

Meta-analysis in financial stability topics

What do we know and what we have learnt

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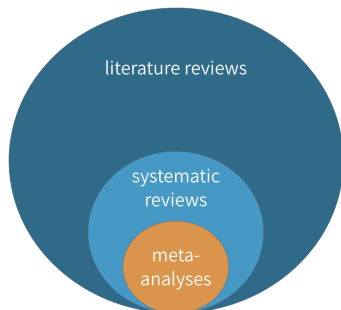
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What is meta-analysis?

- Systematic review of the existing literature
- Not just an overview, but a quantitative evaluation
- Allows study publication bias problems
- Clarify inter-study differences
- Explain the differences across the primary estimates



Source: Global Health Research (2023)

Origins of meta-analysis

- Developed in medicine to combine many small studies into a large one
- Goal was to increase the degrees of freedom; costly clinical trials
- Economic research is less expensive, but the degrees of freedom in macroeconomics are limited as well – so we hold the original purpose of meta-analysis
- One of the overviews of use of meta-analysis in economics is, for example, Moral-Benito (2015)
- Some prominent economic meta-analytical publications:
 - Andrews, I., & Kasy, M. (2019). Identification of and Correction for Publication Bias. *American Economic Review*, 109(8), 2766-94.
 - Anderson, R. G., & Kichkha, A. (2017). Replication, Meta-Analysis, and Research Synthesis in Economics. *American Economic Review*, 107(5), 56-59.
 - Card, D., & Krueger, A. B. (1995). Time-Series Minimum-Wage Studies: a Meta-Analysis. *American Economic Review*, 85(2), 238-243.

Our motivation

- Rapidly **expanding literature** on, for example, the bank capital-lending relationship, regulation and credit, ir->credit, credit<->GDP...
- Increasingly **fragmented** literature
- **Changing** regulatory and economic **environment**
- Benchmark for policies
 - Stress tests settings
- What is the true effect?
 - The literature shows that the reported effects are often overestimated (Ioannidis et al., 2017)
 - We are interested in the effect beyond bias
- What drives the heterogeneity?
 - The literature usually reports a spectrum of results depending on different circumstances for the given phenomena
 - We are interested in the key drivers

Overview of our work

- Works on the first meta-analysis by our team started in April 2019
- Till now 5 Journal publications, 1 WP, 4 close to finish
- Topics: Monetary policy, Macroprudential policy, International Finance, Financial Markets
- 6/47 CNB WP in last 4 years
- But the meta-analysis have in Czech National Bank a long history
 - Especially based on work of Tomas Havranek
 - 10 meta-analyses during the years 2010-2016
- Thus, Czech National Bank is very established in this area

Selected Publications

- Malovaná, S., Hodula, M., Bajzík, J., & Gric, Z. (2023). Bank Capital, Lending and Regulation: A Meta-analysis. *Journal of Economic Surveys*, forthcoming.
- Ehrenbergerova, D., Bajzík, J., & Havranek, T. (2022). When Does Monetary Policy Sway House Prices? A Meta-Analysis. *IMF Economic Review*, 1-36.
- Gechert, S., Havranek, T., Irsova, Z., & Kolcunova, D. (2022). Measuring Capital-Labor Substitution: The Importance of Method Choices and Publication Bias. *Review of Economic Dynamics*, 45, 55-82.
- Bajzík, J., Havranek, T., Irsova, Z., & Schwarz, J. (2020). Estimating the Armington Elasticity: The Importance of Study Design and Publication Bias. *Journal of International Economics*, 127, 103383.
- Gric, Z., Bajzík, J., & Badura, O. (2023). Does Sentiment Affect Stock Returns?: A Meta-analysis Across Survey-based Measures. *International Review of Financial Analysis*, forthcoming.
- Malovaná, S., Hodula, M., Gric, Z., & Bajzík, J. (2022). Borrower-Based Macroprudential Measures and Credit Growth: How Biased is the Existing Literature?. CNB WP 8/2022.

Policy implications

- Provide “instructions” on how to conduct future policy-relevant empirical research
 - E.g., how to estimate the effect of capital regulation on bank lending accurately
- Findings:
 - Overall: The effects exist but are exaggerated
 - The effect of borrower-based limits on bank lending grows stronger over time
 - Borrower-based measures are effective policy tools in terms of directly restricting (mortgage) credit growth.
 - One-percentage-point increase in the policy rate is associated with a decrease of 0.7% in house prices after two years.

Steps in the (meta-) analysis

- Data collection
 - Google scholar
 - Data set creation
- Publication bias tests
 - Visual tests
 - Linear tests
 - Non-linear tests
- Finding drivers of the heterogeneity
 - Standardization
 - BMA
- Robustness tests
- Implied elasticity

Data collection

- Follow classical meta-analytical guidelines:
 - Havránek et al. (2020)
- Through calibrated string on Google Scholar
- Usually first 500 hits
- Forward and Backward snowballing
- Abstract reading, selection criteria
 - The standard error, t-statistics, or p-value needs to be included
 - Journal articles or working papers
- PRISMA diagram - Preferred Reporting Items for Systematic Reviews and Meta-Analyses

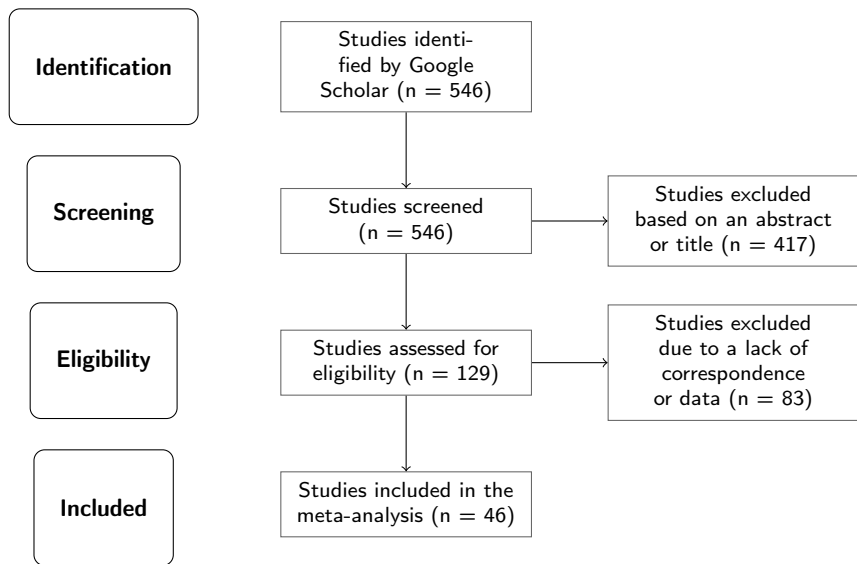
Data-collection: Capital-based measures meta-analysis – example

- Google Scholar search for all empirical studies with bank capital or capital requirements on the RHS and lending on the LHS

“bank capital regulation” OR “capital requirements” OR “bank capital” OR “capital surplus” OR “capital ratio” OR “macroprudential regulation” OR “macroprudential policy” AND “lending” OR “credit” OR “loans”

- Limited to studies published in 2010 and later (to capture changes to capital regulation since the GFC)
- 546 studies screened
 - 417 excluded based on abstract or title
 - 83 excluded due to lack of correspondence or data
 - 46 included (26 journal articles and 20 working papers)
- 1,639 estimates retrieved (app. 36 per study)

Data-collection – example of PRISMA



Publication bias

- Are only selected results published – statistically significant and/or with the “correct” sign?
- The best-published study in our data set admits that publication bias may be an issue:

*“The coefficient on the standard capital-to-asset ratio often has an **incorrect negative sign**, which casts some doubt on the role of this indicator in capturing the effect of a bank’s capital position on bank lending.” (Gambacorta and Marques-Ibanez, 2011; EP)*

- Regarding borrower-based measures:

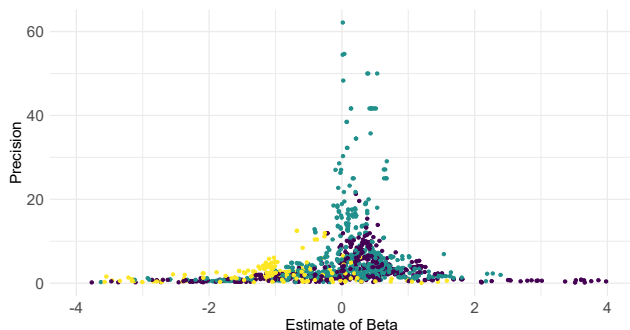
*“All have **the correct (negative) sign**, indicating that a policy tightening (coded as +1) reduces credit growth and a loosening (coded as -1) increases credit growth.” (Kuttner and Shim, 2016; JFS)*

- Tools:

- Graphical inspection – funnel plot, distribution of t-statistics
- Empirically – a battery of linear and non-linear tests

Publication bias – example of funnel plot

- Precision is calculated as an inverse of standard error
- In the absence of publication bias the funnel should be symmetrical around the most precise estimates
- As a whole, the funnel plot is symmetrical, **BUT** it is asymmetrical and visibly skewed towards positive or negative values for different subgroups



Publication bias – empirical tests

- Linear tests:

$$\hat{\beta} = \alpha + \gamma S\hat{E}_{it} + e_{it}$$

- α – effect beyond bias (true effect)
- γ – intensity of the publication bias
- Estimated by, for example, simple or weighted OLS, fixed-effects or random-effects regression
- Logic behind
 - Assumption I: Absent selectivity in publication, there is no association between the estimate ($\hat{\beta}$) and its standard error ($S\hat{E}_{it}$)
 - Assumption II: Potential publication selection bias has a linear association with the estimates' standard errors
 - If low and/or negative estimates that are imprecise are more likely to get discarded than equally imprecise high estimates then reported estimates that are high are more likely to have higher standard errors

Publication bias – empirical nonlinear tests

- But the two assumptions might be violated
- Tests that do not need to satisfy the criteria were created
- **Non-linear tests** – based on various assumptions:
 - Based on the 10% of the most precise estimates (Top10 method)
 - Based on the adequately powered estimate (WAAP method)
 - Optimizing trade-off between bias and variance (stem-based method)
 - Searching for a precision threshold above which publication bias is unlikely (kinked method)
 - Giving more weight to underreported intervals (selection method)

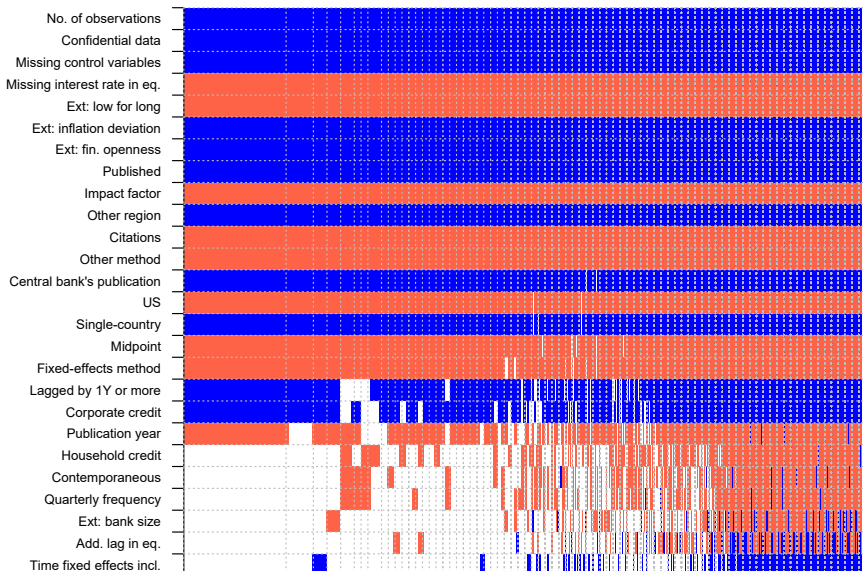
Drivers of heterogeneity

- How do different **data and estimation methods** influence reported elasticity?
- Do also **publication characteristics** matter?
- What is the role of **structural characteristics** of the economy?
- **Explanatory variables** collected to understand the differences between studies better
 - LHS specifics: type of credit (households, NFCs...)
 - Data characteristics: time span and frequency, confidentiality, region
 - Methodology: estimation method, model specification, lags (VAR models), control variables
 - Publication characteristics: journal, impact factor, citations, publication year
 - External variables: cross-country or cross-regional differences (macro-financial variables, e.g., interest rates, financial development, credit and house price growth, LIRE)

Drivers of heterogeneity - estimation

- Bayesian model averaging (baseline + robustness checks), simple OLS (robustness checks)
- Objective
 - The most influential factors across models
 - Contend with heterogeneity
- Model averaging techniques solve:
 - Omitted variable problem
 - Parsimony problem
 - Best model choice
- Comparison with previous findings

BMA results meta-analysis – example



Implied elasticity

- What would be the effect based on:
 - Current knowledge
 - Corrected for publication bias
 - The best econometrical approaches
- Recommendations
- Guidelines for future research
- Useful in calibration for different countries etc.

	Capital-to-Asset Ratio		Regulatory Capital Ratio	
	Estim.	68% CI	Estim.	68% CI
Baseline ("best practice")	1.78	(1.12, 2.52)	-0.74	(-1.00, -0.16)
Corporate credit	1.93	(1.29, 2.67)	-0.78	(-1.03, -0.19)
Household credit	1.71	(1.06, 2.45)	-0.75	(-1.00, -0.17)
Public data & annual frequency	1.62	(0.94, 2.39)	-1.03	(-1.30, -0.47)
Multi-country, public data & annual freq.	0.32	(-0.45, 0.95)	-2.05	(-2.41, -1.55)
Inferior empirical approach	1.55	(0.89, 2.27)	-0.67	(-0.92, 0.00)
Prolonged period of low interest rates*	-1.22	(-1.98, -0.57)	-0.98	(-1.10, -0.22)

The effect of capital-based measures on lending: meta-analysis

- We synthesise the empirical literature on the relationship between banks capital, capital requirements, and lending – **more than 1,600 estimates from 36 studies**
- We collected additional 40 variables to explain the heterogeneity of collected estimates
- The literature is **fragmented** in terms of the magnitude and direction
- The fragmentation is well explained by
 - capital ratio used in the primary study,
 - publication bias, and
 - primary study characteristics, such as model specification, estimation method, and data characteristics
- **Corrected mean effects** of 1 pp increase in capital ratio on annual credit growth:
 - Capital-to-asset ratio: 0.3 pp (1.8 pp)
 - Regulatory capital ratio: 0.2 pp (-0.7 pp)
 - Capital requirements: -0.5 to -2.0 pp

The effect of borrower-based measures on lending: meta-analysis

- We synthesis the empirical literature on the effects of borrower-based measures on bank lending – **more than 700 estimates from 34 studies**
- The literature is **fragmented** in terms of the magnitude and direction of the effect
- The uncorrected mean effect is -1.69 – **strong negative publication bias**
- **Two sources of publication bias:**
 - Researchers over-report negative and significant estimates, and positive and not significant estimates
 - The corrected mean is about half the size of the uncorrected mean (-0.9).
- **Model specification, estimation method and data characteristics** also explain a large part of the variation in estimates

The effect of monetary policy on house prices: meta-analysis

- 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

Capital-Labour substitution: meta-analysis

- Large elasticity of substitution between capital and labour estimated in the literature on average, 0.9 is explained by:
 - publication bias
 - cross-country variation
 - omission of the first-order condition for capital
- The mean elasticity conditional on the absence of these issues is 0.3
- 3,186 estimates, 121 studies, 71 control variables coded
- BMA and FMA used, nonlinear techniques for publication bias
- The weight of evidence accumulated in the empirical literature emphatically rejects the Cobb-Douglas specification

Armington elasticity: meta-analysis

- Wide **application** of Armington elasticity in international economics
- **Vary** systematically across countries
- Results exaggerated by **publication bias**
- Depending on method and **data characteristics**
- Elasticities are larger **in peer-reviewed** and highly cited studies
- Mean **Armington elasticity** implied by the literature, corrected for publication bias and potential misspecification, is 3.8 (median)

The effect of sentiment on returns: meta-analysis

- We conducted the first meta-analysis of sentiment – return relationship using 1311 estimates from 30 primary studies
- We proved presence of negative publication bias in most of the specifications
- We show that the true effect of sentiment is negative but in some specifications not different from zero
- We examine additional 47 variables as potential drivers of heterogeneity:
 - More negative estimates for individual sentiment and US region or higher data frequency
 - Less negative (or positive) estimates for contemporaneous effect horizon and more financially developed countries
- We proposed implied estimates:
 - 1SD increase in sentiment decreases returns by 0.198 SDs

Short- and Long-run effects of shareholder activism: meta-analysis (preliminary)

- Short-run - 1973 Estimates from 67 studies
- Long-run - 1186 Estimates from 49 studies
- Studying not only geographical aspects but even **institutional setting**
- Focus on **activism sponsors**, their objectives and approaches + other characteristics
- **Substantial publication bias** revealed
- **Institutional settings** explain most of the variability across the estimates
- Long-run - **benchmark setting** is important
- Valuable **insights to regulators**

Conclusion

- Meta-analysis **origins in medicine**, but has its place even in the **economics**
- It is not just summary of the literature, but the **quantitative evaluation**
- Allows for determining the seminal **drivers of heterogeneity**,
- Controls for **publication bias**
- Suggests the **implied estimates**
- Benchmark for policies
- In Czech National Bank **since 2010**, 15+ publications
- Current topics: **monetary and macroprudential policy**, business and financial cycles

Thank you!

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