Macro Modules 12 + 13: Demand for money and the price level

Practice problems and illustrative test questions for the final exam

(The attached PDF file has better formatting.)

This posting gives sample final exam problems. Other topics from the textbook are asked as well; these problems are just examples. All final exam problems are multiple choice; practice problems are not multiple choice so that the solutions can be better explained.

** Exercise 13.1: Legal tender

A. What is *legal tender*?
B. If the price level is not specified, why is the definition of legal tender unclear?

Part A: Legal tender means that the national paper currency, such as the U.S. dollar, has to be accepted in trade for goods and services.

Part B: The principle of legal tender does not specify the price level. Mandating that U.S. dollars must be accepted as payment for bread means little if the seller demands $10,000 for a loaf. Rather, legal tender is important for what it excludes. It says that stores need not accept Euros or Yen of British pounds for their goods, even though the currency exchange rate is known.

Question: Is this a serious problem?

Answer: As long as inflation is low and the price level is relatively stable, this should not be a problem. It is only if inflation accelerates greatly that paper money may lose its value as a medium of exchange.

See Barro, Macroeconomics, Chapter 10, demand for money and price level, page 172

** Exercise 13.2: Definitions of money

The textbook discusses five money aggregates:

A. Currency held by the public
B. Total currency in circulation
C. High-powered money = monetary base
D. M1
E. M2

1. What is the definition of each money item?
2. What is the size relation of these five items?
3. Why is currency held by the public different for the U.S. than for other countries? How has the ratio of currency to checkable deposits in the U.S. changed over the past 30 years?

Item 1: Definitions

Currency held by the public is the coins and the paper money owned by private persons, not held in bank vaults; currency in circulation includes the money in bank vaults, but not the funds held by the U.S. Treasury of the Federal Reserve banks; high-powered money includes the deposits with the Federal Reserve. M1 adds checkable deposits: that is, bank deposits that can be withdrawn by writing checks. M2 adds retail (personal) savings and money market deposits at banks. See Barro, *Macroeconomics*, Chapter 10, demand for money and price level, pages 172-173

Item 2: Size

In round figures, currency is about 5% of U.S. GDP, checking deposits are another 5%, and personal savings deposits are about 35%.

Item 3: U.S. vs other countries

The size of currency is somewhat misleading for the U.S. dollar. Over half the currency held by the public is in large bills held by foreigners seeking a safe, liquid, and often untraceable store of value. It is not intended to buy goods and services in the U.S.

The ratio of currency to checkable deposits in the U.S. was 1 to 4 in 1960 and 1 to 1 in 2006. In 1960, persons in developing countries were generally poor. Wealthy persons owned land or capital in those countries. Now many persons in developing countries have money, and they want a safe, liquid way to hold it. They don't want bank accounts, since it may not be easy to get the cash. They prefer to hold high denomination U.S. Treasury bills, which can be stored at home and are accepted as money everywhere. See Barro, *Macroeconomics*, Chapter 10, demand for money and price level, page 173, column 1

Question: Must we know the exact size of each monetary aggregate?

Answer: Know the relations: the list above shows the sequence, with each bullet point included in the next bullet point (e.g., M1 is included in M2).

** Exercise 13.3: Household budget constraint

A. What is the household budget constraint, ignoring all government items (taxes, transfers, debt)?
B. Distinguish real vs nominal terms in the budget constraint.
C. Explain the budget constraint intuitively.

Part A: The household budget constraint (equation 6.11 and 10.1 on page 175) says that

$$PC + \Delta B + P \times \Delta K = \prod + wL + i \times (B + PK),\text{ where}$$

- P = price level
- C = consumption
- B = bonds
- K = capital sock
- $\prod$ = profits
- w = nominal wage rate
- L = labor
- i = nominal interest rate

Question: Why do we exclude taxes, transfer, and government debt from this equation?

Answer: Barro presents this equation in chapter 10; he discusses government spending in later chapters. In truth, we should include taxes, transfer, and government debt in the equation.

Part B: The budget constraint (like other macroeconomic formulas) can be expressed in real or nominal terms. Some variables denote real amounts; others denote nominal amounts. Here are the principles

- Real quantities are expressed in real terms. Consumption and capital are real items, so C = real consumption and K = real capital stock.
- Monetary items are expressed in nominal terms. Bonds have a face value in dollars, and money is denoted in dollars, so B = bonds in dollars and M = money in dollars. Profits are a monetary item, so $\prod$ = nominal profit. Rates are monetary items: the wage rate is the dollars per hour of labor and the rental rate is the dollars per hour of one unit of capital, so these rates are in monetary terms: w = nominal wage rate and R = the nominal rate of return on capital.

Part C: Budget constraints say "the use of funds = the source of funds." This budget constraint expresses all items in nominal terms.

- Households use funds to consume goods and services or to buy more assets.
- C = real consumption (goods and services are parts of the real economy), so PC = nominal consumption.

The new assets = the change in assets during the year. Assets of two types: monetary assets = B (bonds) and real assets = K (capital stock). The change in assets is ΔB and ΔK. To convert the change in real assets to a nominal amount, multiply by P to get $P \times \Delta K$.

The right hand side of the household budget constraint is the source of funds. Households (persons) get funds two ways: from their labor and from lending (renting out) the assets they own. Their labor times the nominal wage rate is the nominal income from labor. The assets the own (not the change in the assets they own) times the nominal interest rate is the nominal income from assets. Real assets (K) must be multiplied by P to give nominal assets.

Question: Why don't we subtract depreciation from ΔK on the left side of this equation? Some income is used to offset the obsolescence (depreciation) of worn-out machines.

Answer: We do subtract depreciation. K is assets net of depreciation. Suppose K is $100,000 on January 1, 20X2; depreciation in 20X3 is 5% of beginning capital; and new capital of $12,000 is bought in 20X2. The capital K at December 31, 20X2, is $100,000 + $12,000 – $5,000 = $107,000. The change in capital, ΔK, is $107,000 – $100,000 = $7,000 = new capital minus depreciation.

Question: Why do some formulas have a δ or a δ(κ) in them?

Answer: The income from capital is the rental rate on capital minus depreciation. The rental rate is not net of depreciation. Continuing the example above, suppose the rental rate is R = 12% and depreciation is 5%. The income from owning capital is (12% – 5%) × $100,000 = $7,000.

Question: The right hand side of the household budget constraint has the income from capital, and it does not subtract depreciation.

Answer: The nominal interest rate = the return on capital, and the real interest rate = the real return on capital. The rental rate is not net of depreciation; the return on capital is net of depreciation. This household budget constraint uses the nominal interest rate = the return on capital, not the rental rate.

See Barro, Macroeconomics, Chapter 10, demand for money and price level, page 175, column 1

** Exercise 13.4: Nominal vs real terms

For each item below, give the expressions in real vs nominal terms.

A. Wage rate
B. Rental price
C. Consumption
D. Capital stock
E. Investment
F. Government spending
G. Income
H. Bonds
I. Money
J. Profits

Solution 13.4:

A. Nominal wage rate = w; real wage rate = w/P
B. Nominal rental price = R; real rental price = R/P
C. Real consumption = C; nominal consumption = C × P
D. Real capital stock = K; nominal capital stock = K × P
E. Real investment = I; nominal investment = I × P
F. Real income Y; nominal income = Y × P
G. Real government spending = G; nominal government spending = G × P
H. Nominal bonds = B; real bonds = B / P
I. Nominal money = M; real money = M / P
J. Nominal profits = $\prod$; real profits = $\prod$ / P

Question: This is confusing: of the ten variables, five are in real terms and five are in nominal terms.

Answer: Understand the logic for these conventions.

Real income items are in real terms.

- Y = real income = real GDP
- C = real consumption (goods and services)
- K = real capital stock
- G = real government expenditures
- I = real investment (in real capital stock, not bonds)

Monetary items are in nominal terms:

- M = money in nominal terms; M/P = money in real terms
- B = bonds (that is, interest bearing assets) in nominal terms; B/P = real value of bonds

Dollar rates are in nominal terms: wage rate, rental price. Profits are the products of nominal rates and real variables.

- w = nominal wage rate; w/P = real wage rate
- R = nominal rental price; R/P = real rental price
- $\prod$ = profit = nominal wage rate × labor + nominal rental price × nominal capital stock

Question: Is labor in real or nominal terms?

Answer: Labor is in real terms: worker-hours. Its units have no dollars.

** Exercise 13.5: Money and the price level

A. How does real GDP affect the real demand for money?
B. How does the real demand for money affect the real money supply, the nominal money supply, and the price level?
C. If real GDP doubles and there are no economies of scale in cash management, what happens to the real demand for money?
D. How do economies of scale in cash management affect the real demand for money?

Part A: People use money to buy goods, so the real demand for money is proportional to real income (GDP).

Part B: For the money markets to clear, the real money supply must equal the real demand for money. The nominal money supply does not change unless the government prints money or uses open market operations to buy or sell Treasury securities. Instead, the price level changes so that

$$\text{nominal money supply} / \text{price level} = \text{real money supply} = \text{real demand for money}$$

Part C: If real GDP doubles and there are no economies of scale in cash management, the real demand for money doubles.

Part D: If real GDP doubles, real consumption doubles, and people need twice the money to buy goods and services. Instead of holding twice the amount of money, people put more effort into money management. They keep the money in interest bearing bonds or money-market accounts, and they withdraw money as needed for consumption, called "economies of scale in cash management." The size of this effect is not large. The textbook mentions that empirical data show a strong correlation of the real demand for money with real GDP and a weaker effect of economies of scale in cash management.

See Barro, Macroeconomics, Chapter 10, demand for money and price level, page 177, column 1

** Exercise 13.6: Money, population growth, and the price level

The nominal money supply increases 4%, the price level increases 7%, and the population decreases 1%.

No changes occur in transaction costs for bank visits.

A. What is the change in the real money supply?
B. What is the change in the real demand for money?
C. What is the change in real GDP?
D. What is the change in real GDP per capita?

Part A: The nominal money supply increases 4%, and the price level increases 7%, so the real money supply decreases 3%.

Part B: The real money supply decreases 3%, so the real demand for money decreases 3%.

Part C: The real demand for money decreases 3%, so real GDP must have decreased 3%.

Part D: The population decreases 1%, so the real GDP per capita decreases 2%.

See Barro, Macroeconomics, Chapter 10, demand for money and price level.

** Exercise 13.7: Transactions efficiency

Suppose banks install EDP software that enables consumers to keep their money in interest-bearing savings accounts with funds transferred automatically to checking accounts as bills come due. Payments to stores would be done with cell phones, with funds automatically transferred between accounts. What happens to

A. The real demand for money?
B. The real money supply?
C. The nominal money supply?
D. The price level?

Part A: People need less cash and less money in checking accounts to pay bills, so the real demand for money decreases.

Part B: The real money supply equals the real demand for money, so the real money supply decreases.

Part C: The nominal money supply does not change, since the government have not printed new bills or traded Treasury securities.

Part D: The nominal money supply does not change and the real money supply decreases, so the price level must increase.

See Barro, Macroeconomics, Chapter 10, demand for money and price level, page 183

** Exercise 13.8: Economic cycles and the price level

Assume the monetary authorities keep the money growth rate constant at the long-term trend in real GDP.

Are the following items pro-cyclical, counter-cyclical, or a-cyclical?

A. The real demand for money
B. The real money supply
C. The nominal money supply
D. The price level

Part A: The real demand for money is proportional to real GDP, so it is pro-cyclical.

Part B: In equilibrium, the real money supply equals the real demand for money, so it is also pro-cyclical.

Part C: The nominal money supply grows with the long-term trend in real GDP, so it is a-cyclical.

Part D: The price level is the nominal money supply divided by the real money supply, so it is counter-cyclical.

See Barro, Macroeconomics, Chapter 10, demand for money and price level, page 183

** Exercise 13.9: Seasonality in money supply and price level

People use money for shopping. Assume people adjust their holding of money at the beginning of each month so they have enough currency to pay for that month's shopping.

Retail store revenue (shopping) is highest in December (for holiday shopping) and lowest in February (with no holidays and cold weather).

The monetary authorities increase the nominal money supply at the *long-term* growth rate in real GDP, so that the *long-term* inflation rate is zero.

A.   What is the seasonal pattern of real GDP?
B.   What is the seasonal pattern of the real demand for money?
C.   What is the seasonal pattern of the nominal money supply?
D.   What is the seasonal pattern of the real money supply?
E.   What is the seasonal pattern of the price level?

Part A: The real demand for money varies with real GDP, which is consumption + investment + government. Consumption is measured by sales of final goods and services. Private investment and government spending are constant by month, so real GDP varies with consumption: highest in December and lowest in February.

Part B: The real demand for money is positively correlated with consumption, so it is positively correlated with real GDP. It is pro-cyclical: highest in December and lowest in February.

Part C: The nominal money supply depends on the long-term trend in real GDP, not seasonal fluctuations. It is acyclical, with no variation by month.

Part D: In equilibrium, the real money supply equals the real demand for money. The price level adjusts to equate the real supply and demand for money; this is part of *general equilibrium*. The real money supply is pro-cyclical, just like the real demand for money.

Part E: The real money supply = the nominal money supply divided by the price level. If the nominal money supply is acyclical and the real money supply is pro-cyclical, the price level must be counter-cyclical. It is lowest in December and highest in February.

Take heed: Know the relation: the real money supply = the nominal money supply divided by the price level.

Question: Do we observe this seasonal pattern in the price level? Is the price level actually lowest in December and highest in February?

Answer: The monetary authorities (the Federal Reserve Board) adjusts the nominal money supply through the year to offset some of the seasonality in the price level. The adjustment is not perfect, since it is difficult to fine tune macroeconomic variables. The FED prefers to under-adjust than to over-adjust, since it wants to reduce macroeconomic fluctuations, not increase them. Empirically, the price level is counter-cyclical: lowest in December and highest in February. But the seasonality is weak, and most consumers don't notice.

** Exercise 13.10: Seasonality in money supply and price level

People use money for shopping. Assume people adjust their holding of money at the beginning of each month so they have enough currency to pay for that month's shopping.

Retail store revenue (shopping) is highest in December (for holiday shopping) and lowest in February (with no holidays and cold weather).

The monetary authorities adjust the nominal money supply so that the price level is constant. Assume the adjustment is perfect: the FED does not over-adjust or under-adjust.

A. What is the seasonal pattern of real GDP and the real demand for money?
B. What is the seasonal pattern of the nominal money supply?
C. What is the seasonal pattern of the real money supply?
D. What is the seasonal pattern of the price level?

Part A: The seasonal pattern of real GDP and the real demand for money is the same as in the previous exercise.

Part B: The price level is constant over the year, so it is acyclical. In practice, the FED may target a slow increase in the price level, such as 3% per annum, which is still acyclical.

Part C: The real money supply varies with the real demand for money, so it is pro-cyclical. Note the directions of causation:

● Real GDP affects real demand for money.
● Real demand for money affects real money supply.
● Monetary policy (printing money and open market operations) affects the nominal money supply.

Part D: The nominal money supply divided by the real money supply is the price level. If the price level is acyclical and the real money supply is pro-cyclical, the nominal money supply must also be pro-cyclical. The actions of the monetary authorities (the FED) are as one might expect intuitively.

● The monetary authorities print money in December, when money is needed for holiday shopping.
● They decrease the nominal money supply in February, when less money is needed for shopping.

Question: Printing money is easy in December. How does one decrease the money supply in February?

Answer: In the United States, printing of money is not actually the method used to adjust the nominal money supply. New dollar bills are printed to replace worn out bills and to satisfy overseas demand for U.S. dollars, which has been steadily growing, unrelated to holiday shopping. The domestic money supply is adjusted by buying and selling U.S. Treasury bonds.

Question: Does the U.S. Treasury issue bonds to adjust the nominal money supply?

Answer: The U.S. Treasury is part of the federal government; the Federal Reserve Board is independent of the government. Don't confuse fiscal policy of the government with monetary policy of the FED (central bank).

The Treasury issues bonds to pay for government expenditures. The FED buys and sells Treasury bonds to adjust the nominal money supply.

● If it buys bonds, it pays for them with currency. The currency held by the public increases, and the nominal money supply increases.
● If it sells bonds, it receives currency. The currency held by the public decreases, and the nominal money supply decreases.

Question: Barro's textbook has a few paragraph on open market operations. Other macroeconomic textbooks have entire chapters on this subject.

Answer: Some economists believe money affects the real economy; see chapters 15 and 16 for two models that assume the price level affects the real economy. Politics affects the choice of model. Those who support a large role for government in the economy are likely to support Keynesian models; those who want less government involvement in the economy are likely to support equilibrium business cycle models. The *Wall Street Journal* prefers Barro's type of model; the *New York Times* prefers a Keynesian model.