Chapter 6
The Monetary Approach to International Macroeconomics

The monetary approach is one of the central pillars of international macroeconomics. Its point of departure is the so called *monetary model*, which identifies the factors affecting long-term nominal exchange rates. The monetary model was originally used as a framework of analysis of the balance of payments in a fixed exchange rate regime (Frenkel and Johnson 1976), and then as a framework for analysis of the determination of nominal exchange rates in a flexible exchange rate regime (Frenkel and Johnson 1978).

The basic monetary approach assumes that there is full flexibility in prices and focuses on the equilibrium conditions in the money market and the international foreign exchange markets. Although this is basically an ad hoc model, like the Mundell-Fleming model, many of its theoretical properties are confirmed by inter-temporal optimization models in monetary economies (see Lucas 1982).

However, the monetary model has a number of empirical shortcomings. It relies on the assumption of purchasing power parity, which is rejected empirically, and it has difficulties in accounting for the high volatility of nominal exchange rates observed in practice.

The monetary model can be combined with the assumption of gradual adjustment in prices, and deliver a model that is more in accordance with the evidence, and which, in many ways, looks like the Dornbusch (1976) model. Thus, combining the monetary model with the assumption of gradual price adjustment, one can account for phenomena like exchange rate overshooting and the positive correlation between nominal and real exchange rates.

6.1 Purchasing Power Parity

A key component of the monetary approach is the concept of *purchasing power parity*. The idea originated from the early 19th century, and one can find it in the writings of Ricardo. The idea was revived in the early 20th century by Cassel (1921).

The approach of Cassel starts with the observation that the exchange rate is the relative price of two currencies. Since the purchasing power of the domestic currency is $1/P$, where P is the domestic price level and the purchasing power of the foreign currency is $1/P^*$, where P^* is the foreign price level, the relative price of two currencies should reflect their relative purchasing power. In this case, it should follow that,

$$S = P / P^* \tag{6.1}$$

or, in logarithmic form,

$$s = p - p^* \quad (6.2)$$

where for any variable X, $x=lnX$.

It is worth noting that the theory of purchasing power parity can be derived from the IS curve of an open economy, when the elasticity of aggregate demand with respect to the real exchange rate tends to infinity. For example, the IS curve in the Mundell Fleming that we examined took the form,

$$y = \delta(s + p^* - p) + \gamma y - \sigma i + g$$

As δ tends to infinity, aggregate demand will be finite only if the logarithm of the real exchange rate $s+p^*-p$ tends to zero, that is if (6.2) is satisfied. If the elasticity of aggregate demand with respect to the real exchange rate is very high, then there cannot be large deviations between domestic and international prices, expressed in a common currency, as even small deviations would produce large changes in aggregate demand. Effectively, the theory of purchasing power parity asserts that domestic and foreign goods are *perfect substitutes*.

The purchasing power theory approach essentially requires that the real exchange rate should be constant. However, this prediction is generally rejected by empirical evidence. Real exchange rates are not constant, but display considerable fluctuations. Moreover, there seems to be a strong positive correlation between nominal and real exchange rates, which is not consistent with purchasing power parity.

A variant of this approach, which we will examine below, allows fluctuations in the real exchange rate and treats purchasing power parity as a theory determining the long-term real exchange rate.

In any case, for the monetary model with fully flexible prices, the assumption of purchasing power parity is central.

6.2 The Monetary Approach to the Balance of Payments

The monetary approach to the balance of payments (Frenkel and Johnson 1976), uses the monetary model to explain the behavior of the balance of payments, under a regime of fixed exchange rates.

Consider a small open economy that maintains a constant exchange rate through interventions of its central bank in the foreign exchange market.

The domestic money supply is determined by,

$$M = \mu B = \mu(B_f + B_d) \quad (6.3)$$

where M denotes the money supply, B the monetary base (high powered money), μ the multiplier of the monetary base, B_f net foreign exchange reserves of the central bank, and B_d net domestic credit of the central bank to the public and the banking system.

In logarithms, assuming a multiplier μ close to unity, (6.3) can be approximated as,

$$m = \theta b_f + (1-\theta)b_d \tag{6.4}$$

where θ is the equilibrium share of net foreign exchange reserves in the monetary base. (6.4) determines the money supply.

The demand for money function takes the form,

$$m - p = \phi y - \lambda i \tag{6.5}$$

where y is the logarithm of domestic output, assumed exogenous, and i the domestic nominal interest rate.

The domestic nominal interest rate is determined by uncovered interest parity. Because of fixed exchange rates, it cannot differ from the international nominal interest rate, assumed exogenous.

$$i = i^* \tag{6.6}$$

where i^* is the international nominal interest rate.

Combining the assumption of fixed exchange rates, uncovered interest parity and purchasing power parity, by substituting (6.6) and (6.2) in 6.5), we get,

$$m = \bar{s} + p^* + \phi y - \lambda i^* \tag{6.7}$$

where $\bar{s}$ denotes the constant level of the nominal exchange rate.

From (6.7), the demand for money is determined by the level at which the exchange rate is fixed (because it co-determines the domestic price level), the international price level, domestic income and the international nominal interest rate. All these variables are assumed exogenous.

Equilibrium in the domestic money market implies that (6.4) and (6.7) must be satisfied simultaneously. Solving for the logarithm of net foreign exchange reserves we get,

$$b_f = \frac{1}{\theta}\left[\bar{s} + p^* + \phi y - \lambda i^* - (1-\theta)b_d\right] \tag{6.8}$$

Equation (6.8) incorporates all the predictions of the monetary approach to the balance of payments.

A devaluation (increase in s), a rise in the international price level, an increase in domestic output and income and a reduction in international nominal interest rates, increase the demand for money, and, for given domestic credit, cause increases in foreign reserves. The increase in foreign exchange reserves will occur through surpluses in the balance of payments.

On the other hand, if there is an expansion in domestic credit expansion, the only result will be a loss of net foreign exchange reserves, as the demand for money will not change. Thus, a domestic credit expansion will cause a deficit in the balance of payments.

It is worth noting that the monetary approach to the balance of payments is not concerned with the determination of the *current account*, but the so-called *official balance*, which is none other than the sum of the current account and the capital account, without taking account of changes in the net foreign exchange reserves of the central bank.

6.3 The Monetary Approach to Flexible Exchange Rates

In a regime of flexible exchange rates, the central bank can determine the money supply without loss of foreign reserves, such as when it has to intervene in order to stabilize the exchange rate. The focus of the monetary approach shifts from the balance of payments to the determination of the nominal exchange rate.

The model consists of the money demand function (6.5), the purchasing power parity condition (6.2), and uncovered interest rate parity, which is given by,

$$i = i^* + \dot{s}^e \tag{6.9}$$

where $\dot{s}^e$ is the rational expectation of the change in the exchange rate.

Substituting (6.2) and (6.9) in the money demand function (6.5), and solving for the expected change in the exchange rate, we have,

$$\dot{s}^e = \frac{1}{\lambda}\left(s - m + \phi y - \lambda i^* + p^*\right) \tag{6.10}$$

As the exchange rate is a jump variable, in the absence of bubbles, (6.10) will be satisfied for expectations of no further depreciation. As a result, the exchange rate will jump to the level,

$$s = m - \phi y + \lambda i^* - p^* \tag{6.11}$$

(6.11) is the basic equation of the determinants of the nominal exchange rate based on the monetary approach.

Increases in domestic money supply and international interest rates cause a depreciation of the nominal exchange rate, while increases in domestic income and the international price level cause an appreciation. In an equilibrium without "bubbles" there can be no expectations of future changes in the exchange rate. The exchange rate, as a non-predetermined variable, immediately adjusts to the steady state equilibrium described by (6.11).

The problem with this model is that it requires that the real exchange rate is constant, and that as long as domestic inflation differs from international inflation there will be a continuous adjustment of the exchange rate, in order to satisfy the purchasing power parity condition. However, empirically, purchasing power parity does not appear to be valid. Real exchange rates fluctuate, and their fluctuations are closely related to fluctuations in nominal exchange rates.

A variant of the monetary model, combines it with the assumption of the gradual adjustment of the price level in order to achieve purchasing power parity in the steady state. Thus, the assumption of purchasing power parity is only assumed to hold in the steady state and not in the short run.

6.4 Gradual Adjustment of the Price Level and the Monetary Approach

Suppose, on the lines of the Dornbusch (1976) model, that the domestic price level adjusts gradually towards its steady state equilibrium level, which is considered to be the price level that satisfies purchasing power parity. Instead of the short purchasing power condition (6.2), we now assume that,

$$\dot{p} = \pi(s + p^* - p) \tag{6.12}$$

where $\pi > 0$. π is a parameter denoting the speed of adjustment of the domestic price level towards its steady state equilibrium.

The model now consists of the equilibrium condition in the money market (6.5), the uncovered interest parity condition (6.9), and the price adjustment equation (6.12).

Substituting the uncovered interest parity condition (6.9) in the equilibrium condition for the domestic money market (6.5), and using the hypothesis of rational expectations, we get,

$$\dot{s} = \dot{s}^e = \frac{1}{\lambda}\left(p - m + \phi y - \lambda i^*\right) \tag{6.13}$$

(6.13) indicates that as the domestic price level is a predetermined variable, and cannot adjust in the short run to equilibrate the domestic money market, this role must be played by the domestic nominal interest rate. Since the domestic nominal interest rate can only differ from the international nominal interest rate to the extent that there are expectations of future changes in the exchange rate, the expected and actual change in the exchange rate must be such as to maintain equilibrium in the domestic money market.

Our model is now described by (6.12) and (6.13). The equilibrium and the adjustment path are presented in Figure 6.1, which has significant similarities with the model of Dornbusch (1976), as analyzed in the previous chapter.

The 45^0 line represents purchasing power parity, as a steady state equilibrium condition. In fact, it represents (6.12) for no change in the price level. The vertical line is the long-term equilibrium condition in the money market (6.13), for a constant exchange rate. The steady state equilibrium is at point *E*, which is a saddle point, since the price level is a predetermined variable and the exchange rate is a non-predetermined variable. The adjustment path depicted is unique, as all other adjustment paths lead away from the steady state.

A change in the money supply causes fluctuations in both the nominal and real exchange rate. A permanent increase in the money supply shifts the equilibrium condition in the domestic money market to the right. In the new steady state equilibrium the domestic price level increases by the same percentage as the change in the money supply, and the same happens to the nominal exchange rate which depreciates by the same percentage, so that long run purchasing power parity is satisfied. However, since the price level cannot adjust in the short term, the exchange rate depreciates more in the short term, to generate expectations of a future appreciation, so that the domestic money remains in equilibrium. For the increased money supply to be willingly held, the domestic nominal interest rate must fall, and this can only happen if there are expectations of a future appreciation of the exchange rate. The overshooting of the depreciation of the nominal exchange rate, combined with the gradual adjustment of the price level, results in a depreciation of the real exchange rate as well. After the initial depreciation, the exchange rate begins to appreciate towards its new steady state value, since the price level gradually adjusts. Thus, during the adjustment path, we observe a gradual appreciation of both the nominal and the real exchange rate. In the new steady state, real money balances and the domestic nominal interest rate have returned to their initial values, and the real exchange rate has returned to purchasing power parity. The nominal exchange rate and the domestic price level have risen by the same percentage as the increase in the domestic money supply.

This analysis is shown in Figures 6.2, 6.3 and 6.4.

Figure 6.2 is a phase diagram. The initial equilibrium is at *E*. A previously unexpected permanent increase in the domestic money supply causes an immediate depreciation of the exchange rate to point E_0, located on the saddle path that leads to the new steady state equilibrium E'. Given that the domestic price level is predetermined in the short run, the nominal depreciation is a real depreciation. Gradually, the exchange rate begins to appreciate, the price level to rise, and the economy to approach the new long-run equilibrium.

The path of nominal variables over time is depicted in Figure 6.3. The nominal exchange rate depreciates immediately, and indeed at a rate that exceeds the long-term depreciation. Then he begins to appreciate towards its new long-run equilibrium. The price level begins to rise gradually to its new steady state level, which is higher by the same percentage as the increase in the money supply. The domestic nominal interest rate falls below the level of international interest rates, and remains lower during the adjustment path, as there are expectations of appreciation of the exchange rate. Gradually the domestic nominal interest rate returns to the level of the international interest rate.

The path of the nominal and real exchange rate is depicted in Figure 6.4. The nominal depreciation initially causes a real depreciation by the same percentage. Gradually, the real exchange rate starts to appreciate for two reasons. First, due to the gradual appreciation of the nominal exchange rate, and secondly, due to the gradual increase in the price level. The real exchange rate gradually returns to purchasing power parity.

We therefore see that in the model of the monetary approach, when there is a gradual adjustment of the price level, there may be fluctuations in the real exchange rate, although purchasing power parity applies in the long run. Moreover, there is a positive correlation between short run fluctuations in nominal and real exchange rate. A nominal depreciation causes a real depreciation, because of the short-term rigidity of the domestic price level.

One can also show that an increase in international interest rates will have a corresponding impact to an increase in the domestic money supply. There will be immediate depreciation of the domestic exchange rate, which will exceed the long-term depreciation. A gradual appreciation of both the nominal and the real exchange rate will follow, and the domestic price level will gradually increase. Since a increase in the international nominal interest rate implies a reduction in the demand for real balances, if the domestic money supply does not change, the price level will have to adjust in the steady state.

Similar effects follow previously unexpected changes in full employment output. For example, a permanent fall in full employment output entails a reduction the demand for real money balances. If the domestic money supply does not change, domestic interest rates should be reduced below international rates, for the domestic money market to remain in equilibrium. In the short run this can only take place through adjustments in the exchange rate. Thus, following a previously unanticipated permanent reduction in real output and income the exchange rate, nominal and real, will initially depreciate. Because of the overshooting of the depreciation relative to the steady state depreciation, the exchange rate will be appreciating during the adjustment path, as prices increase and the domestic nominal interest rate gradually rises towards international nominal interest rates.

Finally, it can be shown that an increase in the international price level does not cause an overshooting of the nominal exchange rate. Starting from the initial equilibrium level, an increase in the international price level causes an immediate appreciation of the nominal exchange rate by the same percentage, to satisfy purchasing power parity. This case is depicted in Figure 6.5.

6.5 A Stochastic Version of the Monetary Approach

Up to now, we have examined a deterministic version of the monetary model, under the assumption that time is continuous. The monetary model can easily by adapted to a accommodate discrete time and stochastic shocks. A stochastic version of the monetary model takes the following form,

$$m_t - p_t = \phi y_t - \lambda i_t \tag{6.14}$$

$$i_t = i_t^* + E_t s_{t+1} - s_t \tag{6.15}$$

$$p_t = s_t + p_t^* \tag{6.16}$$

(6.14) is domestic money market equilibrium condition, (6.15) is the foreign exchange market equilibrium condition (uncovered interest parity), and (6.16) is the product market equilibrium condition (purchasing power parity).

Using (6.14), (6.15) and (6.16) to eliminate the other two endogenous variables, i and p, the exchange rate is determined by,

$$s_t = \frac{\lambda}{1+\lambda} E_t s_{t+1} + \frac{1}{1+\lambda}(m_t - \phi y_t + \lambda i_t^* - p_t^*) \tag{6.17}$$

The current nominal exchange rate is a weighted average of the expected future nominal exchange rate, and the so called *fundamentals,* which in the case of the monetary model are the exogenous variables that affect the domestic money market. These are the domestic money supply m, full employment output y, the international nominal interest rate i^* and the international price level p^*.

We shall denote the fundamentals by,

$$f_t = m_t - \phi y_t + \lambda i_t^* - p_t^* \tag{6.18}$$

6.5.1 The Fundamental Rational Expectations Solution for the Nominal Exchange Rate

From (6.17), through successive substitutions, we get that the *rational expectations solution* for the exchange rate must satisfy,

$$s_t = \frac{1}{1+\lambda}\sum_{i=0}^{k}\left(\frac{\lambda}{1+\lambda}\right)^i E_t\left(m_{t+i} - \phi y_{t+i} + \lambda i_{t+i}^* - p_{t+i}^*\right) + \left(\frac{\lambda}{1+\lambda}\right)^{k+1} E_t s_{t+k+1} \tag{6.19}$$

If expectations about the future evolution of the exchange rate grow at a rate which does not exceed *1/λ,* then, it follows that,

$$\lim_{k\to\infty}\left(\frac{\lambda}{1+\lambda}\right)^{k+1} E_t s_{t+k+1} = 0 \tag{6.20}$$

(6.20) is called a *transversality condition*, and essentially precludes explosive expectations about the future evolution of the exchange rate.

Taking the limit of (6.19), as k tends to infinity, and using the transversality condition (6.20), the *rational expectations equilibrium* solution for the exchange rate can be written as,

$$s_t = \frac{1}{1+\lambda}E_t\sum_{i=0}^{\infty}\left(\frac{\lambda}{1+\lambda}\right)^i\left(m_{t+i} - \phi y_{t+i} + \lambda i_{t+i}^* - p_{t+i}^*\right) = \frac{1}{1+\lambda}\sum_{i=0}^{\infty}\left(\frac{\lambda}{1+\lambda}\right)^i E_t f_{t+i} \tag{6.21}$$

In the right hand side of (6.21) we have used the definition of the fundamentals from (6.18).

(6.21) is the so called *fundamental* solution of (6.17), as it depends only on the expected future evolution of the fundamentals of the domestic money market.

As an asset price, the exchange rate adjusts to equilibrate the domestic money market, through its effects on the domestic price level and the domestic nominal interest rate. Because of uncovered interest parity, the current equilibrium nominal exchange rate depends on the expected future exchange rate. Thus, the current exchange rate depends on the expected future evolution of all exogenous variables that affect the domestic money market, such as the domestic money supply, full employment output, which affects money demand, international nominal interest rates, which affect domestic nominal interest rates and hence money demand, and the international price level, which affects the domestic price level and hence money demand.

6.5.2 Expectations and "Bubbles" for the Exchange Rate

The *fundamental* solution of (6.17) is not its only solution. A more general solution would take the form,

$$s_t = \frac{1}{1+\lambda}\sum_{i=0}^{\infty}\left(\frac{\lambda}{1+\lambda}\right)^i E_t f_{t+i} + z_t \tag{6.22}$$

where *z* is an extraneous variable, following a stochastic process defined by,

$$z_t = \frac{1+\lambda}{\lambda} z_{t-1} + \varepsilon_t^z \tag{6.23}$$

where ε^z is a white noise process, with zero mean and constant variance.

One can easily prove that (6.23) is also a solution of (6.17). *z* follows an explosive stochastic process, and is often referred to as a *bubble*. If the exchange rate depends on a bubble, then the bubble will eventually dominate its behavior, and the path of the exchange rate will be explosive. Thus, the bubble solution (6.22) and (6.23) will not satisfy the transversality condition (6.20).

If we confine ourselves to non explosive paths for the exchange rate, we can rule out solutions like (6.22) and (6.23), by imposing the transversality condition (6.20). The fundamental solution is the only solution for which the rate of growth of the exchange rate is non explosive, and satisfies (6.20).

6.5.3 Closed Form Solutions for the Exchange Rate

In order to say more about exchange rate determination in the monetary model, we need to make assumptions about the exogenous processes driving the fundamentals.

Let us initially assume the the fundamentals follow a stationary AR(1) process, around a constant mean. Thus, the fundamentals follow,

$$f_t = (1-\rho)f_0 + \rho f_{t-1} + \varepsilon_t^f \tag{6.24}$$

where f_0 is the mean of the fundamentals, ρ is the degree of persistence of the fundamentals, and ε^f is a white noise process driving the fundamentals. Stationarity requires that $|\rho|<1$.

If the fundamentals follow the stochastic process (6.24), the *k* period ahead predictor, i.e the rational expectation about their value *k* periods ahead, depends only on the current fundamentals, according to,

$$E_t f_{t+i} = (1-\rho^i)f_0 + \rho^i f_t \tag{6.25}$$

Substituting (6.25) in the rational expectations equilibrium solution (6.21), it follows that the current exchange rate is determined only by the current fundamentals. The solution for the exchange rate takes the form,

$$s_t = f_0 + \frac{1}{1+\lambda(1-\rho)}\left(f_t - f_0\right) \tag{6.26}$$

The mean of the exchange rate is equal to the mean of the fundamentals, and the current exchange rate depends on the deviation of the current fundamentals from their mean.

It is worth noting that the response of the nominal exchange rate to deviations of the current fundamentals from their mean is less than one to one, since λ is positive. Thus, the variance of the nominal exchange rate will be lower than the variance of the fundamentals. From (6.26), the variance of the nominal exchange rate will be given by,

$$Var(s_t) = \left(\frac{1}{1+\lambda(1-\rho)}\right)^2 Var(f_t) < Var(f_t) \tag{6.27}$$

Thus, the monetary model is not compatible with the excess volatility of nominal exchange rates that has been observed if the fundamentals follow a stationary AR(1) process.

Assuming that the fundamentals follow a non stationary random walk process ($\rho=1$) does not solve this problem either. If $\rho=1$, it follows that the k period ahead predictor of the fundamentals is given by,

$$E_t f_{t+k} = f_t \tag{6.28}$$

Substituting (6.28) in the rational expectations equilibrium solution (6.21), it follows that the solution for the current nominal exchange rate takes the form,

$$s_t = f_t \tag{6.29}$$

The current nominal exchange rate is always equal to the current fundamentals, as in the deterministic monetary model.[1]

From (6.29), the change in the nominal exchange rate is given by,

$$\Delta s_t = \Delta f_t \tag{6.30}$$

where Δ is the first difference operator. From (6.30), the variance of changes in the nominal exchange rate is given by,

$$Var(\Delta s_t) = Var(\Delta f_t) \tag{6.31}$$

The variance of the nominal exchange rate is the same as the variance of the fundamentals. This is not compatible with the evidence on excess volatility in nominal exchange rates.

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[1] See equation (6.11) which was derived under the assumption of constant fundamentals in the deterministic model. The stochastic equivalent of constant fundamentals in a deterministic model is a random walk for the fundamentals.

Thus, the monetary model cannot explain the excess volatility of nominal exchange rates under the assumption of non-stationarity of the fundamentals, if the fundamentals follow a random walk process.

Let us finally assume that the fundamentals follow an integrated AR(1) process, i.e that the change in the fundamentals follows an AR(1) process. This process takes the form,

$$\Delta f_t = \rho \Delta f_{t-1} + \varepsilon_t^f \tag{6.32}$$

Under such a process, the *k* period ahead predictor of the fundamentals takes the form,

$$E_t f_{t+k} = f_t + \sum_{i=1}^{k} \rho^i \Delta f_t = f_t + \left(\frac{1-\rho^k}{1-\rho} \right) \rho \Delta f_t \tag{6.33}$$

Substituting (6.33) in (6.21), the closed form solution for the nominal exchange rate is given by,

$$s_t = f_t + \frac{\lambda\rho}{1+\lambda(1-\rho)} \Delta f_t \tag{6.34}$$

From (6.34), the first difference in the nominal exchange rate is stationary, and follows,

$$\Delta s_t = \frac{1+\lambda}{1+\lambda(1-\rho)} \Delta f_t - \frac{\lambda\rho}{1+\lambda(1-\rho)} \Delta f_{t-1} \tag{6.35}$$

From (6.35), after some algebra, one finds that,

$$Var(\Delta s_t) = \left(1 + \frac{2(1-\rho)(1+\lambda)\lambda\rho}{\left(1+\lambda(1-\rho)\right)^2} \right) Var(\Delta f_t) > Var(\Delta f_t) \tag{6.35}$$

If the fundamentals follow an integrated AR(1) process of the form of (6.32), then the monetary model can potentially explain the excess volatility of nominal exchange rates. However, it cannot explain fluctuations in the real exchange rate, nor can it account for the very high positive correlation of fluctuations in nominal and real exchange rates.

Figure 6.1
The Monetary Approach with Gradual Adjustment of the Price Level

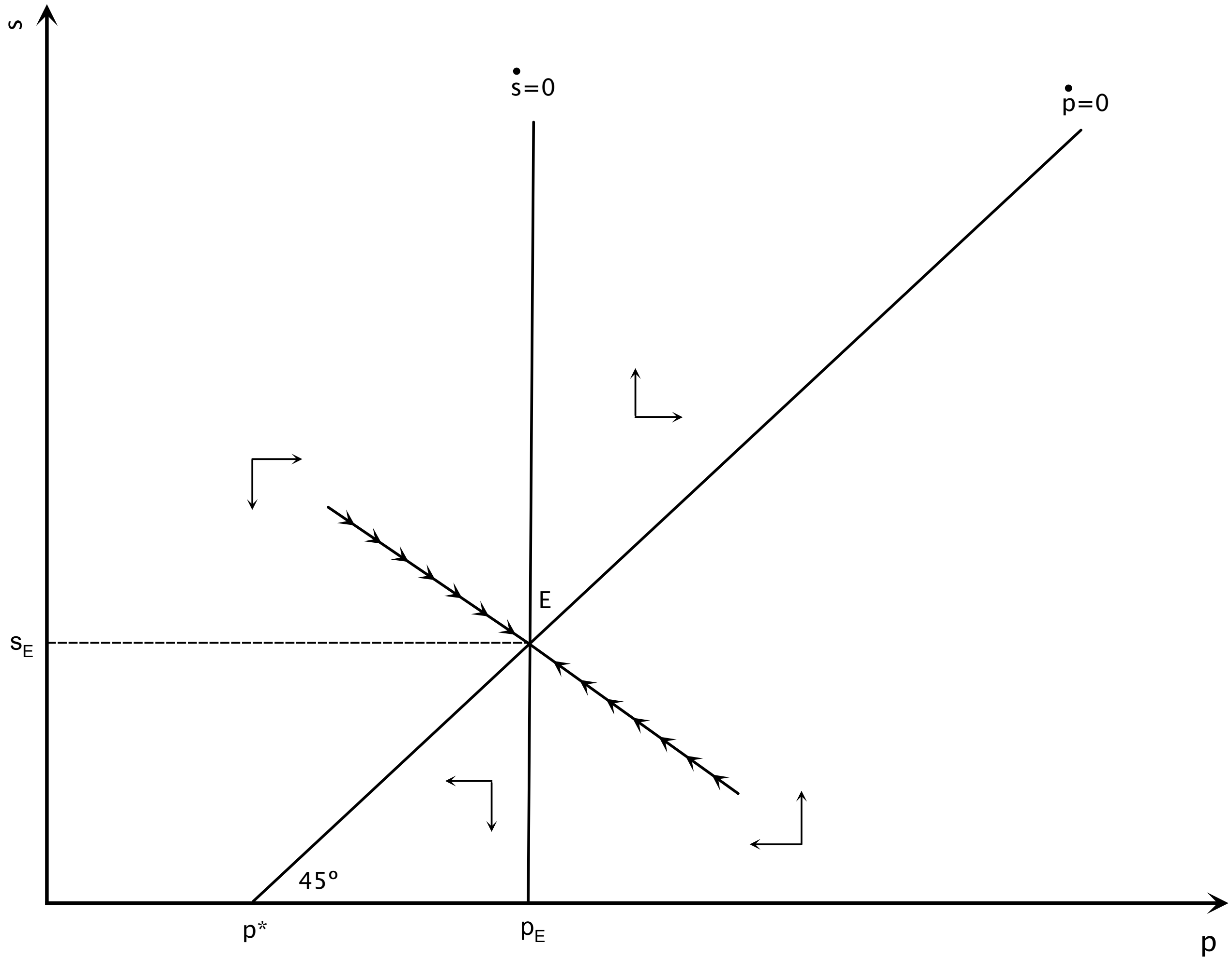


Figure 6.2
Adjustment to a Permanent Change in the Money Supply

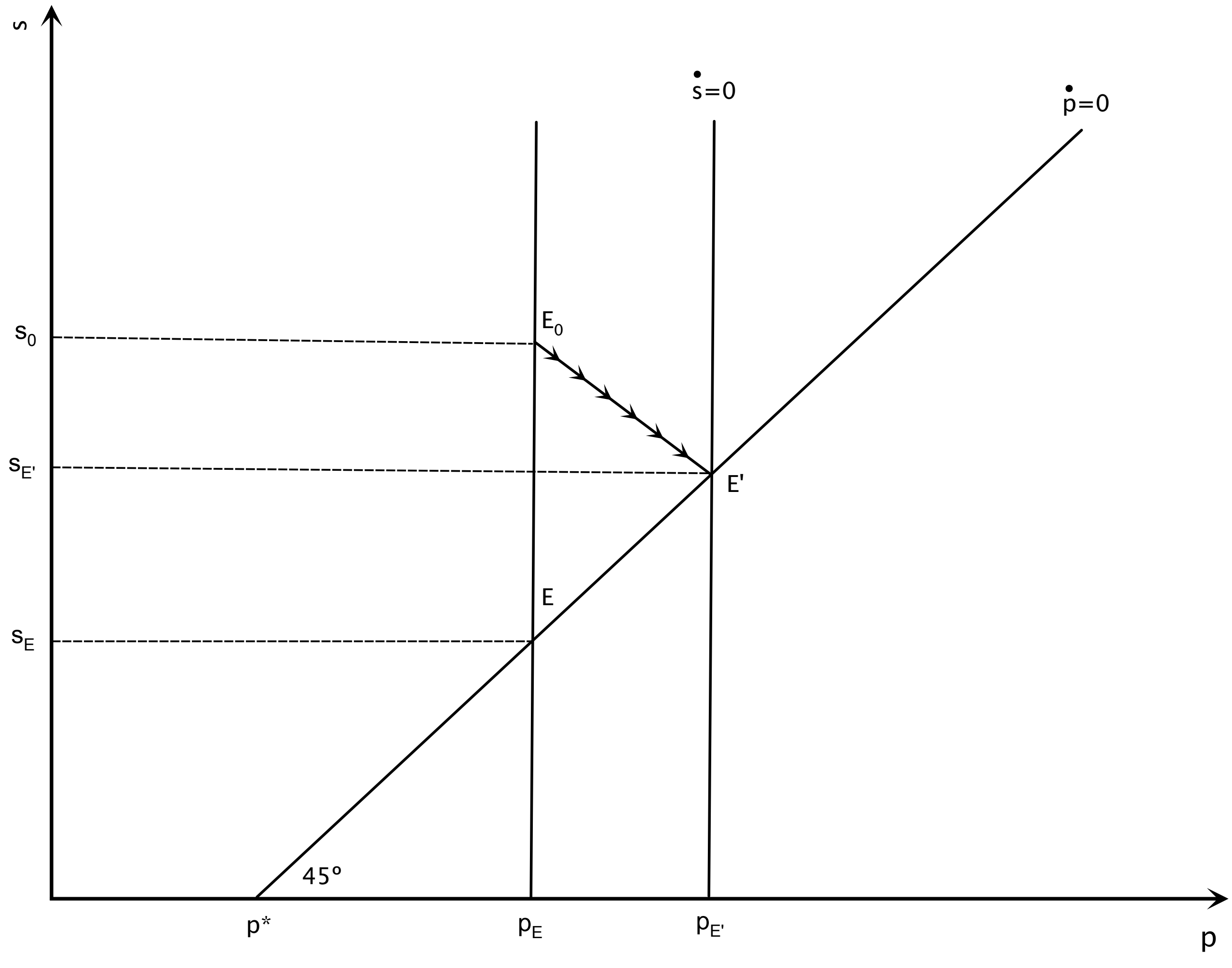


Figure 6.3
The Dynamic Path of the Nominal Exchange Rate, the Price Level and the Domestic Nominal Interest Rate, Following a Permanent Increase in the Money Supply

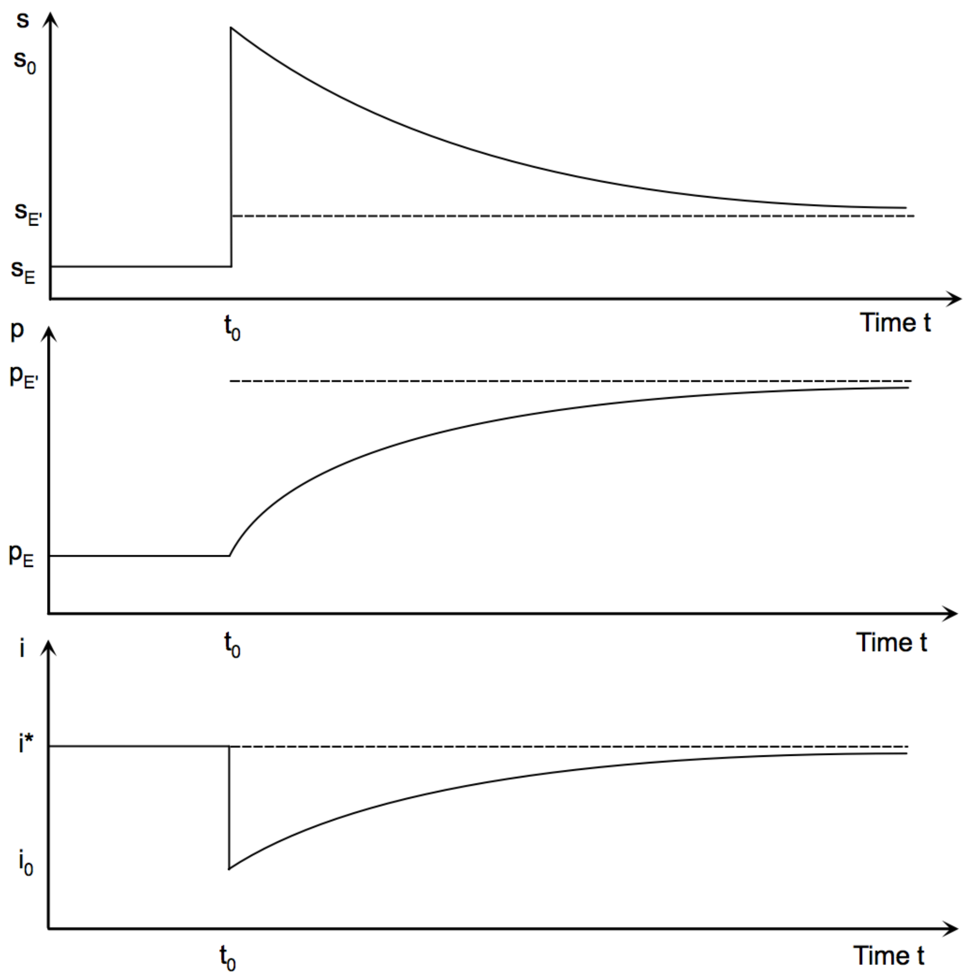


Figure 6.4
The Adjustment Path of the Nominal and the Real Exchange Rate
Following a Permanent Increase in the Money Supply

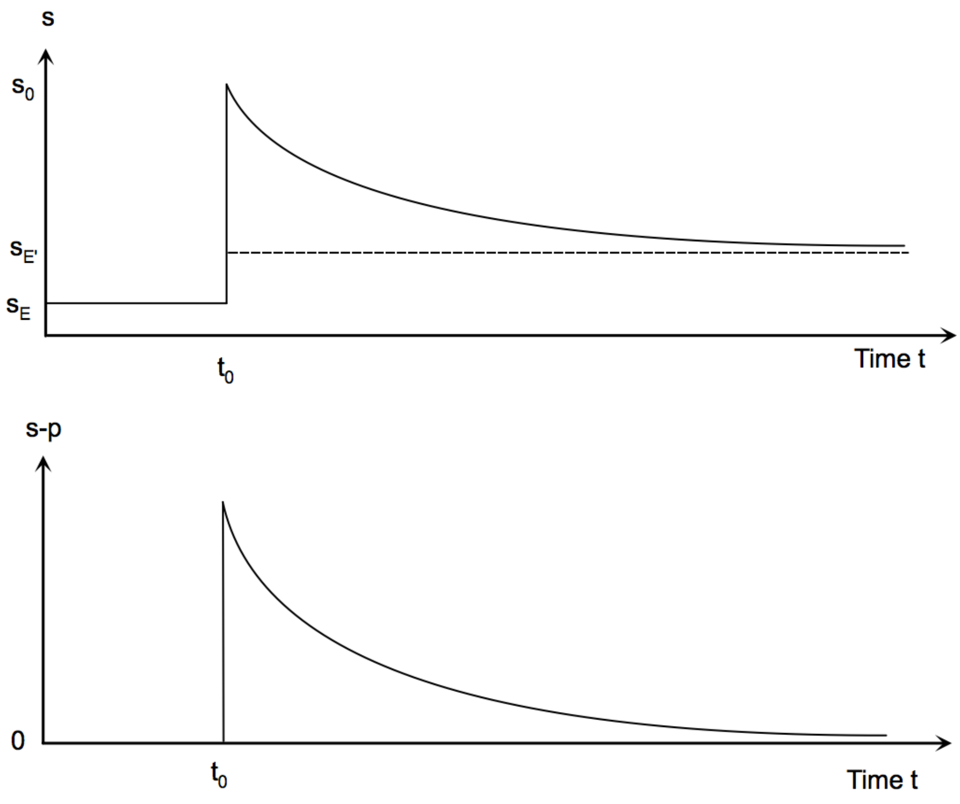
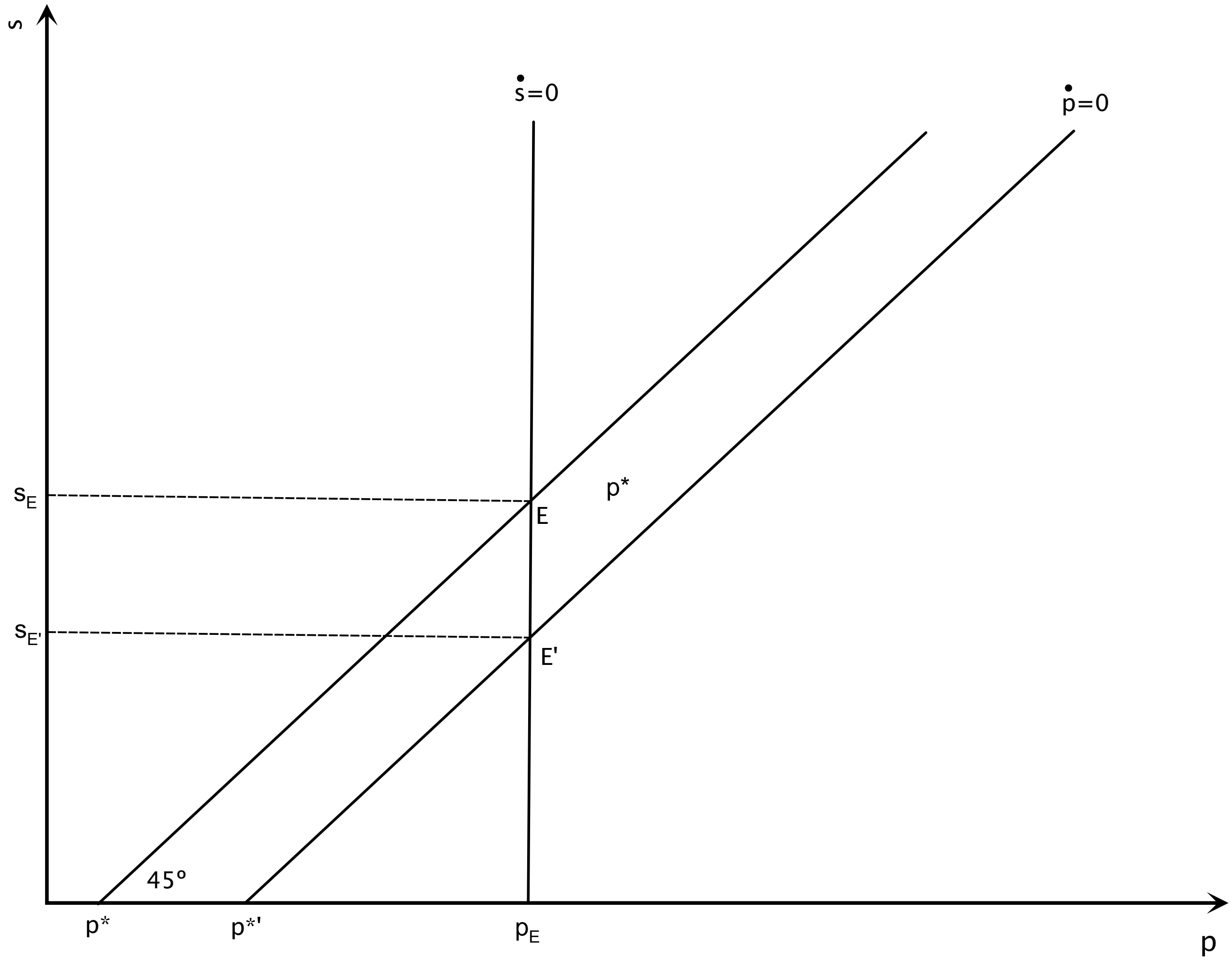


Figure 6.5
Adjustment Following a Permanent Increase in the International Price Level



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