Indeterminacy and Sunspots in Macroeconomics

Thursday September 7th: Lecture 8
Gerzensee, September 2017
© Roger E. A. Farmer
Warwick University and NIESR
Topics for Lecture 8

• Facts about the labor market
• Classical search theory
• Keynesian search theory
Reading

• Farmer, Prosperity for All
• Farmer, The Evolution of Endogenous Business Cycles
Supplementary Reading

If you want to better understand my approach to unemployment, see

Classical View of the Labor Market

How should we model the labor market?

Classical and New-Keynesian: the labor market is an auction

\[ w^* \]

\[ L^* \]

Real wage

The quantity of labor demanded

The quantity of labor supplied

Quantity of Labor
Classical View of the Goods Market

When the quantities of labor demanded and supplied are equal, the economy produces $Y^*$

$Y^*$ is potential output.
Keynesian Economics in 1950

Keynesian economics in the 1950s was demand determined

\[ X_t \quad \text{Expenditure} \]
\[ Y_t \quad \text{Income} \]
\[ C_t \quad \text{Consumption} \]
\[ I_t \quad \text{Investment} \]
Keynesian Economics in 1950

The complete Keynesian model is called the Keynesian Cross

\[ X_t = C_t + I_t \quad \text{Expenditure} \]

\[ X_t = Y_t \quad \text{Aggregate Supply} \]

\[ C_t = a + bY_t \quad \text{Consumption Function} \]

\[ I_t = \bar{I}_t \quad \text{Animal Spirits} \]

\[ a \quad \text{Autonomous consumption} \]

\[ b \quad \text{Marginal Propensity to Consume} \]
The Keynesian Cross

Keynesian economic theory as it was taught in the 1950s

Here $Y^K$ is called a Keynesian equilibrium

$Y^*$ is potential output

Keynesian economic theory as it was taught in the 1950s

Here $Y^K$ is called a Keynesian equilibrium

$Y^*$ is potential output
The Keynesian Cross

Keynesian argued that if the animal spirits of investors are weak, the economy can come to a rest point like $Y^K$ at less than full employment

$$Y^K = \frac{a + \bar{I}}{1 - b}$$

Here, $Y^*$ is the output that would be produced if the quantity of labor demanded was equal to the quantity of labor supplied and if labor was traded in an auction market.
The Keynesian Critics

Critics argued that $Y^K$ cannot be an equilibrium.

If the quantity of labor demanded is less than the quantity of labor supplied, the money wage, the money price and the money interest rate will change.

As prices and wages fall, these critics showed that aggregate demand would increase to restore full employment and bring output back to full employment output $Y^*$.
Price and wage adjustment will, it was argued, cause the aggregate demand curve to increase from $AD_1$ to $AD_2$.

Price and wage changes will restore income from the Keynesian underemployment equilibrium $Y^K$ to the classical full employment equilibrium $Y^*$ where output is back at potential.
The Keynesian Critics

Paul Samuelson formalized that idea with a model he called the neo-classical synthesis

According to the neo-classical synthesis:

The economy is Keynesian in the short-run, when wages and prices have not fully adjusted to their Walrasian equilibrium values.

The economy is classical in the long-run when wages and prices have fully adjusted back to their Walrasian equilibrium values.
The Disequilibrium Approach

There is a deep theoretical problem with the neo-classical synthesis: there is no good theory of how trades take place if prices are not equal to their Walrasian equilibrium values.

Recall that the fictional Walrasian auctioneer does not permit any trades to take place until he has computed an equilibrium.

There were attempts to solve this problem in the 1970s by Robert Barro and Herschel Grossman, Jean Pascal Benassy, and Edmond Malinvaud.
The Disequilibrium Approach

The disequilibrium theorists developed a new equilibrium concept.

They assumed that prices are fixed by some Deus Ex Machina and they studied how people would trade if they were quantity constrained.

For example, if you can’t sell as much labor as you would like, you will be forced to spend less on goods. That, in turn, could be self-reinforcing and lead firms to hire less labor than they should at the Walrasian equilibrium.
The Disequilibrium Approach

The purpose of the disequilibrium approach was to provide a rigorous theoretical basis for the neo-classical synthesis.

It was thought that this theory was empirically sound because Phillips had observed a stable relationship between wage inflation and unemployment in a century of data.

When the Phillips curve disappeared in the data in the 1970s, the neoclassical synthesis had two strikes against it. It had weak theoretical foundations and it was contradicted by the data.
The Rational Expectations Equilibrium Approach

In 1972, Robert Lucas argued that we should go back to classical foundations and he reintroduced the idea that the quantity of labor supplied is always equal to the quantity of labor supplied.

In my view: this was a big mistake.

The correct response should have been to develop a consistent theory of unemployment.

That is what I will turn to next.
Search Theory

Search theory is an alternative approach to the auction theory of the labor market that provides a theory to explain why some people are unemployed. In search theory, the labor market is modelled as a dynamic process.

In search theory there are four categories of people:

<table>
<thead>
<tr>
<th>The Total Population</th>
<th>The Labor force</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) In the labor force</td>
<td>(3) Employed</td>
</tr>
<tr>
<td>(2) Out of the labor force</td>
<td>(4) Unemployed</td>
</tr>
</tbody>
</table>
The labor market is dynamic.
Classical and Keynesian Search Theory

Search theory was developed by Peter Diamond, Dale Mortensen and Chris Pissarides. I call their work classical search theory.

In my own work I have developed an alternative approach. I call my work, Keynesian search theory.
Classical Search Theory

In classical search theory the wage is determined by bargaining

Classical search theory fits the data badly

1) It maintains a version of the natural rate hypothesis
2) It cannot explain why unemployment is so persistent in the data
Keynesian Search Theory

In Keynesian search theory the wage is determined by animal spirits. In this approach, as with Keynes, animal spirits are fundamental.

Keynesian search theory fits the data well

1) It drops the natural rate hypothesis

2) It explains why unemployment is very persistent in the data
Matching frictions

In search theory there are two technologies

The production technology produces goods from labor, $X$ and capital, $K$

$$Y = f(K, X)$$

The match technology produces filled jobs from vacancies and unemployment

$$M = g(U, V)$$
Important Concept: the Matching Function

\[ M = g(U, V) \equiv \frac{1}{U^2} \frac{1}{V^2} \]

This is an example of a matching function

# Newly hired people per week

# Unemployed People

# Corporate Recruiters
Important Concept: the Matching Function

\[ 1 = \left( \frac{U}{M} \right)^{\frac{1}{2}} \left( \frac{V}{M} \right)^{\frac{1}{2}} \]

If every corporate recruiter services one vacancy per week we can write this in terms of flows

\[ u = \left( \frac{U}{M} \right) \quad \text{is the unemployment rate} \]

\[ v = \left( \frac{V}{M} \right) \quad \text{is the vacancy rate} \]
One vacancy per week can be filled when 80% of the labor force is unemployed and 5% of employed people are recruiters.

Or one vacancy per week can be filled when 5% of the labor force is unemployed and 80% of employed people are recruiters.
Evidence for a Matching Function

In data, there is a stable connection between job vacancies and unemployment

This is named the Beveridge Curve after the English politician, William Beveridge
The Beveridge Curve in Data


2008-2014 data in red

vacancy rate (percent)

unemployment rate (percent)
The Planning Problem and Search Equilibrium

In the remaining part of this afternoon’s lecture:

1) I will ask why would the social planner choose to leave some people unemployed?

2) I will ask: Why can’t markets do what the planner would do?
Why is there Unemployment

Suppose you are a social planner

You would like to produce as much output as possible

People are always leaving jobs to move across the country, to get married, because they are fed up and want a new job, etc etc

Your task is to find new jobs for these people
Matching is Costly

In order to find jobs for unemployed people you must expend resources to make sure they are well matched.

For example, you probably don’t want to assign a nurse to become a construction worker.

The more resources you devote to search, the fewer resources are left to produce goods.
The Natural Rate of Unemployment

Milton Friedman defined the natural rate of unemployment, as the equilibrium rate in an economy subject to frictions

In a model with a continuum of equilibria, like the one I will build here, that does not make sense

Instead, I will define the Natural Rate of Unemployment to be the (unique) solution to a social planning problem
Some Definitions

\[ L \] # of employed people

\[ N = 1 \] the labor force

\[ U = N - L \] # of unemployed people

\[ V \] # of corporate recruiters

\[ X = L - V \] # of production workers
Matching is a Dynamic Process

\[ L_{t+1} = L_t (1 - \delta) + \frac{1}{2} U_t^2 V_t^2 \]

\[ U_t = 1 - L_t \]

\[ L_t = X_t + V_t \]

\[ \delta \quad \text{is the job separation rate} \]
The Natural Rate of Unemployment

\[ L_{t+1} = L_t (1 - \delta) + \frac{1}{2} (1 - L_t)^2 (L_t - X_t)^2 \]

If the capital stock is fixed (think of this as land) and the production function is Cobb-Douglas then,

\[ Y_t = X_t^\alpha \]
The Steady State

In a steady state

\[ L = L(1 - \delta) + (1 - L)^2(L - X)^2 \]

Rearranging this expression gives

\[ X = L - \frac{\delta^2 L^2}{1 - L} \]

Output is maximized when \( X \) is maximized
The Natural Rate of Unemployment

Why isn’t everyone employed?

Because people are constantly exiting jobs. To match the newly unemployed with a new job instantaneously would take resources away from production.

This shows up in the equation that relates productive labor, $X$ to employment $L$

$$X = L - \frac{\delta^2 L^2}{1 - L}$$
The Natural Rate of Unemployment

$U^*$ is the natural rate of unemployment
An Even Simpler Model

Now I will turn to a version of this problem that abstracts from dynamics

I will illustrate the difference between a social planning optimum and an equilibrium

I will highlight the role of externalities
An Even Simpler Model

The problems of the social planner, and the firm are dynamic

If we set $\delta = 1$ the problem becomes static

In this simple case, everyone is fired and re-hired every period and

$$L = \sqrt[2]{V^1}$$

Can you see why unemployment is not there any more in the match technology?
In a Walrasian model, price signals decentralize allocations

If the social planner demands that the unemployment rate should equal $u^*$ and the vacancy rate should equal $v^*$, there must be two relative prices, $p_u$ and $p_v$ that send signals to market participants.
Search and Markets

If $p_u$ is high, market participants will know that unemployed people are costly to society and jobs will be filled relatively quickly.

If $p_v$ is high, market participants will know that vacancies are costly to society and jobs will be filled relatively slowly.

The efficient allocation of resources requires two relative prices.
In reality, there is no market to decide if jobs are filled with a high vacancy rate or a high unemployment rate.

There is only one relative price: the wage.

If workers and firms take wages and prices as given: a competitive model does not have enough equations to solve for all of the unknowns.
Search and Steady State Indeterminacy

Competitive search models always have steady state indeterminacy of equilibria

Classical search models resolve the indeterminacy by assuming that firms and workers DO NOT take wages as given

Instead, they bargain over the wage
Keynesian search models resolve the indeterminacy by assuming that firms hire enough workers to meet aggregate demand.

In Keynesian search models, firms and workers DO take wages and prices as given.

In a dynamic version of the model that we will study tomorrow, animal spirits select the equilibrium.
Search Externalities

Variables in **black** are individual. Variables in **red** are economy-wide averages. In equilibrium they are equal

Individual

\[ X = L - V \]

Economy-wide average

\[ X = L - V \]
Planner and Equilibrium

\[ Y = X^\alpha \]

\[ X = L - V \]

\[ L = qV \]

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

In equilibrium, \[ q = \frac{1}{L} \]
Search Externalities

Unemployed workers are like fish

Recruiters for firms are like fishermen

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

Higher $V$ causes $q$ to fall
US Productivity and Unemployment

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

This graph plots US labor productivity (in blue) against the unemployment rate one year earlier (in red). Both series have been HP filtered.
I opened this lecture by asserting that classical economics, where the labor market is an auction, cannot easily explain why there is persistent unemployment.

I argued that search theory CAN explain why there is persistent unemployment.

But we need the right kind of search theory.
Classical Search and Keynesian Economics

Classical search theory is an improvement over the auction model of the labor market.

It can explain why unemployment exists in equilibrium.

But it cannot explain why unemployment is persistent and why unemployment fluctuates so much over business cycles.
Classical search theory can explain why unemployment exists at the steady state.

Steady state output $Y^{CS}$ is less than the frictionless output $Y^*$ that would occur in an auction market.
Classical Search and Keynesian Economics

But it is still a rocking horse model. Adjustments to prices and wages always cause unemployment to return to its natural rate
The Keynesian Cross

Keynesian search theory is different

In Keynesian search theory aggregate demand determines equilibrium
Summary

• Labor market search models are necessarily models with incomplete markets
• They provide a natural way of modeling Keynes’ idea of involuntary unemployment
• In the classical search model: steady state equilibrium output is determined by aggregate supply
• In the Keynesian search model: steady state equilibrium output is determined by aggregate demand