

4. The aggregate supply, aggregate demand model

1. Gross domestic product (GDP)

A good is final if it is not used to produce other goods. The gross domestic product (GDP) of an economy is the market value of all the final goods produced in the economy during a period of time.

2. Relevance of the GDP concept

GDP is the most common measure of aggregate production, a crude estimator of how rich and how big an economy is and a measure of economic performance: a rough quantitative evaluation of aggregate economic activity. GDP has become a key macroeconomic variable because of the general perception that it is a key variable. Macroeconomic policy is mostly driven by the policy maker's perception of reality through the dynamics of GDP.

3. GDP data as fiction

It is practically impossible to compute GDP according to the definition because of in a modern economy millions of goods are produced and because their prices vary during the period with respect to which GDP is defined. In practice GDP is an estimated value. The actual calculation of GDP involves a large amount data (statistics on employment, trade, industrial production, tax revenue, transportation...) and the participation of many organizations (surveys from manufacturers, builders, retailers, financial institutions...). Macroeconomic statistics is in practice a branch of politics.

4. Limitations of the GDP concept: a short list of accusations

1. The GDP of different economies cannot be compared. It is even difficult to compare the GDP of the same economy in two moments of time.
2. GDP ignores negative byproducts and externalities of economic activity, like pollution or crime. Ironically, polluting activities (such as burning fossil fuels or emissions from industrial facilities) increase GDP. And GDP rises again when conducting activities to clean up pollution.
3. GDP ignores how it is distributed among the agents of the economy. GDP does not worry about inequality or equity. Top 10% earners tend to make around 60-70% of income.
4. GDP ignores the exhaustion of natural wealth. The depletion of natural resources (clean water, breathable air, virgin landscapes) is good for GDP. GDP includes the new wealth created but not the wealth destroyed when natural resources are used to produce goods.
5. Structural changes in the economy tend to make obsolete the way GDP is estimated. Conceptually, GDP seems to presume that all wealth created in an economy is physical wealth (manufactured goods). Yet most economic activity in modern economies (between 50% and 80%) involves services, which in general do not create physical output and are difficult to measure.
6. The information sector contributes marginally to the computation of GDP (less than 5%?), just as a generation ago, despite the ongoing transition to an information-based digital economy. GDP looks like a concept more suited for a 20th century economy than for a 21st century economy.
7. GDP ignores home production and do-it-yourself activities. GDP does not value goods such as the quality of education, life expectancy, income inequalities, pollution, social and political institutions, leisure time, moral values, loss of natural resources, environmental damage...

8. GDP does not properly account for changes in the quality, novelty, and diversity of the goods manufactured and services provided. Moreover, should services that merely contribute to create and circulate debt instruments (and make the economy more vulnerable to a financial or debt crisis) be considered equivalent to services that increase wealth?
9. Underground, hidden, black market and illegal economic activities (the shadow economy) are excluded from GDP, as they are not taxed, not reported, or illegal (like prostitution or the illegal drug trade). Second-hand sales are also excluded (they represent production previously counted).

5. Nominal GDP

Nominal GDP (GDP^n) values production at current prices. Changes in nominal GDP are misleading: they reflect changes in both production and prices.

6. Real GDP

Real GDP (GDP^r or GDP at constant prices or GDP adjusted for inflation) values production each period using the prices of a fixed period (the base period). By valuing the production in two periods using the same prices, changes in real GDP can only be attributed to changes in the amount of goods produced.

7. Real vs nominal GDP: an example

This example computes GDP in an ideal situation. The table on the right presumes that there are only two goods (1 and 2) and lists, for two periods, the amount q produced of each good i and its price p .

8. Real vs nominal GDP: an example

This example computes GDP in an ideal situation. The table on the right presumes that there are only two goods (1 and 2) and lists, for two periods, the amount q produced of each good i and its price p .

time t	p_1^t	q_1^t	p_2^t	q_2^t
1	4	6	2	8
2	9	5	3	5

- Nominal GDP in $t = 1$. $GDP_1^n = p_1^1 \cdot q_1^1 + p_2^1 \cdot q_2^1 = 4 \cdot 6 + 2 \cdot 8 = 40$ (monetary units of $t = 1$).

- Nominal GDP in $t = 2$. $GDP_2^n = p_1^2 \cdot q_1^2 + p_2^2 \cdot q_2^2 = 9 \cdot 5 + 3 \cdot 5 = 60$ (monetary units of $t = 2$).

From $t = 1$ to $t = 2$, GDP^n has increased by 50% : the rate of GDP^n is $\widehat{GDP^n} = \frac{60-40}{40} = \frac{1}{2} = 0.5 = 50\%$.

- Real GDP in $t = 1$ at constant prices of period $t = 1$ is $GDP_1^{r,t=1} = p_1^1 \cdot q_1^1 + p_2^1 \cdot q_2^1 = 4 \cdot 6 + 2 \cdot 8 = 40$ (monetary units of $t = 1$). Conclusion: $GDP^r = GDP^n$ at the base period (this always happens).

- Real GDP in $t = 2$ at constant prices of period $t = 1$ is $GDP_2^{r,t=1} = p_1^1 \cdot q_1^2 + p_2^1 \cdot q_2^2 = 4 \cdot 5 + 2 \cdot 5 = 30$ (monetary units of $t = 1$).

From $t = 1$ to $t = 2$, GDP^r has fallen a 25%: $\widehat{GDP^r} = \frac{30-40}{40} = -\frac{1}{4} = -0.25 = -25\%$.

- Real GDP in $t = 1$ at constant prices of $t = 2$ is $GDP_1^{r,t=2} = p_1^2 \cdot q_1^1 + p_2^2 \cdot q_2^1 = 9 \cdot 6 + 3 \cdot 8 = 78$.

- Real GDP in $t = 2$ at constant prices of $t = 2$ is $GDP_2^{r,t=2} = p_1^2 \cdot q_1^2 + p_2^2 \cdot q_2^2 = 9 \cdot 5 + 3 \cdot 5 = 60$.

Hence, by taking the base period to be $t = 2$, GDP^r has fallen by 23%. What is 'actually' the change in real GDP? There is no answer for this question. Real GDP solves the problem of the dependence of nominal GDP on the change of prices but real GDP has the shortcoming of depending on the base period chosen. This makes the revelation of economic information subject to manipulation. In the example above, a government would prefer to reveal $\widehat{GDP^n}$ to $\widehat{GDP^r}$ and $\widehat{GDP^{r,t=2}}$ to $\widehat{GDP^{r,t=1}}$.

9. Price indices

A price index is a measure of the general price level of an economy. This level can be thought of as a weighted average of the prices of all the goods. By assuming the fiction that there is a unique, aggregate good (the domestic product), the price level would represent the price of the aggregate good just as GDP would measure the amount of good. As distinguished from GDP, price indices have no units and the value by itself means nothing. It is the rate of change of the index that is relevant.

10. GDP deflator

The GDP (implicit price) deflator measures the changes in prices in all the goods produced in an economy between the base period used to calculate real GDP and the current period. The GDP deflator is the price index defined as

$$\text{GDP deflator} = \frac{\text{Nominal GDP}}{\text{Real GDP}}.$$

11. GDP deflator: an example

If $\text{GDP}_{2015}^n = 100$, $\text{GDP}_{2015}^r = 80$, $\text{GDP}_{2016}^n = 135$ and $\text{GDP}_{2016}^r = 90$, then GDP_{2015} deflator = $100/80 = 1.25$ and GDP_{2016} deflator = $135/90 = 1.5$. The fact that GDP_{2016} deflator $>$ GDP_{2015} deflator indicates that a general price increase took place between 2015 and 2016.

12. Consumer price index (CPI)

The CPI is a measure of the cost of purchasing a fixed basket of goods of a consumer considered representative. The formula on the right defines CPI_t in period t . For the index to have base 100, the right-hand side of the formula must be multiplied by 100. Criticisms analogous to those levied on the GDP concept could be adduced against the CPI concept, its definition and the way in which it is in practice implemented.

$$\text{CPI}_t = \frac{\text{value of the basket at prices of period } t}{\text{value of the basket at prices of the base period}}$$

13. Consumer price index: an example

Suppose the basket of goods is given by $(x, y, z) = (3, 2, 1)$, where the numbers represent the amounts of each of the three goods. The table below shows the prices of the goods in four periods and the value of the basket in each period. Taking $t = 1$ as the base period, $\text{CPI}_1 = \frac{V_1}{V_1} = 1$ (or 100 in base 100); $\text{CPI}_2 = \frac{V_2}{V_1} = \frac{16}{16} = 1$; $\text{CPI}_3 = \frac{V_3}{V_1} = \frac{12}{16} = 0.75$; (75 in base 100); and $\text{CPI}_4 = \frac{V_4}{V_1} = \frac{20}{16} = 1.25$ (125 in base 100).

period	p_x	p_y	p_z	$V_t = \text{basket value in period } t$	CPI_t	CPI_t (base 100)	π_t
1	1	4	5	$3 \cdot 1 + 2 \cdot 4 + 1 \cdot 5 = 16$	1	100	–
2	2	1	8	$3 \cdot 2 + 2 \cdot 1 + 1 \cdot 8 = 16$	1	100	0%
3	3	1	1	$3 \cdot 3 + 2 \cdot 1 + 1 \cdot 1 = 12$	0.75	75	–25%
4	2	5	4	$3 \cdot 2 + 2 \cdot 5 + 1 \cdot 4 = 20$	1.25	125	66.6%

14. Inflation rate

The inflation rate π based on, or associated with, the price index P is the rate of change of the price index P . The formula on the right defines the inflation rate π_t from period $t - 1$ to period t , where P_t is the price index in the current period t and P_{t-1} is the price index in the immediately preceding period $t - 1$. To express the inflation rate as a percentage, the right-hand side of the formula has to be multiplied by 100.

$$\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}}$$

15. Inflation rate: examples

If $P_t = 50$ and $P_{t-1} = 40$, then $\pi_t = \frac{50-40}{40} = \frac{1}{4} = 0.25$ (= 25%): the price index has been pushed up a 25%. The last column in the table in §13 shows the inflation rate π_t from $t - 1$ to t . The values are obtained as follows: π_1 is not defined (since there is no CPI_0); $\pi_2 = \frac{CPI_2 - CPI_1}{CPI_1} = \frac{1-1}{1} = 0$; $\pi_3 = \frac{CPI_3 - CPI_2}{CPI_2} = \frac{0.75 - 1}{1} = -0.25$ (or -25%); and $\pi_4 = \frac{CPI_4 - CPI_3}{CPI_3} = \frac{1.25 - 0.75}{0.75} = \frac{2}{3}$ (or 66.6%). Lastly, if π were calculated, for instance, from $t = 1$ to $t = 4$, then $\pi_{1 \rightarrow 4} = \frac{CPI_4 - CPI_1}{CPI_1} = \frac{1.25 - 1}{1} = 0.25$ (25%).

16. Differences between CPI and GDP deflator

- The CPI generally includes imported goods. Contrariwise, the GDP deflator does not: it only includes the goods produced in the economy, not abroad.
- The basket of goods in the GDP deflator may vary from period to period, whereas the basket in the CPI generally does not.

Despite the theoretical differences, when the two indices are computed from empirical data, both indices appear to be strongly correlated and in general tend to move in parallel.

17. Inflation concepts

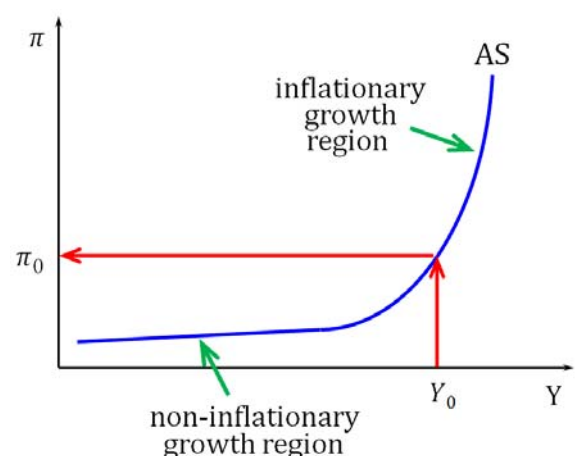
- **Inflation.** As an economic phenomenon (not as a number), the term 'inflation' refers to the sustained increase in the CPI. It occurs for periods during which the inflation rate is positive.
- **Deflation.** Deflation is the phenomenon opposite to inflation: it is a sustained reduction in the CPI (negative inflation rates, not negative CPI values).
- **Disinflation.** Disinflation takes place when, during an inflation, the inflation rate diminishes, but remains positive.
- **Reflation.** Reflation refers to a period of inflation in which the inflation rate increases. By association, it is also said that the economy itself 'reflates' when the inflation rate increases (since, typically, when economy activity expands, the inflation rate tends to go up).
- **Hyperinflation.** Hyperinflation occurs with astronomical inflation rates (monthly inflation rates of at least 50%). Under a hyperinflation, inflation is out of control.
- **Core inflation rate.** Core inflation rate is an inflation rate computed by excluding the prices of food and energy prices, which tend to be very volatile. Core inflation rate (as opposed to headline inflation rate) is a measure of underlying long-term inflation and can be used as an indicator of future inflation.

18. The aggregate supply, aggregate demand (AS-AD) model

The AS-AD model is an elementary model to explain how (real) GDP Y and the inflation rate π are determined and what may cause them to fluctuate. In particular, the model is supposed to be helpful to ascertain the impact on Y and π of exogenous shocks.

19. The aggregate supply (AS) function

The AS function (represented on the right) establishes, for each level Y_0 of aggregate production (real GDP), the inflation rate π_0 that results in the economy during the period in which Y is produced. In short, to produce Y_0 the economy generates inflation rate π_0 .



20. Characteristics of the AS function

The AS function is assumed to be upward-sloping up to a certain inflation rate (see π_0 in the figure in §23). In that section, production determines inflation: more production creates more inflation. The upward-sloping section has two regions: the inflationary and the non-inflationary regions.

21. Non-inflationary region of the AS function

The non-inflationary region (that may start for negative inflation rates) of the AS function represents the states of the economy in which Y can grow without rising π significantly: there are idle resources usable to increase production without creating a pressure on costs and prices.

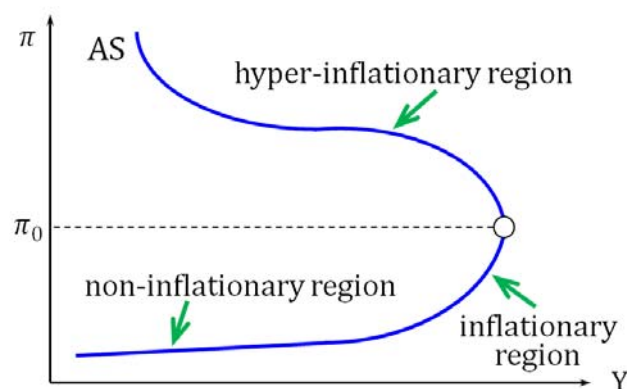
22. Inflationary region of the AS function

The inflationary region of the AS function represents the states of the economy where producing more requires accepting more inflation (inflation in this region is cost-push inflation). Some reasons for the speed-up of inflation in the inflationary region are listed next.

- Competition for resources. The amount of resources is finite. As the economy approaches what is physically possible, firms encounter resource bottlenecks. Eventually, firms can only obtain more inputs by detracting them from other firms, which requires paying more for these inputs.
- Training costs. More production eventually demands hiring more workers, who in general should be trained to be able to operate efficiently.
- Reorganization costs. Changing the scale of production may require a redesign of the production process, which is costly.
- Diminishing marginal productivity. Apparently, production processes face the principle of diminishing marginal productivity: each additional unit of input will add less to total production. This means that, to produce the same again, more inputs are needed and costs therefore increase.

23. Hyperinflationary region of the AS function

The hyperinflationary region of the AS function (see figure on the right) represents the states of the economy where the production activities no longer run smoothly and are negatively affected by increases in the inflation rate. Under hyperinflation, prices change so fast that people are more concerned with preserving purchasing power of the money they earn or have than with carrying the usual economic activities. As the normal operation of



the productive system is disturbed under an excessive inflation, AS functions on the hyperinflationary region are assumed downward-sloping: above a certain inflation rate (π_0 in the figure above), the higher the inflation rate, the smaller aggregate production. As advanced economies do not experience hyperinflations, the hyperinflationary region will be disregarded from the analysis.

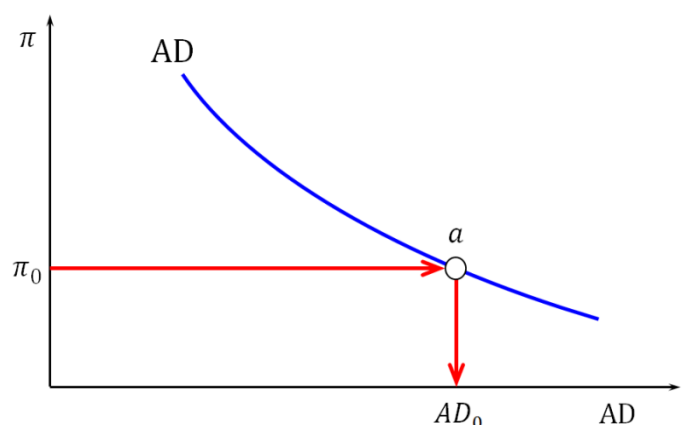
24. What is likely to shift the AS function?

The AS function captures the productive capacity/plans of an economy and the associated aggregate costs of production. Therefore any factor affecting that capacity or those costs may alter the AS function. The following is a general list of such factors.

- ‘Technology’. Technological improvements (which include improvements in the organization of the production processes) allow firms to produce more with less. Such improvements represent positive shocks to the AS function: the AS function shifts to the right.
- Resources. Having more resources increases the productive potential of an economy. Resources becoming cheaper stimulates production. Both events then shift the AS function to the right.
- Workers. By analogy with ‘resources’, having more workers (the working population expands), paying them less (wages are cut) or improving the workers’ skills or abilities (more human capital accumulated) shift the AS function to the right; the opposite, to the left.
- Capital goods. Capital goods are goods (like machines) used to produce other goods. Having more such goods or a fall in their price shifts the AS function to the right.
- Expectations. An economy has a given productive capacity, but it is up to producers to decide how much of this capacity actually use. Optimistic expectations regarding aggregate demand (‘the economy’, profits) may induce producers to intensify the use of the productive capacity.
- Markups. A markup is a percentage added to production costs and represents the profits accruing to producers. An increase in markups shifts the AS function to the left.
- Credit. Production activities rely on credit and borrowing: having more or cheaper credit available to producers shifts the AS function to the right.
- Number of firms/producers. More firms or, in general, producers increases the productive capacity of the economy and therefore shifts the AS function to the right.
- Economic policy decisions. Regulations making easier the creation, management or operation of firms can be considered positive shocks to the AS function. Subsidies to firms can be interpreted as free credit: having more funds to finance production will encourage production. Taxes paid by firms and producers are like production costs: just as higher prices of raw materials, energy, fuel, workers, capital goods, credit... constitute negative shocks to the AS function, by analogy, higher taxes can also be viewed as negative shocks to the AS function (the AS function shifts to the left).
- Supply-side policies. These are policy measures whose goal is to expand the economy’s ability to supply goods. Hence, their implementation shifts the AS function to the right and their removal is likely to shift the AS function to the left. Examples of supply-side policies: measures that improve the way markets operate (stimulate competition, reduce market power, improve infrastructures), improve the quality of factors of productions (retraining programmes for unemployed people, scholarships to train researchers), encourage technological progress (funds assigned to research and development) and, more debatable, measures that rationalize the government intervention in the economy (removal of ‘unnecessary’ regulation, efficient provision of public services, privatization of public monopolies, tax reductions...).

25. The aggregate demand (AD) function

The AD function (represented on the right) indicates, for each inflation rate π , the total amount AD of planned aggregate expenditure: under inflation rate π_0 , the intended amount of total expenditure is AD_0 .



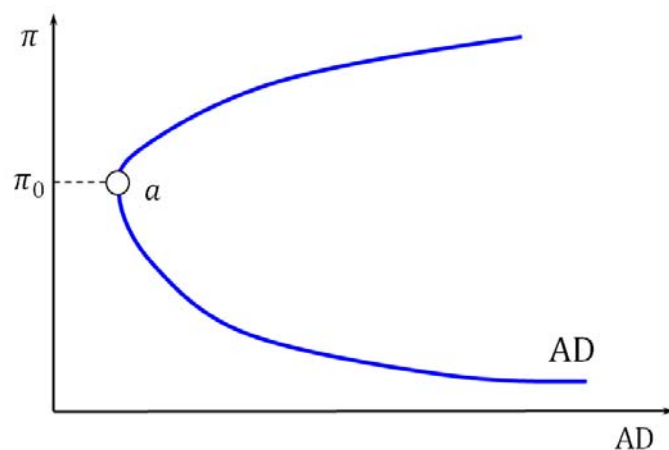
26. Characteristics of the AD function

Aggregate demand AD is the sum of four categories: C (aggregate planned consumption), I (aggregate planned investment), G (planned government purchases) and NX (aggregate planned net exports, the difference between aggregate planned exports and aggregate planned net imports). The AD function is assumed to be downward-sloping: the higher the inflation rate, the smaller total desired expenditure. The following are basic reason that could justify that AD decreases as π increases.

- **Reason 1:** as the inflation rate grows, purchasing power diminishes and, as a result, consumption tends to diminish.
- **Reason 2:** as the inflation rate grows, the central bank raises the nominal interest rate i , which leads to a fall in consumption and investment. The rise in the interest rate causes an appreciation of the nominal exchange rate e , which erodes competitiveness and makes net exports decline.
- **Reason 3:** a rise in the inflation rate erodes competitiveness, which tends to reduce net exports, and induces domestic consumers to switch from domestic to foreign goods, which also lowers net exports.
- **Reason 4 (Keynes effect):** a higher inflation rate may increase the sales of financial assets (to pay for goods with higher prices), which tends to lower the price of financial assets, this raises the interest rate, this contract borrowing and, as a result, consumption and investment are both reduced. Higher prices may increase the direct demand for liquidity (more money needed to buy the same goods).
- **Reason 5 (Pigou effect):** prices growing at a faster rate reduce, also at a faster rate, the purchasing power of nominal wealth (the same money value buys fewer goods). A rising inflation lowers wealth measured in real terms. The perception of being poorer justifies cutting consumption and investment. Prices going down at a faster rate would justify the opposite: to consume and invest more.

27. Upward-sloping AD function? I. Hyperinflation

As with the AS function, hyperinflation is also likely to alter the conventional shape of the AD function. When the inflation rate escalates without control, the higher the inflation rate the more pressing the need to spend (get rid of) money. The figure on the right illustrates this possibility: for inflation rates higher than π_0 , desired expenditure grows with the inflation rate. This pathological possibility is not considered, as it characterizes extremely unhealthy economies and the AS-AD model presumes a healthy economy or at least one operating in 'normal' circumstances.



28. Upward-sloping AD function? II. Deflation

The Polish economist Michał Kalecki put forward some objections to the Pigou effect, at least for negative inflation rates (that is, when the general price level P falls). The following arguments show that lower prices may not induce an aggregate demand increase.

$$\downarrow P \Rightarrow \uparrow \text{debt in real terms} \Rightarrow \uparrow \text{bankruptcies} \Rightarrow \downarrow \text{loans} \Rightarrow \downarrow C \downarrow I \Rightarrow \downarrow AD$$

$$\downarrow P \Rightarrow \text{consumption delayed if further price falls are expected} \Rightarrow \downarrow C \Rightarrow \downarrow AD$$

29. Why debt matters

To illustrate Kalecki's debt objection, suppose you owe $D = €500$ and the price level is $P = 100$ €/basket. In real terms, your debt is $D/P = 500/100 = 5$ baskets. That is, with price level $P = 100$, owing €500 is equivalent to owing 5 baskets of goods. Suppose you repay €80 (the 16% of the debt) and that the price level goes down to $P' = 70$ €/basket (30% drop). In nominal terms, your debt is lower: from $D = 500$ to $D' = 420$. Yet, in real terms, your debt has increased: from $D/P = 5$ baskets to $D'/P' = 420/70 = 6$ baskets. This means that you may have to save more (consume less) to pay a higher debt. The lesson: in a highly indebted economy, lower prices may not stimulate spending.

30. What is likely to shift the AD function?

The AD function captures the expenditure plans/capacity of an economy. Therefore any factor affecting that capacity may alter the AD function. The following is a general list of such factors.

- Positive shocks to consumption. Consumption (and therefore AD) is positively affected by:
 - increases in income and wealth (for instance, a rise in the price of financial assets);
 - 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. Investment (and therefore AD) is positively affected by:
 - favourable expectations by businessmen on profits or on the evolution of the economy;
 - an increase in the number of firms;
 - subsidies stimulating investment;
 - a reduction in taxes on profits;
 - the reduction in the (real) interest rate;
 - credit made more easily available;
 - technological progress and, in general, the diffusion of innovations.
- Positive shocks to net exports. Net exports (and therefore AD) are 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.

31. Aggregate supply and aggregate demand are interdependent

The AS function captures the production capacities of an economy. These capacities depend on the capital goods (means of production) available. Capital goods are the accumulation of a previous flow of investment. And investment is a component of the AD function. It then follows that an increase in investment affects the aggregate demand (initially) and the aggregate supply (later). On the other

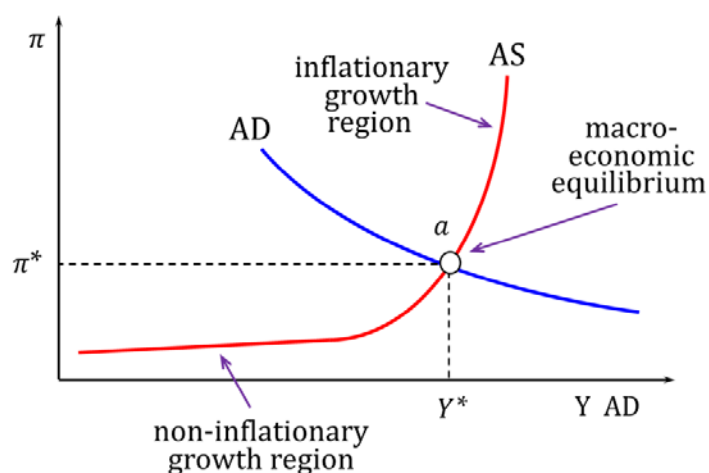
hand, consumption depends on income, which is turn is generated by production activities. In view of this, whether the change in a variable modifies the AS or the AD function will depend on which variables are allowed to change when each function is defined. That makes the AS-AD model a tool of doubtful usefulness.

32. Aggregate supply and aggregate demand are different from their microeconomic counterparts

Calling the AS and AD functions 'supply' and 'demand', respectively, is misleading, because they are conceptually different from supply and demand functions in microeconomics. One substantial difference is that not everything is constant along the AS function: the activities that generate GDP simultaneously (endogenously) induce may other changes. For example, by raising GDP more (and possibly also higher) wages are paid, which is in part what would explain a boost to the inflation rate. Similarly, not everything is constant along the AD function. Specifically, the aggregate demand value summarizes all the effects that a change in the inflation rate π causes in expenditure decisions. For instance, a rise in the inflation rate is likely to cause a rise in the interest rate i (Fisher effect) and an appreciation of the exchange rate e . The increase in i and e both tend to reduce expenditure. This contraction in desired spending as a result of a higher π is precisely what the AD function captures. Unfortunately for the AS-AD model it is in general hard to tell what changes and what stays constant along the AS and the AD functions, because it all depends on the period of time over which the two functions are defined: time could magnify a change occurred at a given moment or dissolve its effects.

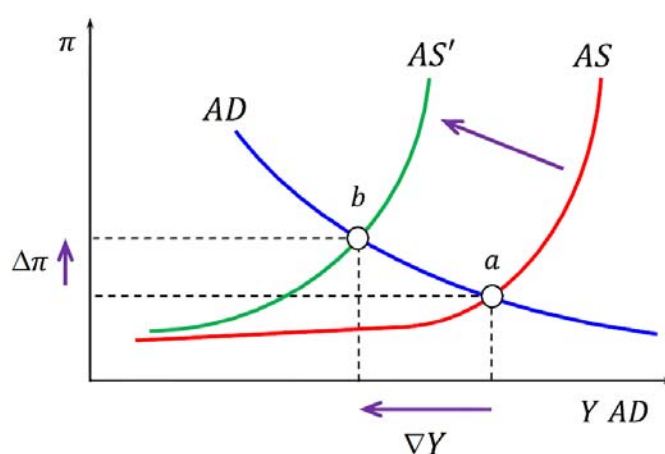
33. Macroeconomic equilibrium in the AS-AD model

The macroeconomic equilibrium condition states that $Y = AD$: aggregate production equals planned aggregate expenditure. Any pair (Y^*, π^*) satisfying the macroeconomic equilibrium condition is a macroeconomic equilibrium, where Y^* is the equilibrium production (equilibrium GDP, equilibrium income) and π^* is the equilibrium inflation rate. Geometrically, a macroeconomic equilibrium is represented by the intersection of the AS and the AD functions; see the figure on the right.



34. Changes in the macroeconomic equilibrium due to shifts in the AS function

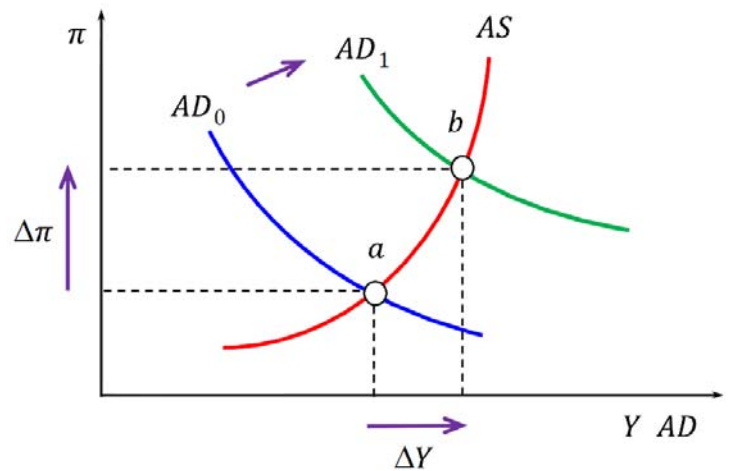
The figure on the right shows the primary (most immediate) effect on the macroeconomic equilibrium of a contraction (shift to the left) of the AS function: the equilibrium inflation rate rises but production declines. Stagflation is a short-hand for 'stagnant economy with rising inflation' and corresponds to the simultaneous occurrence of an increase of the inflation rate and a decrease of GDP (Western economies all experienced stagflation in the 1970s). An expansion (shift to the right) of the AS



function causes the opposite result: non-inflationary growth. The US economy experienced non-inflationary growth in the 1990s and it was at the time speculated that a *New Economy* was born capable of sustaining non-inflationary growth thanks to continuous productivity gains created by the digital revolution.

35. Changes in the macroeconomic equilibrium due to shifts in the AD function

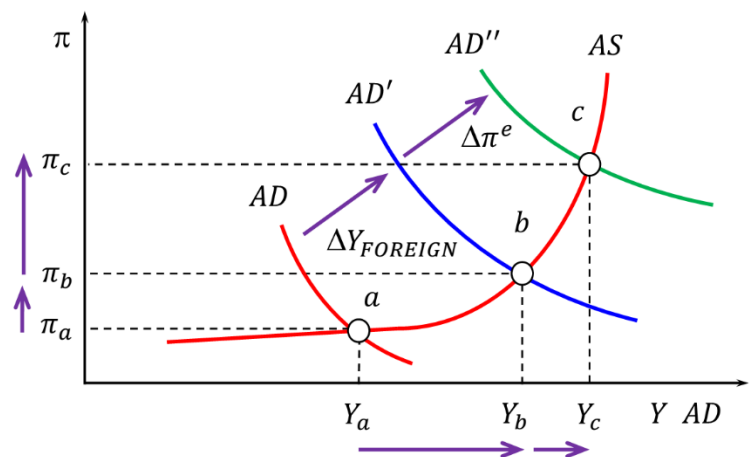
The figure on the right shows the primary (most immediate) effect on the macroeconomic equilibrium of an expansion (shift to the right) of the AD function: the equilibrium inflation rate and production both rise. A contraction (shift to the left) of the AD function causes the opposite result. This general conclusion should be qualified: if the economy lies in the non-inflationary region, the increase in the inflation rate may be negligible (and the expansion only creates growth). In contrast, if the economy lies ahead in the inflationary region (and near the potential GDP), it is the increase in production that may be negligible (so the expansion mostly creates inflation).



36. Changes in the macroeconomic equilibrium are in general self-replicating

The effects of either an AD or an AS 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. For instance, subsequent changes in the macroeconomic equilibrium may be easily caused by the revision of expectations that the initial shock, in altering the state of the economy, proved to be wrong. In particular, when representing the AD and AS functions, the expected inflation rate (π^e) caused by the initial shock is supposed given. Hence, after a shock leads the inflation rate to an unexpected level, the update of expectations may cause further changes in the AD and/or the AS function.

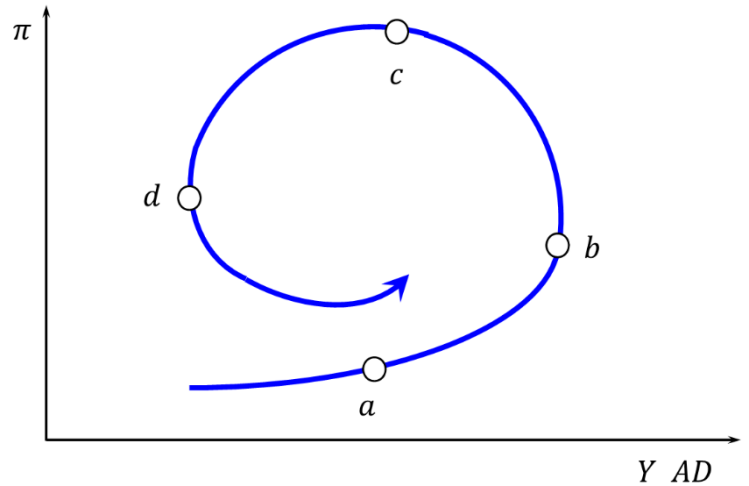
To illustrate the role of inflationary expectations, suppose the economy is at point *a* in the figure on the right. The initial shock is an increase in foreign income (foreign GDP). This represents a positive shock to the AD function, because the higher foreign income leads a higher value of net exports. As the AD function shifts to the right, the macroeconomic equilibrium moves from *a* to *b*. Suppose the initial AD function is drawn assuming a correct expected inflation rate: $\pi^e = \pi_a$. After the shock, the inflation rate raises to π_b , so people realize that their former expectation was incorrect: inflation is higher than expected. People will probably revise π^e upwards. As the inflation rate is expected to increase, consumers anticipate purchases. This shifts the AD function from *AD'* to *AD''*, which stimulates the economy further. If the revised expectation on the



inflation rate is smaller than the new equilibrium inflation rate π_c , inflationary expectations will continue to grow. The expectation of a higher inflation generates a higher inflation (Tinkerbell effect).

37. The business cycle in the AS-AD model

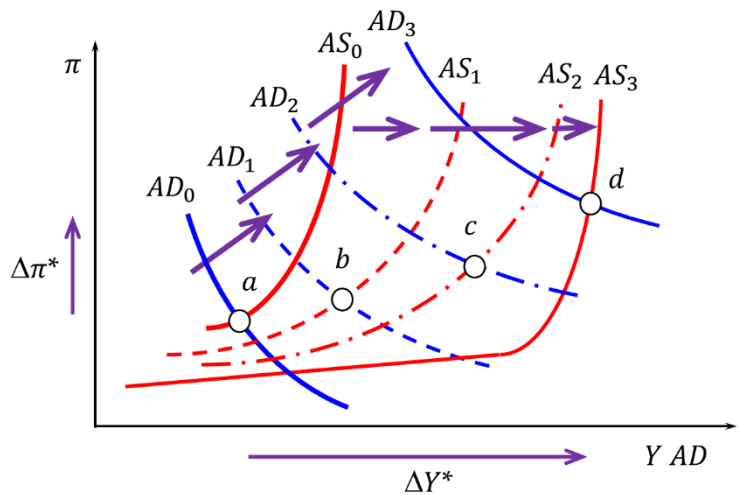
The self-replicating nature of shocks explains the sustainability of the expansionary phase of the business cycle (and also the sustainability of the contractionary one). The figure on the right represents the dynamic pattern that is reasonable to expect during the business cycle.



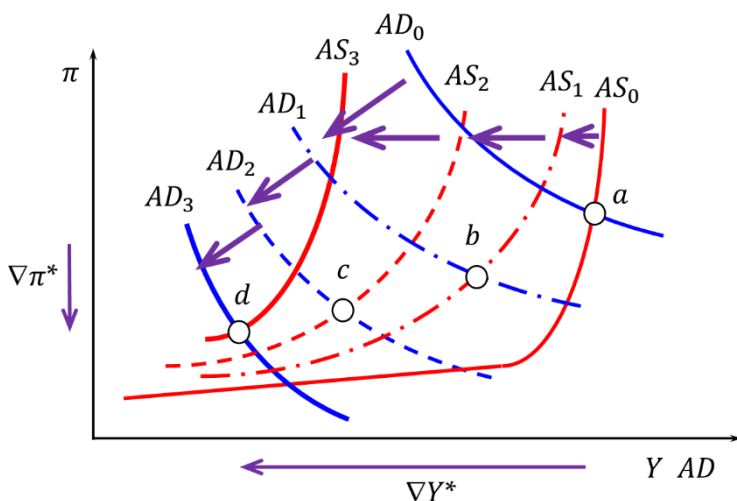
- From *a* to *b* the economy lies in the expansionary phase of the business cycle: GDP and π both grow.
- From *b* to *c* the economy enters the contractionary phase: GDP falls while some inflation inertia still pushes π up.
- From *c* to *d* the economy deepens into the contractionary phase: GDP and π both fall.
- From *d* onwards the economy enters again an expansionary phase, now enjoying GDP growth with declining π .

38. Slumping and booming economy

The figures on right and left illustrate how the expansion and recession periods of the business cycle arise: a continuous shift in, typically, both functions. The figure on the right (booming economy)



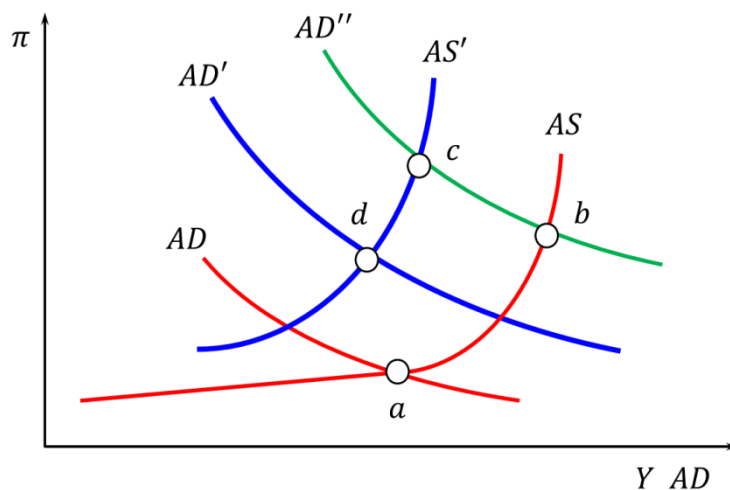
economy) shows the typical changes in the AS and AD functions that characterize the expansionary phase of the business cycle, whereas the figure on the left (slumping economy) displays the typical changes in the AS and AD functions that characterize the contractionary phase.



39. An example that generates a business cycle in the AS-AD model

The following example provides an illustration of how the path of production and inflation rate in the figure in §37 may arise. Let *a* in the figure next represent the initial state of the economy. Wages are being negotiated and workers expect a certain increase in wages. At the expense of the future wage increase, workers rise consumption now. AD shifts to AD'' and *b* is reached. By then the result of the negotiations are known: wages rise but less than expected.

Being wages a production cost, the wage increase shifts the AS function to the left, from AS to AS'. The equilibrium goes from *b* to *c*. But since the wage surge was smaller than expected, workers cut consumption (AD'' moves to AD') and *d* is reached. An interesting lesson of this example is that the cause of the business cycle is the incorrect perception of reality: specifically, mistakes in anticipating the future. If ignorance causes business cycles, there is little hope in eliminating GDP fluctuations completely.



40. The textbook view: short run vs long run

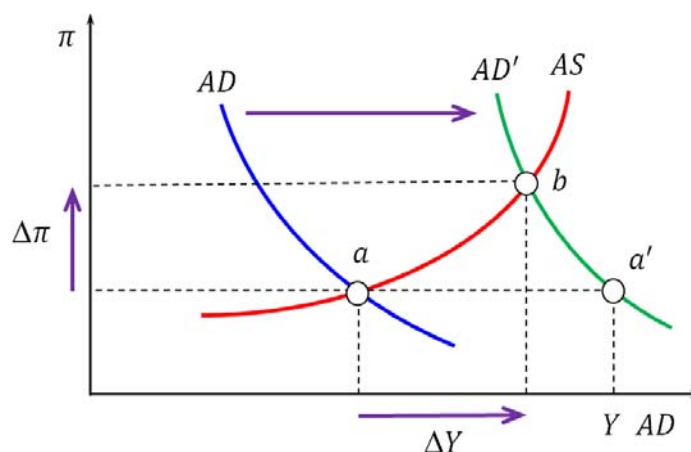
Orthodox textbooks make production converge to a long run fixed production level representing potential GDP, which is (unrealistically) presumed to be given and unaffected by short run decisions. This assumption is debatable, as one may contend that there is no long run but a sequence of short runs. The orthodox textbook view seems to miss at least two relevant considerations.

- AD and AS are interdependent: investment is an AD component that contributes to the productive capacity of the economy; and the installed capacity depends on expected sales (and thus on AD).
- The phenomenon of hysteresis: short run decisions may have long run permanent and different consequences (the butterfly effect), so the state eventually reaches an economy depends on history: the sequence of decisions that made each short run. [The butterfly effect states that chaotic and/or complex systems are sensitively dependent on initial conditions: a trivially small change in the characteristics of an economy can lead to large qualitative changes in economic outcomes (a butterfly flapping its wings could in theory cause a large-scale change in the weather on the other side of the planet). For economic modeling and analysis, the butterfly effect means that small errors in data, or criteria to aggregate or round off data, could drastically alter the predicted results.]

“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.” John Maynard Keynes, *A Tract on Monetary Reform*, 1923, Ch. 3.

41. The expenditure multiplier effect

The AS-AD model just provides a brief summary of the changes that occur in an economy as a result of altering its expenditure plans or its production capacities. For instance, in the figure on the right, the model simply tells that the macroeconomic equilibrium would shift from *a* to *b* when aggregate planned expenditure expands: more GDP and a higher inflation rate. The



expenditure multiplier effect explains how the transition from a to b actually unfolds. The following numerical example illustrates the concept and the mechanism generating the multiplier effect.

42. Numerical example of the expenditure multiplier effect

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 $I = 10$ (where π is a percentage and the value 0.8 is the marginal propensity to consume: which fraction of an additional unit of income is consumed). The AS function is $Y = 30 \cdot \pi$. The macroeconomic equilibrium (Y^*, π^*) is obtained from the equilibrium condition $Y = AD$. That is, $Y = 4 + 0.8 \cdot Y - \pi + 10$. Therefore, $0.2 \cdot Y = 14 - \pi$. As $Y = 30 \cdot \pi$, $\pi^* = 2$ is the equilibrium inflation rate. Given $\pi^* = 2$, the AS function yields the equilibrium production level $Y^* = 30 \cdot 2 = 60$. Suppose that investment I increases. This may be due to the fact that businessmen's expectations suddenly become more optimistic about the level of economic activity or the expected level of profits. The impact on Y^* of a change in the AD function is the result of an expenditure multiplier effect. Given that expenditure AD depends on income Y and, in equilibrium $Y = AD$, the sequence $\uparrow AD \rightarrow \uparrow Y \rightarrow \uparrow AD \rightarrow \uparrow Y \rightarrow \dots$ is generated, so a change in AD multiplies itself.

43. Numerical example, case 1: temporary demand boost with constant inflation rate

Suppose investment jumps from 10 to 17 but only temporarily, just for one period (for example, businessmen's optimism vanishes quickly). To make the multiplier effect easier to grasp, assume that the inflation rate does not change and remains at 2%. This means that it is as if the AS function were horizontal at $\pi = 2$: the economy absorbs any increase in planned expenditure without fuelling inflation. Table 1 shows the dynamics of all the variables involved when it is presumed that GDP today is yesterday's aggregate demand AD.

temporary shock on I with constant inflation

time	$Y_t = AD_{t-1}$	ΔY	$C_t = 4 + 0.8 \cdot Y_t - \pi$	I	$AD = C + I$	$\pi = 2$
0	60	-	$4 + 0.8 \cdot 60 - 2 = 50$	10	60	2
1	60	0	$4 + 0.8 \cdot 60 - 2 = 50$	17	$50 + 17 = 67$	2
2	67	7	$4 + 0.8 \cdot 67 - 2 = 55.6$	10	$55.6 + 10 = 65.6$	2
3	65.6	-1.4	$4 + 0.8 \cdot 65.6 - 2 = 54.48$	10	$54.48 + 10 = 64.48$	2
4	64.48	-1.12	$4 + 0.8 \cdot 64.48 - 2 = 53.58$	10	$53.58 + 10 = 63.58$	2
5	63.58	-0.896	$4 + 0.8 \cdot 63.58 - 2 = 52.86$	10	$52.86 + 10 = 62.86$	2
...	...	...	...	10	...	...
∞	60	-	$4 + 0.8 \cdot 60 - 2 = 50$	10	$50 + 10 = 60$	2

← equilibrium →

Table 1. The multiplier effect generated by a temporary AD shock with constant inflation rate

The increase in investment takes place in period 1. Seven additional investment (AD) units become seven additional aggregate production units in period 1. In period 2, production adjusts to the demand boost, so aggregate income in period 2 is 67. AD in period 2 is subject to two changes: first, investment returns to its previous level (from 17 to 10); and second, as income has grown (from 60 to 67), consumption also grows. Unfortunately, the fall in investment (7 units) is larger than the rise in consumption (5.6 units). For this reason, AD diminishes 1.4 units: from 67 to 65.6.

For period 3, then, aggregate production (and, hence, income) declines, from 67 to 65.6. Investment remains constant but the fall in income causes a fall in consumption, which goes from 55.6 to 54.48. As a result, AD goes down as well in period 3. Consequently, production and income fall in period 4: from 65.6 to 64.48. And what occurred in period 3 repeats itself in period 4: the income reduction contracts consumption, which decreases aggregate demand. The sequence of events is then as follows:

$$\begin{array}{c} \uparrow I_1 \Rightarrow \uparrow AD_1 \Rightarrow \uparrow Y_2 \Rightarrow \uparrow C_2 \Rightarrow \downarrow AD_2 \Rightarrow \downarrow Y_3 \Rightarrow \downarrow C_3 \Rightarrow \downarrow AD_3 \Rightarrow \downarrow Y_4 \Rightarrow \downarrow C_4 \Rightarrow \downarrow AD_4 \Rightarrow \dots \\ \uparrow \\ \downarrow I_2 \end{array}$$

The economy eventually converges to a state described by equations $Y = AD$, where $AD = 4 + 0.8 \cdot Y - \pi + 10$, and $\pi = 2$. Hence, $Y = 4 + 0.8 \cdot Y - 2 + 10 = 12 + 0.8 \cdot Y$. That is, $0.2 \cdot Y = 12$, so $Y = 60$. The final conclusion is that the temporary increase in aggregate demand has no permanent effect on aggregate production and income: the impact of the initial spending stimulus eventually vanishes.

44. Numerical example, case 2: permanent demand boost with constant inflation rate

Suppose now that investment jumps permanently from 10 to 17. Assume again that the inflation rate does not change and remains at 2%. Table 2 provides the sequence of changes caused by the permanent demand boost. The sequence of events is

$$\uparrow I_1 \Rightarrow \uparrow AD_1 \Rightarrow \uparrow Y_2 \Rightarrow \uparrow C_2 \Rightarrow \uparrow AD_2 \Rightarrow \uparrow Y_3 \Rightarrow \uparrow C_3 \Rightarrow \uparrow AD_3 \Rightarrow \uparrow Y_4 \Rightarrow \uparrow C_4 \Rightarrow \uparrow AD_4 \Rightarrow \dots$$

permanent shock on I with constant inflation

time	$Y_t = AD_{t-1}$	ΔY	$C_t = 4 + 0.8 \cdot Y_t - \pi$	I	$AD = C + I$	$\pi = 2$
0	60	-	$4 + 0.8 \cdot 60 - 2 = 50$	10	60	2
1	60	0	$4 + 0.8 \cdot 60 - 2 = 50$	17	$50 + 17 = 67$	2
2	67	7	$4 + 0.8 \cdot 67 - 2 = 55.6$	17	$55.6 + 17 = 72.6$	2
3	72.6	5.6	$4 + 0.8 \cdot 72.6 - 2 = 60.08$	17	$60.08 + 17 = 77.08$	2
4	77.08	4.48	$4 + 0.8 \cdot 77.08 - 2 = 63.66$	17	$63.66 + 17 = 80.66$	2
5	80.66	3.58	$4 + 0.8 \cdot 80.66 - 2 = 66.53$	17	$66.53 + 17 = 83.53$	2
...	...	...	...	17	...	...
∞	95	-	$4 + 0.8 \cdot 95 - 2 = 78$	17	$78 + 17 = 95$	2

multiplier effect

equilibrium

Table 2. The multiplier effect generated by a permanent AD shock with constant inflation rate

The difference with respect to Case 1 is the multiplier effect of the additional investment that takes place every period. Given that the investment boost of 7 units is permanent, there are 7 units more of expenditure each period, so aggregate income is at least 7 units higher each such period. But with higher income comes higher consumption, which represents more demand and, for the next period, more income: that is the multiplier effect. The initial increase in demand and income multiplies itself period after period due to the feedback between consumption and income: more consumption today is more income tomorrow and more income tomorrow is more consumption tomorrow.

The economy eventually converges to a state described by equations $Y = AD$, where $AD = 4 + 0.8 \cdot Y - \pi + 17$, and $\pi = 2$. Thus, $Y = 4 + 0.8 \cdot Y - \pi + 17 = 19 + 0.8 \cdot Y$. That is, $0.2 \cdot Y = 19$, 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 $1/(1 - c)$: one additional unit of expenditure eventually generates 5 units of income.

45. Numerical example, case 3: permanent demand boost with variable inflation rate

Suppose finally that investment jumps permanently from 10 to 17, but that the inflation rate changes according to the AS function. It is assumed that current consumption depends on past inflation. Table 3 calculates the path followed by the variables in the model as a result of the permanent demand boost and the inflation adjustment.

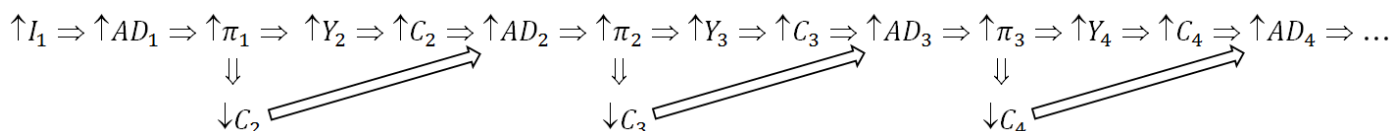
permanent shock on I with inflation adjustment

time	$Y_t = AD_{t-1}$	ΔY	$C_t = 4 + 0.8 \cdot Y_t - \pi_{t-1}$	I	$AD = C + I$	$\pi = Y/30$
0	60	-	$4 + 0.8 \cdot 60 - 2 = 50$	10	60	2
1	60	0	$4 + 0.8 \cdot 60 - 2 = 50$	17	$50 + 17 = 67$	2.23
2	67	7	$4 + 0.8 \cdot 67 - 2.23 = 55.37$	17	$55.37 + 17 = 72.37$	2.41
3	72.37	5.37	$4 + 0.8 \cdot 72.37 - 2.41 = 59.48$	17	$59.48 + 17 = 76.48$	2.54
4	76.48	4.11	$4 + 0.8 \cdot 76.48 - 2.54 = 62.64$	17	$62.64 + 17 = 79.64$	2.65
5	79.64	3.16	$4 + 0.8 \cdot 79.64 - 2.65 = 65.06$	17	$65.06 + 17 = 82.06$	2.73
...	...	...	...	17	...	...
∞	90	-	$4 + 0.8 \cdot 90 - 3 = 73$	17	$73 + 17 = 90$	3

Diagrammatic annotations: A blue arrow labeled 'multiplier effect' points from the value 60 at time 1 to 90 at time infinity. A red arrow points from the value 10 at time 0 to 17 at time 1. A green arrow labeled 'equilibrium' points from the value 90 at time infinity to the value 90 at time infinity.

Table 3. The multiplier effect generated by a permanent AD shock with variable inflation rate

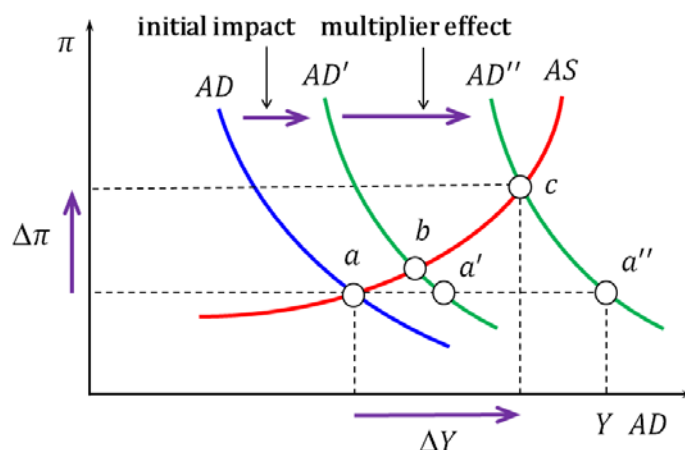
When the AS function enters the picture, part of the expenditure is transformed into inflation. With $Y = 30 \cdot \pi$ and $AD = 4 + 0.8 \cdot Y - \pi + 17$, the new macroeconomic equilibrium is given by $\pi^* = 3$ and $Y^* = 90$. This means that inflation eats up 5 units of income, which is 90 instead of 95. In particular, the sequence of events is:



In every period, a factor pushes consumption down (the increase in the inflation rate from the previous period) and another one pushes it up (the increase in aggregate demand from the previous period that generates an increase in aggregate income in the current period). In the above example, the positive effect compensates the negative effect, so consumption increases each period (the multiplier effect) but each time the increase is smaller.

46. The AS-AD model as a summary of the expenditure multiplier process

The interpretation of the AS-AD model presumes that the transition from one equilibrium (period 1 in Tables 1-3) to the next one (period ∞) occurs swiftly (according to the orthodox view, almost instantaneously). The graphical representation of the AS-AD hides the underlying multiplier process



and gives the false impression that the initial change in expenditure shifts the AD function directly to its final position. The figure above separates the initial impact from the multiplier effect. For instance, an increase in investment would shift the AD function from AD to AD'. Without the inflation impact, the immediate transition would be from point a to a' . When the effects on both economic activity and inflation are taken into account, the immediate passage would be from point a to b . Finally, when the effects of the multiplier process are included, the final outcome would be represented by a'' (if the inflation rate is presumed unaltered) or c (if the impact of the multiplier process on the inflation rate is also considered).

47. The expenditure multiplier process also works in the reverse

As Table 1 illustrates, the expenditure multiplier process also magnifies the effect of a contraction in expenditure or in economic activity. The left-hand figure below shows that the expenditure multiplier process makes the AS and AD functions interdependent. A contraction in the AS function from AS to AS' causes the equilibrium to move from a to b . Since this transition lowers income, aggregate demand is negatively affected and the AD function shifts to the left, from AD to AD'. The intensity of this shift is uncertain. The left-hand figure corresponds to the case in which the fall in the inflation rate caused by the demand contraction dominates the inflation rise associated with the supply contraction, whereas the right-hand figure displays the opposite case in which the supply contraction is dominant.

