Topic 8: New Keynesian Business Cycles

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Overview

- Last class we saw the main limitations of the RBC model: it cannot explain:
  - how demand shocks could be causing recessions
  - why monetary policy appears to influence real interest rates in the short run
  - why monetary policy appears to influence *economic activity* (C, I, Y, N, etc.)
  - why countercyclical fiscal policy could be a good idea
- Today we introduce sticky prices in the RBC model. This leads us to the New Keynesian model.
- We see how the model remedies these deficiencies of RBC, and allows us to understand monetary policy.

Outline

1. Price stickiness and changes in M 8.3–8.6
2. Actual practice of monetary policy: changing i 8.7–8.17
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Prices stickiness and changes in M

Consider the quantity theory equation and assume constant velocity v:

$$M_t v = P_t Y_t$$

Review Q: derive the effect of $\Delta \log M$ on P and Y in the RBC model (both SR and LR)

New Q: assume instead P cannot change in the SR. What are the effects in the SR?

$\rightarrow$ sticky prices imply that monetary policy affects Y!

Price adjustment

Assume that $P_0 = M_0 = Y_0 = 1$ and $\Delta \log M = 1$. Suppose that prices adjust as

$$\log P_t = \theta \log P_{t-1} + (1 - \theta) \cdot 1$$

Derive the effect on the whole path of P_t and Y_t.

Summary time paths in SR and LR

$\rightarrow$ The effects of monetary policy on output are *transitory*. In the LR, prices adjust.

In the data, prices change about every 6 months. Suggests monthly $\theta = \frac{5}{6}$.

Macroeconomists debate how long the effects of monetary policy on Y last.

Actual practice of monetary policy

We've described monetary policy as changing the money supply M directly.

In practice, the relevant "M" is outside the direct control of the central bank.

The central bank controls the nominal interest rate i_t and the quantity of *reserves* M_t^{res}.

How does this work?

Note: this is only a short introduction to central banking.
For more, see Econ 111 (Money & Banking) and Econ 112 (Financial Markets).

What are reserves?

Reserves are liabilities of the Federal Reserve and assets of private banks

Reserves = Vault Cash + Fed Funds $\equiv M^{res}$

Fed Funds = electronic funds that private banks have in their central bank account

Reserves = Required Reserves + Excess reserves

Required Reserves = Required Reserve Ratio $\times$ Deposits $= \frac{1}{\mu} \times M$

Notes on reserves

The Federal Reserve (the U.S. central bank) is a bank for private banks

Private banks use vault cash to accommodate cash withdrawals

Private banks use their Fed Funds to make electronic transfers to and from other private banks or to the Fed

Example of electronic transfers:

- Inflows: customer deposits, loan repayments, asset sales
- Outflows: customer withdrawals, loan disbursements, asset purchases.

The required reserve ratio ensures banks keep Reserves≥ 0 given plausible outflows

Open market operations (OMOs)

The central bank has a regulatory *monopoly* over the total supply of reserves M_t^{res}

Electronic transfers between private banks do not affect the total supply of reserves, they just shift them around among banks

The central bank creates reserves out of thin air by *buying* assets and paying with reserves

The central bank decreases reserves when it *sells* assets to banks

These are known as *open market operations* (OMOs). A typical OMO involves the purchase or sale of a U.S. government bond.

The Federal Funds rate

The Federal Funds market is a market for overnight loans between private banks

The Federal Funds Rate (FFR) is the interest rate i_t on these overnight loans

The Fed does not set i_t administratively, but it controls M_t^{res}

It uses OMOs to alter the supply of M_t^{res} to hit a target i_t

The Federal Funds market before 2008

Pre-2008 monetary policy

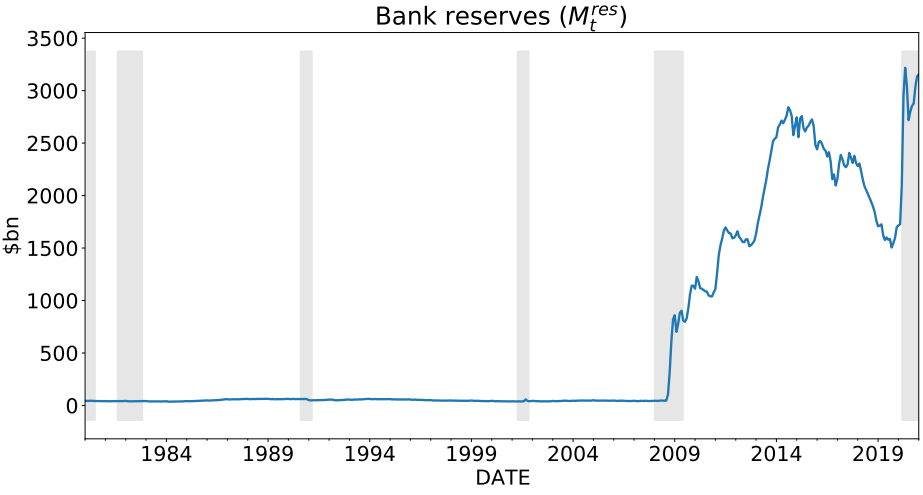
Before 2008, banks did not want to hold excess reserves. Reserves paid $i_t^{res} = 0$, so if they had excess reserves, banks preferred to lend them and get i_t.

Hence, we always had $M_t^{res} =$ Reserves $=$ Required Reserves$= \frac{1}{\mu} M_t$

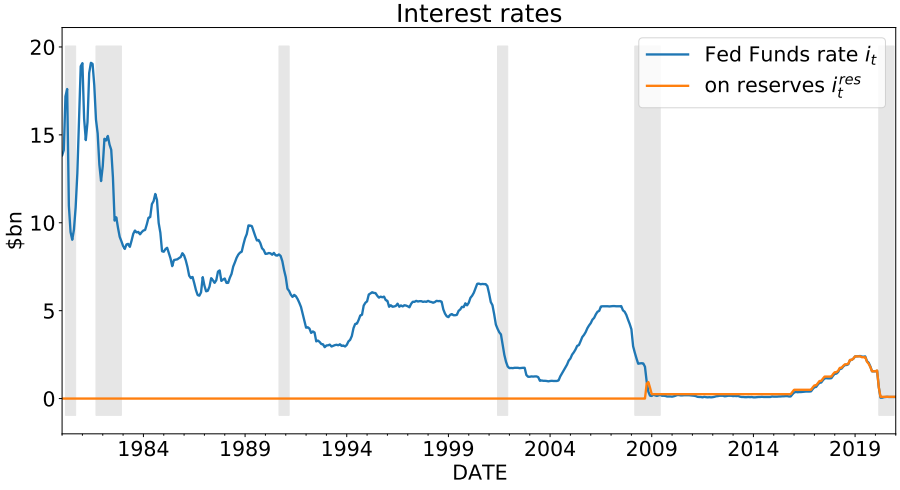
By setting i_t, the Fed was therefore affecting the total money supply

$$M_t = \mu \times M_t^{res}$$

Reserves before and after 2008



Interest rates before and after 2008



The Federal Funds market since 2008

In the current "ample reserves regime", the central bank pays interest rate on reserves i_t^{res} (sometimes referred to as the IOER, for Interest On Excess Reserves).

This ensures that the Fed Funds rate $i_t \geq i_t^{res}$.

Notes on the FOMC, the FFR target, and the interest on reserves

The Federal Open Market Committee (FOMC) meets every 6 weeks

After each meeting, they issue a directive to the Open Market Trading desk at the Federal Reserve Bank of New York with a target FFR

Recent example: *Effective January 28, 2021, the Federal Open Market Committee directs the Desk to Undertake open market operations as necessary to maintain the federal funds rate in a target range of 0 to 1/4 percent.*

In addition, it sets the interest on reserves. eg, *The Board of Governors voted unanimously to maintain the interest rate paid on required and excess reserve balances at 0.10 percent.*

Bottom line: **the central bank sets i_t.** This then affects ST nominal rates on all assets.

Price stickiness and changes in i_t

Recall the Fisher equation

$$i_t = r_t + E_t\left[\pi_{t+1}\right]$$

Review Q: derive the effect of a permanent increase in i_t in the RBC model (SR&LR)

New Q: assume SR sticky prices instead. What are the SR effects?

$\rightarrow$ sticky prices imply that monetary policy affects r!

Dynamics in the previous question

$\rightarrow$ as r increases, in the SR output and inflation go *down.* We now see why.

Monetary policy and aggregate demand

Define aggregate demand as

$$Y^{demand} = C + I + G + NX$$

Q: What happens to Y^{demand} when monetary policy causes $r \uparrow$?

- C:
- I:
- NX: $\downarrow$ because $r \uparrow$ appreciates the country's exchange rate (see Econ 165!)

Equilibrium with sticky prices

For the goods market to be in equilibrium in the SR we must have

$$Y^{demand} = Y^{supply} = F(K, N)$$

Q: under flexible prices, what happens to Y^{supply} when $r \uparrow$ in SR?

- K:
- N:

This is why monetary policy cannot change r under flexible prices.

What happens with sticky prices? w/p falls! We will see why.

Summary: goods market equilibrium

Output and interest rate gaps

In a sticky-price model:

- the real interest rate r can differ from the RBC interest rate r^*
- the level of output Y can differ from the RBC level Y^* (with $Y = Y^{demand}$)

We call $Y - Y^*$ the output *gap*

- positive output gap: the economy is producting above capacity (eg, after accomodative monetary policy $r \downarrow$)
- negative output gap: the economy has unused resources/is in a recession (eg, after tight monetary policy, $r \uparrow$)

What happens to inflation when there is a gap? Let's consider the producer's problem

Demand constrained production

Recall profits of a firm with capital stock K:

$$\Pi = pAK^{\alpha}N^{1-\alpha} - wN$$

Review Q: calculate optimal labor demand N^* under flexible prices

New Q: calculate optimal labor demand under a production constraint:

$$AK^{\alpha}N^{1-\alpha} \geq Y^{demand}$$

Profits with demand constrained production

Q: Derive profits Π as a function of $Y^{demand} = Y$

Q: Derive $d\Pi/dY$

Incentives to change price

Q: Draw Π as a function of Y. Derive incentives to change p

The Phillips Curve

When $Y > Y^*$, firms want to increase profits by raising p.

When $Y < Y^*$, firms want to increase profits by lowering p.

Bottom line: inflation π increases with the output gap

$$\pi = \kappa \left(\frac{Y - Y^*}{Y^*} \right)$$

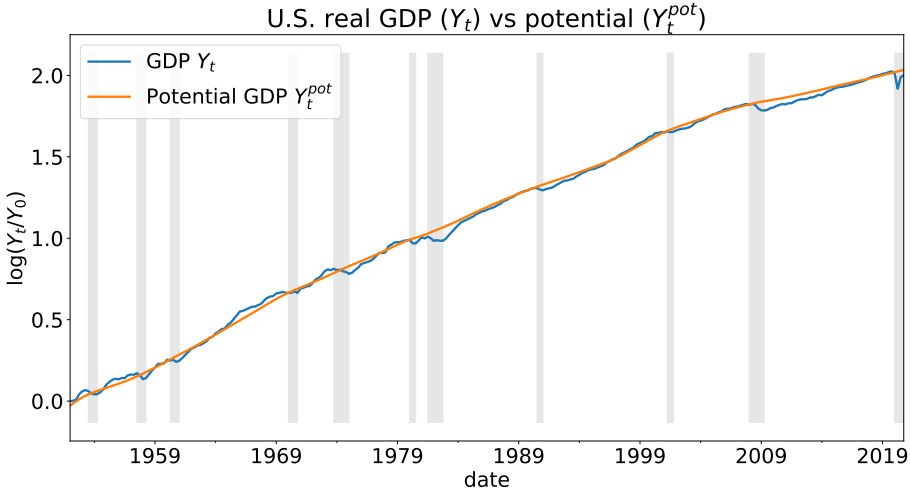
This relation between inflation and the output gap is called the **Phillips Curve**.

Inefficient booms and recessions

Q: Derive welfare $u(C) - v(N)$ as a function of $Y^{demand} = Y$.

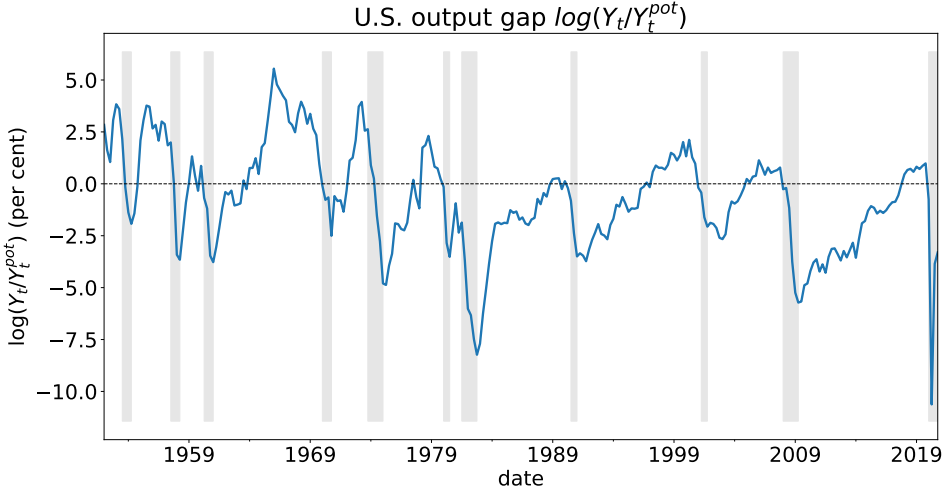
Bottom line: under sticky prices, recessions and boom are both inefficient.

Output and potential output in the data



Source for Y_t^*: Congressional Budget Office

Output gap


U.S. output gap $log(Y_t/Y_t^{pot})$
$\log(Y_t/Y_t^{pot})$ (per cent)
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
1959
1969
1979
1989
1999
2009
2019
date

Phillips Curves in the data

1. Level Phillips curve:

$$\pi_t = \kappa \left(\frac{Y_t - Y_t^*}{Y_t^*} \right)$$

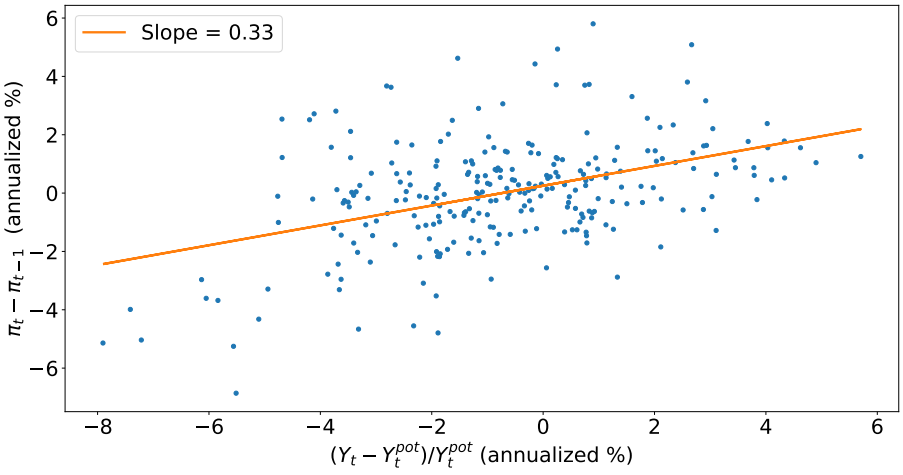
2. Forward looking Phillips curve

$$\pi_t = \kappa \left(\frac{Y_t - Y_t^*}{Y_t^*} \right) + E_t \left[\pi_{t+1} \right]$$

3. Phillips curve in terms of changes ("backward looking")

$$\pi_t - \pi_{t-1} = \kappa \left(\frac{Y_t - Y_t^*}{Y_t^*} \right)$$

Backward looking Phillips curve in the data



Inflation effect of stimulus?

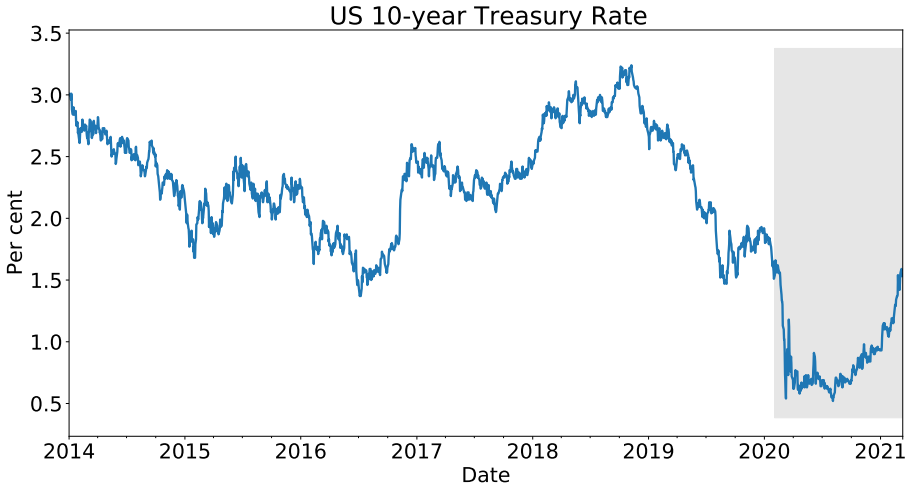
- Larry Summers, Washington Post op-ed (Feb 4, 2021)

"there is a chance that macroeconomic stimulus on a scale closer to World War II levels than normal recession levels will set off inflationary pressures of a kind we have not seen in a generation, with consequences for the value of the dollar and financial stability"

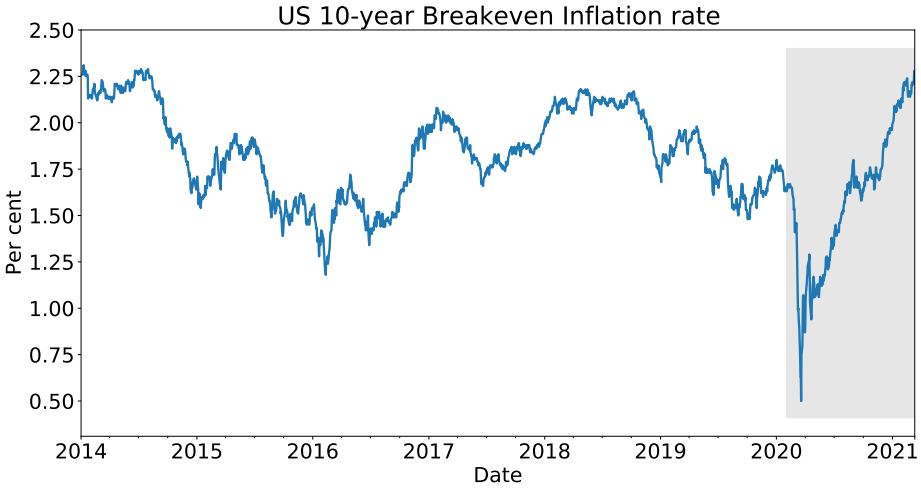
Mechanism:

Janet Yellen response, "I've spent many years studying inflation and worrying about inflation. And I can tell you we have the tools to deal with that risk if it materialises."

Consequence for nominal rates?



Consequence for breakeven inflation rates?



Fiscal policy and aggregate demand

Recall

$$Y^{demand} = C + I + G + NX$$

Q: How does fiscal policy affect Y?

A: Depends on what monetary policy does with r!

Consider first $G \uparrow$ financed by $T \uparrow$ today. How does this *shift* Y^{demand}?

Effects of $G \uparrow$ under flexible prices or if monetary policy sets $r = r^*$

Effects of $G \uparrow$ if monetary policy does not change r

Now suppose that monetary policy does not change r ("accommodates")

- Direct effect on demand is $\Delta Y^{demand} = -MPC\Delta T + \Delta G$
- Demand constrained production: Y^{supply} adjusts to Y^{demand} with higher $\frac{w}{p}$.
- What's the effect on household income?

- Final effect on demand:

$$\Delta Y = -MPC\Delta T + MPC\Delta Y + \Delta G$$

Effects of $G \uparrow$ if monetary does not change r

Conclusion: if monetary policy does not change r, effect of fiscal policy on output:

$$\Delta Y = \frac{\Delta G - MPC\Delta T}{1 - MPC}$$

Option 1: balanced budget G

$$\Delta Y = \Delta G$$

Option 2: deficit finance G

$$\Delta Y = \frac{1}{1 - MPC}\Delta G$$

Option 3: deficit finance stimulus check T

$$\Delta Y = \frac{-MPC}{1 - MPC}\Delta T$$

If dollar amount is the same, which gives largest effect?

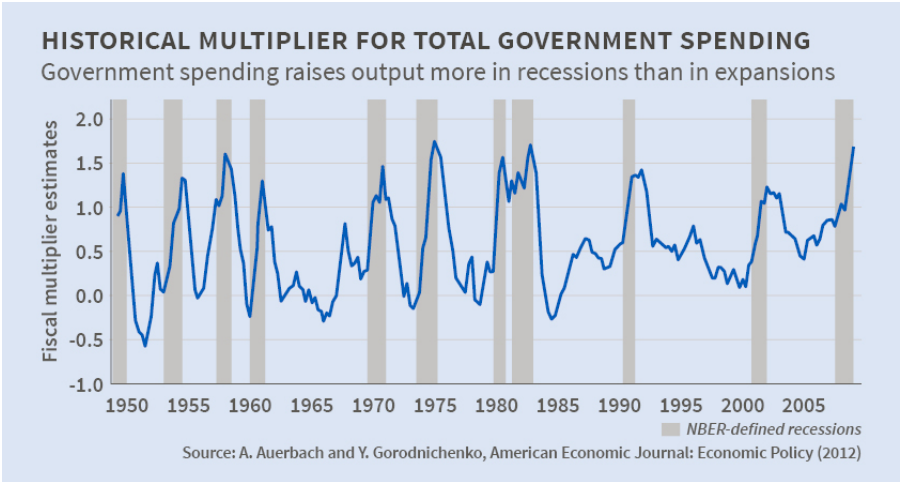
Conclusion on the fiscal multiplier

Fiscal multiplier $\equiv \frac{\Delta Y}{\Delta G}$. Effect on output of extra \$1 of consumption G. We saw:

- If monetary policy raises r, fiscal multiplier < 1 (C, I "crowded out")
- If monetary policy does not change r, balanced budget fiscal multiplier $= 1$
- What happens if monetary policy is at the zero lower bound, $i = 0$?

Bottom line: what monetary policy does in response to fiscal expansion is critical.

Empirical evidence confirms this



Objectives of monetary policy

What *should* monetary policy do?

The Fed Mandate:
"Congress has assigned the Fed to conduct the nation's monetary policy to support the goals of maximum employment, stable prices, and moderate long-term interest rates"

One simple answer: set $r = r^*$. Then $Y = Y^*$, $\pi = \pi^*$, and $i = r^* + \pi^*$.

"Divine coincidence": the Fed's objectives are aligned in principle

Obstacles to the divine coincidence

Can the Fed simply set $r = r^*$ at all times?

- Hard to know what r^* is
- Some factors push inflation up without affecting $Y - Y^*$ (eg, oil shocks)
- May conflict with distributional objectives, eg Chair Powell speech (August 2020)

With regard to the employment side of our mandate, our revised statement emphasizes that maximum employment is a broad-based and inclusive goal. This change reflects our appreciation for the benefits of a strong labor market, particularly for many in low- and moderate-income communities

Taylor rule

What can the Fed do if it does not know r^* or there are "cost-push" shocks?

Useful rule of thumb: follow a *Taylor rule*

$$i = (r^*)^{LR} + 1.5\,(\pi - \pi^*) + 0.5\left(\frac{Y - Y^*}{Y^*}\right)$$

where $(r^*)^{LR}$ is an estimate of long-run r^*

What does this suggest now?

Optimal rate of inflation

Zero lower bound episodes such as now always generate renewed calls for raising π^*

What are the costs and benefits of changing the inflation target π^*?

Conclusion

- The New Keynesian model provides a coherent framework to understand how monetary policy works.
- It can explain:
  - how demand shocks could be causing recessions
  - why monetary policy appears to influence real interest rates in the short run
  - why monetary policy appears to influence *economic activity* (C, I, Y, N, etc.)
  - why countercyclical fiscal policy could be a good idea
- In addition we saw that:
  - The objectives of monetary policy are to maintain $r = r^*$, $\pi = \pi^*$ and $Y = Y^*$
  - The effects of fiscal policy depend heavily on how monetary policy responds to it