10. Money, the Price Level and Inflation in the Medium and the Long Run
Monetary Growth, Inflation and Interest Rates in the Medium and the Long Run

With regard to output and financial markets, until now we have concentrated on the short run, assuming that prices are fixed. Much as in the labor market, this assumption may be appropriate for the short run, but it is clearly inappropriate in the medium and the long run.

In the medium to long run, prices adjust to equilibrate both output markets and financial markets.

Continuous increases in the money supply, as implied by an expansionary monetary policy, will eventually result in continuous rises in the price level, i.e inflation. Hence, in the medium to long run, as output and employment settle at their “natural” rates, an expansionary monetary policy will result in higher inflation.

What are the effects of higher inflation on interest rates?

To answer these questions, we shall look at financial markets in the medium to the long run.
Expected Inflation and the Distinction between Nominal and Real Interest Rates

To the extent that there is expected inflation, this will affect nominal interest rates. Consumers and investors are interested in the real return to investment and the real return on savings. To the extent that prices are expected to rise, they will seek to be compensated for this rise, as they are interested in the purchasing power of the extra income they earn in the form of interest on their savings and investment.

How is the real interest rate defined? This question was first posed and answered by the American economist Irving Fisher. He argued that the real and the nominal return on saving for one period is determined by comparing what would happen if you invested in real assets (i.e. commodities) and nominal financial assets (i.e. bonds).

Suppose that in period $t$ you lent the equivalent of 1 unit of a given commodity. If the real interest rate is equal to $r_t$, in period $t+1$ you would receive $(1+r_t)$ units of the commodity. If the dollar price of the commodity in period $t$ was equal to $P_t$, and the expected price of the commodity in period $t+1$ was equal to $P_{e,t+1}$, the return on your loan expressed in money terms, would be equal to,

$$(1+r_t)P_{e,t+1}$$

Suppose that alternatively you lent money with the same value as the commodity, at a money (nominal) interest rate equal to $i_t$

You would thus lend $P_t$ units of money, and in period $t+1$ you would receive $(1+i_t)P_t$ units of money. Hence, the return on your loan expressed in money terms, would be equal to,

$$(1+i_t)P_t$$

In equilibrium, you should be indifferent between lending commodities and lending money. Hence the two forms of loans should have the same return. It then follows that,

$$(1+r_t)P_{e,t+1} = (1+i_t)P_t$$

This can be rearranged as,

$$(1+r_t) = (1+i_t)(P_t/P_{e,t+1}) = (1+i_t)/(1+\pi_{t+1})$$

where, $\pi_{t+1} = (P_{e,t+1}/P_t - 1)$ is the expected future inflation rate.
The Fisher equation and the Distinction between Nominal and Real Interest Rates

Thus, to the extent that there is expected inflation, this will affect real interest rates for given nominal interest rates. Consumers and investors are interested in the real return to investment and the real return on savings. This real return is then defined by,

\[ (1+r_t) = \frac{(1+i_t)}{(1+\pi_{t+1})} \]

This is called the Fisher equation. One can show that for low enough inflation and interest rates, this can be accurately approximated by the linear relationship,

\[ r_t \approx i_t - \pi_{t+1} \]

Thus, the real interest rate is (approximately) equal to the difference between the nominal interest rate and expected inflation.

This is the version of the Fisher equation that we shall utilize from now on. Keep in mind however that this is not a very accurate representation for inflation rates in excess of 10-20%.
Irving Fisher (1867-1947)

American economist, statistician, inventor, and Progressive social campaigner. One of the earliest American neoclassical economists. Joseph Schumpeter described him as "the greatest economist the United States has ever produced", an assessment later repeated by James Tobin and Milton Friedman.

Fisher made important contributions to utility theory and general equilibrium theory. He was also a pioneer in the rigorous study of intertemporal choice in markets, which led him to develop a theory of capital and interest rates. His research on the quantity theory of money inaugurated the school of macroeconomic thought known as “monetarism." Fisher was also a pioneer of econometrics, including the development of index numbers.

Some concepts named after him include the Fisher equation, the Fisher hypothesis, the international Fisher effect, the Fisher separation theorem and Fisher market.
The Fisher Equation and the Short Run Analysis of Monetary Policy

The Fisher equation implies, that for given medium to long run inflation, and hence for given medium to long run inflationary expectations, temporary increases in the money supply reduce not only nominal but also real interest rates.

Thus, even if investment demand depends on real and not nominal interest rates, our short run analysis using the IS-LM framework is not affected.

Note that from the Fisher equation, the current real interest rate is defined by,

\[ r = i - \pi^e \]

If inflationary expectations are constant, then the short run real interest rate will depend on the current nominal interest rate.

Hence, our analysis of the short run effects of monetary policy through the IS-LM model goes through, as long as monetary policy does not affect inflationary expectations, or does not affect inflationary expectations very quickly.

By reducing the current nominal interest rate the central bank reduces the real interest rate and hence affects investment demand, even if investment demand depends on real and not nominal interest rates.
The Real Federal Funds Rate in the USA
Expected Inflation and the Distinction between Nominal and Real Interest Rates in the Medium and the Long Run

However, as with real wages and unemployment, in the medium to long run, the real interest rate will be determined by real factors, and will tend towards its “natural rate”.

Thus, to the extent that there is expected inflation, this will affect nominal interest rates. In the medium to long run, the Fisher equation determines the equilibrium nominal interest rate as a function of the equilibrium (“natural”) real rate of interest and expected long run inflation. It thus takes the form,

\[ i_n = r_n + \pi^e \]

where \( r_n \) is the equilibrium (natural) real interest rate, equal to the real rate of return on capital, and \( \pi^e \) is the expected rate of inflation in the medium run. In the medium to long run, expected inflation will be equal to actual inflation. Hence, \( \pi^e = \pi \), and the equilibrium, or “natural” nominal interest rate is equal to,

\[ i_n = r_n + \pi \]

Thus, high inflation economies will tend to have high equilibrium nominal interest rates and low inflation economies will tend to have low equilibrium nominal interest rates.

The concept of the “natural” rate of interest is due to the Swedish economist Knut Wicksell, and was the inspiration for Milton Friedman’s definition of the “natural” rate of unemployment.
Knut Wicksell (1851-1926)

Johan Gustaf Knut Wicksell (December 20, 1851 – May 3, 1926) was a leading Swedish monetary economist of the Stockholm school.

Wicksell’s most influential contribution was his theory of interest, originally published in German, as Geldzins und Güterpreise, in 1898. The English translation Interest and Prices became available in 1936; a literal translation of the original title would read Money, Interest and Commodity Prices. Wicksell invented the key term natural rate of interest and defined it at that interest rate which is compatible with a stable price level.

Wicksell’s contributions to economics would influence both the Keynesian and Austrian schools of economic thought. They have been described by some economists, including historian of economics Mark Blaug, as fundamental to modern macroeconomics. Michael Woodford has especially praised Wicksell’s advocacy of using the interest rate to maintain price stability, noting that it was a remarkable insight when most monetary policy was based on the gold standard.

Elements of his public policy advice were taken strongly to heart by the Swedish government, including his price-level targeting rule during the 1930s.
Inflation and Nominal Interest Rates in the USA
1954-2017
Medium Run Effects of Rises in the Money Supply

In the medium run, when both output and nominal interest rates settle at their “natural” rates, permanent changes in the money supply can only push prices to a higher level. Hence permanent changes in the money supply do not affect the level of real income or interest rates in the medium run but only the price level.

As we have demonstrated in our analysis of the labor market in the medium run, real GDP tends to settle at its “natural rate” $Y_n$. What determines the natural rate are the available stocks of natural resources and capital and the “natural” rate of employment in the economy, which as we have seen depends on the characteristics of product and labor markets.

The stock of the money supply has no medium-run effects on interest rates either. If you double the money supply and real income is at its “natural rate”, the price level doubles and there is no effect on the nominal interest rate, which is at its own “natural” rate, determined by the equilibrium real interest rate and equilibrium inflation.

From the money demand function it then follows in the medium run the price level is determined by the relation,

$$P = M/L(Y_n, i_n)$$
The Medium and Long Run Neutrality of Money

Thus, in the medium to the long run, the stock of the money supply does not affect either real output and income, but only the level of prices. The money supply is merely a "veil" for the real economy and just determines the price level.

This medium to long-run neutrality of money is a property of all consistent general equilibrium economic models with flexible prices.

Thus, while in the short-term an increase in the money supply causes equilibrating changes in interest rates and output, in the medium term, what adjusts to equilibrate the money market is the price level, as interest rates and output return to their “natural” rates.
In the same way that a permanent increase in the money supply causes a medium to long run increase in the price level by the same proportion, monetary growth, in the form of continuous increases in the money supply that exceed the long run growth rate of output cause continuous price inflation.

Inflation, in the medium to long run, is equal to the difference between the rate of growth of the money supply and the rate of growth of money demand, which is equal to the medium to long run rate of growth of output. Thus, long run inflation is determined by,

\[ \pi = \mu - g \]

where \( \pi \) is inflation, \( \mu \) the rate of growth of the money supply, and \( g \) the rate of growth of output and the demand for real money balances, assumed to be independent of monetary growth. This relationship is derived by taking the rates of growth of prices, money and output in the quantity theory equation, assuming a constant medium to long run nominal interest rate.

The positive one to one relation between monetary growth and inflation is related to the so called long run super-neutrality of money. A high rate of growth of the money supply by the central bank results in medium to long run inflation, and does not affect the rate of growth of output.
Monetary Growth and Inflation in 110 Countries 1960-1990

Source: McCandles and Weber [1995], “Some Monetary Facts”, Federal Reserve Bank of Minneapolis Quarterly Review, 19, pp. 2-11. It shows the close correlation between inflation and the rate of growth of the money supply, as measured by a broad measure of the money stock (M2) in 110 countries, for the period 1960-1990. The correlation coefficient is equal to 0.95.
Monetary Growth and Output Growth in 110 Countries 1960-1990

*Source: McCandles and Weber [1995], “Some Monetary Facts”, Federal Reserve Bank of Minneapolis Quarterly Review, 19, pp. 2-11. It shows the complete absence of any correlation between the growth rate of real GDP and the rate of growth of the money supply. The correlation coefficient is -0.014, and is not statistically significant.*
The Welfare Cost of Inflation

What is the cost of high medium to long run inflation? High inflation economies will tend to have high nominal interest rates. High nominal interest rates will result in a reduction in money demand. Thus, high inflation economies will be associated with lower real money balances in the medium to the long run. This will result in a loss of consumer surplus from the use of money, which is the welfare cost of inflation.

Essentially, in high inflation economies households and firms hold smaller quantities of money for their transactions, because of the higher opportunity cost of holding money implied by higher inflation, and hence the monetary system is less efficient, as it forces them to make more transactions (trips to the “bank”) in order to convert interest yielding assets into money. Hence, high inflation in the medium run implies a welfare cost in the form of higher transactions costs.

In the limit, in economies with very high inflation and hyperinflation, households reduce their demand for money so much that the system of monetary exchange gets seriously disrupted and either there is currency substitution (dollarization) or a return to barter.
Inflation, Nominal Interest Rates and Money Demand in the Medium Run

\[ i = \rho + \pi \]

\[ L(Y_0) \]

Welfare Cost of Inflation