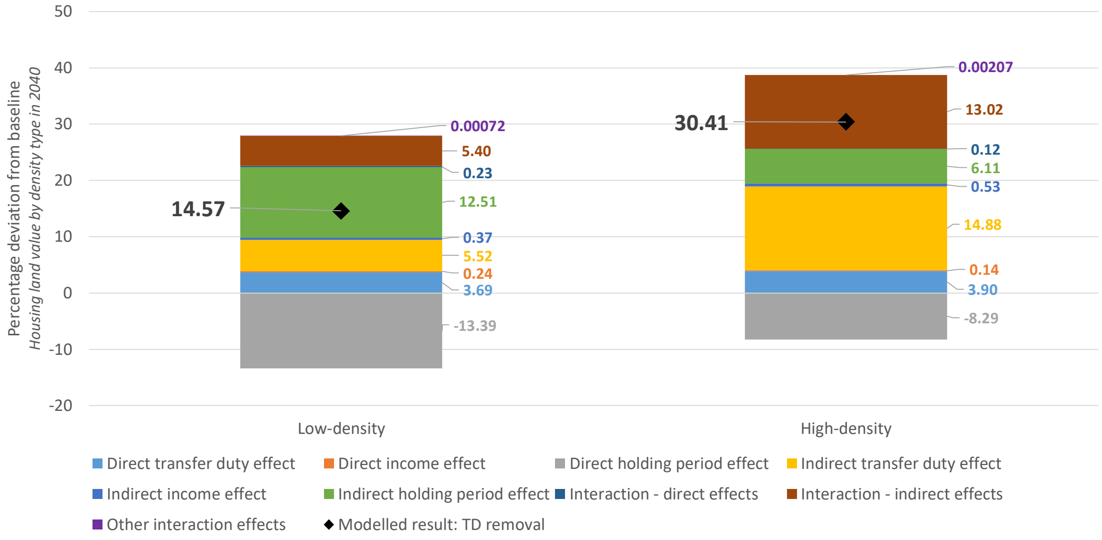
From column [3] row A.1 of Table 2, we observe large, negative NEBs when TD is removed and replaced using a non-distortionary LST on households. As expected, the magnitude is smaller than the MEB in column [3] of row 1 in Table 1, because the reported NEB in Table 2 is essentially the negative of the average excess burden of NSW TD, i.e., the economic distortion removed when we forgo collecting the final dollar of TD in is much less than the economic distortion removed when we forgo collecting the first dollar of TD. Regarding the market housing price responses in columns [4i] and [5i], in Figure 8 we report these results as grey bars, alongside the housing capital price response (blue bars) and housing land price response (orange bars). By value weighting the blue and orange bars, we can derive the market price responses; see equation (3).

Figure 8: Housing price response for row A.1 in Table 2, together with the capital and land price responses.



From Figure 8, we see that in order to understand the housing price response from TD replacement, we must explain the impact of replacing TD with a non-distorting lump sum tax on housing land prices. To this end, we construct a decomposition diagram of the low- and high-density housing land price responses (the orange bars in Figure 8) using the attribution indices in section 3.2.1 and report our results in Figure 9. The results in Figure 9 are derived from a counterfactual simulation where $\mathrm{RTD}_{\mathrm{P|i,NSW,t}}$ is permanently set to zero for all *t* from 2022 onwards. For the readers convenience, $\mathrm{RTD}_{\mathrm{B|i,NSW,2040}}$ is equal to 4.66 percent for i=*DwellingLow*, while its equivalent value for *i*=*DwellingHigh* is 4.4 percent.

Figure 9: Decomposition of the long-run impact on housing land prices of TD removal and revenue replacement with a non-distorting lump sum tax on households.



The total variation of the land price from baseline, i.e., $100\cdot\left(\mathrm{PVL}_{\mathrm{P|i,q,t}}-\mathrm{PVL}_{\mathrm{B|i,q,t}}\right)/\mathrm{PVL}_{\mathrm{B|i,q,t}}$, is reported as black diamonds in Figure 9. These values match the orange bars in Figure 8. From Figure 9, we see that *other effects,* shaded purple and appearing at the top of each column, are infinitesimally small, i.e., the total deviation of the land price from baseline forecast is almost completely described by the deviations in the eight decomposition factors defined in equations (58), (59), and (61) – (66). The results are largely explicable in terms of these equations. For example, from equation (58) we would expect to see a direct effect of TD removal (light blue bars in Figure 9) that lies slightly below the TD rate for each type of housing land. This is because the incidence of the TD falls proportionately on the purchaser and the seller. Half the tax load must therefore be discounted to present value terms, and hence the overall direct effect is less than the size of the shock to $\mathrm{RTD}_{\mathrm{P|i,NSW,t}}$. This effect is larger for high-density housing land, because the holding period is much lower, and thus the present value of the TD effect at sale is larger.

As shown by the black diamonds and the associated labels in Figure 9, land prices rise much more for a unit of high-density housing land (+30.41 percent relative to baseline in 2040) than a unit of low-density housing land (+14.57 percent relative to baseline in 2040) when TD is replaced by a non-distorting lump sum tax on households. Why? From the decomposition diagram, we see this relative response is driven by indirect effects. Two dominate in particular: the indirect TD effect [yellow bars in Figure 9 and equation (59)] and indirect interaction effects [brown bars in Figure 9 and equation (66)].

If we compare the indirect TD effect for high-density housing to that for low-density housing, we find the former to be about 2.7 times larger than the latter. Studying equation (59), and for the moment treating the transfer duty rate between the two land types as being homogeneous, we would expect different price impacts from the indirect TD effect if the discount factor $\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}} \big/ \left(1-\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}\right)$ of the two types of housing land were very different. Herein, the ratio between the high-density housing land discount factor and the low-density housing land discount factor is approximately equal to 2.6, which is broadly in line with the differences in the indirect TD responses, i.e.,

$$\frac{\dfrac{\mathrm{LRDFACT}_{\mathrm{B|LND,DwellingHigh,NSW,2040}}}{1-\mathrm{LRDFACT}_{\mathrm{B|LND,DwellingHigh,NSW,2040}}}}{\dfrac{\mathrm{LRDFACT}_{\mathrm{B|LND,DwellingLow,NSW,2040}}}{1-\mathrm{LRDFACT}_{\mathrm{B|LND,DwellingLow,NSW,2040}}}} \approx 2.6. \tag{67}$$

This difference in discount factors is caused by differences in the holding periods between the two land types. As discussed in section 2.4.1, our analysis of the NSW housing market suggests high-density housing is transacted more frequently than low-density housing. The turnover rates are thus very different; as of 2017, 9.2 years for high-density housing in 2017 and 24.6 years for low-density housing. Because TD is paid each time a property is transacted, we would expect stronger upward revaluations in the expected price at sale if transfer duty is removed from a type of land that is expected to be transacted more frequently over its lifetime, because the future tax burden is now lower.

In this simulation, indirect interaction effects are strong and positive for both low- and high-density housing. Why? When we remove transfer duties, holding periods for all types of housing fall. This means that housing land is now expected to be turned over more rapidly than under the baseline. Each of these turnover events are also now free of transaction taxes in the counterfactual scenario.

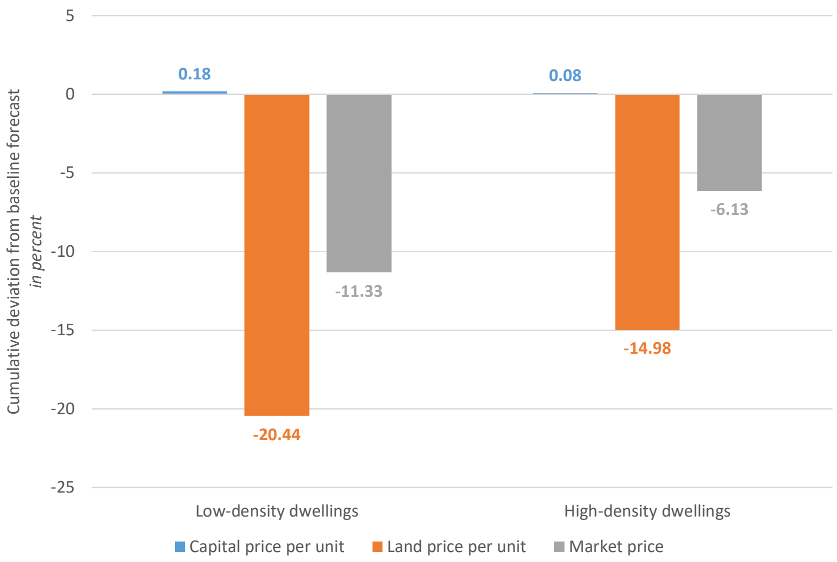
Together, this interaction between indirect holding period and TD effects would amplify the price rise that would have been anticipated if the two effects were studied independently of one another.

Indirect holding period effects [green bars in Figure 9 and equation (64)] also make positive contributions to both low-density and high-density housing land price responses, but these are offset by similar magnitude and opposite signed contributions from direct holding period effects [grey bars in Figure 9 and equation (63)]. These two effects are expected to offset one another when holding periods adjust. Why? When we remove TDs, holding periods shorten because a large barrier to transacting property has been removed. Shorter holding periods reduce earnings over the expected holding period. The impact of this reduction in earnings is captured by the large, negative direct effect (grey bars in Figure 9). The income foregone due to faster turnover of the land parcel is not eliminated, however. Instead, it is now earned beyond $H_{P|i,q,t}$. This drives the positive indirect holding period response (green bars in Figure 9), which is the discounted present value of additional income expected to be earned after the initial holding period.

The response of housing prices to revenue-neutral imposition of a new BBUIV tax

Figures like 8 and 9 can be produced for the simulation results reported in row A.2 of Table 2; see Figures 10 and 11. From Figure 10, we once more see how long-run housing price responses to tax reform are driven by changes in land prices. As described by Wood *et al.* (2012), broad-based land taxes such as the BBUIV tax introduced in simulation A.2 drive falls in post-tax land rents, which are in turn capitalised into lower land prices. Land tax burdens therefore fall on landowners. The ratio of the high- to low-density housing price response (the ratio of the grey bars in Figure 10) are approximately equal to 0.6; see equation (45) and the discussion that supports its derivation in section 3.1.5. Dividing the grey bars by the long-run land value ratios yields the orange bars in Figure 10, which exhibit similar relativities to the grey bars and are equivalent to the black diamonds in Figure 11.

Figure 10: Housing price response for row A.2 in Table 2, together with the capital and land price responses.



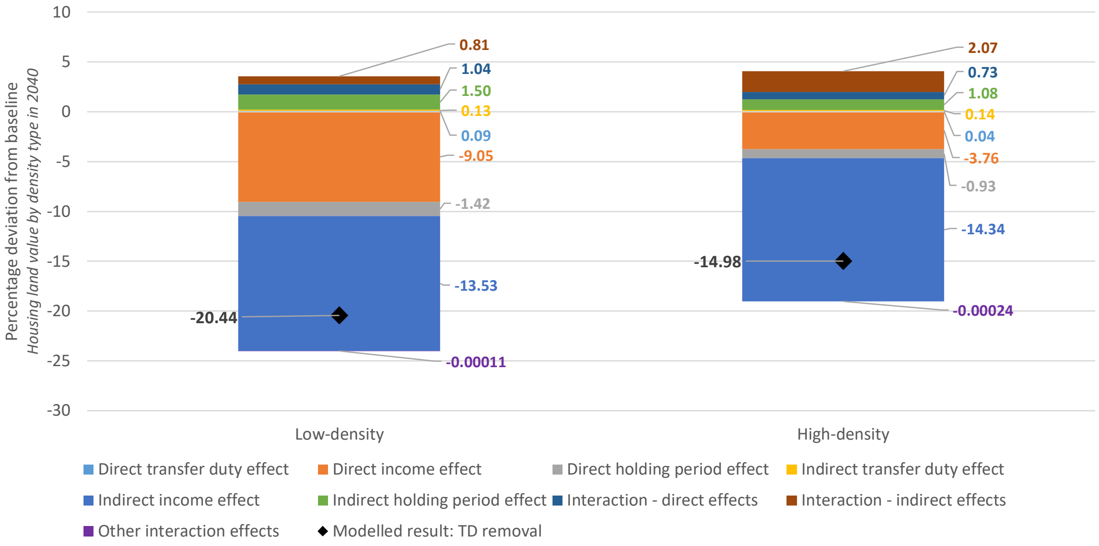
As expected, Figure 11 shows that income effects dominate the land price response when we introduce a BBUIV tax. Direct income effects (orange bars in Figure 11) dominate the relative response, with the cumulative impact of all other responses being similar across the two land types. Why does the direct income effect differ so markedly between high- and low-density housing? $\mathrm{ATDFACT}_{\mathrm{LND,i,q,t}}$ drives the relative response here; because the average holding period for low-density housing is approximately 2.7 times the high-density housing holding period, *ceteris paribus* we would expect the relative direct income effect to display a similar relativity. The idea here is that the holder of the low-density zoned land must make approximately 2.7 times as many annual land tax payments as the owner of the high-density land over their respective holding periods. From Figure 11, we see that the orange bar for low-density housing is about 2.4 times as large as the orange bar for high-density housing; it is slightly lower that the holding period ratio, because the discount rate is positive. This is very similar to the ratio of $\mathrm{ATDFACT}_{\mathrm{LND,i,q,t}}$ for low- and high-density housing land, i.e.,

$$\frac{\mathrm{ATDFACT}_{\mathrm{B|LND,DwellingHigh,NSW,2040}}}{\mathrm{ATDFACT}_{\mathrm{B|LND,DwellingLow,NSW,2040}}} \approx \frac{1}{2.4}. \qquad \textbf{(68)}$$

If the BBUIV rate and discount rate is homogeneous across low- and high-density housing types, then the present value of the land tax payments should be similar identical across the low- and high-density housing. The sum of indirect and direct income effects should therefore be very similar. While these two conditions are met herein (the discount rate is approximately 2.25 percent in the long-run, while the rate shock is approximately 50 basis points across both housing land types), from Figure 11 we see the sum of direct and indirect income effects differ across the two types of housing. Indirect income effects for high-density housing (dark blue bars in column 2 of Figure 11, and equal to -14.34 percent in simulation year 2040 herein) are only marginal larger in magnitude than the equivalent result for low-density housing (-13.53 percent, column 1 in Figure 11), despite large differences in direct income effects across the two land types. Why? When large new land taxes are introduced, land valuations fall. This impacts collections from other land taxes levied in the state, particularly SLT in this case. While the new BBUIV tax therefore raises the desired level of tax-specific revenue via a homogeneous rate shock of 50 basis points, collections from other land taxes fall. Overall, this means the change in land tax collections falls short of the total collected from the new BBUIV. The impact of this shortfall is most pronounced for high-density housing, because its rental tenure share is large relative to low-density housing. This effect reduced the effective tax rate shock for high-density housing by approximately 10 basis points, from 50 basis points to 40 basis points.

With this in mind, we can approximate the direct and indirect income effects in Figure 11 and in so doing, elucidate the economic mechanisms driving the relative response across low- and high-density housing. For both land types, we assume the discount rate to be 2.25 percent for all time. The stream of BBUIV payments at a rate of 0.005 percent per annum for low-density housing land can be modelled as a perpetuity, with a present value of $-0.005/0.0225=-0.222$ or -22.2 percent. This is very close to the sum of the direct and indirect income effects (orange and dark blue bars) for low-density housing in column 1 of Figure 11. For high-density housing, we set the tax rate to 0.004 percent and the discount rate to 2.25 percent, yielding a present value of $-0.004/0.0225=-0.178$ or -17.8 percent. Once again, this is very close to the sum of the orange and dark blue bars in Figure 11. Under this framework, the orange bars in Figure 11 represent the present value of two annuities, where the number of annual payments are set equal to the holding period of low- and high-density housing. For example, the direct income effect of a tax levied at a rate of 0.005 or 50 bps (the orange bars in column 1 of Figure 11) for n=24 years where the real discount rate is equal to 2.25 percent is $-0.005\cdot\left[\left(1-1.0225^{-24}\right)/0.0225\right]=-0.0919$ or 9.19 percent. which is very close to the modelled result of 9.05 percent in column 1 of Figure 11. For high-density housing, the approximated result (-3.5 percent, where the rate is now 0.004 and the number of payments n=10) is once more very close to the modelled outcome of 3.76 percent. The dark blue bars (or indirect income effects) in columns 1 and 2 of Figure 11 can then be understood as the difference between the present value of the perpetuity, and the present value of the annuities in each case.

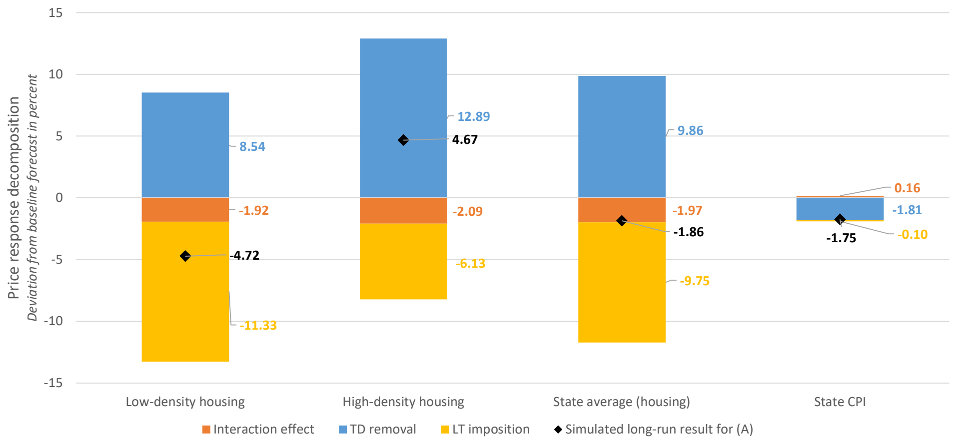
Figure 11: Decomposition of the long-run impact on housing land prices of BBUIV tax introduction, with revenue neutrality achieved by providing a non-distorting lump sum transfer to households.



The response of housing prices to a swap of TD with a new BBUIV tax

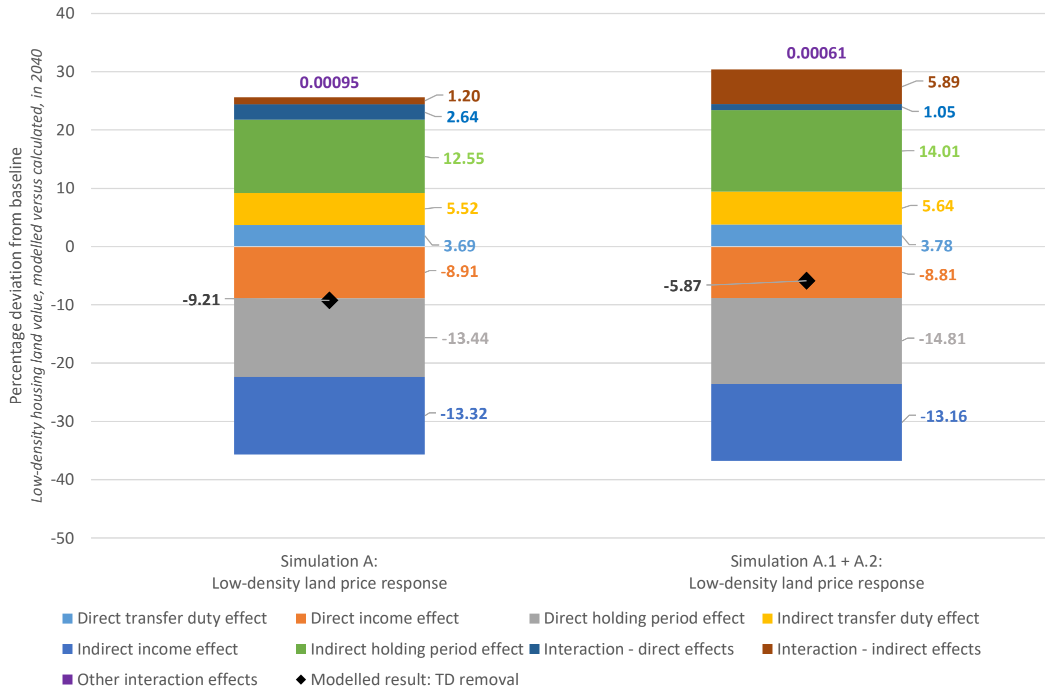
Having described the key drivers of the relative housing price response for rows A.1 and A.2, we now consider the simulation in row A. Figure 12 plots the results in columns [4i], [5i], [6i] and [7] in the same graph, for all of rows A (black diamonds, where TD is replaced by a BBUIV tax), A.1 (blue bars, where TD is replaced with a lump sum tax on households), and A.2 (yellow bars, where a BBUIV is levied to raise the same revenue as TD and that revenue is returned to households as a lump sum transfer). In addition, we include an *Interaction effect* (the orange bars in Figure 12), which reports the deviation of the modelled response in row A (the black diamonds) from the sum of the blue (row A.1 modelled result) and yellow (row A.2 modelled result) bars. From column 4 (State CPI) in Figure 12, interaction effects are very small at the macro level, i.e., the sum of the state CPI price response from simulations A.1 (blue bars) and A.2 (yellow bars) are very similar to the response in simulation A (black diamonds). The interaction effect is thus one order of magnitude smaller than the aggregate effect (the orange bars are at least ten times smaller in magnitude than the black diamonds). This contrasts markedly with housing price responses in columns 1 – 3 of Figure 12, where interaction or general equilibrium effects between simulations A.1 and A.2 (orange bars) are of similar order to the modelled result (black diamonds) from simulation A in Table 2. This finding emphasises the merit of a general equilibrium approach, with a detailed housing price module, when modelling tax reform scenarios of this nature.

Figure 12: Breakdown of the modelled housing market price and state CPI responses in scenario A from Table 2, using the responses in scenario A.1 in Table 2, scenario A.2 in Table 2, and interaction effects.



Why are interaction effects in housing prices significant? Because capital values are largely tied down in the long-run by construction costs, the interaction effect can be traced to land price responses. To elucidate its origins, we used a two-staged approach: (i) first, we applied equations (58), (59), and (61) – (66) to decompose the land price response in the TD->BBUIV simulation (see the black diamonds in Figure 12 or row A in Table 2); and, (ii) second, we compared the modelled decomposition results in (i) to approximations derived by adding the decomposition responses in Figures 9 and 11 to one another. The realisation of this process is Figure 13. For brevity, Figure 13 includes results for low-density housing land price responses only. Column 1 in Figure 13 includes modelled decomposition responses for low-density housing land in simulation A, while in column 2 summarises the approximation derived following the steps in (ii). Land-value share weighting the results in column 1 of Figure 13, and adding them to share-weighted housing capital responses, yields the black diamonds in column 1 of Figure 12.

Figure 13: Decomposition of the modelled low-density land price response in simulation A from Table 2 versus the approximate result calculated by summing the low-density responses in Figure 9 and Figure 11.



From Figure 13, we see that many of the modelled responses for simulation A (TD->BBUIV) in column 1, are broadly consistent with their approximations derived by summing the results from Figures 9 and 11, for simulations A.1 (TD->LST) and A.2 (LST->BBUIV) respectively. There is one exception, namely indirect interaction effects; see the brown bars in Figure 13, where the modelled response (+1.2 percent in column 1) is much smaller than the approximated response (+5.89 percent in column 2). The difference (column 2 *less* column 1 = -4.7 percent) can be land value share weighted; the result is broadly consistent with the interaction effect in column 1 of Figure 12, i.e., other discrepancies between column 1 and column 2 in Figure 13 balance each other out.

To understand the cause of this differential response, consider equation (66) where we define indirect interaction effects more formally. When calculating the deviation from baseline reported in column 1 of Figure 13, we replace all values on the right-hand side the carry a subscript *P* with their counterfactual simulation values. This means $\mathrm{RTD}_{\mathrm{P|i,q,t}} = 0$, $\mathrm{UNITINC\_L}_{\mathrm{P|i,q,t}}$ is smaller than $\mathrm{UNITINC\_L}_{\mathrm{B|i,q,t}}$, and contractions in holding periods mean $\mathrm{ATDFACT}_{\mathrm{P|LND,i,q,t}}$ falls relative to $\mathrm{ATDFACT}_{\mathrm{B|LND,i,q,t}}$ while $\mathrm{LRDFACT}_{\mathrm{P|LND,i,q,t}}$ rises relative to $\mathrm{LRDFACT}_{\mathrm{B|LND,i,q,t}}$. Overall, these changes impact land prices, causing $\mathrm{PVL}_{\mathrm{P|i,q,t}}$ to fall relative to $\mathrm{PVL}_{\mathrm{B|i,q,t}}$. The cumulative impact of these responses drive interact, and drive housing land prices up by 1.2 percent relative to their baseline forecast level. When we break this into two parts, i.e., we first remove TD *then* we raise revenue from a new BBUIV tax, we inadvertently double-count a cost saving. To be more specific, consider simulation A.2 where when we impose the BBUIV tax but hold TD rates fixed. The fall in housing prices caused by the new tax carries an indirect cost saving in simulation A.2, because the TD liabilities on future land sales are reduced. This saving in transaction costs damps the fall in housing land prices slightly in simulation A.2; see the positive, brown bars in Figure 11. Critically, this saving is already captured in simulation A.1, because TD is completely removed there. In column 2 of Figure 13, the brown bars (+5.89 percent) count this indirect cost saving twice, while column 1 does not because TD is removed along with the imposition of the BBUIV tax in simulation A.

4. Comparison with previous studies of housing prices and property taxes

Previous commentary regarding tax mix changes and property prices in Australia have suggested that short-run housing prices would be largely unaffected by property tax swaps. For example, Coates (2019) notes that Freebairn (2017) and Coates (2017) suggest that, because stamp duty and land tax should be fully capitalised in land prices, a tax swap will have little impact on house prices. Our findings differ, for several reasons. First, not all TDs are capitalised into housing prices. Because TD is partly incident upon the housing capital, and long-run capital values are tied down by construction costs, we find that the degree to which TD is capitalised into housing prices depends on the land value share of the house. Second, our data analysis shows that the proclivity to turnover housing differs across housing density. The holding period is important when studying the impact of TDs on housing prices, because a property that is turned over more frequently will carry a greater TD load over any given time frame. Third, while our tax mix swaps are revenue-neutral in totality, they are not revenue neutral across land zone types, as described by Freebairn (2017) and Coates (2017). Specifically, in our counterfactual experiments we do not set distinct land tax rates for low-density housing, high-density housing, commercial, retail and industrial land to match precisely the TD revenue derived from transactions of these land types. In simulation A in Table 2, our BBUIV tax rate is homogeneous across all land types. Some price responses thus materialise, as TD tax collections for some land zone types differ from BBUIV collections from the same land zone type. Coates (2019) further suggests that property tax reform might lower long-run housing prices via improved allocation of the housing stock.

Our results in Table 2 and the discussion in section 3 shows that in the long-run, housing price responses are likely to be non-zero, and differ across different types of housing. Here, we distinguish our housing stock according to development density, i.e., land value shares differ across the two types of housing we consider (high- and low-density). High- and low-density housing also exhibit markedly different holding periods: in 2017, our analysis of NSW transaction data shows that average holding periods for low-density housing are more than twice those for high-density housing. Our analysis shows that differences in transaction frequency, particularly where the more frequently transacted housing type carries low land value shares, can generate differential price responses to property tax reform. When swapping a transaction tax, where the tax load on high-density housing is large relative to its land value share, with an unimproved land value tax levied at a uniform rate (see simulation A in Table 2), we find high-density housing prices rise while low-density housing prices fall. This result holds irrespective of whether our focus is the pre-duty or the duty-inclusive price.

Other approaches to studying the impact of tax reform in Australia rely on spatial modelling. For example, Wood *et al.* (2012) explores the impact of swapping TD on housing with a new unimproved land value tax on housing land in Melbourne, using Victorian Valuer-General data from 2006. In Wood *et al.* (2012), the land tax introduced differs from the BBUIV tax we consider herein, because it is levied at a differential rate that depends on the land value per square metre of the property, i.e., a higher load is imposed on properties close to the CBD. Tax mix swaps are also focused on replacing TD collected from housing transactions, with new land taxes on housing. In contrast, the BBUIV tax introduced herein is levied as a uniformly rated ad valorem tax across land of all zone types, to replace TD revenues from housing and non-residential property TD. Wood *et al.* (2012) find average housing land price reductions of 5 percent would occur in Victoria if TD on housing were replaced with a differentially-rated land tax. Herein, the land price responses for the imposition of a new BBUIV tax are reported in Figure 11, and are much larger (-20% for low density and -15% for high density).

There are several reasons for this. First, if the discount rate applied herein was higher, and thus closer to the rate of 6 percent applied in Wood *et al.* (2012), our measured land price response would be smaller and thus correspondingly closer to that found by Wood *et al.* (2012). Second, as outlined previously, in simulation A in Table 2 we replace all TDs with a new land tax levied at a uniform rate across for all land types. This means that the rate of the BBUIV tax introduced is the same across low-density housing, high-density housing, and commercial, industrial and rural land. Why is this important? From Figure 3 we see that TD collections from housing transfers account for 76 percent of TD revenue in 2017. Under a BBUIV tax such as the one introduced in simulation A herein, the housing tax load lies above 76 percent. A reasonable approximation would be the housing land value share in Figure 4, which is 81 percent. This means that for each dollar of TD foregone in simulation A, housing tax loads fall by an average of 76 cents, while for each dollar of BBUIV tax collected, housing tax loads rise by an average of 81 cents. In contrast, these two loads were balanced in Wood *et al.* (2012), because TDs on housing were replaced with land taxes on housing. We thus expect larger, negative aggregate housing price responses under the BBUIV studied herein than that in Wood *et al.* (2012). Other factors at play include the likely impact of bracket creep on TD collections between 2006 and 2016/17. This has driven the TD tax rate, and thus TD tax load, higher over time.

Interestingly, our rate adjustment simulations for TD suggest that the purchasers' price of a house falls when TD rates rise (see row 1 of Table 1). A similar conclusion was reached by two recent econometric studies: Davidoff and Leigh (2013) for Australia, and Kopczuk and Munroe (2015) for

New York. In contrast, Besley *et al.* (2014) found that the 2008-09 TD holiday in the UK (a temporary TD rate cut) caused a fall in the purchasers' prices of housing. Our results show that these differing views on the sign of the purchasers' price of housing response to TD rate changes can be reconciled. To see why, consider the land price attribution model in section 3.2.1 and its application in Figure 9. In Figure 9, we decompose land price responses for low- and high-density housing caused by TD rate reductions into a series of effects. Two effects dominate the overall response: direct and indirect transfer duty effects. By studying TD holidays, where cuts in TD rates are temporary, indirect TD effects in Besley *et al.* (2014) are effectively zero: housing market participants see no long-term changes in TD rates, and so the impact on housing prices is dominated by direct effects. Such a policy would drive purchasers' prices down, because direct TD effects are smaller in magnitude than the size of the TD rate adjustment. In the simulations conducted herein, and possibly also the econometric studies by Davidoff and Leigh (2013) and Kopczuk and Munroe (2015), TD rate adjustments are permanent and thus carry large indirect effects (see the yellow bars in Figure 9). These indirect TD effects represent the impact of future TD events on current land prices. Our model highlights that these indirect effects are larger the larger are land value shares (because they impact land prices) and the shorter are holding periods.

5. Concluding remarks

Recent reviews of Australia's tax system by Henry *et al.* (2010), the Productivity Commission (2017), and Thodey *et al.* (2020) have each described how property tax reform could improve the system's resilience and efficiency. These reviews and reform proposals have been supported by simulation-based assessments of the economic efficiency of these taxes, e.g., see Cao *et al.* (2015) and the assessment of state tax efficiency using VURMTAX by Nassios *et al.* (2019a). While they carry variables that serve as inputs to the determination of housing prices, these computable general equilibrium (CGE) studies of tax efficiency have been largely silent on the impact of property tax reform on Australian housing prices. With Australian housing prices already high, both relative to other developed countries and relative to Australian household income, the ongoing public policy debate surrounding property taxation reform would be aided by a study of the implications for both tax system efficiency, and housing prices.

To this end, in this paper we describe how outputs from the VURMTAX model of Australia’s state and territory economies can be used to create a housing price module. The VURMTAX housing price module decomposes the value of a house into two components: the value of its land, and the value of its capital or structure. Several key features of the Australian property market are recognised. First, we identify two distinct housing densities (low- and high-density), and two distinct housing tenures (rented and owner-occupied), in each state/territory. Low-density housing in each region carries a higher land value share, a lower rented tenure share, and a longer holding period than its high-density counterpart. The differences in these parameters across the two housing types is informed by 2016/17 data from a variety of publicly-available sources, such as the Australian Bureau of Statistics, the NSW Valuer General, and the NSW State Revenue Office. Once activated, the housing price module endogenously determines paths for these land value shares, holding periods, post-tax rates of return, rented tenure shares and thus housing prices over the simulation period, which runs for 2017 to 2040. Against a baseline forecast that accounts for the impact of COVID-19 on the Australian economy, we use VURMTAX with the housing price module to quantify the impact on efficiency and housing prices of seventeen property tax mix swap scenarios. Our results discussion in section 3.2 focuses on one tax mix swap in particular: the exchange of property transfer duty for a hypothetical broad-based tax on unimproved land value. In applying a single framework to derive both the housing price and welfare responses under several property tax mix alterations, we add to a debate that has long focused exclusively on the latter of these two metrics.

We see further avenues for adding to the Australian tax policy debate in future work. First, while we find that housing prices fall on average when transfer duties are replaced by a hypothetical, broad-based and uniformly rated land tax, important compositional effects are evident in the relative response between high- and low-density housing prices. Because high-density housing has much shorter holding periods than low-density housing, removing property transfer duty causes high-density housing prices to rise relative to low-density prices. This high-density housing price rise is not entirely offset by the offsetting hypothetical land tax we introduce because high-density housing carries a lower land value share than low-density housing. This finding lends weight to transfer duty-land tax swaps such as those proposed by Henry *et al.* (2010); specifically, land taxes introduced when replacing property transfer duties should include tax schedules that are progressive, with thresholds tied to the per square metre land value of a given property. Under such a system, differential rates would conceivably apply to high-density housing land closer to the CBD, and low-density housing land in outer suburbs and regional areas. Follow up research to that presented herein could explore how large a differential in land tax rates would be required to yield high- and low-density housing price responses that are broadly in line with the average housing price response we report.

Second, we plan to explore how other tax mix swaps, for example, a revenue-neutral switch across all states and territories between transfer duty and the GST, affect economic efficiency and housing prices. Why is this of interest? Equations (26) and (27) herein suggest that such a swap might cause property price appreciation.

Finally, we plan to expand the range of policy-relevant variables on which we report results. Ranking of tax instruments in the Australian tax policy debate has tended to focus on excess burden measures. In this study, we have added house prices as a policy-relevant variable of interest. But policy makers are concerned with a wider range of economic variables, in addition to the time paths for these variables between the point of policy change and future distant dates. Many of these variables are natural outputs of models like the VURMTAX model used in this study. In future work we plan to expand the benchmark set of key results classified by tax instrument, to include reporting and analysis of state and national outcomes for employment, GDP, national income, prices, and a range of other macroeconomic variables through time.

References

ACT Treasury (2012). *2012-12 Taxation Reform: 2012-13 Budget Paper No. 3.* Available at http://www.treasury.act.gov.au/budget/budget_2012/files/budgetpaper3/03_2taxationreform.pdf

Adams, P. D., J. M. Dixon and J. M. Horridge (2015). *The Victoria University Regional Model (VURM): Technical Documentation, Version 1.0*. CoPS/IMPACT Working Paper no. G-254. Available at https://www.copsmodels.com/elecpapr/g-254.htm

Adams, P. D., J. Nassios and N. Sheard (2020). *The economic and efficiency impacts of altering elements of the ACT's tax mix*. Report prepared for the ACT Treasury, available at https://apps.treasury.act.gov.au/__data/assets/pdf_file/0009/1618407/cops-final-report.pdf

AHURI (2020). *Scrap stamp duty, replace with land tax – what are the impacts? AHURI Brief, March 2020*. Available at https://www.ahuri.edu.au/research/brief/scrap-stamp-duty-replace-land-tax-what-are-impacts

Australian Federal Budget (2021). *Statement 2: Economic Outlook.* Available at https://budget.gov.au/2021-22/content/bp1/download/bp1_bs2.pdf

Ballantyne, A., T. Cusbert, R. Evans, R. Guttmann, J. Hambur, A. Hamilton, E. Kendall, R. McCririck, G. Nodari, and D. M. Rees (2020). *MARTIN Has Its Place: A Macroeconometric Model of the Australian Economy*. Economic Record 96 (**314**), pp. 225 – 251.

Ballard, C. L., J. K. Scholz, and J. B. Shoven (1987). *The Value-Added Tax: A General Equilibrium Look at Its Efficiency and Incidence.* In: Feldstein (Ed.) The effects of taxation on capital accumulation. University of Chicago Press, Chicago, 105-107.

Besley, T., N. Meads and P. Surico (2014). *The incidence of transaction taxes: evidence from a stamp duty holiday*. Journal of Public Economics 119, pp. 61 – 70.

Bird, R. M., and E. Slack (2004). *International handbook of Land and Property Taxation*. Edward Elgar Publishing.

Butler, J. R. (1999). *Estimating elasticity of demand for private health insurance in Australia*. Working Paper No. 43. National Centre for Epidemiology and Population Health, ANU.

Coates, B. (2017). *State property tax reform: balancing economic principle and political realism*. Presentation at the University of Adelaide Federal Relations and Tax Reform workshop. Available at https://grattan.edu.au/news/state-property-tax-reform-balancing-economic-principle-and-political-realism/

Coates, B., and J. Nolan (2019). *NSW should swap stamp duties for a broad-based property tax*. Submission to the NSW Productivity Commission. Available at https://grattan.edu.au/wp-content/uploads/2019/12/NSW-productivity-Commission-Tax-submission-final-standalone.pdf

Copenhagen Economics (2007). *Study on Reduced VAT Applied to Goods and Services in the Member States of the European Union.* Final Report for the European Commission. Brussels: Directorate General Taxation and Customs Union, European Commission, Taxation Papers.

Dagnall, H. (1994). *Creating a Good Impression: Three Hundred Years of the Stamp Office and Stamp Duties.* H. M. Stationary Office.

Davidoff, I., and A. Leigh (2013). *How do stamp duties affect the housing market?* Economic Record 89 (286), pp. 396–410.

Dixon, P. B., and M. T. Rimmer (1999). *Changes in indirect taxes in Australia: a dynamic general equilibrium analysis*. The Australian Economic Review, 32 (**4**), 327-48.

Dixon, P. B., and M. T. Rimmer (2002). *Dynamic General Equilibrium Modelling for Forecasting and Policy: A Practical Guide and Documentation of MONASH*. North Holland Publishing Company.

Dixon, P.B. and M.T. Rimmer (2013). *Validation in computable general equilibrium modelling*, In P.B. Dixon and D. W. Jorgenson (Eds.) *Handbook of Computable General Equilibrium Modelling*, Chapter 19, Vol. 1B, Elsevier, Amsterdam, 2013.

Dixon, J. M., J. Nassios (2018). *A dynamic economy-wide analysis of company tax cuts in Australia*. CoPS/IMPACT Working Paper no. G-287. Available at https://www.copsmodels.com/elecpapr/g-287.htm

Fox, R., and R. Finlay (2012). *Dwelling prices and household income.* Reserve Bank of Australia Bulletin 2012 (**4**), pp. 13 – 22.

Freebairn, J. W. (2015). *Reconsidering royalty and resource rent taxes for Australian mining.* The Australian Journal of Agricultural and Resource Economics 59, pp. 586 – 601.

Freebairn, J. W. (2017). *Reform options for state property taxes.* Melbourne Institute Policy Brief No. 2/17.

Freebairn, J. W. (2020a). *Reforming state taxes on property.* Tax and Transfer Policy Institute Working Paper 6/2020. Available at https://taxpolicy.crawford.anu.edu.au/sites/default/files/publication/taxstudies_crawford_anu_edu_au/2020-06/complete_working_paper_6_2020_j_freebairn.pdf

Freebairn, J. W. (2020b). *Reform state taxes to Increase Productivity.* Melbourne Institute Policy Brief No. 2/17.

Gesualdo, M., J. A. Giesecke, N. H. Tran, and F. Felici (2019). *Building a computable general equilibrium tax model for Italy*. Applied Economics, 51 (**56**), 6009-6020.

Giesecke, J. A., P. B. Dixon, and M. T. Rimmer (2008). *Regional macroeconomic outcomes under alternative arrangements for the financing of public infrastructure*. Papers in Regional Science, Vol 87 (1), March, pp. 3–31.

Giesecke, J. A., and N. H. Tran (2010). *Modelling value-added tax in the presence of multi-production and differentiated exemptions*. Journal of Asian Economics, 21 (**2**), 156-173.

Giesecke, J.A., and N. H. Tran (2012). *A general framework for measuring VAT compliance rates.* Applied Economics, 44 (**15**), 1867-1889.

Giesecke, J. A., and N. H. Tran (2018). *The national and regional consequences of Australia's Goods and Services Tax.* Economic Record 94 (**306**), pp. 255 – 275.

Giesecke, J. A., C. King, J. Nassios and N. H. Tran (2021). *The impact of GST reform on Australia's state and territory economies.* Applied Economics 53 (**51**), pp. 5929 – 5947.

Hao, M., A. S. Macdonald, P. Tapadar, and R. G. Thomas (2018). *Insurance loss coverage and demand elasticities*. Insurance: Mathematics and Economics 79, pp. 15–25.

Henry K., J. Harmer, J. Piggott, H. Ridout and G. Smith (2010). *Australia's future tax system: Final Report.* May 2010 (Henry Tax Review), prepared for the Treasurer of the Commonwealth of Australia.

Horridge J. M., M. Jerie, D. Mustakinov, and F. Schiffmann (2018). *GEMPACK manual*. GEMPACK Software, Centre of Policy Studies, Victoria University, Melbourne, ISBN 978-1-921654-34-3.

IPART (2016). *Review of the Local Government Rating System.* Available at https://www.ipart.nsw.gov.au/files/sharedassets/website/shared-files/investigation-section-9-legislative-review-of-the-local-government-rating-system/issues_paper_-_review_of_local_government_rating_system_-_april_2016.pdf

Kaldor, N. C. (1966). *Marginal Productivity and the Macro-Economic Theories of Distribution: Comment on Samuelson and Modigliani*. The Review of Economic Studies. 33 (**4**), pp. 309–319.

Kehoe, P. J., A. Manreas, P. J. Noyolo, C. Polo, F. Sancho (1988). *A General equilibrium analysis of the 1986 tax reform in Spain*. European Economic Review, 32, 334-342.

Kopczuk, W. and D. Munroe (2015). *Mansion Tax: The Effect of Transfer Taxes on the Residential Real Estate Market*. American Economic Journal: Economic Policy 7 (**2**), pp. 214-257.

Local Government Rating System Review Ministerial Panel (2019). *Local Government Rating System Review Discussion Paper*. Available at https://s3.ap-southeast-2.amazonaws.com/hdp.au.prod.app.vic-engage.files/3115/6438/3140/DiscussionPaperLocalGovernmentRatingReviewFinal2019.pdf.

Malakellis, M. and M. Warlters (2020). *The economic costs of transfer duty: a literature review.* Treasury Technical Research Paper Series TTRP 21-08. Available at https://www.treasury.nsw.gov.au/sites/default/files/2021-06/the_economic_costs_of_transfer_duty_a_literature_review.pdf

Nassios, J., J. R. Madden, J. A. Giesecke, J. M. Dixon, N. H. Tran, P. B. Dixon, M. T. Rimmer, P. D. Adams and J. W. Freebairn (2019a). *The economic impact and efficiency of state and federal taxes in Australia*. CoPS/IMPACT Working Paper no. G-289. Available at https://www.copsmodels.com/elecpapr/g-289.htm

Nassios, J., J. A. Giesecke, P. B. Dixon and M. T. Rimmer (2019b). *Modelling the allocative efficiency of landowner taxation*. Economic Modelling 81, pp. 111 - 123.

NSW Government (2017). *Fire and Emergency Service Levy to be reviewed to ensure fairness.* Press Release available at https://www.treasury.nsw.gov.au/sites/default/files/2017-05/30052017%20-%20Media%20Release%20-%20Berejiklian%20and%20Perrottet%20-%20Fire%20and%20Emergency%20Services%20Levy%20to%20be%20reviewed%20to%20ensure%20fairness.pdf

NSW Treasury (2012). *Funding our Emergency Services.* Discussion Paper, July 2012.

NSW Treasury (2018). *Interstate comparison of taxes 2017-18.* Available at https://www.treasury.nsw.gov.au/sites/default/files/2018-04/TRP18-01%20Interstate%20Comparison%20of%20Taxes%202017-18.pdf

NSW Treasury (2020). *The NSW property tax proposal: Budget consultation paper*. Available at https://www.treasury.nsw.gov.au/sites/default/files/2020-11/NSW%20Treasury%20property%20tax%20proposal%20Consultation%20Paper.pdf

NSW Valuer General (2017). *Valuer General Annual Report 2016-17*. Available at https://www.valuergeneral.nsw.gov.au/__data/assets/pdf_file/0008/217754/Valuer_General_annual_report_2016-17.pdf.

Passant, J., and J. Mclaren (2011). *The Henry Review of Australia's Future Tax system: Implications for Local Government*. Working Paper No. 3, Faculty of Law, University of Canberra. Available at https://www.uts.edu.au/sites/default/files/Henry-Review-LG-Implications.pdf.

Productivity Commission (2017). *Shifting the Dial: 5 Year Productivity Review.* Inquiry Report No. 84, report for the Australian Commonwealth Government. Available at https://www.pc.gov.au/inquiries/completed/productivity-review/report/productivity-review.pdf

Saunders, T., and P. Tulip (2020). *A model of the Australian Housing Market*. Economic Record 96 (**S1**), pp. 1 - 25.

Thodey, D., B. English, J. Anderson, A. Twomey, J. Freebairn, and J. Halton (2020). *NSW Review of Federal Financial Relations*. Report for the NSW Treasury. Available at https://www.treasury.nsw.gov.au/sites/default/files/2020-10/FFR%20Final%20Report%20-%20200828%20%281%29.pdf

Thomas, M. and A. Hall (2016). *Housing affordability in Australia.* Parliamentary Library Briefing Book – 45th Parliament. August 2016. Available at https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/BriefingBook45p/HousingAffordability

Tobin, J. and W. C. Brainard (1977). *Asset Markets and the Cost of Capital.* In Economic progress, private values and public policy: Essays in honor of William Fellner, North-Holland, pp. 235-262.

Tooth, R. (2015). *Analysis of demand for home and contents insurance*. Report for the Insurance Council of Australia by Sapere Research Group. Available at https://www.insurancecouncil.com.au/assets/report/27082015%20-%20Analysis_of_demand_for_home_and_contents%20(1).pdf .

Viswanathan, K. S., J. Lemaire, K. K. Withers, K. Armstrong, A. Baumritter, J. Hershey, M. Pauly, and D. A. Asch (2007). *Adverse selection in term life insurance purchasing due to the BRCA ½ Genetic Test and elastic demand*. Journal of Risk and Insurance 74 (**1**), pp. 65–86.

Wood, G., R. Ong, M. Cigdem, and E. Taylor (2012). *The spatial and distributional impacts of the Henry Review recommendations on stamp duty and land tax*. Report for AHURI, February 2012. Available at https://www.ahuri.edu.au/__data/assets/pdf_file/0007/2221/AHURI_Final_Report_No182_The_spatial_and_distributional_impacts_of_the_Henry_Review_recommendations_on_stamp_duty_and_land_tax.pdf

Tables

Table 1: Summary outputs when we reduce tax revenue from a subset of existing NSW state and local government taxes by A$100m in 2022 (rows 1 – 4), and when we raise tax revenue from a set of hypothetical NSW state and local government taxes by A$100m in 2022 (rows 5 – 7).

	Tax line	Direct effects Tax rate ↑ / ↓	Marginal excess burden	Housing price response* *Sim. year 2040*						State CPI*
			Sim. year 2040	**Low-density** Column [4]		**High-density** Column [5]		**Average** Column [6]		
				Market price	Purchasers price	Market price	Purchasers price	Market price	Purchasers price	
	Column [1]	Column [2]	Column [3]	Column [4i]	Column [4ii]	Column [5i]	Column [5ii]	Column [6i]	Column [6ii]	Column [7]
	Results for reductions in revenue sourced from a set of existing NSW taxes									
1	**Property transfer duty (TD)**	**↓ $\mathbf{RTD_{i,NSW,2022}}$ ↓ $\mathbf{RTDN_{i,NSW,2022}}$**	**82**	**0.124**	**0.037**	**0.155**	**0.077**	**0.133**	**0.049**	**-0.028**
1.1	Housing TD	↓ $RTD_{i,NSW,2022}$ ↓ $RTDN_{i,NSW,2022}$	112	0.171	0.056	0.215	0.109	0.184	0.072	-0.032
1.1.1	Existing housing transfers	↓ $RTD_{i,NSW,2022}$	132	0.214	0.082	0.275	0.155	0.232	0.104	-0.034
1.1.2	New housing transfers	↓ $RTDN_{i,NSW,2022}$	43	-0.139	-0.140	-0.226	-0.228	-0.166	-0.167	-0.018
1.2	Non-residential TD	-	40	-0.010	-0.010	-0.013	-0.013	-0.011	-0.011	-0.011
1.2.1	Existing non-res. transfers	-	37	-0.009	-0.009	-0.012	-0.012	-0.010	-0.010	-0.010
1.2.2	New non-res. transfers	-	62	-0.013	-0.014	-0.020	-0.020	-0.015	-0.016	-0.016
2	**State land tax (SLT)**	**↓ $\mathbf{TL_{SLT,i,NSW,2022}}$**	**-15**	**0.022**	**0.022**	**0.177**	**0.177**	**0.069**	**0.069**	**-0.007**
2.1	SLT (housing)	↓ $TL_{SLT,i,NSW,2022}$	3	0.082	0.082	0.395	0.396	0.177	0.178	-0.002
2.1.1	SLT (housing, low-den.)	↓ $TL_{SLT,DwellingLow,NSW,2022}$	7	0.163	0.164	0.003	0.004	0.115	0.115	-0.003

				Housing price response* *Sim. year 2040*						
	Tax line	**Direct effects** Tax rate ↑ / ↓	**Marginal excess burden**	**Low-density** Column [4]		**High-density** Column [5]		**Average** Column [6]		**State CPI***
			Sim. year 2040	Market price	Purchasers price	Market price	Purchasers price	Market price	Purchasers price	
	Column [1]	Column [2]	Column [3]	Column [4i]	Column [4ii]	Column [5i]	Column [5ii]	Column [6i]	Column [6ii]	Column [7]
2.1.2	SLT (housing, high-den.)	$\downarrow TL_{SLT,DwellingHigh,NSW,2022}$	-3	-0.002	-0.002	0.801	0.803	0.243	0.243	0.000
2.2	SLT (non-res.)	-	-33	-0.035	-0.035	-0.027	-0.027	-0.032	-0.032	-0.013
3	**Local council rates (LCR)**	$\downarrow \mathbf{TL_{LCR,i,NSW,2022}}$	**-11**	**0.108**	**0.108**	**0.054**	**0.054**	**0.091**	**0.092**	**-0.002**
3.1	LCR (housing)	$\downarrow TL_{LCR,i,NSW,2022}$	-5	0.171	0.171	0.089	0.089	0.146	0.146	0.003
3.1.1	LCR (housing, low-den.)	$\downarrow TL_{LCR,DwellingLow,NSW,2022}$	-5	0.197	0.198	-0.003	-0.003	0.136	0.137	0.002
3.1.2	LCR (housing, high-den.)	$\downarrow TL_{LCR,DwellingHigh,NSW,2022}$	-11	-0.006	-0.006	0.702	0.704	0.209	0.210	0.003
3.2	LCR (non-res.)	-	-26	-0.029	-0.030	-0.023	-0.023	-0.027	-0.027	-0.011
4	**The Emergency Service Levy on insurance (ESL)**	**-**	**42**	**-0.001**	**-0.001**	**-0.003**	**-0.003**	**-0.001**	**-0.001**	**-0.015**
	Results for increases in revenue from a set of hypothetical NSW taxes									
5	**Broad-based unimproved value tax (BBUIV)**	$\uparrow \mathbf{TL_{BBUIV,i,NSW,2022}}$	**-8**	**-0.135**	**-0.136**	**-0.073**	**-0.073**	**-0.116**	**-0.117**	**-0.001**
6	**Broad-base capital-improved value tax (BBCIV)**	$\uparrow \mathbf{TL_{BBCIV,i,NSW,2022}}$ $\uparrow \mathbf{TC_{BBCIV,i,NSW,2022}}$	**3**	**-0.086**	**-0.086**	**-0.029**	**-0.029**	**-0.069**	**-0.069**	**0.003**
6.1	Broad-based capital tax	$\uparrow TL_{BBCIV,i,NSW,2022}$	15	-0.007	-0.007	-0.003	-0.003	-0.006	-0.006	0.009

				Housing price response* *Sim. year 2040*						
	Tax line	**Direct effects** Tax rate ↑ / ↓	**Marginal excess burden** Sim. year 2040	**Low-density** Column [4]		**High-density** Column [5]		**Average** Column [6]		**State CPI***
				Market price	Purchasers price	Market price	Purchasers price	Market price	Purchasers price	
	Column [1]	Column [2]	Column [3]	Column [4i]	Column [4ii]	Column [5i]	Column [5ii]	Column [6i]	Column [6ii]	Column [7]
7	**Narrow-base capital-improved value tax (NBCIV)**	↑ $\mathbf{TL}_{NBCIV,i,NSW,2022}$ ↑ $\mathbf{TC}_{NBCIV,i,NSW,2022}$	**14**	**-0.077**	**-0.077**	**-0.048**	**-0.049**	**-0.068**	**-0.068**	**0.006**

** Response reported is relative to the national CPI.*

Table 2: Summary outputs when we alter the NSW state tax mix in 2022 (rows A – Q).

				Housing price response* *Sim. year 2040*						
	Tax line	**Direct effects** Tax rate ↑ / ↓	**Net excess burden**	**Low-density**		**High-density**		**Average**		**State CPI***
			Sim. year 2040	Market price	Purchasers price	Market price	Purchasers price	Market price	Purchasers price	
	Column [1]	Column [2]	Column [3]	Column [4i]	Column [4ii]	Column [5i]	Column [5ii]	Column [6i]	Column [6ii]	Column [7]
	Direct mix swap experiments									
A	**TD -> BBUIV**	**↓ $RTD_{i,NSW,2022}$** **↓ $RTDN_{i,NSW,2022}$** **↑ $TL_{BBUIV,i,NSW,2022}$**	**-30**	**-4.72**	**-9.38**	**4.67**	**0.27**	**-1.86**	**-6.42**	**-1.75**
A.1	TD -> LST	↓ $RTD_{i,NSW,2022}$ ↓ $RTDN_{i,NSW,2022}$	56	8.54	3.87	12.89	8.49	9.86	5.30	-1.81
A.2	LST -> BBUIV	↑ $TL_{BBUIV,i,NSW,2022}$	-2	-11.33	-11.86	-6.13	-6.30	-9.75	-10.17	-0.10
B	**TD -> BBCIV**	**↓ $RTD_{i,NSW,2022}$** **↓ $RTDN_{i,NSW,2022}$** **↑ $TC_{BBCIV,i,NSW,2022}$** **↑ $TL_{BBCIV,i,NSW,2022}$**	**-24**	**0.16**	**-4.51**	**7.72**	**3.33**	**2.46**	**-2.10**	**-1.53**
C	**LCR (UIV) -> BBCIV**	**↓ $TL_{LCR,i,NSW,2022}$** **↑ $TL_{BBCIV,i,NSW,2022}$** **↑ $TC_{BBCIV,i,NSW,2022}$**	**11**	**1.40**	**1.41**	**0.63**	**0.64**	**1.16**	**1.17**	**0.09**

				Housing price response* *Sim. year 2040*						
	Tax line	**Direct effects** Tax rate ↑ / ↓	**Net excess burden**	**Low-density**		**High-density**		**Average**		**State CPI***
			Sim. year 2040	Market price	Purchasers price	Market price	Purchasers price	Market price	Purchasers price	
	Column [1]	Column [2]	Column [3]	Column [4i]	Column [4ii]	Column [5i]	Column [5ii]	Column [6i]	Column [6ii]	Column [7]
D	**SLT -> NBCIV**	↓ $\mathbf{TL}_{\mathbf{SLT,i,NSW,2022}}$ ↑ $\mathbf{TL}_{\mathbf{NBCIV,i,NSW,2022}}$ ↑ $\mathbf{TC}_{\mathbf{NBCIV,i,NSW,2022}}$	**11**	**0.17**	**0.17**	**3.38**	**3.40**	**1.15**	**1.15**	**0.01**
E	**SLT -> BBCIV**	↓ $\mathbf{TL}_{\mathbf{SLT,i,NSW,2022}}$ ↑ $\mathbf{TL}_{\mathbf{BBCIV,i,NSW,2022}}$ ↑ $\mathbf{TC}_{\mathbf{BBCIV,i,NSW,2022}}$	**6**	**-1.73**	**-1.74**	**9.91**	**9.97**	**1.81**	**1.82**	**-0.05**
F	**SLT -> BBUIV**	↓ $\mathbf{TL}_{\mathbf{SLT,i,NSW,2022}}$ ↑ $\mathbf{TL}_{\mathbf{BBUIV,i,NSW,2022}}$	**1**	**-4.15**	**-4.18**	**8.25**	**8.29**	**-0.37**	**-0.39**	**-0.21**

				Housing price response* *Sim. year 2040*						
	Tax line	**Direct effects** Tax rate ↑ / ↓	**Net excess burden**	**Low-density**		**High-density**		**Average**		**State CPI***
			Sim. year 2040	Market price	Purchasers price	Market price	Purchasers price	Market price	Purchasers price	
	Column [1]	Column [2]	Column [3]	Column [4i]	Column [4ii]	Column [5i]	Column [5ii]	Column [6i]	Column [6ii]	Column [7]
G	**ESL -> BBUIV**	**↑ $\text{TL}_{\text{BBUIV,i,NSW,2022}}$**	**-24**	**-1.03**	**-1.04**	**-0.58**	**-0.58**	**-0.89**	**-0.90**	**-0.12**
H	**ESL -> BBCIV**	**↑ $\text{TL}_{\text{BBCIV,i,NSW,2022}}$** **↑ $\text{TC}_{\text{BBCIV,i,NSW,2022}}$**	**-18**	**-0.66**	**-0.66**	**-0.38**	**-0.38**	**-0.57**	**-0.58**	**-0.09**
	Combination experiments									
I	B *plus* C TD and LCR -> BBCIV	↓ $\text{RTD}_{\text{i,NSW,2022}}$ ↓ $\text{RTDN}_{\text{i,NSW,2022}}$ ↓ $\text{TL}_{\text{LCR,i,NSW,2022}}$ ↑ $\text{TC}_{\text{BBCIV,i,NSW,2022}}$ ↑ $\text{TL}_{\text{BBCIV,i,NSW,2022}}$	-15	1.14	-3.52	8.35	3.96	3.34	-1.23	-1.47

				Housing price response* *Sim. year 2040*						
	Tax line	**Direct effects** Tax rate ↑ / ↓	**Net excess burden**	**Low-density**		**High-density**		**Average**		**State CPI***
			Sim. year 2040	Market price	Purchasers price	Market price	Purchasers price	Market price	Purchasers price	
	Column [1]	Column [2]	Column [3]	Column [4i]	Column [4ii]	Column [5i]	Column [5ii]	Column [6i]	Column [6ii]	Column [7]
J	I *plus* H TD, LCR and ESL -> BBCIV	↓ $RTD_{i,NSW,2022}$ ↓ $RTDN_{i,NSW,2022}$ ↓ $TL_{LCR,i,NSW,2022}$ ↑ $TC_{BBCIV,i,NSW,2022}$ ↑ $TL_{BBCIV,i,NSW,2022}$	-15	0.32	-4.35	7.85	3.45	2.61	-1.95	-1.55
K	I *plus* D TD and LCR -> BBCIV SLT -> NBCIV	↓ $RTD_{i,NSW,2022}$ ↓ $RTDN_{i,NSW,2022}$ ↓ $TL_{LCR,i,NSW,2022}$ ↓ $TL_{SLT,i,NSW,2022}$ ↑ $TC_{BBCIV,i,NSW,2022}$ ↑ $TL_{BBCIV,i,NSW,2022}$ ↑ $TL_{NBCIV,i,NSW,2022}$ ↑ $TC_{NBCIV,i,NSW,2022}$	-8	1.05	-3.62	12.07	7.68	4.41	-0.16	-1.48
L	J *plus* D TD, LCR and ESL -> BBCIV SLT -> NBCIV	↓ $RTD_{i,NSW,2022}$ ↓ $RTDN_{i,NSW,2022}$ ↓ $TL_{LCR,i,NSW,2022}$ ↓ $TL_{SLT,i,NSW,2022}$ ↑ $TC_{BBCIV,i,NSW,2022}$ ↑ $TL_{BBCIV,i,NSW,2022}$ ↑ $TL_{NBCIV,i,NSW,2022}$ ↑ $TC_{NBCIV,i,NSW,2022}$	-8	0.18	-4.49	11.40	7.00	3.60	-0.97	-1.56

				Housing price response* *Sim. year 2040*						
	Tax line	**Direct effects** Tax rate ↑ / ↓	**Net excess burden**	**Low-density**		**High-density**		**Average**		**State CPI***
			Sim. year 2040	Market price	Purchasers price	Market price	Purchasers price	Market price	Purchasers price	
	Column [1]	Column [2]	Column [3]	Column [4i]	Column [4ii]	Column [5i]	Column [5ii]	Column [6i]	Column [6ii]	Column [7]
M	C *plus* D LCR -> BBCIV SLT-> NBCIV	$\downarrow TL_{LCR,i,NSW,2022}$ $\downarrow TL_{SLT,i,NSW,2022}$ $\uparrow TC_{BBCIV,i,NSW,2022}$ $\uparrow TL_{BBCIV,i,NSW,2022}$ $\uparrow TL_{NBCIV,i,NSW,2022}$ $\uparrow TC_{NBCIV,i,NSW,2022}$	11	1.62	1.63	4.55	4.58	2.51	2.53	0.09
N	A *plus* G TD and ESL -> BBUIV	$\downarrow RTD_{i,NSW,2022}$ $\downarrow RTDN_{i,NSW,2022}$ $\uparrow TL_{BBUIV,i,NSW,2022}$	-30	-5.91	-10.57	3.92	-0.48	-2.92	-7.48	-1.85
O	N *plus* F TD, SLT and ESL -> BBUIV	$\downarrow RTD_{i,NSW,2022}$ $\downarrow RTDN_{i,NSW,2022}$ $\downarrow TL_{SLT,i,NSW,2022}$ $\uparrow TL_{BBUIV,i,NSW,2022}$	-19	-11.26	-15.93	12.22	7.82	-4.11	-8.68	-2.00
P	A *plus* F TD and SLT -> BBUIV	$\downarrow RTD_{i,NSW,2022}$ $\downarrow RTDN_{i,NSW,2022}$ $\downarrow TL_{SLT,i,NSW,2022}$ $\uparrow TL_{BBUIV,i,NSW,2022}$	-18	-10.02	-14.68	13.19	8.79	-2.95	-7.51	-1.91

				Housing price response* *Sim. year 2040*						
	Tax line	**Direct effects** Tax rate ↑ / ↓	**Net excess burden**	**Low-density**		**High-density**		**Average**		**State CPI***
			Sim. year 2040	Market price	Purchasers price	Market price	Purchasers price	Market price	Purchasers price	
	Column [1]	Column [2]	Column [3]	Column [4i]	Column [4ii]	Column [5i]	Column [5ii]	Column [6i]	Column [6ii]	Column [7]
Q	B *plus* E TD and SLT -> BBCIV	↓ $RTD_{i,NSW,2022}$ ↓ $RTDN_{i,NSW,2022}$ ↓ $TL_{SLT,i,NSW,2022}$ ↑ $TC_{BBCIV,i,NSW,2022}$ ↑ $TL_{BBCIV,i,NSW,2022}$ ↑ $TL_{NBCIV,i,NSW,2022}$ ↑ $TC_{NBCIV,i,NSW,2022}$	-17	-8.79	-13.45	14.16	9.77	-1.80	-6.36	-1.85

* *Response reported is relative to the national CPI.*