Learning about Fiscal Policy and the Effects of Policy Uncertainty

Josef Hollmayr and Christian Matthes

Deutsche Bundesbank and Richmond Fed

What is this paper about?

- What are the effects of *subjective* uncertainty about fiscal policy on economic outcomes?
- To have something to say about this in a general equilibrium setting, we have to take a stand on how to model uncertainty

Approach

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- Does learning matter for outcomes?

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- Does learning matter for outcomes?
- In other words: are previous results in the literature robust to the specification of expectation formation?

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- Learning matters! - Outcomes of key macro variables (GDP, consumption and capital etc.) can be several percentage points lower for substantial periods of time under learning
- Very robust trade-off between either lower outcomes or higher business cycle volatility

Related Papers

1. Strand of learning Literature
    - Giannitsarou (2006)
    - Eusepi and Preston - multiple papers
2. Uncertainty in the economy
    - Bloom et al. (2012)
    - Born and Pfeifer (2011)
    - Fernandez-Villaverde, Guerron, Kuester and Rubio-Ramirez (2012)

Households

Each period, households maximize the infinite sum of discounted utility with the period utility function:

$$U_t = \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{L_t^{1+\phi}}{1+\phi} \tag{1}$$

subject to the budget constraint:

$$C_t(1+\tau_t^C) + B_t + I_t = W_t L_t(1-\tau_t^L) + (1-\tau_t^K)R_t^K K_{t-1} + R_{t-1}B_{t-1} + Z_t \tag{2}$$

and the law of motion for capital:

$$K_t = (1-\delta)K_{t-1} + I_t \tag{3}$$

and subject to their beliefs about fiscal policy (their perceived policy rule)

Firms

The production function follows the standard Cobb-Douglas type:

$$Y_t = A_t K_{t-1}^{\alpha} L_t^{1-\alpha} \tag{4}$$

with the exogenous process for technology given by:

$$A_t = \rho_a A_{t-1} + \epsilon_t^A \tag{5}$$

Fiscal Sector

The government is allowed to run deficits over time. The corresponding budget constraint is then given by:

$$B_t = B_{t-1}R_{t-1} - R_t^K K_t \tau_t^K - W_t L_t \tau_t^L - C_t \tau_t^C + G_t + Z_t \tag{6}$$

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The fiscal rules follow Leeper et al. (2010) - except for timing:
Government Expenditure:

$$\log(G_t) = G_c - \rho_{g,y} \log(Y_{t-1}) - \rho_{g,b} \log(B_{t-1}) + \epsilon_t^G \tag{7}$$

Transfers:

$$\log(Z_t) = Z_c - \rho_{z,y} \log(Y_{t-1}) - \rho_{z,b} \log(B_{t-1}) + \epsilon_t^Z, \tag{8}$$

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Consumption Tax Rate Rule:

$$\log(\tau_t^C) = \tau_c^c + \epsilon_t^C \tag{9}$$

Other Tax Rate Rules:

$$\log(\tau_t^i) = \tau_c^i + \rho_{i,y} \log(Y_{t-1}) + \rho_{i,b} \log(B_{t-1}) + \epsilon_t^i \tag{10}$$

with i=L,K

Calibration of Parameters

Description	Parameter	Value
impatience	β	0.99
Capital share	α	0.33
Depreciation rate	δ	0.025
CES utility Consumption	σ	2
CES utility labor	ϕ	2
coeff. on Y in gov. exp. rule	$\rho_{g,y}$	0.034
coeff. on B in gov. exp. rule	$\rho_{g,b}$	0.23
coeff. on Y in transfer rule	$\rho_{z,y}$	0.13
coeff. on B in transfer rule	$\rho_{z,b}$	0.5
coeff. on Y labor tax rule	$\rho_{L,y}$	0.36
coeff. on B labor tax rule	$\rho_{L,b}$	0.049
coeff. on Y capital tax rule	$\rho_{K,y}$	1.7
coeff. on B capital tax rule	$\rho_{K,b}$	0.39
AR parameter technology	ρ_a	0.9
Std.deviation technology	σ_a	0.0062
Std.deviation gov. spending	σ_g	0.031
Std.deviation transfers	σ_z	0.034
Std.deviation cons.tax	σ_c	0.04
Std.deviation labor tax	σ_l	0.03
Std.deviation capital tax	σ_k	0.044

Table : Calibrated Parameters of the model

Calibrated parameters of the real economy in line with the literature on US economy. The fiscal parameters are taken from the estimation of Leeper et al. (2010).

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- The only thing private agents do not know is the vector of coefficients in the fiscal policy rules

Estimation

- some notation: Ω_t represents the vector of coefficients of all fiscal policy rules and τ_t the vector of fiscal policy instrument at time t
- firms and households learn via the Kalman filter
- the state space system is given by:

$$\tau_t = X_{t-1}\Omega_t + \eta_t \tag{11}$$

$$\Omega_t = \Omega_{t-1} + \mathbf{1}_t \nu_t \tag{12}$$

- We assume agents know the volatility of the innovations in the policy rules

What happens under learning? - An illustration

- Let's focus on one policy rule for simplicity:

$$\log(G_t) = G_c - \rho_{g,y} \log(Y_{t-1}) - \rho_{g,b} \log(B_{t-1}) + \epsilon_t^G$$

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- agents are going to estimate the coefficients.
- their perceived policy rule is given by:

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- note the form of the perceived policy shock $\widetilde{\epsilon}_t^G$:

$$\widetilde{\epsilon}_t^G = \epsilon_t^G + G_c - G_{c_t} - (\rho_{g,y} - \rho_{g,y,t})\log(Y_{t-1}) - (\rho_{g,b} - \rho_{g,b,t})\log(B_{t-1})$$

Within-period timing

- Private agents enter period t with beliefs (or point estimate) Ω_{t-1}, which is the posterior mean coming out of the Kalman filter.
- They treat estimated parameters as if they were known with certainty and formulate plans accordingly (Kreps 1998 calls this 'anticipated utility').
- The fiscal authority sets the systematic part of policy at the beginning of the period.
- Then shocks are realized, and agents observe the technology shock and the perceived fiscal policy rule shocks.
- Outcomes are determined in accordance with beginning-of-period plans.
- After observing outcomes, private agents update estimates and carry them forward to $t+1$.

Perceived Equilibrium Dynamics - How the economy evolves according to private agents

- $A(\Omega_{t-1})\mathbb{Y}_t = B(\Omega_{t-1})E_t^*\mathbb{Y}_{t+1} + C(\Omega_{t-1})\mathbb{Y}_{t-1} + D\varepsilon_t^*$
- log-linearized around perceived steady state
- Conditional on beliefs, this equation can be solved using standard algorithms (e.g. Gensys)
- $\mathbb{Y}_t = S(\Omega_{t-1})\mathbb{Y}_{t-1} + G(\Omega_{t-1})\varepsilon_t^*$

Solving for actual equilibrium dynamics

- Some more notation: we modify $C(\Omega_{t-1})$ to now include the *true* policy coefficients. We call this matrix $C^{true}(\Omega_{t-1})$
- $A(\Omega_{t-1})\mathbb{Y}_t = B(\Omega_{t-1})E_t^*\mathbb{Y}_{t+1} + C^{true}(\Omega_{t-1})\mathbb{Y}_{t-1} + D\varepsilon_t$
- $\mathbb{Y}_t = H(\Omega_{t-1})\mathbb{Y}_{t-1} + G(\Omega_{t-1})\varepsilon_t$
- $H(\Omega_{t-1}) = S(\Omega_{t-1}) + (A(\Omega_{t-1}) - B(\Omega_{t-1})S(\Omega_{t-1}))^{-1}(C^{true}(\Omega_{t-1}) - C(\Omega_{t-1}))$

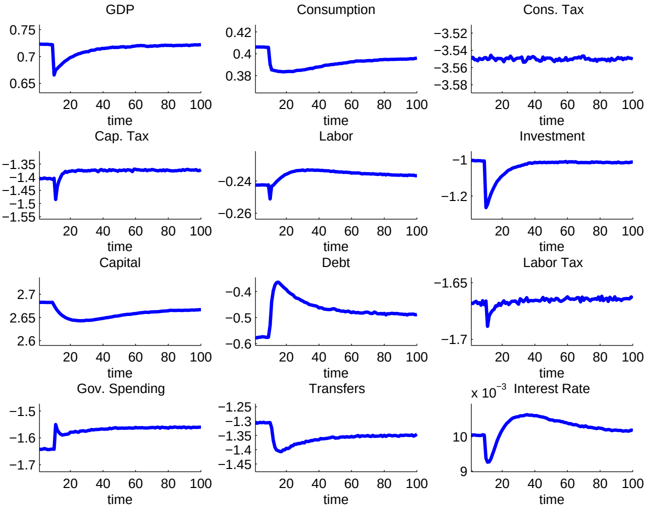
Outline of Results

- Setup of our experiments
- Effects of Learning/Uncertainty vs. RE benchmark
- What would be the effects of different fiscal measures?
- Do results hold under different specifications?

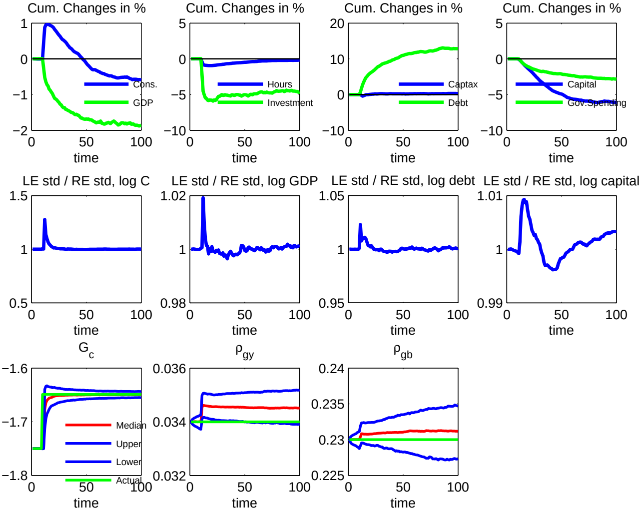
Setup of the Computational Experiment

- We start off our simulations at the original steady state
- In period 9, there is a negative technology shock that puts technology 5% below steady state
- The following period the government permanently increases government spending by 1% of initial steady state GDP (unanticipated)
- The government does so by changing the intercept in the policy rule for government spending
- policy change represents a 2 standard deviation shock according to agents' views

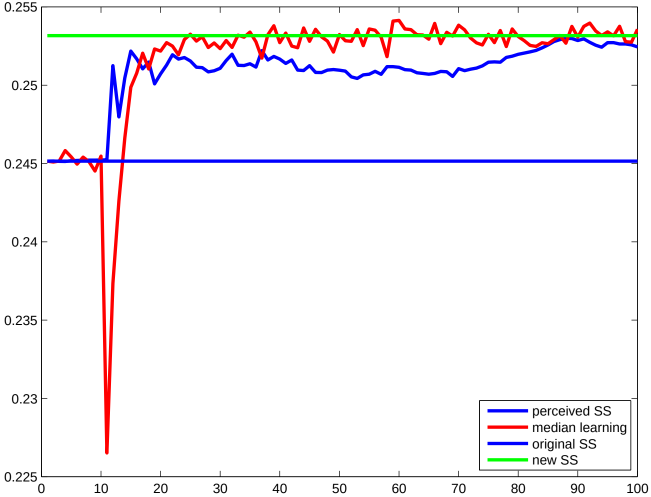
Rational Expectations - Outcomes



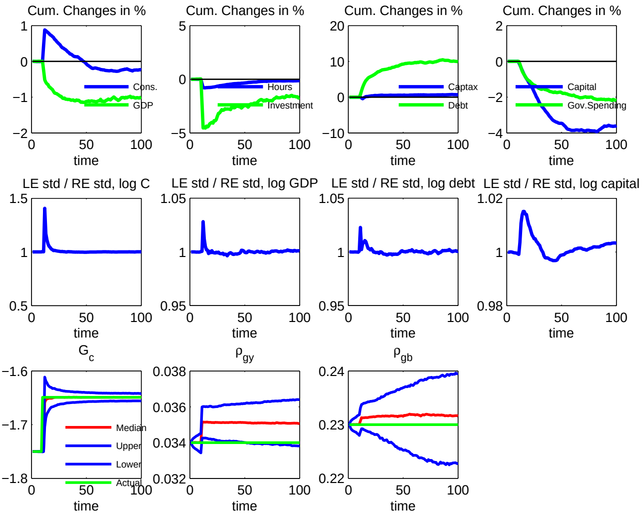
Learning - Outcomes: Benchmark



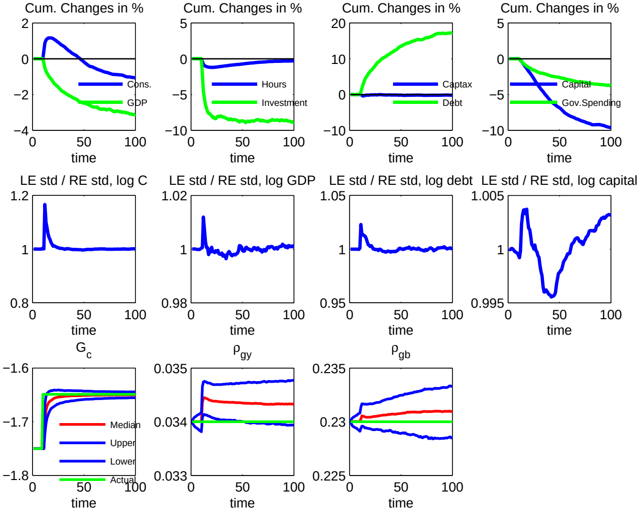
A Partial Explanation



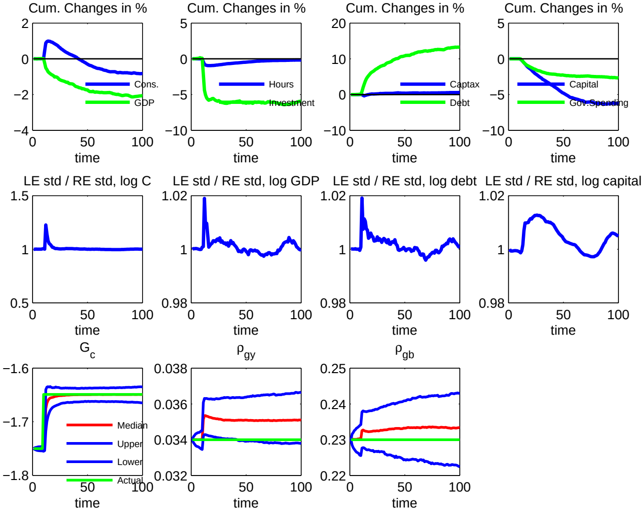
Learning - Outcomes: 1 Standard Dev.



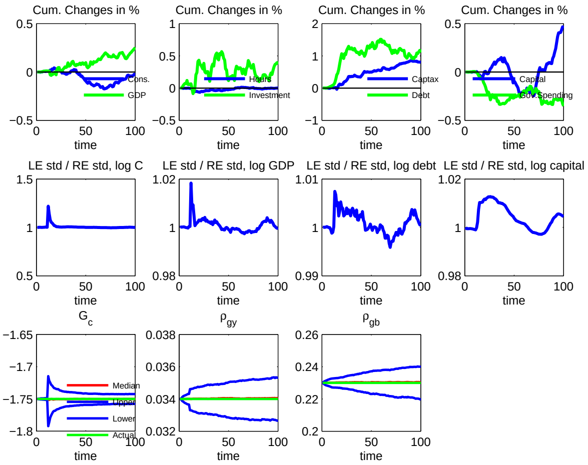
Learning - Outcomes: 3 Standard Dev.



Including Irrelevant 'Regressors'



The Case Of No Policy Changes



Concluding Thoughts

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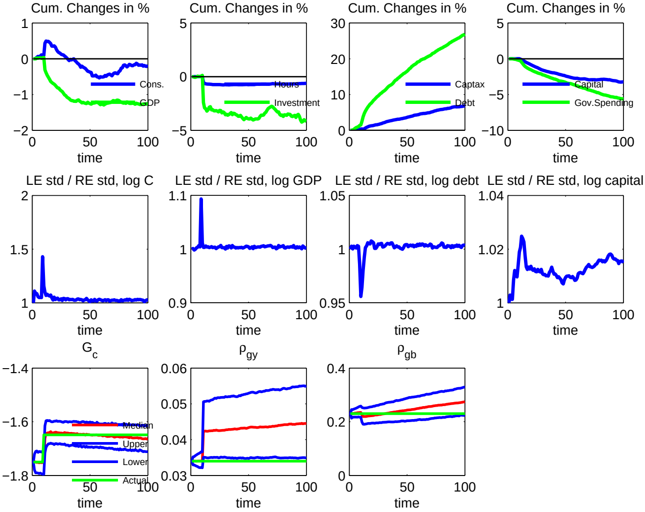
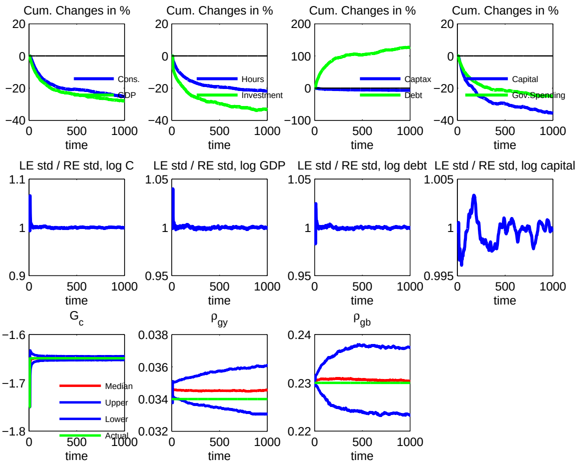
2. Differences can be substantial: either large average differences or increased volatility
3. robust across a large variety of simulation exercises

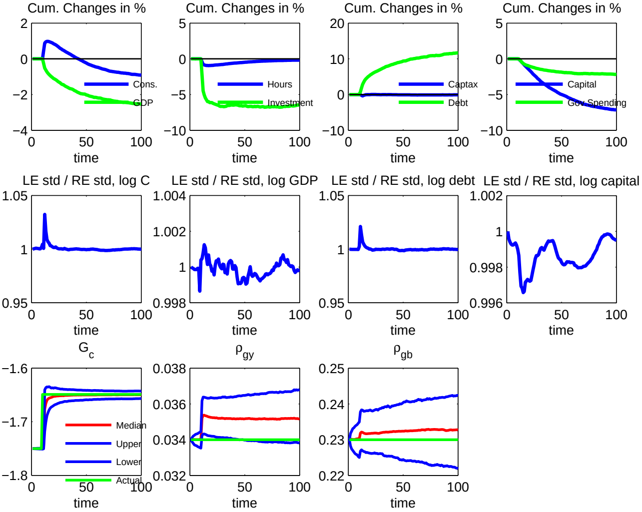
Different Utility Functions



Different Utility Function II



Learning only about G



Capital Tax Decrease

Suppose now that capital tax respond by a 1% (of GDP) decrease