EPA143A – Macroeconomics for Policy Analysis
Week Five

THE IS-LM MODEL

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LECTURE NOTE W-5

This required reading for Week 5 includes:

- Lecture Note EPA143A Week 5
- P. Krugman. 2011. IS-LMentary. (A short note posted on Brightspace).

Supportive videos:

- https://www.youtube.com/watch?v=pAX7mR4ii5Y
- https://www.youtube.com/watch?v=_19w5dcGhCo
- https://www.youtube.com/watch?v=vx6w5JFIjzw

Lecture Note W-5 and the exercises of Week 5 are part of the exam materials.

Introduction

The IS–LM model was first introduced at a conference of the Econometric Society held in Oxford during September 1936. John R. Hicks presented a paper attempting to summarize John Maynard Keynes' *General Theory of Employment, Interest, and Money*. Hicks proposed the IS–LM model as a suggested interpretation as well as a synthesis of the neoclassical and Keynesian approach. Hicks later agreed that the model missed important points of Keynesian theory.

The first problem was that it presents the real and monetary sectors as separate, something Keynes attempted to transcend. Hicks assumed that money supply is exogenous (a policy instrument to be used by the central bank), whereas money supply is endogenous (determined by the demand for money) in the Keynesian macro model. In addition, Hicks' equilibrium model ignores uncertainty— which is problematic, because (Keynes') liquidity preference only makes sense in the presence of uncertainty "For there is no sense in liquidity, unless expectations are uncertain." A shift in one of the IS or LM curves will cause a change in expectations, which shifts the other curve.

However, Hicks' IS-LM model is generally seen as such a useful pedagogical model for imparting an understanding of the questions which macroeconomists today attempt to answer, that it is included in almost all macroeconomics textbooks.

The IS-LM model: a basic formulation

The IS-LM model is a macroeconomic model which consists of two parts: (i) the IS part, which describes the 'goods market' based on the (ex-post) equilibrium condition that investment (I) is equal to savings (S); and (ii) the LM part, which describes the 'money market' based on the (ex-post) equilibrium condition that the demand for money (or liquidity L) must equal the exogenous supply of money (M). We will begin by looking at the 'goods market'.

The IS-curve: investment = savings

We know from the circular flow of income that

$y = d = c + i$ real GDP = aggregate demand for goods & services = $c + i$

and

$y = c + s$ real GDP is either used for consumption or for savings

This means that in (ex-post) equilibrium, it must be true that $i = s$, or investment equals savings. This condition holds in the Keynesian macro-model (where investment determines income, through the multiplier process, and income determines savings) as well as in the neoclassical macro-model (where savings are deposited as loanable funds in banks, which channel these funds back into the circular flow as investment).

Let us now assume that (*a*) real investment is partly autonomous (*i.e.* determined by 'animal spirits', or i_0) and partly influenced by the cost of capital (= the real rate of interest *r*); and (*b*) that real savings are a fixed proportion σ of real income (*y*). This gives:

$$(1) \qquad i = i_0 - \alpha \times r = s = \sigma \times y$$

Coefficient α reflects the (negative) sensitivity of (business) investment to the real interest rate; if *r* increases, it becomes more expensive for firms to borrow money (for investment purposes) – and firms will either postpone or cancel investment projects. Equation (1) represents equilibrium in the 'goods market', because if $i = s$, then aggregate demand *d* is equal to value added (or output) *y*. From eq. (1), we can derive the following 'equilibrium relationship' for real GDP:

$$(2) \qquad y = (\frac{1}{\sigma}) \times (i_0 - \alpha \times r)$$

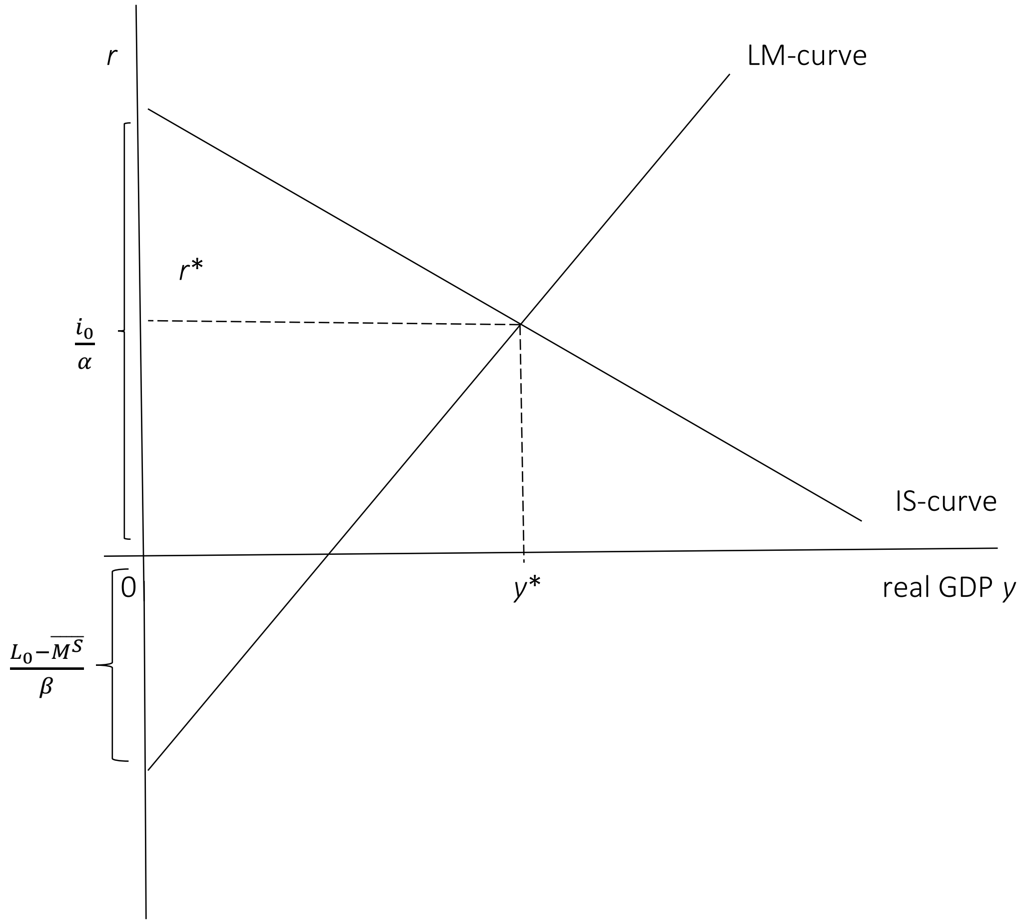
It can be seen that (equilibrium) real GDP depends on the (Keynesian) multiplier (1/ σ), autonomous investment i_0, and the real interest rate *r*. If autonomous investment increases and if the real interest rate stays constant, real GDP will increase by $(\frac{1}{\sigma}) \times \Delta\, i_0$ (which captures the Keynesian multiplier process). We can also rewrite equation (2) as follows:

$$(3) \qquad r = (\frac{1}{\alpha}) \times (i_0 - \sigma \times y) \qquad \rightarrow \text{ the IS-curve}$$

Equation (3) is the downward-sloping IS-curve in (*y*,*r*) plane (see Figure 1); it represents all combinations of real GDP (*y*) and the real interest rate (*r*) for which the 'goods market' is in equilibrium or $i = s$. What the downward-sloping IS-curve shows is that for high real interest rates, real GDP will be low (because business investment will be low), and for low real interest rates, real GDP will be high (because business investment will be high). All points on the IS-curve constitute equilibria in the 'goods market'.

Let us now turn to the second macro-market: the money market.

Figure 1
The standard IS-LM Model



The LM-curve

The money market balances money supply (M^S) and money demand (M^D). Unlike Keynes, Hicks assumed that money supply is exogenous: M^S is a policy instrument of the central bank, which can increase or reduce money in circulation by open-market operations. If the central bank wants to increase M^S, it will buy government and corporate bonds (in the secondary bonds market), paying the sellers of bonds with new money. If the central bank decides to reduce M^S, it will sell government and corporate bonds (which the central bank already owned) and the money it receives is 'destroyed' (*i.e.* taken out of money circulation). Hence, in the IS-LM model, it is assumed that

(4) $$M^S = \overline{M^S}$$ → money supply = exogenous

We will see that this assumption is of fundamental importance to how the IS-LM model works. It is also an assumption which is in line with the neoclassical macro-model (Week 2) but in conflict with the Keynesian macro-model (Week 3).

The demand for money (M^D) is more complicated. Money demand or the demand for 'liquidity' consists of two parts:

(5) $$M^D = L_1 + L_2$$ → money demand = demand for liquidity (*L*)

$L_1 =$ the transactions demand for money, or the demand of the public and businesses for cash and near-cash to pay for economic transactions (including paying for the groceries, paying the wages of employees, paying the cost of intermediate inputs, *etc*.). The transactions demand for money is a function of the level of economic activity (real GDP or *y*) and the general price level *p*, as follows:

(6) $$L_1 = v \times p \times y$$

where *v* = a constant. We further assume (for the moment) that the price level *p* is exogenous. When the economy grows and *y* increases, the demand for cash and near-cash to pay for (more) transactions increases. Similarly, if there is inflation and the general price level *p* rises, the public and businesses need more cash to pay for the same number of transactions. The transactions demand for money L_1 is similar to the money demand function in the neoclassical model.

$L_2 =$ the speculative demand for money, or the demand of financial speculators (financial investors) for cash and near-cash. Financial speculators hold on to cash-balances, *i.e.* they have a demand for liquidity. Keynes called this demand 'liquidity preference'. When financial investors have a strong liquidity preference, they will hold large amounts of money; when their liquidity preference is low, their money holdings will be low. Currently, the liquidity preference of financial investors is high: financial firms are sitting on large global 'cash pools', worth $4 to $5 trillion. This is quite remarkable, because holding on to such large amounts of cash (liquidity) in bank accounts is both costly and risky.

It is costly, because the cash is not generating a rate of return but is losing value (in real terms) if there is inflation. Suppose you manage a global cash pool of $1 billion and the rate of inflation this year is 2%. The real value (purchasing power) of your cash pool will then be only $980 million after this year – you will lose $20 million just by holding on the cash balance. If you had used the $1 billion to buy (safe) one-year government bonds (with a rate of interest of, say, 2.1%), you would have been able to 'protect' the real value of your wealth and even make a small return (of $1 million). Keeping 'liquidity' has, in other words, a significant opportunity cost, and apparently the liquidity preference of the speculator is so strong that he/she is willing to bear those costs.

It is risky, because the cash (deposited in banks) is not insured. Bank deposits (for normal people) are generally insured up to a maximum of (say) $250,000. This means that if your bank goes bankrupt, you will get your savings back up to the maximum of $ 250,000. If your bank deposit is $1 billion, however, your money is almost completely uninsured. If your bank goes bankrupt, you will lose 99,975% of your wealth. Keeping (large amounts of) liquidity is therefore a deliberate decision – the preference for liquidity is so strong that speculators accept the risks.

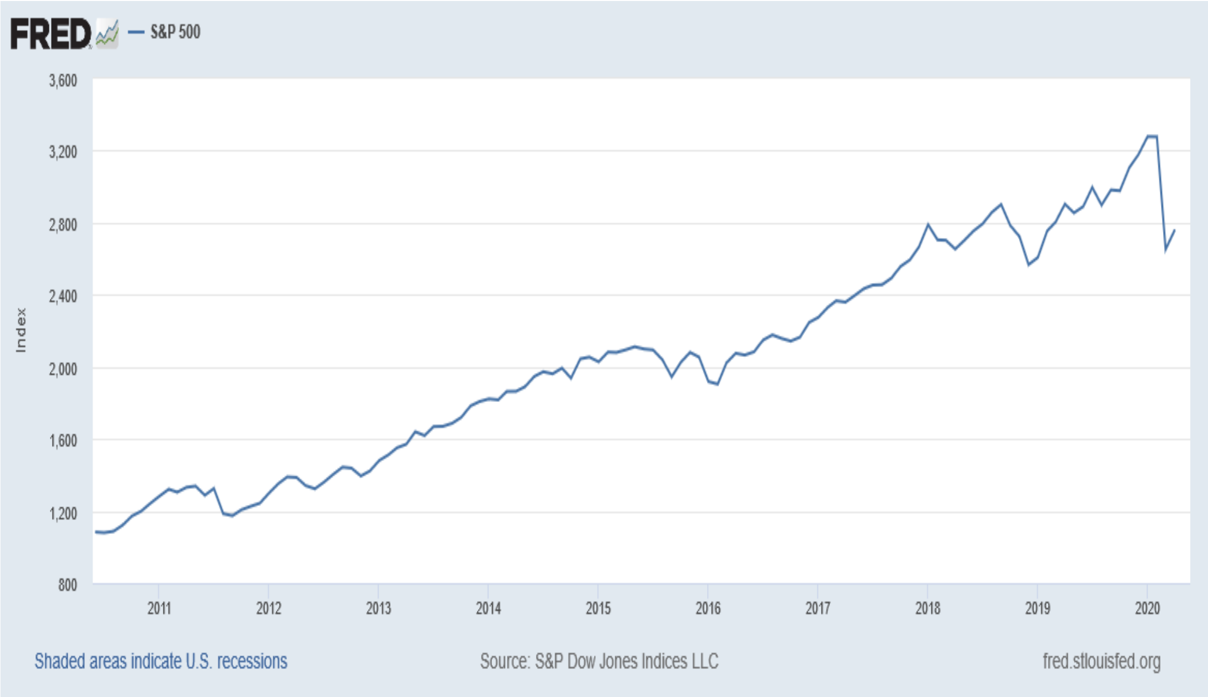
Why would financial investors hold on to (large) cash balances if it is both costly and risky? Keynes' answer is that they have a very strong 'liquidity preference', *i.e.* they have a reason to prefer holding cash money over holding assets (such as government bonds, stock market shares, land, real estate, financial derivative contracts).

What is the difference between holding money and holding assets? The difference is that money = liquid and assets = non-liquid. 'Money is liquid' means that cash and near-cash (such as the electronic money in your checkable bank-account) have <u>two properties</u> (which non-liquid assets such as gold, bitcoins, real estate property, stock market shares *etc.* do not have):

- money is immediately (on-the-spot) usable as a means of payment; it is generally accepted as a legal means of payment and hence can be used <u>instantaneously</u> and <u>without any (transaction) cost</u>. Both money and assets (say, stock market shares) constitute wealth, but if you want to pay with shares, your counterpart will likely not accept these as a means of payment. Converting these shares into cash (by selling them) carries transaction costs (trading fees) and takes time – and one may be obliged to sell these shares at a lower price than expected or desired (*i.e.* incur a loss).
- keeping money allows you to '<u>keep all options open</u>', including the option to 'wait' and hold on to the cash. This flexibility offered by money is of crucial importance to speculators, whose goal is to 'buy assets cheaply' and 'sell them dearly'. All speculators believe they can outsmart other speculators by buying bonds or shares at the right time (when prices are relatively low) and selling them at the right time (just before the moment when asset prices peak). To do so, these speculators needs flexibility which is exactly what cash (= liquidity) offers them – and which bonds, gold or shares do not offer them. (The reason is that one first has to convert these assets into cash, by selling them – which takes time, has a cost, and may lead to the incurrence of losses).

  To illustrate the importance of 'timing' (when to buy, when to sell), Figure 2 presents the S&P 500 Stock Market Index of the share prices of the largest 500 U.S. stock-market-listed corporations. The S&P 500 Index increased from a value of 1083 in June 2010 to a value of 3280 in February 2020, before crashing to a value of 2305 in March 2020 (due to the corona-lockdown recession). An investment of $ 100.000 in a S&P 500 tracking fund in June 2010 would have increased in value to (around) $ 302.500 by February 2020 – the average annual rate of return was around 11%. But one would have lost about one-third of that value (if one had kept holding these shares) in March 2020, as the stock prices came crashing down. Money gives financial speculators the flexibility and freedom to buy and sell at the moment they deem right.

Figure 2
The S&P 500 Stock Market Index: May 2010 – May 2020



In the IS-LM model, the speculative demand for money L_2 is assumed to partly exogenous (L_0) and partly it is a negative function of the real rate of interest (r):

$$L_2 = L_0 - \beta \times r \quad (7)$$

While we can understand (based on the discussion so far) why there is an exogenous demand for liquidity L_0, we must look more closely at why equation (7) posits that an increase in the real interest will reduce the speculative demand for money L_2. To understand this, we need to look at how financial speculators decide to buy or sell financial assets such as government bonds. How does the bond market work?

Money demand L_2 *and the bond market*

A government or sovereign bond represents debt that is issued by a government and sold to financial investors including banks, pension funds, money market funds and (rich) individuals. A government bond has a notional value (say € 10.000), may pay periodic interest payments (say of 2.5%) and has a particular duration (varying between 1 month, 3 months, 6 months, 1 year, to 3, 5 or 10 years; there also exist perpetual bonds which are never to be paid back).

Governments issue bonds on a regular basis (a number of times per year) in order to (*a*) finance a government budget deficit; and (*b*) to retire (or pay back) earlier debt; in this case, the government issues new debt (on the primary bond market) to amortize its old debt. Let us see how this works.

On January 1st 2020, the Dutch state had a public debt of €395 billion (52% of Dutch GDP). Due to the corona-lockdown crisis, the Dutch government has to finance a huge budget deficit of around 10% of Dutch GDP or around €70 billion. In addition, the Dutch government will have to redeem (pay back) € 30 billion of long-term bonds which will mature in 2020, and roll over € 14 billion of short-term debt (bonds with a duration of 1 year or less). The total borrowing requirement of the Dutch state in 2020 therefore is €114 billion. The Dutch government can fund this by borrowing from commercial banks or, alternatively, by issuing debt paper (bonds) which are bought by financial investors (including banks).

Let us suppose the Dutch government issues new (2020) bonds, worth €50 billion. Each individual bond has a notional value of €10.000, a duration of 5 years and pays a fixed interest rate of (say) 2% per year. The Dutch Ministry of Finance will therefore issue 50 million bonds. These bonds are considered 'safe' financial investments, because the Dutch state is perceived to be creditworthy (as its debt-to-GDP ratio is 'only' 52%). Large financial investors may purchase (say) 1000 bonds (with a value of €10 million), but individual buyers may buy (say) just 1 bond. If I purchase 1 bond, I am lending €10.000 to the Dutch state for a period of five years (2020-25); each year, I will receive an interest income of €200; after the five years, the Dutch government will redeem the loan and I will receive the €10.000. Over the five-year period, I earned 5 x €200 = €1000 (as interest). The (undiscounted) nominal rate of return of my financial investment is 2% (per year).

New (2020) government bonds will be issued in the primary bond market. Older bonds, issued in the past, are traded in the secondary bond market. Both primary and secondary bond markets are highly liquid (which means that large numbers of bonds are sold and bought on each trading day) and global (as foreign speculators will also purchase Dutch bonds). Let us compare the new (2020) Dutch 5-year government bond (with a notional value of €10.000 and paying a 2% interest rate) and an older (2018) Dutch 5-year government bond (with a notional value of €10.000 and paying a 3⅓ % interest rate).

Suppose you hold a cash balance L_2 and have the intention to 'invest' in Dutch government bonds. With your cash, you intend to buy 10 new (2020) bonds in the primary bond market, which will earn you €2.000 of interest income per year during 2020-25 (or €10.000 over five years in total). Alternatively, you could buy the older (2018) bond which will earn you €3.333⅓ of interest income per year during 2020-23 (or €10.000 over just three years in total). Clearly, the older (2018) bond is the preferred one (in terms of relative returns).

To purchase the older (2018) Dutch bonds, you have to go to the secondary bond market and find a party owning those 2018 bonds and willing to sell them. Let us assume that financial firm WhiteRock owns these bonds and is willing to sell. WhiteRock knows what you know, namely that the older (2018) Dutch bonds generate a higher rate of return than the new (2020) bonds. WhiteRock purchased these bonds in 2018 at the notional value of €10.000 per bond. WhiteRock understands that you will be willing to buy these bonds at a higher price than the notional price of €10.000, as long as your return on this bond remains (sufficiently) higher than 2% (which is the return on the 2020 bond).

This means that there is space for bargaining (over the bond price) between you (the prospective buyer of the 2018 bonds) and WhiteRock (the seller). To illustrate this 'bargaining space', let us note that buying a 2020 bond will earn you €600 over the period 2020-23, while the 2018 bond will earn you €1000 (in the same period). The difference of €400 per bond is the extra return (or yield) you will obtain when buying the 2018 bond. WhiteRock could (for example) demand that you pay a price of €10.300 per 2018 bond (instead of the notional price of €10.000). In this case, you will pay €103.000 for ten 2018 bonds; you will earn €10.000 in three years and will receive €100.000 from the Dutch state (in 2023). Your (undiscounted) net return over the period 2020-23 is equal to €10.000 – €3.000 = €7.000, which is still higher than earning €6.000 by buying the primary (2020) bond.

This leads to the following lessons. First, whereas new bonds are issued at the notional price (of €10.000) in the primary bond market, bond prices in the secondary market will differ from the notional price. Second, if the interest rate on new (primary) bonds is lower than on older (secondary) bonds, the bond market price of secondary bonds will go up; if the interest rate on new bonds is higher than on older bonds, the bond market price of secondary bonds will go down. Hence, if the (bond) interest rate goes down, the bond market price in the secondary bond market goes up. There exists a negative relationship between the interest rate and the price of bonds in the secondary market.

Let us return, with this knowledge, to equation (7). Suppose the (real) interest rate is relatively low at this moment; the interest rate has been higher in the past. What this means is that new (primary) government bonds pay a low interest rate compared to older bonds, which are traded in the secondary market. Financial speculators understand that (secondary) bonds have a relatively high price (since the current interest rate is low). Buying 'dear' reduces the prospective return on the bond investment – and financial investors will not buy, but rather wait for the interest rate to increase and the price of (secondary) bonds to decline. Accordingly, when the interest rate is rather low, financial investors will hold on to their cash; their speculative money holdings L_2 will be high, because their liquidity preference will be high. This explains equation (7):

$$L_2 = L_0 - \beta \times r$$

Vice versa, if the rate of interest on new bonds will go up, financial speculators will expect that bond prices in the secondary bond market will do down. They will now act and start buying – their speculative money holdings L_2 will go down.

We can now return to the money market. Money market equilibrium implies that money supply is equal to money demand, or:

$$M^S = \overline{M^S} = M^D = L_1 + L_2 = v \times p \times y + L_0 - \beta \times r$$

which can be simplified to: $\overline{M^S} = v \times p \times y + L_0 - \beta \times r$
and to:

(8) $$r = (\frac{1}{\beta}) \times (v \times p \times y + L_0 - \overline{M^S})$$ → the LM-curve

Equation (8) is the upward-sloping LM-curve in (*y*,*r*) plane (see Figure 1); it represents all combinations of real GDP (*y*) and the real interest rate (*r*) for which the money market is in equilibrium and $M^S = \overline{M^S} = M^D$. To understand what the upward-sloping LM-curve shows, we must first recognize that money supply is exogenous $M^S = \overline{M^S}$. This means that money demand $M^D = L_1 + L_2$ has to be brought into balance with a given $\overline{M^S}$.

If real interest rates are low, the speculative demand for money L_2will be (relatively) high; by implication, the transaction demand for money L_1 has to be low, which in turn constrains the level of economic activity; real GDP will be low. On the other hand, if real interest rates are high, L_2 will be relatively low and L_1 can be higher; there is more money available for economic transactions, and real GDP can be higher. All points on the LM-curve constitute equilibria in the money market.

Macro-economic equilibrium in the IS-LM model

Macro-economic equilibrium requires that the goods market and the money market are both in equilibrium (simultaneously). This occurs in Figure 1 at the point of intersection between the downward-sloping IS-curve and the upward-sloping LM-curve. *y** is equilibrium real GDP and *r** is the equilibrium real interest rate. The combination (*y**, *r**) is the only configuration of real GDP and real rate of interest at which $i = s$ and $M^S = \overline{M^S} = M^D$.

The IS-LM model is widely used to evaluate the impacts of fiscal and monetary policy on real GDP and the real rate of interest. Fiscal policy concerns government spending (including public investment spending on infrastructure) and (income) taxation. Monetary policy, in the IS-LM model, concerns decisions by the central bank (the 'monetary authority') to increase or decrease money supply. Note that the interest rate is an endogenously determined macro-price, and not a monetary policy instrument, in the IS-LM model.

The macro-economic impacts of fiscal policy

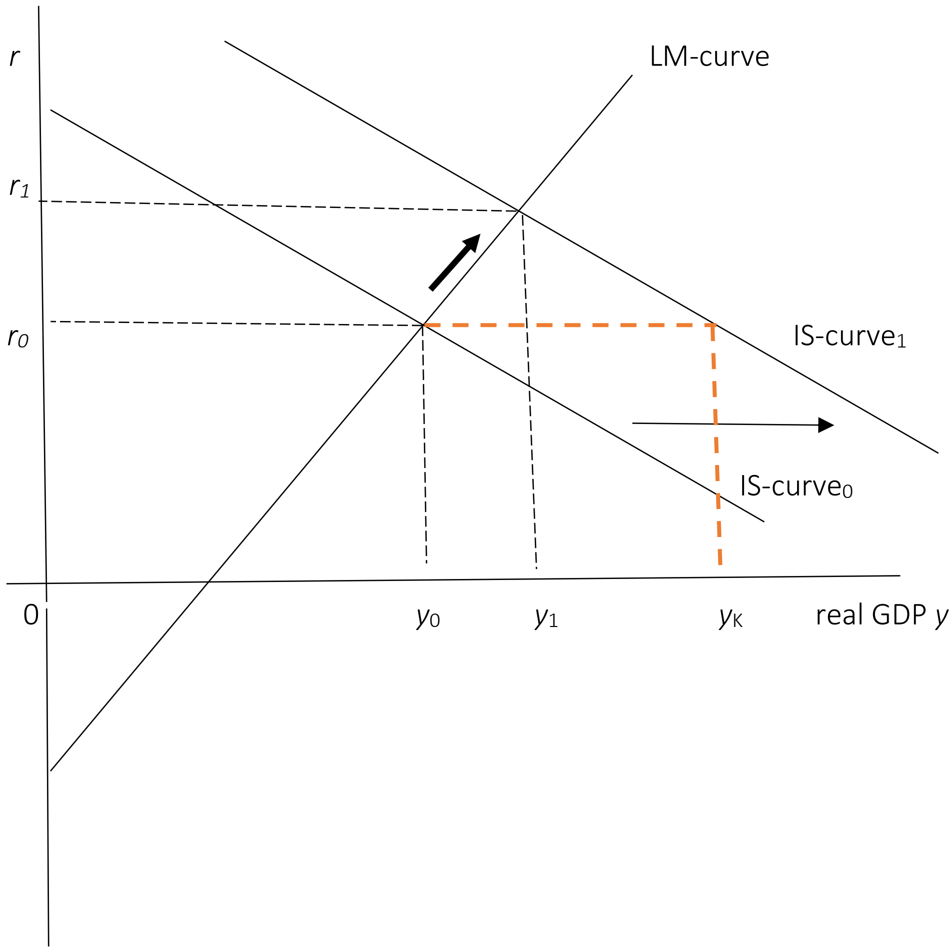
Let us consider the case of fiscal stimulus: the government decides to raise public investment in an attempt to promote growth and reduce unemployment. Figure 3 illustrates the argument. The initial macro-economic equilibrium (before the fiscal stimulus takes place) is (y_0, r_0). In our basic formulation of the IS-LM model, the increase in public investment can be expressed as an increase in the autonomous component of investment, $\Delta\, i_0 > 0$. We can see from equation (2), that $\Delta\, i_0 > 0$ will have a (positive) multiplier impact on real GDP: *y* will increase (as in the standard Keynesian model). In Figure 3, the increase in i_0 leads to a shift to the right of the IS-curve – from IS-curve$_0$ to IS-curve$_1$. Keeping the interest rate unchanged (at r_0), real GDP would increase from y_0 to y_K (where the 'K' stands for Keynesian).

But what happens next? The increase in real GDP raises the transaction demand for money L_1 and this upsets equilibrium in the money market. Recall that money supply is exogenous and fixed: $M^S = \overline{M^S}$. Higher L_1 means that money demand exceeds money supply: $L_1 + L_2 > \overline{M^S}$. The real economy needs more money (to finance the economic growth), and banks can only provide it (assuming that $M^S = \overline{M^S}$) if they succeed in persuading financial speculators to reduce speculative cash balances L_2. To do so, banks raise the (real) rate of interest.

The real interest rate thus increases in response to the excess demand for money. The higher interest rate reduces business investment. The lower private investment partly offsets the multiplier impact of the fiscal stimulus on real GDP. The net impact on real GDP of increased public investment and reduced business investment is positive: in the new macro-economic equilibrium (point A in Figure 3), real GDP is y_1. The level of economic activity has increased, notwithstanding the increase in the real interest rate from r_0 to r_1.

Fiscal stimulus does lead to partial crowding out of business investment in this version of the IS-LM model. The difference between y_K and y_1 is an indication of the extent to which private investment has been reduced ('crowded out') by the higher real interest rate, caused by the fiscal stimulus. Fiscal stimulus is effective, *i.e*. it succeeds in raising real GDP, but with the qualification that it also leads to a higher interest rate – which lowers business investment.

Figure 3
The standard IS-LM Model: Fiscal Stimulus



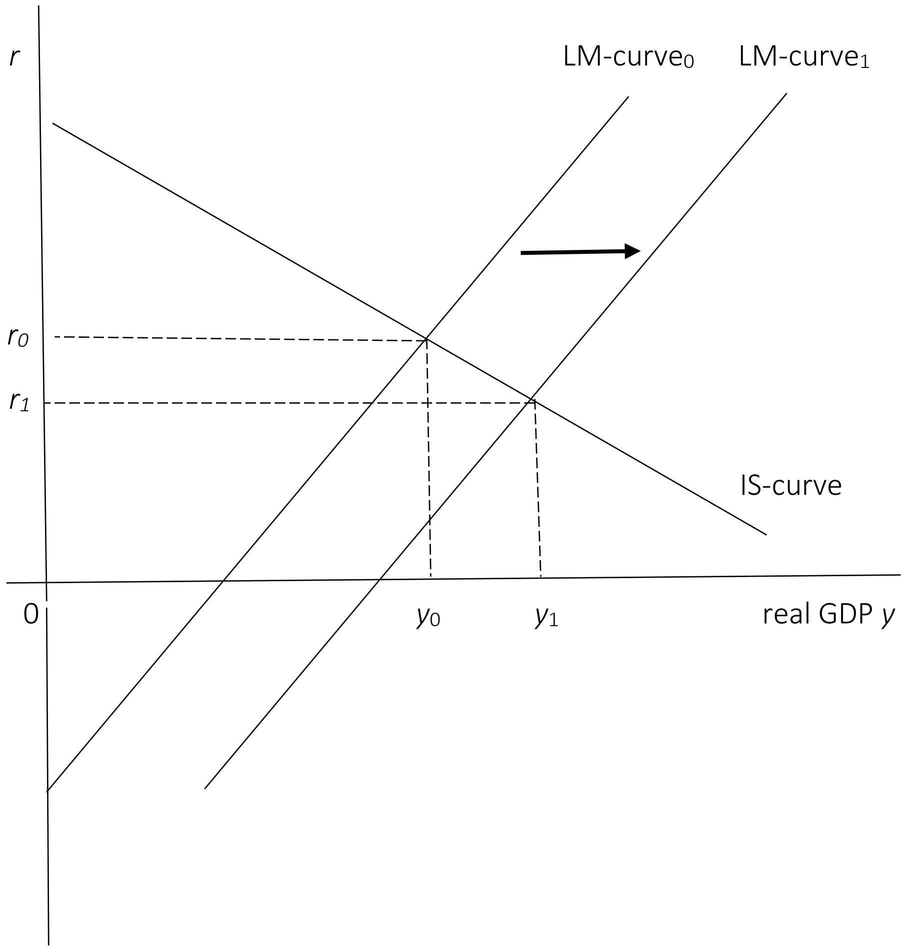
The macro-economic impacts of monetary policy

Let us now consider the case of monetary stimulus: the central bank increases money supply with the intention to raise the level of economic activity and real GDP (which in turn will lower unemployment). What happens in the IS-LM model? Figure 4 illustrates the argument, showing that the LM-curve will shift to the right due to the increase in $\overline{M^S}$.

Due to the (exogenous) increase in money supply, there arises an excess supply in the money market: $\overline{M^S} > L_1 + L_2$. The economy is initially operating at a level of activity y_0, and this level of real GDP determines the transaction demand for money L_1. This means that the increase in money supply will not be 'absorbed' by L_1, but must be taken up by the speculative demand for money L_2. Financial speculators will only be willing to hold more cash if the rate of interest is lowered. Hence, in response to the excess supply of money, banks reduce the rate of interest. This has two consequences.

First, speculators raise their demand for liquidity; L_2 goes up. Second, the lower (real) interest will lead to an increase in business investment: *i* goes up. Higher business investment has a multiplier impact on real GDP, and higher *y* raises the transaction demand for money. Hence, L_1 goes up as well. The end result is that the economy grows: real GDP increases from y_0 to y_1 in Figure 4. The equilibrium real interest rate goes down from r_0 to r_1. Monetary expansion (= the increase in $\overline{M^S}$) leads to a lower interest rate, which in turn crowds in business investment. Hence, whereas fiscal stimulus leads to crowding out of private investment, monetary stimulus leads to crowding in. Monetary expansion is also found to be effective in raising real GDP (and lowering unemployment).

Figure 4
The standard IS-LM Model: Monetary Expansion



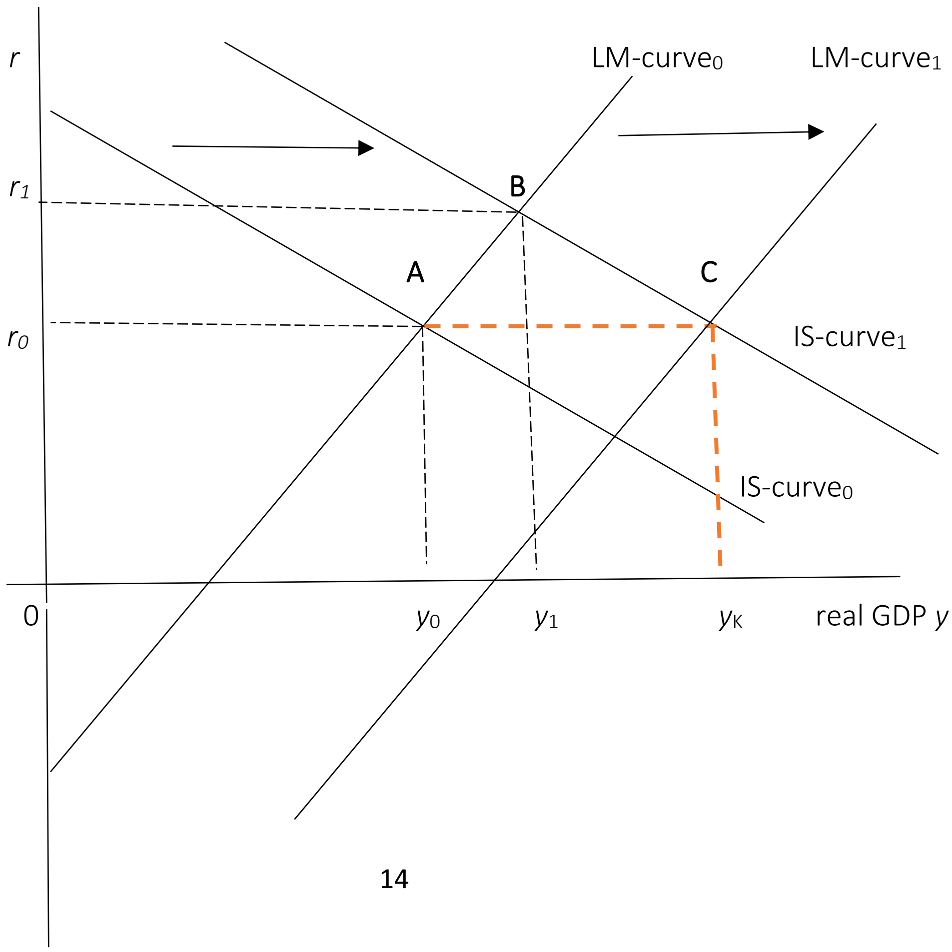
Coordination of fiscal and monetary policies

Fiscal and monetary policies can be combined in ways which are mutually supportive – which means that the effectiveness of (say) fiscal policy can be enhanced by coordinated monetary policy support. Let us look at Figure 5 to see how this could work – according to the IS-LM model. The economy is in an initial macro equilibrium in point A.

Suppose the government raises public investment (as before, see Figure 3). Without supportive monetary policy, the new equilibrium would be point B: real GDP has increased, but so has the real interest rate – and this has led to the partial crowding out of the fiscal stimulus. The central bank can decide to support the fiscal stimulus – by adopting an accommodating monetary policy. An accommodating monetary policy means that the central bank will increase $\overline{M^S}$ to such an extent so as to keep the real interest rate constant at r_0.

In Figure 5, the accommodating monetary policy is illustrated by the rightward shift of the LM-curve (caused by the increase in $\overline{M^S}$). What happens? The fiscal stimulus raises real GDP and money demand L_1. To satisfy the higher demand for money, the central bank increases $\overline{M^S}$; as a result, the equilibrium interest rate stays unchanged and the economy can expand from at y_0 to y_K. There is no longer any crowding out (of business investment) and the multiplier process does work without any limitations.

Figure 5
The standard IS-LM Model:
Coordinated Fiscal and Monetary Policies



The IS-LM Model: a first special case

In a real-world policy application of the IS-LM model, the main model parameters α, β and σ have to be empirically estimated (based on data for the macro-economy under consideration). Suppose we have done this (for a particular country during a particular time-period) and suppose that we have found, based on statistical analysis, that $\alpha = 0$. That is, investment is found to be non-sensitive to the real interest rate. This is quite realistic for our times – many empirical studies show that (business) investment is not statistically significantly associated with real interest rates in recent years (2008-2020). If $\alpha = 0$, the IS-LM model changes. Let us see what happens.

Let us go back to equation (1) and indeed assume that $\alpha = 0$:

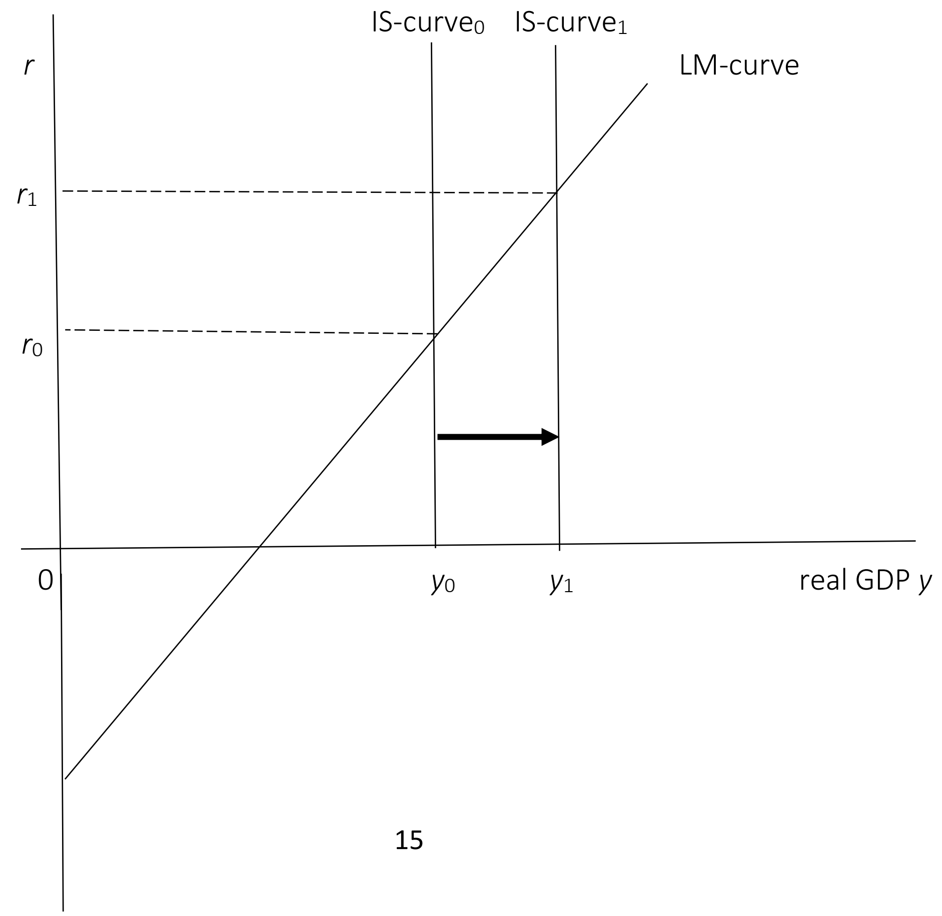
(1) $$i = i_0 = s = \sigma \times y$$

This gives the following 'equilibrium relationship' for real GDP:

(2) $$y = (\frac{1}{\sigma}) \times i_0$$ → the IS-curve

We see that (equilibrium) real GDP now depends on the (Keynesian) multiplier ($1/\sigma$) and autonomous investment i_0. The IS-curve becomes vertical – as in Figure 6.

Figure 6
The IS-LM Model: a Keynesian version



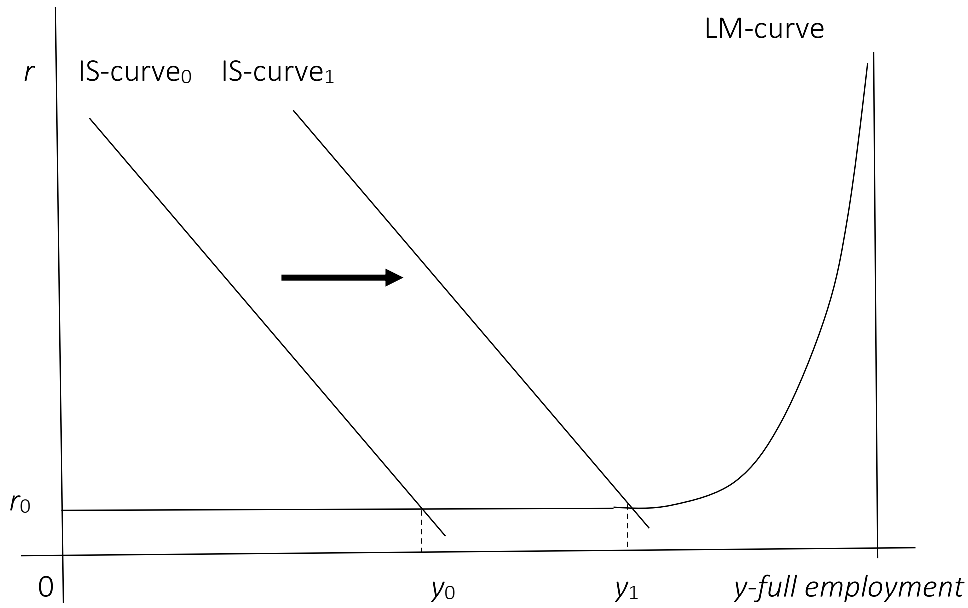
If $\alpha = 0$, fiscal policy becomes very effective, because there is no longer any crowding out (of business investment, caused by the higher interest rate). Fiscal stimulus (as above) shifts the (vertical) IS-curve to the right. The LM-curve does not change position. In the new equilibrium, real GDP is higher and so is the real interest rate. But the increase in the real interest rate does not lower investment, because $\alpha = 0$. The multiplier process does work without restrictions.

What about the macro-economic impacts on monetary expansion (an increase in money supply)? This you can check for yourself. What will happen is that the LM-curve in Figure 6 will shift to the right. But the vertical IS-curve does not change position. Equilibrium real GDP stays unchanged, as the equilibrium real interest rate goes down. Monetary expansion does not raise real GDP if $\alpha = 0$. Its only impact is inside the money market: since L_1 does not change (because real GDP stays the same), L_2 has to 'absorb' the increase in money supply; speculators will only do this, if banks reduce the real rate of interest.

The IS-LM Model: a second special case

A second special case of the IS-LM model is illustrated in Figure 7. The IS-curve is downward-sloping as in the standard IS-LM model. The difference concerns the LM-curve, which is horizontal (at a low interest rate r_0) and which starts to slope upwards only at high levels of real GDP.

Figure 7
The IS-LM Model: the Liquidity Trap



We must remember that the money supply continues to be the instrument of central bank policy; in the IS-LM model, the central bank cannot fix or determine the interest rate; the (equilibrium) interest rate is determined in the money market in the IS-LM model. What does the horizontal LM-curve imply in this context? Let us look at the equation for the LM-curve:

$$r = (\frac{1}{\beta}) \times (v \times p \times y + L_0 - \overline{M^S})$$

The real interest rate is constant along the horizontal part of the LM-curve in Figure 7. Coefficients β and v are constant as well and we also assume that *p* remains the same. If animal spirits remain unchanged, real GDP is also not changing, since the real interest rate is found to be constant (in Figure 7). What happens when the central bank increases $\overline{M^S}$? The answer is: nothing. The LM-curve will not shift (to the right) in response to the increase in $\overline{M^S}$. The reason is that the increase in money supply is absorbed by an increase in L_0 – the speculative cash holdings of financial investors. L_0 is the only variable left in the equation for the LM-curve to absorb the increase in money supply. Hence, along the horizontal part of the LM-curve it is assumed that $\Delta L_0 = \Delta\overline{M^S}$; the real interest rate does not (need to) change.

Why do speculators absorb the increase in money supply? They do so, because the economy is in a depressed state and no one expects that there will soon be a recovery. The interest rate is low and asset prices will be (relatively) high. Speculators are willing to hold the (new) money in the expectation that once economic growth starts to increase and the interest rate will go up again, they have the cash to buy financial assets (the prices of which will then go down). This equilibrium is called a 'Liquidity Trap': the stagnating economy is flushed with money (liquidity), but the money lies idle (in the bank accounts of the speculators) and is not used for transaction purposes.

<u>Monetary policy (increasing $\overline{M^S}$) is ineffective in a liquidity trap</u>: the increase in $\overline{M^S}$does not lower the real interest rate and hence, there is no impact on business investment or real GDP. The only escape from a liquidity trap is <u>fiscal stimulus</u>: an increase in public spending, which shifts the IS-curve to the right (in Figure 7), raising real GDP (and reducing unemployment), (initially) without any effect on the real interest rate. The interest rate will rise only after real GDP increases above y_1.

<u>The IS-LM Model: a third and final special case</u>

Monetarist economists (such as Milton Friedman) reject the Keynesian notion of 'liquidity preference'. According to monetarist economists, because financial markets work efficiently and without significant transaction cost, there is no reason for 'rational' speculators to hold large money balances. The opportunity cost of holding cash is – in this view – large, and this will motivate 'rational' financial investors to hold assets, rather than money. In terms of the IS-LM model, monetarists argue that the speculative demand for money does not exist; this means, they claim that $L_2 = 0$. This changes the LM-part of the model. Money market equilibrium then becomes:

$$M^S = \overline{M^S} = M^D = L_1 = v \times p \times y$$

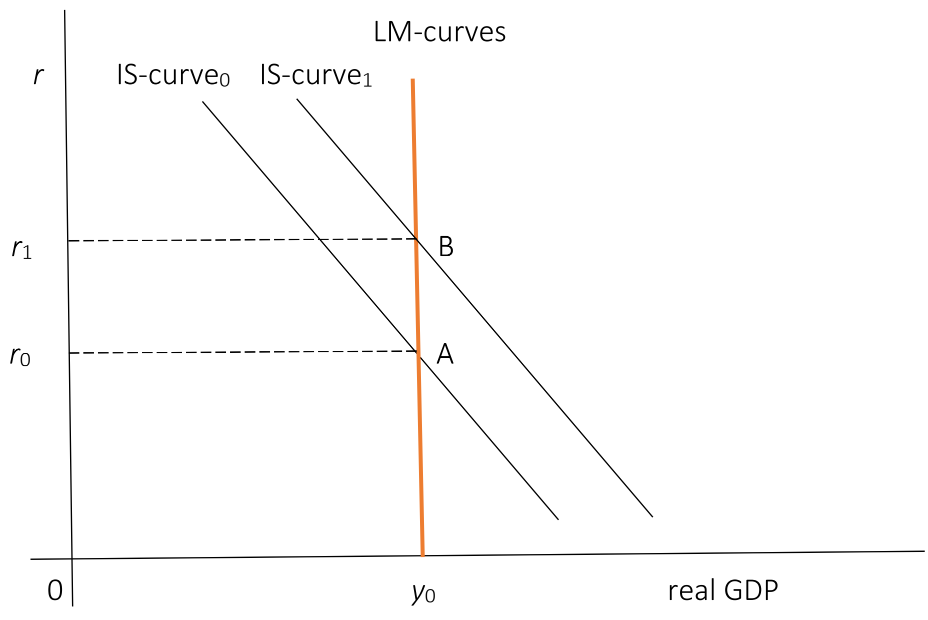
which gives the following – vertical – LM-curve:

$$(9) \qquad p \times y = Y = \frac{\overline{M^S}}{v}$$

Nominal GDP ($= p \times y$) depends on available (exogenous) money supply. The Monetarist version of the IS-LM model is illustrated in Figure 8. In the Monetarist formulation, money-market equilibrium determined nominal (not real) GDP. For example, if the central bank increases $\overline{M^S}$ by 10%, the greater availability of money will allow an expansion of nominal GDP by 10%. Nominal GDP can increase, because of an increase in real GDP, an increase in the general price level, or a combination of higher real GDP and inflation. The Monetarist model is under-determined, because we do not know (without more information) what will happen to real GDP and inflation if $\overline{M^S}$ increases (by, say, 10%).

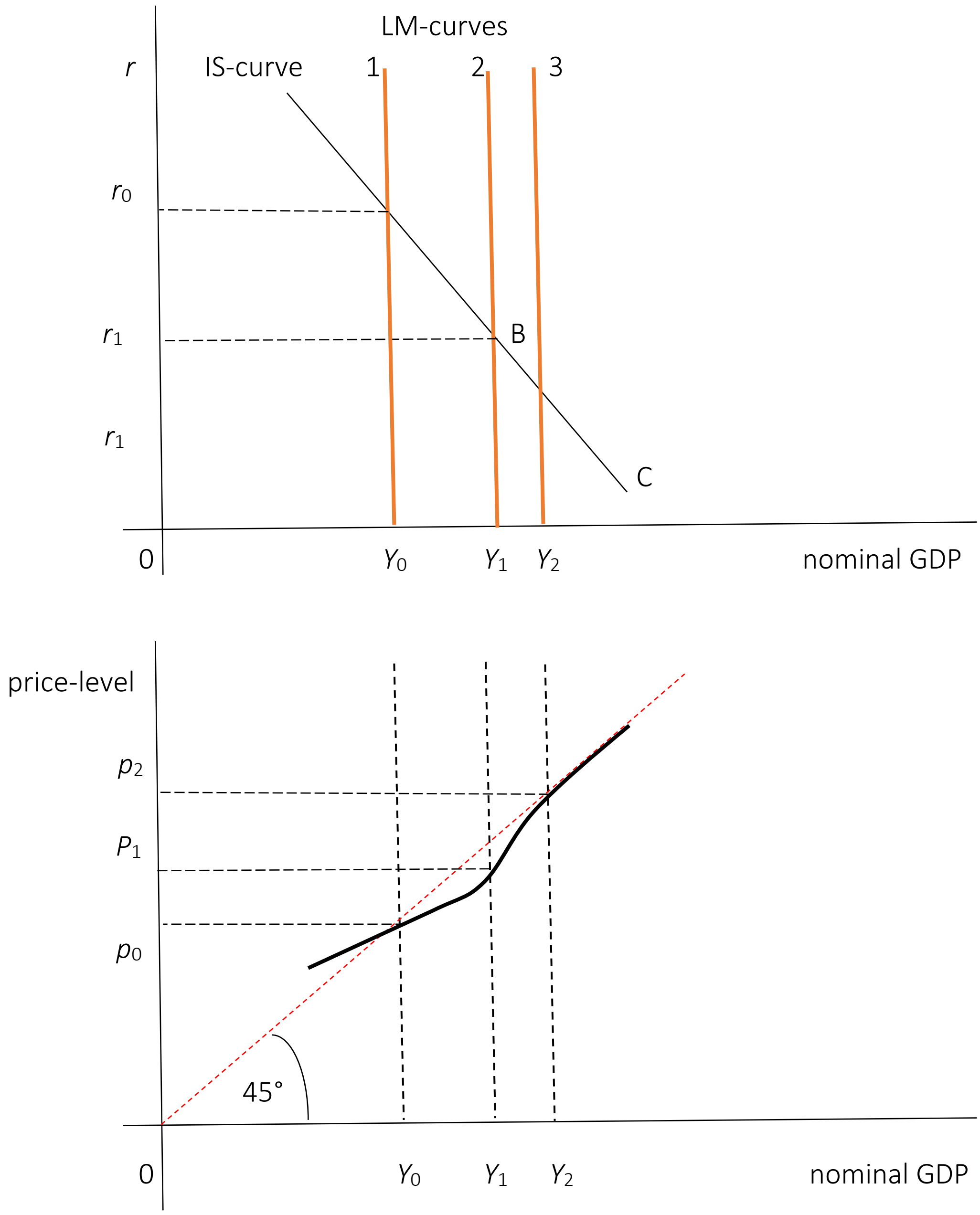
We will continue to assume that the general price level *p* is exogenous. Let us consider the macro effects of fiscal stimulus in the Monetarist version of the IS-LM model. As before, due to the increase in public investment the downward-sloping IS-curve will shift to the right. However, the vertical LM-curve does not shift. As a result, the economy will go from old equilibrium A to new equilibrium B: real GDP stays the same, but the interest rate has increased. The increase in the interest rate has depressed private spending – there is complete crowding out of private demand by public spending. Fiscal stimulus is ineffective in the Monetarist IS-LM model.

Figure 8
The IS-LM Model: the Monetarist version



What are the impacts of an increase in $\overline{M^S}$ by, say, 10%)? Figure 9 provides the answer. Due to the increase in $\overline{M^S}$, the vertical LM-curve shifts to the right (from LM-curve$_1$ to LM-curve$_2$). What we know from eq. (9) is that nominal GDP will rise (by 10%) as well; this is the shift from Y_0 to Y_1 in Figure 9. Partly, the increase in nominal GDP will reflect an increase in real GDP and partly it will be due to higher inflation. The lower panel of Figure 9 helps us to determine how much of the nominal GDP increase is due to inflation.

Figure 9
The IS-LM Model: the Monetarist version + Phillips-curve



In the lower panel of Figure 9 appears the relationship between (nominal) GDP and the price level *p*; this is the solid black line. Due to the increase in increase in $\overline{M^S}$, nominal GDP has increased Y_0 to Y_1. Real economic activity increases, unemployment is going down, and wages and prices will start to increase. Based on our knowledge of the empirical relation between (nominal) economic activity and inflation (the Phillips-curve), we know that the price level increases from p_0 to p_1. Initially, the general price level increases less than proportionally with an increase in GDP (and money supply). This implies that as nominal GDP rises from Y_0 to Y_1, the nominal income growth is due to (*a*) real GDP growth, and (*b*) inflation.

The price level increases less than proportionally with an increase in money supply, because of 'money illusion': the increase in $\overline{M^S}$ is creating inflation, but the public and firms initially mistakenly view the purchasing power of their incomes as measured by the nominal (not the lower real) value of their income. However, once they recognize the inflation and the decline in their purchasing power, they will reduce their demand and spending – and real GDP will revert back to its original level. To illustrate this in Figure 9, suppose the central bank decides to increase $\overline{M^S}$ even further. This time, nominal GDP rises from Y_1 to Y_2. But now the Phillips-curve tells us that the general price level will rise (almost) proportionally with the increase in nominal GDP – as *p* increases from p_1 to p_2; the public and firms now understand that the increase in money supply will only lead to inflation. If the price level rises in the same proportion as nominal GDP, then real GDP growth must be zero. This is what Monetarist economists argue: a monetary stimulus (higher $\overline{M^S}$) may for a short period raise real GDP as well as inflation, but after some time (in the longer run), increases in $\overline{M^S}$ will only and exclusively raise the price level – and real GDP will remain stagnant. Monetary stimulus cannot, therefore, increase real GDP in the long run, but will be inflationary in the long run.

The IS-LM Model: a critique

We conclude by highlighting two major critiques of the IS-LM model.

1. The first critique (made by John Hicks himself) is that the IS-LM model ignores uncertainty and the role of expectations. The IS-LM model has an internal contradiction, as it recognizes the important role of liquidity preference. Liquidity preferences will be high, when there is much uncertainty about the (near) future – as is for instance the case right now. Speculators, but also businesses and households will not spend, but keep cash balances (also out of precaution for possible future problems). This will increase L_0, a variable assumed to be 'autonomous' or exogenous. If L_0 increases, the LM-curve will shift to the left. However, uncertainty will also depress autonomous investment i_0 – and thus the IS-curve will shift to the left as well. Real GDP will fall – and expectations may become more pessimistic. It is not clear what the new macro-economic equilibrium will be, if at all the economy converges to a new stable outcome.

2. The second critique concerns the assumption that $\overline{M^S}$ is exogenous and can be used as a monetary policy instrument by the central bank. We will see (in Week 7) that money supply – in real life – is endogenous and that central banks cannot control the quantity of money. Central banks (in reality) use the interest rate as the instrument of monetary policy. The fact that money supply is endogenous (not exogenous) changes the way the IS-LM model quite fundamentally. This is illustrated in Figure 10 in which there is no longer an LM-curve.

   Suppose the initial equilibrium is point A. In response to fiscal stimulus, the IS-curve shifts to the right. If the central bank keeps the interest rate at r_0, real GDP will increase from y_0 to y_B (point B). However, if the growth of real GDP leads to inflation, the central bank may react and increase the rate of interest – in order to contain or reduce inflationary pressure. If the new rate of interest is r_1, the economy will settle in equilibrium C – with higher real GDP than initially, and a higher interest rate.

   Fiscal stimulus does no longer 'automatically' crowd out business investment. The increase in the interest rate is a discretionary policy decision by the central bank. It depends on how strongly the central bank wants to control inflation and on the extent to which the fiscal stimulus does raise inflation, by how much the interest rate will be increased.

Figure 10
The IS-LM Model: Endogenous Money Supply