

**BRIDGING THE GAP  
BETWEEN THE INTEREST RATE AND  
PRICE LEVEL APPROACHES IN  
THE AD-AS MODEL**

**THE ROLE OF THE LOANABLE FUNDS MARKET**

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**INTRODUCTION**

There are two generally accepted ways of plotting the aggregate demand (AD) and aggregate supply (AS) curves in the goods market. The first, and certainly the more conventional, approach is to put the price level ( $P$ ) on the vertical axis (the  $P$ - $y$  approach). Aggregate demand and aggregate supply curves plotted in  $P$ - $y$  space appear in almost every macroeconomics textbook. In this approach, the price level is assumed to adjust to clear the market for goods. Second, and less commonly seen, is a graph with the real interest rate ( $r$ ) on the vertical axis (the  $r$ - $y$  approach). Prominent examples of the  $r$ - $y$  approach are Barro [1997], who explicitly plots the AD and AS curves against the real interest rate ( $r$ ), and Mankiw [1997] who does so implicitly.<sup>1</sup> In this approach the real interest rate is assumed to adjust to clear the market for goods. The objective of this paper is to develop the theoretical connections between these two approaches within the framework of a simple end-of-period disequilibrium macroeconomic model and then explore the conditions under which one or the other yields the greater insight into the working of the model.

The essential link between the  $P$ - $y$  and  $r$ - $y$  approaches to modeling the goods market is the market for loanable funds, in which, we assume, the interest rate is determined. At first glance, this would seem to be inconsistent with the  $r$ - $y$  approach, which shows the equilibrium interest rate for the goods market as corresponding to the intersection of the AD and AS curves. The  $r$ - $y$  approach, however, merely indicates what the interest rate would have to be for the goods market to be in equilibrium. It does not *determine* the equilibrium interest rate. That is the role of the

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loanable funds market. Moreover, there is no guarantee that the loanable funds market will produce the interest rate that also equilibrates the goods market. In particular, whenever the economy is out of general equilibrium, the loanable funds market will equilibrate at an interest rate that is inconsistent with equilibrium in the goods market. The proximate cause of this is a spillover from the money market.<sup>2</sup> How is equilibrium in the goods market restored? This is where the  $P$ - $y$  approach is illuminating. Whenever the interest rate is, say, below the rate that equilibrates the goods market in  $r$ - $y$  space, the price level must be below the intersection of the AD and AS in  $P$ - $y$  space. That is, both approaches must indicate an excess demand for goods. If  $P$  is the variable that responds to excess demand and supply in the goods market,  $P$  will rise. However, this rise in  $P$  does not directly impact the goods market. Instead, it restores the *money* market to equilibrium and therefore eliminates the spillover that caused the loanable funds market to equilibrate at the “wrong” interest rate in the first place. In and of itself, a change in  $P$  does not clear the goods market. This is widely misunderstood. What happens is that the change in  $P$  impacts the market for loanable funds through its effect on the money market, driving the interest rate up when there is an excess demand for goods and down when there is an excess supply of goods. How this happens and what ensures that the loanable funds market eventually settles on the interest rate that also clears the goods market are the major themes of this paper.

Our analysis proceeds in several logical steps. First, we demonstrate that, absent a real balance effect and ignoring, for simplicity, the adjustment dynamics implicit in an upward-sloping, short-run aggregate supply curve, standard specifications of the goods market leave no role for the price level. Instead, it is the interest rate that must adjust to clear the goods market. Second, we show that, in general equilibrium, the equilibrium conditions for the loanable funds market and the goods market are identical. This means that in the long run the loanable funds market generates the “right” interest rate for goods market equilibrium. Third, we develop the theoretical connections between the loanable funds market, the goods market, and, necessarily, the money market. Of particular interest is the spillover from the money market that is the crucial link between the loanable funds market and the goods market. Finally, we use our model to analyze the process by which the goods market is restored to equilibrium following a change in the money supply.

## THE GOODS MARKET EQUILIBRIUM CONDITION

Our framework of analysis is the flexible-price, closed-economy model, in which the aggregate supply of goods is exogenously fixed at  $y^*$  (that is,  $y^s = y^*$ ). This approach permits us to abstract from the very significant complications that arise in the context of open economies and short-run dynamics (specifically an upward-sloping SRAS). On the demand side, we assume that  $c = c(y^* - t)$ , in which  $c$  is real planned consumption and  $t$  is (lump sum) real taxes net of transfer payments.<sup>3</sup> Real planned investment,  $i = i(r)$ , varies inversely with the (real) interest rate, while real planned government purchases of goods and services,  $g$ , are determined exogenously. Aggregate demand is  $y^d = c + i + g$ , from which it follows that the long-run equilibrium condition for the goods market is

$$(1) \quad y^* = c(y^* - t) + i(r) + g .$$

Notice that the price level does not appear in equation (1). Since  $P$  affects neither aggregate demand nor aggregate supply in the long run it cannot play any role in equilibrating the goods market.<sup>4</sup> Instead, it is clearly the interest rate that must adjust to equilibrate the goods market. No doubt this is the justification that Barro and Mankiw would give for plotting the AD and AS curves as functions of  $r$ , not  $P$ .<sup>5</sup>

Planned consumption can be rewritten as  $c = y^* - t - s$ , where  $s$  is planned saving. Making this substitution for  $c$  in equation (1), the goods market equilibrium condition becomes:

$$y^* = (y^* - t - s) + i(r) + g , \text{ or}$$

$$(2) \quad s = i(r) + (g - t) = i(r) + def,$$

in which  $def$  is the government budget deficit. While most macroeconomists would immediately recognize equation (1) as the goods market equilibrium condition, they would likely identify equation (2) as the equilibrium condition for the loanable funds market, which, of course, it is. The left-hand side of equation (2) is the supply of loanable funds arising from (net) household saving, while the right-hand side is the total demand for loanable funds arising from firms' need to finance purchases of capital goods and the government's need to finance its deficit. It is essential to note that equation (2) implicitly assumes there is no spillover from the money market to the loanable funds market, otherwise there would be an additional term reflecting the excess supply of or demand for money. An excess supply of money, for example, would supplement the supply of loanable funds arising from household saving on the left-hand side of equation (2). Thus, equation (2) tells us that as long as the money market is in equilibrium, the loanable funds market will equilibrate at the interest rate that also equilibrates the goods market. This will no longer be true, however, if there is disequilibrium in the money market. Put somewhat differently, equation (2) is simultaneously the equilibrium condition for the goods market and the equilibrium condition for the loanable funds market as long as there is no spillover from the money market.

We are therefore led to two important questions. First, what causes  $r$  to adjust when the goods market is out of equilibrium since it is  $P$ , not  $r$ , that responds to disequilibrium in that market? Second, since  $r$  is determined in the market for loanable funds, what happens to cause this market to generate the "right" interest rate for equilibrium in the goods market in the long run? To address these puzzles, we develop a model of the loanable funds market that explicitly incorporates spillovers from the money market. This model permits us to determine the conditions under which the loanable funds market will generate the "wrong" interest rate for the goods market and the feedback mechanism that puts things right again. In addition, the model sheds light on the appropriateness of modeling the goods market in  $P$ - $y$  space as opposed to  $r$ - $y$  space. Finally, we illustrate the working of this model by examining the effect of an increase in the money supply.

### THE MARKET FOR LOANABLE FUNDS

The supply of loanable funds, a flow, derives from households. It is equal to the net flow demand for bonds by households, or:

$$(3) \quad LF^s = \Delta b_{t+1}^{d(h)},$$

in which  $\Delta b_{t+1}^{d(h)}$  represents the desired change in household bond holdings between period  $t$  and period  $t+1$ . It must also be the case that:

$$(4) \quad \Delta b_{t+1}^{d(h)} = s_{t+1} - \Delta m_{t+1}^d,$$

in which  $s_{t+1}$  is the amount that households save over the interval from  $t$  to  $t+1$ , and  $\Delta m_{t+1}^d$  is the desired change in real money holdings over the same interval. It follows directly that:

$$(5) \quad LF^s = s_{t+1} - \Delta m_{t+1}^d.$$

The demand for loanable funds equals the flow supply of bonds over the interval from  $t$  to  $t+1$  by firms and the government:

$$(6) \quad LF^d = \Delta b_{t+1}^{s(f)} + \Delta b_{t+1}^{s(g)}.$$

Firms supply bonds  $\Delta b_{t+1}^{s(f)}$  to finance investment spending over the interval from  $t$  to  $t+1$  (which we denote as  $i_{t+1}$ ), and the government supplies  $\Delta b_{t+1}^{s(g)}$  bonds equal to its deficit less the real value of the money it creates over the same interval.<sup>6</sup> The government deficit equals  $g_{t+1} - t_{t+1}$ , where  $g_{t+1}$  represents real government expenditures and  $t_{t+1}$  represents real government tax revenues, both measured over the interval from  $t$  to  $t+1$ . The amount of (nominal) money created by the government over this same interval is  $\Delta M_{t+1}^s$ . If we deflate using the end-of-period equilibrium price level, which is appropriate since ours is a flex-price model, real money balances created by the government are  $\Delta M_{t+1}^s / P_{t+1}$ . It follows that:

$$(7) \quad LF^d = i_{t+1} + (g_{t+1} - t_{t+1}) - \Delta M_{t+1}^s / P_{t+1}.$$

Instead of including the change in the money supply over the period, the third term in equation (7), as a negative contribution to the demand for loanable funds, it makes just as much sense to include it as a positive contribution to the supply of loanable funds. Moving this term from equation (7) to equation (5), we can rewrite the supply and demand for loanable funds as:

$$(8) \quad LF^s = s_{t+1} + (\Delta M_{t+1}^s / P_{t+1} - \Delta m_{t+1}^d), \text{ and}$$

$$(9) \quad LF^d = i_{t+1} + (g_{t+1} - t_{t+1}) .$$

Equation (8) can be rewritten as:

$$LF^s = s_{t+1} + (M_{t+1}^s / P_{t+1} - M_t^s / P_{t+1}) - (M_{t+1}^d / P_{t+1} - M_t^d / P_{t+1})$$

or, rearranging, as:

$$(10) \quad LF^s = s_{t+1} + (M_{t+1}^s / P_{t+1} - M_{t+1}^d / P_{t+1}) - (M_t^s / P_{t+1} - M_t^d / P_{t+1}) .$$

The third term in equation (10) is the excess supply of money at the beginning of the period deflated by the price level at the end of the period. Since, however, this is a flex-price model it must be the case that  $M_t^s = M_t^d$ . Consequently, it makes no difference whether we divide by  $P_{t+1}$  or  $P_t$ . Either way, the third term in equation (10) is zero. We conclude, then, that in a flexible price model the supply of loanable funds is:

$$(11) \quad LF^s = s_{t+1} + (M_{t+1}^s / P_{t+1} - M_{t+1}^d / P_{t+1}),^7$$

and that the equilibrium condition for the loanable funds market is:

$$(12) \quad s_{t+1} + (M_{t+1}^s / P_{t+1} - M_{t+1}^d / P_{t+1}) = i_{t+1} + (g_{t+1} - t_{t+1}) .$$

Given the end-of-period stock supply of nominal money balances, the end-of-period price level must assume the value required to equate the real supply of money and the real demand for money. Consequently, the second term on the left-hand side of equation (12) will be zero when the money market clears at the end of the period. The initial temptation is simply to drop this term on grounds of irrelevance, in which case we would have done nothing more than reproduce equation (2). But this would be a mistake because equation (12) contains critically important information about the relationship between the money, loanable funds, and goods markets when the economy is out of equilibrium. To clarify this point, notice that the equilibrium condition for the goods market continues to be given by equation (2). Equation (2) and equation (12) are identical *at the end of the period* since that is when the money market clears. This is not the case, however, *during the period* following a shock to the system but before the price level adjusts. During the disequilibrium there will be an excess demand for or supply of money that spills over into the market for loanable funds.

To keep things simple, suppose that the price level is constant at its beginning-of-period equilibrium value (i.e., at  $P_t$ ) during the period, up to the very end at which time it jumps discretely to  $P_{t+1}$ . *During the period*, then, the supply of loanable funds will be:

$$(13) \quad LF^s = s_{t+1} + (M_{t+1}^s/P_t - M_{t+1}^d/P_t).$$

The second term on the right-hand side of equation (13) represents the within-period spillover from the money market to the loanable funds market and is, in general, nonzero. Consequently, the *within-period* equilibrium condition for the loanable funds market is:

$$(14) \quad s_{t+1} + (M_{t+1}^s/P_t - M_{t+1}^d/P_t) = i_{t+1} + (g_{t+1} - t_{t+1}),$$

which is *not* the same as the equilibrium condition for the goods market. The point is that a within-period spillover from the money market to the loanable funds market causes the latter to equilibrate at an interest rate that is inconsistent with equilibrium in the goods market. We can use equations (2) and (14) to describe the process by which the goods market returns to equilibrium following a shock to aggregate demand or aggregate supply.

Equation (14) offers a rationale for adopting the  $P$ - $y$  approach to modeling the goods market. Consider what one might call a within-period version of Walras' Law which, in this model, states that the sum of the excess demands across the goods, money, and loanable funds markets must equal zero (holding  $P$  constant at its beginning-of-period level). Formally, this within-period version of Walras' Law can be expressed as:

$$(15) \quad (c_{t+1} + i_{t+1} + g_{t+1} - y_{t+1}^*) + (M_{t+1}^d/P_t - M_{t+1}^s/P_t) + \{i_{t+1} + (g_{t+1} - t_{t+1})\} - [s_{t+1} + (M_{t+1}^s/P_t - M_{t+1}^d/P_t)] \equiv 0.$$

The obvious implication of Walras' Law is that one of the three markets in the model is redundant. If any two markets are in equilibrium the third market must be in equilibrium as well. Assume, then, that the interest rate adjusts instantaneously within the period so that the loanable funds market is always in equilibrium. The third term in equation (15), the excess demand for loanable funds, will always equal zero. This reduces Walras' Law to:

$$(16) \quad (c_{t+1} + i_{t+1} + g_{t+1} - y_{t+1}^*) + (M_{t+1}^d/P_t - M_{t+1}^s/P_t) \equiv 0,$$

which can be rearranged as follows:

$$(17) \quad (c_{t+1} + i_{t+1} + g_{t+1} - y_{t+1}^*) \equiv (M_{t+1}^s/P_t - M_{t+1}^d/P_t) .$$

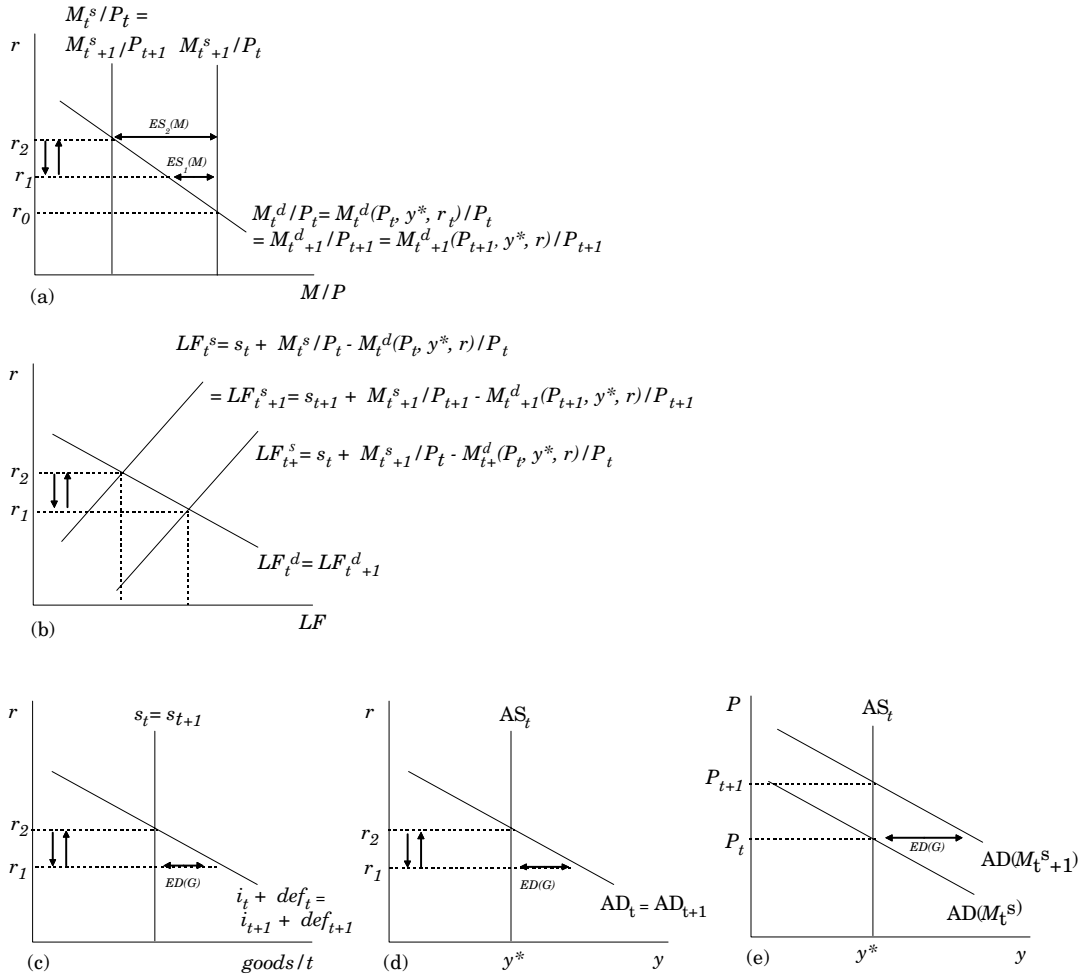
The left-hand side of equation (17) is the excess demand for goods, and the right-hand side is the excess supply of money. If the interest rate adjusts to maintain continuous equilibrium in the loanable funds market, the *within-period* excess demand for goods must equal the excess supply of money. Moreover, we see from equation (17) that a change in price that reduces the excess supply of money simultaneously reduces the excess demand for goods by exactly the same amount. That is, the change in price that restores the money market to equilibrium also restores equilibrium in the goods market. We believe this result is the primary rationale for adopting the  $P$ - $y$  approach to modeling the goods market, even though, as demonstrated above, the price level does not directly impact the excess demand for or supply of goods. In the following sections we develop a graphical representation of this model, and explore these issues further by analyzing the macroeconomic effects of an increase in the money supply.

### THE COMPLETE MODEL

Figure 1 graphically depicts the (end-of-period) equilibrium for the money, loanable funds, and goods markets. For this figure, the interval of analysis is  $t-1$  to  $t$ , not  $t$  to  $t+1$ . Panel a plots the end-of-period real stock supply of and demand for money balances (that is, the stock supply and demand as of  $t$ ) against the interest rate. We assume that expected inflation is zero, so the nominal and real interest rates are identical. The money supply curve is vertical, while the money demand curve is downward sloping. End-of-period nominal money demand, denoted  $M_t^d(P_t, y^*, r_t)$ , is positively related to  $P$  and  $y^*$  and negatively related to  $r$ . In particular, the end-of-period stock demand for money is proportional to the price level, which implies that a doubling of the price level doubles nominal money demand. Dividing the end-of-period nominal demand by the end-of-period price level,  $P_t$  yields the end-of-period real demand for money, denoted  $M_t^d(P_t, y^*, r_t)/P_t$ . Notice that  $y^*$  is the only shift parameter for the money demand curve. Since money demand is plotted against the interest rate, a change in the interest rate does not shift money demand (although it does change the quantity demanded). The effect of a change in the price level is less obvious. An increase, say a doubling, of the price level doubles both the numerator (because nominal money demand is proportional to the price level, *ceteris paribus*) and the denominator. Hence, a change in the price level leaves the real demand for money unchanged. Given  $M_t^s$ ,  $P_t$ , and  $y^*$ , the interest rate consistent with equilibrium in the money market is  $r_t$ . This should not be taken to imply that the interest rate is *determined* in the money market.

Panel b shows the market for loanable funds. The (real) demand for loanable funds is negatively sloped and equals the sum of investment and the government budget deficit. The (real) supply of loanable funds is given by equation (11) (except that here the interval of analysis is from  $t-1$  to  $t$  and not from  $t$  to  $t+1$ ). We assume that saving,  $s_t$ , is entirely determined by real disposable income. That is,  $s_t = s(y^* - t)$ .

**FIGURE 1**  
**General Equilibrium**



Since saving does not depend on the interest rate, the saving function (panel c) is vertical. The reason the loanable funds supply curve is upward sloping is that an increase in the interest rate above  $r_t$ , *ceteris paribus*, creates an excess supply of real money balances that must be added to the supply of loanable funds. Alternately, a decline in the interest rate below  $r_t$ , results in an excess demand for money and a decrease in the supply of loanable funds as households attempt to build up their holdings of real money balances. Consequently, the loanable funds supply curve is positively sloped even though the saving function is vertical. The  $r$ - $y$  and  $P$ - $y$  approaches to modeling the goods market are illustrated in the remaining panels. Panel c is the graphical version of equation (2), the equilibrium condition for the goods market. The goods market will be in equilibrium whenever saving equals investment plus the government deficit. This is the same as saying that the goods market will be in equilibrium whenever aggregate planned expenditure equals aggregate planned



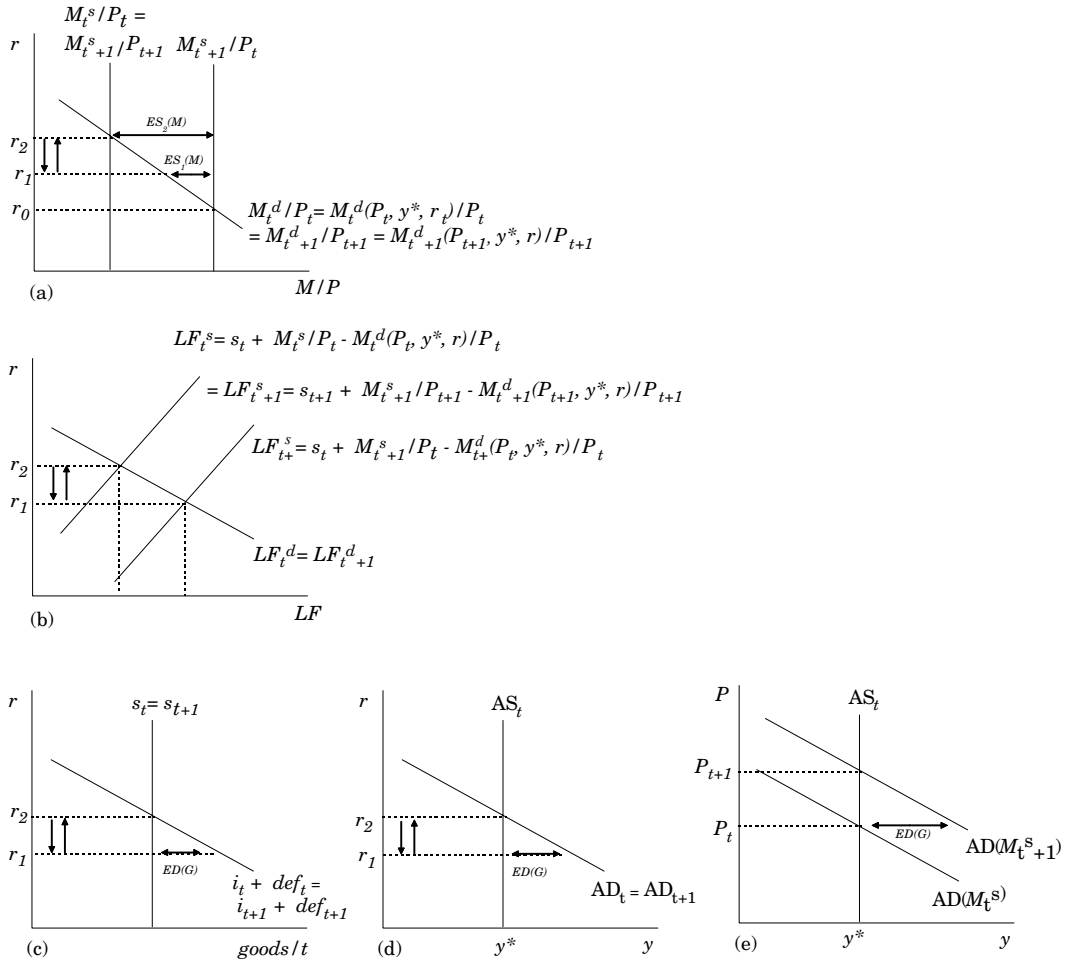
output. In panel d we plot the AD and AS curves in  $r$ - $y$  space. The AD is downward sloping for the straightforward reason that a decrease in the interest rate causes investment spending to increase. Necessarily, the AD and AS in panel d and the  $s$  and  $i + def$  curves in panel c intersect at the same interest rate. Moreover, this interest rate, denoted  $r_t$  must be the same interest rate that equilibrates the loanable funds market when there is no spillover from the money market. Finally, panel e illustrates the  $P$ - $y$  approach to modeling AD and AS. The reason for the downward slope of the AD curve in  $P$ - $y$  space is slightly more complicated. *Ceteris paribus*, a lower price level creates an excess supply of money by raising the real supply. The resulting spillover into the loanable funds market raises the supply of loanable funds, lowers the interest rate, and raises investment spending. If the goods market had been in equilibrium initially, there would now be an excess demand, which can only be eliminated by a rise in the interest rate. Plotting the AD and AS curves against the price level tends to obscure this crucial fact. Hence, when employing the  $P$ - $y$  approach, it is important to note that the increase in the price level that results from an excess demand for goods has no *direct* effect on the excess demand. What happens is that the rise in the price level eliminates the spillover from the money market that is depressing the interest rate below that required for equilibrium in the goods market. When the spillover disappears and the interest rate subsequently rises, the goods market returns to equilibrium. The effect of the change in the price level on the goods market is indirect, operating through the markets for money and loanable funds. We return to this point below.

### AN INCREASE IN THE MONEY SUPPLY: A SIMPLE STORY OF DISEQUILIBRIUM ADJUSTMENT

Suppose, now, that the nominal money supply rises from  $M_t^s$  to  $M_{t+1}^s$  over the interval from  $t$  to  $t+1$ . In the following discussion, we adopt the slightly artificial convention of allowing everything to change during the period following this increase in the money supply except for the price level. Then, at the end of the period, the price level is allowed to jump discretely to its new long-run equilibrium value. In this way we can easily observe the excess demands and supplies that build up during the period and ultimately drive the endogenous variables to their new general equilibrium values. With this in mind, notice that the initial effect of the increase in the nominal money supply is to shift the supply curve to the right from  $M_t^s / P_t$  to  $M_{t+1}^s / P_t$  in panel a of Figure 2. This creates an excess supply of real money balances initially designated  $ES_2(M)$ .

During the period, this excess supply of money spills over to the loanable funds market, shifting the  $LF^s$  curve to the right as indicated by equation (13). As a result, the interest rate falls. The interest rate cannot fall all the way to  $r_0$ , however. The reason is that at  $r_0$  the money market would be back in equilibrium so there could be no spillover and, therefore, no fall in the interest rate—in other words, a logical contradiction.<sup>8</sup> Put somewhat differently, the decline in the interest rate raises the real demand for money (through a movement down the money demand curve), which reduces the excess supply of money and the spillover from the money market to the

**FIGURE 2**  
**Effects of an Increase in the Money Supply**



loanable funds market. This mitigates the effect on  $r$  and prevents it from falling all the way to  $r_0$ .

Suppose, then, that the interest rate falls to  $r_1$  during the period<sup>9</sup> such that the excess supply of money is  $ES_1(M)$  and the loanable funds supply curve is  $LF_{t+}^s$ . Here we employ the notation  $t+$  (as opposed to  $t$  or  $t+1$ ) to indicate the supply of loanable funds over the interval from  $t$  to  $t+1$  up to, but not including, the very end of the period at which the price level jumps discretely to  $P_{t+1}$ . The spillover from the money market *during the period* is the real supply minus the real demand, or  $M_{t+}^s/P_t - M_{t+}^d(P_t, y^*, r_1)/P_t$ . Notice that the nominal money supply has already assumed its end-of-period value since, by assumption, it changed at the beginning of the period and will not change again. Nominal money demand during the period,  $M_{t+}^d$ , is determined by the price level, real output, and the interest rate during the period (that is,  $P_t, y^*$ , and  $r_1$ ). The nominal money supply and demand are both deflated by  $P_t$  *during the period*, since  $P_t$  is the beginning-of-period price level.

The decline in the interest rate to  $r_1$  during the period results in an excess demand in the goods market, designated ED(G) in panels c and d, as investment (plus the deficit), and hence aggregate demand, rises in response to the fall in the interest rate. In the  $P$ - $y$  approach to modeling the goods market (panel e), the AD curve shifts to the right, resulting in an excess demand for goods at the initial price level. The excess demand for goods is identical in panels c, d, and e. Since the loanable funds market is in equilibrium, this excess demand for goods must equal the excess supply of money in panel a. In both the  $r$ - $y$  and  $P$ - $y$  approaches, this excess demand is caused by the decline in the interest rate from  $r_2$  to  $r_1$ . This is obvious in the case of the  $r$ - $y$  approach but must be inferred in the  $P$ - $y$  approach.

During the period, then, an excess supply of money gives rise to a quantitatively equal excess demand for goods through a decrease in the interest rate. The market for loanable funds is in a short-run equilibrium at an interest rate that is inconsistent with equilibrium in the goods market. This is an illustration of the more general statement that the market for loanable funds will equilibrate at an interest rate that also equilibrates the goods market unless there is a spillover from the money market. Since there is a spillover during the period in this example, the goods market is thrown out of equilibrium.

Finally, at the end of the period we allow the price level to react to the excess demand for goods and jump discretely to its new equilibrium level,  $P_{t+1}$ . Since the percentage rise in the price level is the same as the percentage rise in the nominal money supply that took place at the beginning of the period, the real money supply curve shifts back to its original position at  $M_{t+1}^s / P_{t+1} = M_t^s / P_t$ . Ingrained as we are to think of the interest rate as being determined in the money market, it is tempting at this point to say that this leftward shift in the money supply curve raises the interest rate back to  $r_2$ . But this is not quite accurate if the interest rate is determined in the loanable funds market. To get the intuition right it is helpful to suppose that the price level *slowly* rises from  $P_t$  to  $P_{t+1}$ . As the price level rises, the excess supply of money starts to decrease, which shifts the loanable funds supply curve to the left and causes the interest rate to increase. This rise in  $r$  tends to counteract the effect of the rise in  $P$  because it raises the excess supply of money at the same time that the rise in  $P$  is reducing the excess supply of money. The change in  $P$  is the stronger effect, however, otherwise the interest rate could not have started back up to begin with. Therefore, as the price level increases the excess supply of money falls and the loanable funds supply curve shifts left, driving the interest rate up and reducing the corresponding excess demand for goods. When the price level reaches  $P_{t+1}$  the excess supply of money disappears, and the loanable funds supply curve returns to its original position, now denoted  $LF_{t+1}^s$ . The interest rate is back at  $r_2$ , and the excess demand for goods is zero. In the  $r$ - $y$  approach, the effect of the rise in the interest rate on the excess demand for goods is explicit and obvious. In the  $P$ - $y$  approach, by contrast, it may appear to the untutored eye as if the changing price level is directly impacting the excess demand for goods. It is not. The changing price level eliminates the spillover from the money market to the loanable funds market and permits the interest rate to rise, thus clearing the goods market indirectly.

All three markets are now back in equilibrium. In terms of comparative statics, there are no surprises in these results. Money is neutral in its effects on the economy. Still, we can gain some important insights by closely examining this example. First, the model demonstrates that the loanable funds market will equilibrate at the interest rate that also equilibrates the goods market, so long as there are no spillovers from the money market. Second, the model makes it clear that it is really the interest rate, not the price level, that equilibrates the goods market. Third, the variable that directly responds to disequilibrium in the goods market is the price level. And although a change in the price level has no direct effect on the excess demand for or supply of goods, it restores equilibrium in the money market and eliminates the spillover effect on the interest rate that caused the goods market to be in disequilibrium in the first place. Finally, as long as the interest rate is adjusting to maintain equilibrium in the loanable funds market, any excess supply of (demand for) money must be quantitatively equal to the excess demand for (supply of) goods. Thus, in both the  $P$ - $y$  and  $r$ - $y$  approach it is the interest rate that rises to eliminate an excess demand for goods. The  $r$ - $y$  approach has the advantage of showing the relationship between  $r$  and the excess demand for goods explicitly. But it does not explain *why* the interest rate rises because the interest rate is not responding directly to excess demands and supplies of goods. The  $P$ - $y$  approach, by contrast, has the advantage of showing the variable that does respond directly to an excess demand for goods. But, by itself, it does not tell a particularly compelling story about how the excess demand for goods is eliminated. Thus, each approach may be seen to have a singular advantage and a singular disadvantage.

### SOME CONCLUDING REMARKS

Given these conclusions, how should the goods market be depicted graphically? Should the AD and AS curves be plotted against the price level (as is done in the conventional AD-AS model) or should they be plotted against the interest rate (as Barro does in his intermediate macroeconomic theory text)? In our view, the formally correct model is that provided by the  $r$ - $y$  approach. It is, in fact, the interest rate that adjusts to clear the goods market, and a change in the interest rate directly impacts the excess supply of or demand for goods. The  $r$ - $y$  approach is particularly insightful when the intent is to analyze the long-run consequences of a shock to aggregate demand or aggregate supply. The obvious disadvantage of this approach is that the AD and AS curves in  $r$ - $y$  space can't be used to determine the price level, although one can finesse this point in various ways. Mankiw, for example, uses the quantity theory equation to determine the price level given the money supply and the long-run equilibrium rate of output. A second disadvantage of the  $r$ - $y$  approach is that it conveys the false impression that the interest rate responds directly to excess supplies and demands in the goods market. It does not. The effect on the interest rate, which works through the money and loanable funds markets, is indirect.

The appeal of the  $P$ - $y$  approach is obvious. It is analogous to the  $P$ - $Q$  model of microeconomic theory. As in microeconomics, an increase in the price level eliminates an excess demand and a decrease in the price level eliminates an excess sup-

ply. The difference, of course, is that in the microeconomic model the effect is direct.<sup>10</sup> A change in price directly impacts quantity supplied and quantity demanded. But this is not the case in the  $P$ - $y$  model of macroeconomic theory. The effect, which operates through the markets for money and loanable funds, is decidedly indirect. Thus, while an excess demand for goods will cause the price level to increase, the  $P$ - $y$  approach conveys the false impression that a change in the price level directly equilibrates the goods market. Still, if the objective is to analyze short-run, or business cycle-type, dynamics, it makes sense to plot the AD and AS (both SRAS and LRAS) curves against the price level. The reason is that the deviation of the actual price level from the expected price level is such an important element of modern theories of short-run aggregate supply. It is hard to see how this could be incorporated into a model of AD-AS plotted against the interest rate. Thus, the conventional approach may be preferred for business cycle analysis (not including, of course, “real” business cycle analysis). Indeed, Mankiw [1997] himself switches from the  $r$ - $y$  approach to the  $P$ - $y$  approach when analyzing short-term fluctuations in real output. That said, when using the conventional model, it is important not to lose sight of the disequilibrium dynamics that a change in the price level sets in motion that eventually results in equilibrium being restored in the market for goods and services. The standard AD-AS model is seriously deficient in this regard.

## NOTES

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1. Mankiw states, “Now you can see why the interest rate plays a key role: it must adjust to ensure that the demand for goods equals the supply. ... If the interest rate is too high, investment is too low, and the demand for output falls short of the supply. If the interest rate is too low, investment is too high, and the demand exceeds the supply. *At the equilibrium interest rate, the demand for goods and services equals the supply*” [1997, 61, italics in the original].
2. The notion of spillover has a long history in the literature. Patinkin [1952] first emphasized that markets in disequilibrium imply a general pattern of spillover. Grossman [1969, 1971] provided the microfoundations for spillover while Ferguson and Hart [1980, 1985] were among the first to formally incorporate market spillover into a generalized disequilibrium macroeconomic model and explore its significance for the conduct and design of monetary policy. Our work in this paper has been influenced by this literature.
3. This specification of the consumption function excludes two potential ways in which planned consumption can depend directly on the price level: the real balance effect and the international substitution effect. The former appears to be empirically irrelevant and is generally not included in the standard AD-AS model. The latter is ruled out by our assumption of a closed economy. Even in open-economy models, however, there is good reason to be suspicious of the international substitution effect. See Elwood and Fields [1998]. In addition, consumption and saving could be made to depend on the interest rate as well as disposable income. The empirical evidence for this, too, is weak. Moreover, this specification would greatly complicate the analysis without changing any of the conclusions.
4. A little noted assumption here is that the government is holding its purchases of goods and services constant in real terms, not nominal terms. If government purchases are constant in nominal terms then a change in  $P$  will change real government purchases in the opposite direction.
5. It should be pointed out, however, that in his later chapters discussing short-run dynamics, Mankiw [1997] switches to the conventional approach of plotting the AD and AS curves against the price level.

6. If the government were instead running a budget surplus, its demand for bonds (equal to the amount of the surplus plus the real value of money created over the same interval) would be added to the supply of loanable funds. None of our conclusions would be affected by this change.
7. Similar equations for a *fixed* price model are given by Meyer [1980] and Barron and Lowenstein [1996]. We owe a heavy intellectual debt to Barron and Lowenstein for stimulating our thoughts on this subject.
8. See Fields and Hart [2002] for a discussion of the inability of the interest rate to simultaneously clear the money market and the loanable funds market when the economy is out of general equilibrium. Consequently, one may assume that the interest rate clears either the money market or the loanable funds market but not both. In this paper, we assume that the interest rate adjusts to clear the loanable funds market.
9. In conventional terminology, this within-period decline in the interest rate is the *liquidity effect* of the increase in the nominal money supply
10. And, of course, in the *P-Q* model the change in price is a relative price change, not a change in the absolute price level.

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