

# **HNZC Housing demand and supply model for New Zealand**

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# Model Purpose & Character



- Model developed to meet HNZC business planning requirements and provide insights into drivers of need, demand and supply
- Set in context of understanding operation of NZ housing market and systems and capable of providing a view of prospects which should be of wider interest
- A medium-term model geared for policy simulations
- Informed by UK experience with similar models + NZ & wider evidence/literature
- Commissioned in 2011, developed over 2+ phases

# Main Components of Model



- House prices
- Private rents, lettings and stock
- Migration & population x age
- Household formation & types
- Supply (new construction) – various options
- 'Needs' in general population
- Net applicant flow demand & waiting list stocks (x type & level of need, size, etc)
- State housing stock and turnover (lets) supply

# Main Outputs



- Population and Household Growth
- Dwelling stock growth, household-dwelling balance & vacancies
- Tenure – own, rent, state
- House prices & market rents
- Affordability indicators
- Needs in general population – crowding, concealed, affordability, composition
- Net flow demand and waiting list stock
- Demand-supply balance for state housing, & size analysis
  
- Geography: national, 15 'Motu' Regions, 72 Territorial Authorities, HNZC Local Board Areas

# Key Data Sources



- Censuses 1981-2006
- Population & household projections\*
- Births, deaths & international migration data
- Macro-economic & national financial time series
- Consents data
- Rental bond data (new lets and rents)
- Property IQ House prices (& stock estimates\*)
- HNZC state housing stock
- HNZC RENTEL waiting list stocks & flows & turnover
- Household Labour Force Survey & NZ Income Survey
- NZ deprivation index
- Accommodation Supplement takeup data
- Distance & density analyses from meshblock census data

# House Price Model



Regional panel Partial Adjustment Price Model			
Varname	Variable description	Coefficient	Signif
	Constant	0.107	***
SPDLP(-1)	Ave own/contig price growth (LD) lag	0.344	***
SPDLP(-2)	Ave own/contig price growth (LD) lag	0.437	***
DLMDINC	Change median income (log diff)	0.346	***
POPDS(-1)	Ratio Wkg Age Pop:Dwelling lag 1	0.004	**
UNP(-1)	Unemployment Rate (%) lag 1	-0.003	**
MDPMDI(-1)	Median Price:Income ratio lag 1	-0.014	***
ROI(-1)	Mortgage Rate of Interest lag 1	-0.005	***
DLRGSHR(-1)	Change Gross Share Index (LD) lag	0.092	***
	Adjusted R-squared	0.517	***
	S.E. of regression	0.055	
	F-statistic	47.82	
	Durbin Watson	1.653	

# Comments on Price Model



- Preferred approach in Phase 1 used regional (15) time series from 1981-2011
- Partial adjustment approach preferred to more complex cointegration approach (but could revisit)
- Most effects reasonable, but Weighted average Population:Dwellings ratio weak (data problems – would prefer to use household:dwellings or vacancies)
- Spatial & temporal lags combined
- Auxiliary equation to predict relative price at TA level within regions
- In current simulation, impose additional feedback from excess or deficient vacancies (relative to thresholds)
- Intend to revisit this equation

- NZ PRS always larger than UK, despite OO dominance, but reflecting small SRS as well as l. t. deregulation
- PRS grew from 20% to 29% 1991-2006
- PRS main option for low income households in potential need; affordability & security issues
- Relatively good data, including 5 yr censuses with rent & income data, and quarterly/annual data on rents & numbers of new lets (Rental Bond system)
- Descriptive analyses show large recent and expected rise in 'intermediate' renters and better off renters
- NZ saw big economic changes in 1980s/90s, with much widened inequalities
- 2 distinct pairs of models (a) pooled census C-S of LA's (4 periods); (b) annual time series panel of 15 regions x 19 years



# Rent Level Model 2a

**Table 4: Model for New Let Rent level for NZ sub-regional annual panel 1993-2010**  
(IV estimation, \$ week, 2-bed ,real terms @ 2011 prices, 15 'Motu' sub-regions)

<i>Varname</i>	<i>Variable description</i>	<i>Coeff</i>	<i>Robust Std. Err.</i>	<i>t-stat</i>	<i>signif</i>
constant		72.097	16.779	4.300	0.000
Pplets*	Private lettings % all hhd	-1.717	0.871	-1.970	0.050
rlrnt_1	Lag real med rent 2br n l	0.954	0.027	35.010	0.000
b2	Propn stock 2 bedroom	-65.250	29.801	-2.190	0.029
b4pl	Propn stock 4+ bedroom	-133.591	39.465	-3.390	0.001
eg6tot	Degree level qualifs prop	55.925	22.927	2.440	0.015
mcostinc	Med mortgage cost:income	11.844	5.644	2.100	0.037
unempct	Unemployment %	-2.315	0.422	-5.490	0.000
pchwapop	Change in wkg age pop % pa	0.357	0.154	2.330	0.021
Psh	State housing % all stock	0.915	0.341	2.690	0.008
*Instrumented					
	Number of obs	285		R-squared	0.980
	F( 9, 275)	1416.17		Root MSE	8.619
	Prob > F	0.000			

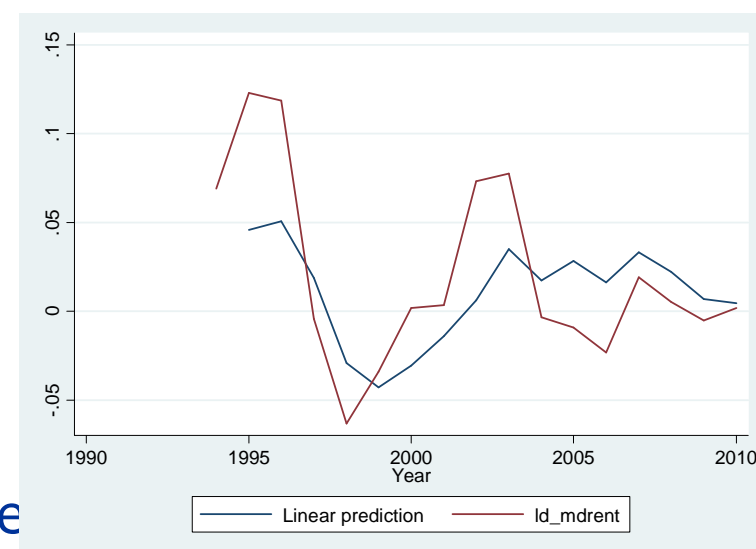
# NZ Rent Change Model (2b)

**Table 6: Partial Adjustment Model for New Let Rents in New Zealand, MOTU Region Level 1992-2011**

(log differences, annual panel data by MOTU Region Level, 1992-2011)

<i>Vname</i>	<i>description</i>	<i>Coefficient</i>	<i>z statistic</i>	
Constant		0.6810	5.65	***
l_mdrent(t-2)	Log real median rent t-2	-0.1186	-4.54	***
Mdmcostinc	Med Mort Cost:Income	0.1504	4.59	***
Unempct	Unemployment rate %	-0.0069	-4.35	***
Mint	Mortgage interest rate %	-0.0063	-3.43	***
pplets(t-1)	Private lettings % hhd, t-1	-0.0075	-3.23	***
GBond10(t-1)	Govt. Bond int rate % t-1	0.0071	2.31	**
Psh	State housing %	0.0074	4.85	***
rlmdrnt2_s(t-2)	Real med rent spatial t-2	-0.0002	-2.39	**
eg6tot	High degree qualifs propn	0.2928	3.6	***
Pchwapop	Change working age pop %	0.0015	2.47	**
	rho_ar	0.2501		
	sigma_u	0.0078		
	sigma_e	0.0283		
	rho_fov	0.0709		
	Theta	0.2364		
R-sq:		0.4681	within	
		0.0786	between	
		0.2912	overall	
Wald chi2(11)		106.3	***	

**Pred & Actual Rent Change  
Auckland City (below)**



## Results of Model 2 Rents

- Modified model based on subregional annual panel data – new let rents, with flows approach to supply (lettings, turnover)
- Current active market, better estimate of economic & financial effects, spatial spillovers & lags
- Strong effect from lagged rent
- Lettings supply –ve
- Mortgage cost +ve, unemployment –ve, qualifications +ve
- Demographic growth +ve
- Dwelling size effects different
- State housing +ve – unexpected, but Auckland proxy
- Partial adjustment formulation may be better
- Time series drivers predominate

## Private Lettings Supply NZ (2)

**Table 6: Sub-Regional Model for Private Lettings in New Zealand**  
((IV estimation, % of households, 15 'Motu' sub-regions, annual 1993-2010))

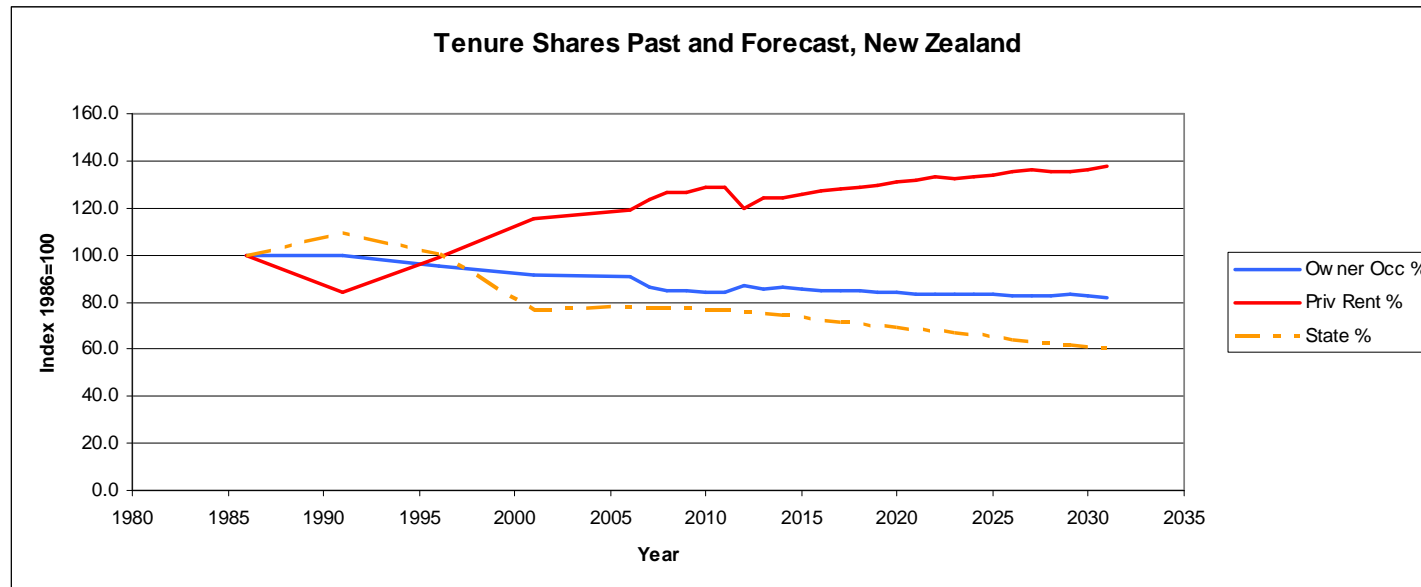
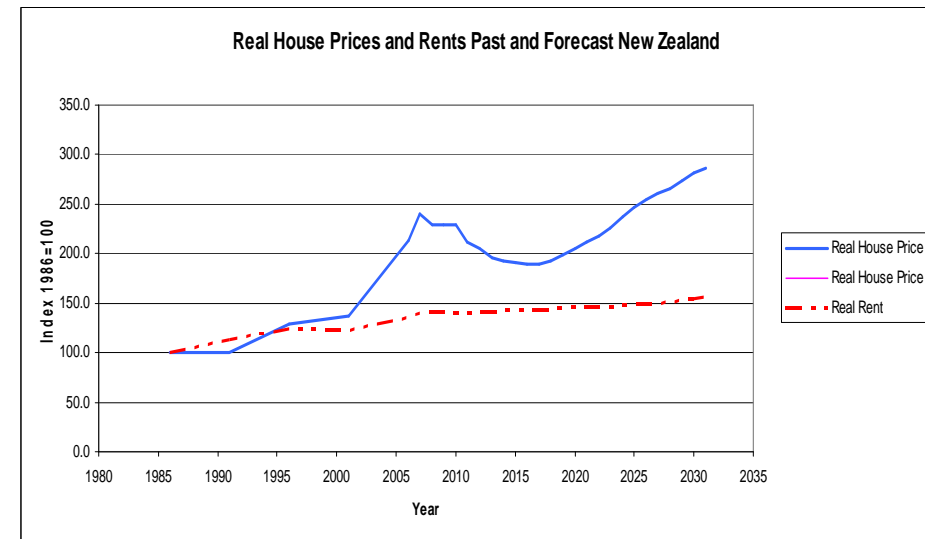
<i>Varname</i>	<i>Variable description</i>	<i>Coeff</i>	<i>Robust Std. Err.</i>	<i>t-stat</i>	<i>signif</i>
constant		-7.292	0.757	-9.630	0.000
rlmdrnt2*	(pred) Real Med Rent 2br n l	0.004	0.001	3.950	0.000
pprturn2*	(pred) Private Rental Turnover	0.292	0.014	20.490	0.000
ppletss1	Spatial lag priv lets	-0.093	0.027	-3.490	0.001
pprvrent	Priv Rent % all stock lag1	0.228	0.016	14.310	0.000
pvac	Vacancy rate propn	3.595	2.092	1.720	0.087
	Real house price grwth 2yr				
pchhpr2	%pa	-0.006	0.007	-0.920	0.359
pchdwstk	Net change dwelling stock %	0.488	0.045	10.870	0.000
gbond10	Government Bond rate (10 yr)	0.062	0.060	1.030	0.302
*					
instrumented	Number of obs	285		R-squared	0.944
	F( 8, 276)	300.33	(2SLS)	Root MSE	0.613
	Prob > F	0.000			

## PR Supply Results Model 2

- Model is for flow of lettings, with endogenous rents and turnover
- Rents +ve but relatively low elasticity
- Stock share and turnover +ve as expected
- Spatial effect (-) implies substitutability
- Vacancies +ve
- New build strongly +ve (unlike model 1)
- Recent house price growth –ve not signif
- Turnover function reflects mortgage int rate (-ve), 2-bed (+) vacancy rate (+) high qualifications (+), younger households (+), Maori/Pacific (-)
- Stock change can be inferred from lettings & turnover predictions

# Baseline scenarios NZ

- Using Model 2
- Rise in PRS share continues
- Corresponding falls in OO and State housing
- Prices more volatile than rents
- Rents pretty flat in future



# New 'Endogenous' Demographics



- It is argued that it is more realistic to recognise that internal migration and household formation will respond to market conditions, supply, etc.
- Model design influenced by UK research
- Models fitted to TA-level pooled census cross sections
- 10 equations for gross in- & out-migration rates x 5 age groups
- 4 equations for household representative rates x 4 age groups
- Some allowance for spatial linkages based on 2006 flows matrix
- Most effects in models look sensible
- Simulations evolve populations x 5 age groups in annual steps
- Household types & age structures derived from models
- Set up so that total NZ population approx tracks SNZ projection
- Simulation also includes feedback from excess/deficient vacancies

# Examples of Migration Equations

Migration Equations by Age			Variable		lout1524		linf1524		lout2539		linf2539	
	Log out and inflow 5yr % base popn	shortname	Variable		coeff	signif	coeff	signif	coeff	signif	coeff	signif
		(Constant)			2.634	0.000	0.744	0.019	2.255	0.000	2.457	0.000
InMR!H31*£!	5 year lagged inflow age <15	infL15_5										
InMR!BH31*£!	5 year lagged inflow age 15-24	inf1524_5			0.005	0.008			0.010	0.000		
InMR!DH31*£!	5 year lagged inflow age 25-39	inf2539_5							0.012	0.000		
InMR!FH31*£!	5 year lagged inflow age 40-64	inf4064_5										
SIOM!CI31	Outflow spat-related origs <15	ofl15_s										
SIOM!EI31	Outflow spat-related origs 25-39	of1524_s					0.003	0.001				
SIOM!GI31	Outflow spat-related origs 40-64	of4064_s										
HHD!HI31	International net inflow 5 yr %	intinf										
\$C31	Relative size of area (hhd)	TAHHdWgt			-0.094	0.000	-0.059	0.000	-0.015	0.050	-0.107	0.000
Mkt!FI31	Real median rent 2 Br \$pw	rlmdrent2			-0.002	0.000	-0.001	0.123				
Mkt!I31*Mkt2!I31	Real user cost buy \$pw	uccpw			0.00044	0.051			0.00056	0.001		
Mkt2!DI31	House price relative to NZ	relprice									0.201	0.000
Emp!J31	Propn Wkg Age HRPs in Paid Work	workall					0.511	0.075			0.446	0.086
Ten!BI31	All renters % all hhd	pallrent			0.006	0.057	0.019	0.000	0.001	0.568	0.020	0.000
Ten!DI31	State housing propn all stock	psh										
Size!i31	Propn all stock 1br	b1			5.008	0.000	3.250	0.000	-1.556	0.024	3.681	0.000
Size!Bi31	Propn all stock 2 br	b2			-1.379	0.001	0.989	0.025	-1.220	0.002		
Size!Di31	Propn all stock 4+ br	b4pl										
Supp!I31	Net growth dwg stock % pa	dwggropa			-0.020	0.002	0.027	0.000	-0.017	0.005	0.023	0.001
HHT!HI31	One person hhd propn all hhd	opall			1.326	0.023	-1.381	0.008	3.270	0.000	-2.698	0.000
HHT!BI31	Couple hhd propn all hhd	pcpl			3.645	0.000	3.927	0.000	-1.600	0.000	2.484	0.000
Hrage!I31	Younger HRP propn all hhd	pynggh			-4.150	0.000	11.546	0.000	2.967	0.002	-1.279	0.065
Hrage!DI31	Older HRP propn all hhd	poldh										
Quals!I31*1.2	Lower or no qualifications	eg12tot										
Quals!BI31	Degree & higher qualifs	eg6tot			-2.458	0.000	-0.559	0.091	-0.192	0.295	-1.524	0.000
Ethnic!I31	Maori ethnic popn	tallm			0.647	0.000	-0.458	0.018			-0.419	0.016
Ethnic!BI31	Pacific island popn	tallp			0.713	0.008	-0.975	0.001	0.637	0.005		
Ethnic!DI31	Asian popn	talla			1.951	0.000						
In(CSV!\$J31)	Log distance major cities km	lidistmaj			0.020	0.015	-0.037	0.000	0.014	0.053	-0.046	0.000
CSV!\$K31	Distance nearest med city km	iDistAny										
CSV!\$E31	Bach (holiday) home propn	bachp										



# Household Formation Equations

Household Repres Rate Equation: Variable		hrr_1524		hrr_2539		hrr_4064		hrr_65pl	
propr base popn	shortname	B	Sig.	B	Sig.	B	Sig.	B	Sig.
	(Constant)	0.559	0.000	0.141	0.009	-0.258	0.001	-0.388	0.001
Inflow age 15-24 rate	inf1524	0.001	0.001						
Inflow age 25-39 rate	inf2539_5			0.000	0.007				
Inflow age 40-64 rate	inf4064_5								
5 year lagged HRR age 1524	hrr_1524_5	0.699	0.000						
5 year lagged HRR age 2539	hrr_2539_5			0.567	0.000				
5 year lagged HRR age 4064	hrr_4064_5					0.721	0.000		
5 year lagged HRR age 65pl	hrr_65pl_5							0.806	0.000
Birth rate to age 15-24 adults	birthrt1524	0.001	0.000						
Birth rate to age 25-39 adults	birthrt2539			0.001	0.000				
Death rate to age 40-64 adults	deathrt4064					0.009	0.000		
Death rate to age 65+ adults	deathrt65pl							0.001	0.001
Lwr qtl mortgage cost:income ratio	lqmcostinc	-0.026	0.000	-0.058	0.000	-0.034	0.000	-0.045	0.000
Real median income \$000 pa	rlmdinck			0.000	0.008	-0.001	0.000		
Deprivation Index Score /1000	nzdepk	-0.372	0.000	0.108	0.036	0.423	0.000	0.438	0.000
Propn Wkg Age HRPs in Paid Work	workall	-0.257	0.000			0.199	0.000	0.168	0.000
All renters % all hhd	pallrent	0.002	0.000	0.00000	0.012			-0.001	0.000
Private rental turnover rate % pa	prturn			-0.011	0.050				
Propn all stock 2 br	b2			0.067	0.000	-0.047	0.083	0.132	0.003
Net growth dwg stock % pa	dwggropa	-0.001	0.051					0.003	0.001
Lower or no qualifications	eg12tot			-0.046	0.001	-0.207	0.000	-0.140	0.000
Maori ethnic popn	tallm	-0.091	0.000	-0.061	0.001	-0.144	0.000	-0.059	0.064
Pacific island popn	tallp	-0.091	0.001	-0.139	0.000	-0.108	0.000	-0.090	0.004
Asian popn	talla			-0.071	0.012	-0.113	0.000	-0.120	0.008
Log distance major cities km	lidistmaj			0.001	0.019			0.001	0.101
Hotel & other tourist estabs /1000pop	nesttourpt							0.002	0.061
Residents in educ inst's /100 pop	ppeduc	-0.001	0.066						
Students /100 pop	pstud	0.021	0.050						
Total Non-Private Hhd Popn/100 pop	pnpoptot			-0.003	0.001	-0.005	0.000		
Resids in Homes for Elderly /100 pop	phmfeld							-0.001	0.189
Resids in Hotel & Boarding Hs /100 pop	ppbdhshot							-0.015	0.018
Adj r-sq		0.841		0.916		0.826		0.881	

# New Baseline Population Simulations

	SNZ Projn Pop 2031	D&Smod Popn Forecast 2031	D&Smod Popn Diff % 2031
New Zealand	5,148,500	5,169,493	0.4%
<b>MOTUReg</b>			
Northland	171,250	181,357	5.9%
Nth Auckland	703,700	563,464	-19.9%
Auckland City	584,500	659,037	12.8%
Sth Auckland	682,100	613,084	-10.1%
Waikato	438,790	477,747	8.9%
Bay of Plenty	327,370	273,323	-16.5%
Gisborne/Hawkes Bay	204,030	203,016	-0.5%
Taranaki	108,660	116,792	7.5%
Manawatu	236,750	252,160	6.5%
Wellington West	355,200	401,179	12.9%
Wellington East	186,110	189,573	1.9%
Nelson Tasman West Co:	183,060	183,523	0.3%
Canterbury	650,970	714,702	9.8%
Otago	227,450	241,594	6.2%
Southland	88,560	98,941	11.7%

# Household Growth Rates



Area	Growth Rates of households		New Forecast		SNZ Projection	
	1986-2006	2006-11	2011-21	2021-31	2011-21	2021-31
New Zealand	1.23	2.10	1.12	0.82	1.25	1.03
Northland	1.37	2.34	1.55	1.01	1.13	0.76
Nth Auckland	2.12	2.08	0.99	0.61	1.79	1.53
Auckland City	1.17	3.50	1.28	0.81	1.78	1.50
Sth Auckland	2.03	2.41	1.16	1.11	2.12	1.82
Waikato	1.19	2.46	1.43	1.16	1.11	0.86
Bay of Plenty	1.94	-0.46	1.36	0.02	1.35	1.09
Gisborne/Hawkes Bay	0.53	1.49	0.84	0.66	0.69	0.42
Taranaki	0.26	1.50	0.75	0.66	0.46	0.18
Manawatu	0.47	1.62	0.62	0.62	0.64	0.39
Wellington West	1.21	2.45	1.38	1.23	1.23	1.04
Wellington East	0.54	1.47	0.53	0.53	0.63	0.38
Nelson Tasman W C	1.39	2.13	1.30	0.76	0.90	0.61
Canterbury	1.23	2.24	1.18	1.06	1.09	0.92
Otago	0.73	2.57	0.90	0.65	0.80	0.61
Southland	-0.02	1.61	0.30	0.22	0.15	-0.14

School of the Built Environment

- Starting with models similar to those we have used in UK
- Experimenting with alternatives, e.g. production function, inventories approach.
- Data present both opportunities (land values) but also problems
  - lack of robust direct data on completions
  - lack of any data on demolitions, conversions
  - lack of data on stock of outstanding consents
  - lack of data on zoning for whole country
- We are conscious of differences between NZ and UK in terms of structure of provision
- We are further exploring measures of potential land availability
- Models estimated so far may be usable, but not currently used in simulations (which use a simpler approach, taking consents and net addition ratios from historic base & enabling testing of different supply rates)

# Illustrative models for net additions

Variable	Definition	Log of net additions (housing)			Log of net additions (apartments)		
		Coef.	z	P>z	Coef.	z	P>z
constant		6.023247	1.52		21.15159	3.79	***
l_netadd_h	Log of net additions (houses)				0.2366447	3.6	***
dl_roi	diff. in logs interest rates	-1.882781	-3.22	***	-1.366544	-2.27	**
l_ccind(-1)	log of construction cost index t-1	-1.648605	-2.32	**	-4.477807	-5.01	***
l_resvl	log of residual value defined as real median price (weighted real median land price / 100)	0.5928696	1.72	*			
l_resvl(-2)	As above, t-2				0.9624343	2.17	**
l_ppflow(-1)	Log of flow of new consents t-1	0.7854071	5.13	***			
l_ppstock_cons	Log of stock of outstanding consents				0.390676	2.28	**
dlrgshr	diff. in logs of real gross share returns	-2.375447	-3.16	***			
y1997	1997 dummy	2.311873	5.57	***			
y2001	2001 dummy	-1.027556	-2.6	***			
motu3	Auckland motu dummy	-1.619221	-5.6	***			
motu9	Manawatu motu dummy	-0.8914441	-4.06	***			
motu13	Canterbury motu dummy	-0.8044033	-3.66	***	1.799733	2.56	**

- Further research on composition of needs in terms of types and severity and on drivers of need
- Analysis of 2 years of NZ General Social Survey – enables breakdown x HNZN 5 categories and combinations (complexity)
  - suggests drivers, esp hhd size, low living standards, income/benefits, partner, health, born o/s, regional rent level
- Further analysis of RENTEL data using different breakdowns
- Model for 'net flow demand' fitted to annual data 2002-11 x region (much better fit)
- Revised approach to simulation including mechanistic /constrained WL stock, size breakdown, turnover (incl transfers)

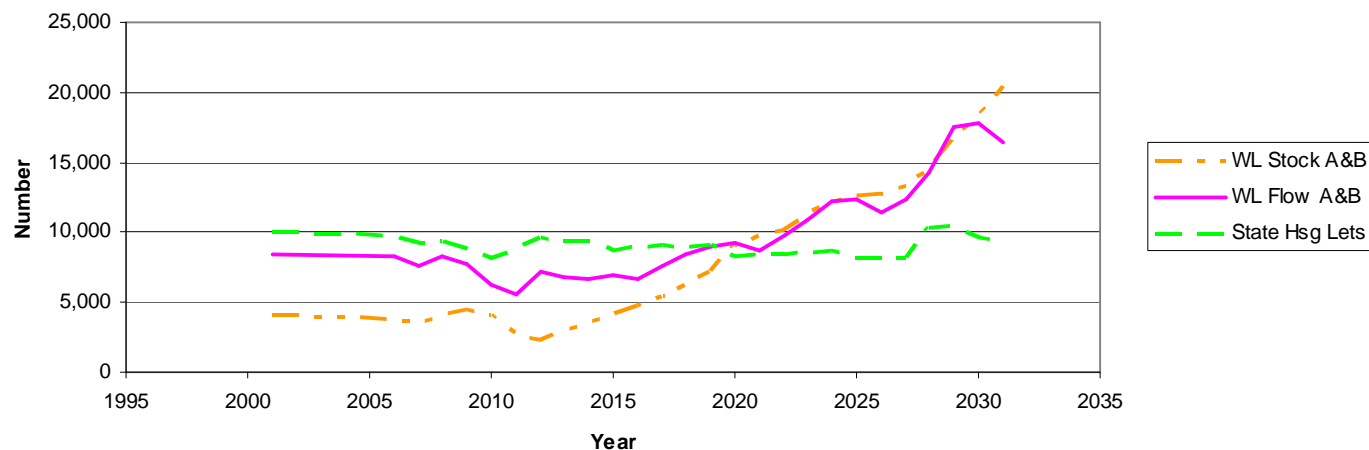
# Model for Flow Demand (A&B)

*Table 1: Regression model for Log All Net Flow Demand (as % of households)*

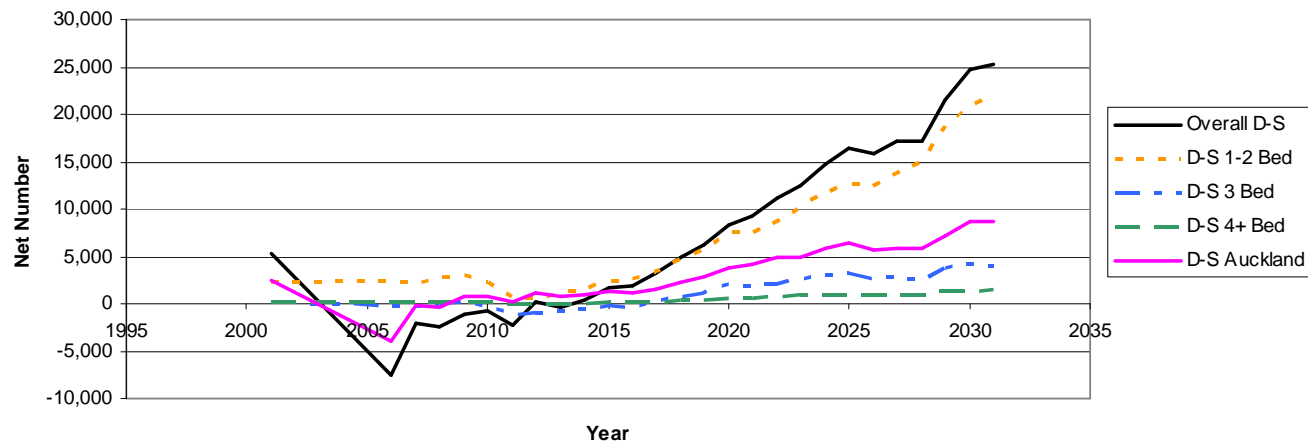
Description	Varname	Coeff B	Std Err	Std Coeff Beta	t stat	Signif	VIF
Constant	(Constant)	-5.548	0.849		-6.532	0.000	
Ave % state hsg x compos needs	avpshxneed	0.023	0.003	0.532	8.222	0.000	4.167
Maori & Pacific population share	tallmp	2.475	0.439	0.379	5.636	0.000	4.500
Lagged vacancy rate	pvac_1	-4.289	0.812	-0.202	-5.284	0.000	1.455
Employment rate % wkg age	emprrt	3.991	1.074	0.180	3.717	0.000	2.328
Household growth rate p a	hhdgpa	0.190	0.072	0.198	2.627	0.010	5.686
Lagged private lets % hhd	pplets_1	-0.064	0.014	-0.260	-4.404	0.000	3.481
One person households %	opall	8.336	1.523	0.427	5.473	0.000	6.061
Low state housing share dummy	losh	-1.559	0.150	-0.411	-10.371	0.000	1.562
Accom Supp Boarders % hhd	pasbd	0.085	0.027	0.273	3.108	0.002	7.717
Year 2010 dummy	y10	-0.372	0.065	-0.193	-5.748	0.000	1.126
Year 2011 dummy	y11	-0.505	0.073	-0.264	-6.933	0.000	1.441
a. Dependent Variable:	lpnfdall						
b. Weight	hhdwgt						
Model Summary			<b>R</b>	<b>R Sq</b>	<b>Adj R Sq</b>	<b>S E Est</b>	<b>D-W</b>
		1.000	0.928	0.862	0.851	0.233	1.443
		<b>SS</b>	<b>deg frdm</b>	<b>Mn Sq</b>	<b>F ratio</b>	<b>Sig.</b>	
1	Regression	46.5	11.0	4.226	78.091	0.000	
	Residual	7.5	138.0	0.054			
	Total	54.0	149.0				

# New Baseline Outputs – Demand & Supply

**Waiting List Stock and Flow (A&B) and State Housing Lets, Recent Past and Forecast**



**State Housing Demand-Supply Balance, Overall, by Size and in Auckland, Recent past and forecast**





# NZ Sensitivity Tests



Scenario & Year	PRS Share	Real Rent	Compos Needs	State D-S
	% all hhd	\$ pw 2b	% all hhd	Number
Baseline 2016	31.1	235	3.0	1,909
Baseline 2031	33.7	256	3.4	25,367
	% diff	% diff	% diff	% diff
Poor economic 2016	-0.1%	-1.5%	0.3%	-35.4%
Poor economic 2031	-2.9%	-9.0%	8.3%	-30.0%
Fav economic 2016	0.1%	1.4%	-0.3%	42.5%
Fav economic 2031	3.0%	8.0%	-0.1%	46.4%
Worse recession 2016	-1.7%	-1.9%	-0.9%	-17.1%
Worse recession 2031	-2.4%	-2.4%	-3.0%	-10.7%
Better recession 2016	1.7%	1.2%	0.5%	20.5%
Better recession 2031	2.6%	1.8%	2.8%	15.3%
Adverse financials 2016	3.4%	2.8%	0.0%	33.0%
Adverse financials 2031	8.8%	5.5%	8.8%	36.1%
Fav financials 2016	-2.2%	-1.5%	0.0%	-10.2%
Fav financials 2031	-4.8%	-3.8%	-5.9%	-7.9%
Low supply 2016	-0.3%	0.1%	-0.1%	20.3%
Low supply 2031	-0.6%	0.9%	-0.7%	6.4%
High supply 2016	0.3%	-0.1%	0.1%	-10.3%
High supply 2031	0.8%	-0.9%	0.7%	-2.2%

High & Low supply are +/- 25% consents in 3 most pressured regions

School of the Built Environment

- Poorer economic performance would *reduce* PRS and rents, increase composite needs but see *reduction* in Dem-Supp for state housing, and vice versa
- Worse recession would have bigger short run effect but smaller persistent long run effects, mainly in same directions
- Adverse financial conditions would *increase* PRS % & rents, also *increasing* needs & D-S balance; vice versa for favourable financials
- Low supply of new build in key regions would have modest effects, *reducing* PRS, raising rents, slightly reducing compos needs but *increasing* D-S balance; and vice versa.
  - effects in key regions would be larger

# Conclusions



- New model is significantly enhanced relative to phase 1 version
- PR models are better and tenure scenarios look plausible
- Economically-influenced demographic models work well and results seem sensible
- Needs and demand-supply models also improved, although still some further work on detailed breakdowns
- Further work to be done on supply side and revisiting price model
- Current 'vacancy feedback' functions need to be sensitivity tested and may in some cases be replaced by direct estimated effects
- Substantively, forecasts suggest modest increase in demand-supply balance for state housing in medium term, but stronger increase in longer term, with major differences between regions

# Formal Model Structure (background)



A formal if stylised demand and supply model for private renting could take the following form.

$$QRD = HH.(1 - HO / HH - HS / HH) \quad (1)$$

Where

QRD = Demand for private rental units

HH = Number of households

HO = Demand for owner occupier units (ho=HO/HH)

HS = Stock of state/social housing units (hs=HS/HH)

The household formation function could take the following form

$$\ln(HH / N) = \ln\left[\sum_{a=1}^A b_a \cdot (N_a / N)\right] + \{b_{ho} + b_{h1}Y - b_{h2}r.P - b_{h3}R + b_{h4}E + b_{h5}HE + b_{h6}M + b_{h7}K + b_{h8}hs\}$$

Where

N = Population

a = age groups

Y = income or earnings

r = mortgage interest rate

P = house price

R = market rent

E = employment rate

HE = higher education students

M = in-migration

K = wealth

b's = coefficients (expected signs indicated as +/-)

The tenure choice function for home ownership could take the corresponding form

$$\ln(HO) / HH = +\{b_{oo} + b_{o1}Y - b_{o2}r.P + b_{o3}R + b_{o4}E - b_{o5}HE - b_{o6}M + b_{o7}K - b_{o8}hs \quad (3)$$

Note the change in expected signs of coefficients on R, HE, M and hs.

# Formal model contd.

$$\ln(QRD / HH) = \ln(N) + \ln\left[\sum_{a=1}^A b_a \cdot (N_a / N)\right] + \{b_{ho} - b_{o0} + (b_{h1} - b_{o1})Y - (b_{h2} - b_{o2})r.P - (b_{h3} + b_{o3})R + \lambda R\}$$

(4)

where

$$\lambda R = \{+(b_{h4} - b_{o4})E + (b_{h5} + b_{o5})HE + (b_{h6} + b_{o6})M + (b_{h7} - b_{o7})K + (b_{h8} + b_{o8})qs\}$$

If we equate QRD with QRS in equilibrium, and re-arrange (invert) the function to place Rent on the left hand side, we obtain the following expression for Rent

$$R = \left\{ \frac{1}{(b_{h3} + b_{o4})} \right\} \cdot \{ \ln(N) + \ln\left[\sum_{a=1}^A b_a \cdot (N_a / N)\right] - \ln(qrs) + [b_{ho} - b_{o0} + (b_{h1} - b_{o1})Y - (b_{h2} - b_{o2})r.P + \lambda R] \}$$

(5)

Turning to the supply side, we posit a supply function for private renting share as follows

$$\ln(QRS) / D = +b_{so} + b_{s1}\Delta P / P - b_{s2}r.P + b_{s3}R + b_{o4}D_f / D - b_{s5}D_s / D - b_{s6}\Delta D / D + b_{s7}K - b_{s8}TPR$$

(6)

Where

QRS = private rental supply units

D = dwelling stock units

D<sub>f</sub> = flats

D<sub>s</sub> = small dwelling units

TPR = tax rate applicable to private rental investment