Real Effects of the ECB's Quantitative Easing: A Housing Portfolio Channel

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Motivation

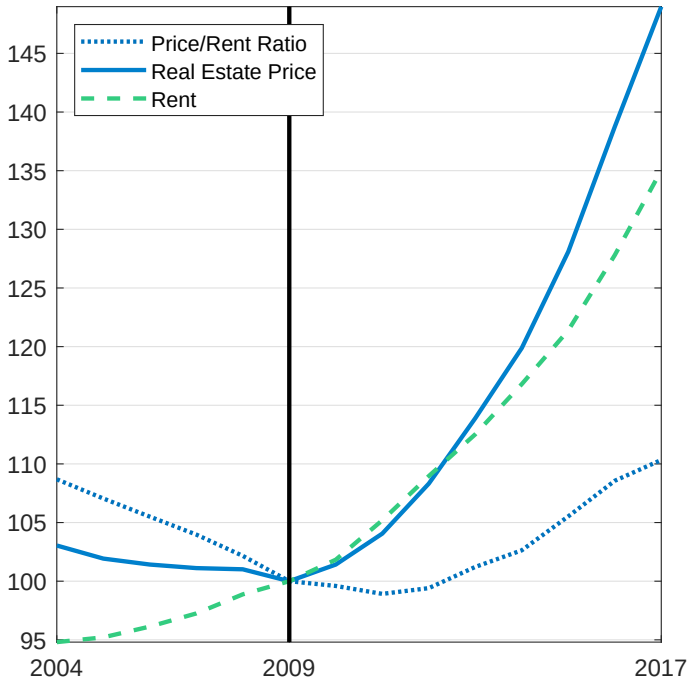
- Following the global financial crisis, advanced economy central banks have adopted new tools, the so-called unconventional monetary policies
  - Chiefly balance sheet expansion through long-term asset purchase programs (Quantitative Easing-QE)
  - In the case of the ECB, also negative deposit facility interest rate (Negative Interest Rate Policy, NIR)
- Time-honored questions on the transmission mechanism of monetary policy:
  - What are the effects on the objective and intermediate targets of monetary policy?
  - What are the mechanisms?
  - What is the role of the housing, credit, and financial markets in the transmission?

This paper

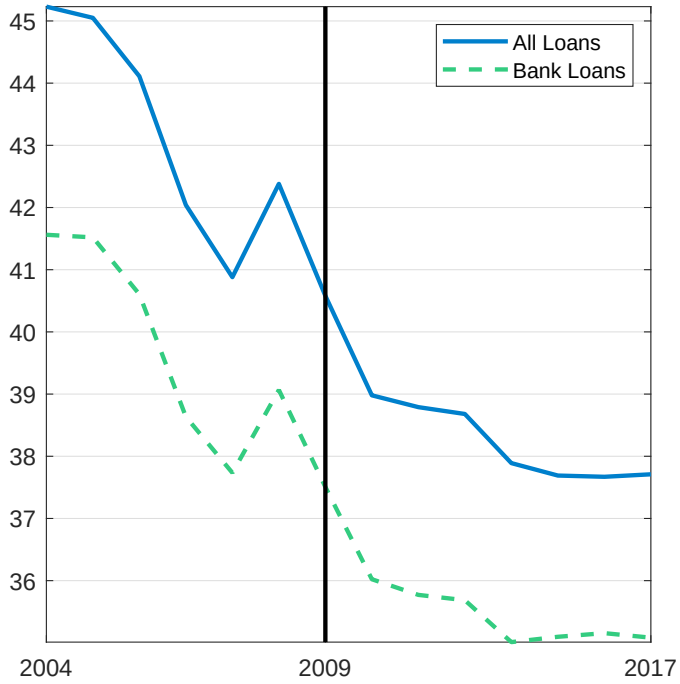
- Proposes a new housing portfolio channel of QE transmission that differs from traditional credit and collateral channels
  - QE lowers the net supply of bonds, depressing their returns
  - Portfolios rebalance toward housing (i.e., cash purchases to rent out for income), which bids up prices and lowers expected future housing returns if the two asset returns comove positively
  - Expected future portfolio return decline can stimulate current consumption and output
- Identifies this new channel in German region-level data and runs a horse race with the traditional collateral and credit channels
  - Exploits geographic variation in land scarcity to identify the real effects of QE on expected future housing returns and output growth across regions
  - For this purpose, we assembles a rich region-level data set on residential property prices and rents, land use and land cover, output, and other regional characteristics

Germany: a housing boom without credit boom

Panel A: Residential house price and rent indexes (2009=100)



B: Domestic housing credit to households (% GDP)



German household

German household portfolios loads heavily on housing as in other countries, but unlike the US they are not leveraged

- low home ownership
- low leverage
- high share of housing wealth in total assets or net worth

	2005	2010	2015	2019
Home Ownership Rate	0.53	0.53	0.52	0.51
Real Estate/Total Assets	0.53	0.55	0.55	0.56
Real Estate/Non-Financial Assets	0.97	0.97	0.98	0.98
Real Estate/Liquid Assets	1.18	1.27	1.28	1.31
Real Estate/Net Worth	0.64	0.65	0.64	0.64
Leverage (Loans/Total Assets)	0.17	0.15	0.13	0.12

Table: Household Balance Sheet Data

The German case is not unique

- Many other countries have underdeveloped household credit markets
- Episodes of housing booms without credit booms are not uncommon (Cerutti, Dell'Ariccia, and Dagher, 2017)

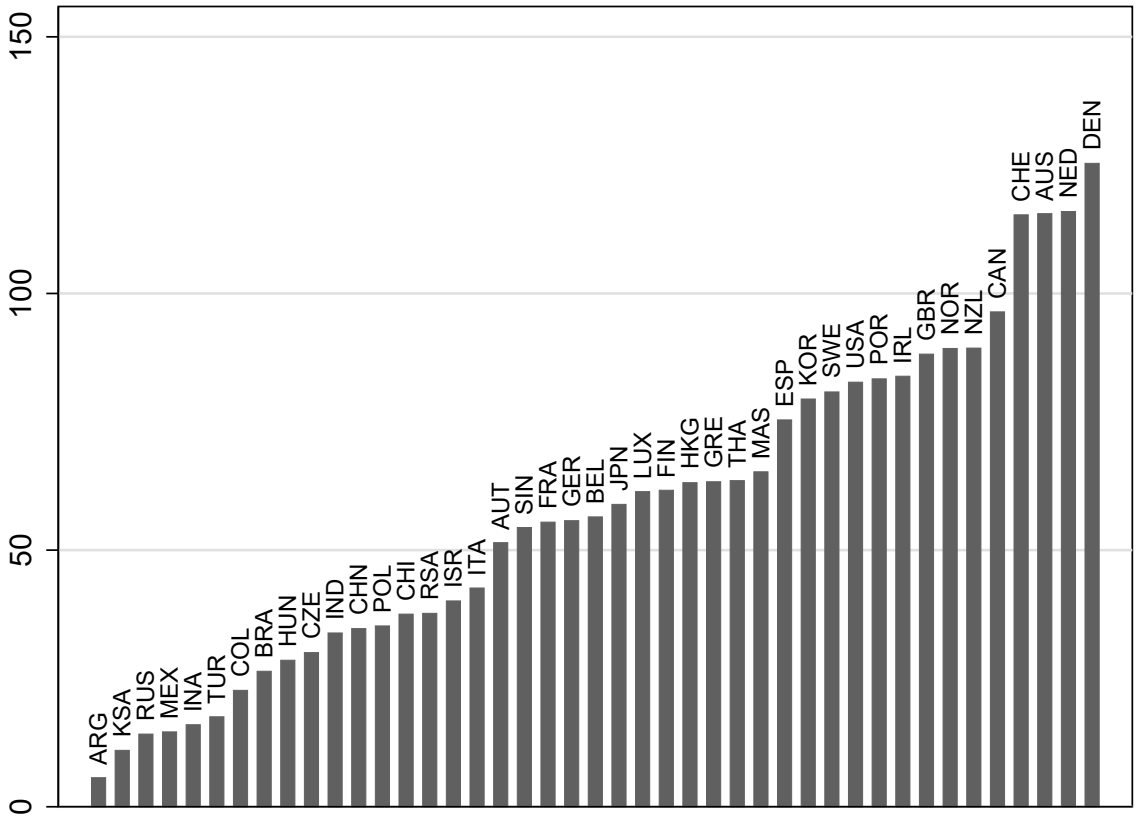


Figure: Household Credit as a Share of GDP: 2010-2017 Average (BIS)

Preview of results

1. Theoretically, we develop a simple housing portfolio model with segmented asset markets to guide the empirical analysis and identification

2. Empirically, we find that QE has a stronger impact on output growth in regions with more land scarcity and hence tighter housing supply, controlling for other channels and confounding factors
   - The estimated regional growth differential is sizable: **2-3%** between high vs. low exposed regions during 2010-2017
   - Mechanism: QE works through expected future housing returns, not through the credit market or collateral channels
   - Housing portfolio channel accounts for **60-80%** of total impact on the regional growth differential

Related literature

- **Unconventional monetary policy on bank and firm behavior and macroeconomic outcomes**
  - Kurtzman, Luck and Zimmermann (2017); Rodnyansky and Darmouni (2017); Chakaraborty, Goldstein, MacKinlay (2019); Acharya, Eisert, Eufinger and Hirsch (2019); Todorov (2020)
  - Altavilla, Burlon, Gianetti and Holton (2019); Bottero, Minoiu, Peydro, Polo, Presbitero and Sette (2019); Heider, Saidi and Schepens (2019); Bubeck, Maddaloni and Peydro (2020)
  - Eberly, Stock and Wright (2019); Luck and Zimmermann (2020); Fabo Jancoková, Kempf and Pástor (2021)

- **Literature on house prices, credit and household consumption**
  - Iacoviello (2005);
  - Chaney, Sraer and Thesmar (2012); Aladangady (2017); Chodorow-Reich, Novand and Simsek (2021)

- **Literature that views housing as a risky asset in household portfolios**
  - Flavin and Yamashita (2002); Yao and Zhang (2005); Cocco (2005); Cocco, Gomes and Maenhout (2005)
  - e.g., Vayanos and Vila (2021); in the international context, Greenwood et al. (2020); Maggiori (2021); Gabaix and Maggiori (2015)

- **Post-2009 German housing boom**
  - Le Blanc, Kindermann, Piazzesi, Schenider (2020), Bednarek, te Kaat, Ma and Rebucci (forthcoming);

Outline

- The model and its implications
- Reduced form estimates
- Inspecting the mechanism
- Conclusions

Model

Model has two blocks

- **Real block**: A representative household solves a standard consumption/saving problem
  - Household saves s given a total portfolio return r
  - Return r is determined by the equilibrium in financial markets (delegated investment)
  - Think about this household as the representative citizen of a German city (this version only one region; extension to multiple regions straightforward)
  - Similarly, for simplicity, we focus on consumption c, but link to output easily introduced with endogenous production
- **Financial market block** combines housing portfolio literature (Flavin and Yamashita, 2002) with preferred-habitat literature (e.g., Vayanos and Vila, 2021)

Real block

Consumption/saving problem

$$\max_{s} u(c) + \beta u(c'), \quad \text{s.t. } c + s = w \quad \text{and} \quad c' = (1+r)s \tag{1}$$

Optimality requires

$$u'(c) - \beta(1+r)u'((1+r)(w-c)) = 0 \tag{2}$$

One can easily see that

$$\frac{dc}{dr} = \frac{\beta u'(c') + \beta(1+r)u''(c')(w-c)}{u''(c) + \beta(1+r)^2 u''(c')} \tag{3}$$

- Denominator always negative
- For CRRA utility with risk aversion σ, numerator given by $(1-\sigma)\beta c'^{-\sigma}$
- Consumption increases when saving return falls if intertemporal elasticity of substitution is high enough (i.e., $\frac{dc}{dr} < 0$ iff $\sigma < 1$)

Financial market block

- Two risky assets: houses and long-term bonds
  - Houses with price P and pays off $\mu_1 + \epsilon_1$
  - Bonds with price Q and pays off $\mu_2 + \epsilon_2$
  - Assumption: $E[\epsilon_1] = E[\epsilon_2] = 0$, $Var(\epsilon_1) = \sigma_1^2$, $Var(\epsilon_2) = \sigma_2^2$ and $Cov(\epsilon_1, \epsilon_2) = \sigma_{12}$
- Three agents: two preferred-habitat investors and one national arbitrager
  - *Local* preferred-habitat investor in city housing market with demand: $\tilde{h} = -\alpha_1(P - \beta_1)$
  - *National* preferred habitat investors in bond market with demand: $\tilde{b} = -\alpha_2(Q - \beta_2)$
  - National arbitrager trades in all markets with mean-variance preferences

Financial market block (Cont.)

A national intermediary (e.g., a bank, hedge fund, mutual fund, ETF or a REIT) trades two assets, houses (h) and bonds (b), has access to a storage technology (x) and solves the following mean-variance portfolio problem:

$$\max_{h,b,x} \quad h\mu_1 + b\mu_2 + x - \frac{\gamma}{2}(h^2\sigma_1^2 + b^2\sigma_2^2 + 2hb\sigma_{12}) \tag{4}$$

$$\text{s.t.} \qquad W = hP + bQ + x, \quad \text{with multiplier } \lambda \tag{5}$$

Optimality requires

$$\lambda P = \mu_1 - \gamma h\sigma_1^2 - \gamma b\sigma_{12} \tag{6}$$

$$\lambda Q = \mu_2 - \gamma b\sigma_2^2 - \gamma h\sigma_{12} \tag{7}$$

$$\lambda = 1 \tag{8}$$

And market clearing is

$$b + \tilde{b} = \bar{b} \tag{9}$$

$$h + \tilde{h} = \bar{h} \tag{10}$$

Financial market impact of QE

- The equilibrium conditions above can be solved for $\{h, \tilde{h}, b, \tilde{b}, P, Q\}$ with comparative statistics given by

$$\frac{db}{d\bar{b}} = \frac{(1/\alpha_1 + \gamma\sigma_1^2)/\alpha_2}{(1/\alpha_1 + \gamma\sigma_1^2)(1/\alpha_2 + \gamma\sigma_2^2) - \gamma^2\sigma_{12}^2} > 0$$

$$\frac{dQ}{d\bar{b}} = \frac{1}{\alpha_2}\left(\frac{db}{d\bar{b}} - 1\right) = \frac{1}{\alpha_2}\frac{-(1/\alpha_1 + \gamma\sigma_1^2)\gamma\sigma_2^2 + \gamma\sigma_2^2}{(1/\alpha_1 + \gamma\sigma_1^2)(1/\alpha_2 + \gamma\sigma_2^2) - \gamma^2\sigma_{12}^2} < 0$$

$$\frac{dh}{d\bar{b}} = \frac{-\gamma\sigma_{12}/\alpha_2}{(1/\alpha_1 + \gamma\sigma_1^2)(1/\alpha_2 + \gamma\sigma_2^2) - \gamma^2\sigma_{12}^2}$$

$$\frac{dP}{d\bar{b}} = \frac{1}{\alpha_1}\frac{dh}{d\bar{b}}$$

- **Proposition 1:** A reduction in the net-supply of bonds, $\bar{b}$, (a QE intervention) increases demand for houses and their prices (i.e., $\frac{dh}{d\bar{b}} \leq 0$ and $\frac{dP}{d\bar{b}} \leq 0$) if and only if housing and bond returns are positively correlated ($\sigma_{12} \geq 0$)

Real impact of QE

- QE affects consumption through its impact on the household return on wealth, r
- Assume r is a weighted average of the housing and bond yields offered by the financial industry, with weights given by the financial intermediary's portfolio weights (delegated investing): $r = h\mu_1 + b\mu_2$
  - Here, for simplicity, returns exclude capital gains but result holds including capital gains
- **Proposition 2.** As long as σ_{12} is positive and sufficiently low, QE lowers household portfolio returns:

$$\frac{dr}{d\bar{b}} > 0 \;\; iff \;\; \sigma_{12} < \frac{\mu_2}{\mu_1}\left(\frac{1}{\gamma\alpha_1} + \sigma_1^2\right),$$

- And hence increases consumption if IES high enough (i.e., $\frac{dc}{dr} < 0$ iff $\sigma < 1$)

Model predictions about a QE intervention ($\bar{b}$ declines)

Following QE, bond supply to private sector ($\bar{b}$) drops

- Bond holding goes down, bond price increases, and return falls
- House holdings (of financial intermediary) and prices also increase with expected return falling
- Overall household portfolio return decreases
- Consumption and hence output increase
- The tighter the housing supply, i.e., the lower $\bar{h}$, the stronger the consumption response (we need to specific portfolio return inclusive of capital gains to show this)
- For identification purposes, we explore this channel in a cross section of German urban and rural areas (called regions)
- Use rental yields as proxy for expected housing returns (more on this)
- Identification using geographic variation

Empirical Analysis

Data

- Matched data on output, residential property prices and rents, land cover and land use based on a common region identifier (Gemeindekennziffer); Annual frequency, from 2010 to 2017 covering all 401 urban and rural regions
- Policy variables are the EONIA rate and alternative measures of the ECB balance sheet over nominal GDP for QE
- Land cover and land use from German Monitor of Settlement and Open Space Development (IOER Monitor)
- Residential price and rent indexes from Bulwiengesa: average of new and existing apartments, based on transaction and valuation data
  - We use rental yields as predictor of housing returns
  - Aggregate data on total housing returns, inclusive of capital gain component, are from the Macro-history Database of Jorda et al. (2017, 2019)

Present value identity for housing (e.g., Cochrane, 2011)

- Accounting identity implies that

$$dp_t \approx \sum_{j=1}^{k} \rho^{j-1} r_{t+j} - \sum_{j=1}^{k} \rho^{j-1} \Delta d_{t+j} + \rho^k dp_{t+k} \tag{11}$$

  - where the current rental yield $dp_t \equiv d_t - p_t = \log(D_t/P_t)$, $r_t \equiv \log R_t$ is the log housing return, Δd_t is the log rent growth and ρ is a constant of approximation
  - We decompose the components by running the following regressions

$$\sum_{j=1}^{k} \rho^{j-1} r_{t+j} = a_r + b_r^k \times dp_t + \varepsilon_{t+k}^r \tag{12}$$

$$\sum_{j=1}^{k} \rho^{j-1} \Delta d_{t+j} = a_d + b_{\Delta d}^k \times dp_t + \varepsilon_{t+k}^{\Delta d} \tag{13}$$

$$dp_{t+k} = a_{dp} + b_{dp}^k \times dp_t + \varepsilon_{t+k}^{dp}. \tag{14}$$

Current rental yields predict housing returns in Germany during 1963-2009

	Future Housing Returns				Future Div. Growth				Future Rent/Price Ratio			
	Obs.	b_r^k	SE	R^2	Obs.	$b_{\Delta d}^k$	SE	R^2	Obs.	$\rho^k\ b_{dp}^k$	SE	R^2
k=1	47	0.04	0.04	0.03	47	-0.09	0.02	0.36	47	1.00	0.03	0.95
k=5	43	0.32	0.16	0.09	43	-0.31	0.09	0.23	43	0.78	0.13	0.58
k=10	38	0.84	0.25	0.23	38	-0.29	0.17	0.07	38	0.56	0.23	0.28
k=15	33	1.82	0.28	0.57	33	0.13	0.21	0.01	33	0.00	0.35	0.00

- A large fraction of variation in expected returns comes from rental yield variance at long horizons (e.g., k=10)
- A significantly smaller fraction corresponds to variation in expected rent growth or future price-to-rent ratios
- **We use the current rental yield as a proxy for expected housing returns** (as long-run estimate close to 1 and multiplying a variable by a constant does not affect its effect in the estimating regression)

Empirical strategy

- Identification by geographic variation: consistent with our model's predictions, the impact of QE on output growth should be higher in regions in which real estate supply is tighter (as captured by land scarcity)

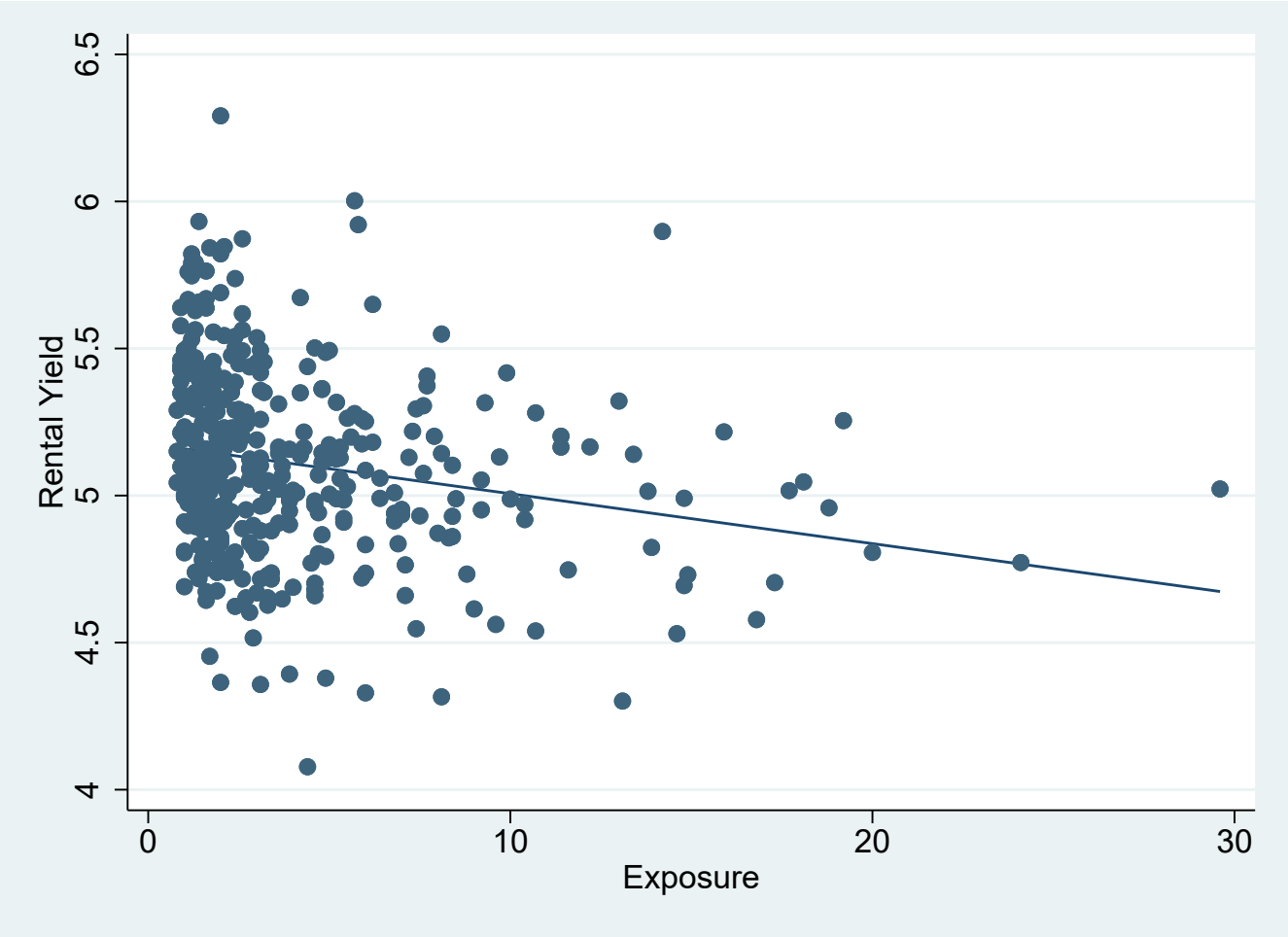
- Regional real estate supply proxied by land scarcity: land covered by water bodies and urban open space

  - Consistent with traditional indicators of supply-side elasticity in the spirit of Saiz (2010) and Hilber and Vermeulen (2016)
  - To control for a possible endogenous response of land use regulation, we evaluate land scarcity at the pre-sample value in 2008

Alternative land supply scarcity indicators and regional rental yields

	Regional Rental Yields		
	All regions	West	East
Open Space	0.17 (0.00)	0.14 (0.01)	0.15 (0.19)
of which:			
Water	-0.18 (0.00)	-0.22 (0.00)	-0.19 (0.10)
Agriculture	0.01 (0.91)	-0.03 (0.64)	0.02 (0.84)
Forest	0.19 (0.00)	0.20 (0.00)	0.17 (0.14)
Other Open Space	-0.04 (0.48)	-0.04 (0.53)	-0.14 (0.23)
Urban Open Space	-0.15 (0.00)	-0.14 (0.01)	-0.15 (0.19)
Land scarcity, Exposure	-0.21 (0.00)	-0.22 (0.00)	-0.22 (0.05)

Exposure and rental yields



NOTE. The correlation coefficient is equal to -21% with a p value of 0.

Reduced form results

	(1) ΔGDP	(2) ΔGDP	(3) ΔGDP	(4) ΔGDP	(5) ΔGDP	(6) ΔGDP	(7) ΔGDP	(8) ΔGDP
$\text{Exposure}_{r,2008} \times \text{EONIA}_t$	-0.068**		-0.015	-0.406	-0.050	-0.010	-0.026	-0.016
	(0.030)		(0.039)	(0.301)	(0.054)	(0.039)	(0.045)	(0.039)
$\text{Exposure}_{r,2008} \times \text{QE}_t$		0.007***	0.006***	0.008***	0.006*	0.006***	0.008***	0.007***
		(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)
$\text{Exposure}_{r,2008} \times \text{QE}_t \times \text{EONIA}_t$				0.013				
				(0.010)				
$\text{Pop. Dens}_{r,2008} \times \text{EONIA}_t$					0.000			
					(0.000)			
$\text{Pop. Dens}_{r,2008} \times \text{QE}_t$					0.000			
					(0.000)			
$\text{Age above 65}_{r,2008} \times \text{EONIA}_t$						-0.112		
						(0.069)		
$\text{Age above 65}_{r,2008} \times \text{QE}_t$						0.001		
						(0.005)		
$\text{Agriculture}_{r,2008} \times \text{EONIA}_t$							-0.006	
							(0.013)	
$\text{Agriculture}_{r,2008} \times \text{QE}_t$							0.001	
							(0.001)	
$\text{Permits}_{r,2008} \times \text{EONIA}_t$								-0.033
								(0.109)
$\text{Permits}_{r,2008} \times \text{QE}_t$								-0.003
								(0.002)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	3208	3208	3208	3136	3208	3208	3208	3208
R^2	0.264	0.265	0.265	0.266	0.266	0.266	0.266	0.266

- **Econometric specification** (as in Chaney, Sraer and Thesmar 2012; Aladangady 2017)

$$\Delta GDP_{r,t} = \alpha_r + \alpha_t + \gamma \cdot (\text{EONIA}_t \times \text{Exposure}_r) + \beta \cdot (\text{QE}_t \times \text{Exposure}_r) + \varepsilon_{r,t}$$

Economic significance and additional robustness checks

- **Economic significance:** more exposed regions (at the 75th percentile of the distribution) grew 10-20 bps more per year than less exposed ones (25th percentile) given a 6.5 pp (one-sd) increase in QE (1-2 percentage points cumulative growth differential during the sample period)

- Results robust to controlling for other macroeconomic variables (fiscal policy, financial uncertainty etc.) ▸ robustness

- Interact all regressors with NIR dummy - no statistically significant difference during NIR period

- Most importantly, results are robust to using alternative QE proxies, i.e., total debt securities, private debt securities, government debt securities and financial debt securities as a share of nominal GDP

Mechanism: Controlling for rental yield turns QE insignificant

	(1) ΔGDP	(2) ΔGDP	(3) ΔGDP	(4) ΔGDP	(5) ΔGDP	(6) ΔGDP	(7) ΔGDP	(8) ΔGDP	(9) ΔGDP
$\text{Exposure}_{r,2008} \times \text{EONIA}_t$	0.181**	0.109*	0.003	0.006	0.106	0.185**	0.153	0.183**	0.173*
	(0.088)	(0.064)	(0.038)	(0.042)	(0.082)	(0.088)	(0.100)	(0.088)	(0.089)
$\text{Exposure}_{r,2008} \times \text{QE}_t$	0.003	0.004	0.008***	0.003	0.002	0.003	0.004*	0.001	0.004
	(0.002)	(0.002)	(0.002)	(0.005)	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)
$\text{Exposure}_{r,2008} \times \text{Rental Yield}_t$	-0.307***					-0.221	-0.249*	-0.292***	-0.441*
	(0.109)					(0.144)	(0.134)	(0.111)	(0.255)
$\text{Exposure}_{r,2008} \times \text{Term Spread}_t$		-0.097**				-0.046			
		(0.039)				(0.051)			
$\text{Exposure}_{r,2008} \times \Delta Credit$			0.004**				0.002		
			(0.002)				(0.002)		
$\text{Exposure}_{r,2008} \times \text{Mortgage Rate}_t$				-0.052				-0.029	
				(0.057)				(0.057)	
$\text{Exposure}_{r,2008} \times \text{National HP Index}_t$					0.005*				-0.004
					(0.003)				(0.007)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	3208	3208	3208	3208	3208	3208	3208	3208	3208
R^2	0.267	0.267	0.266	0.266	0.266	0.267	0.267	0.267	0.267

- National rental yields as proxy for expected housing returns

Mechanism: Decomposing the channels

	(1) Rental Yield	(2) Term Spread	(3) ΔCredit	(4) Mortgage Rate	(5) National HP Index
QE_t	-0.044***	-0.069***	-0.334*	-0.076***	1.076***
	(0.004)	(0.010)	(0.192)	(0.010)	(0.087)
Obs	96	96	96	96	96
R^2	0.546	0.287	0.024	0.306	0.554

- QE predicts all aggregate mediating variables, except for credit growth
- Based on column (1) of previous slide: 82% of QE impact can be explained by changes in rental yield, 18% are unexplained
  (Direct effect: (-0.044)*(-0.307)=0.0135; unexplained effect: 0.003; hence, we explain 0.0135/(0.0135+0.003)=82%)
- Based on column (6) of previous slide: 61% of QE impact can be explained by changes in rental yield, 20% by flattening of yield curve, 19% are unexplained
- In all other specifications, we explain 77-100% through our housing portfolio channel

Instrumental Variables: 2SLS

- Previous regressions employ rental yields for Germany as a whole
- We next use our **region-level** rental yield data set to show that QE affects output growth via changes in regional rental yields

Econometric specification: (e.g. Chaney, Sraer and Thesmar 2012; Bednarek, te Kaat, Ma and Rebucci, forthcoming)

$$\begin{aligned} \Delta GDP_{r,t} &= \alpha_r + \alpha_t + \beta \cdot \text{Rental Yield}_{r,t} + \varepsilon_{r,t} \\ \text{Rental Yield}_{r,t} &= \alpha_r + \alpha_t + \gamma \cdot (\text{QE}_t \times \text{Exposure}_r) + \eta_{r,t} \end{aligned}$$

where r and t stand for region r and year t

IV: QE affects output growth by reducing region-level rental yields

	1st stage	2nd stage
	(1)	(2)
	Rental Yield	ΔGDP
Exposure$_{r,2008}$ $\times$ QE$_t$	-0.001***	
	(0.000)	
Rental Yield$_{r,t}$		-7.407**
		(3.479)
Time FE	Yes	Yes
Region FE	Yes	Yes
Obs	3208	3208
F-Stat (1st stage)	13.3	-

Mechanism: Cross-regional analysis

	West	East	rich	poor	high pop. density	low pop. density
	(1) ΔGDP	(2) ΔGDP	(3) ΔGDP	(4) ΔGDP	(5) ΔGDP	(6) ΔGDP
$\text{Exposure}_{r,2008} \times \text{EONIA}_t$	0.010	-0.068	-0.031	-0.017	-0.013	-0.451*
	(0.046)	(0.084)	(0.045)	(0.114)	(0.040)	(0.264)
$\text{Exposure}_{r,2008} \times \text{QE}_t$	0.008***	0.003	0.008***	0.006	0.006**	0.002
	(0.003)	(0.004)	(0.003)	(0.007)	(0.003)	(0.012)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	2592	616	1581	1610	2400	808
R^2	0.264	0.283	0.282	0.290	0.268	0.253

- Consistent with household portfolio channel, we see a stronger impact of QE in more densely populated regions with wealthier residents

Conclusions

- We propose a housing portfolio channel of quantitative easing
  - show its plausibility in a simple model with housing portfolio and asset segmentation
  - provide supporting empirical evidence using German region-level data

- Empirically, regions in which housing supply is less elastic respond more to QE
  - We estimate that German regions at the 75th percentile of the exposure distribution grow 2-3 percentage points more than regions at the 25th percentile cumulatively during 2010-2017.
  - Controlling for expected housing returns turns QE insignificant
  - Other channels (credit and collateral channels) quantitatively less important for our results
  - Housing portfolio channel accounts for 60-80% of total impact on the regional growth differential

THANK YOU!

Additional Material

Traditional setup

Consider an alternative setup with housing and bond as follows.

$$\begin{aligned} & \max_{c,h,b} u(c,h) + \beta u(c') \\ \text{s.t.} \quad & c + hP + bQ = w, (\lambda) \\ & c' = (1+r)b \end{aligned}$$

The optimality condition implies that

$$\lambda = u_1(c,h) \tag{15}$$
$$P\lambda = u_2(c,h) \tag{16}$$
$$Q\lambda = \beta(1+r)u'(c') \tag{17}$$

Market clearing: $h = \bar{h}$ and $b = \bar{b}$

Equilibrium conditions

Plugging all equilibrium conditions into the period-1 budget constraint we have:

$$F(c,\bar{b}) \equiv c + \bar{h}\frac{u_2(c,\bar{h})}{u_1(c,\bar{h})} + \bar{b}\frac{\beta(1+r)u'((1+r)\bar{b})}{u_1(c,\bar{h})} - w = 0 \tag{18}$$

By the implicit function theorem we have:

$$\frac{dc}{d\bar{b}} = -\frac{F_2(c,\bar{b})}{F_1(c,\bar{b})} \tag{19}$$

We standard preferences we have $F_1(c,\bar{b}) > 0$

Therefore, if $F_2(c,\bar{b}) > 0$, then $\frac{dc}{d\bar{b}} < 0$, i.e. QE increases consumption

The latter holds if $\sigma < 1$ for CRRA utility

Comparison with our set up

Three key differences

- Decouple IES ($1/\sigma$) that controls intertemporal consumption smoothing, from risk aversion (γ in our model) that matters for asset pricing in a simple manner

- Separate home ownership from housing as asset (REITs investing): German households cannot add rooms to their apartments following QE!
- Testable predictions for household portfolio shares

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Reduced form results: robustness

	(1) ΔGDP	(2) ΔGDP	(3) ΔGDP	(4) ΔGDP	(5) ΔGDP
$\text{Exposure}_{r,2008} \times \text{EONIA}_t$	0.005	0.035	0.042	0.028	
	(0.064)	(0.080)	(0.048)	(0.044)	
$\text{Exposure}_{r,2008} \times \text{QE}_t$	0.007**	0.007***	0.004*	0.005*	
	(0.003)	(0.002)	(0.002)	(0.002)	
$\text{Exposure}_{r,2008} \times \text{GIPS Spread}_t$	-0.004				
	(0.009)				
$\text{Exposure}_{r,2008} \times \text{VIX}_t$		-0.007			
		(0.005)			
$\text{Exposure}_{r,2008} \times \text{Gov. Lending}_t$			0.025**		
			(0.012)		
$\text{Exposure}_{r,2008} \times \text{Gov. Cons.}_t$				-0.032**	
				(0.015)	
$\text{Exposure}_{r,2008} \times \text{EONIA Shock}_t$					0.008*
					(0.004)
$\text{Exposure}_{r,2008} \times \text{QE Shock}_t$					0.003*
					(0.002)
Time FE	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes
Obs	3208	3208	3208	3208	3208
R^2	0.265	0.266	0.267	0.267	0.264

Reduced form results: robustness (2)

	(1) ΔGDP	(2) ΔGDP	(3) ΔGDP	(4) ΔGDP	(5) ΔGDP
$\text{Exposure}_{r,2008} \times \text{EONIA}_t$	-0.015	0.035	0.037	0.021	0.023
	(0.039)	(0.059)	(0.059)	(0.057)	(0.055)
$\text{Exposure}_{r,2008} \times \text{QE}_t$	0.039***				
	(0.015)				
$\text{Exposure}_{r,2008} \times \text{QE(TOTAL DEBT)}_t$		0.051**			
		(0.023)			
$\text{Exposure}_{r,2008} \times \text{QE(GOV. DEBT)}_t$			0.052**		
			(0.023)		
$\text{Exposure}_{r,2008} \times \text{QE(FIN. DEBT)}_t$				0.044**	
				(0.022)	
$\text{Exposure}_{r,2008} \times \text{QE(PRIVATE DEBT)}_t$					0.047**
					(0.022)
Time FE	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes
Obs	3208	3208	3208	3208	3208
R^2	0.265	0.265	0.265	0.265	0.265

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