Macro Problem Set 4 Solutions

Q1

a.

To make things simple, assume that you and the restaurant both have deposit accounts with OCBC. When you make the payment, the restaurant's deposits rise immediately by $100. However, your bank account balance *does not* immediately go down by $100. You are paying by credit, i.e. by borrowing.

OCBC expands both sides of its balance sheet, making a loan of $100 to you (adding $100 to its assets) and creating $100 of deposits into your account (adding $100 to its liabilities). Then it transfers the freshly created $100 in deposits from your account to the restaurant's account.

Thus, **deposits are created when the credit card is used to make payments.** Credit cards are not money, but their use involves money creation. A corollary is that when you pay your credit card bill at the end of the month, money is being destroyed!

b.

Suppose Bank Z attempts to buy $1 trillion in government bonds in the bond market and pays for it by creating $1 trillion of deposits in the names of the sellers. When the sellers use the deposits to pay for other transactions and their counterparties have accounts with other banks, Bank Z must be prepared to transfer $1 trillion of bank reserves to these other banks to support the transactions. But Bank Z cannot create reserves – only the central bank can.

If Bank Z has insufficient reserves, it must then borrow reserves from other banks or from the central bank or else abandon its purchase. These other entities may not be willing to lend such a large quantity of reserves. Moreover, even if they do lend to Bank Z, the borrowing will raise Bank Z's leverage ratio to extremely high levels, putting into question its financial soundness. Thus, the need to back up transactions with reserves is a major constraint on a bank's power to create money.

Q2

a.

Harford explains the unit of account function as a standard unit of value, much like the metre is a standard unit for length. To be useful, this standard must be "reasonably stable

over time", in the sense that the unit values for the goods and services available in your economy are not changing rapidly.

b.

Bitcoin is a digital "currency" that mimics gold in some ways – it can be "mined" but not "printed", and there is a (technologically) limited total quantity of 21 million bitcoins.

In January 2014, bitcoin was valued at between US$750 to US$1,000.[1] Since then its value has moved like a roller-coaster, surging in 2021 and hitting an all-time high of US$68,789 on Nov 10 that year, but plummeting to less than $20,000 in mid-October 2022, with large swings in between[2]. This prevents bitcoin from being a suitable standard unit of value for the goods and services in a typical economy. Moreover, the fact that there will only be 21 million bitcoins also suggests that it is unsuitable as a unit of account, for in a growing economy this will require prices of goods and services to be continually falling over time, i.e., continuous deflation. Reflecting this realization, many commentators are switching to calling Bitcoin and its ilk "crypto assets" rather than "cryptocurrencies."

Q3

a.

i. Refer to the T-account below, which shows changes to Bank A's balance sheet. On the asset side of Bank A's balance sheet, $100,000 is added to reserves, and $100,000 of government bonds is subtracted. Nothing happens immediately to the liabilities side.

Bank A

Assets		Liabilities
Reserves	+$100,000	
Govt. Bonds	–$100,000	

In "Step 0" of the deposit creation process as described in the Macro 4 lecture video, the central bank purchases government bonds from an individual Adam who has an account with Bank A. Here, the central bank purchases government bonds from Bank A.

Compared to the current scenario,

- The similarity is that in both cases the Central Bank adds reserves to Bank A.

[1] See CoinWiki for records of bitcoin's price before 2015. https://en.bitcoinwiki.org/wiki/Bitcoin_history#Bitcoin_price_history_2009_to_2019

[2] See Coinbase for charts of bitcoin's price in USD since 2015. https://www.coinbase.com/price/bitcoin

- The difference is that in the video's "Step 0" deposits are added to Bank A's liabilities to reflect that it is Adam being paid, whereas in the current scenario no deposits are added since it is Bank A being paid.

In real life, when central banks conduct open market operations, they typically buy bonds from, and sell bonds to, a select group of "primary dealers", which are mostly commercial banks.[3] Thus, the actual process is closer to the example here than the example discussed in the lecture video. As we will find out later in the question, this difference is inconsequential for money creation.

ii. Bank A now has $100,000 in excess reserves. It will make $100,000 in new loans to borrowers, confident that it has the reserves to support the transactions that those borrowers will make with their borrowing. Let's simplify by assuming it lends to a single borrower X, who now sees $100,000 added to his deposit account.

Bank A

Assets		Liabilities	
Loans	+$100,000	Deposits	+$100,000

Xavier has borrowed presumably to spend. Let's simplify by assuming X pays another person (say,) Y $100,000 for a transaction, and Y has an account at Bank B. To support that transaction, Bank A transfers $100,000 of reserves to Bank B. Thus, its balance sheet will change accordingly.

Bank A

Assets		Liabilities	
Reserves	-$100,000	Deposits	-$100,000

Consolidating all of Bank A's balance sheet changes gives

Bank A (Consolidated)

Assets		Liabilities	
Bonds	-$100,000		
Loans	+$100,000		

[3] For instance, Singapore's central bank, the Monetary Authority of Singapore, maintains a list of 13 primary dealers, all of which are commercial banks. See https://www.mas.gov.sg/bonds-and-bills/investing-in-singapore-government-securities/Find-a-Primary-Dealer.

Note that Bank A now exactly meets its 10% required reserve ratio.

b.

Bank B will have deposits and reserves rise by $100,000.

Bank B

Assets		Liabilities	
Reserves	+$100,000	Deposits	+$100,000

Now that its deposits have increased by $100,000, Bank B needs 0.1 x $100,000 = $10,000 more reserves to meet the required reserve ratio (RRR). But its reserves have increased by $100,000. Thus, it now has $90,000 in excess reserves. It will thus make new loans (and deposits) of $90,000 to a borrower U, confident that it can support transactions that U makes with those new deposits.

Bank B

Assets		Liabilities	
Loans	+$90,000	Deposits	+$90,000

When U pays (say) V $90,000 for a transaction, and V has an account with another bank, Bank B's balance sheet changes as follows:

Bank B

Assets		Liabilities	
Reserves	-$90,000	Deposits	-$90,000

Consolidating all of Bank B's balance sheet changes gives the following:

Bank B (Consolidated)

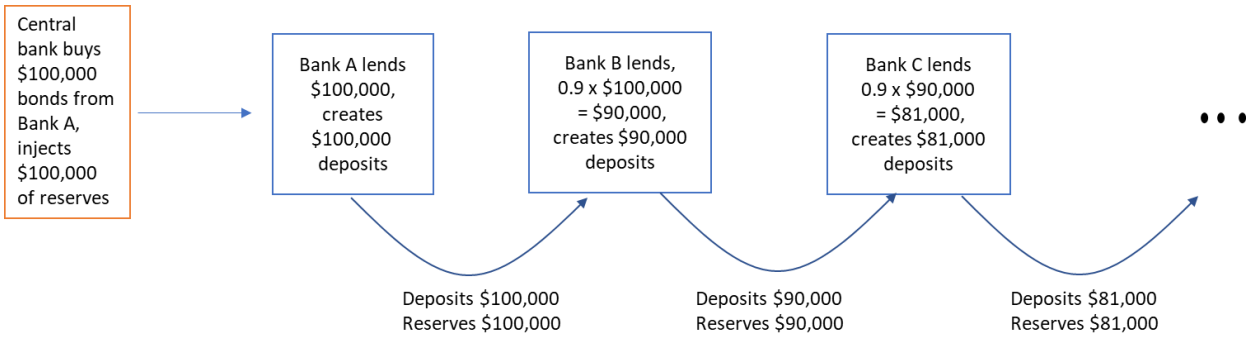
Assets		Liabilities	
Reserves	+$10,000	Deposits	+$100,000
Loans	+$90,000		

Note that Bank B now exactly meets the 10% required reserve ratio.

c.

Bank C in turn receives \$90,000 of deposits and reserves. It only requires 0.1 x \$90,000 = \$9,000 in reserves to meet the RRR. It thus creates 0.9 x \$90,000 = \$81,000 of loans and deposits. As an exercise, construct the consolidated changes to its balance sheet.

The flow-chart below shows the deposit-creation process.



Run the process across the entire banking system, and obtain:

Total deposits created = \$100,000 + \$90,000 + \$81,000 + …

$$= \$100{,}000\,(1 + 0.9 + 0.9^2 + \ldots)$$

$$= \$100{,}000 / (1 - 0.9)$$

$$= \$100{,}000 / 0.1$$

$$= \$100{,}000 \times 10$$

$$= \$1{,}000{,}000.$$

The money multiplier is given by 1 / RRR = 1 / 0.1 = 10.

Q4

a.

i.

Bank A makes \$100,000 of loans to borrower X, who pays Y for a transaction, whereupon Bank A transfers \$100,000 in reserves to Bank B. There are no changes to the steps that involve Bank A.

ii.

Bank B receives $100,000 in reserves, same as before. **But now, Bank B wants to keep 0.2 x $100,000 = $20,000 in reserves. It thus chooses to make only 0.8 x $100,000 = $80,000 in new loans to U**. U pays V $80,000 for a transaction, and Bank B transfers out $80,000 in reserves to support the transaction. The consolidated changes to Bank B's balance sheet for Bank B, including U's payment to V, is depicted in the T-account below.

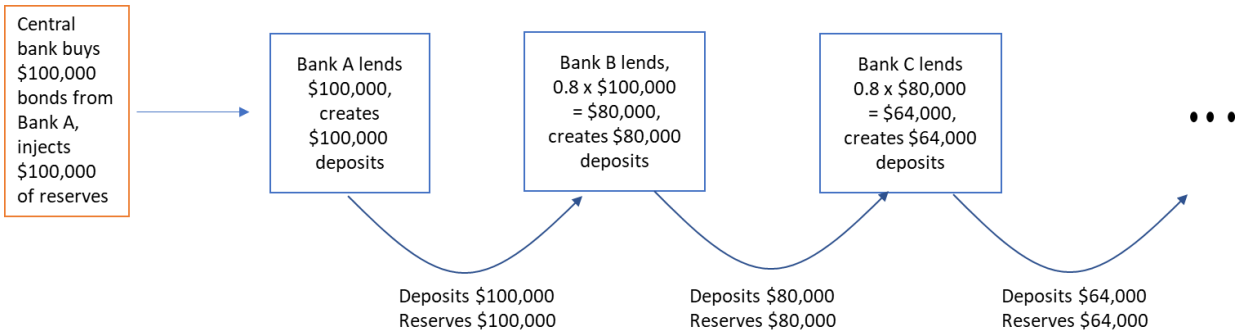
Bank B (Consolidated)

Assets		Liabilities	
Reserves	+$20,000	Deposits	+$100,000
Loans	+$80,000		

iii.

Bank B creates $80,000 in deposits, or 0.8 times the deposits that Bank A creates. Taking the process further, Bank C creates $64,000 in deposits, or 0.8 times the deposits of Bank B, and so on.

The flow-chart below depicts the deposit-creation process when the **actual reserve ratio** is 20 percent.



Running the process to its conclusion,

Total deposits created = $100,000 $(1 + 0.8 + 0.8^2 + \ldots)$

$= \$100{,}000 / (1 - 0.8)$

$= \$100{,}000 / 0.2$

$= \$100{,}000 \times 5$

$= \$500{,}000.$

The **actual reserve ratio** is now 20%, and the money multiplier is now 1 / 20% = 5.

b.

Bank A continues to lend $100,000 to X, creating $100,000 of deposits initially. However, X will choose to convert $20,000 of his deposits into cash, since people (including himself and Y) want to hold 20 percent of their money in cash. Bank A is obliged to do the conversion because deposits are supposed to be exchangeable for cash, dollar for dollar. Bank A's vault cash (part of its reserves) thus falls by $20,000[4]. X makes $20,000 cash payment to Y, and $80,000 via bank transfer. In support, Bank A transfers out $80,000 of reserves to Bank B. While these transactions are more involved, nonetheless the consolidated changes to Bank A's balance sheet remains the same.

Bank A (Consolidated)

Assets		Liabilities	
Bonds	-$100,000		
Loans	+$100,000		

ii.

Bank B now only receives $80,000 in deposits and reserves. To maintain its RRR, it lends 0.9 x $80,000 = $72,000 to U. Initially it creates $72,000 of deposits, but U exchanges 20 percent ($14,400) for cash. Thus, Bank B only sends 0.8 x $72,000 = $57,600 to Bank C when U completes her transaction with V. New deposit creation is significantly reduced compared to that in part b!

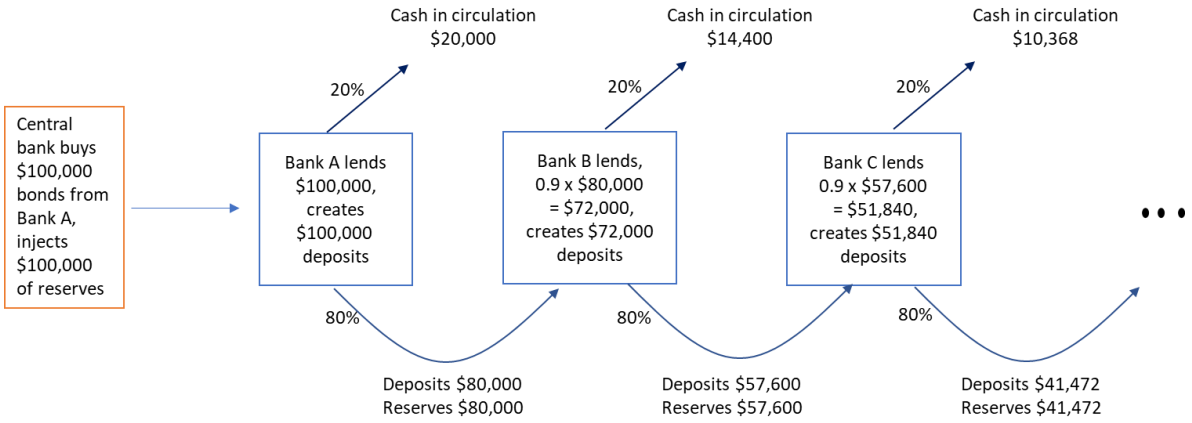
Bank B (Consolidated)

Assets		Liabilities	
Reserves	+$8,000	Deposits	+$80,000
Loans	+$72,000		

iii.

The following flow-chart depicts the deposit creation process when the actual reserve ratio equals the required 10%, and people hold 20% of their money as cash.

[4] If Bank A is short of vault cash, it can exchange its own deposits at the Central Bank for cash. Bank A's relationship with the Central Bank is akin to X's relationship with Bank A.



By its lending, Bank A creates $100,000 of deposits, of which 20% ($20,000) is converted to cash in circulation, and 80% ($80,000) end up with Bank B.

By its lending, Bank B creates $72,000 of deposits, equal to 0.8 x 0.9 = 0.72 times that created by Bank A. Of this, 20% is converted to cash in circulation, while 80% ($57,600) end up in Bank C.

By its lending, Bank C creates deposits equal to 0.72 times that created by Bank B, which is equal to 0.72^2 times that created by Bank A.

Running the process to its conclusion, and recognizing that money now includes both deposits and cash in circulation:

Total deposits and cash-in-circulation created = $\$100{,}000 \times (1 + 0.72 + 0.72^2 + \ldots)$

$= \$100{,}000 / (1 - 0.72)$

$= \$100{,}000 / 0.28$

$= \$357{,}142$

The money multiplier is now just 1 / 0.72 = 3.57142. When people want to hold 20 percent of their money in cash, the amount of reserves that flow into the next bank falls by 20 percent, resulting in less loan creation and less money creation. The money multiplier thus depends on the willingness of people to hold cash.

c.

The money creation process now receives a double whammy. Banks want to keep an actual reserve ratio of 20 percent, higher than the RRR. People want to hold 20 percent of their money as cash. Thus, loan creation is further reduced, and even less money is created. What remains is to compute the amount of money created.

As before, Bank A still creates $100,000 of deposits, for which $20,000 is converted to cash in circulation and $80,000 ends up in Bank B.

Bank B now creates 0.8 x $80,000 = $64,000 in deposits, equal to 0.8 x 0.8 = 0.64 times that created by Bank A. Of this, 20% ($12,800) is converted into cash in circulation, while 80% ($51,200) ends up in Bank C.

Bank C now creates 0.8 x $51,200 = $40,960 in new deposits, equal to 0.64 times that created by Bank B, and equal to 0.64^2 times that created by Bank A.

Extrapolating from this, one finds that the money multiplier has now become even smaller!

Total creation of deposits and cash in circulation = $\$100{,}000 \times (1 + 0.64 + 0.64^2 + \ldots)$

$= \$100{,}000 / (1 - 0.64)$

$= \$100{,}000 / 0.36$

$= \$277{,}778.$

Q5

a. Total assets = $(200 + 620 + 65 + 15 +100) million = $1,000 million. Since the totals on both sides of the balance sheet must be equal, total liabilities + bank capital = $1,000 million. Liabilities are $(550 + 350) million = $900 million. Thus, bank capital = $1,000 million – $900 million = $100 million.

b. "Government bonds" refer to bonds issued by the government that the bank currently holds. Thus, the value is placed on the assets side of the balance sheet. "Bonds payable" refers to bonds issued by Southern Rock Bank that other entities hold. Thus, the value is placed on the liabilities side of the balance sheet. "Deposits with central bank" refer to the deposits that Southern Rock Bank holds in an account with its central bank. Thus, this is an asset for Southern Rock Bank. "Deposits" refer to deposits that customers hold in accounts at Southern Rock Bank. These are liabilities of the bank and assets for the customers.

c. The capital ratio is bank capital/assets = $100 million / $1,000 million = 10 percent. This meets the capital requirement of 10 percent.

d. Yes, Southern Rock Bank is insolvent. Its liabilities remain at $900 million, while assets are now $880 million. Thus, bank capital is negative $20 million, and the bank is insolvent.

e. Let the value of assets sold be $X. Since assets sold are used to pay down liabilities, the reduction in assets will be matched by the reduction in liabilities, leaving bank capital unchanged at $100 million. With assets now given by $(1,000 million – X), the capital ratio would then be $100 million / $(1,000 million – X). Setting this to be 15% and solving for X gives X = 333.3 million. Thus, the bank needs to liquidate $333.3 million of assets, becoming a smaller bank in the process.

f. Let the value of new stock issue be $Y. Bank capital is then $(100 million + Y). Since all the proceeds from recapitalization are used to pay down liabilities, the value of assets is unchanged. The capital ratio would then be $(100 million + Y) / $1,000 million. Setting this to be 15% and solving for Y gives Y = $50 million. Thus, the bank must raise an additional $50 million in bank capital.

Q6

a.

From the article, here are some startling facts about Sweden's use of cash in 2016, and some guesses as to how far Singapore is from Sweden:

- 900 bank branches out of 1,600 no longer keep cash on hand, and many don't have ATMs (all Singapore bank branches have cash, and ATMs are ubiquitous).
- Cash is used in only 20% of transactions at shops (likely a higher percentage in Singapore, especially at provision shops and hawker centres).
- Wages are paid by digital transfers (also done in Singapore).
- The average Swede uses 207 credit card payments per year (not sure about SG numbers, but likely lower).
- Use of phone numbers to transfer money (Singapore has only started this recently).
- One Stockholm church reports only 15% of its members' donations were in cash (some mega-churches in Singapore also use electronic transfers).

b.

Benefits include

- Saving on printing costs.
- Saving on storage costs.
- Hygiene and public health improvements: cash is rife with germs and the use of cash spreads the germs throughout the population.
- Illicit activities (e.g., corruption, tax evasion, smuggling) are more detectable.
- Monetary authorities may be able to control money supply more accurately.
- Easier for negative interest rates to be imposed on household deposits as they cannot convert deposits into cash anymore (this is a benefit from the perspective of the central bank because monetary policy becomes less limited).

c.

Problems include:

- Fraud can potentially be more widespread.
- Privacy is lost, since all transactions are recorded.
- The elderly may struggle as they are not used to going cashless.
- Easier for negative interest rates to be imposed on household deposits as they cannot convert deposits into cash anymore (this is a problem from the perspective of consumers).
- Installation and maintenance costs. How these costs will be shared between banks, users, and government (i.e. taxpayers) is a thorny problem.
- Susceptibility to disruptions by power outages or hacking.