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EQUILIBRIUM INCOME AND MONETARY POLICY STRATEGY: TEACHING MACROECONOMICS WITH THE MP CURVE

Rosaria Rita Canale*

Abstract

The aim of the paper is to present a derivation of a simple tool describing monetary policy behaviour, useful to teach macroeconomic policies in open economies, the MP curve. The objective is to overcome the limits of the standard IS-LM model and underline the importance of the central bank strategy in influencing output and employment. We demonstrate that if the main policy instrument is the interest rate, the monetary policy authorities have very great influence in determining macroeconomic equilibrium.

In fact the monetary policy strategy - of which the MP curve is the representation - is able to create, once given the dynamic supply curve and the IS curve, different levels of income in accordance to the inflation target, or different levels of inflation in accordance to the income target. Furthermore - because the nature and form of the MP curve depends both on constraints and targets the monetary policy considers and they might not be correctly interpreted - the central bank could assume a misleading behaviour, guiding the economic system toward a level of activity, not consistent with full employment and price stability.

JEL classification: A20, E58, E61

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Abstract

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1. Introduction

The most diffused tool economists has been using to teach macroeconomic policy till the end of the XX century is the IS-LM model because – despite its limits - it has been considered a very powerful instrument to understand the demand side.

However from the beginning of the '80s the power to explain through it money market working and policy strategies has been becoming weaker and weaker.

In fact economists moved some internal critiques¹ concluding that the IS-LM model is unable to capture the real-world working and the dynamic adjustments of supply and demand. As Colander (1995) says “if supply and demand are independent *the standard disequilibrium analysis do not lead to a unique equilibrium with anything less than instantaneous price level adjustment*”². This happens

¹ The external critiques can be widely re-conducted to the increasing role of monetary policy and central banks in determining equilibrium income and to the theoretical refuse of fiscal interventions as active policy instruments.

² Colander (1995) p.178.

because – briefly summarizing what authoritative authors have underlined - the IS-LM model does not include in its analysis the inflation rate and labour market dynamics (see for example Walsh 2002 and Bofinger et al. 2006 e Bofinger 2008). Further limits have raised from the working of modern economies in which money cannot be directly controlled by monetary policy authorities, because banking and financial systems can create or destroy payment instruments each time a central bank conducts a restrictive or expansive monetary policy respectively. Therefore – not in accordance with the money market equilibrium represented by the LM curve - the central bank can control money growth just indirectly through the interest rate setting (Kaldor 1982. The point is now accepted by all stream of thoughts). As Romer (2000 and 2005) writes, the IS-LM model is not consistent with modern central banks practice of fixing the discount rate. Moreover the international enlargement of countries economic dimension makes evident that the introduction of the external balance and of the exchange rate is not just a further complication of the model but an essential element that ought to be considered.

These conclusions were clearly introduced in the economic reasoning at the beginning of the '90s with the Taylor article titled *Discretion versus policy rules in practice* (1993). He found a practical rule through which the monetary policy, aiming at controlling output and inflation growth can be conducted. The money market equilibrium was transformed – through this instrument known as Taylor rule - in the one resulting from the monetary policy strategy.

More recently the contributions of David Romer (2000) *Keynesian macroeconomics without the LM curve* appeared on the *Journal of Economic Perspectives* and *Short-run fluctuations* (2005) explicitly introduced in common teaching a new instrument to be easily substituted to the LM curve taking into account the new findings of monetary policy theory: the MP curve. Then, the contributions of Walsh (2002) and Bofinger (the most recent is 2008, but see also Bofinger et al. 2002 and 2006) tried to fill the gap correlated to the inflation rate elaborating a model including price dynamics in open economies.

The Romer's solution – however - has the very important advantage that can be superimposed to the old IS-LM model without great changes in the graphical and analytical tools, at least if we consider the closed economy or the flexible exchange rates . It appears that it is not only able to overcome the limits of the standard model, but has also theoretical implications of the utmost importance: in fact it transforms the money-market equilibrium, once represented in the LM curve, into one resulting from the monetary policy strategy.

The aim of the paper is to present a simple analytical derivation of the MP curve, useful to teach macroeconomics in open economies and through which underline the importance of monetary policy in influencing output and employment – as the Taylor rule asserts - at least in the short run. We demonstrate that if the main policy instrument is the interest rate, the monetary policy authorities have, because we include in the analysis inflation and supply curve, very great influence in determining equilibrium income,.

The paper is organized as follows: next paragraph present a simple analytical derivation of the monetary policy rule - the MP curve - in a closed economy, taking into account the income multiplier determined constraint and the supply curve constraint. Paragraph three extends the analysis to the open economy, differentiating the conclusions between flexible exchange rates and fixed exchange rates. The last paragraph summarizes the reasons why this representation of the MP curve is able to overcome the limits of the model including the implications of the policy strategies on the definition of the aggregate equilibrium of inflation and income. In fact the monetary policy strategy of which the MP curve is the representation is able to create, once given the dynamic supply curve and the IS curve, different levels of income in accordance to the inflation target, or different levels of inflation in accordance to the income target. Furthermore, because the constraints might not be correctly interpreted, the central bank could assume a misleading behaviour, guiding the economic system toward a level of activity, not consistent with full employment and price stability.

This means that we cannot talk anymore about the money the market equilibrium determining the values of inflation and income at aggregate level, but, at least in the short run, we have to talk about

monetary policy equilibrium and its influence on macroeconomic conditions because the nature and form of the MP curve depends both on constraints and targets the monetary policy considers.

2. The MP curve in a closed economy

Without recalling the LM curve, whose equations are well known to whoever studies or teaches basic macroeconomics, we can start from the relations between supply and demand in modern monetary market.

As usual the equation representing real money demand is:

$$(1) M_d = (kY - hi)P$$

Where M_d is the nominal demand for money and P the general level of prices.

The real demand for money is positively related to income Y following the parameter k and negatively related to the interest rate following the parameter h .

According to current conclusions of economic theory – making a simplification of the arguments bringing to the point - means of payment supply responds to the request coming from the market.

Therefore we can say that money supply depends on money demand so that:

$$(2) M_d = M_s = \bar{M}$$

Where \bar{M} is the quantity of means of payment endogenously determined.

From which follows:

$$(3) \bar{M} = (kY - hi)P$$

The same relation can be expressed – using logs - in terms of growth rate:

$$(4) m = ky - hi + \pi$$

where m is broad money growth rate, π is the inflation rate and k and h measure, as in previous page, the influence of income and interest rate on money growth respectively.

We can assume, without going too far from the truth, that a generic Central Bank wants to control the quantity of broad money growth through the interest rate instrument in order to reach its objectives which are output growth and/or the inflation rate.

We can assume also that, if the banking system creates too many means of payment, the currency loses its value. The monetary policy authority has therefore a loss function linked to the growth rate of money:

$$L = L(m)$$

Or, considering the variables upon money growth depends on:

$$L = L(y, i, \pi)$$

Writing the loss-function in an explicit and very simple form we have:

$$(5) \sum L_i = \frac{1}{2} \sum (ky_i + \pi_i - hi_i)^2$$

The Central Bank looks for the rate of interest - the instrument – which minimizes the loss-function or the m rate of growth.

$$\text{Min} \sum L_i = \text{Min} \frac{1}{2} \sum (ky_i + \pi_i - hi_i)^2$$

We can – without being mistaken – suppose also that the central bank wants to control the money growth taking into account the level of the equilibrium aggregate demand of goods and the relation between inflation and income on the side of supply. We have therefore a constrained minimization problem to solve.

The loss function can be considered to be subject to the following constraints:

$$(6) \text{ sub} \begin{cases} y_i = -\rho(i - \pi_i^e) \\ \pi_i = \sigma y_i + \pi_i^e \end{cases}$$

The first equation is a dynamic IS curve and represent the multiplier determined income equation; ρ measures the effect of the interest rate and inflation expectations variations on the demand determined equilibrium income. The second one is the supply curve where current inflation

is put into relation with income growth and inflation expectations; σ represent the slope of the supply curve.

Suppose as first step that the central bank targets inflation.

We can reduce the constraint in one single equation. Substituting the IS in AS, we have just one constraint:

$$(6') \pi_t = -\sigma\rho i_t + (1 + \sigma\rho)\pi_t^e$$

Considering - for the sake of simplicity - just one period of time, substituting the constraint in the loss-function and solving for the rate of interest we have:

$$(7) i_t = \frac{1 + \sigma\rho}{\sigma\rho + h} \pi_t^e + \frac{k}{\sigma\rho + h} y_t$$

The (7) is the reaction function of the central bank to income increase and inflation expectations increase. Because it derives from a constrained minimization process it is also the optimal strategy a central bank can use if it wants to reach a certain inflation.

Indicating with:

$$\alpha = \frac{1 + \sigma\rho}{\sigma\rho + h}; \text{ and with } \beta = \frac{k}{\sigma\rho + h}$$

We can write:

$$(8) i = \alpha\pi_t^e + \beta y_t$$

or

$$(9) i = \alpha\pi_t + \beta y_t$$

if $\pi_t^e = \pi_t$ i.e. if prices expectations coincide with current values.

Suppose now as a second step that the central bank targets also the income level.

There is a quantity of money growth m^* consistent with the level of full employment y^* and target inflation π^* and it is:

$$m^* = ky^* - hi^* + \pi^*$$

We can derive, following the same way of reasoning as before, the following reaction function:

$$(10) i^* = \alpha\pi^* + \beta y^*$$

Where i^* can be interpreted as equilibrium interest rate, i.e. the rate that allows to reach the level of full employment and the target inflation³.

Subtracting equation (10) from equation (9) and solving for the rate of interest we have:

$$(11) i = i^* + \alpha(\pi - \pi^*) + \beta(y - y^*)$$

Which is the equation known as Taylor rule.

According to equation (11) central bank fixes the interest rate taking into account a kind of an equilibrium interest rate, the inflation gap and the output gap.

Precisely the central bank increases interest rates above i^* each time inflation grows and each time income grows, but reduces it each time the inflation gap increases and output gap increases too.

We can represent this equation through the so called MP curve which puts into relation interest rate and output, other things being equal. (Figure 1)

As said before it is the result of a constrained maximization process, and is therefore a reaction function. Its slope depends on the value of β which in turn depends on money demand preferences k and h and on the slope of the supply curve σ and on the value of the multiplier ρ ; in particular assuming $0 < \rho < \infty$ if

$$\sigma = \infty \rightarrow \alpha = 1 \text{ e } \beta = 0;$$

$$\sigma = 0 \rightarrow \alpha = \frac{1}{h} \text{ e } \beta = \frac{k}{h}.$$

In this last case the slope of the MP curve is equal to that of the old LM curve.

Examining in depth the value of the coefficients we can say that the higher the slope of the supply curve the lower the interest rate reaction on income increase or decrease (panel b). This happens because the equilibrium income does not increase as a consequence of the demand increase and

³ The great part of authors considers this value of the rate of interest as equal to the real capital revenue, i.e. the rate of interest.

therefore does not press on prices⁴. The higher is the slope of the supply curve the flatter is the MP curve. If we assume that σ has a value of infinite it means that *via* setting the interest rate the central bank determines the value of equilibrium aggregate demand just looking at inflation gap. The lower the slope of the supply curve, the greater is the importance of money demand preferences in defining policy strategy as in the model of the neoclassical synthesis.

Figure 1. The MP curve

Each point above or below the MP curve is not consistent with the optimal monetary policy strategy: each point above describes a situation of excess of restriction and each point below describes a situation of a too easy monetary policy in respect with target inflation and income (panel (a)).

The MP curve changes its position on the panel when the values of target inflation, or full employment income, or equilibrium interest rate vary and precisely: the higher the target inflation the lower the interest rate, the higher the output gap the lower the interest rate, other things being equal (panel (c)) .

3. The MP curve in an open economy

The same way of reasoning can be extended to an open economy. Obviously we have to distinguish between flexible and fixed exchange rates. Let's start from flexible exchange rates because it appears to be very similar to the case of a closed economy.

Case A: flexible exchange rates

Policy authority chose flexible exchange rates to use monetary instruments to be free to stabilize inflation and output, because under this condition monetary policy can be managed autonomously.

⁴ The same considerations can be done if we consider the value of ρ . In fact the lower the value of the multiplier the lower is the effect on income of interest rate increase and therefore the lower the reaction needed to preserve the target inflation.

The analytical derivation of the MP – i.e the monetary policy rule – in an open economy under pure flexible exchange rate regime starts from the loss function which is the same as in a closed economy, because the monetary policy authority still has the control on money growth. More precisely we have again:

$$\sum L_i = \frac{1}{2} \sum (ky_i + \pi_i - hi_i)^2$$

Otherwise the constraint is :

$$\text{sub} \begin{cases} y_i = -\rho(i - \pi_i^e) + \xi E \\ \pi_i = \sigma y_i + \pi_i^e \end{cases}$$

Because now the IS curve is influenced by exchange rate movements. In fact ξE is the effect of the exchange rate on aggregate demand showing that – under the most diffused circumstances – an increase of E (depreciation) increases exports and decreases imports, increasing therefore the component of aggregate demand coming from abroad.

Expressing the constraint in one single equation we have:

$$\pi_i = -\sigma\rho i + (1 + \sigma\rho)\pi_i^e + \sigma\xi E$$

Which, if substituted in the loss function, gives the equation of the MP curve in an open economy under flexible exchange rate regime:

$$(12) \quad i = \frac{1 + \sigma\rho}{\sigma\rho + h} \pi_i^e + \frac{k}{\sigma\rho + h} y_i + \frac{\sigma\xi}{\sigma\rho + h} E$$

According to which a depreciation of the exchange rate requires an increase of interest rates the central bank sets. This happens because the current account surplus is a source of money growth.

Or indicating with $\gamma = \frac{\sigma\xi}{\sigma\rho + h}$

$$(12') \quad i = \beta\pi_i^e + \delta y_i + \gamma E$$

Which becomes as above:

$$(13) \quad i = i^* + \alpha(\pi - \pi^*) + \beta(y - y^*) + \gamma(E - E^*)$$

Where E^* can be interpreted as the exchange rate allowing the balance of payments equilibrium. E^* is in fact the exchange rate that at the same time sets in equilibrium the current account and the internal and external interest rates. If $(E - E^*) = 0$ the last term of the reaction function can be omitted.

Case B: Open economy and fixed exchange rates

The monetary policy rule and the reaction function of the central bank changes if we consider a fixed exchange rate regime. Under this currency regime the Central bank cannot control anymore the domestic quantity of money. It depends on the fact that monetary policy authorities have as first objective the balance of payment equilibrium under the condition that the exchange rate is fixed.

The loss function can therefore be expressed as dependent on assets and liabilities of foreign exchange accounts:

$$L = L(BP)$$

Under fixed exchange rates the balance of payments surplus or deficit is equal to the variation of official reserves:

$$BP = \Delta RU$$

Which in turn is equal to:

$$\Delta RU = x_0 Y_w + \xi E - m_0 Y + \omega(i - i_E - \Delta E^e)$$

Because the variation of official reserves is a function of all that determines the balance of payment, i.e. a positive function of world income, exchange rate and of the difference between internal interest rate and foreign one and expected devaluations of the exchange rate, or the *uncovered interest parity* following the parameter ω which measures the degree of capital mobility.

Therefore the loss function can be written also:

$$\sum_i L_i = \frac{1}{2} \sum_i \Delta RU_i^2$$

Or in an explicit form:

$$\sum_i L_i = \frac{1}{2} \sum_i \left[x_{0i} Y_{wi} + \xi E_i - m_0 Y_i + \omega (i_i - i_{Ei} - \Delta E_i^e) \right]^2$$

Differently from previous cases the constraint is given by the exchange rate fixed by policy authorities:

$$\text{Sub } E = E_0$$

Substituting the constraint in the loss function and deriving for the instrument – the rate of interest, we have the following monetary policy rule under fixed exchange rate regimes:

$$i = -\frac{\xi}{\omega} E_0 - \frac{x_0}{\omega} Y_w + \frac{m_0}{\omega} Y + i_E + \Delta E^e$$

Which is – looking at it carefully – precisely the equation of the balance of payment, once fixed the exchange rate. It says that the monetary policy authority, if wants to respect the exchange rates agreements and at the same time preserve the balance of payment equilibrium, has to increase interest rates each time internal income increases or foreign income reduces in order to compensate with capital inflows the current account deficit. In the same way the central bank has to rise interest rates each time there is an expected depreciation of the exchange rate and an increase of the foreign one. An increase of the exchange rate resulting from the agreements would cause a reduction of the interest rate.

If there is perfect capital mobility or

$$\omega = \infty$$

The reaction function becomes:

$$i = i_E + \Delta E^e$$

And if the exchange rate is credible and operators do not expect devaluations or revaluations of the currency

$$\Delta E^e = 0$$

The reaction function is totally dependent from abroad.

$$i = i_E$$

According to which it is not possible to fix the interest rate at a value not consistent with the balance of payment equilibrium if we want to maintain the exchange rate agreements.

Figure 2 The MP curve and BP curve under different exchange rates regimes

Figure 2 shows the case of the open economy: in section (a) we have the MP curve under flexible exchange rates whose slope and position on the panel is set by the same equations as in a closed economy, but we have to add the shifts caused by the exchange rate movements. In particular an increase of E moves the curve upward and leftward, while a decrease rightward and downward. In the same panel we have represented the BP curve in order to show the difference with the monetary policy strategy. In section (b) we represent an MP curve under fixed exchange rate that could be laid over the line representing the balance of payments and whose slope therefore depends especially on the capital mobility. So if $\omega = 0$ the MP curve is vertical while if $\omega = \infty$ the MP curve is horizontal.

4. The MP curve and the aggregate demand

We said that the Central Bank interest setting process in a closed economy or under flexible exchange rate regime follows a reaction function which depends on its loss function and on the functions the IS and AS curves follows or the monetary policy authority think follows. In other words the central bank follows a reaction function that represent a monetary policy strategy allowing to reach the targets, given the constraints. Because the monetary policy strategy curve (MP) – as the LM is – is the lacking curve to complete the demand function, we can say that the monetary policy authority sets the demand curve, given the constraints coming from the market, or the central bank thinks come from the market.

The graphical representation can help us to understand the point. (Figure 3):

Suppose the monetary policy authority targets inflation: once given the IS (panel a) consistent with the exchange rate equal to that allowing the balance of payments equilibrium ($BP = 0$ because

$E = E^*$) and the AS (panel b) the central bank sets a reaction function (an MP curve) which allows to determine an AD curve crossing the supply curve (point A) once given the level of income Y_1 precisely at that value of inflation π_1 . The same way of reasoning can be applied if the Central Bank has an output target.

Figure 3 Macroeconomic equilibrium and monetary policy under flexible exchange rates

The fact that the central bank targets just inflation or just output depends on its estimate on the supply curve. The monetary policy authority follows a macroeconomic model in which the supply curve can be considered to have different slopes or in which the long-run values – if they exist - are considered to be much more important than short run ones.

Figure 4. Macroeconomic equilibrium and monetary policy: inflation targeting and wrong estimate of the supply curve

Problems arise when the central bank has an estimate of the market working different from what it really is, in particular in relation to the supply curve. Suppose for example that the supply curve is horizontal while the monetary policy authority thinks it is vertical or, observing facts from another point of view, observes long-run values and not short run ones (according to the central bank $\sigma = \infty$ so as the reaction function is $i = i^* + (\pi - \pi^*)$ while it is $\sigma = 0$).

As figure 4 shows, because the supply curve of the Central Bank is AS_{bc} while the market supply curve is AS_m , the AD curve created by the monetary policy authority determines an inflation higher than the target level $\pi_1 > \pi_0$ and a level of income lower than the equilibrium level $y_1 < y_0$. Next period, because observed inflation is again higher than the target one, monetary policy increases again interest rates, moving the MP curve upward in MP' and the AD curve downward in AD' , obviously causing a further reduction of equilibrium income. In this case if a central bank that targets just inflation when the supply curve has great unemployment features, sets the economic

system in a condition of equilibrium of unemployment removing also any spontaneous mechanism allowing to reach an higher income level.

Mutatis mutandis it can be said also that a Central bank that just targets the output, considers the supply curve horizontal, when it is not, lowers too much interest rates causing excessive inflation that undermines the economic system working. The situation is depicted in figure 5 where as before AS_{bc} is the Central bank supply curve, while AS_m is the effective one. The monetary policy authority lowering interest rates from i_0 to i_1 moves aggregate demand rightward from AD in AD' in the attempt to increase output to $y_1 > y_0$ but reaching just the level of y_2 . Because the supply curve is upward oriented, output cannot increase as desired, while inflation increases from π_0 to π_1 . Additional movements can occur if we consider the balance of payments. In this case the process of interest rate setting has to take into account external revenues. In fact the difference between these two values causes exchange rate movements which in turn cause also movements of the IS curve. But these additional cases do not change the nature of the phenomena.

Figure 5. Macroeconomic equilibrium and monetary policy: output targeting and wrong estimate of the supply curve

We can now consider the case of the MP curve of an open economy under fixed exchange rates. It is a very simple case because the MP curve moves upward or downward only if the current policy strategy is not consistent with the balance of payment equilibrium, given the exchange rate agreements. This means that the level of aggregate demand depends entirely on the balance of payments equilibrium. The supply curve can influence the aggregate demand through the effects inflation has on the expected depreciation or appreciation of the exchange rate and therefore on the balance of payments. As figure (6) shows if inflation is high or is thought to be high and agents sell national currency in exchange for external one, the central bank has to increase the interest rate to compensate this pressure moving the MP=BP in MP'=BP' and therefore the aggregate demand.

Figure 6. Monetary policy and equilibrium income under fixed exchange rates regime

In this case the form and position of the supply curve is not relevant for the definition of the policy strategy, but it enters in defining private operators inflation expectations and therefore national currency value expected variations. The slope of the supply curve defines the output effects of a demand movement and the long run sustainability of the fixed parity. In fact, for example a decrease of demand, due to the increase of interest rate necessary to preserve the balance of payments equilibrium after an expected depreciation - reduces the equilibrium income and affects the general consensus about the exchange rate agreements.

5. Conclusions

The monetary policy strategy of which the MP curve is the representation is able to create, once given the supply curve different level of income in accordance to the inflation target, or different level of inflation in accordance to the income target. The same conclusions can be extended to an open economy in which the interaction of the balance of payments introduces some additional variables to be considered. In particular under flexible exchange rates regime, the MP curve – even remaining as in a closed economy – moves also in accordance with the effects of interest rates movements on the equilibrium of the external accounts. Under fixed exchange rates the MP curve exactly coincides with the balance of payments curve because no monetary policy is possible other than that consistent with the balance of payment equilibrium.

This change in perspective underlines the role of monetary policy in defining the macroeconomic equilibrium and furnish a useful tool to overcome the limits of the old IS-LM model.

In fact, following Colander (1995), in this representation supply and demand are considered reciprocally dependent. The central bank defines its policy strategy in relation to the estimated supply curve and therefore “creates” an aggregate demand consistent with its targets.

Following Walsh (2002) and Bofinger (2008 and Bofinger et al. 2002 and 2006), the IS-MP model considers through the supply curve also the labour market dynamics. Finally following Romer contribution (2000 and 2005), this it considers the central bank practice of setting the interest rates instead of the quantity of money.

The additional conclusion of the paper is that it is underlined the fact that the monetary policy strategy defined by the MP curve is deeply influenced by the vision of the economic system has . In turn this vision – if not coincident with the real market working - determines problems in the definition of aggregate equilibrium income. This is true both under flexible exchange rate in which the policy strategy determines the level of inflation and unemployment, in relation to supply curve (actual or presumed) and under fixed exchange rates under which the policy strategy is determined exchange rates agreements.

Figure 1.
The MP curve

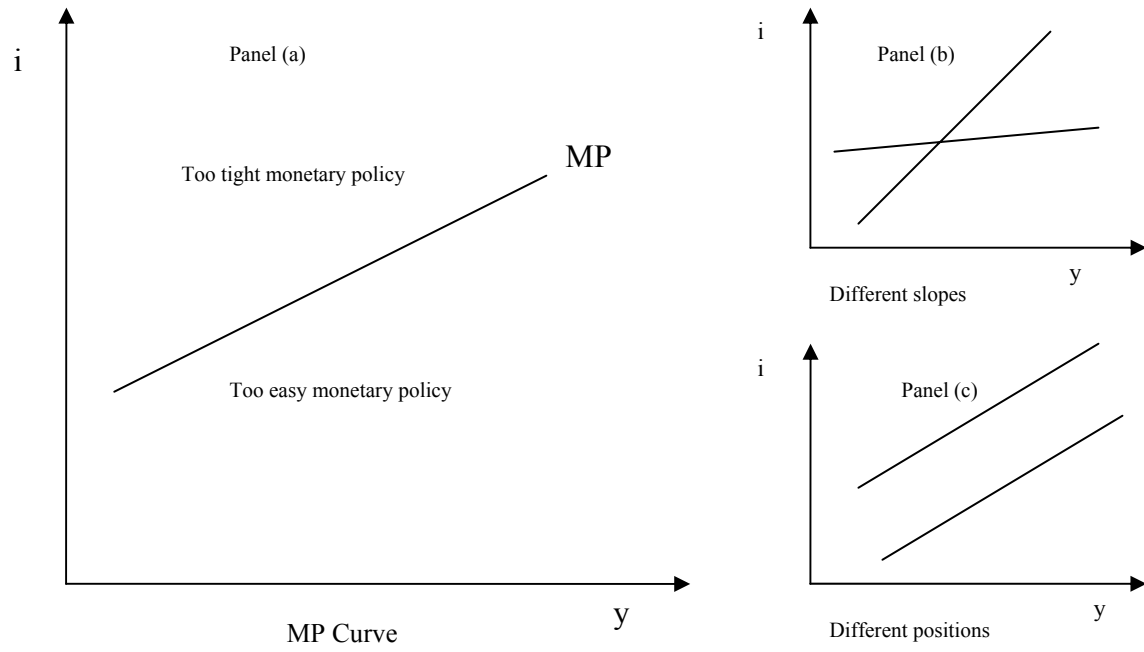


Figure 2.

The MP curve and BP curve under different exchange rates regimes

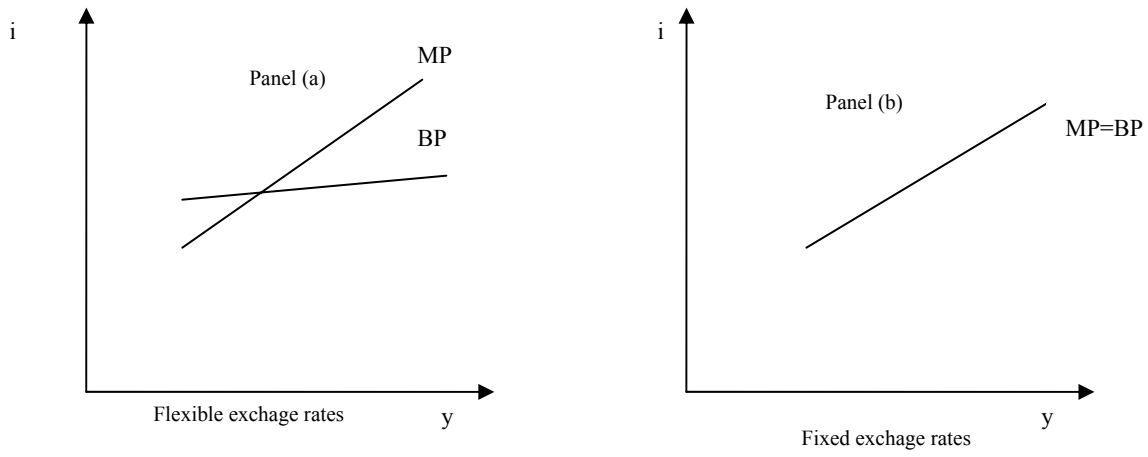


Figure 3

Macroeconomic equilibrium and monetary policy under flexible exchange rates

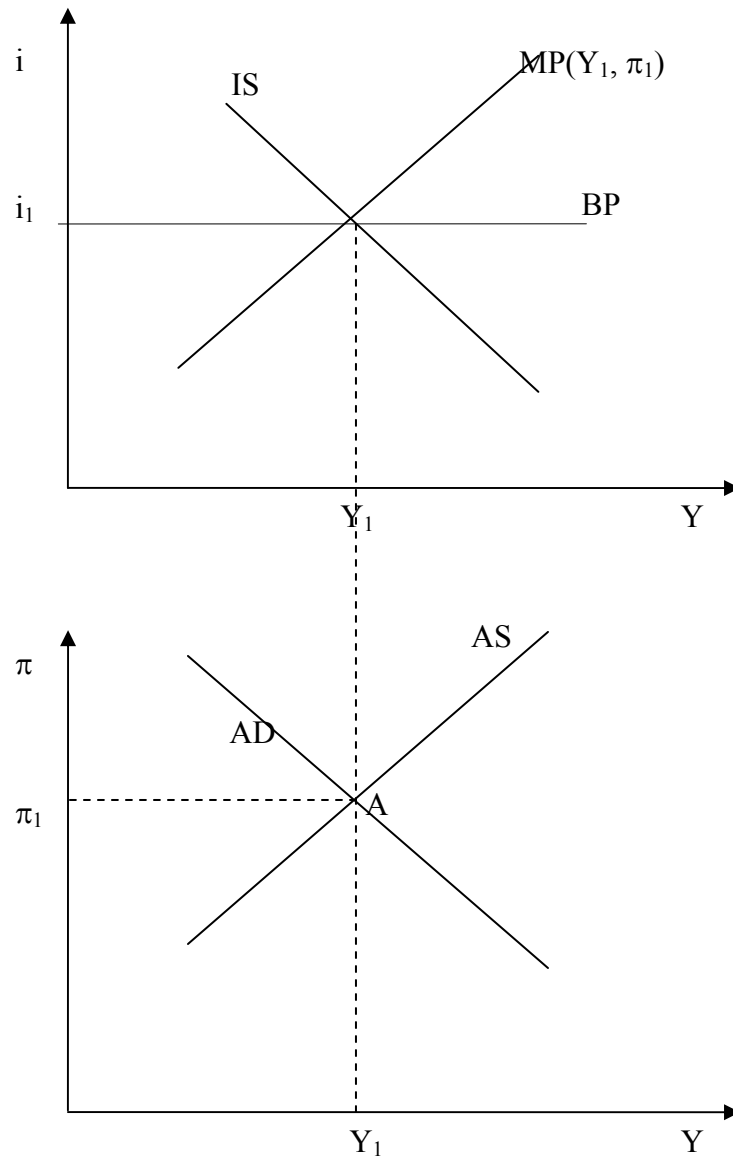


Figure 4.

Macroeconomic equilibrium and monetary policy: inflation targeting and wrong estimate of the supply curve

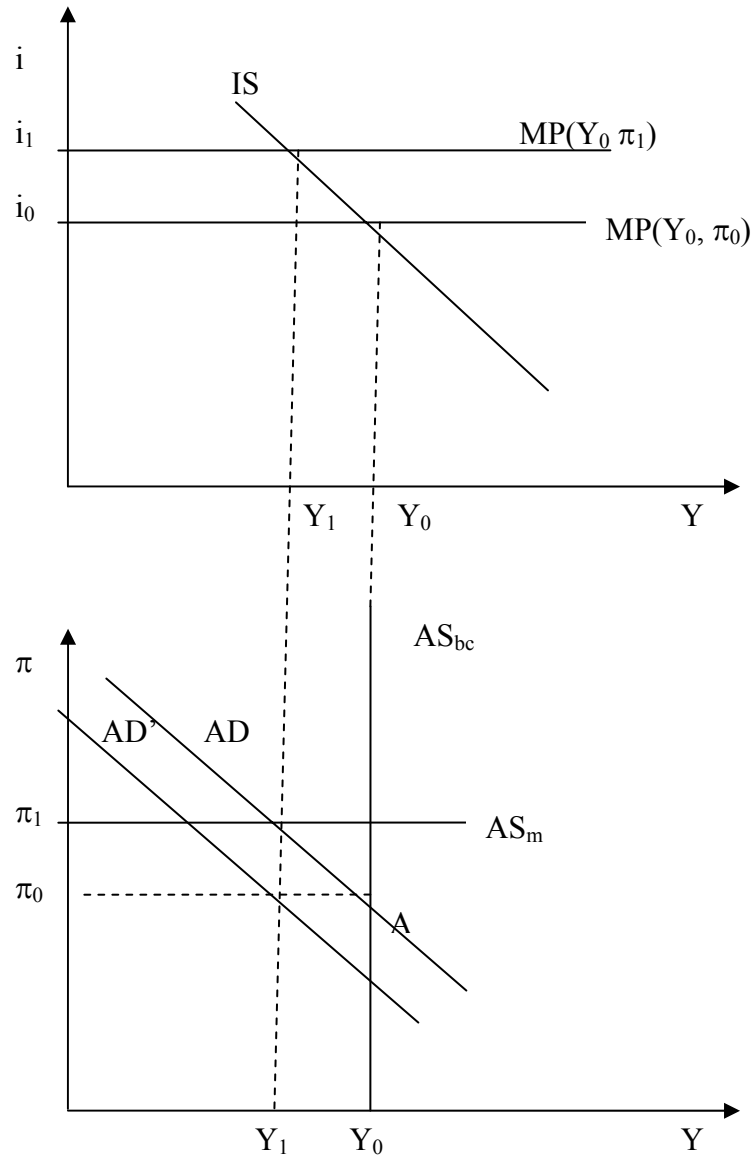


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Macroeconomic equilibrium and monetary policy: output targeting and wrong estimate of the supply curve

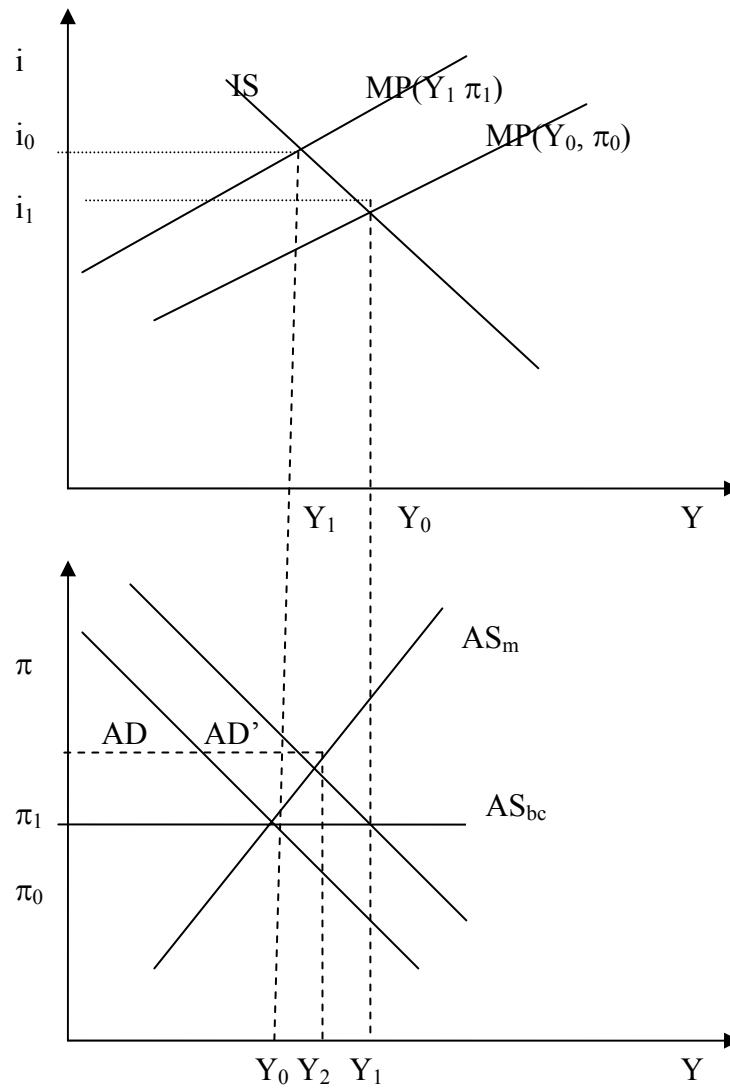
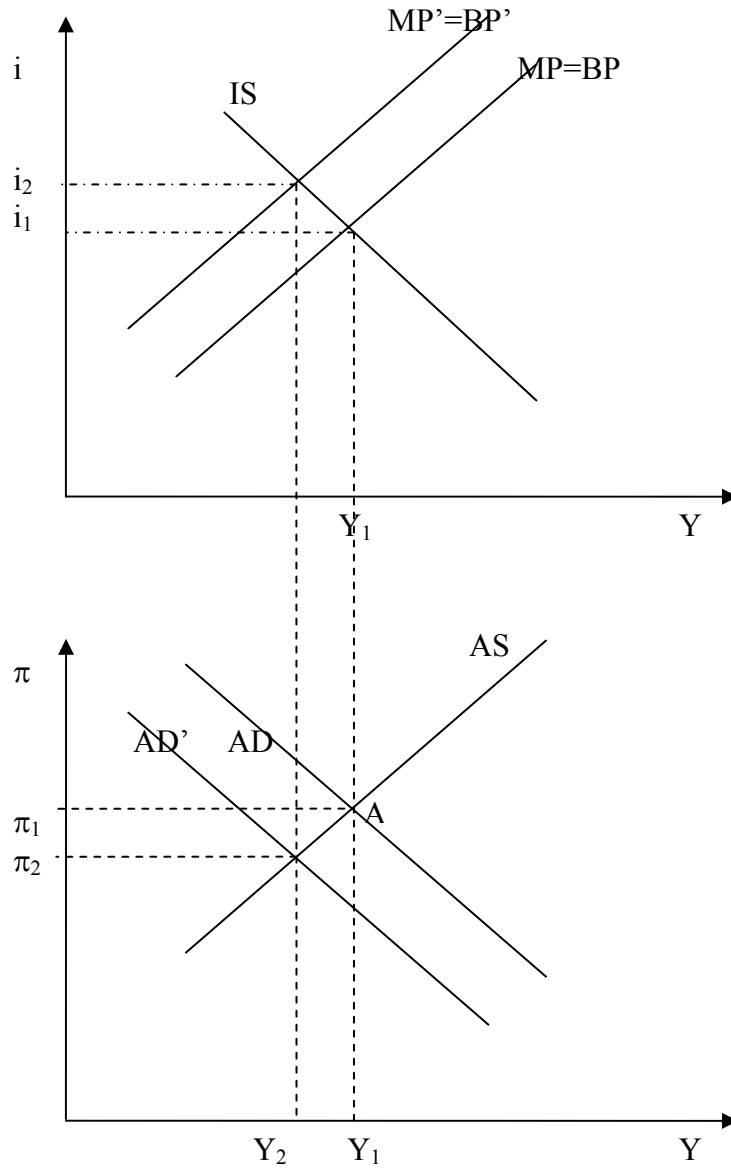


Figure 6.

Monetary policy and equilibrium income under fixed exchange rates regime



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