Housing Markets and the GFC: The Complex Dynamics of a Credit Shock

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Abstract

Housing markets globally were affected by the GFC. In New Zealand, real house prices fell 15% while housing starts plummeted. We analyse the multiple channels of influence that GFC-induced credit restrictions had on the housing market, isolating dynamics caused by impacts on both the supply and demand sides of the market. These dynamics are compared to those caused by a migration shock, a more common form of housing shock in New Zealand. We focus on the impacts that these shocks had on two key outcome variables: house prices and housing supply, which are each modelled (together with land prices and rents) across 72 TLAs from the early 1990s to 2011.

JEL codes

R21, R31

Keywords

House prices, housing supply, credit restrictions, GFC, migration

1. Introduction

Housing markets around the world were affected significantly by the Global Financial Crisis (GFC). Real house prices in New Zealand fell by 15% while housing starts plummeted. In other countries, including the United States, house price falls were much larger. Using a model of regional housing markets in New Zealand, we analyse the multiple channels of influence that the GFC had on the housing market and plot the resulting dynamics caused by GFC-induced credit restrictions. The dynamics caused by this shock are compared to a migration-induced population shock that provides a yardstick for housing responses to a more common form of housing shock within New Zealand.

The model that we use for our simulations, the New Zealand Regional Housing Model (NZRHM), provides a framework to analyse the impacts of key exogenous influences on housing market outcomes. NZRHM (Grimes and Hyland, 2013; henceforth GH) is a revised and updated version of the model in Grimes and Aitken, 2010 (henceforth GA) that modelled housing supply and house prices across New Zealand territorial local authorities (TLAs). In NZRHM, four housing market variables are modelled: house prices, new housing supply (dwelling consents), residential vacant land (lot) prices, and average rents. Each of these is modelled at the TLA level across 72 TLAs within New Zealand. Equations are estimated using quarterly data from the early to mid 1990s to 2011.

The four modelled variables interact with each other and are influenced by a range of exogenous influences. Each of the four modelled relationships has a long term equilibrium component (cointegrating vector) that shows the value to which the modelled variable tends given the values of the policy and exogenous variables in the system. The values of the policy and exogenous variables vary over time, so the equilibrium path of each modelled variable also varies over time. Values of the exogenous variables differ across TLAs and so each TLA – while driven by the same underlying economic forces – has differing housing market outcomes reflecting its own population and other developments.

In addition, the model is estimated with a dynamic (error correction) component that shows how each endogenous variable moves on a quarterly basis relative to the equilibrium. Recent changes in other variables may impact the dynamic adjustment path, potentially causing some initial movements away from equilibrium. Price expectations, for instance, may cause housing market adjustments that lead to temporary deviations in outcomes away from equilibrium.

For the simulations in this paper, population changes (via internal or external migration) affect both land prices and house prices directly. An increase in population places upward pressures on house prices and this, in turn, leads to an increase in new house construction. Tighter credit restrictions have two effects in the model. First, they reduce some borrowers' access to credit which reduces the amount that will be bid for a house, so placing downward pressure on house prices. Second, they reduce developers' access to credit that is required to construct new houses, so reducing the housing supply response to a given set of price signals. This latter effect temporarily reduces housing supply, so placing upward pressure on house prices. Thus credit restrictions place two opposing pressures on house prices. Our model enables us to consider both influences together, and each influence separately, so disentangling the complex dynamics that a credit shock has on housing markets. In order to model credit effects, we use a proxy variable for the severity of credit restrictions being the proportion of banks' non-performing loans (NPL) relative to total assets. This proxy is chosen as it is a pre-determined variable that is likely to cause banks to change their lending criteria. It is not driven directly by changes to credit demand so can be considered an exogenous indicator of credit restrictions emanating from the supply side of the finance sector.

We simulate shocks to the model using the (former) Manukau TLA as our focus. The first shock is an exogenous shock to population, simulated as an immigration surge into the TLA of a magnitude reflecting the actual "abnormal" population increase in the Manukau TLA between the 2001 and 2006 censuses. The abnormal increase is taken to be the actual percentage increase in the Manukau population over that period less the New Zealand average rate of population increase over a prolonged period. This shock causes housing demand, and hence house prices, to jump which in turn induces an increase in housing supply. It takes around eight years for the housing supply to catch up with the exogenous increase in demand so that house prices stay above their control (counterfactual) level for a similarly prolonged period.

The second shock that we simulate is a cut to credit supply, driven by an exogenous prolonged increase in the banks' NPL ratio. The increase mirrors the jump (and subsequent gradual decline) in New Zealand banks' NPL ratio after the GFC. The countervailing effects of the shock on housing demand and housing supply result in complex dynamics as a result of the shock to credit supply. The demand effect, which dominates, causes house prices to fall substantially almost immediately after the shock but the subsequent shortage of supply that this creates causes prices to bounce back so that house prices exceed their baseline level after four years, with the price rise (relative to baseline) eventually mirroring the initial degree of price decline. The cycle in house prices is damped but the effects of the shock on house price dynamics are still apparent fifteen years following the shock's onset.

One over-arching conclusion across the two simulations is that housing markets (at least in New Zealand) are very slow to adjust to shocks causing disequilibria, so that exogenous shocks have very long lasting effects. Specifically, we find that an increase in population leads to a prolonged period of upward pressure on prices (houses, land and rents), continuing until the dwelling stock adjusts to restore dwellings per capita. Full adjustment takes around eight years for the modelled population shock. Similarly, tighter credit restrictions following a GFC-sized shock lead to a very prolonged and highly cyclical adjustment in housing construction and prices reflecting both the demand and supply effects emanating from the credit market.

The rest of the paper is structured as follows. Section 2 briefly outlines the key equations within NZRHM. Section 3 describes the impacts of the population shock while section 4 outlines the impacts of the credit supply shock. Section 5 compares the simulation results and discusses what they imply for actual housing markets and policies.

2. The Model

2.1 Model Overview

The NZHRM comprises four key relationships explaining: house prices, house construction (and hence dwelling stock), residential land (lot) prices, and rents. The model is estimated across all 72 TLAs in mainland New Zealand (keeping the newly amalgamated Auckland TLAs as separate authorities, and incorporating the former Banks Peninsula TLA as part of Christchurch City). All modelling uses quarterly data extending from the early to mid 1990s to 2011Q2.

For modelling purposes, a single aggregate housing market is assumed to exist within each TLA; thus we do not differentiate between housing of different quality. The same housing market relationships (e.g. functional form and elasticities) are assumed to operate across all TLAs. However, specific features of individual TLAs are included in the model through inclusion of TLA values for exogenous influences (e.g. population) and through inclusion of TLA fixed effects or TLA-specific time trends. Data availability influences the choice of variables included in the model specification and lies behind the assumption of a homogeneous housing market within each TLA.

Two of the four key relationships are based on the model in GA, specifically a supply equation for new houses and a demand equation. The supply equation is based on a Tobin's Q approach to investment in which new housing demand responds positively to a deviation between house prices and the full cost of producing a new house, where the cost includes both construction and land costs. The demand equation, which is based on a consumer optimisation model, takes the supply of houses (dwellings) as given in the short run and therefore takes the form of a house price equation.

The third relationship in NZRHM is an equation determining residential lot (vacant section) prices, which is based on a bargaining game between landowners and developers. This relationship is included both because of its intrinsic interest and because lot prices themselves influence the supply of new dwellings (and hence long run house prices).

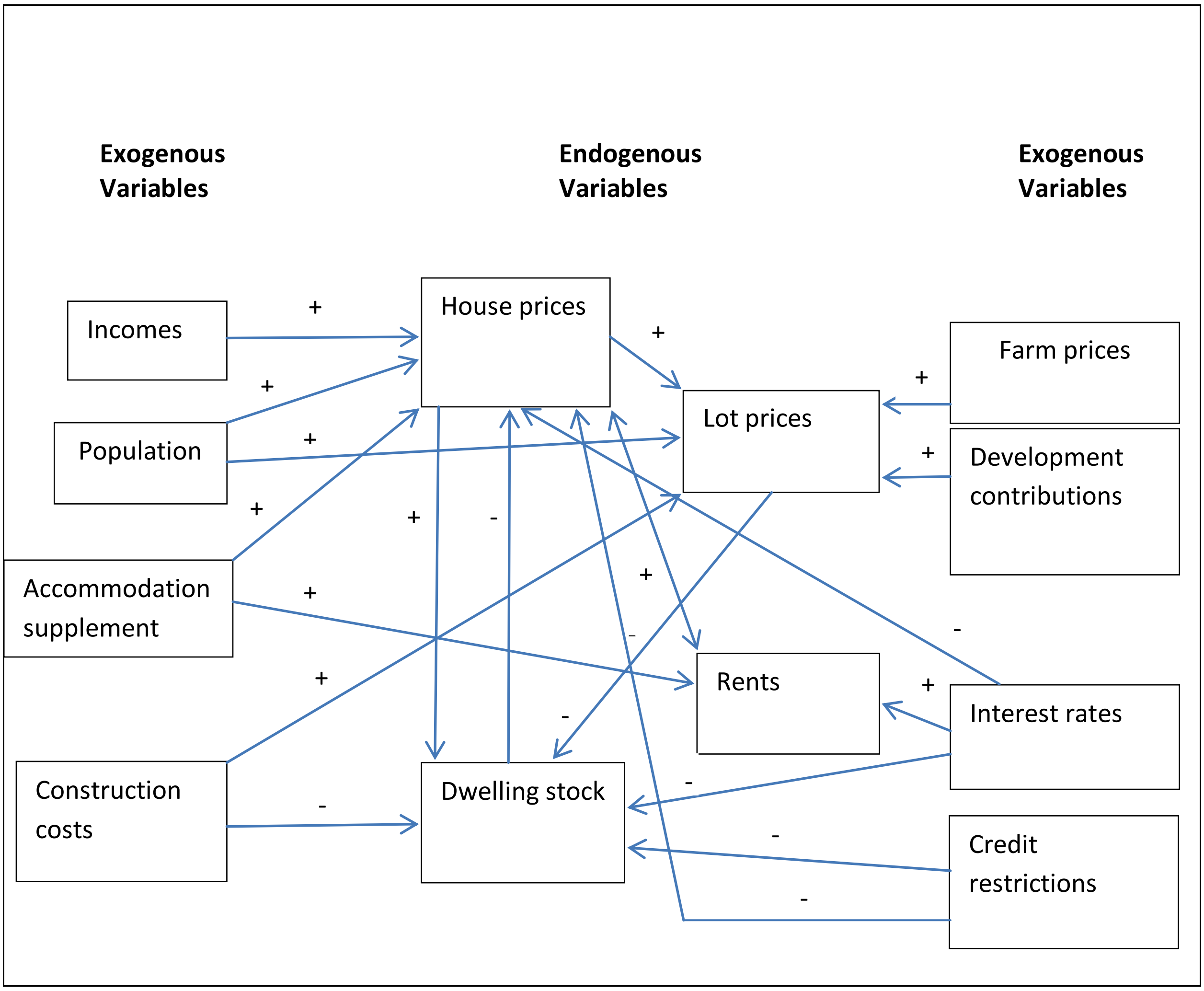
The fourth relationship is an equation determining residential rents. Some policies that could affect rents (e.g. accommodation supplement receipts) may also affect house prices, so we treat rents and house prices as an inter-related system.

Other variables are treated as exogenous to this system of equations. These variables, which have important roles in influencing housing outcomes, include: population, building construction costs (at national level), incomes, interest rates and credit restrictions, and housing-related policy variables (e.g. development and financial contributions and accommodation supplement).

Given the time series properties of the data, the equations are modelled using panel cointegration and error correction approaches. This enables us to identify long run equilibrium relationships between variables and to model the dynamics of adjustment towards equilibrium following shocks to the system. The recursive nature of the model enables us to simulate the effects of an individual shock as it feeds through to multiple variables in the model over time (taking the values of exogenous variables as given).

Figure 1 provides a schematic representation of the model. The four endogenous variables (house prices, dwelling stock, lot prices and rents) are affected by a range of exogenous factors. In addition, endogenous variables interact amongst themselves.

Figure 1: Schematic Representation of Housing Model



Our panel covers all 72 TLAs in mainland New Zealand and is estimated using data available from the early to mid 1990s (depending on the equation) to 2011Q2. The estimated residual (ε_i) from the long run equilibrium (cointegrating) equation must be stationary. Accordingly, over time, the values of the variables that are included in the equation return to the estimated relationship amongst themselves, implying that a long run equilibrium exists between these variables.

This long run equilibrium equation is supplemented by a short run (error correction) equation. The latter equation tests whether changes in the variable of interest respond significantly to the lagged disequilibrium term (i.e. to the lagged residual from the cointegrating equation). A significant response to the lagged disequilibrium term is required to establish that the variable of interest does adjust towards equilibrium following a shock. The error correction equations also include other (stationary) variables to model the dynamics of adjustment. All variables in the error correction equations are lagged to avoid endogeneity (simulataneous determination) problems.[1]

We use the Im Pesaran and Shin (IPS) and the Levin-Lin-Chu (LLC) panel unit root tests to test for stationarity (versus the null hypothesis of a unit root) of the residual from the long run equation. The LLC test assumes that the same time series processes operate across TLAs whereas the IPS does not make this restriction. For this reason, the IPS is our preferred test. We note that neither the IPS nor the LLC test is strictly appropriate to test the stationarity of a residual obtained using estimated parameters. We therefore supplement these tests with the requirement that the residual from the cointegrating regression be strongly significant ($p<0.01$) in the error correction equation.[2]

The cointegrating equations all include area (TLA) fixed effects, which allow for a different constant term for each TLA reflecting (unchanging) local conditions. Three of the four equations (i.e. excluding the house price equation) also include time fixed effects reflecting national developments. For the house price equation we instead include TLA-specific time trends to reflect unobserved deterministically trending factors applicable to housing demand in specific TLA's (e.g. income and consumption per capita, and changing preferences towards certain amenities within that TLA). The short run equations do not include separate area or time fixed effects (or time trends) given that these are incorporated into the long run relationships. No spatial interactions between TLAs have been incorporated.

All long run equations are estimated by ordinary least squares (OLS) given the super-consistency properties of OLS estimates with non-stationary variables. The short run equations have been estimated using both OLS and seemingly unrelated regressions (SUR). In presenting the OLS results, GH include the Prais-Winston estimate of the autoregressive parameter in the residuals to indicate the degree of any residual autocorrelation, and also compare the OLS standard errors with Newey-West standard to examine whether the OLS specification is broadly free of heteroskedasticity and autocorrelation.[3] Given the satisfactory outcome of these tests, we estimate all four short run equations (for house prices, house supply, lot prices and rents) using SUR, where the estimation period is given by the equation with the shortest time span for data (1996Q4-2011Q2). These estimates take account of the information in all four equations when estimated as a system, and so are more efficient than the single equation estimates. Table 1

[1] Endogeneity is not an issue in the cointegrating regressions given the super-consistency property of coefficients on non-stationary variables in such regressions. .
[2] Our estimation software (Stata) did not incorporate panel cointegration tests.
[3] In one case, the short run equation for housing supply, the specification of the dependent variable is chosen so as to avoid problems of autocorrelation that would otherwise be present.

defines all variables used in the long and short run equations. GH provide detailed definitions of all variables, their derivation and sources, and test all variables for a unit root; only non-stationary variables are included in the long run equations and only stationary variables are included in the short run equations.

The house price (housing demand) equation is based on the theoretical outline derived in Pain and Westaway (1997) and, more succinctly, in GA. The latter's derivation of this equation is reproduced in the Appendix.

House prices, in the long run, are determined by the demand for housing relative to the existing supply of dwellings. The latter is pre-determined in the short-run by the stock of houses at the end of last quarter (with new supply being unable to react to new information within a quarter). Housing demand (and hence house prices) is affected positively in the long run by a rise in population relative to the existing dwelling stock, incomes[4] and governmental support for owner-occupiers.[5] House prices are affected negatively in the long run by the user cost of capital (interest rates less extrapolative expectations of house price inflation[6]) and by bank credit restrictions. The latter may conceivably take a variety of forms including a higher home equity requirement (lower loan to value ratio), tighter covenants on debt servicing ratios or stricter criteria on borrower eligibility (Claus and Grimes, 2003). Rather than modelling each of these directly (and especially given the lack of data on each), we include the banking system's proportion of loans that are non-performing (impaired loans plus those at least 90 days overdue). This variable is predetermined at any given time; a higher ratio is likely to cause banks to adopt stricter loan criteria while they are working to reduce their NPL ratio. Thus we take the banks' non-performing loan ratio (CR) as our underlying variable that proxies the restrictiveness of banks' credit rationing policies.[7] In addition to the long run determinants, changes in (real) rents impact positively on house prices in the short run.

The housing supply equation is based on the theoretical outline in GA, with key elements reproduced in the Appendix. In accordance with a Tobin's Q approach to investment, additions to the dwelling stock occur when it is profitable for builders/developers to build new dwellings. Thus new construction responds positively to increased house prices, but is affected negatively

[4] TLA-specific income trends are captured in the long run equations through inclusion of deterministic time trends with TLA-specific coefficients; short run income changes are captured through inclusion of the relevant per capita Regional Economic Activity index calculated by the ANZ/NBNZ.

[5] Government support for owner-occupiers is captured through inclusion of the real (CPI-adjusted) level of accommodation supplement paid to eligible owner-occupiers.

[6] Consistent with GA, all price expectation variables in the model are based on extrapolation of the past three years' rate of price growth in a TLA (or nationally for national variables).

[7] We do not have similar information on non-performing loans of other parts of the financial system, although finance company loan impairments could be particularly important for the availability of credit to developers. The CR variable will be correlated with non-performing loans from other financial intermediaries, so will also pick up some of these effects, albeit imperfectly.

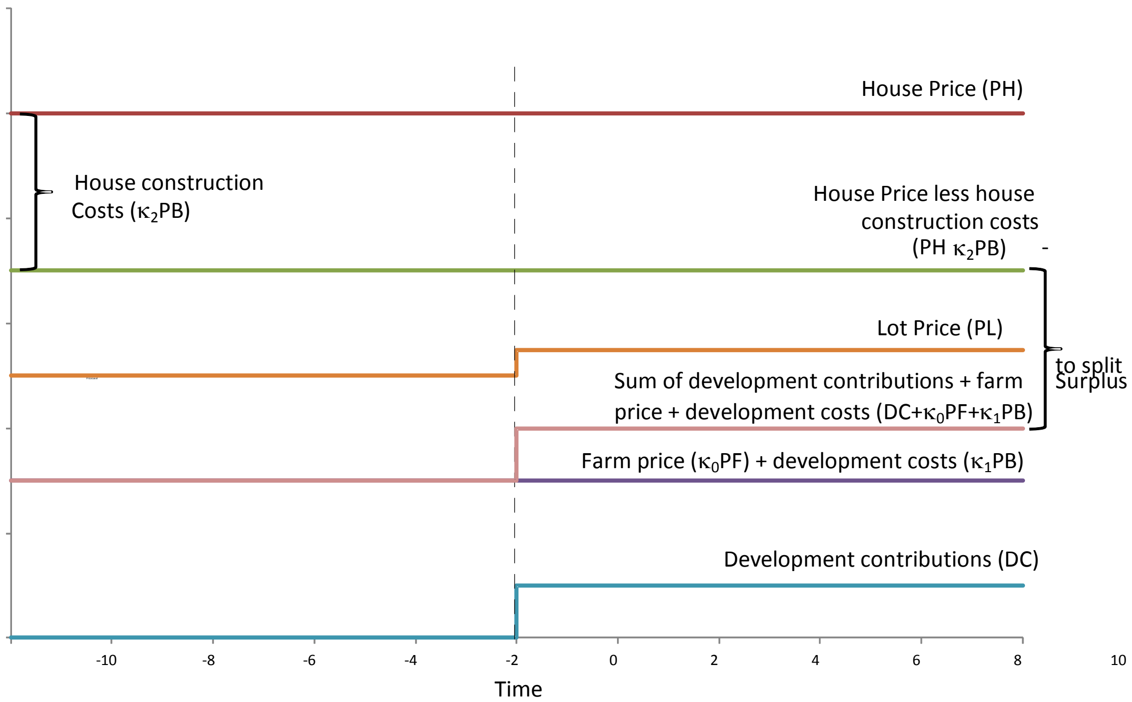
by rises in residential lot prices and/or construction costs. New construction may be restricted by tighter credit conditions which reduce the ability of builders/developers to access the finance required to purchase land, materials and labour to construct a house even where Tobin's Q is greater than unity. In the short run, house construction is also affected positively by expectations of rising housing market prices. The dynamics of adjustment incorporate non-linear and asymmetric adjustment coefficients with especially strong adjustment as the Q ratio rises well above unity.

Lot prices are set as a result of a bargaining game between landowners (farmers) and developers who act as intermediaries for the ultimate homebuyer. As captured in Figure 2,[8] a farmer owns lot-sized farm land valued at $\kappa_0 PF$ (where *PF* is the price of farmland per hectare and κ_0 controls for the number of lots per hectare). She can prepare the land for residential use through incurring development costs ($\kappa_1 PB$, where PB is an index of construction costs) and paying a development contribution to the council levied under the Local Government Act (and/or a financial contribution levied under the Resource Management Act), where the development plus any financial contribution per lot is denoted DC[9] (see Palmon and Smith, 1998, on ways that development contributions may affect property prices). The minimum lot price that allows for zero profit on converting farmland to residential land is, therefore, $DC + \kappa_0 PF + \kappa_1 PB$. In a TLA that has perfectly elastic supply of farmland with all development occurring at the periphery of an urban area, this expression will determine PL. However, some residential lot development may occur through subdivision within an urban area, especially where planning controls or geographical constraints inhibit expansion at the urban periphery (Grimes and Liang, 2009; Saiz, 2010). New lots cannot be sold to a prospective house owner at more than $PH - \kappa_2 PB$ where $\kappa_2 PB$ represents the cost of building a house on a vacant lot. The lot price will be higher the closer it is to the city centre (or other sought-after amenity); and, for any chosen lot, this convenience yield will be higher the greater is the pressure on population in the area. We therefore hypothesise that the average urban lot price may rise above the minimum lot price $(DC + \kappa_0 PF + \kappa_1 PB)$ according to: (a) the level of house prices less construction costs for a new house $(PH - \kappa_2 PB)$, and (b) the impact of population pressures on land for new housing development in the presence of residential land constraints. The current TLA boundaries became operational in 1991. In the absence of explicit regulatory measures, we hypothesise that the current population level relative to that in 1991 provides an indicator of

[8] Figure 2 is drawn to illustrate the effects that an increase in development contributions has on lot prices.
[9] Our data for this variable only starts with the start of the development contribution regime in 2002Q3. Dummy variables are included in the equations to account for this data discontinuity.

relative land constraints. Consistent with this bargaining game approach, our estimated long run equation finds that the real residential lot price is set as a function of real farm prices, real development plus financial contributions per housing consent, real house prices and the interaction of house prices with population growth relative to the 1991 population level (which has an additional positive short run effect).[10]

Figure 2: Stylised Bargaining Game (Land Price per Lot)



As in Grimes and Aitken (2007), rents are set so as to provide landlords with a market yield, given the level of house prices. The total real yield to landlords equals the rental yield plus expected real capital gains on the house; thus (in accordance with our long run estimates) rental yields fall as expected capital gains rise, while rents rise in response to increases in both house prices and interest rates. Rents (relative to house prices) are also estimated to rise, in the short term, as the rate of government rental assistance (accommodation supplement) rises; we find no evidence of a long run effect of this variable on rents, consistent with a market in which there is a high supply elasticity of new landlords (Coleman and Scobie, 2009).

[10] The influence of real construction costs (a national variable) is captured through the time fixed effects.

Table 1: Data Definitions

Variable	Definition	Source
AS^{O-Real}	Accommodation Supplement; real value to eligible homeowners	MSD
AS^{R-Rate}	Accommodation Supplement; rate paid to eligible renters	MSD
CR	Credit restrictions (banks' non-performing loan ratio)	RBNZ
DC_HC_i	Development contributions per housing consent	DBH, SNZ
H_i	Dwelling stock	SNZ
HC_i	Housing consents	QVNZ
i^m	1 year mortgage interest rate	RBNZ
N_i	Population	SNZ
PB	Residential construction cost index	SNZ
PC	Consumer price index	SNZ
PF_i	Farm price per hectare	QVNZ
PH_i	House price	QVNZ
PL_i	Residential lot price	QVNZ
R_i	Average rent	DBH
REA_i	Regional economic activity index	ANZ/NBNZ
UC_i	Real user cost of capital	RBNZ, SNZ

Notes:
ANZ/NBNZ=ANZ/National Bank of New Zealand; DBH=Department of Building and Housing (now MBIE); MSD=Ministry of Social Development; QVNZ=Quotable Value New Zealand; SNZ=Statistics New Zealand; RBNZ=Reserve Bank of New Zealand.

Series with an i subscript have TLA-specific data; non-subscripted variables are national.

A supercript G added to a price variable denotes an expectations measure for the rate of change in the variable where the rate of (extrapolative) expectation is based on data for the 3 years up to the the last quarter.

Table 2: Long Run Equations

	House Prices	Housing Supply	Lot Prices	Rents
	$\ln\left(\frac{PH_{it}}{PC_t}\right)$	$ln\left(\frac{PH_{it}}{PB_{it}}\right)$	$\frac{PL_{it}}{PC_t}$	$\frac{R_{it}}{PH_{i,t-1}} - i_t^m$
$Constant$	9.7634*** (0.1334)	4.0169*** (0.0184)		0.0007 (0.0008)
$\ln(H_{it}/N_{it})$	-2.1854*** (0.2015)			
UC_{it}	-0.0498*** (0.0014)			
CR_{it}	-0.0146*** (0.0052)			
AS_{t-1}^{O-Real}	0.0160*** (0.0007)			
$\ln(PB_{it}/PL_{it})$		-0.2162*** (0.0047)		
PF_{it}/PC_{it}			0.1401*** (0.0389)	
$(DC_{it\_}HC_{it})/PC_t$			0.3792*** (0.0764)	
PH_{it}/PC_{it}			0.3607*** (0.0146)	
$(PH_{it}/PC_t) \times \ln(N_{it}/N_{i,1991})$			0.4278*** (0.0192)	
$PH_{i,t}^G$				-0.2274*** (0.0069)
Obs	4320 1996Q3-2011Q2	6192 1990Q1-2011Q2	5832 1991Q1-2011Q2	5328 1993Q1-2011Q2
$\overline{R^2}$	0.9544	0.9531	0.9824	0.9285
Area fixed effects included	Y	Y	Y	Y
Time fixed effects included	N	Y	Y	Y
Area specific time trends included	Y	N	N	N

In Table 3, *** (**) (*) denote significance at the 1% (5%) (10%) level respectively. The same notation is used to denote equivalent t-statistics in Table 2, but these should not be taken as true measures of significance as the distribution of these t-statistics follows a non-standard distribution in the presence of non-stationary variables.

Table 3: Short Run Equations (SUR Estimates)

	House Prices	Housing Supply	Lot Prices	Rents
	$\Delta\ln\left(\frac{PH_{it}}{PC_t}\right)$	$\frac{HC_{it}}{H_{it-1}} - 0.6\frac{HC_{i,t-1}}{H_{it-2}}$	$\Delta\frac{PL_{it}}{PC_t}$	ΔR_{it}
$Constant$	0.0080***	0.0014***		111.8199***
	(0.0009)	(0.0001)		(7.5179)
$\varepsilon_{i,t-1}$	-0.1585***		-0.1866***	
	(0.0069)		(0.0092)	
$\Delta\ln(H_{i,t-1}/N_{i,t-1})$	-0.4339			
	(0.2764)			
$\Delta\ln(REA_{i,t-1}/N_{i,t-1})$	0.2694***			
	(0.0537)			
$\Delta UC_{i,t-1}$	-0.0018			
	(0.0012)			
ΔCR_{t-1}	-0.0703***	-0.0009***		
	(0.0056)	(0.0002)		
ΔAS_{t-1}^{O-Real}	0.0051***			
	(0.0005)			
$\Delta\ln(R_{i,t-1}/PC_{t-1})$	0.0274***			
	(0.0083)			
$\varepsilon_{i,t-1}^{+}$		0.0002		
		(0.0014)		
$(\varepsilon_{i,t-1}^{+})^2$		0.0227***		
		(0.0072)		
$\varepsilon_{i,t-1}^{-}$		0.0038***		
		(0.0013)		
$(\varepsilon_{i,t-1}^{-})^2$		-0.0006		
		(0.0061)		
$\Delta PH_{i,t-1}^{G}$		0.0079*		
		(0.0047)		
$\Delta PL_{i,t-1}^{G}$		0.0001		
		(0.0026)		
$\Delta PB_{i,t-1}^{G}$		0.0913***		
		(0.0243)		
$\Delta(PH_{i,t-1}/PC_{t-1} \times \ln(N_{i,t-1}/N_{i,1991}))$			0.6050***	
			(0.0607)	
$PH_{i,t-1} \times \varepsilon_{i,t-1}$				-0.1130***
				(0.0093)
$\Delta R_{i,t-1}$				-0.3716***
				(0.0145)
$\Delta(PH_{i,t-1} \times PH_{i,t-1}^{G})$				0.0192***
				(0.0061)
$\Delta(PH_{i,t-1} \times AS_{t-1}^{R-Rate})$				0.0106***
				(0.0020)
Obs (1996Q4-2011Q2)	4248	4248	4248	4248
$\overline{R^2}$	0.1915	0.049	0.1022	0.2168

Notes: $\varepsilon_{i,t-1}$ is the lagged residual from the corresponding long run equation.
No area fixed effects, time fixed effects or area specific time trends are included in the short run specifications.

3. Population (Migration) Shock

We subject the model, as characterised in Tables 2 and 3 (long run and short run equations respectively), to two separate shocks. These shocks are conducted over a fifteen year window for a single TLA, Manukau, which is a major housing growth area in the south of Auckland. The shocks could equally be applied to any other TLA. The simulated shock outcomes are compared to a baseline without the shock.[11] For each simulation, we present four graphs comparing simulated versus baseline results. The first graph shows the time-path of the shocked variable. The second and third graphs show the paths of the housing stock and housing investment (consents) respectively, while the fourth graph shows the path of house prices. Each graph is in the nature of an impulse response function. The population, housing stock and house price graphs are presented in terms of percentage deviation from baseline, while the housing consent graph (and, in the next section, the credit restrictions graph) are presented in terms of percentage point deviation from baseline.

The first shock (Figure 3[12]) is an exogenous shock to population, simulated as a migration surge into the TLA of a magnitude reflecting the actual "abnormal" population increase in the Manukau TLA between the 2001 and 2006 censuses. Over the 1991 to 2006 period, the New Zealand population experienced an average quarterly growth rate of 0.23%. By contrast, the growth rate in the Manukau city population between 2001 and 2006 was 0.76% per quarter (0.54% per quarter[13] higher than the long run New Zealand population growth rate). This was the highest inter-censal expansion of population in any of New Zealand's main city TLAs over our estimation period. Our chosen shock is a simulation of the impact on a TLA housing market where its simulated population growth rate is 0.54% per quarter above its baseline rate for a period of five years beginning in period 0, dropping back to its baseline growth rate from quarter twenty onwards.

As a result of the twenty quarter migration surge, the population level in the simulation is permanently above baseline from the start of period 0 onwards. From quarter 20 onwards, population is 11.2% above baseline. The increase in population, coupled with the inability of new housing investment to keep pace with the migration surge, places upward pressure on house prices as the ratio of population to housing stock rises. The sustained increase in house prices becomes embedded in expectations of further capital gains in housing which contributes to a reduction in the (perceived) user cost of capital. This reduction in the user cost of capital

[11] The baseline is the predicted path of each variable.
[12] Figures 3 to 7 are included at the end of the paper.
[13] Rounding causes the difference to be 0.54% per quarter rather than 0.53%.

temporarily exacerbates the increase in house prices. House prices eventually rise to almost 25% above baseline after five years, before dissipating. The population increase also places upward pressure on residential lot prices (through the interaction term between population and house prices).

The increase in house prices leads to Tobin's Q exceeding unity (since building costs are assumed not to rise, and lot prices do not increase sufficiently to cause the total development cost increase to outweigh the house price increase). The increase in the Q ratio causes housing investment to increase, with the path of the housing investment rate broadly mirroring the path of house prices. The peak expansion in housing investment occurs in the sixth year with the housing investment rate being 0.6 percentage points above baseline.

The increased housing investment causes the housing stock to increase gradually throughout the first eight years of the simulation. The fact that the stock is increasing materially for a further three years beyond the end of the migration surge indicates the lags involved in meeting the residential needs of an abnormal increase in the population. Once the additions to the housing stock start outweighing the increase in population, the house price path starts turning down (relative to baseline). House prices eventually return to approximately the baseline level after eight years, with a slight downward overshoot of house prices exacerbated through the (negative) expected capital gains channel, before lifting again. Eventually, house prices are left slightly above their baseline level owing to a permanent increase in lot prices caused by the added population pressure.

The equilibrium condition in the supply equation requires that long run house prices increase by 22% of the long run increase in lot prices (holding construction costs constant). The resulting increase in real house prices causes a reduction in demand for housing (relative to the population), so the final increase in the housing stock is less than the increase in population. After fifteen years, the housing stock in the model increases by 9.2% compared with the 11.2% increase in population. Thus there is a permanent increase in the number of people per dwelling following the migration surge as a result of pressure on residential land prices.

One key finding of the simulation, other than the directions and magnitudes of effects, is that a five year migration surge (of a scale recently witnessed in New Zealand) causes an eight year house price cycle, with slight cyclical echoes stretching even beyond fifteen years. Thus a population shock has a long term impact on the housing market (and broader economy) over an extended cycle.

4. Credit Restrictions Shock

The second shock that we simulate is a cut to credit supply, driven by an exogenous prolonged increase in banks' NPL ratio. The increase mirrors the jump (and subsequent gradual decline) in the New Zealand banks' NPL ratio after the GFC. We simulate the impacts of the tighter credit restrictions initially just with the demand side channel operating, then just with the supply side channel operating, and finally with both channels operative. This enables us to decompose the full effects of the credit channel on the housing market into its two competing sources.

In each case, the same shock is considered. The average NPL ratio over the period 1996Q1 to 2008Q3 was around 0.6%, albeit varying with the state of the economy (Figure 4). In 2008Q4, this ratio jumped markedly above 0.6%, and by 2011Q1 had reached a peak of over 2.1% before subsiding to 1.4% in 2012Q4. The ratio in 2012Q4 was similar to that at the start of the series in 1996Q1. We use the subsequent (smoothed) rate of decline in the ratio of 5% per quarter from 1996Q1 to 1999Q4 to project forward the path for the NPL ratio beyond 2012Q4. The result (as depicted in the first quadrant of Figures 5 to 7) is that the NPL ratio is elevated relative to baseline for a total of 32 quarters, with a peak NPL ratio eleven quarters after the onset of the shock that is approximately 1.5 percentage points above baseline.

4.1. Credit Restrictions (Housing Demand Channel)

Figure 5 shows the impacts of the shock to the NPL ratio on the housing market where we activate only the housing demand (house price) channel. Thus, in the housing supply equation, we hold the NPL ratio at its baseline path while we use the simulated path of NPLs in the house price equation.

The reduction in credit supplied to prospective house purchasers leads to a significant fall in the house price level (relative to baseline), with a peak fall of almost 8% seven quarters after the start of the shock. This fall compares with an actual peak to trough fall in national real house prices after the onset of the GFC of 15.3%, implying that credit restrictions accounted for approximately half of the fall in real house prices. (Other factors, such as falls in real incomes, are held constant in our simulation.) The fall in house prices causes a reduction in the housing investment rate with housing investment being below baseline for eighteen quarters following the start of the shock. Consequently, the housing stock is below baseline for almost eight years, with a peak fall relative to baseline of approximately 1%.

The reduction in the housing stock places upward pressure on house prices as the population to dwelling stock ratio increases. Thus house prices gradually return to baseline and then over-shoot baseline by almost 8% seven years after the onset of the shock. This price increase reverses the housing investment shortfall, with investment exceeding baseline from quarters 18 to 42, thereafter remaining just below baseline through to the end of our fifteen year simulation. The higher investment rate, caused by the house price overshoot, leaves the housing stock slightly above (but returning to) baseline from around year eight onwards.

The nature of the cycle in house prices and new construction mirrors the shape of the actual cycle witnessed since the GFC. House prices initially fell in the post-GFC period and new housing construction collapsed. Subsequently, house prices have increased sharply (particularly in Auckland[14] where house construction has fallen well behind population growth) and new construction activity is underway.

4.2. Credit Restrictions (Housing Supply Channel)

Figure 6 shows the impacts of the shock to the NPL ratio on the housing market where we activate only the housing supply (house consents) channel. In the house price equation, we hold the NPL ratio at its baseline path while we use the simulated path of NPLs in the housing investment equation.

The credit restrictions reduce new housing investment as developers are constrained through a reduced access to credit. Housing investment remains below baseline for almost three years and the housing stock is below baseline for approximately five years. The result of the supply shortfall is an increase in house prices consequent on the credit shock. However the peak increase is a little less than 1%, with the small size of the increase mirroring the subdued nature of the housing supply responses. Overall, while the impact on house prices through the housing supply channel is in the opposite direction to that through the demand-side channel, the demand-side effect is the larger of the two.

4.3. Credit Restrictions (Both Channels)

With both channels operating, the dynamics in house prices are similar to those emanating from the demand channel (Figure 7). House prices fall by a maximum of almost 8% relative to baseline in the seventh quarter before rising to a peak of over 7% above baseline after 25 quarters. The housing supply response is magnified relative to the demand case since both the supply and demand channels cause an initial reduction in new housing investment. Investment is

[14] Christchurch has its own construction and price surge as a consequence of the earthquakes. GH examine the specific case of post-earthquake housing outcomes in Christchurch.

below baseline for four years after the onset of the shock while the housing stock remains below baseline for seven years, with a maximum reduction in the stock of 1.2% relative to baseline. As the stock falls relative to population, prices increase which induces new supply. Housing investment consequently rises above baseline for a period of six years before tracking just below its baseline level.

In contrast to the dynamics of the NPL ratio, which is characterised by a rapid rise to a peak ratio followed by a continuous decline until the ratio returns to baseline, the housing market displays marked cyclical behaviour. As expected, the credit shock causes a reduction in house prices and construction activity, but it also sets in train the prerequisites for a housing boom, even while the NPL ratio is still above its baseline level. Thus house prices and new house construction both peak approximately six years after the onset of the credit shock at which time the NPL ratio is still almost 0.5 percentage points above its baseline level. The complex dynamics of the housing market – in which the housing dynamics differ materially from the dynamics of the underlying shock – are illustrated clearly through this simulation.

5. Conclusions

The New Zealand Regional Housing Model (NZRHM) provides a framework to analyse the impacts of key policy and exogenous influences on housing market outcomes. It models four key variables within local housing markets: house prices, housing supply (new dwelling consents), residential vacant land (lot) prices, and average rents. The four modelled variables interact with each other in a system of long run (equilibrium) and short run (dynamic) equations.

We use the model to simulate the effects on TLA housing markets of two separate exogenous shocks. The first is a permanent population shock (temporary migration surge) which mirrors the actual abnormal increase in population experienced by Manukau between 2001 and 2006. The shock causes a rise in house prices, as new supply falls short of the increased population. The higher prices in turn induce new housing investment so that the housing stock rises to a new plateau. However, the rise in the housing stock falls short of the rise in population owing to a permanent increase in land prices caused by population pressures. In our simulation, the housing stock rises by 9.2% after fifteen years, compared with the 11.2% increase in population. The dynamics are such that there is a single major cycle (i.e. starting at baseline, rising to a peak in house construction and house prices, and then back to baseline), with only a minor cyclical effect thereafter.

The second shock is a prolonged increase in the restrictiveness of credit provided by the financial system. The source of the credit shock is an exogenous increase in banks' non-performing loans which causes them to increase the stringency of their lending criteria. The size of the shock mirrors the actual rise in NPLs experienced by banks after the GFC. The shock has a direct negative effect on housing supply (as developers find it difficult to access credit for new developments) and also a direct negative effect on house prices as prospective purchasers curtail their bids for houses. The house price reduction induces a further decrease in new housing investment. The result of these two influences (in which the demand channel predominates) is that the housing market exhibits marked dynamics in which prices and activity initially fall below baseline and then rise to a peak above baseline of a similar magnitude to the initial trough. This cycle continues in a muted fashion even beyond the end of our fifteen year simulation period.

In absolute terms, the (actually experienced) population shock has a greater impact on construction outcomes relative to baseline than the (actually experienced) credit shock. Housing investment rises to a peak above baseline of approximately 0.6 percentage points for the population shock whereas the peak rise is less than 0.2 percentage points for the credit shock. Similarly, the peak house price rise relative to baseline with the population shock is almost 25% whereas the peak rise for the credit shock is around 8%. However the trough to peak changes under the credit shock are much closer to the population shock, with a trough to peak rise in housing investment of approximately 0.3 percentage points and a trough to peak rise in house prices of approximately 16%.

One overarching conclusion from these simulations is that shocks cause long-lived dynamics within the housing market. The key reason for these prolonged dynamics is the time that it takes to achieve a material change in the dwelling stock through new construction. For instance, our population simulation shows that the stock takes around eight years to almost fully respond to a population increase spread smoothly over five years. There are therefore prolonged upward impacts on house prices in the model (as well as on lot prices and rents), with a significant cycle in the rate of new dwelling construction. Housing market cycles are even more apparent in the credit shock simulation where even after fifteen years the cyclical effects remain quite pronounced.

Thus, given the institutional settings that exist in New Zealand, market participants and policy-makers should expect even temporary housing market shocks to have a prolonged impact on those markets. Consistent with the work of Kydland and Prescott (1982), these fluctuations in the "time to build" new capital equipment (of which housing is an example) can potentially have major effects on the cyclical behaviour of the wider economy. As discussed by the New

Zealand Productivity Commission (2012), policy-makers may therefore need to consider how the responsiveness of housing supply to demand shocks can be increased in order to reduce the cyclicality and prolonged nature of responses to the myriad of shocks that hit the housing market.

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Appendix: Derivation of Long Run Demand & Supply Equations

Long run house price equation

GA consider an economy with N_t identical individuals at time t, each of whom derives utility from real non-housing consumption (cx_t) and housing services (θh_t) where h_t is the individual's housing stock and θ is the ratio of the individual's housing services to housing stock.[15] In each period, the individual earns y_t; the individual's real wealth, w_t, can be allocated between h_t and real financial assets (f_t). The prices of the housing stock and non-housing consumption are PH_t and PC_t respectively; their ratio is denoted $g_t = PH_t/PC_t$, and $\dot{g}_t$ is the expected rate of change of g between t and $t+1$. The real after-tax return on f_t is r_t; the real return on h_t equals the real rate of capital gain $(\dot{g}_t)$ less the rate of depreciation (κ) and less the foregone rate of earnings (or the after-tax cost of borrowing), r_t, on the real housing capital ($g_t h_t$). Thus the intertemporal constraint for the state variable, w_t, is given by (1):

$$w_{t+1} = (1 + r_t)(w_t + y_t - cx_t) + \left(\dot{g}_t - r_t - \kappa\right) g_t h_t \tag{1}$$

In each period, the individual has a constant relative risk aversion utility function that is separable in non-housing consumption and housing services; thus the individual's value function in t (with ρ being the discount factor) is given by:

$$V_t = \left\{ \left[\frac{{cx_t}^{1-\delta} + (\theta ht)^{1-\delta}}{1-\delta}\right] + \rho V_{t+1}(w_{t+1}) \right\} \tag{2}$$

Taking the ratio of the first order conditions for (2) with respect to cx_t and h_t respectively, yields the optimum ratio of housing stock to consumption for the individual:

$$\frac{h_t}{cx_t} = U \tag{3}$$

where: $UC_t \equiv (r_t - \dot{g}_t + \kappa)/(1 + r_t)$ is the real user cost of capital for housing.

Aggregating (3) over all N individuals and solving for g_t, we obtain:

$$g_t = \theta^{1-\delta} \left(\frac{Nt}{Ht}\right)^{\delta} CX_t^{\delta}\, UC_t^{-1} \tag{4}$$

[15] Lower case letters denote individual-level variables; upper case letters denote the corresponding aggregate variables or variables faced identically by all individuals.

Expressing g_t as PH_t/PC_t, adding regional subscripts to relevant variables, and taking logs yields expression (5) for the equilibrium house price:

$$\ln\left(\frac{PH_{it}}{PC_t}\right) = (1-\delta)\ln\theta - \delta\ln\left(\frac{H_{it}}{N_{it}}\right) + \delta\ln\left(\frac{Cons_{it}}{N_{it}}\right) - \ln UC_{it} \quad (5)$$

where: $Cons_{it}$ is total non-housing consumption in i at t.

Equation (5) forms the basis for the long run house price equation shown in Table 2 where ln*UC* is replaced by *UC* (multiplied by a coefficient), per capita consumption is proxied by TLA-specific time trends, and credit restriction and accommodation supplement terms are added as additional variables impacting respectively on per capita consumption and on the effective user cost of capital.

Long run housing supply equation

We assume that a builder seeks to build a new house where the house sale price exceeds the full cost of developing and building a new house. Total costs are a function of building costs and residential lot (vacant land) costs plus builders' financing costs. We further assume that some substitutability exists between land and structures for a given level of utility for the ultimate purchaser, but that both sets of inputs are required for any development to proceed. Accordingly, we adopt a divisia index for total costs in TLA i at time t (TC_{it}) as a function of residential land costs (PL_{it}) and (national) building costs (PB_t) with weights summing to one. In addition, real financing costs (i_t^r) must be borne by the developer. Thus, we postulate:

$$TC_{it} = [e^{\lambda_i} PL_{it}^{\beta} PB_{it}^{1-\beta}](1+i_t^r)^{\gamma} \quad (6)$$

where λ_i incorporates TLA-specific cost factors and γ reflects the holding period between the builder raising finance and selling the house. In equilibrium, house prices equal total costs so that $\ln(PH_{it}) = \ln(TC_{it})$. Using this equilibrium condition, and rearranging (6), we obtain the long run relationship:

$$ln\left(\frac{PH_{it}}{PB_{it}}\right) = \alpha - \beta\, ln\left(\frac{PB_{it}}{PL_{it}}\right) + \lambda_i + \lambda_t + \varepsilon_{it} \quad (7)$$

where λ_t incorporates the finance cost term and any other national factors affecting the equilibrium relationship. If (7) forms a cointegrating vector then it is valid to model housing consents relative to the housing stock (a stationary variable) as a function of the (stationary) residual from equation (7).

Figure 3: Simulation of Population Shock

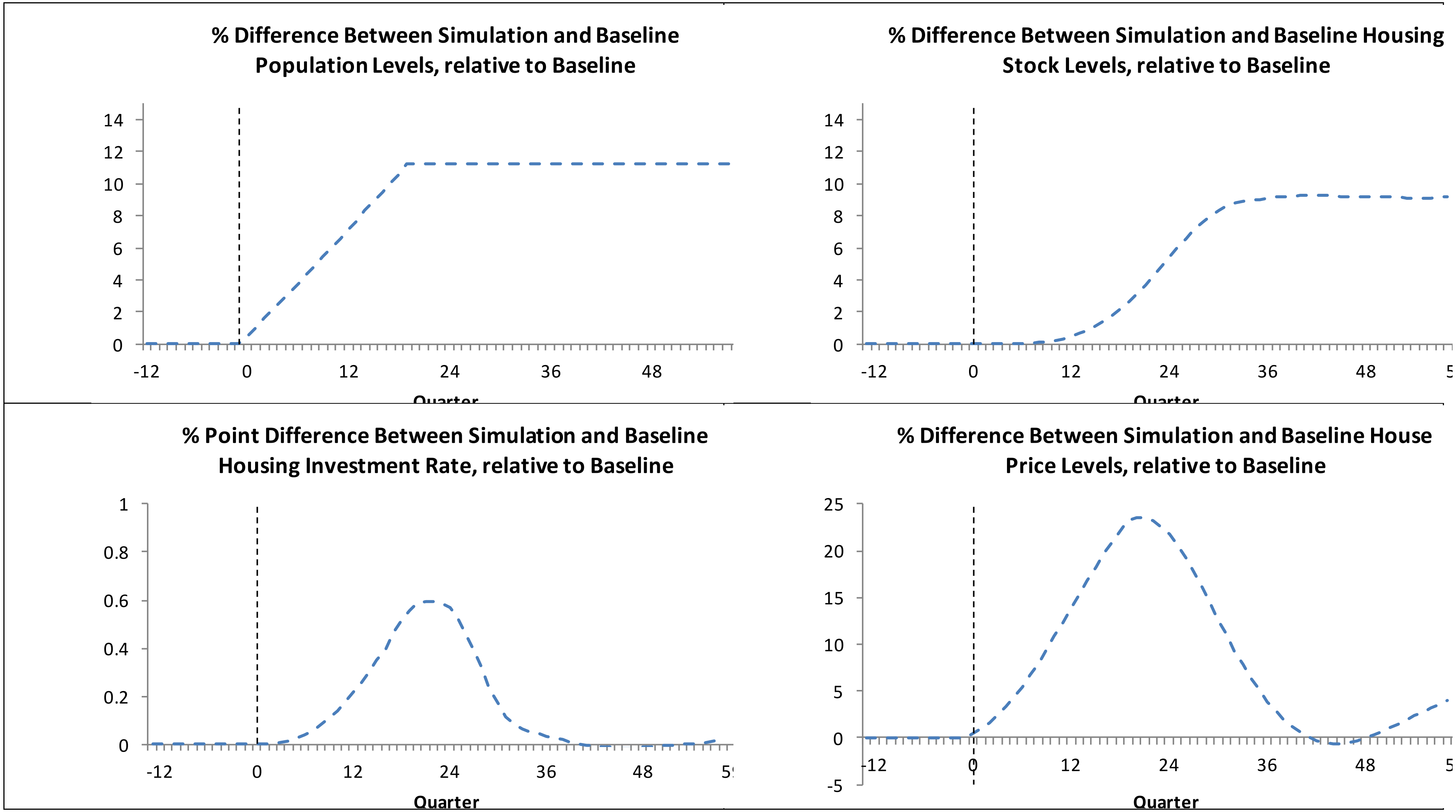

Figure 4: Ratio of Non-performing Loans to Total Assets, NZ Banks, 1996Q1-2012Q4

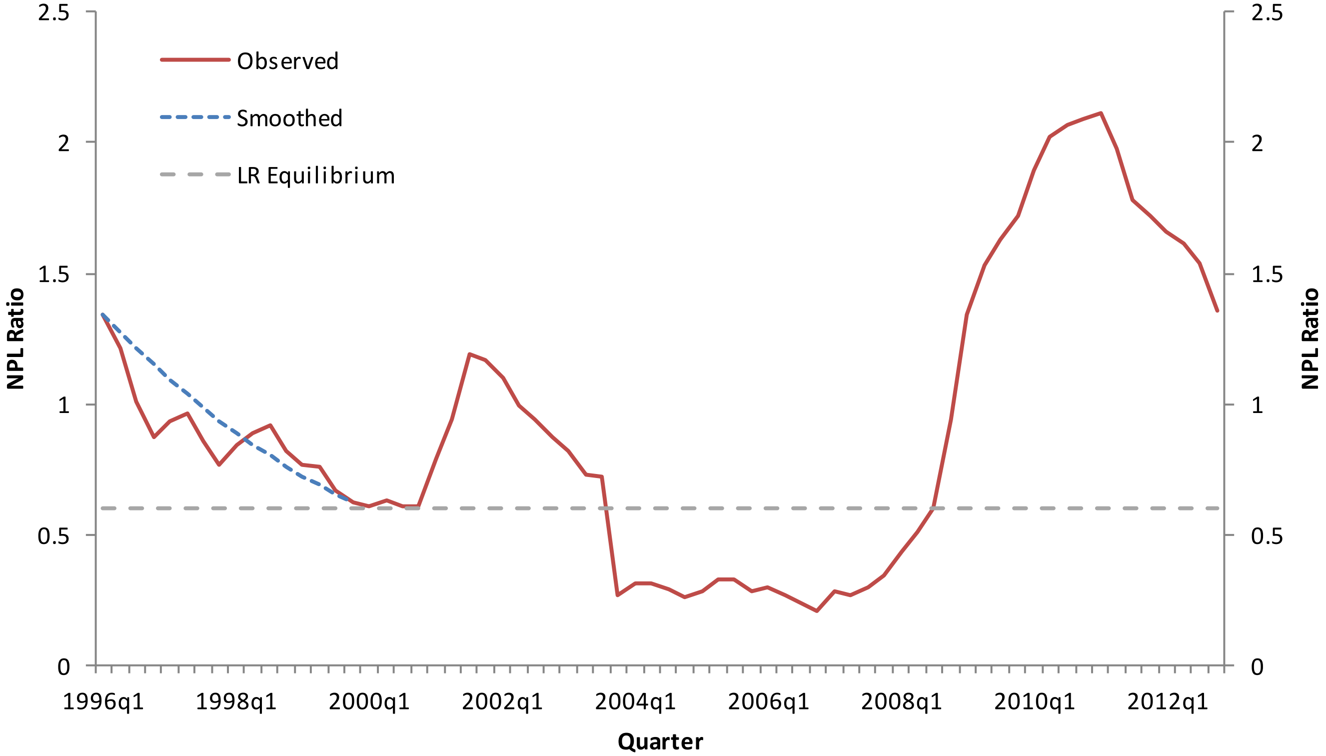

Figure 5: Simulation of Credit Shock (Demand Side Only)

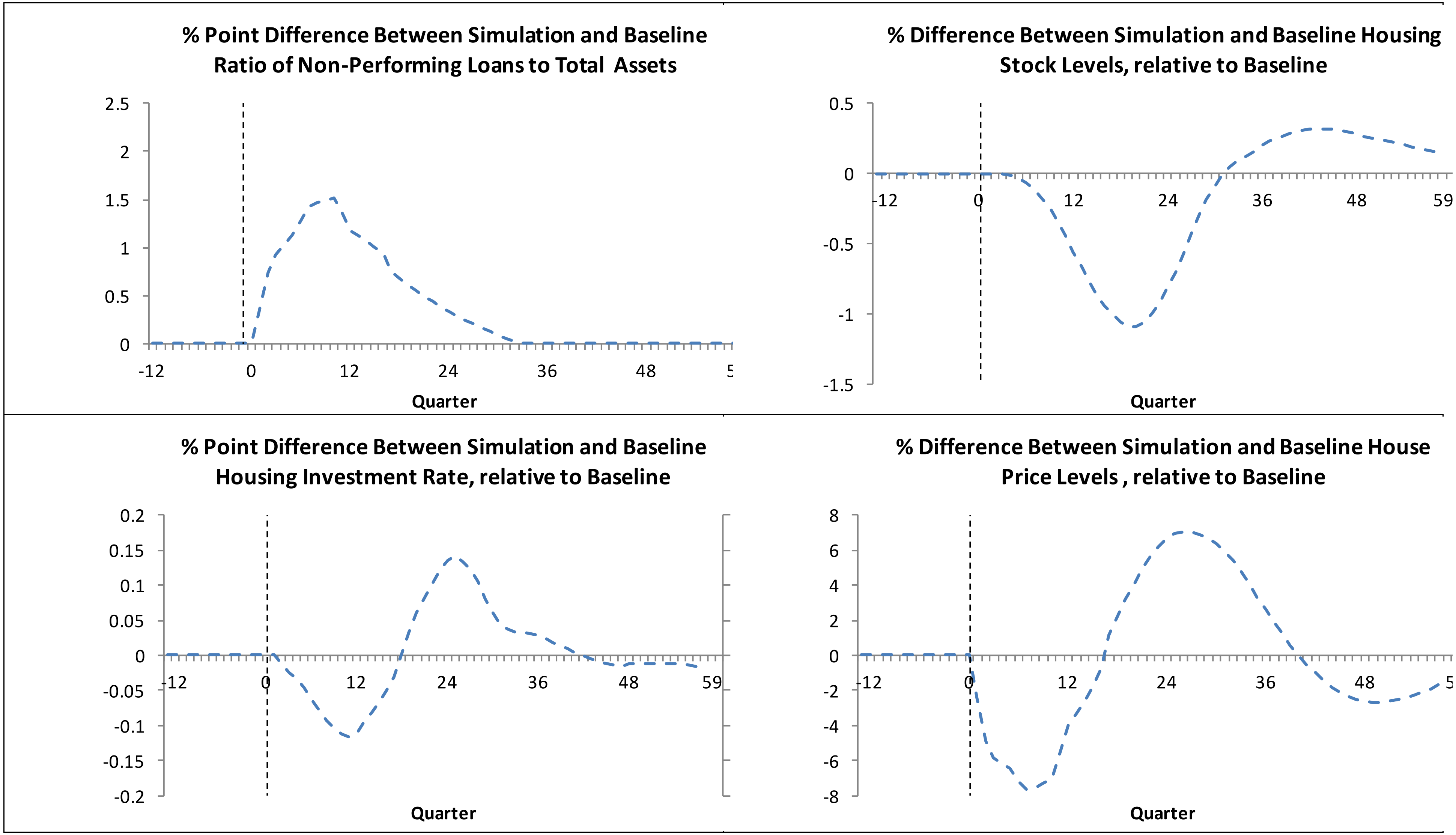

Figure 6: Simulation of Credit Shock (Supply Side Only)

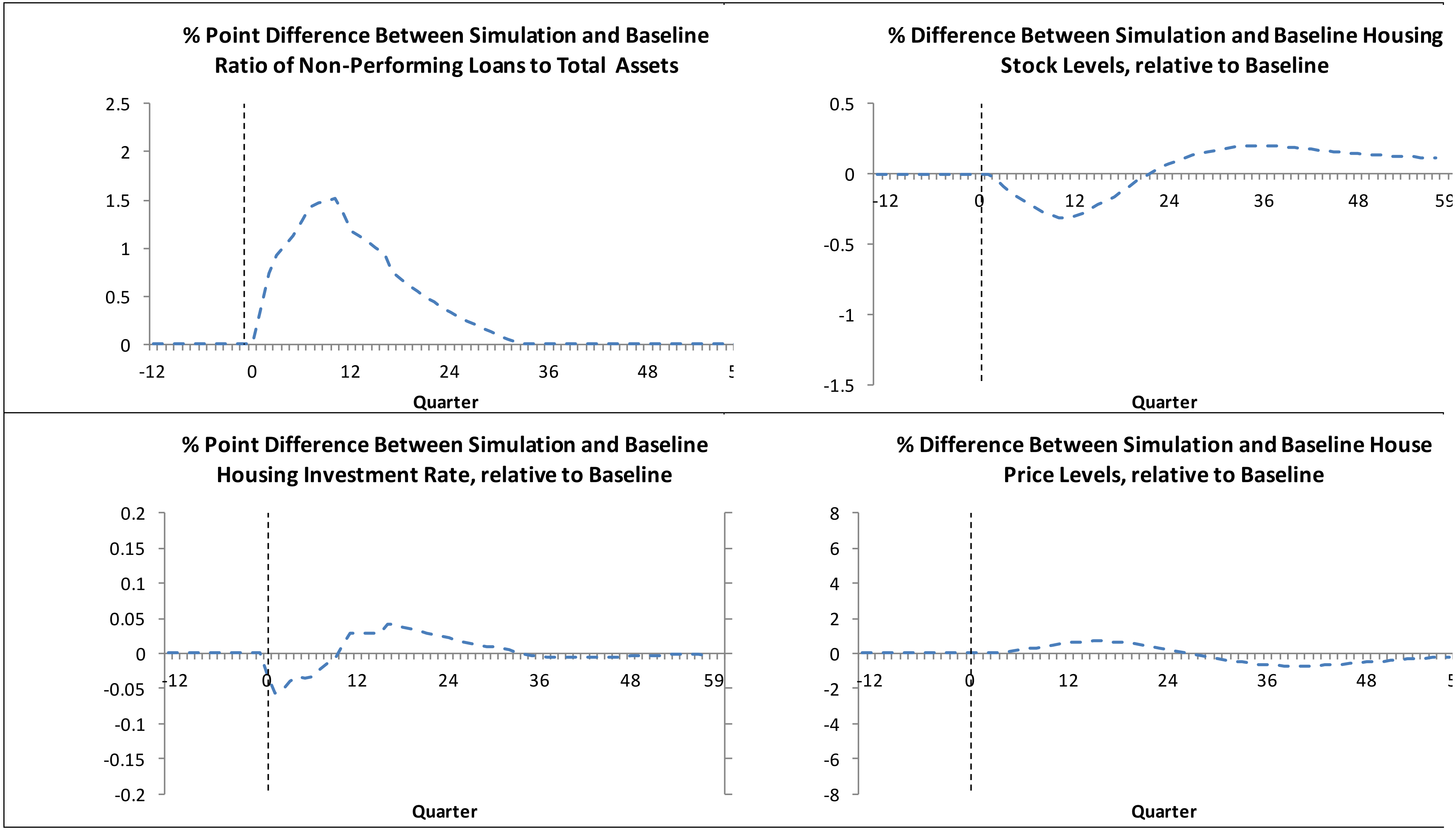

Figure 7: Simulation of Credit Shock (Both Channels)