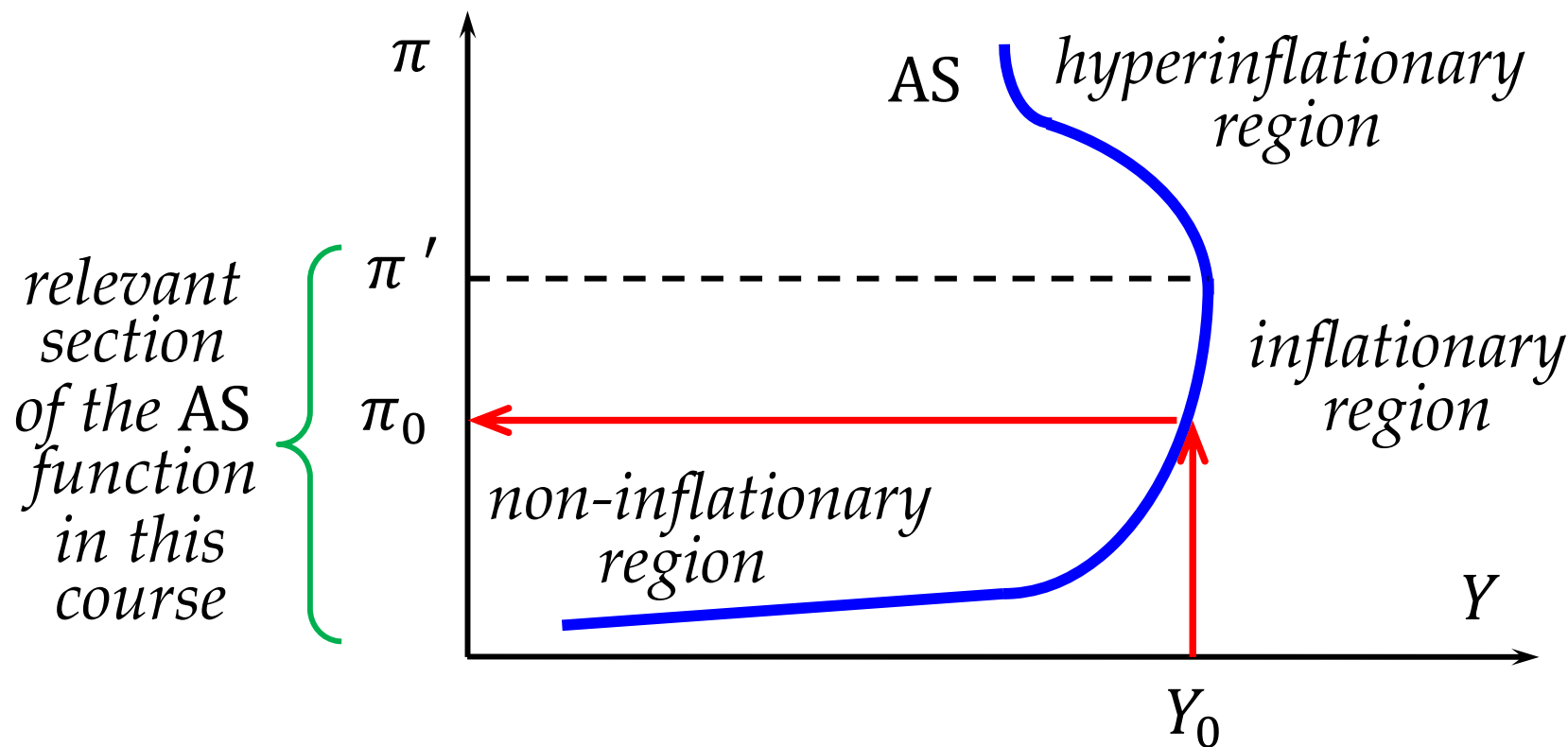


# The AS-AD model

- The aggregate supply-aggregate demand (AS-AD) model is a model built to analyze the fluctuations of both the real GDP  $Y$  and the inflation rate  $\pi$ .
- The AS-AD model can be used to provide explanations of the business cycle and to determine the effect of exogenous shocks on the business cycle.
- Loosely speaking, the AS-AD model can be viewed as a macroeconomic version of the competitive market model in which the whole economy is taken to be the market. The model is used to ascertain the impact on  $Y$  and  $\pi$  of economic shocks.

# Aggregate supply (AS) function

- The AS function establishes, for every amount  $Y$  of aggregate production (real GDP), the inflation rate  $\pi$  that results in the economy during the period of time in which  $Y$  is produced (when  $Y_0$  is produced, the economy generates inflation rate  $\pi_0$ ).



# Upward-sloping section

- The AS function is assumed to be upward-sloping up to a certain inflation rate  $\pi'$ . It is for that section that the AS function is read in the direction  $Y \rightarrow \pi$ : production determines inflation.
- The upward-sloping section has two regions. In the non-inflationary region (that may start for negative  $\pi$ ), the economy can grow without rising  $\pi$  significantly: there are idle resources usable to increase production without creating a pressure on costs.
- Along the inflationary region, the price to be paid for producing more is having more inflation.

# Explaining the inflationary region /1

- Inflation in this region is cost-push inflation.
- Competition for resources. The amount of resources is finite. Hence, as the economy approaches the maximum value of  $Y$  that is feasible, firms encounter resource bottlenecks. Eventually, firms can only obtain more inputs by detracting them from other firms. This requires paying more for those inputs to attract them.
- Training costs. More production eventually demands hiring more workers, who in general should be trained to be able to operate efficiently.

# Explaining the inflationary region /2

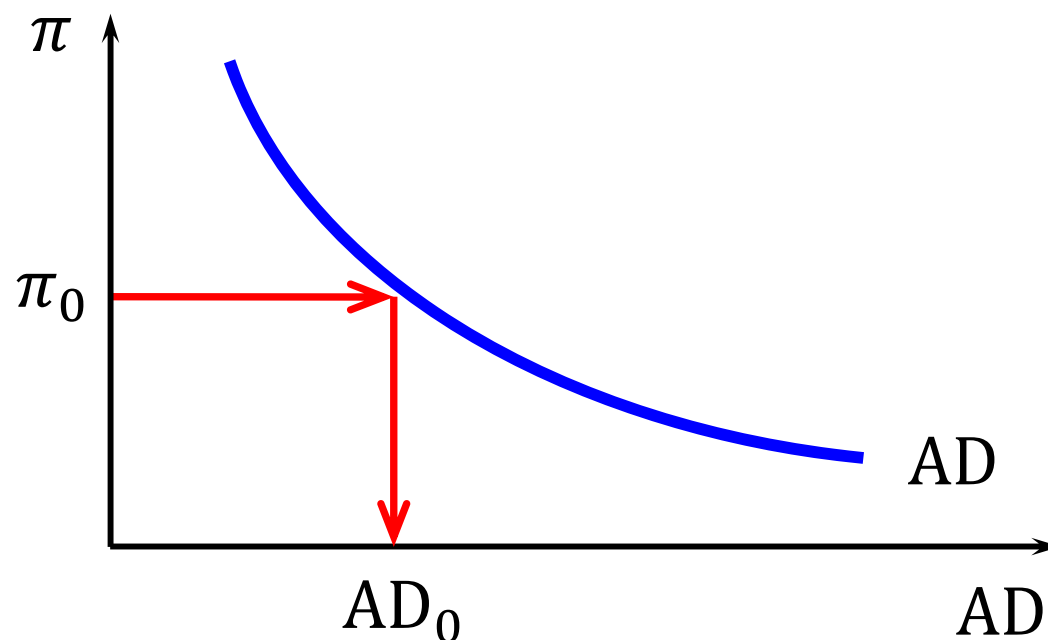
- Reorganization costs. Changing the scale of production may require a production process redesign, which is costly.
- Diminishing marginal productivity. All production process eventually face the law of diminishing marginal productivity: each additional unit of input will in the long run add less to total production. So, to produce the same again, more inputs are needed and costs therefore increase.
- Example: hours of study is the input to produce knowledge. With all likelihood, the tenth hour does not add as much knowledge as the first one.

# Downward-sloping section

- The AS function is assumed downward-sloping above a certain inflation rate  $\pi'$ .
- For a high enough inflation rate (hyperinflation), the production activities no longer run smooth, because, as prices are changing so fast, agents in the economy are more concerned with preserving purchasing power.
- The normal operation of the productive system is disturbed (it is hard to make correct decisions when prices may vary every minute). So it is reasonable to expect a drop in  $Y$  when  $\pi$  goes up in an economy suffering from hyperinflation.

# Aggregate demand (AD) function

- The AD function establishes, for each inflation rate  $\pi$ , the amount AD of planned aggregate expenditure. AD is the sum of four components: C (aggregate planned consumption) + I (aggregate planned investment) + G (planned government purchases) + NX (aggregate planned net exports).



# The AD function is downward-sloping

- Reason 1: as the inflation rate grows, purchasing power diminishes (so consumption tends to be reduced) and competitiveness is eroded (so net exports NX diminish).
- Reason 2: as the inflation rate grows, the CB reacts by rising the interest rate  $i$ , which tends to reduce C and I. The increase in  $i$  tends to rise the exchange rate  $e$ . This rise erodes competitiveness, making net exports NX fall.
- Reason 3: a rise in the inflation rate directly erodes competitiveness, which tends to reduce NX.



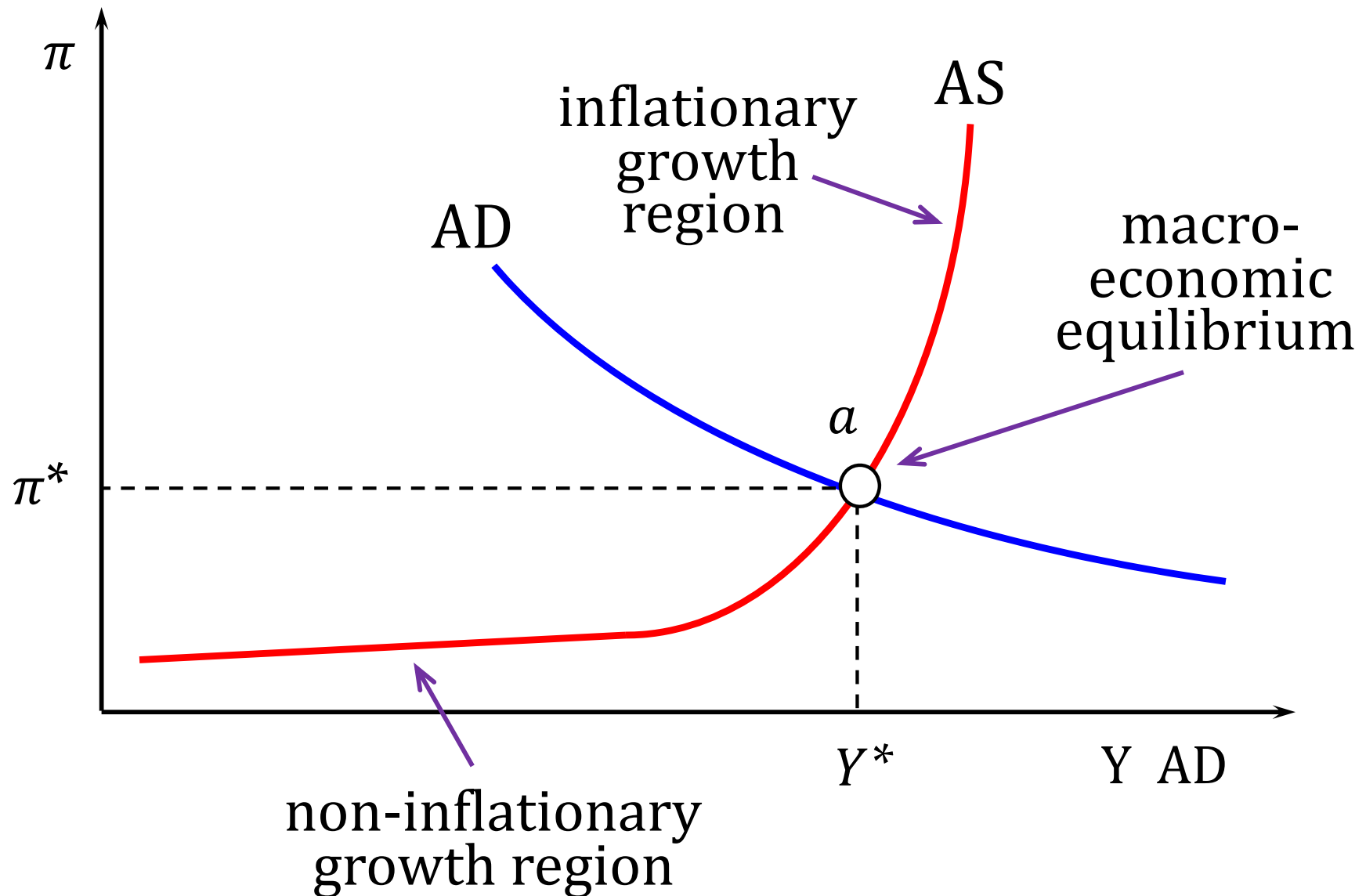
# The Keynes and Pigou effects

- Keynes effect (starts with the price level P):  
$$\downarrow P \Rightarrow \uparrow \frac{M1}{P} \Rightarrow \text{excess of money holdings} \Rightarrow$$
$$\Rightarrow \uparrow \text{purchases of financial assets} \Rightarrow$$
$$\Rightarrow \uparrow \text{price of financial assets} \Rightarrow \downarrow i \Rightarrow \uparrow I \Rightarrow \uparrow AD .$$
- Pigou (real balance) effect:  
$$\downarrow P \Rightarrow \uparrow \text{wealth in real terms} \Rightarrow \uparrow C \uparrow I \Rightarrow \uparrow AD .$$
- Reply by M. Kalecki:  $\downarrow P \Rightarrow \uparrow \text{real value of debt} \Rightarrow$   
 $\uparrow \text{bankruptcies (confidence crisis)}$ . As Japan in the 1990s illustrates,  $\downarrow P$  may imply  $\downarrow C$  because spending is delayed expecting a future fall in P.

# Macroeconomic equilibrium

- The macroeconomic equilibrium condition states that  $Y = AD$ : aggregate production equals planned aggregate expenditure.
- Any pair  $(Y^*, \pi^*)$  satisfying the macroeconomic equilibrium condition is a macroeconomic equilibrium. Whereas  $Y^*$  is the equilibrium production (equilibrium income or equilibrium expenditure),  $\pi^*$  is the equilibrium inflation rate.
- Geometrically, a macroeconomic equilibrium is represented by the intersection of the AS function and the AD function.

# Macroeconomic equilibrium displayed



# Changes in macro equilibrium

- Not everything is constant along the AS function: wages, for instance, may change. That change is endogenous in the sense that it is generated by the production sector itself.
- Not everything is constant along the AD function: the  $i$  and  $e$ , for instance, may change (the change of  $i$  is the result of a built-in feature of the model: the automatic response of the CB to rising inflation).
- Since it may not be obvious what can change or not along these functions, it is convenient to list factors that naturally shift them.

# Negative shocks to the AS function

- The AS function is expected to shift left when
  - production costs exogenously rise (for instance, an oil shock for an oil importing economy or the government declares a wage increase);
  - the amount of resources (factors of production) falls;
  - less credit is available;
  - the number of firms is reduced;
  - the government raises taxes;
  - the inflation rate is expected to rise the next period (likely effect);
  - more pessimistic expectations of businessmen on the evolution of the economy.

# Positive shocks to the AS function

- The AS function is expected to shift right when
  - production costs exogenously fall;
  - the amount of resources increases;
  - more credit is available;
  - the number of firms rises;
  - the government lowers taxes;
  - previous investments become operative;
  - technological progress applied to production;
  - improvements in the organization of production;
  - productivity increases;
  - businessmen adopt optimistic (profit) expectations.

# Positive shocks to consumption

- Aggregate planned consumption  $C$  (and, therefore,  $AD$ ) is positively affected by
  - increases in income and wealth (for instance, a rise in the price of shares);
  - an increase in the number of consumers (more population);
  - the expectation that income, wealth, the inflation rate, or the interest rate will grow in the future (better to consume now than later);
  - a reduction in taxes or a rise in transfers;
  - the reduction in the (real) interest rate;
  - credit made more easily available.

# Positive shocks to investment

- Aggregate planned investment  $I$  (and, therefore,  $AD$ ) is positively affected by
  - favourable expectations by businessmen (on profits, the evolution of the economy);
  - an increase in the number of firms;
  - subsidies stimulating investment;
  - a reduction in the tax rate on profits;
  - the reduction in the (real) interest rate;
  - credit made more easily available;
  - technological progress.



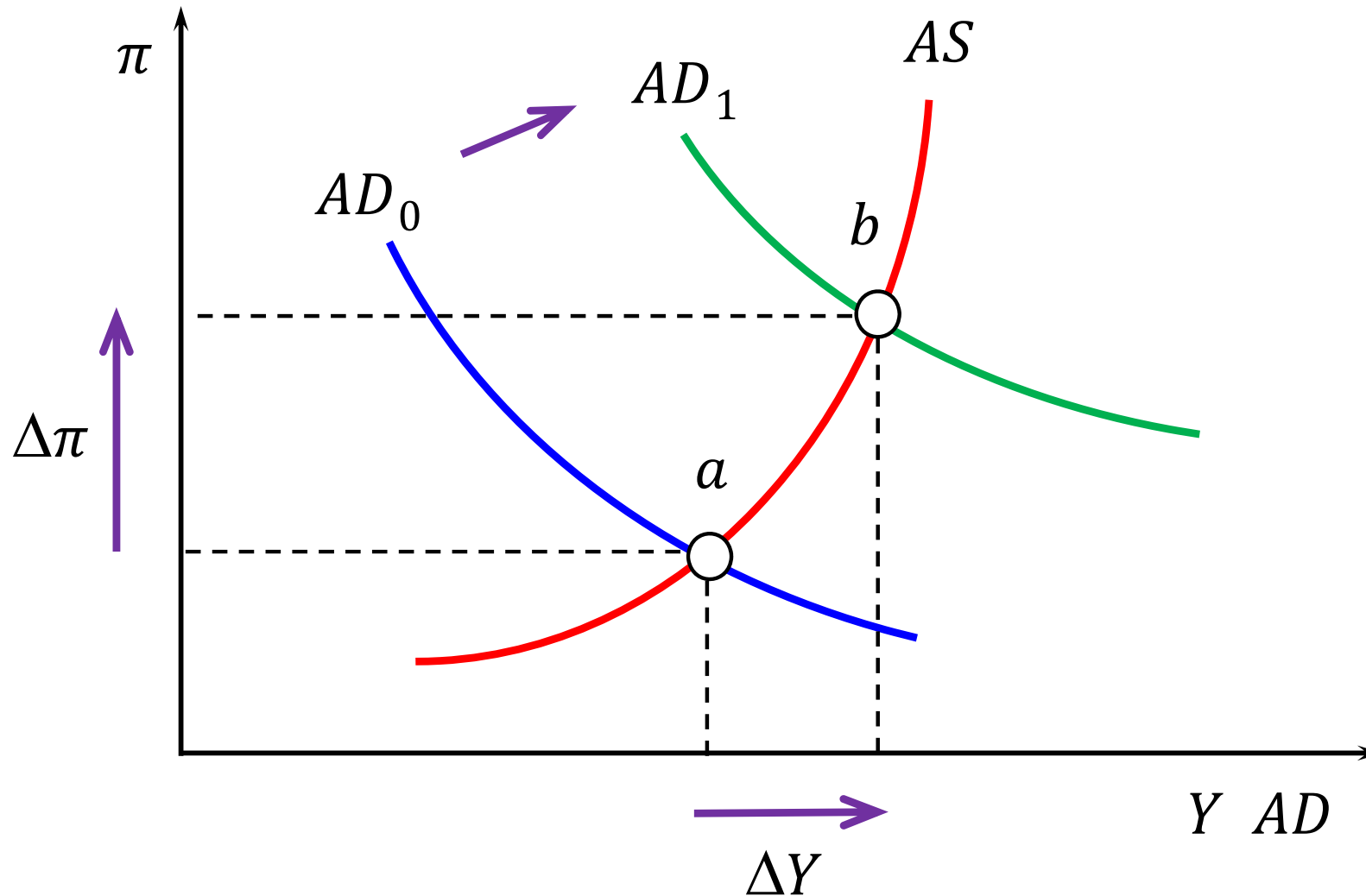
# Positive shocks to net exports

- Aggregate planned net exports NX (and, therefore, AD) is positively affected by
  - a reduction in domestic income (less imports);
  - an increase in foreign income (more exports);
  - a depreciation of the nominal exchange rate (domestic goods become cheaper);
  - a reduction in domestic inflation in comparison to the rest of the world (competitiveness is gained);
  - an increase in foreign inflation in comparison to domestic inflation;
  - government subsidies to exports;
  - a rise in tariffs.

# Effects of an AD expansion

- The next slide shows the effect of an AD expansion: the equilibrium inflation rate and production both rise (an AD contraction causes the opposite result).
- This general conclusion should be qualified: if the economy lies in the non-inflationary region, the increase in the inflation rate may be negligible (and the AD expansion only creates GDP growth).
- If the economy lies ahead in the inflationary region (and near the largest feasible amount of production), it is the increase in production that may be negligible (so the AD expansion only creates inflation).

# Positive demand shock: primary effects



# Multiplier effect /1

**AD function**  $AD = C + I = (4 + 0.8 \cdot Y - \pi) + 10 =$   
 $= 14 + 0.8 \cdot Y - \pi$

**AS function**  $Y = 30 \cdot \pi$

**Macroeconomic equilibrium condition**  $Y = AD$

- In equilibrium,  $Y = 4 + 0.8 \cdot Y - \pi$ , with  $Y = 30 \cdot \pi$ . Hence,  $0.2 \cdot Y = 14 - \pi$ . And  $Y = 30 \cdot \pi$ ,  $0.2 \cdot 30 \cdot \pi = 14 - \pi$ . That is,  $6 \cdot \pi = 14 - \pi$ , so  $\pi^* = 2$  is the equilibrium inflation rate. Given  $\pi^* = 2$ , the AS function yields the equilibrium production level  $Y^* = 30 \cdot 2 = 60$ .

# Multiplier effect /2

- The impact on  $Y^*$  of a change in the  $AD$  function is the result of an expenditure multiplier effect.
- Since expenditure  $AD$  depends on income  $Y$  and, in equilibrium  $Y = AD$ , the sequence

$$\Delta AD \rightarrow \Delta Y \rightarrow \Delta AD \rightarrow \Delta Y \rightarrow \dots$$

is generated, so a change in  $AD$  multiplies itself.

- Example. Let the  $AD$  function only depend on  $C$  and  $I$ , so  $AD = C + I$ . Let  $I$  be constant. Specifically,  $C = 4 + 0.8Y - \pi$  and  $I = 10$  (the 0.8 is the marginal propensity  $c$  to consume: which fraction of an additional unit of income is consumed).

# Multiplier effect /3

- The *AS* function is  $Y = 30 \cdot \pi$ . The macroeconomic equilibrium is obtained from the condition  $Y = AD$ . That is,  $Y = 4 + 0.8 \cdot Y - \pi + 10$ . Thus,  $0.2 \cdot Y = 14 - \pi$ . As  $Y = 30 \cdot \pi$ ,  $\pi = 2$  ( $\pi$  is a percentage).
- Imagine now that there is an increase in investment, from 10 to 17 (for instance, businessmen become more optimistic).
- To better illustrate the multiplier effect, assume that the inflation rate does not change and remains at 2% (it is as if the *AS* function were horizontal at  $\pi = 2$ : the economy absorbs any increase in planned expenditure without fuelling inflation).

# Multiplier effect /4

- The state of the economy is described by equations  $Y = AD$  and  $\pi = 2$ . Hence,  $Y = 4 + 0.8 \cdot Y - \pi + 17 = 19 + 0.8Y$ . That is,  $0.2Y = 19$ , so  $Y = 95$ .
- To sum up, expenditure has only been increased 7 units (from  $I = 10$  to  $I = 17$ ), but production and income have risen 35 units (from  $Y = 60$  to  $Y = 95$ ). This is caused by the multiplier effect. In this case, the multiplier is 5, which equals  $1/(1 - c)$ .
- When the AS function enters the picture, part of the expenditure is transformed into inflation. With  $Y = 30 \cdot \pi$  and  $AD = 4 + 0.8 \cdot Y - \pi + 17$ ,  $\pi^* = 3$  and  $Y^* = 90$  (inflation eats up 5 units of income).

# Temporary shock

$$\pi = 2$$

temporary shock on  $I$

time	$Y$	$C = 4 + 0.8 \cdot Y - \pi$	$I$	$AD = C + I$
0	60	$4 + 0.8 \cdot 60 - 2 = 50$	10	60
1	60	$4 + 0.8 \cdot 60 - 2 = 50$	17	$50 + 17 = 67$

$$\Delta Y_2 = 7$$

2	67	$4 + 0.8 \cdot 67 - 2 = 55.6$	10	$55.6 + 10 = 65.6$
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$$\Delta Y_3 = 1.4$$

3	65.6	$4 + 0.8 \cdot 65.6 - 2 = 54.48$	10	$54.48 + 10 = 64.48$
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$$\Delta Y_4 = 1.12$$

4	64.48	$4 + 0.8 \cdot 64.48 - 2 = 53.58$	10	$53.58 + 10 = 63.58$
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$$\Delta Y_5 = 0.896$$

5	63.58	$4 + 0.8 \cdot 63.58 - 2 = 52.86$	10	$52.86 + 10 = 62.86$
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...	...	...	10	...
$\infty$	60	$4 + 0.8 \cdot 95 - 2 = 78$	10	$50 + 10 = 60$

equilibrium



# Permanent shock

$$\pi = 2$$

permanent shock on I

multiplier effect

time	$Y$	$C = 4 + 0.8 \cdot Y - \pi$	$I$	$AD = C + I$
0	60	$4 + 0.8 \cdot 60 - 2 = 50$	10	60
1	60	$4 + 0.8 \cdot 60 - 2 = 50$	17	$50 + 17 = 67$
2	67	$4 + 0.8 \cdot 67 - 2 = 55.6$	17	$55.6 + 17 = 72.6$
3	72.6	$4 + 0.8 \cdot 72.6 - 2 = 60.08$	17	$60.08 + 17 = 77.08$
4	77.08	$4 + 0.8 \cdot 77.08 - 2 = 63.66$	17	$63.66 + 17 = 80.66$
5	80.66	$4 + 0.8 \cdot 80.66 - 2 = 66.53$	17	$66.53 + 17 = 83.53$
...	...	...	17	...
$\infty$	95	$4 + 0.8 \cdot 95 - 2 = 78$	17	$78 + 17 = 95$

$$\Delta Y_2 = 7$$

$$\Delta Y_3 = 5.6$$

$$\Delta Y_4 = 4.48$$

$$\Delta Y_5 = 3.58$$

equilibrium

# Shock with inflation adjustment

multiplier effect

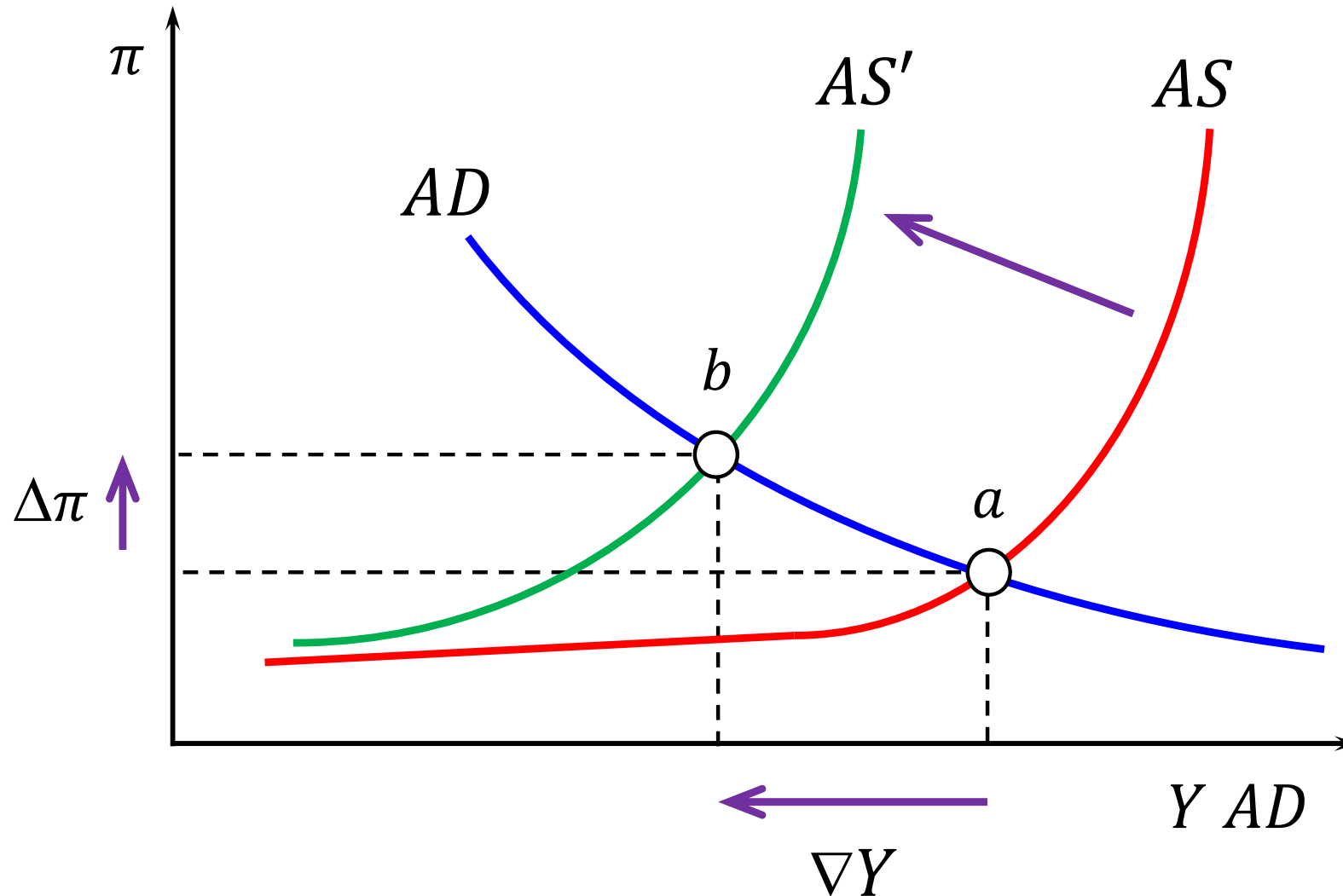
time	$Y$	$C = 4 + 0.8 \cdot Y - \pi$	$I$	$AD = C + I$	$\pi = \frac{Y}{30}$
0	60	$4 + 0.8 \cdot 60 - 2 = 50$	10	60	2
1	60	$4 + 0.8 \cdot 60 - 2 = 50$	17	$50 + 17 = 67$	2.23
$\Delta Y_2 = 7$					
2	67	$4 + 0.8 \cdot 67 - 2.23 = 55.37$	17	$55.37 + 17 = 72.37$	2.41
$\Delta Y_3 = 5.37$					
3	72.37	$4 + 0.8 \cdot 72.37 - 2.41 = 59.48$	17	$59.48 + 17 = 76.48$	2.54
$\Delta Y_4 = 4.11$					
4	76.48	$4 + 0.8 \cdot 76.48 - 2.54 = 62.64$	17	$62.64 + 17 = 79.64$	2.65
$\Delta Y_5 = 3.16$					
5	79.64	$4 + 0.8 \cdot 79.64 - 2.65 = 65.06$	17	$65.06 + 17 = 82.06$	2.73
...	...	...	17	...	...
$\infty$	90	$4 + 0.8 \cdot 90 - 3 = 73$	17	$73 + 17 = 90$	3

equilibrium

# Effects of an AS contraction

- The next slide shows the effect of an AS contraction: the equilibrium inflation rate rises but production falls.
- This phenomenon is called stagflation: stagnant economy with rising inflation. Western economies all experienced stagflation in the 1970s.
- An AS expansion causes the opposite result: non-inflationary growth. The US economy experienced this result in the 1990s (it was then speculated that a *New Economy* was born capable of sustaining non-inflationary growth thanks to continuous productivity gains created by the digital revolution).

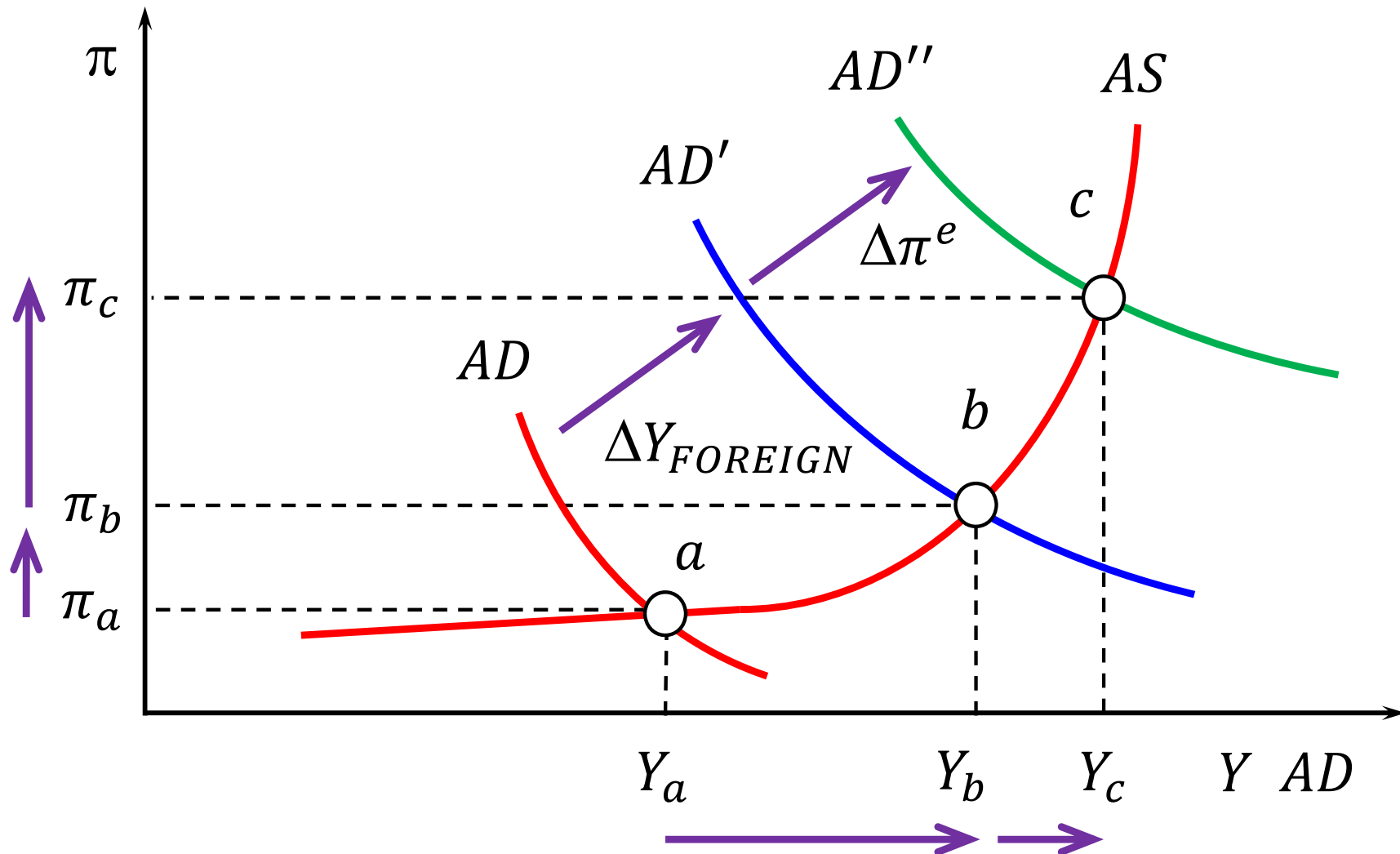
# Negative supply shock: primary effects



# Secondary effects of shocks

- The effects of a shock need not be limited to the primary effects, because the new macroeconomic equilibrium need not be stable. Consequently, the initial shock may induce more shocks.
- The additional changes in the macro equilibrium are typically generated by changes in the expected inflation rate ( $\pi^e$ ) caused by the initial shock.
- Suppose, for instance, that foreign outcome raises. This causes a positive demand shock ( $\Delta NX$ ) that shifts right the *AD* function; see the next slide.

# Role of inflationary expectations



# Self-replicating shocks

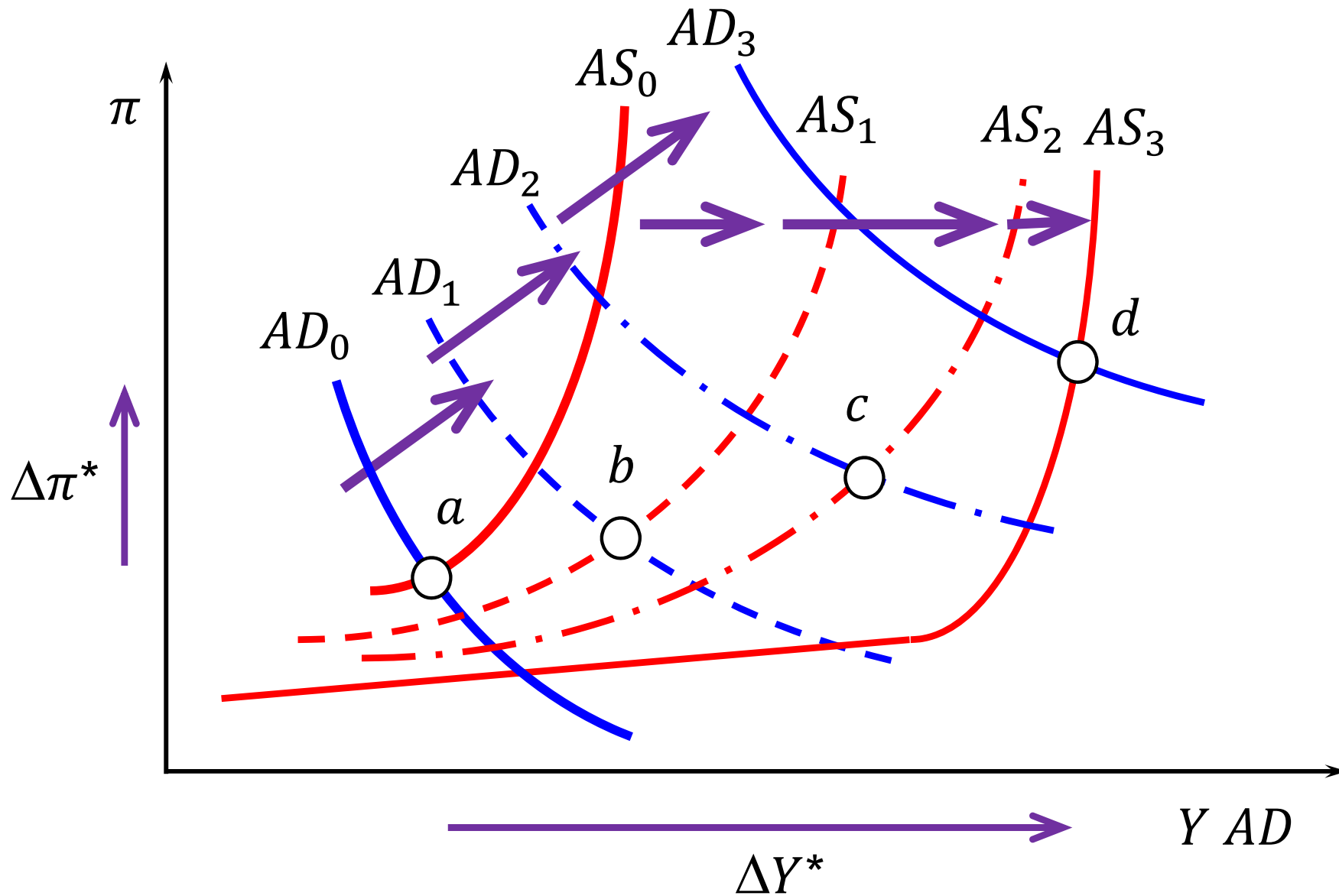
- Suppose  $AD$  is drawn assuming a correct expected inflation rate:  $\pi^e = \pi_a$ . After the shock, the inflation rate rises to  $\pi_b$ , so people realize that their expectation is incorrect: inflation is higher than expected.
- It is reasonable to presume that people will rise  $\pi^e$ . This shifts the  $AD$  function from  $AD'$  to  $AD''$ , which stimulates the economy further.
- If  $\pi^e$  in  $AD''$  is smaller than the new equilibrium inflation rate  $\pi_c$ , inflationary expectations will continue to grow. Curiously, it is the expectation of a higher inflation that generates a higher inflation.

# Business cycle in the AS-AD model

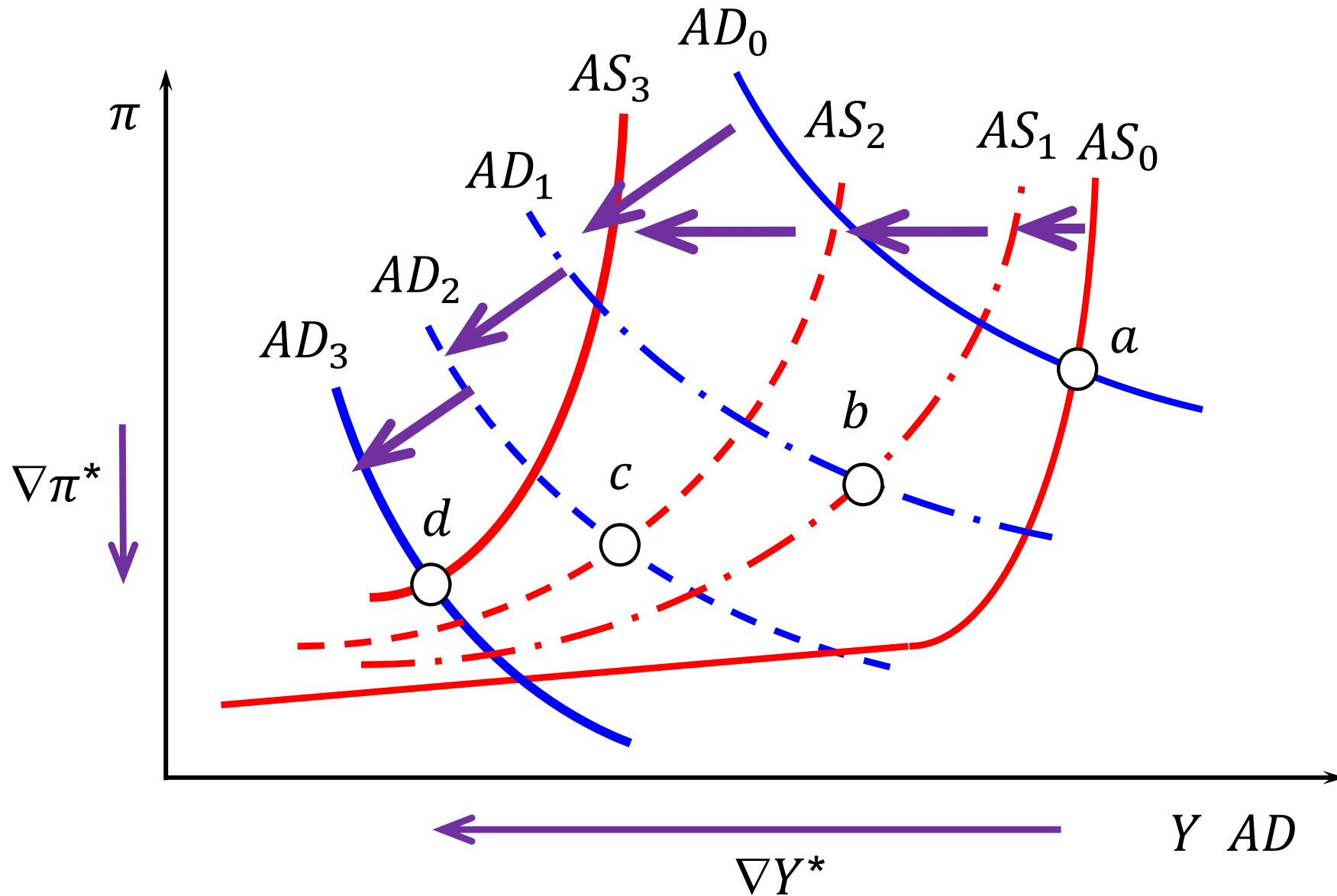
- That same logic explains the sustainability of the expansion period of the business cycle (and also the sustainability of the recession period).
- The next two slides (33 and 34) illustrate how the expansion and recession periods arise: a continuous shift in, typically, both functions.
- The third slide (35) depicts the typical evolution of production and the inflation rate during the business cycle. The fourth slide (36) shows how this pattern can be generated by a simple example.



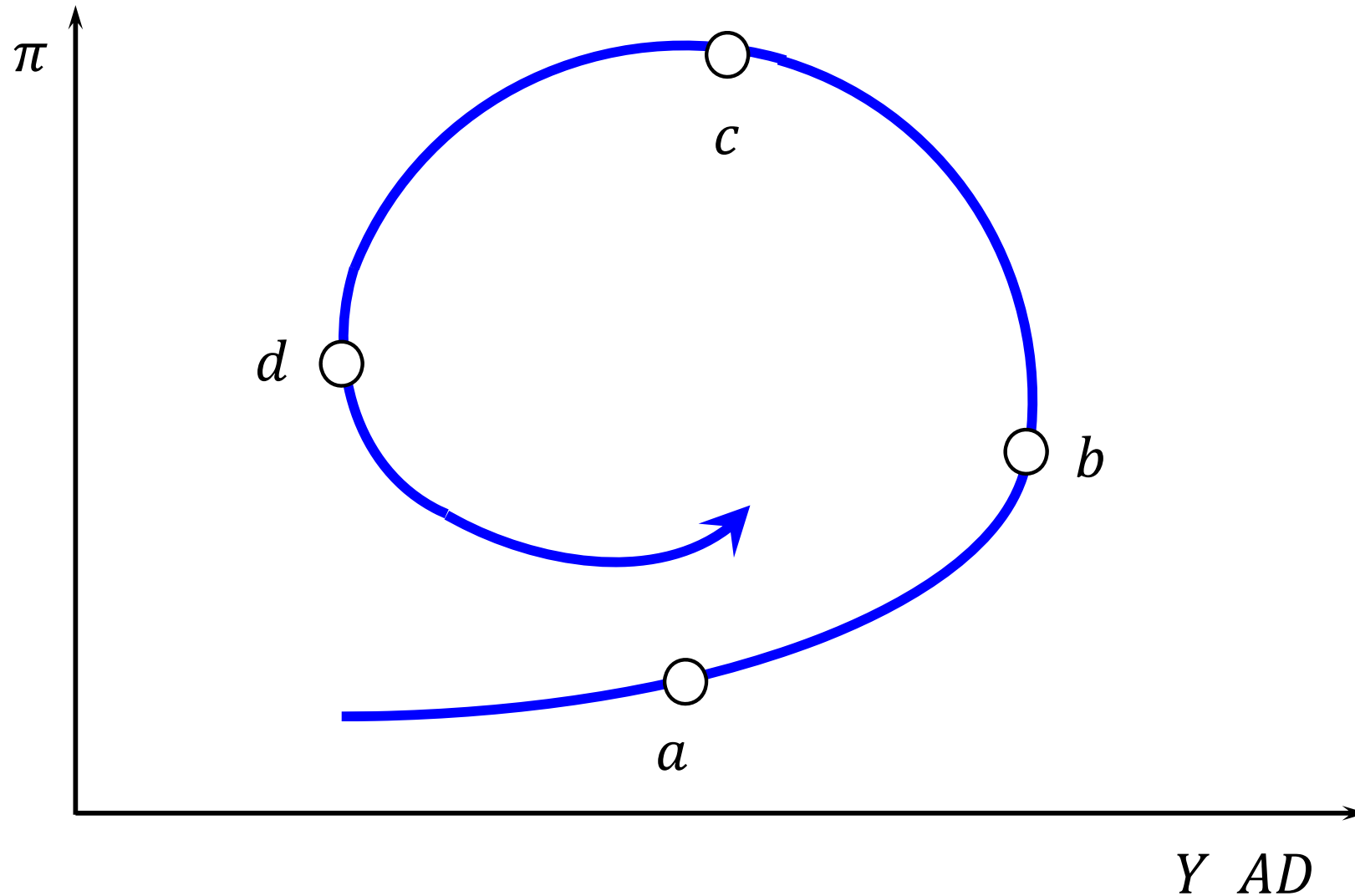
# A booming economy



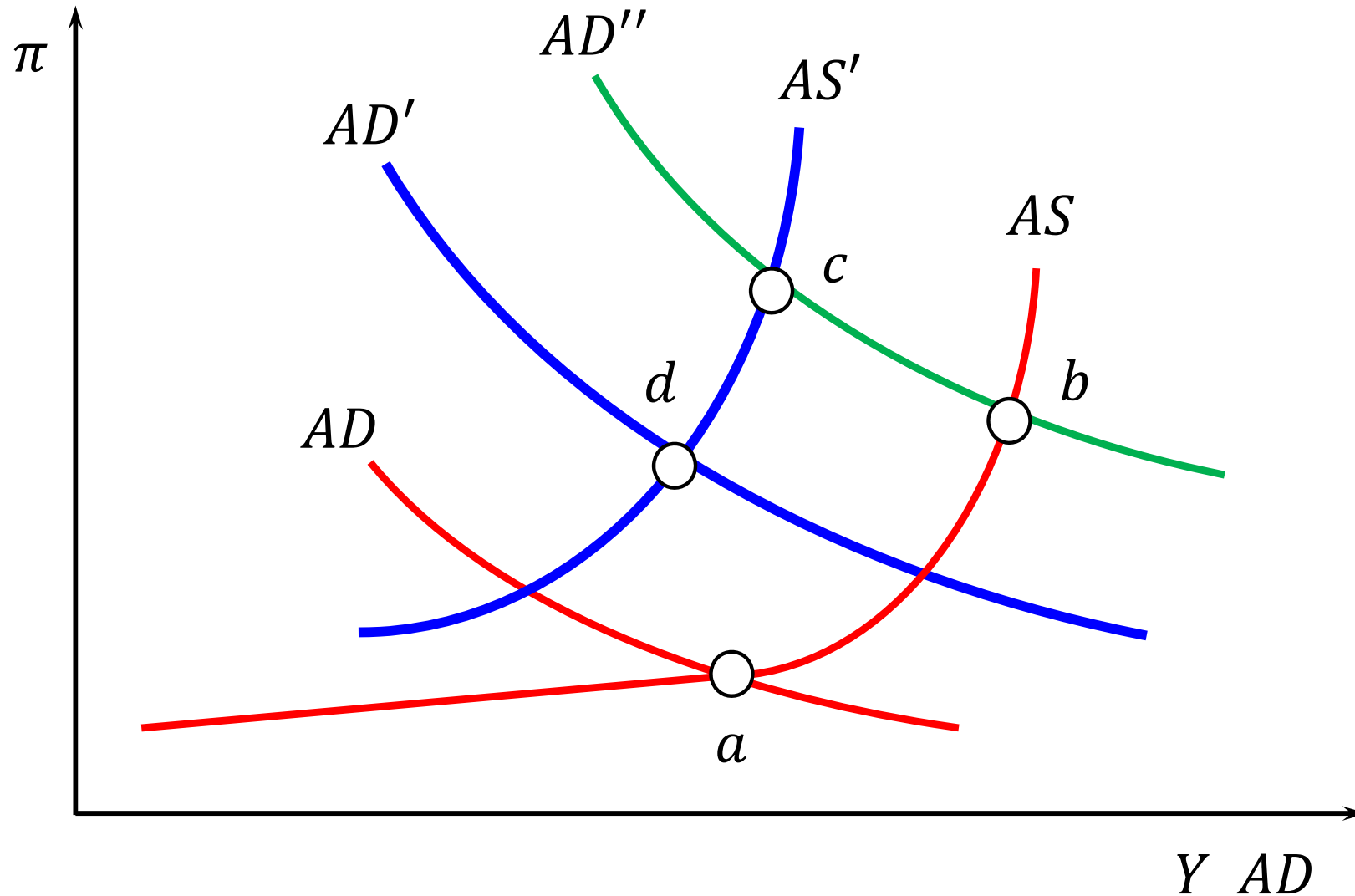
# A slumping economy



# Typical business cycle loop



# Business cycle example



# Creating business cycles: an example

- The initial point is  $a$ . The collective agreement of wages is being negotiated and workers expect a certain increase in wages. At the expense of the future wage increase, workers raise consumption now.  $AD$  shifts to the right and  $b$  is reached.
- By then the agreement terms are known: there is a surge in wages but less than expected. That increase shifts  $AS$  to the left. The equilibrium goes from  $b$  to  $c$ . But since the wage rise was smaller than expected, workers cut consumption ( $AD'$  moves to  $AD''$ ) and  $d$  is reached.

# Long-run & short-run macroeconomics

- Textbooks make production converge to a long run fixed production level representing potential GDP, which is presumed to be given and unaffected by short run decisions. This is a quite debatable assumption (in fact, there does not appear to be a long run but a sequence of short runs).
- “The long run is a misleading guide to current affairs. In the long run we are all dead. Economists set themselves too easy, too useless a task if in tempestuous seasons they can only tell us that when the storm is past the ocean is flat again.” J. M. Keynes, *A Tract on Monetary Reform*, 1923, Ch. 3.