The Keynesian System: Aggregate Supply and Demand

The fixed-price–fixed-wage version of the Keynesian system highlights the role of aggregate demand. The demand-determined nature of output in this Keynesian model stands in sharp contrast to the supply-determined nature of output in the classical system. In this chapter, we examine the Keynesian system when prices and wages are not held constant and see that demand as well as supply factors play a role in determining output. In this sense, the models in this chapter are a synthesis of the classical and Keynesian systems.

In section 1, we illustrate the demand-determined nature of output in the Keynesian models. We construct a Keynesian aggregate demand schedule. In section 2, this Keynesian aggregate demand schedule is put together with the classical supply side. It will be seen that as long as we retain the classical assumptions of perfect information in the labor market and perfect price and wage flexibility, the substitution of the Keynesian aggregate demand schedule does not change the classical nature of the model. As long as the supply schedule remains vertical, as it does if the foregoing labor market assumptions are made, aggregate output will be determined independent of demand. For aggregate demand to play a role in output determination, the classical labor market assumptions must be modified.

Alternative Keynesian assumptions about the supply side of the economy are analyzed in Sections 3 and 4. In these sections, we develop the Keynesian aggregate supply function. In section 5, we see how shifts in this aggregate supply function play a role in determining price and output in the Keynesian model. The final section of the chapter compares the classical and Keynesian systems.

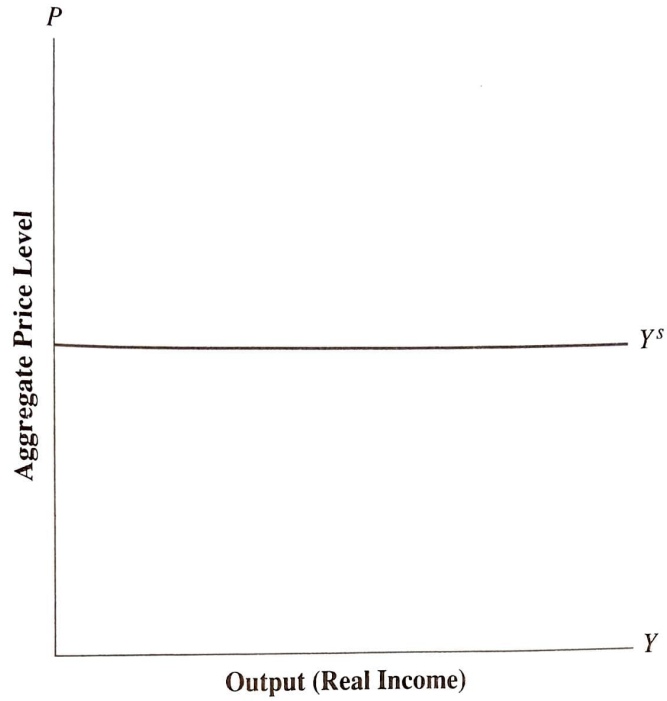
1 The Keynesian Aggregate Demand Schedule

The notion in the simple Keynesian model is that for output to be at an equilibrium level, aggregate demand must equal output. For an output (Y) and interest-rate (r) combination to be an equilibrium point, output must equal aggregate demand and money demand must equal money supply.

What guarantees that this level of output will be equal to aggregate supply—equal to the amount the business sector will choose to produce? Our implicit assumption about the aggregate supply schedule is depicted in Figure 1. We assumed that any level of output demanded would be forthcoming at the given price level.

Such an assumption could be plausible when output is far below the capacity of the economy. In these conditions—for example, during the Depression of the 1930s—increases in output might not put upward pressure on the level of the

FIGURE 1 Aggregate Supply Schedule in the Fixed-Price Keynesian Model



Where the price level is fixed and output is determined by aggregate demand, we assumed that the aggregate supply schedule is horizontal.

money wage, given the high level of unemployment. Also, the marginal product of labor (MPN) might not fall, as more labor is employed when we begin at a low level of employment. As a consequence, the cost of producing additional units of output W/MPN might remain constant, even with increases in output. In more normal conditions, an increase in output would put upward pressure on both the wage and price levels. We would expect the supply schedule to be upward-sloping.

In the more general case of the upward-sloping aggregate supply schedule, we cannot assume that price is given (supply is no constraint) and determine output simply by determining aggregate demand. Output and price will be jointly determined by supply and demand factors. The Keynesian aggregate supply schedule is discussed in Sections 3 and 4. First, we construct the Keynesian aggregate demand schedule, the relationship between aggregate demand and the price level in the Keynesian model.

The factors that determine aggregate demand in the Keynesian system determine the positions of the *IS* and *LM* schedules and, therefore, the income–interest-rate combination that equilibrates the money market and causes output to equal aggregate demand. In constructing an aggregate demand schedule, we want to find the output demanded for each price level. To do this, we examine how the position of the *IS* and *LM* schedules, and consequently how the levels of the interest rate and output at which the schedules intersect, are affected by price changes. The level of output at which the *IS* and *LM* schedules intersect for a given price level is a point on the Keynesian aggregate demand schedule. Consider, first, how a change in the price level affects the position of the *IS* schedule. The condition for equilibrium along the *IS* schedule is

$$I(r) + G = S(Y) + T \tag{1}$$

where I = investment
G = government spending
S = saving
T = taxes
Y = output

To see how the price level influences the position of the *IS* schedule, consider how each variable in equation (1) is affected by price changes.

Two variables, government spending (G) and taxes (T), are assumed to be fixed by the government in *real terms*; that is, we have assumed and will continue to assume that their real levels are unaffected by price changes. The level of investment is also assumed to be determined in real terms; a given interest rate determines a level of real investment. Changes in the price level do not *directly* affect investment.

Similarly, *real* saving is assumed to depend on real income and is not directly affected by changes in the price level. None of the four terms in equation (1), the *IS* schedule equilibrium condition, depends directly on the price level, so a change in the price level does not shift the *IS* schedule.

What about the *LM* schedule? The equilibrium condition for the money market, the *LM* schedule, is

$$\frac{M}{P} = L(Y, r) \tag{2}$$

The condition equates the real supply of money (M/P) with the demand for money in real terms. The real money supply is equal to the exogenously fixed *nominal* money supply (M) divided by the price level (P).

The Keynesian theory of the demand for money relates the demand for money in *real* terms to the level of *real* income and to the interest rate, although as long as prices are held constant, there is no need to distinguish between changes in real and nominal values. People wish to hold a certain amount of real money balances for a given volume of transactions measured in real (constant-dollar) terms, where real income is a proxy for the real volume of transactions. Consequently, equilibrium in the money market occurs when the demand for real money balances is just equal to the real money supply. It is the nominal money supply—not the real money supply—that can be exogenously fixed by the monetary authority. Any change in the price level will affect the real money supply and consequently will shift the *LM* schedule.

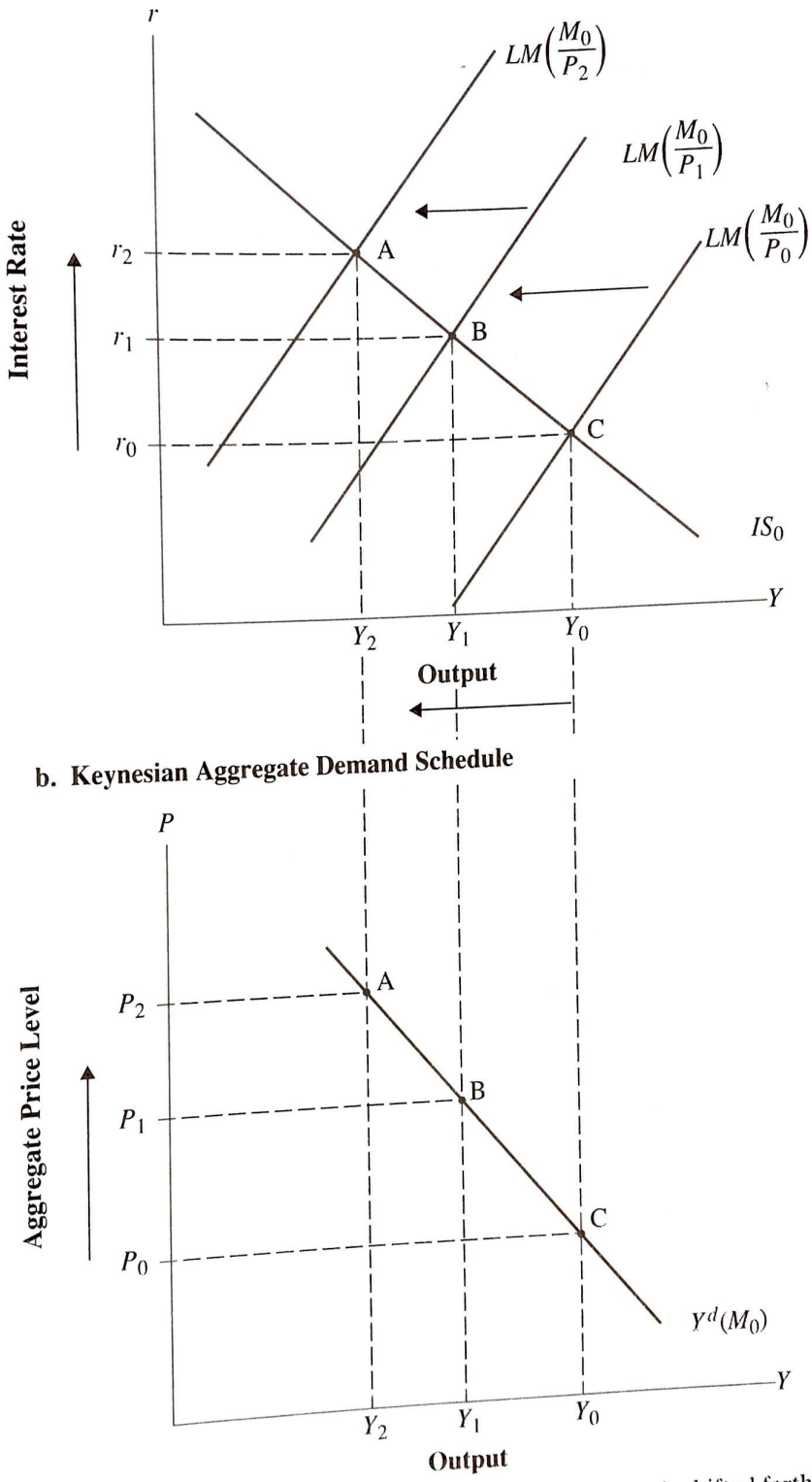
Figure 2*a* illustrates the effect of changes in the price level on the real money supply and, therefore, on the position of the *LM* schedule. Holding the nominal money supply fixed at M_0, three price levels are considered, where $P_2 > P_1 > P_0$. Notice that as we consider the effect of a price increase from P_0 to P_1, then from P_1 to P_2, at the higher price level the *LM* schedule is shifted to the left. The effect of a higher price level reduces the real money supply,

$$\left(\frac{M_0}{P_2}\right) < \left(\frac{M_0}{P_1}\right) < \left(\frac{M_0}{P_0}\right)$$

Overall, the effect of a higher price level is the same as that of a fall in the nominal supply of money; both reduce the real money supply (M/P). The *LM* schedule shifts to the left, raising the interest rate and lowering investment and aggregate demand.

In Figure 2*b*, we plot the level of aggregate demand corresponding to each of the three price levels considered. This schedule, labeled Y^d, is the aggregate demand schedule. As can be seen from the construction of the schedule, this level of output demanded is the equilibrium output level from the *IS*–*LM* schedule model, the output

FIGURE 2 Construction of the Aggregate Demand Schedule



At successively higher price levels, P_0, P_1, P_2, the LM schedule in part *a* is shifted farther to the left. This shift results in successively lower levels of aggregate demand Y_0, Y_1, Y_2. These combinations of price and aggregate demand are plotted to give the negatively sloped aggregate demand schedule in part *b*.

level that for a given price level just equates output and aggregate demand while simultaneously clearing the money market.

The aggregate demand schedule reflects monetary influences (factors that affect the *LM* schedule) as well as direct influences on aggregate demand (factors affecting the *IS* schedule). Factors that increase the level of equilibrium income in the *IS–LM* model (increase the level of output demanded at a given price level) will shift the aggregate demand schedule to the right. Factors that cause equilibrium income to decline in the *IS–LM* framework will shift the aggregate demand schedule to the left.

Consider the effect of an increase in the money supply, from M_0 to M_1, as shown in Figure 3. From equilibrium point A, with

$$LM\left(\frac{M_0}{P_0}\right),$$

the increase in the money supply shifts the *LM* schedule to

$$LM\left(\frac{M_1}{P_0}\right)$$

The new equilibrium point is at B, as shown in Figure 3*a*. Equilibrium income for a given price level P_0 in the figure increases from Y_0 to Y_1. The aggregate demand schedule shown in Figure 3*b* shifts to the right, from $Y^d{}_0$ to $Y^d{}_1$.[1] Notice that the distance of horizontal shift in the aggregate demand schedule is $(Y_1–Y_0)$, the amount of the increase in equilibrium income in the *IS–LM* schedule model. This is the increase in income and aggregate demand that results *at a given price level.* Similarly, changes in government expenditures or taxes that shift the *IS* schedule shift the aggregate demand schedule such that the distance of the horizontal shift in the schedule equals the amount of the change in equilibrium income from the *IS–LM* model.

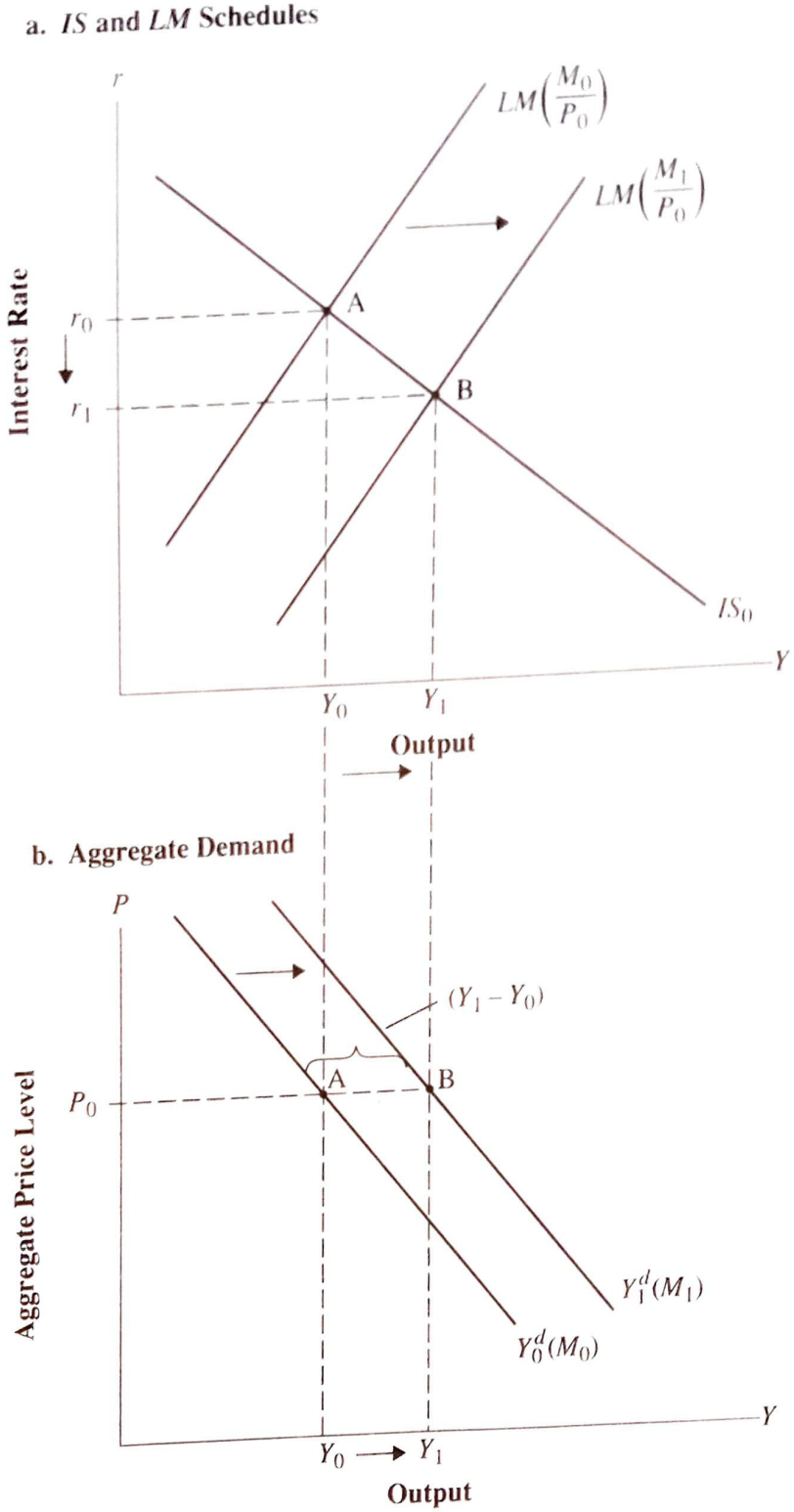
2 The Keynesian Aggregate Demand Schedule Combined with the Classical Theory of Aggregate Supply

When prices and wages are not constant, knowing the effects of policy actions on demand is not enough to determine their effects on income. The effect on income will depend on the assumptions we make about aggregate supply. In Figure 4, the effect of an increase in government spending is compared for three different assumptions about aggregate supply.

In each case, the increase in government expenditures shifts the aggregate demand schedule to the right, from $Y^d{}_0$ to $Y^d{}_1$. If the supply schedule is given by $Y^s{}_2$, a horizontal schedule, then output increases by the full amount of the horizontal shift in the aggregate demand schedule. Recall from section 1 that this is the increase in equilibrium income from the *IS–LM* model, which implicitly assumed that the supply schedule was horizontal. If the supply schedule is upwardsloping ($Y^s{}_1$), prices will rise, and the increase in income will be less, $Y_1–Y_0$ compared with $Y_2–Y_0$ in Figure 4. If the supply schedule were vertical ($Y^s{}_0$ in Figure 4), there would be no increase in income. Clearly, then, the effects of policy changes on income depend on the assumption made concerning aggregate

[1] For simplicity, the Keynesian aggregate demand schedule here and in later graphs is drawn as a straight line. The curvature of the aggregate demand schedule is not important for our analysis.

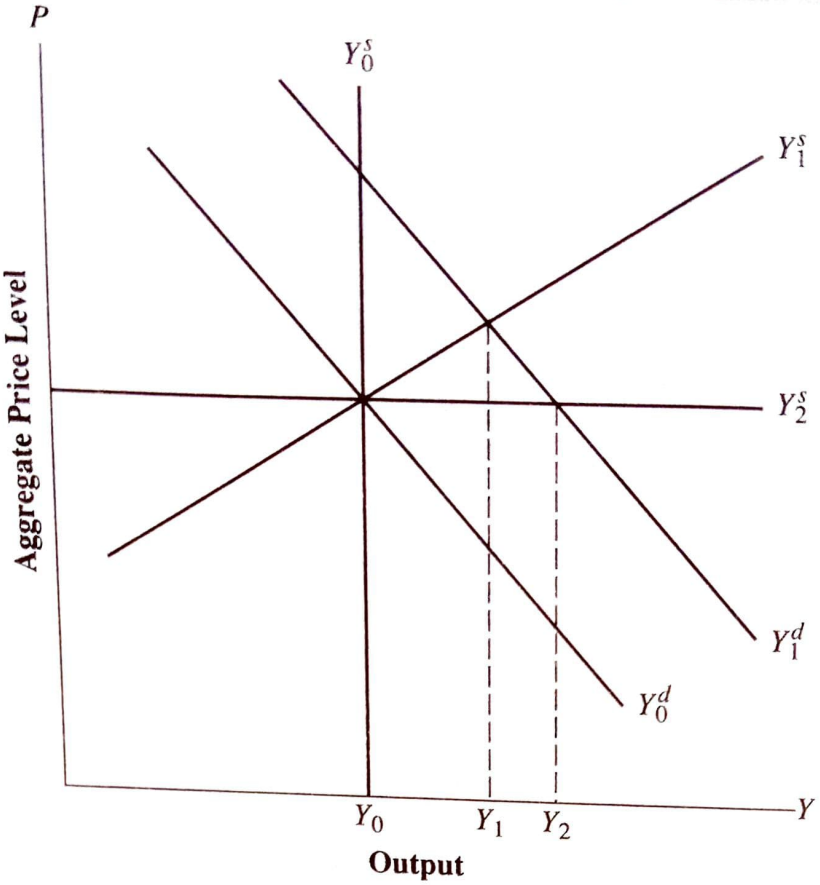
FIGURE 3 Effect on Aggregate Demand of an Increase in the Money Supply



An increase in the money supply shifts the LM schedule in part *a* to the right, from $LM(M_0/P_0)$ to $LM(M_1/P_0)$, and shifts the aggregate demand schedule to the right, from $Y^d{}_0$ to $Y^d{}_1$, in part *b*.

supply. What are the implications of making the classical assumptions about supply while maintaining the Keynesian apparatus behind the aggregate demand schedule?

The central elements of classical analysis are that in the labor market, both supply and demand depend solely on the real wage (W/P), which is assumed to be known to all. Further, the labor market is assumed always to be in equilibrium with a perfectly flexible money wage, adjusting to equate supply and demand.



An increase in government spending shifts the aggregate demand schedule from Y^d_0 to Y^d_1. If the aggregate supply schedule is horizontal (Y^s_2), output increases from Y_0 to Y_2. If the aggregate supply schedule slopes upward (Y^s_1), output increases only to Y_1. If the supply schedule is vertical (Y^s_0), output is unchanged at Y_0.

These classical assumptions result in a vertical aggregate supply schedule. With the classical assumptions, the aggregate supply schedule would be given Y^s_0 by in Figure 4; output would be supply determined. Factors such as changes in government spending, taxes, and the money supply, which shift the demand schedule, would not affect the equilibrium output.[2]

This analysis shows that *the classical theory of aggregate supply based on the classical auction market characterization of the labor market is fundamentally incompatible with the Keynesian system.* The central feature of Keynesian analysis is the theory of aggregate demand. With classical assumptions about aggregate supply, leading to the vertical supply schedule, there is no role for aggregate demand in determining output and employment. It was necessary for Keynes and his followers to attack the classical assumptions and to develop a Keynesian theory of the supply side.

3 A Contractual View of the Labor Market

Keynes believed that the money wage would not adjust sufficiently to keep the economy at full employment. In the classical system, both labor supply and demand are functions of the real wage, and the intersection of the labor supply and demand schedules determines an equilibrium real wage and level of employment. Wage bargains are

[2]Some fiscal policy changes, such as a change in the marginal tax rate, have supply-side effects in the classical system. These are being ignored here.

however, set in terms of money wages, and one assumption crucial to the classical model is that the money wage is perfectly flexible.

Sources of Wage Rigidity

The Keynesian theory offers a number of reasons why the money wage will *not* quickly adjust, especially in the downward direction, to maintain equilibrium in the labor market. The most important of these explanations for the *rigidity* of money wages are as follows.

1. Keynes argued that workers are interested in their relative as well as absolute wage. There exists in any labor market a set of wage differentials between workers with different trades and skills. Much of the work of wage bargaining is done to arrive at a relative wage structure that is acceptable to both labor and management. Wage differentials can be measured by relative money wages, because price-level changes affect all wages symmetrically.

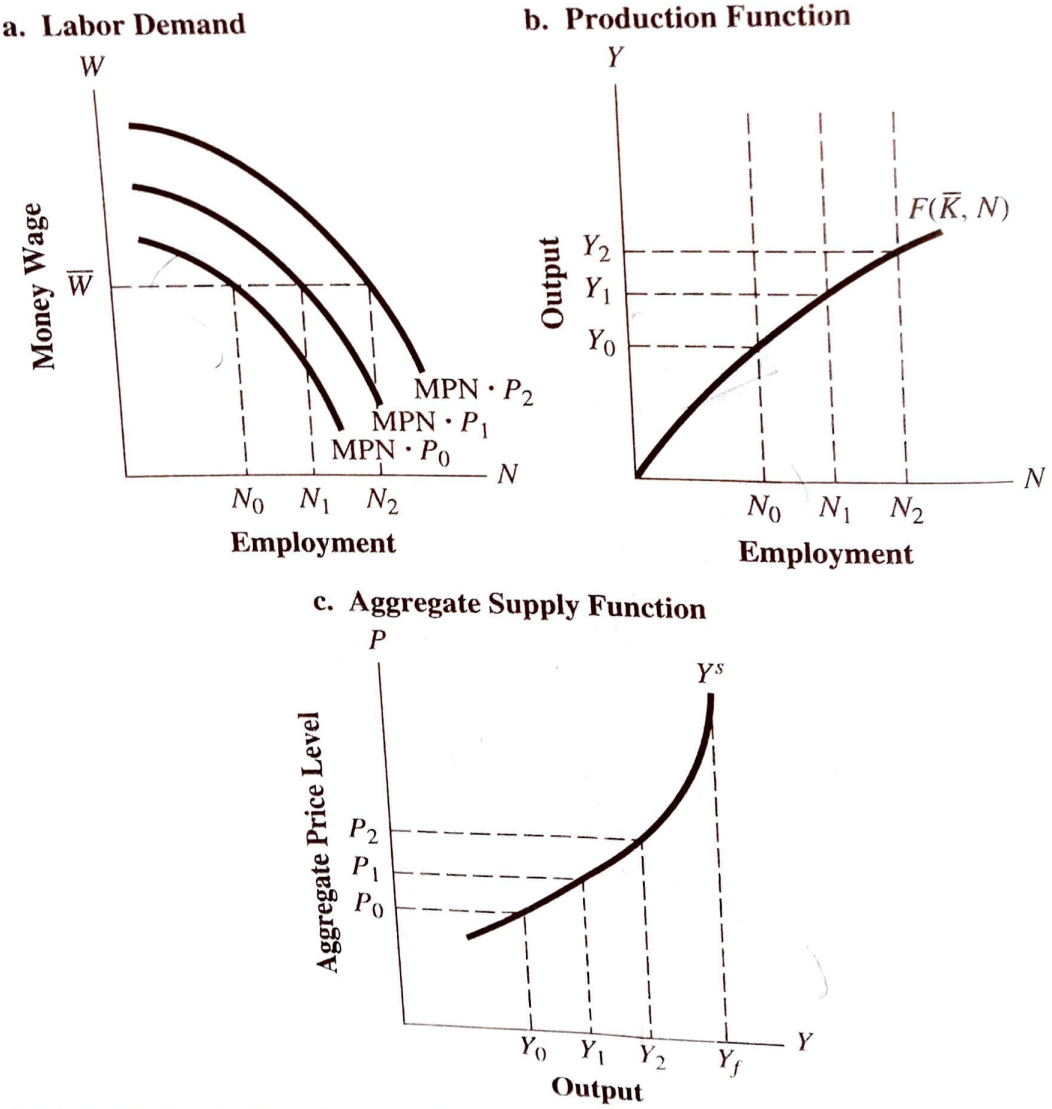
   Keynes believed that workers would resist money wage cuts even as the demand for labor fell. They would see the wage cuts as unfair changes in the structure of relative wages. Workers in one firm or industry would have no assurance that if they accepted a cut in money wages, workers in other sectors of the labor market would do the same. A decline in the real wage as a result of a rise in prices would not be seen by labor as affecting the structure of relative wages. For this reason, Keynes believed that declines in real wages caused by price-level increases would meet much less resistance from labor than an equivalent fall in the real wage from a money wage cut.
2. Another factor leading to stickiness in the money wage level is an institutional one. In the unionized sector of the labor market, wages are set by labor contracts, often of 2 or 3 years' duration. Such contracts typically fix money wage levels for the life of the contract. The money wage will not respond to events, such as a decline in labor demand, over the life of the contract. Indexation of the money wage set in the contract (i.e., provisions that tie changes in the money wage to changes in the price level) provides some flexibility in the money wage over the length of the contract. In the United States, however, when any indexation of labor contracts exists, it is generally incomplete. Thus fixed-money-wage contracts impart stickiness to the money wage. Once such a labor contract is signed, the decision of how much labor to hire is left to the employer. The labor supply function no longer plays a role in determining employment. The firm hires the profit-maximizing amount of labor at the fixed money wage.
3. Even in segments of the labor market in which no explicit contract fixes the money wage, there is often an implicit agreement between employer and employee that fixes the money wage over some time period. In particular, such implicit contracts keep employers from cutting money wages in the face of a fall in the demand for their products and a consequent decline in labor demand. The incentive for employers to refrain from attempting to achieve such wage cuts, or alternatively from hiring workers from among the pool of the unemployed who might be willing to work for a lower wage, is their desire to maintain a reputation as a good employer. Firms might achieve a temporary gain by forcing a money wage cut to reduce labor costs, but this gain could be more than counter-balanced by the effect of poor labor relations with existing employees and difficulties in recruiting new employees. Keynesians believe that the conventions of labor markets are such that firms find it in their interest to cut the length of the workweek or to have layoffs in response to falls in demand rather than to seek money wage cuts.

a consequence the amount of output they will supply, depends on the price level. This relationship between output supplied and the price level is developed in Figure 6.

Figure 6*a* shows the level of employment that will result at three successively higher price levels, P_0, P_1, and P_2, with the money wage fixed at $\overline{W}$. An increase in the price level (from P_0 to P_1, then from P_1 to P_2) will increase the money value of the MPN corresponding to any level of employment and therefore will increase labor demand for a given money wage. The labor demand ($\text{MPN} \cdot P$) schedule shifts to the right, and employment increases. As employment increases, output is shown to rise in Figure 6*b*, where we have plotted the aggregate production function giving the level of output for each level of employment.

Figure 6*c* combines the information from Figures 6*a* and 6*b* to show output supplied for each price level. Higher prices result in higher supply; the aggregate supply function is upward sloping. At some level of output (Y_f in Figure 6*c*), full employment would be reached, and further increases in price would have no effect on output. The aggregate supply schedule becomes vertical at this level.

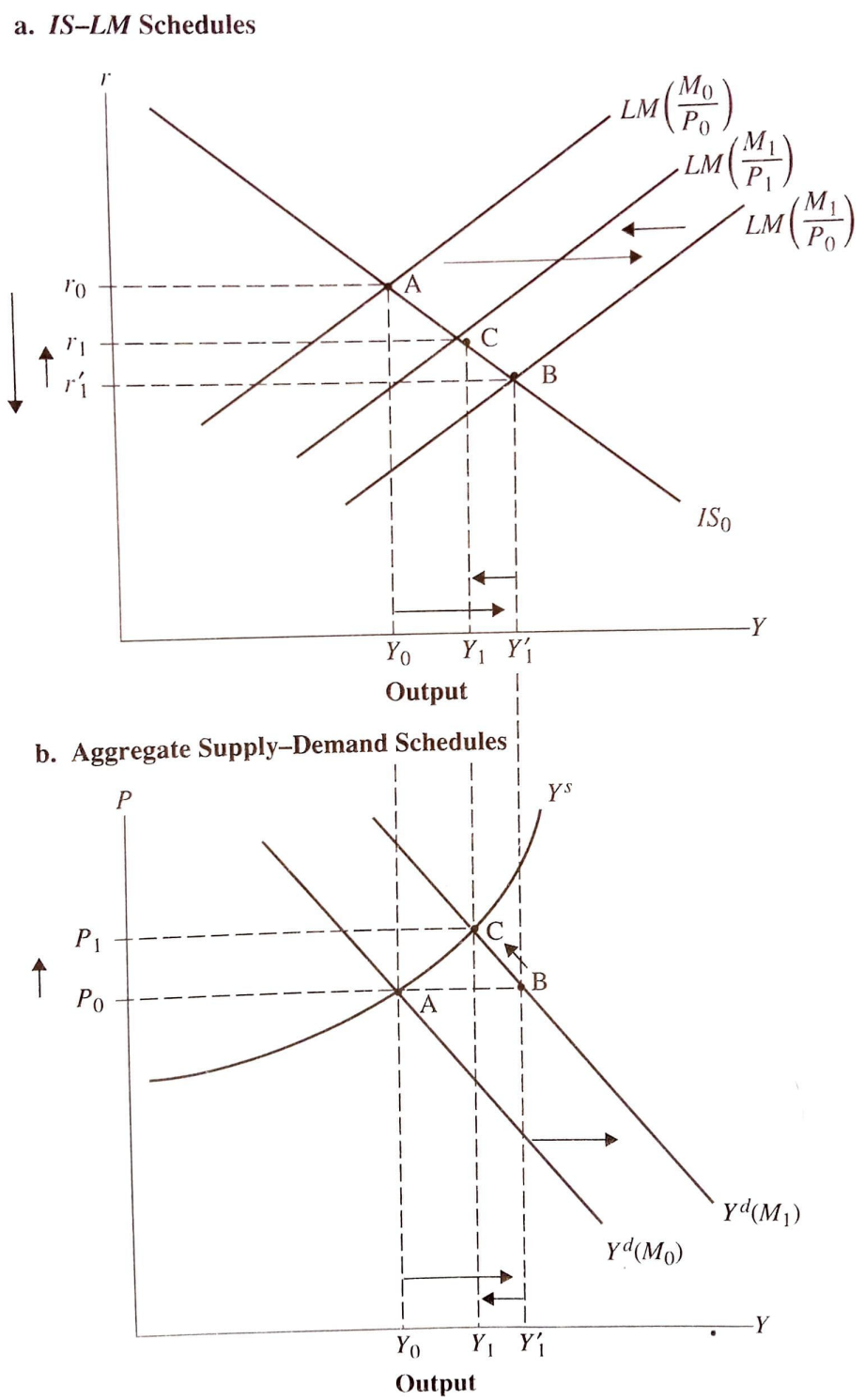
FIGURE 6 The Keynesian Aggregate Supply Schedule When the Money Wage Is Fixed



Part *a* shows the levels of employment N_0, N_1, N_2 for three successively higher price levels, P_0, P_1, P_2. Part *b* shows the levels of output, Y_0, Y_1, Y_2, that will be produced at these three levels of employment. In part *c*, we put together the information in *a* and *b* to show output supplied at each of the three price levels. Notice that at higher price levels, employment, and hence output supplied, increase: *the aggregate supply curve* (Y^s) *is upward-sloping.*

Below full employment, the supply schedule will not be vertical; shifts in the aggregate demand schedule will change the level of output. The effects of an increase in the money supply and the effects of an increase in government spending are illustrated in Figures 7 and 8, respectively.

FIGURE 7 Effects of an Increase in the Money Supply When the Price Level Is Flexible



An increase in the money supply shifts the LM schedule from $LM(M_0/P_0)$ to $LM(M_1/P_0)$ (part *a*) and shifts the aggregate demand schedule from $Y^d(M_0)$ to $Y^d(M_1)$ (part *b*). The increase in aggregate demand causes output to rise from Y_0 to Y_1 and the price level to rise from P_0 to P_1. The increase in the price level shifts the LM schedule from $LM(M_1/P_0)$ to $LM(M_1/P_1)$.

A rise in the real wage increases the income that can be gained from supplying labor or, looked at in reverse, increases the opportunity cost of taking 1 hour of leisure. Consequently, an increase in the real wage increases labor supply.

The Keynesian theory of labor supply begins with the observation that the wage bargain is struck in terms of the *money* wage, not the real wage. The classical theory assumes that suppliers of labor (workers) know the price level (P) and money wage (W) and therefore know the real wage (W/P). Keynesians argue that because the labor bargain is in terms of the money wage, we can assume that workers know the money wage but not the price level. As explained previously, through implicit or explicit contracts, workers agree to provide labor services over some period, let us say for a year. They have no way of knowing the value that the aggregate price level will take on over the coming year. It is this aggregate price level that will determine the purchasing power of any money wage they agree to in a current wage bargain. As a consequence, Keynesians believe that decisions about labor supply depend on the current money wage and the *expectation* of the aggregate price level. Further, the Keynesian view has been that workers' expectations about the price level depend for the most part on the past behavior of prices.

To see the implications of the Keynesian view of workers' bargaining for a known money wage with only imperfect information about prices, we construct a Keynesian labor supply schedule, which we compare with the classical labor supply schedule [equation (4)]. We then consider a model in which the money wage is perfectly flexible but labor supply is given by the Keynesian labor supply function. In this analysis, we neglect the factors enumerated previously, which Keynesians believe cause the money wage to be sticky. One purpose of this analysis is to show that *even if the money wage were perfectly flexible*, with the Keynesian labor supply schedule, the aggregate supply schedule would not be vertical. Output and employment would not be completely supply determined; aggregate demand would also play a role. In reality, Keynesians believe that the money wage *is* sticky in the downward direction and that much unemployment is the result of the failure of the money wage to clear the labor market. Imperfect information about prices is, however, an additional factor that Keynesians believe explains fluctuations in output and employment.

The Keynesian labor supply function can be written as

$$N^S = t(W/P^e) \tag{5}$$

An increase in the money wage (W) for a given value of the expected price level (P^e) would increase labor supply because it would be viewed by workers as an increase in the real wage. An increase in the expected price level would cause labor supply to decline. Fundamentally, workers are interested in the real wage, not the money wage, and they reduce their supply of labor when they perceive that the real wage has declined. The difference between the Keynesian and classical labor supply functions is that in the Keynesian version workers must form an expectation of the price level. Labor supply therefore depends on the *expected* real wage. In the classical system, workers know the real wage; labor supply depends on the *actual* real wage.

The Keynesian theory of labor supply is incomplete without an assumption about how workers form an expectation of the price level (P^e). The Keynesian assumption is that such price expectations are based primarily on the past behavior of the price level. Thus

$$P^e = a_1 P_{-1} + a_2 P_{-2} + a_3 P_{-3} + \ldots + a_n P_{-n} \tag{6}$$

where P_{-i} ($i = 1, 2, 3, \ldots$) is the price level from i periods back and $a_1, a_2, \ldots, a_n$ are the weights given to a number of past observations on the price level in forming the expectation of the current price level. Clearly, there is additional information that might

prove useful in accurately predicting the behavior of prices. The Keynesian assumption is that the cost of gathering and processing such additional information is high enough that the price expectations of labor suppliers are reasonably accurately represented by a simple formulation such as equation (6). As we will see later, this assumption has not gone unchallenged.

According to equation (6), price expectations are essentially *backward looking*, adjusting to the past behavior of the price level. Moreover, in the Keynesian view, there is considerable inertia in this adjustment process; price expectations adjust only *slowly* to the past behavior of the price level. If this is the case, then price expectations do not change as a result of current economic conditions. In analyzing the effects of various policy changes, for example, we can take P^e as constant. In the longer run (after many short periods have passed), we will need to take account of how stabilization policies affect P^e.

The Keynesian Aggregate Supply Schedule with a Variable Money Wage

Figure 9 illustrates the construction of the aggregate supply schedule, where labor supply is given by equation (5) and the money wage is assumed to adjust to equate labor supply and labor demand. In Figure 9*a*, labor supply (N^s) and labor demand are plotted as functions of the money wage. As in the previous analysis, labor demand depends on the real wage; firms are assumed to know the price level at which they will be able to sell their products. The labor demand schedule will shift to the right with an increase in the price level. Figure 9*a* shows labor demand schedules for three successively higher price levels: P_0, P_1, and P_2, respectively.

The labor supply schedule is drawn for a given value of the *expected* aggregate price level. As just explained, this expected price level is assumed to be fixed in the short run. With the fixed labor supply schedule, increases in the price level shift the labor demand schedule along the supply schedule, so that for a higher price level the equilibrium levels of employment and the money wage are increased. The process at work here is as follows. The increase in price (from P_0 to P_1, for example) causes an excess demand for labor at the old money wage (W_0). The money wage is bid up, and for a given value of P^e, an increase in the money wage causes more workers to accept jobs (or to increase the number of hours worked in existing jobs); employment rises.

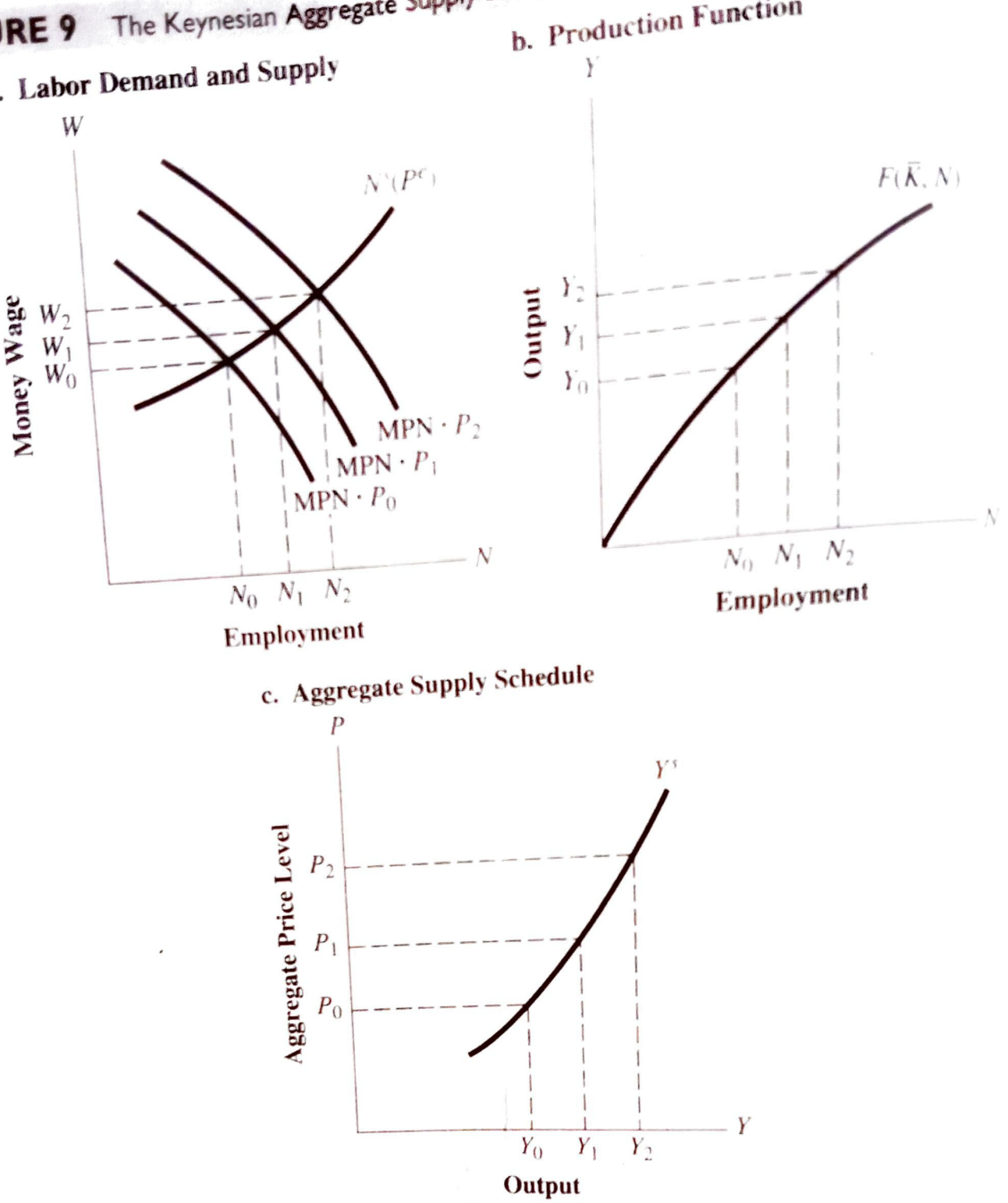
At the higher levels of employment N_1 and N_2, corresponding to the higher price levels P_1 and P_2, output is higher at the levels shown by Y_1 and Y_2 in Figure 9*b*. Thus, a higher price level corresponds to a higher level of output supplied. This information is reflected in the upward-sloping aggregate supply schedule in Figure 9*c*, plotting output supplied for each price level.

Policy Effects in the Variable-Wage Keynesian Model

Because the variable-wage Keynesian aggregate supply schedule is still upward sloping (nonvertical), changes in aggregate demand that shift the aggregate demand schedule will affect output. Increases in the money supply or level of government expenditures will shift the aggregate demand schedule to the right, increasing both output and the aggregate price level. Graphical illustrations of such policy shifts are *qualitatively* the same as Figures 7 and 8.

Suppose that we compare the effects on price and output of a given change in aggregate demand when the money wage is variable with the effects for the case in

FIGURE 9 The Keynesian Aggregate Supply Schedule When the Money Wage Is Variable



Part *a* shows equilibrium levels of employment N_0, N_1, N_2, corresponding to successively higher values of the price level, P_0, P_1, P_2. Part *b* gives the level of output, Y_0, Y_1, Y_2, that will be produced at each of these employment levels. Part *c* combines the information in parts *a* and *b* to show the relationship between the price level and output supplied. At higher values of the price level, output supplied increases; as in the fixed-wage case, *the aggregate supply curve* (Y^s) *is upward-sloping.*

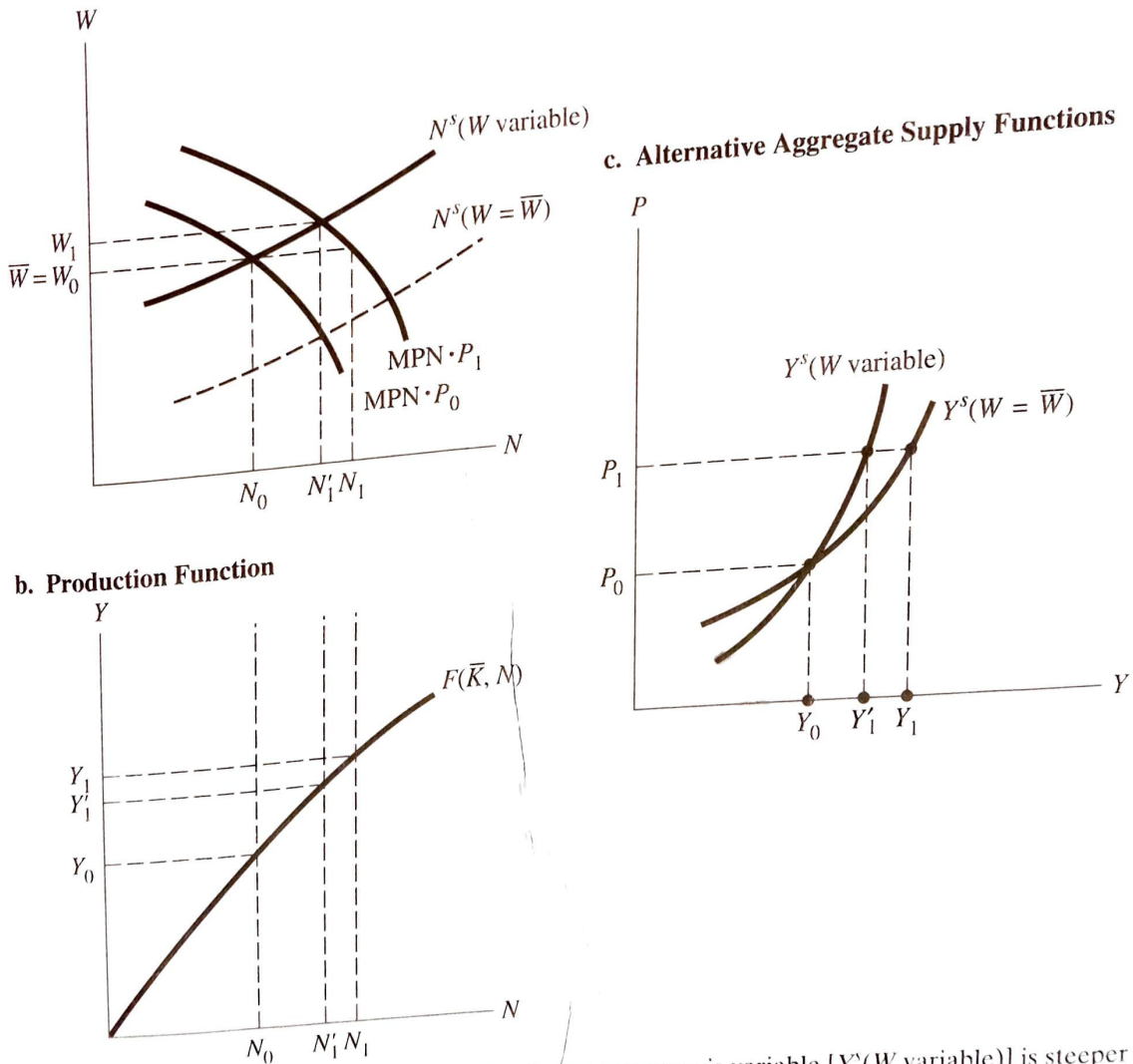
which the money wage is fixed. Is there a predictable *quantitative* difference? The answer is yes. When the money wage is variable, a given increase in aggregate demand will cause output to increase by less than when the money wage is fixed. When the money wage is variable, an increase in aggregate demand will cause the price level to rise by more than when the money wage is fixed. The reason for these results is that the aggregate supply schedule when the money wage varies is steeper than when the money wage is fixed. As the aggregate demand schedule is shifted to the right along the steeper aggregate supply schedule, the increased demand results less in increased output and more in increased price.

The reason the aggregate supply schedule is steeper in the variable-money-wage case is illustrated in Figure 10. In Figure 10*a*, the labor market response to an

increase in the price level is illustrated for the fixed- and variable-money-wage
the money wage is fixed at $\overline{W} = W_0$ an increase in the price level from P_0 to P_1 shifts
the labor demand schedule from MPN $\cdot P_0$ to MPN $\cdot P_1$, and employment rises from N_0
to N_1. Recall from the previous section that in the fixed-money-wage case, we assume
there is an excess supply of labor. The labor supply schedule in this case, $N^s(W = \overline{W})$,
is to the right of N_0 at $\overline{W}$ (as in Figure 5). Labor supply is no constraint on employment,
which is determined solely by labor demand. For this case of $(W = \overline{W})$, output supplied
can be seen from Figure 10*b* to rise from Y_0 to Y_1. The aggregate supply schedule is
given by $Y^s(W = \overline{W})$ in Figure 10*c*.

With a variable money wage, when the labor demand schedule shifts from
MPN $\cdot P_0$ to MPN $\cdot P_1$, as a result of the increase in price, employment rises only to

FIGURE 10 Keynesian Aggregate Supply Schedules for the Fixed- and Variable-Money-Wage Cases



The aggregate supply schedule in part *c* for the case when the money wage is variable [$Y^s(W$ variable)] is steeper than when the money wage is fixed [$Y^s(W = \overline{W})$] because the increase in employment (part *a*) with a rise in price and therefore the increase in output (part *b*) are smaller when the money wage is variable than when it is fixed. This outcome follows because the rise in the money wage in the variable-wage case dampens the effect on employment and output from an increase in the price level.

N_1. Here we are assuming that there is no initial excess supply of labor. At W_0, labor demand equals supply along the labor supply schedule N^s (W variable). The money wage must rise from W_0 to W_1 to increase labor supply. This increase in the money wage dampens the effect of the increase in labor demand. Because employment increases by less than in the fixed-wage case, output supplied also increases by less, rising only to Y_1', as shown in Figure 10*b*. The increase in the price level leads to a smaller rise in output supplied, and this relationship is reflected in the steeper aggregate supply schedule for the variable-money-wage case, as shown in Figure 10*c*, the Y^s (W variable) schedule.

At this point, it is useful to draw some conclusions from the preceding two sections concerning how allowing price and wage flexibility affects the policy implications of the Keynesian system. In section 3, we saw that when the price level was assumed to vary (the money wage still fixed), policy multipliers were reduced relative to their values in the simple *IS–LM* model, where both the price level and the money wage had been fixed. In that simple *IS–LM* model, the assumption was that the aggregate supply schedule was horizontal. Supply was no barrier to an increase in output. In the model in section 3, we were taking account of the fact that in normal circumstances, as output increases, the MPN declines. Because the unit cost of producing additional units of output is the money wage divided by the MPN, firms will supply a greater output only at a higher price—even if the money wage is fixed. The aggregate supply schedule was upward sloping, and increases in aggregate demand consequently had smaller output effects than with the horizontal aggregate supply schedule.

When the money wage is also assumed to be variable, the implied aggregate supply schedule becomes steeper. Now as output is increased, not only does the MPN decline, causing an increase in unit costs (W/MPN), but the rise in the money wage required to induce workers to supply more labor will also push up the unit cost. As a result, any increase in output supplied requires a larger increase in price; the aggregate supply schedule is steeper. Aggregate demand changes have still smaller output effects.

In the classical system, the aggregate supply schedule was vertical; output was completely supply determined. The price and wage were perfectly flexible. In the simple *IS–LM* model, output was completely demand determined. Prices and wages were completely rigid. The models in these two sections, by introducing price and wage flexibility in the Keynesian system, have brought the Keynesian results closer to those of the classical model.

Effects of Shifts in the Aggregate Supply Schedule

So far in our development of the Keynesian theory of aggregate supply, we have focused on how taking account of supply factors changes the role of aggregate demand in determining output. The output and employment effects of changes in aggregate demand—shifts in the aggregate demand schedule—depend on the slope of the aggregate supply schedule. In addition, supply factors have an independent role in determining output and employment. Shifts can occur in the aggregate supply schedule, and such shifts will affect output, employment, and the price level.

Shifts in the aggregate supply schedule have at times played an important part in the Keynesian explanation of movements in price, output, and employment. In fact, if

TABLE 2 Percentage Growth Rates in Real GNP and the GNP Price Deflator, 1973–81

Year	*Growth in Real GNP*	*Increase in GNP Deflator*
1973	5.8	5.8
1974	−0.6	8.8
1975	−1.2	9.3
1976	5.4	5.2
1977	5.5	5.8
1978	5.0	7.4
1979	2.8	8.6
1980	−0.3	9.2
1981	2.5	9.6

shifts in the aggregate supply schedule are not taken into account, the behavior of price, output, and unemployment over the decade of the 1970s cannot be explained within a Keynesian framework. To see why, consider the data in Table 2. Notice that while the GNP deflator increased substantially in each year between 1973 and 1981, real output fell in 3 of those years. In fact, output fell in 3 of the 4 most inflationary years.

This pattern of price and output changes is inconsistent with the Keynesian model unless shifts in the aggregate supply schedule are taken into account. Consider Figure 11. In part *a*, movements in output and price are caused by shifts in the aggregate demand schedule (from $Y^d{}_0$ to $Y^d{}_1$, then to $Y^d{}_2$). In this case, increases in price (from P_0 to P_1, then to P_2) would be accompanied by increases in output (from Y_0 to Y_1, then to Y_2). The demand schedule shifts to the right along the fixed upward-sloping supply schedule, increasing both price and output. Shifts to the left in the aggregate demand schedule cause *both* output and price to fall. Therefore, shifts in the aggregate demand schedule do not explain the behavior of price and output in years such as 1974, 1975, and 1980, when output fell but price rose.

In Figure 11*b*, we can see that shifts to the left in the aggregate supply schedule (from $Y^s{}_0$ $Y^s{}_1$ and to $Y^s{}_2$) would result in price increases (from P_0 to P_1, then to P_2) associated with declines in output (from Y_0 to Y_1, then to Y_2). Such "supply shocks" could explain the U.S. economy's inflationary recessions over the 1970s—periods when output declined and prices increased.

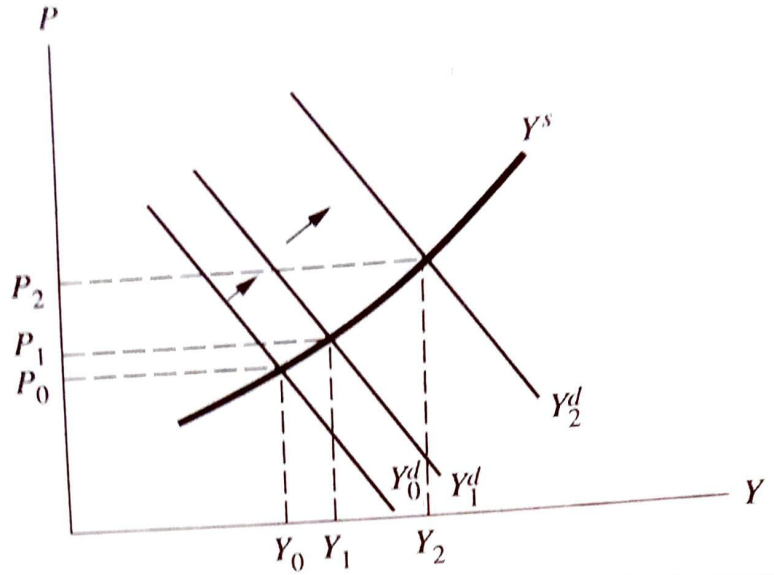
Factors That Shift the Aggregate Supply Schedule

The question remains of the causes of shifts in the aggregate supply schedule—the nature of supply shocks. Recall that points on the aggregate supply schedule give the desired output of the firms for each aggregate price level. Each firm, and therefore firms in the aggregate, will choose the level of output that maximizes profits. This implies that firms produce up to the point where P is equal to marginal cost (MC):

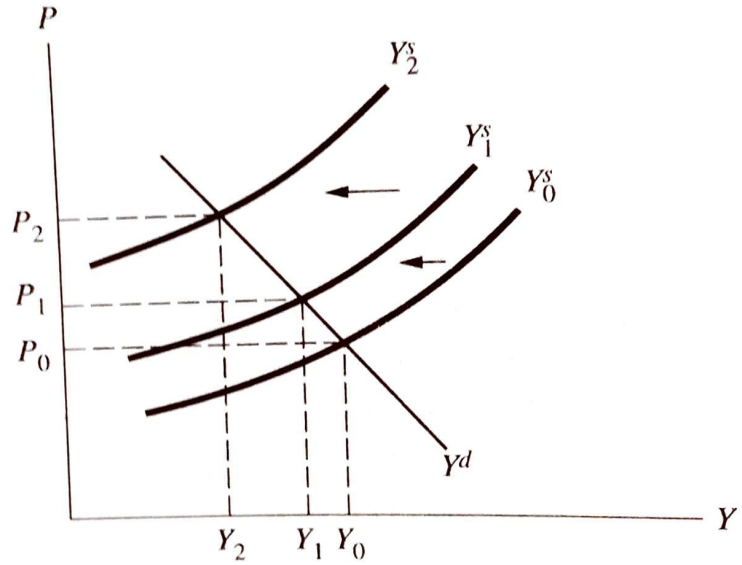
$$P = MC \tag{7}$$

MC is the addition to total cost as a result of increasing the use of variable factors of production to increase output. In our previous analysis, we assumed that labor was the only variable factor of production. In this case, the MC of producing an additional unit of output was the money wage (W), the amount paid for an additional unit of labor, divided by the MPN. Marginal cost (W/MPN) increased as output increased because as

a. Price and Output Changes with



b. Price and Output Changes with Shifts in Aggregate Supply



If changes in output were the result of shifts in the aggregate demand schedule along a fixed supply schedule, as in part *a*, we would expect a positive relationship between price and output changes. On the other hand, if output changes resulted from shifts in the aggregate supply schedule along a fixed demand schedule, as in part *b*, we would expect a negative association between price and output changes.

more labor was hired, the MPN declined. In addition, in the variable-wage model of the preceding section, for workers to supply additional labor, the money wage had to be increased, a further factor causing marginal cost to rise as output increased. These two factors, the declining MPN and increasing upward pressure on money wages as output and employment increase, explain why the aggregate supply schedule is upward sloping.

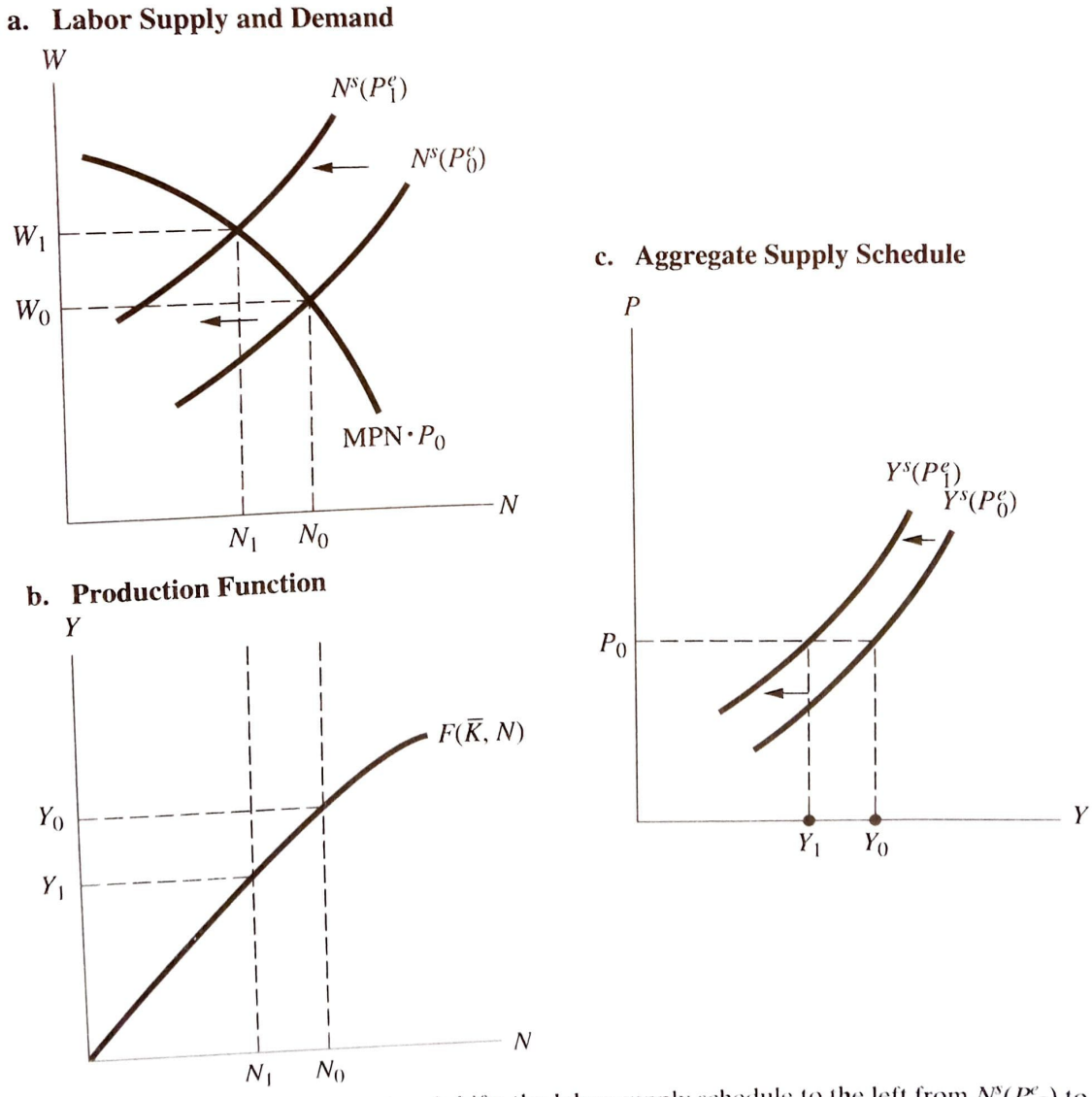
A shift in the aggregate supply schedule—for example, a shift upward to the left, as in Figure 11*b*—means that after the shift, firms will produce less for a given price or, put differently, firms will find it optimal to continue to produce the same output, only at a higher price. From condition (7) it can be seen that any factor that causes MC to increase *for a given output level* will cause such a shift upward and to the left in the aggregate supply schedule. If MC increases for a given output, then to continue to meet condition (7) *at a given price*, the firm must decrease output. As output declines, MC will decline (MPN will rise and W will fall) and equality (7) can be restored.

Alternatively, price would have to rise by the amount of the increase in MC for the firm to find it optimal to continue to produce the same level of output.

This is only half the story; the next task is to determine the factors that will change MC for a given output level. Such factors are often termed *cost push factors* because they affect price independent of the level of demand, acting by shifting the supply schedule. One set of cost push factors affects the money wage demands on the part of labor at a given level of employment; these are factors that shift the labor supply schedule as drawn, for example, in Figure 9. So far, we have considered one factor that shifts the labor supply schedule, a change in workers' expectation about the aggregate level of price (P^e).

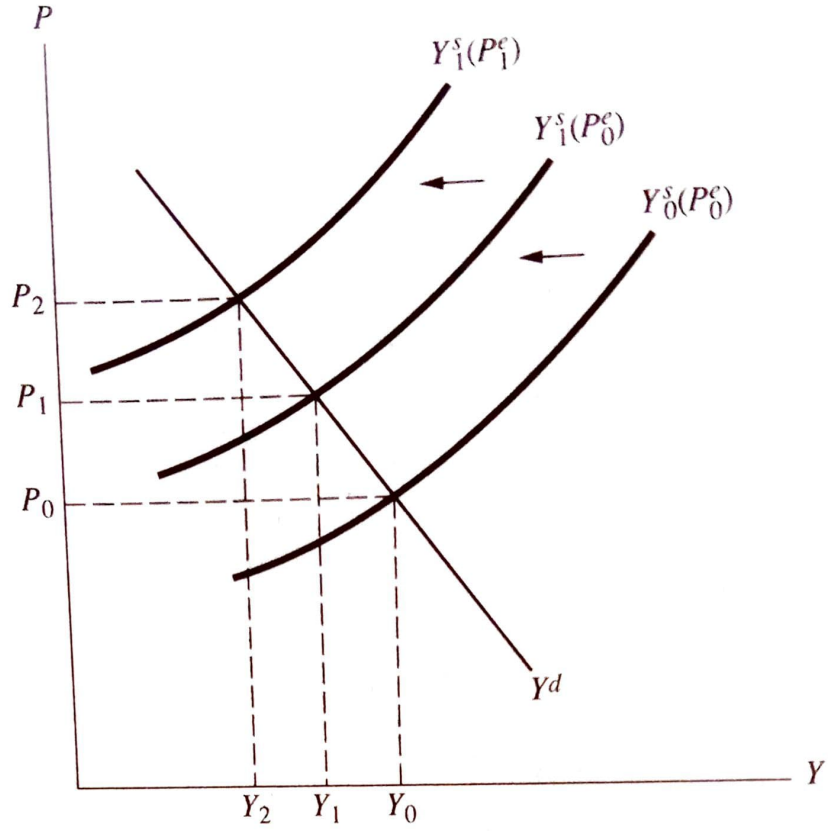
In the preceding section, we assumed that workers' expected price level depended on the past behavior of prices and, hence, was given in the short run. Over time, however, as new information is received, workers will adjust their price expectation. Figure 12 shows the effect on labor supply and on the aggregate

FIGURE 12 Shift in the Aggregate Supply Schedule with an Increase in the Expected Price Level



An increase in the expected price level shifts the labor supply schedule to the left from $N^s(P^e_0)$ to $N^s(P^e_1)$ in part *a*. At a given price level, P_0, employment declines from N_0 to N_1, and output falls from Y_0 to Y_1 (part *b*). This decline in output for a given price level is reflected in a shift to the left in the aggregate supply schedule from $Y^s(P^e_0)$ to $Y^s(P^e_1)$ in part *c*.

FIGURE 14 Effects of an Autonomous Increase in the World Price of Energy Inputs



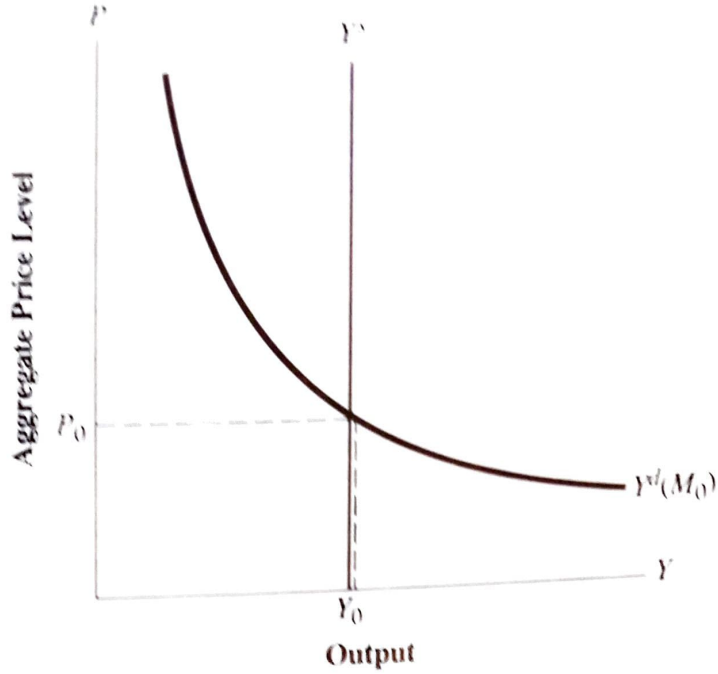
An autonomous increase in the price of energy inputs shifts the aggregate supply schedule to the left from $Y^s_0(P^e_0)$ to $Y^s_1(P^e_0)$; output falls from Y_0 to Y_1 and the price level rises from P_0 to P_1. As labor suppliers perceive the rise in the price level, the expected price level rises from P^e_0 to P^e_1. The aggregate supply schedule shifts farther to the left to $Y^s_1(P^e_1)$. Output falls to Y_2, and the price level rises to P_2.

financial crisis and world recession, the oil price collapsed to below $40 per barrel. Then there was a sharp rise back over $100 per barrel in late 2011. Volatility of the price of oil and of other basic commodities continues to be a source of macroeconomic instability and a challenge to policy makers. In the summer of 2008, for example, at the peak of the run up in the price of oil, the European Central Bank tightened monetary policy due to concern about inflation. Two months later as the financial crisis intensified with the failure of Lehman Brothers, the central bank hurriedly reversed course.

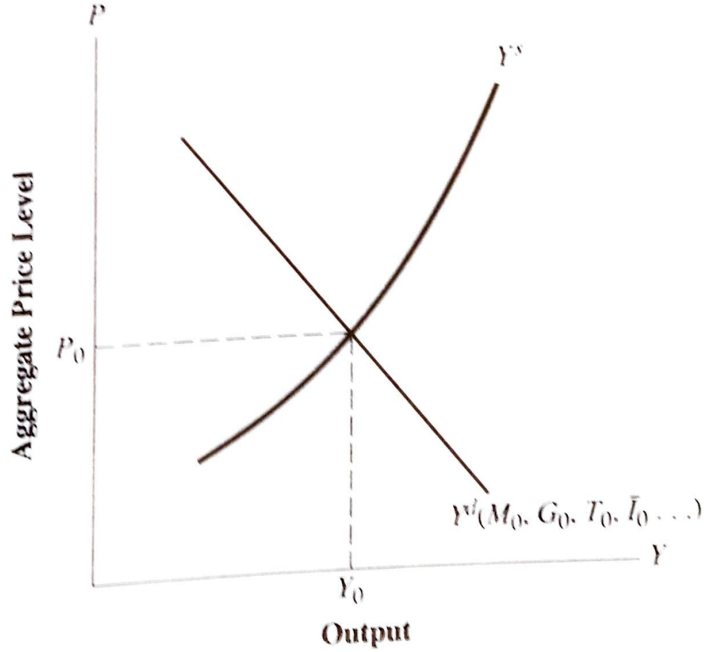
Conclusion: Keynes versus the Classics

What are the major differences between the Keynesian view and the classical macroeconomic theory that Keynes attacked? In this chapter, we have seen how the Keynesian system can be summarized by the aggregate supply and aggregate demand relationships. A convenient way to summarize the differences between the Keynesian and classical theories is to examine the differences between the respective aggregate demand and aggregate supply relationship in the two models.

a. Classical Case



b. Keynesian Case



The classical aggregate supply schedule is vertical, whereas the Keynesian aggregate supply schedule slopes upward to the right. The classical aggregate demand schedule depends only on the level of the money supply (M_0); in the Keynesian system, aggregate demand depends also on fiscal variables (G_0, T_0), autonomous investment (I_0), and other variables.

Keynesian versus Classical Theories of Aggregate Demand

The classical model did not contain an explicit theory of aggregate demand. The *quantity theory of money* provided an implicit classical theory of aggregate demand. Using the quantity theory relationship

$$MV = PY \tag{8}$$

with the assumption that V is constant, we can determine PY for a given value of M. This relationship gives the rectangular hyperbola $Y^d(M_0)$ plotted in Figure 15*a* for M equals M_0. This was the classical aggregate demand schedule.

8. Assume that there is an exogenous decline in the price of imported oil. Using the graphical analysis in this chapter, explain how such a shock would affect output and the price level. Explain the role inflationary expectations play in this adjustment.
9. "Money is more important in the Keynesian system than in the classical system." Do you agree? Or would you maintain that the opposite is true?
10. What do you see as the essential differences between the classical and Keynesian theories of aggregate supply?
11. What do you see as the essential differences between the classical and Keynesian theories of aggregate demand?
12. Compare the effects of an expansionary fiscal policy action—an increase in government spending financed by government bond sales to the public, for example—in the Keynesian and classical models. Include in your answer the effects of this policy shift on the level of real income, employment, the price level, and the rate of interest.
13. Within the variable price–fixed wage version of the Keynesian model analyze the effects of an increase in money demand (shift in liquidity preference) due to a loss of confidence in risky stocks and bonds such as occurred in the 2007–09 financial crisis.