Problem Set 7: Monetary Policy
Due April 20/21

1) Monetary Policy and Inflation: Use our standard Keynesian macroeconomic model:

- $Y = E = C + I + NX + G$ — GDP equals the sum of consumption, investment, net exports, and government purchases
- $C = c_0 + c_y \times Y$ — consumption equals the consumer-confidence term plus the mpc times GDP or income
- $I = I_0 - I_r \times r$ — business investment spending equals the business animal-spirits term minus the interest sensitivity of investment times the long-run real risky interest rate
- $\mu = 1/(1 - c_y)$ — the multiplier is the inverse of one minus the mic
- $Y = \mu(c_0 + I_0 + NX) - (\mu I_r) \times r + \mu G$ — our summing-up equation, telling us how the level of annual GDP depends on the multiplier μ, on the private spending flows $c_0 + I_0 + NX$, on the interest-sensitivity parameter I_r, on the interest rate r, and on government purchases G

For this problem, assume a value of the Keynesian multiplier of $\mu = 2$, and with I_r, the sensitivity of investment spending I to the interest rate r, such that $I_r = \$0.15T$. And let's use the Greek letter Δ—capital delta—as a shorthand symbol for changes from the previous equilibrium situation.

The Federal Reserve controls the short-term safe interest rate on government securities—it can nail that value to whatever it wants by buying and selling bonds for cash. We call this interest rate i. But the interest rate that matters for determining investment spending is the long-term real risky interest rate at which banks lend to companies. We call this interest rate r.

a) Suppose that the interest rate r that matters for investment spending falls by 1.5%-pts:

$$\Delta r = -1.5$$

By how much would you expect investment spending to fall given the parameter values of our model? How large is ΔI?

With a sensitivity of investment spending I to the interest rate r of $I_r = \$0.15T$…

ΔI is $-\$0.15T \times -1.5 = +\$0.225T$.

Annual investment spending is boosted relative to the previous equilibrium situation by $0.225 trillion a year.

b) Continue your analysis from (a): given the parameter values of our model and the boosting of investment spending you calculated in (a), by how much would you expect GDP Y to grow?

With a multiplier $\mu = 2$ and an increase in investment spending $\Delta I = +\$0.225T$, the boost to GDP is:

$\Delta Y = \mu \times \Delta I = 2 \times \$0.225T = \$0.45T$

You would expect annual real GDP to grow by $450 billion relative to the previous situation and its previous trend path as a result of this monetary policy intervention.

c) Annual real GDP in the mid-2000s was about $15T. How large is this boost to GDP ΔY you calculated in (b) as a percentage of the then-level of real GDP?

The boost is 0.45/15 = 3%

d) On average, a 1% extra boost to GDP is associated with a 0.5% extra decrease in the unemployment rate. By how much extra would you expect the unemployment rate to fall as a result of the boost to GDP you calculated in (b) and (c)?

An extra boost to GDP of 3% should reduce the unemployment rate by an extra 1.5%.

e) Suppose that with the interest rate decline the unemployment rate falls from 6% to 4.5%. What would the unemployment rate have been without this interest-rate decline?

4.5% + 1.5% = 6%

The unemployment rate would have stayed at 6%.

f) Suppose that real GDP had been lower for each of three years by the amount you calculated in (b). How much poorer would Americans have been in terms of reduced income over those three years had the interest rate r not fallen?

$0.45T less real GDP a year for 3 years = $1.35T less in income

g) In an America with about 135 million workers, how much is this lost income per worker?

$1.35T divided 135 million = $10,000 per worker.

2) Finance and Monetary Policy: Use our standard Keynesian macroeconomic model:

- $Y = E = C + I + NX + G$ — GDP equals the sum of consumption, investment, net exports, and government purchases
- $C = c_0 + c_y \times Y$ — consumption equals the consumer-confidence term plus the mpc times GDP or income
- $I = I_0 - I_r \times r$ — business investment spending equals the business animal-spirits term minus the interest sensitivity of investment times the long-run real risky interest rate
- $\mu = 1/(1 - c_y)$ — the multiplier is the inverse of one minus the mic
- $Y = \mu(c_0 + I_0 + NX) - (\mu I_r) \times r + \mu G$ — our summing-up equation, telling us how the level of annual GDP depends on the multiplier μ, on the private spending flows $c_0 + I_0 + NX$, on the interest-sensitivity parameter I_r, on the interest rate r, and on government purchases G

For this problem, assume a value of the Keynesian multiplier of $\mu = 3$, and with I_r, the sensitivity of investment spending I to the interest rate r, such that $I_r = \$0.2T$. And let's use the Greek letter Δ—capital delta—as a shorthand symbol for changes from the previous equilibrium situation.

Also use this equation for the relationship between the r that matters for investment spending and the i that the Federal Reserve controls is:

$$r = i + \rho + \tau - \pi$$

The difference between i and r—the slippage—is made up of three components. To calculate the second from the first, take the *nominal* short-term safe interest rate on government bonds—here the three-month interest rate on U.S. Treasury bills—and:

- add the so-called *risk premium*, the extra interest rate financiers demand for lending to a business that might go bankrupt rather than to the government (which will always repay). For this we use ρ, the lower-case Greek letter rho.
- add the so-called *term premium*, the extra interest rate financiers demand (or accept) for lending long-term rather than short-term because they think the Federal Reserve will make future short-term interest rates higher (or lower) than they are in the present. For this we use τ, the lower-case Greek letter tau.
- subtract off the expected *inflation rate.* For this we use π, the lower-case Greek letter pi.

a) Suppose that the short-term safe nominal interest rate on government securities the Federal Reserve controls $i = 5\%$, the expected inflation rate $\pi = 2.5\%$, the term premium $\tau = -1\%$, and the risk premium $\rho = 3\%$. What is the real risky interest rate r at which banks lend to companies—the rate that matters for investment spending?

Simple arithmetic: that interest rate r is 4.5%

b) Suppose that the expected inflation rate π stays the same, but a financial crisis causes the risk premium to spike from 3% to 8%. What happens to the long-term risky real interest rate r if the term premium τ and the short-term safe interest rate on government securities i remain constant?

The interest rate r jumps up to 9.5%

c) Suppose that, for each one percentage-point the Federal Reserve reduces the interest rate it controls i, the term premium τ moves by 1/2 percentage point in the opposite direction. What happens to the long-term risky real interest rate r if the risk premium spikes from 3% to 8% and the Federal Reserve responds by lowering the short-term safe nominal interest rate i it controls by as much as possible?

The most the Federal Reserve can lower i is from 5% to 0%—interest rates cannot go negative. And if the Federal Reserve lowers i by 5 percentage-points to zero the term premium τ increases from -1% to 1.5%. The interest rate r is then:

$$r = 0\% + 8\% + 1.5\% - 2.5\% = 7\%$$

d) Suppose that the interest sensitivity of investment I_r is \$0.2T—that a 1%-point change in r moves annual investment spending I by \$0.2T in the opposite direction. By how much downward pressure would the shift from the situation in (a) to the situation in (c) have put on investment spending?

The interest rate r goes up by 2.5%. 2.5 x \$0.2 = \$0.5. Annual investment spending I goes down by \$0.5 trillion.

e) With a multiplier μ of 3, and holding other things constant, how much downward pressure on annual GDP Y would have been generated by the downward pressure on investment spending in (d)?

A simple multiplier calculation: 3 x \$0.5 = \$1.5T. The downward pressure on annual GDP is \$1.5 trillion as a result of the interest rate spike, even offset by much more expansionary monetary policy.

f) Suppose that the Federal Reserve had kept the i it controls the same. How much downward pressure would the financial crisis and its interest rate spike have put on annual GDP Y?

The interest rate r would have jumped up by twice as much—from 4.5% to not 7% but 9.5%. So annual GDP would have fallen by twice as much—by $3 trillion

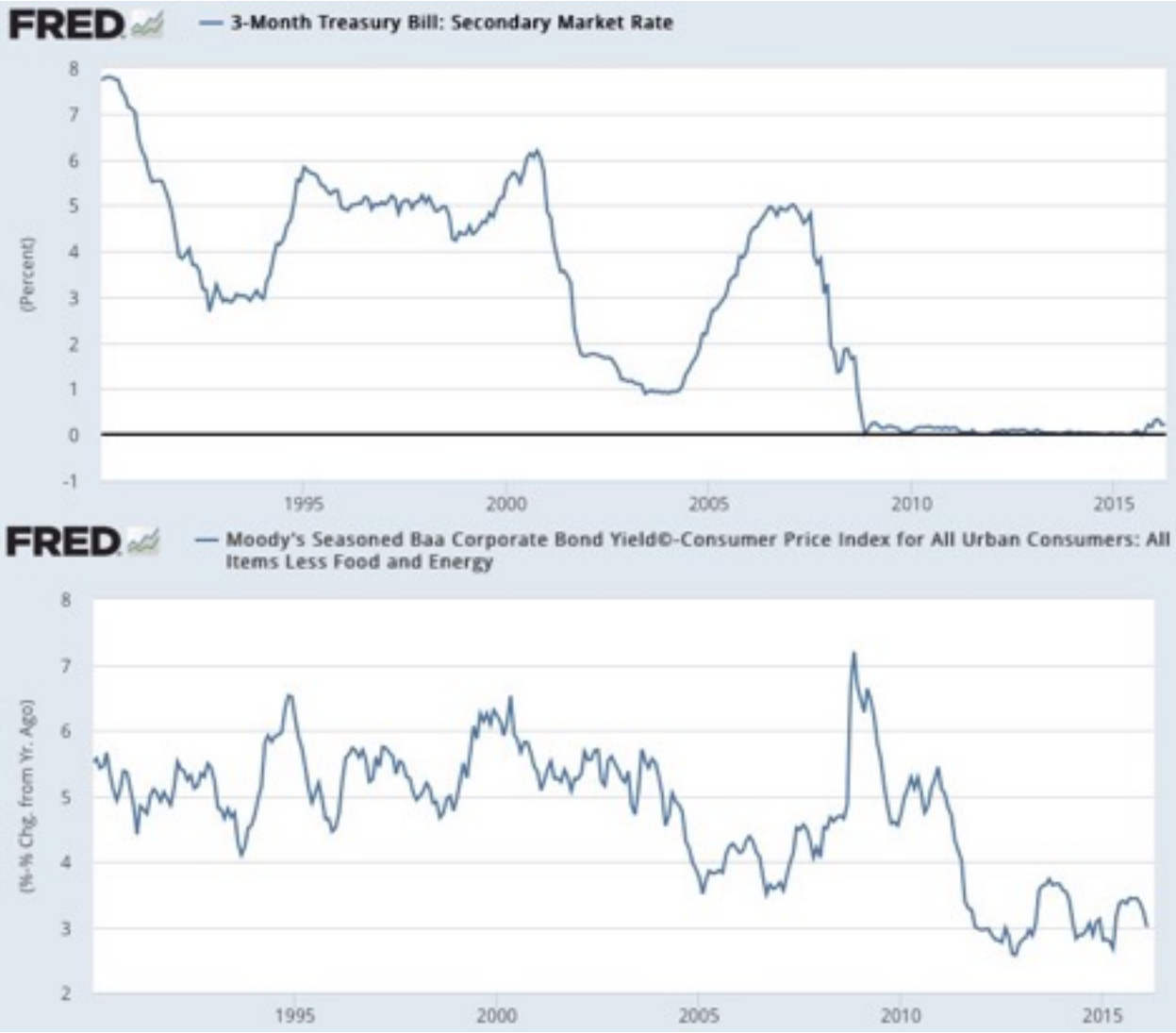
g) Suppose the Federal Reserve took active, aggressive, and successful policy steps to convince people that it would keep the interest rate i it controlled at zero for a long time into the future, and so had nailed the term premium τ to the value of 0. What would your answer to (f) have been?

With a term premium at 0 rather than at +1.5%, the increase in the interest rate r would have been not 2.5% but 1%, and the downward pressure reducing annual GDP would have been not $1.5 trillion but only $0.6 trillion. Convincing the markets that the Federal Reserve did indeed intend to keep interest rates very low for a very long time is difficult, and greatly reduces the Federal Reserve's ability to keep the economy near full employment.

Background Memo for Problem Set 7

Why did we consider a 1.5%-point reduction in the long-term real risky interest rate in problem 1?

Below we have plotted, for 1990-2016, the interest rate the Federal Reserve can actually control by buying and selling government bonds—the *nominal* short-term safe interest rate on government bonds—above the interest rate that actually matters for investment spending—the *real* (i.e., corrected for inflation) long-term interest rate at which banks lend to businesses seeking to expand their capacity by undertaking pieces of investment spending I:



Look at 2003-2005:

Over 2003-2005 the Federal Reserve continues to keep short-term interest rates very low for longer than financiers had been expecting given that the economy was strengthening and the unemployment rate was falling, and then raises interest rates more slowly than expected.

The top panel below shows this:

This later- and slower-than-expected raising of interest rates by the Federal Reserve puts the *term premium* on a previously-unexpected downward path, and leads the r, the interest rate that matters for investment spending in:

$$I = I_0 - I_r \times r$$

to fall from the 5.5% it had been from late 2000 to 2003 down to the 4% or so it was to be over 2005-2007. The bottom panel above shows this.

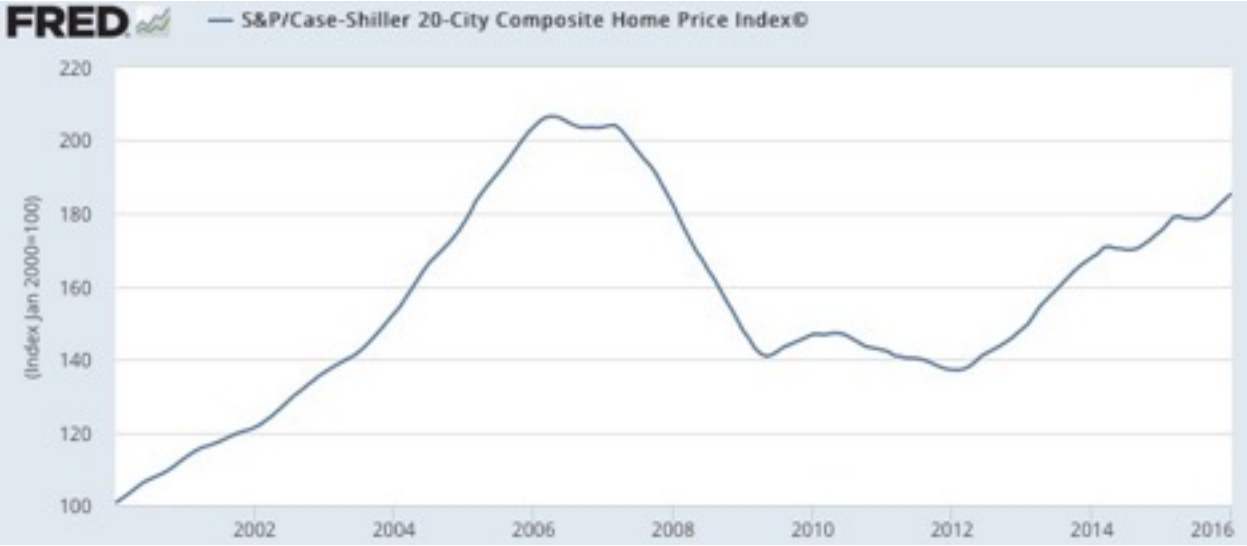
Stanford economist, perennial advisor to Republican presidential candidates, and former Undersecretary of the Treasury John Taylor blames this policy move by George W Bush-appointed Fed Chairs Alan Greenspan and Ben Bernanke for an unstable, overheated, booming economy that set the stage for the financial crisis of 2007-9 and our subsequent economic problems. Is this plausible? The calculations in problem 1 on this problem set bear on this question.

Alan Greenspan and Ben Bernanke reply that the economy of 2006-2007 was not "overheated", but rather was at full employment. They say that raising interest rates earlier and faster and keeping the unemployment rate at 6% would have unnecessarily kept a lot of Americans from getting jobs and prevented the creation of a great deal of wealth. They argue that real GDP would have been lower over the three years 2005-2007 and America poorer by the amounts you calculated in problem 1.

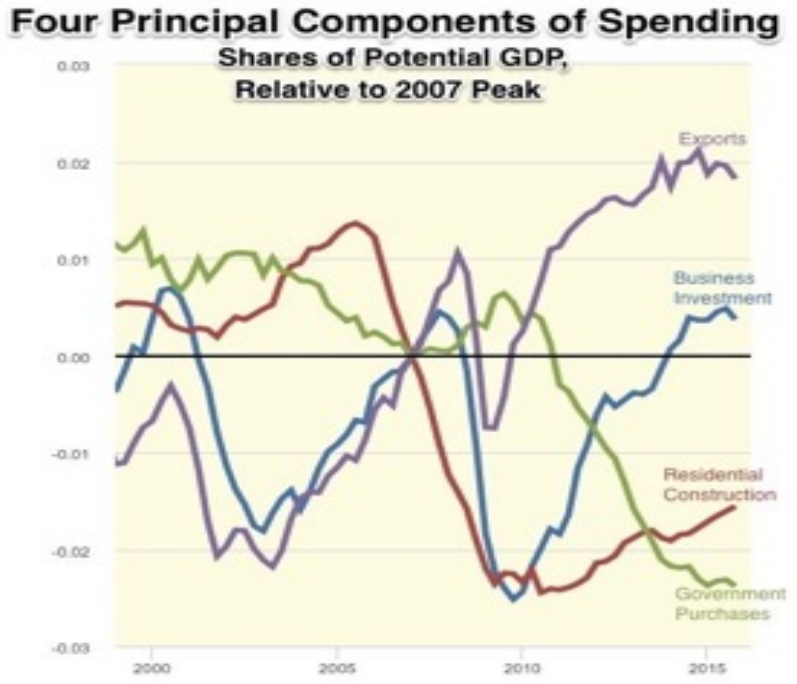
Moreover, they continue, the chart below plots the inflation rate. Since the mid-1990s, the Federal Reserve regards an inflation rate that exceeds 2.5%/year as measured by the "Core CPI" Consumer Price Index inflation measure as a possible sign that the economy is "overheated" and that demand is too strong for economic balance, just as it regards an an inflation rate that falls short of 2.5%/year as measured by the "Core CPI" Consumer Price Index inflation measure as a possible sign that the economy has too much "slack" for economic balance and that demand is too weak with unemployment unnecessarily high and GDP unnecessarily low. What signals was the inflation rate sending the Federal Reserve in the mid- and late-2000s?

The inflation rate was sending the Fed signals that the economy perhaps had too much "slack" and unemployment unnecessarily high from mid-2002 up to the start of 2006. Then there is a period of less than a year during which there was a weak signal that the economy was perhaps moving into an "overheated" situation. Then from the start of 2007 on there are signals of balance and weak signals of slack, then starting in 2008 the inflation rate is signaling "slack".

Thus I call this one for Greenspan and Bernanke and against Taylor. Housing prices were indeed very high in 2006-2007—at levels that were not sustainable given the shaky finances and limited ability to make their mortgage payments of many people to whom the banks had made subprime loans.

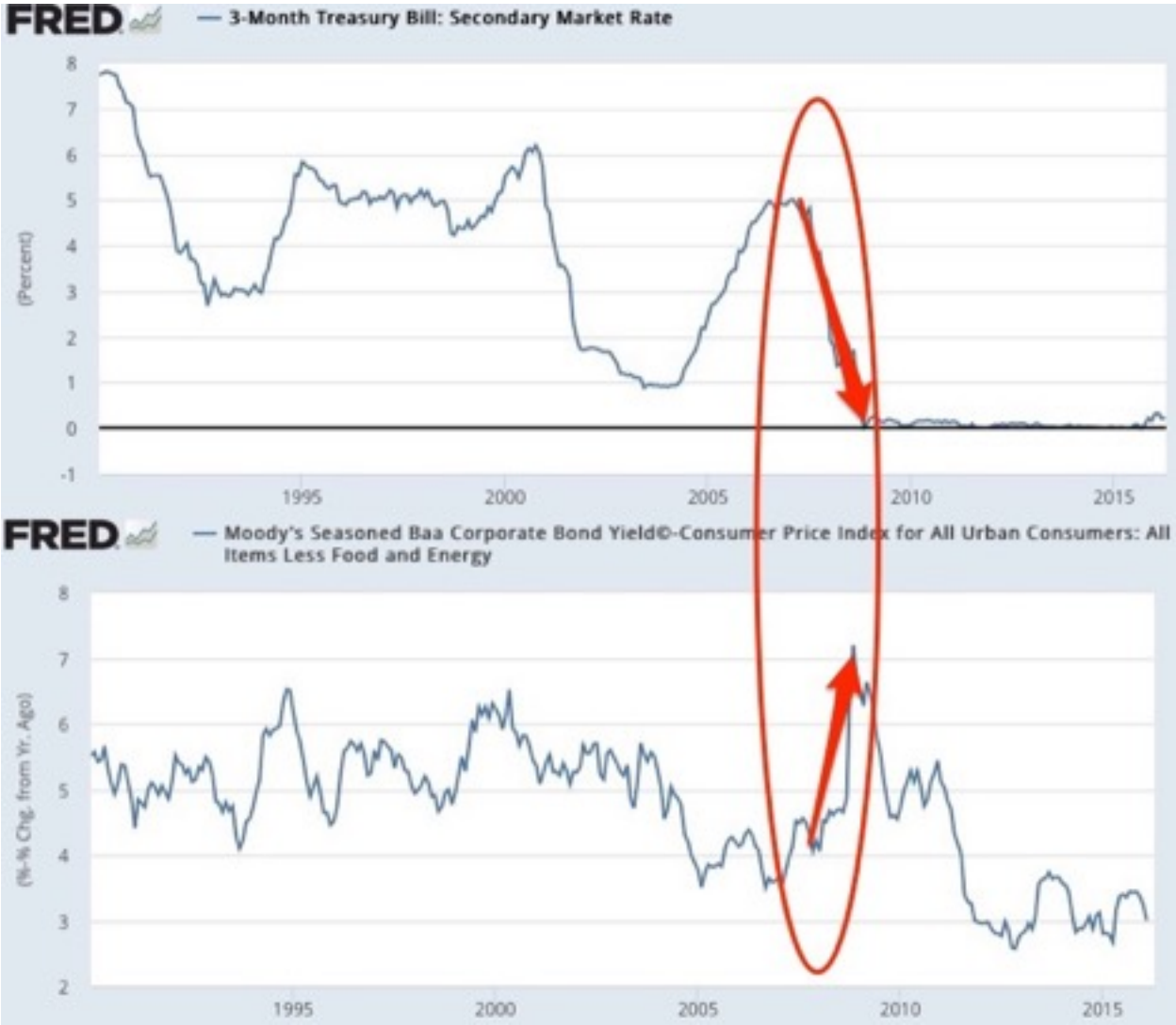


But that the housing construction sector was "overheated" does not mean that the economy as a whole was overheated. And 2006-2007 saw the economy rebalance itself away from excessive housing construction to a more sustainable structural constellation of demand—until Wall Street fell apart in 2008:



Why did we consider a 5% jump in the risk premium for problem 2?

Well, once again look at our chart of the r interest rate that matters for investment spending and the i interest rate that the Federal Reserve controls. This time focus on 2008-9:



In 2003-5, the Federal Reserve had been expected to raise interest rates—and because it delayed doing so, the interest rate that mattered for investment spending dropped. In 2008-9, the financial crisis causes the risk premium to spike—and even though the Federal Reserve takes aggressive steps to reduce interest rates, it cannot keep the interest rate that matters for investment spending from rising sharply.