

Evidence on the determinants and variation of idiosyncratic risk in housing markets

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Motivation

- House price appreciation is very heterogeneous. (Case and Shiller, 1989)
 - Indices severely underestimate risks.
- The family home has the largest weight in households' investment portfolios. (50% on average, OECD, 2021)
- Housing idiosyncratic risk cannot be easily diversified away.

This paper: estimates of idiosyncratic risk in house price appreciation in NZ.

1. Is there any systematic variation in idiosyncratic risk?

- Evidence of variation across time, location, house price, and holding period.

2. Why does idiosyncratic risk vary?

- Role of credit conditions and information quality.

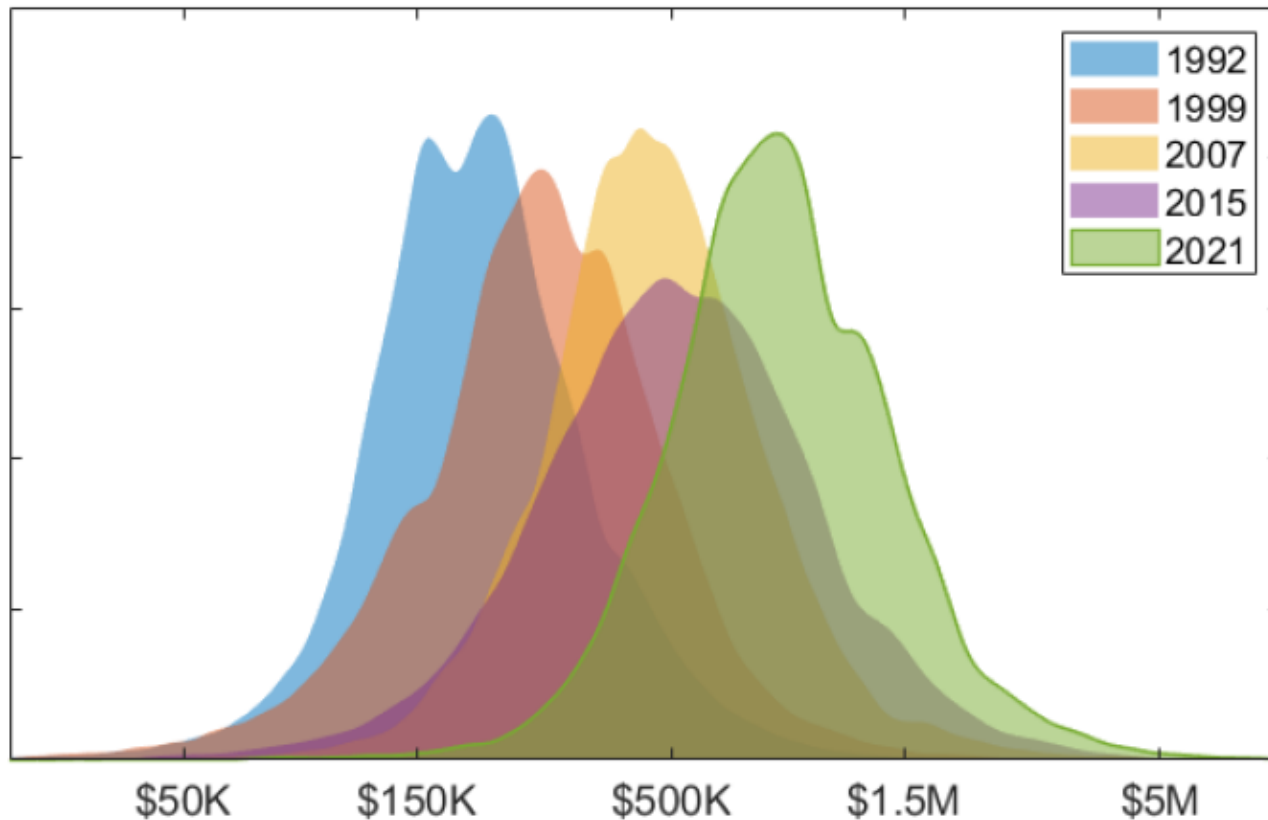
3. Is idiosyncratic risk priced in capital returns?

- Mostly, except across locations.

Idiosyncratic* risk

(*change in house price that is specific to each individual house, and not explained by market fluctuations or common characteristics across houses)

Distribution of House Prices in New Zealand



- Individuals are exposed to much more risk than implied by indices.
- Sources of idiosyncratic risk:
 - Market illiquidity
 - Asymmetric information
 - Shocks

Note: real prices (2021 CPI) depicted in log-scale.

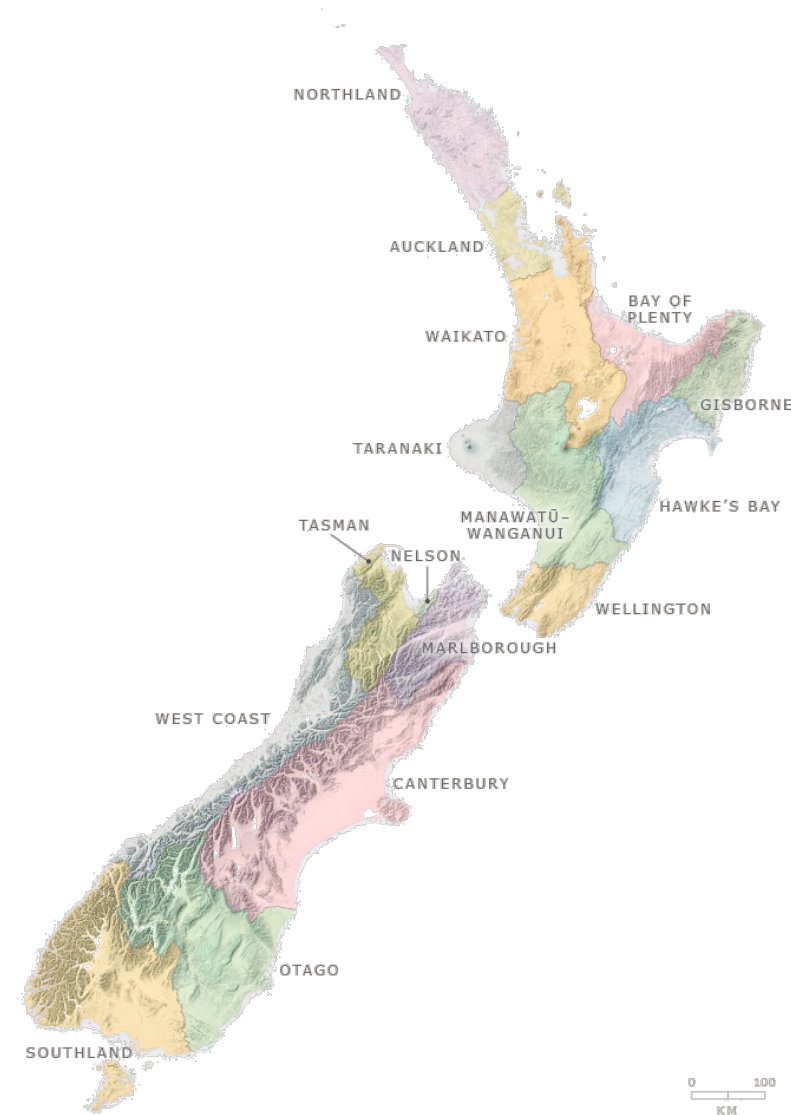
Selected papers from the literature

- Case and Shiller (AER 1989):
 - probably the first to investigate cross section of house prices, reporting high standard deviation, and using repeat sales data to criticize index-based indicators of risk and return.
- Lando, Piazzesi, and Schneider (AER 2015):
 - investigate distribution of house prices on San Diego County, finding that cheaper credit for poor households was a major driver of prices, especially at the low end of the market.
- Jorda, Knoll, Kuvshinov, Schularick, and Taylor (QJE 2019):
 - calculate rate of return on everything, finding that residential real estate provides the best risk-return investment opportunity over the long-run – however, ignoring idiosyncratic risk.
- Bourassa, Haurin, Haurin, Hoesli, and Sun (REE 2009):
 - investigate cross-section of housing returns in New Zealand, finding that appreciation depends on characteristics of the property and the strength of the housing market.
- Giacoletti (RFS 2021):
 - investigate idiosyncratic risk in California's housing market, controlling for remodeling and holding period, and finding that risk is associated with information quality and market liquidity.

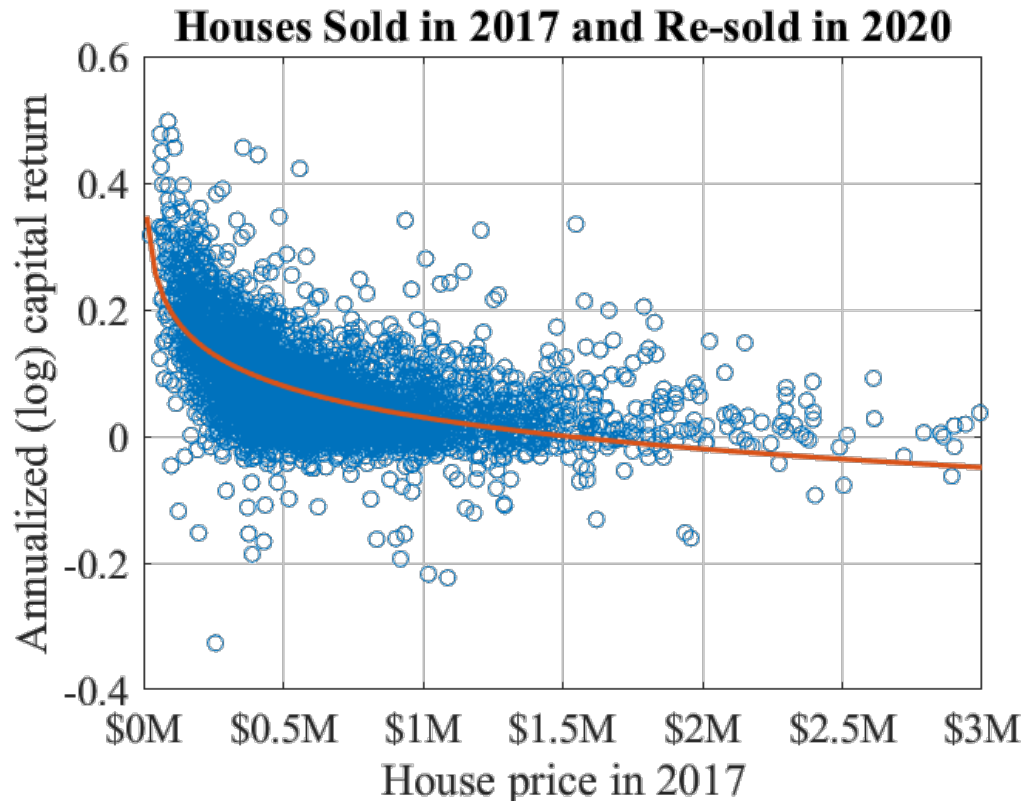
Housing data

- Residential sales data, as reported by realtors.
Source: Real Estate Institute of New Zealand (REINZ).
- Between 1992 and 2021, nationwide:
 - About 2.5M house sales => over 1M repeat sales.

Variable	Mean	Std. dev.	1 st	Percentiles				N. Obs.
				25 th	50 th	75 th	99 th	
House characteristics:								
Bedrooms	3.06	0.82	1	3	3	3	5	1,054,105
Bathrooms	1.43	0.69	0	1	1	2	4	541,315
Garages	1.46	0.87	0	1	1	2	4	1,026,847
Floor area (m ²)	143.11	65.16	50	100	126	174	351	1,029,021
Repeat sales:								
Initial price deviation* (%)	12.67	66.63	-71.43	-25.64	-1.27	32.90	253.69	1,058,391
Price change (% ann.)	5.52	8.20	-12.27	1.20	4.28	8.30	34.96	1,058,391
Holding years	6.70	5.23	1	3	5	9	24	1,058,391



Repeat sales model (extended from Landvoigt et al., 2015)



- Cheaper houses appreciating faster. (convergence)
- Larger dispersion of returns for cheaper houses. (heteroskedasticity)

Model of price changes:

$$p_{i,t+1} - p_{i,t} = \alpha_{r,t} + \beta_t(p_{i,t} - \tilde{p}_{r,t}) + \Psi X_{i,t} + \varepsilon_{i,t}$$

- $p_{i,t}$: log price of a house i in year t
- $\alpha_{r,t}$: average price change of houses in region r
- β_t : effect of house price deviation from regional median, $\tilde{p}_{r,t}$
- Ψ : effect of changes in house features, $X_{i,t}$
- $\varepsilon_{i,t}$: idiosyncratic shock with mean zero and variance $\sigma_{\varepsilon,i,t}^2$

Idiosyncratic risk

$$p_{i,t+1} - p_{i,t} = \alpha_{r,t} + \beta_t(p_{i,t} - \tilde{p}_{r,t}) + \Psi X_{i,t} + \varepsilon_{i,t}$$

- Idiosyncratic risk = variance of idiosyncratic shocks, $\sigma_{\varepsilon,i,t}^2$
- Estimated by Maximum Likelihood from residuals of returns model:
(assuming Normal distribution)

$$\sigma_{\varepsilon,i,t}^2 = \exp\left(\phi_{r_i} + \delta \ddot{p}_i + \rho(k_i - 1)\right) \sigma_t^2$$

- ϕ_r : regional variation in idiosyncratic risk
- δ : sensitivity of risk to house price deviation from regional median, \ddot{p}
- ρ : effect of holding period (k) on idiosyncratic risk
- σ_t^2 : time variation in idiosyncratic risk

How does idiosyncratic risk vary?

Effects of time, location, house price, and holding period

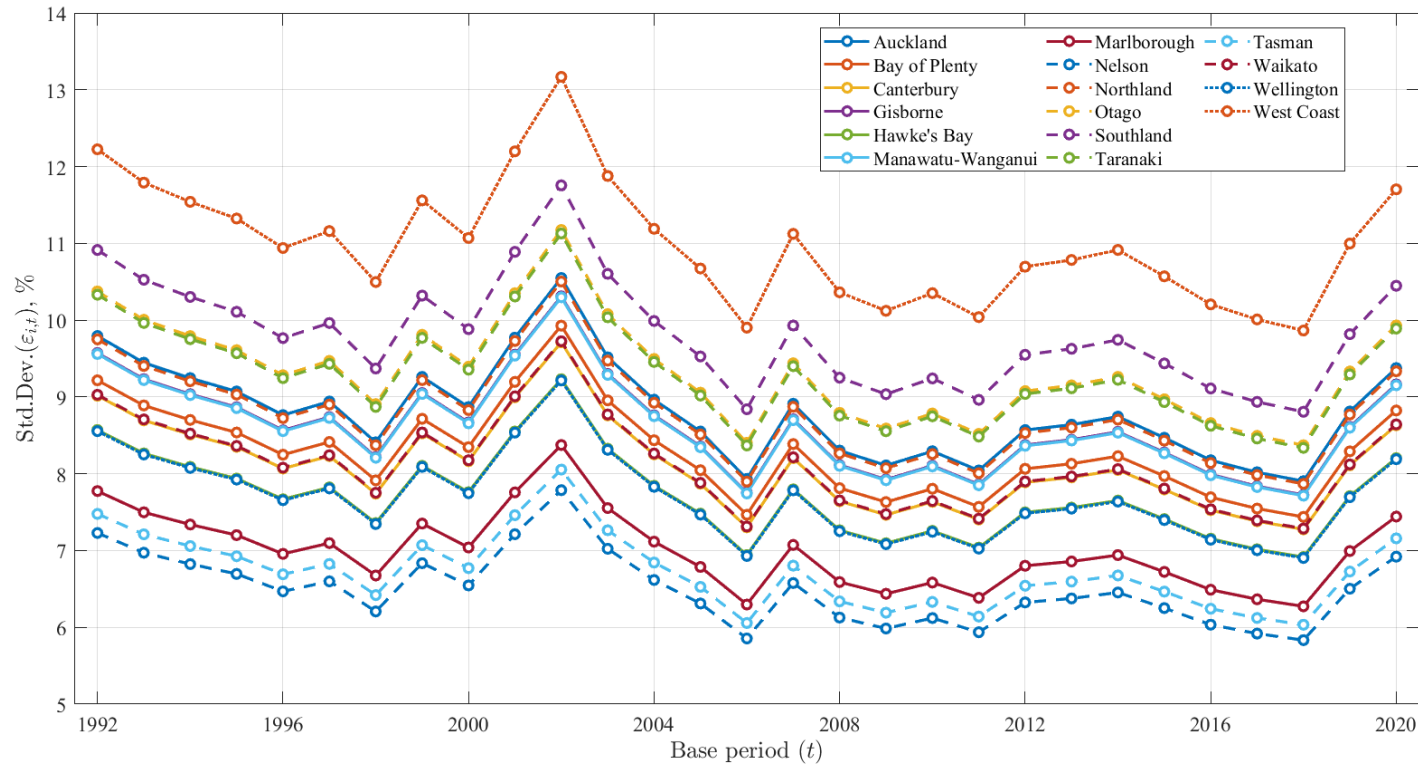
Model estimates: risk parameters

	(1)	(2)	(3)	(4)
Elasticity estimates:				
Bedrooms	6.515 (0.061)	6.446 (0.062)	6.092 (0.081)	7.331 (0.069)
Bathrooms	1.467 (0.082)	1.477 (0.082)	1.284 (0.085)	1.574 (0.097)
Garages	0.637 (0.050)	0.645 (0.049)	0.331 (0.058)	0.666 (0.053)
Floor area (25m ²)	0.539 (0.029)	0.531 (0.030)	0.545 (0.035)	0.587 (0.032)
New dwelling	2.402 (0.125)		2.834 (0.172)	1.925 (0.157)
Variance parameter estimates:				
Initial price deviation, $\hat{\delta}$	-0.278 (0.008)	-0.286 (0.008)	-0.332 (0.011)	-0.275 (0.008)
Holding period, $\hat{\rho}$	-0.156 (0.003)	-0.152 (0.003)	-0.192 (0.005)	-0.117 (0.003)
Sample	All	Excluding new dwelling	Excluding missing	Excluding hold < 2 years
R-squared (equation 1)	0.760	0.761	0.776	0.773
Avg. log likelihood (equation 2)	0.192	0.195	0.261	0.143
N. Obs.	1,058,391	1,026,613	522,616	947,089

$$\sigma_{\varepsilon,i,t}^2 = \exp\left(\phi_{r_i} + \delta\dot{p}_i + \rho(k_i - 1)\right) \sigma_t^2$$

- $\hat{\delta} < 0$: cheaper houses are riskier.
 - House 25% cheaper than regional median is 4.1% riskier
- $\hat{\rho} < 0$: holding longer reduces idiosyncratic risk.
 - Every additional year the house is held risk declines by 7.8%.

Risk estimates: region and time



$$\sigma_{\varepsilon,i,t}^2 = \exp(\underbrace{\phi}_{=0} r_i + \delta \underbrace{\dot{p}}_{=5} + \rho(k_i - 1)) \sigma_t^2$$


- Some variation over time:
 - Auckland low of 7.90% (2018).
 - Auckland high of 10.55% (2002).
- Wider variation across regions:
 - Nelson low of 5.83% (2018).
 - West Coast high of 13.17% (2002).

Note: estimates for a median priced house in the corresponding regions and holding period of 5 years between repeat sales.

Why does idiosyncratic risk vary?

The roles of credit conditions and valuation uncertainty

Regression framework

$$\left(\ln \hat{\sigma}_{\varepsilon,i,t} - \ln \tilde{\sigma}_{\varepsilon,i,t} \right) = \alpha + \Lambda \mathbf{X}_{i,t} + u_{i,t}$$


- Log estimate of idiosyncratic risk excluding controlled variation:
 - Separate regressions focusing on Time, Region, Price, Hold period variation, and total variation in risk.

- Set of explanatory variables:
 - Credit conditions:
 - Interest rate & loan-to-value ratios (LVR).
 - Informational asymmetries:
 - House atypicality & internet access.
 - Control variables for market activity and size.

Regression results on idiosyncratic risk estimates

Explanatory variables	(1)	(2)	(3)	(4)	(5)
(i) Credit conditions:					
• Interest rate (%, national)	-2.080** (0.773)		0.017 (0.026)	-2.372*** (0.532)	-2.262*** (0.616)
• Loan-to-value ratio (%, national)	0.156 (0.105)		-0.012* (0.006)	-0.536** (0.198)	-0.443** (0.153)
(ii) Informational asymmetries/uncertainty:					
• Average house atypicality (regional)		0.276** (0.116)	0.009 (0.036)	1.425*** (0.466)	0.982** (0.399)
• Internet access, 2006 (%, regional/SA2)		-1.363** (0.511)	-0.266*** (0.071)	0.013** (0.005)	-0.328*** (0.045)
Variation in risk	Year	Region	Price	Hold	All
Explan. vars. aggregation	Country	Region	SA2	SA2	SA2
N. Obs.	7,088,089	6,834,835	6,535,077	6,535,077	6,535,077
R-squared	0.575	0.275	0.282	0.137	0.101

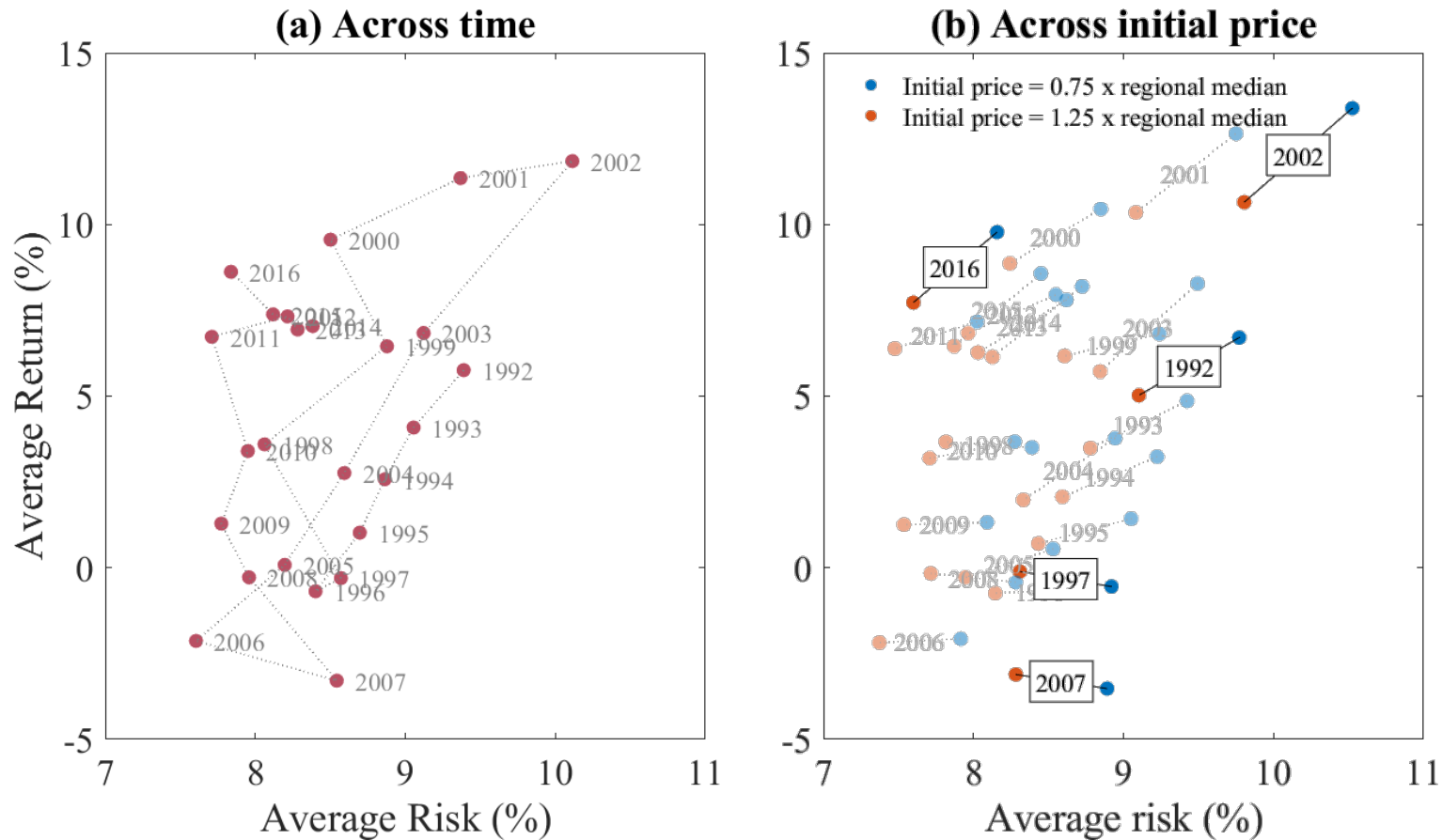
- Credit tightening:
 - ↑ borrowing costs ↓ risk
 - ↓ mortgage rollover
 - ↑ forced sales
 - ↑ pool of houses
 - ↓ risk-taking
- Valuation uncertainty:
 - ↓ LVR ↑ risk
 - ↓ pool of buyers
- Valuation uncertainty:
 - ↑ atypicality ↑ risk
 - ↑ house heterogeneity
- Valuation uncertainty:
 - ↓ internet access ↑ risk
 - ↓ information access

Notes: Each column represents a regression with dependent variable equal to the repeat sales (log) estimate of idiosyncratic risk excluding the controlled variation. All regressions include additional controls for market activity/size given by year/region/SA2 number of sales, total population, and new building consents area. Cluster robust standard errors are presented between brackets. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels of significance, respectively.

Is idiosyncratic risk priced in housing returns?

And how can different estimation methods bias risk assessments?

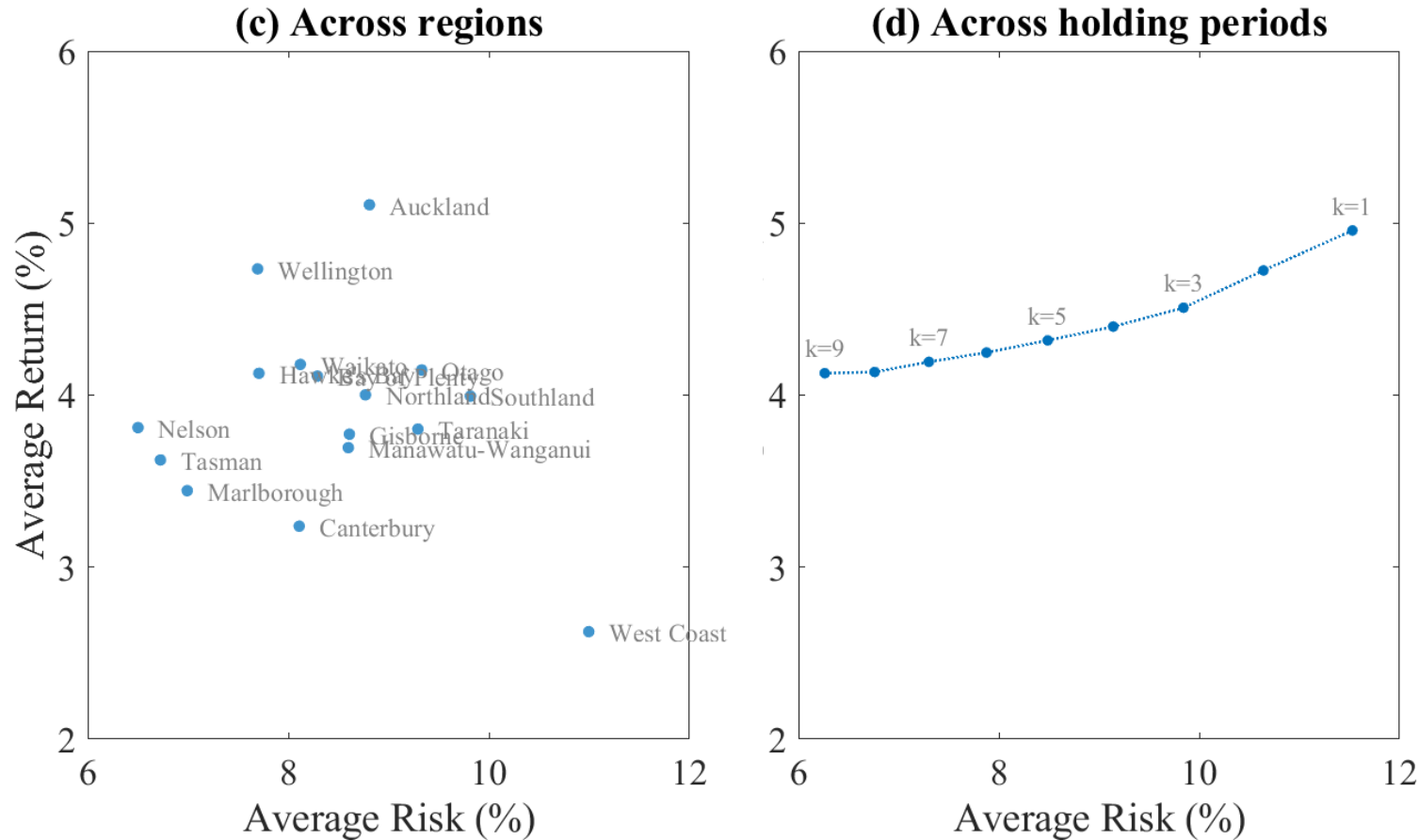
Risk-return across time and price



Note: Risk and return estimates are annualized rates for a 5-year holding period starting at the indicated year.

- Idiosyncratic risk is (mostly) priced in returns over time.
- Time-varying risk-return trade-offs by initial price.
- During “normal” times, the higher risk associated with cheaper houses is priced in higher returns.
- During housing market busts, the risk-return trade-off by initial price inverts.
 - Cheaper houses depreciate faster than more expensive ones.

Risk-return across regions and holding period



Note: Risk and return estimates in (c) are annualized rates for a 5-year holding.

- Regional variation in idiosyncratic risk is not priced in regional returns.
- Idiosyncratic risk priced in returns across holding periods.
- But the trade-off is relatively flat.

Conclusions and policy implications

- Idiosyncratic risk in house pricing varies systematically across time, location, house price (-), and holding period (-).
 - Inequality: poorer households buy cheaper houses, hence facing higher risk.
- Across time and holding periods, risk is associated with credit conditions.
 - Macroprudential regulation can complement interest rate policy in the control of housing risk.
- Across regions and house prices, risk is associated with informational asymmetries.
 - Housing market regulation should target better access to information and transparency in house valuation.
- Systematic variation in idiosyncratic risk is mostly priced in returns across:
 - Time: ✓, Locations: ✗, Holding periods: ~, House prices: depends on state of the market.

Thank you.

Selected references

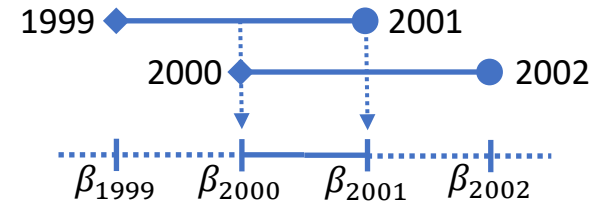
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Extra slides

Estimation over all possible repeat sales pairs (435)



- Time-variation in α 's and β 's identified from overlapping repeat sales.



- System of non-linear equations on α 's and β 's:

$$p_{i,t+k} - p_{i,t} = a_{r,t,k} + b_{t,k}p_{i,t} - c_{t,k} + d_{t,k}\Psi X_{i,t} + e_{i,t,k},$$

- $a_{r,t,k} = a_{r,t,k-1}(1 + \beta_{t+k-1}) + \alpha_{r,t+k-1}$,
- $b_{t,k} = b_{t,k-1}(1 + \beta_{t+k-1}) + \beta_{t+k-1}$,
- $c_{t,k} = c_{t,k-1}(1 + \beta_{t+k-1}) + \beta_{t+k-1}\tilde{p}_{r,t+k-1}$,
- $d_{t,k} = d_{t,k-1}(1 + \beta_{t+k-1}) + 1$,
- $e_{i,t,k} = e_{i,t,k-1}(1 + \beta_{t+k-1}) + \varepsilon_{t+k-1}$.

- 2-stages non-linear least squares.
(1st unweighted, 2nd weighted)

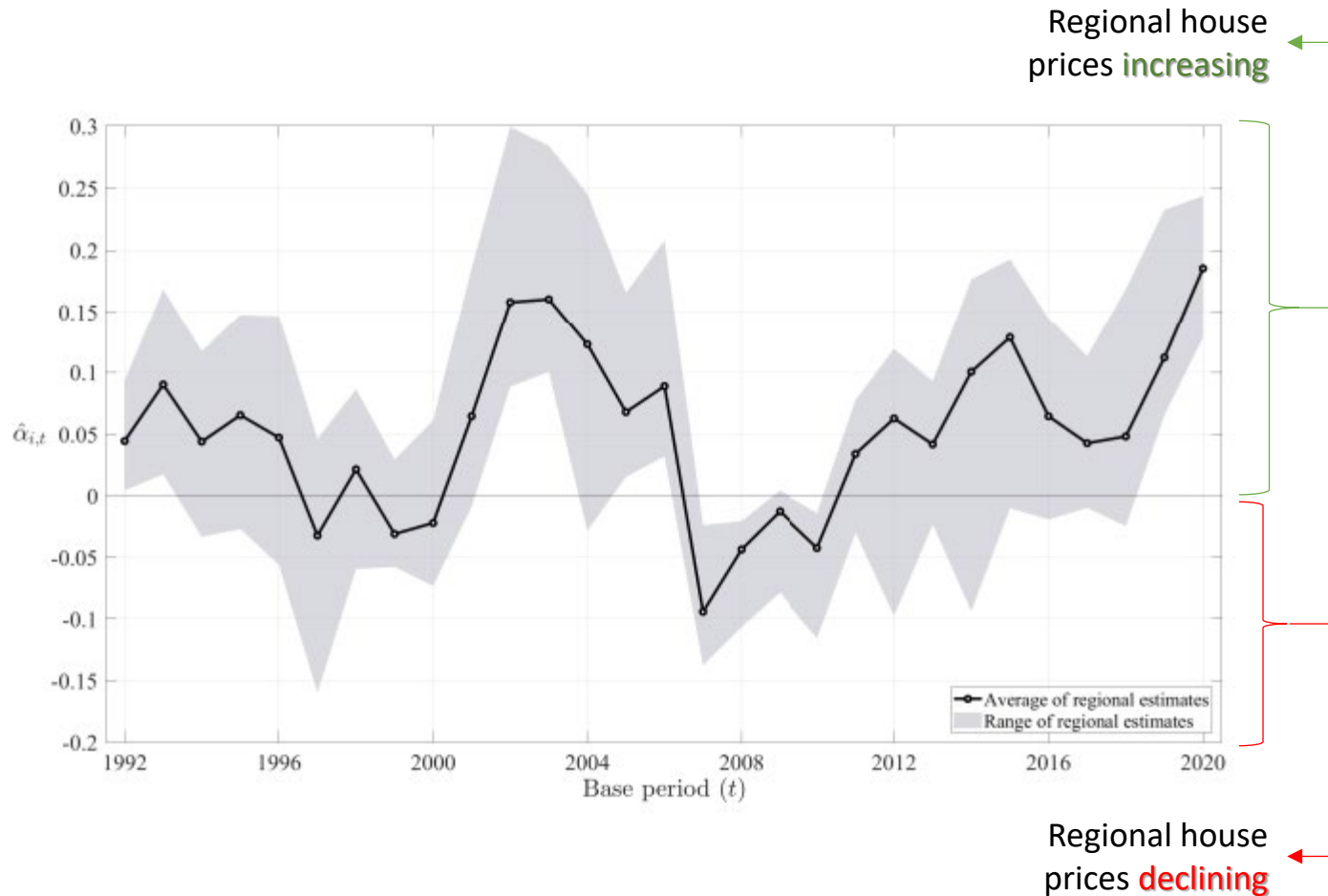
Model estimates: remodeling elasticities

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Avg. log likelihood (equation 2)	0.192	0.195	0.261	0.143
N. Obs.	1,058,391	1,026,613	522,616	947,089

$$\Delta p_{i,t+1} = \alpha_{r,t} + \beta_t \dot{p}_{i,t} + \Psi X_{i,t} + \varepsilon_{i,t}$$

- All estimates significant.
- Robust across samples.
- Interpretation:
 - +1 bedroom => +6.5% house price
 - +1 bathroom => +1.5% house price
 - +1 garage => +0.6% house price
 - + 25m² => +0.5% house price
 - New dwelling => +2.4% house price

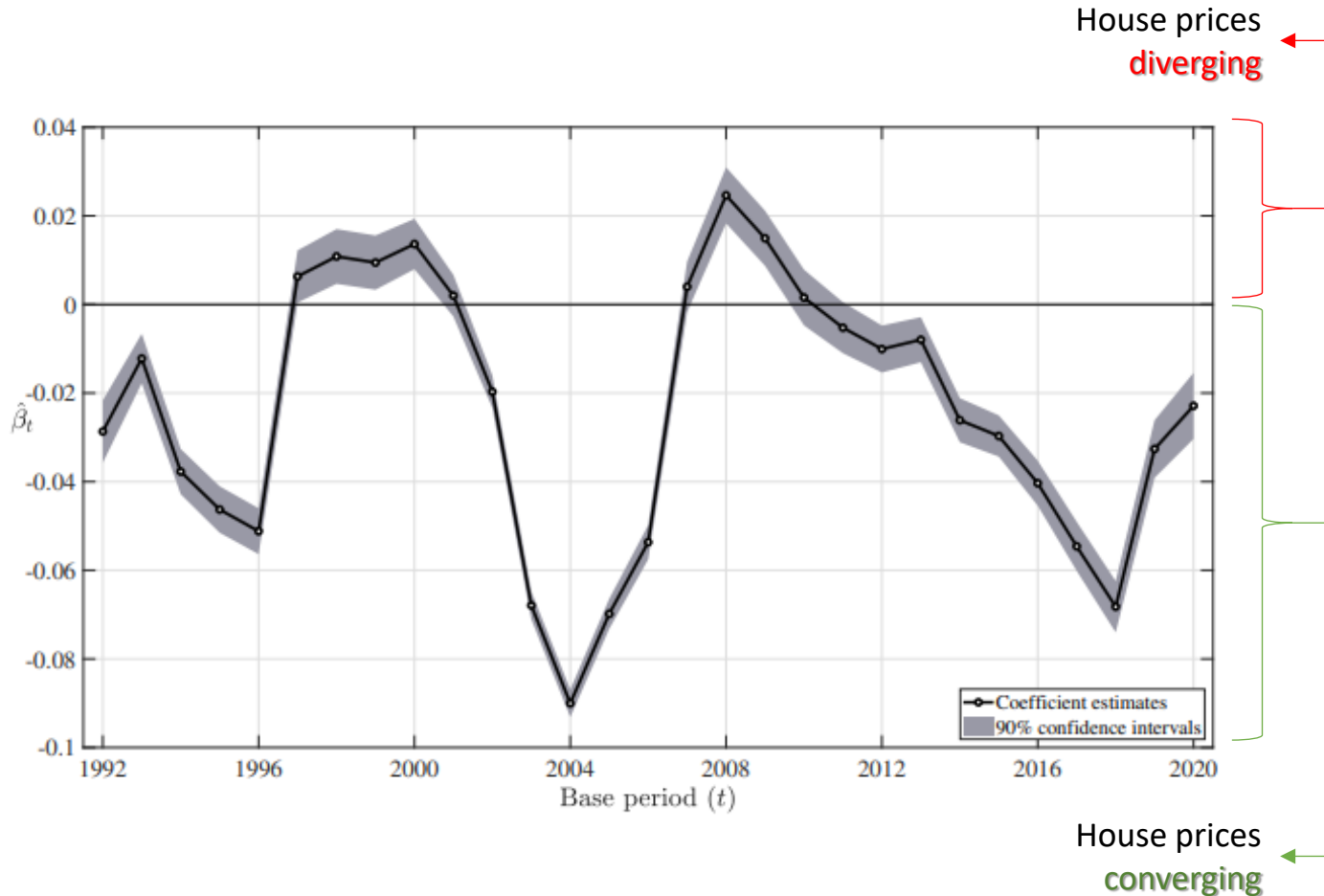
Model estimates: regional returns



$$\Delta p_{i,t+1} = \alpha_{r,t} + \beta_t \ddot{p}_{i,t} + \Psi X_{i,t} + \varepsilon_{i,t}$$

- Consistent with price trends.
- Some regional variation.
- Interpretation:
 - Between 2020-21, average regional prices increased by almost 20%.

Model estimates: initial price effect



$$\Delta p_{i,t+1} = \alpha_{r,t} + \beta_t \dot{p}_{i,t} + \Psi X_{i,t} + \varepsilon_{i,t}$$

- Mostly negative (convergence).
- Divergence during bust phases of housing cycle.
- Interpretation:
 - Between 2004-05, a house 50% below the regional median appreciated about 6.2% more than regional median house, on average.
 - Gap between a house 50% below the regional median in 1992 and one 50% above, decreased to 51% in 2021, on average.

Number of observations by region

Region	Repeat sales	Houses	Re-sold 1x	Re-sold 2x	Re-sold >2x
Auckland	325,677	183,684	96,143	51,266	36,275
Bay of Plenty	70,002	38,975	19,979	10,981	8,015
Canterbury	140,602	79,479	41,710	22,195	15,574
Gisborne	8,897	4,614	2,148	1,332	1,134
Hawke's Bay	36,375	19,932	9,972	5,766	4,194
Manawatu-Wanganui	60,777	32,407	15,489	9,381	7,537
Marlborough	13,655	7,105	3,352	2,006	1,747
Nelson	14,361	7,823	3,932	2,195	1,696
Northland	25,746	14,767	8,005	3,968	2,794
Otago	59,688	32,025	15,798	8,948	7,279
Southland	33,020	15,535	6,392	4,315	4,828
Taranaki	29,525	15,572	7,479	4,385	3,708
Tasman	8,802	4,903	2,520	1,375	1,008
Waikato	101,635	54,822	27,039	15,494	12,289
Wellington	124,574	68,836	34,941	19,353	14,542
West Coast	5,055	3,082	1,780	833	469
Total	1,058,391	583,561	296,679	163,793	123,089

Descriptive statistics of explanatory variables

Variable	Mean	Std. dev.	Min.	Max.	N
Interest rate ^(a)	0.050	0.023	0.004	0.094	7,088,089
	[0.048]	[0.025]	[0.004]	[0.094]	[29]
Loan-to-value ratio ^(a)	0.951	0.099	0.700	1.000	7,088,089
	[0.940]	[0.109]	[0.700]	[1.000]	[29]
Internet access, 2006, region ^(b)	0.607	0.048	0.466	0.656	7,088,089
	[0.568]	[0.051]	[0.466]	[0.656]	[16]
Internet access, 2006, SA2 ^(b)	0.605	0.131	0.183	1.000	6,785,587
	[0.605]	[0.138]	[0.183]	[1.000]	[2,125]
Total population, national (million) ^(b)	4.198	0.338	3.538	5.094	7,088,089
	[4.205]	[0.435]	[3.538]	[5.094]	[29]
Total population, region (million) ^(b)	0.669	0.523	0.032	1.436	7,088,089
	[0.274]	[0.340]	[0.032]	[1.436]	[16]
New build consent area, national (million) ^(b)	4.255	0.962	2.618	6.158	7,088,089
	[4.291]	[1.040]	[2.618]	[6.158]	[29]
New build consent area, region (million) ^(b)	0.659	0.576	0.010	2.473	7,088,089
	[0.268]	[0.387]	[0.010]	[2.473]	[464]
Average house atypicality ^(c)	0.758	0.037	0.637	0.919	6,834,835
N. Sales, national (thousand) ^(c)	82.375	17.089	55.505	119.701	7,088,089
N. Sales, region (thousand) ^(c)	12.785	10.682	0.230	39.798	7,088,089
N. Sales, SA2 ^(c)	54.255	28.121	1.000	342.000	6,778,603

Sources: ^aReserve Bank of New Zealand; ^bStats New Zealand; ^cAuthor's construction based on data from the Real Estate Institute of New Zealand. All variables are matched to the repeat sales data extended to cover every period between purchase and sale. Original statistics for the variables not derived directly from the repeat sales data are presented between brackets.

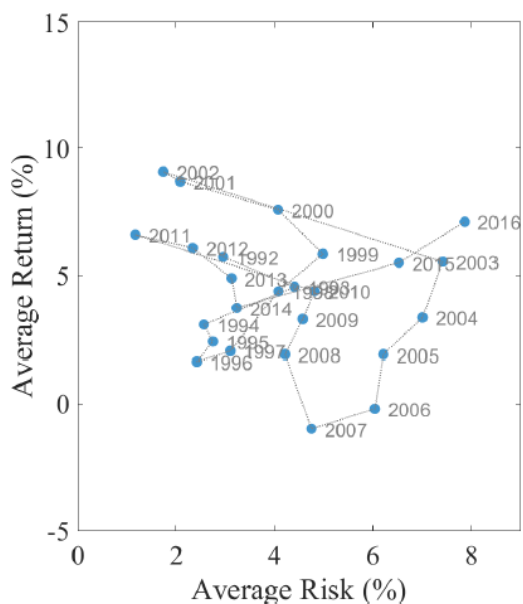
Back of envelope calculation

- Relative importance of each factor in the variation of idiosyncratic risk:

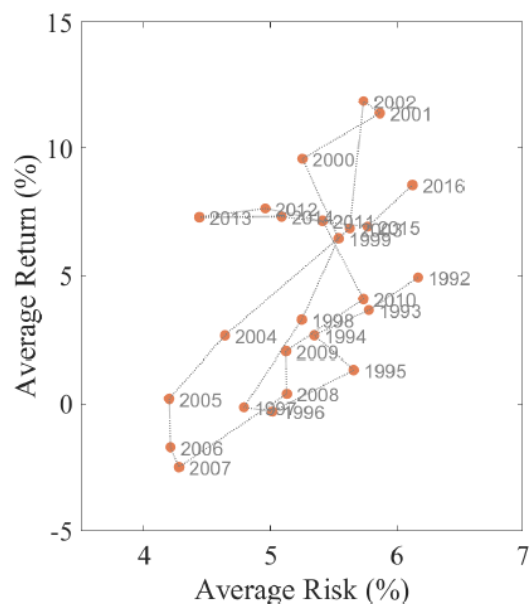
House	Region	Price deviation	Holding period	Year	Total risk
10 th percentile of risk	Tasman	80% above median	14 years	2017	2.8%
90 th percentile of risk	Otago	43% below median	2 years	2003	13.8%
Shares in risk difference	21%	10%	58%	11%	Δ = 11pp

Risk-return across time

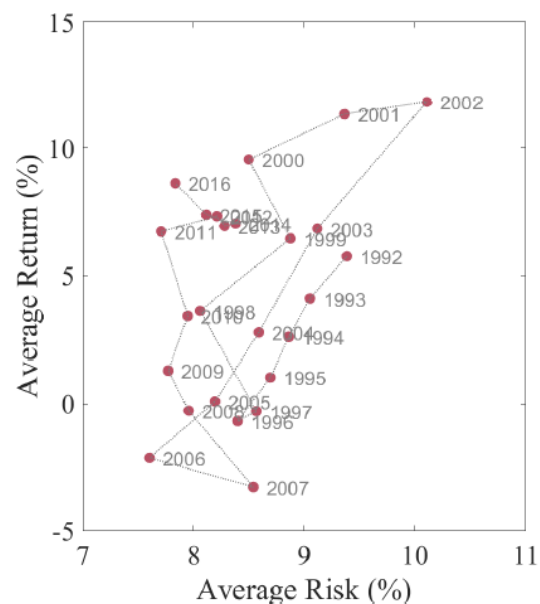
(a) Index-based.



(b) Raw repeat sales.



(c) Model-based.



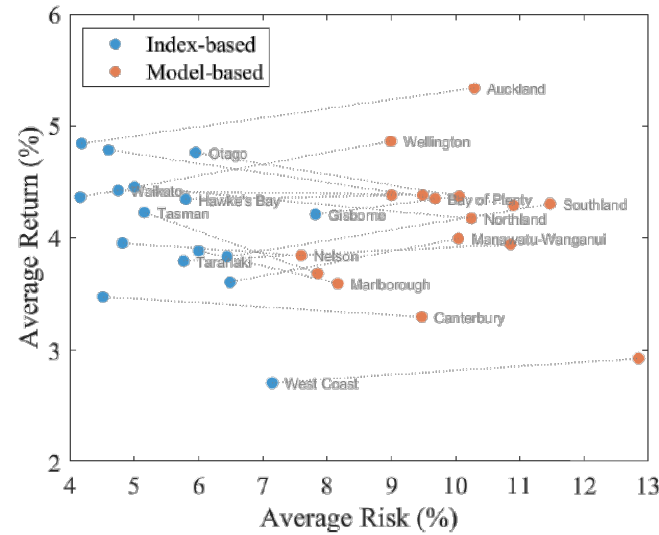
- Index-based and raw repeat sales underestimate risk.
- Idiosyncratic risk mostly priced in returns over time.

Note: All risk and return statistics are annualized rates for a 5-year holding period starting at the indicated year.

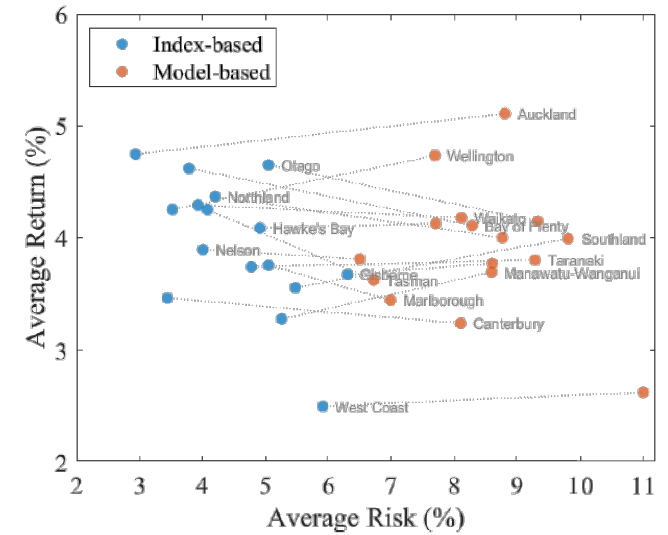
Risk-return across regions

- Regional variation in idiosyncratic risk is not priced in regional returns.

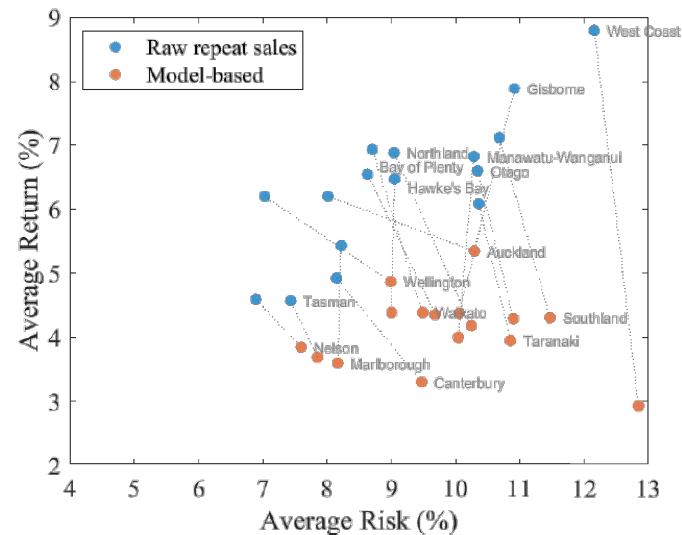
(a) Index vs. model, 3-years hold.



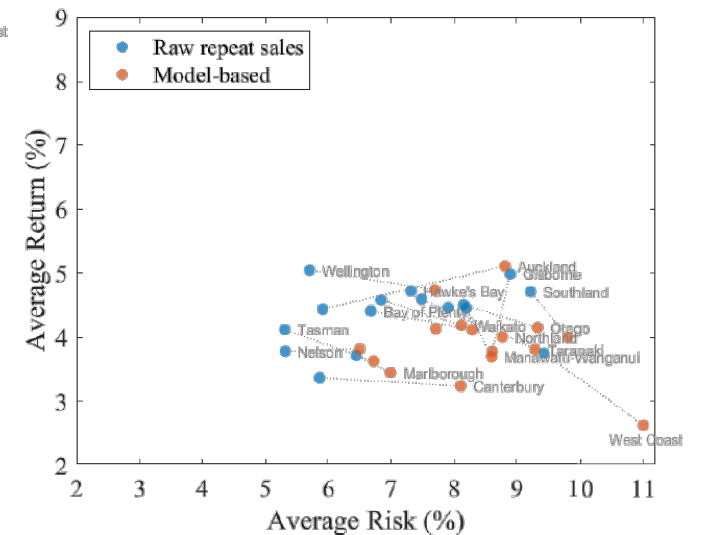
(b) Index vs. model, 5-years hold.



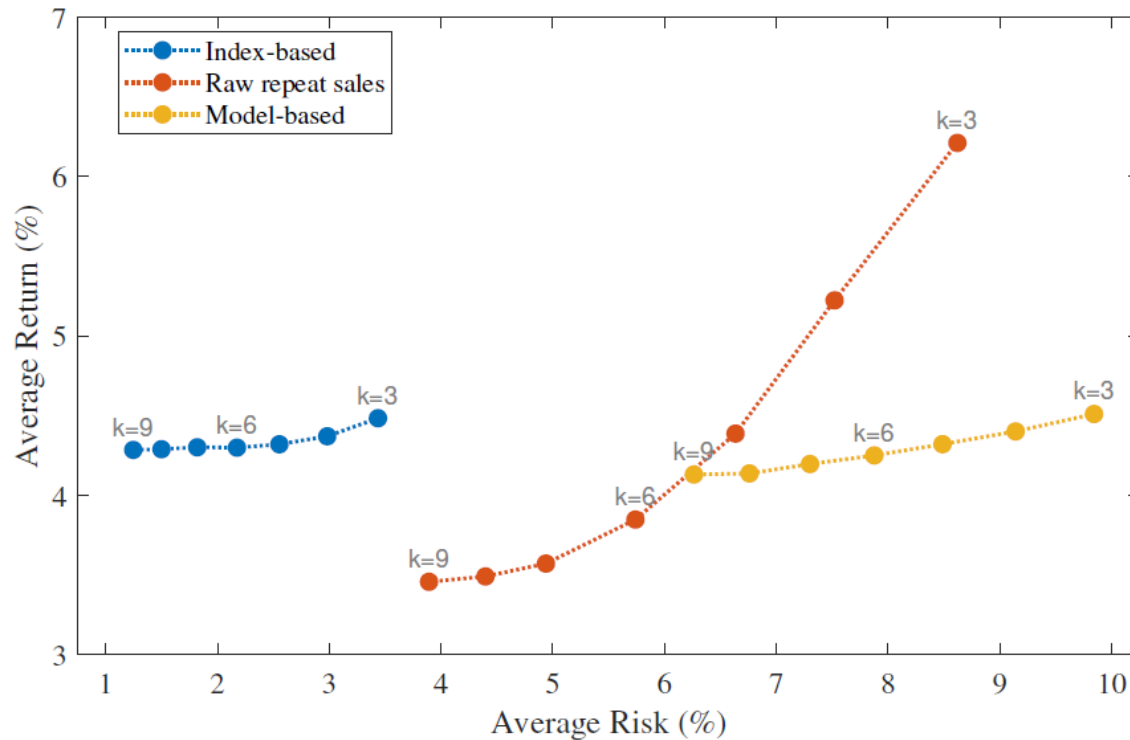
(c) Raw repeat sales vs. model, 3-years hold.



(d) Raw repeat sales vs. model, 5-years hold.

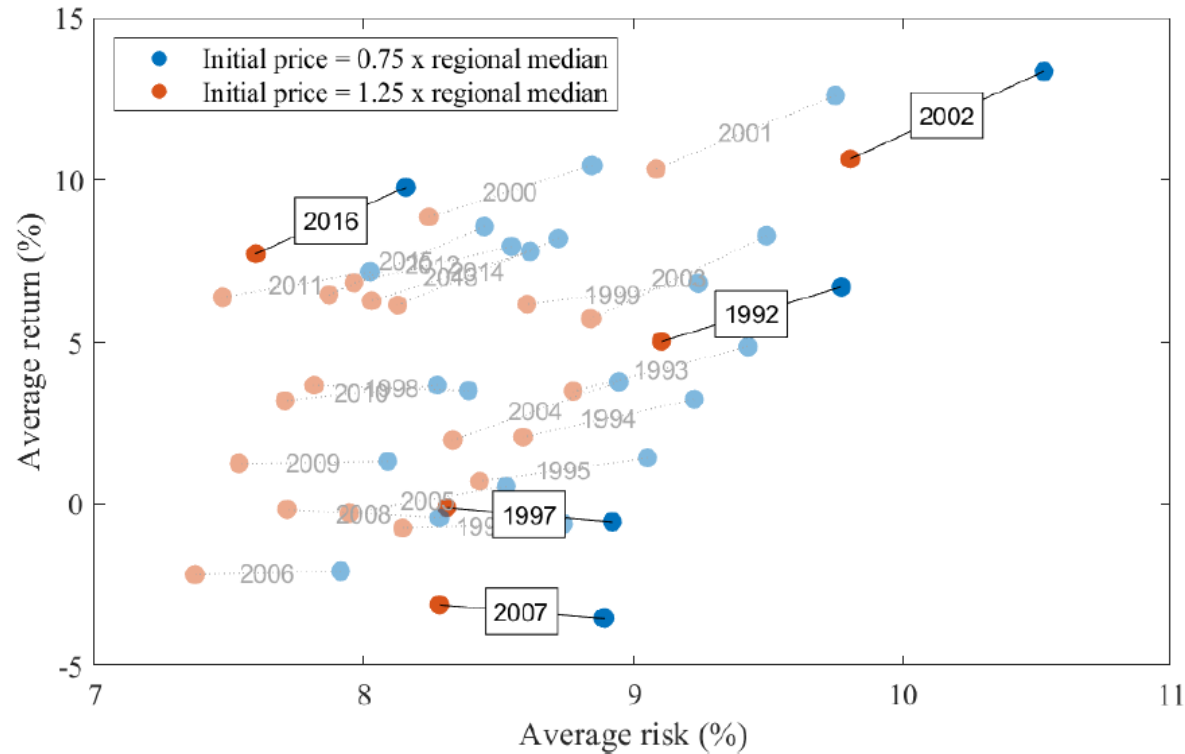


Risk-return across holding periods



- Idiosyncratic risk priced in returns across holding periods.
- But the trade-off is relatively flat.
- Raw repeat sales misleadingly suggest a larger role for holding periods.

Risk-return across initial price



Note: Model-based risk and return estimates are annualized rates for a 5-year holding period starting at the indicated year.

- Time-varying risk-return trade-offs by initial price.
- During “normal” times, the higher risk associated with cheaper houses is priced in higher returns.
- During housing market busts, the risk-return trade-off by initial price inverts.
 - Cheaper houses depreciate faster than more expensive ones.

Comparative of regional risk estimates

