A Simple Model of Housing Rental and Ownership with Policy Simulations

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Abstract

The housing market is both large and complex. This paper develops a simple model that captures the essential features of the supply and demand for housing, and which is used to evaluate the impact of a range of policy interventions. Increases in the stock of housing would reduce rents and house prices. A reduction in tax concessions for landlords would raise rents and moderate house prices. Additional subsidies for owner-occupancy would tend to reduce rents and raise house prices. Significant reductions in rents and house prices would follow a fall in the cost of housing, through, for example lower regulatory and consent costs. Falling real interest rates result in lower rents, higher house prices and lower owner-occupancy rates. Despite the widespread attention owner-occupancy rates have attracted, the paper concludes that they are not a particularly helpful guide to the state of the housing market. Typically they are quite insensitive to policy interventions, a result that follows from the integrated view of both the rental and ownership market, adopted in this study.

JEL CLASSIFICATION

R21 Housing Demand

R31 Housing Supply and Markets

R38 Government Policies

KEYWORDS

Housing markets; New Zealand; rental and owner-occupancy; elasticities; rents; house prices; policy simulations

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A Simple Model of Housing Rental and Ownership with Policy Simulations

1 Introduction

The housing market is large. In most countries it is a key component of investment and consumption expenditure. In New Zealand, residential houses are a significant part of total infrastructure and residential investment is typically over a quarter of capital formation. Rent paid to landlords is 5 to 6% of household expenditure, while imputed rent on owner occupied houses comprises 6 to 7% of household income.[1]

It is a complex market. Residential houses are long-lasting durable goods whose value is large compared to income. Their expense and durability means a house is not usually paid for in full at the time of purchase. Rather, houses are leased or paid off over long periods of time using sophisticated financial instruments. For this reason, private landlords have an unusually large role in the market: in New Zealand, approximately 30% of houses are rented. In addition, bank lending is dominated by advances against mortgages and housing features prominently in the retirement saving of many households.

The market is further complicated because a set of wide-ranging government interventions influence the decisions of owner-occupiers and private landlords. In most countries governments play a major role through their investment in and ownership of public housing, their involvement in financial markets, and through significant interventions via the taxation system and welfare programmes. New Zealand is no exception. Furthermore, monetary policy is sometimes conducted with a conscious focus on outcomes in the housing market.[2]

The complexity of the market means it is difficult to analyse the effect of different policy interventions without a model. A model is needed because the long run responses to policy changes involve a number of feedback loops. For example, an increase in the

1 Between 2003 and 2007, residential housing comprised between 47 and 49 of the capital stock, and residential investment was 27-29 percent of gross capital formation. Imputed rent was 6-7 percent of total disposable income.

2 See for example Alan Bollard and Chris Hunt (2008) "Coping with shocks - A New Zealand perspective." A background paper prepared for an address to the Canterbury Employers' Chamber of Commerce, Christchurch, 25 January. http://www.rbnz.govt.nz/speeches/3208927.html

number of new dwellings will increase the total stock of housing and result in lower prices (everything else equal). Lower house prices will mean that some existing renters will be able to purchase a house, leading to an increase in the rate of owner occupied housing. However, potential investors in rental properties will also face lower house prices, and will find further investment profitable at existing rents. This will drive down rents, leading to a decrease in the owner-occupancy rate as new households form. The net effect on the owner-occupancy rate is ambiguous. In general, the overall effect on various housing market variables can only be assessed using a consistent analytical framework, incorporating estimates of the essential behavioural parameters.

To date, models that simultaneously capture the incentives facing home-owners, landlords, and developers have been large and extremely complicated. The principal aim of this paper is to develop a simple model that, while abstracting from much of the complexity, captures the essential dual nature of housing as both a consumption good and an investment good. The model incorporates owner-occupiers, a rental sector, and a construction sector.

The second aim of the paper is to analyse the effects of different policy options. Examples include policies that lower the marginal costs of housing (eg, through changes to regulation of land use, consent processes and building codes); policies that support the demand for housing (eg, housing related welfare payments); policies that influence the demand for home ownership through taxes and subsidies (eg, changes in the taxation of investment income from rental housing); and policies that change the cost of mortgage finance. The model is used to simulate how house prices, rents, and the quantity of rented and owner occupied houses are affected by these different policy interventions. In turn, these variables can be used to calculate the owner-occupancy rate.[3] In each case the long run (equilibrium) state of the housing market is calculated. The model is silent on the dynamic adjustment path that house prices might take in moving from one state to another in response to a policy change.

The analytical approach developed here can be used to guide policy formation in two ways. First, it indicates the scale of the change in a policy instrument that may be needed to achieve a given target level of an outcome variable in the housing market. For example, a policy analyst might wish to ask how much new dwelling construction would be needed to generate a rise of five percentage points in the owner-occupancy rate. Secondly, it can provide insights into the confidence that can be placed on these estimates by indicating how the answers depend on the various parameters in the model. To this end, we show how some results are indeed sensitive to a range of values for key parameters.

The paper is structured as follows. In the following section we provide a brief synoptic view of a selected section of the literature on modelling the housing sector. Section 3 presents a graphical representation while Section 4 sets out the formal derivation of the model. This is followed by a discussion of the parameterisation (Section 5) and the policy simulations (Section 6). After a consideration of the robustness of the findings (Section 7), the paper concludes with a discussion and conclusions (Section 8). Additional details of the modelling are presented in two appendices.

[3] We adhere to the term “owner occupied” rate rather than the more commonly used home ownership rate. The latter must, by definition, always be 100% as all homes must be owned.

2 Existing studies

There is a vast literature on the economics of housing, and a wide range of models of the housing sector have been developed. These can be broadly characterised as models which focus on a particular aspect of the market (eg, the demand for rental housing, tenure, or hedonic price measures), and large scale, relatively complex, simulation models.

Examples of the first type abound. Recent work includes models of the tenure choice of young households (Haurin, Hendershott *et al* 1996); models that incorporate spatial effects (Glaeser and Gyourko 2007); models of spatial and temporal influences on house price formation (Hwang and Quigley 2008); models that measure demand responses (Khaled and Lattimore 2008); models of the impact of the taxation of landlords (Wood and Kemp 2003); and models of the effect of supply restrictions (Grimes and Aitken 2004, 2006).

A number of large scale simulation models have been built. Notable among these are Meen and Andrew (2008) for the UK, and Wood, Watson *et al* (2003) for Australia. The UK model allows for population growth, different types of households, household formation, tenure choice, interregional migration, housing supply and earnings. The model can be used to simulate the effect of changes in policies such as an increase in the supply of land for new construction. The Australian Housing Market Microsimulation (AHMM) model captures the housing supply and demand decisions of consumers and investors and allows for the effect of taxation. Policies such as a grant to first home buyers or changes to the depreciation allowances for new construction can be assessed for their impact on tenure choice and home ownership rates. The model captures the effect of government interventions on incomes, costs and prices paid by decision makers on both the demand and supply side of the housing market.

Like these large models, the model in this paper is designed to capture the fundamental economics of the housing market. By allowing for a range of feedback effects, it allows the analysis of the impact of policy changes or other externally imposed shocks on the long run level of prices and quantities. The model provides a more general and integrated view of the housing market than many other “single issue” models, while avoiding the very substantial resource costs of building and maintaining a large scale simulation model.

The model is most closely related to small scale models of the housing sector that incorporate renters and owners. An example is the paper by Abelson and Joyeux (2007). They developed a model that specifically addressed the effect of taxes and subsidies in the housing market, recognising both an ownership and rental sector. However, their model does not allow for the full range of feedback effects from an initial exogenous shock. For example, they do not allow for shifts in the demand for owner occupied houses when they analyse the effect of a tax or subsidy to investors in rental property, nor do they permit the total supply of housing to vary. The model we develop here relaxes these restrictions and allows for a full range of feedback effects from any exogenous change in the housing market.

3 A graphical representation

In Figure 1 we provide a four quadrant graphical representation of the basic relationships. This particular form allows us to represent simultaneously the four key endogenous variables of interest: the price of houses, P^H, rents P^R, the quantity of rental houses, Q^R, and the total quantity of houses, Q^T.

We assume all houses are identical so that there is a single price of housing and a single rental rate. Clearly this assumption is counterfactual. Nonetheless, it may not be as restrictive as it first seems. Many of the results derived using these assumptions can be interpreted as the demand for standardised housing units which have incorporated an adjustment for quality. Floor area would be one such simple adjustment.

A convenient starting point is in the north-east quadrant where we depict the supply of rental housing (S^R) and the demand for rental housing (D^R) as functions of the rent. Both these relationships are drawn for an initial price of houses (denoted P_0^H). As we show subsequently, changes in the price of houses will result in shifts in the demand and supply of rental housing, as distinct from movements along the demand and supply curves. In addition, the supply function for rental housing has as arguments real interest rates (r) and taxes on income derived from rental property (t). The demand function for rental property has as shifters the real interest rate (r), real incomes (Y) and a variable to capture the effect of subsidies to owner-occupancy (τ), the total demand.

The downward sloping rental demand curve (D^R) comes about through three distinct effects. In the first instance, a rise in rents will encourage renters to economise on rental space by having more individuals share a dwelling; this is an “intensification effect”. Second, higher rents will slow down the rate at which new households form and enter the rental market; this is a “formation effect”. Treating household formation as endogenous is critical to developing a full understanding of the effect of policy changes (Börsch-Supan 1986). Finally there is a “substitution effect”: as rents rise for a given price of houses, some existing renters will choose to become home owners.

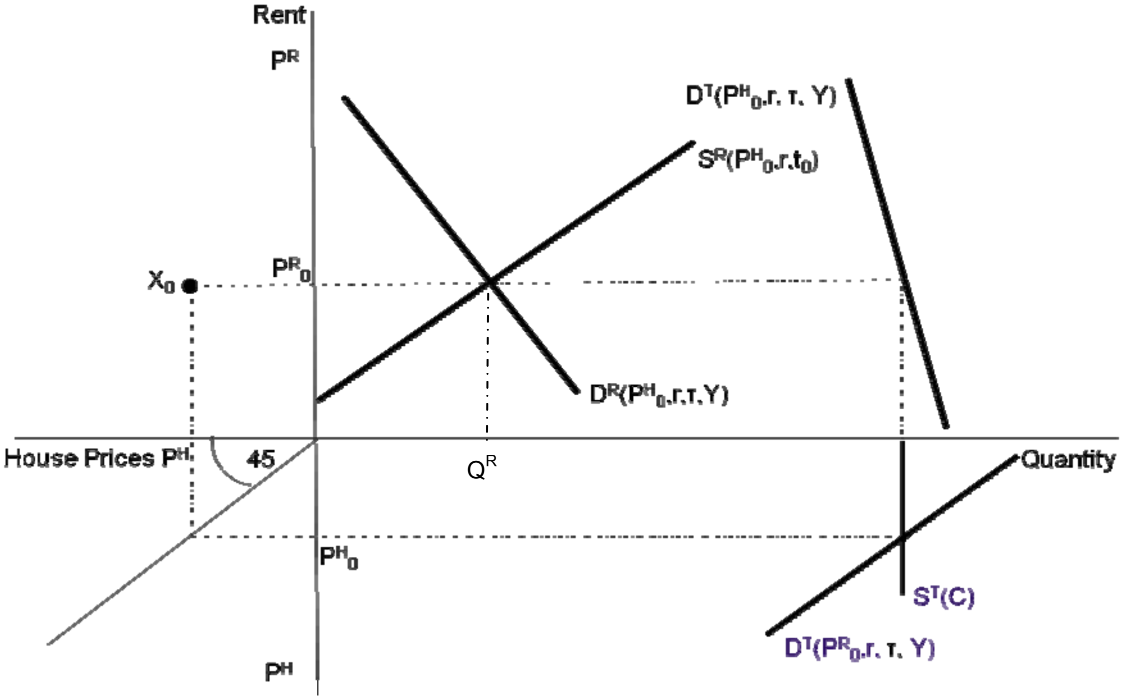
To satisfy the long run equilibrium market clearing condition in the rental market, the quantity of houses demanded for rental must be equal to the total quantity of rental housing supplied by investors. The intersection of the supply and demand curves for rental housing simultaneously sets the market clearing rent (denoted P_0^R), and the quantity of rental housing (Q^R).

The demand curve D^T in the north-east quadrant represents the total demand for housing. The curve traces out the demand for housing as rent varies, for a fixed level of house prices. The demand for housing is made up of the demand by renters and the demand by home owners. It is deliberately drawn steeper than the rental demand curve to reflect the way that substitution between renting and ownership is netted out at the level of total housing demand. The total demand for housing is also a function of the real interest rate (r), real incomes (Y), and subsidies to owner-occupancy (τ).

The supply of housing is drawn as a function of house prices in the south-east quadrant, denoted $S^T(C)$, where C denotes costs of constructing additional housing units. For ease of illustration we will assume the supply of housing is initially fixed (ie, the supply curve is vertical at a given quantity). In the more general case, however, the supply of housing would be an upward sloping function of house prices; other things equal we would expect higher house prices to induce an increase in supply.

The south-east quadrant also displays the demand for housing curve. Each point on this curve corresponds to the level of total demand (D^T) when the rental market (as shown in the north-east quadrant) is in equilibrium. It has the standard downward slope of a demand function: at lower house prices, a greater quantity of housing is demanded.

Figure 1: Prices and quantities in the housing market



The initial equilibrium position in the housing market occurs at a price that equates the supply and demand for housing in the south-east quadrant. When the three curves in the north-east quadrant are drawn incorporating this housing price, the equilibrium rent is shown (P_0^R). In the north-west quadrant, the intersection point marked X_0 corresponds to the equilibrium values of the house price (P_0^H) and the rental price (P_0^R).

The graphical model can now be used to illustrate a change in policy settings (Figure 2 and Figure 3). To illustrate this, we use the case of a "tax" on investors in rental housing. This could take the form of a capital gains tax or a limitation on deducting losses from other sources of taxable income (the so-called "ring-fencing" strategy).

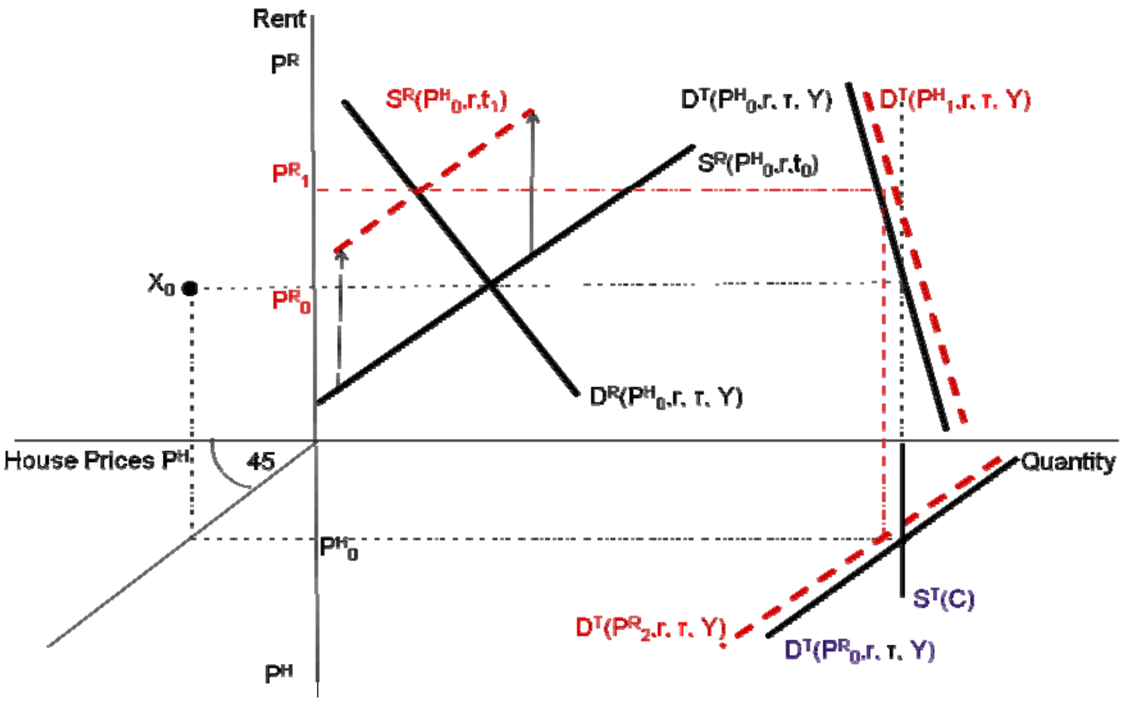
The initial impact is denoted by an increase in the "tax" effect on the supply of rental housing (shown as an increase from t_0 to t_1 in Figure 2). This moves the rental supply curve upward in the north-east quadrant. This movement corresponds to the assumption that the profitability of rental housing would be reduced by the tax for any given rental price, and hence the amount of housing offered for rent by investors would be reduced. To re-establish equilibrium in the rental market, leaving house prices unchanged, requires an increase in rents from their initial level of P_0^R to a new higher level of P_1^R.

Further responses to the initial policy change are shown in Figure 3 which is a continuation of Figure 2. When the stock of housing is fixed, the inward shift in demand will lead to a lower price of housing (P_2^H). However, there are further adjustments in the rental market following this decline in house prices. At any given rent, landlords will be prepared to offer a greater supply of houses. This shifts the rental supply curve to the right in the NE quadrant. At the same time the lower house price makes ownership more attractive than renting so that the demand for rent will contract at any rent level. This shifts the rental demand curve to the left in the NE quadrant.

The consequences of these moves on the supply and demand for rental properties is that a new equilibrium rent P_2^R is reached, which is unambiguously lower than (P_1^R). At this point, the rental and owner occupied markets will be in a new equilibrium position. The effect of the "tax" on rental property will be to lower the price of houses and raise rents, while at the same time increasing home ownership rates.

To this point, we have assumed the initial price of housing is unchanged. However, the change in rents leads to a contraction in demand in the NE quadrant. This reduction in demand at the initial price level corresponds to an inward shift of the demand curve in the SE quadrant. At every house price the total quantity demand will be lower due the higher rents.

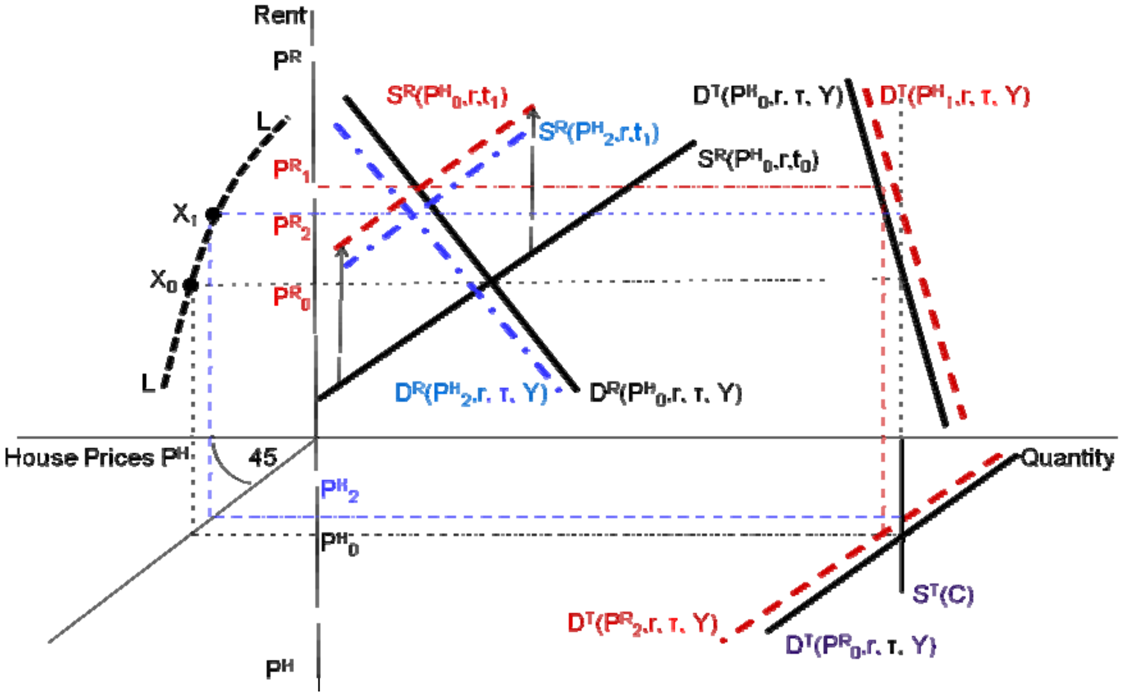
Figure 2: The effect of a policy change on the housing market



This decrease in the total demand for housing occurs because the increase in rents causes households to economise on rental space, all else equal. This comes about through two avenues. In the first place, the average number of occupants per rental unit tends to rise. Second, some people who might have entered the rental market are discouraged by the rise in rents and remain in the house where they are currently living. In other words there is both an intensity effect and a formation effect. The magnitudes of these two effects determine how the demand for rental housing (and hence the total demand for housing) responds to changes in house prices and rents.

The intersection of the new equilibrium prices P_2^H and P_2^R is shown by the point X_1 in the north-west quadrant. There is a curve denoted LL which traces out the locus of the equilibrium prices for rent and houses. In the case of an increase in the tax on rental property, the locus slopes upward to the right as rents rise and house prices fall. Other policies may well result in different changes to the two equilibrium prices and would therefore trace out different loci.

***Figure 3**: The effect of a policy change on the housing market (contd.)*



This example has focussed on the situation in which the stock of housing is fixed. This corresponds to the short run, a period in which changes in policy do not induce a response in the total supply of houses given the lags involved in the preparation of new sites, the obtaining of permits and the construction itself.

What happens in the longer term when the supply can adjust? Following a policy change such as a tax on rental property, the fall in house prices would be muted as the quantity of houses decreases.[4] In fact, in the extreme case when the supply curve is infinitely elastic, shifts in the demand for housing have no effect on house prices as additional houses can be added at the existing costs of land and construction. In this case, the final equilibrium in Figure 3 occurs at rents P_2^R and house prices P_2^H: the increase in taxes causes rents to rise, the quantity of rental houses to fall, and the total quantity of houses to fall. Homeownership rates increase, although this occurs at the expense of less accommodation overall. Clearly, this is the upper bound and in reality we would expect the outcome to be an intermediate case, where there is some decline in house prices and some decline in the total stock of housing.

The diagrams are useful as a guide to the workings of the model and to indicate the *direction* of changes in prices and quantities that could be expected following a change of policy. However, the *magnitude* of any changes is arguably of equal or greater interest. Would rents rise by 1% or 20%? Would house prices fall 2% or 10%? To calculate the magnitude of changes, we require a formal statement of the model in a form that can be used to derive numerical estimates. The next section sets out the model.

[4] The supply of houses would be allowed to contract through depreciation.

4 The Model

The following model of the housing market calculates the equilibrium level of housing quantities, prices and rents as a function of various exogenous factors such as construction costs, interest rates, subsidies and taxes.

The model comprises four basic supply and demand functions:

(i) the demand to rent housing;
(ii) the demand to own housing;
(iii) the supply of housing for rent;
(iv) the total supply of housing.

The five endogenous variables for which the model solves are:

(i) the price to rent a house (P^R);
(ii) the purchase price of a house (P^H);
(iii) the number of houses that are rented (Q^R);
(iv) the number of houses that are owned by owner-occupiers (Q^O); and
(v) the total number of houses $(Q^T = Q^R + Q^O)$.

The last equation simply states that all houses are rented or owner occupied. Each of the four basic equations is specified in terms of prices and a set of exogenous variables. We now describe each equation in turn.

4.1 Demand to rent houses

$$Q^{RD} = D^R(P^R, P^H, \tau, r, Y) \tag{1}$$

The demand to rent houses (Q^{RD}) depends on the rent (P^R), the price of owning a house (P^H), any additional government subsidies to assist home purchase by owner-occupiers (τ), the interest rate (r), and mean household income (Y)[5].

We assume:

$\partial D^R / \partial P^R < 0$: as rents increase, demand for rental property decreases.

$\partial D^R / \partial P^H > 0$: as house prices increase, demand to rent increases.

$\partial D^R / \partial \tau < 0$: as subsidies for ownership increase, demand to rent decreases.

$\partial D^R / \partial r > 0$: as interest rates increase, demand to rent increases.

$\partial D^R / \partial Y > 0$: as mean incomes increase, demand to rent increases.

5 In the formulation of the model that follows we have assumed real incomes are constant. The model could easily be generalised to allow for changes in real incomes.

It is possible that the partial derivatives of the rental demand equation vary considerably with rents and prices. This is because renting a house and owning a house are close substitutes for many people, so small changes in rents, prices or interest rates may lead to sizeable changes in ownership patterns.

4.2 Demand to own houses

$$Q^O = D^O(P^R, P^H, \tau, r, Y) \tag{2}$$

The demand to own houses depends on the rent, the price of owning a house, any subsidies to owner occupiers, the interest rate, and income.

In particular, we assume:

$\partial D^O / \partial P^R > 0$: as rents increase, demand to own houses increases.

$\partial D^O / \partial P^H < 0$: as house prices increase, demand to own decreases.

$\partial D^O / \partial \tau > 0$: as subsidies for ownership increase, demand to own increases.

$\partial D^O / \partial r < 0$: as interest rates increase, demand to own decreases.

$\partial D^O / \partial Y > 0$: as incomes increase, demand to own increases.

4.3 Total demand for houses

$$Q^{TD} = D^T(P^R, P^H, \tau, Y, r) \tag{3}$$

The demand to own and rent are substitutes with partial derivatives of opposing sign. We assume that the total demand for housing is less elastic with respect to the price of houses than either the demand to own or the demand to rent, as these are substitutes for each other.

Spefically:

$\partial D^T / \partial P^R < 0$: as rents increase, total demand for houses decreases.

$\partial D^T / \partial P^H < 0$: as house prices increase, total demand decreases.

$\partial D^T / \partial \tau > 0$: as subsidies for ownership increase, total demand increases.

$\partial D^T / \partial r < 0$: as interest rates increase, total demand decreases.

$\partial D^T / \partial Y > 0$: as incomes increase, total demand increases.

4.4 Supply of houses for rent

$$Q^{RS} = G^R + S^R(P^R, P^H, r, t) \tag{4}$$

The supply of houses for rent comprises the government supply G^R plus the private supply $S^R(P^R, P^H, r, t)$, where t is a measure of the tax on income derived from leasing residential property. We assume the government supply is determined exogenously. The decision to become a private landlord will depend on the relative returns of investing in housing versus other asset types. For a given price and interest rate, an increase in rents makes investment in housing relatively more attractive.

We assume a tax on leased residential property reduces the willingness of landlords to invest in housing. In practice, the tax on leased residential property is lower than the tax on some other classes of investments such as interest earning loans, as various tax concessions exist. For example, in New Zealand tax is not paid on capital appreciation whereas income tax is paid on the inflation component of interest earnings. In the remainder of the paper we primarily analyse the effect of increasing the tax *concession* on residential property earnings, rather than the effect of increasing the tax on residential property earnings. The value of the tax concession to residential property investors increases if there is an increase in the inflation rate or in general income tax rates, as capital gains on residential property are not taxed.[6]

We assume:

$\partial S^R / \partial P^R \geq 0$: as rents increase, willingness to supply rentals increases.

$\partial S^R / \partial P^H \leq 0$: as prices increase, willingness to supply rentals decreases.

$\partial S^R / \partial r \leq 0$: as interest rates rise, willingness to supply rentals decreases.

$\partial S^R / \partial t < 0$: as taxes increase, willingness to supply rentals decreases.

4.5 Total supply of houses

$$Q^{TS} = G^T + S^T(P^H, C) \tag{5}$$

The total supply of houses comprises those built by the government G^T plus those built by the private sector. The level of government construction is assumed to be determined exogenously. The private supply of houses depends on the price P^H and construction costs, C. Construction costs include the cost of developing land, the cost of building materials, labour, and regulatory costs. We examine the supply response over two different time horizons. In the short term, supply is assumed to be perfectly inelastic $(\partial S^T / \partial P^H = 0)$; but in the long term, an increase in prices results in an increase in the number of houses $(\partial S^T / \partial P^H > 0)$.

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[6] In this paper we have not directly modelled the process by which inflation causes property price appreciation, although we do analyse the consequences of an increase the value of the tax concession because of an increase in the inflation rate.

Market clearing conditions

There are two market clearing conditions. First, the supply of rental housing equals the demand for rental housing:

$$F_1(P^R, P^H, \tau, t, r, Y, G^R) = G^R + S^R(P^R, P^H, t, r, Y) - D^R(P^R, P^H, \tau, Y, r) = 0 \qquad (6)$$

Secondly, the total supply of housing equals the total demand for housing:

$$F_2(P^R, P^H, \tau, r, Y, C, G^T) = G^T + S^T(P^H, C) - D^T(P^R, P^H, \tau, Y, r) = 0 \qquad (7)$$

In equilibrium, there is a pair of values of rent (P^R) and prices (P^H) that are consistent with equations (6) and (7). These values are functions of the sets of exogenous variables.

We can write equations (6) and (7) as a system

$$F(P, x) = \begin{bmatrix} F_1(P, x) \\ F_2(P, x) \end{bmatrix} = 0 \qquad (8)$$

where $P = \begin{bmatrix} P^R \\ P^H \end{bmatrix}$ and x is a vector of the exogenous variables.

The implicit function theorem can be used to derive the relationship between rents and prices and the exogenous variables:

$$\begin{bmatrix} \partial P^R/\partial x \\ \partial P^H/\partial x \end{bmatrix} = -\begin{bmatrix} \partial S^R/\partial P^R - \partial D^R/\partial P^R & \partial S^R/\partial P^H - \partial D^R/\partial P^H \\ \partial S^T/\partial P^R - \partial D^T/\partial P^R & \partial S^T/\partial P^H - \partial D^T/\partial P^H \end{bmatrix}^{-1} \begin{bmatrix} \partial F_1/\partial x \\ \partial F_2/\partial x \end{bmatrix} \qquad (9)$$

or $P_x = -F_P^{-1}[F_x]$.

Price effects of the exogenous variables

Equation 10 describes the effect on prices and rents of changes in the level of government ownership (G^R and G^T), taxes on landlords (t), home-owner subsidies (τ), construction costs (C), interest rates (r), and income (Y).

$$\begin{bmatrix} \partial P^R/\partial G^R & \partial P^R/\partial G^T & \partial P^R/\partial t & \partial P^R/\partial \tau & \partial P^R/\partial C & \partial P^R/\partial r & \partial P^R/\partial Y \\ \partial P^H/\partial G^R & \partial P^H/\partial G^T & \partial P^H/\partial t & \partial P^H/\partial \tau & \partial P^H/\partial C & \partial P^H/\partial r & \partial P^H/\partial Y \end{bmatrix} =$$

$$-[F_P]^{-1} \begin{bmatrix} 1 & 0 & \partial S^R/\partial t & -\partial D^R/\partial \tau & 0 & \partial S^R/\partial r - \partial D^R/\partial r & -\partial D^R/\partial Y \\ 0 & 1 & 0 & -\partial D^T/\partial \tau & \partial S^T/\partial C & -\partial D^T/\partial r & -\partial D^T/\partial Y \end{bmatrix} \qquad (10)$$

Note that in the short run $\partial S^T/\partial C = 0$.

These derivatives can be converted into elasticities. Noting that $\partial S / \partial x = \varepsilon_x^s \dfrac{S}{x}$, then

$$F_p = \begin{bmatrix} Q^R / P^R (\varepsilon_{pr}^{SR} - \varepsilon_{pr}^{DR}) & Q^R / P^H (\varepsilon_{ph}^{SR} - \varepsilon_{ph}^{DR}) \\ Q^T / P^R (-\varepsilon_{pr}^{DT}) & Q^T / P^H (\varepsilon_{ph}^{ST} - \varepsilon_{ph}^{DT}) \end{bmatrix}$$

$$= Q^T / P^H \begin{bmatrix} \left({}^{Q^R}\!/\!{}_{Q^T} \right) \left({}^{P^H}\!/\!{}_{P^R} \right) (\varepsilon_{pr}^{SR} - \varepsilon_{pr}^{DR}) & \left({}^{Q^R}\!/\!{}_{Q^T} \right) (\varepsilon_{ph}^{SR} - \varepsilon_{ph}^{DR}) \\ -\left({}^{P^H}\!/\!{}_{P^R} \right) \varepsilon_{pr}^{DT} & (\varepsilon_{ph}^{ST} - \varepsilon_{ph}^{DT}) \end{bmatrix}$$

or $\quad F_p = (Q^T / P^H)[E_p] \qquad (11)$

Let $\quad \alpha^Q = {}^{Q^R}\!/\!{}_{Q^T}$ be the fraction of houses that are rented (approximately 0.3);

$\alpha^P = {}^{P^H}\!/\!{}_{P^R}$ be the ratio of house prices to rents (approximately 20); and

$\alpha^G = {}^{G^T}\!/\!{}_{Q^T}$ be the fraction of houses owned by the government (approximately 0.05).

Then equation (10) can be converted into elasticities as follows:

$$\begin{bmatrix} \varepsilon_{GR}^{PR} / \alpha^P & \varepsilon_{GT}^{PR} / \alpha^P & \varepsilon_{t}^{PR} / \alpha^P & \varepsilon_{\tau}^{PR} / \alpha^P & \varepsilon_{C}^{PR} / \alpha^P & \varepsilon_{r}^{PR} / \alpha^P & \varepsilon_{Y}^{PR} / \alpha^P \\ \varepsilon_{GR}^{PH} & \varepsilon_{GT}^{PH} & \varepsilon_{t}^{PH} & \varepsilon_{\tau}^{PH} & \varepsilon_{C}^{PH} & \varepsilon_{r}^{PH} & \varepsilon_{Y}^{PH} \end{bmatrix} =$$
$$-\left[E_p \right]^{-1} \begin{bmatrix} \alpha^G & 0 & \alpha^Q \varepsilon_t^{SR} & -\alpha^Q \varepsilon_\tau^{DR} & 0 & \alpha^Q (\varepsilon_r^{SR} - \varepsilon_r^{DR}) & -\alpha^Q \varepsilon_Y^{DR} \\ 0 & \alpha^G & 0 & -\varepsilon_\tau^{DT} & \varepsilon_C^{ST} & -\varepsilon_r^{DT} & -\varepsilon_Y^{DT} \end{bmatrix} \qquad (12)$$

Appendix A sets out the predicted signs of the elasticities of rents (P^R) and house prices (P^H) with respect to the exogenous variables.

The response of rents and house prices to changes in incomes, taxes, interest rates, subsidies, construction costs and the quantity of government owned houses can be calculated using equations (8) to (12). To do this, however, we must first establish values for the elasticities involved on the right hand side of these equations. Estimates are presented in the next section.

5 Parameter estimates

Table 1 displays the assumed values of the underlying elasticities. The first entry is for the elasticity of supply of rental housing with respect to the price of rents (denoted in equation (12) as ε_{pr}^{SR}). It has been assigned a value of 1, implying that a 10% increase in the price of rents would induce a 10% increase in the supply of rental housing. The values in the table should be taken as reasonable "guesstimates" consistent with the literature on housing.[7] In Section 7 we illustrate the extent to which our results are sensitive to changes in the values of these parameters.

The elasticities of the total demand for housing with respect to rents and house prices are assumed to be small, -0.2 and –0.1 respectively. The latter value implies a 10% increase in house prices reduces total demand for housing by 1%. While these numbers are small, they appear broadly consistent with New Zealand macroeconomic data, for over the last four decades New Zealand has experienced large variations in real house prices but only very small changes in per capita housing stocks (see the discussion in Appendix B). These elasticities are smaller than estimates for New Zealand recently made by Khaled and Lattimore (2008) using household budget data. Their estimate of the own price elasticity of demand for housing is -0.44. It is not entirely clear how to reconcile these numbers. However, in our model there is no allowance for quality changes, whereas the actual data used by Khaled and Lattimore will capture how price changes lead to changes in the size of houses, or to improvements to existing houses. In contrast, our elasticity only refers to the number of houses.

Table 1: Values assigned to the basic parameters of the model

With respect to…	Elasticity of…			
	Supply of rental housing	Demand for rental housing	Total demand for housing	Total supply of housing
Rent	1.0	-2.0	-0.2	
House price	-1.0	1.0	-0.1	0 or 0.5 or ∞
Tax concession to landlords	-1.0			
Subsidy to ownership		-1.0	0.1	
Interest rate	-1.0	1.0	-0.1	

7 For a summary of empirical studies that estimate a range of elasticities for OECD countries see(Girouard, Kennedy et al 2006).

6 Results

Using the baseline set of elasticity assumptions set out in Table 1, we calculate the response of rents, house prices, and the quantity of houses to five different policy changes or shocks to the housing market. In addition, we calculate the new owner-occupancy rate. (The owner-occupancy rate is always equal to 70% before the shock.)

Table 2: Description of the changes in the policy simulations

Exogenous variables changed in the policy simulations		Description of the change
A.	A 0.5% change in the stock of housing	A 0.5% increase in the total stock of housing is equivalent to a 10% increase in the stock of government owned housing, or 7,500 houses.
B.	A 10% change in the tax concession for landlords (t)	The subsidy to landlords is made up principally of the non-taxation of capital gains, estimated as 1.5% of the value of the house per annum. This is about 30% of the assumed total real return to landlords of 5.0%. A 10% increase would imply this rises by 0.15% from 1.5 to 1.65%. so total returns would increase to 5.15%, equivalent to a 3% increase in total returns.[(a)]
C.	A 10% change in the subsidies to owner-occupancy (τ)	Total subsidies to home owners, comprising principally of the non-taxation of imputed rents, increase by 10%. This is computed as the product of the average owner's equity share and the marginal rate of tax, giving an initial estimate of 16% of the cost of financing. A 10% increase in the subsidy implies a rise from 16.0 to 17.6%.[(a)]
D.	A 10% change in the cost of constructing houses (C)	The cost of building a house, including the land, increases by 10%.
E.	A 10% change in the mortgage interest rate (r)	The mortgage interest rate increase by 10%; for example from 8.0 to 8.8%.

(a) See Appendix B for further details

Each shock represents a 10% change in one of the exogenous variables. The shocks are changes in (i) the stock of housing, (ii) the tax concession to landlords, (iii) the subsidies to owner-occupancy, (iv) the cost of constructing a house, and (v) the interest rate. The description of each of the changes is given in Table 2.

The results, set out in Table 3, are calculated for three values of the housing supply elasticity that reflect three ways that the supply of housing could respond to an increase in house prices. In the first case, it is assumed that the elasticity equals zero, and total supply of housing is fixed. This corresponds to the short run (1 to 2 years), when it is assumed that there is no significant change in the total supply due to lags in the planning, consenting and building process. In the second case, the elasticity is 0.5. This corresponds to the medium term, when there is a supply response to a price increase. In the third case the elasticity is infinity. This corresponds to the long run, when any change in demand is met by sufficient additional supply to hold prices constant. In this case the price of houses is only determined by the cost of land and construction costs. The cases of inelastic supply (the very short run) and infinitely elastic supply (the very long run) can be regarded as the bounds on the responses of rents and house prices to economic shocks.

Table 3: Estimated responses of rents, house prices and quantities

Percentage change in a specified variable:	Responsiveness of the total supply of housing to changes in house prices (The elasticity of total housing supply with respect to the price of houses)		
	Short run (1-2 years) 0 (fixed supply)	Medium term (3-5 years) 0.5 (intermediate case)	Long run (>5 years) ∞ (infinitely elastic)
A. The response to an increase in the stock of housing			
Rents	-1.3	-0.4	0.0
House prices	-2.3	-0.7	0.0
Quantity of rental units	0.3	0.1	0.0
Quantity of total housing	0.5	0.2	0.0
Resulting rate of owner-occupancy	70.05	70.02	70.00
B. The response to an increase in the tax concession to landlords			
Rents	-0.3	-0.5	-0.6
House prices	0.6	0.2	0.0
Quantity of rental units	1.19	1.25	1.28
Quantity of total housing	0.00	0.09	0.13
Resulting rate of owner-occupancy	69.64	69.65	69.66
C. The response to an increase in the subsidy to owner-occupancy			
Rents	0.1	-0.5	-0.85
House prices	1.7	0.5	0.0
Quantity of rental units	-0.55	-0.38	-0.30
Quantity of total housing	0.0	0.26	0.37
Resulting rate of owner-occupancy	70.17	70.19	70.20
D. The response to an increase in the cost of constructing a house			
Rents	0.0	4.0	5.7
House prices	0.0	7.1	10.0
Quantity of rental units	0.0	-1.04	-1.49
Quantity of total housing	0.0	-1.50	-2.15
Resulting rate of owner-occupancy	70.0	69.65	69.76
E. The response to an increase in real interest rates			
Rents	0.3	4.6	6.4
House prices	-10.6	-3.2	0.0
Quantity of rental units	-1.19	-2.29	-2.77
Quantity of total housing	0.0	-1.59	-2.28
Resulting rate of owner-occupancy	70.36	70.21	70.15

The three cases for the elasticity of supply do not imply a dynamic response in the sense that the market would evolve through these stages if a shock occurred. Rather, the model is based on comparative static positions. The results for the inelastic supply case give the equilibrium values of the endogenous variables (prices and quantities) that would occur in the long run if the supply were inelastic. The same equilibrium interpretation is appropriate for the other two cases we present. Provided this caveat is kept in mind it will be convenient to refer to the three cases as the short, medium and long run.

The results are used to calculate the size of the policy change or shock that is necessary to increase the owner-occupancy rate by 1 percentage point in the medium term. In some cases, the results appear quite fanciful, because some policies have only tiny effects on the owner-occupancy rate even though they can have large effects on other aspects of the housing market such as the total quantity of housing. These results suggest that the owner-occupancy rate is, in many respects, a poor indicator of the welfare consequence of housing policies.

6.1 An increase in housing supply

Section A of Table 3 shows the effects of the government increasing the total stock of housing by 0.5%, equivalent to about 7,500 additional houses, or 10% of the government stock. In the short run, the increased stock of houses would reduce rents and house prices by an estimated 1.3% and 2.3% respectively (see the top left hand cells of Table 3) thus improving affordability for both buyers and renters, other things constant. In contrast, in the long run case (with perfectly elastic supply) the government building programme has no effect on prices or quantities as the public investment merely crowds out private investment and the total supply of housing is unchanged (see the third column of Table 3). Only the relative proportions of public and privately constructed housing are altered.

In the medium term, the increase in the stock of housing has very little effect on the owner-occupancy rate: it increases from 70 to 70.02%. The increase is tiny for two reasons. First, there is an offsetting reduction in private sector construction, so that the total stock of houses increases by less than the number of houses the government builds. Second, rents as well as house prices fall, so many of the new houses are occupied by tenants as the low rents induce new households to form. These figures suggest that to increase the owner-occupancy rate by 1% it would be necessary for the government to build houses equal to 25% of the initial stock (375,000 houses) - a clearly fanciful number. If it were to do this, rents would fall by 20%, house prices would fall by 35%, the number of rental units would increase by 5%, and the total stock of houses would increase by 10%. Put another way, a building programme of this size would have enormous effects on the housing market, but very little effect on the owner-occupancy rate. The owner-occupancy rate is the wrong way of measuring the impact of this policy, because it misses the extent to which the number of households increases to take advantage of the lower rents and house prices.

A variant of this scenario is for the government to build the additional houses and then retain them as rental units.[8] This would be equivalent to the case where the Housing New Zealand Corporation owned and managed an increased stock of social housing. The short run increase in the supply of rental housing would result in a fall in rents of 1.6% (in contrast to the initial case of 1.3%), and a fall in house prices of 1.6% (instead of 2.3%). In other words, the drop in house prices is moderated in the event these units are not put up for sale to the private sector. In the long run case there is still no effect on rents and prices but the additional rental properties owned by the government would, other things equal, lower the owner-occupancy rate.

[8] These results, not reported in detail here, are available on request.

6.2 An increase in the tax concession to landlords

Under the existing tax regime, there are two principal concessions made to landlords. In the first instance, landlords typically do not pay tax on capital appreciation. If there is inflation, investors in leased residential property have a tax advantage over investors who simply invest in interest-bearing accounts, in which the inflation component of interest earnings is subject to tax. When the inflation rate is 3%, this tax advantage is worth 1.5% of the value of the property. This has the effect of making investment in rental property more attractive than would otherwise be the case. Furthermore, those who have some debt financing have the opportunity to reduce their tax liability by offsetting any interest payments associated with the rental property against other sources of income.

A 10% increase in tax concessions to landlords is worth 0.15% of the value of the property (ie, 10% of 1.5%). If the total real return to property investors (rent plus capital appreciation) is assumed to be 5% in the long run, the increase in the tax concession increases the total yield by 3%, from 5 to 5.15%. In the short run, an increase in the tax concession received by landlords leads to a 1.2% increase in the quantity of properties for rent, lowering rents by 0.3% and increasing house prices by 0.6%. In the long run, the quantity of properties for rent increases by a similar amount, but house prices are unchanged and rents fall by 0.6%. In all cases the effect of increasing the tax concession is to shift the tenure mix towards a lower proportion of owner-occupancy and a higher proportion of renting. In the medium term scenario, the effect of the increase in the tax concession is to lower the owner-occupancy rate from 70 to 69.65%.

These figures suggest that it would be necessary to reduce the size of the tax concession by 29% in order to increase the owner-occupancy rate by 1% in the medium term, that is from 1.5% of the value of the property to 1.1% of the value of the property, or by approximately $1,200 per year per property. A reduction of this size could be achieved by increasing the amount of tax paid by landlords or by lowering the inflation rate from 3% per annum to 2%. If the tax concession was reduced by this amount, rents would increase by 1.5%, house prices would decrease by 0.6%, the quantity of rented homes would decline by 3.6%, and the total quantity of houses would decline by 0.25%, equivalent to some 4,000 houses. The increase in owner-occupancy rates and the increase in the welfare of those who buy would therefore come at the expense of a decrease in the welfare of those who rent. The results in the long run case are similar except house prices do not decrease.

6.3 An increase in subsidies to owner-occupancy

There is an extensive range of subsidies to home ownership, both indirect and explicit. Indirect subsidies are delivered by the tax system through the exemption of imputed rents from taxation (although the inability to deduct mortgage-interest payments has to be set against this). The government offers inducements to home ownership through such programmes as Welcome Home, a recently introduced shared equity scheme (essentially an interest-free second mortgage) and through the first home deposit subsidies for eligible households linked to KiwiSaver. We estimate these subsidies reduce the financing cost of owning a home (the real interest rate multiplied by the price of a house) by 16%, or approximately $2,500 per year.[9] A 10% increase in the value of the subsidies (compared

[9] At 5% real interest rates, the financing cost of owning a $300,000 home is $15,000 per year. $2,500 is 16% of this amount. The benefit disproportionately goes to those who own their own home outright.

with no subsidies) therefore reduces the financing cost of owning a home by 17.6% (ie, 16% * 1.1).

In the short run a 10% increase in the subsidy will increase the demand for housing, and house prices will be driven up, by 1.7%. In effect, a part of any subsidy is capitalised into house prices. The higher house prices lead to a modest increase in rents, by 0.1%, and a 0.55% decline in the quantity of rented housing. The net effect is to raise the rate of owner-occupancy from 70 to 70.17%. In the long run, there is no effect on house prices, as more houses are constructed in response to the higher demand. In this case, the ownership subsidies lead to a 0.85% reduction in rents (due to the lower demand), and a 0.13% increase in the total quantity of housing. The effect on the owner-occupancy rate is similar to the short run case.

These figures imply that to increase the owner-occupancy rate by 1% in the medium term, it would be necessary to increase the subsidy to home-owners by 53%. This would be equivalent to approximately $1,250 per owner-occupier household per year. This would have the additional effect of lowering rents by 2.6%, increasing house prices by 2.6%, lowering the quantity of rental accommodation by 2%, and increasing the total quantity of houses by 1.4%. The results in the perfectly elastic case are similar, except there is no change in house prices and a larger increase in the housing stock.

6.4 Increase in the cost of constructing a house

The cost of a house reflects three major components: the land, the materials and labour input, and the costs of the regulatory regime and consent process. Suppose there is a 10% increase in the cost of a house from any one (or combination) of these elements. In the short run, with an inelastic supply, there is no impact on the housing market. In the medium and longer terms however, house prices rise; in the extreme case they simply rise by the full 10% of the cost increase. Rents also rise, by up to 5.7%. The combined effect of an increase in building costs is to reduce the quantity of rented houses by more than 1% and the total quantity of houses by more than 1.5%. The owner-occupancy rate falls.

This model suggests it would be necessary to reduce building costs by 29% in order to increase the owner-occupancy rate by 1% in the medium term. This would have the additional effects of lowering rents by 11%, reducing house prices by 22%, increasing the quantity of rental accommodation by 3%, and increasing the total quantity of houses by 4%. The results in the perfectly elastic case are qualitatively similar, except there is a larger change in house prices and a larger increase in the housing stock. This is the only policy that simultaneously reduces rents and house prices, increases the quantity of housing and raises owner-occupancy rates.

6.5 Increase in real interest rates

The final case corresponds to a 10% increase in mortgage interest rates. This increases the financing costs of home purchase and reduces demand. In the short run house prices fall by 10.6% and rents increase marginally. This fall is moderated in the medium term, and in the case of an infinitely elastic supply of housing there is no price adjustment, but rents increase by 6%. The total quantity of housing declines by more than 1.5% but the owner-occupancy rate increases. Higher real interest rates then are typically associated with a combination of a fall in house prices, higher rents and a rise in owner-occupancy rates.

These figures suggest that to increase the owner-occupancy rate by 1% in the medium term, real interest rates would need to *increase* by 48%. This would have the additional effects of increasing rents by 22%, reducing house prices by 15%, reducing the quantity of rental accommodation by 11%, and reducing the total quantity of houses by 8%. Thus an increase in interest rates will raise owner-occupancy rates, but at the expense of sharply reducing the quantity of housing.

In this regard, it is instructive to recall the period from the late 1980s until 2005. Real interest rates fell from over 10% to under 5%; ie, a 50% reduction. The current model predicts that such a change would be accompanied by a substantial increase in real house prices, a construction boom, a fall in rents and a drop in home ownership rates. These outcomes were exactly those observed over this period.

Table 3 indicates that the effect of interest rates on the housing market is very different in the short run and the long run. In the short run, a decline in interest rates leads to a large increase in house prices, and little change in rents, whereas in the medium term and long term there is only a small effect on house prices but a large expansion in the quantity of housing and a significant decline in rents. By most welfare metrics *except* the owner-occupancy rate, low interest rates are much better for the housing market than high interest rates. The transition from a high interest rate environment to a low interest rate environment can be difficult to manage, however, because of the tendency for house prices to overshoot in the short run (Coleman and Landon-Lane 2007).

7 Sensitivity to changes in the underlying assumptions

To this point the results have been based on the basic set of parameters assumed in Table 1. Inevitably, one never has precise estimates of these parameters. It is therefore prudent to explore the extent to which the results are robust to changes in the underlying parameters. Models of the type developed here are more useful for policy analysis if the results hold broadly across a range of possible values for the key parameters.

The sensitivity of the model's results to a wide range of parameters was tested. In order to explore a substantial change, we varied five of the key parameters over a wide range, assigning four values to each. We then re-estimated the changes in each of the five endogenous variables to each of the five shocks. In each case we computed the responses for the three values of the supply elasticity of housing, corresponding to the short, medium and long run cases.

The results in Section 6 remained remarkably consistent across this extensive range of alternative assumptions about the values of the underlying parameters.[10] For example, consider Table 4, which shows the effect of varying the elasticity of the demand for housing with respect to rents (denoted ε_{pr}^{DT}) when there is an increase in the tax concession to landlords. As this elasticity varied from -0.05 to -0.40, rents declined by between 0.48 and 0.59%; house prices rose by between 0.16 and 0.20%; and there was virtually no variation in the change in the number of houses in response to the increased tax concessions. However, in contrast to this robustness, a notable exception was the response to changes in the elasticity of supply of rental property with respect to the real rate of return to landlords. This term (denoted as ε_{ϕ}^{SR}), describes how the quantity of rental property supplied by landlords responds to changes in the real rate of return.[11] To illustrate: if the long run real return to investors were to increase from 4% to 5% (a 25% increase), and this were to result in a 12.5% increase in the supply of rental property, the value of this elasticity would be 0.5 (=12.5/25).

Table 5 presents the changes in prices and quantities following a 10% increase in the tax concession to landlords (raising their overall yield from 5 to 5.15%). The results are given for four values of the elasticity of rental supply with respect to the real pre-tax return to investors: 0.25, 0.5, 1.0 and 2.0. The base case, used in Table 3, is 0.5.

To illustrate, consider the first block in Table 5 which indicates the amount by which rents would fall given a 10% increase in the tax concession to investors.[12] The top left hand cell contains the value -0.17. This means that if the elasticity of rental supply (denoted ε_{ϕ}^{SR}) were 0.25, and if the pre-tax real return were to be raised by 10% as a result of an *increase* in the tax concessions, rents would *fall* in the short run by 0.17%.[13] Looking

[10] Results are available on request.

[11] Full details of this key elasticity are developed in Appendix B.

[12] Alternatively, these results can be read as the amount by which rents would rise if the tax concessions to landlords were to be curtailed such that their real pre-tax returns fell by 10%. This simply involves reversing the sign on the responses shown in the body of the table.

[13] Alternatively, a reduction in the tax concessions would lead to a rise in rents of this amount (ie =0.17%).

down the same column it will be seen that the quantity of rental units would increase by 0.66%. If landlords were very sensitive to their real after-tax returns (ε_{ϕ}^{SR} = 2.0, as in the last column of Table 5), a 10% *increase* in the tax concessions to investors would lead to a *fall* in rents of 0.73% and an expansion in the long run supply of rental properties of 2.93%.

Table 4: The responses of prices and quantities in the housing market following a 10% increase in the tax concession to landlords under a range of values for the elasticity of demand for property with respect to the price of rents

	Elasticity of supply of housing with respect to price of houses (ε_{ph}^{ST})	Values of the elasticity of the demand for property with respect to rents (ε_{pr}^{DT})			
		-0.05	-0.1	-0.2 Base case(a)	-0.4
% change in rents	0.0	-0.50	-0.41	-0.30	-0.19
	0.5	-0.59	-0.57	-0.54	-0.48
	∞	-0.64	-0.64	-0.64	-0.64
% change in house prices	0.0	0.25	0.40	0.59	0.77
	0.5	0.20	0.19	0.18	0.16
	∞	0	0	0	0
% change in quantity of rental units	0.0	1.24	1.22	1.19	1.16
	0.5	1.23	1.23	1.25	1.28
	∞	1.28	1.28	1.28	1.28
% change in quantity of total housing	0.0	0	0	0	0
	0.5	0.10	0.10	0.09	0.08
	∞	0.03	0.06	0.13	0.26
Resulting owner-occupancy rate	0.0	69.63	69.63	69.64	69.66
	0.5	69.66	69.66	69.65	69.64
	∞	69.63	69.64	69.65	69.69

(a) The numbers in bold correspond to the values of the base case reported in Table 3, Section B.

In general these results show that there can be quite significant changes in the relative sizes of the responses in prices and quantities as we vary the elasticity of supply of rental properties with respect to the return to investors. In short, much depends on how sensitive investors are to changes in after-tax real returns on rental property. This is clearly a critical issue and there has been only limited work in New Zealand on the behaviour of investors in rental property (van Zijl de Jong and Scobie 2007).

Table 5: The responses of prices and quantities in the housing market following a 10% increase in the tax concession to landlords under a range of values for the elasticity of supply of rental housing with respect to the return to landlords

	Elasticity of supply of housing with respect to price of houses (ε_{ph}^{ST})	Values of the elasticity of supply of rental property with respect to the real pre-tax rate of return to investors (ε_{ϕ}^{SR})			
		0.25	0.5 Base case(a)	1.0	2.0
% change in rents	0.0	-0.17	-0.33	-0.49	-0.73
	0.5	-0.29	-0.54	-0.92	-1.43
	∞	-0.35	-0.64	-1.11	-1.76
% change in house prices	0.0	0.33	0.59	0.98	1.46
	0.5	0.10	0.18	0.31	0.48
	∞	0	0	0	0
% change in quantity of rental units	0.0	0.66	1.19	1.97	2.93
	0.5	0.68	1.25	2.14	3.33
	∞	0.69	1.28	2.22	3.53
% change in quantity of total housing	0.0	0	0	0	0
	0.5	0.05	0.09	0.15	0.24
	∞	0.07	0.13	0.22	0.35
Resulting owner-occupancy rate	0.0	69.81	69.64	69.41	69.12
	0.5	69.81	69.65	69.40	69.07
	∞	69.81	69.66	69.40	69.05

(a) The numbers in bold correspond to the values of the base case reported in Table 3, Section B.

8 Conclusions

The complexity of housing markets makes it difficult to draw conclusions about the possible impact of public policies in the absence of an analytical framework. The principal objective of this paper has been to provide a framework that is rich enough to capture the key characteristics of the housing market, but which is simple enough for everyday use. This was done by developing a model of the housing market that captures the essential supply and demand elements of both the rental market and the owner-occupancy market, and which allows prices and quantities to adjust in response to policy interventions. The model is simple enough to have a straightforward graphical representation, and to be solved on a spreadsheet, while sophisticated enough to allow for complex feedback loops.

The key feature of the model is that it allows both rental and ownership tenure options. The interaction between the rental and owner-occupancy segments of the market means that prices and quantities in the rental market are determined simultaneously with prices and quantities in the owner-occupancy market. The demand for both classes of property includes a household formation effect, an intensification effect (a change in the number of people per household), and the substitution between the two market segments. Because of the substitution effect, the rental property demand is much more elastic than total housing demand.

The model can be used to assess the impact of a range of policy interventions in the housing market. A series of policy simulations are presented, based on estimates of the underlying parameters. The simulations investigate the consequence on the housing market of five different classes of policy interventions or economic shocks: changes in the number of houses, tax concessions to landlords, home-ownership subsidies, construction costs, and interest rates. The model shows how rents, house prices, the number of houses and the owner-occupancy ratio are impacted by the changes.

An important insight stemming from these simulations is that the owner-occupancy rate is a very poor measure of the state of the housing market. The owner-occupancy rate could be increased by 1% by any one of the following policies: the government could build (and sell) 375,000 houses; construction costs could fall by 29%, real interest rates could increase by 48%; the government could reduce the tax concession available to landlords by 29%, or approximately $1,200 per property; or the government could increase the subsidy to owner-occupiers by 53% or approximately $2,500 per household.

The first three of these changes represent enormous interventions. However, they are large not because these interventions have little effect on the housing market but because they change the incentives facing landlords and homeowners in the same way, so induce only minor changes in the owner-occupancy ratio. For example, the reduction in construction costs that increases the owner-occupancy rate by 1% lowers house prices by 22%, rents by 11% and increases the quantity of houses by 4%; the change in interest rates that has the same effect on the owner-occupancy rate lowers house prices by 15% but raises rents by 22% and reduces the quantity of housing by 8%. In these cases the owner-occupancy rate says little about the overall state of the housing market. Clearly the former change has better housing market outcomes than the latter.

Even in the case that a policy intervention has a direct effect on the incentives facing landlords or homeowners, the owner-occupancy rate is a poor measure of the state of the housing market. For example, a rise in the owner-occupancy rate can be induced by either an increase in the tax on landlords or an increase in the subsidy for home-owners. The former raises rents, lowers house prices and reduces the quantity of housing; the latter lowers rents, raises house prices and increases the quantity of housing. The distributional implications for those who rent and those who already own homes are clearly different, yet the effect on the owner-occupancy rate is the same. Part of the problem is that the owner-occupancy rate largely misses the way that households endogenously form or dissolve in response to changes in rents and house prices.

Overall owner-occupancy rates can fall even if the number of young households owning their own home increases. This is because household formation can change in response to lower rents. There may be more couples deciding to split up because they can afford to live separately (with at least one renting). Young people and students may leave home earlier than otherwise and rent. Flats of four people may form two flats of two people, or flats of two people may choose to live as singles. All of this increases the number of renting households and improves welfare, without decreasing the number of people owning their own home. Hence as more households form the owner-occupier rate may fall, merely because of greater numbers of people choosing to rent. This result carries no implication that overall welfare was lower, and highlights the need for caution when using the owner-occupancy rate as either a target for, or an indicator of public policy in the housing sector.

The model suggests that in the medium term the largest effect on housing affordability would result from either lowering construction costs or reducing real interest rates. A 10% reduction in either would increase the quantity of housing by 1.5%, and lower rents by 4%. Both would reduce the financing cost of owning a house by 7%, although in the event that real interest rates declined, house prices would rise and owner-occupancy rates would fall.

Both changes are feasible. First, real construction costs were at record levels in 2007 as a result of a construction boom. It therefore seems likely they could fall as demand pressures ease. Furthermore, current policy initiatives could well reduce some elements of the various regulatory and compliance costs. In addition, for the last two decades New Zealand has had some of the highest real interest rates in the world. Were New Zealanders able to borrow at real interest rates closer to world averages, housing affordability could improve by an amount that would dwarf any likely effect of interventions that subsidise owner-occupancy.

Two critical factors influence the success of any intervention in the housing market. These are the responsiveness of the supply of rental property to the rate of return to investors, and the responsiveness of the construction sector to house prices. Rents, house prices and the quantity of rental units are all much more responsive to a change in the investor returns when the supply elasticity of rental property with respect to returns is higher rather than lower. Unfortunately, little is known about this parameter, or the factors that influence entry and exit of investors into the residential property market. The importance of this parameter in the model suggests that it is a prime topic for further research.

The model also shows that the way demand conditions effect house prices depends critically on the elasticity of the total supply of housing with respect to prices. This underscores the importance of regulatory and consent procedures that facilitate rather than hinder the growth of the housing stock. The speed that housing supply responds to demand shocks is particularly important in an environment where demand shocks such as changes in interest rates or migration inflows and outflows are common. If the supply of housing responds only slowly to demand shocks, price bubbles may occur, resulting in exaggerated swings in the housing market.

The tractability of the model required some simplifying assumptions. The model treats the housing market as a national integrated market of houses of uniform quality and thus makes no allowance for regional patterns. Nor does it explicitly address differences in the quality of housing. To the extent that regional markets and the markets for houses of varying quality are linked, this is not as serious a limitation as might first appear. A change in one part of the market will have flow through effects on other regions. In regard to quality, the quantity supplied and demanded can be thought of as applying to standardised housing units that have incorporated an adjustment for quality.

A second limitation is that the model is purely static. It allows us to consider the market with or without a change in taxes, for example, but is silent on the adjustment path from the existing to the new position. As it focuses on the fundamental drivers of the housing market, it abstracts from the role played by expectations in determining house prices in the short run. This is quite appropriate when choosing between different long run housing policies. In this case, the short run dynamics are of less concern. Nonetheless, there is considerable evidence that house prices fluctuate excessively in the short run because price expectations in housing markets are not fully rational. For this reason, it may be worth adding dynamic elements to the model to enhance its capacity to track short run movements in house prices.

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Appendices

Appendix A: Signs of the elasticities

This appendix sets out the predicted signs of the elasticities of rents (P^R) and house prices (P^H) with respect to the five exogenous variables: income (Y), taxes (t), interest rate (r), subsidies (τ) and construction costs (C).

Consider the matrix (E_p) from equation (4). Given our assumptions,

$$E_p = \begin{bmatrix} \alpha^Q \alpha^P (\varepsilon_{pr}^{SR} - \varepsilon_{pr}^{DR}) & \alpha^Q (\varepsilon_{ph}^{SR} - \varepsilon_{ph}^{DR}) \\ -\alpha^P \varepsilon_{pr}^{DT} & (\varepsilon_{ph}^{ST} - \varepsilon_{ph}^{DT}) \end{bmatrix} \text{has signs} \begin{bmatrix} + & - \\ + & + \end{bmatrix} \text{and } \det(E_p) \text{ is positive.}$$

It follows that

$$E_p^{-1} = \frac{1}{\det(E_p)} \begin{bmatrix} (\varepsilon_{ph}^{ST} - \varepsilon_{ph}^{DT}) & -\alpha^Q (\varepsilon_{ph}^{SR} - \varepsilon_{ph}^{DR}) \\ +\alpha^P \varepsilon_{pr}^{DT} & \alpha^Q \alpha^P (\varepsilon_{pr}^{SR} - \varepsilon_{pr}^{DR}) \end{bmatrix} \text{ has signs } \begin{bmatrix} + & + \\ - & + \end{bmatrix}.$$

The signs of the derivatives in equation 4:

$$\text{If } \begin{bmatrix} -\alpha^Q \varepsilon_Y^{DR} \\ -\varepsilon_Y^{DT} \end{bmatrix} \quad \text{has signs} \begin{bmatrix} ambiguous \\ - \end{bmatrix} \quad \text{then} \begin{bmatrix} \varepsilon_t^{PR} \; ambiguous \\ \varepsilon_t^{PH} \; ambiguous \end{bmatrix} \qquad \text{(A1)}$$

$$\text{If } \begin{bmatrix} \alpha^Q \varepsilon_t^{SR} \\ 0 \end{bmatrix} \quad \text{has signs} \begin{bmatrix} - \\ 0 \end{bmatrix} \quad \text{then} \begin{bmatrix} \varepsilon_t^{PR} > 0 \\ \varepsilon_t^{PH} < 0 \end{bmatrix} \qquad \text{(A2)}$$

$$\text{If } \begin{bmatrix} \alpha^Q (\varepsilon_r^{SR} - \varepsilon_r^{DR}) \\ -\varepsilon_r^{DT} \end{bmatrix} \quad \text{has signs} \begin{bmatrix} - \\ + \end{bmatrix} \quad \text{then} \begin{bmatrix} \varepsilon_r^{PR} ambiguous \\ \varepsilon_r^{PH} < 0 \end{bmatrix} \qquad \text{(A3)}$$

$$\text{If } \begin{bmatrix} -\alpha^Q \varepsilon_\tau^{DR} \\ -\varepsilon_\tau^{DT} \end{bmatrix} \quad \text{has signs} \begin{bmatrix} + \\ - \end{bmatrix} \quad \text{then} \begin{bmatrix} \varepsilon_\tau^{PR} ambiguous \\ \varepsilon_\tau^{PH} > 0 \end{bmatrix} \qquad \text{(A4)}$$

$$\text{If } \begin{bmatrix} 0 \\ \varepsilon_C^{sT} \end{bmatrix} \quad \text{has signs} \begin{bmatrix} 0 \\ + \end{bmatrix} \quad \text{then} \begin{bmatrix} \varepsilon_C^{PR} > 0 \\ \varepsilon_C^{PH} > 0 \end{bmatrix} \qquad \text{(A5)}$$

Appendix B: Derivation of the values of key elasticities

(1) The elasticity of supply of rental property

(a) Preliminaries

The first step in calculating the elasticity of supply of rental property with respect to rents, house prices, and taxes is to calculate how the supply of rental property varies with the pre-tax real rate of return. The pre-tax rate of return depends on the rent (after costs such as insurance and rates), the capital appreciation on a property, and the tax arrangements. We define a pre-tax-equivalent return for a particular after-tax return as the pre-tax return that would generate that after-tax return if income tax were paid on the full return. This is derived below.

Let:

P^H = the price of a rental house;

P^R = the rent on a leased house;

$p^r = P^R / P^H$ = rent as a fraction of the house price;

π = the rate of property appreciation, which is untaxed;

m = the income tax rate;

t = the pre-tax value of the tax concession of not taxing property appreciation;

Φ = annual pre-tax equivalent return from owning a rental property, in dollars;

ϕ = annual pre-tax equivalent return from owning a rental property, in percentage terms.

The after-tax return to a property investment is

$$[p^r(1-m)+\pi]P^H$$

Let $t = m\pi/(1-m)$ be the pre-tax value of the tax concession that comes from not taxing the capital appreciation on property. Then

$$[p^r(1-m)+\pi]P^H = [p^r+\pi+t](1-m)P^H \tag{B.1}$$

Consequently the pre-tax equivalent return is :

$$\Phi = \left[p^r+\pi+t\right]P^H$$
$$\phi = \left[p^r+\pi+t\right] \tag{B.2}$$

Currently in New Zealand, $p^r \approx 0.035$, $\pi \approx 0.03$, $m = 0.33$, and $t \approx 0.015$. Thus the total pre-tax nominal return is approximately 8% $(0.035+0.03+0.015)$ and the pre-tax real return is approximately 5% $(8-\pi)$.

Let ε_{ϕ}^{SR} be the elasticity of rental supply with respect to the real rate of return: $\varepsilon_{\phi}^{SR} = \frac{\partial Q^R}{\partial \phi} \cdot \frac{\phi}{Q^R}$. This is the key elasticity from which the others are calculated. Our baseline assumption is that $\varepsilon_{\phi}^{SR} = 0.5$. This means, for example, that a one percentage point increase in the real rate of return from 5 to 6% increases the quantity of rentals by 10%. We judge that a reasonable range for this parameter is $0.25 \le \varepsilon_{\phi}^{SR} \le 1$, implying a one percentage point increase in the expected real rate of return raises the quantity of rentals by between 5 and 20%.

(b) The elasticities of rental supply with respect to various prices

(i) Elasticity of rental supply with respect to rent

The elasticity with respect to the rent P^R is calculated as follows:

$$\varepsilon_{pr}^{SR} = \frac{\partial Q^R}{\partial P^R} \cdot \frac{P^R}{Q^R} = \frac{\partial Q^R}{\partial \phi} \frac{\partial \phi}{\partial P^R} \cdot \frac{P^R}{Q^R} = \frac{\partial Q^R}{\partial \phi} \cdot \frac{1}{P^H} \cdot \frac{\phi}{\phi} \cdot \frac{P^R}{Q^R} = \frac{p^r}{\phi} \varepsilon_{\phi}^{SR} \tag{B.3}$$

In the above parameterization, $p^r = 0.035$ and $\phi = 0.05$, so $\varepsilon_{pr}^{SR} \approx 0.7 \varepsilon_{\phi}^{sr}$.

(ii) Elasticity of rental supply with respect to tax

The elasticity with respect to the tax concession t is calculated as follows:

$$\varepsilon_{t}^{SR} = \frac{\partial Q^R}{\partial t} \cdot \frac{t}{Q^R} = \frac{\partial Q^R}{\partial \phi} \frac{\partial \phi}{\partial t} \cdot \frac{t}{Q^R} = \frac{\partial Q^R}{\partial \phi} \cdot \frac{\phi}{Q^R} \cdot \frac{t}{\phi} = \frac{t}{\phi} \varepsilon_{\phi}^{SR} \tag{B.4}$$

In the above parameterization, $t \approx 0.015$ and $\phi = 0.05$, so $\varepsilon_{t}^{SR} \approx 0.3 \varepsilon_{\phi}^{SR}$.

(iii) Elasticity of rental supply with respect to interest rates

We assume that the elasticity with respect to interest rates is equal but opposite in sign to the elasticity with respect to the rate of return on property: $\varepsilon_{r}^{SR} = -\varepsilon_{\phi}^{SR}$.

(iv) Elasticity of rental supply with respect to house prices

The elasticity of rental supply with respect to house prices is complicated. For a given rental income, an increase in house prices lowers the rate of return. However, if the property continues to appreciate at the inflation rate π, a 1% increase in house prices will not lead to a 1% decrease in the total rate of return. Rather, the total return will have only decreased by the ratio p^r / ϕ:

$$\varepsilon_{ph}^{SR} = \frac{\partial Q^R}{\partial P^H} \cdot \frac{P^H}{Q^R} = \left(\frac{\partial Q^R}{\partial \phi} \cdot \frac{\phi}{Q^R} \right) \left(\frac{\partial \phi}{\partial P^H} \cdot \frac{P^H}{\phi} \right) = -\frac{p^r}{\phi} \varepsilon_{\phi}^{SR} \tag{B.5}$$

as $\phi = \left(P^R / P^H + \pi + t \right)$ and so $\partial \phi / \partial P^H = -P^R / (P^H)^2 = -p^r / P^H$.

In the above parameterization, $p^r = 0.035$ and $\phi = 0.05$, so $\varepsilon_{ph}^{SR} \approx -0.7 \varepsilon_{\phi}^{SR}$.

(2) The elasticity of demand to rent or own property for own use

(a) Preliminaries

We assume that the total demand for housing and the demand to live in rental housing depend on the rent charged and the after-subsidy cost of financing the purchase of a house, P^{h*}. The latter can be thought of as the annual opportunity cost of purchasing a house at a price P^H; this is $P^{h*} = (1-\tau)rP^H$. The demand functions can thus be written as

$$Q^{DR} = D^R(P^R, P^{h*}, X)$$
$$Q^{DT} = D^T(P^R, P^{h*}, X) \tag{B.6}$$

The key parameters to estimate that correspond to the first equation are the elasticity of the demand to rent housing with respect to the price of rent and the elasticity of the demand to rent housing with respect to the finance cost of housing.

Denote the elasticity of the demand to rent with respect to the financing cost of housing P^{h*} as ε^{DR}_{ph*}. The elasticities with respect to τ, r, and P^H are given by:

$$\varepsilon^{DR}_{\tau} = \frac{\partial D^R}{\partial \tau}.\frac{\tau}{Q^R} = \frac{\partial D^R}{\partial P^{h*}}.\frac{\partial P^{h*}}{\partial \tau}\frac{P^{h*}}{Q^R}\frac{\tau}{P^{h*}} = \frac{-\tau}{(1-\tau)}\varepsilon^{DR}_{ph*} \tag{B.7}$$

$$\varepsilon^{DR}_{r} = \frac{\partial D^R}{\partial r}.\frac{r}{Q^R} = \frac{\partial D^R}{\partial P^{h*}}.\frac{\partial P^{h*}}{\partial r}\frac{P^{h*}}{Q^R}\frac{r}{P^{h*}} = \varepsilon^{DR}_{ph*} \tag{B.8}$$

$$\varepsilon^{DR}_{ph} = \frac{\partial D^R}{\partial P^h}.\frac{P^h}{Q^R} = \frac{\partial D^R}{\partial P^{h*}}.\frac{\partial P^{h*}}{\partial P^h}\frac{P^{h*}}{Q^R}\frac{P^h}{P^{h*}} = \varepsilon^{DR}_{ph*} \tag{B.9}$$

A similar derivation holds for the elasticities of the total demand for housing with respect to home-ownership subsidies, interest rates, and house prices.

(b) Subsidies to home ownership

The main subsidy or tax concession to home ownership in New Zealand occurs because imputed rent is not taxed, whereas interest and dividends from other sorts of capital are taxed. *If one owns capital* and is choosing whether to (a) rent a property and invest in interest and dividend earning assets or (b) purchase a property to live in, there is an incentive to purchase a property to live in because the imputed rent is not taxed. The subsidy in this case is the average tax rate on capital income. If one does not own capital and must borrow the purchase price, there is no advantage. The extent of the subsidy therefore depends on the extent to which property is owned outright.

We use a value of $\tau = 1/6$. This is calculated by averaging the value of the subsidy across three groups: the third of households that own a house without a mortgage, the third of households that own a house with a mortgage, and the third of households that rent.[14] In each case, we assume the average tax rate on capital income is 0.30.

[14] Even though people who rent are not taking advantage of the subsidy, the subsidy affects their decision of whether to rent or buy. We include in this calculation the value of the subsidy to renters if they were to purchase.

The first group is easiest to calculate, as they get the full tax concession. The tax concession for the other groups depends on the capital they have to contribute to the purchase of a house. We assume the average mortgage is half the value of the property for the group that has mortgages, and the average mortgage would be 90% of the value of the property for those that do not. This implies a value for $\tau = 0.30*1/3(1+0.5+0.1) = 0.16$. We round this to 1/6. We use the same parameter in the equation for the total demand for housing.

(c) Demand elasticities with respect to rent and housing finance costs

The data in Tables B.1 and B.2 summarise the evolution of property prices, rents, and the quantity of properties in New Zealand since 1991. The population figures and number of houses come from the census while the price and interest rate data are from the Reserve Bank of New Zealand. The interest rate is the average mortgage rate adjusted for the inflation rate.[15] The data refer to the March quarter of each census year.

The raw data are in Table B.1. In Table B.2, two adjustments are made to these data to aid comparability between years. First, the prices of houses and rents are deflated by the consumer price index. Second, the quantity of houses is adjusted for population. This is done by multiplying the number of houses in an earlier year *t* by the ratio of the 2006 population to the population in year *t*. Thus the table shows the number of houses that would have existed if the country had the 2006 population but same per capita ratios of houses.

The data show that on a per capita basis the total number of houses increased by only 4% over the 15 year period. The number of rental units increased by 23%. Almost all of the latter increase took place between 1996 and 2001. During this period real house prices increased by 110%, while real mortgage rates declined by 60% . Thus the real financing cost of purchasing a house declined by 44% between 1991 and 2001 before increasing by 53% between 2001 and 2006. The fact that there was almost no change in the per capita quantity of houses demanded over the fifteen years despite these enormous variations in house prices and interest rates suggests that the elasticity of total housing demand with respect to the price of housing must be very small – probably less than 0.1.

The data appear to be more informative about the effect of rents on the demand for rental property. Between 1996 and 2001 there was almost no change in real house prices, but a 9% decrease in real rents. Real mortgage rates declined from 8 to 5%, making home ownership somewhat more attractive. During this period the total number of houses (normalized for population) increased by 2%, while the number of rental houses increased 19%. If the main factor affecting the housing market was the 9% decrease in rents, the elasticity of rental houses with respect to rents would be $19/(-9) \approx -2$ while the total elasticity with respect to rents would be $2/(-9) \approx -0.2$. Of course, as noted above, other things such as interest rates did change; however, they changed in a direction that would have made renting less attractive, suggesting these ballpark figures could underestimate the true elasticity.

15 The inflation rate is the average change in the CPI from the March quarter of the preceding year to the March quarter of the subsequent year.

On the basis of the aggregate movements in house prices, rents, and housing quantities, it seems reasonable to postulate that $\varepsilon_{pr}^{SR} \approx -2$, $\varepsilon_{pr}^{ST} \approx -0.2$. The total demand elasticities are much more difficult to guess, given that the total quantity of houses per capita increased by about 1% every five years, despite a wide variation in house prices and interest rates. Nonetheless, these data are suggestive that the total demand elasticity with respect to house prices is small, perhaps -0.02 to -0.10.

Table B.1: Number and price of houses in New Zealand, 1991-2006

Census Year	Population	Number of Houses		CPI	Rents	House Prices (P^H)	Real interest rate (r)
		Rental	Total				
	'000			Index 1995=1000			%
1991	3,488	267	1177	924	808	812	11.7
1996	3,723	290	1268	1012	1069	1122	8.0
2001	3,876	359	1344	1091	1045	1212	5.2
2006	4,134	388	1454	1237	1173	2295	4.8

Source: Statistics New Zealand Census of Populations and Dwellings

Table B.2: Number and price of houses in New Zealand, 1991-2006 (normalized)

Census Year	Number of Houses normalized to the population in 2006		Rent (r)	House Prices (P^H)	rP^H
	Rental '000	Total '000	Real indices 1995 =1000		
1991	316	1395	874	878	1444
1996	322	1408	1056	1108	1249
2001	383	1433	958	1111	809
2006	388	1454	949	1855	1238

Source: Statistics New Zealand Census of Population and Dwellings; Reserve Bank of New Zealand

(d) Trends in household formation and household size

An important feature of the New Zealand housing market in the last forty years has been the declining size of the average household. The average number of people in each house declined steadily from 3.8 to 2.96 from 1966 to 1991, or by 1% per year. It declined a little further between 1991 and 2006 to 2.84. Several factors have been behind this trend. Amongst these has been a sharp decline in the average size of households with children, most notably a sharp decline in the number of families with three or more children. Between 1966 and 1991, the fraction of households with five or more people declined from 28 to 13%. Secondly, there has been a big increase in the number of households comprising a single person or a couple. Trends in the fraction of households of different size are shown in Table B.3.

Table B.3: Distribution of households by size

	1 person	2 people	1or 2 people	3-4 people	5+people
1966	12.5%	24.8%	37.3%	34.9%	27.8%
1971	14.1%	26.4%	40.5%	34.2%	25.3%
1976	15.6%	27.9%	43.5%	34.6%	21.9%
1981	18.4%	29.2%	47.7%	34.5%	17.8%
1986	19.4%	30.5%	50.0%	34.8%	15.2%
1991	20.2%	32.7%	52.9%	33.9%	13.2%
1996	20.8%	33.1%	54.0%	32.9%	13.1%
2001	22.9%	33.7%	56.6%	31.5%	12.0%

Source: Statistics New Zealand Census of Population and Dwellings

Changes in the average size of a household are a key aspect of the model, for total demand for housing changes in response to variation in rents and house prices only through changes in household formation. Excluding changes in the average size of a household that stem from a reduction in the average number of children, there are several ways that household formation might respond to prices:

- older children change the time they leave their parents' home;
- the number of people living in households comprising unrelated people changes; in particular the number of people deciding to live by themselves as individuals or couples changes;
- the number of families choosing to split up and form two households changes;
- the number of families deciding to live in multiple family households changes; and
- the number of older people choosing to move in with their children or into institutional housing changes.

Aggregate census data suggest that the rising number of single households has been the most important factor since 1991. As Table B.4 indicates, there have only been small changes in the number of multiple family households and the number of "unrelated people" households. It is not clear why the total number of single family (including solo parent and couples) households has been declining, although the decline has been driven by falling numbers of households with four or more people.

Table B.4 Distribution of households by type

	1986	1991	1996	2001
Single	18.5%	20.2%	20.2%	22.9%
1 family	73.3%	72.2%	69.6%	67.6%
2-3 families	1.5%	1.7%	2.7%	2.1%
unrelated people	5.9%	5.9%	5.2%	5.2%
Total	1,078,005	1,166,568	1,268,094	1,344,267

Source: Statistics New Zealand Census of Population and Dwellings