Post Keynesian Dynamic Stochastic General Equilibrium Theory:

How to retain the IS-LM model and still sleep at night.

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Important ideas in Keynes' *General Theory*

- Unemployment is involuntary and high unemployment may persist as a steady state equilibrium
- Animal spirits select the equilibrium
- Government has an obligation to intervene to maintain full employment

This talk

- I provide a different reconciliation of Keynes with general equilibrium theory: “Confidence Crashes and Animal Spirits”, *Economic Journal* 2012
- I explain the implications of this idea for the IS-LM interpretation of Keynes “Animal Spirits in a Monetary Economy” (working paper joint with Konstantin Platonov NBER wp 22228 2017). Empirical application in joint work with Giovanni Nicoló.

Multiple equilibria

- Multiple equilibria are pervasive in dynamic models
- The rational expectations assumption does not help to select an equilibrium
- Close the model with the: *the belief function* (Farmer 1993 book)
- Main idea: Beliefs are fundamental

Farmer-Platonov paper

- We develop a simple graphical framework for analyzing the effects of policy changes on the macroeconomy
- Our model is based on the theory of multiple steady state unemployment rates from Farmer (EJ 2012)
- In this paper we add money and we move beyond the representative agent assumption

Farmer-Nicoló Paper

- In a working paper joint with Giovanni Nicoló, “Keynesian Economics without the Phillips Curve”, we compare a model closed with a belief function with a standard New Keynesian model.

Feature of Data

- Monetary shocks have real effects
  - This is often explained by models of price stickiness
  - We explain this feature with dynamic indeterminacy
- Low frequency movements in the unemployment rate
  - These are filtered out in many models
  - We explain this feature with steady-state indeterminacy

Assumptions of the model

- Two-period OLG
- One produced good
- Two-factors land and labor
- Money in the utility function
- Labor traded in a search market

Technology

Private Technology

$$Y = K^{\alpha} X^{1-\alpha}$$

$$L = X + V$$

$$L + U = H$$

$$L = qV$$

q is taken parametrically by the firm

Social Technology

$$\bar{Y} = \bar{K}^{\alpha} \bar{X}^{1-\alpha}$$

$$\bar{L} = \bar{X} + \bar{V}$$

$$\bar{L} + \bar{U} = \bar{H}$$

$$\bar{L} = \bar{V}^{\frac{1}{2}} \bar{U}^{\frac{1}{2}}$$

q is determined in equilibrium by social technology

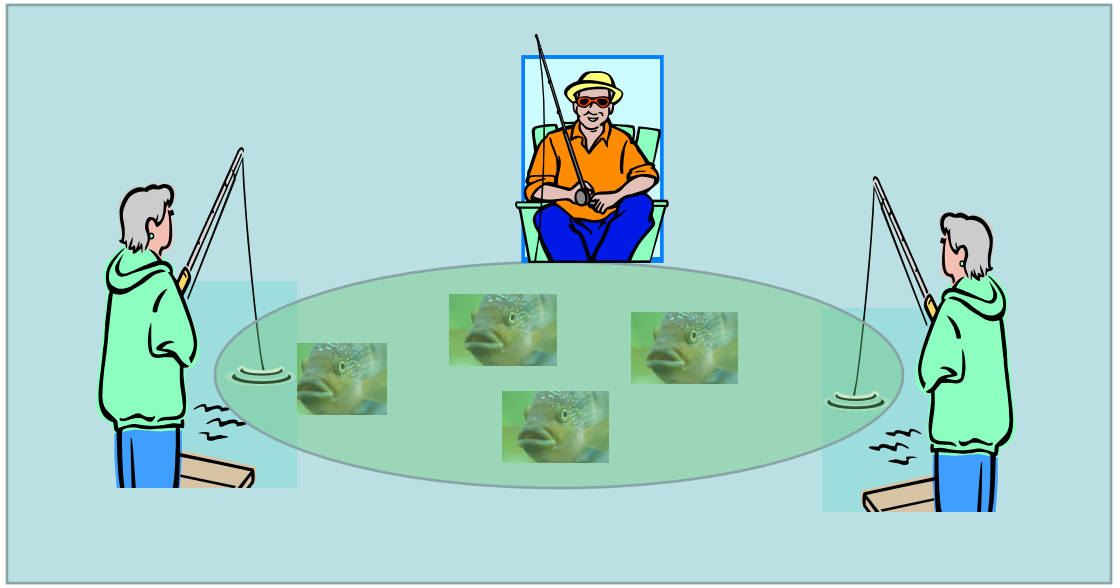
Search Externalities

Unemployed workers are like fish

Recruiters for firms are like fishermen

The more fisherman around a pond,
the harder it is to catch a fish

Higher $\bar{V}$ causes q to fall



Symmetry and Endowments

$L = \bar{L}$ $K = \bar{K}$ $U = \bar{U}$ $H = \bar{H}$ Symmetric equilibrium

$\bar{K} = 1$ $\bar{H} = 1$ Endowments

Social and Private

Private Technology

$L = qV$

$q = \frac{1}{\bar{L}}$

$Y = [L(1 - \bar{L})]^{1-\alpha}$

Social Technology

$\bar{L} = m(\bar{V}, \bar{U}) \equiv (\bar{V})^{\frac{1}{2}}$

$\bar{U} = 1$ because workers are fired and rehired every period

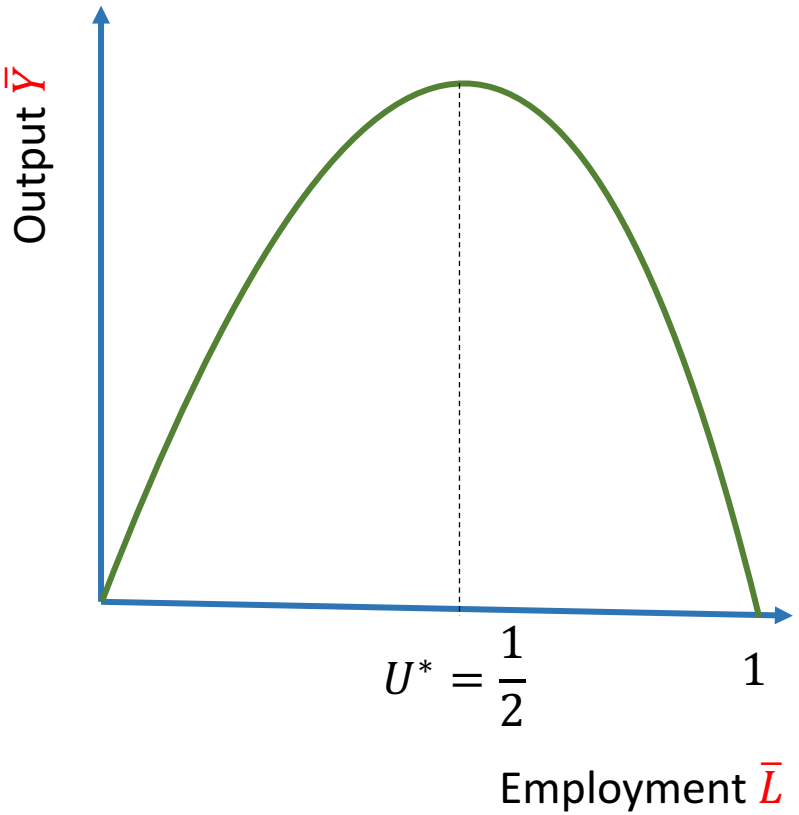
$\bar{Y} = [\bar{L}(1 - \bar{L})]^{1-\alpha}$

Factor prices are neo-classical

$$(1-\alpha)\frac{Y}{L}=\frac{W}{P} \qquad \& \qquad \alpha\,\frac{Y}{1}=\frac{R}{P}$$

W is the money wage
R is the money rental rate
P is the money price of goods

The social production function



- The model has an obvious candidate for the 'natural rate of unemployment' U^*
- (Not the same as Friedman's definition)

Keynesian Search Equilibrium

$$\Pi = K^{\alpha}X^{1-\alpha} - \frac{W}{P}L - \frac{R}{P}K$$

$$L = X + V = qV$$

Productivity and Unemployment in Theory

$$\Pi = K^{\alpha} L^{1-\alpha} \left(1 - \frac{1}{q}\right)^{1-\alpha} - \frac{W}{P} L - \frac{R}{P} K$$

$$1 - \bar{L} = 1 - \frac{1}{q}$$

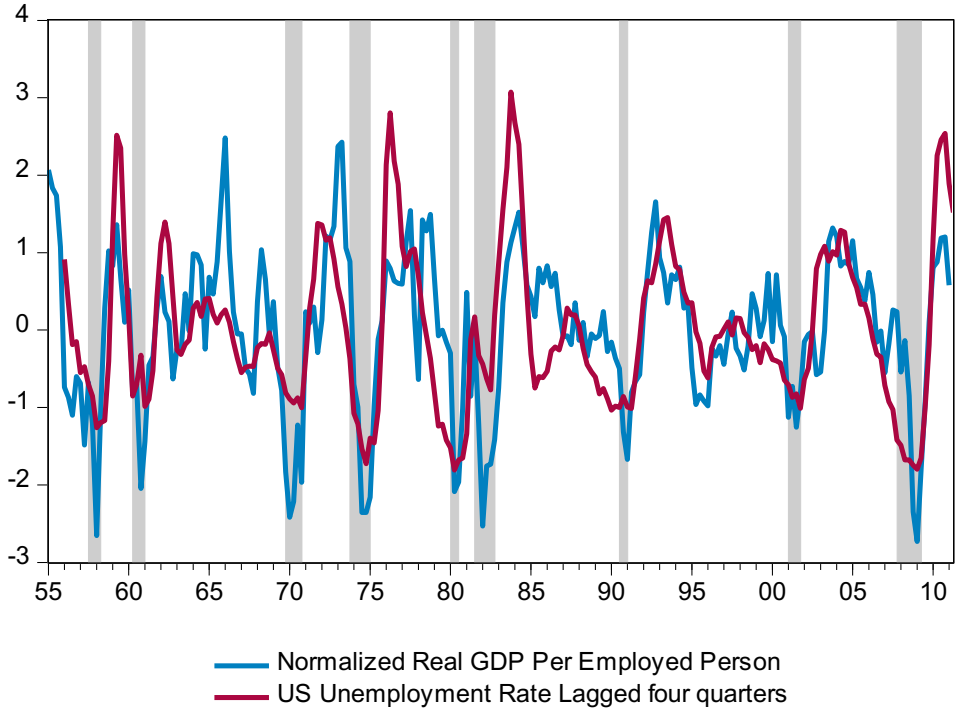
The theory predicts that unemployment and labor productivity should move in the same direction. (Countercyclical labor productivity)

$\bar{U} = 1 - \bar{L}$ ↑

q ↑

$\frac{Y}{L} = L^{1-\alpha} \left[1 - \frac{1}{q}\right]^{1-\alpha}$ ↑

Productivity and Unemployment in Data



This graph plots labor productivity (in blue) against the unemployment rate one year earlier (in red). Both series have been HP filtered.

In a recession firms fire people and unemployment increases. One year later, q increases. Firms shift workers into production and labor productivity increases.

Classical and Keynesian search theories

- In classical search theory (Diamond-Mortensen-Pissarides) the model is closed by Nash-bargaining
- In Keynesian search theory (my definition) the model is closed in the asset markets
- Does the stock market reflect labor market fundamentals? (classical view)
- Or are animal spirits themselves fundamental? (Keynesian view)

Aggregate demand

$$u_t = \log\left(C_t^y\right) + \beta \mathbb{E}_t\left[\log\left(C_{t+1}^o\right)\right] + \delta \log\left(\frac{M_{t+1}}{P_t}\right)$$

- Utility

$$P_t C_t^y + M_{t+1} + B_{t+1} + P_{K,t} K_{t+1} = W_t L_t,$$

$$P_{t+1} C_{t+1}^o = (R_{t+1} + P_{K,t+1}) K_{t+1} + (1 + i_t) B_{t+1} + M_{t+1}$$

- Budget constraints

Aggregate demand

$$\mathbb{E}_t\left[\frac{\beta}{C^o_{t+1}}\left(\frac{1+i_t}{P_{t+1}/P_t}-\frac{\left(P_{K,t+1}+R_{t+1}\right)/P_{t+1}}{P_{K,t}/P_t}\right)\right]=0.$$

- No arbitrage condition

$$\mathbb{E}^*_t\left[\frac{P_{K,t+1}}{P_{t+1}}\right]=\Theta_t$$

- (New to our model. We make beliefs about future P_K a new fundamental

$$\mathbb{E}^*_t\left[\frac{P_{K,t+1}}{P_{t+1}}\right]=\mathbb{E}_t\left[\frac{P_{K,t+1}}{P_{t+1}}\right]=\Theta_t$$

- Expectations are both fundamental and rational

Policy

- FISCAL: For this paper (and this talk) we set government debt equal to zero and we assume no taxes and no government expenditure
- MONETARY: We choose monetary policy by setting the money stock equal to a constant
- We will analyze the effect of an unanticipated monetary transfer to the old (an MIT shock)

The complete model

$$\frac{1-\alpha}{1+\beta+\delta}\left(\beta-\frac{\delta}{i_t}\right)Y_t=\frac{P_{K,t}}{P_t}$$

- Dynamic IS

$$\frac{M^*_{t+1}}{P_t}=\frac{(1-\alpha)\delta}{1+\beta+\delta}\left(\frac{1+i_t}{i_t}\right)Y_t.$$

- LM

$$\mathbb{E}_t\left[\frac{\beta}{C^o_{t+1}}\left(\frac{1+i_t}{P_{t+1}/P_t}-\frac{\left(P_{K,t+1}+\alpha P_{t+1}Y_{t+1}\right)/P_{t+1}}{P_{K,t}/P_t}\right)\right]=0$$

- NAC

These equations determine {*P,Y,i*} sequences

The complete model

$$P_t C_t^o = \alpha P_t Y_t + P_{K,t} + M_{t+1}^*.$$

- This determines the consumption of the old

$$Y_t = \left[\left(1 - \frac{L_t}{\Gamma}\right) L_t\right]^{1-\alpha}.$$

- This determines employment (recursively)

$$\mathbb{E}_t \left[\frac{P_{K,t+1}}{P_{t+1}}\right] = \Theta_t.$$

- This is our fundamental theory of animal spirits

Policy

- Importantly: the effect of a shock depends on how beliefs are formed
- We analyze two belief formation mechanisms
  - Fixed beliefs

$$\mathbb{E}_t\left[\frac{P_{K,t+1}}{P_{t+1}}\right] = \Theta.$$

  - Adaptive beliefs

$$\mathbb{E}_t\left[\frac{P_{K,t+1}}{P_{t+1}}\right] = \frac{P_{K,t}}{P_t}$$

The steady state

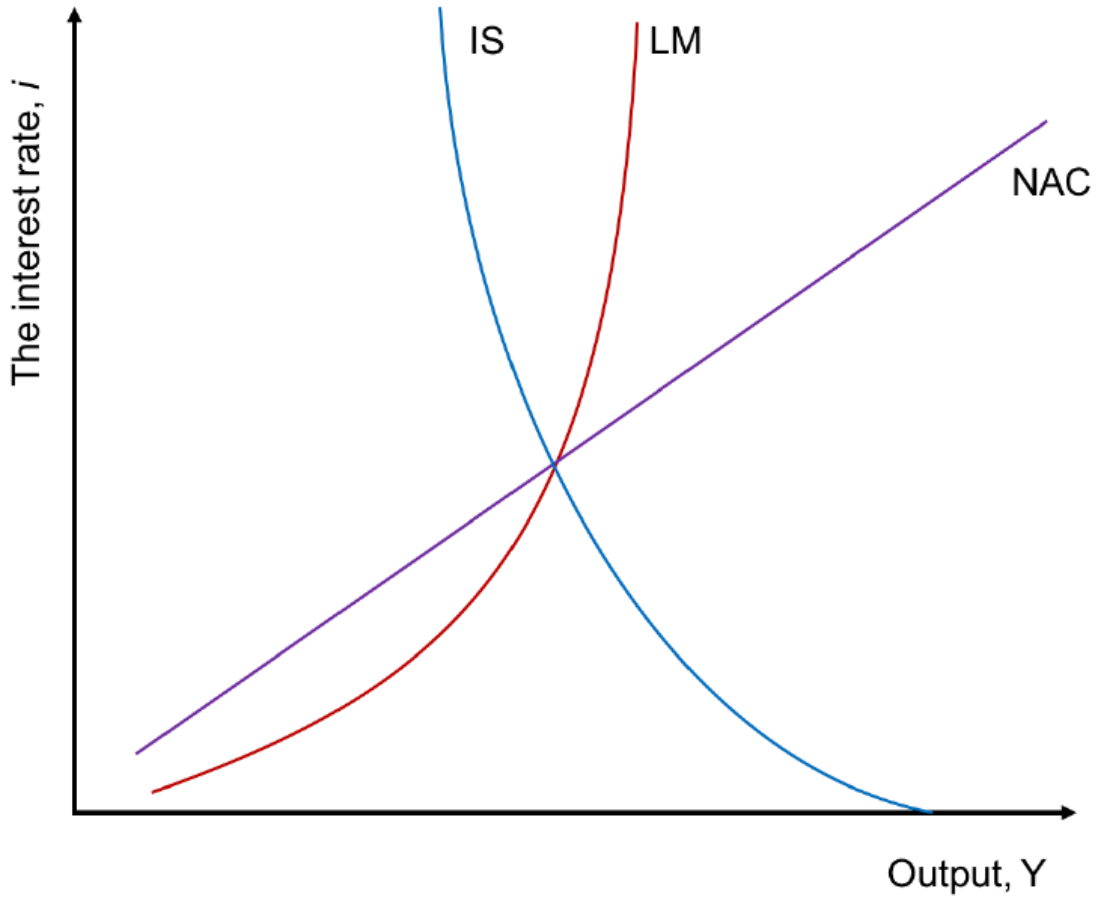
$$\text{IS:} \quad \frac{1-\alpha}{1+\beta+\delta}\left(\beta-\frac{\delta}{i}\right)Y=\Theta$$

$$\text{LM:} \quad \frac{M}{P}=\frac{(1-\alpha)\delta}{1+\beta+\delta}\left(\frac{1+i}{i}\right)Y$$

$$\text{NAC:} \quad i=\frac{\alpha Y}{\Theta}.$$

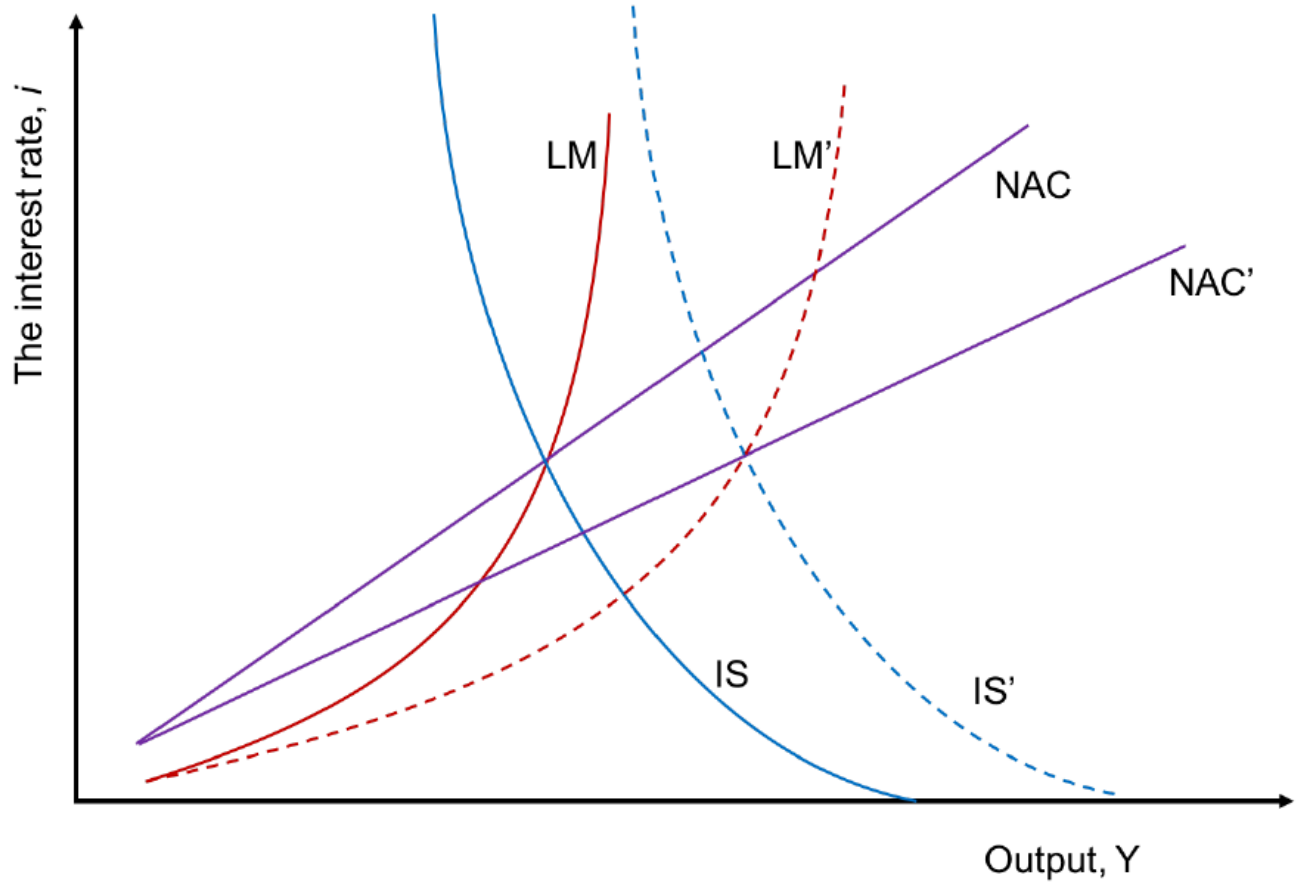
- These are the steady state equations
- Following Farmer (1993) we treat animal spirits, aka Θ as a fundamental

The steady state



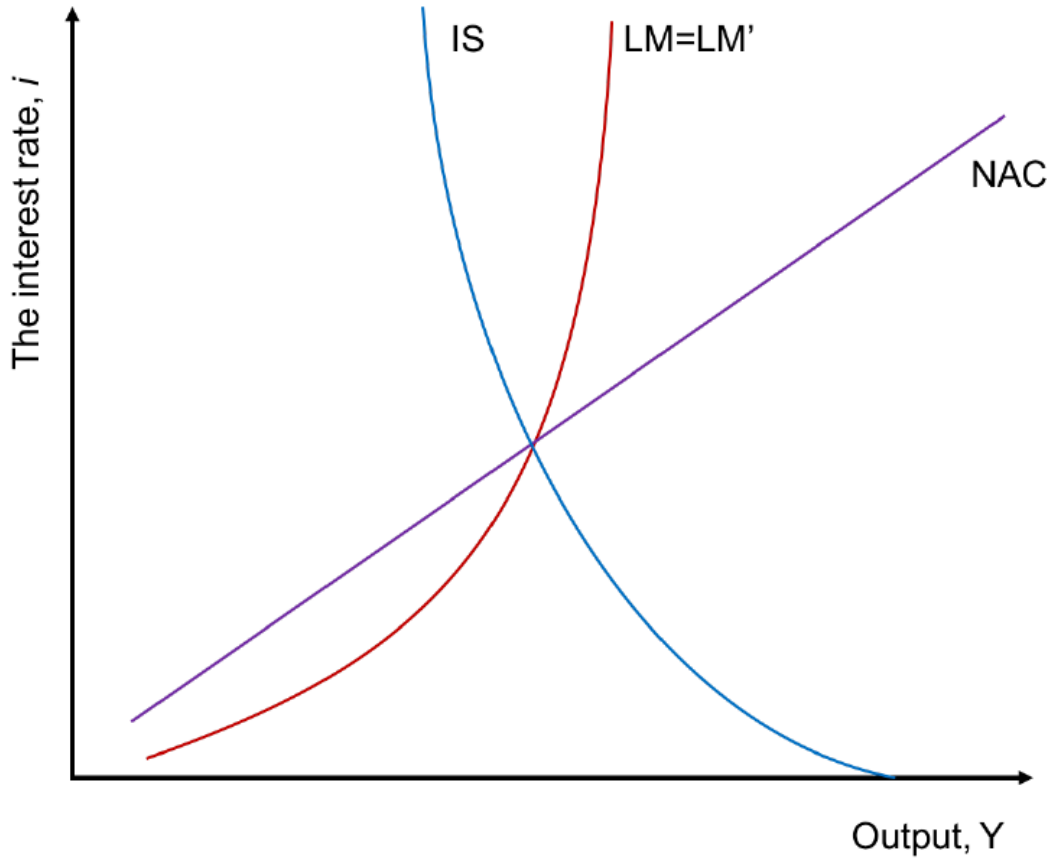
- This is the steady state representation of our model
- The fact that it is a steady state representation differentiates our work from NK models

The steady state



- A confidence shock has a permanent effect on equilibrium GDP

Money is neutral if beliefs are fixed



- A shock to the money supply (under fixed beliefs) is neutral
- This not true if beliefs are adaptive

Dynamic equilibria

$$x_t \equiv \left[y_t, \tilde{i}_t, p_t, p_{K,t}, \mathbb{E}_t\left[y_{t+1}\right], \mathbb{E}_t\left[p_{t+1}\right], \mathbb{E}_t\left[p_{K,t+1}\right]\right]'$$

$$\varepsilon_t \equiv [m_t, \theta_t]'$$

- Variables of the model
- Policy shocks

$$\eta_t^1 \equiv p_t - \mathbb{E}_{t-1}[p_t],$$
$$\eta_t^2 \equiv p_{K,t} - \mathbb{E}_{t-1}[p_{K,t}],$$
$$\eta_t^3 \equiv y_t - \mathbb{E}_{t-1}[y_t].$$

- Expectational errors

Our calibration

TABLE 1—CALIBRATION

Parameter	Definition	Value
α	Share of capital in output	.33
β	Subjective discount rate	.50
δ	Coefficient on real money balances in utility	.05

Static and dynamic indeterminacy

- The model always has static indeterminacy
- We resolve this by making beliefs fundamental
- Under our calibration, the model also has dynamic indeterminacy
- We resolve this by selecting a belief function where prices are believed to be (and are in equilibrium) predetermined one period in advance

Static and dynamic indeterminacy

$$\Gamma_0 x_t = \Gamma_1 x_{t-1} + \Psi \varepsilon_t + \Pi \eta_t$$

$$\eta_t^1 \equiv p_t - \mathbb{E}_{t-1}[p_t] = 0.$$

- We use gensys to solve the model (Sims 2001)
- We resolve indeterminacy using the method of Farmer-Khramov-Nicoló. We select a predetermined price equilibrium

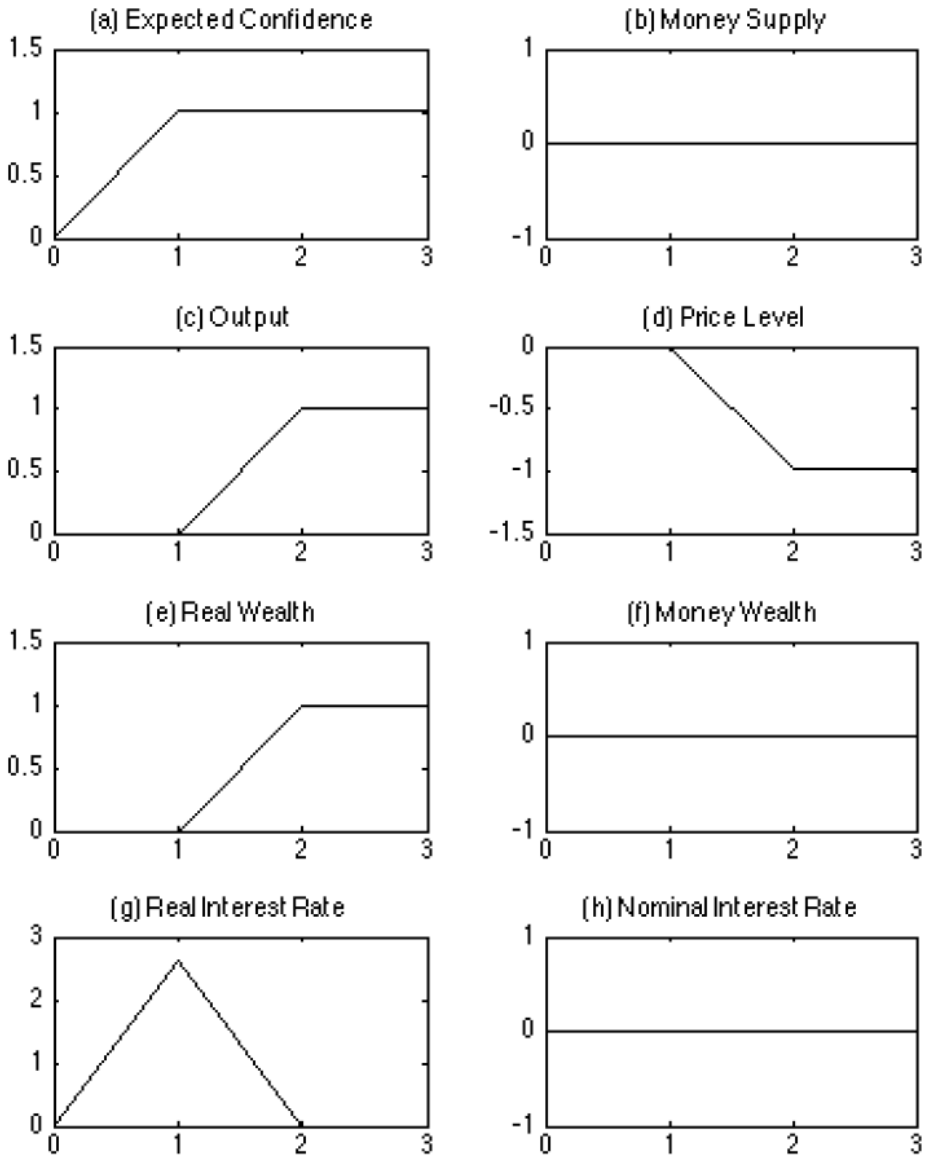


FIGURE 5. A PERMANENT SHOCK TO CONFIDENCE

A shock to confidence (fixed beliefs)

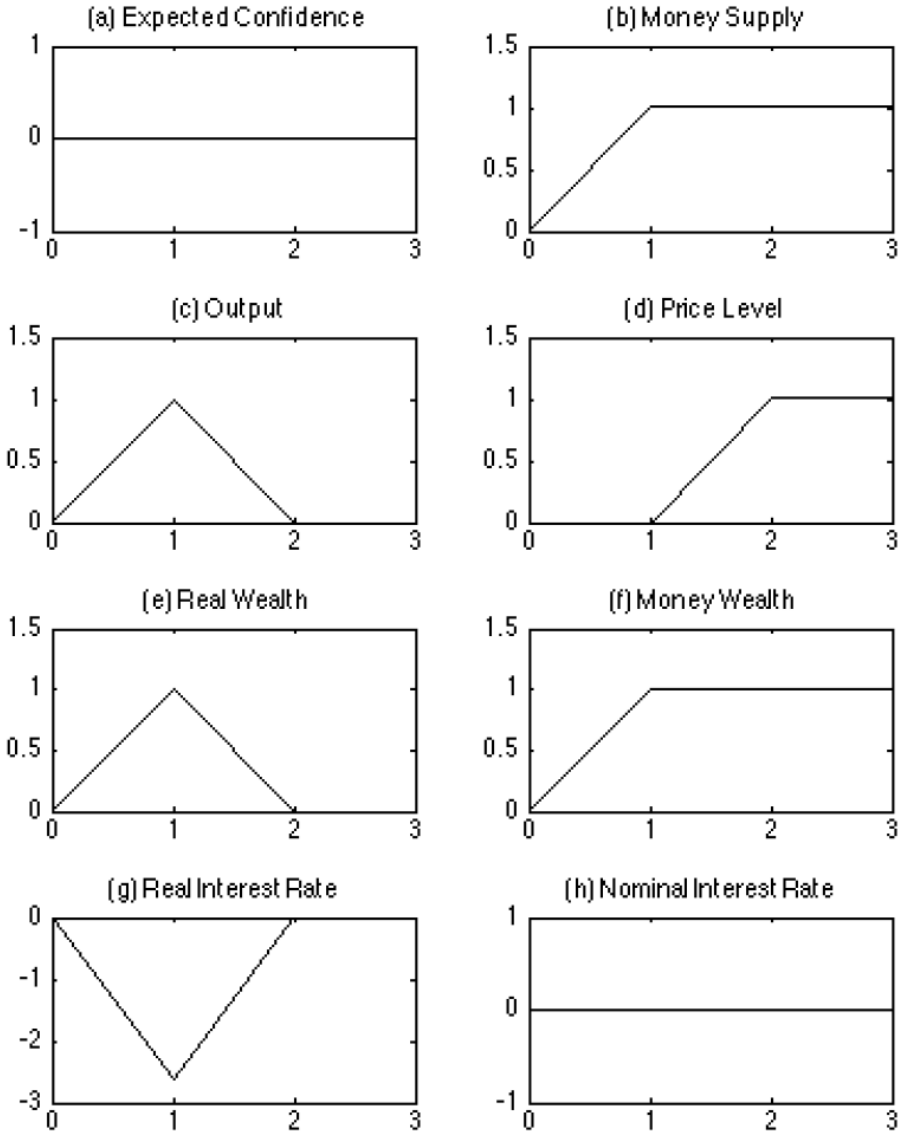


FIGURE 6. A PERMANENT SHOCK TO THE SUPPLY OF MONEY UNDER FIXED BELIEFS

A shock to money (fixed beliefs)

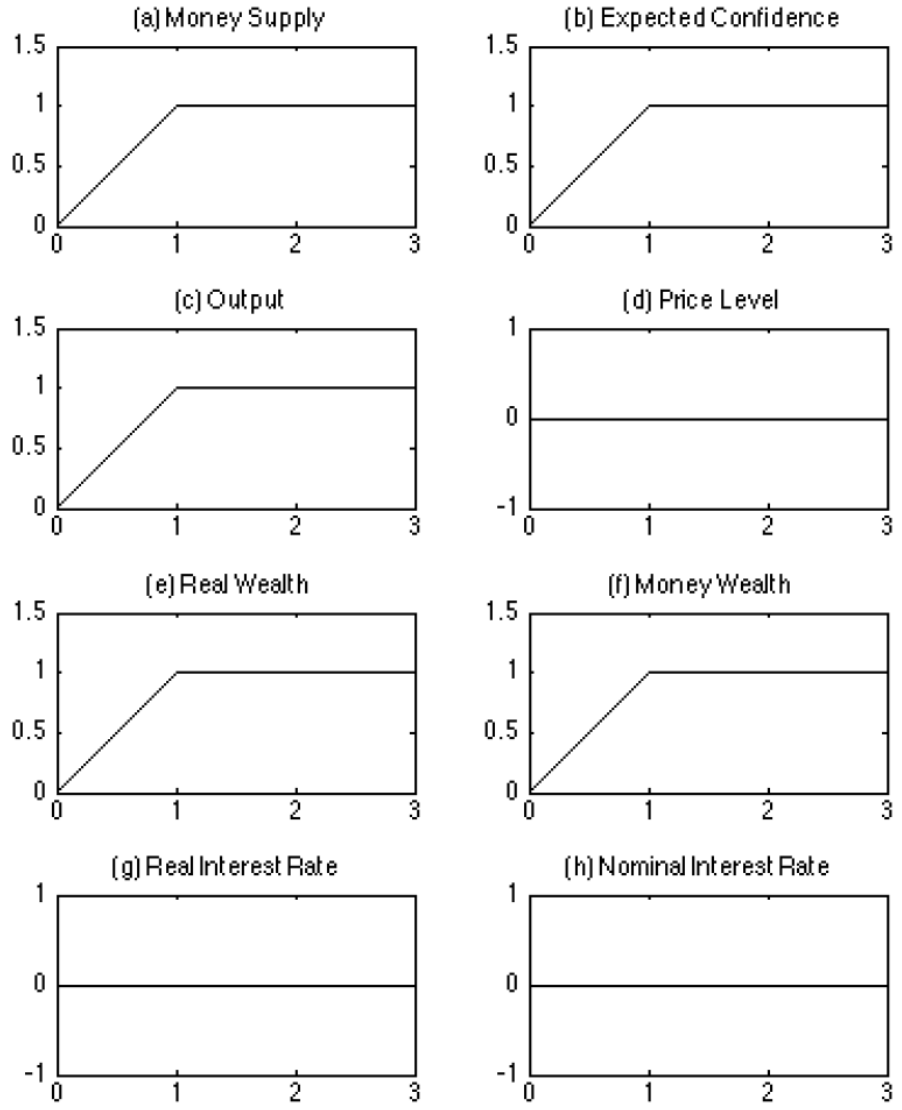
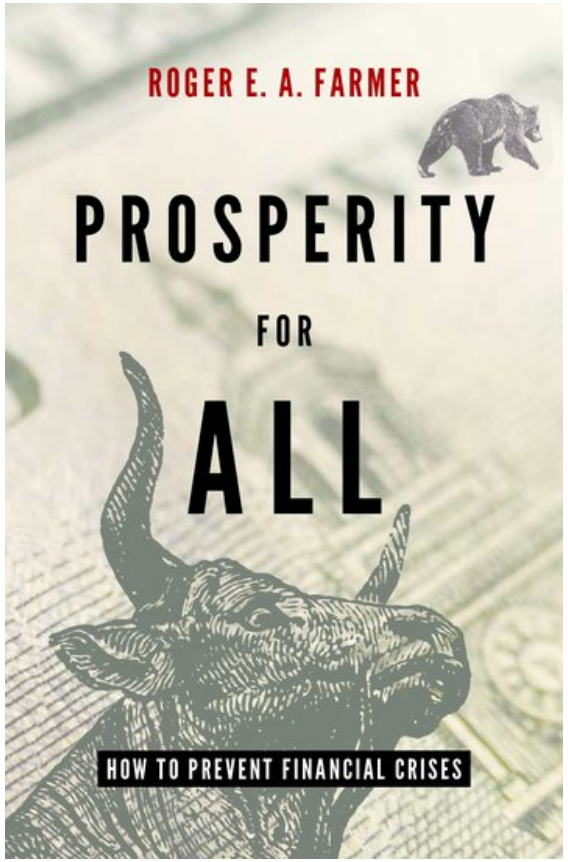


FIGURE 7. A PERMANENT SHOCK TO THE SUPPLY OF MONEY UNDER ADAPTIVE BELIEFS

A shock to money (adaptive beliefs)

I discuss the policy implications of these ideas in my new book

- Animal spirits matter because capital markets are inefficient
- Unemployment is involuntary because markets are missing
- Financial policy is the answer



Thank You for Listening