Coordinating Business Cycles

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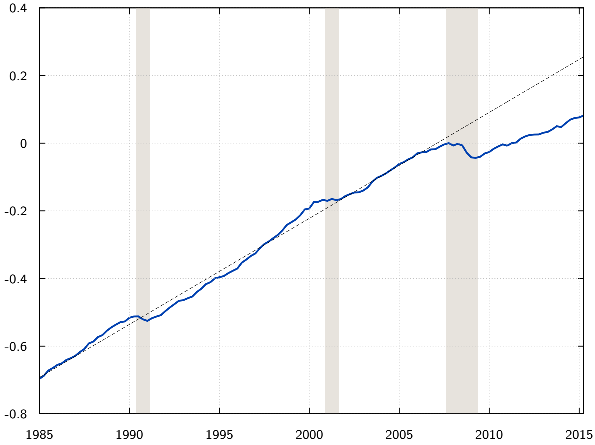
Motivation



Sources: NIPA

Figure: US real GDP per capita (log) and linear trend 1985-2007

Historical Detrending

Motivation

- U.S. business cycles
  - Usually strong tendency to revert back to trend
  - 2007-09 Recession: economy fell to a lower steady state?
- We propose the idea that the economy is a nonlinear system that can transit through different regimes of aggregate demand/production
- Our explanation relies on coordination failures
  - Diamond (1982); Cooper and John (1988); Benhabib and Farmer (1994);...
  - *Hypothesis:* the economy can be trapped in lower output equilibria as agents fail to coordinate on higher production/demand

Our Contribution

- We develop a model of **coordination failures** and **business cycles**
- We respond to two key challenges in this literature:
  - Quantitative
    - Typical models are stylized or use unrealistic parameters,

    $\Rightarrow$ Our model: RBC + monopolistic comp. + nonconvexities
  - Methodological
    - Equilibrium indeterminacy limits welfare/quantitative analysis

    $\Rightarrow$ Global game approach to discipline equilibrium selection Why?
- Simple benchmark for quantitative and policy analysis

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Main Results

- Dynamics
  - Multiple steady states in the multiplicity region
  - Deep recessions: the economy can fall in a *coordination trap* where coordination on high steady state is difficult
  - Potentially consistent with various features of the recovery from 2007-2009 recession
- Policy
  - Fiscal policy is in general welfare reducing as coordination problem magnifies crowding out
  - But sometimes increases welfare by helping coordination close to a transition
  - Optimal policy is a mix of input and profit subsidies

Literature Review

- Coordination failures and business cycles
  - Diamond (1982); Cass and Shell (1983); Cooper and John (1988); Kiyotaki (1988); Benhabib and Farmer (1994); Farmer and Guo (1994); Farmer (2013); Kaplan and Menzio (2013); Golosov and Menzio (2016); Schaal and Taschereau-Dumouchel (2016)
- Dynamic coordination games
  - Global games: Morris and Shin (1999); Angeletos, Hellwig and Pavan (2007); Chamley (1999)
  - Inertia: Frankel and Pauzner (2000), Guimaraes and Machado (2015)
- Sentiments
  - Angeletos and La'O (2013); Benhabib et al. (2014); Angeletos et al. (2014)
- Big Push and Poverty Trap
  - Murphy et al. (1989); Azariadis and Drazen (1990)

Roadmap

1. Discussion: nonconvexities + monopolistic competition
2. Complete Information Case
3. Incomplete Information Case
4. Quantitative Exploration
5. Policy Implications
6. Conclusion

Nonconvexities and Monopolistic Competition

Our model: standard neoclassical model with:

- Monopolistic competition
  - Aggregate demand externality provides a motive to coordinate
- Nonconvexities in production
  - Firms adjust output along various margins which differ in lumpiness/adjustment/variable costs
    - Labor and investment: lumpy adjustments (Cooper and Haltiwanger, 2006; Kahn and Thomas, 2008)
    - Number shifts: 32% of variation in capacity utilization (Mattey and Strongin, 1997)
    - Capital workweek: 55% of variation in capacity utilization (Beaulieu and Mattey, 1998)
    - Plant shutdowns/restart: 80% of output volatility at plant-level in auto manufacturing explained by shiftwork, Saturday work and intermittent production (Bresnahan and Ramey, 1994)

Evidence of Non-Convexities

- Ramey (JPE 1991) estimates cost functions
  - Example food industry:

$$C_t\left(Y_j\right) = 23.3 w_t Y_j - 7.78^{**} Y_j^2 + 0.000307^{*} Y_j^3 + \ldots$$

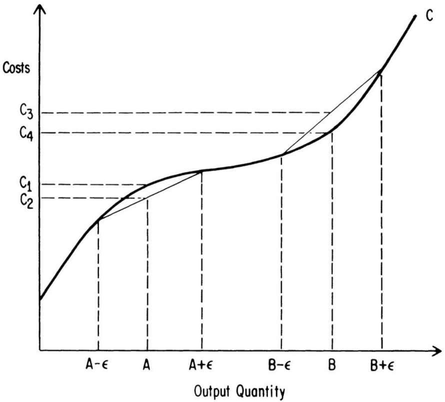
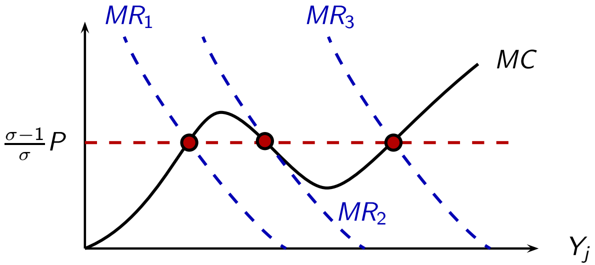


Figure: Nonconvex cost curve (Ramey, 1991)

Nonconvexities and Monopolistic Competition

$$\max_{Y_j} PY^{\frac{1}{\sigma}} Y_j^{1-\frac{1}{\sigma}} - C(Y_j)$$

$$\text{FOC} \Rightarrow \frac{\sigma - 1}{\sigma} PY^{\frac{1}{\sigma}} Y_j^{-\frac{1}{\sigma}} = C'(Y_j)$$



- Result: monopolistic competition + nonconvexities $\Rightarrow$ multiplicity
  - 3 equilibria supported by different expectations about demand

Perfect comp.

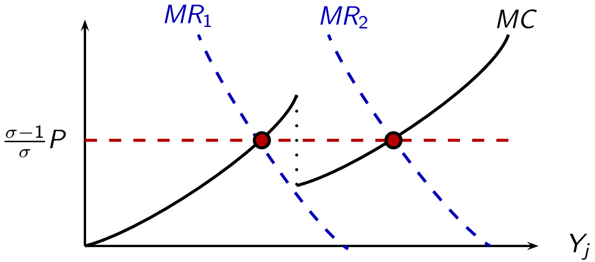
What we do

We capture these general nonconvexities with technology choice

$$C\left(Y_j\right) = \min \left\{ w \left(\frac{Y_j}{A_l}\right)^{\frac{1}{\alpha}}, w \left(\frac{Y_j}{A_h}\right)^{\frac{1}{\alpha}} + f \right\}, \quad A_h > A_l$$

Interpretations

- Adding shifts/production lines
- Plant restart/shutdown
- More broadly: hierarchy levels, trade, etc.



II. Model: Complete Information Case

- Infinitely-lived representative household that solves

$$\max_{C_t, L_t, K_{t+1}} \mathbb{E} \sum_{t=0}^{\infty} \beta^t \left[\frac{1}{1-\gamma} \left(C_t - \frac{L_t^{1+\nu}}{1+\nu} \right)^{1-\gamma} \right], \gamma \geqslant 0, \nu \geqslant 0$$

under the budget constraints

$$C_t + K_{t+1} - (1-\delta) K_t \leqslant W_t L_t + R_t K_t + \Pi_t$$

Production

- Two types of goods:
  - Final good used for consumption and investment
  - Differentiated goods $j \in [0,1]$ used in production of final good
- Competitive final good industry with representative firm

$$Y_t = \left(\int_0^1 Y_{jt}^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}}, \sigma > 1$$

yielding demand curve and price index

$$Y_{jt} = \left(\frac{P_{jt}}{P_t} \right)^{-\sigma} Y_t \quad \text{and} \quad P_t = \left(\int_0^1 P_{jt}^{1-\sigma} dj \right)^{\frac{1}{1-\sigma}} = 1$$

Intermediate Producers

- Unit continuum of intermediate goods producer under monopolistic competition

$$Y_{jt} = A_{jt}(\theta_t) K_{jt}^{\alpha} L_{jt}^{1-\alpha}$$

- Aggregate productivity θ follows an AR(1)

$$\theta_t = \rho\theta_{t-1} + \varepsilon_t^{\theta}, \quad \varepsilon_t^{\theta} \sim \text{iid } \mathcal{N}\left(0, \gamma_{\theta}^{-1}\right)$$

- Technology choice $A_{jt}(\theta_t) \in \left\{A_l e^{\theta_t}, A_h e^{\theta_t}\right\}$
  - $A_h > A_l$ and denote $\omega = \frac{A_h}{A_l} > 1$
  - Operating high technology costs f (goods)

Intermediate Producers

The intermediate producer faces a simple static problem that can be split into two stages

- Production stage: for *given technology* $j \in \{h, l\}$,

$$\Pi_{jt} = \max_{P_{jt}, Y_{jt}, K_{jt}, L_{jt}} P_{jt} Y_{jt} - W_t L_{jt} - R_t K_{jt}$$

  subject to

$$\begin{aligned} Y_{jt} &= A_{jt}(\theta_t) K_{jt}^{\alpha} L_{jt}^{1-\alpha} && \text{(technology)} \\ Y_{jt} &= P_{jt}^{-\sigma} Y_t && \text{(demand curve)} \end{aligned}$$

- Technology choice

$$\Pi_t = \max \{\Pi_{ht} - f, \Pi_{lt}\}$$

Definition

An equilibrium is policies for the household $\{C_t(\theta^t), K_{t+1}(\theta^t), L_t(\theta^t)\}$, policies for firms $\{Y_{jt}(\theta^t), K_{jt}(\theta^t), L_{jt}(\theta^t)\}, j \in \{h, l\}$, a measure $m_t(\theta^t)$ of high technology firms, prices $\{R_t(\theta^t), W_t(\theta^t)\}$ such that

- Household and firms solve their problems, markets clear,
- Mass of firms with high technology is consistent with firms' decisions

$$m_t\left(\theta^t\right) \equiv \begin{cases} 1 & \text{if } \Pi_{ht} - f > \Pi_{lt} \\ \in (0,1) & \text{if } \Pi_{ht} - f = \Pi_{lt} \\ 0 & \text{if } \Pi_{ht} - f < \Pi_{lt} \end{cases}$$

Characterization

- Producers face a positive aggregate demand externality

$$\Pi_{jt} = Y_t^{\frac{1}{\sigma}} Y_{jt}^{1-\frac{1}{\sigma}} - W_t L_{jt} - R_t K_{jt}$$

  where σ determines the strength of externality

- In partial equilibrium, the technology choice collapses to

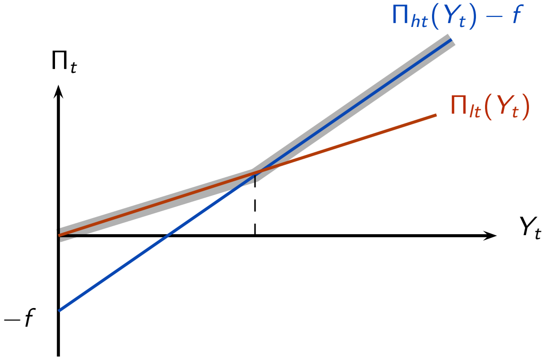
$$\Pi = \max\left[\frac{1}{\sigma}\frac{Y_t}{P_{ht}^{\sigma-1}} - f, \frac{1}{\sigma}\frac{Y_t}{P_{lt}^{\sigma-1}}\right]$$

  with the cost of a marginal unit of output

$$P_{jt} = \frac{\sigma}{\sigma-1} MC_{jt} \quad \text{and} \quad MC_{jt} \equiv \frac{1}{A_{jt}(\theta)}\left(\frac{R_t}{\alpha}\right)^{\alpha}\left(\frac{W_t}{1-\alpha}\right)^{1-\alpha}$$

Characterization

- Incentives to use high technology increase with aggregate demand Y_t



Characterization

- Under GHH preferences,
  - Labor supply curve is independent of C,
  - Production side of the economy can be solved independently of consumption-saving decision
- We thus proceed in two steps:
  - First, study *static* equilibrium (production and technology choice)
  - Then, return to the *dynamic* economy (C and K' decisions)

Static Equilibrium

- Simple aggregate production function:

$$Y_t = \overline{A}(\theta_t, m_t)K_t^{\alpha}L_t^{1-\alpha}$$

$$L_t = \left[(1-\alpha)\frac{\sigma-1}{\sigma}\overline{A}(\theta_t, m_t)K_t^{\alpha}\right]^{\frac{1}{\nu+\alpha}}$$

- *Endogenous* TFP:

$$\overline{A}(\theta, m) = \left(mA_h(\theta)^{\sigma-1} + (1-m)A_l(\theta)^{\sigma-1}\right)^{\frac{1}{\sigma-1}}$$

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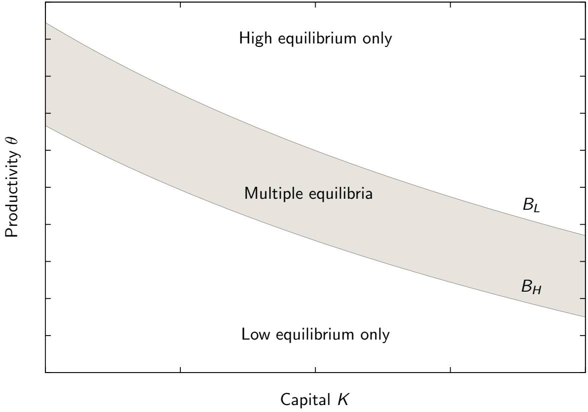
Proposition 1

Suppose that $\frac{1+\nu}{\alpha+\nu} > \sigma - 1$*, then there exists cutoffs* $B_H < B_L$ *such that there are multiple static equilibria for* $B_H \leqslant e^{\theta} K^{\alpha} \leqslant B_L$.

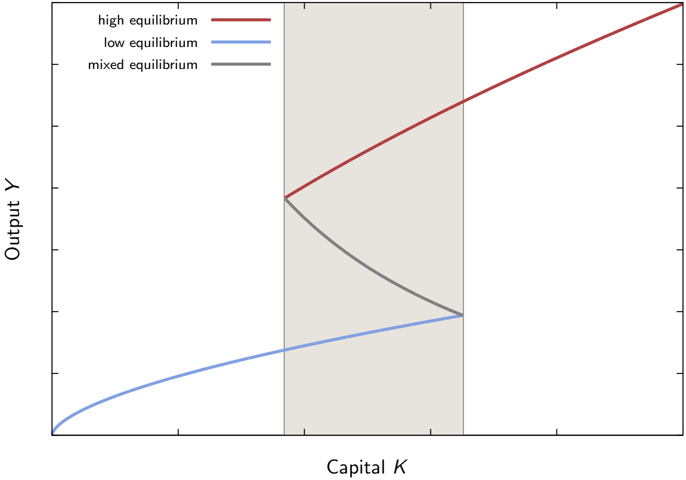


▸ Intuition

Static Equilibrium: Role of K and θ

- High equilibrium is more likely to exist when:
  - Productivity θ is high
  - Or capital K is high
- Why?
  - Larger profits, more incentives for individual to pick high technology
  - Anticipate others to do the same
  - Coordination on the high equilibrium is easier
- The role of K is crucial to explain long-lasting recessions and impact of fiscal policy

Static Equilibrium: Multiplicity



Multiplicity vs. Uniqueness

Is the static equilibrium efficient?

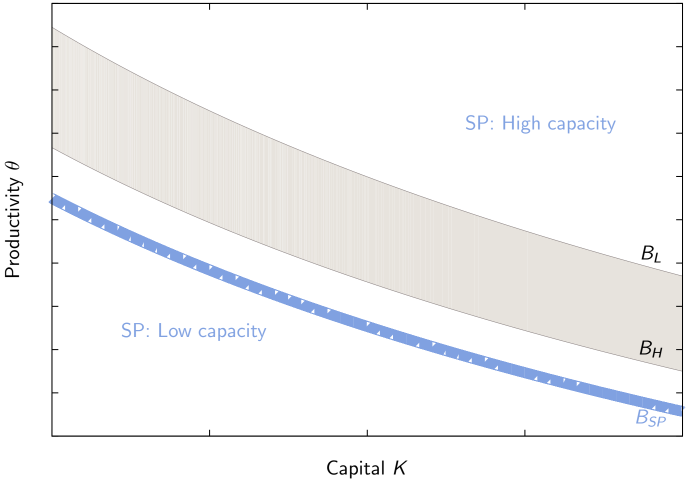
Proposition 2

For $\frac{1+\nu}{\alpha+\nu} > \sigma - 1$*, there exists a threshold* $B_{SP} < B_L$ *such that*

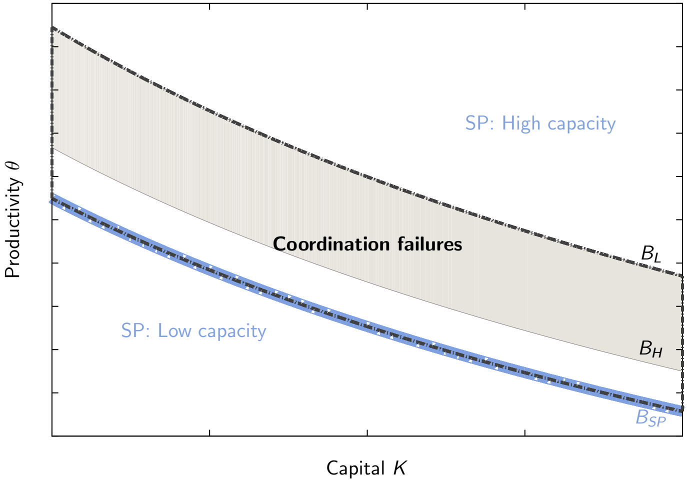
- *For* $e^{\theta} K^{\alpha} \leqslant B_{SP}$*, the planner chooses* $m = 0$*,*
- *For* $e^{\theta} K^{\alpha} \geqslant B_{SP}$*, the planner chooses* $m = 1$*.*

In addition, for σ *low enough,* $B_{SP} < B_H$*.*

Static Equilibrium: Efficiency



Static Equilibrium: Coordination Failure



Dynamic Equilibrium

- Dynamics in the complete information case:
  - Infinity of dynamic equilibria
  - Economy can fluctuate wildly under sunspots
  - But how do we discipline the equilibrium selection?
- We now embed the model in a global game environment
  - Study uniqueness and existence
  - Allows for policy and quantitative evaluation

III. Model: Incomplete Information Case

Model: Incomplete Information

- Model remains the same, except:
  - Technology choice is made under uncertainty about current θ_t
- New timing:
  1. Beginning of period: $\theta_t = \rho\theta_{t-1} + \varepsilon_t^\theta$ is drawn
  2. Firm j observes private signal $v_{jt} = \theta_t + \varepsilon_{jt}^v$ with $\varepsilon_{jt}^v \sim$ iid $\mathcal{N}\left(0, \gamma_v^{-1}\right)$
  3. Firms choose their technology $A_j \in \{A_l, A_h\}$
  4. θ_t is observed, production takes place, C_t and K_{t+1} are chosen

- Firms now solve the following problem:

$$A_j^* = \underset{A_j \in \{A_h, A_l\}}{\text{argmax}} \Big\{ \mathbb{E}\left[U_c\left(C, L\right)\left(\Pi_h\left(K, \theta, m\right) - f\right) \mid \theta_{-1}, v_j \right], \\ \mathbb{E}\left[U_c\left(C, L\right)\Pi_l\left(K, \theta, m\right) \mid \theta_{-1}, v_j \right] \Big\}$$

  where

  - Expectation term over θ and m
  - m is now uncertain and firms must guess what others will choose!

Proposition 3

For γ_v large and if

$$\frac{\sqrt{\gamma_v}}{\gamma_\theta} > \frac{1}{\sqrt{2\pi}} \frac{\omega^{\sigma-1} - 1}{\sigma - 1},$$

then the equilibrium of the static global game is unique and takes the form of a cutoff rule $\hat{v}(K, \theta_{-1}) \in \mathbb{R} \cup \{-\infty, \infty\}$ such that firm j chooses high technology if and only if $v_j \geqslant \hat{v}(K, \theta_{-1})$. In addition, $\hat{v}$ is decreasing in its arguments.

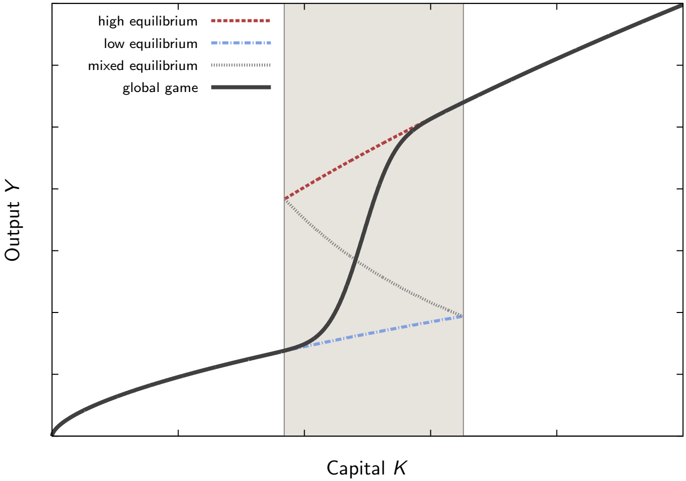
- **Remark:** the number of firms choosing high technology is

$$m \equiv 1 - \Phi\left(\sqrt{\gamma_v}\left(\hat{v}(K, \theta_{-1}) - \theta\right)\right)$$

where Φ is the CDF of a standard normal

Details

Uniqueness of Static Game



Dynamic Equilibrium

Returning to the full dynamic equilibrium:

Proposition 4

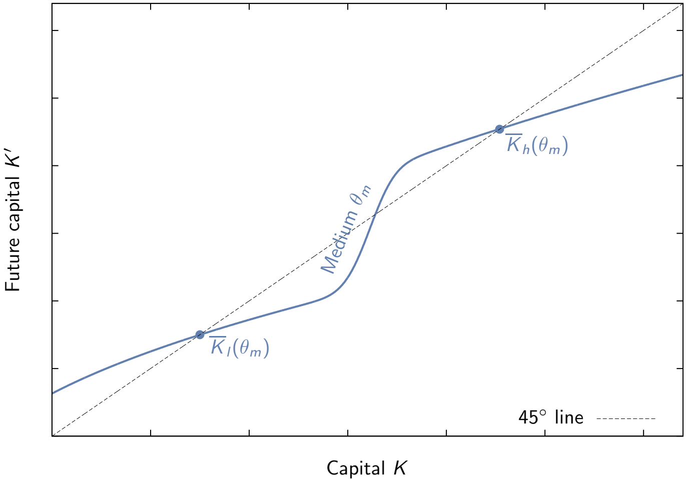
Under the same conditions as proposition 3 and with f sufficiently small, there exists a unique dynamic equilibrium for the economy.

- Two difficulties in the proof:
  1. The economy has *endogenous TFP* and is distorted by *external effects*
  2. Two-way feedback between global game and consumption-saving decision
- Proof based on lattice-theoretic arguments (Coleman and John, 2000)

Dynamic Equilibrium

- Dynamics in the incomplete information case:
  - Typically, multiple steady states in K for intermediate values of θ
  - Only one steady state for extreme values of θ
- Dynamic system characterized by
  - Two regimes: high output/technology vs. low output/technology,
  - Random switches between basins of attraction because of shocks to θ

Dynamics: Multiple Steady States



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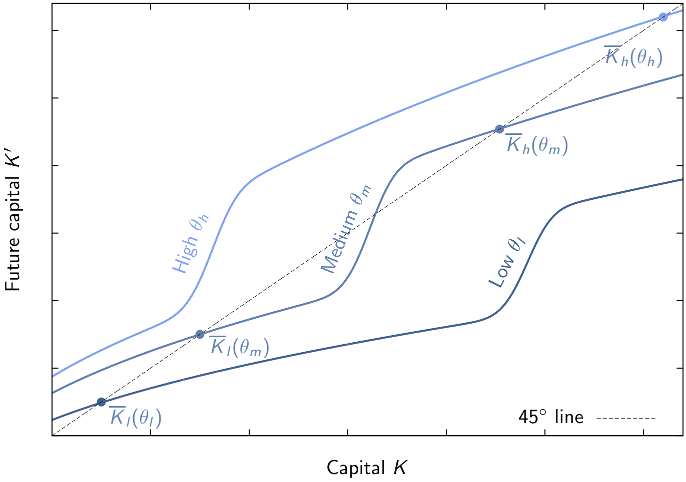
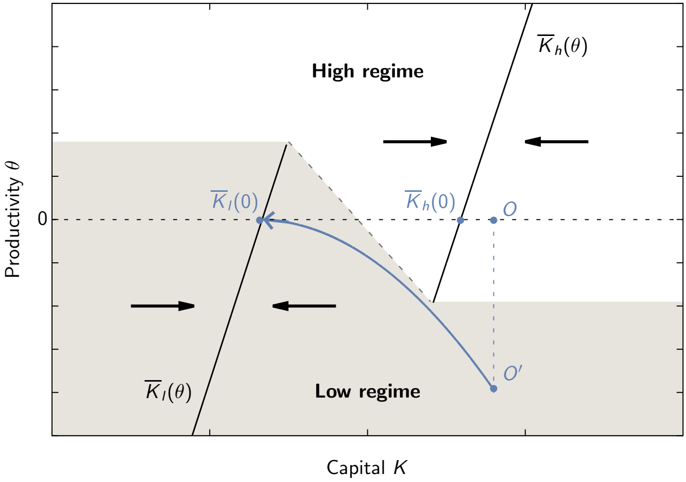


Dynamics: Phase Diagram



IV. Quantitative Exploration

Calibration

- The model is very tractable
  - Standard growth model but *endogenous* TFP

$$U_c(C,L) = \beta\mathbb{E}\left[\left(1-\delta+R\left(K',\theta',m'\right)\right)U_c\left(C',L'\right)\right]$$
$$Y(K,\theta,m) = \overline{A}(\theta,m)K^{\alpha}L^{1-\alpha}$$
$$\overline{A}(\theta,m) = \left(mA_h(\theta)^{\sigma-1}+(1-m)A_l(\theta)^{\sigma-1}\right)^{\frac{1}{\sigma-1}}$$

  - m is solution to the global game

$$m(K,\theta_{-1},\theta) = 1-\Phi\left(\sqrt{\gamma_v}\left(\hat{v}(K,\theta_{-1})-\theta\right)\right)$$

- The model nests a standard RBC model ($\gamma_v=\infty$, $f=0$, $\omega=1$, $\sigma\to\infty$), we thus choose standard targets in RBC literature

Parametrization

Standard parameters:

Parameter	Value	Source/Target
Time period	one quarter	
Capital share	$\alpha = 0.3$	Labor share 0.7
Discount factor	$\beta = 0.95^{1/4}$	0.95 annual
Depreciation rate	$\delta = 1 - 0.9^{1/4}$	10% annual
Risk aversion	$\gamma = 1$	log utility
Elasticity of labor supply	$\nu = 0.4$	Jaimovich and Rebelo (2009)
Persistence θ process	$\rho_\theta = 0.94$	Autocorr log output
Stdev of θ	$\sigma_\theta = 0.009$	Stdev log output

Parametrization

- Elasticity of substitution σ:
  - Plant-level empirical trade studies find $\sigma \approx 3$
    - Broda and Weinstein (QJE 2006)
    - Bernard, Eaton, Jensen, Kortum (AER 2003)
  - Macro papers use various number with average $\sigma \approx 6$ or 7
  - We adopt $\sigma = 3$ and do robustness with $\sigma = 5$
- Precision of private information γ_v:
  - Governs the dispersion of beliefs about θ and other variables
  - Target dispersion in forecasts about GDP growth of 0.24% in SPF
  - $\gamma_v = 1,154,750 \simeq 0.1\%$ stdev of noise

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Parametrization

- Technology choice parameter $\omega = \frac{A_h}{A_l}$:
  - Interpret the technology choice as capacity utilization
  - Post-2009 average decline is -5.42%
  - Ratio of output $\frac{Y_h}{Y_l} = \omega^{\sigma}$, so $\omega \simeq 1.0182$
- Fixed cost f:
  - Governs the frequency of regime switches
  - Use probabilistic forecast from SPF
  - Target probability GDP (with trend) falls < -2 of 0.63%, $f = 0.021 \simeq 1\%$ of GDP

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Capacity Utilization and Measured TFP

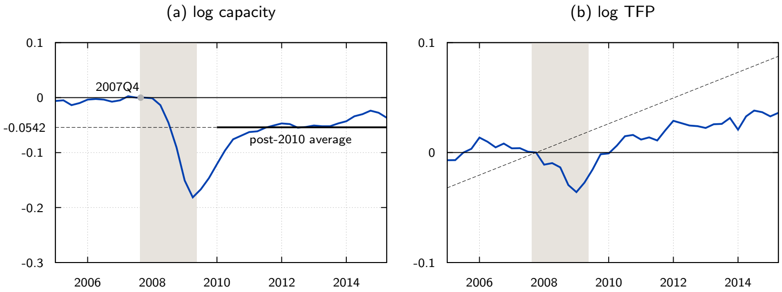


Figure: Capacity Utilization and Measured TFP

▸ Detrending ▸ Measures ▸ Calibration

Quantitative Evaluation

- We now evaluate the model on the following dimensions:
  - Business cycle moments: similar to RBC ▸ RBC moments
  - Asymmetry: skewness and bimodality
  - Persistence: the 2007-2009 recession, a secular stagnation?

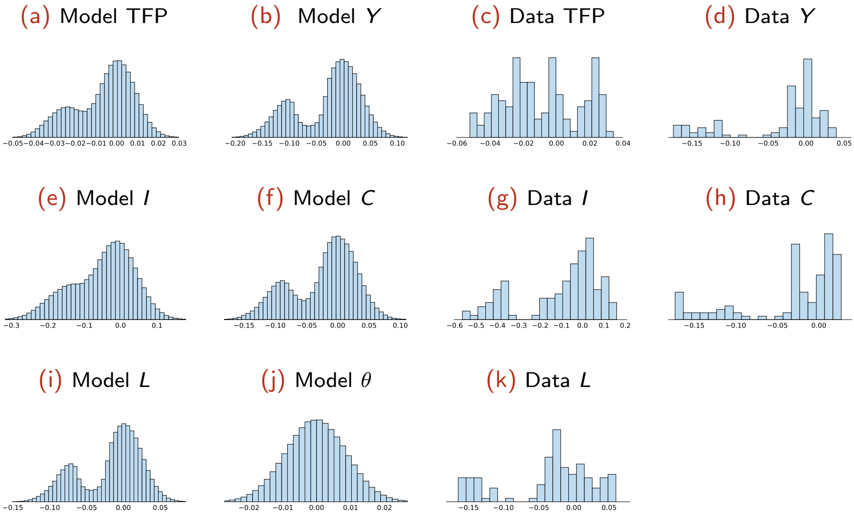
Skewness

- The model explains between 46%-93% of the emprical skewness:

	Output	Investment	Hours	Consumption
Data	-1.24	-0.92	-0.62	-1.31
Full model	-0.58	-0.44	-0.58	-0.53
RBC model	-0.00	-0.03	-0.00	-0.00

Table: Skewness

Skewness and Bimodality

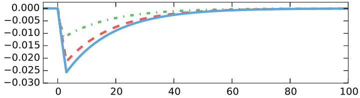


Impulse Responses

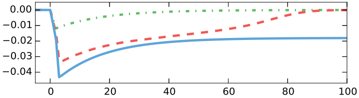
- The model dynamics display strong non-linearities
- We hit the economy with negative θ shocks:
  1. Small
  2. Medium and lasts 4 quarters
  3. Large and lasts 4 quarters
- Results:
  - The response to small shock is similar to standard RBC model
  - Strong amplification and propagation for larger shocks
  - Large, long-lasting shocks can push the economy towards low steady state: coordination trap

Impulse Responses

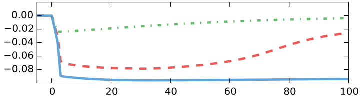
(a) θ



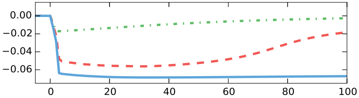
(b) TFP



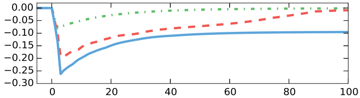
(c) Output



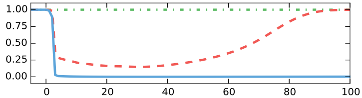
(d) Labor



(e) Investment



(f) Capacity m



$\sigma = 5$

2007-2009 Recession

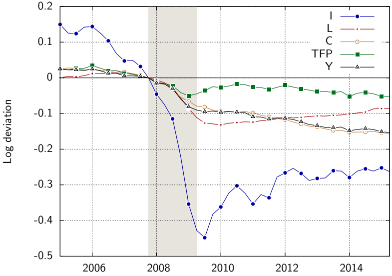


Figure: US series centered on 2007Q4 (left) vs model (right)

2007-2009 Recession

Two remarks:

- The coordination channel is mainly a propagation mechanism:
  - Shocks that affect the capital stock can produce similar results
    - E.g.: destruction of capital stock, financial shock
- The model is consistent with the economy reverting to trend for normal recessions
  - Only large or long-lasting shocks can shift regimes
- Possibly consistent with the Great Depression? the Japanese Lost Decades? Great Depression Japan

V. Policy Implications

Policy Implications

- The competitive economy suffers from two (related) inefficiencies:
  1. Monopoly distortions on the product market,
     - Correct this margin immediately with input subsidy s_{kl} that offsets markup $1 - s_{kl} = \frac{\sigma - 1}{\sigma}$,
  2. Inefficient technology choice due to aggregate demand externality.
- We analyze:
  - Impact of fiscal policy
  - Optimal policy and implementation

Fiscal Policy

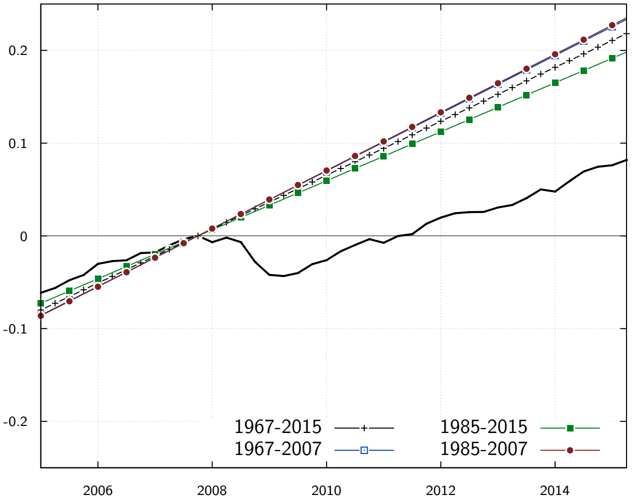
- Fiscal policy:
  - Government spending is in general detrimental to coordination
    - Crowding out effect *magnified* by coordination problem ▸ Crowding
    - This effect dominates in most of the state space
  - But negative wealth effect can overturn this result ▸ Why?
    - When preferences allow for wealth effect on labor supply, fiscal policy may be *welfare improving* by helping coordination ▸ Welfare
    - Possibly large multipliers without nominal rigidities ▸ Multiplier
- Optimal policy:
  - A mix of constant input and profit subsidy implements the constrained efficient allocation ▸ Optimal Policy

VI. Conclusion

Conclusion

- We construct a dynamic stochastic general equilibrium model with coordination failures
  - Provides a foundation for demand-deficient effects without nominal rigidities
- The model generates:
  - Deep recessions: secular stagnation?
  - Fiscal policy can be welfare improving
- Future agenda:
  - Quantitative side:
    - Understand the role of firm-level heterogeneity
    - Use micro-data to discipline the non-convexities
  - Nominal rigidities, learning, optimal fiscal policy, etc.

Impact of Detrending on GDP



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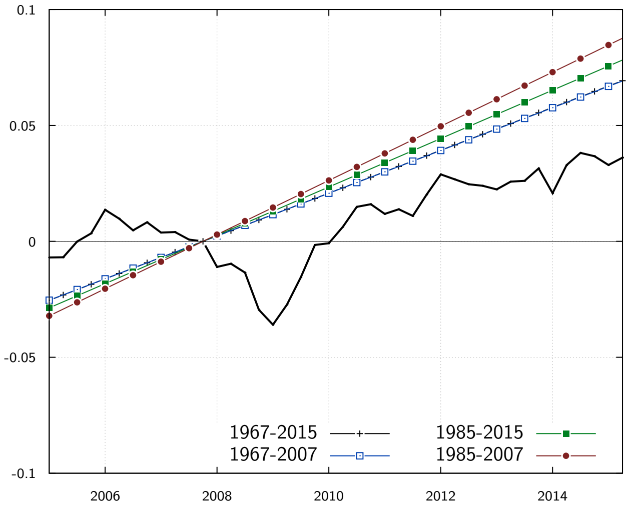
Impact of Detrending on TFP



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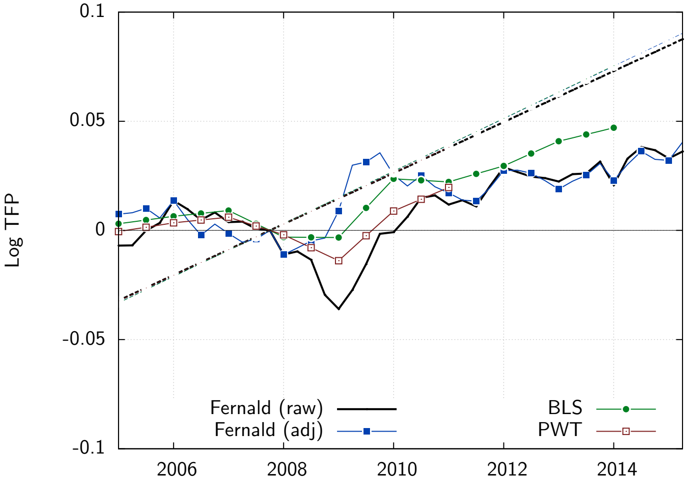
Various Measures of TFP



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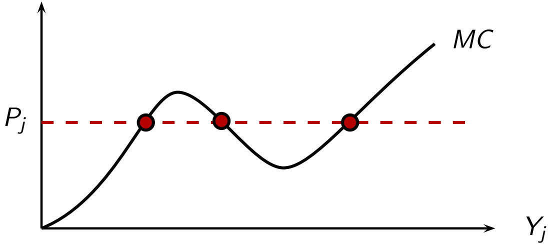
Nonconvexities and Perfect Competition

Perfect competition + nonconvexities case:

$$\max_{Y_j} P_j Y_j - C(Y_j)$$
$$\Rightarrow P_j = C'(Y_j)$$



- Result: perfect competition + nonconvexities $\Rightarrow$ uniqueness (FWT)

◂ Return

Static Equilibrium: Multiplicity

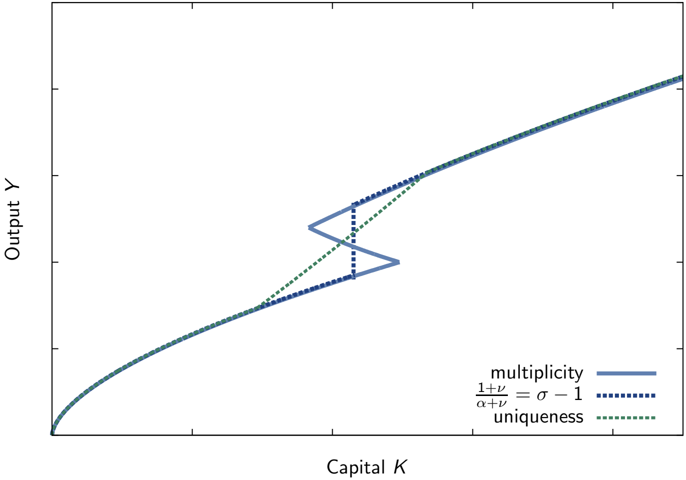
- Condition for multiplicity is

$$\frac{1+\nu}{\alpha+\nu} > \sigma - 1$$

- This condition is more likely to be satisfied if
  - σ is small: high complementarity through demand,
  - ν is small: low input competition (sufficiently flexible labor),
  - α is small: production is intensive in the flexible factor (labor).

◂ Return

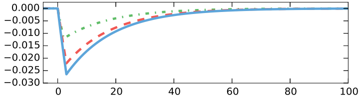
Static Equilibrium: Multiplicity vs. Uniqueness



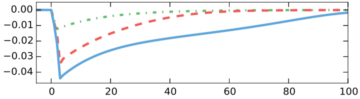
Multiplicity

Impulse Responses for $\sigma = 5$

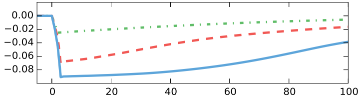
(a) θ



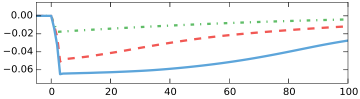
(b) TFP



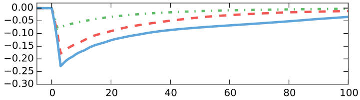
(c) Output



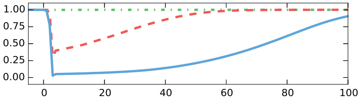
(d) Labor



(e) Investment

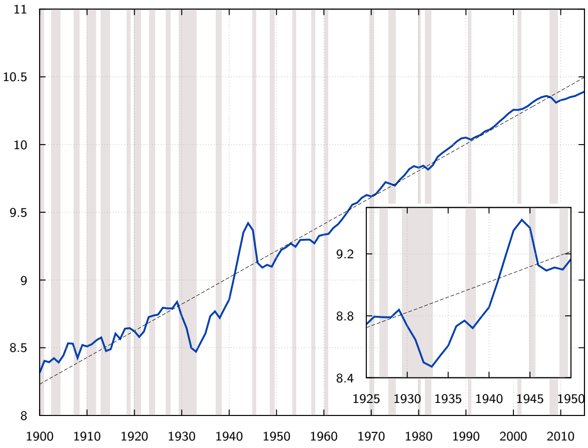


(f) Capacity m



Return

Great Depression

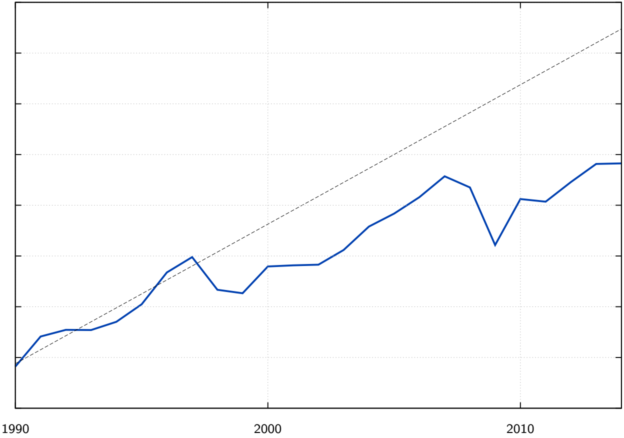


Sources: Maddison and NIPA

Figure: US real GDP per capita (log) and linear trend 1900-2007

Intro Great Recession

Lost Decades



Sources: Maddison and OECD/World Bank

Figure: Japan real GDP per capita (log) and linear trend

◂ Return

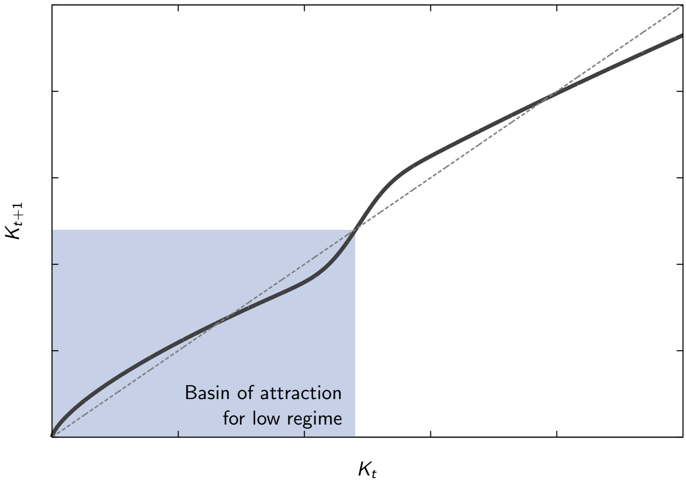
Why Global Games?

- Just like any selection device?
  - Global games have been successfully applied to bank runs, currency crises, etc.
  - Why not sunspots?
    - Arbitrary selection, possibly subject to Lucas critique
    - Instead, global games let the model pick the equilibrium
  - Selection driven by information technology, which we can discipline with the data
  - Continuously extends results/intuitions from cases without indeterminacy
- Cons:
  - Eliminates any nonfundamentalness, no self-fulfilling fluctuation

Return

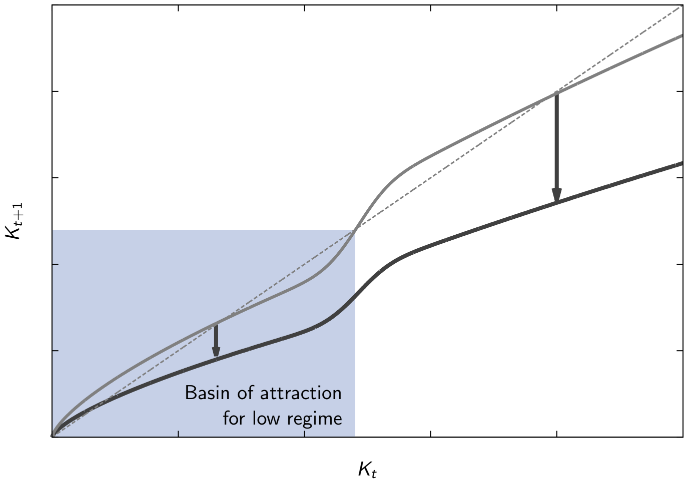
Fiscal Policy: Crowding Out

- Crowding out:



Fiscal Policy: Crowding Out

- Crowding out: decline in investment



Fiscal Policy: Crowding Out

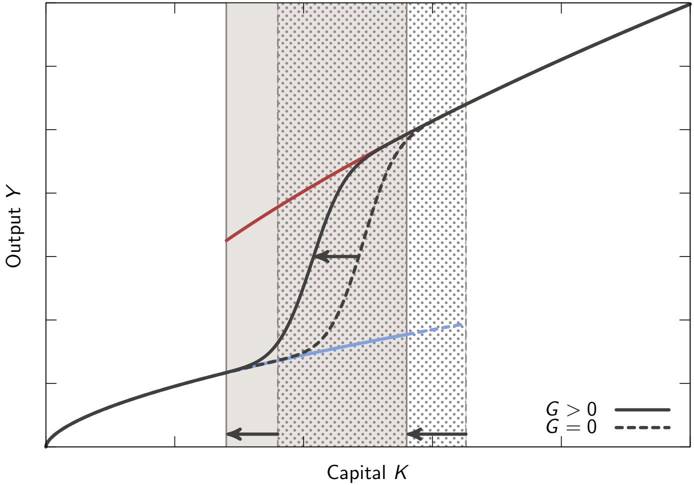
- Coordination is worsened by crowding out:
  - Capital K plays a crucial role for coordination,
  - By crowding out private investment, government spending makes coordination on high regime less likely in the future!
  - Large dynamic welfare losses
- Result: Under GHH preferences,
  - For γ_v large, firms' choice of m unaffected by G,
  - Government spending is *always* welfare reducing

Return

Fiscal Policy: Wealth Effect

- Relax GHH assumption to allow for wealth effects on labor:
  - As G increases:
    - Household is poorer
    - Increase in labor supply through wealth effect
    - Wage decreases
  - Firms expand and are more likely to choose high technology
  - Potentially welfare improving if increase in m is large enough

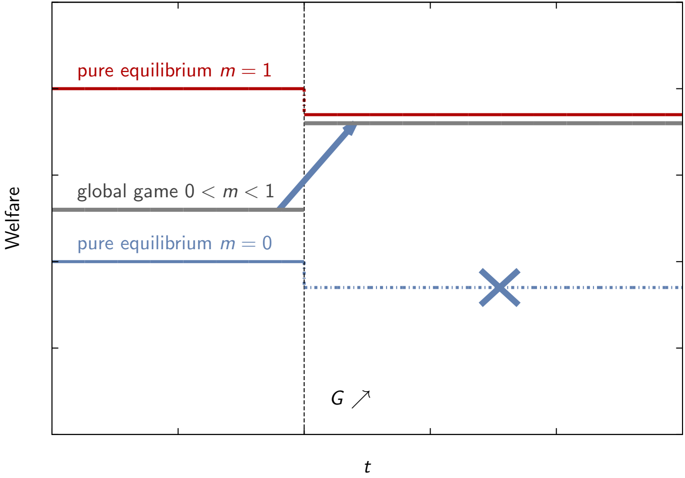
Fiscal Policy: Wealth Effect



Return

Fiscal Policy: Wealth Effect

- How can a negative wealth effect be welfare improving?



Return

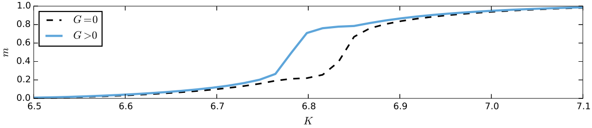
Fiscal Policy

- We simulate the response to government spending shock G_t
  - Pure government consumption financed with lump-sum tax
  - G_t is high $G_t = G > 0$ with probability $1/2$ or low $G_t = 0$
  - High G is calibrated to 0.5% of steady-state output
  - Non-GHH preferences
- Trace out the regions in which spending is welfare improving

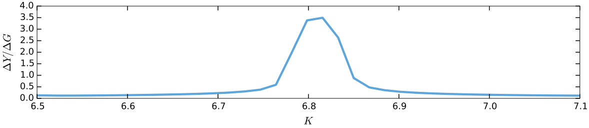
Details

Fiscal Policy

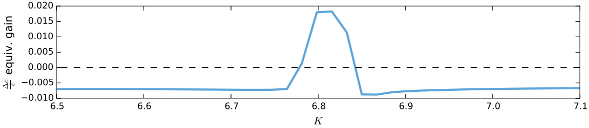
(a) Impact of G on technology choice m



(b) Fiscal multiplier



(c) Welfare gains in consumption equivalent



Optimal Policy

- We study a constrained planner with same information as outside observer:
  - At the beginning of period, only knows θ_{-1}
  - Does not observe firms' private signals

Constrained Planner Problem

- The planner chooses a probability to choose high technology $z(v_j)$ for all signals v_j

$$V(K, \theta_{-1}) = \max_{z,C,L,K'} \mathbb{E}_\theta \left[\frac{1}{1-\gamma} \left(C - \frac{L^{1+\nu}}{1+\nu} \right)^{1-\gamma} + \beta V(K', \theta) \right]$$

subject to

$$C + K' = \overline{A}(\theta, m) K^\alpha L^{1-\alpha} + (1-\delta) K - mf$$

$$m(\theta) = \int \sqrt{\gamma_v} \phi\left(\sqrt{\gamma_v}(v-\theta)\right) z(v)\, dv$$

$$\overline{A}(\theta, m) = \left(m A_h(\theta)^{\sigma-1} + (1-m) A_l(\theta)^{\sigma-1} \right)^{\frac{1}{\sigma-1}}$$

Proposition 5

The competitive equilibrium with imperfect information is inefficient, but the efficient allocation can be implemented with:

1. *An input subsidy* $1 - s_{kl} = \frac{\sigma-1}{\sigma}$ *to correct for monopoly distortions,*
2. *A profit subsidy* $1 + s_{\pi} = \frac{\sigma}{\sigma-1}$ *to induce the right technology choice.*

- **Remark:**
  - The profit subsidy is just enough to make firms internalize the impact of their technology decision on others

▸ Why? ◂ Return

Constrained Planner Problem

- The planner's technology decision

$$E\left[U_c\left(C,L\right)m_{\hat{v}}\left(\theta,\hat{v}\right)\left(\overline{A}_m\left(m,\theta\right)K^{\alpha}L^{1-\alpha}-f\right)|\theta_{-1}\right]=0$$

is equivalent to

$$\mathbb{E}\left\{U_c\left(C,L\right)\left[\frac{1}{\sigma-1}\left(\left(\frac{A_h\left(\theta\right)}{\bar{A}\left(m,\theta\right)}\right)^{\sigma-1}-\left(\frac{A_l\left(\theta\right)}{\bar{A}\left(m,\theta\right)}\right)^{\sigma-1}\right)\bar{A}\left(m,\theta\right)K^{\alpha}L^{1-\alpha}-f\right]|\theta_{-1},\hat{v}\right\}=0$$

- Coincides with the competitive economy with profit subsidy when $1+s_{\pi}=\frac{\sigma}{\sigma-1}$:

$$\mathbb{E}\left\{U_c\left(C,L\right)\left[\frac{1+s_{\pi}}{\sigma}\left(\left(\frac{A_h\left(\theta\right)}{\bar{A}\left(m,\theta\right)}\right)^{\sigma-1}-\left(\frac{A_l\left(\theta\right)}{\bar{A}\left(m,\theta\right)}\right)^{\sigma-1}\right)\bar{A}\left(m,\theta\right)K^{\alpha}L^{1-\alpha}-f\right]|\theta_{-1},\hat{v}\right\}=0$$

Return

Uniqueness of Static Game

- Condition for uniqueness

$$\frac{\sqrt{\gamma_v}}{\gamma_\theta} > \frac{1}{\sqrt{2\pi}} \frac{\omega^{\sigma-1} - 1}{\sigma - 1}$$

- This condition requires:
  1. Uncertainty in fundamental θ (γ_θ low),
  2. High precision in private signals (γ_v high)
     - Ensure that beliefs about fundamental (in γ_v) dominates feedback from others (in $\sqrt{\gamma_v}$)

Return

Business Cycle Moments

	Output	Investment	Hours	Consumption
	Correlation with output			
Data	1.00	0.90	0.91	0.98
Full model	1.00	0.90	1.00	0.99
RBC model	1.00	0.95	1.00	0.99
	Standard deviation relative to output			
Data	1.00	3.09	1.03	0.94
Full model	1.00	1.44	0.71	0.88
RBC model	1.00	1.30	0.71	0.95

Table: Standard business cycle moments

- The full model behaves similarly to a standard RBC model

Return

Solution of the Model

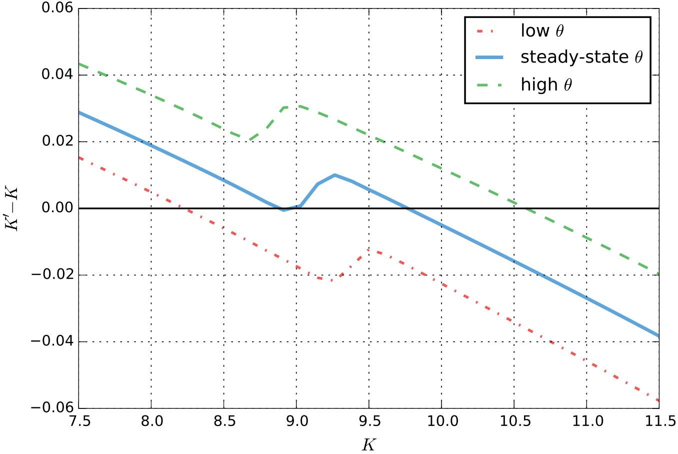


Figure: Two steady states in K for $\theta = 0$

Return

Calibration Government Spending

- Utility function: $U(C, L) = \log C - (1+\nu)^{-1} L^{1+\nu}$

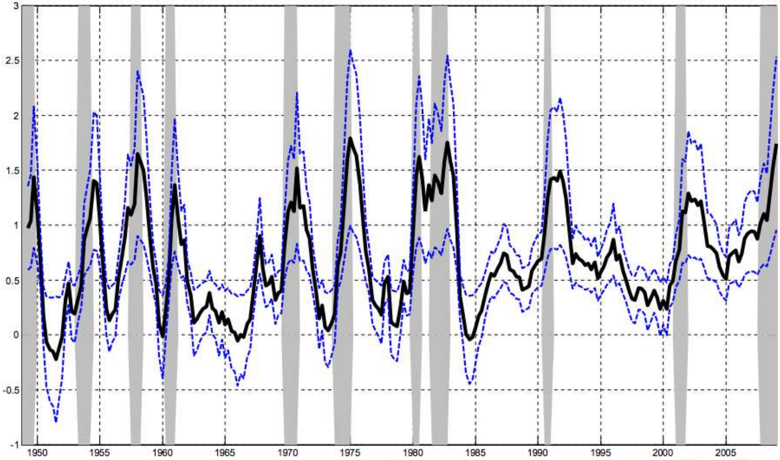
Parameter	Value	Source/Target
Time period	one quarter	
Capital share	$\alpha = 0.3$	Labor share 0.7
Discount factor	$\beta = 0.95^{1/4}$	0.95 annual
Depreciation rate	$\delta = 1 - 0.9^{1/4}$	10% annual
Elasticity of substitution	$\sigma = 3$	Hsieh and Klenow (2014)
Risk aversion	$\gamma = 1$	log utility
Elasticity of labor supply	$\nu = 0.4$	Jaimovich and Rebelo (2009)
Persistence θ process	$\rho_\theta = 0.94$	Cooley and Prescott (1985)
Stdev of θ	$\sigma_\theta = 0.006$	Stdev output
Fixed cost	$f = 0.016$	
High capacity	$\omega = 1.0182$	
Precision of private signal	$\gamma_v = 1,013,750$	
Government spending	$G = 0.00662$	0.5% of steady-state output

Return

Fiscal Policy

- Gorodnichenko and Auerbach (2012)

Figure 5. Historical multiplier for total government spending



Notes: shaded regions are recessions defined by the NBER. The solid black line is the cumulative multiplier computed as $\sum_{h=1}^{20} Y_h / \sum_{h=1}^{20} G_h$, where time index h is in quarters. Blue dashed lines are 90% confidence interval. The multiplier incorporates the feedback from G shock to the business cycle indicator z. In each instance, the shock is one percent increase in government spending.

Return