Investment Housing Tax Concessions and Welfare: Evidence from Australia*

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Abstract

We build a general equilibrium OLG model with heterogeneous agents to study the welfare implications of housing investment tax concessions in Australia. Comparing stationary equilibria, we find that removing these concessions significantly reduces housing investment. This lowers house prices and raises rents and the homeownership rate. The steady state welfare analysis suggests that eliminating concessions leads to a welfare gain of 1.7 per cent, for which increased redistribution is a key mechanism. Along the transition, a majority of households are better off, but younger landlords and landlords with higher incomes benefit the least.

Keywords: Housing investment; Taxation; OLG model; Heterogeneous agents; Welfare.

JEL code: H24; H31; R21; R31.

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1 Introduction

Governments adopt different policies that affect the incentives of households to purchase and to invest in housing. A prominent example is the treatment of investment housing in the tax system. The treatment of profits from housing investment is fairly uniform across countries. Typically, individuals pay tax on the profit from any investment housing that they own. However, the tax treatment of investment housing losses varies across countries. In some countries, such as the United States and the United Kingdom, if an individual suffers a loss on their housing investment they are not allowed to reduce their taxable income from other sources.[1] In contrast, other countries take a different approach. In Australia, Canada, Japan and New Zealand, losses on investment housing can be deducted from other sources of income when calculating taxable income. These differences in the tax system alter the incentive to invest, the size of investment and the method via which they are financed.

This paper seeks to examine the welfare implications of these different tax treatments. To do so, we study the Australian housing market; an economy in which investment housing losses are deductible from other income sources. This tax concession is widely used. Over 50 per cent of housing investors declare a net loss on their investment housing portfolio. In these cases, the rental income is not sufficient to cover the expenses associated with their housing investment. As a result, these individuals may reduce the amount of tax they pay on, for example, labour income.Within Australia, this feature of the tax system is called *negative gearing* and we adopt this terminology throughout the paper.

The policy of negative gearing has generated a large amount of debate in Australia.[2] Supporters argue that the policy promotes housing construction and stabilizes the rental market as it encourages the supply of rental properties. However, opponents argue that the policy raises the price of housing, lowers ownership rates, and encourages excessive household debt.[3] Furthermore negative gearing is a tax concession that favours the wealthy. Landlords are usually high income earners and high income earners benefit more from negative gearing due to the progressive nature of the income tax system. This debate has been qualitative in nature. The exact size of these effects and the welfare implications are, to date, unexplored.

[1] In the terminology of the Internal Revenue Service, rental income is described as *passive income* and losses on passive income can not be deducted from other sources of income such as labour incowhen calculating taxable income.

[2] In the 2019 Australian federal election, negative gearing was a key policy area in which the major political parties presented different policy options.

[3] Real house prices have increased more than threefold in past three decades, and household debt has doubled to 120 percent of GDP relative in the last two decades. The bulk of this increase has been in residential mortgages.

To examine the welfare implications of different investment housing tax systems we develop a general equilibrium OLG model and compare the welfare outcomes with and without negative gearing. The model is populated by overlapping generations of finitely-lived households facing age-dependent survival rates. Households derive utility from a non-durable consumption good and housing services and may save by investing in either housing or a risk-free financial asset. In each period, they choose to become a renter or homeowner and if they own a home, they may also choose to become a landlord. As in Sommer and Sullivan (2018) and Floetotto, Kirker and Stroebel (2016), this choice of housing tenure allows us to endogenize demand and supply in both rental and purchase markets. Hence, both rents and house prices respond to changes in the tax system.

In addition to age, there are two key sources of individual heterogeneity within our model. First, households are subject to an exogenous income shock that is estimated to match the stochastic income process observed in the Household, Income, and Labour Dynamics in Australia (HILDA) survey. This heterogeneity allows us to explore how the removal of negative gearing affects welfare of households in different life-cycle and financial situations. Following Jeske, Krueger and Mitman (2013) and Gete and Zecchetto (2017), the second source of heterogeneity is an idiosyncratic depreciation shock that captures unexpected gains or losses to property. This source of uncertainty is included to ensure a reasonable proportion of negatively geared landlords in equilibrium.

Additional features are included to generate a realistic environment. Housing transactions are subject to transaction costs and households face borrowing constraints although they may use their housing assets as collateral to access debt. A construction sector is present and allows the overall supply of housing to respond to prices. A tax function is used that replicates the current Australian tax system. This includes a progressive income tax and a realistic depiction of the taxation of housing investment returns. The removal of negative gearing eliminates a tax concession and, other things equal, results in an increase in government revenue. In our main counterfactual experiment, we assume that this revenue is redistributed to households in a lump sum fashion.

The model is calibrated to match important moments that characterize the Australian housing market, such as the homeownership rate, the landlord rate, the proportion of negatively geared landlords, and the rent-to-income ratio. Though not targeted, the model can match well homeownership and landlord rates over the life-cycle and across the wealth distribution in the data.

When examining steady states, eliminating negative gearing reduces house prices by 1.5 per cent, and increases rents by 3.6 per cent and the homeownership rate by

4.3 percentage points. In the counterfactual economy where negative gearing is not present, the effective cost of housing investment is higher, depressing investment demand for housing and thereby reducing house prices. Lower house prices improve housing affordability and this particularly benefits low-income credit constrained households who are at the margin of becoming homeowners. An increase in rents is driven by the fall in rental supply and this also makes homeownership relatively less expensive leading renters with high earnings to become homeowners. The policy change has significant impacts on the composition of landlords. Landlords who rely heavily on debt to finance their investment, and hence benefit the most from negative gearing, are driven out of the market for investment properties. Most of these landlords are young but rich enough to afford the downpayment requirement for their investment.

For steady state welfare comparisons we use the notion of ex-ante consumption equivalent variation, that equates the expected discounted utility of newly born households in the baseline and counterfactual economies.[4] In an economy without negative gearing, the ex-ante welfare rises by 1.7 per cent. There are three important mechanisms via which removing negative gearing affects welfare. First, there is a general equilibrium effect. As markets adjust to the change in tax policy the purchase price of housing falls and the rental price rises. Second, changes in the tax policy hurt some individuals by removing housing investment tax concessions. Finally, individuals gain as the government raises additional revenue that is redistributed.

The redistribution of additional government revenue is a crucial source of welfare gains. To support this, we conduct two alternative counterfactual experiments: (1) does not allow for any change in redistribution; and (2) distributes additional revenue to renters only, i.e. rental assistance. In experiment (1) only the first two mechanisms operate. In experiment (2) all mechanisms discussed above are active. We find that removing negative gearing without changing redistributive transfers reduces welfare by 0.9 per cent.

Having established the steady state effects of the policy change, we extend our analysis to transition dynamics. We analyze transition dynamics under the two policy scenarios: (1) with redistribution; and (2) with rental assistance. With redistribution, 96 per cent of households experience welfare gains along the transition whilst only 72 percent of households experience welfare gains under rental assistance. This result again highlights the role of redistribution. In both scenarios, younger landlords and landlords with higher incomes are hurt the most, as they are the households who benefit the most from negative gearing. In the case of rental assistance, older owner-occupiers

[4] In our steady state comparisons, we focus only on newly born households since it is unclear how to weigh individuals in different states when calculating an aggregate *cev* that compares across stationary equilibrium. In our study of transition dynamics we focus upon the welfare of all individuals in an initial steady state.

are also worse off due to a lower value of their housing asset.

Our paper belongs to a large literature of taxation in housing markets: Poterba (1984, 1992), Rosen (1985), Berkovec and Fullerton (1992), Kopczuk and Munroe (2015), Barseghyan and Coate (2016), and Gruber, Jensen and Kleven (2018). A series of papers study the implications of tax policies in the housing markets using quantitative life-cycle models: Gervais (2002), Chambers, Garriga and Schlagenhauf (2009), Sommer and Sullivan (2018) and Floetotto, Kirker and Stroebel (2016), İmrohoroğlu, Matoba and Tüzel (2018). Unlike Gervais (2002), Chambers et al. (2009) and İmrohoroğlu et al. (2018), our model allows for endogenous house prices, rents, and buy vs. rent decisions. Relative to Sommer and Sullivan (2018) and Floetotto et al. (2016) who focus on the mortgage interest deductibility in the U.S., our paper examines the effects of investment housing tax concessions and therefore, we place more emphasis on modeling the behavior of landlords and matching the relevant moments of housing investment. None of the previous papers discuss the implications of investment housing tax concessions although it is a common practice in several OECD countries.

To the best of our knowledge, the most related academic study that focuses on negative gearing in Australia is Fane and Richardson (2005). They examine the interaction between negative gearing and capital gains tax, and estimate the effective rate of income tax. Our model provides the equilibrium effects of negative gearing on house prices, rents and homeownership rates, as well as the welfare consequences on heterogeneous households. Ours is the first paper that provides a rigorous analysis of the implications of investment tax concessions in a quantitative environment.

The rest of this paper is organized as follows: Section 2 describes the background of negative gearing in the Australian housing market. Sections 3 discusses the model. Section 4 describes the calibration strategy and some important quantitative properties of the calibrated model. Section 5 discusses the quantitative results, including the price and quantity effects of negative gearing and its impacts on aggregate and distributional welfare. Section 6 concludes.

2 Background

This section describes recent changes in the Australian housing market and provides an overview of how the policy of negative gearing alters household decision-making. We begin by noting that the Australian housing market has undergone significant changes in the last three decades. There has been an increase in the number of individuals investing in housing. In addition, over time housing investors have become more likely to take advantage of negative gearing. That is, for a large and increasing proportion of landlords, the rental income earned from their investment property

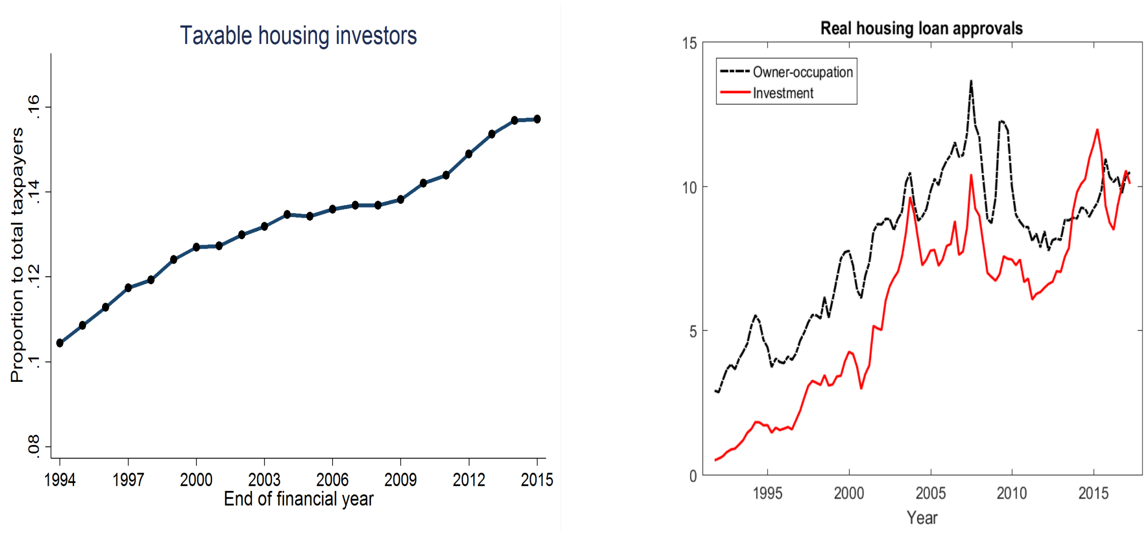

Figure 1: Taxable landlords (left) and Real housing loan approvals in billions (right)

Source: Taxation Statistics, Table 1 Individual, Australian Taxation Office (ATO); Cat. No. 5609.0 Housing Finance Commitment, Australian Bureau of Statistics (ABS). Note: Housing loan approval series are deflated by the price index of housing, sourced from Cat. No. 6401.0 Consumer Price Index, ABS.

does not cover the mortgage interest and other expenses associated with managing that property. Taken together, these facts imply that over time the process of negative gearing has played a more significant role in the Australian housing market.

Since the early 1990s, housing investors as a fraction of total taxpayers has steadily increased from around 10 per cent to 16 per cent (Figure 1, left hand panel). This increase in the stock of housing investors is also evident in the data for loan approvals collected by the Australian Bureau of Statistics. The value of loan approvals for investment purposes has increased more rapidly than loan approvals for owner occupied purposes, although both have increased dramatically in past few decades (Figure 1, right hand panel). The value of investment housing loan approvals was only one-fifth of the value of owner-occupied housing loan approvals in 1992. In recent years, however, they have become comparable in size. Consistent with the increase in loan approvals for investment housing purposes, there has also been a decline in the home ownership rate in Australia (from 70 per cent in early 2000s to 68 per cent in 2013) and a concomitant rise in the fraction of households renting.

The tax treatment of negative gearing allows landlords to fully deduct any losses from an investment property from their gross taxable income. Although interest expenses are the bulk of costs associated with housing loans, other expenses may include depreciation, body corporate fees, insurance, property agent fees, maintenance costs, and etc. In Australia, the proportion of negatively geared landlords (landlords

Figure 2: Negatively geared landlords (left) and Net rental income (right)

Source: Taxation Statistics, Table 1 Individual, ATO

who claim a net rental loss) has exceeded 50 per cent since 1994 (when our data commence). There has been a significant increase in this proportion from the early 2000s and it remains above 60 per cent despite a mild drop in recent years (Figure 2, left hand panel). Corresponding to the rise in the proportion of negatively geared landlords, the total amount that they claim in net rental losses has also increased rapidly since 2000 (Figure 2, right hand panel). Figures 1 and 2 show that Australian households increasingly participate in the property market as investors and when they do so, they take advantage of negative gearing.

The policy of negative gearing is used more intensively by specific segments of the population. Conditional on being a housing investor, younger households are more likely to be negatively geared. This is demonstrated in the left panel of Figure 3. While around 80 per cent of landlords under 35 years of age are negatively geared, less than 30 per cent of landlords over the age of 65 are negatively geared. Younger households have a longer time horizon in which to repay debt and are able to access relatively large mortgages. As a result, they face larger interest payments and are more likely to be negatively geared.

Due to the progressive nature of the Australian tax system, the benefits of negative gearing are typically larger for individuals with higher levels of taxable income, who are subject to higher marginal tax rates. Hence, a reduction in taxable income due to a net loss in their investment housing portfolio leads to a larger tax saving for high-income individuals than it does for low-income individuals. Hence, negative gearing subsidizes housing investment and the size of the subsidy is linked to an individual's taxable income. As a result, there are clear distributional effects associated with this policy. This is reflected in the proportion of negatively geared landlords (conditional upon being a landlord) by tax bracket, as displayed in the right panel of Figure 3. In the lowest tax bracket, less than 10 per cent of housing investors are engaged in negative gearing. For other tax brackets, a significant proportion of investors are negatively geared and this proportion tends to rise with income brackets. The decline in negative gearing among the highest income households could reflect that these households are less reliant upon borrowing to fund housing investment.

A large proportion, even the majority, of investors in the Australian housing market have rental incomes that do not meet their rental expenses. This does not imply that investment in the housing market has been a poor investment for these households. Two points are worth making. First, investors in the Australian housing market have received significant capital gains over the last three decades.[5] Second, even though investors may incur a loss on their investment in some periods, it is still possible that investment returns will be positive over the lifetime of the asset.

These features of the data motivate our use of a heterogeneous life-cycle model to examine the impact of negative gearing upon the Australian economy. Clearly the life-cycle plays a large role in the timing of housing investment purchases and the use of negative gearing. Also important is the differences in incomes among different individuals; those with relatively high incomes may benefit from negative gearing.

3 Model

To analyze the effects of negative gearing on the Australian housing market, we develop a general equilibrium OLG model with heterogeneous agents and incomplete markets. The economy is populated by overlapping generations of households who are subject to idiosyncratic earnings shocks. Household utility depends upon a non-durable consumption good and upon housing services. Houses may be rented or purchased. Homeowners can purchase additional units of housing stock and lease this housing to other households. The decision to become a landlord is affected by government tax policy. The purchase and sale of houses incur transaction costs and homeowners must pay maintenance costs to prevent housing from depreciating. In every period, the equilibrium price and rent are determined by the appropriate market clearing conditions. A competitive construction sector adjusts the supply of new housing stocks in response to price changes.

[5] These capital gains have been driven by a number of factors, including the decline in interest rates, strong population growth, and potentially supply constraints.

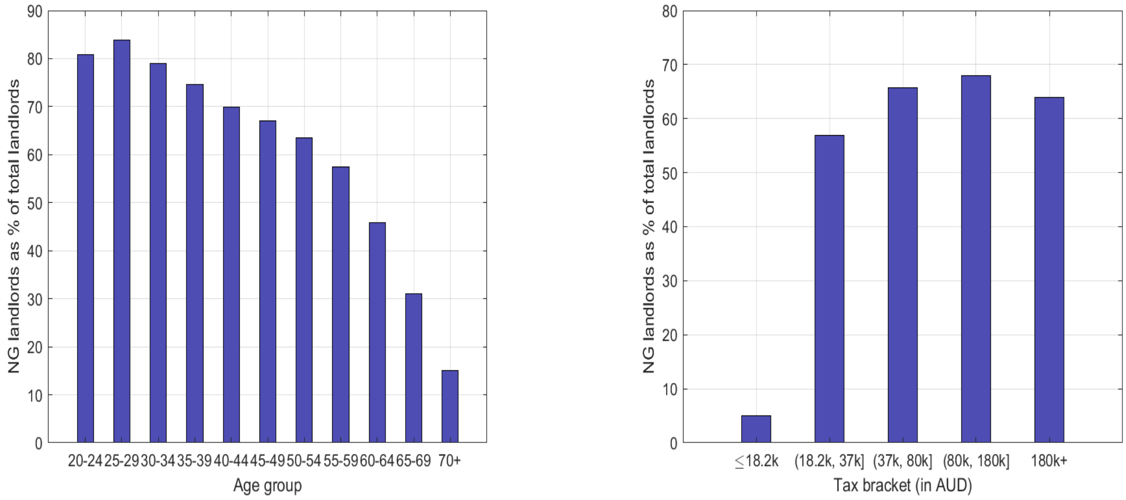

Figure 3: Proportion of negatively geared landlords by age group and tax bracket

Source: Taxation Statistics 2014-15, Individual Table 3, ATO. No tax is paid on income less than $18,200. The marginal tax rates are 19 percent (18.2-37k), 32.5 percent (37-80k), 37 percent (87-180k) and 45 percent (180k+).

3.1 Households

Demographics. The economy is populated by a continuum of finitely-lived households who live and work for $a = 1, 2, ..., A$ periods. Throughout the life-cycle, households face an age-dependent survival rate of κ_a, and they all die with certainty after period A. To maintain a constant population over time, households that exit the economy are replaced by new-born households. These new-born households enter the economy with zero wealth but may have different income levels.

Preferences. Households derive utility from consumption of non-durables, c, and housing services, $\tilde{h}$. The expected lifetime utility of a household is given by

$$\mathbb{E}_0 \left[\sum_{a=1}^{A} \beta^{a-1} \left[\kappa_a u(c_a, \tilde{h}_a) + (1 - \kappa_a) v(\mathrm{b}) \right] \right] \tag{1}$$

with $0 < \beta < 1$. The flow utility upon survival is given by:

$$u(c, \tilde{h}) = \frac{\left[c^{\alpha} (\lambda \tilde{h})^{1-\alpha} \right]^{1-\sigma}}{1 - \sigma}, \tag{2}$$

where α measures the preference for non-durable consumption and σ is the coefficient of relative risk aversion. Households receive an additional utility benefit from living in an owned home, so that $\lambda = 1$ if $\tilde{h}$ is rented and $\lambda > 1$ if $\tilde{h}$ is owned by the household.

We follow De Nardi (2004) and assume households have a warm-glow bequest motive with a functional form given by

$$\nu(\mathrm{b}) = \vartheta \frac{\mathrm{b}^{1-\sigma}}{1-\sigma}, \tag{3}$$

where ϑ is a measure of the importance of bequest provision in utility and b is the bequest size. We assume that bequests are collected by the government to fund government consumption which does not enter into the household utility function.[6]

Endowment. A household i with age a supplies a unit of labor inelastically and receives an income $y_{i,a}$. The process of earnings is expressed as

$$\log y_{i,a} = \eta_a + z_{i,a}, \tag{4}$$

where η_a is a deterministic component of income that depends on the household's age, and $z_{i,a}$ is a persistent idiosyncratic component which follows an AR(1) process as below

$$z_{i,a} = \rho z_{i,a-1} + u_{i,a}, \qquad u_{i,a} \sim N(0, \sigma_u^2). \tag{5}$$

The stochastic earnings process is a key source of exogenous household heterogeneity in the model. It generates dispersion in economic resources within and across age groups. This dispersion in resources generates differential consumption, saving and housing tenure choices. Primarily on this basis, households will vary in their decision to rent or purchase property. Conditional upon this housing choice, households will also vary in the quantity of housing services they consume and in the amount of housing investment.

Housing. Housing services $\tilde{h}$ can be obtained by purchasing or renting. A household may purchase a quantity of h units of housing at a purchase price of p per unit of housing stock. Alternatively, households may rent instead of purchasing a home $(h = 0)$. In that case, they face a rental price of p^r per unit of housing services. Besides, households can own more housing stock than they consume ($h > \tilde{h}$) in which case they become landlords with an investment housing stock of $h - \tilde{h}$. We assume homeowners can not consume more housing services than they own. Renters are also restricted

[6] This assumption is also made by Sommer and Sullivan (2018). An alternative would be to distribute bequests to new-born (or other) households as they enter the economy. We do not follow this route as it would mean that the bequests would increase the utility of households as they die and also increase the lifetime utility of new-born households indirectly by increasing their assets and hence future consumption. This generates a source of double-counting, so to speak, and favours policies that encourage larger bequests.

from purchasing housing stock for investment purposes, i.e., no renter-landlords.[7]

Depreciation and maintenance costs. Homeowners incur a stochastic maintenance expense, which is linear in the value of the house. The mean rate of depreciation is given by $\bar{\delta}$ and the realized depreciation rate is $\delta = \bar{\delta} + \omega$ where ω is the realization of a mean zero random variable drawn from a set Ω with the probability of ω occurring given by π_ω. The maintenance cost incurred by the household as a result of this shock is δph. We allow δ to be negative in some states of the world, in which case the stochastic shock leads to a capital gain for the household. These potential capital gains are taxed in our model at a 50 per cent discount, which is consistent with the rules of the Australian tax system.[8] We view this as capturing an increase in the value of the house due to changes in the quality of the neighbourhood or other amenities associated with the house.

With this structure, on average, households must set aside $\bar{\delta} ph$ to cover depreciation costs. In some periods, depreciation is higher than average and in other periods, the household may even enjoy a profit. This feature allows households to profit in the form of a capital gain despite zero expected capital gain ex-ante.[9] The inclusion of this shock does not alter the expected rate of depreciation but it does allow the model to generate a realistic proportion of negatively geared housing investors, which is important for the question we aim to address. This is discussed further after we formulate the dynamic programming problem of the household.

Transaction costs. Housing transactions are subject to transaction costs that generate inaction regions in the households' decisions to buy or sell. Following the literature (Floetotto et al. (2016), Sommer and Sullivan (2018), Kaplan et al. (2019)), we assume the transaction cost of buying (selling) a house is a constant fraction ϕ^b (ϕ^s) of the market value of the house. That is, the total transaction costs of changing housing stock from h_{-1} to h, denoted by $TC(h_{-1}, h)$, is

$$TC(h_{-1}, h) = \begin{cases} 0 & \text{if } \; h_{-1} = h \\ \phi^b ph + \phi^s ph_{-1} & \text{if } \; h_{-1} \neq h \end{cases}$$

These transaction costs are a dead-weight loss. Finally, landlords incur an additional

[7]Both HILDA and the Survey of Income and Housing (SIH) report that approximately 3 per cent of the sampled households are renters who are also landlords.

[8]A stochastic depreciation shock is also considered in Jeske et al. (2013) as a way to generate capital gains and losses in housing.

[9]Technically, this gain from a negative depreciation shock differs from a capital gain in the following sense: the gain from a negative depreciation is realized in the period in which the shock occurs. In reality, capital gains are realized in the period in which a house is sold. We abstract from this complication to maintain a feasible state vector.

fixed cost ζ per period which reflects the cost related to finding tenants and managing a rental property.

Financial assets. Households have access to a risk-free financial asset, s, with an associated interest rate of r. In any period, a household can save by purchasing this risk-free asset in which case $s > 0$. They can also borrow in which case $s < 0$. Housing is used as collateral when borrowing and we assume the following borrowing constraint:

$$s \geq -(1-\theta)ph, \qquad 0 < \theta < 1, \tag{6}$$

where θ is the minimum downpayment required to purchase a house. If the household is a borrower, the interest rate they face is $r+m$ where m is a mortgage premium. We treat Australia as a small open economy, so both r and m are exogenous.

Taxation and transfers. Households pay tax on labor income, income from financial assets, and net rental income (NRI) (if they are landlords) which is defined as

$$NRI \equiv \left[(p^r - p\delta\iota)(h-\tilde{h}) + \Big((r+m)s\Big)\left(\frac{h-\tilde{h}}{h}\right)\mathbb{1}_{\{s<0\}} - \zeta\right]\mathbb{1}_{\{h>\tilde{h}\}}, \tag{7}$$

where $\mathbb{1}$ is an indicator function which takes a value of 1 if its argument is true and a value of zero otherwise. The NRI consists of three components. First, there is the rental income earned net of maintenance costs. Note that ι is an indicator which assigns 0.5 if a negative depreciation shock is realized or 1 otherwise. The maintenance costs landlords claim is based on the depreciation rate realized in current period, even though the actual depreciation rate on their investment housing stock will be realized in next period and hence is unknown to them today.[10]

The second term reflects the total interest expense on mortgages associated with housing investment. Note that $(r+m)s$ is the interest expenses on total debt. We assume that only a proportion $\frac{h-\tilde{h}}{h}$ of total debt is deductible as an investment expense while the remaining proportion is associated with interest expenses on owner-occupied housing which are not deductible.[11] Finally, the third term is the per period fixed cost associated with being a landlord.

[10]This assumption facilitates the calculation of net rental income as it allows all the income and losses associated with housing investment in current period to be considered in current period for tax purposes. We regard it as a reasonable assumption considering a model period is 5 years.

[11]Here to reduce the size of the state variable, we make the simplifying assumption that mortgages for investment and owner-occupied housing face the same interest rate and the amount of debt associated with investment housing is proportional to the size of investment housing in the overall housing portfolio. Note that there is no mortgage interest rate tax deduction for owner-occupied housing in Australia.

The total taxable income of a household is given by:

$$Y = y_a(z) + rs_{-1}\mathbb{1}_{\{s_{-1}>0\}} + NRI, \tag{8}$$

where $y_a(z)$ is used to denote the household's income which depends on her age a and idiosyncratic income shock realization z. If the household is making a loss from housing investment, i.e. $NRI < 0$, negative gearing applies and reduces her taxable income. The total tax payment is represented by $T(Y)$, which is described in Section 3.2. In Section 5, we run a counter-factual policy experiment by setting the taxable income as below:

$$Y = y_a(z) + rs_{-1}\mathbb{1}_{\{s_{-1}>0\}} + NRI\,\mathbb{1}_{\{NRI>0\}}. \tag{9}$$

In this case, households cannot reduce the taxable labour or asset income when a loss is realized. This is similar to the tax treatment in the US and the UK.

Households receive lump-sum transfers, F, which the government finances through taxation. We can now express the budget constraint for a household in an arbitrary policy regime as follow:

$$\begin{aligned} c + s + ph + \delta ph_{-1} + TC(h_{-1}, h) + \zeta\mathbb{1}_{\{h>\tilde{h}\}} + T(Y) = y_a(z) + ph_{-1} + p^r(h - \tilde{h}) \\ + (1 + r + m\mathbb{1}_{\{s_{-1}<0\}})s_{-1} + F. \end{aligned} \tag{10}$$

Household Dynamic Programming Problem

In each period, given house price, rent and transfer payment, (p, p^r, F), households first decide whether (i) to rent, or (ii) to own a house. This decision is conditional on the household's age a, the current realization of idiosyncratic income shock z, housing assets h_{-1}, and savings s_{-1}. For notational convenience, we group these state variables into a state vector $x \equiv (a, z, s_{-1}, h_{-1})$. The value functions are written as:

$$V(x) = \max\{V^{\text{rent}}(x), V^{\text{own}}(x)\} \tag{11}$$

Then conditional on being a renter or owner, a household chooses consumption c_ω, housing services $\tilde{h}_\omega$, housing stock h_ω to purchase if choosing to be an owner, and saving or borrowing s_ω, contingent upon the realization of the depreciation shock ω.

Renters do not purchase any housing assets. Instead, they consume housing services via the rental market. Renters face the following problem:

$$V^{\text{rent}}(x) = \max_{c_\omega, \tilde{h}_\omega, s_\omega} \sum_{\omega\in\Omega} \left\{ \pi_\omega \left[u(c_\omega, \tilde{h}_\omega) + \beta \left(\kappa_a \mathbb{E}_{z'|z} V(x'_\omega) + (1-\kappa_a)\nu(b_\omega) \right) \right] \right\} \tag{12}$$

subject to

$$
\begin{aligned}
c_\omega + s_\omega + p^r \tilde{h}_\omega + \delta_\omega\, ph_{-1} + TC(h_{-1}, 0) + T(Y) \\
&= y_a(z) + ph_{-1} + (1 + r + m\mathbb{1}_{\{s_{-1}<0\}})s_{-1} + F \\
\mathrm{b}_\omega = s_\omega \geq 0,
\end{aligned}
$$

where

$$
\begin{aligned}
x'_\omega &\equiv (a+1, z', s_\omega, 0) \\
Y &= y_a(z) + rs_{-1}\mathbb{I}_{\{s_{-1}>0\}}
\end{aligned}
$$

Homeowners consume housing services by purchasing housing stocks. They also have an option to buy more housing stock than they consume ($h > \tilde{h} > 0$) in which case they become landlords. Homeowners solve:

$$
V^{\mathrm{own}}(x) = \max_{c_\omega, \tilde{h}_\omega, s_\omega, h_\omega} \sum_{\omega\in\Omega} \left\{ \pi_\omega \left[u(c_\omega, \tilde{h}_\omega) + \beta\left(\kappa_a \mathbb{E}_{z'|z} V(x'_\omega) + (1-\kappa_a)\nu(b_\omega)\right)\right]\right\} \tag{13}
$$

subject to

$$
\begin{aligned}
c_\omega + s_\omega + ph_\omega + \delta_\omega\, ph_{-1} + TC(h_{-1}, h_\omega) + \zeta\mathbb{1}_{\{h_\omega > \tilde{h}_\omega\}} + T(Y_\omega) \\
&= y_a(z) + ph_{-1} + p^r(h_\omega - \tilde{h}_\omega) + (1 + r + m\mathbb{1}_{\{s_{-1}<0\}})s_{-1} + F \\
\mathrm{b}_\omega = s_\omega + ph_\omega \\
s_\omega \geq -(1-\theta)ph_\omega,
\end{aligned}
$$

where

$$
\begin{aligned}
x'_\omega &\equiv (a+1, z', s_\omega, h_\omega) \\
Y(\omega) &= y_a(z) + rs_{-1}\mathbb{I}_{\{s_{-1}>0\}} + NRI \\
NRI &\equiv \left[(p^r - p\delta_\omega\iota)(h_\omega - \tilde{h}_\omega) + (r+m)s_\omega\left(\frac{h_\omega - \tilde{h}_\omega}{h_\omega}\right)\mathbb{1}_{\{s_\omega<0\}} - \zeta\right]\mathbb{1}_{\{h_\omega > \tilde{h}_\omega\}}
\end{aligned}
$$

Notice that all choice variables are now indexed by ω since households' choices are contingent upon the realization of the i.i.d. depreciation shock.

We now explain why the presence of the depreciation shock leads to a substantial proportion of landlords to be negatively geared. There are a number of mechanisms at play. First, although in expectation, an investor may be expected to make a profit from investment housing there is some probability they are exposed to a large depreciation shock. This shock increases the expenses of being a landlord and hence may lead to a rental loss within a period, even if ex ante the investment was profitable.

Second, at the beginning of every period, a proportion of homeowners experience a large depreciation shock on their existing housing stock. This depreciation shock serves as a negative income shock and encourages them to reduce both the consumption of the non-durable good and of housing services. In the presence of transaction costs, rather than selling a household may prefer to become a landlord which can bring them extra rental income, which can mitigate the negative income impact of the large depreciation shock. Furthermore, becoming a landlord allows them to take advantage of the negative gearing policy. Recall that the depreciation cost claimed by landlords on their investment housing is based on the current depreciation rate. Therefore a large depreciation shock gives them stronger motive to become a landlord and make them more likely to claim a net rental loss, i.e., to be negatively geared.

Finally, the interaction of the depreciation shock with the tax system encourages negative gearing. If a household incurs a loss on her existing housing stock due to a larger than average depreciation shock then the impact upon after-tax income is moderated by negative gearing. If a household receives a capital gain (negative depreciation shock), our model follows Australian tax policy, and these profits are only taxed at 50 per cent of the household's marginal income tax rate. As a result, although the depreciation shock adds risk to housing investment and has a mean zero impact upon the value of the house, the operation of the tax system implies that the impact upon the after-tax income is asymmetric with a positive mean. As a result, the inclusion of the depreciation shock raises the rate of return and makes households more willing to invest in housing.[12] In the absence of this shock, the model has difficulty in generating a realistic proportion of negatively geared housing investors.

3.2 Government

We replicate the progressive nature of the Australian tax system. The total amount of taxation imposed on households is:

$$T(Y) = \begin{cases} 0 & \text{if } Y \leq \bar{Y}_1 \\ \tau_1(Y - \bar{Y}_1) & \text{if } \bar{Y}_1 < Y \leq \bar{Y}_2 \\ T_1 + \tau_2(Y - \bar{Y}_2) & \text{if } \bar{Y}_2 < Y \leq \bar{Y}_3 \\ \vdots & \\ T_{Q-1} + \tau_Q(Y - \bar{Y}_Q) & \text{if } Y > \bar{Y}_Q \end{cases}$$

[12] In our baseline calibration, the average return on housing investment is 9.5 per cent when not taking into account the tax benefits. This is marginally above the risk-free rate of 9.2 per cent. However, it is 11.4 percent if the tax benefits are taken into account.

where $\bar{Y}_q$ for $q \in \{1, 2, \cdots, Q\}$ are income thresholds at which marginal tax rates change, τ_q are the corresponding marginal tax rates, and T_q is the tax paid at a threshold so that $T_q = T_{q-1} + \tau_q(\bar{Y}_{q+1} - \bar{Y}_q)$.

The government runs a balanced budget. The government spends all of its tax revenue by distributing a lump-sum transfer F to each surviving household. The removal of negative gearing eliminates a source of tax deductions and, other things equal, raises government revenue that will in turn, increase government transfers.

3.3 Construction Sector

We introduce a competitive construction firm to endogenize housing supply. This firm buys existing dwellings from households who sell housing assets, develops new dwellings, and sells existing and new dwellings at price p to households who choose to purchase housing assets. The construction firm also collects household expenditure on depreciation and uses part of the newly developed housing stock to offset the depreciation of existing housing stock. Because there is no capital gain on average, the competitive construction firm does not earn profits from buying and selling existing dwellings.

Following Floetotto, Kirker and Stroebel (2016), we assume that the production technology to create new housing stock is given by

$$H^{\text{new}} = \psi_1 L^{\psi_2}$$

where L is the amount of land issued by the government every period. The firm purchases the land at a competitive market price which is normalized to 1, and sells the newly produced housing stock at price p. The parameter ψ_2 is a scale parameter that is less than 1. The construction firm therefore solves the following static problem:

$$\max_L \left(p\left[\psi_1 L^{\psi_2} - \bar{\delta} H_{-1}\right] + p\bar{\delta} H_{-1} - L\right\} = \left\{\psi_1 L^{\psi_2} - L\right\} \tag{14}$$

which results in the following new housing stock,

$$H^{\text{new}} \equiv p\psi_1 (L^*)^{\psi_2} = \psi_1 \left(\frac{1}{\psi_1 \psi_2 p}\right)^{\frac{\psi_2}{\psi_2 - 1}}.$$

Note that the aggregate housing supply elasticity is given by $\varepsilon = \psi_2/(1 - \psi_2)$. The transition equation for the aggregate housing stock is given by

$$H = H_{-1}(1 - \bar{\delta}) + H^{\text{new}}. \tag{15}$$

3.4 Stationary Equilibrium

Recall, the state vector of a household is defined as $x \equiv (a, z, s_{-1}, h_{-1})$, which reflects the household's age, earnings, financial assets and housing stock. Here $a \in A = \{1, ..., A\}$, $z \in Z = \{z_1, ..., z_J\}$, $s \in S = \mathbb{R}_+$, and $h_{-1} \in \mathbb{R}_+$. The individual state space is given by $X = A \times Z \times S \times H$. A stationary equilibrium consists of value functions $V(x), V^{\text{rent}}(x), V^{\text{own}}(x)$ household decision rules $\{c_\omega(x), s_\omega(x), h_\omega(x), \tilde{h}_\omega(x)\}$, an aggregate housing stock $\overline{H}$, a lump-sum transfer F, and a stationary distribution on X, μ, such that:

1. Household optimize by solving (11)-(13) with value functions $\{V(x), V^{\text{rent}}(x), V^{\text{own}}(x)\}$ and decision rules $\{c_\omega(x), s_\omega(x), h_\omega(x), \tilde{h}_\omega(x)\}$.

2. The aggregate housing stock satisfies (15) with $H = H_{-1} = \overline{H}$.

3. The housing and rental markets clear:

$$\int_X h_\omega(x) d\mu = \overline{H} \tag{16}$$

$$\int_X \left(\tilde{h}_\omega(x) - h_\omega(x)\right) d\mu = 0 \tag{17}$$

4. The government budget is balanced

$$\int_X T(Y(x)) d\mu = \int_X F d\mu \tag{18}$$

5. The distribution μ is stationary and consistent with household behavior.

4 Calibration

We calibrate the model in two stages. In the first stage, parameters are selected by appealing to evidence from the existing literature. In the second stage, we calibrate the remaining parameters by matching the model moments of the baseline steady state to their data counterparts as closely as possible. We summarize parameters that are externally determined in Table 1. The parameters calibrated internally are summarized in Table 2 while the respective data and model moments are reported in Table 3.

Table 1: Externally Chosen Parameter Values

	Parameter	Model value	Annual value	Source
r	Risk-free interest rate	0.092	0.018	RBA
m	Mortgage premium	0.118	0.023	RBA
σ	Coefficient of risk aversion	2		Literature
ϕ^b	Trans. cost for buyer	0.037		Avg. stamp duty
ϕ^s	Trans. cost for seller	0.03		Avg. agent fee
δ	maintenance/depreciation cost	0.104	0.02	SIH
ι	capital gains tax	0.5		ATO
η_a	deterministic part of income			HILDA
ρ	Persistence of income shock	0.65	0.94	HILDA
σ_u	Std. dev. of income shock	0.44	0.173	HILDA
κ_a	Survival probability (age-dependent)			ABS life table
$T(Y)$	Taxation thresholds and proportions	Refer to text		ATO
ε	Housing supply elasticity	2		Liu and Otto (2014)

4.1 Model parameters

Demographics and Preferences. The model period is set to 5 years.[13] Households enter the model at age 21 and exit at age 90. Thus, the number of age cohorts is 14. The age dependent survival probability, κ_a, is obtained from the ABS Life Tables 2007–2009. The coefficient of risk aversion, σ, is set to 2.

Income. Following the procedure in Heathcote, Perri and Violante (2010), the income process is estimated using the age, income and other demographics information from the HILDA survey. To be consistent with the model, we construct the exogenous income by subtracting the investment income (e.g. savings and rental income) from the *household total gross income*. Accordingly, our income measure reflects before tax income excluding any investment income. We extract the deterministic component, $\{\eta_a\}_{a=1}^{A=14}$ using a fourth order polynomial in age. This component captures the life-cycle earnings profile that is increasing and then decreasing over the life-cycle. The stochastic component of earnings, $z_{i,a}$, is estimated to follow an AR(1) process with persistence of 0.65 and standard deviation for innovations of 0.45.[14] To approximate the income process we discretize the continuous stochastic component of earnings into seven states using the method of Tauchen and Hussey (1991). The median income in the data over a 5-year period is estimated to be $347,800 which is used to normalize variables in monetary units.

[13]We use a 5 year period for computational tractability and since households tend to hold housing assets for a relatively long period of time due to the significant transaction costs.

[14]These are the 5-year values converted using the annual estimates of $\rho = 0.94$ and $\sigma_u^2 = 0.03$. See Appendix C in the online appendix for more details on the estimation of the income process, at the following link: https://drive.google.com/file/d/1D8ijYwPHgGUT-VTK1NJuSG59OuA0zmG-/view

Housing. We set the transaction cost for buyers $\phi^b = 0.0375$ which is the weighted average stamp duty rate across the seven capital cities in Australia from 2001 to 2014. The transaction cost for sellers is $\phi^s = 0.03$ which corresponds to the average real-estate agent fee. The mean depreciation rate is set to match the average maintenance cost. According to the SIH 2013-14, homeowners pay maintenance expenses around 2.2 per cent of the housing value. This is similar to values reported in U.S. studies.[15] This annual rate translates to a model value of $\bar{\delta} = 0.104$, keeping in mind that our period length is 5 years. We place a structure on ω by restricting $\omega \in \{-\omega_0, 0, \omega_0\}$ and let $\pi_\omega = 1/3$ for each realization of ω. The size of depreciation shock, ω_0, is internally calibrated to help the model match some data moments that are described below. The downpayment requirement, θ, is set at 0.2, consistent with the practice of residential mortgage lending in Australia.[16]

We discretize the size of housing that households may purchase into $K = 9$ discrete sizes, $h \in \{0, h(1), ..., h(9)\}$, and following Cocco (2004) and Floetotto et al. (2016), we allow renters to consume housing services less than the minimum housing size available for owner-occupied purposes. The set of housing services renters may select from is given by $h^{\text{rent}} \in \{h^{\text{rent}}(1), h^{\text{rent}}(2), h^{\text{rent}}(3), h(1), ..., h(9)\}$. The minimum housing size available for purchase is internally calibrated below to help the model match some data moments. The largest house size is set at four times the minimum housing size. We choose $h^{\text{rent}}(j)$ such that $h^{\text{rent}}(1) = h(1)/4$, $h^{\text{rent}}(2) = h(1)/2$ and $h^{\text{rent}}(3) = 3h(1)/4$

Interest rates. The risk-free interest is calibrated to the average yield of the 5-year Commonwealth government bond from January 2001 to December 2015, deflated by annual CPI inflation. This implies a real interest rate of 1.66 per cent per annum, equivalent to a model value of $r = 0.092$. The annual mortgage premium is calculated by subtracting the risk-free rate from the real variable lending rates for owner-occupied housing over the same period. The annual average is 2.26 per cent which translates to a model value of $m = 0.118$.

Taxation. The income tax function captures the progressivity of the Australian tax system. The parameters to be calibrated are income thresholds for each tax bracket $\bar{Y}_q$, the marginal tax rates τ_q, and the tax payment thresholds for each bracket, T_q. These

[15] Floetotto, Kirker and Stroebel (2016) report $\delta = 0.02$ and Sommer and Sullivan (2018) set $\delta = 0.015$.

[16] Simon and Stone (2017) document a median loan-to-valuation ratio of 83 per cent among first home buyers implying a θ of 0.17. However, repeat buyers are older and are likely to have a higher downpayment requirements to account for their shorter expected duration of repayment. We settle on an average value of $\theta = 0.2$. This is also consistent with regulations that require households purchase mortgage insurance if the loan-to-value ratio exceeds 0.8.

Table 2: Internally calibrated parameters

	Parameter	Value
λ	Utiliy premium for homeowners	1.09
h_{min}	Minimum housing size for owning	0.87
ϑ	Bequest intensity	3.58
β	Discount factor (5-year)	0.64
α	Share of non-durable consumption	0.85
ζ	Fixed cost of being a landlord	0.007
ω	Size of depreciation shock	0.23
ψ_1	Scale parameter for housing production	15.29

are obtained from the Australian Taxation Office using the income tax system for the 2012-13 financial year. The function is given by:

$$T(Y) = \begin{cases} 0 & \text{if } Y \leq 0.2612 \\ 0.19(Y - 0.2612) & \text{if } 0.2612 < Y \leq 0.5310 \\ 0.0513 + 0.325(Y - 0.5310) & \text{if } 0.5310 < Y \leq 1.1481 \\ 0.2518 + 0.37(Y - 1.1481) & \text{if } 1.1481 < Y \leq 2.5832 \\ 0.7828 + 0.45(Y - 2.5832) & \text{if } 2.5832 < Y \end{cases}$$

Note that the income and tax payment thresholds are normalized by the average household income.

Housing supply elasticity. Estimates of housing supply elasticity are not readily available for the aggregate economy. Liu and Otto (2014) estimate the supply elasticity of houses in the Sydney metropolitan area between 0.07 and 0.96 while that of apartments is between 0.16 and 4.34. As far as we are aware, these are the only measures available for the Australia. In our baseline model, we set $\varepsilon = 2$. This value is slightly above their average estimate since we believe the Sydney housing market is more constrained by geography and regulation than other regions in Australia.[17]

Internally calibrated parameters. The remaining parameters are calibrated internally by jointly matching important moments observed in the data using a simulated method of moments procedure. These internally calibrated parameters and the relevant moments are reported in Tables 2 and 3 respectively.

The utility premium for home ownership, λ, is calibrated to match the average homeownership rate in Australia, which is around 67.9 per cent, and we reach a λ

[17] In Appendix B of the online appendix, we provide the steady state results for two alternative elasticity values, $\varepsilon = 8$ and $\varepsilon = 0$. The results are broadly similar to those under the baseline calibration.

Table 3: Target moments for internal calibration

Target Moment	**Data**	**Model**
Homeownership rate	0.679	0.679
Homeownership rate under 40 years old	0.385	0.374
Homeownership rate for 65+	0.823	0.784
Fraction of mortgaged homeowners	0.532	0.553
Rent-to-income ratio	0.235	0.189
Fraction of landlords	0.174	0.165
Fraction of negatively geared landlords	0.618	0.460
Net wealth-to-income ratio	0.884	0.866

Notes: The data moments are obtained from the SIH 2013-14 except for the fraction of negatively geared landlords which is obtained from ATO's Taxation Statistics 2014-15.

value of 1.09.[18] We also match the average homeownership rates for households under 40 and for households over 65 in the data by calibrating the minimum house size for owner-occupied housing, h_{min}, and the parameter governing bequest intensity, ϑ. All three homeownership rates are closely matched. The discount factor, β is chosen to match the fraction of mortgaged homeowners among all homeowners, as it affects a household's willingness to borrow. We obtain a value of 0.64 as the five-year discount factor, with a close match of this moment. The parameter that captures the share of non-durable consumption, α, governs the allocation of resources between non-durable consumption and housing services in the model, so we choose the rent-to-income ratio as the target moment. A value of 0.85 for α produces a rent-to-income ratio of 0.189 in the model, which is slightly lower than its data counterpart. This value of α is in line with the value used in Floetotto et al. (2016).

The fixed cost of being a landlord, ζ, is chosen to match the average landlord rate in the data, which is around 17.4 per cent according to the SIH 2013-14. We reach a ζ value of 0.007 and a landlord rate of 16.5 per cent. A value of 0.007 for ζ corresponds to an additional cost of being a landlord (above the standard maintenance cost) of $486 per year. The size of the depreciation shock, ω, greatly influences the proportion of negatively geared landlords in the model. According to Taxation Statistics 2014-15, around 61.8 per cent of landlords are negatively geared. With a value of ω equal to 0.23, the model generates a fraction of negatively geared landlords of 46 per cent. Finally, the scale parameter for housing production function, ψ_1, largely determines the total size of housing stock. It is pinned-down by matching the net wealth to income ratio, where net wealth is the total value of financial asset and housing asset.

[18]This value of λ is slightly higher than the values used in other studies that focus on the U.S. market, see for example Kaplan et al. (2019). We believe the difference arises due to the institutional setting: the U.S. housing market allows for mortgage interest deductibility which favors homeownership.

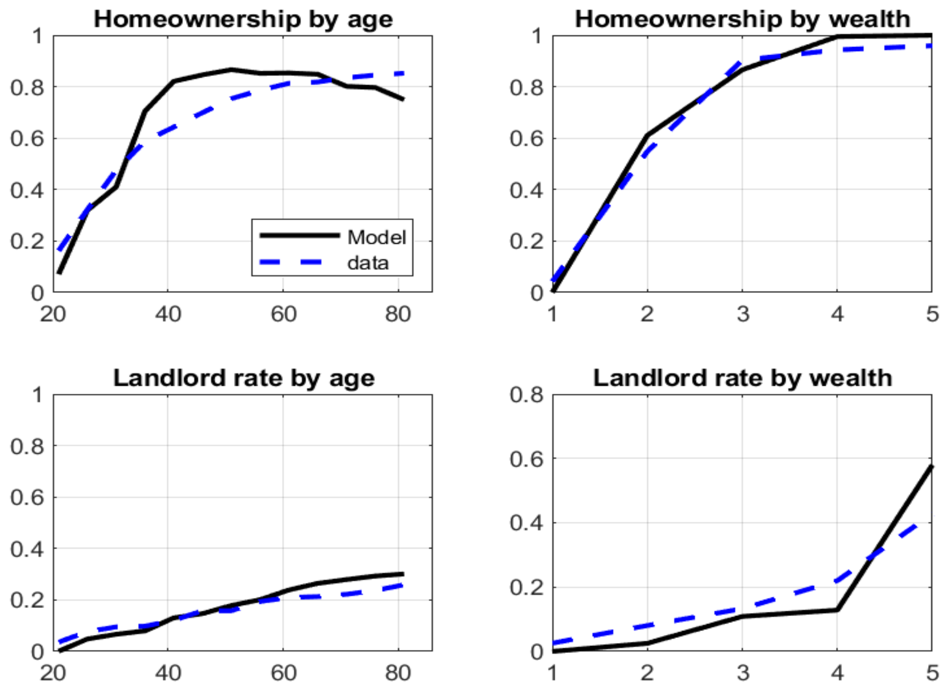

Figure 4: Homeownership and landlord rates by age and wealth (model vs. data)

4.2 Quantitative Properties of the baseline model

Homeownership and landlord rates. We first have a look at some important quantitative properties of the stationary equilibrium (see Appendix A in the online appendix for compuational details). The top left panel in Figure 4 plots the average homeownership rate over the life-cycle in the calibrated model. The model generates a life-cycle profile of homeownership similar to that observed in the data where the homeownership rate increases from 12 per cent for the first cohort (age 21-25) and reaches the peak of 82 per cent for the age cohort 56-60. In the top-right panel, we report the average homeownership rate across wealth quintiles. Although the model marginally overestimates the homeownership rate for the fourth and fifth quintile, it matches the positive relationship between homeownership and wealth. The bottom two panels in Figure 4 shows that the model is also able to match the landlord rate over the life-cycle as well as across wealth quintile.

Negatively geared landlords. In order to draw realistic policy implications of removing negative gearing, it is important for the model to generate a reasonable amount of negatively geared landlords. In our baseline steady state, around 46 per cent of landlords are negatively geared. This is below the fraction of negatively geared landlords

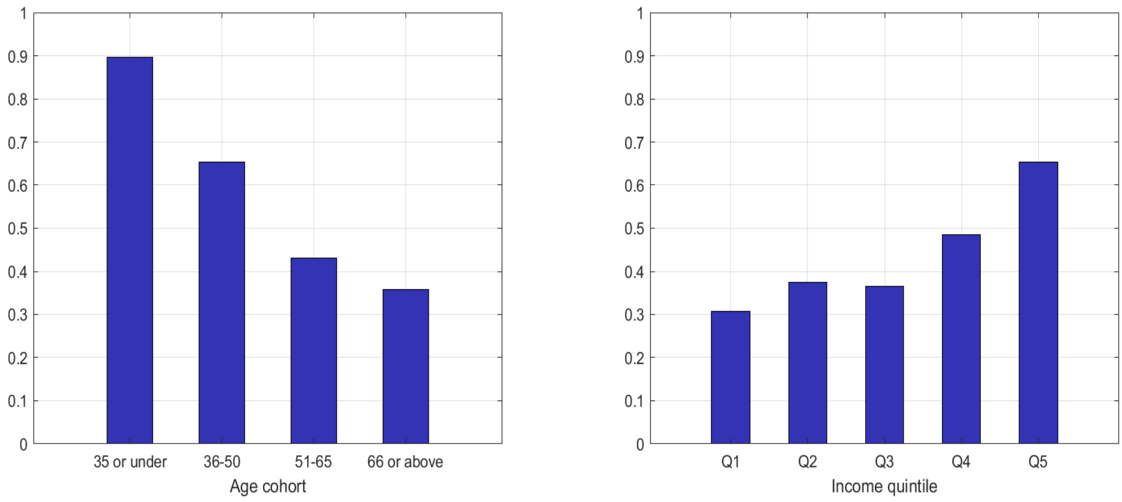

Figure 5: Negatively geared landlords (relative to total landlords) by age and income

observed in the data which is about 62 percent on average during the sample period. We can see from comparing Figure 3 with Figure 5 that the model replicates the trends in negative gearing by age and income although the levels are slightly different.

5 Removing Negative Gearing

This section presents the quantitative impact of removing negative gearing concessions on house prices, rents and welfare. We first compare the differences in steady state between the baseline economy in Section 4 and a counterfactual economy. In the baseline economy, negative gearing applies and the taxable income is given by (8). In the counterfacutal economy, negative gearing is removed and taxable income follows (9) so that landlords cannot deduct net rental losses from total taxable income. In both cases the government redistributes tax revenues equally to every household. We also examine the effects of two alternative counterfactual experiments in Section 5.3: (1) the government disposes the additional tax revenue so that the size of redistribution is constant across steady states; and (2) the government redistributes additional revenue to renters only, i.e. as rental assistance. Once the steady state outcomes are analyzed, we turn to the dynamic effects of eliminating negative gearing in Sections 5.4 and 5.5.

5.1 Steady state prices and moments

Table 4 compares the steady state outcomes of key variables in an economy with negative gearing (baseline) to one without negative gearing (counterfactual). In this subsection, we compare the outcomes between the baseline model (second column) and the

Table 4: Removing negative gearing: policy experiments

	Baseline	**Counterfactual (No NG)**		
		Redist.	**w/o Redist.**	**Rental assist.**
Price	0.988	0.973	0.974	0.971
Rent	0.280	0.290	0.294	0.293
Price-rent ratio	3.525	3.351	3.315	3.312
Frac. of homeowners	0.679	0.722	0.719	0.689
- Frac. of owner-occupiers	0.514	0.615	0.612	0.573
- Frac. of landlords	0.165	0.108	0.120	0.116
Frac. of renters	0.321	0.278	0.281	0.311
Proportion of NG landlords	0.460	0.395	0.407	0.396
Total housing supply (normalized)	1	0.971	0.974	0.967
Rental supply (relative to total housing supply)	0.163	0.116	0.120	0.132
Total tax revenue (normalized)	1	1.019	1.019	1.011
Avg. tax paid by landlords (normalized)	1	1.093	1.133	1.051
Transfer	0.201	0.206	0.201	0.201
Rental assistance	-	-	-	0.009
Ex-ante *cev*	-	1.70%	-0.90%	1.98%

counterfactual policy experiment where the government redistributes the additional revenue gained from repealing negative gearing (third column).

Removing negative gearing reduces demand for investment housing in the purchase market and leads to a reduced supply of rentals. This reduction in demand decreases house prices by 1.5 per cent while rents increase by 3.6 per cent. The landlord rate and the total housing investment or rental supply fall by 34.5 and 28.8 per cent, respectively. The lower house prices lead some renters to become homeowners which lowers the demand for rental housing. This is more than offset by the fall in rental supply so that the counterfactual economy has higher rents.

Turning to the effects on quantities, when negative gearing is eliminated, we find that the average homeownership rate increases by 4.3 percentage points, from 67.9 per cent to 72.2 per cent. The following mechanism is at work. The fall in house prices and the rise in rents reduce the price-to-rent ratio by 4.9 per cent. This has a direct impact on housing affordability. The fraction of owner-occupiers (homeowners without housing investment) increases by 10.1 percentage points of which 4.3 percentage points come from renters who become homeowners and the remaining 5.7 percentage points are landlords who would become owner-occupiers in the counterfactual economy.

Eliminating negative gearing increases the total tax revenue by 1.9 per cent. After the policy change, the government collects more tax revenue from landlords with the average tax paid by landlords increasing by 9.3 per cent. An increase in government tax revenue translates into an increase in lump-sum transfers. The increased transfer has important implications for our welfare analysis to be discussed below.

Figure 6 compares the life-cycle and wealth profiles of homeownership and land-

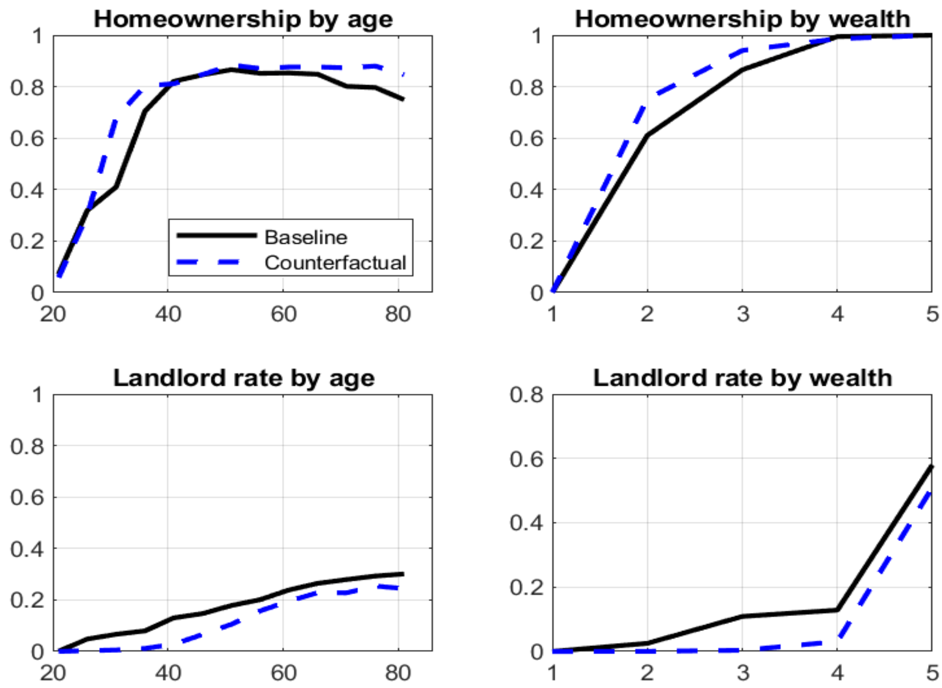

Figure 6: Homeownership and landlord rates by age and wealth

lord rates between the two steady states. As the top-left panel depicts, most of the rise in the homeownership rate occurs among age 35 to 40 households. The homeownership rates of the youngest cohorts are barely changed since they are most likely to be financially constrained. The fall in house prices is not large enough for them to meet the downpayment requirement for mortgages. The top-right panel shows that repealing negative gearing would increase the homeownership rate for households in the middle of the wealth distribution the most.

We now discuss how the removal of negative gearing would alter the composition of landlords in the economy. The bottom panel in Figure 6 shows that the average landlord rate is significantly lower for households under age 50 in the counterfactual economy. Young landlords have, on average, less wealth and rely more on borrowing to finance their housing investment. These landlords benefit the most from negative gearing. As presented in the bottom-right panel, the reduction in the landlord rate is mostly driven by households in the middle wealth quintiles. These households are relatively young household with high income. The progressive tax system allows these high income landlords to benefit proportionately more from negative gearing. The policy change therefore drives these young landlords out of the market for housing investment.

We next look at changes in housing investment by age and income. The left panel of Figure 7 shows that the decline in housing investment, normalised by the total demand

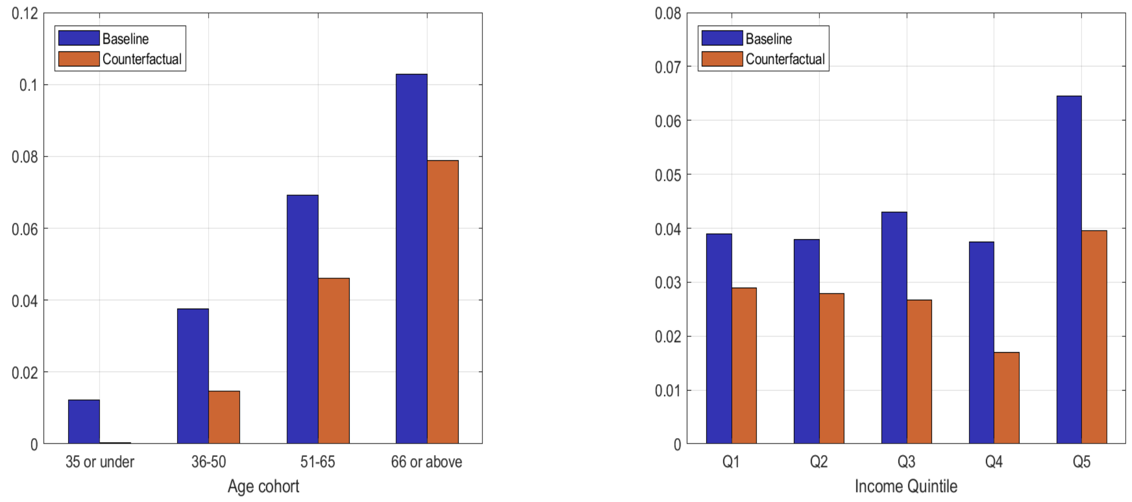

Figure 7: Housing investment (relative to total housing demand) by age and income

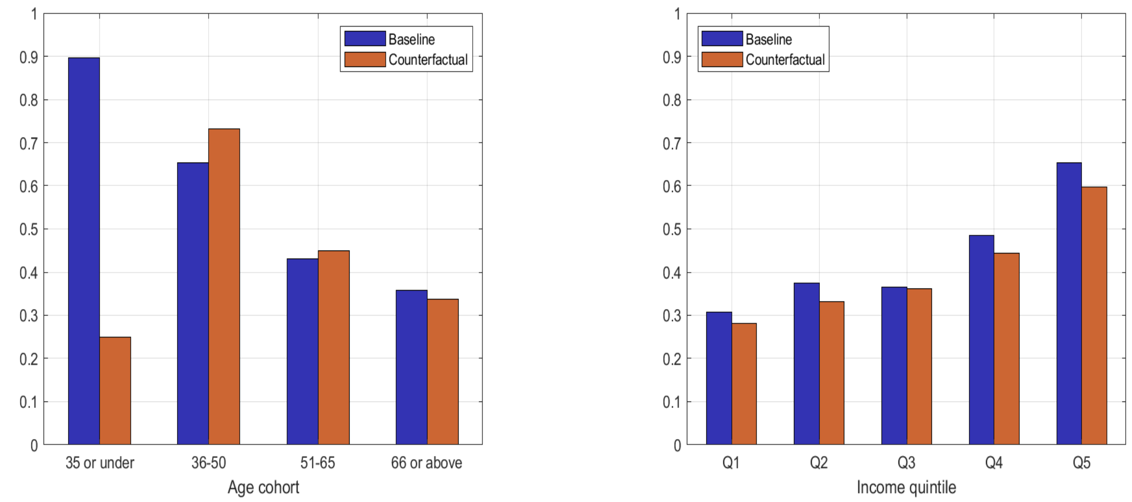

Figure 8: Proportion of negatively geared landlords by age and income

for housing, is proportionately larger for the youngest age group. Along the income quintiles, on the right panel, we find that groups with higher income exhibit larger decreases in housing investment. Similar patterns are also observed in the changes in negatively geared landlords by age and income. In the left panel of Figure 8, we observe a large reduction in the proportion of negatively geared landlords under 35 years of age. Examining the relationship between income and negative gearing in the right panel of Figure 8, we see that removing investment housing tax concessions leads to a reduction in negative gearing among all income quintiles.

5.2 Steady state welfare

Our welfare analysis is based on the notion of consumption equivalent variation (*cev*).[19] That is, we calculate the percentage change in the current period consumption of non-durables that equates the expected discounted utility in the counterfactual economy with that in the baseline economy. For the steady state welfare comparison, we consider the *ex-ante cev* of newly born households. These newborns are endowed with zero assets. Formally, we solve for the *cev* for each newborn with state vector $x \equiv (1, 0, 0, z)$ (and transform them into percentage change) such that

$$V^{nong}(x) = u\left(c^*(x) + cev, \tilde{h}^*(x)\right) + \beta\left[\kappa_a \mathbb{E}_{z'|z} V^{ng}(x'^*(x)) + (1-\kappa_a)\nu(b^*(x))\right], \quad (19)$$

where $V(x)^{ng}$ and $V(x)^{nong}$ denote the value functions with and without negative gearing, respectively, and $\{c^*(x), \tilde{h}^*(x), x'^*(x), b^*(x)\}$ are policy functions for the baseline economy. Therefore, the LHS of (19) is the expected discounted utility of a newborn with income z in an economy without negative gearing, and the RHS is that of a new born with the same income entering the baseline economy. Our welfare measure, $cev(x)$, is the percentage change in first period non-durable consumption required by a newborn in the baseline economy to ensure she would be as well off as in the counterfactual economy. A positive value of $cev(x)$ implies that a newborn with income z would prefer to be born into an economy without negative gearing. Averaging $cev(x)$ over the stationary distribution of z gives a measure of the ex-ante welfare comparison; a positive value implies that repealing negative gearing improves the ex-ante welfare of households.

Eliminating negative gearing raises the average $cev(x)$ for newly born households by 1.7 per cent and all households prefer entering an economy without negative gearing, regardless of their initial income. Welfare improves since these newly born households benefit from lower house prices and higher transfer payments. The fall in house prices makes it easier to become homeowners and allows them to move up the housing ladder more easily. The redistribution through an increase in government tax revenue is also an important mechanism for the welfare gain. An increase in periodic transfer payments compensates renters for higher rents and also compensates those who would become negatively geared landlords for higher tax burden. The importance of the redistribution mechanism is further illustrated in the additional counterfactual experiments described below.

[19] See Conesa, Kitao and Krueger (2009) and Hong and Ríos-Rull (2012) for a discussion of welfare in life-cycle models. We adopt a similar approach as Nakajima (2012), Chambers, Garriga and Schlagenhauf (2009), and Floetotto, Kirker and Stroebel (2016) who study life-cycle housing decisions.

5.3 Other policy experiments

In this subsection we discuss two alternative policy experiments. In the first experiment, negative gearing is removed but the additional government revenue is not redistributed so households receive the same lump-sum transfer as in the baseline case. In the second experiment, the additional revenue from removing negative gearing is distributed only to renters as rental assistance.

The results of these two policy experiments are reported in the last two columns of Table 4. The qualitative effects on house price and rent are similar across experiments. However, we find that removing negative gearing without redistribution reduces welfare. The ex-ante *cev* for newborn households is -0.9 per cent. Ex-ante welfare decreases because without redistribution, the fall in house prices alone does not compensate for the loss of potential investment housing tax concessions. In addition, a rise in rents adversely affects the welfare of newborns that enter the economy with zero housing assets. Hence, the results imply that redistribution is a crucial determinant for the elimination of negative gearing to increase welfare.

The last column of Table 4 reports the results of the counterfactual economy with rental assistance. The market clearing value of rental assistance is 0.009, around 4 per cent of the total transfer. While the effects on price, rent and homeownership rate are similar to the main counterfactual experiment, the size of ex-ante welfare gain (1.98 per cent) exceeds that in the main counterfactual economy. In our model, all households start their lives with zero housing assets, thus they prefer to be born into the counterfactual economy with rental assistance.

5.4 Transition dynamics

We now examine the dynamic effects of an unexpected and permanent removal of negative gearing under the two policy experiments: (1) with redistribution, i.e., the main counterfactual experiment we focus on; and (2) with rental assistance. Examining the transition dynamics of these scenarios allows us to consider the welfare impact on all workers. We assume that households have perfect-foresight of aggregate variables along the transition path to the new steady state. Figure 9 displays the transition dynamics of house prices, rents, transfers, the homeownership rate, the landlord rate and the rental supply following the removal of negative gearing in the first experiment (see Appendix A in the online appendix for a brief procedure of computing the transition dynamics). The convergence from the baseline to the new steady state takes about 4 to 5 periods, i.e. 20 to 25 years. However, most of the effects on price, rent and transfer happen in the first two periods. Around 52 per cent of the total decline in house prices occurs immediately after the reform is implemented. Interestingly, rents overshoot

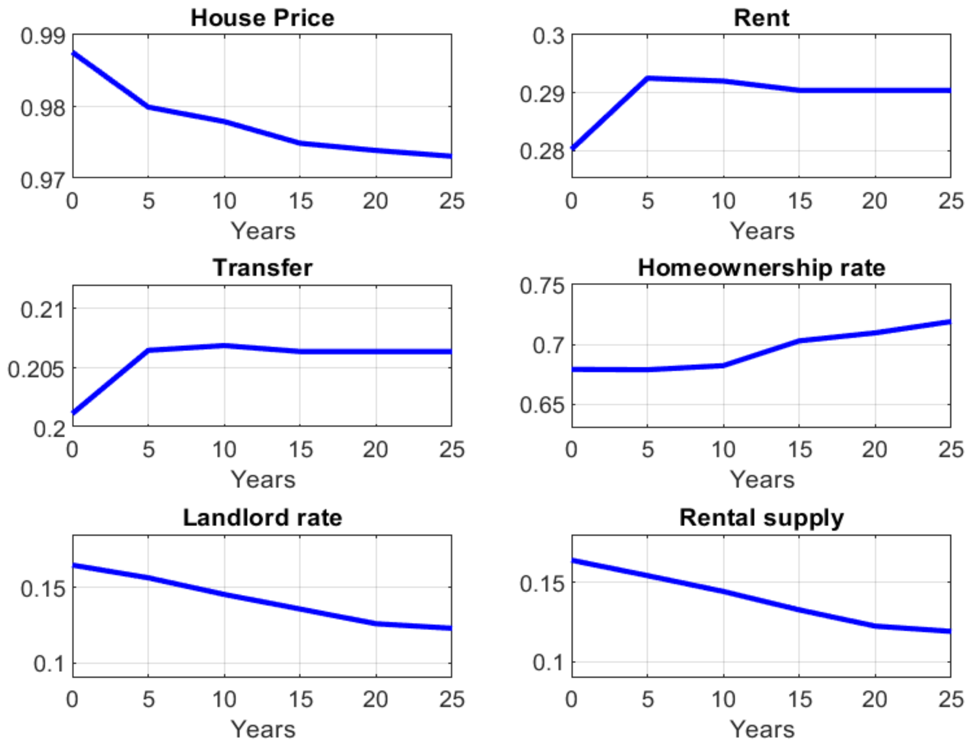

Figure 9: Transition dynamics for permanent removal of negative gearing: Redistribution

the final steady state equilibrium before decreasing gradually to the new steady state level. The contraction in rental supply in the first five years after the policy change leads rents to overshoot. Note that homeownership barely changes during this period which suggests that the fall in rental supply is the main reason for the rise in rents. After this period, homeownership starts to rise as house prices keep falling. This implies a decrease in rental demand and thereafter, rents start to fall and converge to the new steady state level. The lump-sum transfer on the other hand jumps to the new steady state level very rapidly. Lastly, the landlord rate falls smoothly until it reaches the new steady state.

5.5 Welfare along transitions

Along the transition path, our welfare analysis looks at the *cev* for all households alive at the time of the repeal of negative gearing. Analogous to the steady state comparison, for each household we define cev_i as the percentage change in her current non-durable consumption that equates the expected discounted utility she would have achieved in the absence of the policy change to that achieved upon the policy change. This provides our measure of the welfare effects of the policy reform.

Table 5: Welfare over transition: overall

	Redistribution	**Rental assistance**
Mean	1.83	0.75
Median	1.94	0.49
$P(cev_i > 0)$	0.964	0.715

Table 6: Welfare over transition: by initial housing tenure

	Redistribution			**Rental assistance**		
	Mean	Median	$P(cev_i > 0)$	Mean	Median	$P(cev_i > 0)$
Renters	1.78	1.59	0.998	2.23	1.99	0.995
Owner-occupiers	1.85	2.07	0.952	0.03	0.01	0.580
Landlords	1.56	1.78	0.867	0.00	0.01	0.548
NG landlords	1.23	1.51	0.812	-0.04	-0.01	0.478

Table 5 reports the mean and median cev_i, as well as the proportion of households who prefer the redistribution (second column) and rental assistance experiments (third column). With the removal of negative gearing and redistribution, there is an average welfare gain of 1.83 per cent and 96 per cent of households gain. The welfare gain is smaller for the rental assistance case, in which the mean cev_i is 0.75 per cent and 72 per cent of surviving households experience a welfare gain.

The welfare effects vary across households who are heterogeneous in age, income, and wealth. First we present the welfare effects by initial housing tenure in Table 6. The second column shows that with redistribution, renters and owner-occupiers experience larger welfare gains than landlords. Furthermore, negatively geared landlords gain the least. Renters and owner-occupiers are the least likely to benefit from investment housing tax concessions. As a result, the mean cev_i for these groups are between 0.2 to 0.5 percentage points higher than that of landlords and negatively geared landlords.

The majority of landlords, even those who were negatively geared, experience an expected welfare gain with the removal of negative gearing and increased redistribution. Although landlords no longer receive tax concessions for housing investment losses, they are compensated with higher rental receipts and transfer payments. This is verified by examining the welfare effects for the rental assistance case. The last three columns of Table 6 show that about 55 per cent of landlords experience a welfare gain and the mean cev_i is essentially zero. Moreover, the majority of landlords who were negatively geared lose after the policy reform with an average welfare loss of 0.04 per cent.

The welfare effects by age, income and wealth are reported in Table 7. With redis-

Table 7: Welfare over transition: by initial age, income and wealth

	Redistribution			**Rental assistance**		
	Mean	Median	$P(cev_i > 0)$	Mean	Median	$P(cev_i > 0)$
Initial Age cohort						
35 or under	1.62	1.51	0.986	1.40	1.62	0.948
36–65	2.08	2.19	0.977	0.67	0.34	0.733
66 or above	1.46	1.59	0.916	0.16	-0.37	0.396
Initial income						
Bottom 20%	1.66	1.69	0.944	1.71	2.38	0.724
Middle (21-79%)	1.92	2.09	0.976	0.72	0.49	0.699
Top 20%	1.70	1.93	0.954	0.22	0.37	0.827
Initial wealth						
Bottom 20%	1.68	1.46	0.998	1.90	1.72	0.998
Middle (21-79%)	1.92	2.09	0.963	0.52	0.25	0.651
Top 20%	1.71	1.85	0.938	0.35	0.54	0.684

tribution, households aged between 36 and 65 benefit the most from the policy change with an average welfare gain of 2.08 percent. The welfare gain for older households (66 or above) is smaller (1.46 per cent) because the fall in house prices leads to a decrease in their asset values and they are less likely to increase their housing size. However, we do not find much heterogeneity across income and wealth although households in the middle of the income and wealth distribution benefit slightly more than other groups.

The welfare gains are more heterogeneous with rental assistance. Across age groups, households under 35 experience the largest welfare gain as the majority of these households are renters. In contrast, many households who are over 65 are worse off. More than 60 per cent lose and the median *cev* is -0.37 per cent. As these households are closer to the end of their life-cycle, the fall in house prices has a negative impact on their lifetime utility. Looking at income and wealth, households in the bottom 20 percentile benefit the most since a typical renter would be a low income and low wealth household. As negatively geared landlords tend to have higher income and wealth, the welfare gains decreases with income and wealth.

Finally, we examine the welfare effects by initial age and income based on housing tenure. Figure 10 illustrates the mean cev_i by age on the left panel and by income on the right panel for the redistribution case. As illustrated in the left panel, younger landlords are relatively worse off. Most of these landlords are highly leveraged and therefore gained the most from negative gearing. On the other hand, renters in the middle age group have the largest welfare gain. This subset of households benefit the most from the larger transfer payment and lower house prices, which helps them to become homeowners. The right panel in Figure 10 shows that the gain for landlords is negatively related to income. This follows from the fact that negative gearing provides

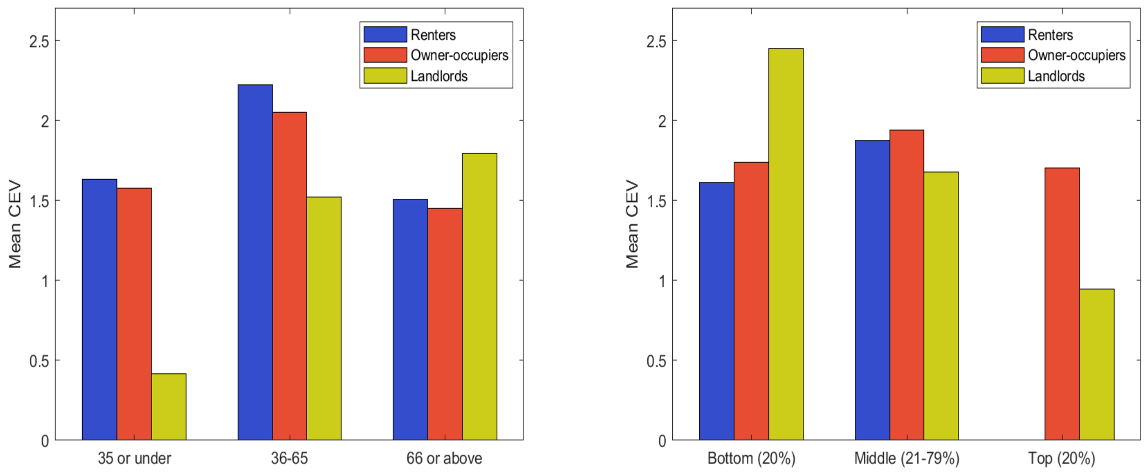

Figure 10: Mean cev_i by age (left) and income (right): Redistribution

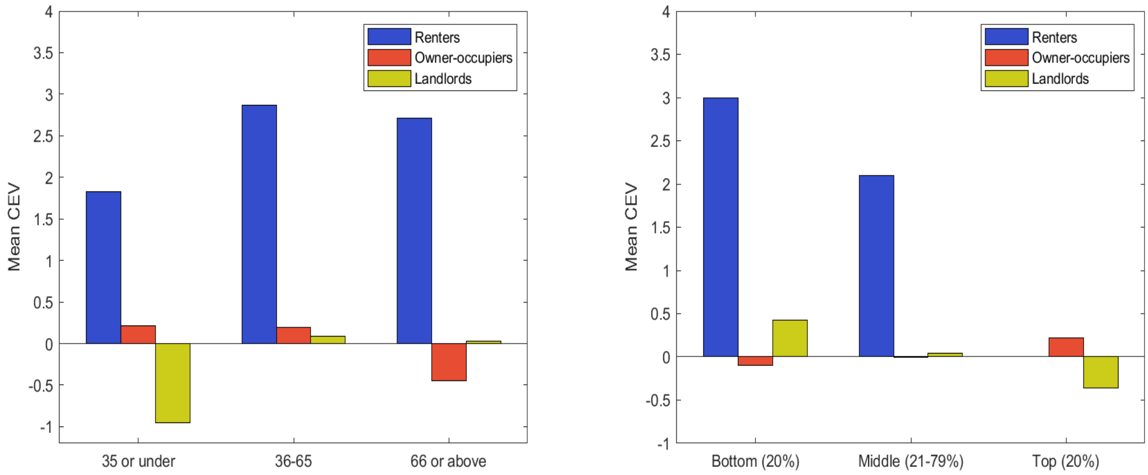

Figure 11: Mean cev_i by age (left) and income (right): Rental assistance

greater benefits for those on higher marginal tax rates.

Figure 11 displays the mean cev_i by age and income across the different housing tenure status for the case of rental assistance. Landlords less than 35 years of age lose; these younger landlords are typically negatively geared (as shown in Figure 5). We also find that older owner-occupiers suffer as the price of their housing asset decreases and they are unlikely to increase their housing size. Examining income, we find that high income landlords with the greatest incentive to be negatively geared experience the largest welfare loss. Taken together, Figures 10 and 11 suggest that younger and higher income landlords are hurt the most from the unexpected removal of negative gearing.

6 Conclusion

Subsidizing the supply of rental properties by providing tax concessions to landlords is a common housing policy in many economies. In this paper, we build a general equilibrium overlapping generations model to analyze and quantify the effects of negating gearing – a tax concession that allows landlords to deduct housing investment losses from their gross income – on house prices, rents, allocations as well as welfare for the Australian economy.

Across steady states, repealing negative gearing decreases house prices and increases rents, thereby raising the homeownership rate. The policy change significantly reduces housing investments, especially by younger landlords and higher income landlords as they are the households that gain the most from negative gearing. Overall, welfare improves when negative gearing is eliminated. Measured by ex-ante consumption equivalent variation, welfare increases by 1.7 per cent. The key mechanism for the welfare gains is redistribution of additional government revenue. When there is no redistribution, removing negative gearing would result in a welfare loss.

Examining transition dynamics, most households gain from the unexpected removal of negative gearing. Again, the greater tax revenue and scope for redistribution plays a key role in driving welfare gains. Younger landlords and landlords with higher income benefit the least from the policy change, whilst middle-aged renters and lower income landlords benefit the most. Fewer households benefit from the policy change when additional government revenue is distributed only to renters. Younger landlords, landlords with higher income, and older owner-occupiers are all hurt by the policy change.

There are a number of potential extensions to this paper. First, the current model focuses on a stationary equilibrium where ex-ante capital gains on housing are absent. Given the recent long boom in the Australian housing market, it may be natural to relax this assumption and consider environments with growth in housing prices, which can be an important consideration in housing investment decisions. The challenge with this extension is that it removes stationarity from the household decision making process. Second, our paper discusses the implications of a complete removal of negative gearing. It would be interesting to examine the impact of some partial reforms of negative gearing recently debated in the Australian political context – such as allowing negative gearing to continue for newly constructed dwellings, or to allow landlords to negatively gear existing investment properties but to eliminate negative gearing concessions on investment properties purchased in the future.

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