

Liquidity Constraints, Transition Dynamics, and the Chinese Housing Return Premium

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Motivation

Context:

- increasing public & academic interest in understanding housing market dynamics since the start of the twenty-first century.

Large housing market boom in China:

- increase in real home price from 2003 to 2012: 170 percent
- more than double the price increase in last US housing boom

Return on housing much (!) higher than alternative assets:

- real housing price return: 12.4 percent
- risk free rates: -0.2 percent (saving), 3.5 percent (borrowing)

Questions:

- Why did home price increase so much from 2003 to 2012?
- Why is return on housing so much higher than alternative assets?

Main Idea

- **Low initial household wealth + Liquidity constraints**

- ① Households face constraints on how much they can invest in housing relative to their wealth
 - funding liquidity: borrowing constraints
 - market liquidity: “illiquidity” and emergency expenditure needs
- ② Large increase in home price reflects housing is undervalued in 2003 relative to the net present value of future rents, and becomes less undervalued over time
 - undervaluation relative to NPV: given low financial return, high expected growth, the net present value is potentially very high, yet market value limited by low initial household wealth
 - home price increase rapidly as household wealth increase rapidly, aided by (1) high household saving and (2) feedback effect from housing appreciation
- ③ Housing return premium reflects liquidity constraints
 - anticipating high returns, household would want to invest more, but are limited in how much wealth they have

What I Do

1. Which cities experienced the largest housing booms?

I construct a panel dataset on housing value, household wealth for Chinese cities, and finds suggestive evidence for “liquidity constraints — wealth accumulation” explanation:

- ① Cities with strongest housing value growth tend to be cities with strongest household (non-housing) wealth growth
- ② Magnitude of comovement between wealth growth and housing value growth more than can be explained by standard income effect and instead more consistent with borrowing constraints

What I Do

2. Develops a **dynamic equilibrium model of the housing market** to quantitatively assess the “liquidity constraints — wealth accumulation” explanation:
 - ① Model accommodates long-run risks in income, consumption-saving decisions, and dual role of housing
 - ② Model calibrated with liquidity constraints and observed evolution of the wealth-to-income ratio, matches large fraction of housing price increase and housing return premium
 - Price dynamics virtually all driven by borrowing constraints
 - Illiquidity helps explain holding of financial assets
 - ③ Model yields sharp predictions on impact of slowdown, financial asset returns on housing prices

Related Literature

- Determinants of House Prices:
 - user cost (Poterba 1984), demographics (Mankiw and Weil 1989), behavioral biases (Case and Shiller 1990), supply (Glaeser, Gyourko and Saiz 2008), credit supply (Favara and Imbs 2015)
- Dynamics of Housing and Wealth:
 - Piketty and Zucman (2014), Rognlie (2016)
- Housing and Liquidity:
 - He, Wright and Zhu (2015), Miao, Wang and Zhou (2015), Favilukis, Ludvigson and Van Nieuwerburgh (2017)
- Chinese housing boom:
 - Fang, Gu, Xiong and Zhou (2015), Chen and Wen (2016), Garriga et al. (2016), Glaeser, Huang, Ma and Shleifer (2017), Han, Han and Zhu (forthcoming)
- Cash in the Market Pricing:
 - Allen and Gale (1994, 2005), Allen and Carletti (2008)

Background and Motivating Facts

Institutional Background of Chinese Housing Market

A brief history of housing provisioning in China:

- Pre-1998: Urban housing is provided by work units as in-kind benefit.
- 1998-2003: State Council No. 23 [1998] abolishes housing as in-kind benefit. Establishes government “affordable housing” as main supply of housing.
- 2003-now: State Council No. 18 [2003] abandons centrality of “affordable housing”. Establishes market housing as primary way of housing provisioning.

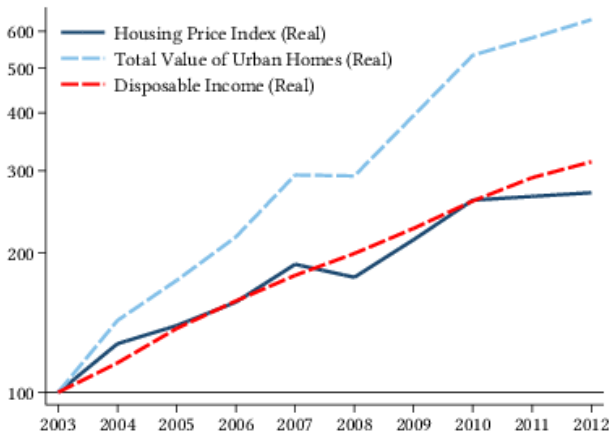
Liquidity constraints in the housing market:

- Tight borrowing constraints for rich and poor:
 - From 30% down for 1st homes to 100% down for 3rd homes
- No HELOC

Low initial wealth in early 2000s:

- The old welfare system (ended in late 1990s) was generous in social benefits
→ Weaker savings needs & relatively low aggregate household wealth-to-income ratio

Aggregate: Housing Value Grows More Than Income

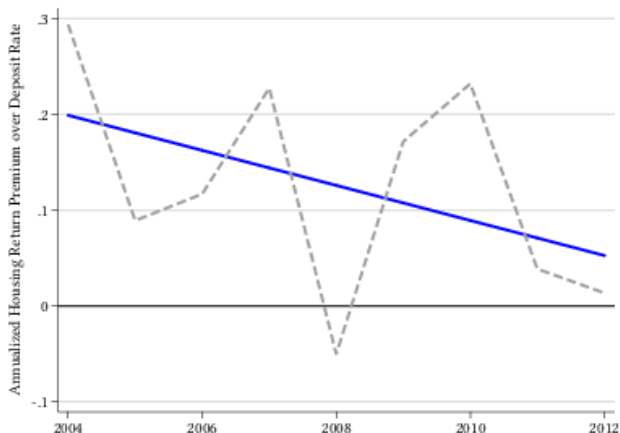


Aggregate: Large Housing Return Premium

	Mean	Standard deviation	Sharpe Ratio
Real housing price appreciation	12.4%	11.6%	
Excess return over deposit rate	12.6%	11.4%	1.11
Excess return over mortgage rate	8.9%	11.4%	0.78

Standard error of sample mean in parentheses. Nobs = 9.

Aggregate: Large Housing Return Premium



Newly-constructed Panel Database for Housing, Wealth

- 99 cities from 2003 to 2012
- Draws from an extensive number of data sources:
Census microdata, constant-quality housing price index, city-level banking snapshots, and more
- Housing value (price, quantity), household wealth (total, non-housing), income, population, retail sales, industrial profits, etc.
- Household Wealth:

$$\text{Net Worth} = \text{Bank Savings} + \text{Housing Value} - \text{Mortgage}$$

- no city-level data on other assets; however, housing and bank savings captures 85~90% of household wealth in national survey
- Housing Value: Perpetual Inventory Approach

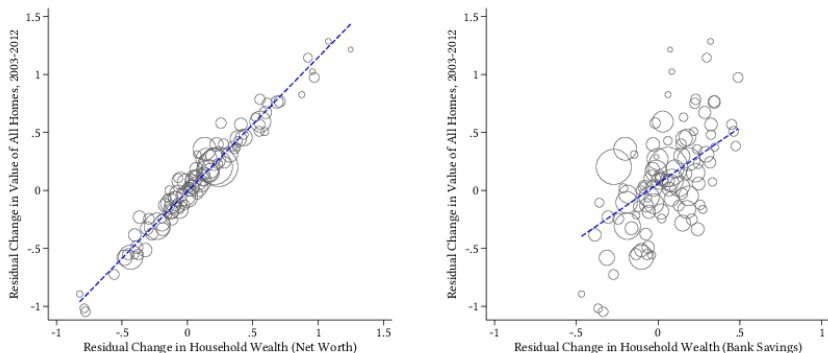
$$\begin{aligned} \text{Housing Value}_T &= (1 - \delta)^T \cdot \frac{p_T}{p_0} \cdot \text{Housing Value}_0 \\ &+ \sum_{t=1}^T (1 - \delta)^{T-t} \cdot \frac{p_T}{p_t} \cdot \text{New Home Sales}_t \end{aligned}$$

Panel Evidence: Regression coefficient close to one between log HH asset wealth, log housing value

Dependent Variable	(1)	(2)
	Log(Housing Value)	
Household Wealth Measures	(Incl. Housing)	(Excl. Housing)
	Net Worth	Bank Savings
Log(Household Wealth)	1.107***	1.062***
Log(Income)	0.0574	0.524***
Log(Population)	-0.0301	0.128
Observations	990	990
Adjusted- R^2	0.99	0.99
Number of Cities	99	99

City fixed effects. Source: City-level database.

Panel Evidence: regression coefficient close to one between log HH asset wealth, log housing value



Source: City-level database.

Preliminary: Instrumenting Wealth Accumulation with Famine Severity

- “Experience mechanism”: Famine experience during 1959-1961 affects discount rate now - Chen, Rupelle and Zilibotti (2016)
- Famine severity associated with (1) significantly lower initial wealth and (2) substantially faster wealth accumulation

Dependent Variable	(1)	(2)
	9-year Growth in Housing Value	
Model	OLS	IV
9-year Growth in Wealth	1.12***	1.23***
9-year Growth in Income	-0.01	-0.04
9-year Growth in Population	0.05	0.05
Observations	99	99
First-stage F-stat		11.65

Clustered standard errors. Source: City-level database.

Regression coefficient of one between log HH asset wealth and log housing value is not natural

- Without constraints:

Regression coefficient between $\log(\text{HousingValue})$ and $\log(\text{AssetWealth})$ is close to 0

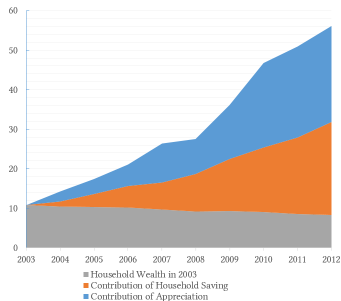
- Permanent Income Hypothesis:

coefficient $\simeq \text{Asset Wealth} / (\text{Asset Wealth} + \text{Human Wealth})$,
with $\text{Asset Wealth} \ll \text{Human Wealth}$

- Regression coefficient = 1 consistent with binding borrowing constraints

Closing the Circle: Transition of Household Wealth from a Low Initial Condition

- From a low initial wealth following welfare reforms in late 1990s, to around median of advance economies in Piketty-Zucman (2014) in 2012
 - The old welfare system prior to the sample period was generous in social benefits, a key determinant of the low initial household wealth.



Model with Liquidity Constraints and Transition Dynamics in Wealth

Big Picture

- Model with:
 - Aggregate uncertainty, borrowing constraint (wealth dynamics), and illiquidity as **competing explanations** for return premium
 - Housing as both a consumption good and an asset
 - Three assets: housing, bank deposits, mortgages
- Targets a gap in the literature:
 - Chen and Wen (2016): housing as intrinsically useless asset
 - Garriga, Hedlund, Tang and Wang (2017): housing as consumption good only
 - CW 2016, GHTW 2017, HHZ 2017: perfect foresight
- Model Challenges and Corresponding Solution:
 - Mechanism is global. Kinks in equilibrium objects.
 - \Rightarrow Global solution. Explicit solution of kinks. Adapted grid interpolation.

Model Setup

- Representative family with continuum of member households
 - Period utility $u(c_t, h_t) = u(c_t^\alpha h_t^{1-\alpha})$
- Endowment:
 - Endowment income y_t in non-housing good, subject to trend growth risks g_t and business cycle risks z_t
- Markets:
 - Three assets: housing (p_t), bank saving a_t (R_a), mortgage b_t (R_b)
 - Liquidity Constraint 1: Borrowing constraint on mortgages

$$b_t \leq \psi p_t h_t$$

- Liquidity Constraint 2: Emergence consumption shocks and illiquidity

$$c_t = (c_t^n)^{1-\kappa} (c_t^m)^\kappa, \text{ with prob } \pi,$$

$$c^m \leq a_t$$

- Housing demand: household decision (consumption, saving)
- Housing supply: $H_t^S = \bar{H}(p_t)^\varepsilon$, upward-sloping curve

Household Problem

$$\max_{\{c_t^n, c_t^m, h_t, a_t, b_t \geq 0\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^\alpha h_t^{1-\alpha})$$

subject to:

[Initial wealth]

$$w_0 = \bar{w}_0,$$

For $t=0, 1, 2, \dots$:

[Budget t]

$$c_t^n + c_t^m + a_t + p_t h_t - b_t \leq w_t,$$

[Borrowing Constraint]

$$0 \leq b_t \leq \psi p_t h_t,$$

[Illiquidity Constraint]

$$c_t^m \leq a_t,$$

$$c_t = \begin{cases} c_t^n & \text{with prob } 1 - \pi \\ (c_t^n)^{1-\kappa} (c_t^m)^\kappa & \text{with prob } \pi \end{cases},$$

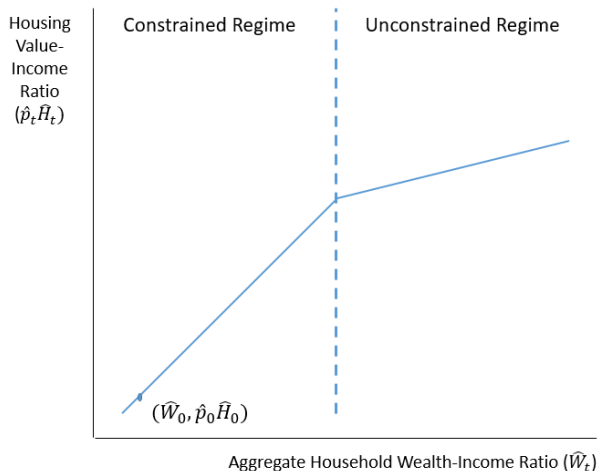
[Budget $t + 1$]

$$w_{t+1} = y_t + R_a a_t + p_{t+1}(1 - \delta)h_t - R_b b_t.$$

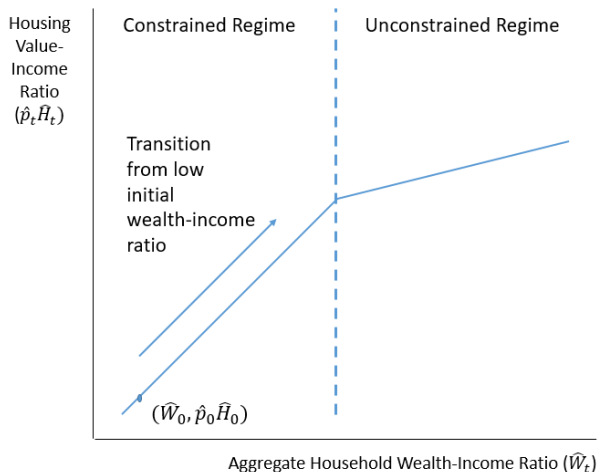
Recursive Equilibrium

- Following Aguiar and Gopinath (2007), normalize around stochastic trend $\Gamma_t = g_0 \cdots g_t$.
- **Aggregate state variable:** Aggregate household wealth-to-income ratio \hat{W} , trend income growth rate g , business-cycle component z
- **Recursive Equilibrium:**
 - value function $\hat{V}(\hat{w}; \hat{W}, g, z)$ and corresponding policy functions $\hat{h}, \hat{a}, \hat{b}, \hat{c}^n, \hat{c}^m$
 - housing price function $\hat{p}(\hat{W}, g, z)$
 - LOM for aggregate wealth-to-income ratio $\hat{W}' = G(\hat{W}, g, Z, g', Z')$
- **such that:**
 - households make optimal decisions taking $\hat{p}(\hat{W}, g, z)$ and LOM as given
 - $\hat{p}(\hat{W}, g, z)$ clears housing market for all \hat{W}, g, z
 - LOM for \hat{W} consistent
- **Balanced growth path not enough:**
 - housing value grows at g , price of housing grows at $g^{\frac{1}{1+\epsilon}}$ on BGP
 - In the data, housing value grows faster than g !

Transition Dynamics from Low Initial Wealth



Transition Dynamics from Low Initial Wealth



Parameterization

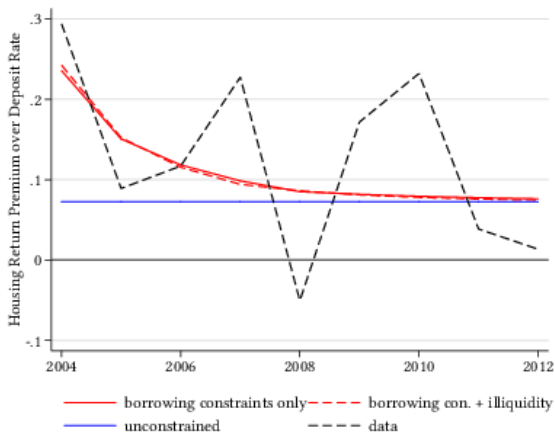
- EZ preference: Help generate high saving during high growth, by separating EIS from risk aversion (Choi, Lugauer and Mark, 2017)
 - $EIS = 1.5$ (Bansal and Yaron, 2004). $RRA = 2$ (Campbell and Cocco, 2015)
- Endowment process: $g \in \{g_H, g_L\}$.
 - $g_H = 12.5\%$ - sample mean urban growth, incl. migration. $\pi_{HL} = 0.05$
 - Set $g_L = 0 \rightarrow$ give best chance to alternative risk premium explanation
- Interest rate: $R_a = 0\%$. $R_b = 4\%$
- Borrowing constraint: $b_t \leq \phi(p_t)p_t h_t$
 - $\phi(p_t)/\bar{\phi}$: shortcut to capture old system homes difficult to borrow against
 - target fraction of new system homes in housing survey
 - $\bar{\phi}$: max LTV = 30% \rightarrow investment buyers
 - Model sensitive to tightness of borrowing constraint
 - \rightarrow Needs borrowing constraint to be quite tight to keep price low at beginning
- Emergency consumption shock:
 - target medical and unemployment risks in microdata

Quantitative Evaluation

Then:

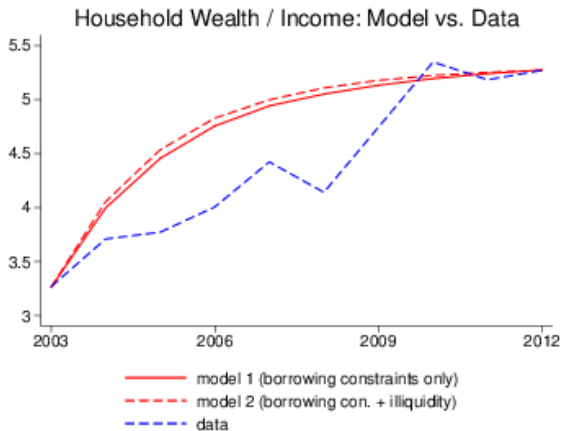
- ① Calibrate discount factor β to match observed evolution of aggregate household wealth-to-income ratio
 - Take initial wealth-to-income ratio from data.
 - Choose balanced growth path wealth-to-income ratio via discount factor β to match observed evolution in the wealth-to-income ratio
- ② Evaluate model fit on price, portfolio.
 - ① Model with borrowing constraint only
 - ② Model with borrowing constraint and illiquidity

Main Result: Model vs Observed Housing Return Premium



- Model generates on average 90% of trend price increase, return premium
- Borrowing constraints drive virtually all price dynamics [▶ volatility](#)

Model versus Observed Wealth Dynamics



- Model abstracting from heterogeneity, downpayment saving potentially key for reconciling wealth dynamics

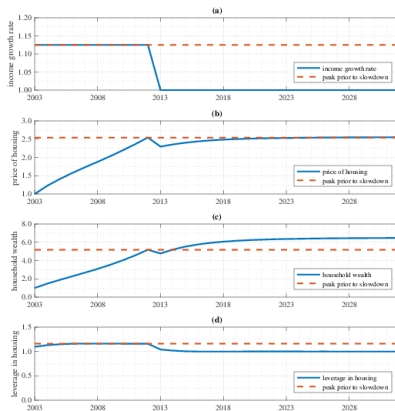
Model versus Observed Household Portfolio

Data	Housing/Wealth		Deposits/Wealth	
	2003	2012	2003	2012
	0.68	0.86	0.42	0.23
Borrowing constraint only	1.10	1.16	0.00	0.00
Borrowing con. + Illiquidity (RRA = 2)	1.05	1.08	0.03	0.07
Borrowing con. + Illiquidity (RRA = 5)	1.01	1.02	0.07	0.10

- With borrowing constraint only, optimal to fully invest in housing
- Illiquidity helps model generate as much as half of non-housing asset holding in the data

Prediction 1: Permanent Slowdown, Temporary Price Decline

- Intuitively, with trend growth uncertainty, a permanent growth slowdown \rightarrow a permanent drop in housing prices. Model says otherwise (**panel b**)

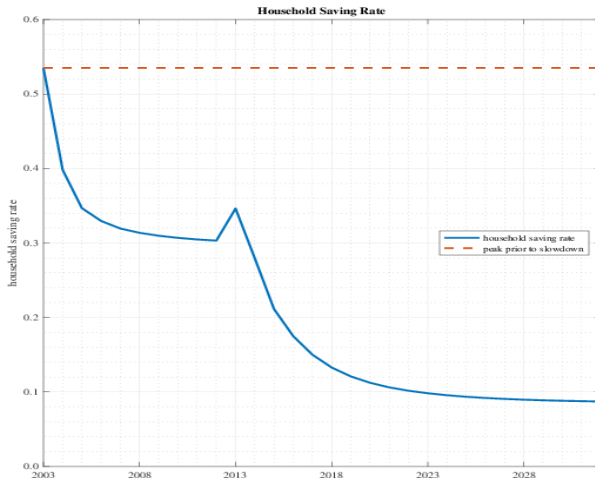


Prediction 2: High Unconstrained Value of Housing, Sensitive to Financial Returns

- Absent the constraints (and hold fixed income effect by holding aggregate household wealth at 2012 empirical level):
- If marginal buyer has a cost of funds of **0%** (“deep-pocketed saver”), value-to-income ratio is **15** in high-growth state, **8** in low-growth state
- If marginal buyer has a cost of funds of **4%** (“unconstrained borrower”), value-to-income ratio is **6** in high-growth state, **5** in low-growth state
- High housing value-to-income ratio relies on low financial asset returns

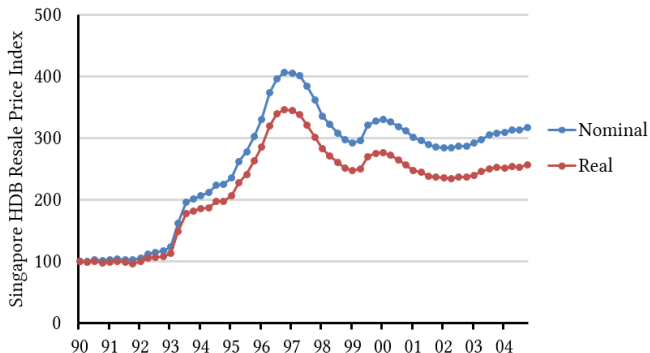
Prediction 3: A Transitionally High Saving Rate

- Transitional high return induce household to save more (in housing)
- Saving rate declines as wealth increases and as growth slows down



Qualitative Example beyond China: Case of Singapore

- Start of 1990s: Permanent residents and high-income citizens allowed for the first time to buy in secondary market for HDB apartments
- Model says real home price sustainedly increased for several years, because it takes time for eligible home buyers in Singapore to build up wealth



Conclusion

- Transition dynamics of household wealth from a low initial condition, coupled with liquidity constraints, provides a quantitatively plausible framework for understanding the Chinese housing boom
- This framework can potentially be applied to other emerging housing markets where there are liquidity constraints and households have low wealth
- Work in progress:
 - ① Indivisibility, downpayment saving and heterogeneity potentially important for reconciling model and data on: (1) speed of transition, and (2) portfolio holdings
 - ② Welfare and policy evaluation: monetary, purchase-restrictions
 - ③ Relaxing assumptions on expectations
 - ④ Interaction with entrepreneurial production: Decline in entrepreneurial returns and the “second wave” of housing market transitions

More regression results: Price vs Quantity

Dependent Variables	(1)	(2)	(3)	(4)
	Log(Home Price Index)	Log(Home Price Index)	Log(Total Value of Housing)	Log(Total Value of Housing)
Household Wealth Measures	(Incl. Housing)	(Excl. Housing)	(Incl. Housing)	(Excl. Housing)
	Net Worth	Bank Savings	Net Worth	Bank Savings
Log(Household Wealth)	0.604***	0.492***	1.107***	1.062***
Log(Income)	-0.0656	0.265***	0.0574	0.524***
Log(Population)	0.0871	0.187	-0.0301	0.128
Observations	990	990	990	990
Adjusted- R^2	0.94	0.89	0.99	0.99
Number of Cities	99	99	99	99
City FE	YES	YES	YES	YES

► back

Regression Robustness: More controls

	(1)	(2)	(3)	(4)
Dependent Variables	Log(Home Price Index)		Log(Total Value of Housing)	
	(Incl. Housing)	(Excl. Housing)	(Incl. Housing)	(Excl. Housing)
Household Wealth Measures	Net Worth	Bank Savings	Net Worth	Bank Savings
Log(Household Wealth)	0.624***	0.516***	1.104***	1.036***
Log(Income)	0.0322	0.296***	0.0508	0.466***
Log(Population)	0.0742	0.207	-0.0278	0.194
Log(RetailSales)	-0.0821	-0.0731	0.00476	-0.0259
Log(ElectricityUse)	-0.0141	0.0349	0.00292	0.0836*
Log(IndustryProfits)	-0.0156*	-0.00447	0.00126	0.0194
Observations	980	980	980	980
Adjusted- R^2	0.94	0.89	0.99	0.99
Number of Cities	98	98	98	98
City FE	YES	YES	YES	YES

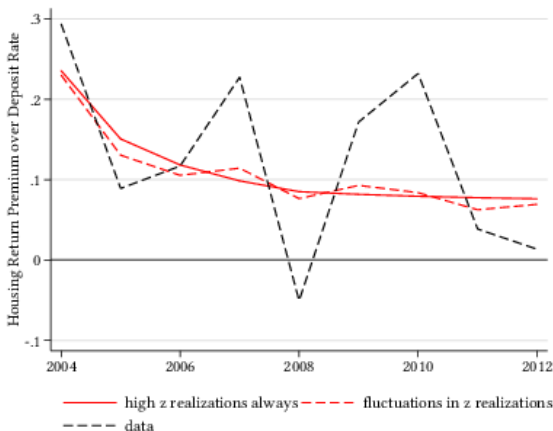
Regression Robustness: Excl. provinces with worse data

Dependent Variables	(1)	(2)	(3)	(4)
	Log(Home Price Index)		Log(Total Value of Housing)	
Household Wealth Measures	(Incl. Housing)	(Excl. Housing)	(Incl. Housing)	(Excl. Housing)
	Net Worth	Bank Savings	Net Worth	Bank Savings
Log(Household Wealth)	0.572***	0.426***	1.080***	0.965***
Log(Income)	-0.0187	0.346***	0.103	0.646***
Log(Population)	0.0588	0.111	-0.0553	0.0249
Observations	880	880	880	880
Adjusted- R^2	0.94	0.90	0.99	0.99
Number of Cities	88	88	88	88
City FE	YES	YES	YES	YES

► back

Fit on housing return premium: Short-run Fluctuations

- Model with liquidity constraints and a fluctuating time path of z generates too little volatility in housing return premium relative to the data
- but still performs better than the unconstrained model (not shown)



US: Model Implication and Empirical Results

Contrast to the United States:

Model implication: I should not find large comovement between household asset wealth and housing price in the United States, where both aggregate household wealth and financial asset returns are high

Results seem to be consistent with this implication:

	$\Delta \text{Log}(\text{MSAHousingPrice}_{2001-2006})$		
$\Delta \text{Log}(\text{BankDeposits} - \text{FDIC})$	-0.073 (0.077)		-0.091 (0.077)
$\Delta \text{Log}(\text{ImputedWealth} - \text{IRS})$		0.161 (0.120)	0.183 (0.121)
$\Delta \text{Log}(\text{Income} - \text{IRS})$	1.65*** (0.442)	1.28*** (0.473)	1.37*** (0.477)
$\Delta \text{Log}(\text{MortgageLoans} - \text{HMDA})$	0.441*** (0.087)	0.441*** (0.085)	0.466*** (0.088)
R^2	0.500	0.504	0.512
Observations	98	98	98

Asset Availability: Preliminary Empirical Results

- Does asset availability matter for the linkage between household savings and housing boom?
 - Measuring difference in asset availability across cities is challenging!
- Divide sample by (Book value local publicly-traded firms / citywide income)
- Linkage between household wealth growth and housing boom **stronger** with lower Ratio

Asset Availability: Growth in non-housing wealth and housing boom, 2003-2012, by Ratio

	$\Delta\text{Log}(\text{Housing MKV})_{2003-2012}$	
	Ratio \geq Median	Ratio $<$ Median
$\Delta\text{Log}(\text{Household Wealth})$	0.75** (0.33)	1.36*** (0.36)
R^2	0.10	0.23
Obs	50	49

Standard errors in parentheses. ** $p < 0.05$, *** $p < 0.01$