Measuring The Natural Rate With Natural Experiments

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  - Natural rate informative about long run equilibrium of economy but hard to measure

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  - Estimates are imprecise e.g. standard errors for UK $\approx$ 4pp
  - Potential for severe model misspecification e.g. r^* unavailable during pandemic
    (Laubach & Williams 2003; Holston, Laubach & Williams 2017)

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    (Laubach & Williams 2003; Holston, Laubach & Williams 2017)

- This paper: natural experiments + microdata to measure natural rate of return on capital

$$r_K^* \equiv r^* + \zeta^* - g^*$$

  - Precise estimate of r_K^*, in real-time, using publicly available data
  - Relies on relatively few structural assumptions

The Natural Experiment Approach to Measuring r_K^*

UK property market:

- Long duration (> 70 year) leased properties quasi-randomly extend lease by 90 years
- New data on $\approx 150,000$ lease extension experiments, 2003 onward
- Difference-in-difference estimate of price change after extension for same property
  - $\rightarrow$ Differences out shorter term shocks + service flow
  - $\rightarrow$ Identifies r_K^* for UK property at very long horizon with limited structure
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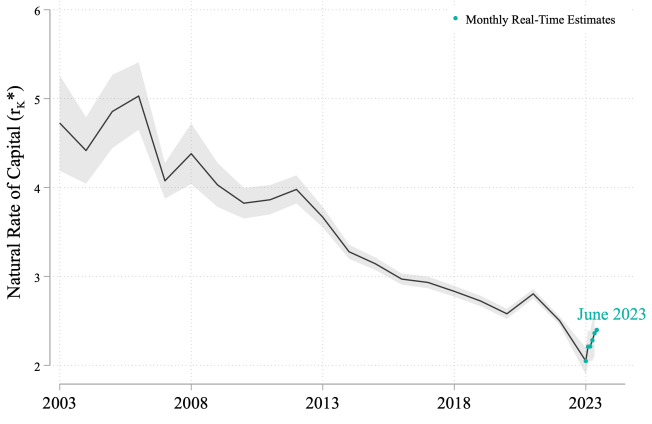
Results:

1. r_K^* for UK property fell from 4.8% to 2.3% between 2000 and 2022
2. Modest rise in r_K^* in 2023 thus far—updated monthly (≈ 900 extensions per month)

Main Results: Big Fall Before 2022, Modest Rise After



Fall of r_K^* from 4.8% to 2.3%, more than doubling of natural price-rent ratio

Literature

Estimates of the natural rate of return of housing (Giglio, Maggiori & Stroebel 2015; Bracke, Pinchbeck & Wyatt 2018)
(i) quasi-experimental identification critical due to unobserved heterogeneity in service flow
(ii) estimate option value of lease extension w/ bunching estimator
(iii) focus on dynamics of r_K^*

Estimates of the dynamics of r^* for safe assets (Laubach & Williams 2003; Holston, Laubach & Williams 2017; Rachel & Summers 2019; Del Negro, Giannone, Giannoni & Tambalotti 2019)

Outline

The Natural Rate of Return of Capital: Definition and Challenges

- Price P_t of capital with dividend R_t:

$$P_t = R_t \int_0^\infty e^{-\int_0^S y(u)du} dS \quad y(u) \equiv r(u) + \zeta(u) - g(u)$$

where r is safe return, ζ is risk premium, g is dividend growth, y is yield

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- The natural rate of return on capital is long-run expected rate of return of capital (net of capital gains)

$$r_K^* = r^* + \zeta^* - g^* \equiv \lim_{u \to \infty} r(u) + \zeta(u) - g(u) = \frac{R_{t+\infty}}{P_{t+\infty}}$$

  → **Equivalent:** r_K^* is long run dividend-price ratio; **or** user cost of capital normalized by price

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  → **Equivalent:** r_K^* is long run dividend-price ratio; **or** user cost of capital normalized by price

- **Two challenges** in estimating r_K^*:
  1. Dividend of capital R_t often hard to observe (e.g. service flow of owner occupied housing)
  2. Shocks to shorter end of yield curve also affects P_t (e.g monetary policy)

Outline

Data

"Leasehold" = long duration lease issued by owner of property ("freeholder"), typically > 70 years

- Originally designed to give liquidity to cash poor aristocrats
- 97.5% of apartments, 7.3% of houses are leaseholds, lease can be bought and sold

Lease extensions:

- Leaseholder entitled to extend lease by 90 years by paying freeholder a one-off negotiated payment
- If no agreement: payment is present value of lease extension assessed by tribunal with market prices

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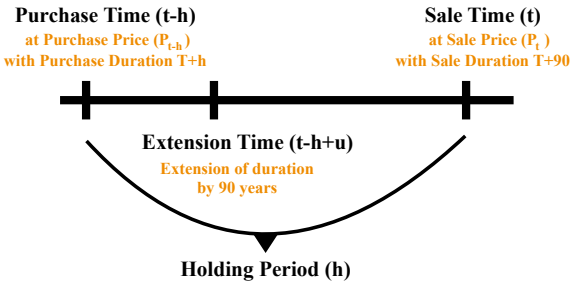
Main datasets:

1. **Land Registry Sales**: all residential sales in England and Wales, 1995-present, public data
2. **Land Registry Leases**: all lease terms for leaseholds, public data
3. **Land Registry Extensions:** new data on date and size of extensions, private data
   - NB: lease extension payments not measured
   - We have made extension data set publicly available on our website, for replication + real time analysis
4. **Rightmove / Zoopla**: hedonics (e.g. # bedrooms, # bathrooms, # living rooms, floor area)

Other Data | Heatmap | Ground Rents

Lease Extensions: Example and Sample Construction



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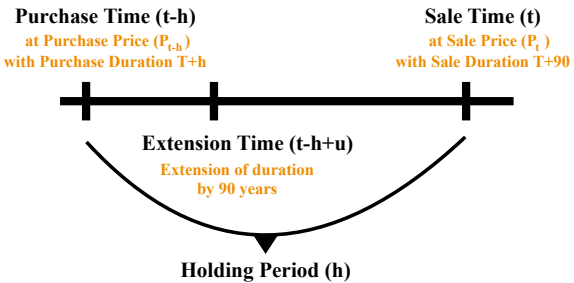

Main Sample:

- Lease extensions with transaction both before and after extension
  Transaction Histogram
- Exclude "flippers" who buy + extend + sell within a year
- Focus on 90 year lease extensions (typical length) Extension Amount Histogram

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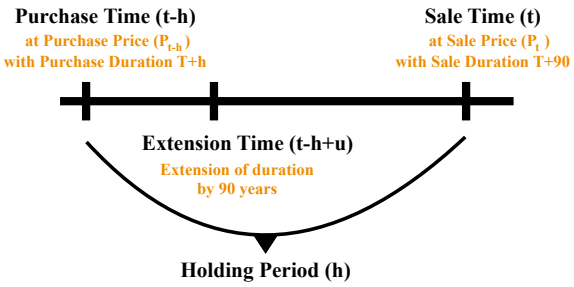

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Summary statistics:

- 43,083 lease extensions for 90 years (132,552 lease extensions total)
- Median duration before extension is **large** $\approx$ 70 years
- Median holding period 10 years, time to extension 7 years

Outline

Empirical Methodology I

Price of **leasehold** P_t^T with T years until expiry +

$$P_t^T = R_t \int_0^T e^{-\int_0^S y(s)ds} dS +$$

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$$P_t^T = R_t \int_0^T e^{-\int_0^S y(s)ds} dS + \underbrace{\max\left[0, (1-\alpha) R_t \int_T^{T+90} e^{-\int_0^S y(s)dS} dS + \text{more extensions}\right]}_{\text{option value of lease extension}}$$

- α = share of gains from lease extension to freeholder

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Option can raise *effective* duration of leasehold:

$$\boldsymbol{\alpha = 1}: \quad P_t^T = R_t \int_0^T e^{-\int_0^S y(s)ds} dS \qquad \boldsymbol{\alpha = 0}: \quad P_t^T = R_t \int_0^\infty e^{-\int_0^S y(s)ds} dS$$

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Baseline assumption: $\alpha = 1$ as recommended by law

- *Later:* estimate α with a discontinuity based estimator, small impact on results Hazard

Empirical Methodology II

Price change after lease extension difference-in-difference:

$$\Delta_{it} \equiv \overbrace{\left[\log P_{it}^{T+90} - \log P_{i,t-h}^{T+h}\right]}^{\text{price growth after extension}} - \overbrace{\left[\log P_{jt}^{T} - \log P_{j,t-h}^{T+h}\right]}^{\text{non-extending control}}$$

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Identification: service flow growth of extender same as **suitably chosen control group** ("parallel trends")

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- NB: estimator independent of holding period h Validation

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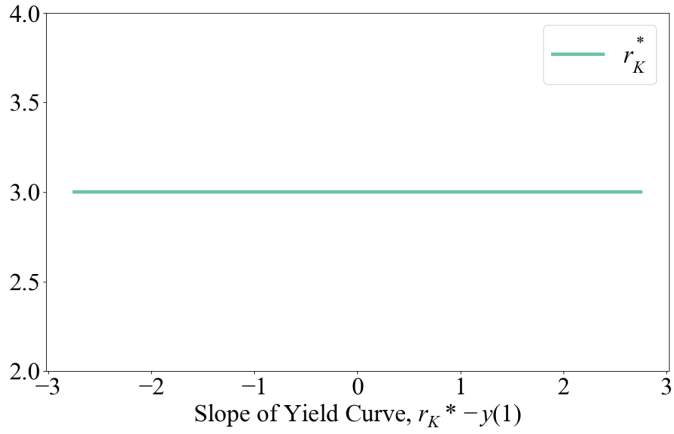
Identification: service flow growth of extender same as **suitably chosen control group** ("parallel trends")

Parameterization: yield curve is constant $y(s) = r_K^*$

Advantages of estimator:

- ✓ Differences out (unobservable) service flow of housing incl. taxes + depreciation
- ✓ Differences out shorter term yields: **when T is large**, r_K^* is identified from long duration cashflows

Estimator "Differences Out" Shorter Term rates (Numerical Result)



- Simulate panel of leases: **flat** yield curve at **long end** ($T > 50$), **sloped** rate at **short end** ($T < 50$)
  - Apply estimator $\hat{r_K^*}$ as slope of yield curve $r_K^* - y(1)$ varies, hold fixed r_K^*

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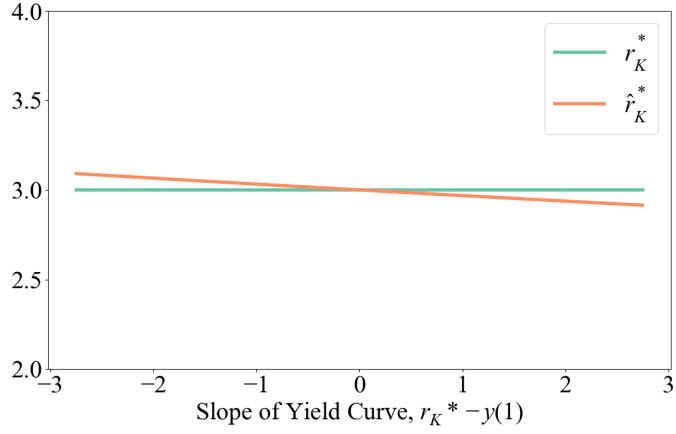
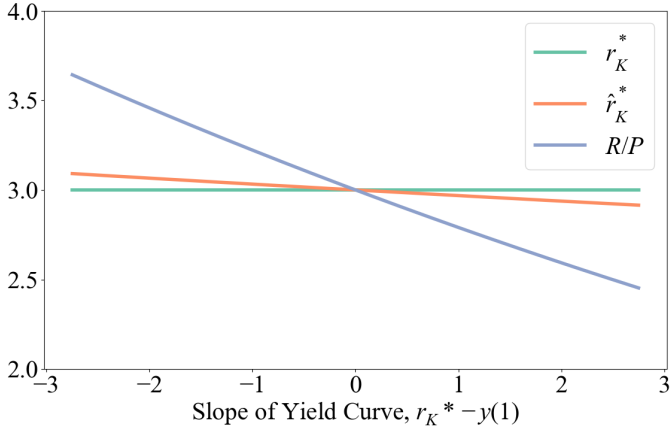


- Simulate panel of leases: **flat** yield curve at **long end** ($T > 50$), **sloped** rate at **short end** ($T < 50$)
- Estimator has **small** bias for **large** variation in slope
  - *Intuition:* **duration at extension is large** $\rightarrow r_K^*$ is identified from long duration cashflows

Estimator "Differences Out" Shorter Term rates (Numerical Result)



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- Estimator has **small** bias for **large** variation in slope
- "Naive estimator" R_t/P_t has large bias when yield curve sloped

Empirical Methodology III

Price change after lease extension difference-in-difference:

$$\Delta_{it} = \log\left(1 - e^{-r^*_{Kt}(T_{it}+90)}\right) - \log\left(1 - e^{-r^*_{Kt}T_{it}}\right)$$

Control: non-extenders within $\{0.1, 0.5, 1, 5, 10, 20\}$ km and $\pm 10\%$ of extender duration T_{it}

- Robustness: residualize prices by hedonic characteristics

Empirical Methodology III

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Validating control group + parallel trends:

- ✓ Balance test: hedonics vs. treatment Balance Test
- ✓ Placebo: growth in (market) rents + hedonics vs. treatment Hedonics
- ✓ Lack of pre-trends: growth in prices before extension vs. treatment No-Pre Trends
- ✓ Stable coefficients w/ controls

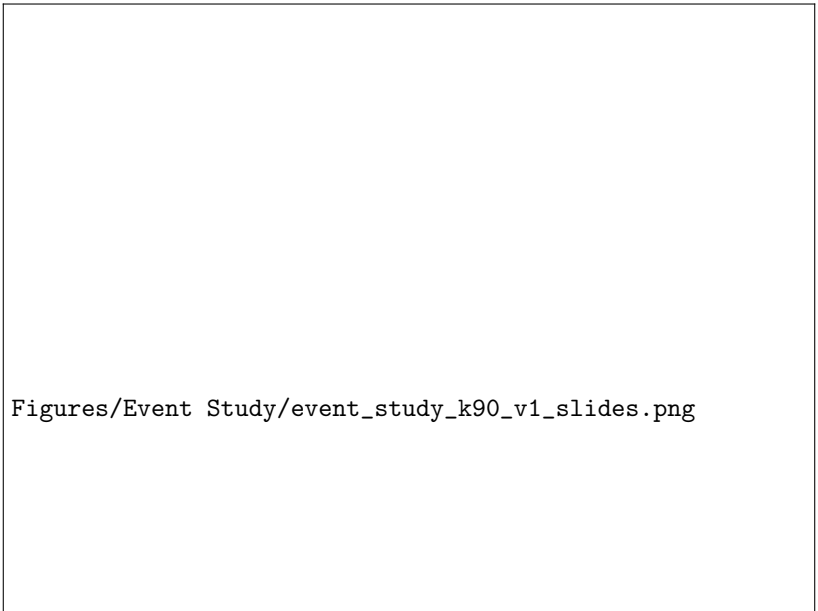
Nonlinear least squares: estimate r^*_{Kt} given (Δ_{it}, T_{it}) from lease extensions

- Time varying estimator of r^*_{Kt} is feasible

Outline

Event Study of Lease Extension

Event Study Plot Over Time & Duration | Lease Term Distribution



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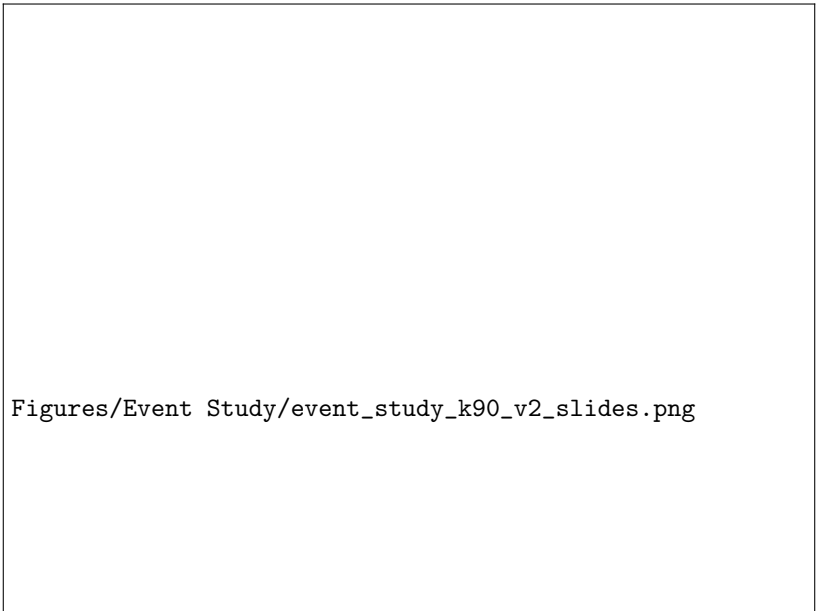

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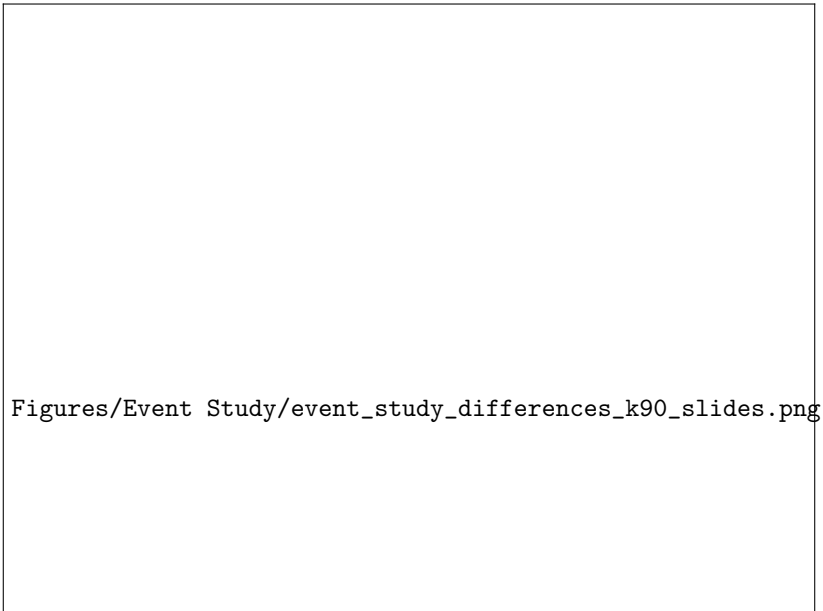

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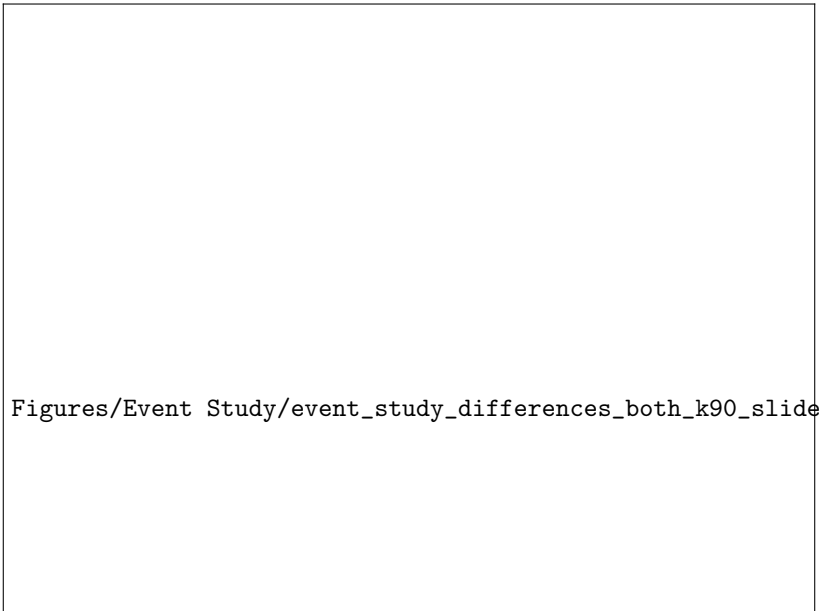
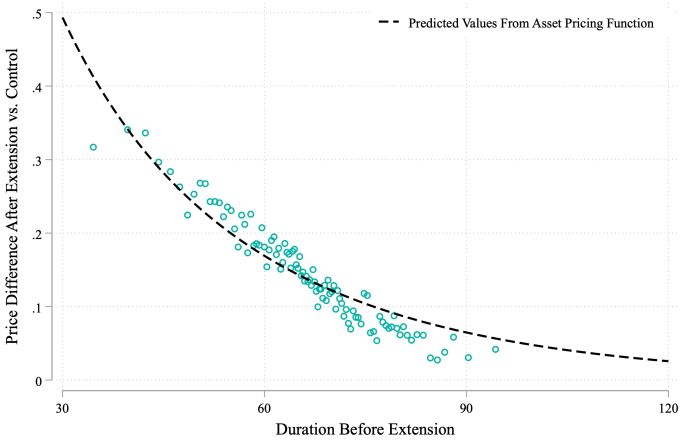


Duration Before Extension Predicts Price Change After Extension



Binscatter with 100 bins, 90 year extensions

Model prediction: price gain from extension decreasing in duration before extension (helps to identify r_K^*)

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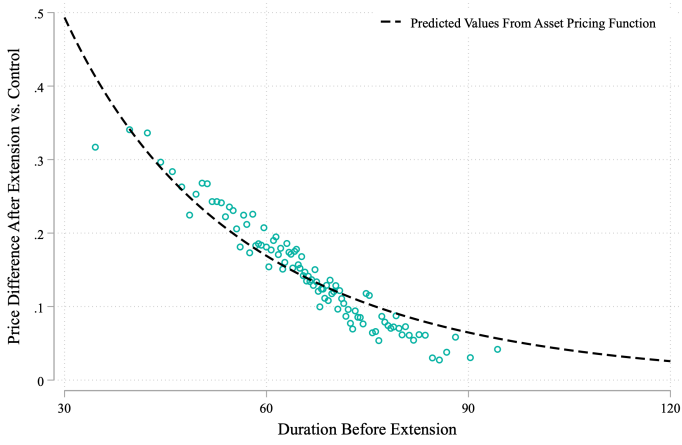
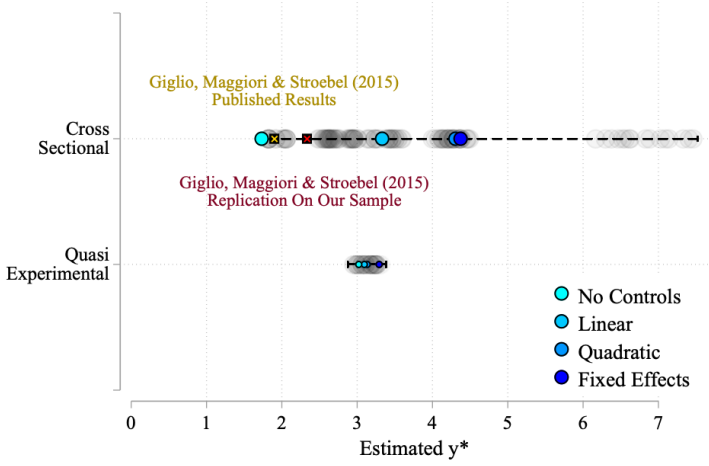


Binscatter with 100 bins, 90 year extensions

Estimates of r_K^* baseline: 3.00% hedonic controls: 2.94% r_K^* Estimates

Robustness to Unobserved Heterogeneity: Stability of Estimates



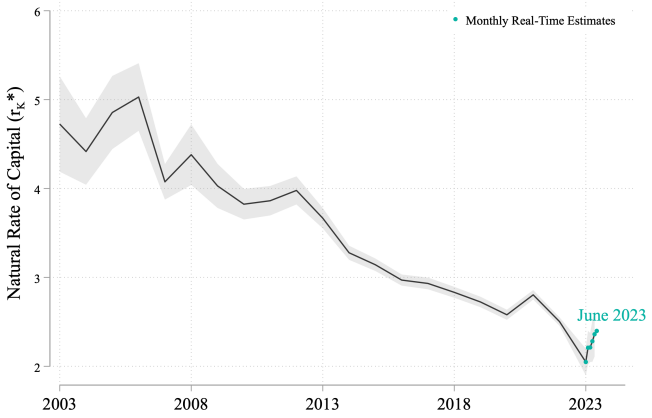
Estimates of r_K^* from quasi-experimental approach are insensitive to observed heterogeneity

- Estimates of r_K^* from cross-sectional approach are more sensitive (cf. Giglio, Maggiori & Stroebel 2015)

Outline

Result #1: Trend Dynamics Of r_K^*

Yield Curve Dynamics | Timeseries by Extension Amount



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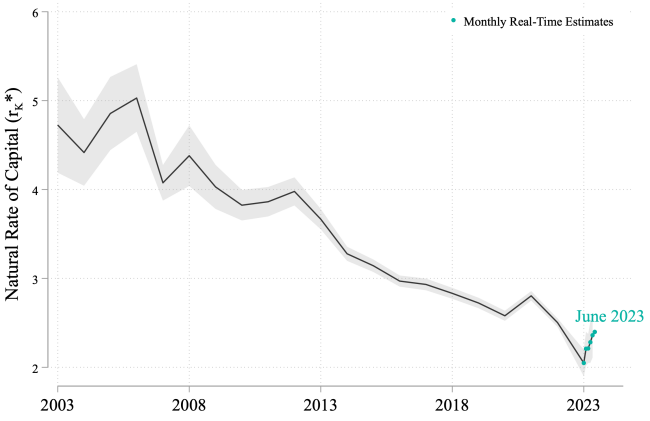

95% confidence intervals shaded

SEs $\approx$ order of magnitude lower than r^* estimate of Holston, Laubach & Williams HLW Estimates

$+$ Valid after pandemic

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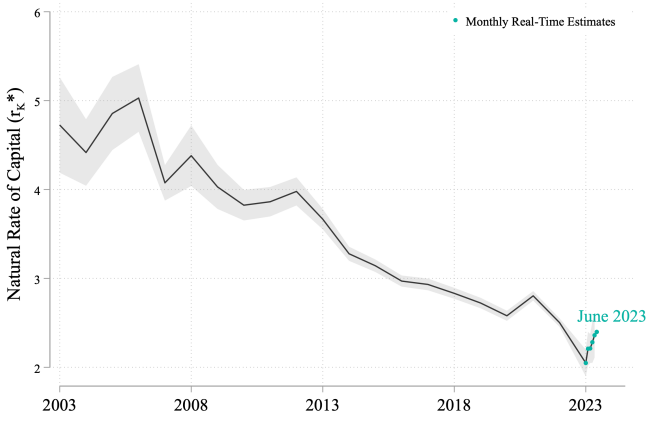
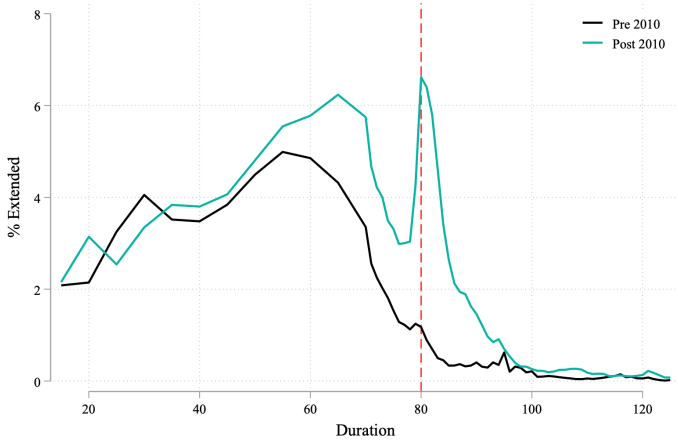


95% confidence intervals shaded

Here: decline in r_K^* for capital

- Previous work shows decline in **government bond yields**

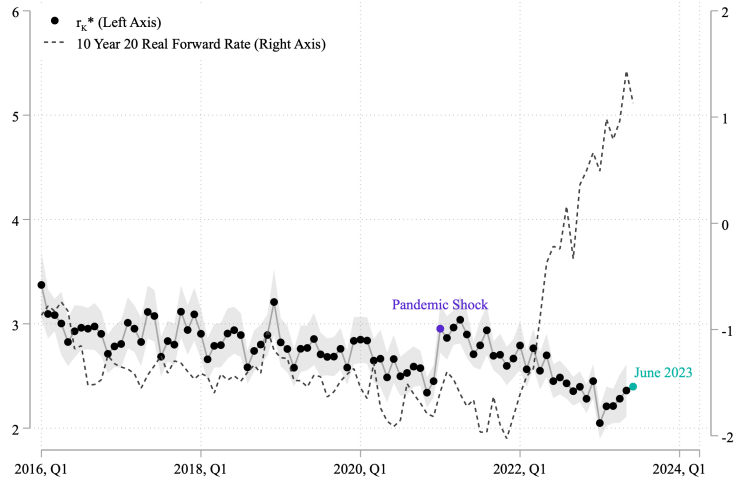
Bunching Estimator for Option Value



- After 2010, due to law: cost paid to freeholder discontinuously increases when lease has $\leq$ 80 years
- Bunching of extensions at 80 years, only after 2010

$\rightarrow$ Identifies extension value paid to free holder i.e. **option value** Corrected Timeseries

Result #2: Real Time Dynamics of r_K^*



3-6 month lag in real-time estimate of r_K^* due to closing period Histogram

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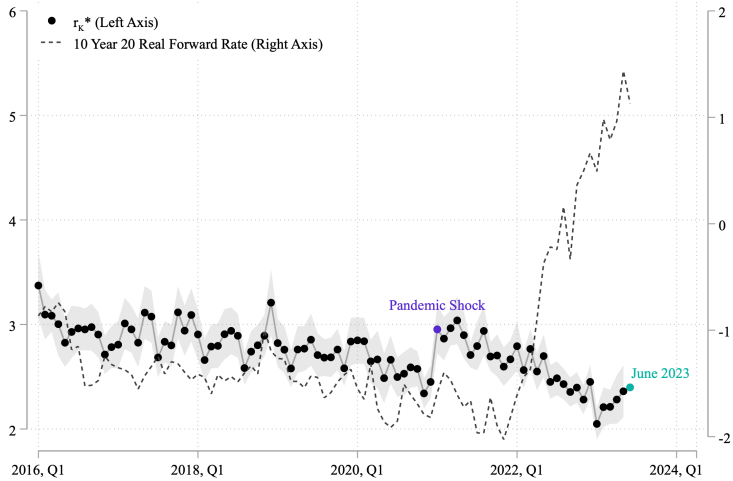


real-time data made public $\approx$ 900 lease extensions per month

Robustness

- Estimating freeholder share of gains from extension α Details
- Liquidity premia + mortgage availability for low duration leaseholds Details
- External validity with longer extensions Details
- Representativeness of leasehold owners Details
- Generalizing results beyond housing Details

Outline

Conclusion

Natural experiment to estimate natural rate of return of capital

1. r_K^* for UK property market fell from 4.8% during 2003-2006 to 2.3% by 2022
2. Modest increase in r_K^* in 2023, monthly updates will provide more clarity

Key advantages:

1. Precision, even at monthly frequency
2. Addresses model misspecification concerns
3. Real time estimates, data made publicly accessible

Other Data

1. **Rightmove Data**: Hedonics including # bedrooms, # bathrooms, # living rooms, floor area, property age, parking, heating type, condition, rental rates
2. **Zoopla Data**: Hedonics including # bedrooms, # bathrooms, # receptions, # floors, rental rates
3. **HMCTS Tribunals Data**: All Residential Property tribunal decisions on extension cases.

◂ Data & Lease Extensions

Ground Rents

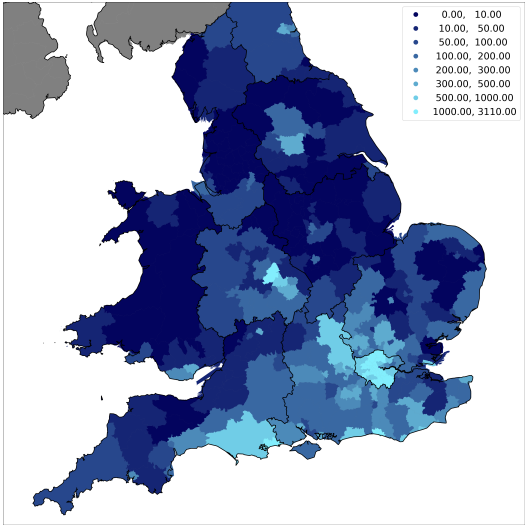
1. Ground rents are typically a negligible amount of the property value, with a median price of £25 per annum, according to English Housing Survey

2. Ground rents are present for leases of all lengths, including very long 700+ year leases

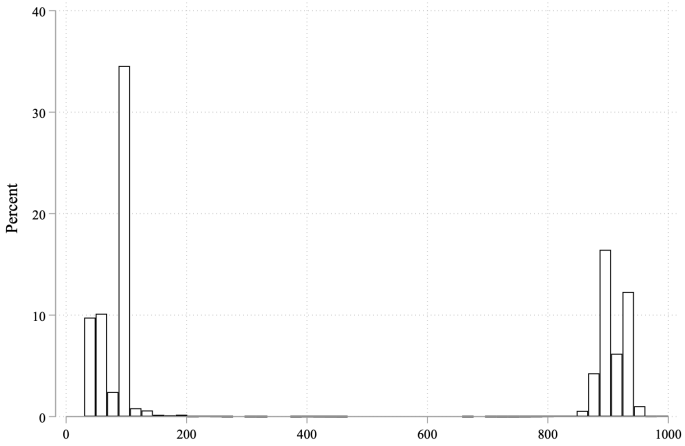
3. To collect ground rents, freeholders must make a specific written request to the leaseholder, so many freeholders find it cheaper not to collect ground rents

◂ Data & Lease Extensions

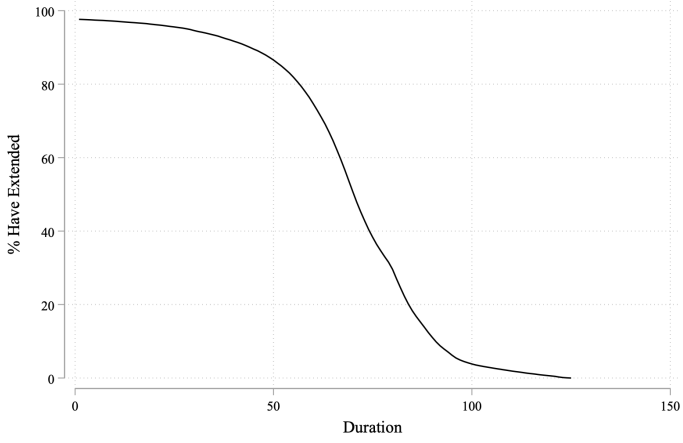
Lease Extension Heat Map



Extension Amount Histogram

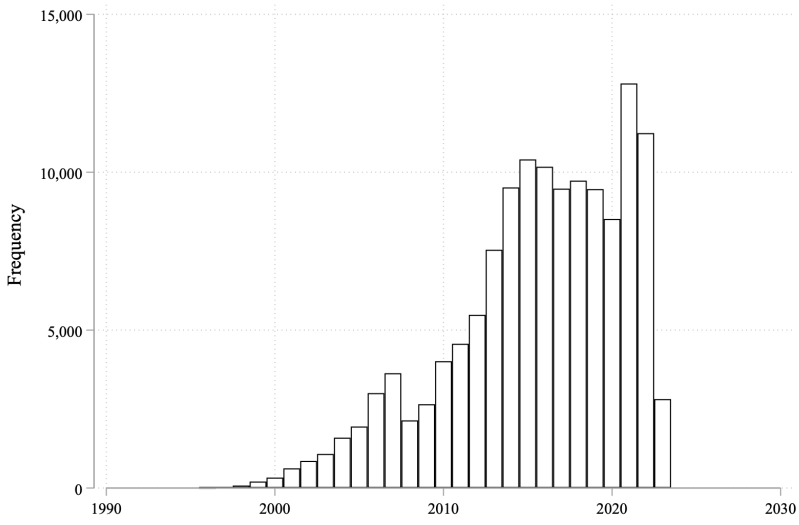


Cumulative Hazard Rate

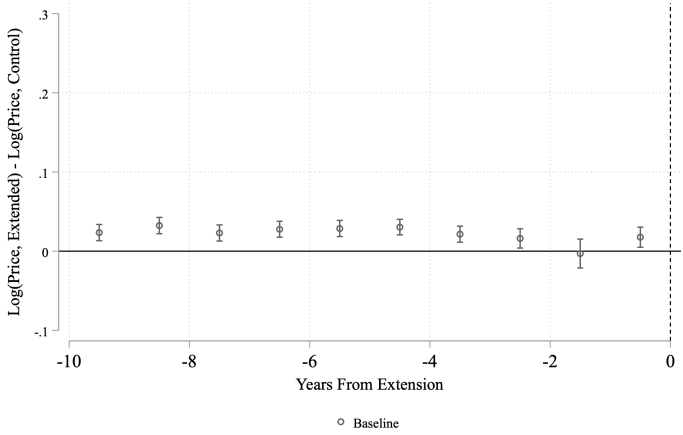


Estimator

Histogram of Transaction Times

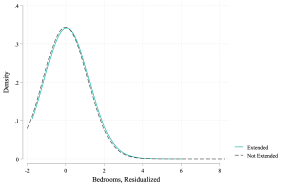


No-Pre Trends

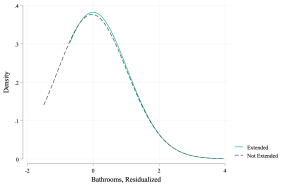


Main Estimator

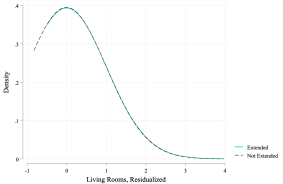
Hedonics Balance Test



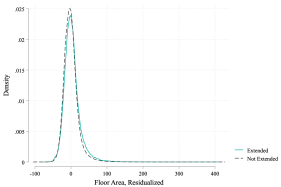
(a) Bedrooms



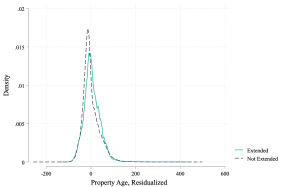
(b) Bathrooms



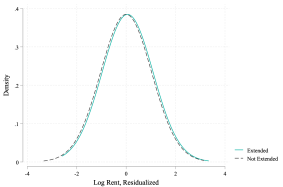
(c) Living Rooms



(d) Floor Area



(e) Age



(f) Log(Rent)

Main Estimator

Hedonics Balance Test

Panel A: Levels

	(1) Num Bedrooms	(2) Num Bathrooms	(3) Num Living Rooms	(4) Floor Area	(5) Age	(6) Log Rental Price
Extension	0.08***	0.04***	0.01***	4.08***	7.46***	7.89***
	(0.005)	(0.004)	(0.001)	(0.246)	(0.428)	(0.239)
Fixed Effects	✓	✓	✓	✓	✓	✓
N	1,353,712	1,066,889	940,298	1,076,266	839,631	747,548

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Panel B: Differences

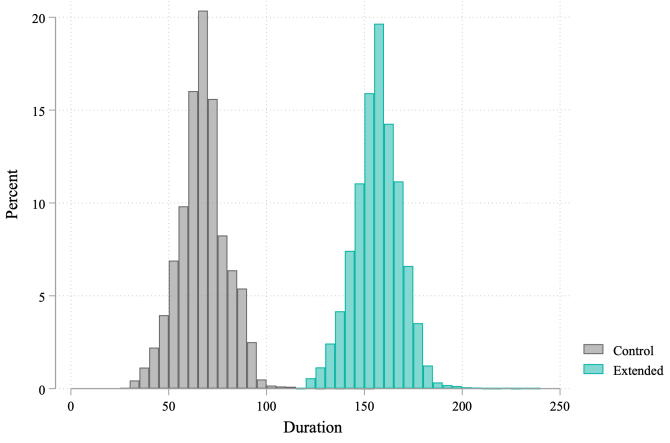
	(1) Δ Num Bedrooms	(2) Δ Num Bathrooms	(3) Δ Num Living Rooms	(4) Δ Floor Area	(5) Δ Log(Rent)
Extension	0.00	-0.00	-0.00*	-0.03	-0.71
	(0.00)	(0.00)	(0.00)	(0.12)	(0.64)
Fixed Effects	✓	✓	✓	✓	✓
N	200,251	154,605	137,590	151,345	76,772

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

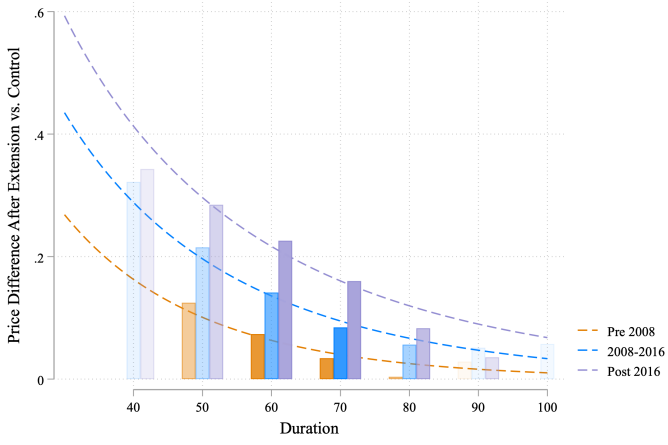
◂ Main Estimator

Lease Term Distribution



◂ Main Estimator ◂ Event Study

Dynamics Of The Natural Housing rate



Transparency shaded by number of observations

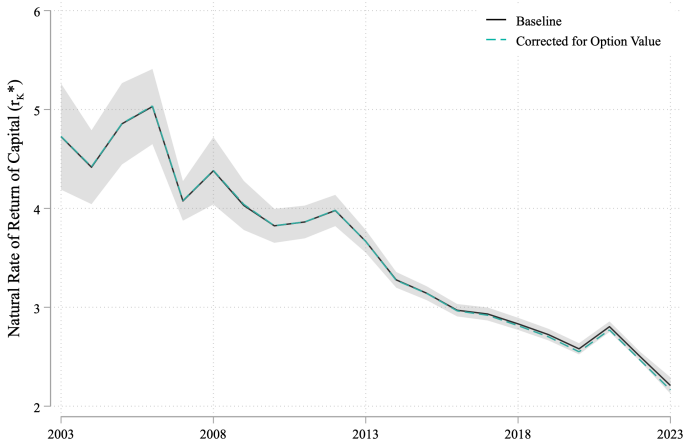
◂ r_K^* Timeseries

Full Holdup: Institutional Justification

- By design, tribunal determined costs should be equal to the "true" market value of a 90-year extension. The reason for discrepancies has to do with the fact that tribunals use larger discount rates than what we observe.
- In addition to tribunal-dictated nominal extension costs, we must account for lawyer costs, time costs and other fees. **By law, the leaseholder is responsible for paying all of the freeholder's fees and lawyer costs**.
- Freehold landowners are often particularly combative in order to intimidate leaseholders.
- Tribunals are not obligated to rule within the two party's proposed costs, so there is a factor of risk with going to the tribunal.

◂ Estimator of r_K^*

Corrected Timeseries



Partial Holdup Above 80 Has Negligible Effect on Estimates

◂ Bunching Estimator ◂ Estimates of Long-Term Housing rates

Liquidity Premium

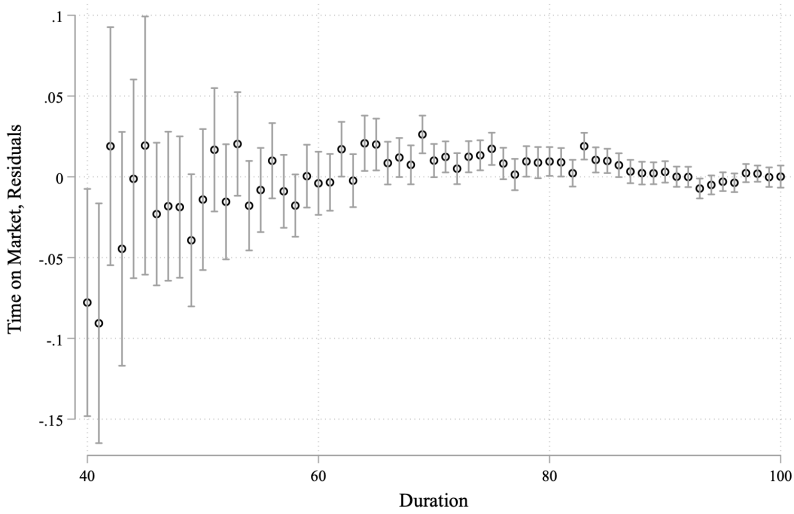
- Short and long duration leaseholds have relatively similar mortgage usage rates and conditions:

	Less Than 50 Years	50-60 Years	60-70 Years	70-80 Years	80-99 Years	100+ Years	Total
Mortgage Length	22.1	22.1	23.9	23.0	23.9	23.1	23.3
	(0.6)	(0.5)	(0.5)	(0.3)	(0.2)	(0.1)	(0.1)
LTV	76.3	80.8	81.4	77.7	73.3	76.5	76.2
	(3.3)	(2.6)	(1.8)	(1.7)	(1.0)	(0.6)	(0.5)
% Have Mortgage	59.9	60.4	62.1	58.1	63.9	55.6	58.2
	(2.4)	(2.4)	(1.6)	(1.4)	(0.8)	(0.5)	(0.4)
% Adjustable Rate	24.2	40.0	38.3	32.8	25.3	31.0	30.2
	(5.3)	(5.2)	(4.1)	(3.4)	(1.5)	(1.0)	(0.8)
N	18,292						

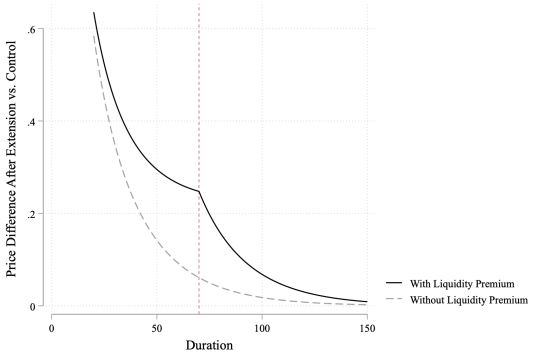
mean reported; standard error of mean in parentheses

Liquidity Premium

- Time on market is similar for leaseholds of varying durations, and is shorter for very short leaseholds



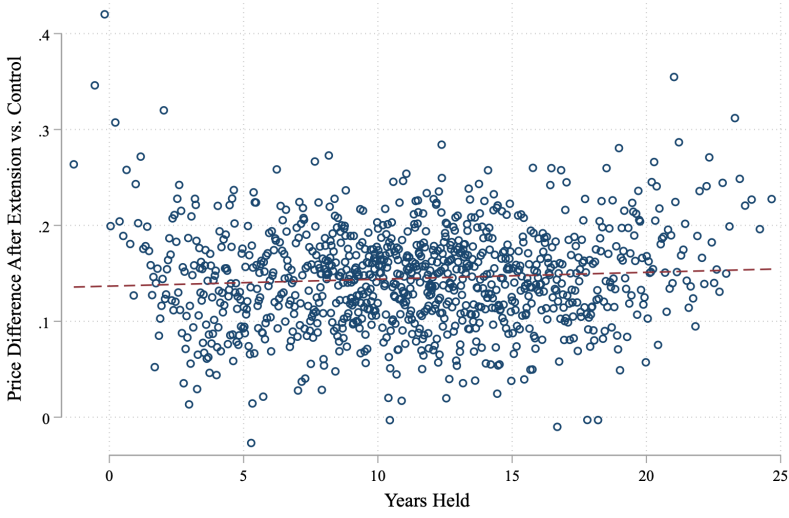
Liquidity Premium



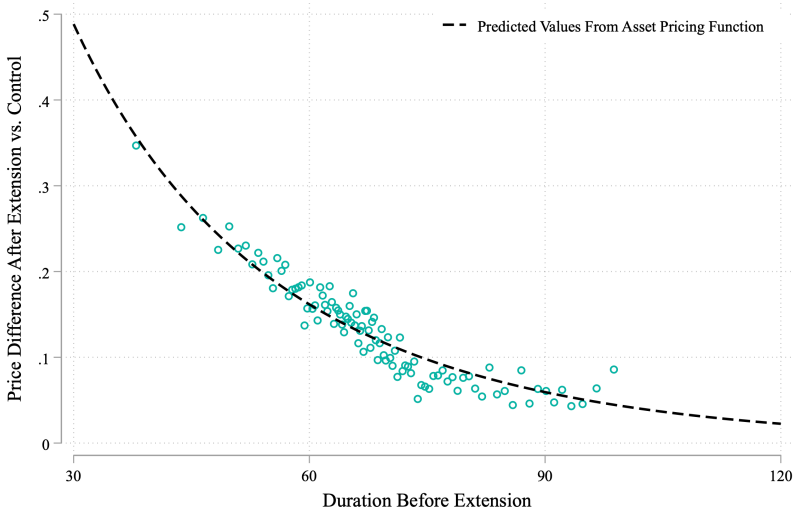
- If there were a liquidity premium at a particular cutoff, we would see a kink in the data.
- We can test for this directly using NLLS — the data rejects a liquidity premium at 70, which is the most prominent cutoff date for several major banks such as Barclays.

◂ Estimates of Long-Term Housing rates

Holding Period

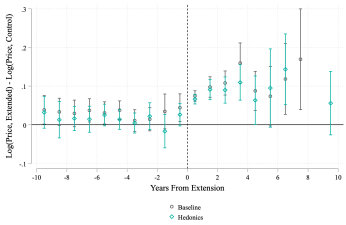


Longer Extensions

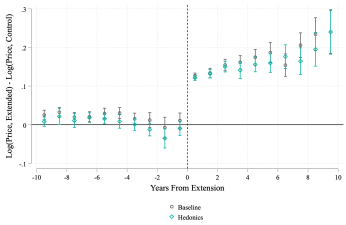


Robustness

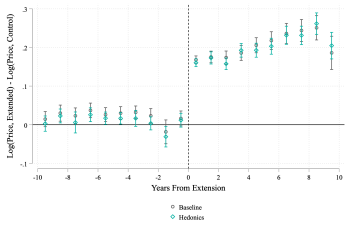
Event Study Plot Over Time



(a) 2003-2010

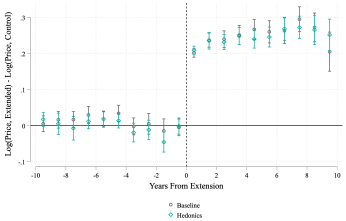


(b) 2010-2018

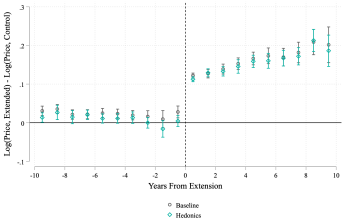


(c) 2018-2023

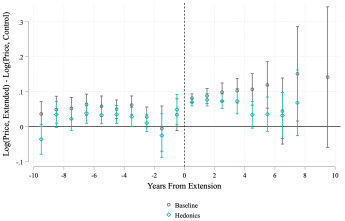
Event Study Plot Over Duration



(a) $40 < T \leq 60$



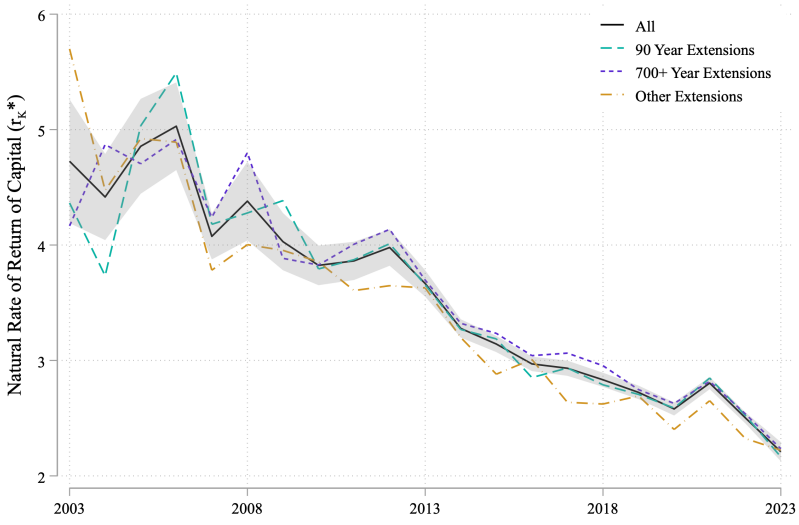
(b) $60 < T \leq 80$



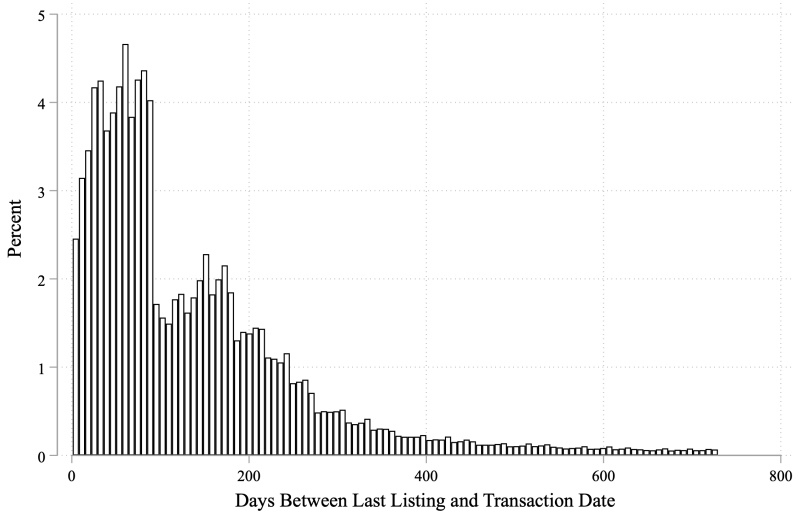
(c) $T > 80$

Event Study

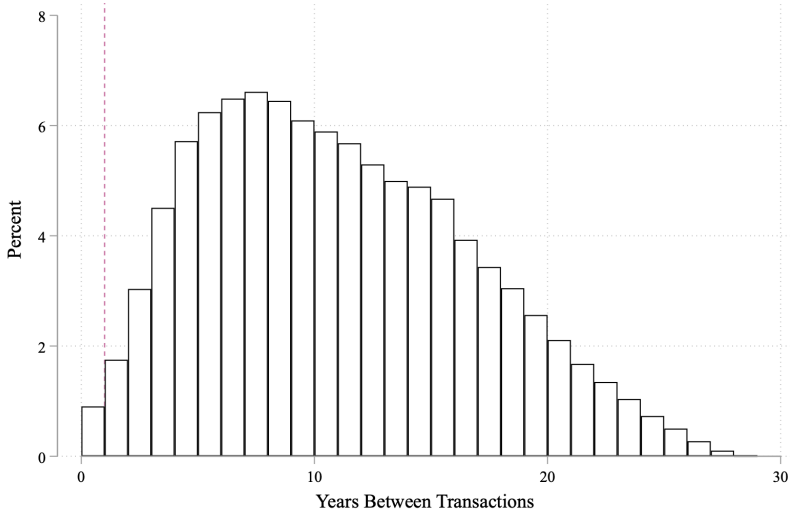
Timeseries by Extension Amount



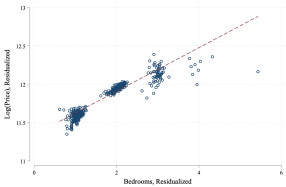
Time Elapsed Between Rightmove Listing and Transaction Date



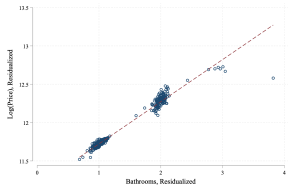
Holding Period Histogram



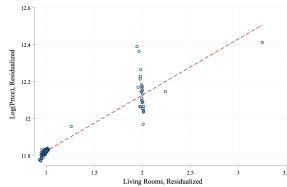
Log(Price) and Hedonic Characteristics Binscatters



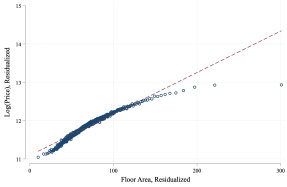
(a) Bedrooms



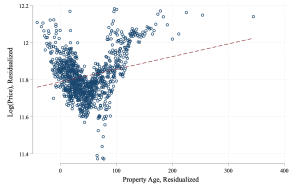
(b) Bathrooms



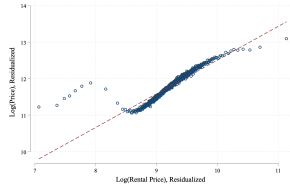
(c) Living Rooms



(d) Floor Area



(e) Age



(f) Log(Rent)

Tribunal Decision Example

Determination of the premium payable for an extended lease of 66 Brownlow Road, London N11 2BS

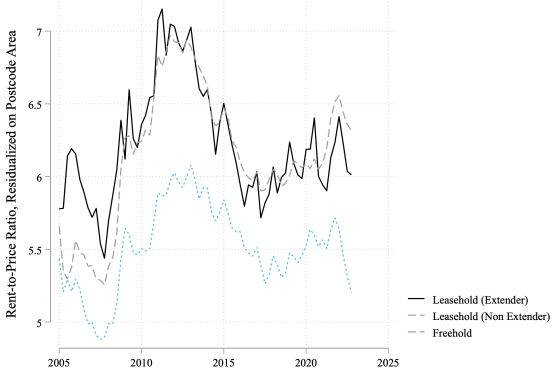
Valuation date: 21 January 2019 – Unexpired term 64.92 years

Diminution in Value of Freehold Interest

Capitalization of ground rent pa	£45		£635
YP for 64.92 years @ 7%	14.109		
Reversion to F/H value with VP	£393,900		
Deferred 64.92 years @ 5%	0.0421		£16,583
			£17,218
Less value of F/H after grant of new lease	£393,900		
Deferred 154.92 years @5%	0.000522		£205
			£17,013
Marriage Value			
After grant of new lease			
Value of extended lease	£390,000		
Plus freehold value	£205	£390,205	
Before grant of new lease			
Value of existing lease @ 83.88%	£328,500		
Plus freehold value	£17,218	£345,718	
		£44,487	
50% share to Freeholder			£22,243
			£39,256
		Premium Payable Say	**£39,250**

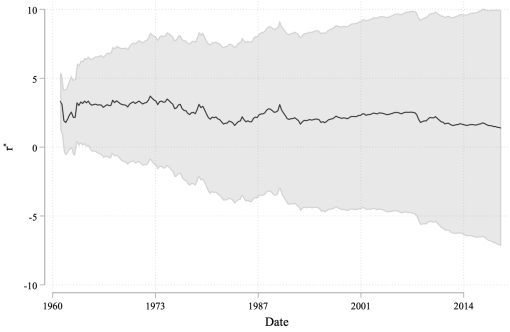
Leaseholder Representativeness

	Freehold	Leasehold
Income	29,628.73	25,653.20
	(52.95)	(138.48)
Age	53.95	51.49
	(0.03)	(0.10)
% Have Mortgage	54.82	59.07
	(0.10)	(0.28)
LTV	72.17	76.16
	(0.14)	(0.39)
N	305,135	

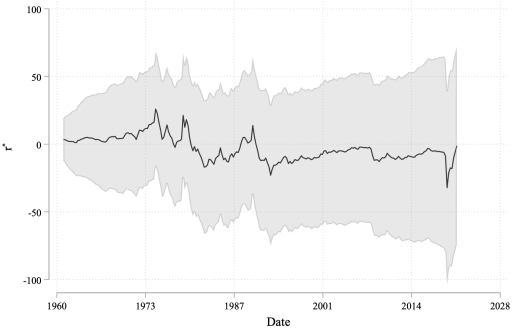


◂ Estimates of Long-Term Housing rates

Holston, Laubach & Williams r^*



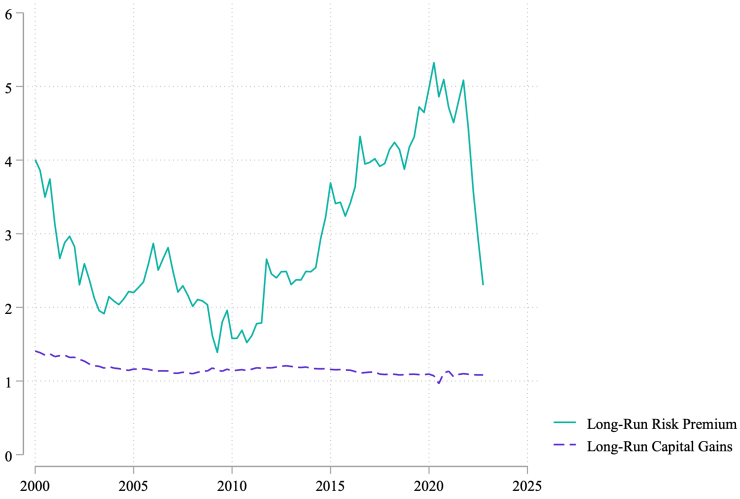
(a) Pre COVID-19 Pandemic



(b) Post COVID-19 Pandemic

◂ Result # 1

Risk Premia and Capital Gains for Housing



No trend in long run risk premia or capital gains Return