Lecture 1: Introduction to Meta-Analysis

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Meta important for research, policy, practice

Research experience:

- Professor at Charles University, Prague
- Affiliate at the Meta-Research Innovation Center, Stanford
- Panel member at ERC (European Research Council) Advanced

Policy experience:

- Former Advisor to the Board, Czech National Bank
- Former member of the Czech National Economic Council
- Affiliate at the Centre for Economic Policy Research, London

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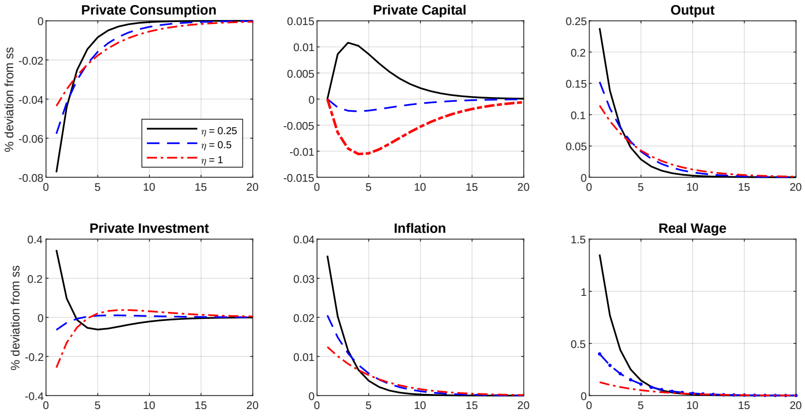
What happens if the government spends more?

Labor supply elasticity is key (but how to calibrate it?):



Meta in monetary policy making: DSGE models

DSGE = dynamic stochastic general equilibrium

1. The dominant policy analysis and forecasting tool
2. Used by central banks and ministries of finance
3. Micro-based with “deep” parameters
4. Immune to Lucas critique (?)
5. Discipline over intuition
6. Hard to understand for policy makers

Dozens or hundreds of equations

To do this we set some auxiliary parameters.

$$a_1 = \frac{\alpha}{1-\alpha}\frac{w}{r}z\mu, \quad a_2 = \frac{\frac{A}{z}}{v^p}, \quad a_3 = \frac{\gamma^L-(1-\delta)}{z\mu}, \quad a_4 = \frac{1}{n^c}\left(\frac{p^c}{p}\right)^{-\epsilon_c}, \quad a_5 = a_4 n^i \left(\frac{p^i}{p}\right)^{\epsilon_i}$$

$$a_6 = a_4 v^x \frac{\frac{exp^W}{p}}{\frac{p^x}{p}}, \quad a_7 = n^x\left(\frac{q^x}{p}\right)^{\epsilon_x}, \quad a_8 = v^M\Omega_X(1-n^x)\left(\frac{\frac{p^M}{p}}{\frac{q^x}{p}}\right)^{-\epsilon_x}, \quad a_9 = a_4\rho_g,$$

$$a_{10} = v^M\Omega^c(1-n^c)\left(\frac{\frac{p^M}{p}}{\frac{p^c}{p}}\right)^{-\epsilon_c}, \quad a_{11} = v^M\Omega^i(1-n^i)\left(\frac{\frac{p^M}{p}}{\frac{p^i}{p}}\right)^{-\epsilon_i}, \quad a_{12} = \frac{z-h\beta\gamma^L}{(1+\tau_C)(z-h)\left(\frac{p^c}{p}\right)},$$

$$a_{13} = \frac{\left[1-\beta\theta_w z^{\eta(1+\vartheta)}\Pi^{\eta(1-\chi_w)(1+\vartheta)}\gamma^L\right]\frac{\eta-1}{\eta}(1-\tau_W)w^*}{\left[1-\beta\theta_w z^{\eta-1}\Pi^{-(1-\eta)(1-\chi_w)}\gamma^L\right]\psi(\Pi^{w*})^{-\eta\vartheta}}, \quad a_{14} = \vartheta, \quad a_{15} = \alpha.$$

Substituting these parameters into above equations, we get

$$k = a_1 l^d, \quad y^d = a_2 k^{a_{15}}(l^d)^{1-a_{15}}, \quad i = a_3 k, \quad x = \frac{a_6}{a_4}M, \quad c = a_4 y^d - a_5 i - a_6 a_7 M - a_4 g,$$

$$g = \rho_g c, \quad M = a_{10}c + a_{11}i + a_8 x, \quad \lambda = a_{12}\frac{1}{c}, \quad (l^d)^{a_{14}} = a_{13}\lambda.$$

After some easy algebra

$$M = a_{10}c + a_{11}i + a_8\frac{a_6}{a_4}M \Rightarrow M = \frac{a_{10}c + a_{11}i}{1-a_8\frac{a_6}{a_4}} \text{ where } a_{16} = 1 - a_8\frac{a_6}{a_4}$$

$$c = a_4 y^d - a_5 i - a_6 a_7 M - a_9 c \Rightarrow c = \frac{a_{16}a_4 y^d - (a_5 a_{16} - a_6 a_7 a_{11})i}{a_{16} + a_6 a_7 a_{10} + a_9 a_{16}}$$

$$= \frac{a_{16}a_4 a_2 a_1^{a_{15}} - (a_5 a_{16} - a_6 a_7 a_{11})a_1 a_3}{a_{16} + a_6 a_7 a_{10} + a_9 a_{16}} l^d$$

$$(l^d)^{a_{14}} = a_{13}\frac{a_{12}}{c} \Rightarrow l^d = \left(\frac{a_{17}}{a_{18}}\right)^{\frac{1}{1+a_{14}}}$$

where $a_{17} = a_{12}a_{13}(a_{16} + a_6 a_7 a_{10} + a_9 a_{16})$, $a_{18} = a_{16}a_4 a_2 a_1^{a_{15}} - (a_5 a_{16} - a_6 a_7 a_{11})a_1 a_3$

When we know l^d, we can simply derive steady states of $k, i, y^d, c, M, \lambda, x$ and g.

$$k = a_1 l^d, \quad i = a_3 k, \quad y^d = a_2 k^\alpha (l^d)^{1-\alpha}, \quad c = \frac{a_{16}a_4 y^d - (a_5 a_{16} - a_6 a_7 a_{11})i}{a_{16} + a_6 a_7 a_{10} + a_9 a_{16}},$$

$$M = \frac{a_{10}c + a_{11}i}{1 - a_8\frac{a_6}{a_4}}, \quad \lambda = \frac{a_{12}}{c}, \quad x = \frac{a_6}{a_4}M, \quad g = \rho_g c.$$

From equations (58), (97), (54), (55), (96), (95) and from the above, we get

$$l = v_w l^d, \quad c^d = n^c\left(\frac{p^c}{p}\right)^{\epsilon_c} c, \quad i^d = n^i\left(\frac{p^i}{p}\right)^{\epsilon_i} i, \quad x^d = n^x\left(\frac{q^x}{p}\right)^{\epsilon_x} x,$$

$$c^M = c^d\Omega^c\frac{1-n^c}{n^c}\left(\frac{p^M}{p}\right)^{-\epsilon_c}, \quad i^M = i^d\Omega^i\frac{1-n^i}{n^i}\left(\frac{p^M}{p}\right)^{-\epsilon_i}, \quad x^M = x^d\Omega^x\frac{1-n^x}{n^x}\left(\frac{p^M}{p}\right)^{-\epsilon_x},$$

$$y^M = c^M + i^M + x^M.$$

From equations (33), (37), (34), (38), (26), (28), (30) and from the above, we get

$$g^{M_1} = \frac{\lambda\frac{\frac{exp^W}{p}}{\frac{p^M}{p}}y^M}{1-\beta\theta_M\gamma^L\left(\frac{(\Pi^M)^{\chi_M}}{\Pi^M}\right)^{-\epsilon_M}}, \quad g^{M_2} = \frac{\epsilon_M}{\epsilon_M - 1}g^{M_1},$$

$$g^{x_1} = \frac{\lambda\frac{\frac{q^x}{p}}{\frac{p^x}{p}}x^d}{1-\beta\theta_X\gamma^L\left(\frac{(\Pi^W)^{\chi_x}}{\tilde{\Pi}^x}\right)^{-\epsilon_x}}, \quad g^{x_2} = \frac{\epsilon_x}{\epsilon_x - 1}g^{X_1},$$

$$f = \frac{d\varphi\psi(\Pi^{w*})^{-\eta(1+\vartheta)}(l^d)^{1+\vartheta}}{1-\beta\theta_w\gamma^L z^{\eta(1+\vartheta)}\Pi^{\eta(1-\chi_w)(1+\vartheta)}}$$

$$g^1 = \frac{\lambda\, mc\, y^d}{1-\beta\theta_p\gamma_L\Pi^{(\chi-1)(-\epsilon)}}, \quad g^2 = \frac{\epsilon}{\epsilon-1}g^1.$$

Net foreign assets evolution is derived from eq. (91)

$$exb^W = \frac{(\frac{exp^W}{p})^{\epsilon_W}(\frac{p^x}{p})^{1-\epsilon_W}(\frac{y^W}{y^d}) - \frac{exp^W}{p}\frac{M}{y^d}}{1 - R^W\dot{ex}\frac{y^d}{\gamma_L z\Pi y^d}}.$$

From eq. (84) and from the fact that $exb^W = 0$, we get

$$prem = 1$$

and from eq. (48)

$$y^W = \frac{x}{v_x\left(\frac{\frac{p^x}{p}}{\frac{exp^W}{p}}\right)^{-\epsilon_W}}$$

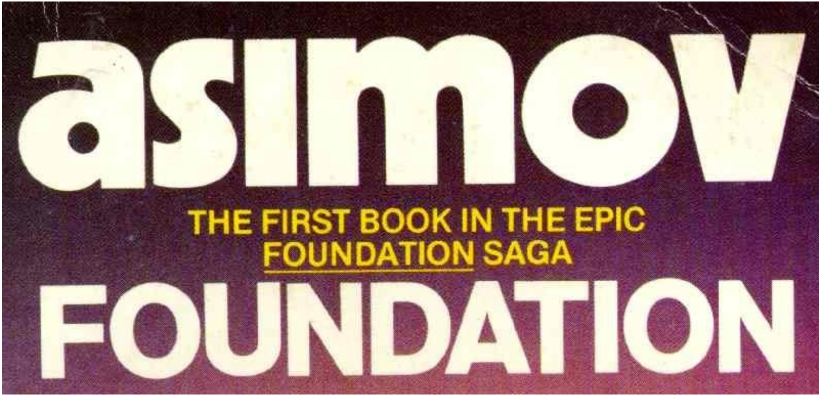
To recapitulate, first we define steady states for z, A, μ, γ_L, u, d, φ, $\frac{exp^W}{p}$, Δex, $a\dot{X}\ target$, Π, Π^c, $a\dot{R}$, κ^{euler}, κ^{forex}, Π^i, $\Pi 4^c$, Π^W, Π^{W*}, Π^x, Π^M, $\tilde{\Pi}^x$, $\dot{c}$, $\dot{i}$, y^d, Π^w, $\dot{g}$, $a\dot{G}$, $a\dot{O}$, $\dot{x}$, $\dot{M}$, $y^{\dot{W}}$, γ^c, γ^i, γ^x, $\gamma^{c,der}$, $\gamma^{i,der}$, $\gamma^{x,der}$, R, R^W and for deep parameters θ_p and χ and observables $(127)-(142)$.

From simple subsequent computation we derive steady states for Π^*, Π^{w*}, mc, v^p, v^w, Π^{M*}, v^M, $\tilde{\Pi}^{x*}$, v^x, $\frac{p^M}{p}$, $\frac{p^i}{p}$, $\frac{q^x}{p}$, $\frac{p^x}{p}$, q, r, w, w^*, $\frac{p^c}{p}$.

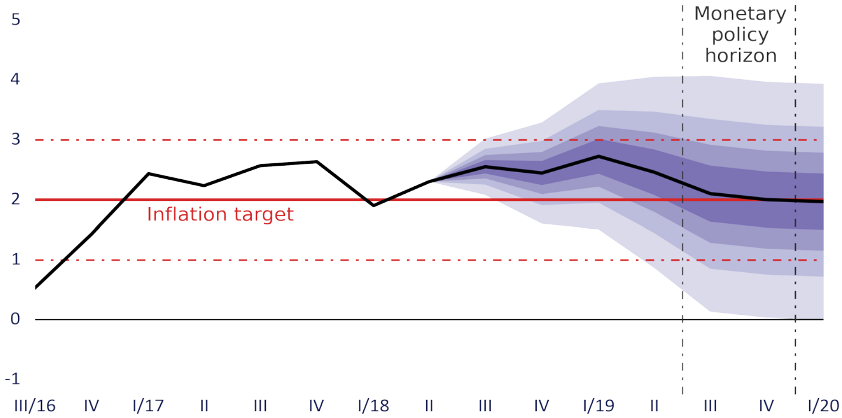
Solving 9 non-linear equations delivers steady states for k, y^d, i, x, c, g, M, λ, l^d.

Then we can compute the rest of steady states as c^d, i^d, x^d, c^M, i^M, x^M, y^M, l, g^{M_1}, g^{M_2}, g^{x_1}, g^{x_2}, f, g^1, g^2, exb^W, $prem$, y^W. We thus have **120 steady state** values from **120 equations**.

Psychohistory accomplished? Civ VII?



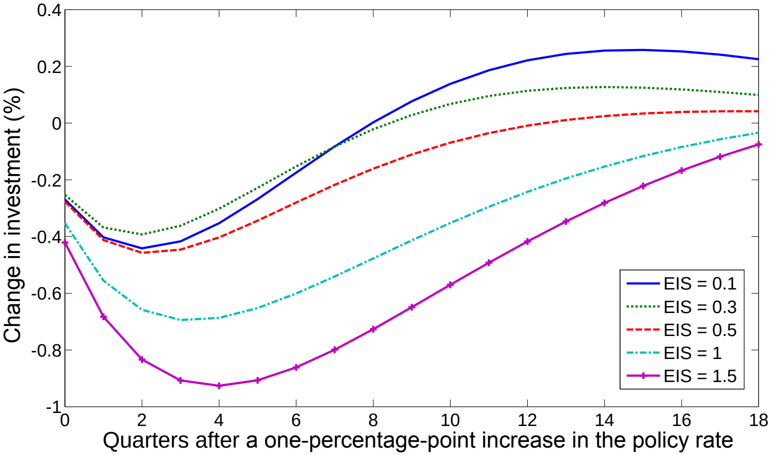
Main output: fan charts



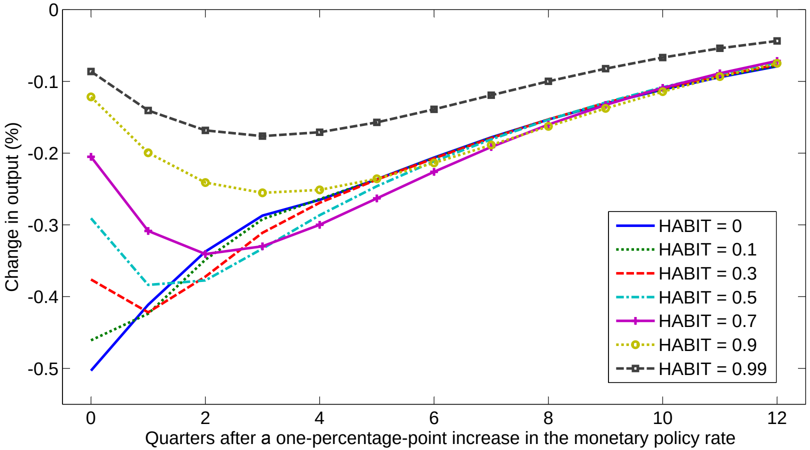
Calibration uncertainty: meta needed!

Parameter		Prior Mean
Preferences		
Habits	h	0.900
Labour supply coef.	ψ	8.832
Frisch elasticity	ϑ	1.250
Wedges		
Euler	κ^{euler}	1.0119
Forex	κ^{forex}	1.0034
Adjustment costs		
Investment	κ	20.000
Capital utilization	$\gamma 2$	0.280
Risk premium	Γ_{bW}	0.800
Elasticities of substitution		
Domestic goods	ϵ	5.000
Import goods	ϵ_M	9.000
Export goods	ϵ_x	9.400
World goods	ϵ_W	0.860
Consumption goods	ϵ_c	7.600
Investment goods	ϵ_i	7.600
Labour types	η	7.000
Price and wage setting		
Calvo dom. prices	θ_p	0.500
Calvo exp. prices	θ_x	0.080
Calvo imp. prices	θ_M	0.750
Calvo wages	θ_w	0.380
Index. dom. prices	χ_p	0.750
Index. imp. prices	χ_M	0.500
Index. exp. prices	χ_x	0.350
Index. wages	χ_w	0.920
Monetary policy		
Taylor rule (int. rates)	γ_R	0.960
Taylor rule (output gap)	γ_y	0.220
Taylor rule (inflation)	γ_Π	1.150
Fiscal policy		
Public consumption	ρ_g	0.750
Home bias		
Home bias in consump.	n_c	0.280
Home bias in invest.	n_i	0.120
Home bias in export	n_x	0.350
Growth rates		
Invest. spec. tech.	Λ_μ	1.000
General tech.	Λ_A	1.009
Population	Λ_L	1.000
ER appreciation	$\dot{ex}$	0.994
Openness tech.	α_O	1.0035
Export spec. tech.	α_X	1.0058

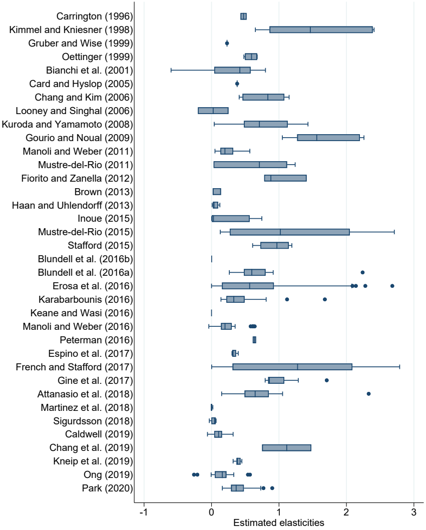
What happens if we change one parameter?



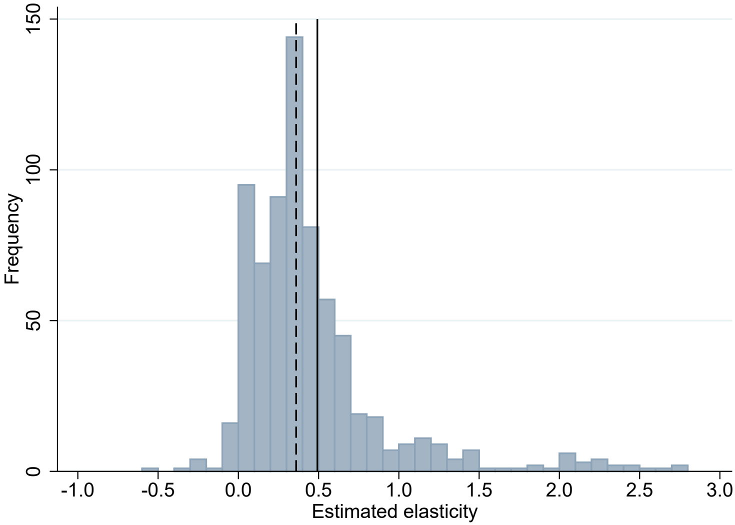
Coincidence? Hardly. Meta-analysis essential



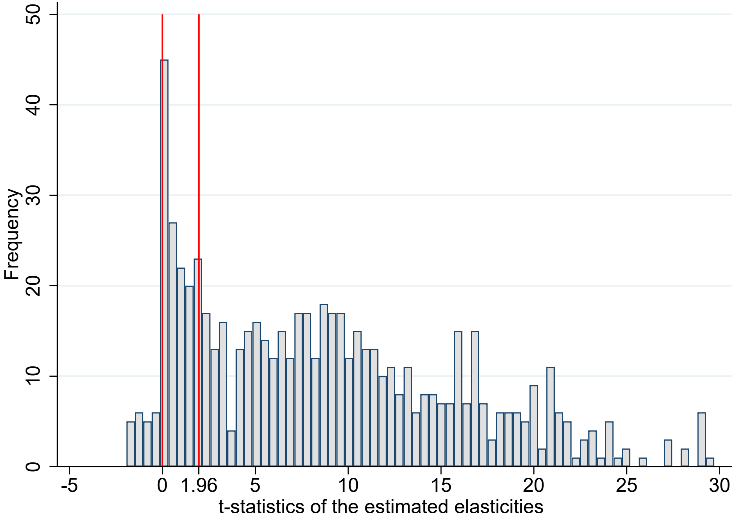
Estimates of the labor supply elasticity vary



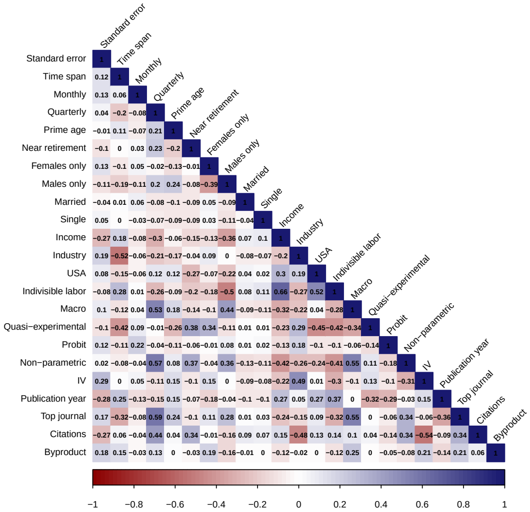
Values around 0.4–0.5 used for calibration (CBO)



Bias: some estimates less likely to be published



Context: different situations yield different estimates



Implied elasticity: taking bias and context into account

Let's construct a hypothetical study that uses all information reported in the literature but puts more weight on selected aspects (high precision, quasi-experimental setup, etc.)

	Subjective best practice	Blundell *et al.* (2016a)
Overall	0.02	-0.03
	$(-0.22, 0.25)$	$(-0.25, 0.18)$
Near retirement	0.14	0.09
	$(-0.14, 0.42)$	$(-0.14, 0.31)$
Women	0.12	0.07
	$(-0.08, 0.32)$	$(-0.10, 0.24)$

Course

1. Intro
2. Applied examples
3. Literature search
4. Data collection
5. Basic meta models
6. Replications (student presentations)
7. Publication bias
8. P-hacking
9. Heterogeneity
10. Meta-research
11. Limitations
12. Applications (student presentations)

Grading

- Applied meta-analysis (40%)
- Replication (20%)
- Discussion (20%)
- Activity (10%)
- Attendance (10%)

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Meta-analysis of social science research: A practitioner's guide

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Abstract

This article provides concise, nontechnical, step-by-step guidelines on how to conduct a modern meta-analysis, especially in social sciences. We treat publication bias, *p*-hacking, and systematic heterogeneity as phenomena meta-analysts must always confront. To this end, we provide concrete methodological recommendations. Meta-analysis methods

Resources

meta-analysis.cz