2

BASIC CONCEPTS AND RELATIONSHIPS: GRAPHICAL PORTRAYAL

Sections —

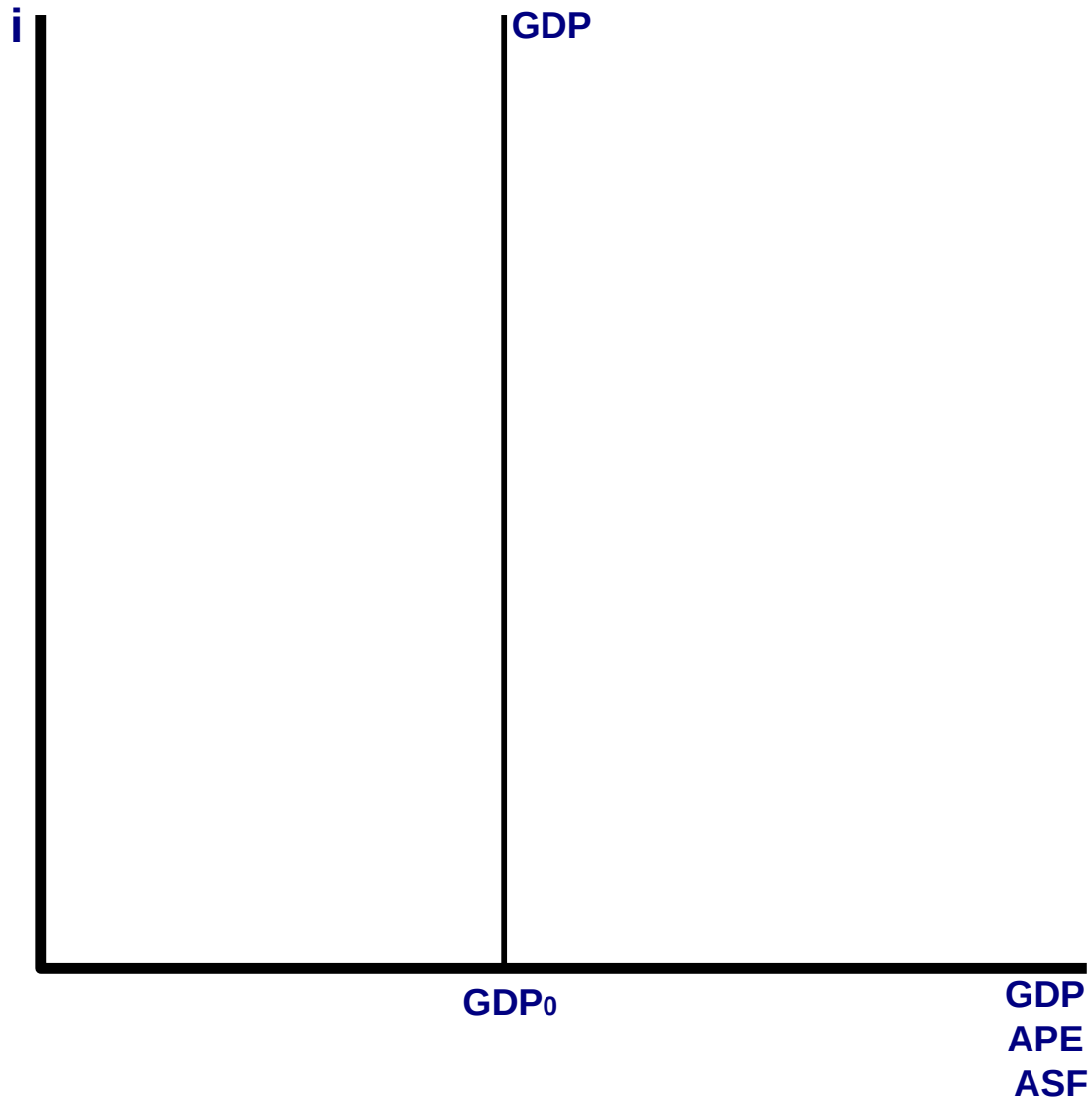
In this chapter, our task is to assemble a graphical presentation for the macroeconomic coordination process. It will involve a single diagram in which the level of interest rates (represented by i) is plotted along the vertical axis and magnitudes for GDP, APE, and ASF are plotted along the horizontal axis. We will be placing on that diagram the relationships spelled out in the columns of Table 2-1:

Table 2-1

Impact of a change in the level of:	upon the level of GDP	upon the level of APE	upon the level of ASF
employment and output	positive (equal to output change)	positive (equals half of output change)	no direct effect
interest rates	no direct effect	negative	positive
prices	no direct effect	no direct effect	negative

Plotting GDP on a Graph

Figure 2-1



The relationships in the GDP column of Table 2-1 map out a vertical line standing at the current level of GDP. It is vertical, because there is no direct impact upon GDP from a change in the level of interest rates. That vertical GDP line will move to the right (left) as the level of GDP increases (decreases) and will move horizontally by the amount of the GDP change. The

vertical line will not move if the level of prices changes, because a price level change has no direct impact upon the level of GDP.

Adding APE to the Graph

We may represent what we have learned about APE in the following equation:

APE = ***a*** + ***b***(GDY) - ***c*****i**, **{1}** where

a measures the combined influences upon APE of all determinants other than GDY and interest rates,**{2}**

b measures the portion of an added dollar of domestic income that would typically be used to purchase current domestic output (for the United States, ***b*** has a value of approximately 0.5 ─ a $1 rise in GDY will generate a 50¢ rise in APE, and a $1 fall in GDY will produce a 50¢ fall in APE),

-c measures the responsiveness of APE to changes in the level of interest rates (-***c*** is relatively small and negative ─ a rise in the level of interest rates will cause a small drop in APE, and a fall in the level of interest rates will cause a small rise in APE),**{3}** and

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1 Strictly for simplicity, we assume that this relationship is linear.

2 People's accumulated wealth, how optimistic or pessimistic or simply uncertain they are about what the future may hold in store for them, the level of prices, the relative level of the prices of foreign products, and the level for foreigners' incomes are some of the many variables (other than i and GDY) that impact the current level of APE. ***a*** is called the **autonomous expenditure** portion of APE.

3 It is primarily the business and foreign trade sectors that are responsive to

i represents the level of interest rates.

Figure 2-2 adds these concepts and relationships to Figure 2-1.

Figure 2-2

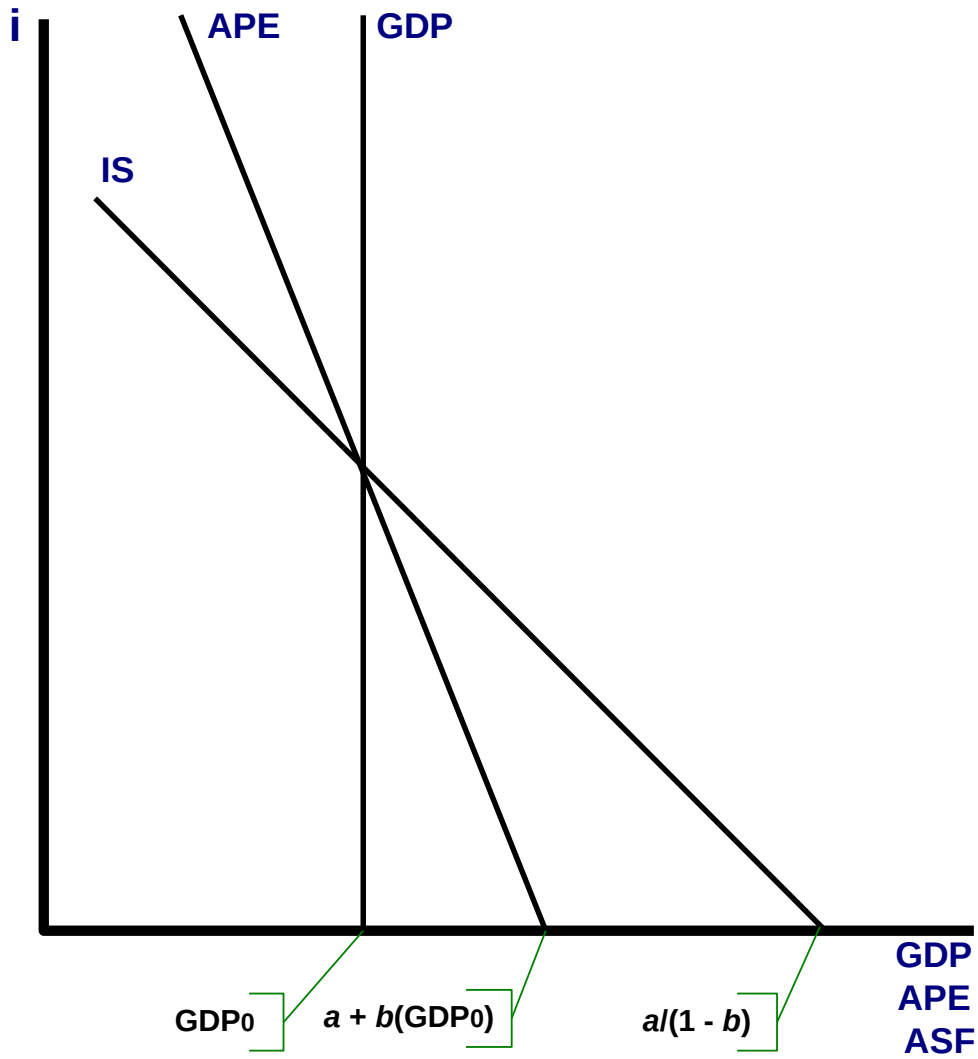

Figure 2-2 contains a **vertical GDP line** that is standing at the prevailing level of GDP, GDP_0. **{4}** Now we can add an **APE**

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changes in the level of interest rates. Business investment in plants, equipment, and new housing units rise (fall) as interest rates fall (rise), but the strength of the response varies inversely with the utilization rates of existing capacity.

4 Remember that It is vertical, because the level of i has no **direct** effect upon the level of GDP. We shall see later on that there are **indirect** interest rate effects

line that plots the equation APE ≡ a + b(GDY) - ci . The **APE line** has a horizontal axis intercept equal to a + b(GDP_0) and slopes upward and to the left (showing the reduction in APE — measured horizontally — as the level of interest rates rises). **{5}** The horizontal distances – at any i level – from the i-axis to the GDP and APE lines measure the prevailing magnitudes of GDP and APE, respectively.

Figure 2-2 also contains a line that is labeled **IS**. Note that – unlike GDP, APE, and ASF, which are magnitudes (each one is a measure of something) – IS is just a name for a line. It does not measure anything. That means that – whereas GDP, APE, and ASF can be equal or unequal – it would not be meaningful to say that IS is equal or unequal to GDP, APE, or ASF.

> The IS line displays **all combinations of i and GDP for which APE = GDP**.

Suppose that the combination i′ and GDP′ lies on the IS line. We know that APE will equal a + b(GDP′) – ci′ , and it is also true (because we are on the IS line) that APE = GDP′. These two values of APE are necessarily equal; so,

$$GDP' = a + b(GDP') - ci' .$$

From this equation, we find that

$$GDP' = [a/(1 - b)] - [c/(1 - b)]\, i'$$

(through operation of the automatic coordination process) upon the level of GDP.

5 Remember, GDY ≡ GDP; so, $GDY_0 \equiv GDP_0$. The horizontal axis intercept of the APE line is determined by setting the level of i to zero in the APE equation.

This is the equation for the IS line. **{6}** It has a horizontal axis intercept equal to $a/(1 - b)$. From that point, it slopes upward and to the left much like the APE curve does. Whereas the magnitude of APE diminishes by *c* for each 1% rise in the level of interest rates, the magnitude of GDP would need to fall by $c/(1 - b)$ ─ which is $1/(1 - b)$ times the corresponding APE change ─ in order to keep GDP equal to APE as the level of interest rates rises 1%. Because *b* has a value of approximately 0.5, the value of $1/(1 - b)$ is approximately equal to 2. **{7}** So, the IS line rises from right to left at one-half the rate that the APE line does.

Observe that the horizontal-axis intercept terms for the APE and IS lines are $a + b(GDP_0)$ and $a/(1 - b)$, respectively. Hence, any increase (decrease) in GDP will shift the vertical GDP line to the right (left) by a horizontal distance equal to the GDP increase (decrease) and will shift the APE curve to the right (left) by a horizontal distance equal to *b* times the GDP increase (decrease). The IS curve will remain stationary (as GDP changes). An increase (decrease) in *a* will shift the APE curve to the right (left) by a horizontal distance equal to the increase (decrease) in *a*. Simultaneously, the IS curve will shift rightward (leftward) by a horizontal distance equal to $1/(1 - b)$ times the increase (decrease) in *a*. The vertical GDP line will remain unmoved (as *a* changes).

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6 See **Graphical IS Line Derivation** following this section.

7 $1/(1 - b)$ is called the **autonomous expenditure multiplier**. It indicates the change in GDP that would – at the existing level of interest rates – restore equality between APE and GDP following a change in the level of *a* (which represents the level of **autonomous expenditures** – those purchases from the GDP that are **not** dependent upon the levels of GDP or i).

These coordinated movements of the GDP, IS, and APE lines assure that these three lines will <u>always</u> cross at a common point.

Figure 2-3

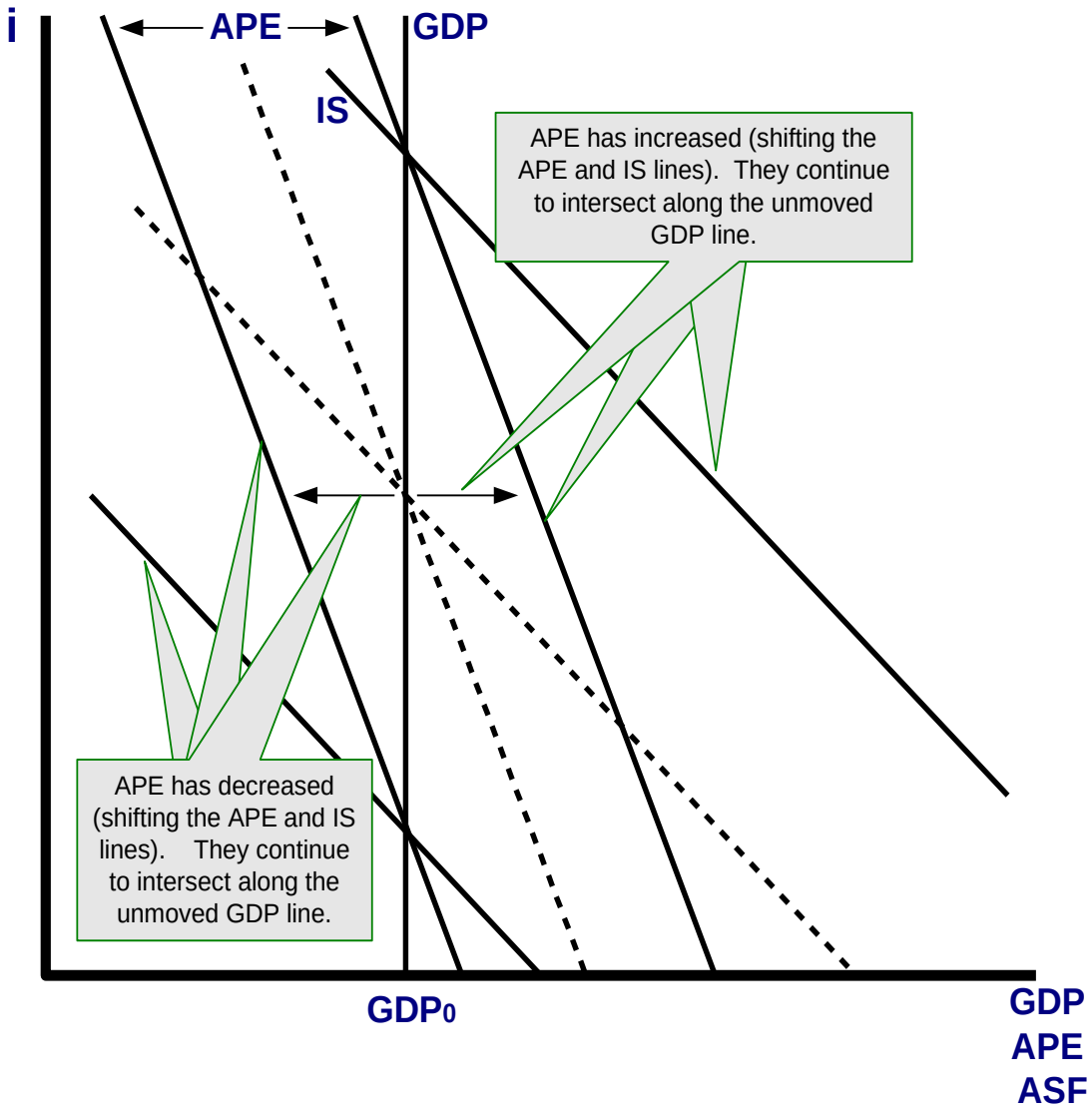


Figure 2-3 shows how the lines behave in response to a rise or fall in APE. The APE line shifts horizontally by the amount that APE increases or decreases. The GDP line remains unmoved. The IS line will shift to maintain a common intersection point

(along the GDP line) with the APE line. The horizontal shift of the IS curve will equal 1/(1 – *b*) times the horizontal shift of the APE curve.

Figure 2-4

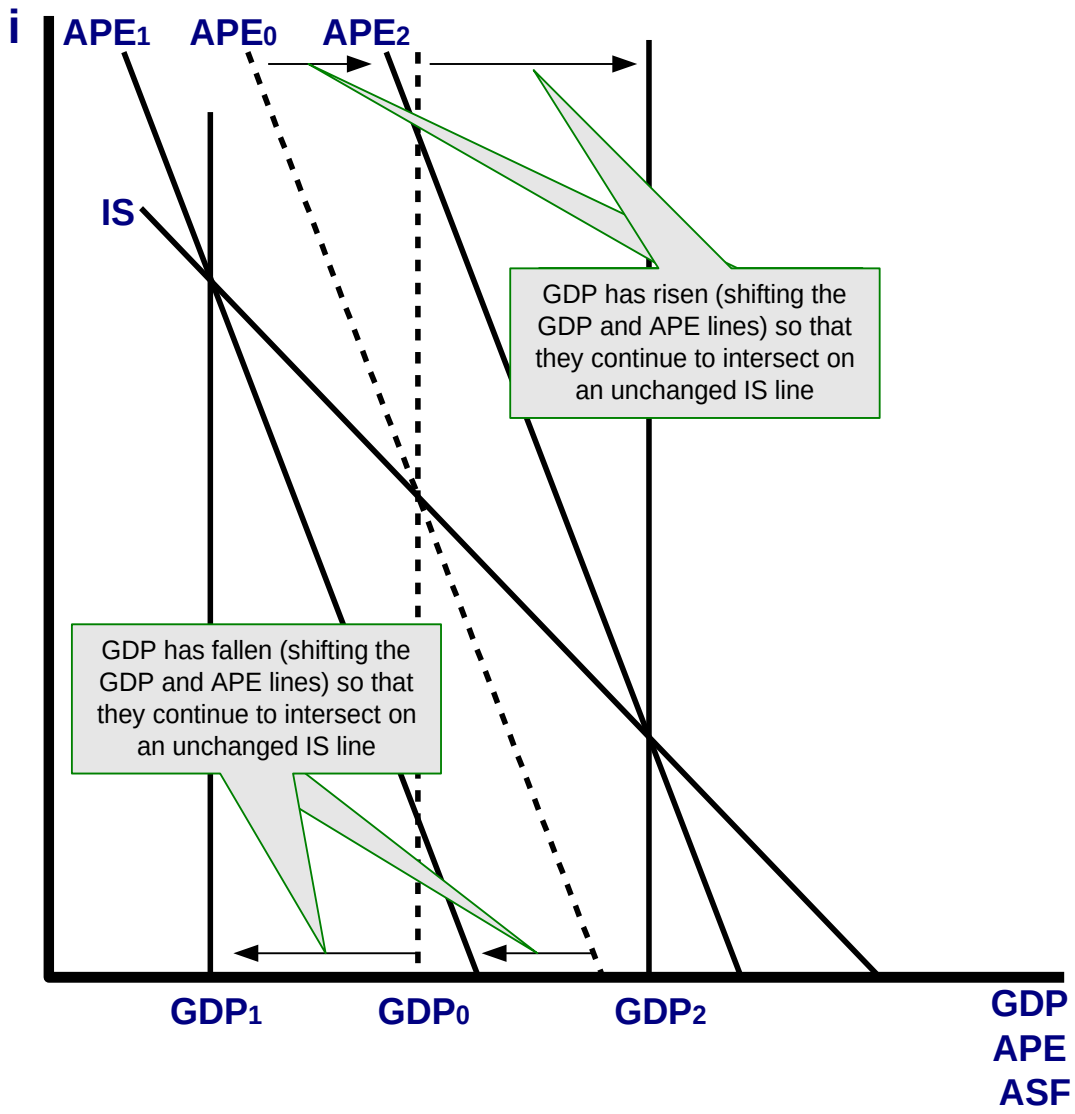


Figure 2-4 illustrates the line shifts in response to an increase or decrease in GDP. The vertical GDP line moves horizontally by the amount that GDP increases or decreases. The IS line does not move. The APE curve will shift to maintain a common intersection point with the GDP line along the unmoved IS line.

The horizontal shift of the APE line will equal *b* times the change in GDP.

Graphical IS Line Derivation

Figure 2-5

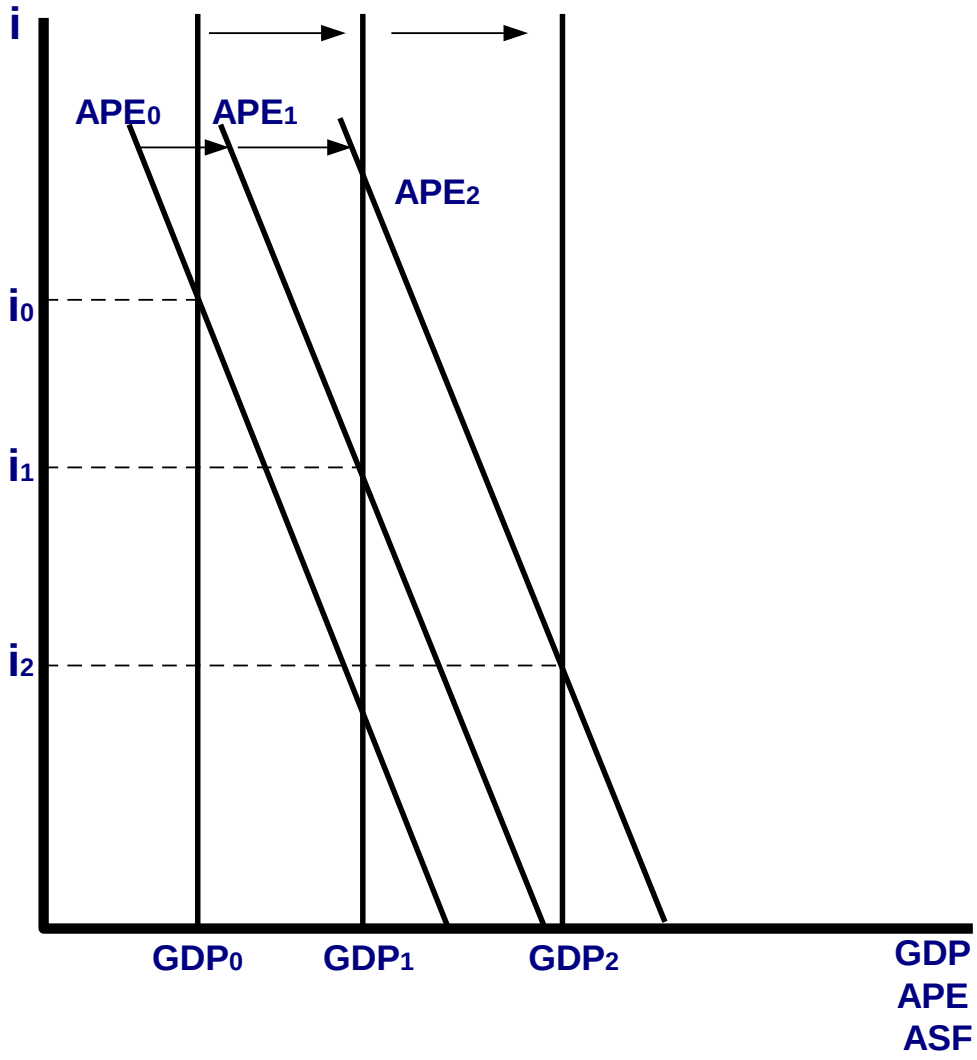
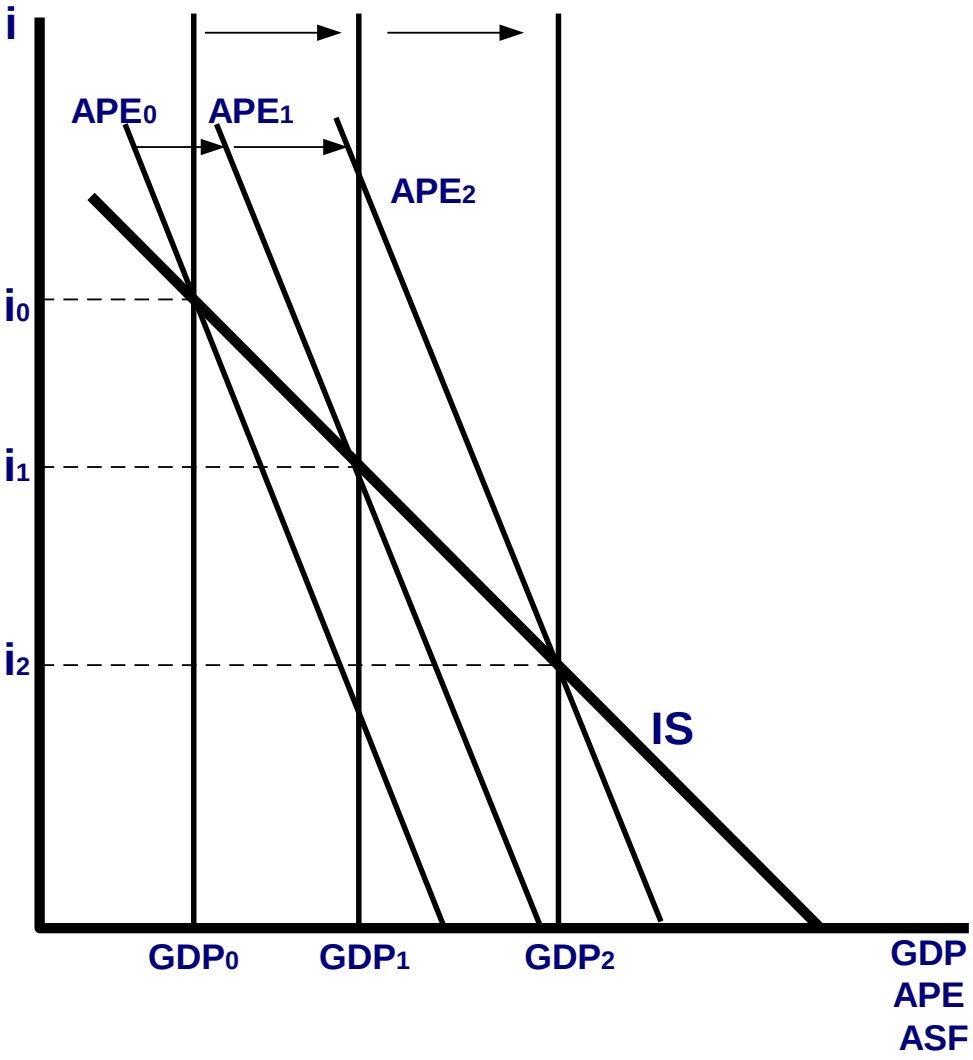


Figure 2-5 shows three different levels for GDP and the corresponding APE lines. Notice the level for interest rates at which each APE line crosses its GDP line. As GDP increases, the horizontal shift of the APE line is only about one-half of the

horizontal shift of the GDP line. Consequently, the level of interest rates at which APE = GDP steadily declines. The IS line is made up of combinations for the interest rate level and GDP at which APE = GDP. Consequently, the IS line passes through all of the intersection points of the APE and GDP lines. Figure 2-6 shows the IS line drawn through those points.

Figure 2-6



Warning: *It is important to recognize that the IS line determines nothing. At each level for the GDP, the IS line merely indicates what the level for interest*

> *rates would need to be in order for APE to be equal to the GDP. Unless the economy has achieved macroeconomic equilibrium, the interest rate level indicated by the IS line will differ from the actual prevailing level that has been determined (as we shall see in Chapter 4) by the interaction between the ADF and the ASF. So, it is wholly inappropriate to look at the sloping IS line and argue that as GDP rises (falls) the level of interest rates will be falling (rising).*

Whereas the IS line measures nothing and determines nothing, it is useful because it shows us where the macroeconomic coordination process is headed. When the ***MCP*** ends, GDP will equal APE, and that outcome will be one of the combinations for interest rates and the GDP that lie on the IS line.

Because we have mapped out the IS line by shifting the level of GDP, it should be clear that changes in GDP will shift the APE line to a new position so that it crosses the new GDP line where that GDP line crosses the unmoved IS line. If, however, it is the APE line that is shifting on its own (not in response to a change in the level of GDP), then the GDP line stays put while the APE line shifts. In this case, the IS line will shift (parallel to its former position) so that it passes through the point at which the new APE line crosses the unmoved GDP line.**{8}**

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8 For example, in Figure 2-6, had all of the APE curves been lying a little farther to the right, their crossing points on the corresponding GDP lines would have been a little higher up and the IS line would have correspondingly passed through those higher crossing points.

Adding ASF to the Graph

ASF – **aggregate supply of funding** – is the upper limit upon aggregate expenditures (measured in "real terms," using constant base-year values) for current domestic output that is imposed by the existing money supply (**M**), given the current level of prices (as reflected in the "price index," ***p***, the average ratio of current prices to those in the base year) and the prevailing average number of times per year, **V**, that a dollar of M is used to fund current domestic output purchases. The ASF does not limit APE (the volume of planned GDP purchases during the year). APE can exceed ASF, and so can GDP. What ASF limits is how much of the APE can actually be executed during the year. If APE exceeds ASF, an amount of planned purchases equal to APE minus ASF will not yet have been made when the year comes to an end.

$$ASF \equiv (M \times V)/p \qquad (1\text{-}4)$$

M and V are both generally positively related to the level of interest rates. That is, both M and V tend to increase as i increases; however, above some high level for i, we must expect that the ability of lenders to respond to i increases will become exhausted. We acknowledge this eventual loss of responsiveness; nonetheless, we shall – for graphical simplicity – represent the relationship as linear.

$$(M \times V) = \boldsymbol{m} + \boldsymbol{e}\mathbf{i}\ ,$$

where ***m*** represents the combined impact upon the magnitude of M x V that results from all influences other than the level of interest rates. The influence of interest rates is captured by ***e***. We assume that $\boldsymbol{m} > 0$ and that $\boldsymbol{e} > 0$ (although we acknowledge that, at very high interest rate levels, the value of

e would likely drop to 0). Because (M x V) = *m* + *e*i, it follows from Equation 1-4 above that

$$ASF \equiv (m/p) + (e/p)i \ .$$

This is the equation for an **ASF line** that we shall add to our diagram Figure 2-2 (page 26). That figure is reproduced here as Figure 2-7 – with three ASF lines to emphasize that the ASF line may lie anywhere relative to the other lines.

The ASF line has a positive slope, which when represented as $\Delta ASF/\Delta i$, is equal to e/p and has a horizontal axis intercept equal to m/p. Any change in the responsiveness of M and V to changes in the level of interest rates will be reflected in an appropriate change in the value of *e*. If M and V become more responsive to i, the value of *e* increases (by Δe), and the ASF line becomes flatter – $\Delta ASF/\Delta i$ increases by $(\Delta e)/p$. A decrease in the price level (by $-\Delta p$) also makes the ASF line flatter – $\Delta ASF/\Delta i$ increases by $(e/p)/[(\Delta p)/(p - \Delta p)]$.**{9}**

If M and V become less responsive to i, the value of *e* decreases (by $-\Delta e$), and the ASF line becomes steeper – $\Delta ASF/\Delta i$ decreases by $(-\Delta e)/p$. An increase in the price level (by Δp) also makes the ASF line steeper – $\Delta ASF/\Delta i$ decreases by $(e/p)/[(\Delta p)/(p + \Delta p)]$.**{10}**

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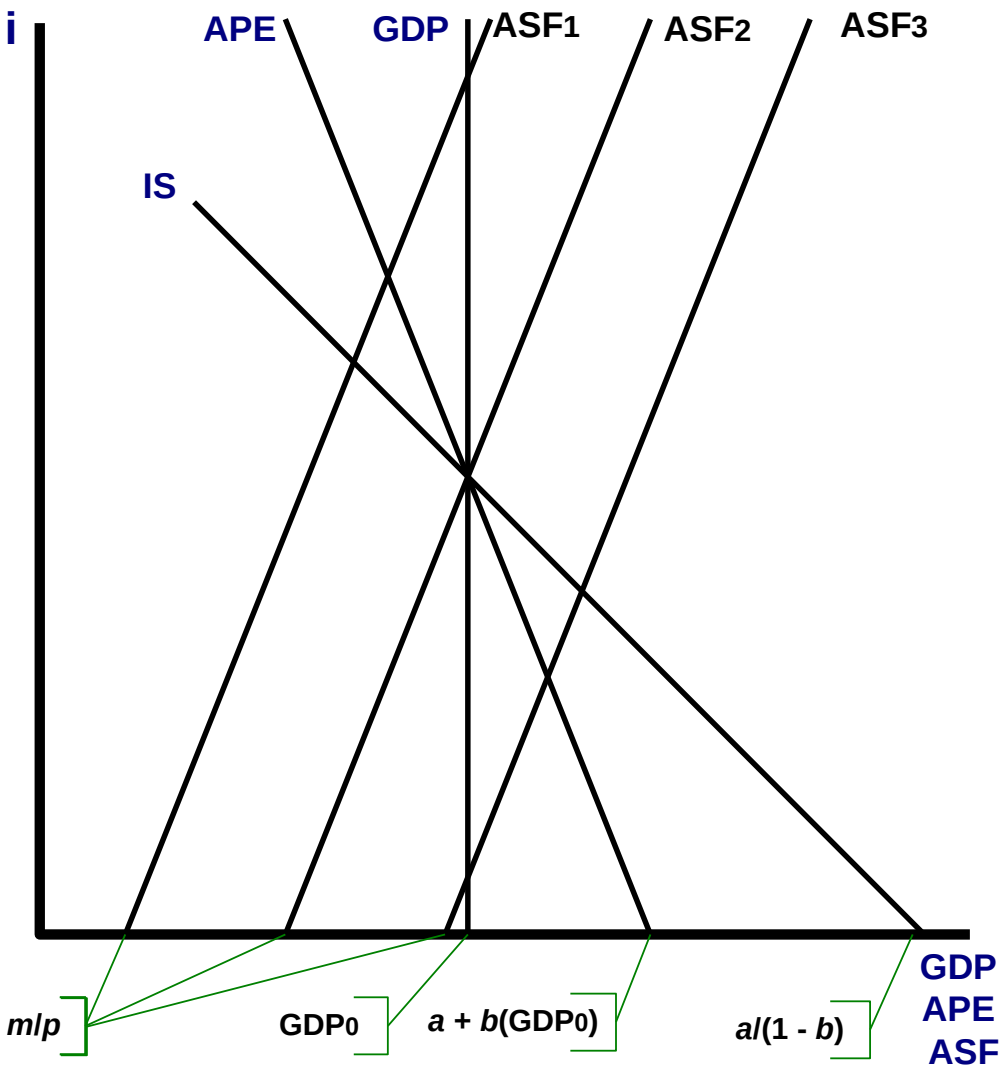
9 This is an algebraic re-write of $[e/(p - \Delta p)] - (e/p)$.

10 This is an algebraic re-write of $(e/p) - [e/(p + \Delta p)]$.

Figure 2-7



The ASF line will shift horizontally in response to changes in *m* and *p*. A price level rise (equal to Δp) will shift the ASF line horizontally to the left by $(m/p)[(\Delta p)/(p + \Delta p)]$.**{11}** A price level fall (equal to $-\Delta p$) will shift the ASF line horizontally to the right by $(m/p)[(\Delta p)/(p - \Delta p)]$.**{12}** Any increase in M or V – for

11 This is an algebraic re-write of $(m/p) - [m/(p + \Delta p)]$.

12 This is an algebraic re-write of $[m/(p - \Delta p)] – (m/p)$.

reasons other than in response to a change in the level of interest rates – will cause a matching rise in *m* (represented by Δm) and will shift the ASF line to the right by a horizontal distance equal to $(\Delta m)/p$. Any decrease in M or V – for reasons other than in response to a change in the level of interest rates – will cause a matching fall in *m* (represented by $-\Delta m$) and will shift the ASF line to the left by a horizontal distance equal to $(-\Delta m)/p$.

The horizontal distances – at any i level – from the i-axis to the GDP, APE, and ASF curves measure the prevailing magnitudes of GDP, APE, and ASF, respectively. Notice that, in Figure 2-7, there is only one interest rate level and ASF line (ASF_2) for which all three – GDP, APE, and ASF – could be equal.

Mapping ADF on the Graph

The **aggregate demand for funding** (**ADF**) equals the larger of APE and GDP. In Figure 2-8, ADF is represented by the kinked line that consists of (1) the portion of the GDP line that lies above the IS line – where APE < GDP – plus (2) the portion of the APE line that lies below the IS line – where APE > GDP.

Figure 2-8