Should monetary policy care about redistribution? Optimal fiscal and monetary policy with heterogeneous agents

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Introduction

- Monetary policy generates redistributive effects through various channels. (Bewley, 1983; McKay et al. 2016; Gornemann et al. 2016; Kaplan et al. 2018; Nuno and Moll 2018; Auclert 2019)
- Research question: Should monetary policy care about redistribution or only focus on monetary objectives (and leave redistribution to fiscal policy) ?
- What we do:
  - Compute optimal fiscal and monetary Ramsey policy with commitment in a quantitative HANK model (het-agent (HA) economy with capital, aggregate shocks and nominal rigidities).
  - **Fiscal policy**: linear labor and capital taxes, lump-sum transfer and one-period nominal public debt
  - **Monetary policy**: nominal interest rate.

How we do it

Computing Ramsey policies in HANK is challenging. We do so thanks to a methodological contribution.

- exensive use of the Lgrangian approach (Marcet and Marimon, 2019). Well adapted for HANK model.
- **Not enough**. To quantify, we derive a "truncated representation" of het-agent model. (Le Grand and Ragot 2020)
- Truncated representation?
  - Consider a well-chosen transfer system such that only the idiosyncratic history over the last N periods matters.

  $\rightarrow$ Finite-state space representation.

  $\rightarrow$ Consistent representation of the underlying Bewley model (same aggregate quantities, same prices).
- Allows for simple and accurate quantitative investigation.

Results' preview

- **Theoretical results.**
  - Irrelevance result: No redistributive role for monetary policy when linear capital and labor taxes are available, for both TFP shock and public spending shock. (in the spirit of Correia, Nicolini, Teles 2008; and Correia et al. 2013)
  - Characterization result: We characterize the Ramsey program for fiscal-monetary policy with various fiscal tools (with/without capital or labor tax).
- **Quantitative results.**
  1. **Fiscal policy**: Heterogeneity matters. Capital tax is much less volatile in HA economy compared to RA, public debt is more volatile.
  2. **Monetary policy**: Even with incomplete fiscal tools (no optimal capital tax), inflation has little role to play for redistribution.

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Literature

- Interactions between monetary and fiscal policies (no idiosyncratic risk): Chari and Kehoe (1999), Aiyagari, Marcet, Sargent, and Seppälä (2002), Bhandari, Evans, Golosov and Sargent (2017), Correia, Nicolini, and Teles (2008) and Correia, Nicolini, and Teles (2013).
- Monetary policy in het-agent economies with nominal frictions: Bilbiie (2008), McKay, Nakamura and Steinsson (2016), Gornemann, Kuester and Nakajima (2017), Kaplan, Moll, and Violante (2018), Nuño and Moll (2018), Auclert (2019).
- Optimal fiscal policy in HA model Acikgoz et al.(2018), Dyrda and Pedroni, (2019), Le Grand and Ragot, (2020)
- Closest paper: Bhandari, Evans, Golosov and Sargent (2020).

Different result from Dyrda and Pedroni, (2019) and Bhandari, Evans, Golosov and Sargent (2020). Main reason: optimal steady state, no transition (under investigation).

Outline of the presentation

1. The environment
2. Optimal fiscal-monetary policy
3. Truncated representation
4. Numerical Simulations

1 - The environment- Preferences

- Unit mass of agents facing uninsurable productivity risk
- Aggregate state Z_t that affects TFP. First-order Markov process.
- Idiosyncratic productivity levels $y \in \mathcal{Y}$: constant discrete first-order Markov process.
- GHH utility function over consumption and labor supply:

$$U(c,l) = u\left(c - \chi^{-1}\frac{l^{1+1/\varphi}}{1+1/\varphi}\right).$$

Program

$$\max_{\left(a_t^i, c_t^i, l_t^i\right)_{t\geq 0}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(c_t^i, l_t^i),$$

$$c_t^i + a_t^i = (1 + r_t)a_{t-1}^i + w_t y_t^i l_t^i + T_t$$

$$a_t^i \geq -\bar{a},\ c_t^i > 0,\ l_t^i > 0$$

where,

- Labor tax: $w_t = (1 - \tau_t^L)\tilde{w}_t$
- Capital tax: $r_t = (1 - \tau_t^K)\tilde{r}_t$
- Lumpsum transfer: T_t

Production

Standard NK production sector with capital.

- Aggregator of intermediate goods: $Y = \left[\int_0^1 y_j^{\frac{\varepsilon-1}{\varepsilon}} dj\right]^{\frac{\varepsilon}{\varepsilon-1}}$.
- Intermediary firms production function : $y = Z\tilde{k}^{\alpha}\tilde{l}^{1-\alpha}$.
- Rotemberg adjustment price, parameter κ
- Pricing kernel to price profits M_t
- Cost minimization. Marginal cost:

$$\zeta_t = \frac{1}{Z_t}\left(\frac{\tilde{r}_t^K + \delta}{\alpha}\right)^{\alpha}\left(\frac{\tilde{w}_t}{1-\alpha}\right)^{1-\alpha}$$

- Generates a Phillips curve ($\Pi_t = \frac{P_{t+1}}{P_t}$ and $Y = ZK^{\alpha}L^{1-\alpha}$).

$$\Pi_t(\Pi_t - 1) = \frac{\varepsilon - 1}{\kappa}(\zeta_t - 1) + \beta\mathbb{E}_t\Pi_{t+1}(\Pi_{t+1} - 1)\frac{Y_{t+1}}{Y_t}\frac{M_{t+1}}{M_t}.$$

Asset markets

- Three assets:
  - Capital shares with pre-tax tax net rate $\tilde{r}_t^K$.
  - Public debt B_{t-1} with nominal pre-tax gross rate $\tilde{R}_{t-1}^{B,N}$ that is predetermined.
  - monpoly rents taxed away.
- Risk-neutral fund collects capital and public debt and issues claims to agents with rate $\tilde{r}_t$ (and borrowing limits).

  $\rightarrow$ no actual portfolio choice by agents.
- Average return (no profit condition)

$$\tilde{r}_t = \frac{\tilde{r}_t^K K_{t-1} + (\frac{\tilde{R}_{t-1}^{B,N}}{\Pi_t} - 1) B_{t-1}}{B_{t-1} + K_{t-1}}$$

and $r_t = (1 - \tau_t^K)\tilde{r}_t$

Government

Has to finance exogenous G_t and transfers T_t. Fiscal tools:

- Distorting taxes on capital and labor (τ_t^K and τ_t^L).
- Public debt issuance B_t.
- Firms' profits are fully taxed (No steady-state distortions).

Governmental budget constraint (Chamley, 1986)

$$G_t + B_{t-1} + r_t \left(B_{t-1} + K_{t-1}\right) + w_t L_t + T_t = B_t + \left(1 - \frac{\kappa}{2}\pi_t^2\right) Y_t - \delta K_{t-1}.$$

Monetary-fiscal instruments:

$$\left(\tau_t^L, \tau_t^K, T_t, B_t, \tilde{R}_t^{B,N}\right)_{t \geq 0}.$$

Market clearing

- Financial market clearing:

$$\int a_t^i \ell(di) = K_t + B_t.$$

- Goods market clearing:

$$\int c_t^i \ell(di) + G_t + K_t = Z_t K_t^{\alpha} L_t^{1-\alpha} + (1-\delta) K_{t-1}$$

- Labor market clearing:

$$L_t = \int_i y_t^i l_t^i \ell\left(di\right).$$

Equilibrium: For given prices and fiscal policy, individual allocations solve agents' program; factor prices are consistent with firms' behavior; government budget is balanced; markets clear.

2 - Optimal fiscal-monetary policy

- Aggregate welfare criterion: $\sum_{t=0}^{\infty} \beta^t \int_i \omega_t^i U(c_t^i, l_t^i) \ell(di)$. Additive with weights (ω_t^i).
- Consistently, pricing kernel $M_t = \int_i \omega_t^i U_c(c_t^i, l_t^i) \ell(di)$.
- **Ramsey program:** Find fiscal and monetary policy that maximizes aggregate welfare among competitive equilibria. I.e. maximize aggregate welfare subject to:
  - individual and governmental budget constraints,
  - individual Euler equations,
  - Phillips curve,
  - market clearing conditions,
  - factor price relationships. See program

The Lagrangian approach

- Rich framework for normative questions.

$\rightarrow$ Rely on Lagrangian approach of Marcet and Marimon (2020): **Factorization of the Lagrangian**. See factorization

- Enables the derivation of first-order conditions. Useful for:
  - Interpretation and understanding of mechanisms.
  - Simulations of solutions.
- Note: **Slater's condition** raises no problem here (FOCs in our problem = limits of FOCs with infinitely concave penalty functions).
- Two Lagrange multipliers of interest:
  - λ_t^i: on agents' Euler equation. $\lambda_t^i > 0$ when the planner perceives excess savings.
  - μ_t: on government budget constraint.

A transformation

Key concept: social valuation of liquidity for agent i, denoted by ψ_t^i.

$$\begin{aligned}\psi_t^i \equiv & \omega_t^i U_c(c_t^i, l_t^i) - U_{cc}(c_t^i, l_t^i)\left(\lambda_t^i - (1+r_t)\lambda_{t-1}^i\right) \\ & - \left((\gamma_t - \gamma_{t-1})\,\Pi_t\,(\Pi_t - 1) - \frac{\varepsilon - 1}{\kappa}\gamma_t\,(\zeta_t - 1)\right) Y_t \omega_t^i U_{cc}(c_t^i, l_t^i).\end{aligned}$$

$\rightarrow$ Benefit, from planner's perspective, of transferring an extra unit of consumption to agent i.

Related concept: net social valuation.

$$\hat{\psi}_t^i = \psi_t^i - \mu_t.$$

Real economy $\kappa = 0$: Ramsey - FOCs

- Euler equation (unconstrained i) for $\hat{\psi}^i$ and μ_t:

$$\hat{\psi}_t^i = \beta \mathbb{E}_t \left[(1 + r_{t+1}) \hat{\psi}_t^i \right] \quad \text{and} \quad \mu_t = \beta \mathbb{E}_t \left[\left(1 + \tilde{r}_{t+1}^K \right) \mu_{t+1} \right].$$

$\rightarrow$ Two different interest rates because two different liquidity costs.

- Transfer T : $\underbrace{\int_i \hat{\psi}_t^i \ell(di)}_{\text{net redistributive effects}} = 0.$
- Capital tax: $\underbrace{\int_i \hat{\psi}_t^i a_{t-1}^i \ell(di)}_{\text{net redistributive effects}} = \underbrace{- \int_i \lambda_{t-1}^i U_c(c_t^i, l_t^i) \ell(di)}_{\text{savings distortions}}.$
- Labor tax: $\underbrace{\int_i \hat{\psi}_t^i y_t^i l_t^i \ell(di)}_{\text{net redistributive effects}} = \underbrace{\varphi \mu_t \left(L_t - (1 - \alpha) \frac{Y_t}{w_t} \right)}_{\text{labor supply distortions}}.$

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Nominal economy with all fiscal tools

An irrelevance result

With the full menu of fiscal tools, the planner exactly reproduces the real-economy allocation and there is no further role for monetary policy.

Intuition. There are sufficient independent instruments to set the mark-up wedge of firms to $\zeta_t = 1$ (as in the real case). Inflation variations are then only costly and $\Pi_t = 1$. (Correia, Nicolini, and Teles, 2008)

Question. What happens with missing fiscal instruments?

With fixed τ^K, possible redistributive role for monetary policy. FOCs computed in the paper $\rightarrow$ need for quantitative investigation.

3 - Truncated representation

$$\{y_{-\infty}, \cdots, y_{-N}, y_{-N+1}, .., y_{-1}, y_0\} = y^i$$

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$$\{y_{-\infty}, \cdots, y_{-N}, \underbrace{y_{-N+1}, .., y_{-1}, y_0}_{y^N}\} = y^i$$

$\uparrow$ Γ^*

3 - Truncated representation

$$\{\underbrace{y_{-\infty}, \cdots, y_{-N}}_{\sim \xi_{y^N}} \underset{\uparrow}{,}_{\Gamma^*} \underbrace{y_{-N+1}, .., y_{-1}, y_0}_{y^N}\} = y^i$$

3 - Truncated representation

Truncation: An insurance system

- Agents face an insurance system $\Gamma_{N+1}(y^{N+1})$ depending on the last $N+1$ period idiosyncratic history $y^{N+1} = (y_{-N}, \ldots, y_0)$.
- Agents have preference shifters depending on y^{N+1}, ξ_{y^N}.

$$V(a, y^{N+1}, X) = \max_{a', c, l} \xi_{y^N} U(c, l) + \beta \mathbb{E} V(a', (y^{N+1})', X')$$

$$a' + c = wyl + (1 + r)a + T + \Gamma_N(y^{N+1}, X),$$

$$c,\, l \geq 0,\, a' \geq -\bar{a},$$

Truncation (cont'd)

Truncation

There exists a balanced insurance system $\Gamma^*_{N+1}(y^{N+1}, X)$ such that agents with the same y^N have the save beginning of period wealth $\tilde{a}_{t,y^N}$.

Only a finite number of different agents: Y^N.

Construction of the ξs

The ξs can be constructed such that, at the steady-state:

- Allocations of the truncated equilibrium are averages of Bewley allocations (among agents with same truncated history).

$\rightarrow$ Same steady-state aggregate quantities and prices in both equilibria.

Truncation removes heterogeneity within truncated history and yields allocations compatible with Euler equations.

Ramsey in the truncated model

Truncated model: well-suited finite state space structure for Ramsey:

$$\max \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \sum_{y^N \in \mathcal{Y}^N} S_{t,y^N} \omega_{y^N} \xi_{y^N} U(c_{t,y^N}, l_{t,y^N}) \right]$$

subject to appropriate constraints. See program

Simulating the model

Once the ξs computed, simulate the (truncated) model:

- With perturbation method (e.g., with Dynare).
- Assuming constant ξs.
- (Assuming constant credit-constrained set.)

Performance?

- **Theory:** When $N \to \infty$, truncated allocations $\to$ 'full-fledged' allocations (even with small aggregate shocks).
- **Quantitative:** Even with short truncation length, model outcomes comparable to Reiter (2009), or Boppart, Krusell, and Mitman (2018), and Auclert et al. (2019). See Le Grand and Ragot, 2020.

See Algorithm

4 - Numerical Simulations

The strategy

1. Calibrate a Bewley model with a relevant fiscal system
2. Project the model. Find the ξ_{y^N}.
3. Find the ω_{y^N} such the *steady-state* fiscal system is optimal. (The closest to utilitarian: Inverse optimal approach, Bargain and Keane, 2010; Bourguignon and Amadeo, 2015; Heathcote and Tsujiyama, 2017; Chang et al. 2018)
4. Optimal dynamics after TFP shocks and G shocks.
   - HA economy with full set of instruments
   - HA economy with constant capital tax
   - Complete-market economy

Calibration

Standard Calibration, Period = quarter. :

- **Preferences:** Frisch el. labor $\varphi = 0.5$, (Chetty, et al. 2011), $\beta = 0.99$
- **Production:** $Z_t = \exp(z_t)$ with $z_t = \rho_z z_{t-1} + \sigma_z \varepsilon_t^z$. $\rho_z = 0.95$ and $\sigma_z = 0.31\%$, such that std dev. of z is 1% (den Haan, 2010).
- **Productivity risk:** $\log y_t = \rho_y \log y_{t-1} + \sigma_y \varepsilon_t^y$ with $\rho_y = 0.99$ and $\sigma_y = 0.14$. (Krueger et al. 2018).
- **Taxes:** $\tau^K = 36\%$, $\tau^L = 28\%$, $T/Y = 8\%$. Yields debt-to-GDP $B/Y = 60\%$ and public spending-to-$G/Y = 12.4\%$. (Trabandt and Uhlig, 2011)

$\rightarrow$ Gini for wealth = 0.77, average capital-to-GDP = 2.5.

$\rightarrow$ Using Rouwenhorst (1995), 5 states with constant transitions.

	Preference and technology	
β	Discount factor	0.99
α	Capital share	0.36
δ	Depreciation rate	0.025
$\bar{a}$	Credit limit	0
χ	Scaling param. labor supply	0.068
φ	Frisch elasticity labor supply	0.5
	Shock process	
ρ_z	Autocorrelation TFP	0.95
σ_z	Standard deviation TFP shock	0.31%
ρ_y	Autocorrelation idio. income	0.99
σ_y	Standard dev. idio. income	14%
	Tax system	
τ^K	Capital tax	36%
τ^L	Labor tax	28%
T	Transfer over GDP	8%
B/Y	Public debt over yearly GDP	60%
G/Y	Public spending over yearly GDP	12.4%
	Monetary parameters	
κ	Price adjustment cost	100
ε	Elasticity of sub.	6

Distribution

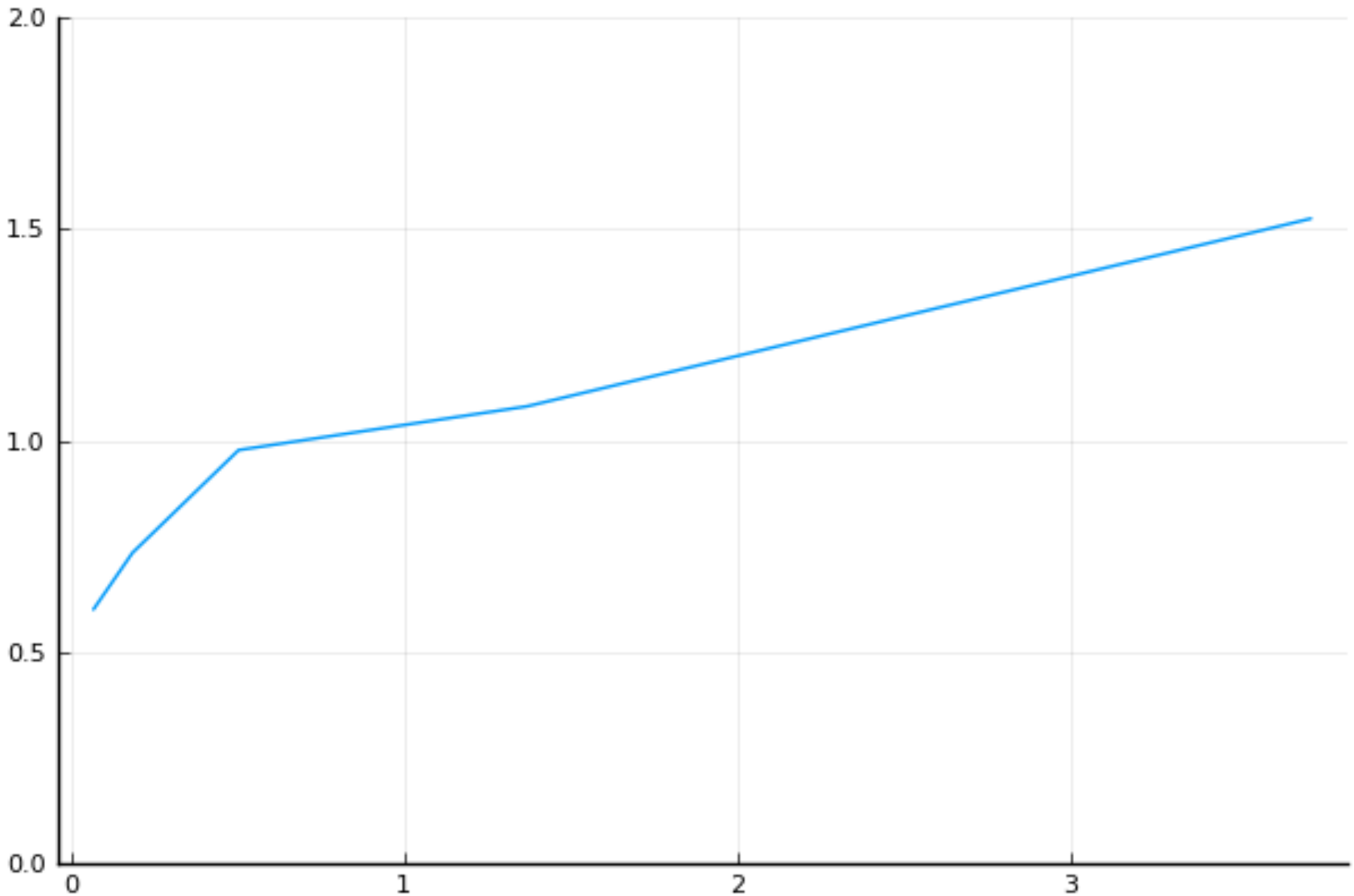
	Data		Model
Wealth statistics	PSID, 06	SCF, 07	
Q1	-0.9	-0.2	0.0
Q2	0.8	1.2	0.1
Q3	4.4	4.6	3.5
Q4	13.0	11.9	15.1
Q5	82.7	82.5	81.3
Top 5%	36.5	36.4	37.8
Top 1%	30.9	33.5	10.7
Gini	0.77	0.78	0.77

Truncated model calibration

Truncation length. $N = 5 \ \rightarrow \ 5^5 = 3125$ truncated histories.

Computing the ξs. Such that allocations in the truncated model $=$ truncation of Bewley allocations. We find: $\text{std}\left(\xi_{y^N}\right) = 0.13$.

Pareto weights vs. current productivity

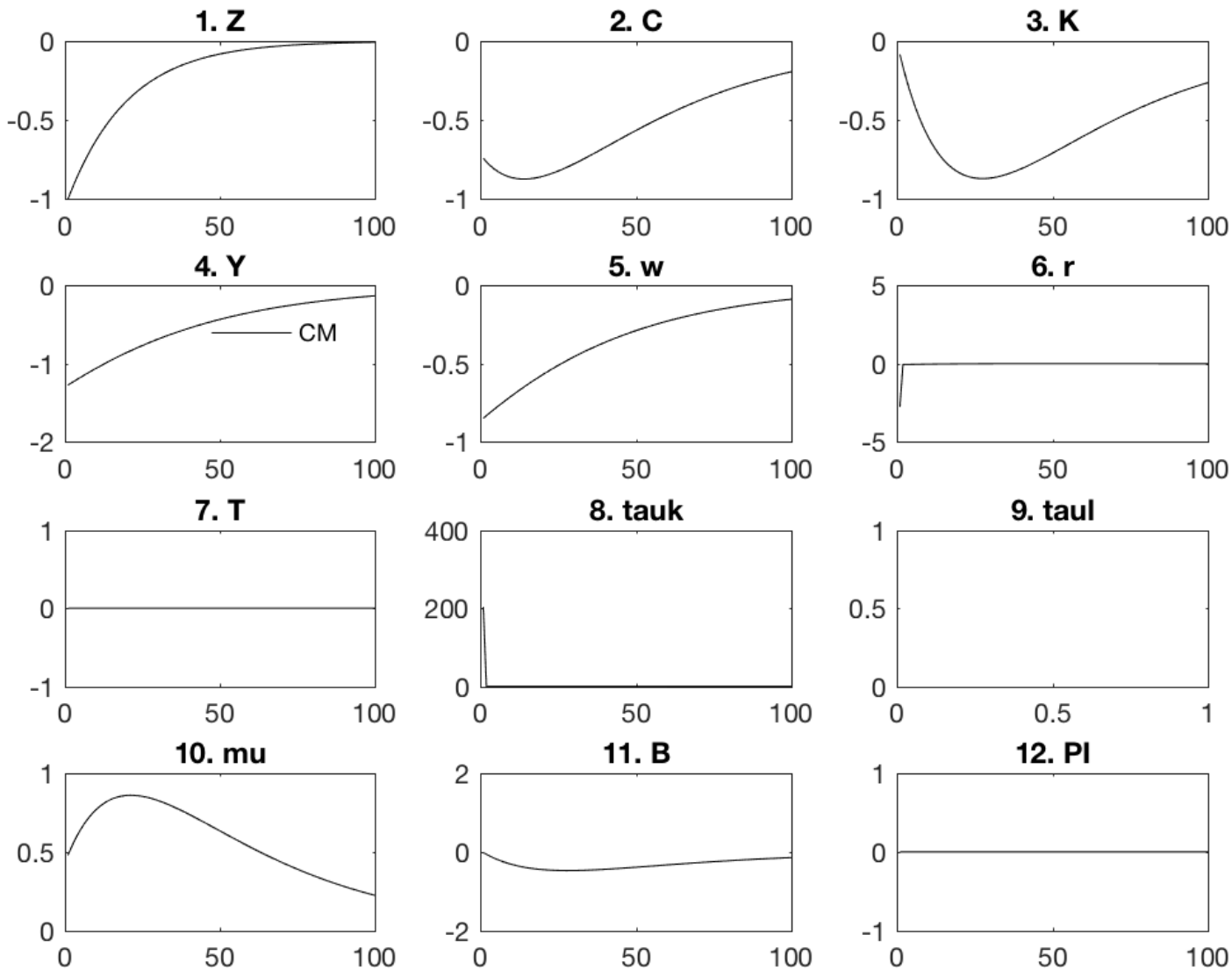


Dynamics

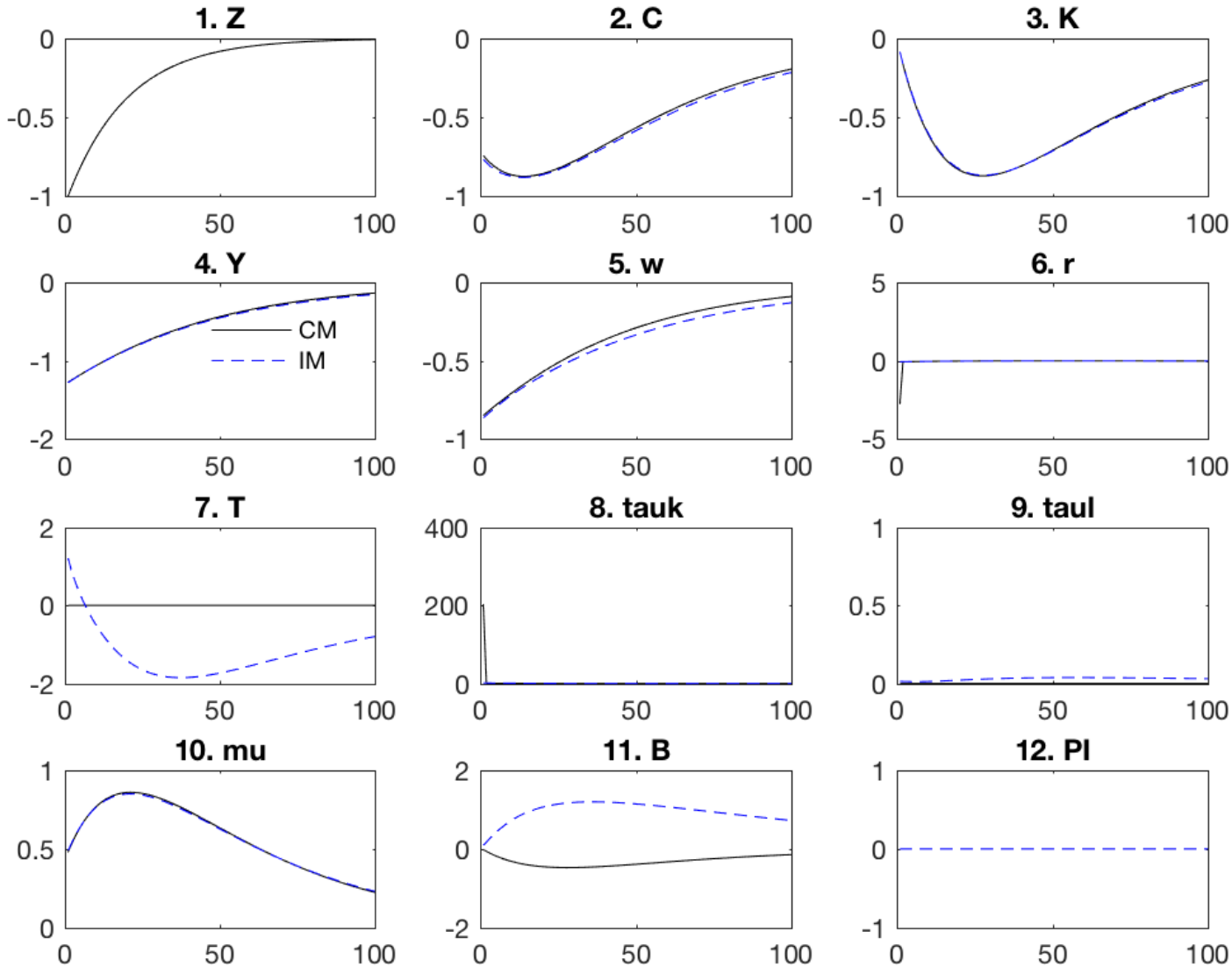
We compare several cases:

- Complete market with a representative agent. Planner holds a negative debt to finance public spendings: $\tau^K = \tau^L = 0$ at steady state.
- Incomplete market with full set of fiscal instruments. Our setup with monetary irrelevance.
- Incomplete market with constant capital tax. Our setup with a possible role for monetary policy.

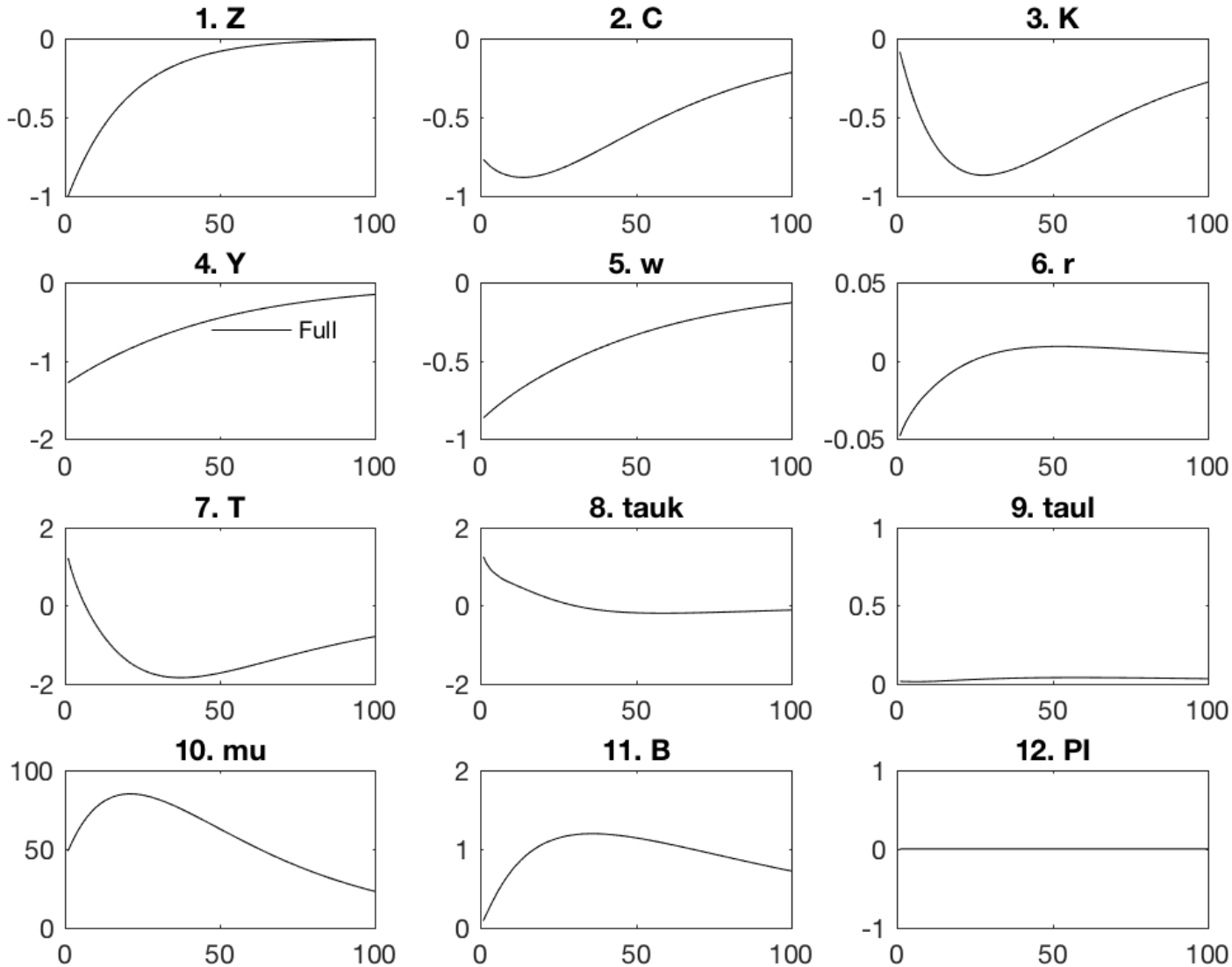
Complete markets (negative TFP shock)



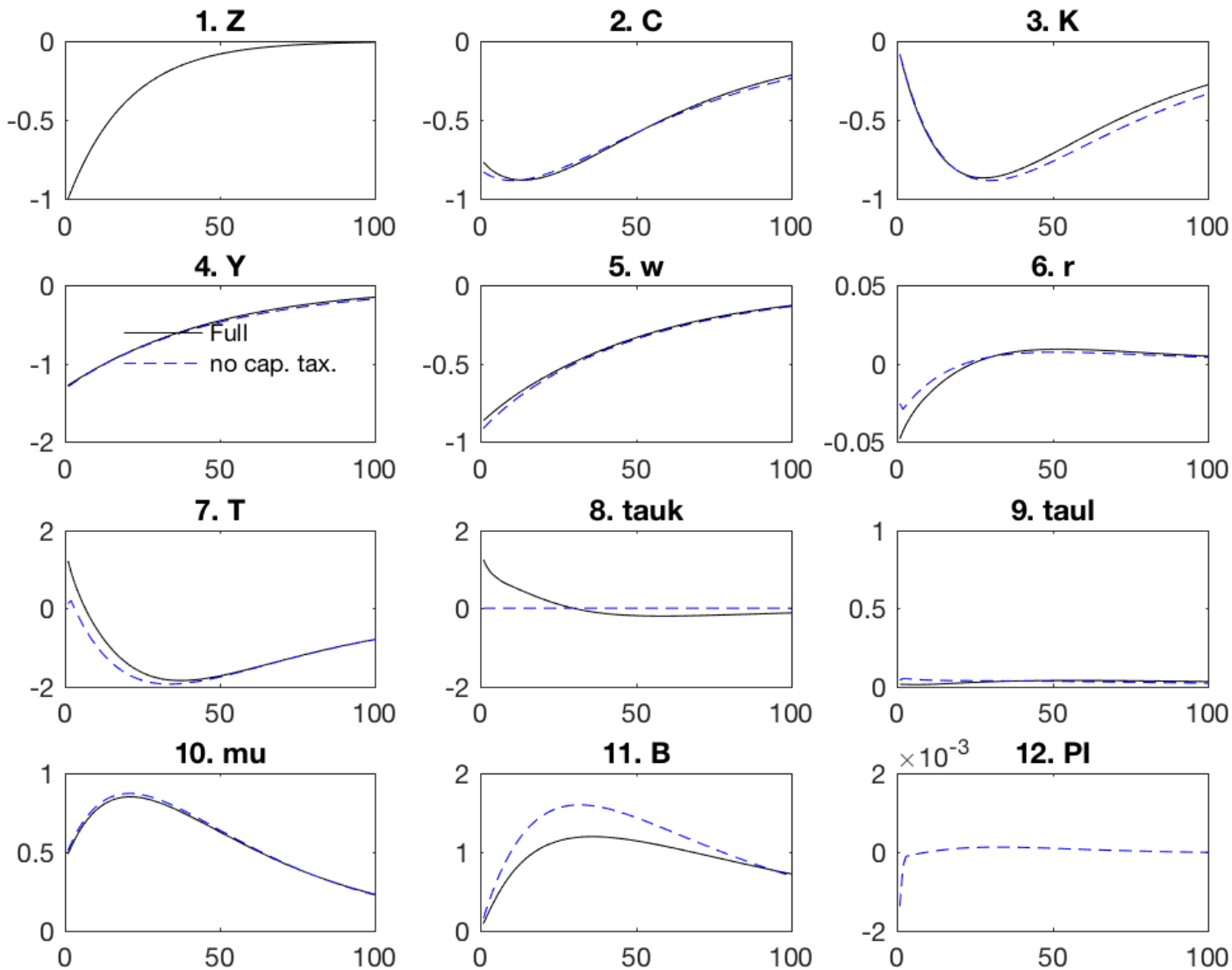
complete markets vs Full set incomplete markets



Full set incomplete markets



Missing capital tax vs. full set (incomplete markets)



Second-order moments

		CM	Full	No cap.tax
C	Mean	0.7543	0.7542	0.7542
	Std	0.0259	0.0266	0.0269
K	Mean	11.0557	11.0536	11.0535
	Std	0.0268	0.0270	0.0288
Y	Mean	1.1760	1.1759	1.1759
	Std	0.0264	0.0268	0.0274
τ^K	Mean	0.0009	0.3600	0.3600
	Std	0.8855	0.0145	0.0000
τ^L	Mean	0.0000	0.2800	0.2800
	Std	0.0000	0.0016	0.0015
B	Mean	−10.9327	2.8435	2.8424
	Std	0.0146	0.0462	0.0541
T	Mean	0.0000	0.0941	0.0941
	Std	0.0000	0.0610	0.0637
π	Mean	0.0000	0.0000	0.0000
	Std	0.0000	0.0000	0.0007
$corr(\tau^K, Y)$		−0.2085	−0.4868	0.0000
$corr(\tau^L, Y)$		0.9273	−0.6374	−0.9249
$corr(B, Y)$		−0.8349	−0.7592	−0.8291
$corr(Y, Y_{-1})$		0.9776	0.9781	0.9785
$corr(B, B_{-1})$		0.9992	0.9996	0.9994

Main take-aways

1. **Irrelevance result** for the monetary policy when the full set of fiscal tools is available. Confirmed in simulations.
2. **Incomplete markets matter.** Public debt is more volatile and capital tax volatility is reduced by two orders of magnitude.
3. **Importance of public debt.** Even in absence of capital tax, shock is mostly smoothed out by public debt.
4. **Monetary policy.** Even in absence of capital tax, monetary policy plays a very little role (though theoretically possible).

Main take-aways (cont'd)

Why is monetary policy so different compared to Bhandari, Evans, Golosov and Sargent (2020)?

- Different setup. Here, capital and occasionally binding credit constraints.
- Different quantitative exercise. Here, perturbation around a steady state. BEGS: transition between an initial and final stochastic distribution.

$\rightarrow$ Last channel is the most important. Similar large effects of the capital tax in the transition in Dyrda and Pedroni (2018).

Robustness checks

- Validation of the truncation method. Comparison with Reiter method.
  See here
- Public spending shock. See here
- Solve optimal policy in the transition.
- Fixed labor tax and fixed labor and capital taxes.

Conclusion

- We construct a truncated representation of het-agent models.
- Enables us to compute optimal fiscal-monetary policy in an economy with incomplete insurance markets, nominal frictions, and aggregate shocks.
- Normative issues can be studied in heterogeneous-agent models

Ramsey program formulation

Go back

$$\max_{(w_t,r_t,\tilde{w}_t,\tilde{r}_t^K,\tilde{R}_t^{B,N},\tau_t^K,\tau_t^L,B_t,K_t,L_t,\Pi_t,(a_t^i,c_t^i,l_t^i)_i)_{t\geq 0}} \mathbb{E}_0\left[\sum_{t=0}^{\infty}\beta^t\int_i \omega_t^i U(c_t^i,l_t^i)\ell(di)\right],$$

$$G_t + B_{t-1} + r_t(B_{t-1}+K_{t-1}) + w_t L_t + T_t = B_t + (1-\frac{\kappa}{2}\pi_t^2)Y_t - \delta K_{t-1}.$$

for all $i \in \mathcal{I}$: $a_t^i + c_t^i = (1+r_t)a_{t-1}^i + w_t y_t^i l_t^i + T_t,$

$$a_t^i \geq -\bar{a},$$

$$U_c(c_t^i,l_t^i) = \beta\mathbb{E}_t\left[U_c(c_{t+1}^i,l_{t+1}^i)(1+r_{t+1})\right] + \nu_t^i,$$

$$l_t^{i,1/\varphi} = \chi w_t y_t^i,$$

$$\Pi_t(\Pi_t - 1) = \frac{\varepsilon-1}{\kappa}(\zeta_t - 1) + \beta\mathbb{E}_t\Pi_{t+1}(\Pi_{t+1}-1)\frac{Y_{t+1}}{Y_t}\frac{M_{t+1}}{M_t},$$

$$K_t + B_t = \int_i a_t^i \ell(di),\ L_t = \int_i y_t^i l_t^i \ell\,(di)\,,$$

$$r_t = (1-\tau_t^K)\frac{\tilde{r}_t^K K_{t-1} + (\frac{\tilde{R}_{t-1}^{B,N}}{\Pi_t} - 1)B_{t-1}}{K_{t-1}+B_{t-1}}$$

Factorization

Go back

The objective of the Ramsey program can be rewritten as maximizing:

$$J = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \int_i \Big[\omega_t^i U(c_t^i, l_t^i) - \left(\omega_t^i \lambda_t^i - (1+r_t)\lambda_{t-1}^i \omega_{t-1}^i \right) U_c(c_t^i, l_t^i) - \left((\gamma_t - \gamma_{t-1})\Pi_t \left(\Pi_t - 1\right) - \frac{\varepsilon - 1}{\kappa} \gamma_t \left(\zeta_t - 1\right) \right) Y_t M_t \Big] \ell(di),$$

with budget constraints (i.e. no expectations in constraints).

$$G_t + B_{t-1} + r_t(B_{t-1} + K_{t-1}) + w_t L_t + T_t = B_t + (1 - \frac{\kappa}{2}\pi_t^2) Y_t - \delta K_{t-1}.$$

for all $i \in \mathcal{I}$: $a_t^i + c_t^i = (1+r_t) a_{t-1}^i + w_t y_t^i l_t^i + T_t,$

$$a_t^i \geq -\bar{a},$$

$$l_t^{i,1/\varphi} = \chi w_t y_t^i,$$

$$K_t + B_t = \int_i a_t^i \ell(di),\ L_t = \int_i y_t^i l_t^i \ell\left(di\right),$$

Projected model

Go back

$$\xi_{y^N} U_c(c_{t,y^N}, l_{t,y^N}) = \mathbb{E} \sum_{y^{N\prime} \in \mathcal{Y}^N} \Pi_{y^N, y^{N\prime}, t+1} \xi_{y^{N\prime}} U_c(c_{t+1,y^{N\prime}}, l_{t+1,y^{N\prime}}) + \nu_{t,y^N},$$

$$c_{t,y^N} + a_{t,y^N} = w_t l_{t,y^N} y_{y^N} + (1 + r_t)\, \tilde{a}_{t,y^N} + T_t,$$

$$\tilde{a}_{t,y^N} = \sum_{\tilde{y}^N \in \mathcal{Y}^N} \Pi_{\tilde{y}^N y^N, t} \frac{S_{t-1,\tilde{y}^N}}{S_{t,y^N}} a_{t-1,\tilde{y}^N},$$

$$l_{t,y^N} = \left(\chi y_{y^N} w_t\right)^{\phi}.$$

$$a_{t,y^N} \geq 0$$

and

$$\sum_{y^N \in \mathcal{Y}^N} S_{y^N} a_{y^N} = \int_i a_i \ell(di)$$

Public spending shocks

Go back

		CM	Full	No cap.tax
C	Mean	0.7541	0.7540	0.7540
	Std	0.0105	0.0113	0.0129
K	Mean	11.0541	11.0509	11.0508
	Std	0.0082	0.0089	0.0109
Y	Mean	1.1758	1.1756	1.1756
	Std	0.0037	0.0047	0.0063
L	Mean	0.3334	0.3333	0.3333
	Std	0.0012	0.0023	0.0037
τ^K	Mean	0.0000	0.3600	0.3600
	Std	22.8698	0.0780	0.0000
τ^L	Mean	0.0000	0.2800	0.2800
	Std	0.0000	0.0017	0.0036
B	Mean	-10.9399	2.8441	2.8436
	Std	0.0098	0.0293	0.0543
T	Mean	0.0000	0.0941	0.0941
	Std	0.0000	0.0502	0.0546
π	Mean	0.0000	0.0000	0.0000
	Std	0.0000	0.0000	0.0027

Comparison Reiter vs Truncation

Go back

		Reiter	Trunc
GDP	mean	1.1757	1.1757
	std	0.0242	0.0239
C	mean	0.7541	0.7541
	std	0.0240	0.0240
K	mean	11.0514	11.0510
	std	0.0265	0.0261
L	mean	0.3333	0.3333
	std	0.0120	0.0119
B	mean	2.8436	2.8436
	std	0.0000	0.0000
τ^L	mean	0.2800	0.2800
	std	0.0086	0.0085
corr(C,Y)		0.9784	0.9904
corr(K,Y)		0.8550	0.8484
corr(L,Y)		0.9998	0.9998
corr(B,Y)		-0.0000	0.0000
corr(τ^L,Y)		-0.9978	-0.9977
corr(Y,Y_{-1})		0.9816	0.9812

Table: Reiter and Truncation - Constant public debt, labor tax adjust

Ramsey in the truncated model (cont'd)

Resolution algorithm for Ramsey policies in our economy.

1. Solve the "true" Bewley model (i.e., without aggregate shocks) for a given fiscal-monetary policy.
2. Construct the truncated model, and compute the ξs.
3. If *truncated* Ramsey optimality conditions hold, stop. Otherwise, go back to Step 1 with updated policy.

$\rightarrow$ Projected model always consistent with a Bewley model.

$\rightarrow$ Perturbation computed around a steady state that exists.

Go back