Connecting Asset and Labor Markets

in a Heterogeneous Agent Model

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Disclaimer

- The views expressed in this talk are my own.
- They may not be shared by others in the Federal Reserve System ...
- Especially my colleagues on the Federal Open Market Committee.

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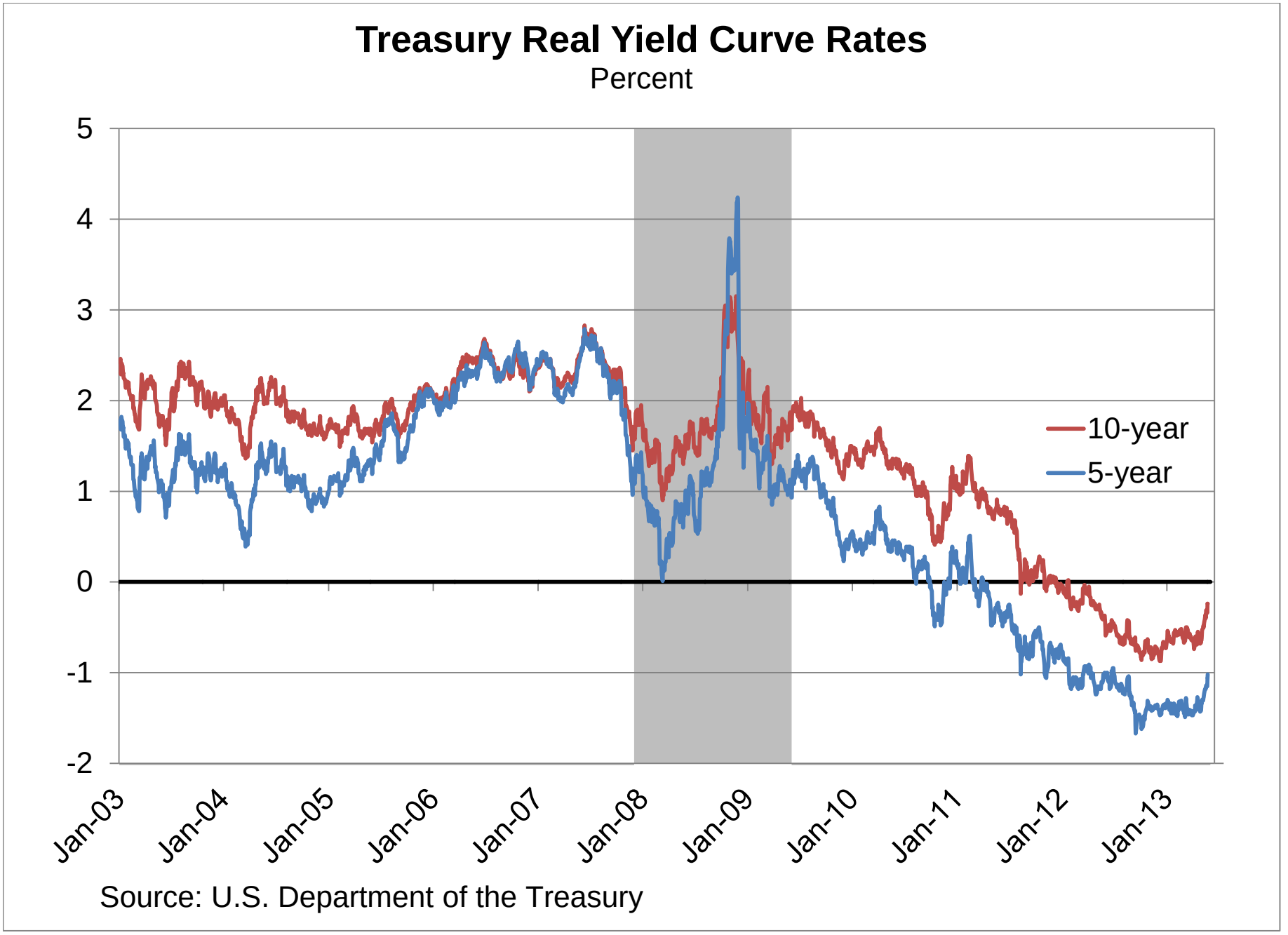
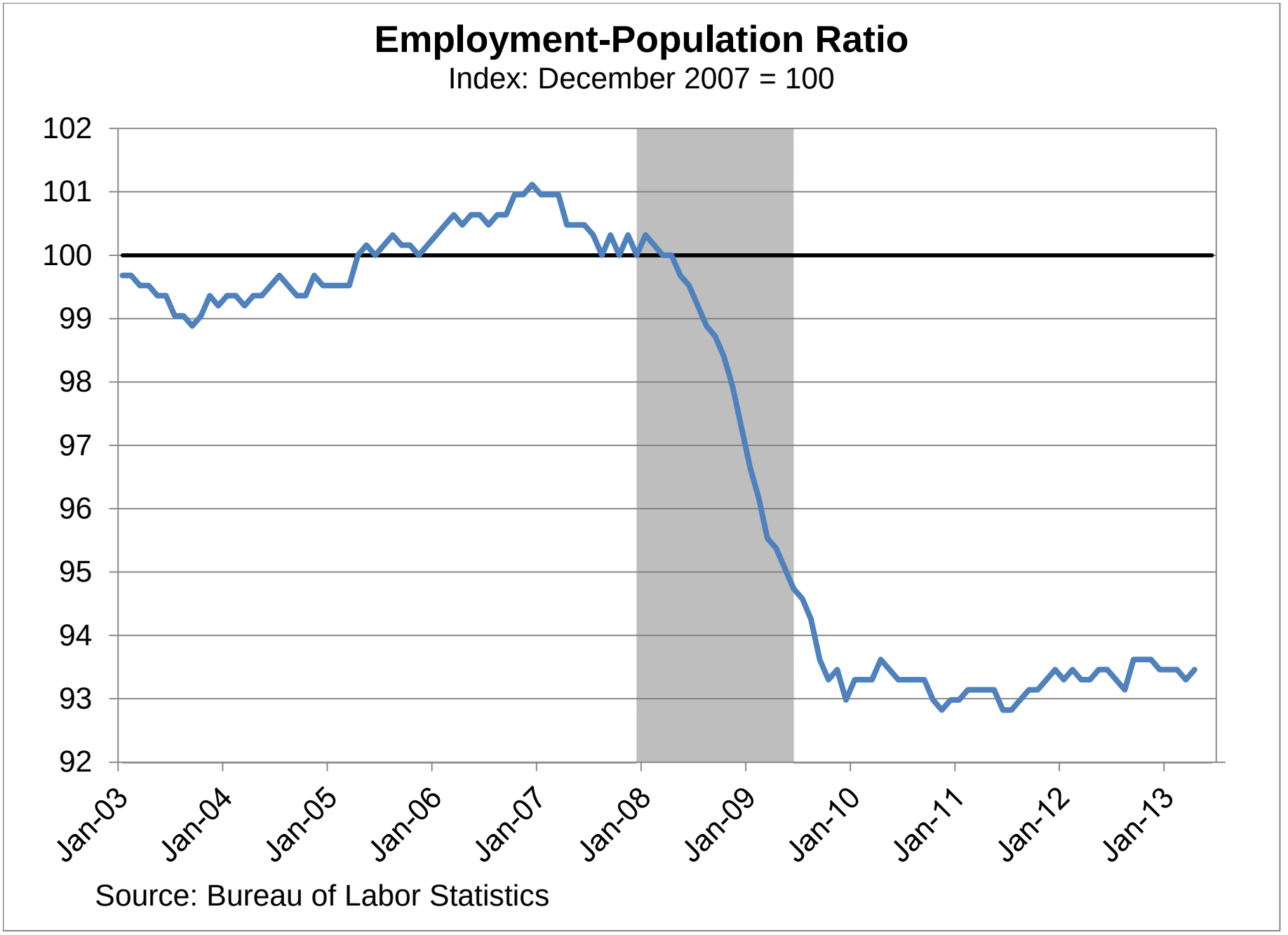
Changes in Asset Markets

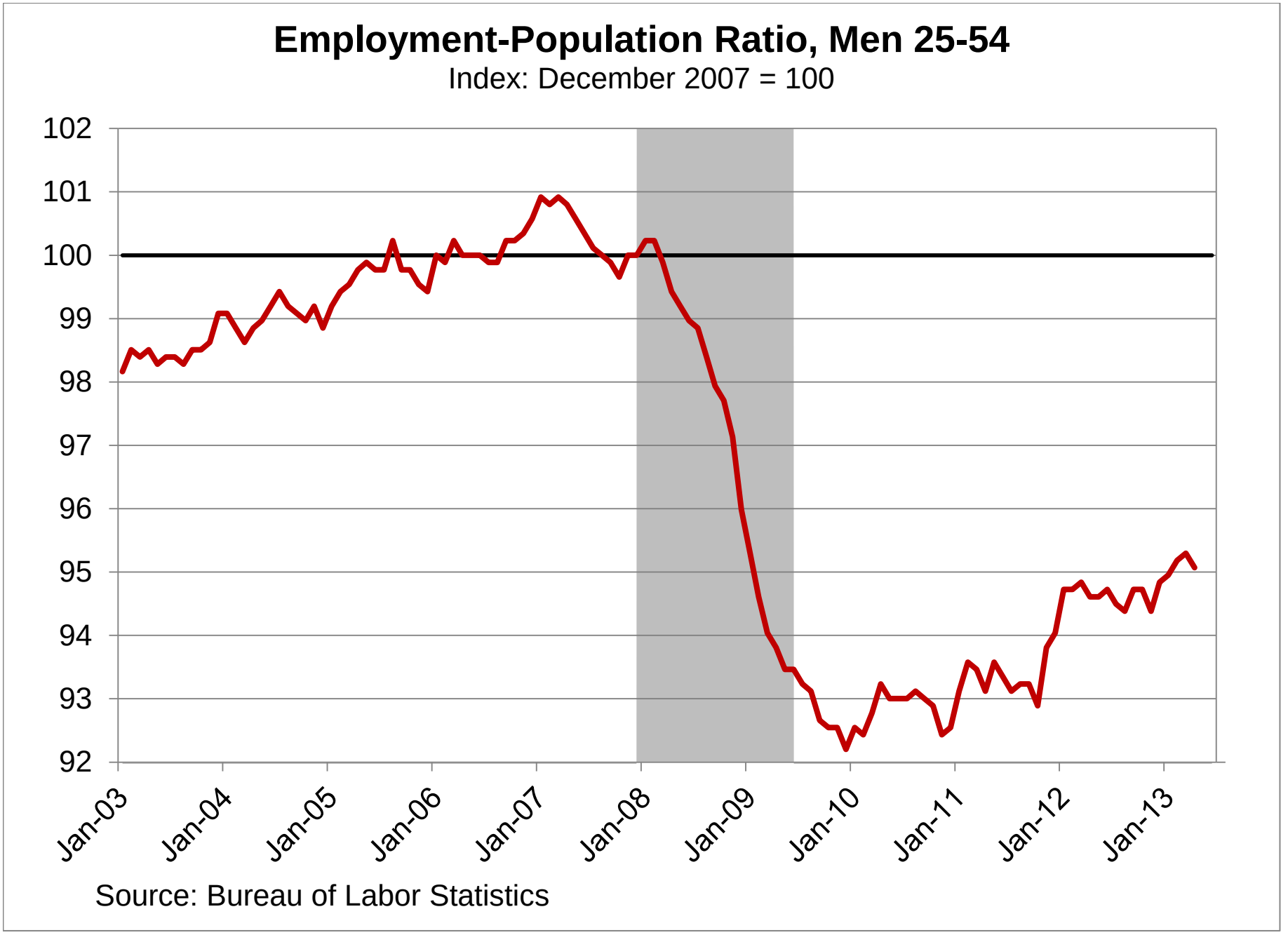
- There have been changes in asset markets since 2007.
  - Borrowing constraints have tightened.
  - Increase in perceived macroeconomic risk.
  - Decline in supply of "risk-free" assets.
- Combined effect: increase in net asset demand.
- These changes seem likely to reverse only slowly.


Treasury Real Yield Curve Rates
Percent
5
4
3
2
1
0
-1
-2
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
10-year
5-year
Source: U.S. Department of the Treasury

Changes in Employment

- Employment/population in US fell sharply from late 2007 to late 2009.
- This change has been highly persistent:
- Employment/population has risen little since late 2009.


Employment-Population Ratio
Index: December 2007 = 100
102
101
100
99
98
97
96
95
94
93
92
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Source: Bureau of Labor Statistics


Employment-Population Ratio, Men 25-54
Index: December 2007 = 100
102
101
100
99
98
97
96
95
94
93
92
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Source: Bureau of Labor Statistics

Connecting the Two Changes: The Model

- In this talk, I link these two persistent changes.

- I use a *heterogeneous agent model* with:
  - **inelastic labor supply** (recent micro-evidence on extensive margin)
  - **incomplete insurance markets** (Bewley-Huggett)
  - **flexible** or **rigid** nominal wage growth

Connecting the Two Changes: The Shock

- I posit a permanent exogenous increase in net asset demand.
  - Many possible sources of this shock - I use tighter borrowing constraints
- The impact of this shock depends on the flexibility of wages.

Connecting the Two Changes: The Results

If wages are flexible:

The shock has no impact on employment.

If nominal wage growth is fixed (can't rise):

The shock causes employment to fall unless monetary policy is eased enough.

Intuition for Flexible Case

- Key equilibrating mechanism:
  - Excess labor supply pushes up nominal wage growth.
- In turn, anticipated inflation rises.
- People buy more goods today and firms demand more workers ...
- Until labor markets clear.

Intuition for Rigid Case

- Suppose nominal wage growth can't rise.
- Then anticipated inflation can't rise.
- If the nominal interest rate is not lowered enough, then ...
- The real interest rate doesn't fall enough.
- Product demand remains too low, and employment is too low.

Outline

1. Model
2. Equilibrium
3. Comparative Statics
4. Conclusions

MODEL

Preferences: Consumption

- Unit measure of agents.

- Each agent maximizes expected value of:

$$\sum_{t=1}^{\infty} \beta^{t-1} u(c_t), 0 < \beta < 1, u', -u'' > 0$$

  where c_t is consumption in period t.

Preferences: Labor

- At each date, each agent wants to work ($\overline{a} = 1$) or not ($\overline{a} = 0$).
- The binary state $\overline{a}_t$ is a Markov chain with transition matrix Φ.
- The autocorrelation of $\overline{a}$ is non-negative.
- No aggregate shocks (evolution is iid across agents).

Involuntary Non-Employment

- Conditional on $\overline{a} = 1$, an agent's labor $\overline{n}$ is equal to:
  - 1 with probability $(1 - \mu)$.
  - ε (ε small but positive) with probability μ.
- Conditional on $\overline{a} = 0$, an agent's labor $\overline{n} = 0$.
- The variable μ is endogenous, while Φ is exogenous.
- I refer to μ as *labor market slack.*

Technology

- There are a large number of competitive firms.

- Firms produce zN units of consumption with N units of labor.

Trading

- At each date, agents trade a one-period risk-free nominal bond.
- Bonds are available in zero net supply.
- Nominal interest rate is set by monetary policy.
- Agents face a real borrowing limit b^*.

Budget Set

$$P_t c_t + B_{t+1}/(1+R) \leq W_t \overline{n}_t + B_t$$

$$B_{t+1} \geq -P_{t+1} b^*$$

EQUILIBRIUM

Budget Equivalence

- Agents have budget sets defined by:

$$P_t c_t + B_{t+1}/(1+R) \leq W_t \overline{n}_t + B_t$$

$$B_{t+1} \geq -b^* P_{t+1}$$

- Define (and assume time invariance of):

$$r \equiv \frac{(R-\pi)}{1+\pi}$$

$$\pi \equiv \frac{P_{t+1} - P_t}{P_t}$$

$$w \equiv \frac{W_t}{P_t}$$

- Divide original budget set through by P_t and define $b_t = B_t/P_t$.

- We get equivalent (Bewley-Huggett) budget sets:

$$c_t + \frac{b_{t+1}}{1+r} \leq w\overline{n}_t + b_t$$

$$b_{t+1} \geq -b^*$$

Bewley-Huggett Demand Functions

- Suppose agent has budget set:

$$c_t + b_{t+1}/(1+r) \leq w\overline{n}_t + b_t$$

$$b_{t+1} \geq -b^*$$

- Labor $\overline{n}_t$ follows the Markov chain determined by:
  - Φ (exogenous transition of willingness to work)
  - μ (endogenous labor market slack)

- Let $\overline{b}^d(r; b^*, \mu, w)$ be (long-run) average bondholdings.

- **Result**: $\overline{b}^d$ is weakly decreasing in the borrowing limit b^*.

- **Result**: $\overline{b}^d$ is increasing in the real interest rate r.

- **Assumption**: $\overline{b}^d$ is decreasing in labor market slack μ.

Stationary Equilibrium

- Wage inflation π_W, price inflation π, and slack μ satisfy:

$$\pi_W = \pi \qquad \textbf{(firm optimality)}$$

$$\overline{b}^d\left(\frac{R-\pi}{1+\pi}; b^*, \mu, z\right) = 0 \qquad \textbf{(asset mkt clears)}$$

- Need a third equilibrium condition somewhere!

Flexible Wage Equilibrium

- Flex-wage equilibrium conditions:

$$\pi_W = \pi \qquad \textbf{(firm optimality)}$$

$$\overline{b}^d(\frac{R-\pi}{1+\pi}; b^*, \mu, z) = 0 \qquad \textbf{(asset mkt clears)}$$

$$\mu = 0 \qquad \textbf{(no slack)}$$

- Nominal wage growth adjusts so that there is no labor market slack.

Equilibrating Mechanism

- Suppose the labor market is out of equilibrium ($\mu > 0$).
- Households bid down current wages (relative to future wages).
- Counterintuitive (?): labor market slack pushes **up** wage growth.

- Product competition: higher wage growth means more inflation.
- People demand more consumption and firms demand more labor.
- Process continues until $\mu = 0$.

Rigid Wage Equilibrium

- Rigid wage eq'm: wage inflation is exogenous ($\overline{\pi}_W$).

- Rigid wage equilibrium conditions:

$$\pi_W = \pi \qquad \textbf{(firm optimality)}$$

$$\overline{b}^d(\frac{R-\pi}{1+\pi}; b^*, \mu, z) = 0 \qquad \textbf{(asset mkt clears)}$$

$$\pi_W = \overline{\pi}_W \qquad \textbf{(rigid wage growth)}$$

- The real interest rate is exogenous.

- Asset market clears via changes in labor market slack.

Equilibrating Mechanism

- Suppose the asset market is out of equilibrium:

$$\overline{b}^d(\frac{R-\overline{\pi}_W}{1+\overline{\pi}_W};\mu,b^*,z)>0.$$

- Too much asset demand implies that there's too little product demand.

- Given that low product demand, firms scale back labor demand (μ rises).

- With less labor income, asset demand falls until market clears.

COMPARATIVE STATICS

Experiments

- How does eq'm output depend on borrowing constraint b^*?

- How does eq'm output depend on monetary policy R?

- The answer depends on eq'm notion (flex or rigid).

Flexible Wage Equilibrium

- In equilibrium, for any R or b^*, slack μ equals 0.

- The borrowing limit and monetary policy don't affect aggregate quantities.

- But they do affect equilibrium outcomes.

- Suppose the borrowing constraint is tighter ($b^{**} < b^{*}$) ...

- Or monetary policy is tighter ($R^{**} > R^{*}$).

- Both of these changes push up on asset demand.

- To clear asset market, the real interest rate must fall.

- That's accomplished via an **increase** in nominal wage growth:

$$\pi^{**} = \pi^{**}_W > \pi^{*}_W = \pi^{*}$$

.

Rigid Wage Equilibrium

- Wages grow at exogenous rate $\overline{\pi}_W$.

- Competition among firms implies that inflation $\pi = \overline{\pi}_W$.

- The real interest rate adjusts through changes in monetary policy (R).

- Suppose the borrowing constraint tightens ($b^{**} < b^{*}$) ...

- OR monetary policy tightens ($R^{**} > R^{*}$) ...

- These changes push up on asset demand.

- The real interest rate can't adjust because R and π_W are fixed.

- To clear asset market, labor market slack must rise:

$$\mu^{**} > \mu^*$$

- The rise in slack pushes down on income and so on asset demand.

Conclusions

- Suppose borrowing limit (b^*) shrinks.

- This fall in the borrowing limit increases net asset demand.

- How does this increase in asset demand affect labor markets?

- Impact on labor markets depends on wage adjustment.

- Flexible wages: no effect on output or employment.

- Rigid wages: output and employment fall.
  - This decline can be offset with easier monetary policy.

CONCLUSIONS

Changes Since 2007

- A number of changes in asset markets since 2007.

- Asset demand has risen:
  - increased uncertainty
  - lower potential growth estimates
  - tighter borrowing constraints

- Outside supply of risk-free assets has fallen.
  - Sovereign debt is riskier.
  - US land values are lower - and land is riskier.
  - Partial offset: increase in sovereign debt.

- Overall: Net asset demand has risen.

Implications of a Heterogeneous Agent Model

- I used a standard incomplete financial markets model.

- After an increase in net asset demand, asset markets clear via:
  - a fall in the real interest rate
  - OR a fall in economic activity

- Suppose nominal wage growth is fixed, so it can't rise.
- Then the real interest rate depends only on R (monetary policy).
- If R is kept too high (ZLB?), then the real interest rate won't fall enough.
- And the asset demand shock results in a fall in economic activity.

Modern Models, Old Implications

- The analysis is based on a standard workhorse "modern macro" model.
- It delivers neoclassical conclusions if wages are flexible.
- It delivers Keynesian conclusions if ...
- Nominal wage growth fails to rise enough to eliminate excess labor supply.

Future Research

- The question is:

How do nominal wages respond to excess labor suppy?

- We need a lot more work on this question.

- Useful approaches: micro-evidence and surveys.