- **Nominal variables** are variables measured in monetary units.
- If you earn $10 per hour, then that is your nominal wage because it is given in terms of dollars.
- **Real variables** are variables measured in physical units.
- If you need to work an hour in order to afford one pizza, then your real wage (in terms of pizzas) is one pizza per hour.
- The separation of real and nominal variables is called the **classical dichotomy**.
- When the central bank doubles the money supply, the price level doubles, the dollar wage doubles, and all other dollar values double.
- Real variables, such as production, employment, real wages, and real interest rates, are unchanged.
- The irrelevance of monetary changes for real variables is called **monetary neutrality**.

Problem 1. The principle of monetary neutrality implies that an increase in the money supply will

(a) increase real GDP and the price level.

(b) increase real GDP, but not the price level.

(c) increase the price level, but not real GDP.

(d) increase neither the price level nor real GDP

Answer 1: (c). The price level is a nominal variable, so a change in the money supply will change the price level. For example, if the money supply doubles, eventually the price level will double.

Real GDP measures productivity. Just because there's more money circulating in the economy doesn't somehow make the economy more productive, so real GDP won't change.

Problem 2. You put money in the bank. The increase in the dollar value of your savings

(a) and the change in the number of goods you can buy with your savings are both nominal variables.

(b) and the change in the number of goods you can buy with your savings are both real variables.

(c) is a nominal variable, but the change in the number of goods you can buy with your savings is a real variable.

(d) is a real variable, but the change in the number of goods you buy with your savings is a nominal variable

Answer 2: (c). Nominal variables are variables measured in monetary units. Real variables are variables measured in physical units.

- The **velocity of money**, V, is the rate at which money changes hands.
- The **quantity equation** says $MV = PY$ where M is the money supply, P is the price level, and Y is the level of real output. The amount of money times how frequently the money changes hands equals nominal GDP.

Problem 3. Which of the following is not implied by the quantity equation?

(a) If velocity is stable and money is neutral, an increase in the money supply creates a proportional increase in nominal output.

(b) If velocity is stable and money is neutral, an increase in the money supply creates a proportional increase in the price level.

(c) With constant money supply and output, an increase in velocity creates an increase in the price level.

(d) With constant money supply and velocity, an increase in output creates a proportional increase in the price level.

Answer 3: (d). If M is fixed and V is fixed, then an increase in Y must be met with a decrease in P so the equality still holds.

Problem 4. Which of the following can a country increase in the long run by increasing its money growth rate?

(a) the nominal wage divided by the price level

(b) real output

(c) real interest rates

(d) None of the above is correct.

Answer 4: (d). Money is neutral, so via it will not change any real variables, e.g. real output or the real interest rate. The nominal wage divided by the price level is the real wage, so it won't affect that either.

Problem 5. Suppose monetary neutrality holds and velocity is constant. A 5 percent increase in the money supply

(a) increases the price level by more than 5 percent.

(b) increases the price level by 5 percent.

(c) decreases the price level by 5 percent.

(d) does not change the price level.

Answer 5: (b). $MV = PY$. A change in M can't change Y, it can only change P. Since the LHS grows by 5%, it must be the case that P also grows by 5%.

- When the government raises revenue by printing money, it is said to levy an **inflation tax**. When the government prints money, the price level rises, and the dollars in your wallet are less valuable. Thus, the inflation tax is like a tax on everyone who holds money.
- We can relate the nominal interest rate i, the real interest r, and the rate of inflation π, via the equation

$$r = i - \pi.$$

- When the Fed increases the rate of money growth, the long-run result is both a higher inflation rate and a higher nominal interest rate. This adjustment of the nominal interest rate to the inflation rate is called the **Fisher effect**. In other words, the Fisher effect says there is a one for one adjustment of the nominal interest rate to the inflation rate.

Problem 6. If a country experienced deflation, then

(a) the nominal interest rate would be greater than the real interest rate.

(b) the real interest rate would be greater than the nominal interest rate.

(c) the real interest rate would equal the nominal interest rate.

(d) None of the above is necessarily correct.

Answer 6: (b). Because $r = i - \pi$. Rewrite as $r + \pi = i$. Deflation means that π is negative, so $r > i$.

Problem 7. Shawn puts money into an account. One year later he sees that he has 5 percent more dollars and that his money will buy 6 percent more goods.

(a) The nominal interest rate was 11 percent and the inflation rate was 5 percent.

(b) The nominal interest rate was 6 percent and the inflation rate was 5 percent.

(c) The nominal interest rate was 5 percent and the inflation rate was -1 percent.

(d) None of the above is correct.

Answer 7: (c). He can buy 6% more stuff, so the real interest rate is $r = 6$. He has 5% more dollars, so the nominal interest rate is 5%. Therefore

$$r = i - \pi \implies 6\% = 5\% - \pi \implies \pi = -1\%.$$

Costs (or not) of Inflation

- When prices rise, each dollar of income buys fewer goods and services. Thus, it might seem that inflation directly lowers living standards.
- But the wage is the price of labor—so peoples' wages also rise.
- Someone might complain that prices have increased 10% and things are more expensive. But if their wage has also increased 10%, then they can still afford the exact same amount of stuff, so they're really not worse off. This confusion is known as the **inflation fallacy**.
- Because of the "inflation tax," people will want to hold less money. This means that they'll have to make more frequent trips to the bank to get cash.
- **Shoeleather costs** are the resources wasted when inflation encourages people to reduce their money holdings
- When inflation is high, firms have to change prices more often, e.g. issue new catalogs, print new menus, etc. The costs of having to change prices more often are called **menu costs**.

Chapter 17, Problem 6

Time Period	Nominal Interest Rate *(Percent)*	Expected Inflation *(Percent)*	Actual Inflation *(Percent)*	Expected Real Interest Rate *(Percent)*	Actual Real Interest Rate *(Percent)*
Before increase in MS	9	3	3		
Immediately after increase in MS	9	3	6		

(a) Suppose the nominal interest rate on car loans is 9% per year, and both actual and expected inflation are equal to 3% Fill in the top row of the table.

(b) Now suppose the Fed unexpectedly increases the growth rate of the money supply, causing the inflation rate to rise unexpectedly from 3% to 6% per year. Fill in the bottom row of the table.

(c) The unanticipated change in inflation arbitrarily harm lenders or borrowers?

(d) Now consider the long-run impact of the change in money growth and inflation. According to the Fisher effect, as expectations adjust to the new, higher inflation rate, the nominal interest rate will fall to what?

Answer: Chapter 17, Problem 6

Time Period	Nominal Interest Rate (Percent)	Expected Inflation (Percent)	Actual Inflation (Percent)	Expected Real Interest Rate (Percent)	Actual Real Interest Rate (Percent)
Before increase in MS	9	3	3	6 ✓	6 ✓
Immediately after increase in MS	9	3	6	6 ✓	3 ✓

Part (c). When a borrower and a lender make a loan, they do so by considering the *expected* real interest rate. In this case, they expected an inflation rate of 3%, wanted a real interest rate of 6%, and thus agreed to a loan with a nominal interest rate of 9%.

Then the money supply unexpectedly increased and the inflation rate rose to 6%. This means the loan had an *actual* real interest rate of $9\% - 6\% = 3\%$. So the borrower is paying less for the loan than anticipated, and the lender is receiving less than anticipated. So it arbitrarily hurts the lender.

Part (d). π rises by 3%, so i rises by 3% in the long run.