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International Finance (Econ 421)
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Handout #5: Money and Exchange Rates

1. Introduction

So far we explained how the interest parity condition determines the exchange rate by taking interest rates and expectations as given. This handout explains how developments in the home and foreign money markets affect the interest rates and expectations regarding the future exchange rate.

The interest rate reflects the cost of holding money and therefore is determined in the money market. We start our discussion with demand and supply of money. Equilibrium in the money market determines the interest rate.

We then turn to distinguish between short run and long run equilibria. We will assume that prices are sluggish in the sense that they react slowly to economic events; that is, the economy goes through a period of adjustment in which prices gradually converge to their new level. The equilibrium before prices adjust is the short run equilibrium, while the equilibrium at the end of the adjustment process is the long run equilibrium.

This distinction between short run and long run is useful for understanding how expectations are formed. Since agents understand the long run effects of each economic event, they can predict correctly, in the absence of additional unanticipated events, the future level of the exchange rate. Therefore, changes in the long run equilibrium may affect expectations.

2. The Money Market

Money serves a few purposes: a medium of exchange, a unit of account, and as a store of value. The first purpose, a medium of exchange, is the most important one and therefore we will focus our analysis accordingly.

Currency and checking deposits are the most liquid assets. That is, they can be most easily traded for goods and services, or in other words they are of the most common mediums of exchange. The aggregate quantity of currency plus checking deposits is called M1[1].

We now turn to discuss the demand and supply of M1.

2.1. Money Supply

The monetary authority, i.e. the central bank, controls the money supply. It has various policy tools for achieving the desired level of money. For example, printing currency, setting the interest rate, and trading in domestic bonds, are some of the ways central banks affect the quantity of money in the economy.

At this stage we will not be concerned with why and how the monetary authority decides what the desired level of money is. We will simply take that level as given. We will denote money supply by M^s.

2.2. Money Demand

The main reason for holding money is for the liquidity services it provides. That is, the demand is for the purchasing power of money. Let M^d denote money demand, and P the price level of some reference basket of goods and services. The quantity M^d can purchase M^d/P units of the basket, or in other words M^d can be exchanged for M^d/P units of the reference basket. Therefore we will specify the demand for *real* money balances, M^d/P.

The main factors that affect the demand for real money balances are the interest rate, R, and real GNP, Y.

Money pays no interest; therefore, it is costly to hold money since by doing so we give up interest income we could have earned if we held other assets. The interest rate is the *opportunity cost* of holding money. The higher the interest rate, the higher the cost; therefore, demand for real money balances falls with the interest rate.

As output increases agents trade more goods and services. Since money is the main medium of exchange, demand for real money balances increases as well in order to carry

[1] Other measures of money include: M0, which is currency alone; M2 and M3, both include M1 plus other less liquid assets.

out these transactions. Therefore, we conclude that demand for real money balances increases with real output.

We will denote the demand function by *L*, for liquidity. We can now summarize the demand for real money balances by:

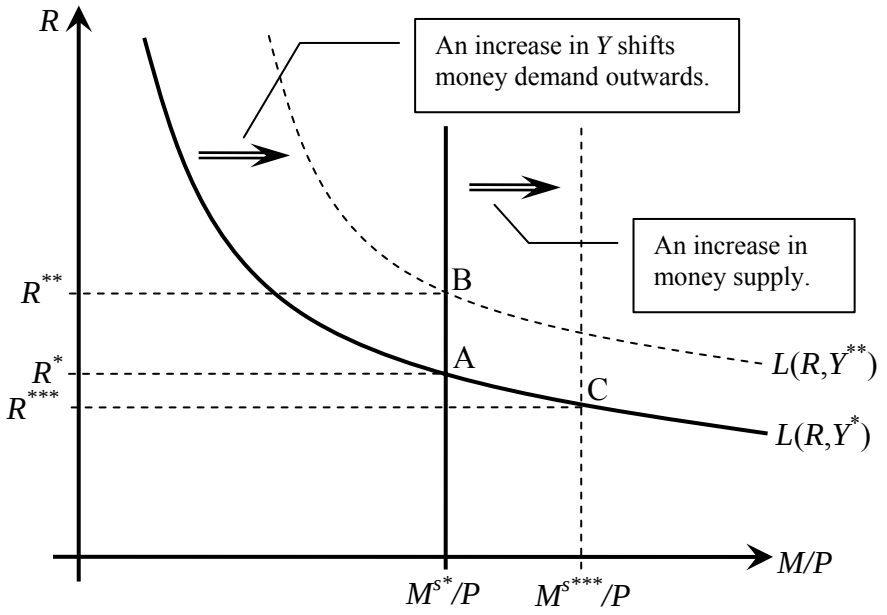
$$M^d/P = L(\underset{-}{R},\underset{+}{Y}) \qquad \textbf{(1)}$$

Where the minus sign under the interest rate indicates that *L* is falling with *R*, and the plus sign under real income indicates that *L* is increasing with *Y*.

2.3. Money Market Equilibrium

Figure 1 plots the demand and supply of real money balances. We plot *M/P* against the interest rate, *R*, taking real GNP, *Y*, and prices, *P*, as given[2]. Equilibrium is achieved at point *A* where demand equals supply.

Figure 1: The Money Maket



[2] We will discuss the determinants of output later in the course. Changes in the price level are analyzed in this handout when we distinguish between short run and long run. In the short run we assume that prices are fixed.

This diagram illustrates how the interest rate is determined. Given money supply, M^{s*}/P, and demand for liquidity, $L(R,Y^*)$, the equilibrium interest rate is R^*. A higher interest rate would result in excess supply of money, and agents would try to get rid of their money by lending it to others (i.e. buy interest-bearing assets). Now there is an excess supply of loans which puts pressure on the interest rate to fall. This process continues until the interest rate reaches it equilibrium level R^*.[3]

An increase in real GNP from Y^* to Y^{**} shifts money demand outward since agents need more liquidity to carry out a higher volume of transactions. At the ongoing interest rate, R^*, there is an excess demand for money. As agents attempt to borrow in order to satisfy their demand for liquidity they put pressure on the interest rate to increase. This process continues until the new equilibrium is achieved at point B[4].

Finally, consider an increase in money supply from M^{s*} to M^{s***}. This shifts outwards the supply of real money balances, creating excess supply of money at the ongoing interest rate R^*. Agents attempt to get rid of the excess liquidity by lending it to others. This, in turn, puts pressure on the interest rate to fall, and the new equilibrium is achieved at point C.

3. Money and Exchange Rate in the Short Run

In handout 4 we used the interest parity condition to analyze how interest rates affect the exchange rate. In the analysis we took the home and foreign interest rates as given. Now, after discussing the money market we understand the mechanism that determines interest rates.

In this section we combine the interest parity condition with the money market to analyze how developments in the latter affect the exchange rate. At this stage we still take prices as given and therefore this is a *short run* analysis.

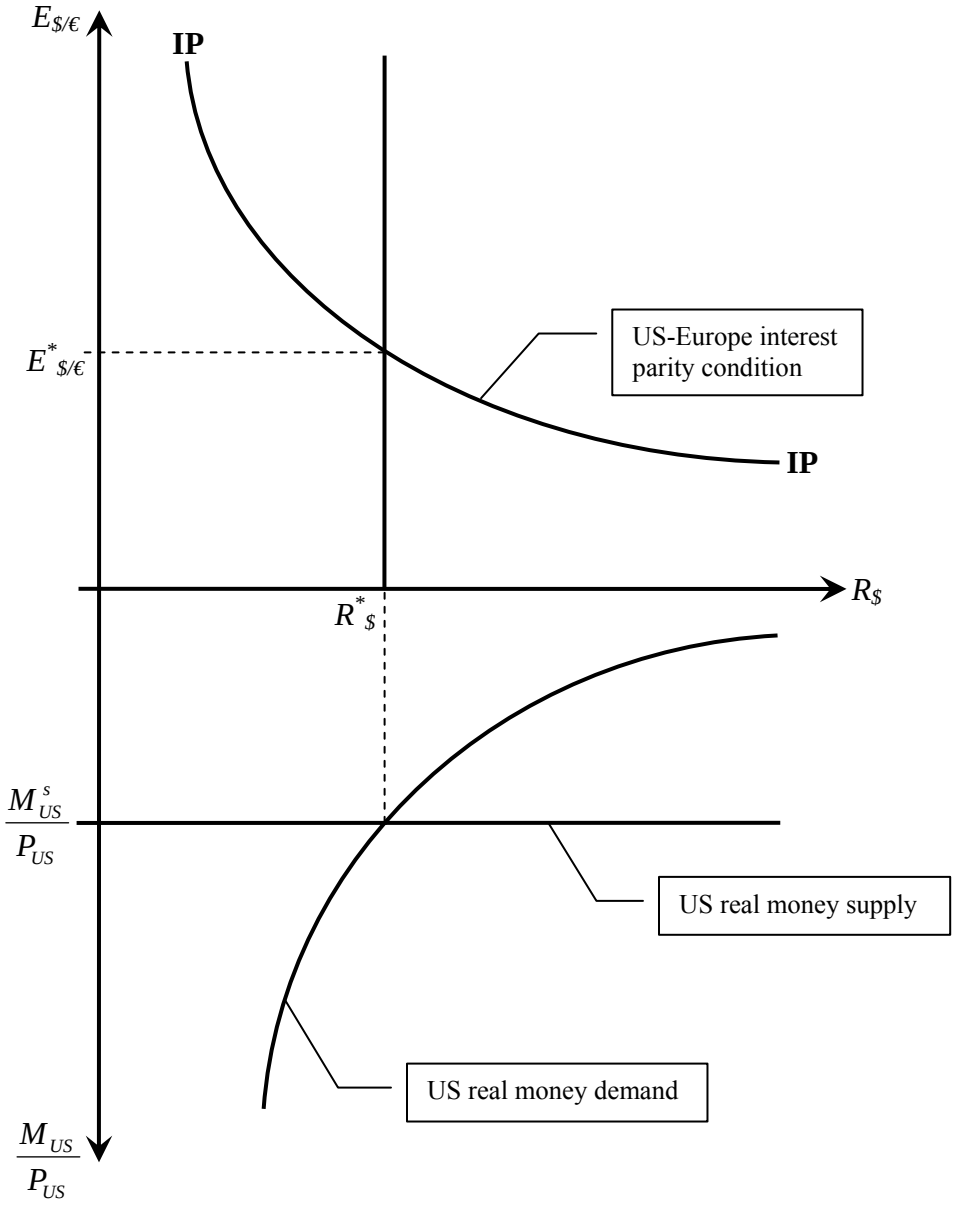
Recall that the diagram we used for describing the interest parity condition plotted the local interest rate against the exchange rate. The money market diagram draws real

[3] Note that we can also think of this process as putting pressure on the price of interest-bearing assets to rise. Agents try to buy assets using their excess liquidity, as a result demand for assets increases and therefore their price increases as well. Higher prices imply lower returns, or in other words the interest rate falls.

[4] Instead of borrowing we can think of agents as trying to sell interest-bearing assets, as a result supply of assets increases and therefore their price falls. Lower asset prices imply higher returns, or in other words the interest rate increases.

money balances against the interest rate. Figure 2 exploits the fact that both diagrams share the same axis, the local interest rate, to plot them together.

Figure 2: Money Market and the Exchange Rate



Using Figure 2 it is easy to see the effect of developments in the money market on the exchange rate. An increase in Y_{US} shifts money demand outwards (that is downward in the diagram), as a result the dollar interest rate, $R_\$$, increases. An increase in $R_\$$ reduces

the dollar-euro exchange rate, i.e. the dollar appreciates. This is seen as a movement along the IP-IP schedule. On the other hand, an increase in the American money supply, M^s_{US}, reduces the dollar interest rate. As a result $E_{\$/€}$ increases, i.e. the dollar depreciates.

Recall that the IP-IP schedule takes the European interest rate, $R_€$, as given. However, $R_€$ is determined in the European money market. We can therefore also analyze the effects of changes in the European money market on the dollar-euro exchange rate.

An increase in the European real GNP, Y_{EU}, increases money demand in Europe, as a result the euro interest rate, $R_€$, increases. An increase in $R_€$ shifts the IP-IP schedule outward and the dollar depreciates ($E_{\$/€}$ increases). On the other hand, an increase in the European money supply, M^s_{EU}, reduces the euro interest rate, the IP-IP schedule shifts to the left, and $E_{\$/€}$ falls, i.e. the dollar appreciates.

4. Price Stickiness and Long Run Money Neutrality

So far our analysis focused on short run effects. Before we turn to analyzing the long run we need to describe the environment in which the economy operates. Specifically we need to discuss how the environment is different from the one we used so far.

In this section we discuss two assumptions: price stickiness and long run money neutrality. The first assumption constitutes the basis for our distinction between short run and long run. In the short run we do not allow prices in the model economy to change, while in the long run prices fully adjust. The second assumption, long run money neutrality, states that the *level* of nominal money holdings, M, does not affect any of the real variables in the long run. This assumption will help us understand how money affects prices in the long run.

4.1. Sticky Prices: Short Run vs Long Run

In our theoretical model we assume that prices are "sticky". That is, unlike other variables, prices respond slowly to economic events. This assumption is motivated by real life nominal rigidity imbedded in different contracts, especially wage contracts. Often, nominal wages are negotiated only periodically and do not change for the duration of the contract. This fixes the nominal cost of labor, and since prices of goods and

services depend heavily on the cost of production, the sluggishness of wages is transmitted to prices.

In what follows we assume that for any economic shock prices do not change *on impact*; other variables may react immediately. We refer to the equilibrium before prices adjust as the **short run equilibrium**. The equilibrium that prevails after prices fully adjust is the **long run equilibrium**. The long run equilibrium is the equilibrium the economy converges to in the absence of any economic shocks.

4.2. Long Run Money Neutrality

We will assume that in the long run money is neutral. That is, the *level* of nominal money in the economy does not affect any of the real variables in the long run.[5]

The assumption of money neutrality suggests that permanent changes in *nominal* money balances, M, do not affect in the long run *real* money balances, M/P. It is therefore must be the case that prices, P, change by exactly the same proportions as nominal money so as to leave the ratio M/P fixed.

We can see that money neutrality helps us to pin down the price level in the long run, but does the money neutrality assumption actually make sense? The best way to develop intuition is to think of currency reforms. Occasionally countries rescale their unit of account, especially after periods of high inflation. They do that by introducing a new currency and announce that each unit of the new currency worth, say, 1,000,000 units of the old one. Of course this change has no *real* effects even though nominal money supply is cut by a factor of one million. The only change is that prices fall by exactly the same factor; that is, a gallon of milk, for example, would cost now 4 new pesos instead of 4,000,000 old ones.

5. Money and Exchange Rate in the Long Run

We are now ready to analyze the long run effect of changes in the money supply on the exchange rate. In the long run the exchange rate behaves just like any other price; that is,

[5] You may be familiar with the concept of super neutrality from macro classes. We say that money is super neutral if not only the level, but also the rate at which nominal money holdings changes ($\Delta M/M$) does not affect the real variables.

a permanent increase in the level of the domestic money supply increases the exchange rate (i.e. depreciates the domestic currency) by exactly the same proportion.

Again, it is useful to think of currency reforms in order to see why this is true. Suppose that the dollar-euro exchange rate is 1.2$/€, and the Federal Reserve decides to issue a new dollar that worth half of the old one. That is, the Federal Reserve System is willing to exchange any old dollar bill for two new ones. Therefore, money supply in the US automatically doubles. What happens to the dollar-euro exchange rate? At the ongoing exchange rate each 1.2 old dollars are exchanged for one euro, or 2.4 new dollars. Therefore, the new exchange rate is 2.4$/€.

6. Expectations and Exchange Rate Overshooting

Now that we understand how current developments in the money market affect the exchange rate in the long run, we actually understand how these developments affect expectations regarding the future exchange rate. A permanent increase in the money supply increases the exchange rate in the long run, and therefore we expect the future exchange rate to be higher than the current one. In our short run analysis we took expectations as given; now we no longer have to do that.

In the remainder of this handout we analyze the effect of an unexpected permanent increase in the domestic money supply. We assume that when the shock hits, the economy is in its long run equilibrium and that initially the home and foreign interest rates are equal.

It turns out that it is convenient to solve the problem backwards; that is, we will first figure out what happens in the long run and only then analyze the short run effects. We carry out the analysis in this order since the short run equilibrium depends on expectations, which in turn depend on the long run equilibrium.

6.1. The Long Run Equilibrium

By the assumption of long run money neutrality we know that the real variables, Y and M/P, are unchanged in the long run. Since M/P returns to its original level, prices must increase by the same proportions as M in the long run.

Recall that equilibrium in the money market requires $M/P = L(R,Y)$. Since both M/P and Y are unchanged, it is therefore must be the case that R is unchanged as well in order to maintain equilibrium in the money market.

Finally, we have concluded that a permanent increase in the money supply increases the exchange rate (i.e. depreciation of the domestic currency) by the same proportions.

6.2. The Short Run Equilibrium (On Impact)

In the short run prices are fixed. Therefore the increase in the *nominal* money supply, M^S, increases the *real* money supply, M^S/P, as well. As a result $R_\$$ falls. Figure 3 illustrates this development by moving from point 1 to point 2 in the money market.

The exchange rate is influenced by two effects that work in the same direction. First, we have just concluded that the dollar interest rate, $R_\$$, falls; therefore, the dollar return on euro deposits must fall as well (by exactly the same amount). Since $R_€$ is fixed, for any level of expectations the dollar must depreciate on impact. Second, we know that in the long run $E_{\$/€}$ increases, therefore the expected future exchange rate increases as well. This, in turn, increases the dollar return on euro deposits; therefore, the dollar must depreciate on impact in order to reduce the expected depreciation and equate the returns. This is illustrated in Figure 3 by a shift of the IP schedule outward and a movement from point 1' to 2'.

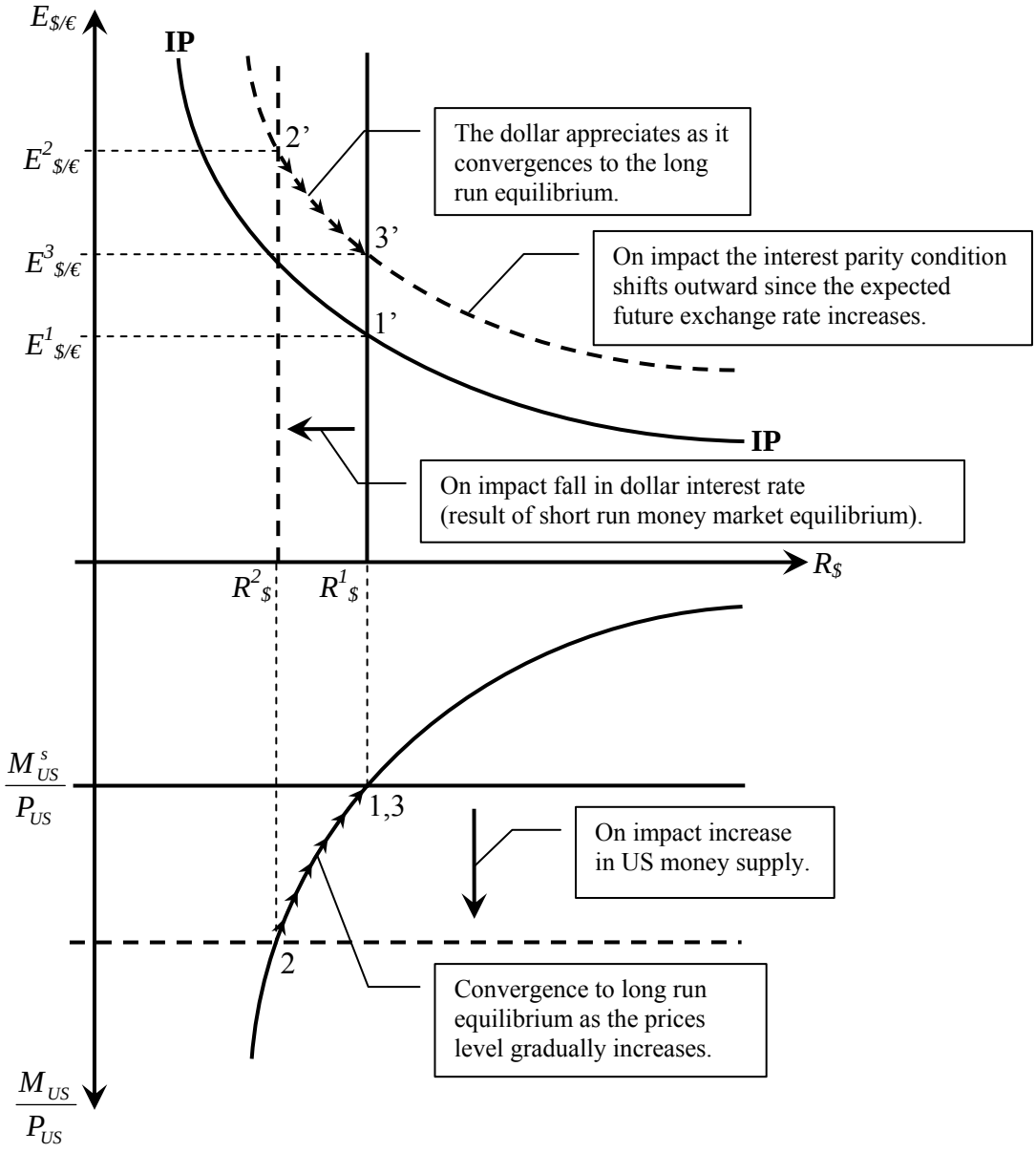
6.3. The Transition

We know that the price level is higher in the long run, but on impact it is unchanged. Therefore, along the transition the price level gradually increases. Panel C in Figure 4 presents the time path of the price level.

Real money balances, M/P, increase on impact since M increases and P is unchanged. After the initial shock M is fixed but P is gradually increasing; therefore, M/P must gradually fall and converge back to its original level (recall that we have concluded that in the long run real money balances are unchanged). This is illustrated in Figure 3 by moving from point 2 to point 3 (which is the same as 1) in the money market. Panel D in Figure 4 presents the time path of M/P.

Figure 3: A Permanent Increase in M^s

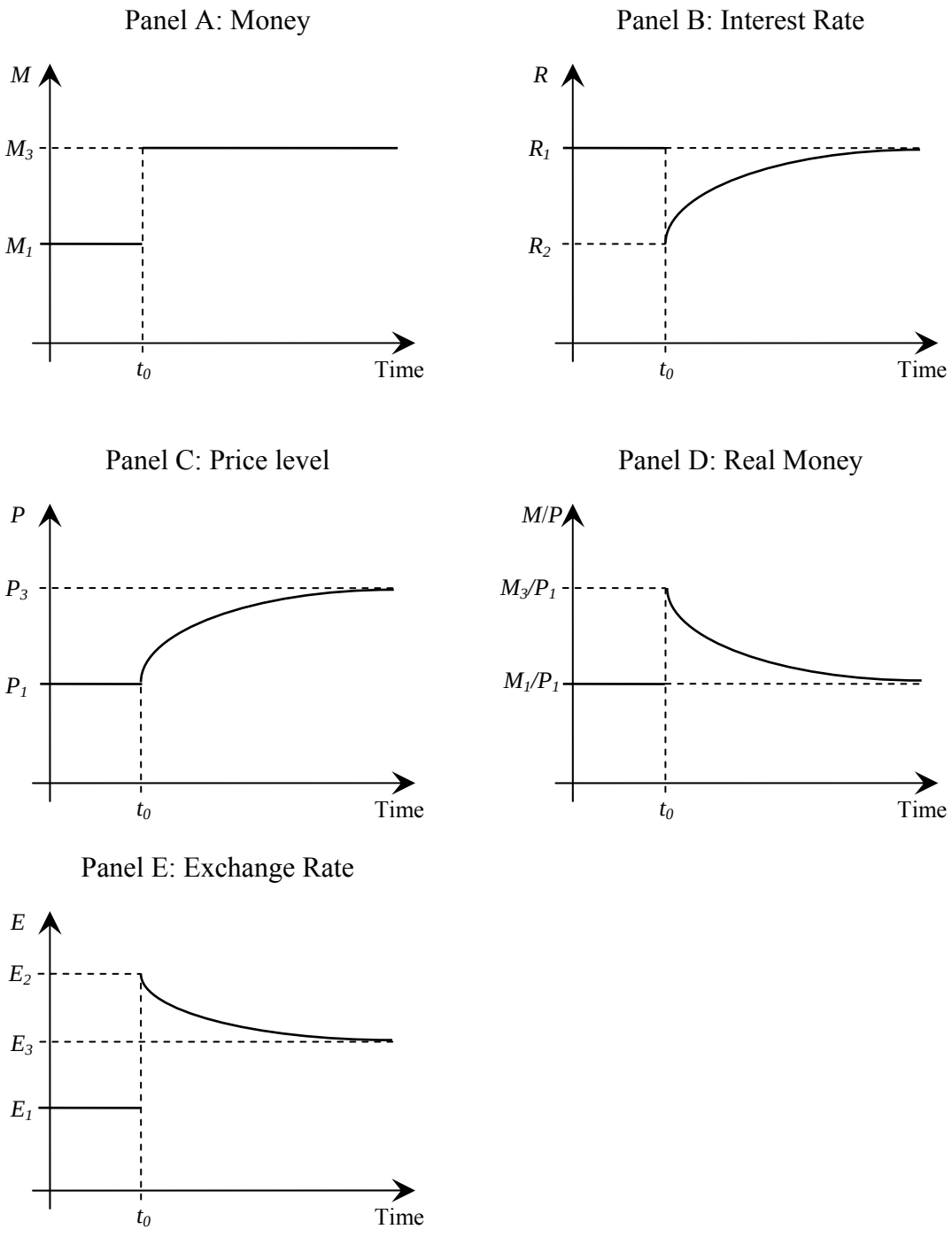
The Money Market and the Exchange Rate



The dollar interest rate, $R_\$$, falls on impact but goes back to its original level in the long run. In the transition $R_\$$ increases gradually as real money supply falls. Again, this is illustrated in Figure 3 by moving from point 2 to point 3 in the money market. Panel B in Figure 4 presents the time path of $R_\$$.

Figure 4: A Permanent Increase in M^s

Time Path of Key Variables



Finally, we know that the dollar depreciates both on impact and in the long run. The problem is to determine which is higher the short run exchange rate or the long run. Here

the assumption that initially home and foreign interest rates are equal becomes useful. Notice that in the transition home interest rate is always lower than the foreign one; therefore, by the interest parity condition it must be the case that during the transition the dollar appreciates against the euro. This is possible only if on impact the dollar-euro exchange rate is greater than its long run value. In other words, the exchange rate overshoots. On impact the exchange rate depreciates by more than the rate necessary for maintaining the long run equilibrium.[6] This is clearly seen in Figure 3 as the system moves from point 2' to 3'. Panel E in Figure 4 presents the time path of the exchange rate.

The overshooting result is important because it helps to explain the high volatility of exchange rates.

[6] In the more general case, if we start with different home and foreign interest rates the overshooting result still hold. However, notice that in this case there is a permanent and constant depreciation (or appreciation) in the long run and therefore the exchange rate is unbounded. The overshooting result holds with respect to the long run trend; that is, on impact the dollar depreciates to a level greater than its new long run trend and then converges to that trend.