THE IS-LM MODEL AND MONETARY POLICY

THEME 7

Index

7.1. SIMULTANEOUS EQUILIBRIUM OF THE GOODS AND MONEY MARKETS

7.1.1. Equilibrium of goods and money markets

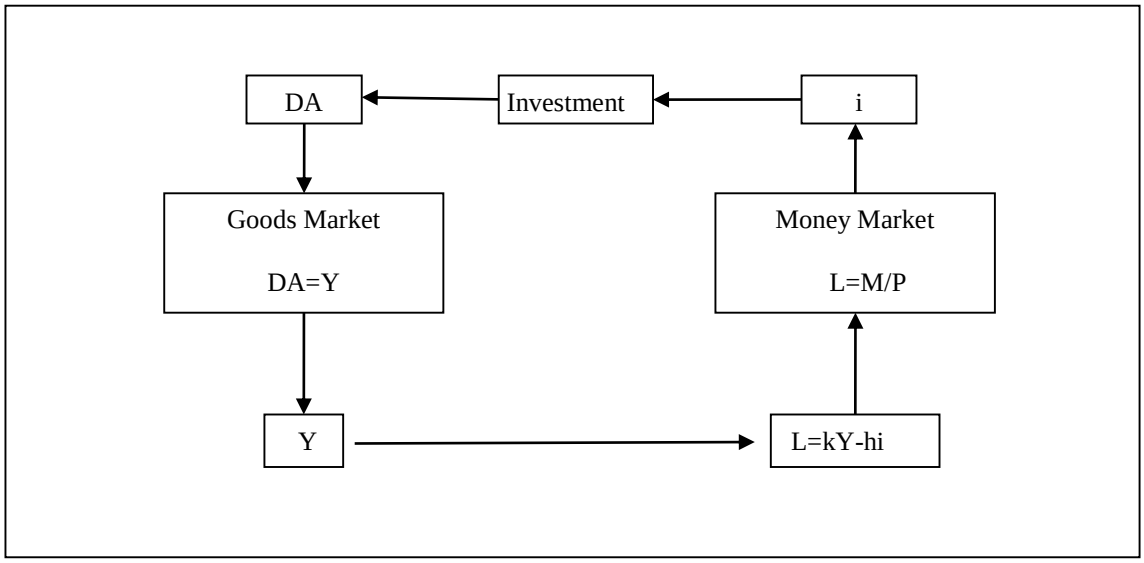
So far we have seen the goods market and the money market as two markets that operate separately, without being able to interact with each other. However, these markets can influence each other, affecting their equilibrium situations.

The goods market is in equilibrium when DA is equal to the level of income in the economy (DA=Y). The money market is in equilibrium when the demand for money is equal to the money supply in real terms (L=M/P).

How can one market influence the other? We have seen that the demand for money depends on income (L=kY-hi). Thus, the equilibrium income of the goods market affects the money demand, and therefore the monetary equilibrium.

On the other hand, the equilibrium of the money market determines the market interest rate. This interest rate affects investment, which is a component of DA. Therefore, money market equilibrium can affect DA and goods market equilibrium. Figure 1 shows these relationships.

Figure 1. Relationship between the goods and money markets

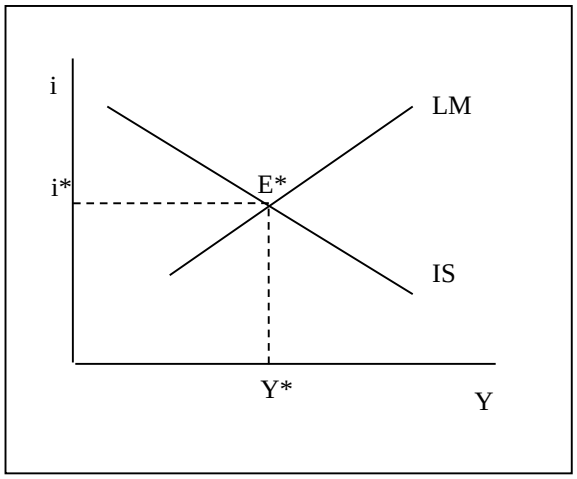


The interaction between the two markets depends, on the one hand, on the effect of income on the demand for money and, on the other hand, on the effect of the money market on the interest rate, on the effect of the interest rate on investment, and on the

effect of investment on DA and, therefore, on equilibrium income. At the same time, the interaction between DA and Y will affect the level of income in the economy, influencing in turn the demand for money and so on. Thus, if the goods market goes into disequilibrium, this will change the money market, and this will again affect and unbalance the goods market. When does the process stop? When both markets are simultaneously in equilibrium, i.e., when it is fulfilled simultaneously that DA=Y and L=M/P.

In order to understand how both markets interact, and when the simultaneous equilibrium situation occurs, we will use the IS-LM model. This model is formed by two curves, the IS and the LM, which represent respectively the equilibrium situations of the goods and money markets. Thus, the simultaneous equilibrium of the goods and money market is found where the IS and LM curves intersect. Any other combination indicates either that the goods or money market is out of equilibrium or that both are out of equilibrium. Figure 2 shows that E* is the simultaneous equilibrium point of the goods and money market. This equilibrium point is obtained for an income level equal to Y* and for an interest rate equal to i*.

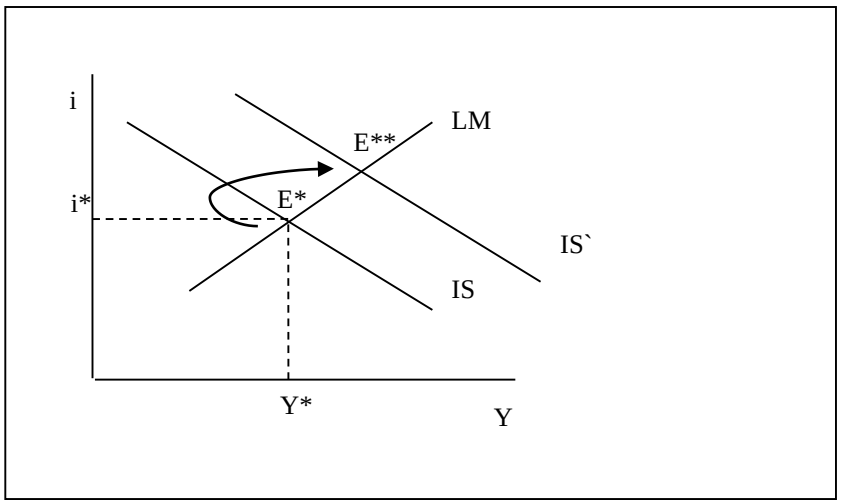
Figure 2. Simultaneous equilibrium of the goods and money market

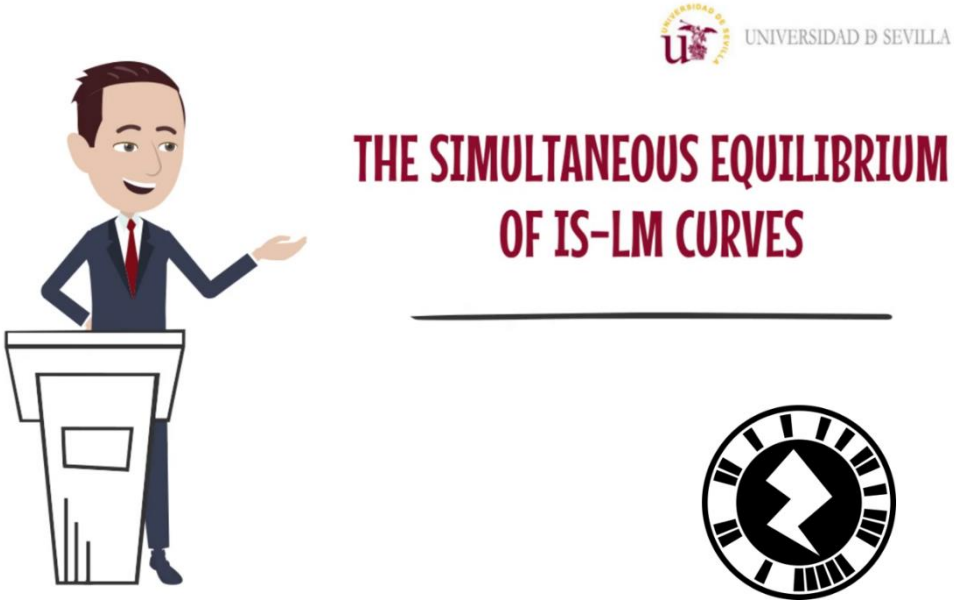


The IS-LM model is also a good tool to analyze the effects of monetary and fiscal policy in the short-term. Starting from an initial equilibrium situation in the IS-LM model, we can observe the effect of monetary and fiscal policy in the short-term, analyzing their effect on that equilibrium position. Any change in the economy that affects the IS or LM curve will affect the equilibrium of the economy. Thus if, for example, government spending were to increase, the IS curve would shift to the right, and point E* would no

longer be a point of equilibrium. The economy would begin to move in search of a new equilibrium, that is, in search of the new cut-off point of the IS and LM curves, which is E**, as shown in Figure 3.

Figure 3. Change of the simultaneous equilibrium position of the goods and money market due to IS variation





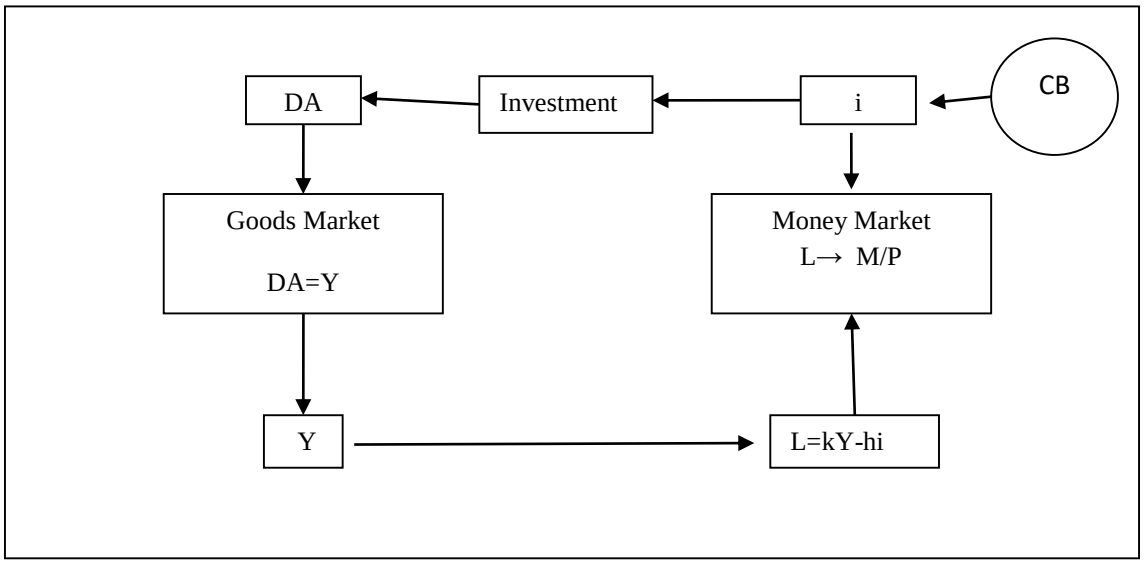
Likewise, this effect can be analyzed in different contexts, by analyzing the change that occurs in the equilibrium positions when the IS and LM curves present certain particularities, which end up affecting their slopes.

What if the central bank determines the interest rate instead of the quantity of money?

In this case, the interest rate is not determined by the equilibrium in the money market, but by central bank policy and the money market will determine the quantity of money in the economy.

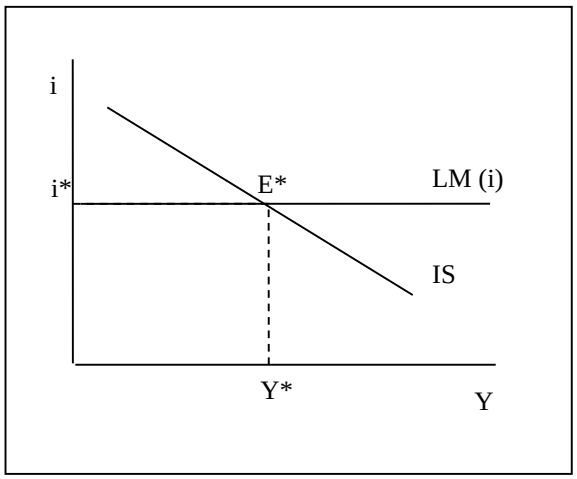
The equilibrium in the goods market will determine the equilibrium income, and this income will affect the demand for money. The central bank will determine the interest rate (based on inflation and income criteria, for example), and given the demand for money, the money market will determine the quantity of money in the economy. But in addition, the interest rate will affect investment, DA and therefore the equilibrium of the goods market, which again will affect the equilibrium income. Figure 4 shows this relationship.

Figure 4. Relationship between goods and money markets when the central bank determines the interest rate



The simultaneous equilibrium of both markets in this case is determined as before by the point where the IS-LM curves intersect, being now the LM curve the one determined when the central bank controls the interest rate, i.e., by LM(i). Figure 5 represents this equilibrium.

Figure 5. Simultaneous equilibrium of the goods and money market, if the central bank controls the interest rate



Any change in the economy that affects the IS curve will affect the equilibrium income of the economy. So, for example, if government spending were to increase, the IS curve would shift to the right, and point E* would no longer be an equilibrium point. The economy would begin to move in search of a new equilibrium, i.e., in search of the new cut-off point of the IS curves with LM. Likewise, the central bank's monetary policy changes will affect the position of the LM curve, and with it the equilibrium point and the equilibrium income level.

7.1.2. Formal analysis of the IS-LM model

What is the equilibrium value? What does the value of the equilibrium income Y* depend on? To calculate this value, we start from the IS and LM equations. Given that

$$Y = \alpha_G \left(\overline{A} - bi \right) = \alpha_G \overline{A} - \alpha_G bi$$

$$\frac{M}{P} = kY - hi$$

We have two equations with two unknowns, Y and i. So, if we solve such a system of equations, we can find out what the value of the equilibrium income Y* depends on.

By taking the interest rate out of the second equation, we get

$$i = -\frac{1}{h}\frac{M}{P} + \frac{k}{h}Y$$

if we substitute this interest rate into the first equation

$$Y = \alpha_G \overline{A} - \alpha_G bi = \alpha_G \overline{A} - \alpha_G b \left(-\frac{1}{h}\frac{M}{P} + \frac{k}{h}Y\right) = \alpha_G \overline{A} + \frac{\alpha_G b}{h}\frac{M}{P} - \frac{\alpha_G bk}{h}Y$$

If we pass the last member of the previous expression to the left of the equality we obtain that

$$Y + \frac{\alpha_G bk}{h}Y = \alpha_G \overline{A} + \frac{\alpha_G b}{h}\frac{M}{P}$$

by taking a common factor out of Y

$$\left(1 + \frac{\alpha_G bk}{h}\right)Y = \alpha_G \overline{A} + \frac{\alpha_G b}{h}\frac{M}{P}$$

if we add the fractions in parentheses

$$\frac{h + \alpha_G bk}{h}Y = \alpha_G \overline{A} + \frac{\alpha_G b}{h}\frac{M}{P}$$

If we clear the value of Y, we obtain the value of simultaneous equilibrium income

$$Y^* = \frac{h}{h + \alpha_G bk}\alpha_G \overline{A} + \frac{h}{h + \alpha_G bk}\frac{\alpha_G b}{h}\frac{M}{P}$$

If we simplify,

$$Y^* = \frac{\alpha_G h}{h + \alpha_G bk}\overline{A} + \frac{\alpha_G b}{h + \alpha_G bk}\frac{M}{P}$$

The equilibrium income depends on the value of autonomous expenditure and the value of the money supply. It also depends on all the parameters that define the IS and LM curves. We have seen above that the IS curve is affected by changes in tax rates, public spending and transfers, i.e., by changes in fiscal policy. Therefore, changes in fiscal policy will affect the IS curve and will cause changes in the simultaneous equilibrium of goods and money in the economy.

We have also seen above that changes in the money supply cause shifts in the LM curve. Therefore, changes in monetary policy lead to changes in the LM curve and in the simultaneous equilibrium of the economy.

Thus, the IS-LM model allows us to assess the effects of fiscal and monetary policy in various short-term scenarios.

Since public expenditure is part of autonomous expenditure A, the value $\frac{\alpha_G h}{h + \alpha_G bk}$ is known as the fiscal policy multiplier. Said multiplier indicates how much the equilibrium income of an economy varies in the face of a unit increase in government spending.

Thus, the increase in income resulting from an increase in public spending depends on the increase in public spending itself (ΔG) and on the expenditure multiplier (α_G), on the sensitivity of money demand to the interest rate (h), on the sensitivity of investment to the interest rate (b) and on the sensitivity of money demand to income (k).

On the other hand, the value $\frac{\alpha_G b}{h+ \alpha_G bk}$ is known as the monetary policy multiplier, and indicates how much the equilibrium income of an economy varies with a unit increase in the quantity of money. Thus, the increase in income caused by an increase in the quantity of money depends on the monetary increase itself (ΔM/P) and the expenditure multiplier (α_G), on the sensitivity of investment to the interest rate (b), on the sensitivity of the demand for money to the interest rate (h) and on the sensitivity of the demand for money to income (k).

Graphically, then, the slope and position of the IS and LM curves are determinant to know the effect of fiscal and monetary policy in the short-term.

What if the central bank determines the interest rate instead of the quantity of money?

In this case, the analysis is simpler. On the one hand we have the expression of the IS curve, and on the other hand we have the interest rate set by the central bank

$$Y = \alpha_G \left(\overline{A} - bi \right) = \alpha_G \overline{A} - \alpha_G bi$$

i=i*

If we substitute the second equation into the first equation, we have that

$$Y^* = \alpha_G \overline{A} - \alpha_G bi *$$

Equilibrium income now depends on fiscal policy (A) and monetary policy (i*). An increase in autonomous expenditure determines an increase in equilibrium income equal to $\alpha_G \Delta \overline{A}$, while an increase in the interest rate will lead to a decrease in equilibrium income equivalent to - $\alpha_G b \Delta i$. The effectiveness of fiscal and monetary policy will then depend on the slope and position of the IS curve.

7.2. EFFECT OF MONETARY POLICY IN THE SHORT-TERM

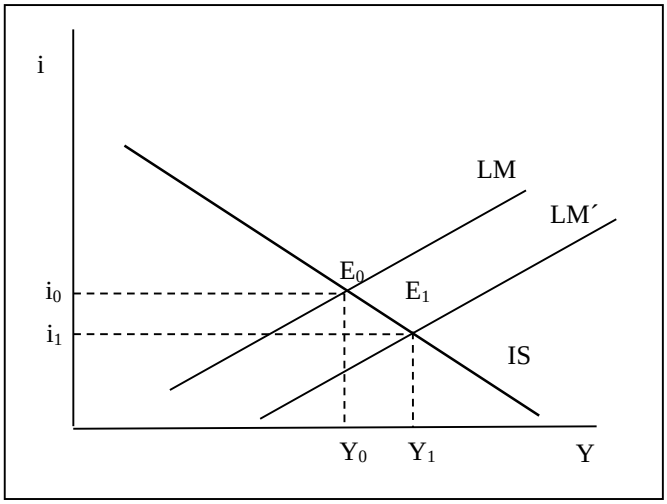
7.2.1. Monetary policy based on the control of the quantity of money and the IS-LM model equilibrium

In order to analyze the effect of monetary policy based on control of the quantity of money on equilibrium in the IS-LM model we will assume that the monetary multiplier is equal to unity. Thus, as we have seen in the previous topic, an increase in the monetary base is equivalent to an increase in the money supply, and the latter does not depend on the interest rate. We have also seen in the previous topic that an increase in the quantity of money affects the LM curve and shifts it parallel to the right, in an amount equal to $1/k\Delta M/P$.

We use the IS-LM model to analyze the effect of monetary policy. We assume that we initially start from an equilibrium position. Figure 6 shows that the initial equilibrium point is E_0, where the IS curve cuts with the initial LM curve. We now assume that the Central Bank conducts a bond buying operation in the open market. The purchase of bonds will increase the monetary base and, therefore, the quantity of money. This effect causes the LM curve to shift parallel to the right. The initial point E_0 is no longer an equilibrium position of the economy, since, although it is on the IS curve and, therefore, the goods market is balanced, it is no longer on the new LM curve, i.e., on LM'. As the money supply increases, at point E_0 now the money supply is greater than the money demand, i.e., $L<M/P$.

Then, where is the new equilibrium point of the economy? After buying bonds and increasing the money supply, the new equilibrium is at E_1. That is, where the IS curve cuts the new LM' curve. After conducting monetary policy, the equilibrium point of the economy changes, causing the economy's interest rate to fall and income to rise.

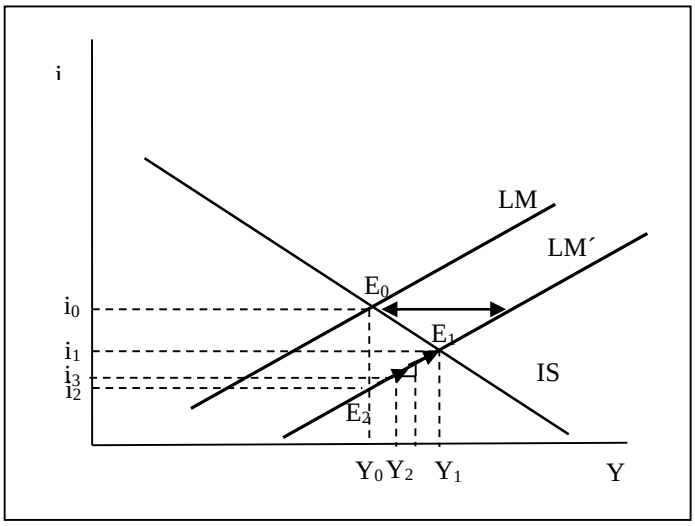
Figure 6. Effect of a monetary policy of increasing the quantity of money



What is the process by which we move from equilibrium point E_0 to E_1? In short, what is the process of adjustment of the economy to the monetary policy conducted by the Central Bank? When the Central Bank buys bonds, the money supply increases, giving rise to a monetary disequilibrium such that M/P>L. The purchase of bonds, however, generates an increase in the demand for bonds, and consequently a decrease in the interest rate. This decrease in the interest rate increases the demand for money, since it is worth remembering that L=kY-hi. Thus, the interest rate will fall until monetary equilibrium is restored, i.e., until we are on the new LM curve, i.e., on LM'. Figure 7 shows that this first effect will cause the interest rate to fall to i_2, placing the economy at the combination of interest rates and income levels corresponding to point E_2. At that point, the money market will again be in equilibrium. This process or adjustment is rapid in the economy, as the money market adjusts quickly.

At the same time, the goods market will enter into disequilibrium, which is shown graphically by the fact that point E_2 is not on the IS curve. Why is the goods market in disequilibrium? As the interest rate decreases, investment will increase (so $I=\bar{I}-bi$) and as investment increases, the DA will also increase. Thus, when DA increases, it will be greater than the economy's income (DA>Y), bringing the goods market into disequilibrium. It is worth noting that up to this point, income has not changed, the economy continues to have an income level equivalent to Y_0.

Figure 7. The effect of monetary policy of increasing the quantity of money: the adjustment process.

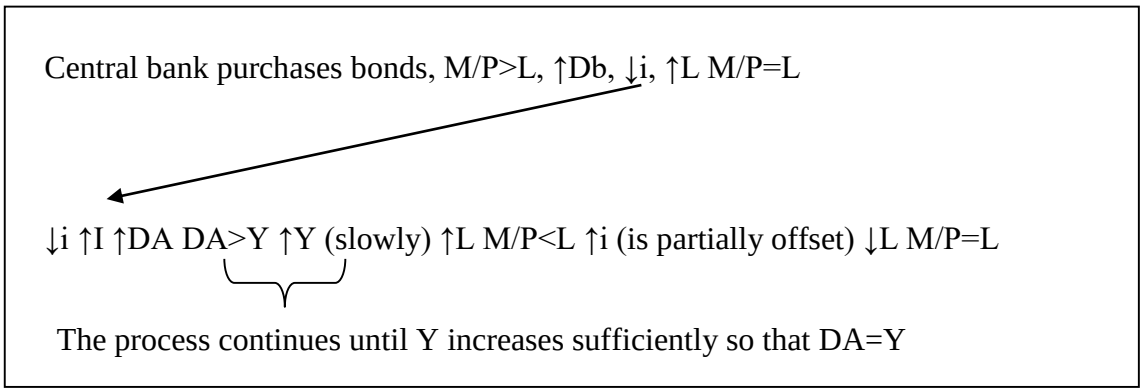


The disequilibrium in the goods market will put pressure on the economy to increase income. Thus, the DA pressure will cause income to increase to cover the excess demand, but this process is slow. Thus, income will increase, but initially not enough to restore equilibrium in the goods market. Graphically, we see that, at this point, income rises until Y_2.

As income increases, the demand for money will increase, since L=kY-hi. Again, the money market will enter into equilibrium. As the demand for money increases, the demand for bonds will fall and, therefore, their price, raising the interest rate, until we are again on the LM' curve, i.e., until i_3. Once again we will be in the LM' curve, in the combination of (i_3,Y_2). Being above LM', the money market will be in equilibrium. However, we are still not over the IS curve, the goods market being in disequilibrium. The increase in income has still been insufficient to cover the excess demand. Therefore, income will continue to grow to a higher level. The increase in income will again put upward pressure on the demand for money, and this increase will cause interest rates to continue to rise in order to restore the disequilibrium in the money market that has just been generated. This process (increase in income, money demand and interest rates) will continue until the goods market enters into equilibrium, i.e., until income is equal to Y_1 and the interest rate i_1, at point E_1.

The adjustment process has been, then, a fast process of adjustment from E_0 to E_2; and a slow process from E_2 to E_1, along the LM' curve. The final effect of the monetary policy carried out by the Central Bank has been an increase in income and a fall in the interest rate. It should be noted that the final increase in income is less than the shift of the LM curve to the right, which is due to the fact that the interest rate increases gradually to partially compensate for the initial decrease in the interest rate, and therefore its effect on investment and DA. Figure 8 summarizes this causal process occurring in the economy.

Figure 8. Causal process of adjustment of the economy due to an increase in the quantity of money.



7.2.2. Effectiveness of monetary policy consisting of a short-term increase in the quantity of money.

In the whole adjustment process, there are two key moments. The first is that the disequilibrium in the money market affects the interest rate, and the second is that the change in the interest rate affects investment. **If either of these two processes does not occur, then the adjustment process stops and income does not increase**. Therefore, the effectiveness of monetary policy depends on these two effects.

Effect of h on the effectiveness of monetary policy consisting of an increase in the quantity of money

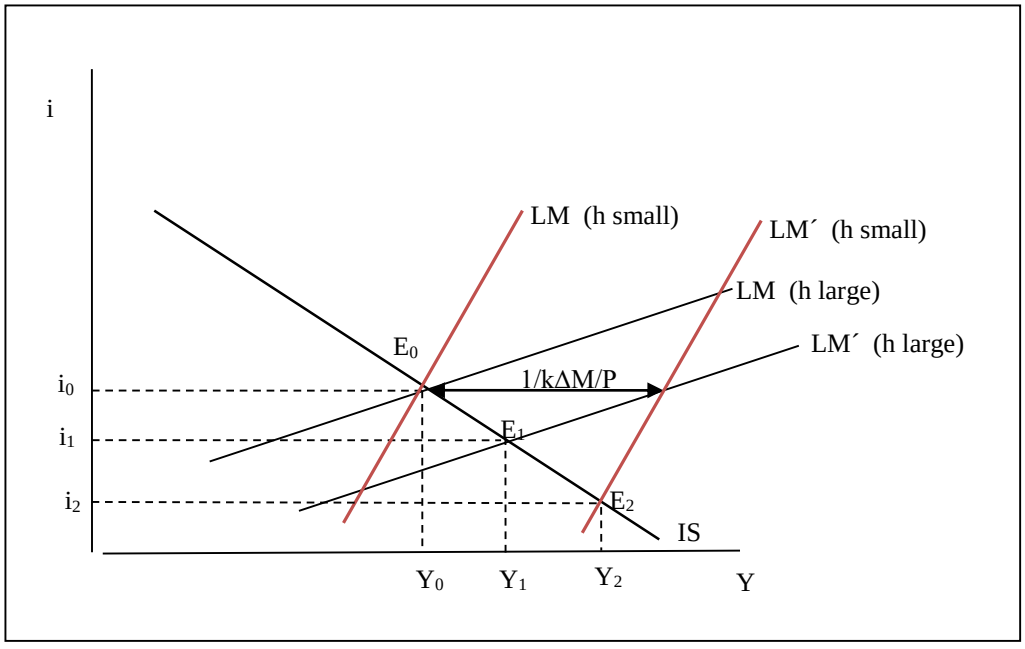
The variation of the interest rate in the face of monetary disequilibrium depends on the sensitivity of the demand for money to the interest rate (h). When h is very high, i.e., when this sensitivity is very high, a small change in the interest rate will be sufficient to restore equilibrium in the money market. Therefore, the interest rate will decrease very little. This will be enough to increase the demand for money a lot and bring the money

market back to equilibrium. If the interest rate decreases little, the effect on investment will be small and DA will increase little. As a result, income will increase by only a small amount. Monetary policy will then have little effect.

However, if h is very low, and the sensitivity of money demand to the interest rate is low, then the opposite will occur. The interest rate will have to fall a lot for the demand for money to increase sufficiently to rebalance the money market. As the interest rate falls sharply, investment will rise sharply, and with it the DA. To reestablish equilibrium in the goods market will then require that income will need to increase a lot as well. Monetary policy will have a large effect on income.

Figure 9 shows the effect of monetary policy on the level of income when the sensitivity of money demand to the interest rate is high or low. If the sensitivity of money demand is high (large h), as we have seen in the previous topic, the slope of LM is fairly flat. Figure 9 plots the LM and LM' curve for a large h value in black. Starting from the initial equilibrium position E_0, an increase in the quantity of money shifts the LM curve to the right (in a value equivalent to $1/k\Delta M/P$), to LM'. The equilibrium is now at E_1, increasing income up to Y_1, and lowering the interest rate to i_1.

Figure 9. Effect of an increase in the quantity of money on the level of income depending on the value of the sensitivity of the demand for money to the interest rate.



If the value of h is small, the slope of the LM curve will be large, and the curve quite steep. If we start from the same initial equilibrium situation, when h is small the LM curve cuts with the IS curve at the same point E_0, but now the LM curve is steeper. It is shown in red. If the quantity of money increases by the same amount as before, then the red LM curve will shift to the right by the same amount as before, i.e., by $1/k\Delta M/P$. Now, the cut-off point of the red LM' curve with the IS curve occurs for a lower interest rate and for a higher level of income. Thus, graphically we can state that the greater the sensitivity of the demand for money to the interest rate, the smaller the effect of monetary policy on income.

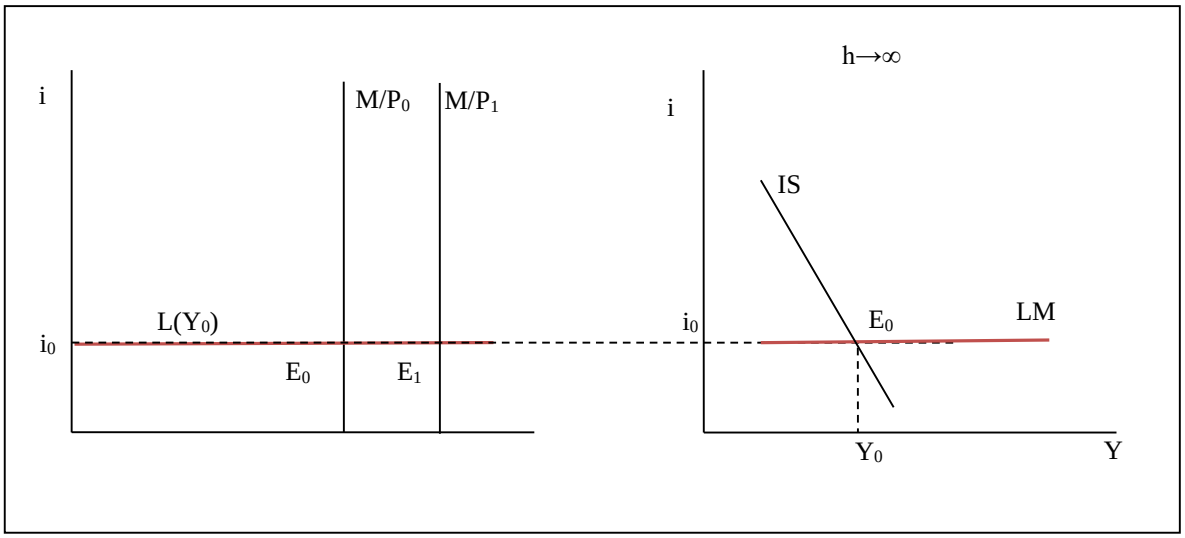
Effect of h on the effectiveness of an increase in the quantity of money: liquidity trap

We can now analyze two special cases. When the sensitivity of money demand to the interest rate is zero and in the case of the liquidity trap. Let us start with the latter case.

The liquidity trap occurs when agents want to keep their money in cash because they expect interest rates to rise. In this case, we have seen that the money demand curve becomes completely flat, and so does the LM curve. What happens when the money supply increases? In this case, as the money supply increases, agents will want to hold that additional amount of money in liquid form and the market will absorb the additional money without affecting the interest rate. Since the interest rate will not change, investment will not change, and production will not be altered. Monetary policy will therefore be totally ineffective.

Figure 10 shows this situation. In the left graph of the figure, it can be seen how the increase in the amount of money from M/P_0 to M/P_1 does not change the equilibrium interest rate. In this case, the graph on the right of Figure 10 shows that the totally flat LM curve will not change its position and, therefore, the equilibrium point (cut-off with IS) will not change. Therefore, the level of income will remain the same. Monetary policy has no effect.

Figure 10. Effect of an increase in the quantity of money in the case of the liquidity trap.



What has been the causal process? Simply, the increase in the quantity of money does not unbalance the money market because the demand for money will increase to the same extent as the supply. Therefore, the interest rate does not change and the process stops at that point without having any effect on income. Figure 11 shows the scheme of such a causal process.

Figure 11. Causal process of adjustment of the economy by an increase in the quantity of money in the case of the liquidity trap.

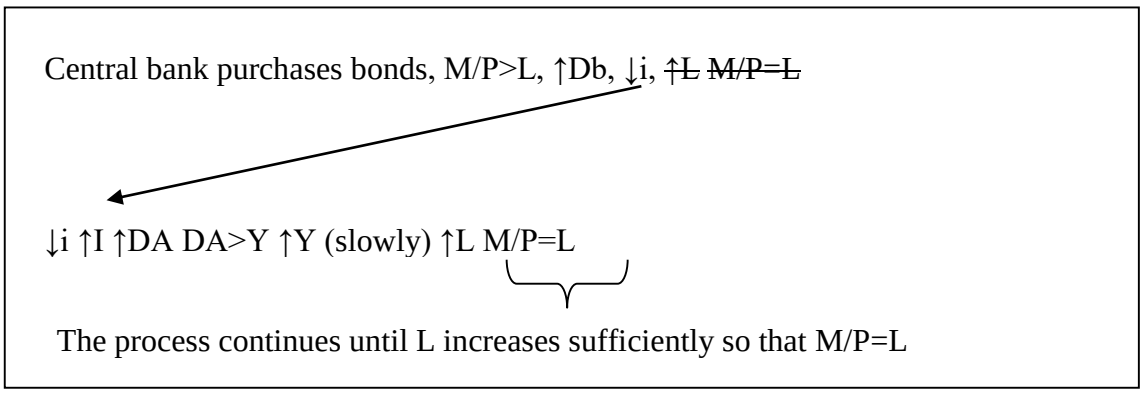
Central bank purchases bonds, M/P=L, ~~↓i,~~

Effect of h on the effectiveness of an increase in the quantity of money: classic case

Another special case that deserves attention is the classical case, i.e., when the value of the sensitivity of the demand for money to the interest rate is zero. In this case, the demand for money does not depend on the interest rate, so that changes in the interest rate have no effect on it (on L). The money market cannot be balanced by changes in the interest rate, only by changes in income. Thus, if the quantity of money increases, there will be a disequilibrium in the money market, the interest rate will decrease and monetary equilibrium cannot be restored. How is this equilibrium restored? As the interest rate

decreases, investment will increase and with it the DA. The increase in DA will put upward pressure on income, and as income rises so will the demand for money. The process will continue until income rises sufficiently so that the increase in the demand for money that causes it to rise will rebalance the money market. Figure 12 shows the causal process.

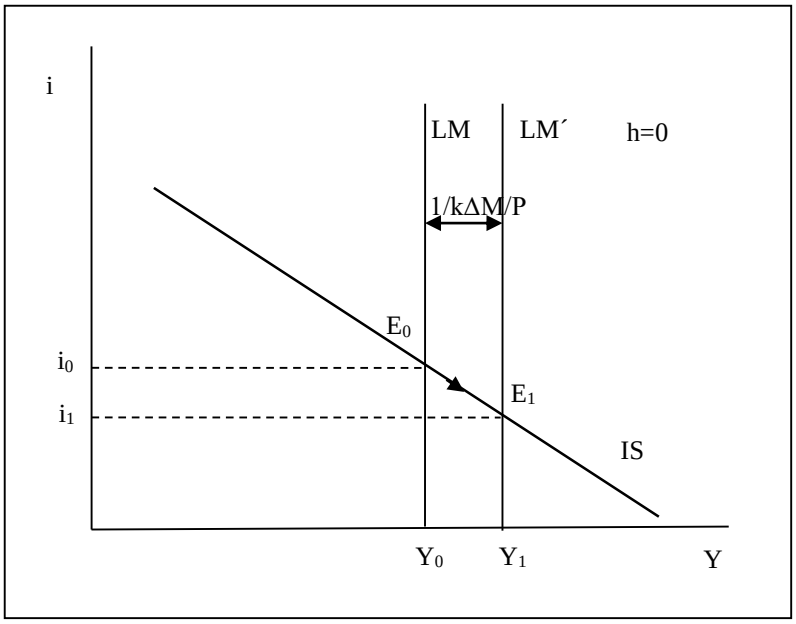
Figure 12. Causal process of adjustment of the economy by an increase in the quantity of money: classic case.



Graphically, Figure 13 shows the effect of monetary policy in this case. First, it should be recalled that when the sensitivity of money demand to the interest rate is zero, the LM curve is completely vertical. If we start from an initial equilibrium position, at E_0, an increase in the quantity of money shifts the LM curve to the right by a value equal to $1/k\Delta M/P$. The interest rate will start to decrease and investment will start to increase, putting upward pressure on DA. The increase in DA puts pressure on income, which will start to increase until it reaches the level of income Y_1.

Two issues are reflected in the graph. First, throughout the adjustment process, the money market is in disequilibrium. Monetary equilibrium is not reached until income grows to Y_1, and with it the demand for money increases by the same amount as the initial increase in money. That is, we are not on the new LM curve until Y is not equal to Y_1. Second, the increase in final income is equivalent to the shift of the LM curve to the right and, therefore, $\Delta Y=1/K\Delta M/P$. This is because the interest rate fell until i_1, but then there was no offsetting process (as in the general case). In this way, the growth of investment and DA has been able to be total. In this case we say that monetary policy has full effect.

Figure 13. Effect of an increase in the amount of money in the classical case.



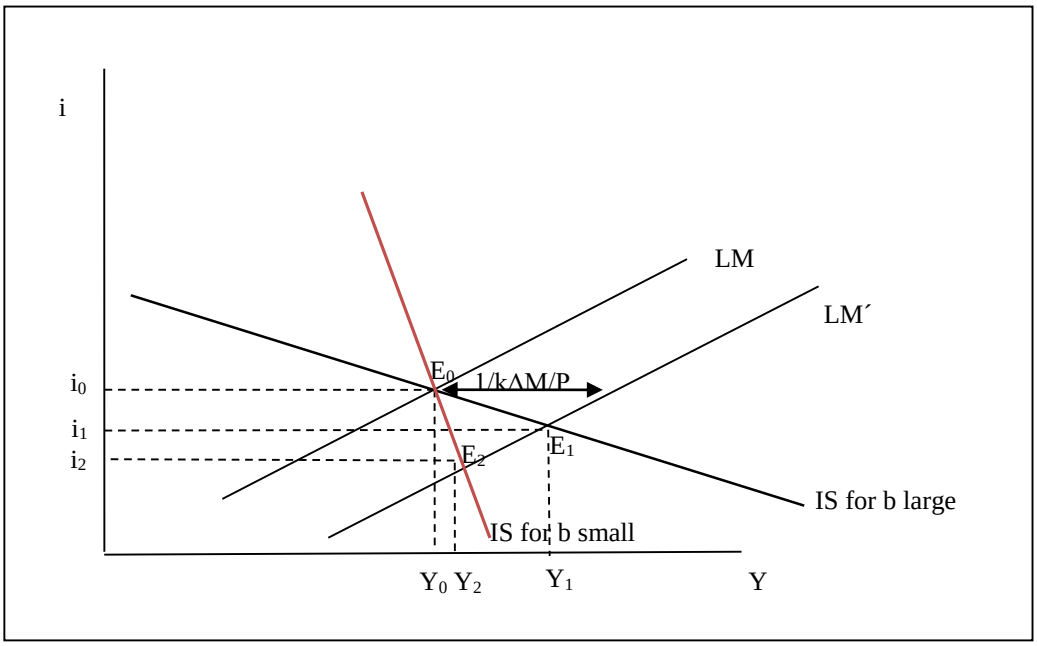
Effect of the sensitivity of investment to the interest rate on the effectiveness of monetary policy

The change in investment when the interest rate changes depends on the sensitivity of the investment to the interest rate (b). When b is very high, a small change in the interest rate causes a large effect on investment. In this case, DA will increase a lot and therefore, income will increase by a large amount. Monetary policy will then have a large effect. However, if b is low, the opposite will happen. The change in the interest rate will have little effect on investment and DA. Income will then increase little and monetary policy will have little effect.

Figure 14 shows the effect of monetary policy on the level of income when the sensitivity of investment to the interest rate is high or low. If the sensitivity of investment is high (large b), as we have seen in the previous topic, the slope of IS is fairly flat. Figure 14 plots the IS curve for a large b value in black.

Starting from the initial equilibrium position E_0, an increase in the quantity of money shifts the LM curve to the right (by a value equal to 1/kΔM/P), to LM´. The equilibrium is now at E_1. Income rises to Y_1, and the interest rate falls to i_1.

Figure 14. Effect of an increase in the quantity of money on the level of income depending on the value of the sensitivity of the demand for money to the interest rate



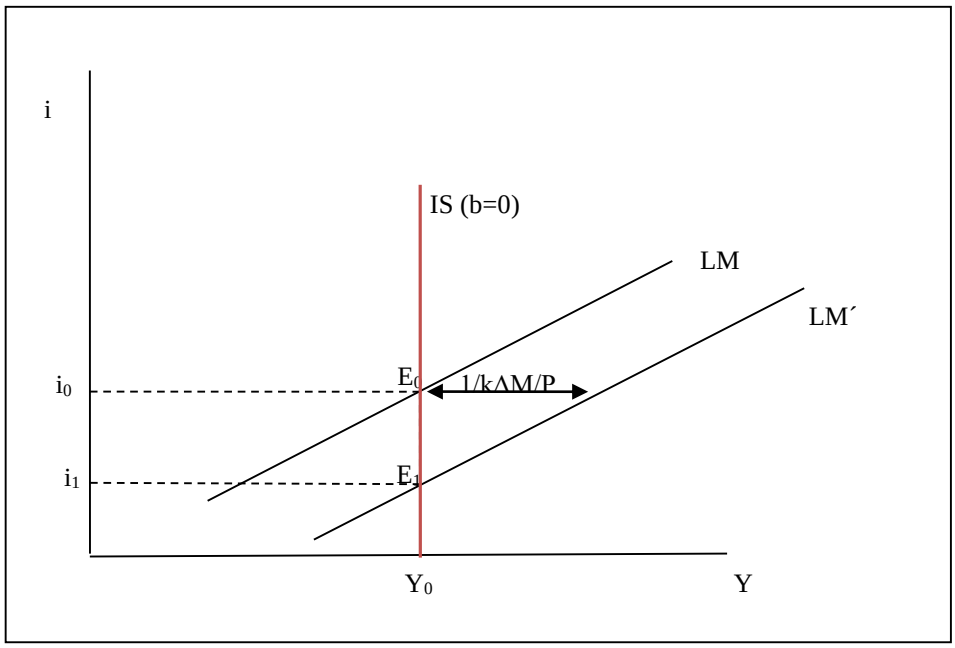
If the value of b is small, the slope of the IS curve will be large, and the curve quite steep. If we start from the same equilibrium situation, the IS curve when b is small cuts with the LM curve at the same point E_0, but now it is steeper. It is shown in red. If the quantity of money increases by the same amount as before, then the LM curve will shift to the right by the same amount as before. Now, the cut-off point of the red IS curve with the LM' curve occurs for a lower interest rate and for a lower level of income. Thus, graphically we can state that the greater the sensitivity of investment to the interest rate, the greater the effect of monetary policy on income.

Effect of b on the effectiveness of an increase in the quantity of money: liquidity constraints

We can now analyze the special case of liquidity restrictions in the money market (when the sensitivity of investment to the interest rate is zero, b=0). In this case investment does not depend on the interest rate, so changes in the interest rate will have no effect on investment and, therefore, on DA. Thus, if DA does not vary, monetary policy will have no effect on the economy's income. Figure 15 shows this situation.

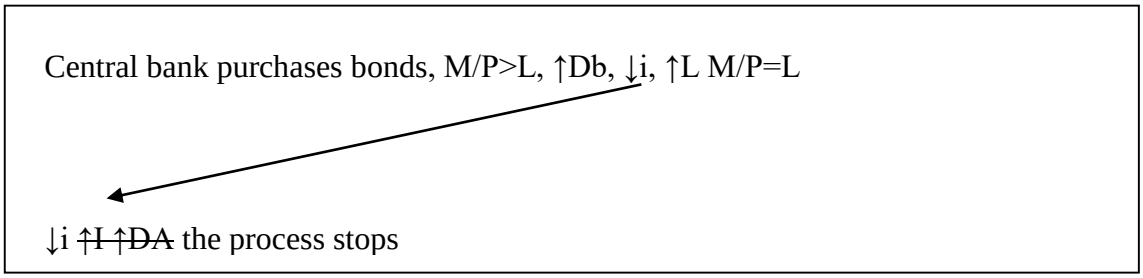
It should be remembered that, if investment does not depend on the interest rate, the IS curve will be totally vertical. In this case, if we start from an equilibrium position E_0 and increase the quantity of money, the LM curve will shift to the right up to LM', the new equilibrium will occur at E_1. At that point, the interest rate will have fallen to i_1, but income will not have increased. The effect of monetary policy will be zero.

Figure 15. Effect of an increase in the quantity of money if the sensitivity of the investment to the interest rate is zero.



What has been the causal process? The increase in the quantity of money unbalances the money market and the interest rate decreases. However, the decrease in the interest rate does not change investment and the process stops at that point without having any effect on income. Figure 16 shows the diagram of this causal process.

Figure 16. Causal process of adjustment of the economy due to an increase in the quantity of money in the case of liquidity restrictions.



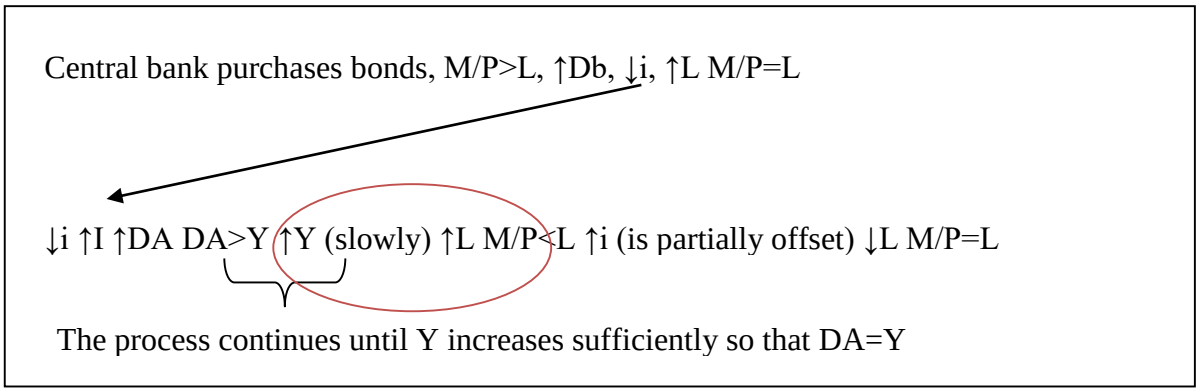
Therefore, in the case where b is zero, monetary policy has no effect.

Effect of the sensitivity of money demand to income and of the expenditure multiplier on the effectiveness of monetary policy consisting of an increase in the quantity of money

In addition to the above parameters, also two other parameters affect the effect of monetary policy. They are k (sensitivity of money demand to the interest rate) and αG (expenditure multiplier).

The first one (k) affects the response of money demand when income increases. If the demand for money increases a lot (because k is large), the interest rate will fall a lot and largely offset the initial decrease in the interest rate, with investment, demand and income then increasing little. Monetary policy will have little effect. Figure 17 shows in a red circle the point where the value of k affects the chain of causal effects.

Figure 17. Effect of k on the effectiveness of an increase in the amount of money.

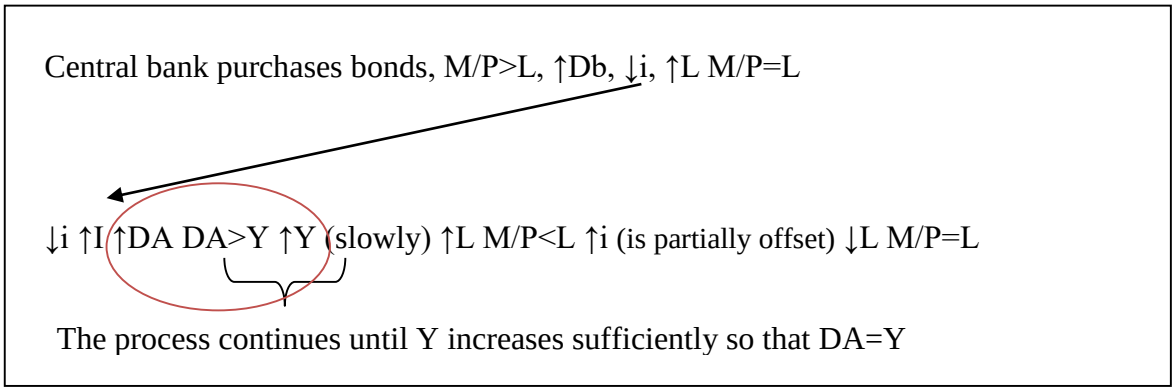


In addition, it should be noted that the increase in k causes the value of the LM curve shift to the right to be smaller, since the value of this shift is 1/kΔM/P. The smaller the LM shift to the right, the smaller the effect of monetary policy.

The second parameter affecting the effectiveness of monetary policy is αG. When investment increases, DA increases and this rise causes income to grow. However, the increase in income is greater than the initial increase in DA, due to the multiplier effect. That is, as income increases, disposable income will increase, and therefore consumption, causing a new increase in DA to arise, which drives income to grow again. As the multiplier increases, this effect will be greater and, therefore, income will increase to a

greater extent. Figure 18 shows with a red circle the point at which the multiplier affects the chain of causal effects.

Figure 18. Effect of αG on the effectiveness of monetary policy consisting of an increase in the quantity of money.



It should also be noted that an increase in αG affects the slope of the IS curve. As αG increases the slope of IS becomes flatter, and if IS is flatter, the effect of monetary policy on equilibrium income is larger (this case is similar to a large b-value).

Analytical analysis of the effect of an increase in the quantity of money

The effect of monetary policy can also be analyzed through the mathematical expression of the monetary policy multiplier that we obtained earlier. We may recall that in equilibrium, the value of income is $Y^* = \frac{\alpha_G h}{h+\alpha_G bk}\bar{A} + \frac{\alpha_G b}{h+\alpha_G bk}\frac{M}{P}$. Thus, the monetary policy multiplier is equal to $\frac{\alpha_G b}{h+\alpha_G bk}$

This multiplier indicates how much income increases when the quantity of money increases if the value of A remains constant. Mathematically

$\Delta Y = \frac{\alpha_G b}{h+\alpha_G bk}\Delta\frac{M}{P}$. So that

$$\frac{\Delta Y}{\Delta\frac{M}{P}} = \frac{\alpha_G b}{h+\alpha_G bk} = PM\ multiplier$$

Therefore, we can see that its value will be higher or lower as the value of the parameters that define it changes.

In general, we can say that the monetary policy multiplier will be larger, i.e., monetary policy will have a greater effect on income, as h and k are smaller and b is larger.

Likewise, we can also assess how much the multiplier is worth in certain extreme cases.

h=0

We begin by analyzing the effect of h on the multiplier. If h is zero, the multiplier will be equal to $\frac{\Delta Y}{\Delta\frac{M}{P}} = \frac{\alpha_G b}{h+ \alpha_G bk} = \frac{\alpha_G b}{\alpha_G bk}$ =1/k.

In this case, $\Delta Y = \frac{1}{k} \Delta \frac{M}{P}$. This is equivalent to saying that the increase in income is equal to the value of the shift of the LM curve to the right. Therefore, the effect of PM is maximum.

h→∞

In this case, in order to be able to assess the value of the PM multiplier when h→∞ we apply this limit to the value of the multiplier. Thus,

$$\lim_{h\to\infty} \frac{\Delta Y}{\Delta \frac{M}{P}} = \lim_{h\to\infty} \frac{\alpha_G b}{h + \alpha_G bk} = \frac{\alpha_G b}{\infty} = 0$$

Therefore, when h→∞ monetary policy has no effect.

b=0

If b is zero, the multiplier will be equal to $\frac{\Delta Y}{\Delta\frac{M}{P}} = \frac{\alpha_G b}{h+ \alpha_G bk} = \frac{0}{h}$ =0.

Therefore, when b=0 monetary policy has no effect.

b→∞

In this case, in order to be able to assess the value of the PM multiplier when b→∞ we apply this limit to the value of the multiplier. So,

$$\lim_{b\to\infty} \frac{\Delta Y}{\Delta \frac{M}{P}} = \lim_{b\to\infty} \frac{\alpha_G b}{h + \alpha_G bk} = \frac{\infty}{\infty}$$

To eliminate this indeterminacy, we apply l'Hopital's rule. In this way

$$\lim_{b\to\infty} \frac{\alpha_G}{\alpha_G k} = \frac{1}{k}$$

Therefore, when b→∞, $\Delta Y = \frac{1}{k} \Delta \frac{M}{P}$. This is equivalent to saying that the increase in income is equal to the value of the shift of the LM curve to the right. Therefore, the effect of PM is maximum.

k=0

It means that the demand for money does not depend on income and this does not make sense. However, we could suppose that its value would be low, so we calculate its value as a reference limit.

If k is zero, the multiplier will be equal to $\frac{\Delta Y}{\Delta \frac{M}{P}} = \frac{\alpha_G b}{h + \alpha_G b k} = \frac{\alpha_G b}{h}$, i.e., directly related to the parameters $\alpha_G b$ and inversely related to h.

k=1

Empirical evidence shows that the value of k can in many cases approach unity. Also, many theoretical studies simplify the expression of the demand for money by considering k=1. Therefore, we also calculate this value. In this case

$$\frac{\Delta Y}{\Delta \frac{M}{P}} = \frac{\alpha_G b}{h + \alpha_G b}$$

k→∞

In this case, in order to assess what the PM multiplier is worth when k→∞ we apply that limit to the value of the multiplier. Thus,

$$\lim_{k \to \infty} \frac{\Delta Y}{\Delta \frac{M}{P}} = \lim_{k \to \infty} \frac{\alpha_G b}{h + \alpha_G b k} = \frac{\alpha_G b}{\infty} = 0$$

Therefore, if k tends to infinity, the effect of PM is zero.

Such large values of k are not seen in reality. However, this study is useful to see how the effect decreases as the value of k increases k

α_G=1

The minimum value that the expense multiplier can have is 1. In this case,

$$\frac{\Delta Y}{\Delta \frac{M}{P}} = \frac{\alpha_G b}{h + \alpha_G b k} = \frac{b}{h + b k}$$

α_G→∞

In this case, in order to be able to assess the value of the PM multiplier when $\alpha_G \rightarrow \infty$ we apply this limit to the value of the multiplier. Thus,

$$\lim_{\alpha G \rightarrow \infty} \frac{\Delta Y}{\Delta \frac{M}{P}} = \lim_{\alpha G \rightarrow \infty} \frac{\alpha_G b}{h + \alpha_G bk} = \frac{\infty}{\infty}$$

To eliminate this indeterminacy, we apply the l'Hopital's rule. Thus,

$$\lim_{\alpha G \rightarrow \infty} \frac{b}{bk} = \frac{1}{k}$$

Therefore, when $\boldsymbol{\alpha_G} \rightarrow \infty$, $\Delta Y = \frac{1}{k} \Delta \frac{M}{P}$. This is equivalent to saying that the increase in income is equal to the value of the shift of the LM curve to the right, being the effect of the MP maximum. Therefore, if $\boldsymbol{\alpha_G}$ tends to infinity, the effect of the PM is maximum.

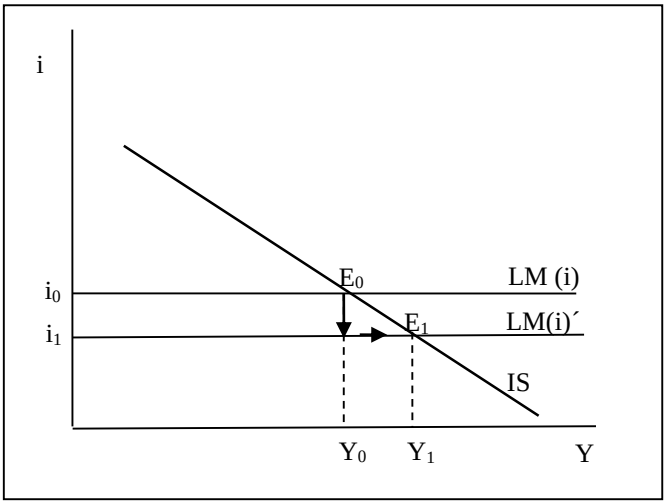
Such large values of $\boldsymbol{\alpha_G}$ are not appreciated in reality, however, this study is useful to see how the effect increases as the value of $\boldsymbol{\alpha_G}$ increases.

7.2.3. Monetary policy consisting of a decrease in the interest rate and the IS-LM model equilibrium.

In order to analyze the effect of this monetary policy we use the IS-LM(i) model. We assume that we initially start from an equilibrium position. Figure 19 shows that the initial equilibrium point is E_0, where the IS curve cuts with the initial LM(i) curve. We now assume that the Central Bank decides to lower the interest rate, for example because the income level of the economy is low. This effect causes the LM(i) curve to shift downward in parallel to the new value of the interest rate i_1. The initial point E_0 is no longer an equilibrium position of the economy, since, although it is on the IS curve and, therefore, the goods market is balanced, it is no longer on the new LM(i) curve, i.e., on LM(i)'.

Then where is the new equilibrium point of the economy? The new equilibrium is at E_1, that is, where the IS curve cuts the new LM(i)' curve. After conducting monetary policy, the equilibrium point of the economy changes, causing income to rise.

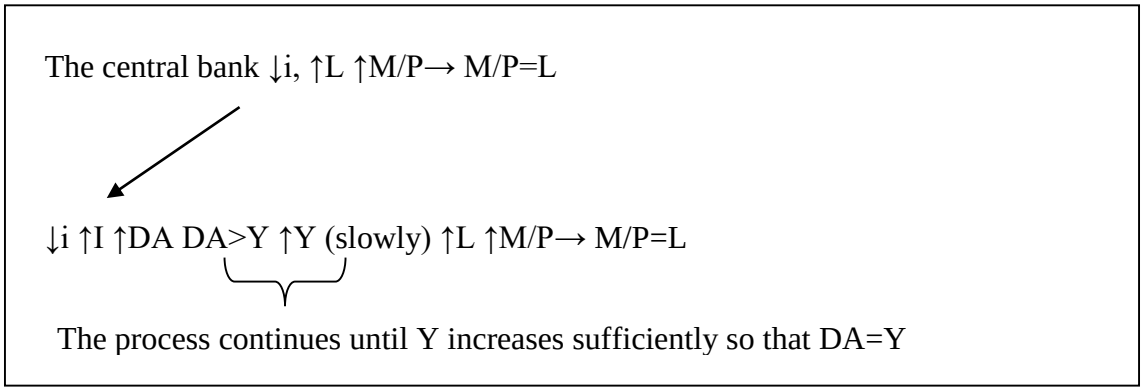
Figure 19. Effect of a decrease in the interest rate on simultaneous equilibrium.



What is the process by which we move from equilibrium point E_0 to E_1? In short, what is the adjustment process of the economy to the monetary policy conducted by the central bank? When the central bank lowers the interest rate to i_1, two effects occur. The first is immediate, lowering the interest rate increases the demand for money and the money supply will increase to balance the money market. The second effect is slower, lowering the interest rate will increase investment (so $I=\bar{I}-bi$) and as investment increases, DA will also increase. Thus, when DA increases, it will be greater than the economy's income (DA>Y), and the goods market will enter disequilibrium. It should be noted that up to this point income has not changed, the economy continues to have a level of income equivalent to Y_0. The disequilibrium in the goods market will put pressure on the economy to increase income until equilibrium is restored in the goods market. This process is slow. Figure 20 shows such a process. In this second process, the increase in income will increase the demand for money, reinforcing the rise of the first effect. As a result, the money supply will increase even more.

The final effect of the monetary policy carried out by the central bank has been to increase income.

Figure 20. Causal process of adjustment of the economy due to a decrease in the interest rate.



Negative interest rates

We have seen that the decrease in the interest rate by the central bank increases income, so if we want to make the income of the economy grow, an effective policy can be to lower the interest rate. But what if the interest rate is already very low? In this case, it would be necessary to lower the interest rate further, even turning the interest rate negative.