The long term effects of capital gains taxes in New Zealand

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Abstract

This paper develops a model of the housing market incorporating a construction sector, a rental sector, and a housing demand sector to examine the long term consequences for the housing market of different types of capital gains taxes. The sector is based on an overlapping generations model of the economy that included a detailed representation of the credit constraints and tax regulations affecting households. The model suggests that capital gains taxes will raise rents, increase homeownership rates, rebalance the housing stock towards smaller houses, and increase the net foreign asset position. The implications for welfare are much less clear, however, particularly for young low income households that will face higher rents.

1. Introduction

This paper develops a model that analyses the long term effects on the New Zealand housing market of introducing a capital gains tax on residential property. The model is an extension of the model developed by Coleman (2008) that analysed how the interaction of inflation with the existing New Zealand tax system distorted housing choices, even when the inflation rate was relatively modest. That paper argued that because the inflation component of interest income is taxed but capital gains are not taxed, and because young households face binding credit constraints whose effects intensify as the inflation rate increases, even 2 – 3 percent inflation rates may significantly delay home ownership, lower homeownership rates and reduce economic welfare. The paper also argued that most of the welfare losses stemming from the interaction of inflation and the tax system could be ameliorated either by reducing the inflation rate to zero, rather than 2 – 3 percent, or by exempting the inflation component of interest income from income tax. This paper assesses the welfare consequences of introducing a tax on residential property capital gains, either on landlords or on both landlords and homeowners.

The model is a version of the overlapping generations lifecycle model pioneered by Modigliani and Brumberg (1980), and adapted to analyse housing issues by Ortalo-Magné and Rady (1998, 2006). It is deliberately complex to capture the key features of the factors that affect how people make housing choices. At the heart of the model is a dynamic, forward looking maximization problem in which agents, who differ by income, age, and wealth, make choices about the type of housing in which they live, how much they consume and save, and how much they borrow and lend. These agents have choices over whether to rent or buy, to live in large or small houses, or to share housing with other people. They face realistic bank imposed constraints on the amount they can borrow and the repayment schedule they face if they a purchase a house, and they face a tax system that closely reflects that prevailing in New Zealand. Particular attention is paid to the various ways that capital income, including housing income, is taxed and how these taxes differ according to whether one is an owner-occupier of housing or a landlord. House prices and rents are determined endogenously in the model, and reflect the interaction of the decisions to supply or demand housing by households, landlords, and a construction sector. The model calculates dynamic steady-state paths for house prices and rents, and a set of equilibrium housing supply and demand patterns that depend on fundamental parameters such as interest rates, construction sector supply elasticities, the inflation rate, and the particulars of the tax system. The paper examines how these prices and demand patterns change as

taxes and the inflation rate change, and uses these results to evaluate the consequences of different possible tax systems.
The paper examines the effects of four variants of a capital gains tax regime. Two of these are accruals based tax systems that treat capital gains as income and taxes these gains at a household's marginal income tax rates, while the other two impose a flat rate tax on capital gains. The regimes also differ according to whether owner-occupied housing is taxed or exempt. Many of the results are similar, although there are important differences, particularly in the amount of revenue that is raised by the tax. In general, when the inflation rate is moderate, capital gains taxes lead to an increase in rents, an increase in the home-ownership rate, a small reduction in number of large houses in the economy, and an increase in the net foreign asset position. The effects on economic welfare are ambiguous, however, for many low-income households will suffer a welfare loss from the increase in rents. The simulations suggests the welfare consequences will be worse for low income households if owner-occupied housing is exempt from the tax, although this result is dependent on the revenue from a capital gains tax being refunded to low income households (and all other households) through a reduction in the GST rate.

The primary purpose of the paper is to explore the possible economic consequences of different types of taxes, not to make a recommendation as to their desirability or practicality. Nonetheless, the paper notes that the welfare consequences of a capital gains tax applied to all households are similar to the welfare consequences of a flat rate property tax. Similarity, the welfare consequences of a capital gains tax that exempts owner-occupied housing are similar to the welfare consequences of a tax system that exempts the inflation component of interest income from income tax. Both of these alternative tax regimes may be easier to implement than a capital gains tax. Consequently, it may be possible to devise alternative tax regimes that have similar effects to a capital gains tax without some of their perceived adverse consequences.

The paper is organized as follows. Section 2 outlines the structure of the model. (The technical details of the model are contained in a lengthy appendix.) Section 3 discusses the results of the simulations, beginning with an exploration of the welfare consequences of the effects of inflation on the housing market, and concluding with a discussion of the welfare consequences of different capital gains tax system. Conclusions are offered in section 4.

2. An intergenerational model of housing demand

2.1 The basic framework

The model is an extension of the model used by Coleman (2008) to analyse the effect of inflation, credit constraints and the New Zealand tax system on the housing market. In turn, it is based on the overlapping generations housing model of Ortalo-Magné and Rady (1998, 2006). The details of the model are described in the appendix, but the basic structure of the model is straightforward. It has four key parts: the demand for housing (both rental and owner-occupied); the supply of rental housing; and the total supply of housing.

The demand for housing is based on an intertemporal utility maximisation model of consumer demand applied to a large number of agents who differ by age, income, and wealth. In the model, there are four cohorts each containing 400 agents, with each agent passing through four distinct stages (two young stages, one middle-aged stage, and one stage in retirement) before dying. The agents have different exogenously determined labour income, which follows a life-cycle pattern. The agents consume a single non-storable good, pay tax, save for retirement, and have choices over different types of housing at each stage of their lives – whether they share housing with other agents, rent a small house (an apartment), buy a small house or buy a large house. The agents choose their most preferred housing options, given their age, wealth and after-tax incomes, the cost of renting or buying different houses (including interest charges), and their ability to raise a mortgage. Agents can borrow or lend at exogenously determined interest rates, although young agents face bank imposed credit constraints limiting the amount they can borrow. In the last period of life agents consume all wealth except their house, which is inherited by a younger generation.

The model is dynamic and house prices and rents can change through time. Indeed, when choosing their housing options agents take into account both the rate at which house prices appreciate and the tax treatment on any capital gains that they make. Strictly speaking, in the model every housing price or rent comprises two parts: a price level at some base period ($t = 0$); and a price (or rent) appreciation rate. The model calculates the rate of property price appreciation as part of the process by which it calculates equilibrium prices; while it is normally the general inflation rate, it does not need to be.

Agents are assumed to be forward looking, so when they choose housing in a particular period they take into account their remaining length of life, their future income stream, and their future housing patterns. Consequently, when choosing housing in their first period, a young person takes into account not only their current income, current house prices, and interest rates and rents, but the fact that their income is likely to rise as they get older and more experienced, that they are likely to want a larger house when they have more money in the future, and that houses are likely to get more expensive. The model includes a careful representation of the conditions imposed by banks on those obtaining mortgage finance to purchase a house, including realistic constraints on the minimum deposit and the maximum mortgage-repayment to income ratio. These constraints mean that young households may choose to rent rather buy a house when inflation and nominal interest rates are high, because they cannot obtain suitable financing.

The utility maximisation model generates housing demand for each of the agents during each of their stages of life, for a given set of rent and house price paths. These different housing demand functions are then aggregated together so that the total demand for housing can be calculated. The resulting aggregate demand functions describe how the demand to rent, the demand for small houses, and the demand for large houses varies as a function of the rent and the price of each type of house, as well as all the basic parameters of the model such as income, interest rates, and tax rates.

There is a supply of rental accommodation because agents can become landlords. It is assumed that entry into the rental sector is competitive, so landlords bid for houses and set rents at levels that leave them indifferent between the after-tax returns from lending money and the after-tax returns from investing in residential property. Particular care has been taken to ensure that taxes in the model replicate the taxes currently imposed on housing in New Zealand. If house prices increase over time, a capital gains tax will lower returns to landlords, and, for a given level of house prices, rents will be higher than they would otherwise have been.

Prices are determined endogenously in the model by equating the total demand for different types of houses with the supply of different types of houses. Cost functions describing the costs of building large and small houses are specified exogenously in the model, and can take any form. In this model, I focus on the case that there are separate upward sloping supply curves for the quantity of large and small houses, each with approximately unit elasticities. This elasticity is broadly consistent with the long run increase in prices and the growth of the housing stock in New Zealand as the population has increased. I examine two different parameterisations reflecting the cases that house prices are relatively high or relatively low in comparison to income because of high or low construction costs. Several other combinations of supply elasticities have also been analysed, including the cases when the supply of both classes of houses are either perfectly elastic or perfectly inelastic, and the case that the supply of small houses is elastic but the supply of large houses is inelastic.

The essential difficulty of finding a solution to the model is to find a set of prices that equates the aggregate demand for different types of housing with the aggregate supply of these types of housing. The prices are solved using a complex numerical routine that keeps choosing a new set of prices and then calculating the demand for each of the 1600 different households until a set is found at which aggregate demand equals aggregate supply. For this equilibrium set of prices, overall demand patterns are calculated.

As Coleman and Scobie (2009) argue, the effect of taxes, inflation, and interest rates on the housing market depend on a few crucial elasticities including (i) the elasticity of the total supply of houses to the price of houses (the elasticity of the supply of housing); (ii) the elasticity of the supply of rental housing with respect to rents; (iii) the elasticity of the demand for rental housing with respect to rents and the prices of houses; and (iv) the elasticity of the total demand for housing with respect to rents and the price of houses. The elasticity of the supply of housing with respect to prices is 1 in the main versions of the model discussed below, but the results have also been analysed when this elasticity is near zero or very large. The supply of rental housing is perfectly elastic with respect to rent, because landlords are assumed to be perfectly competitive and to supply rental housing until the long run after-tax return on rental accommodation is equal to the after-tax return on interest income. The demand elasticities are not directly imposed, but are implicitly derived from the consumer maximization problem and depend on the basic parameters in the model. These elasticities can have a major effect on the model's results and warrant further discussion.

The elasticity of the demand for rental accommodation to housing rentals and the prices of houses is a measure of the extent to which households are prepared to substitute between renting and home-ownership. This will depend on the relative utility households get from sharing, renting, or owning a house. These parameters are explicitly specified in the model; typically, households are assumed to gain less utility from renting rather than owning, because they can shape an owned house in their own image, and less utility from living in shared accommodation than living by themselves. The substitutability between rental and owned accommodation will be greater the smaller the differences between renting and owning. The more willing households are to substitute between rented and owned housing, the less will be the utility loss from various housing market imperfections or policy interventions.

The elasticity of total housing demand with respect to house prices or rents measures the extent to which households "squeeze" together as prices change, by choosing to share rather than living alone. Typically this "squeezing" takes place through household formation, as adult children leave home, or as young adults decide to live by themselves rather than share with a group of others. This elasticity is important as it is the only mechanism by which total housing demand can be altered. The more willing are households to share with others, the smaller are the price changes necessary to equilibriate the housing market.

This paper departs from the earlier work by Ortalo-Magne and Rady (2006) and Coleman (2008) by introducing a mechanism to substantially increase this elasticity. In these earlier papers, the only way households could share was for the youngest households to remain at home with their parents. In this paper, the youngest two cohorts can share by renting half a house. If they do so, they pay half the rent and obtain utility which, while less than the utility of a whole rented house, can either be greater than or less than half the utility of a rented house. This option proves to be an attractive option to many households, particularly to those with low incomes or steep life cycle earnings. Because it is attractive, the elasticity of total demand with respect to both rent and house prices is much higher than in these earlier papers. As a result, smaller price changes are needed to induce changes in total housing demand than in these earlier papers, and the welfare changes of policy interventions are smaller.

The model analyses the way households climb a "housing ladder" over the course of their lives. In large part their ascent can be characterised by two factors: the ultimate height they reach and the speed that they attain that height. The ultimate height is largely determined by the ratio of life-time income to the user-cost of housing: people with higher life-time incomes will be able to afford larger houses than people with low lifetime income. In the parameterisations studied a majority of people choose a large house in middle age, partly because the tax system favours home ownership as imputed rent is not taxed. The speed of ascent is determined by the steepness of the earnings profile, interest rates and the availability of credit from banks, and the tax incentives facing both households and property investors. In equilibrium, the mix of small and large houses in the economy is determined both by the length of time spent climbing the housing ladder and the peak rung a household attains. Policies that extend the length of time climbing the housing ladder do not necessarily reduce the demand for large houses, however, for an agent can use the money saved by living in a small house while young to live for longer in a large house while old.

3. The effect of capital gains taxes.

When the inflation rate is positive, income from interest paying assets is taxed more heavily than income from other forms of capital assets because the inflation component of nominal interest payments is taxed, while capital gains are not. The asymmetry of this treatment means that the tax system generates an incentive for agents to borrow and invest in assets that appreciate over time. There is concern among some policy makers that this distortion is inducing agents to invest too heavily in residential housing assets, either by buying a larger house than would otherwise be purchased or by becoming a landlord. In addition, there is concern the tax incentives favouring investment in residential property are lowering home ownership rates among younger and lower income agents. One potential solution would be to reduce the asymmetrical tax treatment by exempting the inflation component of interest income from income tax, on the basis that it is not actually real income. Another potential solution would be to impose a capital gains tax on residential property and other assets.

Capital gains taxes can take a variety of forms. The main capital gains tax that is examined in this paper is one that that treats capital gains as income, and taxes these gains at a taxpayer's marginal income tax rate. The tax could be applied to all assets including residential housing, or owner-occupied housing could be exempt. The first capital gains tax regime examined in this paper is one in which capital gains are taxed as income but owner-occupied housing is exempt. As landlords are higher income, middle aged agents, the tax rate is ordinarily the top marginal tax rate, 33 percent[1] [2]. Other capital gains tax regimes are also considered. A second regime is similar to the first, in that capital gains are taxed as income at the standard marginal tax rates of 20 or 33 percent, but in this case owner-occupied housing is taxed. A third regime is a flat rate capital gains tax of 20 percent, with an exemption for owner-occupied housing. This tax scheme is similar to that that operates in the United States of

[1] In the model, the marginal landlord is assumed to have a 33 percent tax rate, so this tax rate is used to calculate the relationship between rents and house prices. Each landlord pays tax at their own individual tax rates, however. It is assumed that landlords own 2 rental properties, and that the highest income agents become landlords first. Thus if there were 100 rental houses, the 50 highest income middle-aged agents are landlords. If the number of rental houses is very high, some landlords will have a top marginal tax rate of 20 percent.

[2] The top marginal tax rate in New Zealand is currently 38 percent, although it was 33 before 2000. However, most landlords could choose to put a leased property in a trust which is only taxed at 33 percent. I have chosen to solve the model for a top marginal tax rate of 33 percent in part because this rate is often seen as a goal by political parties, and in part because of the way landlords can use trusts.

America. The fourth regime is similar, except all housing including owner-occupied housing is liable to a flat capital gains tax of 20 percent.

The results when the capital gains of owner-occupied housing are taxed are conceptually problematic. Almost no countries apply capital gains taxes to owner-occupied housing, for a variety of economic and political reasons. One of the economic reasons is that these taxes are usually only imposed on realised gains when a house is sold, a rule that would deter households from moving from one location to another, perhaps in response to work opportunities. Another reason concerns the financial hardship such a tax could cause when a household dissolves, perhaps because of divorce. These negative effects, which may have first order welfare consequences, cannot be modelled in this paper and are thus ignored. To avoid these sorts of issues, the versions of the model that examine the effect of a capital gains tax applied without an exemption for owner-occupied housing assume that the tax is imposed on an accruals basis: that is, the household is liable for capital gains tax each year, whether or not it is realised through the sale of the house. These results are used to provide a reference case for the effect of a capital gains tax.

The rate of property price inflation is an outcome of the model. In the model, property prices increase in real terms over time when there is population or income growth, unless the supply of housing is perfectly elastic. In the parameterisations considered in this paper, however, there is neither income growth nor population growth and so property prices increase at the inflation rate. In these circumstances a capital gains tax only taxes the increase in nominal housing wealth that is due to the debasement of the currency through inflation. Consequently, in the results presented below a capital gains tax reduces the distortion that arises from the asymmetrical taxation of interest income and other assets. Nonetheless, the tax system remains non-neutral with respect to the inflation rate because tax rates on real capital income are an increasing function of the inflation rate unless the inflation component of interest income is tax exempt.

The revenue raised by taxing capital income and/or capital gains depend on both the tax rates and the inflation rate. In the model, any additional revenue raised from changes in the tax system or changes in the inflation rate are refunded through a change in the Goods and Services tax rate. Consequently, the amount of tax raised is invariant to the tax system.

3.1 The effect of inflation.
Inflation has three major effects on the housing market. First, it increases the rate at which property prices increase in nominal terms, generating nominal capital gains for the owners. Since the New Zealand government taxes nominal interest earnings rather than real interest earnings, there is an incentive for owners of capital to invest in residential housing when the inflation rate is high. This incentive applies to both landlords and owner-occupiers, so by itself inflation does not necessarily lead to a decline in the home-ownership rate, although it may lead to over investment in residential housing.
Secondly, inflation may lead to a reduction in nominal rents. This is because (i) real returns from interest earning assets decline as the inflation rate increases because the inflation component of interest income is taxed, and (ii) landlords get a portion of their return as capital appreciation, and are prepared to pay more for houses or to accept less rent in order to become landlords. The balance between lower rents and higher prices will depend on the interaction of the demand and supply sides of the economy. When the supply side is relatively elastic, so that the amount property prices can increase is limited by the construction of new housing, rents will tend to fall.

Thirdly, inflation exacerbates the credit constraints facing agents who borrow to buy houses. This is because bank imposed restrictions on the amount households can borrow are rarely adjusted for inflation, even though nominal interest rates increase when the inflation rate rises. If banks do not increase the amount credit-constrained households can borrow when nominal debt servicing payments increase, it becomes more difficult for these households to purchase houses (Modigliani (1976); Kearl (1979)). In addition, if rents fall, inflation makes it attractive for young, credit constrained agents to rent rather than purchase and home ownership rates are likely to decline.

Tables 1a and 1b show how inflation affects long term housing market outcomes in the model. It shows the equilibrium outcomes when the supply of housing is elastic and construction costs are either high or low. Each table shows how prices and rents, the number of houses, the fraction of people owning, and the steady-state level of net financial assets vary with the inflation rate. Note the fraction of agents renting and the fraction of houses being leased are different, because most of the young agents that rent choose to share with others.

In both of these cases, a 2 percent increase in the inflation rate leads to a 6 percent reduction in rents, a 0.8% reduction in the number of houses in the economy, a 3-4 percentage point increase in the fraction of the population renting, and a 2-3 percentage increase in the fraction of the housing stock that is owned by landlords and leased. The fraction of the population renting reflects an increase in renting at all ages. In both cases, the housing stock declines because of a reduction in the number of small houses. This reduction occurs because the combination of falling rents and tighter credit constraints induces more young households to share, reducing aggregate demand for housing. The effect on the number of large houses in the economy differs in the two cases. When construction prices are high, and large houses are expensive, rising inflation increases the total demand for large houses. This increase in demand occurs despite falling demand for large houses among younger cohorts because of the effect of tighter credit constraints: there is an offsetting increase in the demand for large houses by older households, because of the additional tax advantages of using a house as a saving vehicle rather than accumulating interest earning assets. However, when construction costs are low, most people who want to live in a large house can afford to do so for most of their lives, and inflation has a very small effect on the quantity of large houses.

These results are subtly different than those reported in Coleman (2008). In that version of the model, the only mechanism for household formation and dissolution to affect the total number of households was through variation in the number of adult children who lived with their parents. In that case, a decline in rent attracted children out of the parental home and led to increase in the total demand for housing. In this model, household formation and dissolution occurs through the process of sharing with others. In this case a decline in rents could either lead to an increase in the total demand for housing, as agents decide to stop sharing and rent by themselves, or a reduction in the total demand for housing, as agents decide to stop owning, and rent shared accommodation instead. In the parameterisations studied in this paper, the latter effect dominates, so that total housing demand decreases as inflation increases, credit constraints intensify, and rents decline[3] [4].

[3] Whether or not sharing is attractive will depend on the relative utility of sharing compared to renting a whole house. The model was solved for several different parameterisations in which the utility from sharing half a house was either less than or more than half the utility from renting a whole house. In all of the parameterisations analysed, an increase in inflation led to a decline in the total housing stock.

[4] In future versions of the paper, it is planned to allow both mechanisms to occur: that is, household formation and dissolution can take place either through children adjusting the time they move out of the parental home, or by choosing to share with others. Currently only one option or the other has been allowed.

The welfare effects of inflation

In keeping with earlier work by Modigliani (1976), Kearl (1979), and Feldstein (1996,1997) among others, Coleman (2008) argued inflation had an adverse effect on the welfare of many but not all households in his model. He identified three main effects. First, inflation reduced the after-tax returns from interest earning assets, and thus distorted intertemporal choices. Secondly, inflation worsened the effect of credit constraints on many of those wanting to own a house, delaying the time before they could buy a house or upgrade to a larger one without suffering very low consumption. These two effects tended to lower the welfare of middle-income and higher-income agents. Offsetting these effects was an increase in the welfare of agents who rent, typically agents with low life-time income, because of the decline in rents that occurs when landlords obtain a fraction of their total return as capital gains.

Inflation has a large effect on young people because almost all people would increase their utility if they could borrow more when young, either to smooth consumption in the face of rising life-cycle income, or to buy a house, or both. They do not borrow because in the model (and in reality) banks only make collateral backed loans. In this environment, inflation has ambiguous effects on welfare. Those agents who rent benefit from inflation, because it lowers the rent they pay and enables them to spend more while young than they otherwise could. (Note that this effect occurs because the inflation component of interest income is taxed, so that when the inflation rate is positive the real after-tax interest rate declines, lowering the required return on capital and leading to a decline in rents.) In contrast, those agents who wish to purchase a house find inflation tightens credit constraints, because nominal interest rates increase and banks do not change their lending terms and conditions to make an allowance for the way inflation reduces the real value of the nominal outstanding debt. This makes it more difficult for the agents whose real incomes increase over time to smooth consumption, for they have to lower consumption to make higher nominal interest payments if they purchase a house.

Whether inflation causes welfare losses or improvements on average depends on the relative size of the populations that rent and own when young. In turn, this depends on the ratio of house prices to incomes. When construction costs are high, a large fraction of young people will wish to share accommodation with others rather than live in a house alone. In this case inflation increases their welfare, because it reduces the negative effects of borrowing constraints that prevent them from smoothing their consumption through time. When construction costs are lower, or social norms make it normal for young adults to either live with family or live by themselves, inflation lowers welfare by making it harder for young agents to buy their first homes. In the parameterisations analysed in this paper, inflation is on balance welfare enhancing because there are more agents who benefit from lower rents than there are agents who suffer from higher interest payments at the start of the mortgage. In Coleman (2008), the latter effect dominated, so inflation lowered welfare for most people. This difference reflects two sets of parameter changes: the current model allows agents to share housing with each other, rather than just their parents; and it has a higher house price to income ratio, which makes reduces the attractiveness of home ownership at young ages even when the inflation rate is zero. In the real world, which of these two competing effects dominates is an empirical matter. The answer will depend in part on the social mores and conventions of society, particularly the acceptability of sharing housing with non-family members.

Inflation causes one additional welfare effect in the model: it changes the equilibrium number of houses and house prices, which changes the user costs of housing. If inflation leads to an increase in total housing demand, because lower rents entice adult children to leave home earlier, house prices will rise. This tends to lower the welfare of *other* agents, because the user cost of housing rises and these agents have less to spend on other goods[5]. This effect is an example of the negative pecuniary externality that occurs when agents disregard the effect of their actions on the prices paid by other members of the economy. In contrast, if total housing demand falls in response to inflation, house prices fall, and the welfare of other agents increases. In the parameterisations analysed in this paper, inflation lowers total housing demand, so there is a small positive pecuniary externality that improves the welfare of all agents because of lower house prices.

3.2 The effect of capital gains taxes on leased property.

Tables 2a and 2b show the long term effects of introducing capital gains taxes that exempt owner-occupied housing when the inflation rate is 2 percent. The tables show the steady-state values of various aspects of the housing market under current tax regulations, and then shows how these change when either capital gains are treated as income and taxed at the appropriate 20 percent or 33 percent marginal tax rate or a flat rate 20 percent capital gains tax is introduced. Note that because most landlords are high income middle aged agents, the former scheme is effectively a flat rate capital gains tax with a 33

[5] Annual consumption falls by approximately the real interest rate multiplied by the additional housing cost. The higher house prices also lower the equilibrium net foreign asset position.

percent tax. Table 2a shows the case when the supply of housing is elastic, and construction costs are high, while table 2b shows the case when construction costs are low. In each case, property appreciates at the inflation rate as in the model there is neither income nor population growth. (Consequently, when the inflation rate is zero a capital gains tax has no effect.). The tables also show what would happen if, rather than introducing a capital gains tax, the inflation component of interest income were exempted from income tax.

3.2.1Taxing capital gains on leased property as income at (20%, 33%) marginal rates

The first effect of the (20%, 33%) capital gains tax is to increase rents by approximately $1300 or 11 percent (table 2a).This increase occurs because when the inflation rate is 2 percent, and small house prices are $225000, the capital gain is $4500; if the landlord has to pay 33 percent of this sum in capital gains tax, the rent has to be raised to enable to make the same after tax return as investing in interest earning assets[6]. There is also a small increase in house prices, by 0.6 – 0.8 percent. As there is only a small change in property prices, the increase in rents makes renting less attractive, and there is a substantial reduction in the fraction of agents that rent. As households cease sharing rental accommodation and purchase and live in a house by themselves, the total demand for property increases.

The decline in renting depends on the level of house prices, but is most noticeable among older households. Amongst younger (cohort 0 and cohort 1) households, there is only a modest decrease in renting, for while rents increase, credit constraints are sufficiently tight when the inflation rate is 2 percent and real interest rates are 5 percent that renting is still more attractive to most low income agents than home ownership, particularly as most of these agent share rental housing and thus only experience half of the rent increase. In both tables 2a and 2b, 2.5 – 3.5 percent of cohort 0 and cohort 1 cease renting. In contrast, in both models the rent increase completely curtails the rental market of middle-aged and retired households: in table 2a, the fraction of middle aged agents renting declines from 10 percent to nothing, while it table 2b it declines from 3.5 percent to nothing. This is because the capital gains tax drives a wedge between the long run cost of owning and renting, raising the cost of

[6] The $1300 increase in rent is not exactly equal to 0.33* $4500 for two reasons. First, in the model the timing convention is that the landlord is paid rent and pays income tax at the start of the period, but pays capital gains tax at the end of the period. The after-income-tax value of the $1300 rent increase is invested for the length of the period (in this case 12.5 years); in this case the extra interest is approximately the same value as the income tax paid. Secondly, property prices increase by approximately 1 percent once the CGT is introduced, leading to a 1% or $100 increase in rents.

renting above the cost of owning as landlords but not owner-occupiers have to pay capital gains tax. The total effect of the capital gains tax on the rental market therefore depends on the number of people initially renting, which depends in turn on construction costs and house prices. When construction costs are high, the fraction of agents renting under the current tax system is large and a capital gains tax reduces the fraction of agents renting by over 6 percentage points; when they are low, fewer middle aged and older agents rent, and the capital gains tax only reduces the amount of renting by 3 percent. There is a corresponding reduction in the fraction in the housing stock that is rented in each case, by 6.2% and 2.6% respectively.

There are two other effects. First, the simulations suggest the capital gains tax has little effect on the GST rate, which declines by only 0.1 percentage points. This is partly because the capital gains tax significantly reduces the number of rental houses, and thus leads to a reduction in the income tax paid by landlords on their rental income. Secondly, the simulations suggest that there is a small increase in the net financial asset position of the economy. The amount is larger when construction costs are high rather than low, and reflects the increase in saving that occurs as some households switch from being life-time renters to middle-aged home-owners due to the increase in rents.

3.2.2 Taxing capital gains on leased property at a constant 20% rate

The tables also show what happens if the capital gains tax is applied at a flat 20 percent rate. The results are very similar to the case when capital gains are taxed at marginal income tax rates, except the effects are smaller as the average tax rate is 20 percent rather than 33 percent. For this reason, the increase in rents is only 60 percent as large, and there is a correspondingly smaller decrease in the fraction of agents that rent and the fraction of houses that are leased. The difference in the two tax rates is more noticeable when construction costs are high, because more people rent under the current tax regime in this case, and so large changes in the fraction renting are possible.

While the reduction in the GST rate is small in either case, when construction costs are high, more revenue is raised when the capital gains tax rate is a flat rate of 20 percent than when the rates are 20 and 33 percent. This is because the flat rate capital gains tax leads to a much small decline in renting. Nonetheless, the amount of tax raised under a flat rate capital gains tax is small when the inflation rate is moderate, and the reduction in GST is only 0.2 percent.

Results for other supply functions
The results for the case when the supply of small house is elastic (with high construction costs) but the supply of large houses is inelastic is very similar to the case when both the supply curves are elastic. Once again, the primary effect of the capital gains tax is to increase rents, reduce the fraction of the population that is renting and the fraction of the housing stock that is leased, and increase the total housing stock.

When the supply curve is completely inelastic, the results are a little different. Table 2c shows the results for the case that the supply curve is inelastic and prices are high, because of a shortage of houses. As before, introducing a capital gains tax leads to an increase in rents, a reduction in the number of people renting, particularly amongst those who are middle aged or retired, and a reduction in the fraction of the housing stock that is leased. By assumption, there is no change in the number of houses. However, the model indicates house prices increase quite sharply, by 4 or 5 percent. This house price increase is needed to reduce the total demand for housing, because in the model an increase in rents without an increase in house prices leads to a reduction in shared renting in favour of home ownership. The only way to reduce the total demand for housing is to raise house prices, and make it attractive to share. When the supply of housing is elastic, this mechanism is not necessary. If a rise in rents lead to a reduction in total demand, because some young agents responded to the increase in rents by moving back to their parent's home, a capital gains tax could lead to a fall in house prices as well as an increase in rents. Consequently, the way prices would behave in New Zealand if a capital gains tax were introduced will depend on the size of the elasticity of total demand for housing to rent.

3.2.3 Exempting the inflation component of interest from income tax.
Coleman (2008) argued that the adverse effects that the interaction of inflation and the tax system have on the housing market could be solved by exempting the inflation component of interest income from income tax. This argument, which can be traced back to Viner (1926), is based on the principle that the inflation component of interest income is not income, and thus should not be taxed as such; rather it is merely a compensation to the lender for the loss of purchasing power caused by the debasement of the currency. Coleman argued that by exempting the inflation component of interest income from tax, and by only allowing the deduction of real rather than nominal interest payments, landlords would have less incentive to enter the property market when the inflation rate was positive, raising rents and home ownership rates.

Tables 2a – 2c show what would happen in this model if, instead of imposing a capital gains tax, the inflation component of interest income were exempted from tax. In terms of the effects on rents, prices, and home ownership rates, the results are very similar to what happens if a flat 20 percent capital gains tax regime were applied to landlords in all of the housing supply versions considered. There are two differences, however. Because tax revenue declines slightly when the inflation component of interest income is exempted from income tax, the GST rate has to be increased slightly, rather than cut. The increase is always less than 0.2 percentage points, however, partly because the loss of tax on interest income is offset by a reduction in the deductions allowable against rental income. Secondly, there is a larger increase in the net financial asset position than in either of the capital gains tax regimes considered. This is because exempting the inflation component of interest income from tax raises after tax real interest rates when there is inflation, encouraging saving and capital accumulation among working age agents[7]. Since a capital gains tax does not affect after tax interest rates, after tax returns are higher when the inflation component of interest is tax exempt than when a capital gains tax is introduced, causing saving to rise.

3.2.4 The effect of an accrual capital gains regime applied to all agents

Table 3 shows what happens to the housing market if capital gains taxes are applied to all households on an accruals basis, either as a flat rate (20%) or at marginal income tax rates (20%, 33%), for the case that the housing supply is elastic and construction costs are high. The results for other housing supply parameters are qualitatively similar.

In the model, rents increase because of the capital gains tax. When the capital gains tax rate is a flat 20 percent, this increase in rents has little effect on the rental market, however, because owner-occupiers are also liable for capital gains tax on an accrual basis, so the cost of owning a housing rises by a similar amount. Consequently, there is only a minor decrease in renting. There is a significant switch from large houses to small houses, however, as the capital gains tax raises the user cost of large houses by more than the user cost of small houses. This reduces the demand for large houses at all ages. The substitution between large and small houses also occurs because of a sizeable drop in the GST rate that makes the consumption of goods relatively more

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[7] The model has a steady state saving rate of zero, as people run down the assets they accumulate while working when they are retired. However, even though the aggregate saving rate is zero, the economies net asset position increases when the saving rate among working age people increases.

attractive than the consumption of housing. The capital gains tax revenue is much larger when all households pay tax than when only landlords pay tax, allowing the GST rate to decline by over 2 percentage points rather than 0.2 percentage points when owner-occupied housing is exempt.

When capital gains are taxed as income at marginal income tax rates, there is a substantial decline in the number of middle-aged and retired households renting. This is because rents increase by an amount that is greater than the amount of capital gains tax that would be paid by low income renters, because most landlords pay tax at the high marginal tax rate. This means it is cheaper in the long term for low income households to purchase rather than rent. Indeed, the reduction in the number of households renting is similar as the case that owner-occupied housing is exempt from capital gains tax.

The results from this section are very similar to those that occur when a flat rate property tax are introduced, and are identical in the case that the capital gains tax is a flat rate tax. This is because in this model all property prices increase at the inflation rate, so a flat rate capital gains end up taxing houses at a rate that is proportional to value. Coleman and Grimes (2009) discuss the effects of introducing a property tax at greater length.

3.3 The welfare implications of capital gains taxes.

The above analysis suggests that capital gains taxes raise rents, increase home-ownership rates, cause a substitution towards smaller houses, and improve the net foreign asset position because they reduce the distortions caused by the interaction of inflation with the tax system. The welfare effects of these policies will depend on the way inflation affects welfare. As discussed in section 3.1, these depend will depend on whether the positive effects on credit-constrained renters outweigh the negative effects on credit-constrained owner-occupiers. In the parameterisations of the model analysed in this paper, the welfare losses to the renters exceed the benefits to the owners, for there are more young renters than young owners. In this case, a capital gains tax will tend to have negative welfare effects as it raises rents, although this need not be the case.

Figure 1 shows how different tax schemes affect lifetime welfare for people with different income levels when the supply of housing is elastic and construction costs are low. The figure shows the average change in utility for each income decile except the lowest. Three points stand out. First, a capital gains tax scheme that exempts owner-occupied housing has lower welfare than which does not. Secondly, the welfare changes associated with capital gains taxes that exempt owner-occupied housing are negative for most low and middle income people. Thirdly, the introduction of a capital gains tax that exempts owner-occupied housing has similar welfare consequences as the introduction of a capital gains scheme that exempts the inflation component of interest income from tax. These three results occurred in most of the parameterisations studied, even though the exact nature of the welfare changes depends on a number of factors such as the housing supply elasticites and they way people inherit property.

Several features of these results are of interest. First, the results for the capital gains tax without an exemption for owner-occupied housing are very similar to the results presented in Coleman and Grimes (2009) for the effects of a flat rate property tax. As discussed above, this is not surprising, for when the inflation rate is constant taxing capital gains on an accrual basis is like having a flat rate property tax. Since the welfare effects are similar, and since the effects on rents, prices, and home-ownership rates are similar, a flat rate property tax could be a substitute for a capital gains tax if it were believed the inflation rate would continue to be low and stable. Given the political difficulties of introducing a capital gains tax on owner-occupied residential housing in other countries, a flat rate property tax may be an attractive option.

Secondly, there are significant differences in the welfare properties of capital gains regimes that do or do not exempt owner-occupied housing, even though they have a similar effect on rents. The differences are caused by two factors. First, when owner-occupied housing is included, much more tax is collected and a sizeable cut in the GST rate is possible. This cut in the rate compensates young, low-income renters for the rise in rents they face, and leads directly to an improvement in their welfare. In addition, there is a reduction in the total demand for property, so house prices fall relative to the case that only landlords pay the tax. This leads to a reduction in the direct user cost of housing to all agents. This provides a gain to all agents in the economy except the first generation, who suffer a capital loss.

Thirdly, the introduction of a tax regime that exempts the inflation component of interest income from tax would have similar welfare properties as the introduction of a capital gains tax on leased residential property. Again, it may be politically easier to introduce such a tax regime than a capital gains tax.

The results for the first income decile have not been presented on the graph as they reflect some additional factors that concern the inheritance arrangements in the economy. The simulations suggest there would be large utility gains from a capital gains tax for many but not all of the lowest decile agents in the economy. This is because in these simulations it is assumed that the odd numbered agents receive no inheritance, but the even number agents receive a double inheritance corresponding to the houses of the two retired agents in the economy in the same position of the income distribution. In the model without capital gains taxes, most of these agents rent throughout their lives and thus neither leave an inheritance nor receive one. When the tax regime is changed, and renting becomes less attractive, many of these agents decide to buy a house, and bequeath it in old age. The logic of the model means they also inherit one or more houses, if they are an even numbered agent. Consequently, when the tax rules are changed in the economy, a fraction of the lowest decile agents are much better off. It turns out that this effect dominates the welfare calculations for the lowest income decile. While an effect like this could be an important long-term consequence of a society that moves to a higher owner-occupancy rate, I do not wish to emphasise it and thus have excluded the first decile in the diagram.

Figure 2 shows the welfare effects of different tax regimes when the supply of housing is elastic but construction costs are high. In general the results are similar, although in this case there is a downwards spike in the 6th decile that reflects the effect of inheritance arrangements. (In this case it reflects the change that occurs when people start inheriting large houses rather than smaller houses.) Once again, the welfare consequences of a capital gains tax that includes owner-occupiers are better than a tax that does not; the welfare consequences of capital gains tax regimes that exclude owner-occupiers are negative for low-income and middle-income agents in these parameterisations because the taxes increase rents; and the welfare consequences of capital gains taxes that exempt owner-occupiers are similar to the welfare consequences of tax regimes that exempt the interest component of interest income from tax. The welfare losses for low income agents are higher when construction costs are high, partly because more people rent but also because rents are higher and thus increases in rents cause more severe cuts in consumption.

4. Discussion and conclusions

This paper has explored some of the consequences of introducing a capital gains tax on residential property in New Zealand. It has done this in the context of a stylised model that attempts to understand the factors that determine housing market outcomes in the long term. The model focuses on three main factors: the cost of supplying new housing; the financial incentives facing landlords; and the tax and financial incentives facing households as they climb the housing ladder by choosing different housing options over the course of their lives.

In general terms, the model suggests that a capital gains tax will have the following effects: it will lead to an increase in rents; it will lead to a reduction in the number of people renting, and an increase in homeownership rates; it will lead to an increase in the net foreign asset position; and it will lead to a decline in the fraction of large houses in the economy. It is possible that homeownership rates could rise by several percent if a capital gains tax were introduced, with a similar sized increase in the net foreign asset position. The increase in rents and the increase in home-ownership rates will be larger if there is a difference in the capital gains tax rates that are typically applied to owner-occupied residential property and those applied to leased residential property, either because the former is specifically exempted from capital gains tax or because landlords typically have higher marginal capital gains tax rates than households who typically rent. If a capital gains tax were introduced without exemptions for owner-occupied housing, it could allow a sizeable reduction in the GST rate, but this is not true if it owner-occupied housing were tax-exempt.

Beyond these general outcomes, one of the main outcomes of the paper is the demonstration that the results depend a lot on the underlying structure of the economy. It matters whether the long run supply of housing is elastic or inelastic. It matters whether construction costs are high or low. It matters whether people prefer to own rather than rent, or vice versa. It matters whether young people respond to rent increases by staying longer in shared accommodation, or by deciding to buy a house themselves. Indeed, some of these factors matter so much that they substantially affect whether a capital gains tax is likely to increase welfare or reduce it.

It must be considered both a weakness and a strength of the modelling approach that it cannot be more definitive about the welfare effects of a capital gains tax. From a technical perspective, the weakness is clear: a model that delivers different answers when the housing choice set is structured differently makes it difficult to know whether the model's outcomes are robust or contrived. The strength is more subtle: the modelling approach suggests that the welfare effect of different policies depend a lot on several deep parameters in the models, suggesting empirical research on the nature of these parameters is important before policies are introduced.

The key issue underlying the whole paper is whether the effect of moderate inflation on the housing market largely lowers or improves welfare. In line with earlier work, this paper identifies two ways that inflation affects welfare. First, inflation makes it more difficult for people to purchase a house, or upgrade to a bigger house, because nominal interest rates increase and banks do not change their lending criteria to recognize the way inflation erodes the real value of the existing debt. This is the familiar issue of mortgage tilt, which lowers welfare (Modigliani, 1976.) Secondly, if interest earning assets are taxed more heavily than residential property when the inflation rate is positive, inflation will lead to lower rents because landlords get part of their return as lightly taxed capital gains. This improves the welfare of those who are credit constrained and rent. Whether the effect of inflation on the housing market improves or lowers welfare therefore depends on the fractions of the population who find it eases rather tightens the credit constraints they face. In this paper, I have focussed on parameterisations in which inflation raises welfare for many agents, while in earlier work I focused on the case that inflation lowered welfare. In practice, this is an empirical question, the answer of which will depend on the cost of housing and the way agents value renting and home-ownership. If, under the current tax system, inflation lowers rents and raises the welfare of many people, policies that counteract the effects of inflation on the housing market will tend to lower welfare. Conversely, if inflation mainly cause hardship among those who wish to borrow to purchase a house, a capital gains tax will raise welfare.

This paper has ignored many of the practical and political issues that would have to be solved if capital gains taxes were to be introduced. While the simulations of the model suggest a capital gains tax that includes owner-occupied housing has better welfare properties than a capital gains tax that does not, the political and practical difficulties of introducing an accruals based capital gains tax should not be underestimated. Applying a capital gains tax only to realised gains has its own problems, notably the incentives it generates to remain in unsuitable houses or living arrangements in order to avoid the tax. Yet the simulations also suggest that a flat rate property tax has many of the same properties as an accrual based capital gains tax with no exemptions, and if a capital gains tax is desired but not considered practical this may be a suitable alternative. The similarity between these two taxes will be greater if nominal property price appreciation is dominated by inflation rather than real factors, and if the inflation rate is relatively stable.

Most OECD countries that have capital gains taxes exempt owner-occupied housing from the tax and only tax leased residential property when a sale is realised. This is a much more straightforward tax to implement than an accruals based tax, but still removes some of the housing market distortions that arise from taxing differently that inflation component of interest earnings and the inflation component of capital gains. Nonetheless, the simulations suggest the effects of this type of capital gains tax could be largely replicated by exempting the inflation component of interest income from tax, a strategy that may be easier to implement in practice. Such a strategy would have the added advantage that real after-tax interest rates and returns to capital are unaffected by the inflation rate.

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Table 1a: The effect of inflation on housing outcomes

Elastic supply, high construction costs				
	Π=0	Π=1	Π=2	Π=3
Rent	11900	11650	11250	10850
$P^F(0)$ (small)	225200	224500	223600	222700
$P^H(0)$ (large)	382900	382400	382000	381400
N^{TOT} (all) /popn	93.9%	93.6%	93.1%	92.8%
N^F (small) /popn	53.0%	52.4%	51.4%	50.6%
N^H (large) /popn	40.9%	41.1%	41.8%	42.1%
% houses rented	10.7%	12.2%	13.6%	15.1%
% agents renting	16.1%	17.9%	19.5%	21.2%
% cohort 0 renting	38%	41%	43%	44%
% cohort 1 renting	11%	13%	16%	17%
% others renting	8%	9%	10%	12%
% cohort 1 large	60%	58.5%	57.5%	56%
GST rate	12.3%	12.1%	12.0%	12.0%
Net financial assets/GDP	28%	29%	31%	33%

The table shows how rents, house prices, house numbers (number of houses divided by the population) and the fraction of the population that rents vary with the inflation rate. Net financial assets/GDP is total lending minus total borrowing divided by labour income.

Table 1b: The effect of inflation on housing outcomes

Elastic supply, low construction costs				
Rent	9650	9350	9050	8700
$P^F(0)$ (small)	182400	181300	180500	179500
$P^H(0)$ (large)	325600	324400	323800	322300
N^{TOT} (all)	96.8%	96.4%	96.1%	95.6%
N^F (small)	42.8%	42.5%	42.0%	42.1%
N^H (large)	54.1%	53.9%	54.1%	53.5%
% houses rented	3.6%	5.3%	6.7%	7.9%
% agents renting	6.6%	8.7%	10.4%	11.9%
% cohort 0 renting	25%	26%	28%	30%
% cohort 1 renting	1%	4%	6%	8%
% others renting	1%	2%	3%	5%
%cohort 1 large	71.5%	71%	71%	70%
GST rate	12.0%	11.8%	11.5%	11.5%
Net financial assets/GDP	48%	48%	50%	53%

The table shows how rents, house prices, house numbers (number of houses divided by the population) and the fraction of the population that rents vary with the inflation rate. Net financial assets/GDP is total lending minus total borrowing divided by labour income.

Table 2a: The effects of capital gains taxes on residential property; owner-occupied housing exempt, inflation rate = 2 percent.

Elastic supply, high construction costs				
		Change from introducing ……		
	No CGT	Flat rate CGT, 20%	CGT at marginal rates 20%, 33%	Inflation part of interest tax exempt
Rent	11250	+$750	+$1300	+$800
$P^F(0)$ (small)	223600	+$1000	+$1800	+$900
$P^H(0)$ (large)	382000	+$900	+$1800	+$700
N^{TOT} (all) /popn	93.1%	0.4%	0.8%	0.4%
N^F (small) /popn	51.4%	0.6%	0.9%	0.7%
N^H (large) /popn	41.8%	-0.2%	-0.1%	-0.3%
% houses rented	13.6%	-3.8%	-6.2%	-3.5%
% agents renting	19.5%	-3.9%	-6.5%	-3.6%
% cohort 0 renting	42.5%	-2.0%	-3.5%	-2.3%
% cohort 1 renting	15.5%	-1.0%	-2.5%	-1.8%
% others renting	10.0%	-6.3%	-10.0%	-5.3%
GST rate	12.0%	-0.2%	-0.1%	0.1%
Net financial assets /GDP	30.6%	2.2%	4.1%	7.0%

The table shows how rents, house prices, house numbers (number of houses divided by the population) and the fraction of the population that rents would change if a capital gains tax exempting owner-occupiers were introduced. The inflation rate is assumed to be 2 percent. Net financial assets/GDP is total lending minus total borrowing divided by labour income.

Table 2b: The effects of capital gains taxes on residential property; owner-occupied housing exempt, inflation rate = 2 percent.

Elastic supply, low construction costs				
		Change from introducing ……		
	No CGT	Flat rate CGT, 20%	CGT at marginal rates 20%, 33%	Inflation part of interest tax exempt
Rent	9050	+$600	+$1050	+$650
$P^F(0)$ (small)	180500	+$1100	+$1500	+$1200
$P^H(0)$ (large)	323800	+$1100	+$1600	+$1300
N^{TOT} (all) /popn	96.1%	0.4%	0.6%	0.5%
N^F (small) /popn	42.0%	0.4%	0.5%	0.4%
N^H (large) /popn	54.1%	0.1%	0.1%	0.1%
% houses rented	6.7%	-2.3%	-2.6%	-2.6%
% agents renting	10.4%	-2.7%	-3.1%	-2.9%
% cohort 0 renting	28.3%	-1.8%	-3.0%	-2.3%
% cohort 1 renting	6.3%	-2.0%	-2.5%	-2.5%
% others renting	3.5%	-3.5%	-3.5%	-3.5%
GST rate	11.5%	0.0%	0.0%	0.3%
Net financial assets /GDP	50.0%	1.2%	1.3%	7.1%

The table shows how rents, house prices, house numbers (number of houses divided by the population) and the fraction of the population that rents would change if a capital gains tax exempting owner-occupiers were introduced. The inflation rate is assumed to be 2 percent. Net financial assets/GDP is total lending minus total borrowing divided by labour income.

Table 2c: The effects of capital gains taxes on residential property; owner-occupied housing exempt, inflation rate = 2 percent.

Inelastic supply, high prices				
		Change from introducing ……		
	No CGT	Flat rate CGT, 20%	CGT at marginal rates 20%, 33%	Inflation part of interest tax exempt
Rent	11350	+$1100	+$1850	+$1100
$P^F(0)$ (small)	225900	+$7000	+$11000	+$6300
$P^H(0)$ (large)	378300	+$5000	+$16300	+$6200
N^{TOT} (all) /popn	93.2%	0.0%	0.0%	0.0%
N^F (small) /popn	50.1%	0.0%	0.0%	0.0%
N^H (large) /popn	43.1%	0.0%	0.0%	0.0%
% houses rented	13.3%	-2.6%	-5.1%	-2.4%
% agents renting	19.2%	-2.4%	-4.7%	-2.3%
% cohort 0 renting	42.0%	-0.5%	0.3%	-0.3%
% cohort 1 renting	15.3%	0.8%	0.5%	-0.3%
% others renting	9.8%	-5.0%	-9.8%	-4.3%
GST rate	11.9%	-0.2%	-0.2%	0.1%
Net financial assets /GDP	32.0%	2.1%	3.4%	7.5%

The table shows how rents, house prices, house numbers (number of houses divided by the population) and the fraction of the population that rents would change if a capital gains tax exempting owner-occupiers were introduced. The inflation rate is assumed to be 2 percent. Net financial assets/GDP is total lending minus total borrowing divided by labour income.

Table 3: The effects of capital gains taxes on all households; π = 2.

Elastic supply, high prices					
		Change from introducing taxes on ……			
		All households		landlords only	
	No CGT	Flat rate CGT, 20%	CGT at (20%, 33%)	Flat rate CGT, 20%	CGT at (20%, 33%)
Rent	11250	+$700	+$1200	+$750	+$1300
$P^F(0)$ (small)	223600	-$100	+$400	+$1000	+$1800
$P^H(0)$ (large)	382000	-$2100	-$1500	+$900	+$1800
N^{TOT} (all) /popn	93.1%	0.0%	0.2%	0.4%	0.8%
N^F (small) /popn	51.4%	2.5%	2.6%	0.6%	0.9%
N^H (large) /popn	41.8%	-2.5%	-2.4%	-0.2%	-0.1%
% houses rented	13.6%	-0.4%	-5.4%	-3.8%	-6.2%
% agents renting	19.5%	-0.3%	-5.1%	-3.9%	-6.5%
% cohort 0 renting	42.5%	0.8%	-0.8%	-2.0%	-3.5%
% cohort 1 renting	15.5%	-1.0%	-0.8%	-1.0%	-2.5%
% others renting	10.0%	-0.5%	-9.5%	-6.3%	-10.0%
GST rate	12.0%	-2.2%	-2.5%	-0.2%	-0.1%
Net financial assets /GDP	30.6%	0.8%	6.5%	2.2%	4.1%

The table shows how rents, house prices, house numbers (number of houses divided by the population) and the fraction of the population that rents would change if a capital gains tax on all houses were introduced. The inflation rate is assumed to be 2 percent. Net financial assets/GDP is total lending minus total borrowing divided by labour income.

Table 4. Parameterisation of the model.

Parameter	Description	Value	Source/Rationale
T	Length of period	12.5 years	To approximate work history from age 25 – 75
Y_t^0	Average income of 25-35 cohort	50000	NZ Census 2001: average male and female earnings, 25-35 year olds, are \$32800 and \$23300 respectively
ω_j	Income distribution	Uniform on [25000,85000]	
g_i	Lifecycle income pattern	{1, 1.5, 1.5, 0.15+20000}	NZ Census, 1966- 2001. Based on real lifecycle earnings of cohort turning 20 in 1946, 1961.
B	Discount factor	0.97 annualised	Arbitrary
$\begin{Bmatrix} v^{\frac{1}{2}R}, v^R, \\ v^F, v^H \end{Bmatrix}$	Utility from housing	$\begin{Bmatrix} 0.18, 0.32, \\ 0.35, 0.45 \end{Bmatrix}$	Arbitrary
κ_i	Inheritance timing	{0,0,1,0}	Arbitrary
γ	Annual house maintenance	0.01	Arbitrary
H	Mortgage term	25 years	Standard mortgage term in 1990s
δ	Maximum debt service-income ratio	30%	Reflects NZ banking conditions
Θ	Maximum loan to value ratio	90%	Reflects NZ banking conditions
τ^{g*}	Target GST rate	0.14	Tax take equals 14% of labour income; arbitrary, but close to NZ rate.
τ_1, τ_2, τ^*	Income tax rates and threshold	20%, 33% \$50000	Reflects NZ rates in 2000.

Housing Supply parameters

α_0^F, α_1^F α_0^H, α_1^H	Elastic High price	0, 150 125000, 50	Arbitrary, generates approximately 1% price elasticity for flats.
	Elastic Low Price	-50000, 150 100000, 50	
	Inelastic High Price	-149m, 100000 -68m, 100000	Generates $N^F = 689$ $N^H = 802$
	Inelastic Low Price	-153m, 100000 -83m, 100000	Generates $N^F = 665$ $N^H = 873$
	Flats elastic Houses inelastic	0, 150 -80m, 100000	$N^H = 800$
	Perfectly elastic	$P^F = 225000$ $P^H = 370000$	

Figure 1

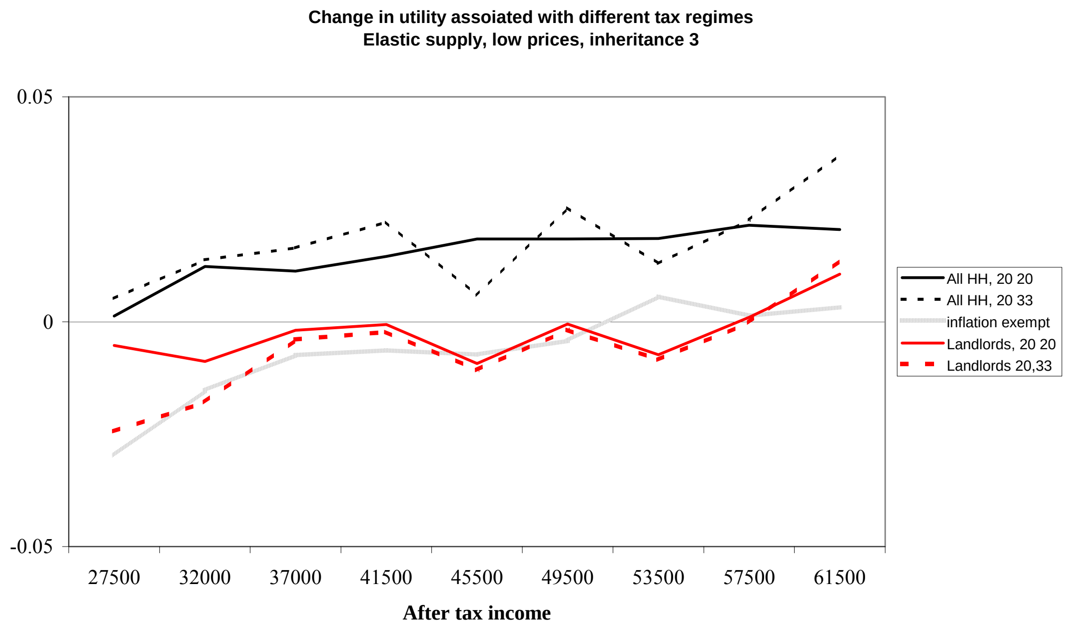
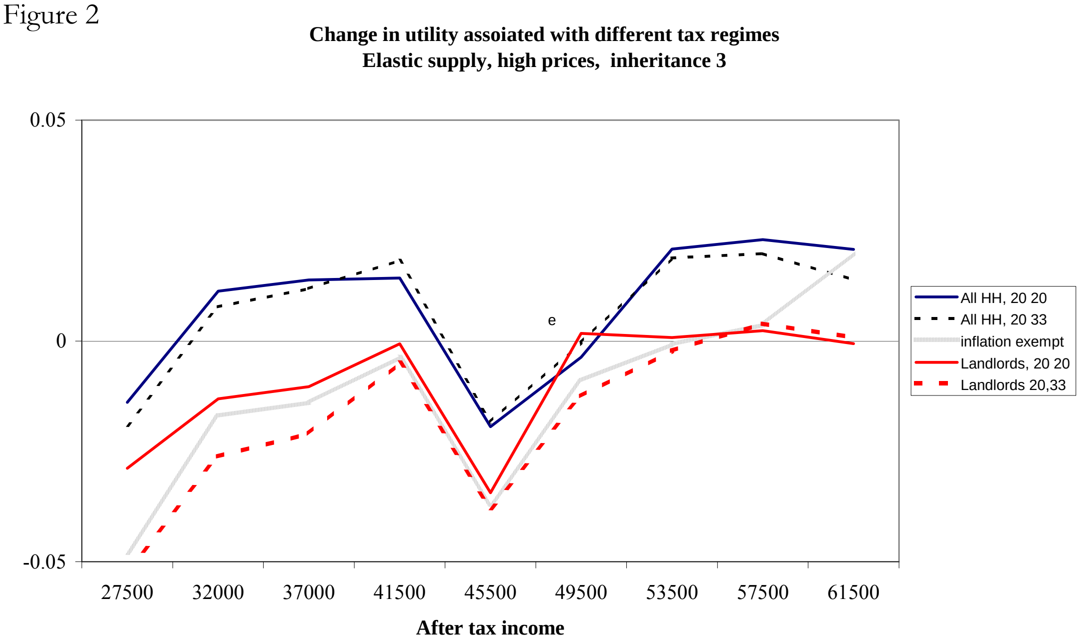


Figure 2



Appendix 1

This appendix provides a formal description of the model. The basic building blocks of the model are equations describing the supply and demand for two different types of houses, small houses (denoted F for flats) and large houses (denoted H). The demand for these houses are derived from the preferences of four separate cohorts of agents. Each cohort comprises a number of different agents. The N agents in each cohort live for four periods labelled $i = \{0,1,2,3\}$. A period is T years long. In the simulations, T = 12.5 years.

A1.1 Agents, housing options, and inheritances

Agents differ by income and while any pattern of income is possible, agents are assumed to have a constant place in the within-cohort income distribution as they age. Agent 1 has the lowest income. In period t, agent j born in period $t\text{-}i$ has real pre-tax labour income

$$Y_t^{i,j} = \omega_j g_i Y_{t-i}^0 \tag{1}$$

where ω_j = idiosyncratic factor affecting agent j relative to average cohort earnings;

g_i = factor reflecting the life-cycle earnings of the cohort in its i^{th} period; and

Y_{t-i}^0 = average income of cohort at time of birth.

Nominal income is $P_t Y_t^{i,j}$, where P_t is the pre-tax price of the good. Agents pay taxes on their nominal incomes[8]. There are two marginal tax rates: τ_1 for agents with real income in period t less than τ^*; and $\tau_2 \geq \tau_1$ for agents with real income greater than or equal to τ^*. It is assumed that the tax threshold is automatically adjusted for inflation and thus constant in real terms. An indirect goods and services tax is applied to goods other than housing at rate τ^g, so the post tax price of the good is $(1+\tau^g)P_t$. Incomes and the prices of goods both increase at a constant inflation rate π, where $1+\pi \; = P_{t+1}/P_t$.

Agents obtain utility from the consumption of goods and housing. An agent chooses real consumption $c_t^{i,j}$, and has housing choices described by a vector of three indicator variables $\mathbf{I}_t^{i,j,h} = \left\{ I_t^{i,j,\frac{1}{2}R} I_t^{i,j,R}, I_t^{i,j,F}, I_t^{i,j,H} \right\}$ that equal one if the agent has housing tenure h in period i of his or her life at time t, and zero otherwise. There are four possible housing tenures: an agent can rent a small

[8] In Coleman (2008) only capital income, not labour income was taxed.

house or flat (R), share a rented flat with another agent (½R), purchase a small house (F), or purchase a large house (H). In period t agents obtain utility

$$u(c_t^{i,j}, \mathbf{I}_t^{i,j,h}) = \ln(c_t^{i,j}) + \sum_h v^h I_t^{i,j,h} \tag{2}$$

It is assumed $v^H > v^F$ as houses are bigger than flats, and $v^F > v^R$, as agents can shape an owned flat in their own image, whereas they cannot modify a rented flat, and $2v^{\frac{1}{2}R} \geq v^R > v^{\frac{1}{2}R}$, as there are diminishing returns to housing. Agents can only choose one housing option in any period. Agents born at time t choose consumption and housing paths to maximise discounted lifetime utility:

$$U = \sum_{i=0}^{3} \beta^i u(c_{t+i,}^{i,j} \mathbf{I}_{t+i}^{i,j,h}) \tag{3}$$

In each period, agents choose between one of the four housing options. Consequently, there are potentially 256 different housing patterns possible through an agent's lifetime. Rather than calculate the utility of each of these patterns, I only let agents choose from a much smaller set of patterns, $\mathcal{H}$. To reduce the number of possible patterns, I impose a series of restrictions on the lifetime housing options available to an agent. The four restrictions are: (i) only period 0 and period 1 agents may choose to share a rental property (½R); (ii) except in the last period, agents' housing choices must not worsen through time; and (iii) agents can only rent in the last period if they rent or share throughout their whole life. . By this means, the set $\mathcal{H}$ is reduced to 31, $\mathcal{H} = \{$½R½RRR, ½R½RRF, ½R½RFF, ½R½RHF, ½R½RHH, ½RRRR, ½RRRF, ½RRFF, ½RRHF, ½RRHH, ½RFFF, ½RFHF, ½RFHH, ½RHHF, ½RHHH, RRRR, RRRF, RRFF, RRHF, RRHH, RFFF, RFHF, RFHH, RHHF, RHHH, FFFF, FFHF, FFHH, FHHF, FHHH, HHHF, HHHH$\}$. An agent's optimal discounted utility is calculated for each of these patterns, and the agent is assumed to choose the pattern that provides the greatest discounted utility.

Households are assumed to receive their income, purchase, rent, or sell property, borrow or lend, and consume at the start of each period, although they gain utility from housing by living in it throughout the period. In the last period, agents are assumed to sell or realise all assets except their last owned housing unit, repay any debts, and consume all of their wealth. They die at the end of period 3, at which point their housing unit is distributed to younger cohorts. At time *t* a fraction κ_i is left to the cohort born at *t-i* for *i=0,1,2*; in this paper, $\kappa_2 = 1$, so that agents do not receive an inheritance until relatively late in life. Two inheritance distributions were considered. In the first one, the housing belong to the jth agent in cohort 3 is left to the jth agent in cohort 2, thus preserving the income distribution. In the second one (and the main one used in the simulations in this paper) the houses owned by agents j and j+1 in cohort 3 are left to agent j+1 in cohort 2, and agent j gets no inheritance. This distribution ensures that half the agents in the model solve optimisation problems in which an inheritance is not taken into account, while the other half solve problems in which credit constraints bind particularly hard early in life because they expect to inherit a large amount of wealth. In the maximisation equation below, $Inherit_t$ is the value of the inheritance expected to be received.

A1.2 Taxes and the housing market

Five features of the tax system have been incorporated into the model. First, interest and rent income is taxed at an agent's marginal tax rate. Secondly, imputed rent is tax exempt. Thirdly, a landlord can deduct interest payments associated with a mortgage when calculating taxable income. Fourthly, there is a goods and services tax that is applied to consumption but not to rent or property. In the model, the goods and service tax rate is set endogenously at a rate that makes the total tax take except for labour income taxes (tax on capital income plus tax on goods and services plus capital gains taxes) equal to a set fraction of labour income, in this case $\tau^{g^*} = 14$ percent. This ensures that any changes in the structure of capital incomes taxes do not have revenue implications for the Government. Agents do not receive utility from government expenditure. Fifthly, there is a capital gains tax that can vary with income, $\tau^c(Y^i)$, We use an indicator variable L^c to indicate whether the capital gains tax applies to all households ($L^c = 1$) or just landlords ($L^c=0$).

Flats and large houses cost P_t^F and P_t^H to purchase. There are also annual property charges γP_t^h which can be thought of as maintenance or property tax charges. The vector $P_t^{\gamma h} = \{0, 0, \gamma P_t^F, \gamma P_t^H\}$ describes the charges paid by the occupiers of the four different housing tenures, for landlords are responsible for paying the charges on rented houses. When the flats are leased, the price P_t^R is paid in advance at the beginning of the lease. Landlords are assumed to be agent in period 2 of their lives. The number of landlords is endogenous; an indicator variable $I_t^{i,j,R*}$ indicates the number of rental properties owned by the j^{th} agent.[9]

[9] If there is demand for $2f$ flats, the f highest income individuals are assumed to own 2 flats each.

Because there is no uncertainty, the after-tax return from purchasing a flat in period *t*, leasing it, and selling it in period *t+1* is equal to the after-tax return from lending money. As such, the relationship between rent, tax rates, flat prices, and interest rates is

$$(P_t^R - \gamma P_t^F)(1-\tau_2)(1+r_t(1-\tau_2))^T + P_{t+1}^F - \tau^c(P_{t+1}^F - P_t^F) = P_t^F(1+r_t(1-\tau_2))^T \quad (4)$$

or

$$P_t^R = P_t^F\left(\frac{(1+\gamma(1-\tau_2)(1+r_t(1-\tau_2))^T - (1+\pi_t^F(1-\tau^c))}{(1-\tau_2)(1+r_t(1-\tau_2))^T}\right) \quad (5)$$

where π_t^F is the rate of price appreciation for flats. The right hand side of equation 4 is the after-tax return in period *t+1* from investing P_t^F in interest earning bonds. The left hand side is the after-tax return at *t+1* from using the same sum to purchase a rental flat at time t. It comprises the after-tax rent paid at time t and reinvested at interest (with an adjustment for property maintenance charges), plus the proceeds from selling the rental unit at time *t+1,* adjusted for capital gains tax. Since interest payments by landlords are fully tax deductible, the return to a landlord is independent of their level of gearing. It is assumed that the landlords are high income agents in period 2 of their lives, so after-tax returns are calculated using the top marginal tax rate τ_2.

There are separate supply functions for the two types of houses, and the quantity of each is determined in equilibrium along with rents and prices. Linear supply functions are specified:

$$\begin{aligned} P_t^F &= \alpha_0^F + \alpha_1^F\left(Q_t^F + Q_t^H\right) \\ P_t^H &= P_t^F + \alpha_0^H + \alpha_1^H Q_t^H \end{aligned} \quad (6)$$

In this specification the price of flats is an increasing function of the total number of properties (to reflect the possible scarcity of land), while the price of houses is determined as a variable premium over the price of flats (to reflect the additional building costs). In most of the simulations presented below, parameters are chosen so that a 1 percent increase in the number of properties leads to about a 1 percent increase in the price of flats.

A1.3: The lending market

There is a non-profit financial intermediary that accepts deposits and issues mortgages at an interest rate r_t. Agents can lend or borrow as much as the bank allows them at the one period interest rate r_t, subject only to the restriction that they have a zero debt position at the end of their life. The economy can either be closed, in which case the interest rate is determined endogenously and aggregate deposits equal aggregate loans, or open, in which case real interest rates are determined exogenously and the net foreign asset position can be non-zero. There are no restrictions on the deposit contract, and interest on a deposit made at time *t* is paid at time *t+1*. Agents pay tax on this interest at their marginal tax rate, but do not get a tax deduction for interest paid on borrowed funds unless they borrow to fund a rental property.[10] An agent's positive funds are labelled $B_t^{i,j}$.

The mortgage contract is subject to three restrictions.[11]
i) *The loan to value restriction.*
The mortgage may not exceed a certain fraction of the value of the property. In particular, the gross amount borrowed $D_t^{i,j-}$ cannot exceed the value of property multiplied by the loan to value ratio θ: that is

$$D_t^{i,j-} \leq \sum_{h \in F,H} \theta P_t^h I_t^{i,j,h} \tag{7}$$

(Note $D_t^{i,j-} > 0$ if the agent borrows.) This restriction means that agents who rent cannot borrow to smooth consumption, although they can save.

ii) *The regular cash payment restriction*.
Banks only issue η-year table mortgages, and require a "cash payment" in the period the mortgage is issued. This restriction is imposed to mimic a standard condition of a table mortgage, namely that a customer is required to make regular cash repayments *CP* of equal size throughout the life of the mortgage rather than a large repayment at its terminal date. The payment size *CP* is chosen to ensure the mortgage is retired at the end of the term: if D^{0-} is initially borrowed, the annual payment is

$$CP = D^{0-} r \left[\frac{(1+r)^{\eta}}{(1+r)^{\eta} - 1} \right] \tag{8}$$

η is assumed to be 25 years.[12]

It is not possible to exactly replicate this feature of a standard mortgage contract in the model. However, a close approximation is achieved by requiring

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[10] To reduce computational complexity, the marginal tax rate is calculated on the basis of labour income, not total income. Otherwise the marginal tax rate is determined endogenously.
[11] Note that banks impose these restrictions even though there is no uncertainty in the model
[12] Until recently, this has been the standard term for a table mortgage in Australia and New Zealand.

the customer to make a payment that pays off some of the interest and principal in any period he or she has debt. In particular, a customer with gross debt of $D_t^{i,j-}$ is required to open up a separate account with the bank and make a deposit of size

$$D_t^{i,j*} = D_t^{i,j-}\frac{r_t}{1+r_t}\left[\frac{(1+r_t)^{\eta/T}}{(1+r_t)^{\eta/T}-1}\right] \qquad (9)$$

into this account. This deposit earns (untaxed) interest at rate r_t. This means the net borrowing position of a borrowing agent, $D_t^{i,j} = D_t^{i,j-} - D_t^{i,j*}$, is less than the gross borrowing position. Without this "cash payment" feature, many agents would prefer to purchase rather than rent simply because the interest payment occurs a period later than the rental payment. When the "cash payment" requirement is imposed, purchasing a house requires a larger payment to the bank in period *t* than the cost of renting a house.

iii) *The mortgage-repayment-to-income restriction.*
The maximum amount an agent can borrow is restricted to ensure the mortgage repayment given by equation 8 is smaller than a fraction δ of income:

$$D_t^{i,j-}\frac{r_t}{1+r_t}\left[\frac{(1+r_t)^{\eta/T}}{(1+r_t)^{\eta/T}-1}\right] \le \delta P_t Y_t^{ij} \qquad (10)$$

Note that this constraint is expressed in terms of nominal interest rates.

The mortgage conditions are only imposed on agents in periods 0 and 1 of their lives in order to simplify the solution algorithm. In period 2 agents can borrow unrestricted amounts. The absence of a restriction in period 2 has little effect because agents are in their peak earning years, receive their inheritance at this time, and are actively saving or reducing debt to finance their retirement.

A1.4 Utility maximisation
An agent born at time *t* solves the following constrained maximisation problem (the jth superscript is omitted):

$$
\begin{aligned}
&Max_{\{c_{t+i},\mathbf{I}_{t+i}^{i,h}\}}\ U=\sum_{i=0}^{3}\beta^{i}u(c_{t+i,}^{i}\mathbf{I}_{t+i}^{i,h}) \qquad (11)\\
&-\lambda_0 \left(P_tY_t^0-B_t^0+D_0^t-(1+\tau^g)P_tc_t^0-\sum_h(P_t^h+P_t^{\gamma h})I_t^{0,h}\right)\\
&-\sum_{i=1}^{3}\lambda_i\left(\begin{array}{l}(1+\pi)^iP_tY_{t+i}^i+B_{t+i-1}^i(1+r_{t+i-1}(1-\tau^i))-D_{t+i-1}^i(1+r_{t+i-1})-B_{t+i}^i+D_{t+i}^i\\ -(1+\pi)^i(1+\tau^g)P_tc_t^i-\sum_h(P_{t+i}^h+P_{t+i}^{\gamma h})I_{t+i}^{i,h}+\sum_{h=F,H}I_{t+i-1}^{i-1,h}(P_{t+i}^h-\tau^cL^c(P_{t+i}^h-P_{t+i-1}^h))\\ +\kappa_iInherit_{t+i}\\ +\left[P_{t+i}^R(1-\tau^i)I_{t+i}^{i,R*}+((P_{t+i}^F-\tau^c(P_{t+i}^F-P_{t+i-1}^F)-P_{t+i-1}^F(1+r_{t+i-1}(1-\tau^i))I_{t+i-1}^{i-1,R*}\right]\end{array}\right)\\
&-\sum_{i=0}^{1}\chi_i\left(D_{t+i}^{i,-}-\sum_h\theta P_{t+i}^h\ I_{t+i}^{i,h}\right)\\
&-\sum_{i=0}^{1}\phi_i\left(D_{t+i}^{i,-}\frac{r_{t+i}}{1+r_{t+i}}\left[\frac{(1+r_{t+i})^{\tau/T}}{(1+r_{t+i})^{\tau/T}-1}\right]-\delta Y_{t+i}^i\right)\\
&-\sum_{i=0}^{3}\varsigma_i\left(B_{t+i}^i\right)-\sum_{i=0}^{3}\nu_i\left(D_{t+i}^i\right)
\end{aligned}
$$

Lines 2 and 3 of equation (11) are the budget constraints facing the agent in the four periods. Lending and borrowing are entered separately as there are different after tax interest rates, and there are terms to reflect the maintenance charges, capital gains tax, inheritance and rental income. Lending and borrowing in period 3 are restricted to equal zero, and τ^i is the marginal tax rate applying in period *i* of the agent's life. The Kuhn-Tucker conditions in lines 4 and 5 reflect the loan-to-value ratio constraints and the mortgage-repayment-to-income ratio constraints respectively. The Kuhn-Tucker conditions in line 6 reflect the requirement that non-negative amount are lent and borrowed. The agent solves the problem by calculating the maximum utility for each housing pattern in the set $\mathcal{H}$, and then selecting the housing pattern with the highest utility. The use of log-linear utility functions means it is relatively straightforward to calculate an analytical solution for the optimal consumption path given a particular housing pattern, even though each solution has 48 parts corresponding to the 48 possible combinations of Kuhn-Tucker conditions.[13]

A1.5 Equilibrium conditions

In the simulations, the steady state equilibrium is found for an open economy in which agents borrow or lend at the world interest rate. In the steady state, the following price relationships hold:

$$(1+r_t)/(1+\pi_t)=r \tag{12a}$$

$$\frac{P_{t+1}^F}{P_t^F}=1+\pi^F \tag{12b}$$

$$\frac{P_t^H}{P_t^F}=\rho^H \tag{12c}$$

$$\frac{P_t^R}{P_t^F}=\left(\frac{(1+\gamma(1-\tau_2)(1+r_t(1-\tau_2))^T-(1+\pi_t^F(1-\tau^c))}{(1-\tau_2)(1+r_t(1-\tau_2))^T}\right)=\rho^R \tag{12d}$$

Equation (12a) states that real interest rates are constant. In the open economy model, the rate *r* is the foreign real interest rate. Equation (12b) states that flat prices appreciate at a constant rate. Equation (12c) states that the ratio of house prices to flat prices is constant. Equation (12d) is a restatement of equation 5, linking rents to interest rates and the flat price appreciation rate.

For a set of parameters $\left\{N,T,Y_t^0,\omega_j,g_i,\pi,\beta,v_h,\kappa_i,\mathcal{H},\gamma,\eta,\theta,\delta,\tau^{g*},\tau_1,\right.$ $\left.\tau_2,\tau^*,\tau^c,L^c\right\}$ and housing parameters $\left\{\alpha_0^F,\alpha_1^F,\alpha_0^H,\alpha_1^H\right\}$ the steady state equilibrium is described by a set of prices $\left\{r,\pi^F,\rho^H,\rho^R\right\}$, a GST rate τ^g, a set of housing and consumption demands $\{c_{t-i+s,}^{s,j}\mathbf{I}_{t-i+s}^{s,j,h}\}_{s=0,\dots,3}$ for each agent j in each cohort born in period *t-i*, and a net foreign asset position B_t^{net} such that all agents have maximal utility and

$$\sum_{i=0}^{3}\sum_{j=1}^{N}c_t^{i,j}+\gamma(Q^F P_t^F+Q^H P_t^H)+Tax_t=\sum_{i=0}^{3}\sum_{j=1}^{N}y_t^{i,j}-\left(\frac{r-\pi}{1+\pi}\right)B_t^{net} \tag{13a}$$

$$\sum_{i=0}^{3}\sum_{j=1}^{N}(B_t^{i,j}-D_t^{i,j})-P_t^F\sum_{j=1}^{N}I_t^{2,j,R*}=B_t^{net} \tag{13b}$$

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[13] In the periods 0 and 1, the financial asset position can be positive, zero, negative, or equal to the borrowing constraint; in period 2, the financial asset position can be positive, zero or negative; and in period 3 it is zero.

$$Tax_t = \sum_{i=0}^{3}\sum_{j=1}^{N} y_t^{i,j}(\tau_1 + (\tau_2 - \tau_1)(y_t^{i,j} - \tau^*)I(y_t^{i,j} - \tau^*)$$
$$+\tau^g \sum_{i=0}^{3}\sum_{j=1}^{N} c_t^{i,j} + \sum_{i=0}^{3}\sum_{j=1}^{N} B_{t-1}^{i,j} r \tau_t^{ij}$$
$$+(\sum_{j=1}^{N} P_t^F \tau_t^{2,j} I_t^{2,j,R*} - \sum_{j=1}^{N} P_{t-1}^F r \tau_t^{3,j} I_{t-1}^{2,j,R*} - \tau^c \sum_{j=1}^{N} (P_t^F - P_{t-1}^F) I_{t-1}^{2,j,R*} \qquad (13c)$$
$$+L^c \sum_{i=1}^{3}\sum_{j=1}^{N} \tau^c (P_t^F - P_{t-1}^F) I_{t-1}^{i-1,j,F} + \tau^c (P_t^H - P_{t-1}^H) I_{t-1}^{i-1,j,H}$$

and
$$\sum_{i=0}^{3}\sum_{j=1}^{N} (\tfrac{1}{2} I_t^{i,j,\frac{1}{2}R} + I_t^{i,j,R} + I_t^{i,j,F}) = Q^F \qquad (13d)$$

$$\sum_{i=0}^{3}\sum_{j=1}^{N} I_t^{i,j,H} = Q^H \qquad (13e)$$

where Q^F and Q^H are the number of houses produced when the supply of properties is elastic,
$Q^H = \dfrac{P^H - P^F - \alpha_0^H}{\alpha_1^H}$ and $Q^F = \dfrac{P^F - \alpha_0^F}{\alpha_1^F} - Q^H$.
Equation (13a) requires that total consumption plus house maintenance plus tax plus real earnings on the net bond position in each period equals total production. Equation (13b) is the net supply of foreign bonds, given that landlords are assumed to borrow 100 percent of the price of a flat. This will change through time if there is inflation. Equation 13c says that the total tax take is equal to labour income tax plus GST revenue plus tax on interest plus tax on rent adjusted for the interest rate tax deduction for landlords and the capital gains tax they pay, plus the capital gains tax paid by home-owners. Note that while it has been assumed landlords borrow 100 percent of the value of the property, tax revenue would not change if landlords had different gearing as the tax rate on positive balances is the same as the tax deduction they get when they borrow. Equations (13d) and (13e) require that the total demand for flats equals the supply of flats, and that the total demand for houses equals the supply of houses.

A1.6 Parameterisation

The set of baseline parameters $\{N, T, Y_t^0, \omega_j, g_i, \pi, \beta, v_h, \kappa_i, \mathcal{H}, \gamma, \eta, \theta, \delta,$ $, \tau^{g*}, \tau_1, \tau_2, \tau^*, \tau^c, L^c\}$ and housing parameters $\{\alpha_0^F, \alpha_1^F, \alpha_0^H, \alpha_1^H\}$ have been chosen to approximate features of the New Zealand economy. These are listed in table 4. Except for income distribution, the income parameters approximately match the basic lifecycle and cohort income patterns of New Zealanders reported in census documents, 1966-2001, under the assumption that the basic agent is a household comprised of a male and female of the same age. For simplicity, annual income is assumed to be uniformly distributed over the range $25000 to $80000.

In the baseline model, the discount rate is 3 percent, the real interest rate is 5 percent (assumed equal to the world rate), and banks impose borrowing restrictions that limit households to borrow up to 90 percent of the value of a property and to pay no more than 30 percent of their income in debt servicing. The banking sector parameters are changed in some of the simulations, but these reflect the conditions facing New Zealand borrowers since the year 2000.

The tax rates also reflect New Zealand tax settings in 2000. In the baseline model, the marginal tax is 20 percent for households with incomes less than $50000, and 33 percent for households with incomes above that level. The model is also solved for a set of tax rules that exclude the inflation component of interest income from tax, and which only allow landlords to deduct real interest payments from their taxable income.[14] The GST rate was chosen to ensure that capital income taxes and consumption taxes total to 14 percent of labour income.

The parameters $(\upsilon^{\frac{1}{2}R}, \upsilon^{R}, \upsilon^{F}, \upsilon^{H}) = (0.18, 0.32, 0.35, 0.54)$ mean (approximately) that at the margin a household would be prepared to spend 18 percent of their income on shared accommodation rather than have no accommodation, and 32 percent of their income to rent a whole flat; the additional benefit from living in an owner-occupied flat rather than a rented flat is 3% of income, and the additional benefit from living in a large house a further 20 percent. These parameters are quite arbitrary, but have been varied by the author to ensure the results are not completely sensitive to these choices. The housing supply parameters were chosen so that that the elasticity of flats with respect to prices was 1 percent in the elastic case. The model was solved for inflation rates ranging from 0 to 3 percent, reflecting the legal

[14] In this case the constraints in equation 11 and the aggregation condition (13c) are modified accordingly.

requirement that the Reserve Bank of New Zealand achieve stability in the general level of prices.

A1.7 Solution technique

The solution is found numerically. The algorithm searches for a set of prices $\left\{\tau^g, P_t^R, P_t^F, P_t^H\right\}_{t=-3,..0,...3}$ so that when each agent *j* born in period *t-i, i= 0,…3* is consuming a sequence of goods and tenure options $\{c_{t-i+s,}^{s,j}\mathbf{I}_{t-i+s}^{s,j,h}\}_{s=0,...,3}$ that solves their constrained utility problem given by equation (11), the aggregation conditions 13a – 13e applied at time *t* are satisfied. In the steady state, the vector $\left\{\tau^g, P_t^R, P_t^F, P_t^H\right\}_{t=-3,..0,...3}$ can be calculated from the vector $P^* = \{\tau^g, P_0^F, \pi^F, \rho^H\}$ and the parameters $\left\{r, \tau_2\right\}$.

The basic structure of the algorithm is as follows.

a) Let the vector $P^{*,k} = \{\tau^g, P_0^F, \pi^F, \rho^H\}^k$ be the *k*th estimate of the steady state solution P^*. Given $P^{*,k}$, calculate the optimal consumption and housing tenure paths for each of the N households who are born at *t=0* by searching over the different possible tenure paths in the set $\mathcal{H}$.

b) Use these results to calculate the demand for consumption goods and housing at time *t=0* for all households in the economy.

c) Use these results to calculate aggregate consumption, the aggregate demand for flats, and the aggregate demand for houses at time *t=0*. Then calculate the excess demand functions given by 13a – 13e.

d) If the excess demand functions are not sufficiently close to zero, a new estimate of the equilibrium prices $P^*, P^{*,k+1}$, is calculated. This is done using a discrete approximation to the Newton-Rhapson method. A set of quasi-derivatives is calculated by recalculating the set of excess demand functions at the prices $\{\tau^g + \Delta_1, P^F, \pi^F, \rho^H\}$, $\{\tau^g, P^F + \Delta_2, \pi^F, \rho^H\}$, $\{\tau^g, P^F, \pi^F + \Delta_3, \rho^H\}$ and $\{\tau^g, P^F, \pi^F, \rho^H + \Delta_4\}$. These quasi derivatives are used to calculate the updated price vector using Broyden's method. The process is continued until the sequence of estimates $P^{*,k}$ converges.

A1.8 Comparison to Coleman 2008

This model has a similar structure to that used in Coleman (2008). Several modifications have been made to the model to make it more realistic.

(1) Labour taxes have been explicitly introduced. (Previously income was treated as after tax income.) At the same time, the ratio of house prices to after tax income has been increased.
(2) An annual property maintenance charge proportional to the value of the property has been introduced. This lowers the fraction of the user cost of housing that is interest.
(3) The housing options for agents have been changed. Young (cohort 0 and cohort 1) agents can now rent half a house for half of the full rent; previously, only cohort 0 agents could share a house, with their parents, for no rent. Middle aged agents are also allowed to rent, and agents can rent in the last period of their lives if they have never owned a house.
(4) The inheritance options have been widened. In this model, some agents may inherit nothing, while others get a double inheritance.
(5) Capital gains taxes have been introduced. The model has also been designed to allow for land taxes. These taxes have been introduced in a manner that allows some classes of property to be exempt from tax.