When Does Monetary Policy Sway House Prices? A Meta-Analysis

Dominika Ehrenbergerova, Josef Bajzik, Tomas Havranek
Charles University Prague
Czech National Bank

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Presentation Overview

Motivation

Monetary policy does have an effect on house prices. But what is the size of the effect?

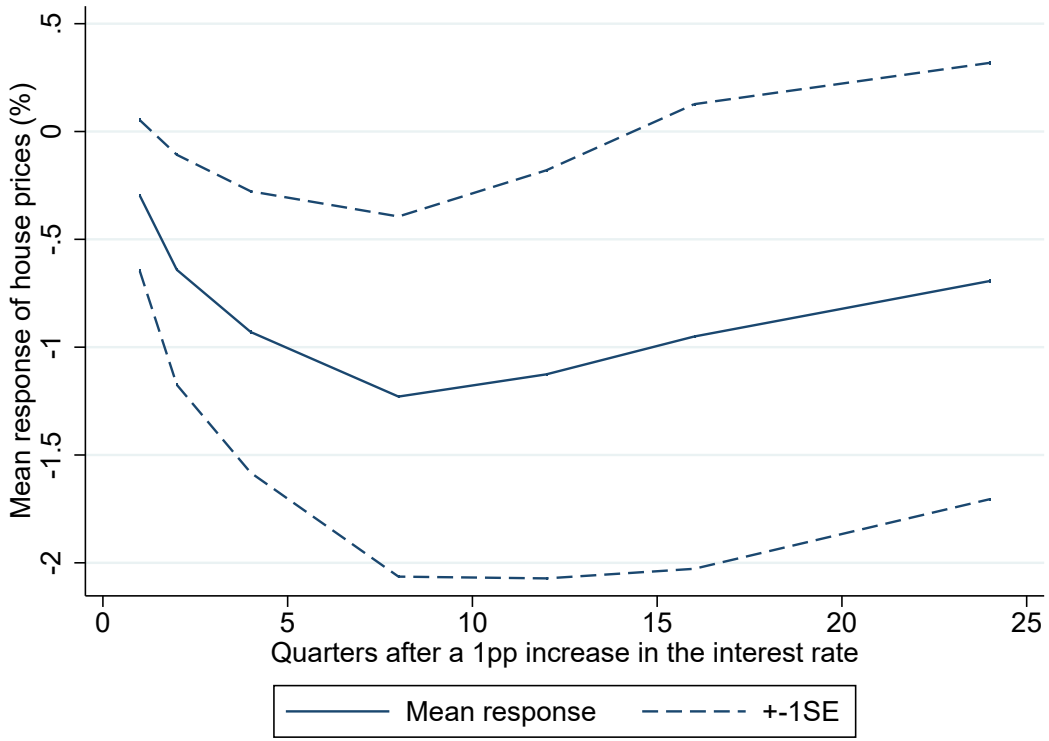
- There are many studies available but systematic overview is missing.
- To conduct a meta-analysis and collect all studies available.
- What is the mean effect reported in rich empirical literature?
- Is there publication bias among the published results?
- What is the effect beyond bias (after correcting for publication bias)?
- What drives heterogeneity found in the empirical literature?
- Implied estimates.

Process of data collection

- We collect studies as comprehensively as possible while comparable.
- We collect impulse responses from VAR models – the most frequently used approach to estimate the transmission of MP.
- Decision rules whether to include a study:
  - Interest rates are used as a monetary policy variable.
  - We only collect studies using house prices in levels, not growth rates.
  - CI are reported so that a standard error can be extracted.
  - We use pixel coordinates to collect the point estimates from figures.
- We collect 1447 observations from 31 studies, both journals and WP.
  - Responses on short-term horizon (1 and 2 Q), medium-term horizon (4 and 8 Q), and long-term horizon (12 and 16 Q, and max. horizon).
  - Around 220 observations for each horizon .
- Estimates are standardized to 1pp increase in interest rate.
- Moreover, 39 control variables collected.

Mean response implied by the literature

- Intuitive response: negative, significant up to 16 quarters.
- The impulse response bottoms out after two years at a 1.2% decrease in house prices following a 1pp increase in the policy rate.



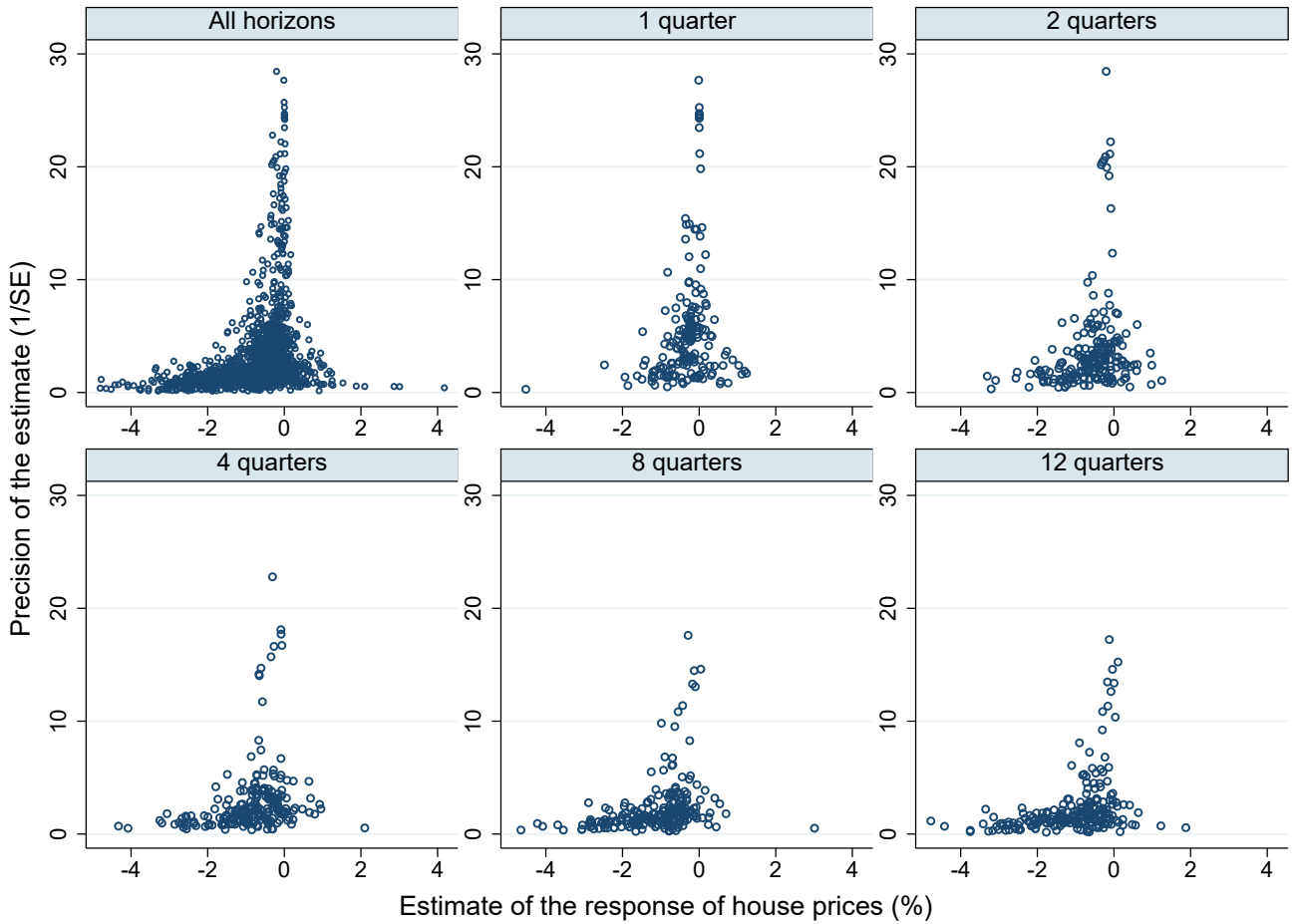
Publication bias

Is the mean effect reported in the literature the "true effect"?
Or is there publication bias which stems from the selective reporting of results based on sign or significance?

- *At a Carnegie-Rochester conference a few years back, Ben Bernanke presented an empirical paper, in which the conclusions nicely lined up with a priori reasoning about monetary policy. Christopher Sims then asked him, whether he would have presented the results, had they turned out to be at odds instead. His half-joking reply was, that he presumably would not have been invited if that had been so. There indeed is the danger (or is it a valuable principle?) that a priori economic theoretical biases filter the empirical evidence that can be brought to the table in the first place.* (Uhlig, 2012, p. 38, emphasis added).
- Discarding near-zero and imprecise estimates but reporting large and imprecise estimates.

Funnel Plot

- In the absence of publication bias, a funnel is symmetrical; reported estimates dispersed randomly around the true effect.



Funnel asymmetry test

$$X_{ij} = \beta_0 + \beta_1 SE_{ij} + \epsilon_{ij} \quad (1)$$

where X_{ij} is an estimated effect i from study j and SE is its standard error.

	Horizon					
	1Q	2Q	4Q	8Q	12Q	16Q
OLS						
Bias	-0.751***	-1.099***	-1.280***	-0.990***	-0.451	-0.281
	(0.238)	(0.378)	(0.456)	(0.288)	(0.281)	(0.182)
Effect	-0.034	-0.055	-0.094	-0.402**	-0.699***	-0.648***
	(0.074)	(0.189)	(0.256)	(0.175)	(0.202)	(0.167)
Weighted by the inverse of the standard error						
Bias	-0.838***	-0.853***	-1.036***	-1.078***	-0.879***	-0.659***
	(0.165)	(0.148)	(0.204)	(0.214)	(0.250)	(0.197)
Effect	-0.004	-0.186***	-0.254***	-0.329***	-0.294**	-0.241**
	(0.012)	(0.051)	(0.064)	(0.100)	(0.135)	(0.112)
Observations	208	211	221	221	216	211

- Publication bias is significant across all horizons.
- Publication bias shrinks the true effect markedly.
- For medium-term the effect remains significant beyond bias.

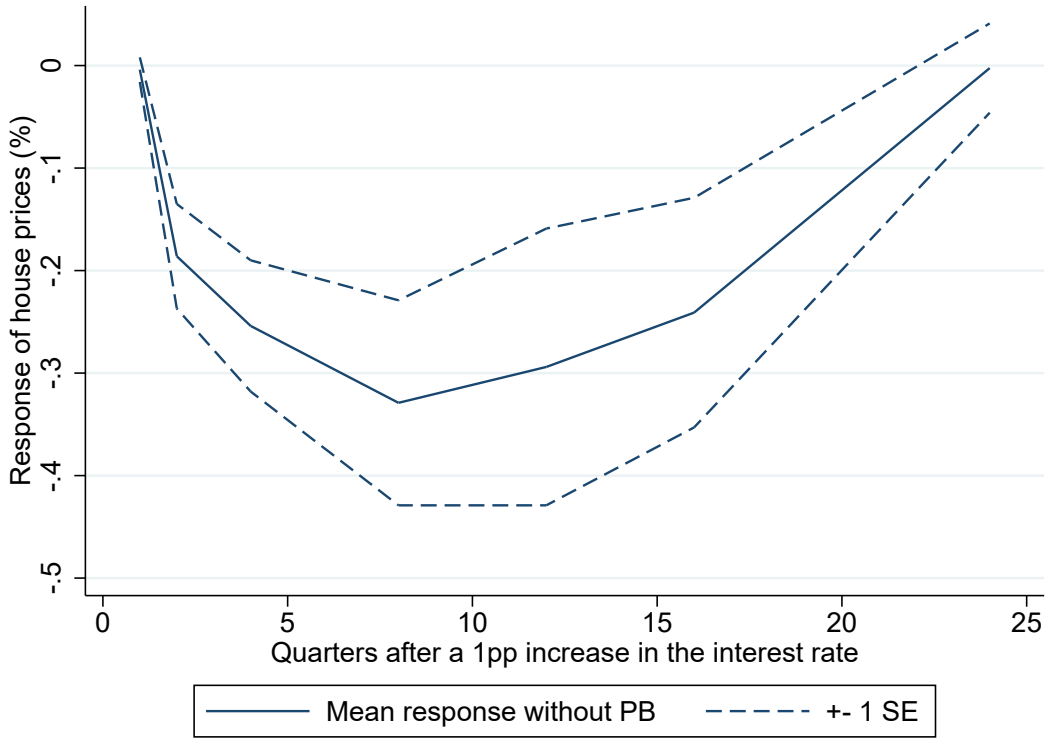
Non-linear tests of publication bias

	Horizon					
	1Q	2Q	4Q	8Q	12Q	16Q
Stem-based method (Furukawa, 2019)						
Effect	-0.006	-0.208***	-0.303***	-0.324**	-0.171	-0.120
	(0.009)	(0.081)	(0.131)	(0.165)	(0.133)	(0.089)
Selection model (Andrews and Kasy, 2019)						
Effect	-0.112**	-0.190	-0.364***	-0.447***	-0.325**	-0.041
	(0.052)	(0.274)	(0.064)	(0.124)	(0.134)	(0.028)
P-uniform* (van Aert and van Assen, 2021)						
Effect	-0.181***	-0.126***	-0.144***	-0.137***	-0.122***	-0.093***
Observations	208	211	221	221	216	211

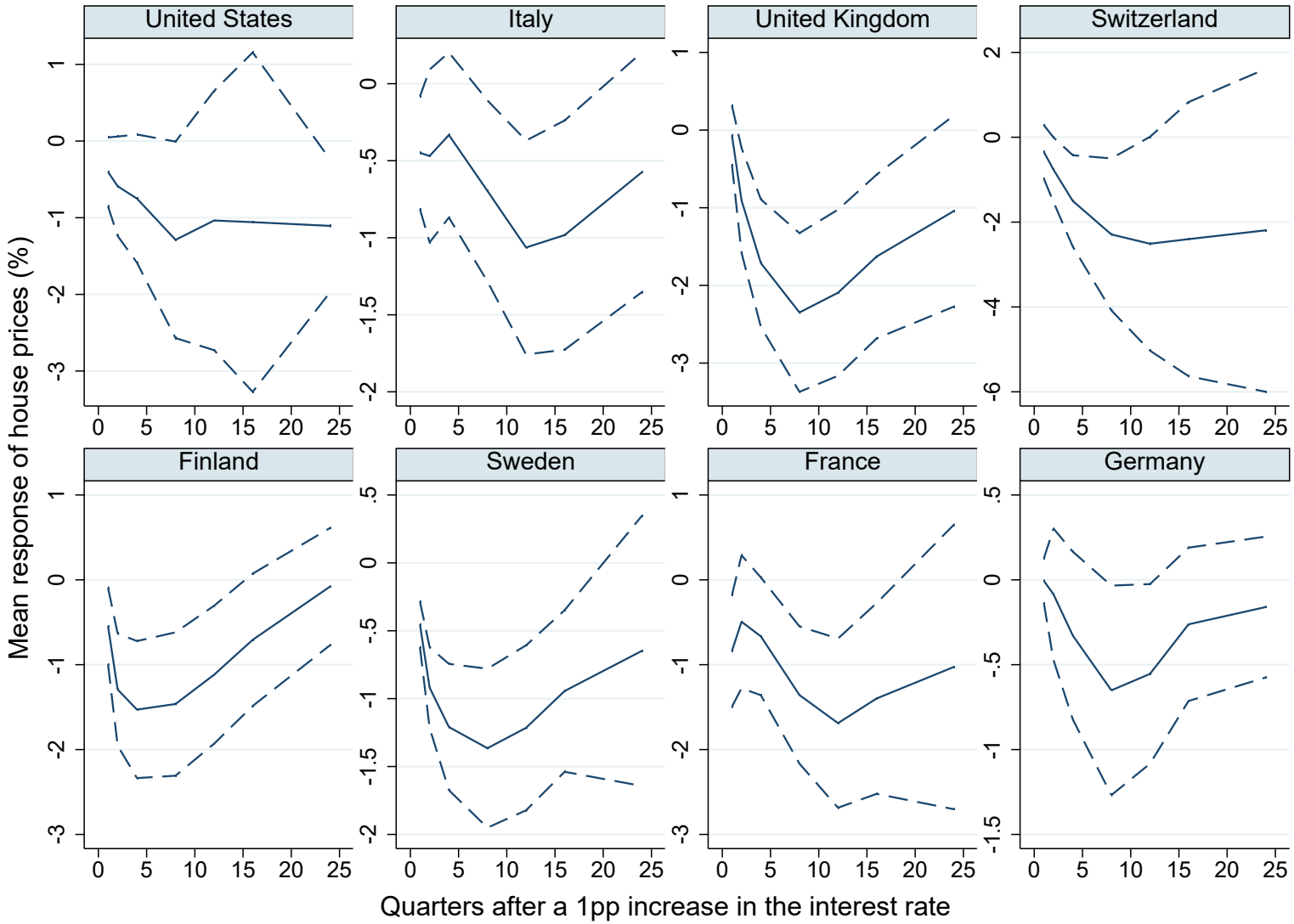
- These methods indicate same conclusions as the previous ones.

Effect beyond bias

- Significant across all horizons
- Bottoms after two years at around -0.33%



Cross-country heterogeneity



Drivers of heterogeneity

The mean effect can also conceal differences in the context of estimation.

1. Data characteristics
   - Frequency, time span, number of observations,...
2. VAR definition
   - Variables included in VAR (a measure of GDP, LR IR, credit, equity prices, residential investment, money supply, etc.), number of lags,...
3. Estimation technique
   - BVAR, Cholesky vs. sign restrictions vs. nonrecursive identification.
4. Publication characteristics
   - Journal vs. WP, impact factor, number of citations per year.
5. Structural characteristics (country-level, external variables)
   - Macroeconomic and monetary conditions: disposable income per capita, IR, prolonged period of low IR, 10Y gov. bond, credit-to-GDP.
   - Population characteristics.
   - Lending market conditions: share of floating interest rates, avg. maturity.
   - House supply factors: number of building permits, share of home ownership.

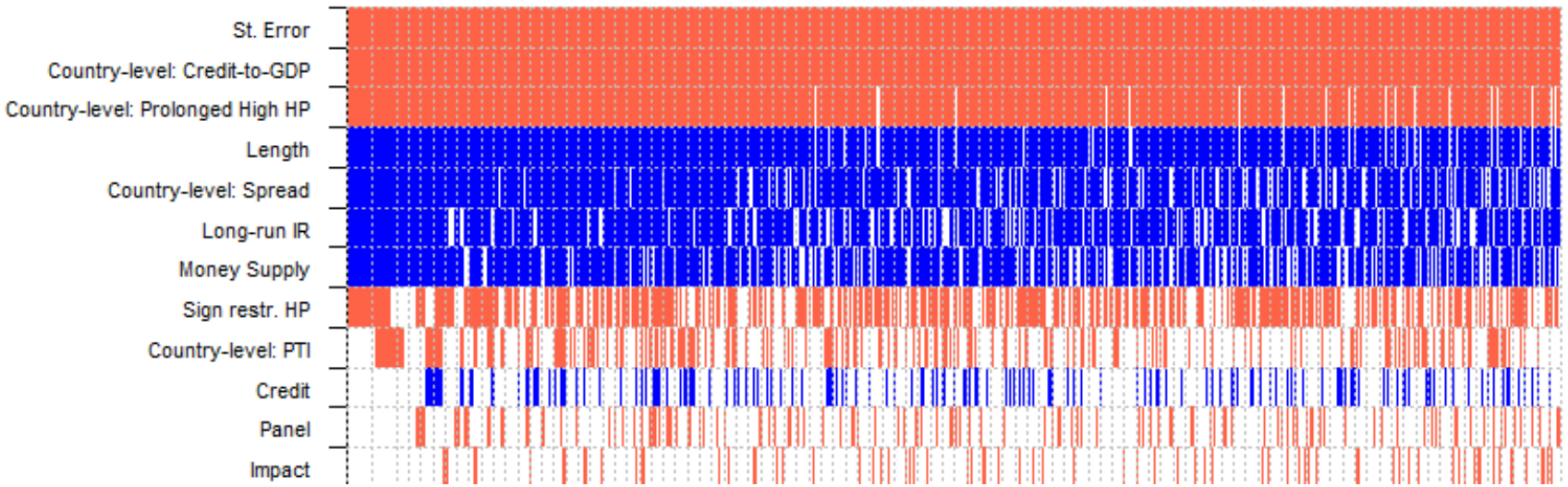
Estimation Method

$$X_{ij} = \beta_0 + \beta_1 SE_{ij} + \sum_{l=1}^{N} \gamma_l Z_{l,ij} + \epsilon_{ij} \tag{2}$$

where X_{ij} is the estimated effect, SE_j its standard error, and $Z_{l,ij}$ is a control variable for an i-th estimate from a j-th study.

1. Bayesian Model Averaging
   - Deals with model uncertainty.
   - Treats the endogeneity problem and the omitted variable bias methodically.
   - Reveals importance and magnitude of each included variable.
2. Frequentist Model Averaging
3. Frequentist approach – OLS

Results - Explaining the Differences in Results at 4Q Horizon



- Red color in BMA = stronger transmission from MP to HP.
- Variables sorted by PIP, the most prominent drivers at the top.
- Standard error – the first top variable – publication bias confirmed.

Results

- Data characteristics: length of the sample matters systematically.
- Specification characteristics: when long-run IR is included, results are less strong, the same direction for money supply as a measure of liquidity.
  - → Crucial to include relevant endogenous variables!
- Identification of shocks in a VAR model matters: systematic differences between Cholesky and sign restrictions – with the latter one, results are significantly stronger – this is a trivial finding, but the effect is large!
- Publication characteristics – below our threshold for PIP.
- Structural heterogeneity
  - Credit-to-GDP and prolonged high HP growth are significant drivers
  - Transmission is stronger in countries with more developed credit markets and in the latter part of the business cycle.

Robustness Checks

- Assuming the drivers of heterogeneity are the same across horizons.
- Various settings of priors.
- Main results remain the same.
- The same conclusion is reached with FMA and OLS frequentist check.

Implied Responses

We calculate fitted values of the regression to get a "true effect".

- We plug preferred values of control variables – maxima / minima / means.
- We prefer long samples, newer studies, nonrecursive identification, and long-run IR and credit included.

Table: Implied responses

	Horizon					
	1Q	2Q	4Q	8Q	12Q	16Q
Implied estimate	-0.001	-0.233	-0.448	-0.678	-0.544	-0.299
Agnostic on specification	-0.737	-0.969*	-1.183**	-1.414**	-1.279**	-1.035*
Finland	0.223	-0.009	-0.224	-0.454	-0.320	-0.075
France	-1.097**	-1.329**	-1.543**	-1.774***	-1.639***	-1.395**
Germany	0.576	0.344	0.129	-0.101	0.034	0.278
Italy	0.300	0.067	-0.147	-0.378	-0.243	0.001
United Kingdom	-0.780	-1.013*	-1.227**	-1.458***	-1.323	-1.079**
United States	-0.186	-0.418	-0.633	-0.863*	-0.728	-0.484

Conclusion

- We review and synthesize 31 studies estimating the effect of monetary policy (short-term interest rate) on house price levels, covering 27 countries, 220 graphical IRFs and more than 1400 point estimates.
- Increase in the interest rate by 1 pp causes a mean decrease of house prices of 0.9% for one-year horizon and 1.2% for two-year horizon.
- We examine the extent of publication bias and find it is significant.
- We identify the most prominent drivers of heterogeneity.
- The largest implied effect, attained at the medium-term horizon, is -0.7%, and varies across countries up to -1.8% as a response to 1pp change in interest rates.

Thank you!

Josef Bajzik
Charles University Prague
Czech National Bank
josef.bajzik@cnb.cz

Bibliography I

Andrews, I. and Kasy, M. (2019). Identification of and correction for publication bias. *American Economic Review*, 109(8):2766–94.

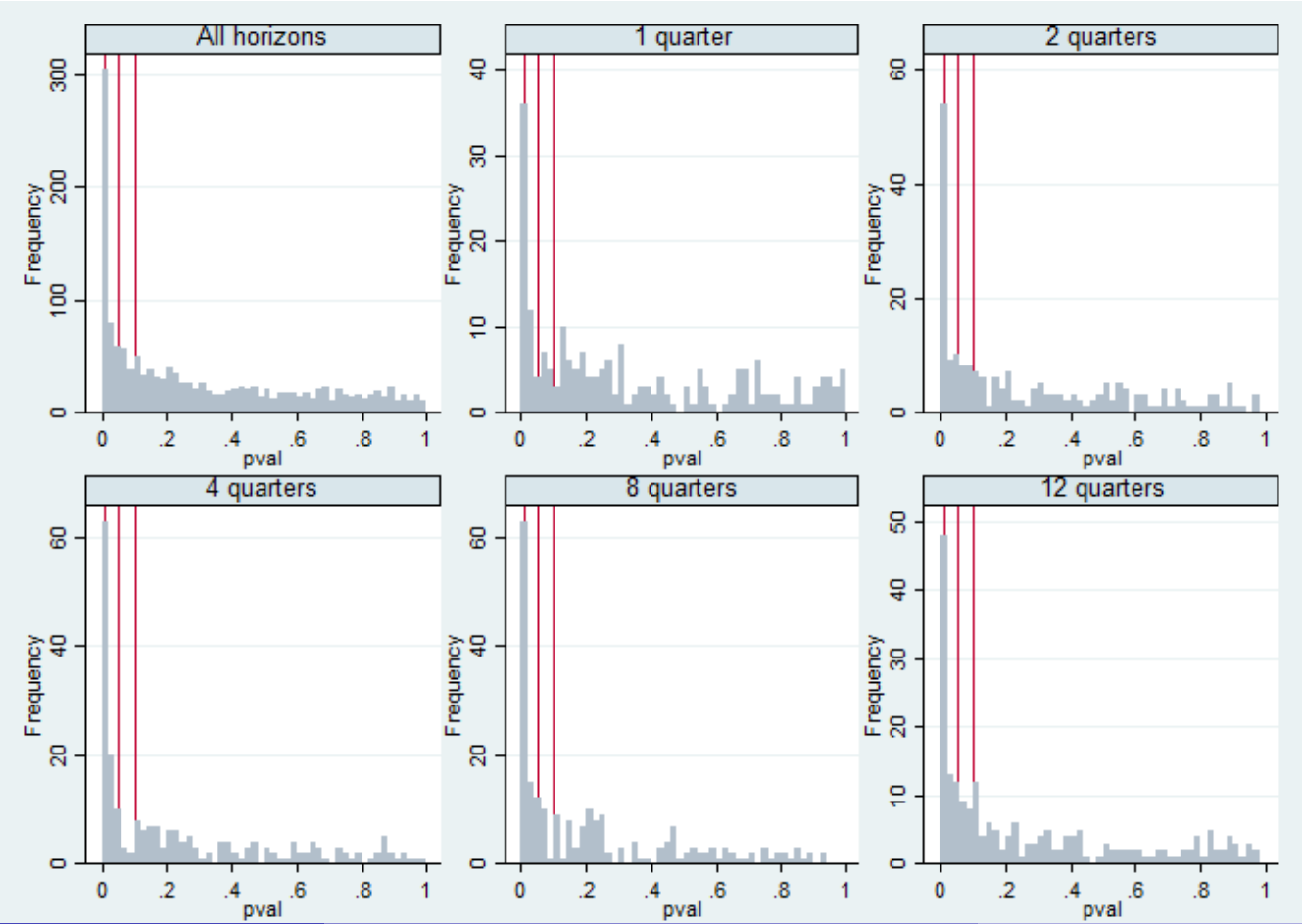
Furukawa, C. (2019). Publication bias under aggregation frictions: Theory, evidence, and a new correction method. *ZBW-Leibniz Information Centre for Economics*.

Uhlig, H. (2012). Economics and reality. *Journal of Macroeconomics*, 34(1):29–41.

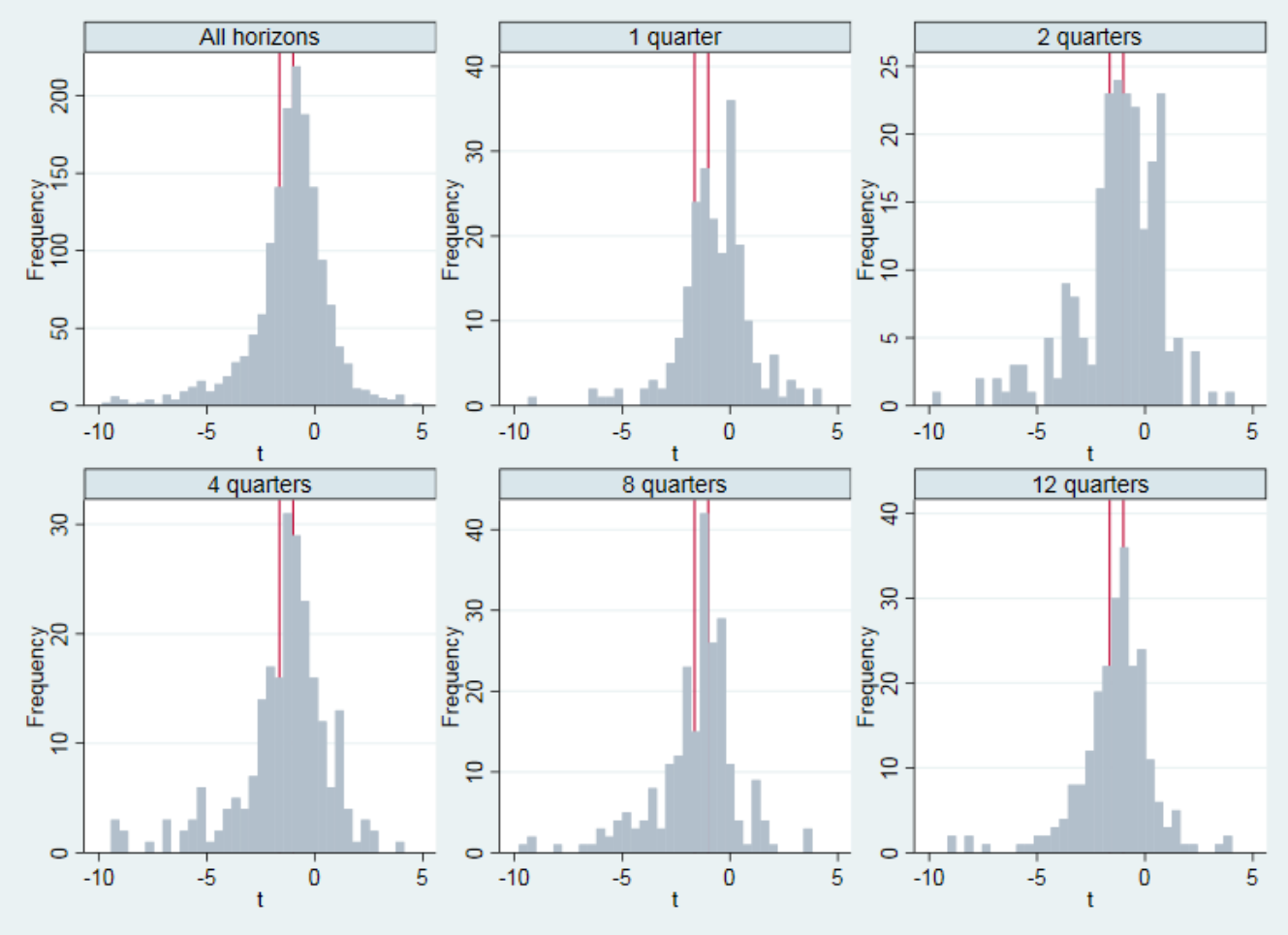
van Aert, R. C. and van Assen, M. (2021). Correcting for publication bias in a meta-analysis with the p-uniform* method. Working paper, Tilburg University.

Publication bias based on significance level

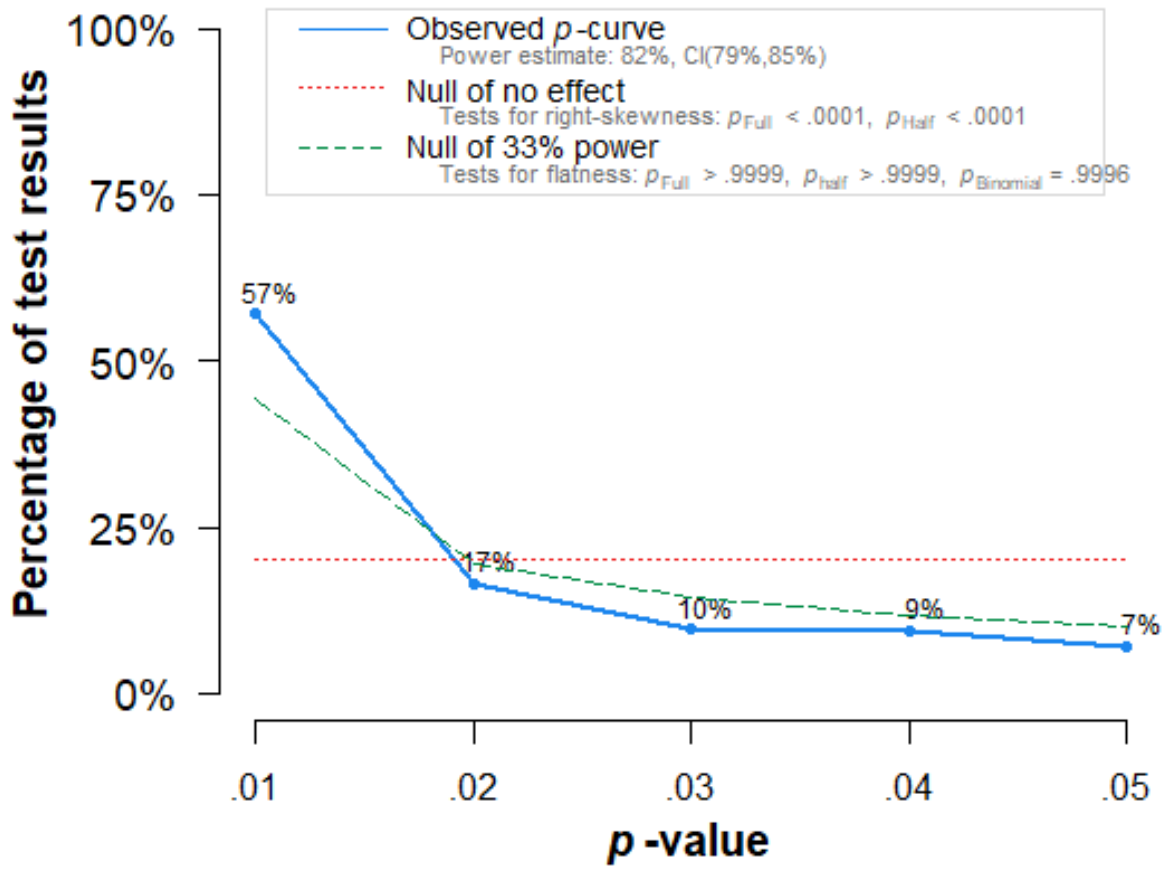
- 28% p-values below 0.05; 37% below 0.1
- probably less bias based on significance in VARs than when point estimate are reported in the literature



Distribution of t-statistics



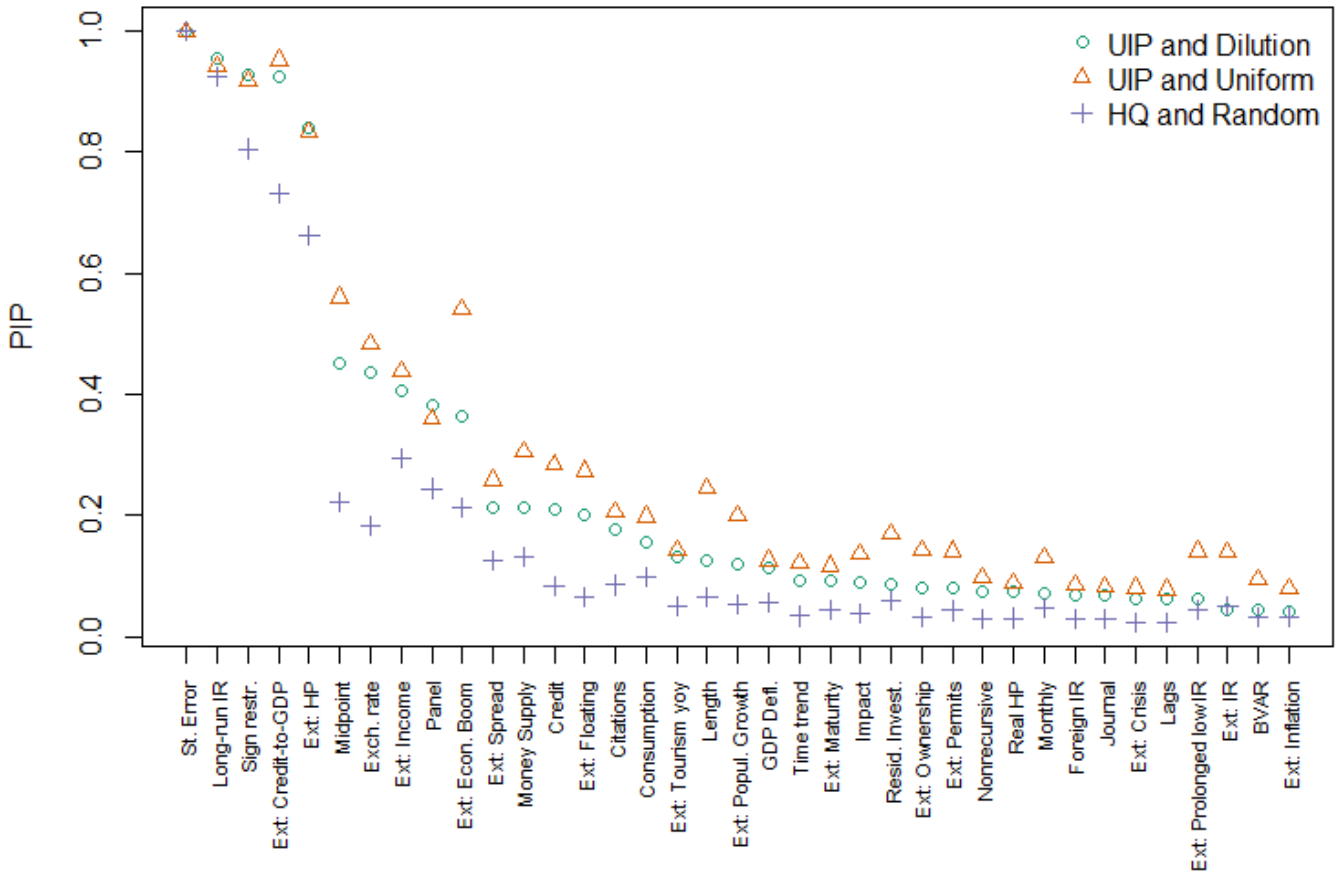
P-curve



Note: The observed p-curve includes 422 statistically significant (p < .05) results, of which 331 are p < .0
There were 1025 additional results entered but excluded from p-curve because they were p > .05.

Robustness Checks - Different Priors

Figure: Posterior inclusion probabilities across different prior setting



Robustness Checks - All horizons

- Assuming all drivers of heterogeneity are the same across horizons
- Remaining differences can be captured by dummy vars for respective horizons
- Main results are the same + additional variables (*Residential investment*, *Floating IR*, *BVAR*, *Nonrecursive*)
- The same conclusion is reached with OLS frequentist check

Variable		1 Quarter	2 Quarters	4 Quarters	8 Quarters	12 Quarters	16 Quarters
Publication bias	SE	-0.781***	-1.271***	-1.515***	-1.433***	-0.607**	-0.366***
		(0.248)	(0.314)	(0.307)	(0.171)	(0.237)	(0.142)
Data characteristics	Panel	-0.258***	-0.253**	-0.128	-0.121	0.155	0.418
		(0.096)	(0.126)	(0.188)	(0.350)	(0.338)	(0.327)
	Length	-0.432	0.466	0.811*	1.403**	-0.0991	-0.363
		(0.278)	(0.319)	(0.425)	(0.631)	(0.508)	(0.385)
	Midyear	0.017	0.378**	0.742***	0.790***	0.178	0.0122
		(0.094)	(0.152)	(0.211)	(0.241)	(0.238)	(0.195)
Specification characteristics	GDP Defl.	0.479**	0.520*	-0.222	-0.738**	-0.800**	-0.820**
		(0.206)	(0.272)	(0.238)	(0.335)	(0.380)	(0.356)
	Foreign IR	-0.645***	0.091	0.408	0.250	-0.039	-0.500
		(0.211)	(0.348)	(0.480)	(0.532)	(0.539)	(0.650)
	Consumption	0.176***	0.217***	0.174	0.132	0.418**	0.428**
		(0.061)	(0.070)	(0.121)	(0.209)	(0.178)	(0.215)
	Resid. Invest.	0.551***	0.507***	0.470**	0.472*	0.855***	0.773***
		(0.174)	(0.093)	(0.220)	(0.284)	(0.252)	(0.269)
	Money Supply	-0.300**	-0.128	0.502**	0.719***	0.0644	-0.103
		(0.128)	(0.172)	(0.245)	(0.272)	(0.235)	(0.321)
	Exch. rate	0.0235	0.254***	0.353***	0.454***	0.640***	0.412***
		(0.079)	(0.087)	(0.091)	(0.145)	(0.135)	(0.105)
	Long-run IR	0.151	0.320***	0.481***	0.431*	0.221	-0.0956
		(0.098)	(0.090)	(0.167)	(0.254)	(0.189)	(0.227)
	Real HP	-0.477**	-0.260	0.0597	0.213***	-0.471	-0.407
		(0.225)	(0.254)	(0.157)	(0.0250)	(0.340)	(0.378)
	Lags	-0.137***	-0.085**	0.051*	0.020	-0.009	-0.081
		(0.030)	(0.037)	(0.026)	(0.059)	(0.056)	(0.066)
Estimation characteristics	BVAR	-0.837***	-0.926***	-0.358	0.239	-0.542	0.0303
		(0.278)	(0.323)	(0.394)	(0.437)	(0.399)	(0.318)
	Sign restr.	-0.388***	-0.758***	-1.072***	-1.042**	-1.200**	-0.504
		(0.136)	(0.239)	(0.362)	(0.458)	(0.573)	(0.565)
	Nonrecursive	0.759***	0.843**	0.143	-0.0647	1.018***	1.086***
		(0.204)	(0.355)	(0.424)	(0.510)	(0.330)	(0.324)
Publication characteristics	Citations	-0.119	-0.0479	0.0173	-0.0528	-0.544**	-0.615***
		(0.103)	(0.210)	(0.282)	(0.315)	(0.228)	(0.182)
	Impact	-0.208**	-0.387**	-0.360**	-0.351	-0.397*	-0.251
		(0.102)	(0.152)	(0.181)	(0.309)	(0.214)	(0.228)
Structural heterogeneity	Ext: IR	-0.126**	-0.255***	-0.151	-0.163	-0.208***	-0.176***
		(0.056)	(0.088)	(0.106)	(0.102)	(0.061)	(0.048)
	Ext: Spread	-0.326***	-0.275	0.103	0.314***	0.339***	0.204*
		(0.111)	(0.187)	(0.148)	(0.0575)	(0.119)	(0.122)
	Ext: Floating	0.006***	0.010***	0.006	0.008	0.012***	0.011***
		(0.0008)	(0.004)	(0.006)	(0.006)	(0.004)	(0.004)
	Ext: Inflation	0.055	0.110***	0.050	-0.021	-0.004	-0.043*
		(0.040)	(0.022)	(0.035)	(0.047)	(0.035)	(0.024)
	Ext: Credit-to-GDP	-0.003	-0.017**	-0.020*	-0.019*	-0.018***	-0.012***
		(0.004)	(0.007)	(0.010)	(0.001)	(0.004)	(0.002)
	Ext: HP	-0.018	-0.101***	-0.069***	-0.030	-0.035	-0.018
		(.)	(0.013)	(0.024)	(0.032)	(0.027)	(0.030)
	Ext: Maturity	0.892***	0.538	-0.037	-0.184	0.978***	1.260***
		(0.231)	(0.485)	(0.563)	(0.620)	(0.209)	(0.261)
	Ext: Econ. Boom	-0.003	-0.002	-0.048*	-0.086**	-0.048	-0.070**
		(0.018)	(0.022)	(0.027)	(0.039)	(0.034)	(0.035)
	Observations	196	199	209	209	204	203

Appendix – Implied responses

Table: Results of the Synthetic Study

	Horizon					
	1 quarter	2 quarters	4 quarters	8 quarters	12 quarters	16 quarters
Baseline	-0.921**	-1.153**	-1.367***	-1.598***	-1.463***	-1.219**
With credit and LR IR	-0.185	-0.417	-0.632	-0.862**	-0.726*	-0.483
With worse public. char.	-0.545	-0.777**	-0.992**	-1.222***	-1.087**	-0.843**
Finland	-0.697	-0.929**	-1.143***	-1.374***	-1.239***	-0.995**
France	-2.016***	-2.249***	-2.463***	-2.694***	-2.559***	-2.315***
Germany	-0.343	-0.576	-0.790	-1.021*	-0.886*	-0.642
Italy	-0.619	-0.851	-1.067	-1.297	-1.162	-0.918
Sweden	-1.737*	-1.968***	-2.183***	-2.414**	-2.279***	-2.035***
Switzerland	-1.734***	-1.966***	-2.180***	-2.411***	-2.277***	-2.032***
United Kingdom	-1.670***	-1.932***	-2.147***	-2.377***	-2.242***	-1.998* **
United States	-1.105**	-1.338***	-1.552***	-1.783***	-1.647***	-1.404***
European Union	-1.241**	-1.473***	-1.687***	-1.918***	-1.783***	-1.539***
Czech Republic	-0.759	-0.991*	-1.205**	-1.436**	-1.301**	-1.057*

Note: The values represent the percentage response of house prices to a 1 percentage point increase in the interest rate. ***, **, and * denote significance at the 1%, 5%, and 10% level.