Monetary policy in a two-country model with behavioral agents

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The paper does not present the offical view of the NBP

Outline

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Motivation

- Rational expectation (RE) assumption dominates in macro modeling
- But growing evidence that people do not act rationally
- Several alternative approaches, e.g. learning, rational inattention, diagnostic expectations, k-level thinking...
- ...& cognitive discounting (behavioral expectations) (Gabaix and Laibson (2001, 2017); Gabaix (2019, 2020))
- Consequences for monetary policy (in particular in open economies) largely unexplored (Kolasa et al., 2022)

This paper

- Plug behavioral expectations (BE) into a two-country (open economy) model
- Bring it to the data, compare the fit to RE
- Explore consequences for:
  - monetary policy
  - economic modeling

Outline

Model structure: overview

- Simple new Keynesian model:
  - Two economies
  - HH work, consume, have access to domestic and foreign bonds
  - Final goods assembled from home and foreign intermediate goods
  - Intemediate goods produced with labor, under monop. competition and sticky prices
  - Monetary policy: Taylor rule
  - Fiscal policy: lump-sum taxes, debt
- + behavioral expectations

Behavioral expectations

- Agents perceive future deviations from the steady state myopically
- Example: interest rate in period $t+k$: $r_{t+k} = \bar{r} + \hat{r}_{t+k}$
  - Behavioral expectations of future deviations shrink by factor m^k, relative to rational expectations
  - $m \in [0, 1]$ captures cognitive discounting
  - $E_t^{BE} r_{t+k} = E_t^{BE}(\bar{r} + \hat{r}_{t+k}) = E_t(\bar{r}) + m^k E_t(\hat{r}_{t+k})$.
- Derived from microfoundations (assuming noisy information)

Households

- Maximize expected lifetime utility

$$E_0^{BE}\left\{\sum_{t=0}^{\infty}\varepsilon_{u,t}\beta^t\left(\frac{c_t^{1-\sigma}}{1-\sigma_c}-\frac{n_t^{1+\gamma}}{1+\gamma}\right)\right\}$$

subject to the budget constraint

$$\begin{aligned} P_t c_t + B_{H,t} + S_t B^*_{H,t} + P_t T_t \quad &\leq \\ W_t n_t + R_{t-1} B_{H,t-1} + S_t \kappa_{t-1} R^*_{t-1} B^*_{H,t-1} + P_t \Gamma_t & \end{aligned}$$

Households - equilibrium conditions

- Behavioral Euler equation

$$\underbrace{\hat{c}_t}_{\text{consumption}} = \underbrace{mE_t\hat{c}_{t+1}}_{\text{behaviorally expected consumption}} - \frac{1}{\sigma_c}\underbrace{\left(\hat{R}_t - mE_t\hat{\pi}_{t+1}\right)}_{\text{behaviorally expected real interest rate}} + \xi(1-m)\underbrace{\left(\hat{b}_{H,t} + \hat{b}^*_{H,t}\right)}_{\text{domestic and foreign debt}}$$

- Behavioral UIP condition

$$\underbrace{\hat{R}_t - mE_t\hat{\pi}_{t+1}}_{\text{behaviorally expected domestic real interest rate}} = \underbrace{\hat{R}^*_t + \hat{\kappa}_t - m\hat{\pi}^*_{t+1}}_{\text{behaviorally expected foregin real interest rate}} + \underbrace{mE_t\hat{q}_{t+1} - \hat{q}_t}_{\text{behaviorally expected RER depreciation rate}}$$

Producers

- Final goods produced with domestic and foreign intermediate inputs

$$y_t = \left((1-\eta)^{\frac{1}{\phi_y}} y_{F,t}^{\frac{\phi_y - 1}{\phi_y}} + \eta^{\frac{1}{\phi_y}} y_{H,t}^{\frac{\phi_y - 1}{\phi_y}} \right)^{\frac{\phi_y}{\phi_y - 1}}$$

- Intermediate goods manufactured with labor input

$$y_{H,t}(i) + \frac{1-\omega}{\omega} y_{H,t}^*(i) = n_t(i)$$

- Prices are sticky

Producers - equilibrium conditions

- Phillips curve (domestic producers, simplified)

$$\begin{aligned}\hat{\pi}_{H,t} &= \frac{(1-\theta)(1-\beta\theta)}{\theta}(\hat{mc}_t - \hat{p}_{H,t}) - (1-m)(1-\theta)\beta\hat{p}_{H,t} \\ &+ m\beta E_t\hat{\pi}_{H,t+1} - m\beta\left(1-M^f\right)E_t\hat{\pi}_{t+1}\end{aligned}$$

where

$$M_{f,H} = (\theta + (1-\theta)\frac{(1-\beta\theta)}{(1-\beta\theta m)})$$

Monetary and fiscal policy

- Taylor rule

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\gamma_R} \left[\left(\frac{\pi_t}{\pi}\right)^{\gamma_\pi} \left(\frac{\tilde{y}_t}{\tilde{y}}\right)^{\gamma_y}\right]^{1-\gamma_R} e^{\varepsilon_{R,t}}$$

- Government budget

$$g_t + R_t b_{G,t-1} = T_t + b_{G,t}$$

- Tax rule

$$T_t - \bar{T} = \nu(b_{G,t} - \bar{b}_G)$$

Calibration/Estimation

- 11 parameters calibrated (e.g. country size, discount factors, home bias)
- Poland's population share calibrated to 5%
- Remaining (18) parameters estimated using Bayesian methods

Estimation

- Data 1q1999-4q2021 for PL and EA
- 2xHICP, 2xConsumption, 2xInterest rate, 1xReal exchange rate
- Bayesian estimation, standard priors of standard parameters
- Prior for m beta with mean 0.85
- 2 MCMC chains, each 250.000 draws
- Robustness: Covid period excluded, shadow rate in EA

Estimation results

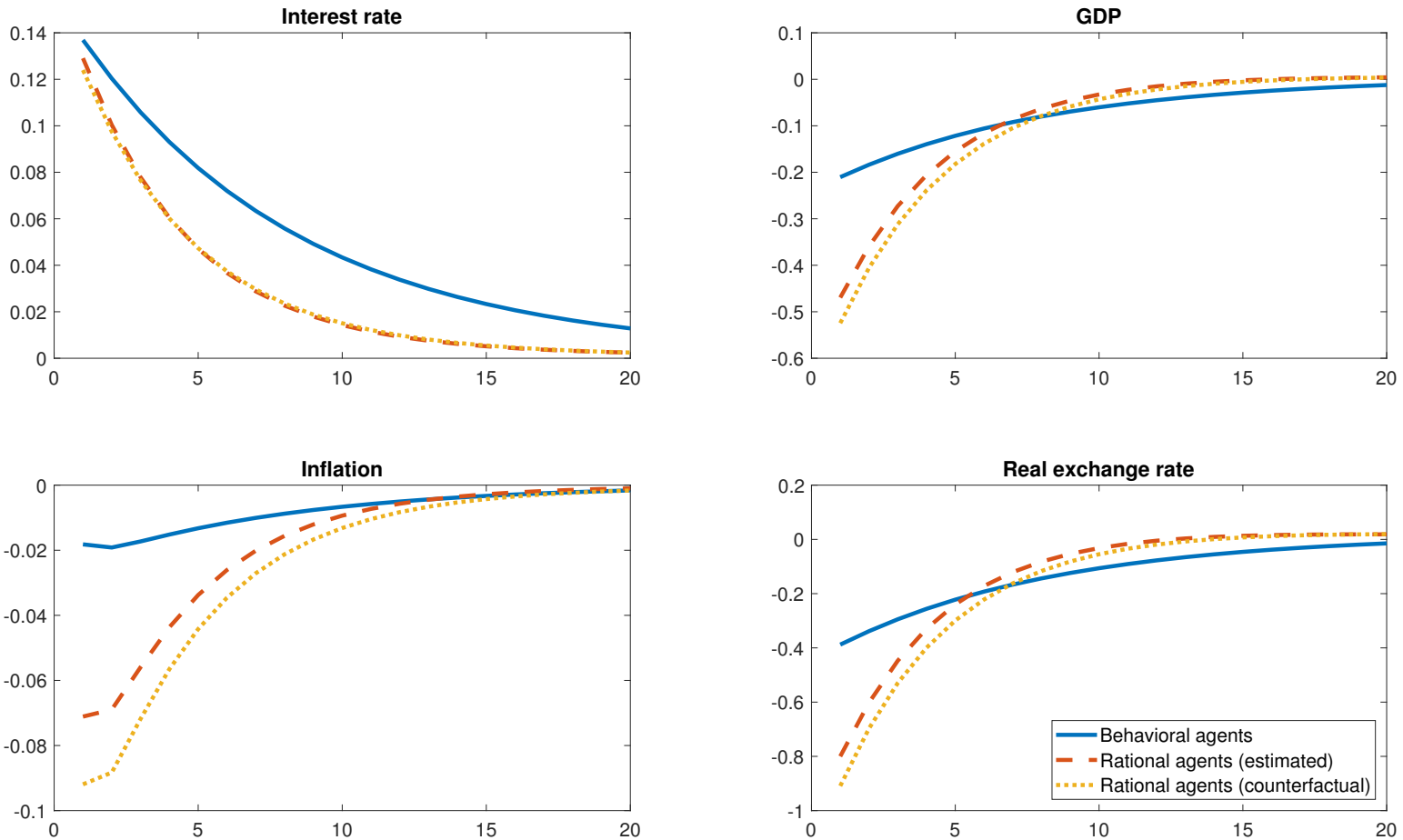
Parameter	Prior distribution			Posterior distribution	
	type	Mean	St. Dev.	Mean	St. Dev.
m	beta	0.85	0.05	0.70	0.04

- We estimate the BE and the RE models
- Bayes factor $6.6 \cdot 10^7$ ("decisive" evidence)
- Hence we treat the BE model as the "true" one

Outline

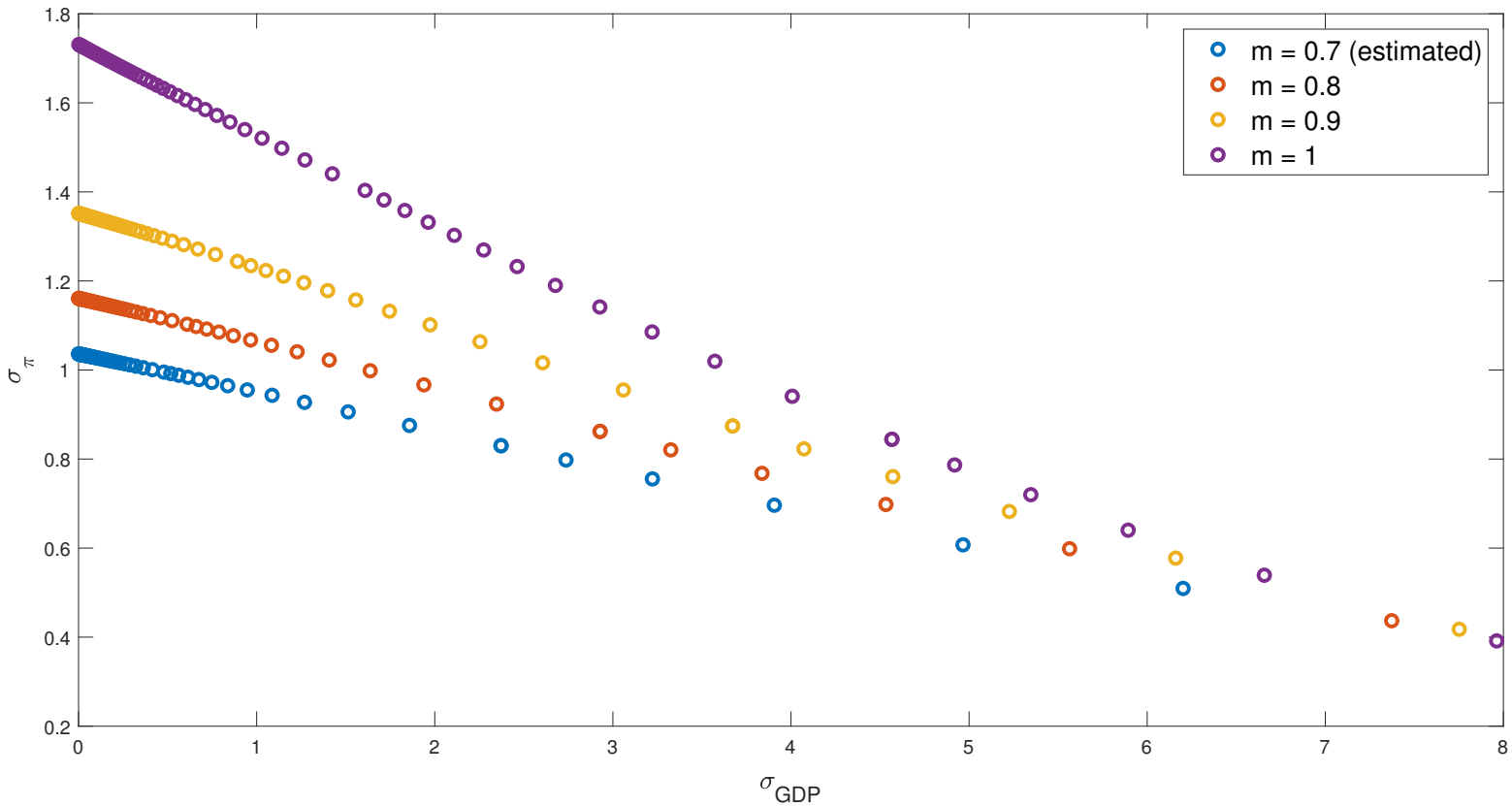
Monetary policy shocks

- Monetary policy less powerfull under BE (in both PL and EA) ...



Monetary policy trade-off

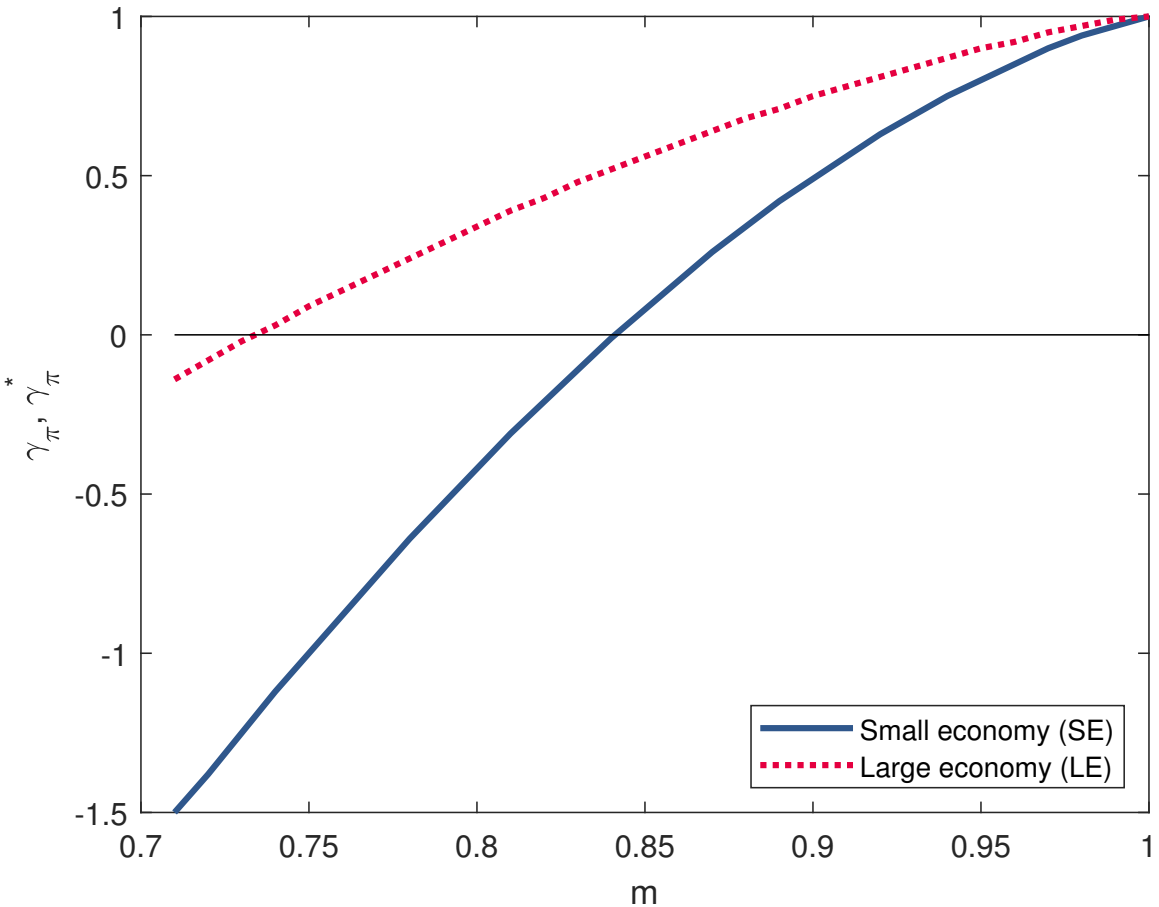
- ... and faces a worse trade-off



Note: efficient policy frontiers for varying weights on output and inflation stabilization

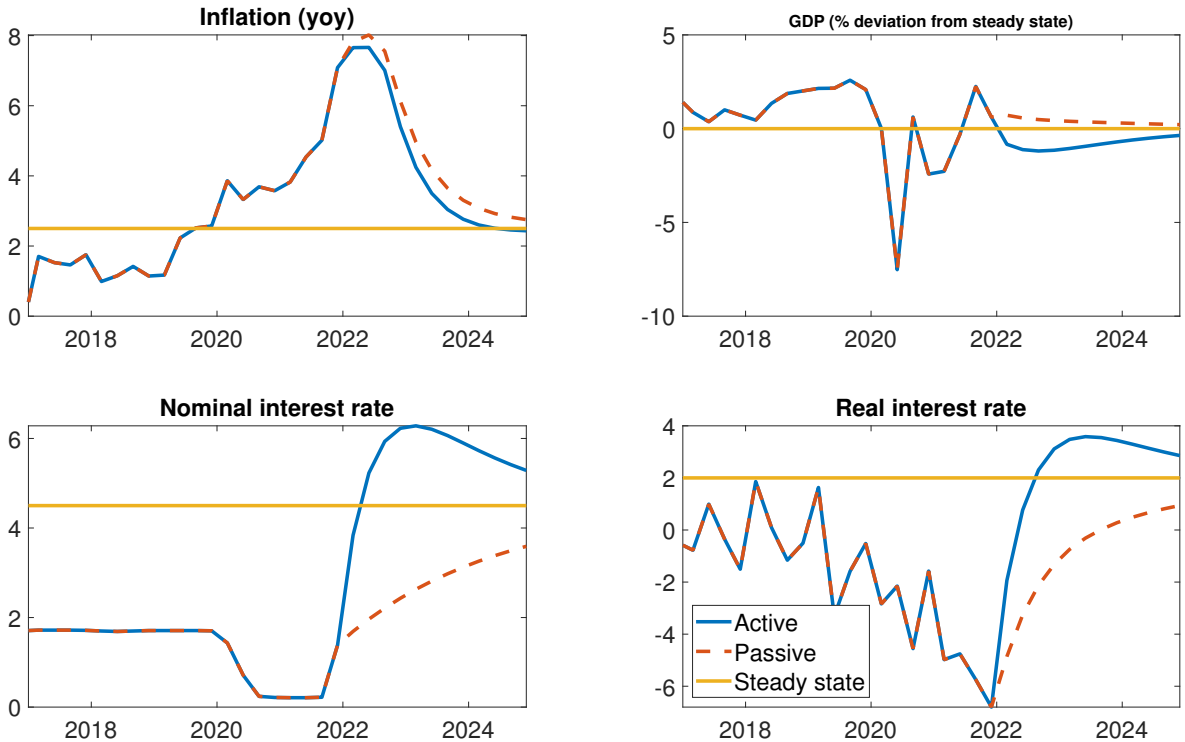
Taylor principle

- ...but determinacy regions are much larger than with RE
- especially for the small economy



Active vs. passive policy reaction

- So, can passive policy bring inflation back to target?
- Yes. But this assumes perfectly credible infl. target



Notes: 1) simulation assumes no shocks after 4q2021
2) this is not revealed truth but just a conditional model simulation

Puzzles

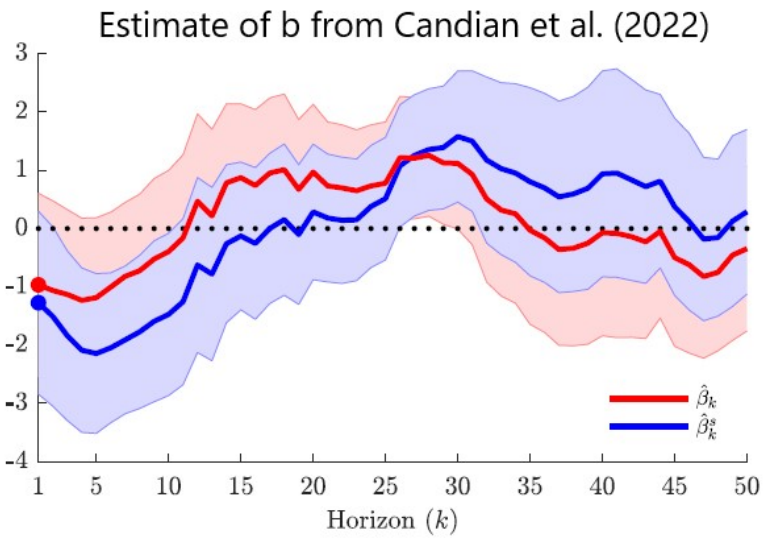
- Modern open-economy macro features a number of puzzles, e.g.
  - UIP puzzle
  - Business cycle comovement puzzle
- We check if/how much the BE framework helps

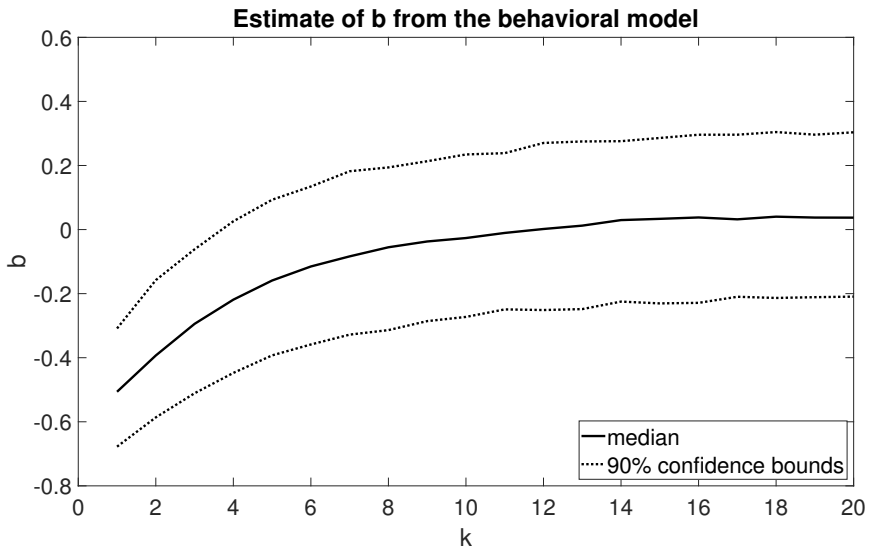
UIP puzzle

- Under RE uncovered interest rate parity holds
- Excess returns on foreign currency $XR_{t+1} \equiv \left(R_t^f - R_t\right) + (S_{t+1} - S_t)$
  - come only by surprise
  - and are unforecastable
- But empirical evidence speaks against it (e.g. Fama 1984; Engel 2013)
- How much does the BE framework solve?

UIP estimation

- Estimated equation $XR_{t+k} = a + b\left(R_t - R_t^f\right) + \epsilon_t \quad k = 1, 2, ...$





International spillovers - any progress?

- Open economy models feature very small international spillovers (and business cycle correlations)
- BE modifies impulse responses, deviates from UIP
- Does this help?

International spillovers - no progress

- No major improvement in:
  - variance share of LE shocks of SE variables

Model \ Variable	GDP	Inflation
Behavioral	6.34%	0.69%
Rational	4.85%	1.19%

  - correlation between LE and SE variables

Model \ Variable	GDP	Inflation
Behavioral	18%	0%
Rational	14%	0%

Outline

Conclusions

1. Agents do not act rationally and taking one aspect (cognitive discounting) into account
    1. is supported by the data
    2. monetary policy weaker
    3. but more stabilizing
    4. improvement on UIP puzzle
    5. no improvement on int. spillovers

Outline

Calibration

Parameter	Value	Description
ω	0.05	Agents residing in the small economy (Poland)
β, β^*	0.995	Discount factors
γ, γ^*	1	Inverse of Frisch elasticity of labor supply
μ, μ^*	2.5	Elasticity of substitution between home and foreign goods
η_H	0.7	Home bias in consumption (Poland)
η_H^*	0.98	Home bias in consumption (EA)
ν,ν^*	0.1	Semi-elasticity of taxes

Estimation

Parameter	Prior distribution			Posterior distribution	
	type	Mean	St. Dev.	Mean	St. Dev.
m	beta	0.85	0.05	0.70	0.04
θ_h	beta	0.75	0.1	0.88	0.03
θ_h^*	beta	0.75	0.1	0.81	0.11
θ_f	beta	0.75	0.1	0.85	0.04
θ_f^*	beta	0.75	0.1	0.89	0.01
ζ_h	beta	0.25	0.1	0.17	0.07
ζ_h^*	beta	0.25	0.1	0.24	0.09
ζ_f	beta	0.25	0.1	0.21	0.09
ζ_f^*	beta	0.25	0.1	0.09	0.04
χ	beta	0.01	0.005	0.01	0.01
σ	beta	2	0.25	2.15	0.23
σ^*	beta	2	0.25	1.92	0.24
γ_r	beta	0.7	0.1	0.91	0.01
γ_π	norm	1.25	0.1	1.32	0.09
γ_y	beta	0.125	0.05	0.17	0.05
γ_r^*	beta	0.7	0.1	0.94	0.01
γ_π^*	norm	1.25	0.1	1.24	0.10
γ_y^*	beta	0.125	0.05	0.13	0.05

Estimation

Parameter	Prior distribution			Posterior distribution	
	type	Mean	St. Dev.	Mean	St. Dev.
ρ_p	beta	0.7	0.1	0.65	0.08
ρ_p^*	beta	0.7	0.1	0.37	0.07
ρ_κ	beta	0.7	0.1	0.79	0.05
ρ_c	beta	0.7	0.1	0.67	0.07
ρ_c^*	beta	0.7	0.1	0.57	0.07
σ_ϕ	invg	0.003	Inf	0.0014	0.0001
σ_ϕ^*	invg	0.003	Inf	0.0009	0.0001
σ_p	invg	0.003	Inf	0.25	0.16
σ_p^*	invg	0.003	Inf	0.27	0.08
σ_κ	invg	0.01	Inf	0.018	0.0023
σ_c	invg	0.01	Inf	0.036	0.0045
σ_c^*	invg	0.01	Inf	0.037	0.0052

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