

Aggregate Demand, Supply, and Phillips Curve Dynamics

Short-run vs. Medium-run Output Determination

In the **short run**, nominal rigidities (sticky wages/prices or fixed expectations) mean output is determined by aggregate demand (AD). Fiscal or monetary expansions shift AD right and raise output above its natural level ¹ ². The labor market may be out of equilibrium, so involuntary unemployment can occur. In contrast, the **medium run** (often called the long run in Blanchard) assumes flexible prices and wages so the labor market clears. Employment N and output Y are determined by the intersection of wage-setting (WS) and price-setting (PS) curves (with $P = P^e$) ³ ¹. In this equilibrium the *natural rate* of unemployment u_n prevails: it is the unemployment rate consistent with $P = P^e$ ⁴. The corresponding output Y_n is called the **natural output** or potential output, to which actual output returns. Thus, whereas short-run output varies with demand, medium-run output is “supply-determined” by labor-market equilibrium ³ ⁴.

Derivation and Implications of the Aggregate Supply (AS) Curve

The medium-run AS curve follows from wage- and price-setting. Workers set nominal wages W based on expected prices P^e , e.g. $W = P^e F(u, z)$ where u is unemployment and z captures labor market factors ⁵. Firms set prices by adding a constant markup μ over wages: $P = (1 + \mu)W$. Since $u = (L - N)/L = 1 - N/L$ and output $Y = N$ (for simplicity), one gets:

$$W = P^e F(u, z), \quad P = (1 + \mu)W \implies P = (1 + \mu) P^e F(1 - \frac{Y}{L}, z).$$

This implies **AS is upward-sloping in the (Y, P) plane**: higher output Y (lower u) raises wages and thus prices ⁵ ⁶. In particular, when $P = P^e$, the price level matches expectations and $Y = Y_n$ (since then $u = u_n$ and $W/P^e = F(u_n, z)$). Thus the point where AS intersects the line $P = P^e$ occurs at the natural output Y_n ⁷ ⁸. Changes in P^e shift AS: an increase in expected prices P^e raises W at each u , shifting AS up (higher P for given Y) ⁹ ¹⁰. Conversely, lower P^e shifts AS down. In summary, AS is given by

$$P = (1 + \mu) P^e F(1 - \frac{Y}{L}, z),$$

an increasing function of Y through the unemployment channel ⁵ ⁶.

Aggregate Demand (AD) and AS Adjustment Mechanisms

Aggregate demand arises from the IS–LM framework: in goods market equilibrium $Y = C(Y - T) + I(Y, i) + G + X - M$ and in money market $M/P = L(Y, i)$. A higher P reduces real money M/P , shifting LM left and raising the interest rate, which depresses investment and output ². Thus AD slopes downward in (Y, P) . For example, if the economy is at a short-run equilibrium (P, Y) with $Y > Y_n$, then $P > P^e$ and unemployment $u < u_n$. **Wage-setters revise expectations upward** (since actual P exceeded P^e), raising P^e and thus W . Higher wages at given Y shift AS upward (leftward) ¹¹. Graphically, the short-run equilibrium moves along AD to a new point with higher P and lower Y .

(point A). If $P > P^e$ still exceeds expectations, this process repeats: P^e is ratcheted up until $P = P^e$ and Y returns to Y_n ¹² ¹³. In each step, the AS curve shifts until it intersects AD at (P^e, Y_n) .

Conversely, if $Y < Y_n$ (so $P < P^e$), then actual prices fall short of expectations. Wage-setters lower P^e , shifting AS down (rightward), raising Y back toward Y_n ¹⁴ ¹⁵. In all cases, output may deviate from Y_n in the short run, but as expectations adjust (sooner or later $P = P^e$), the economy moves along AD back to the **medium-run equilibrium** at (Y_n, P) . Thus AD-AS adjustments ensure that Y returns to its natural level* in the medium run, with only the price level permanently changed.



Figure: A stylized AD-AS diagram. The downward-sloping AD curve intersects the upward-sloping AS curve at equilibrium output. In the short run (P, Y) can lie off the long-run intersection (point A), but price/wage adjustments shift AS until the economy returns to $Y = Y_n$ (point B) with revised $P = P^e$.

The Natural Rate of Unemployment and Expectations

The **natural rate of unemployment** u_n (or NAIRU) is the unemployment consistent with constant inflation. Formally, u_n is the u such that $P = P^e$ (so inflation $\pi = 0$ if P^e is last period's P) ⁴ ¹⁶. In our AS framework, u_n is the rate implied by the WS-PS equilibrium when $P^e = P$. Crucially, the economy's *actual* unemployment tends to drift toward u_n in the medium run: any deviations (due to shocks or policies) feed back through expectation errors so that $u \rightarrow u_n$ over time ¹ ¹⁶. Expectations play a central role: if inflation comes in above (below) what was expected, u will tend to rise (fall) until expectations adjust. In particular, adaptive or rational updating of expected prices anchors medium-run inflation to expectations, so only when $P = P^e$ (i.e. inflation equals expected inflation) does $u = u_n$ in steady state ⁴ ¹⁶.

Medium-run Effects of Monetary and Fiscal Policy

Monetary policy. In the short run an increase in money supply shifts AD right: output temporarily exceeds Y_n and P rises ¹⁷. However, as prices rise unexpectedly, $P > P^e$ leads workers to raise their inflation expectations, shifting AS upward. Eventually, output returns to Y_n and the economy ends up with a higher price level but unchanged real output. In sum, monetary expansions boost Y and π only in the short run; in the medium run $Y = Y_n$ again and only the price level is

permanently higher ¹⁷ ¹⁸. Indeed, the price level adjusts so that the LM curve intersects IS at Y_n , implying that monetary policy cannot affect the real interest rate or output in the long run ¹⁹ ¹⁸. (Monetary policy then only changes inflation and nominal rates via the Fisher effect.)

Fiscal policy. A fiscal contraction (e.g. deficit reduction) shifts AD left. In the short run this lowers output below Y_n and reduces P ²⁰. As $P < P^e$, wage-setters revise expected prices downward, shifting AS down (rightward) over time. The economy gradually moves up along the AD curve, raising Y back to Y_n . Thus in the medium run output is restored to its natural level and only the price level is permanently lower ¹⁵ ²⁰. In both monetary and fiscal cases, the medium-run impact on Y is zero (it returns to Y_n), with the *long-run* effect being a proportional change in P (upward for expansionary policies, downward for contractionary policies) ¹⁸ ¹⁵.

The Phillips Curve and Its Expectations-Augmented Form

Historically, data showed an inverse **short-run Phillips curve (PC)** between inflation π and unemployment u : e.g. Phillips (1958) found higher wage inflation when u was low. Empirically, higher inflation tended to accompany lower unemployment ²¹. This reflected real short-run trade-offs: expansionary policies could temporarily reduce u at the cost of higher π , and vice versa ²¹. In graphical terms, the SR Phillips curve slopes downward, embodying $\pi = f - \alpha(u)$ (for some positive α).

However, Friedman and Phelps showed that once inflation **expectations** are accounted for, the long-run trade-off disappears. In the expectations-augmented PC, higher unexpected inflation raises short-run output (via lower u), but it also raises expected inflation for next period. Each time policies attempt to keep u below u_n , expectations shift up and the SRPC moves upwards. Eventually u returns to u_n even at a higher π . Thus **in the long run the Phillips curve is vertical**: unemployment equals its natural rate regardless of inflation ²² ²³. Monetary expansion, for example, can move the economy from A to B along the SRPC (inflation rises, u falls); but as expectations adjust the curve shifts so the new long-run equilibrium (point E) has the same u_n and only higher π ²³ ²². In short, the expectations-augmented PC implies temporary (short-run) trade-offs, but no permanent gains in unemployment through inflation. ²³ ²²

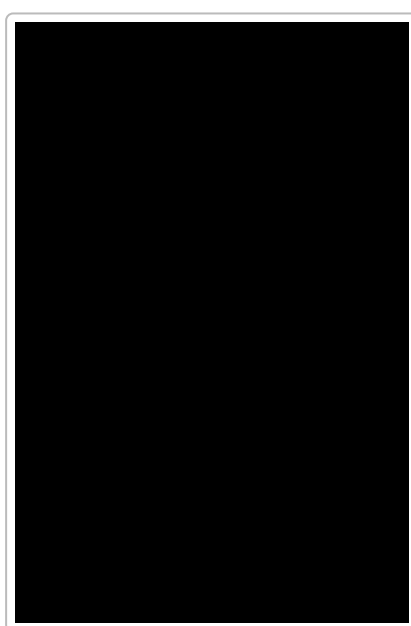


Figure: Original Phillips (1958) diagram for the UK (1913–1948) shows a negative association between inflation (wage inflation) and unemployment ²¹. Modern interpretation distinguishes a short-run Phillips curve (downward sloping) from a long-run Phillips curve (vertical at u_n), reflecting that only unexpected inflation affects unemployment. ²³ ²².

Multiple-Choice Questions

1. Which statement correctly contrasts short-run and medium-run equilibrium in the AD-AS model?

- A. In the short run, $Y=Y_n$ and prices are flexible; in the medium run, Y can deviate from Y_n due to sticky wages.
- B. In the short run, output is determined by AD and may deviate from Y_n ; in the medium run, price expectations adjust so that $Y=Y_n$ again ¹ ⁷.
- C. In the medium run, a monetary expansion permanently increases real GDP; in the short run it only raises prices.
- D. The short-run equilibrium always has $P=P^e$; only the medium-run equilibrium has $P \neq P^e$.

Answer: B. In the short run, nominal rigidities allow output to differ from its natural level, so Y is demand-determined. In the medium run wages and prices adjust (so $P=P^e$), driving output back to Y_n ¹ ⁷. Statement A is reversed. Choice C is false because only in the short run does money affect real GDP; in the medium run Y returns to Y_n ¹⁸ ¹⁹. Choice D is false since typically $P \neq P^e$ in short-run disequilibrium.

1. According to the AS relation $P = (1+\mu)P^e F(1-Y/L, z)$, an increase in expected price level P^e will:

- A. Shift AS downward (increase output at each P).
- B. Shift AS upward (raise P at each Y).
- C. Lower the natural rate of output Y_n .
- D. Have no effect on AS or Y_n .

Answer: B. An increase in P^e raises nominal wages $W = P^e F(u, z)$ at each u , so for any given Y the price $P = (1+\mu)W$ is higher. Thus the AS curve shifts up (higher P for each Y) ⁹ ¹⁰. This does *not* change Y_n (the new Y_n still occurs when $P=P^e$) ¹⁰, so C and D are wrong. Choice A is the opposite effect.

1. Suppose the economy is initially at long-run equilibrium ($Y=Y_n$, $P=P^e$). The central bank permanently increases the money supply. In the medium run we expect:

- A. $Y > Y_n$ and a permanently higher price level.
- B. $Y=Y_n$ and a permanently higher price level ¹⁸ ¹⁹.
- C. $Y < Y_n$ and a permanently higher price level.
- D. $Y=Y_n$ and a permanently lower price level.

Answer: B. A monetary expansion initially boosts demand so $Y > Y_n$, but over time prices and inflation rise (as expected prices adjust) and output returns to Y_n ¹⁸. The lasting effect is a higher price level (and inflation), with no change in Y or unemployment. Thus $Y=Y_n$ eventually, P is higher ¹⁸ ¹⁹.

Option A is incorrect on output in the medium run. C and D are wrong (output returns to Y_n , and the price level rises, not falls).

1. **If in the short run the economy is at a point where $Y > Y_n$ and $P > P^e$, what adjustment will occur?**

- A. Wages will fall and AS will shift down, moving Y above Y_n .
- B. Wages will rise and AS will shift up, reducing Y toward Y_n ¹¹.
- C. Expected price P^e falls, so AD shifts right until Y exceeds Y_n further.
- D. Nothing, since this is already a medium-run equilibrium.

Answer: B. If $Y > Y_n$, firms face lower unemployment than natural, causing $P > P^e$. Workers then raise their wage/price expectations. This raises nominal wages and shifts AS upward (leftward) ¹¹. The result is a higher actual P and lower Y (toward Y_n). Choice A is opposite (wages will not fall). Choice C is incorrect: P^e will rise, not fall, and AD does not shift as a direct reaction to this. D is false: $P \neq P^e$, so it is not medium-run equilibrium ¹¹.

1. **Which best describes the long-run Phillips curve (LRPC) according to expectations-augmented theory?**

- A. Downward sloping, showing a permanent trade-off between inflation and unemployment.
- B. Vertical at the natural rate of unemployment, implying no long-run trade-off ²².
- C. Upward sloping, because higher inflation encourages unemployment.
- D. Zig-zagging, due to inflation inertia and supply shocks.

Answer: B. With fully adjusted expectations, unemployment equals the natural rate regardless of inflation, so the LRPC is vertical at u_n ²² ¹⁶. Friedman's insight (and Blanchard's presentation) was that any reduction of u below u_n can only be temporary. The economy returns to u_n in the long run, so no permanent trade-off exists (ruling out A). C is wrong (the relation is inverse in the short run, not that inflation raises unemployment in the long run). D is not a standard feature of the LRPC in this model.

1. **A fiscal contraction (decrease in G or increase in taxes) will have which *short-run* and *medium-run* effects on output (Y) and the price level (P)?**

- A. *Short run:* $Y \downarrow$, $P \downarrow$. *Medium run:* Y remains below Y_n , $P \downarrow$ further.
- B. *Short run:* $Y \downarrow$, $P \downarrow$. *Medium run:* Y returns to Y_n , $P \downarrow$ ¹⁵.
- C. *Short run:* $Y \uparrow$, $P \uparrow$. *Medium run:* $Y \uparrow$ above Y_n , $P \uparrow$ further.
- D. *Short run:* $Y \uparrow$, $P \downarrow$. *Medium run:* $Y = Y_n$, P unchanged.

Answer: B. A fiscal contraction shifts AD left, so initially output falls and inflation (price level) falls ²⁰. As prices and wages adjust downward (since $P < P^e$), AS shifts down and the economy moves back to Y_n . In the medium run output is back at Y_n , but the price level is permanently lower ¹⁵. Thus Y falls then recovers, P falls and stays low. A is wrong on medium-run Y (it returns to Y_n). C and D misstate short-run effects.

1. **Consider the expectation-augmented Phillips curve $\pi = \pi^e - \alpha(u - u_n)$. If policymakers try to maintain unemployment below u_n by a demand expansion, the model predicts that:**

- A. Inflation will permanently fall below π^e .
- B. Unemployment will stay below u_n indefinitely.

- C. Inflation will accelerate over time as π^e rises, and u returns to u_n ²³.
- D. Output will rise without any change in inflation.

Answer: C. Maintaining $u < u_n$ requires $\pi > \pi^e$, which causes people to raise π^e . This shifts the SR Phillips curve up and forces u back toward u_n , with inflation continuously rising (acceleration) in the interim ²³. Option A is wrong (inflation rises, not falls). B is false: unemployment cannot stay below u_n in the long run once expectations adjust. D contradicts the positive inflationary spiral needed to keep $u < u_n$.

1. Which of the following shifts the short-run Phillips curve (not the long-run)?

- A. A change in expected inflation π^e .
- B. A change in the natural rate u_n .
- C. A change in aggregate demand (holding π^e fixed).
- D. A change in u_n and π^e simultaneously.

Answer: A. The short-run PC $\pi = \pi^e - \alpha(u - u_n)$ shifts when expectations change: if π^e rises, the entire SRPC shifts up (for a given u) ²⁴ ²³. (A higher π^e means at the same u , inflation is higher.) Changes in aggregate demand move the economy along a given SRPC (so C is wrong – AD changes do not shift the curve itself). Changing u_n is an AS-side effect (it shifts the LRPC, not the SRPC at fixed π^e), so B is wrong. D is not a single factor.

1. Which policy is most effective at lowering the inflation rate in the long run?

- A. Permanent increase in money growth.
- B. Persistent fiscal deficits.
- C. Sustained monetary contraction.
- D. Temporary tax cuts to reduce unemployment.

Answer: C. In the long run, only policies that **reduce aggregate demand/inflation expectations** can permanently lower inflation. A sustained monetary contraction (reducing money growth) will lower inflation over time (via the Fisher effect on nominal rates) without long-run output costs beyond the natural rate ¹⁹. A permanent increase in money growth (A) would raise inflation. Fiscal deficits (B) raise demand/inflation. Temporary tax cuts (D) only lower unemployment in the short run and raise inflation; when removed unemployment returns to u_n but inflation may end higher.

1. Suppose an adverse supply shock (e.g. oil price spike) occurs. According to the AS-AD framework, what is the medium-run outcome if no policy responds?

- A. Lower Y_n , higher u_n , but Y stays below the *new* Y_n .
- B. Temporary lower Y and higher P , with Y returning to original Y_n eventually.
- C. Permanent lower Y and permanently higher P , with $u > u_n$ indefinitely.
- D. No short-run impact on Y , only a jump in P .

Answer: B. An adverse supply shock shifts AS up (left), causing output to drop and prices to rise. In the short run $Y < Y_n$ and π is above expectations. Over time, as P^e adjusts upward, AS shifts further, restoring output to the (original) Y_n ¹¹ ¹², although at a permanently higher price level. Thus Y only falls temporarily. (Options A and C are wrong because Y_n itself has not changed in the absence of any structural change in u_n or z ; only real output contracts briefly. D is wrong because output is initially affected.)

Long-Answer Questions

1. (Macroeconomic adjustment) Describe how an unanticipated monetary expansion moves the economy through short-run and medium-run equilibrium. In your answer, use both AD-AS diagrams and the labor market/Phillips curve perspective. *Model Answer:* In the **short run**, an unexpected increase in the money supply shifts the AD curve right (since $M/P \uparrow$ lowers interest rates and raises demand) ¹⁷. Graphically, output rises above Y_n and the price level jumps to $P > P^e$. On the AD-AS diagram, the economy moves from the initial long-run equilibrium at (Y_n, P^e) up along AS to a point with higher Y and P . In the labor market, u falls below u_n . On the Phillips curve, this is movement up along the (current) SRPC: inflation accelerates while unemployment falls.

Soon, **expectations adjust**: with $P > P^e$, workers raise their expected price π^e . In the AS-AD view, this shifts AS upward (since P^e enters into wage-setting) ¹¹. The new short-run equilibrium moves along the AD curve back toward Y_n . On the PC, higher π^e shifts the SRPC up, raising actual inflation for the same unemployment. Through these adjustments, the economy arrives at a new medium-run equilibrium where $Y = Y_n$ again but at a higher price level $P^* such that $P^* = P^e$. Thus the long-run effect of the monetary expansion is purely on the price level and inflation; real output and unemployment return to their natural rates. This illustrates the long-run neutrality of money ^{18 19}.$

2. (Role of expectations and the Phillips curve) Explain the concept of the natural rate of unemployment (NAIRU) and how inflation expectations alter the Phillips curve. How does this affect the ability of policymakers to exploit a trade-off between inflation and unemployment? *Model Answer:* The **natural rate of unemployment** u_n (or NAIRU) is the level of unemployment consistent with stable inflation: formally when actual inflation equals expected inflation ($P = P^e$) ^{4 16}. It reflects labor market equilibrium given structural parameters (μ, z) and does not depend on demand. In the Phillips curve framework, u_n appears as the intercept: $\pi = \pi^e - \alpha(u - u_n)$ (ignoring shocks).

If workers expect an inflation rate π^e , then only when $u = u_n$ will inflation turn out to be π^e (no pressure to change). If $u < u_n$, inflation will exceed expectations; if $u > u_n$, inflation will fall below expectations. Adaptive expectations mean π^e adjusts over time towards realized π ²³. Consequently, any attempt to push u below u_n (e.g. by monetary stimulus) only leads to higher inflation in the future. As expectations rise, the short-run Phillips curve shifts up, moving the economy back to u_n ^{23 22}. Thus, in the medium run the Phillips curve is vertical at u_n ²². Policymakers therefore face only a **temporary trade-off**: they can reduce unemployment below u_n at the cost of above-expected inflation only until expectations catch up. In the long run there is *no* exploitable trade-off: unemployment inevitably returns to its natural rate, and inflation is higher. This is why sustainable reductions in unemployment through demand policies are not possible beyond u_n ^{23 22}.

3. (Derivation of AS and implications) Derive the aggregate supply relation from wage-setting $W = P^e F(u, z)$ and price-setting $P = (1 + \mu)W$, and explain why AS is upward-sloping. Discuss how supply shocks (changes in z or μ) shift AS and affect Y_n . *Model Answer:* Starting with wage-setting $W = P^e F(u, z)$ and price-setting $P = (1 + \mu)W$, eliminate W :

$$P = (1 + \mu)P^e F(u, z), \quad u = 1 - \frac{N}{L} = 1 - \frac{Y}{L}.$$

Thus $P = (1 + \mu)P^e F(1 - Y/L, z)$. Because $F(\cdot)$ is decreasing in unemployment, lower u (higher Y) raises $F(u, z)$ and hence P . In other words, higher output implies tighter labor markets, higher wages, and therefore higher prices. Graphically, this yields an upward-sloping AS curve ^{5 6}.

Changes in P^e or other parameters shift AS: a higher P^e uniformly raises W and P at each Y (shifting AS up) ⁹.

Supply shocks enter via z (which may represent unemployment benefits or regulation) or the markup μ . For example, an adverse supply shock (higher μ or worse z) shifts AS up/left: at the same Y , firms need to charge a higher P to cover higher costs. This reduces the natural output Y_n (the intersection of $P=P^e$ with AS) ⁷ ¹⁰. Conversely, a positive supply shock (e.g. technological progress raising F , or lower μ) shifts AS down/right, raising Y_n . In all cases, supply shifts change the medium-run equilibrium output (the new Y_n) as well as prices.

4. (Policy in the medium run) Consider a government that reduces its deficit through higher taxes and lower spending. Using AD-AS and IS-LM analysis, explain the short-run and medium-run effects on output, inflation, and interest rates. *Model Answer:* A deficit reduction shifts the IS curve left (or AD left). In the **short run**, this lowers output and the interest rate. On the AD-AS diagram, AD shifts left, so equilibrium moves to a lower (Y, P) . Output Y falls below Y_n and prices P fall below P^e ²⁰ ¹⁵. The decline in Y and P increases real money balances (since M is unchanged and P fell), which shifts LM right, lowering the interest rate in the short run.

As time passes, the price drop $P < P^e$ causes expected inflation (price expectations) to adjust downward. Wages are renegotiated lower, shifting AS down/right. This restores Y toward Y_n at a new lower price level ¹⁵. In the medium run output returns to Y_n , so the effect on real GDP is zero, but inflation and price level are permanently lower. The interest rate in the medium run returns to its equilibrium consistent with Y_n and the new lower price level; typically this means a slightly lower nominal rate (since inflation is lower) but the real rate is unchanged relative to initial since fiscal contractions are not assumed to affect real factors in the long run ²⁰ ¹⁵. In summary: short run $Y \downarrow$, $P \downarrow$; medium run Y back to Y_n , P permanently lower, i back up to the level consistent with natural output (reflecting lower inflation expectations) ¹⁵ ²⁰.

5. (Expectation-augmented Phillips curve) Derive the expectations-augmented Phillips curve from the AS relation. Explain why it implies a vertical long-run Phillips curve. *Model Answer:* From the AS formula $P = (1 + \mu)P^e F(1 - Y/L, z)$, take logs (or inflation rates). Let $\pi = \dot{P}$ and $\pi^e = \dot{P}^e$. Using $u = 1 - Y/L$, one can show (as in Blanchard) that inflation depends on expected inflation and the unemployment gap:

$$\pi = \pi^e - \beta(u - u_n) + s_t,$$

where $\beta > 0$ and s_t are supply shocks. Rearranging, $\pi = \pi^e - \beta(u - u_n)$ when shocks are absent. This is the expectations-augmented Phillips curve: inflation π exceeds expected inflation π^e whenever $u < u_n$, and falls short of π^e if $u > u_n$.

Since in the long run expectations catch up ($\pi = \pi^e$), the only solution is $u = u_n$. Thus the long-run Phillips curve (the set of (u, π) with no expectations gap) is vertical at u_n ²² ¹⁶. In other words, any attempt to keep u permanently below u_n would force π^e to rise until u returns to u_n . Therefore the expectations-augmented model predicts a vertical long-run Phillips curve: policy can choose inflation (π) but not the long-run unemployment (which stays at u_n) ²³ ²². This formalizes why the long-run trade-off is null – only unexpected inflation can temporarily affect u , but expectations adjust so $u = u_n$ in equilibrium.

Sources: Standard macroanalysis in Blanchard (AD–AS model and Phillips Curve) ¹ ⁵ ²³, as well as Keynesian–monetarist synthesis (IS–LM and AS–AD dynamics) ¹⁹ ¹⁶, provide the basis for these answers.

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⁶ ⁸ ¹⁰ Aggregate Supply Relation | CourseNotes

https://course-notes.org/economics/macro_economics/topic_notes/aggregate_supply/demand/aggregate_supply_relation

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