## Econ 116

## Problem Set 3

## Answer Key

- 1. Assume that a bank has on its asset side reserves of 1000 and loans of 6000 and on its liability side deposits of 7000. Assume that the required reserve ratio is 10 percent.
  - a. How much is the bank required to hold as reserves given its deposits of 7000?

Required Reserves = Required Reserve Ratio × Deposits

Required Reserves =  $0.10 \times 7000$ 

Required Reserves = 700

b. How much are its excess reserves?

Excess Reserves = Actual Reserves – Required Reserves

Excess Reserves = 1000 - 700

Excess Reserves = 300

c. By how much can the bank increase its loans?

Since excess reserves are positive, the bank can has free lending capacity and thus it can increase lending to businesses and consumers. Here the bank can do two things: either increase deposits or decrease reserves. Suppose the bank chooses to issue new loans through raising new deposits. The bank has 1000 of reserves so it can raise up to 1000/0.1 = 10000 in deposits. If 10000 of deposits are raised, the bank is then able to issue total loans for an amount equal to the difference between deposits and reserves, which is: 10000 - 1000 = 9000.

In this case the bank is issuing 3000 in additional loans. Then the balance sheet of the bank becomes:

Assets	Liabilities
Reserves 1000	Deposits 10000
Loans 9000	

Note that the bank can increase its loans by 3000 only if each loan is deposited at the same bank. Indeed in this case the bank totally absorbs the effect of the multiplier. Alternatively, the bank can just choose to run down reserves and use its reserves surplus to issue loans. Reserves can be run down exactly of the amount of excess reserves, that is 300. In this case the balance sheet would look like:

Assets	Liabilities
Reserves 700	Deposits 7000
Loans 6300	

In this case the bank issues new loans of 300. Still, at economy-wide level, the money supply will increase by 300/0.1 = 3000 because excess reserves that the bank is injecting into the system

will be amplified through the multiplier effect. The only difference with the situation analyzed above is that borrowers here choose to deposit loans in other banks.

d. Suppose a depositor comes to the bank and withdraws 400 in cash. Show the bank's new balance sheet, assuming the bank obtains the cash by drawing down its reserves. Does the bank now hold excess reserves? Is it meeting the required reserve ratio? If not, what can it do?

The bank's balance sheet would be as follows:

Assets	Liabilities
Reserves 600	Deposits 6600
Loans 6000	

The bank no longer holds excess reserves:

Excess Reserves = Actual Reserves – Required Reserves

Excess Reserves =  $600 - (0.10 \times 6600)$ 

Excess Reserves = 600 - 660

Excess Reserves = -60

The bank is also not meeting the required reserve ratio of 10%:

Actual Reserve Ratio = Reserves / Deposits

Actual Reserve Ratio = 600 / 6600

Actual Reserve Ratio = 9.09%

In order to meet the required reserve ratio of 10%, the bank can:

- (1) Attract more deposits (thereby increasing both deposits and reserves by the same amount) from new or existing clients. In particular, if an additional 66.67 are deposited into the bank (thereby increasing deposits and reserves by 66.67), then the bank would meet the required reserve ratio of 10%.
- (2) Borrow money from the Fed or the interbank market. Again, if the bank borrows 66.67 (thereby increasing deposits and reserves by 66.67), then the bank would meet the required reserve ratio of 10%.
- (3) Recall loans (thereby increasing reserves and decreasing loans by the same amount without affecting deposits). In particular, if the bank recalled 60 in loans (that ultimately come from other banks), then it would meet the required reserve ratio of 10%.
- 2. How is the Fed's ability to control the money supply affected if commercial banks hold excess reserves?

If commercial banks hold excess reserves the Fed has less control on the money supply, because the effect of the multiplier is reduced. Assume that the Fed wants to reduce the money supply by \$10 by selling \$10 of securities to some consumer. If banks hold no excess reserves, the multiplier effect implies that money supply is reduced by the amount:

 $(1 / RRR) \times $10 = (1 / 0.2) \times $10 = $50$ 

Now suppose that banks hold excess reserves. In particular suppose that the Fed sells securities to Jane, and the Fed, Janes' bank and Jane have the following balance sheets:

Fed	
Assets	Liabilities
Securities 100	Reserves 30
	Currency 70

Bank	
Assets	Liabilities
Reserves 30	Deposits 100
Loans 70	

Jane	
Assets	Liabilities
Deposits 10	Debt 0
	Net Worth 10

Note that the reserve ratio for the bank is 30 / 100 = 0.3 so that the bank holds \$10 of excess reserves. If the Fed sells \$10 of securities to Jane the situation will be the following:

Fed	
Assets	Liabilities
Securities 90	Reserves 20
	Currency 70

Bank	
Assets	Liabilities
Reserves 20	Deposits 90
Loans 70	

Jane	
Assets	Liabilities
Securities 10	Debt 0
	Net Worth 10

That is, the Fed sells securities to Jane and Jane pays by drawing down her account at her bank. The bank in turn closes the transaction by drawing down its reserve account at the Fed. Now the reserve ratio for the bank is 20/90=22.2%. Then the bank has excess reserves and needs not to recall loans and reduce deposits. Then the situation is stable. Now, before the transaction the money supply was M1= currency + deposits = 70 + 100 = 100. After the transaction we have M1 = 70 + 90 = 160. Therefore the money supply has been reduced by 10, that is one fifth of the reduction we would have had in the case in which the bank had no excess reserves. The reason is that when banks hold no excess reserves, they don't need to adjust loans and deposits after every transaction in order to meet the Federal Reserve required reserve ratio, so that the multiplier effect is weaker and monetary policy is less effective.

3. What is the theory behind the proposition that the demand for money depends negatively on the interest rate?

Defining money as M1, suppose that the decision is to hold M1 or deposit money into an interest bearing instrument. The higher the interest rate on that instrument, the higher the opportunity cost (more interest foregone) from holding M1 and the less M1 people will want to hold.

4. Say you bought a 10-year government bond last year that yielded 2.0 percent per year. Assume that since that time the 10-year government bond rate has risen to 2.5 percent. Are you better off or worse off after this fall? Explain carefully.

There are two ways to think about this. If you assume that the 2% yield is promised per year to you, you have an instrument that pays you 2% per annum at a time when the outside interest rate is 2.5%. You are worse off.

The other way to see that you are worse off is that (given the coupon structure of the bond you bought) when yields increase prices fall. This fact derives just from the fact that bond prices equal the present value of future cash flows. Then you have realized a capital loss on the government bond and you are worse off (the bond's price is lower than when you bought it).

5. Assume that for some reason the 1-year interest rate expected to exist three years from now increased. How will this affect the current 2-year rate? The current 5-year rate? Explain carefully. How will this affect current stock prices, other things being equal, and why?

The term structure equation is:

$$(1 + r_5)^5 = (1 + r_2)^2 (1 + r_{1+2}^e)(1 + r_{1+3}^e)(1 + r_{1+4}^e)$$

If the 1-year interest rate expected to exist three years from now  $(r_{1+3}^e)$  increases, then the current 2-year rate  $(r_2)$  will not change, but the current 5-year rate  $(r_5)$  will increase.

The stock price equation is:

$$SP_{0} = \frac{DIV^{e}}{(1+r_{1})} + \frac{DIV^{e}_{+1}}{(1+r_{1})(1+r^{e}_{1+1})} + \frac{DIV^{e}_{+2}}{(1+r_{1})(1+r^{e}_{1+1})(1+r^{e}_{1+2})} + \frac{DIV^{e}_{+3}}{(1+r_{1})(1+r^{e}_{1+1})(1+r^{e}_{1+2})(1+r^{e}_{1+3})} + \cdots$$

If the 1-year interest rate expected to exist three years from now  $(r_{1+3}^e)$  increases, then the forth term in the formula above will decrease, and so the stock price will decrease.

6. If someone wins a \$100 million lottery in the form of \$10 million a year for 10 years, he or she can cash out and get all the money at once, but the amount is much less than \$100 million. Why? Why does the decision of whether to cash out or not depend on the size of the interest rate?

If someone wins \$10 million a year for 10 years, the net present value of the award would be less than \$100 million because the winner would only be able to start receiving interest immediately on the first \$10 million. He/she would have to wait to receive interest on the future tranches of \$10 million as he/she receives them. Therefore, the equivalent (in terms of net present value) of receiving \$10 million a year for 10 years would be receiving less than \$100 million right away.

A higher interest rate would increase the net present value of receiving the entire amount immediately (because it could all be invested right away), relative to the net present value of receiving \$10 million a year for 10 years (because it could not all be invested right away). Therefore, a higher interest rate would increase the incentives for the winner to cash out right away.

Note that the present value of receiving \$10 million a year for 10 years can be derived as:

$$PV = \$10 \text{ million} + \frac{\$10 \text{ million}}{(1+r)} + \frac{\$10 \text{ million}}{(1+r)^2} + \dots + \frac{\$10 \text{ million}}{(1+r)^9}$$

We can also see from this formula that the present value of the \$10 million tranches decreases from most recent tranche to most distant tranche. The reason is that future money streams need to be discounted by the interest rate.

7. The next time the Fed raises the interest rate, how will it do this?

Since today commercial banks have excess reserves, the Fed cannot use the traditional tools of open market operations, reserve requirement ratio, and discount rate. Rather, the next time the Fed raises the interest rate, it will likely do so by increasing the rate it pays to banks on their reserves. This would induce banks to try to sell their relatively less attractive securities and substitute towards holding more reserves, thereby increasing to a supply of those securities without a change in demand, which would ultimately lead to a decrease in the price of the securities. This would in turn cause the interest rate to rise.