Chp4Problems

September 19, 2023

0.1 Problems and applications

1. Money has the following functions: (i) it stores value, (ii) it serves as a unit of account, and (iii) it is a medium of exchange.

- A credit card - allows for exchange and stores value, but it does not provide a unit of account.
- A painting by Rembrandt - stores value, but is not a medium of exchange (except for in rare cases) and does not provide a unit of account.
- A starbucks gift card - stores value, and is a medium of exchange *for certain sellers (i.e. Starbucks)*, but does not provide a unit of account.

2. Consider the effects of various policy instruments of the central bank:

- open-market operation of buying bonds: increase in the monetary base (B) $\implies$ increase in the money supply (M). The money multiplier (m) is unaffected.
- increase the interest rate associated with holding reserves: increases the reserve-ratio (rr) by incentivizing banks to hold more in reserves $\implies$ decrease in the money multiplier (m) $\implies$ a decrease in the money supply (M). The monetary base (B) is unaffected.
- reduce lending through Term Auction Facility: decrease in the monetary base (B) $\implies$ decrease in the money supply (M). The money multiplier (m) is unaffected.
- people hold more money as currency than as demand deposits: increase the currency-deposit ratio (cr) $\implies$ decrease in the money multiplier (m) $\implies$ a decrease in the money supply (M). The monetary base (B) is unaffected.
- money falls from the sky: since $B = C + R$, increases the monetary base (B) $\implies$ increases the money supply (M).

3. For an economy with a monetary base of \$1000, given the expression

$$M = C + D$$

we have the following:

- $M = \$1000 + 0 = \$1000$
- $M = 0 + \$1000 = \$1000$
- The balance sheet of the bank in this case is given by

Assets	Liabilities
Reserves - \$200	Deposits - \$1000
Loans - \$800	

so, with $C = \$0$, we have $M = \$800 + \$1000 = \$1800$.

- The balance sheet of the bank in this case is given by

Assets	Liabilities
Reserves - \$100	Deposits - \$500
Loans - \$400	

so, with $C = \$500$, we have $M = \$500 + \$400 + \$500 = \$1400$.

- For this final part, if we compute both the currency-deposit ratio (cr) and the reserve ratio (rr), since we know M, we can determine how much B needs to increase so that M increases by 10%. This is due to the following relationship:

$$M = \frac{cr + 1}{cr + rr} * B,$$

  where $B = C + R$.

  - $C = 1000$, $R = 0 \implies B = 1000$. In this case, where all money is held as currency, $cr = 0$ and $rr = 0$. Thus, $M = C \implies M = B$, so increasing the monetary base B increasing by 10% implies that the money supply M also increases by 10%.
  - $C = 0$, $R = 1000 \implies B = 1000$. In this case, where all money is held as demand deposits (i.e. no fractional reserve banking), $M = R \implies M = B$, so increasing the monetary base B increasing by 10% implies that the money supply M also increases by 10%.
  - With 20% of deposits held as reserves and all money held as demand deposits, $C = 0$, $R = 200 \implies B = 200$. Then, $cr = \frac{C}{D} = \frac{0}{1000} = 0$ and $rr = \frac{R}{D} = \frac{200}{1000} = 0.2$; this implies that the money multiplier is $m = \frac{1+0}{0+.2} = \frac{1}{.2} = 5$ and the money supply is given by the expression $M = 5 * B$.

    We want to find B' such that $5 * B' = (1.1)M$. This implies $B' = \frac{1.1}{5}M$. Since we solved $M = 1800$ in part c., we have $B' = (.22)(1800) = 396$. Thus, when B increases from 200 to 396, the money supply increases from 1800 to 1980, an increase of $\frac{1980-1800}{1800} = \frac{180}{1800} = .1$ or 10%. This is an increase of $\frac{396-200}{200} = .98$ or 98% in the monetary base!
  - With 20% of deposits held as reserves and half of all money held as demand deposits (the other half in currency), $C = 500$, $R = 100 \implies B = 500 + 100 = 600$. Then, $cr = \frac{C}{D} = \frac{500}{500} = 1$ and $rr = \frac{R}{D} = \frac{100}{500} = 0.1$; this implies that the money multiplier is $m = \frac{1+1}{0+.1} = \frac{2}{1.1}$ and the money supply is given by the expression $M = \frac{2}{1.1} * B$.

    We want to find B' such that $\frac{2}{1.1} * B' = (1.1)M \implies B' = (\frac{(1.1)^2}{2})M$. Since we solved $M = 1400$ in part d., we have $B' = (.605)(1400) = 847$. Thus, when B increases from 600 to 847, the money supply increases from 1400 to 1540, an increase of $\frac{1540-1400}{1400} = \frac{140}{1400} = .1$ or 10%. This is an increase of $\frac{847-600}{600} = .41166$ or 42% in the monetary base!

4. Given $C = 1000$, $D = 4000$, $rr = .25$, we have

- $rr = \frac{R}{D} \implies .25 = \frac{R}{4000} \implies R = (.25)(4000) = 1000.$

  $B = C + R = 1000 + 1000 = 2000$ $M = C + D = 1000 + 4000 = 5000$

Lastly, since $cr = \frac{C}{D} = \frac{1000}{4000} = .25$, the money multiplier is $m = \frac{1+cr}{rr+cr} = \frac{1.25}{.5} = 2.5$.

- The value of outstanding loans must be 3000, since there is no bank capital nor debt.

Assets	Liabilities
Reserves - \$1000	Deposits - \$4000
Loans - \$3000	

- To increase the money supply, it should buy government bonds. Using the fact that $M = 5000$ and $m = 2.5$, and the expression $M = m * B$, we want to find the new level of the monetary base B' such that

$$(1.1)M = mB' \implies M = \frac{2.5}{1.1}B' \implies B' = 2200.$$

Thus, the monetary base needs to change from $B = 2000$ to $B' = 2200$, so the central bank needs to transact \$200 to increase the monetary base so that the money supply increases by %10.

5. Suppose that the monetary base $B = 1000$. $\frac{1}{3}$ is held in cash. $\frac{2}{3}$ is held in demand deposits, and required to hold $\frac{1}{3}$ of these deposits in reserves.

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$$rr = \frac{\frac{2}{9}}{\frac{2}{3}} = \frac{3}{9} = \frac{1}{3}$$

$$cr = \frac{\frac{1}{3}}{\frac{2}{3}} = \frac{1}{2}$$

$$m = \frac{1 + cr}{cr + rr} = \frac{1 + \frac{1}{2}}{\frac{1}{3} + \frac{1}{2}} = \frac{9}{5}$$

$$M = m * B \implies \frac{9}{5}(1000) = \frac{9000}{5} = 1800$$

- Now, suppose that $\frac{1}{2}$ is held in cash. $\frac{1}{2}$ is held in demand deposits, and required to hold $\frac{1}{3}$ of these deposits in reserves.

$$rr = \frac{\frac{1}{6}}{\frac{1}{2}} = \frac{2}{6} = \frac{1}{3}$$

$$cr = \frac{\frac{1}{2}}{\frac{1}{2}} = 1$$

$$m = \frac{1 + cr}{cr + rr} = \frac{1 + 1}{1 + \frac{1}{3}} = \frac{3}{2}$$

$$M = m * B \implies \frac{3}{2}(1000) = \frac{3000}{2} = 1500$$

- If we want to keep the money supply at 1800 with a money multiplier of $m = \frac{3}{2}$, then

$$1800 = \frac{3}{2} * B' \implies B' = \frac{3600}{3} = 1200$$

So the monetary base needs to increase from 1000 to 1200. This is done by the central bank buying government bonds.

6. Using the data from the table and the money supply equation

$$M = \frac{1 + cr}{cr + rr} * B:$$

- Suppose rr stays the same. Then, using the table, the hypothesized value for the monetary supply in 1933 should be

$$M = \frac{1 + .41}{.41 + .14} * (8.4) = 21.53$$

- Suppose cr stays the same. Then, using the table, the hypothesized value for the monetary supply in 1933 should be

$$M = \frac{1 + .14}{.14 + .21} * (8.4) = 27.36$$

- Thus, since the money supply falls more when the currency-deposit ratio increases, we suspect that it is more responsible for the actual fall in the money supply given the data from the table.

7. Given a tax on checks written on bank account deposits,

- With a tax on checks in this way, deposits should decrease. Since $cr = \frac{C}{D}$, the currency-deposit ratio should increase given the tax.

  (Note: it could be the case that this tax results in a fall in cash holdings instead. In this case, the effects are reversed.)

- When cr increases, the money multiplier falls. This decreases the monetary supply.

- Based on the fact that the tax decreases the money supply through its effect on the currency-deposit ratio, it seems not to be a good policy to implement.

  (Note: Again, if the tax results in a fall in cash holdings instead and the effects are reversed, then by a similar logic this should be a good policy.)

8. Consider an example similar to the ones in the text of a bank with leverage ratio = 20:

Assets	Liabilities
Reserves - \$200	Deposits - \$950
Loans - \$800	Capital - \$50

- Suppose the value of bank assets increase by 2%. Then,

$$1000(1.02) = 1020 \implies 1020 - 950 = 70$$

  this is the new level of bank capital.

- We want to know how much the value of bank assets would need to fall so that the bank no longer has any capital. This means we want to find the value which solves the following expression:

$$1000(x) = 950 \implies x = .95$$

  so, if assets fall by 5% in value, then the bank will have no assets.

9. First, we discuss the balance sheet for the bank in this setting:

Assets	Liabilities
Reserves - \$3000	Deposits - \$14000
Loans - \$10000	Debt - \$4000
Securities - \$7000	Capital - \$2000

- The leverage ratio in this case is $\frac{20000}{2000} = 10$.
- Suppose the value of loans fall by 5% due to bankruptcy. Then, both loans and bank capital fall by \$500. This is captured by the new balance sheet of the bank:

Assets	Liabilities
Reserves - \$3000	Deposits - \$14000
Loans - \$9500	Debt - \$4000
Securities - \$7000	Capital - \$1500

The fall in the total value of bank assets is $\frac{20000-19500}{19500} = .0256$ or 2.5%.

The fall in bank capital is $\frac{2000-1500}{1500} = .3333$ or 33%.

0.2 Visualizing the Model of the Money Supply

Below is a graph capturing the basic elements of the simple model of money supply in a system of fractional-reserve banking, given by the following equations:

$$M = C + D$$
$$B = C + R$$
$$\implies M = \frac{cr + 1}{cr + rr} * B,$$

we may denote the money multiplier as $m = \frac{cr+1}{cr+rr}$.

[5]:
```
import numpy as np
import matplotlib.pyplot as plt
```

```python
# Define the function
def f(x, y):
    return ((x+1)/(x+y))*B

# Pre-specify some level of monetary base (B)
B = 8

# Generate the x and y values
x = np.linspace(0.01, 1, 50)
y = np.linspace(0.01, 1, 50)
X, Y = np.meshgrid(x, y)

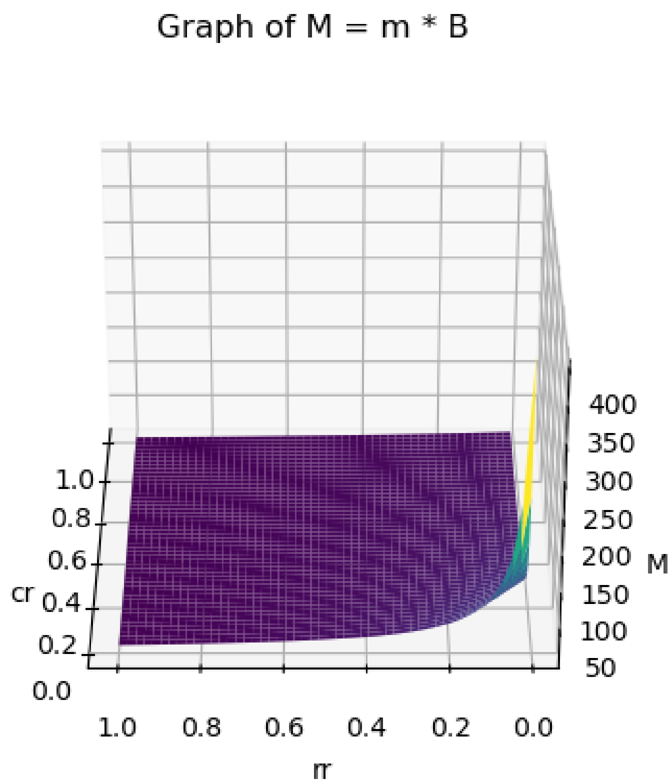
# Calculate the corresponding z values
Z = f(X, Y)

# Create the plot
fig = plt.figure()
ax = plt.axes(projection='3d')
ax.plot_surface(X, Y, Z, cmap='viridis')

# Set labels and title
ax.set_xlabel('cr')
ax.set_ylabel('rr')
ax.set_zlabel('M')
ax.set_title('Graph of M = m * B')

ax.view_init(azim=180)

# Show the plot
plt.show()
```


Graph of M = m * B
cr
1.0
0.8
0.6
0.4
0.2
0.0
1.0
0.8
0.6
0.4
0.2
0.0
rr
400
350
300
250
200
150
100
50
M

```
[ ]:
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