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

\[ \bar{Y} = \bar{K}^\alpha \bar{X}^{1-\alpha} \]
\[ \bar{L} = \bar{X} + \bar{V} \]
\[ \bar{L} + \bar{U} = \bar{H} \]
\[ \bar{L} = \bar{V}^{1/2} \bar{U}^{1/2} \]

\( q \) 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

\[ L = \bar{L} \quad K = \bar{K} \quad U = \bar{U} \quad H = \bar{H} \]  
Symmetric equilibrium

\[ \bar{K} = 1 \quad \bar{H} = 1 \]  
Endowments
Private Technology

\[ L = qV \]

\[ q = \frac{1}{L} \]

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

Social Technology

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

\[ \bar{U} = 1 \text{ because workers are fired and rehired every period} \]

\[ \bar{Y} = [\bar{L}(1 - \bar{L})]^{1-\alpha} \]
Factor prices are neo-classical

\[(1 - \alpha) \frac{Y}{L} = \frac{W}{P} \quad \& \quad \alpha \frac{Y}{1} = \frac{R}{P}\]

\(W\) 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)

$$\bar{U} = 1 - \bar{L} \uparrow$$

$$q \uparrow$$

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

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

\[ P_t C_t^y + M_{t+1} + B_{t+1} + P_{K_t} K_{t+1} = W_t L_t, \]

\[ P_{t+1} C_{t+1}^o = (R_{t+1} + P_{K_{t+1}}) K_{t+1} + (1 + i_t) B_{t+1} + M_{t+1} \]

- Utility
- Budget constraints
Aggregate demand

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

- 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

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

\[
\frac{M_{t+1}^*}{P_t} = \frac{(1 - \alpha)\delta}{1 + \beta + \delta} \left( \frac{1 + i_t}{i_t} \right) Y_t.
\]

\[
E_t \left[ \frac{\beta}{C_{t+1}^0} \left( \frac{1 + i_t}{P_{t+1}/P_t} - \frac{(P_{K,t+1} + \alpha P_{t+1}Y_{t+1})/P_{t+1}}{P_{K,t}/P_t} \right) \right] = 0
\]

These equations determine \( \{P,Y,i\} \) sequences

- Dynamic IS
- LM
- NAC
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)

\[ E_t \left[ \frac{P_{K,t+1}}{P_{t+1}} \right] = \Theta_t \]

- 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

- These are the steady state equations

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

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

\[
\text{NAC: } i = \frac{\alpha Y}{\Theta}
\]

- Following Farmer (1993) we treat animal spirits, aka \( \Theta \) 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

\[ x_t \equiv \left[ y_t, i_t, p_t, pK_t, E_t[y_{t+1}], E_t[p_{t+1}], E_t[p_{K,t+1}] \right]' \]

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

- Variables of the model
- Policy shocks
- Expectational errors

\[ \eta^1_t \equiv p_t - E_{t-1}[p_t]; \]
\[ \eta^2_t \equiv p_{K,t} - E_{t-1}[p_{K,t}]; \]
\[ \eta^3_t \equiv y_t - E_{t-1}[y_t]. \]
Our calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>Share of capital in output</td>
<td>.33</td>
</tr>
<tr>
<td>$\beta$</td>
<td>Subjective discount rate</td>
<td>.50</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Coefficient on real money balances in utility</td>
<td>.05</td>
</tr>
</tbody>
</table>
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

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

\[ \eta_{t}^{1} \equiv \rho_t - \mathbb{E}_{t-1} [\rho_t] = 0. \]

- 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
A shock to confidence (fixed beliefs)
A shock to money (fixed 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

Hmm... Perhaps I need to buy his book.