A Tale of Two U.S. House Price Booms*

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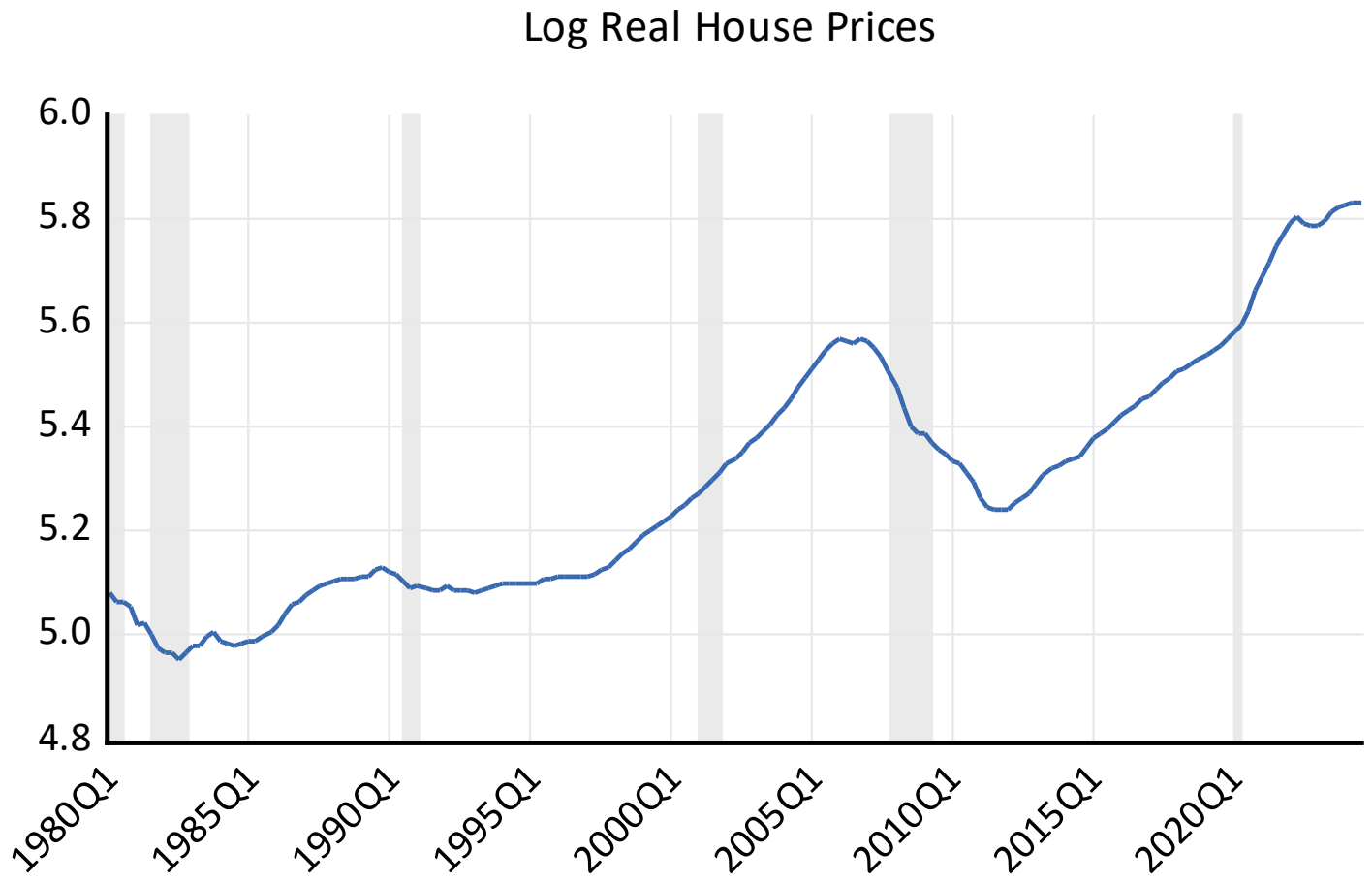
*The view expressed are those of the authors and not those of the Federal Reserve Bank of Dallas or the Federal Reserve System

Abstract

Although real U.S. house prices boomed by similar amounts in both the early 2000s and in the years following the outbreak of the Covid-19 pandemic, the relative roles of factors driving those booms differed. Our econometric model indicate that the former boom was set in motion by higher demand arising from a combination of low interest rates and a weakening of mortgage credit standards. In contrast, the more recent boom arose from higher housing demand—stemming from lower mortgage interest rates and a pandemic-related rise in the preference for detached homes associated with increased work-from-home (WFH)—that has pressed up against a less elastic supply of housing, with homeowners less apt to sell because they locked in low interest rate fixed-rate mortgages early in the pandemic. In both episodes, extrapolative house price expectations amplified demand effects.

We establish these results using a house price-to-rent framework. Our quarterly data span four decades, which allows us to estimate the determinants of the long-run house price-to-rent ratio and their dynamic behavior over several business cycles. We find that while the much of the house price increases this decade was induced by earlier low interest rates which have since rebounded, the rise in WFH and mortgage rate lock-in effects prevented much of the prior run-up from unwinding. We estimate that WHF and mortgage rate lock-in effects boosted the house price-to-rent ratio by about 10 percent and up to 8 percent respectively in the long-run. The model results suggest that the deviation of the house price-to-rent ratio from its longer-run, fundamental value is small.

Two House Price Booms In Past Four Decades



Different Factors Drove The Two Booms

- Real US house prices shot up by similar amounts in the early 2000s before the Great Recession and in recent years after COVID
- Causes and timing of booms differ
- Early to mid-2000's boom driven by roughly equal contributions from low interest rates and easing mortgage lending standards
- 2020s house price boom driven by combination of
  - Initially low interest rates,
  - A jump in working from home (WHF),
  - The mortgage lock-in effect - after the Fed hiked interest rates to tame inflation - reduced the supply of existing homes for sale
- We try to disentangle the drivers of house price inflation during these two periods using time series-based house price-to-rent model
  - Limited number of observations with WFH & lock-in effects hampers identification

Approaches to Modelling House Prices

- Two theory-based approaches to modelling aggregate house price time series – house price-to-rent and inverted housing demand models
- House price-to-rent approach used here is simpler
- Based on notion of no arbitrage between the value of a house and the discounted present value of the rents which the house could generate
- Some disadvantages:
  - HP/Rent ratio nets out some common factors driving rents and prices
  - HP/Rent approach masks the role of housing supply
- Neither approach "works" unless you allow for:
  - Lagged adjustment and extrapolative house price expectations
  - Time varying credit constraints
  - Departures from perfect capital markets and perfect substitutability in the case of the HP/Rent approach
- By "works" we mean finding a reasonably stable, statistically significant cointegrated long-run house price relationship with sensible coefficients / elasticities and reasonable speeds of adjustment etc.

House Price-to-Rent Approach

- Assuming perfect substitution & credit markets, arbitrage between owner and rental markets implies price-rent ratio akin to P/E ratio:

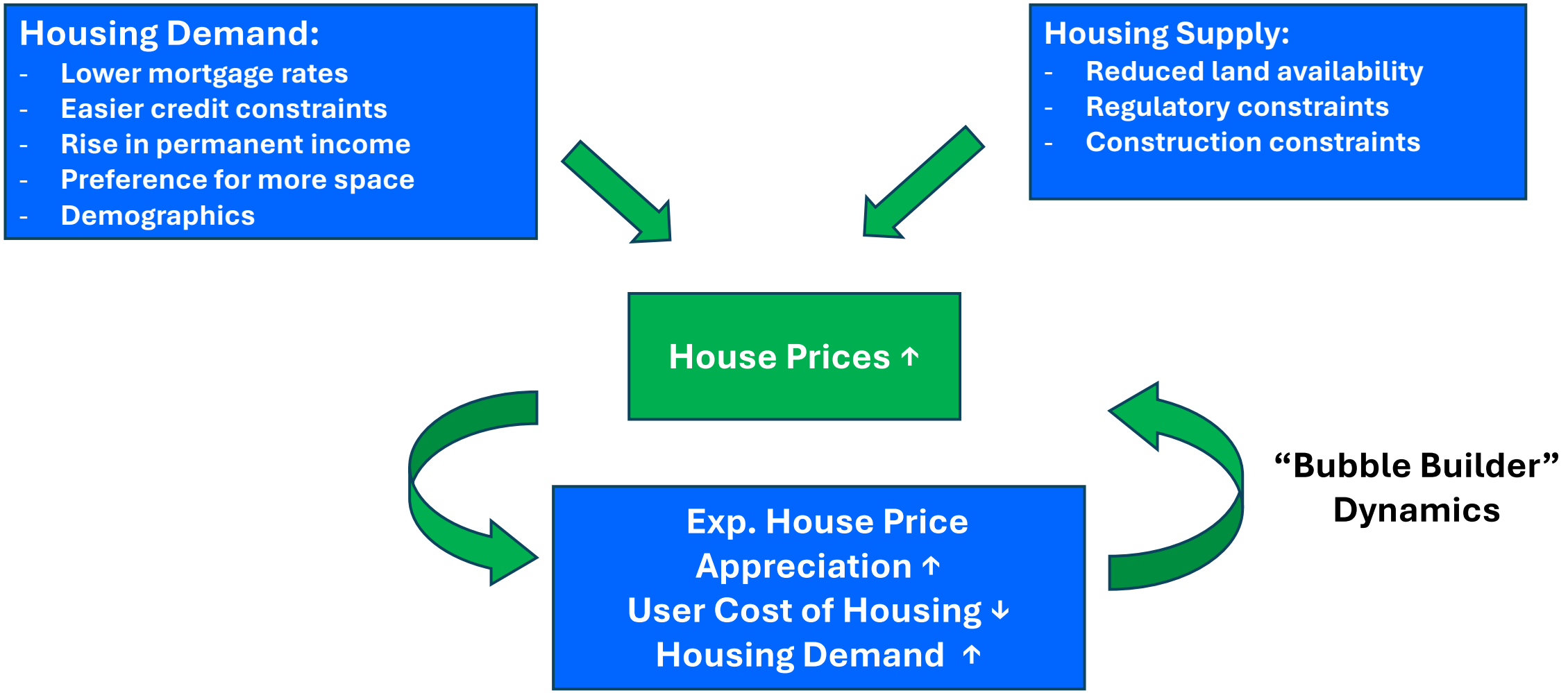
  $$Rent = HPxUC$$

  where UC = user cost of housing, i.e., the after-tax mortgage interest rate + insurance & property taxes + depreciation rate + risk premium – expected rate of house price appreciation (less transactions costs)

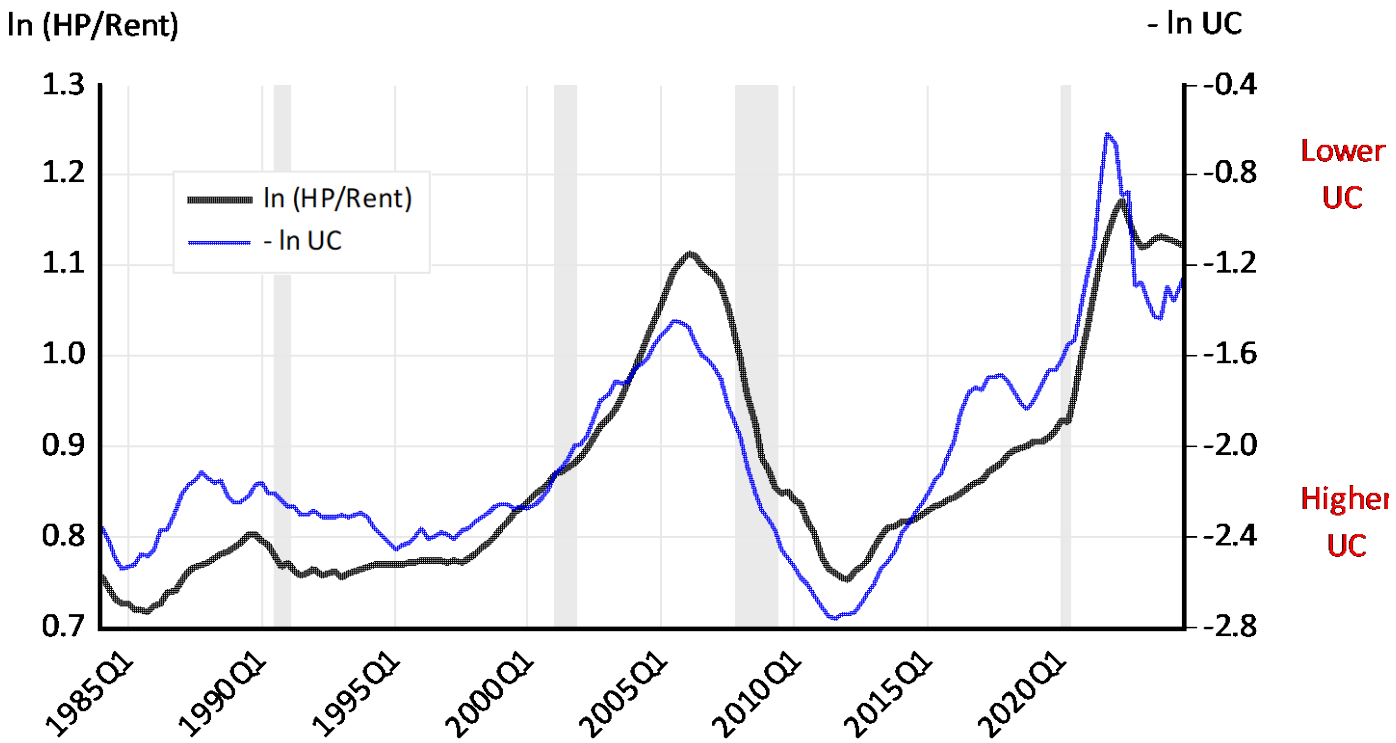
  - In principle, could use time varying risk premium

- Expected house price appreciation proxied by lagged appreciation over past 5 years
  - Extrapolative expectations consistent with survey evidence and previous empirical work
- Inverting arbitrate equation and taking logs: $ln(HP/Rent) = -lnUC$
- In this simple model, $\ln(HP/Rent)$ is invariant to income and housing stock, with user cost elasticity = -1
- Empirically, user cost elasticity of -1 is decisively rejected
  - Estimated elasticity of -0.2 → (aggregate) rental and owner-occupied housing are imperfect substitutes

Extrapolative Expectations Effects on House Prices



HP/Rent Ratio and User Cost of Housing Move Inversely, But Other Factors Matter



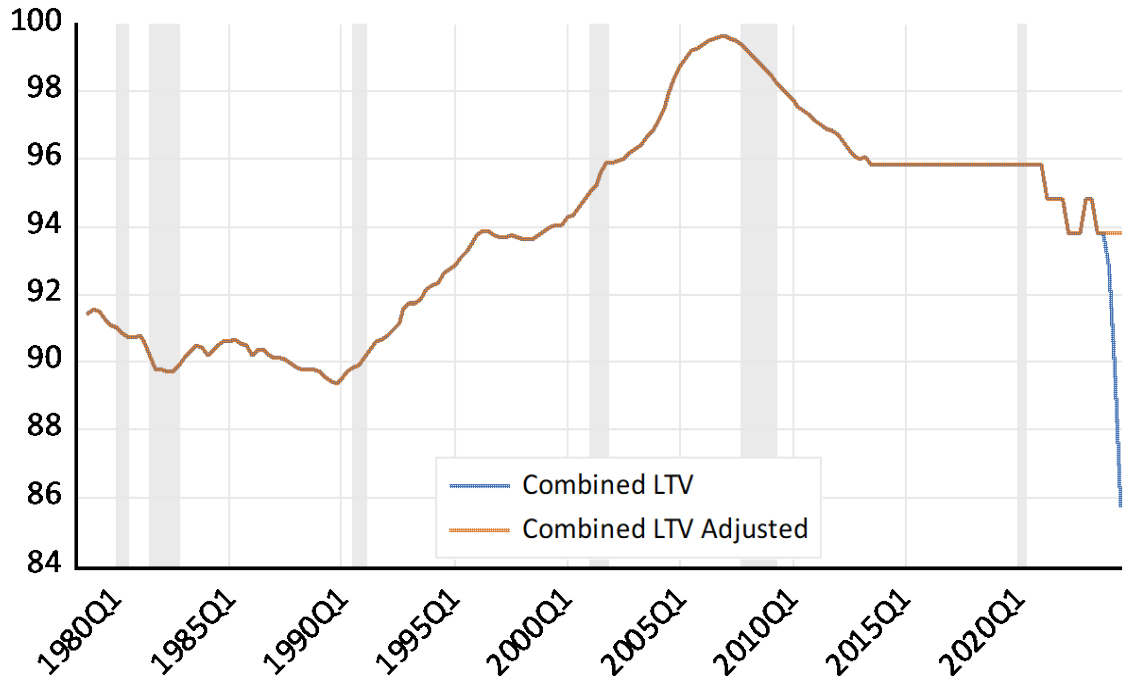
- Mortgage lending standards matter in the earlier house price boom period

$$HP/Rent = f(UC, Lending\ Standards, \ldots)$$

- Binding credit constraints on marginal home buyers => HP/Rent ratio also depends on (time-varying) mortgage lending standards
- We focus on first time buyers, a key marginal group of buyers

Changing Lending Standards

First Time Buyer LTV Ratio

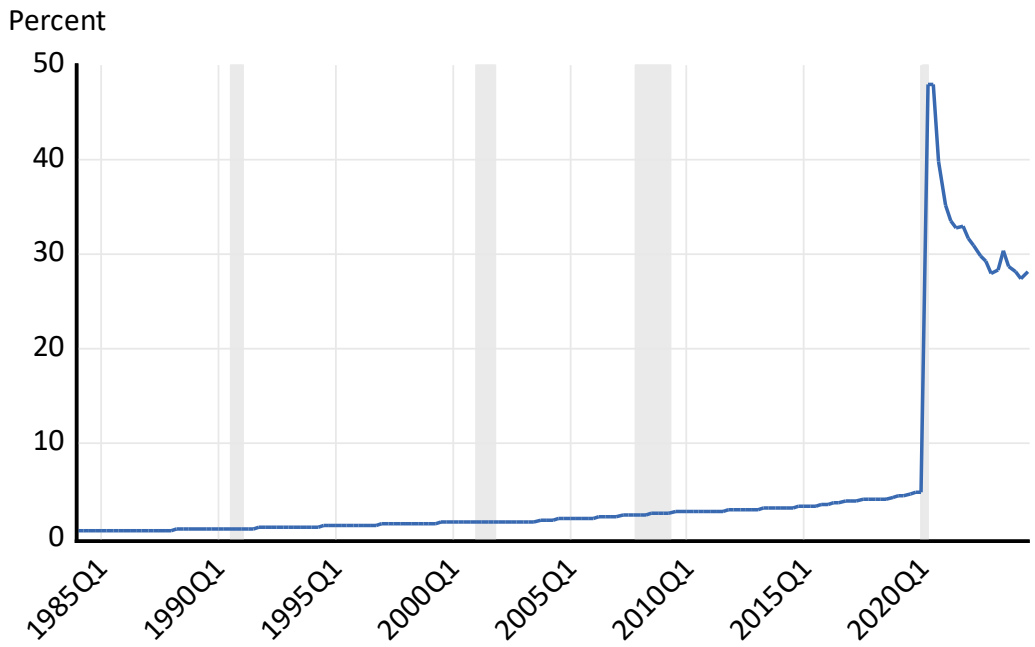


- Before the Qualified Mortgage(QM) rule in 2014, we proxy mortgage lending standards using the combined loan-to-value (LTV) ratio for first time home buyers
  - Debt service to income (DTI) ratios are very endogenous
  - Major shifts in first time buyer LTVs reflected changes in bank capital requirements on non-prime loans as well as changes in the maximum size of FHA mortgages during the Great Recession
- We currently use a QM dummy to capture changes in DTIs in response to the new Dodd Frank Act ability to repay rules for qualified mortgages

Other Important Drivers of House Prices

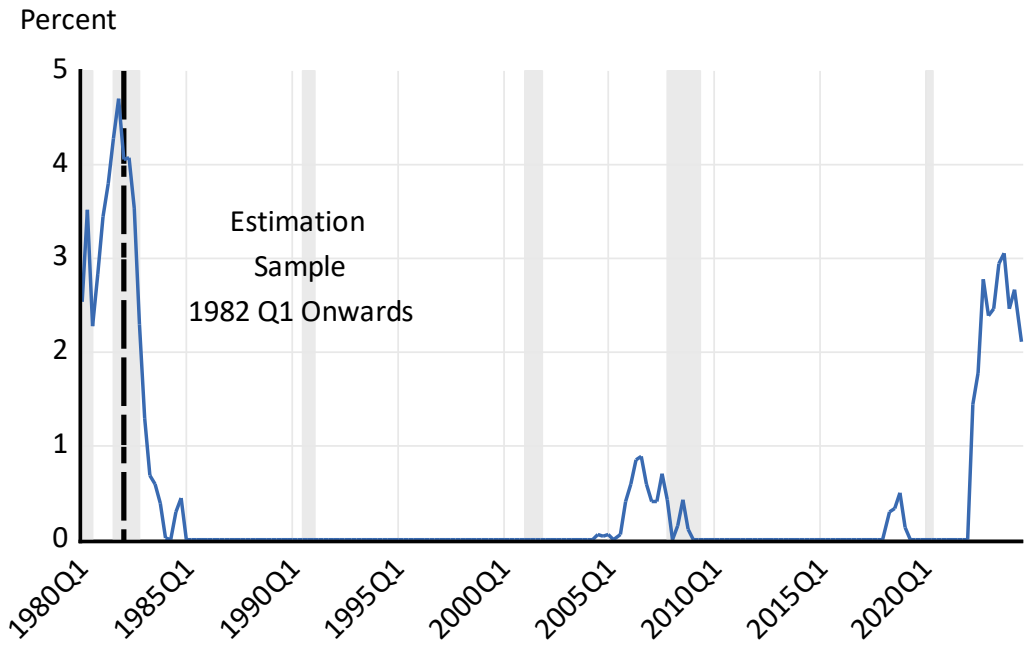
Work From Home

(Barrero et al., 2024, percentage of full pay working days)



Mortgage Rate Lock-In

(Interest Rate Gap Minus 0.5 Percent)



ARDL Model of HP/Rent Ratio

$$\boldsymbol{ln(HP/Rent)_t = const + a(L)\, ln(HP/Rent)_{t-1} + b(L)\, ln\, UC_t + c(L)\, ln\, CLTV_t + d(L)WFH_t}$$

$$\boldsymbol{+ \beta_1 CGT_t^{97q3} + \beta_2 QM_t^{14q1}} + \gamma_1 RateLockIn_t$$

$$+ \delta_1 FHAPrem_t^{83q3} + \delta_2 TaxReform_t^{86q1} + \delta_3 GulfWar_t^{91q1} + \delta_4 Lehman_t^{08q4}$$

$$+ \delta_5 TaxCredit_t^{09q1-10q2} + \delta_6 TaxCreditExpire_t^{09q4} + \delta_7 FDICIns_t^{11q1} + u_t$$

Autoregressive distributed lag (ARDL) model in levels may also be represented as a conditional error correction (EC) model

$$\boldsymbol{\Delta ln(HP/Rent)_t = const' + \tilde{a}(L)\Delta \ln(HP/Rent)_{t-1} + \tilde{b}(L)\, \Delta ln\, UC_t + \tilde{c}(L)\, \Delta ln\, CLTV_t + \tilde{d}(L)\Delta WFH_t}$$

$$\boldsymbol{-\gamma(\ln(HP/Rent)_{t-1} - \alpha_1 lnUC_{t-1} - \alpha_2 lnCLTV_{t-1} - \alpha_3 WHF_{t-1})} + \ldots$$

ARDL Model

$$ln(HP/Rent)_t = const + a(L)\, ln(HP/Rent)_{t-1} + b(L)\, ln\, UC_t + c(L)\, ln\, CLTV_t + d(L)WFH_t$$
$$+ \beta_1 CGT_t^{97q3} + \beta_2 QM_t^{14q1} + \gamma_1 RateLockIn_t$$
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- Existence of long run equilibrium evaluated using bounds test (Pesaran, Shin & Smith 2001), which can handle both I(0) and I(1) variables
  - Long run relationship is a cointegrating vector if some, or all, of the variables are I(1)
  - Simpler approach than VECM when there is a unique cointegrating vector
- Maximum of five lags on *HP/Rent, UC, CLTV* and *WFH*, with lag length chosen using SIC
- Two sample periods: 1982q1 to 2019q4 (pre-Covid) or 1982q1 to 2024q3 (full sample)

HP/Rent Model Summary ARDL Results

Error Correction and Other Long Run Effects Etc.

Variable	Pre-Covid Sample 1982q1-2019q4	Full Sample 1984q1 – 2024q3
ln UC (user cost of housing)	-0.19	-0.19
	(13.4)	(13.2)
ln CLTV (combined first-time buyer LTV)	1.26	1.12
	(4.8)	(4.8)
WFH (Barrero et al. work from home measure)	-0.0050	0.0025
	(0.4)	(3.6)
CGT (change in tax on owner -occupied housing)	0.023	0.029
	(1.6)	(1.9)
QM (introduction of qualified mortgages)	-0.054	-0.053
	(2.7)	(1.8)
Mortgage Rate Lock-In*	0.019	0.027
	(3.2)	(3.5)
EC “speed of adjustment”	-0.12	-0.12
	(7.5)	(5.8)
Adjusted R^2 (conditional EC)	0.83	0.85
Equation SE	0.0043	0.0047
Bounds F Test (null of no relationship)	13.9**	9.99***
5% Critical Values (I(1) and I(0))	3.67/2.79	3.67 / 2.79

Discussion of ARDL Results

Long Run Determinants of HP/Rent Ratio

- Can reject “no long run relationship” null hypothesis
- Identified economically sensible cointegrating vector, although WFH effect only pinned down in full sample

Stability of Results

- Other long run error correction coefficients on user costs, combined CLTV and QM mortgage introduction similar in both periods
- Estimates also similar to those in our 2016 AER P&P article (where the sample ended in mid-2013)

Dynamics

- As expected, estimates display usual “bubble builder” and “bubble burster” dynamics
- Reasonable speed of adjustment

Implications of ARDL Results

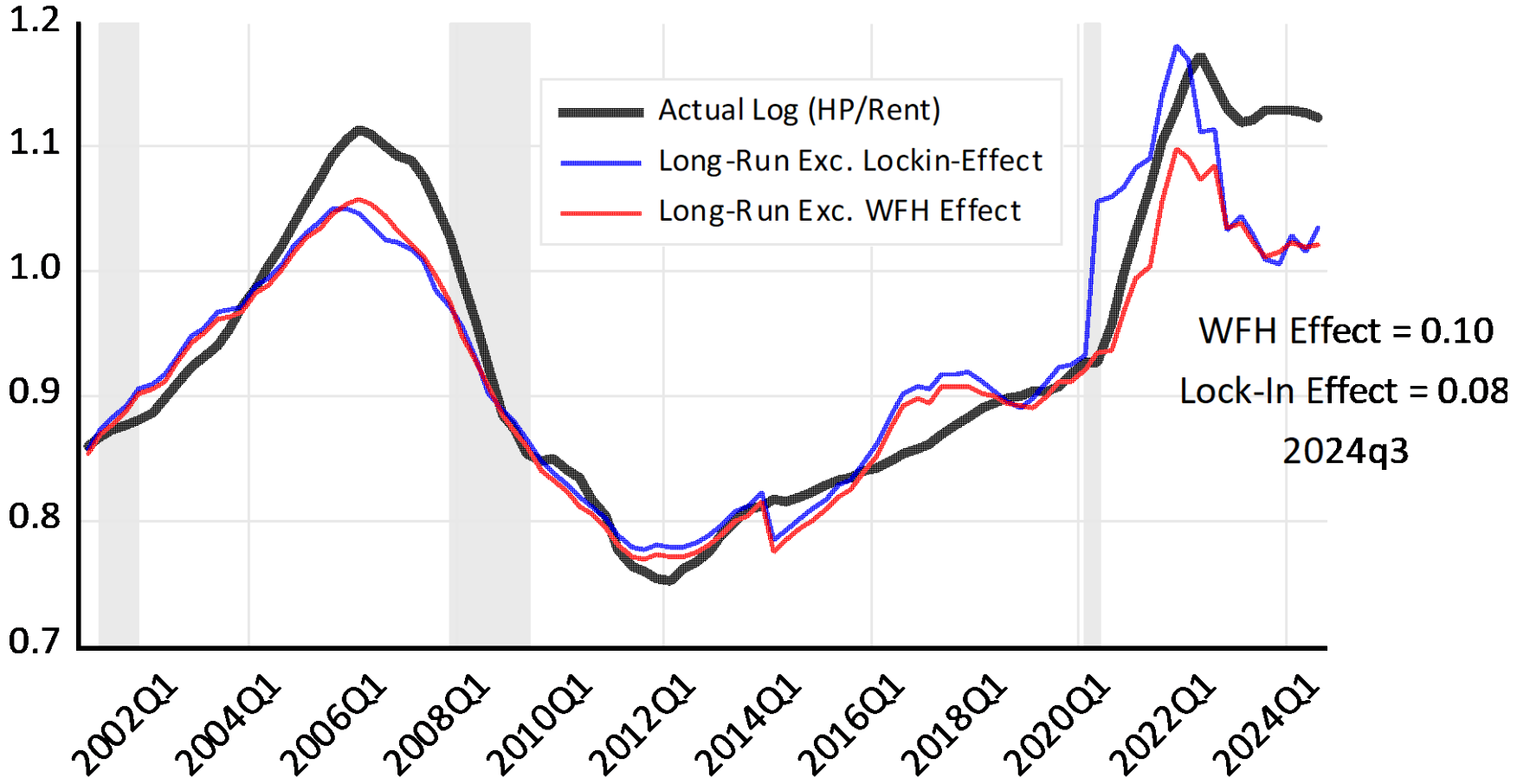
WFH and Mortgage Rate Lock-In Effects?

- Estimated effects on HP/Rent ratio are approx. 10% and 8% respectively
  - Calculations assume lock-in effect is somewhat persistent and not just short-run
  - In the latter case, the lock-in effect is reduced
- Similar, although less precise, estimates obtained using ARDL inverted housing demand model

House Price Overvaluation?

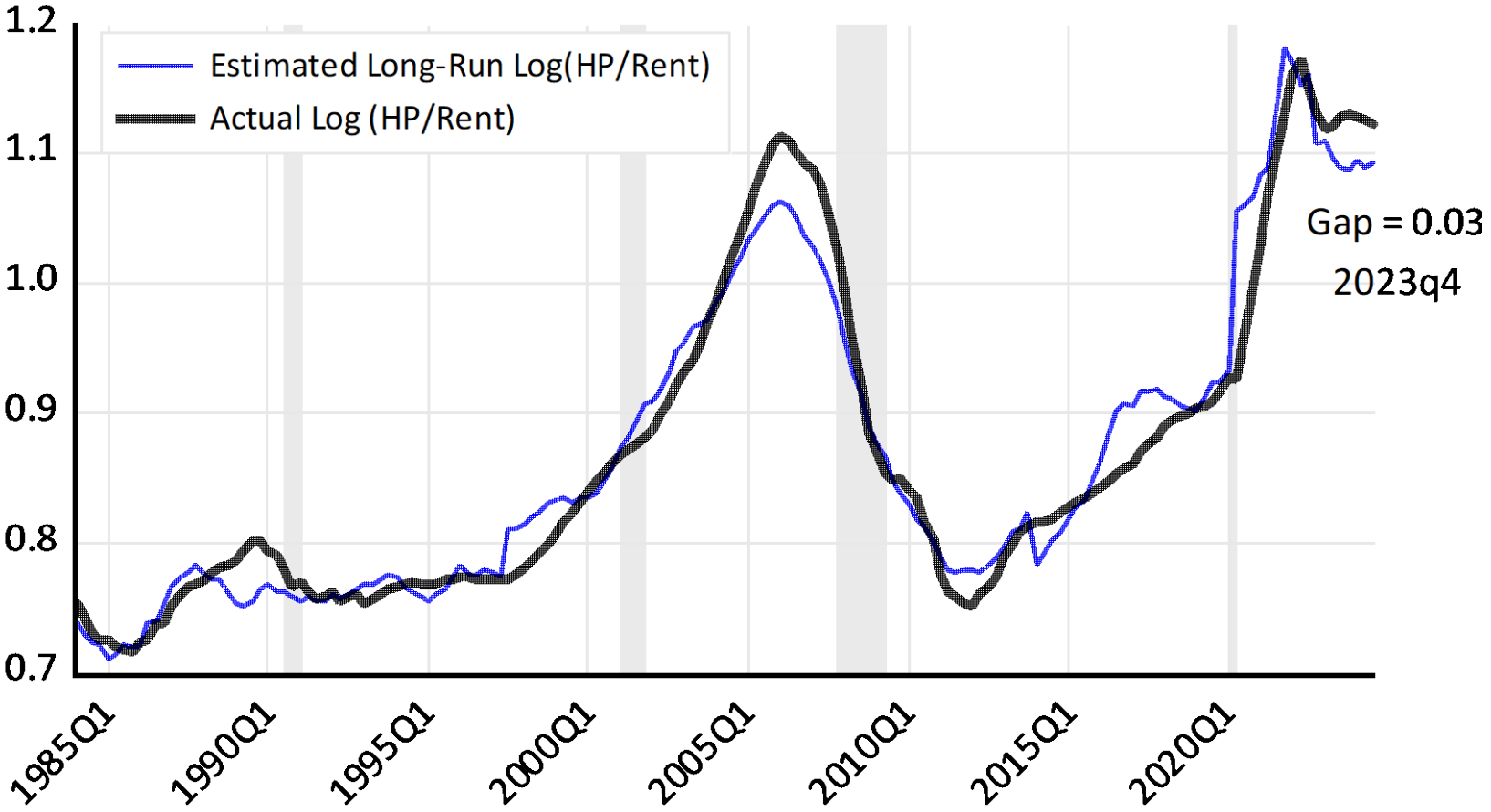
- House prices and rents are both high!
- ARDL results suggests that the deviation of HP/Rent from its longer-run, fundamental value is small
  - Again, assuming lock-in effect is somewhat persistent
- Inverted housing demand models (with housing supply on RHS) more useful for addressing affordability and housing shortage issues

Estimated WFH and Mortgage Rate Lock-In Effects



Little Evidence of HP/Rent Ratio Overvaluation

Given WFH and somewhat persistent lock-in effects



Caveat & Work in Progress

- Caveat: Identification of WHF and mortgage rate lock-in effects based on data for past few years
  - Will exploit geographical variation
- Ideally should confirm HP/Rent model results using inverted housing demand models once estimation complete
- Tackle some data issues, e.g.,
  - Combined first-time buyer LTVs measures: reconcile American Housing Survey (AHS) and National Mortgage Database (NMDB) Measures
  - Lock-in measure: examine measure of “depth” of lock-in