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 quantative 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 durant 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 fossing 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 $t = 1$. $\text{GDP}_1^n = p_1^1 \cdot q_1^1 + p_2^1 \cdot q_2^1 = 4 \cdot 6 + 2 \cdot 8 = 40$ (monetary units of $t = 1$).
- Nominal GDP in $t = 2$. $\text{GDP}_2^n = p_1^2 \cdot q_1^2 + p_2^2 \cdot q_2^2 = 9 \cdot 5 + 3 \cdot 5 = 60$ (monetary units of $t = 2$).

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

- Real GDP in $t = 1$ at constant prices of period $t = 1$ is $\text{GDP}_1^{r,t=1} = p_1^1 \cdot q_1^1 + p_2^1 \cdot q_2^1 = 4 \cdot 6 + 2 \cdot 8 = 40$ (monetary units of $t = 1$). Conclusion: $\text{GDP}^r = \text{GDP}^n$ at the base period (this always happens).
- Real GDP in $t = 2$ at constant prices of period $t = 1$ is $\text{GDP}_2^{r,t=1} = p_1^1 \cdot q_1^2 + p_2^1 \cdot q_2^2 = 4 \cdot 5 + 2 \cdot 5 = 30$ (monetary units of $t = 1$).

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

- Real GDP in $t = 1$ at constant prices of $t = 2$ is $\text{GDP}_1^{r,t=2} = p_1^2 \cdot q_1^1 + p_2^2 \cdot q_2^1 = 9 \cdot 6 + 3 \cdot 8 = 78$.
- Real GDP in $t = 2$ at constant prices of $t = 2$ is $\text{GDP}_2^{r,t=2} = p_1^2 \cdot q_1^2 + p_2^2 \cdot q_2^2 = 9 \cdot 5 + 3 \cdot 5 = 60$.

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 $\widehat{\text{GDP}^n}$ to $\widehat{\text{GDP}^r}$ and $\widehat{\text{GDP}^{r,t=2}}$ to $\widehat{\text{GDP}^{r,t=1}}$.

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 $\text{GDP}^n_{2015} = 100$, $\text{GDP}^r_{2015} = 80$, $\text{GDP}^n_{2016} = 135$ and $\text{GDP}^r_{2016} = 90$, 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 GPI 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	$V_t = \textit{basket value in period } t$	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.

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

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 otained as follows: π_1 is not defined (since there is no CPI_0); $\pi_2 = \frac{\text{CPI}_2 - \text{CPI}_1}{\text{CPI}_1} = \frac{1-1}{1} = 0$; $\pi_3 = \frac{\text{CPI}_3 - \text{CPI}_2}{\text{CPI}_2} = \frac{0.7\ 5-1}{1} = -0.25$ (or −25%); and $\pi_4 = \frac{\text{CPI}_4 - \text{CPI}_3}{\text{CPI}_3} = \frac{1.25 - 0.7\ 5}{0.7\ 5} = \frac{2}{3}$ (or −66.6%). Lastly, if π were calculated, for instance, from $t = 1$ to $t = 4$, then $\pi_{1\to4} = \frac{\text{CPI}_4 - \text{CPI}_1}{\text{CPI}_1} = \frac{1.25-1}{1} = 0.25$ (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

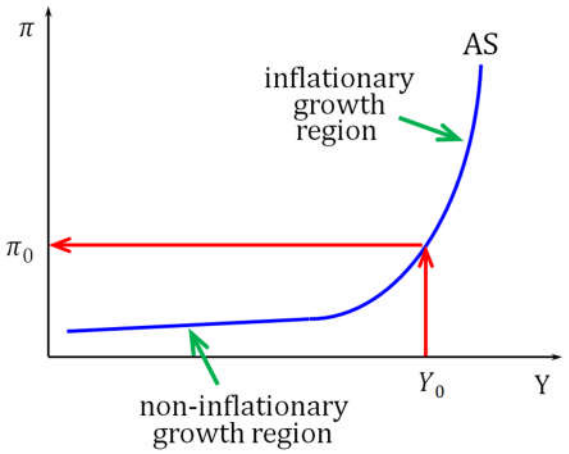
- **Inflation.** As an economic phenomenon (not as a number), the term 'inflation' refers to the sustained increase in the CPI. It occurs for periods during which the inflation rate is positive.
- **Deflation.** Deflation is the phenomenon opposite to inflation: it is a sustained reduction in the CPI (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 (montly 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

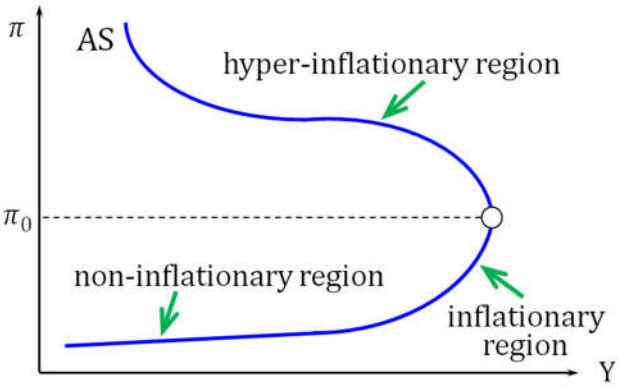
The non-inflationary region (that may start for negative inflation rates) of the AS function represents the states of the economy in which Y can grow without rising π significantly: there are idle resources usable to increase production without creating a pressure on costs and prices.

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.

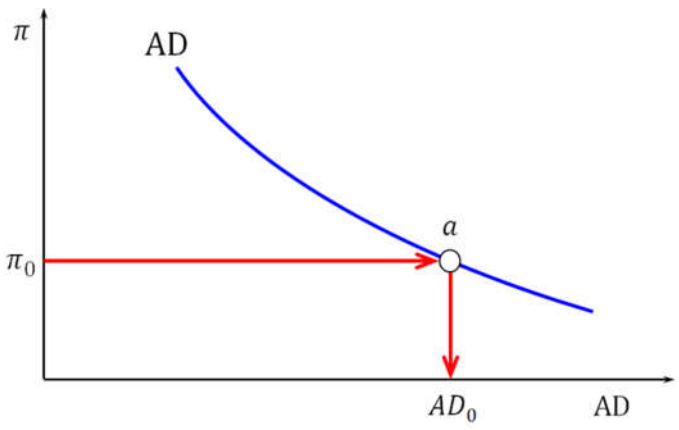
24. What is likely to shift the AS function?

The AS function captures the productive capacity/plans of an economy and the associated aggregate costs of production. Therefore any factor afecting 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.



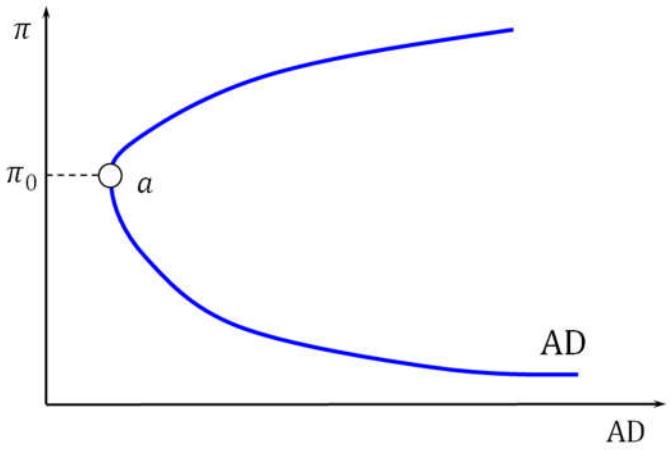
26. Characteristics of the AD function

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.

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

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