Review Notes

EC 4010

1 Money Neutrality

When prices are flexible, a permanent doubling of the money supply just doubles prices in both periods. This is just the classical dichotomy. In this case, you can think of everyone receiving the money and running out to buy goods. But because output is fixed in the long-run, this increase in demand just causes prices to rise. *That* increase in prices then generates an increase in nominal (but not real) money demand to meet the new money supply. Nothing real changes. In particular, the natural real (and nominal) interest rate is still pinned down by the long run model, and output is pinned down by, say, the Solow model. With flexible prices, the money supply simply determines the price level: with flexible prices, a doubling of M induces doubling of P.

$$\frac{M}{P} = L(i, Y)$$

$$\frac{M}{P} = L(r_n + \pi, Y)$$

By contrast, if prices are sticky, then a permanent increase in the level of the money supply will cause i (and hence r, assuming long-run expectations of inflation are fixed) and Y to adjust. In this case, if there is excess supply of money, people try to unload it in the bond market. This puts downward pressure on interest rates. In turn, the corresponding fall in interest rates encourages people to demand money (since the opportunity cost of holding money has fallen).[1] In equilibrium, everyone must in fact hold the money, so we end up with higher money demand and lower real and nominal interest rates. The attendant fall in interest rates is called the *liquidity effect*. We also get an increase in output when people try to unload the money on the goods market, *and* output is demand determined; this rise in output also raises money demand. But as we will see in the New Keynesian model—which gives a microfoundation to the above story—prices will eventually rise, causing interest rates to return again to their initial level. As a result, money is neutral again in the long-run.

2 Short-Run Interest Rates

Having shown how money can affect interest rates in theory, it's time to move beyond helicopter drops and talk about how the FED controls the money supply.[2] The FED controls the federal funds rate, i^*; this is its policy instrument. By buying securities from banks in *open market operations* and giving them dollars in return, it can increase the amount of reserves banking system (and vice versa). In turn, this increases the amount of reserves on the federal funds market, which lowers the federal funds rate. Then, if inflation expectations and prices are fixed in the short-run—the standard assumption—the real federal funds rate will also fall. It's important to keep in mind that the FED does not set rates. Rates are market determined, but the FED manipulates the market by changing the amount of reserves in the banking system. (Central to this story is that banks are compelled by law to hold reserves, but run

[1] It's convenient to think of *you* getting a helicopter drop and then placing the money in the bond market. The attendant fall in interest rates then causes others to increase their money demand. Ultimately, money demand will increase until everyone is happy holding the new supply of money.

[2] Henceforth, I use the "FED" to represent *any* central bank.

out of them regularly, so need to borrow.) The FED has monopoly power over the creation of reserves—i.e., printing money and increasing the monetary base—which is key to its power. However, none of us ever pays the fed funds rate. When banks can borrow money/reserves cheaply, they typically pass that on to consumers. (After all, banks compete to make loans to customers; it's usually in their interest to attract borrowers.) Moreover, with access to cheaper reserves, they will lend more, increasing the money supply.

The fed funds rate moves closely with all short-run interest rates. Why? Well, the fed funds rate is the rate at which banks can lend or borrow reserves from each other. So suppose a bank can lend reserves to another bank overnight at 3 percent, the fed funds rate. But instead of lending to another bank, it can also buy some other short-term financial instrument—say a (hypothetical) two-night Treasury bill. For these fairly riskless markets to be in equilibrium, these rates must move closely. To see why, suppose we have a situation where Treasury bills yield a return of 12%, while the fed funds rate is 5%. If this was the case, all banks would buy Treasury bills. This increase in demand for Treasuries would raise their price and lower their return towards the fed funds rate. Such arbitrage operations means that all short-term instruments of similar risk must pay approximately the same return in equilibrium. It follows, therefore, that a lower fed funds rate will tend to reduce almost all short-run rates.[3] For this reason, it's convenient and common to say the FED "controls" short rates.

2.1 Taylor Rule

The Taylor rule ensures the FED minimizes its loss function, which is increasing in the deviation of both inflation from target and output from potential. According to the Taylor Rule, the target for the fed funds rate is:

$$i^* = 2.5 + \pi + .5(\pi - \pi^*) + .5(y - y^*)$$

[3]Via the term-structure equation, this in turn will affect all long-run rates. It is in this sense that the FED has leverage over the entire term structure of interest rates.

For example if inflation exceeds target the FED will try to contract the economy and lower the real rate below the natural rate and induce a recession.[4] Importantly, $\frac{\partial i^*}{\partial \pi} = 1.5$. So if inflation rises by 1 percent, the FED will raise rates by 1.5%. This way, it will raise real rates, $r^* = i^* - \pi$ by .5 in response to inflation. This idea of raising real rates when inflation rises is called the *Taylor Principle*: the increase in the nominal rate must be sufficiently high that it raises the real rate. In practice, most banks stress that inflation is their prime mandate and don't like to be perceived as targeting output. (Recall the dynamic inconsistency problem, whereby this can generate inflationary expectations.) Finally, to ensure stability in financial markets—and in particular bond prices—banks typically engage in *interest rate smoothing.* Of course the central bank faces a constraint, $i \geq 0$, that is sometimes binding (i.e., a liquidity trap).

2.1.1 Getting Real

Implicit in the Taylor rule is a target *real* rate:

$$r^* = 2.5 + .5(\pi - \pi^*) + .5(y - y^*)$$

Note that the FED targets the neutral real rate on average. Specifically, if output is at potential and inflation at target, the FED will aim for the natural rate. The figure 2.5 above is an estimate of the natural rate. Since the natural rate varies, however, a more general way to write this is

$$r^* = r_n + .5(\pi - \pi^*) + .5(y - y^*),$$

where r_n denotes the natural rate.

[4] The natural rate is the rate consistent with output at potential.

3 Long-Run Interest Rates and The Yield Curve

What really determines economic activity are long-run real rates. Yet the FED only controls the short-run rate. The term structure of interest rates shows how the FED can affect long rates too. The main theory of long-run rate determination is the *expectations theory of the term structure* or *expectations hypothesis*. From now on, this is the main theory we will use when we talk about long rates.[5]

Imagine you have to invest today for two years. If you have to invest now, there are two ways to get money to the same location: invest in a 2 year bond or buy a one year bond this year and then again in the following year. Assume the two year bond pays i_{2l} a year. The one year bond pays i_i this year and you expect it to pay i_2 next year. By an arbitrage argument, these two ways of investing a euro should earn the same return. Therefore,

$$(i + i_{2l})(1 + i_{2l}) = (1 + i_1)(1 + \mathbb{E}i_2)$$

$$(1 + i_{2l})^2 = (1 + i_1)(1 + \mathbb{E}i_2)$$

Taking logs

$$2\log(1 + i_{2l}) = \log(1 + i_1) + \log(1 + \mathbb{E}i_2)$$

For small x, we have the approximation $\log(1 + x) \approx x$. As a result,

$$2i_{2l} = i_1 + \mathbb{E}i_2$$

[5] Another theory is the *market segmentations hypothesis*. According to this theory, bonds of different maturity are not necessarily substitutable and, as such, the markets are segmented or independent. For example, big market players like pension funds or governments might demand long-run bonds, irrespective of their yields. In this case, the yields on long bonds would be artificially low and not necessarily reflective of expectations of future short rates; indeed, in this case, rolling over short run bonds would be more more profitable.

$$i_{2l} = \frac{i_1 + \mathbb{E}i_2}{2}$$

This holds more generally, so

$$i_{nl} = \frac{\sum_{z=1}^{z=n} \mathbb{E}i_z}{n}$$

According to this *expectations hypothesis*, the interest rate on a n year bond equals the average of the expected one-year returns over the next n years.

So far I've assumed risk neutrality; that is, investors only care about expected returns. This makes a long-run bond and rolling over two shorts perfect substitutes. Over long periods, inflation can be quite variable, making the fixed nominal payments associated with long-run bonds risky; in addition, prices of long-run bonds respond more to changes in interest rates. To account for risk, we must add a risk premium

$$i_{nl} = \frac{\sum_{z=1}^{z=n} \mathbb{E}i_z}{n} + \rho$$

Note that ρ typically depends on the maturity of the bond. To account for risk, we'd have $\rho \equiv \rho(n)$, where $\rho'(n) > 0$. More generally, the premium could compensate for liquidity differentials (most likely, it's easier to sell bonds of shorter maturity).

$$i_{nl} = \frac{\sum_{z=1}^{z=n} \mathbb{E}(r_t + \pi_t)}{n} + \rho.$$

3.0.2 The Yield Curve and Monetary Policy

The FED has considerable control over short rates, and hence more control over the short end of the yield curve. The FED can only affect long rates to the extent it affects short rates now and expectations of short rates over the next year or two. That's why communication, "open mouth operations" and, more generally, the management of expectations are all central to monetary policy. The expectations hypothesis is consistent with the fact that when the FED lowers short rates, long rates don't move as much. Relatedly, the hypothesis is consistent with the fact that short-run rates are more volatile than long-run rates (namely, long-run rates are an average and therefore are less volatile.) The risk premium makes the theory consistent with the typically upward sloping yield curve.

For practical purposes, I would say the yield curve reflects FED policy for 1-2 years out and expectations of the natural rate plus inflationary expectations thereafter. Why? Well, our best guess of the state of the economy after 2 years or so is potential output. And when the economy is at potential, the interest rate equals the natural rate. In general, movements in long rates—with short rates held fixed—are typically reflective of changes in inflation expectations and risk premia. By adopting policies such as inflation targeting, central banks can control expectations of inflation right across the term structure. And to the extent such sound monetary policies can also reduce the inflation risk premium, they would also lower real long-term rates. I outline some example of yield curve movements below. Yet, keep in mind, that the yield curve is a perennial source of enigma to economists: many of its movements are inexplicable in terms of economic theory.

1. If FED increases money growth today, short-rates would fall. But long-rates could in fact *rise* if expectations of inflation rise too. (This represents a combination of the liquidity and Fisher effects.) This would happen if policy was deemed permanent. Conversely, if the FED sets short rates high now, long rates might come down in future due to lower risk premia and expectations (if this was a sign the FED is serious about fighting inflation).

2. Romer's text describes how high short rates today often lead to high long rates too—since markets often perceive unusually high rates by the FED as a signal that the FED has information about future inflation that they don't have. Hence as a precaution, they demand a higher risk premium on long-term bonds.[6]

[6] In a similar example of strange asset price movements, sometimes lower interest rates by the FED cause the dollar to *appreciate.* Namely, investors take it as a signal that the FED is doing all it can to stabilize the economy—thus making it a more attractive place to invest.

3. Expectations of Clinton budget surpluses lowered long-run rates. Conversely, expectations of future deficits might raise long-run rates today.

4. Debt monetization would raise long-run rates due to expectations of inflation (and attendant increase in risk premium.)

5. In a currency crisis, the central bank typically raises short-run interest rates to attract inflows of capital. In this case, the yield curve would likely invert and slope downwards.

3.0.3 Bond Prices and Yields

An important relationship is the inverse relationship between bond prices and bond yields/interest rates. To see this (in the simplest way possible), suppose we have a one year bond: this year I pay P for the promise of $D > P$ next year. The key here is that D is fixed; hence a bond is often referred to as a *fixed income security.* The return on the bond (or its yield to maturity) is implicitly given by the relationship

$$P(1+r) = D$$

or equivalently, the price of the bond is given by

$$P = \frac{D}{1+r}$$

where r is the return on the bond. Now, if the FED raises interest rates from r to r', say, then the return on the bond must rise (by the usual arbitrage relationships). Therefore, *to generate* this higher return, r', the price of the bond will be

$$P'(1+r') = D \qquad P = \frac{D}{1+r'}$$

Content yourself the $P < P'$; that is, the price of the bond is now lower.

Another possibility is you buy the bond and two months later (say) the FED raises rates. According to the previous reasoning, the price of your bond now must fall; if you were selling it, it would certainly sell for less than P; namely, *to generate* the new higher required rate of return, you will have to lower the price of the bond. So if you intend selling the bond, this is clearly *bad news* for you: you will make a capital loss (formally, your *holding period return* would fall.)[7] It follows from all of this that bondholders pay close attention to interest rate movements.

3.1 Transmission Mechanisms of Monetary Policy

An important question is how monetary policy affects the real economy. Although the standard channel is through interest rates, there are a multiple of other ways too.

1. Interest rate channel. Lower interest rates lower the cost of capital. This increases investment demand. The purchase of (interest-sensitive) consumer durables also rises if rates fall.

2. By affecting risk-free rates, the FED can change a wide array of asset prices, since all of these are related to the risk-free rate. For example, recall the basic dividend discount formula: $P = \sum \frac{D_t}{(1+r_t+\rho)^t}$, where P is the stock price, r is riskless rate, ρ is risk premium, and D_t is the dividend in period t. The FED affects r_t, and a fall in risk-free rate therefore raises stock prices. Also, by preventing a recession, lower rates might increase profits and therefore expectations of D_t. In addition, the risk premium may fall. For all these reasons, stock prices rise.[8] Equivalently, think of any asset pricing model such as the CCAPM, which predict $r_i = r_f + \rho$, where r_i is the expected return on a stock and ρ is the model's predicted risk premium. Thus a fall in the risk-free rate, r, induces a fall in the stock's return, r_i. But this means the stock price must rise (recall that returns and prices are inversely related). This is why stock prices typically rise when FED cuts rates (in reality, prices will have risen in expectation beforehand, though, if the move was expected.) On

[7] If you are holding the bond until maturity, this issue is of no relevance.

[8] In addition, a fall in the interest rate would make bonds relatively unattractive, inducing people to purchase equities, thereby raising their prices.

this note, many say FED should raise rates to bring down stock/house price "bubbles." Yet this idea is highly controversial. Who is Bernanke to say a rise in stock prices represents a "bubble," rather than fundamentals? According to the *efficient markets hypothesis*, the stock price is an accurate measure of firm's worth. But this view might well change: the worst economic downturns of the twentieth century have all been associated with a collapse of asset price "bubbles."

Anyway, changes in asset prices have lots of indirect effects:

(a) Higher stock prices lower cost of capital since they make it cheaper for a firm to raise equity. Namely, by issuing shares, the firm now makes more revenue. In turn, this increases investment. This is called Tobin's Q theory. For the same reason, a rise in house prices stimulates housing production. Monetary policy raises house prices by making mortgages cheaper and thereby increasing demand.

(b) Higher stock/house prices raise the value of one's portfolio and lifetime wealth. By the permanent income hypothesis, this raises consumption.

(c) When asset prices rise, households have more liquid wealth, so they are "free" to buy more illiquid assets (e.g., consumer durables.) (Households would typically wish to hold liquid assets in case of, say, a medical emergency.)

(d) Balance Sheet effects (banks and lenders). The key here is adverse selection and moral hazard. Most U.S. firms rely on banks (and internal finance) rather than stock issuance. As a result, they are dependent on bank's willingness to lend. When interest rates fall, firm's profits typically rise (due to greater aggregate demand). Also, if firms are on adjustable loans, their debt payments fall, again raising profits. These increases in cash flow improve their balance sheets, so they can offer more collateral to banks, raising banks willingness to lend. Also, greater collateral reduces the risk of moral hazard (i.e., the fear firms might use funds recklessly and default) since firms lose now lose more under default. Again, this makes banks more willing to lend. (This idea that banks make more loans in good economic times leads—leading to further good times—is what's called a "financial accelerator.") The same reasoning applies for households. For consumers on adjustable rate loans, lower interest rate costs increase reduce their short-term debt burden which again improves balance sheet.

3. The lending channel. Most importantly, this is different from the interest rate channel, since it represents a response on the *supply side*, not the demand side. With cheaper access to reserves in a monetary expansion, banks will be able and willing to lend more, which in turn leads to more investment. This view also emphasizes that banks will lend more if they have more capital themselves; for example, if banks suffer losses from default, they will lend less. According to this view, small firms are especially affected by banking problems, since they are reliant on bank lending (small firms rarely issue equity.) In addition, it stresses that banks have considerable "informational capital," (credit records of clients etc) which is essential for financial intermediation. Therefore, a collapse of banks destroys all of this and will reduce overall lending in the economy. Both the lending channel and balance sheet effects come under the heading of "the credit channel."

4. Lower interest rates reduce *credit rationing*. Recall that high interest rates increases the adverse selection problem since they attract riskier clients. Low interest rates alleviated this problem and make banks more willing to lend.

5. When the interest rate falls, the exchange rate depreciates. This stimulates exports and improves the current account.

6. A greater money supply will ultimately raise the price level and in turn reduces the real value of nominal debt. This can improve debtors balance sheets, making them better lending propositions.

4 Issues in Monetary Policy

- Liquidity Trap: this is when the fed funds rate hits zero. One way out is foreign exchange intervention; i.e., print money and use to purchase foreign currency. The associated increase in domestic currency causes a currency depreciation, which should improve the current account. The bank can also buy long-run bonds to reduce their returns and lower cost of borrowing. More generally, the FED can buy a range of assets so as to increase the money supply. Central bank can generate expectations of large money growth/inflation in the future to increase demand today. (A corollary of this is for the government to run large deficits to generate expectations of debt monetization.) Because $r = i - \pi^e$, such expectations of inflation can lower real rates for a given nominal rate and thereby stimulate economy. Paradoxically, Japan couldn't do this, since they had (too) successfully generated expectations of low inflation to combat dynamic inconsistency problem. Finally, one extreme solution is to make money bills go "obsolete" after a year (say) to encourage spending today.

- Why to banks target positive inflation?

  1. First, targeting non-zero inflation gives monetary policy more leverage. Suppose natural real rate is 1%. If inflation was 5%, we know the short-run nominal *natural* rate will be 6%. By contrast, if inflation was 0%, the short-run nominal natural rate would be 1%. Because the FED targets the nominal natural rate *on average*, it'd have greater "power" to reduce rates if inflation were higher. In particular, it can lower real rates. With low average rates of inflation, the risk of falling into a liquidity trap rises.
  2. Second, inflation can reduce real wages if nominal wages are sticky. (this is called "greasing the wheels" of the labour market to make it more flexible.)
  3. Third, a positive rate of inflation also makes deflation less likely. Deflation

is dangerous since it encourages households to put off spending to future, thereby reducing spending today (leading to more deflation and creating a vicious circle). Central banks try to avoid deflation at all costs. Deflation typically associated with "depression-like" economies like Japan's "lost decade" in the 90s and the Great Depression.

4. High inflation can be used as a source of finance for the government. Because raising tax rates on capital or labour might be highly distortionary (costs of taxation on anything are convex), this can be an efficient source of revenue.

- Preemptive policy: banks act early and react to inflation *forecasts*. If inflation rises, it generates expectations of inflation, which can be hard to counter.

- In the famous words of Milton Friedman, money affects output with "long and variable lags." Monetary policy is widely believed to be effective than fiscal policy.

- Money Multiplier: So far, I've assumed the money multiplier is constant and increases in the monetary base lead to increases in the money supply. This typically happens but sometimes does not. In particular, there's no guarantee banks will actually *lend*. As such, the Fed only controls the money supply *indirectly* via the monetary base. What economists mean by the money supply is the total money created from the initial monetary base. With banks lending money and consumers depositing it etc, the monetary base is continually "recycled." The money supply is given by $M = \mu mb$, where μ is money multiplier and mb is monetary base. The monetary authority controls the monetary base; and cet par the money supply; this normally works fine. For a high multiplier, we need banks holding few excess reserves and households depositing their money at banks (not under mattress!) Falls in the money multiplier are invariably associated with severe downturns (Japan 90s, Great Depression). See the credit channel discussion above for why the multiplier is procyclical and for why the money supply rises endogenously in booms.

- Why is monetary policy less effective in inflationary environment? Prices more flexible since people are more "switched on" to policy regime. Example of Lucas Critique: response coefficients change in different policy environments. Consequence: monetary policy should be more powerful when people don't expect it (i.e., in low inflation environments.)