Practice Set 9 – KEY

Banking & The Monetary System

This set contains problems for your own practice. It is highly recommended to work on the problems on your own. Do not just read the provided solutions. Instead, try to solve the problems and use the solutions only when you cannot continue on your own. Reading problems that someone else has solved has the same value for your preparation like watching someone else running a marathon on TV and then expecting to be able to run it, too. If you have questions on this set, please ask your section's teaching assistant.

1. The Central Bank sets the reserve ratio (RR) at 20% and a commercial bank receives a deposit of $1,000.

   (a) How much money will be created from the $1,000 deposit if the commercial bank can reloan it 5 times (assuming that each time the money from the loan will end up being deposited to the same bank)? Include the initial $1,000 in your answer.

   The first time, the bank must reserve $1,000·0.2 = $200 and will loan out $800 (ΔM1 = +$800). The recipient of the loan will spend the $800 and whoever receives the cash will deposit it under her name to the same bank as the question assumes. From those, the bank must reserve $800·0.2 = $160 and can loan out $640 (ΔM1 = +$640). Again, this loan will be spent and the money will eventually end up at the bank. For the third loan, the bank must reserve $640·0.2 = $128 and can loan out $512 (ΔM1 = +$512). For the fourth loan, the bank must reserve $512·0.2 = $102.4 and can loan out $409.6 (ΔM1 = +$409.6). Finally, for the fifth loan, the bank must reserve $409.6·0.2 = $81.92 and can loan out $327.68 (ΔM1 = +$327.68). The total amount of money created from the initial deposit during the 5 loans (including the initial deposit) is 1,000 + 800 + 640 + 512 + 409.60 + 327.68 = $3,689.28.

   (b) How much is the total money that can be created from the $1,000 deposit, if the bank can reloan it indefinitely? Include the initial $1,000 in your answer.

   In the first loan the bank can reloan $1{,}000(1-RR)$. *In the second loan, it can reloan* $1{,}000(1-RR)(1-RR)$ *(that is,* $(1-RR)$ *times the amount of the first loan), which is equal to* $1{,}000(1-RR)^2$. *In the same manner, in the third loan it can reloan* $1{,}000(1-RR)^3$, *in the fourth* $1{,}000(1-RR)^4$. *The total amount created, therefore, is given by the infinite sum:*

$$1{,}000 + 1{,}000(1-RR) + 1{,}000(1-RR)^2 + 1{,}000(1-RR)^3 + 1{,}000(1-RR)^4 + 1{,}000(1-RR)^5 + \cdots$$

   which is equivalent to the geometric series:

$$1{,}000(1-RR)^0 + 1{,}000(1-RR)^1 + 1{,}000(1-RR)^2 + 1{,}000(1-RR)^3 + 1{,}000(1-RR)^4 + 1{,}000(1-RR)^5 + \cdots$$

   because $1{,}000(1-RR)^0 = 1{,}000$ *and* $1{,}000(1-RR)^1 = 1{,}000(1-RR)$. *The series can be written as:*

$$1{,}000[(1-RR)^0 + (1-RR)^1 + (1-RR)^2 + (1-RR)^3 + (1-RR)^4 + (1-RR)^5 + \cdots]$$

   and from the algebra of geometric series, we know that the expression in the square bracket equals

$$1/RR.$$

   Therefore, the total money created by a deposit is equal to: $\boldsymbol{deposit}\ \frac{1}{RR}$. *In our task, the total amount of money created from the $1,000 deposit with RR = 0.2 is 1,000/0.2 = $5,000.*

   (c) If the CB reduces the RR to 10%, will the money created from the initial deposit go up or down?

   The total amount of money created from the $1,000 deposit with RR = 0.1 is 1,000/0.1 = $10,000. Thus, the total money created by commercial banks increases when the RR decreases.

(d) How much money can be created by the $1,000 deposit, if the CB requires the commercial banks to reserve 100% of the deposits.

The total amount of money created from the $1,000 deposit with RR = 1 is 1,000/1 = $1,000. Thus, commercial banks will not be able to create money if the RR = 1.

(e) How much money can be created by the $1,000 deposit, if the CB does not require the commercial banks to reserve deposits.

The total amount of money created from the $1,000 deposit with RR = 0 is 1,000/0. This expression is mathematically invalid but if we calculate the limit of the expression (make the denominator smaller and smaller approaching zero but not exactly zero) we will see that the expression will tend to positive infinity. That is, if an infinite amount of loans could be given, the total quantity of money in the economy would theoretically become infinite. Practically, this would mean that money would become worthless. However, in reality, even when RR = 0, commercial banks will still hold reserves in order to be able to serve their customers' short-term cash needs. For a full presentation on how commercial banks can generate money take a note on Lecture 9 video (52:40-1:10:00).

2. The Monetary Authority of Singapore (MAS, the Central Bank of Singapore) owns a large amount of Government's securities. Firms and households in Singapore also own such securities as a form of saving.

(a) If MAS offers to buy more of these securities from firms and households, how will this action affect the money supply of Singaporean Dollar?

MAS will buy the securities from firms and households using fresh money, so the M1 money circulated in the economy will increase. In this way, MAS actually injects money to the monetary system, increasing the money supply. Such an Open Market Operation by a CB is known as Open Market Purchase, since securities are being purchased from the so-called open market.

(b) If MAS offers to sell some of its securities to firms and households, how will this action affect the money supply of Singaporean Dollar?

When MAS sells its securities, it collects some of the M1 money that firms and households used to own and effectively takes it out of circulation. This Open Market Operation causes the money supply to decrease and it is known as an Open Market Sale.

(c) How can MAS convince firms and households to sell their securities (as in subtask b) or to buy more securities from MAS (as in subtask b)?

MAS can convince firms and households to buy or sell securities by offering tempting prices. If MAS wants to sell a $100 bond that yields $1 coupon per year, it may put it for sale for $80. Since the coupon is fixed to $1, this is equivalent to an increase of the interest rate from 1% ($1/$100) to 1.25% ($1/$80) and it is consistent with our expectation that a decrease in M1 will come with an increase in the interest rate.

On the contrary, when MAS wants to buy an $100 bond from the open market, it may offer $120 for it, decreasing the interest rate to 0.833% ($1/$120). Again, this is consistent with our expectation that when the M1 increases, the interest rate decreases. For a full presentation on how Open Market Operations work take a note a note on Lecture 9 video (1:18:27-1:23:37).

3. A commercial bank pays 1% interest rate per year to its depositors. The RR is 0.5 and the bank can loan out the rest at a 3% rate per year. The bank does not have ample reserves and when it cannot close its daily position meeting the reserve requirements, it must borrow from the central bank at the discount rate.

(a) How much profit will the bank make per year if it has deposits of $1,000 and the discount rate is 15%?

In order to derive the profit, we must calculate the revenue and the cost for the bank. On the revenue side, the bank must reserve $0.5 \cdot \$1{,}000 = \$500$ *and loan out the rest at 3% per year. The revenue from the loans is* $0.03 \cdot \$500 = \$15$*. Notice that the bank will never want to loan out its reserves. By*

doing so it will be earning 3% while borrowing at 15% by the CB in order to replenish its reserves and meet the reserve requirement, experiencing a loss.

On the cost side, the bank will have to pay to its depositors $0.01 \cdot \$1{,}000 = \$10$. *(The bank pays interest even for the money it keeps as reserves). Thus, the bank's profit will be* $\$15 - \$10 = \$5$.

(b) What will happen if the CB sets the discount rate to 1%?

Now, the bank can loan out at 3% while it costs only 1% to replenish its reserves. Theoretically, the bank will give all loans it can possibly give and will borrow from the CB in order to catch the RR in the end of the day. Practically, this is an ample reserve regime, where the RR is not really a binding constraint for loans.

4. A $1,000-bond requires $30 commission for selling it. You currently have $2,000 in cash in order to make a payment of $1,000 to someone in 1 month from now and another payment of $1,000 to someone else in 2 months from now.

(a) How much will you hold in cash now if the bond yields 4% per month?

The $1,000 for the first payment will yield $40 of interest in one month if you buy a bond for a month, at a cost of $30 to cash it in the end of the month. This will yield profit of $\$40 - \$30 = \$10$.

The 1,000 dollars for the second payment will yield $40 of interest for the first month and another $40 of interest for the second month, again at a cost of $30 to cash it at the end of the second month. This will return a profit of $\$40 + \$40 - \$30 = \$50$.

The money for both payments would be profitable to be placed in bonds now. Thus, your cash holdings now will be zero.

(b) How much will you hold in cash now if the bond yields 2% per month?

The $1,000 for the first payment will yield $20 of interest in one month if you buy a bond, at a cost of $30 to cash it at the end of the month. This will produce a profit of $\$20 - \$30 = -\$10$.

The 1,000 dollars for the second payment will yield $20 of interest for the first month and another $20 of interest for the second month, at a cost of $30 to cash it at the end of the second month. This will produce a profit of $\$20 + \$20 - \$30 = \$10$.

Only the amount for the second payment is profitable to be placed in a bond now. Thus, cash holdings now will be $1,000.

(c) How much will you hold in cash now if the bond yields 1% per month?

The $1,000 for the first payment will yield $10 of interest in one month if you buy a bond, at a cost of $30 to cash it at the end of the month. This will yield a profit of $\$10 - \$30 = -\$20$.

The 1,000 dollars for the second payment will yield $10 of interest for the first month and another $10 of interest for the second month, at a cost of $30 to cash the bond at the end of the second month. This will return a profit of $\$10 + \$10 - \$30 = -\$10$.

No amount is profitable to be placed in bonds now. Thus, cash holdings now will be $2,000.

5. A perpetual bond with face value of $1,000 was issued two years ago and pays a yearly coupon of $40. Perpetual bonds never mature. The only way to cash them is to sell them in the open market at their current price. In some cases, the issuer may offer to buy the bond in order to terminate the loan.

(a) What is the interest rate for this bond?

The interest rate for this bond will be $\$40$ *per* $\$1{,}000$ *or* $\$40/\$1{,}000$ *or* 4%.

(b) What would happen to this bond if the interest rate of newer bonds is 5%?

The interest rate of this bond will also need to adjust to 5% in case you need to sell it. Since the coupon in bonds is always fixed, its price will need to adjust so that $\$40/price = 5\%$ *or* $price = \$800$. *If you try to sell it for its face value (*$\$1{,}000$*), nobody will want to buy it.*

(c) What would happen to this bond if the interest rate of newly issued bonds was 2%?

The interest rate of this bond will also need to adjust to 2% in case you need to sell it. This means that its price will need to adjust so that $\$40/price = 2\%$ *or* $price = \$2{,}000$. *If you sell it for less than $2,000, you will lose money.*

6. Consider the country of Cornovia, which produces only corn and nothing else. This year, Cornovia's real GDP was 1,000 kg of corn. Cornovia's Central Bank issues a fiat money supply of 500 cornals (the currency of Cornovia).

(a) If the price of 1 kg of corn is 10 cornals, for how many transactions per year on average is a cornal used?

If there are 1,000 kg of corn to be transacted for 10 cornals each, the total value that has to be transacted is $1{,}000 \cdot 10\ cornals = 10{,}000\ cornals$. *Since there are only 500 cornals available, each cornal should be used for* $10{,}000/500 = 20$ *transactions on average.*

Cornovia's Central Bank prints another 50 cornals and gives it to the government for spending it to buy corn and trade it with another country for vaccines against cornvid-19.

(b) If the number of average transactions for each cornal remains constant, what will happen to the price of corn?

Now there are in circulation 550 cornals capable of transacting value of $550 \cdot 20 = 11{,}000$ *cornals. Cornovians now think that they have more purchasing value and when they attempt to spend it buying more corn, they will effectively increase the demand for corn. Since the supply of corn has not increased, the price of corn will increase to 11,000 cornals / 1,000 kg of corn or 11 cornals per kg.*

(c) How much purchasing power will a Cornovian lose if he holds 20 cornals?

From the increase in price from 10 to 11 cornals, we can figure that inflation is 10%. Thus, one who holds 20 cornals will lose the 10% of its purchasing value or equivalently 2 cornals.

(d) How much purchasing power will all Cornovians who held cornals lose in total?

There is 10% inflation in Cornovia, thus they will lose the 10% of the 500 cornals they all together were holding. That is, $0.1 \cdot 500 = 50$ *cornals. They all together lost exactly as much as the central bank printed and gave to the government. That is why we say that seignorage transfers purchasing power from the citizens to the government and that inflation acts like a tax.*

(e) How much purchasing power will a Cornovian lose if she used all her 20 cornals of cash holdings to buy 2 kg of corn just before the central bank prints the extra 50 cornals?

She will lose no purchasing power because she holds no cash. Only cash holders are affected by inflation, and thus, seignorage.

You are kindly requested to report any *typos, mistakes* or *proposals* for the improvement of this practice set key at kmarinakis@smu.edu.sg.