Very Long-Run Discount Rates

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Discounting the Very Long Run

- Long-run discount rates play crucial role in many economic questions
  - Climate change: trade-off immediate costs and very distant benefits
- Little direct empirical evidence on very long-run discount rates
  - OMB recommends using wide range of discount rates (1% - 7%) for "intergenerational" projects
  - While markets provide a reference for discounting within a generation, "for extremely long time periods no comparable private rates exist."
- Empirical Challenge:
  - Would like to observe prices of claims to cash flows at all maturities
  - We generally only observe:
    - Infinite maturity assets: equities
    - Relatively short maturity assets: bonds or dividend strips

Our Approach

- Exploit a feature of housing markets in the UK and Singapore to provide *first direct estimates of very long-run discount rates*
- Residential property ownership:
  - **Freeholds:** Permanent ownership (as in US)
  - **Leaseholds:** Temporary ownership for varying tenure (99 - 999 years)
  - Key: Prepaid; Liquid secondary market for leaseholds; similar properties; Few contractual restrictions on leaseholders

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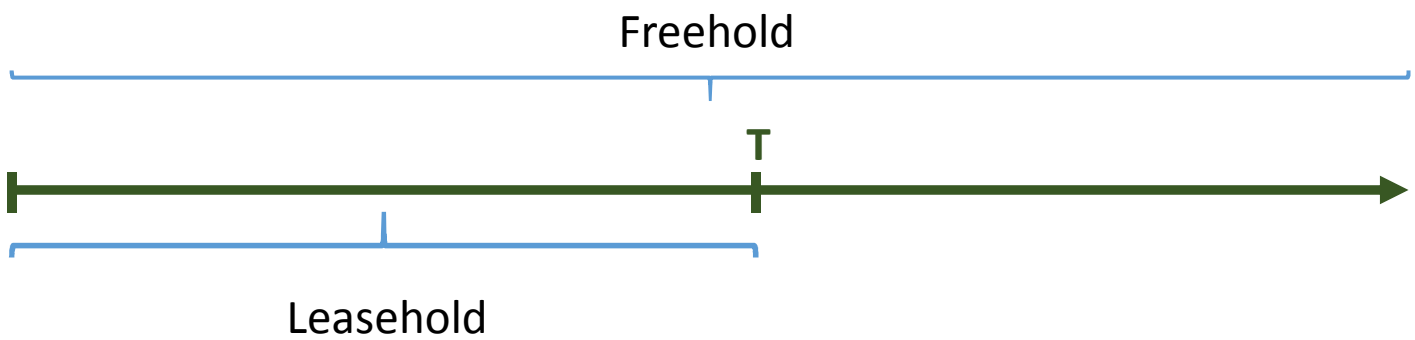

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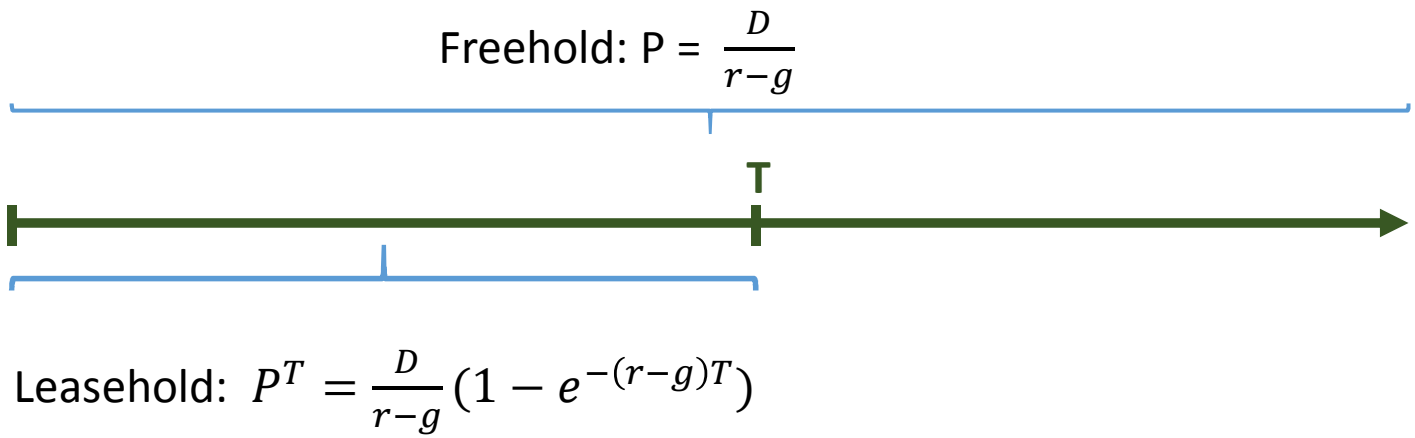

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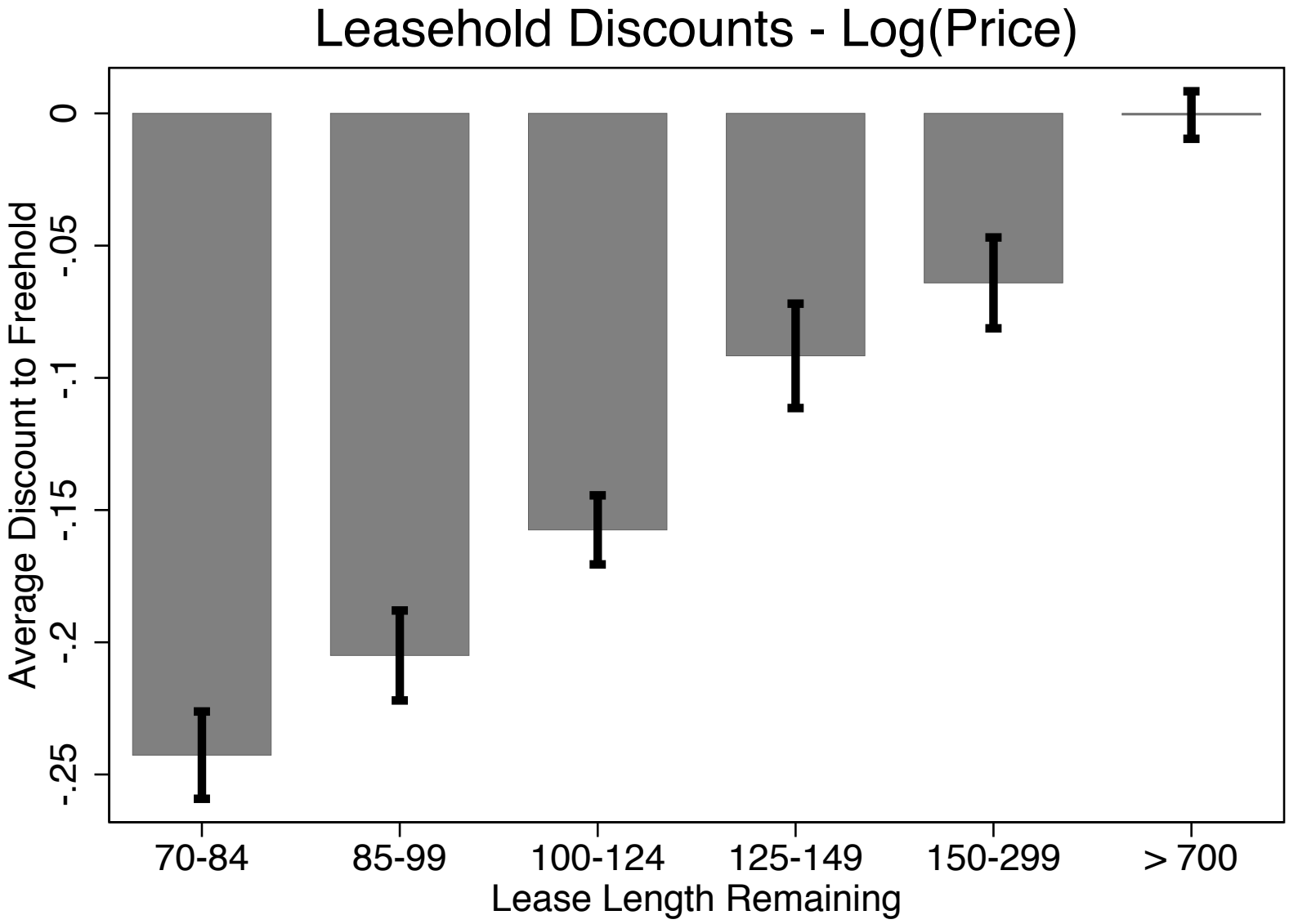
This paper

- Construct dataset of all freehold and leasehold transactions
- Estimate:
  - Term structure of leasehold discounts using hedonic regressions
  - Average returns to housing (6-8%) and rent growth (0.5%)
- Learn about long-run discount rates (risk free and risk premia)
- Discuss implications for asset pricing, macroeconomics, and environmental economics

Results Preview - Leasehold Discounts (UK)

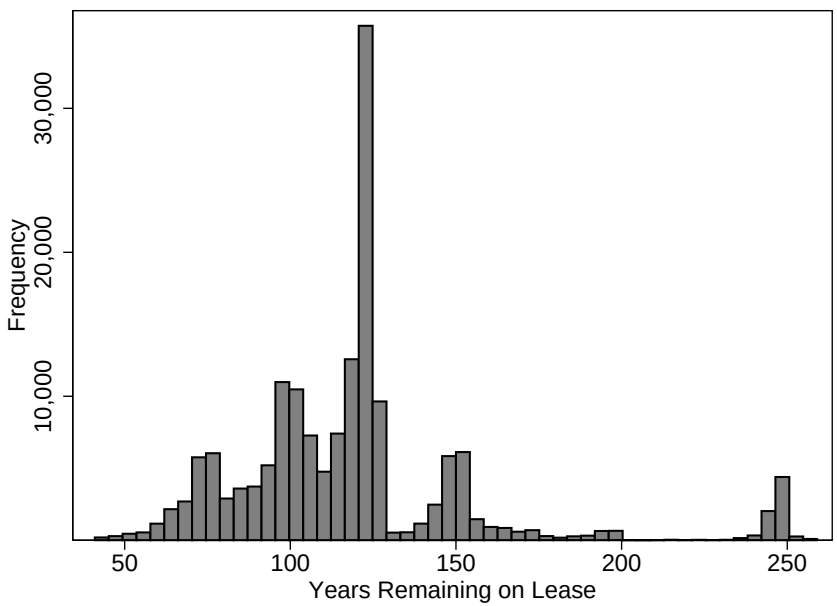


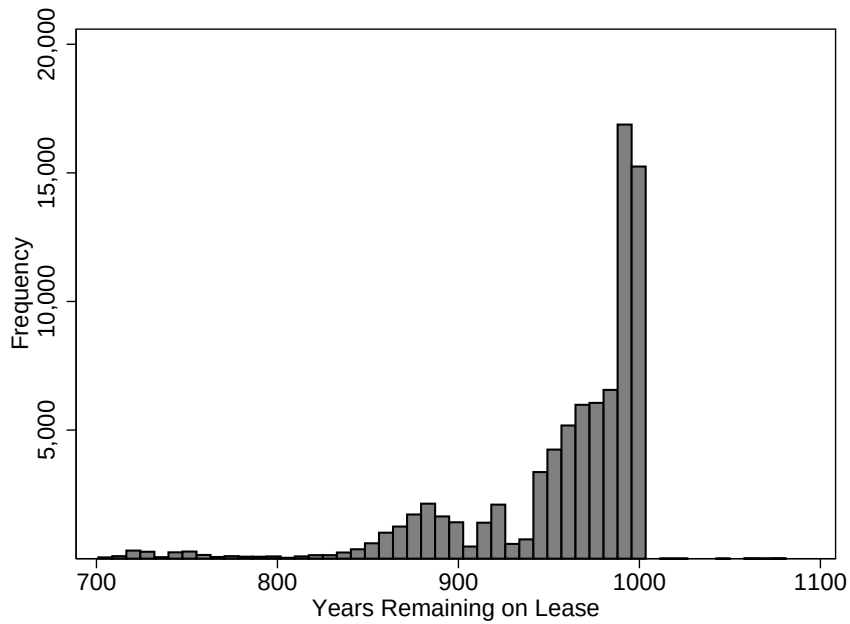
Results Preview - Average and Long-run Discount Rates

- *Jointly*, high average return and large discounts for long-term leases:
  - Average return uninformative about long-run discount rates
    - Low long-run discount rates
    - Downward sloping term structure of discount rates
  - Many leading asset pricing models struggle to *qualitatively* match this.
- If long-run housing is risky:
  - Low long-run risk-free rate
  - Low long-run price of risk

Data for the UK

- Administrative data on all transactions and lease terms since 2009
  - 2 million transactions; 22% leasehold properties.
  - Recently purchased data for 1995+ (18 million transactions)
- Property characteristics from Rightmove.co.uk
- Common initial lease length: 99, 125, 150, 250, 999 years.



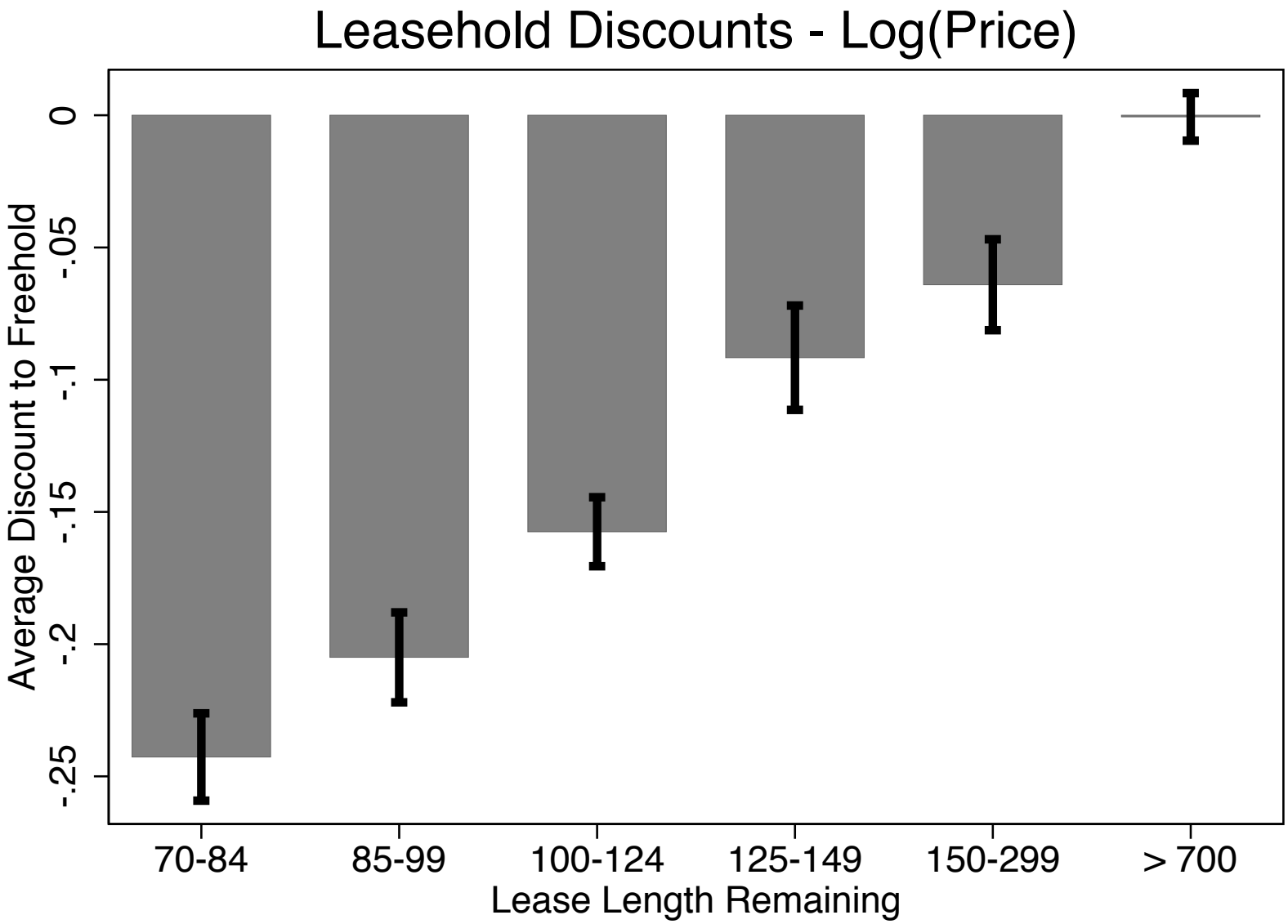


Hedonic Regressions: Specification

$$\log\left(Price\right)_{i,h,g,t} = \alpha + \sum_{i \in TenGroup} \beta_i \mathbf{1}_{\{Tenure \in i\}} + \gamma Controls_{i,t} + \\ + \xi_h \times \phi_g \times \psi_t + \epsilon_{i,h,g,t}$$

- $TenGroup_i$: Buckets of *remaining* lease length
- ξ_h: Property Type Fixed Effect (e.g. Apartment, Semi-Detached,...)
- ϕ_g: Postcode Fixed Effect
- ψ_t: Time Fixed Effect (Month)
- **Controls**: Age, Number of bedrooms, Property size

Hedonic Regressions: UK Results



Key Take-Aways

- Sizable discounts for relatively long-run leaseholds.
- Slope of the term structure of leasehold discounts suggests discounts related to remaining lease length.
- 700+ year leaseholds priced identically to freeholds.
  - No systematic unobserved structural heterogeneity between leasehold and freehold properties.
  - Discounts not driven by covenants on leaseholders.
- Similar disocunts when comparing leaseholds with different maturities.
  - Keeps contract structure constant.
- Very similar leasehold discounts observed in Singapore.

Other explanations

- **Differences in Buyer Characteristics**:
  - Priced by different marginal buyers?
  - Survey of English Housing
  - Conditional on our controls, leasehold owners:
    - Are 1.3 years younger (mean 52.4 years)
    - Have £5.6 higher weekly income (mean £350)
    - Have 0.02 more household members (mean 2.53)

- **Financing Frictions**:
  - Most UK banks require 30 years remaining at term-end
  - Leases with duration 70 years are unaffected
  - For reasonable "collateral values" of housing and conventional discount rates, no impact on leases with > 150 years remaining.

▸ Financing Frictions ▸ Buyer Characteristics

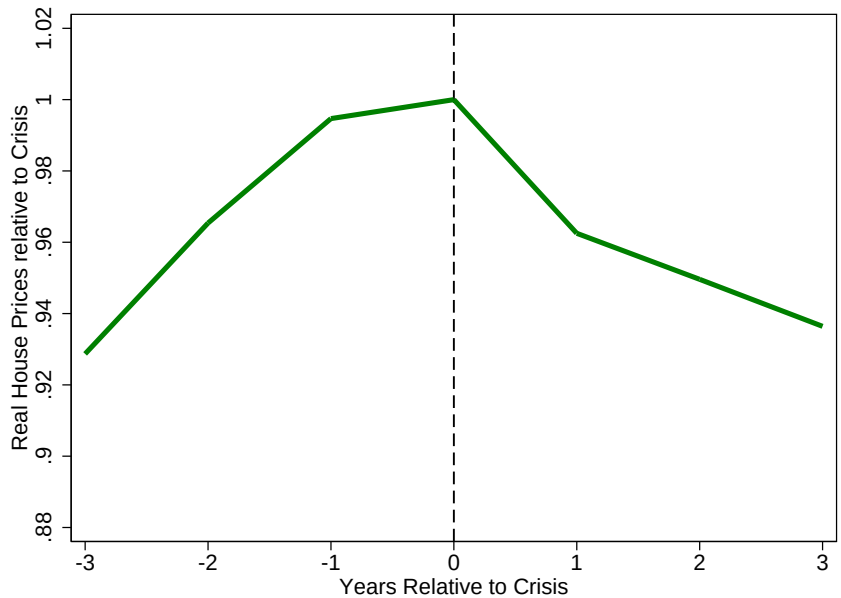
Freehold Properties' Expected Returns

- Balance Sheet approach: National Accounts Data
- Price/Rent approach: Price series + Initial Baseline

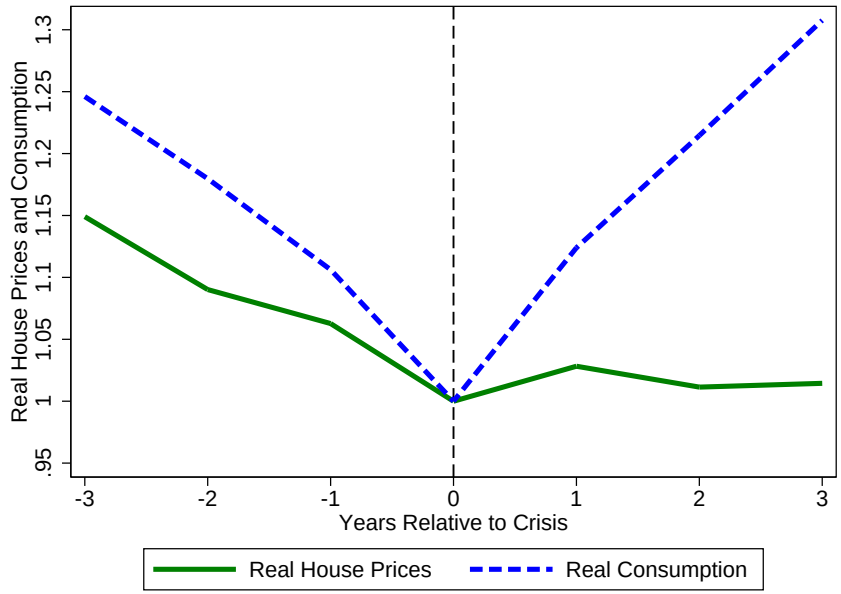
	United States		Singapore		United Kingdom	
	Balance Sheet	Price/Rent	Balance Sheet	Price/Rent	Balance Sheet	Price/Rent
Gross Return	10.3%	10.7%	10.4%	10.3%	12.5%	10.9%
Rental Yield	8.3%	9.8%	6.1%	6.0%	9.7%	6.9%
Capital Gain	2.0%	0.8%	4.3%	4.3%	2.8%	4%
Depreciation	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
Taxes	0.67%	0.67%	0.5%	0.5%	0%	0%
Real Net Return	**8.1%**	**8.5%**	**8.4%**	**8.3%**	**11%**	**9.4%**
Sample	1953-2012	1988-2012	1985-2012	1990-2012	1989-2012	1996-2012
Real Rent Gr.		**0.1%**		**0.2%**		**0.7%**
Sample		1988-2012		1990-2012		1996-2012

Riskiness of Housing

- High returns consistent with riskiness of housing
- Real house prices fall:
  - After financial crises
  - During consumption disasters and wars
- Positive correlation between house price and consumption growth



(c) 44 Financial Crises in 21 Countries (Reinhart & Rogoff)



(d) 16 Consumption Disasters in 8 Countries (Barro)

Leading Asset Pricing Models

- **Empirical Results:** High returns and high leasehold discounts
- Deterministic Gordon-Growth model:

$$Disc_t^{100} \equiv \frac{P_t^{100}}{P_t} - 1 = -e^{-(0.06-0.005)100} = -0.4\%$$

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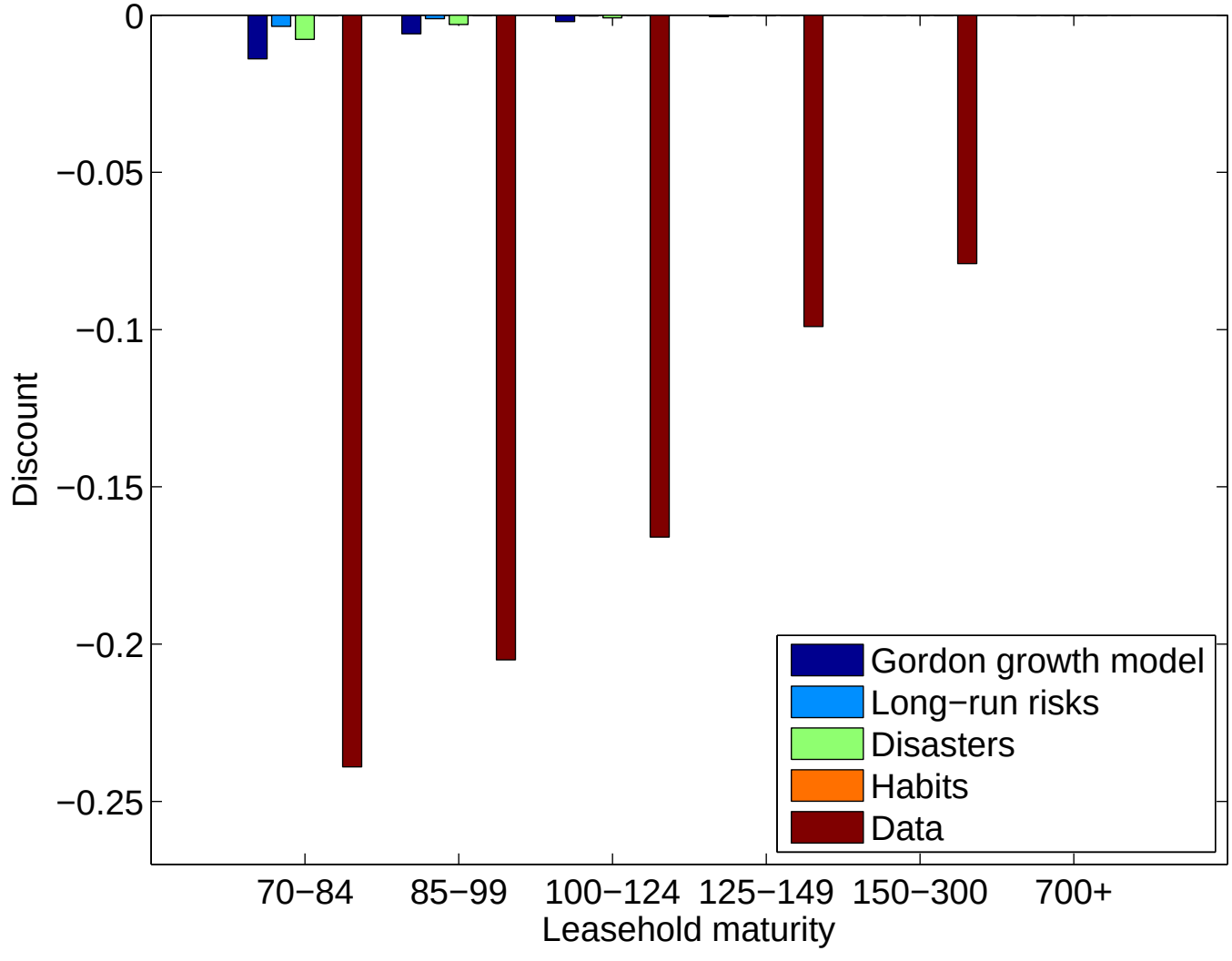
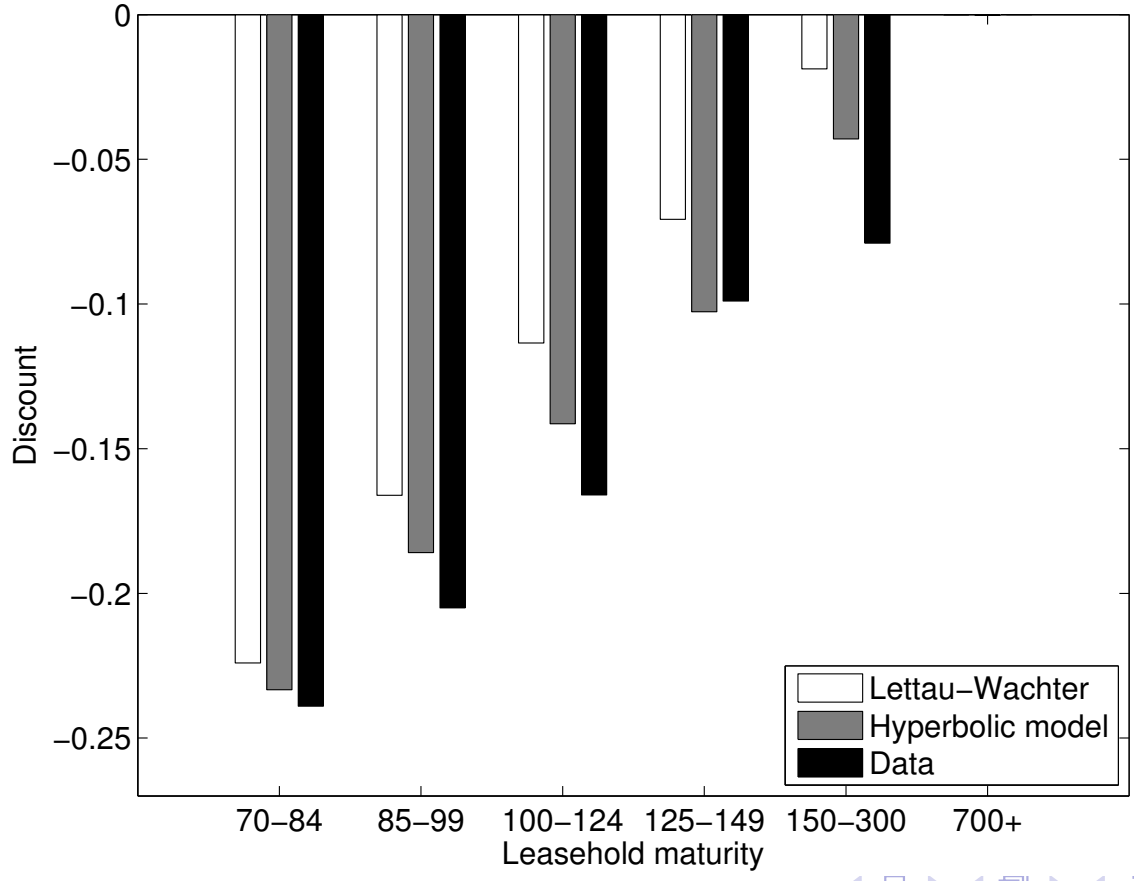
- Since housing is risky, most GE asset pricing models predict upward sloping or flat term structure of discount rates (van Binsbergen, Brandt, Koijen, 2012):
  - Long-run risk (Bansal and Yaron, 2004)
  - Habits (Campbell and Cochrane, 2005)
  - Rare Disaster (Barro, 2006; Gabaix, 2012)

Data vs. Model: UK



Reduced-form matching of term-structure

- **Empirical Results:** High returns and high leasehold discounts
- Suggests downward sloping term structure of discount rates:
  - Hyperbolic functional form
  - Reduced-form model of Lettau and Wachter (2011)



Application: Climate Change

Any consideration of the costs of meeting climate objectives requires confronting one of the thorniest issues in all climate-change economics: How should we compare present and future costs and benefits? [...] A full appreciation of the economics of climate change cannot proceed without dealing with discounting. (Nordhaus, 2013)

- Stern Report argued for 0%, Weitzman/Nordhaus/Pindyck higher rate.
- We showed low overall long-run discount rates.
- If long-run housing is risky:
  - Long-run risk-free discount rates are relatively low.
  - Long-run price of risk is relatively low.
- Implications for climate change policy:
  - High willingness to pay to reduce very long-run climate costs **for sure**.
  - Less willingness to pay to reduce **uncertainty** about climate outcomes.

Conclusion

- Exploit unique feature of housing markets in the UK and Singapore
- Provide first direct estimate of very long-run discount rates (100+ y)
  - Long-run discount rates are low, much lower than suggested by most asset pricing models.
  - To also match expected returns, need a term structure of discount rates that slopes down in the long-run.
  - Low long-run risk-free rate, and low price of long-run risk.
- Important imput for many important questions:
  - Evaluating climate change policy (and other cost-benefit analyses)
  - Long-run implications of fiscal policy

BACKUP SLIDES

Buyer Characteristics

- Segmented Markets? Buyers for different contract types could be different.
- Survey of English Housing (SEH) - Annually between 1994 and 2008.
- 200,000 observations

$$Outcome_i = \alpha + \beta Leasehold_i + \xi X_i + \phi_{PropertyType \times Region} + \varepsilon_i.$$

Buyer Characteristics

Table: Characteristics of Buyers of Leaseholds and Freeholds

	Sample		Leasehold Δ		
	Mean	St. Dev.	Unconditional	Conditional I	Conditional II
	(1)	(2)	(3)	(4)	(5)
Age Head of Household (years)	52.30	16.01	-2.68	-1.54	-1.30
				(0.21)	(0.20)
Weekly Income (£)	350.2	450.6	-48.07	-3.01	5.60
				(4.56)	(4.45)
Number of people in household	2.53	1.27	-0.48	-0.03	0.02
				(0.01)	(0.01)
Number of dependent children	0.55	0.94	-0.19	-0.01	0.02
				(0.01)	(0.01)
Head of Household Married	0.64	0.48	-0.21	-0.01	0.01
				(0.01)	(0.01)
First Time Buyer	0.40	0.48	0.11	-0.00	-0.01
				(0.01)	(0.01)
Currently Has Mortgage	0.59	0.49	0.03	0.02	0.02
				(0.01)	(0.01)
Very Satisfied with Neighborhood	0.47	0.50	-0.06	0.00	0.00
				(0.00)	0.00

Return

Financing Frictions

- Harder to mortgage-finance leases with short remaining duration.
- UK: No issues for leaseholds with more than 60-70 years remaining; these are treated like freeholds

Mortgage Lender	Leasehold Financing Rules
The Royal Bank of Scotland	Mortgage term plus 30+ years
Santander	Unexpired lease term 55+ years, 30+ years at mortgage end
HSBC	Mortgage term plus 25+ years
Nationwide Building Society	Unexpired lease term 55+ years, 30+ years at mortgage end
Lloyds TSB	Unexpired lease term 70+ years, 30+ years at mortgage end
Halifax	Unexpired lease term 70+ years

Financing Frictions

Some elements mitigate financing frictions:

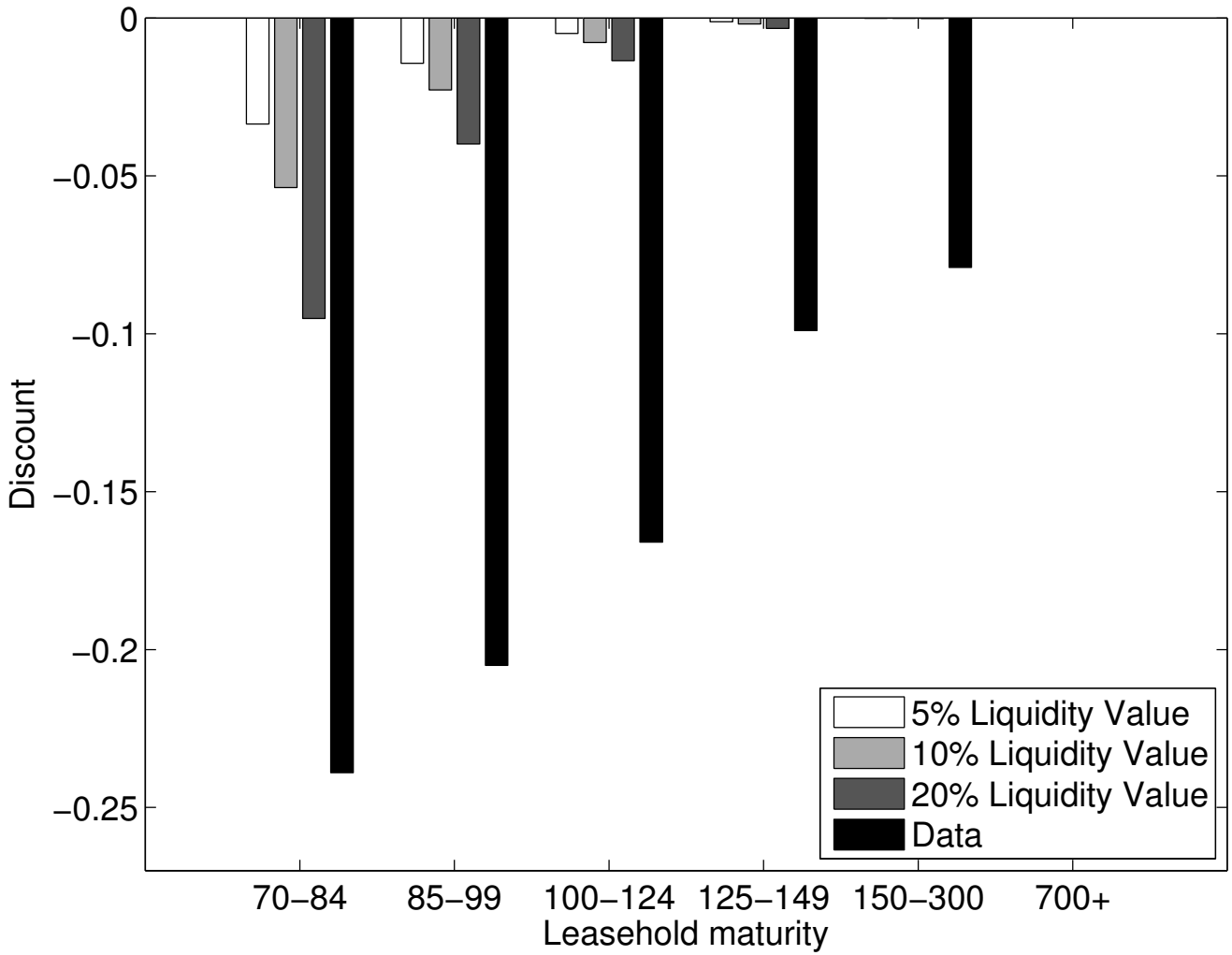
- Right to lease extensions in UK
- If the problem is liquidity, then leaseholds are more attractive

We parametrize reduced-form model of “collateral value of housing":

$$\begin{aligned} P_t^T &= \int_t^{t+T} e^{-\rho(s-t)} D_t e^{g(s-t)} (1 - \alpha \mathbf{1}_{\{s>t+T-\bar{T}\}}) ds = \\ &= \frac{D_t}{\rho - g} \left[1 - e^{-(\rho-g)T} - \alpha \left(e^{-(\rho-g)(T-\bar{T})} - e^{-(\rho-g)T} \right) \right]. \end{aligned}$$

A fraction α of the rents are lost when the remaining lease length is less than $\bar{T}$

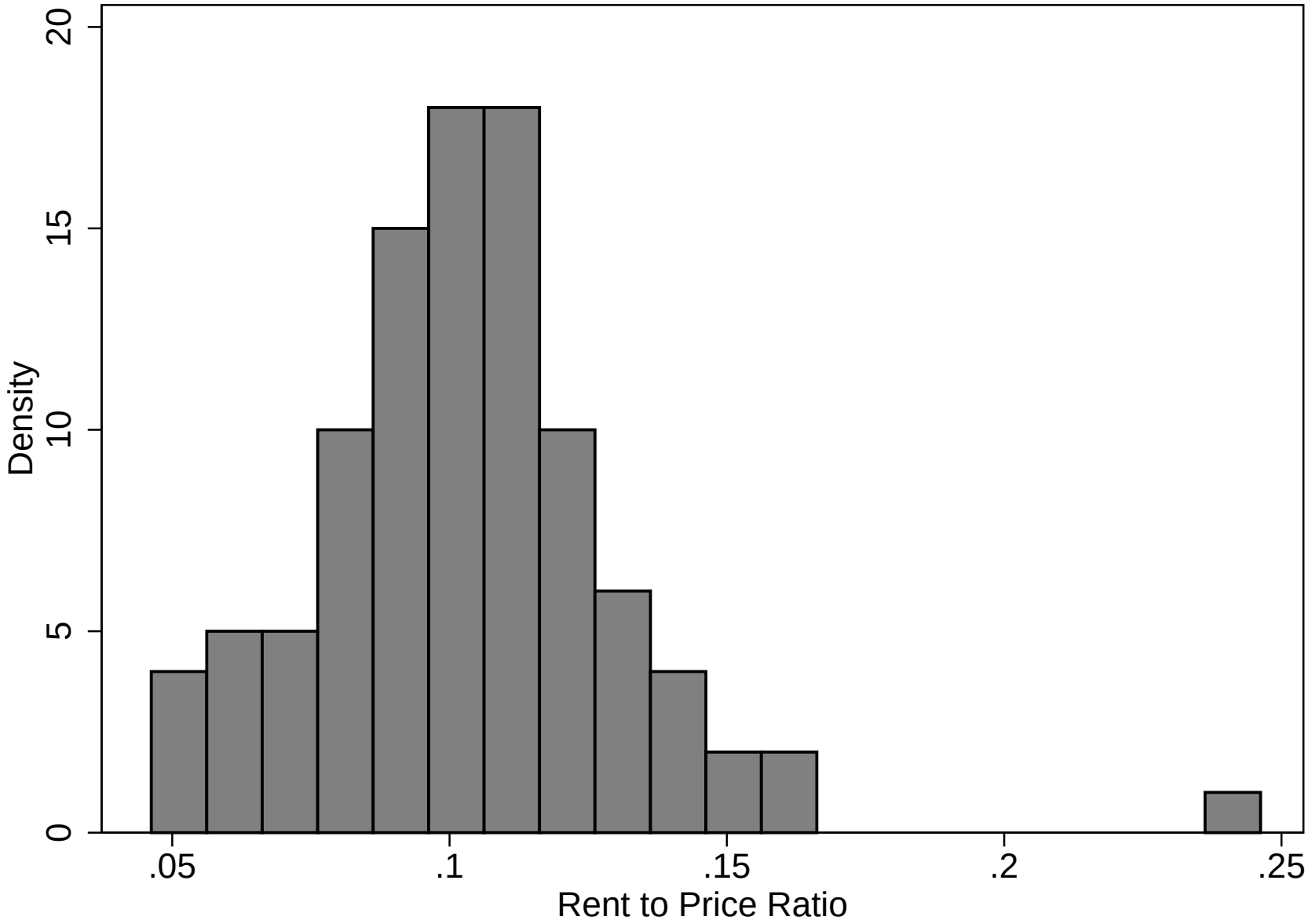
Data Vs Model with Frictions



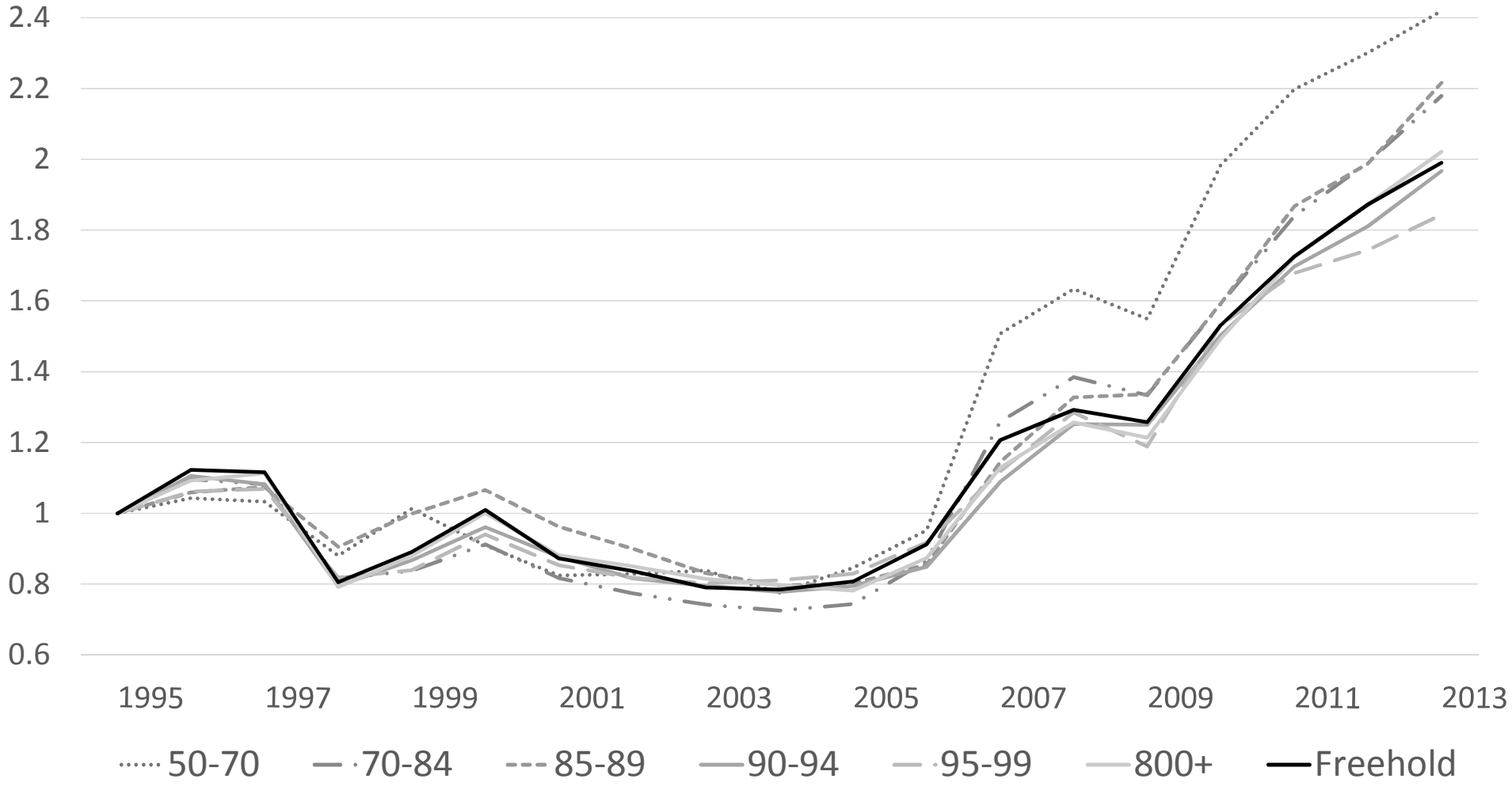
- Take Away: frictions have essentially no impact on long-maturity leases: e.g. 150-years

▸ Return

Rent-Price Ratio: 100 Largest MSAs



Singapore Time Series



Housing: A Hedge?

	Real HP Growth		Real PDI Growth		
	Mean	Std. Dev.	Mean	Std. Dev.	Correlation
Australia	3.20%	6.89%	1.43%	2.77%	0.093
Belgium	2.80%	5.87%	1.17%	2.27%	0.436
Canada	2.51%	7.63%	1.37%	2.10%	0.489
Switzerland	0.94%	4.73%	1.12%	1.63%	0.445
Germany	-0.29%	2.31%	1.27%	1.70%	0.288
Denmark	1.57%	8.99%	1.09%	2.29%	0.211
Spain	2.05%	8.26%	0.83%	2.46%	0.631
Finland	2.04%	8.19%	2.07%	3.21%	0.482
France	2.52%	5.23%	1.22%	1.58%	0.358
U.K.	3.53%	8.54%	2.20%	2.74%	0.355
Ireland	3.70%	9.73%	1.83%	3.59%	0.529
Italy	0.60%	8.28%	0.82%	2.44%	0.325
Japan	-0.24%	4.28%	1.55%	1.40%	0.587
S. Korea	0.59%	7.70%	3.95%	4.58%	0.235
Luxembourg	3.94%	6.68%	2.84%	3.75%	0.054
Netherlands	2.32%	9.43%	0.48%	3.25%	0.472
Norway	2.76%	7.23%	2.22%	2.52%	0.064
New Zealand	2.20%	7.73%	0.98%	3.45%	0.530
Sweden	1.50%	7.27%	1.34%	2.28%	0.431
U.S.	1.13%	3.89%	1.60%	1.56%	0.371
S. Africa	0.88%	9.65%	0.53%	3.05%	0.373

▸ Return

Robustness: cointegration argument

- In the model, the effective discounting for the long run depends on $r - g$.
- What if g becomes really big? (superstar-city effect)
- If prices and rents are cointegrated, in the long run g and capital gains have to grow at the same rate
- If g explodes, CG explodes, and $r - g = CG + DY - g = DY$.
- But real, net DY is always at least 4% -> net price-rent ratio of 25 at the most.
- Still, way too large.

▸ Return

Infinitely-Lived Rational Bubbles

Classic infinitely-lived rational bubble models: Blanchard and Watson (1982) and Froot and Obstfeld (1991)

- Rely on failure of the no-bubble condition:

$$\lim_{T\to\infty} E_t[\xi_{t,T} P_T] \neq 0,$$

  For some model-implied SDF $\xi_{t,T}$
- Long literature attempted indirect tests: afflicted by serious econometric problems
- We provide a simple direct test:

$$H_0: \quad P_t - P_t^T \approx \lim_{T\to\infty} E_t[\xi_{t,T} P_T] = 0, \qquad \text{for large T.}$$

- We find no evidence of infinitely-lived rational bubbles even at the peak of the housing-boom (2006-7) in London and Singapore

Rational bubbles: Singapore