

Macroeconomics

Lecture 3 — AD-AS, Time consistency of monetary policy

Ilya Eryzhenskiy

PSME Panthéon-Sorbonne Master in Economics

Fall 2022

Building theoretical Phillips curve: battle of markups

Prices as mark-up on labour costs

Firms with market power aim to set price as a markup over unit labor cost (or setting labor cost share):

$$P = (1 + \theta) \frac{WL}{Y},$$

where $\theta > 0$ the markup.

Wages as a mark-up on prices

Workers (unions) bargain with firms for higher wages. **Sticky wages:** negotiated wage fixed for some periods \Rightarrow firms exposed to change of $\frac{W}{P}$ in the future under a fixed $W \Rightarrow P^e$ used in wage setting. Bargaining determines firms' labor cost share under expected future prices P^e . In the negotiation, firms have reference price \bar{P} and workers have reference (minimum) wage \bar{W} .

$$\frac{WL}{Y} = (1 + \gamma) \bar{S}_L P^e,$$

where \bar{S}_L is reference labor cost share $\bar{S}^L = \frac{\bar{W}L}{\bar{P}Y}$ and γ is the markup.

From price to inflation: deriving AS and Phillips curve

Taking logs and total differential of the equation:

$$P = (1 + \theta)(1 + \gamma)\bar{S}_L P^e$$

$$\ln P = \theta + \gamma + \ln \bar{S}_L + \ln P^e \text{ (as } \ln(1 + x) \xrightarrow{x \rightarrow 0} x\text{)}$$

total differential: $\frac{dP}{P} = d\theta + d\gamma + \underbrace{\frac{d\bar{S}^L}{\bar{S}^L}}_{=0} + \frac{dP^e}{P^e}$

$$\pi = d\theta + d\gamma + \pi^e$$

$$\theta + \gamma \text{ procyclical} \rightarrow d\theta + d\gamma = a \cdot Y^{gap} \Rightarrow$$

$$\pi = a \cdot Y_{gap} + \pi^e$$

Finally, using **Okun's law** to replace Y^{gap} with U^{gap} :

$$\pi = -b \cdot U_{gap} + \pi^e$$

AS, Phillips Curve — final form

Two elements are added to obtain full **Phillips curve** and **Aggregate Supply** relationships:

1. Underlying rate of inflation $\tilde{\pi}$

- ▷ generalization of expected inflation rate π^e in wage setting
- ▷ wages sticky \Rightarrow not only current expectations, but past expectations influence wage setting
- ▷ explicit rules might exist for adjusting W to $\pi \Rightarrow$ past inflation rates enter $\tilde{\pi}$

2. Supply shocks s

- ▷ Shocks to non-wage marginal costs
- ▷ Taken into account by firms when setting prices

Results:

$$\pi = -bU_{gap} + \tilde{\pi} + s \quad (\text{Phillips Curve})$$

$$\pi = aY_{gap} + \tilde{\pi} + s \quad (\text{AS})$$

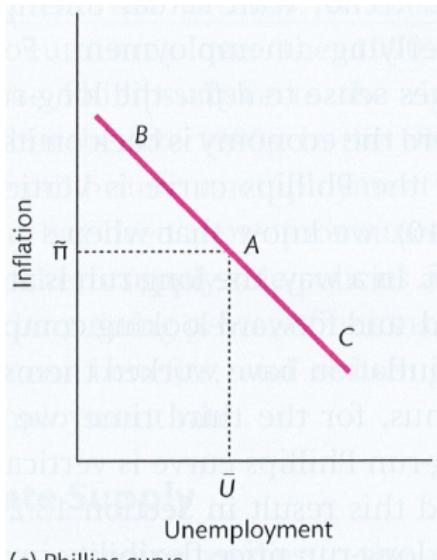
AS and Phillips curve: symmetry

$$\pi = -bU_{gap} + \tilde{\pi} + s$$

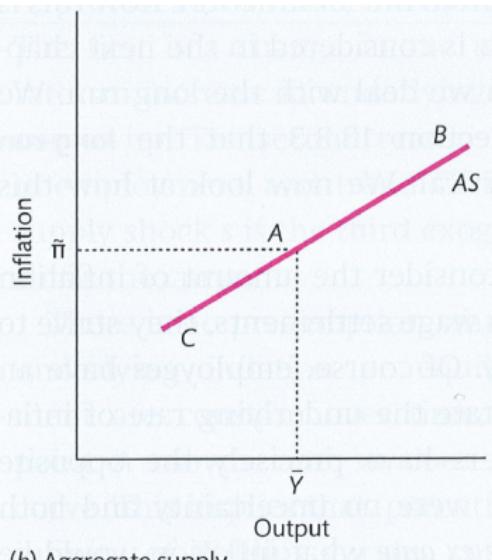
(Phillips Curve)

$$\pi = aY_{gap} + \tilde{\pi} + s$$

(AS)



(a) Phillips curve



(b) Aggregate supply

Note. The new Phillips curve. Source. Burda and Wyplosz (2017), Figure 13.12.

Non-labor costs and supply shocks

Firms have small supply shocks all the time, but which ones are macroeconomic?

Energy prices, especially fossil fuels, have a big role:

- ▷ First oil shocks: 1973/74, 1979/81
- ▷ Second sequence of shocks: 1999/2001, 2005/12
- ▷ Favourable oil shocks: 1986 and 2015
- ▷ Current: war & sanctions ⇒ Russian oil shut off: 2022



Brent Europe crude oil price. **Source.** St. Louis Fed.

Underlying inflation, long-run Phillips curve

▷ Rational expectations

- ▷ Forecast errors occur, but must average to zero over longer horizons
- ▷ Differences in π and $\tilde{\pi}$ must be temporary
- ▷ Long-run link equivalence of actual and underlying inflation:
if $s = 0$ and $U = \bar{U}$, then $\pi = \tilde{\pi}$

▷ Implies a **vertical Phillips Curve in the long run**

▷ The level of **long run inflation?**

→ $\bar{\pi}$, **inflation target of the central bank.**

Long-run Aggregate Supply (LAS)

- ▷ Recall that **trend output** \bar{Y} determined by technology, demographics
 - ▷ No relation of \bar{Y} level to $\pi \Rightarrow$ **vertical LAS**
- ▷ Another way to obtain — long-run Phillips curve & Okun's law

Implications:

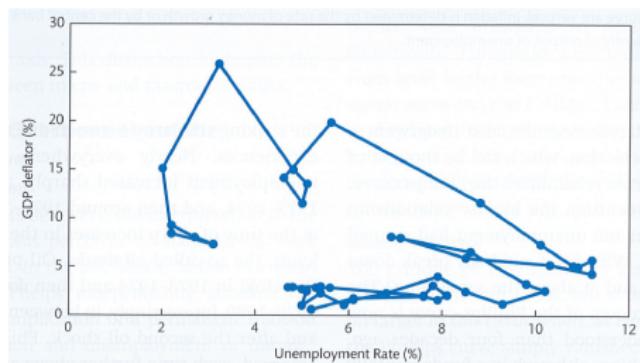
- ▷ **Short run:** Actual inflation deviates from underlying inflation $\tilde{\pi}$ in tandem with the business cycle
- ▷ **Long-run:** output returns to its growth path, independent of price level.

Horizontal movement due to trend output \bar{Y} growing at rate g

Shifts in Phillips curve and AS — unstable relationships

- ▷ $\tilde{\pi}$, \bar{U} , \bar{Y} , s are taken as exogenous and can shift the curves
→ a set of Phillips curves, not a stable negative relationship
- ▷ A. W. Phillips was **lucky** to find one stable curve
- ▷ At least two strong reasons for shifts since 1970s:
 - ▷ Supply shocks (oil prices)
 - ▷ Shifts in the equilibrium unemployment rate

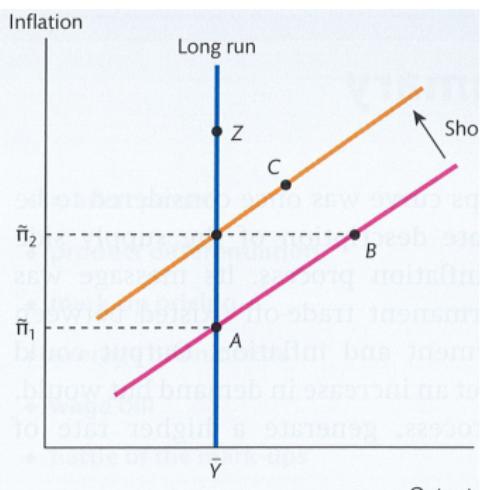
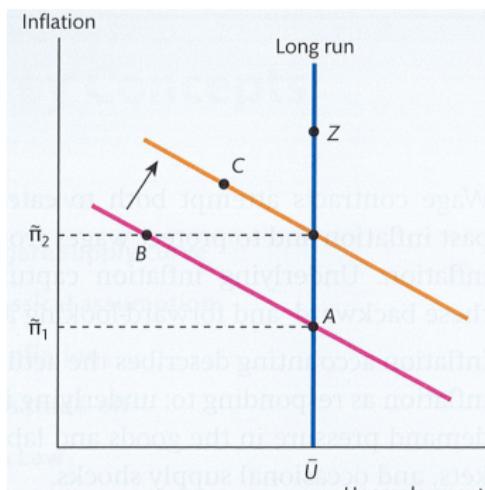
Figure. United Kingdom, 1970-2015



Source. Burda and Wyplosz (2017), Figure 13.10.

Phillips curve and AS: summary

- ▷ Instead of a simple U, π relationship found originally, theoretical Phillips curve is more flexible:
 1. Short-run Phillips curve depends on expectations and supply shocks
 2. Long-run Phillips curve is vertical — no inflation-unemployment link
- ▷ Via **Okun's law**, short-run and long-run AS are obtained



Source. Burda and Wyplosz (2017), Figure 13.13.

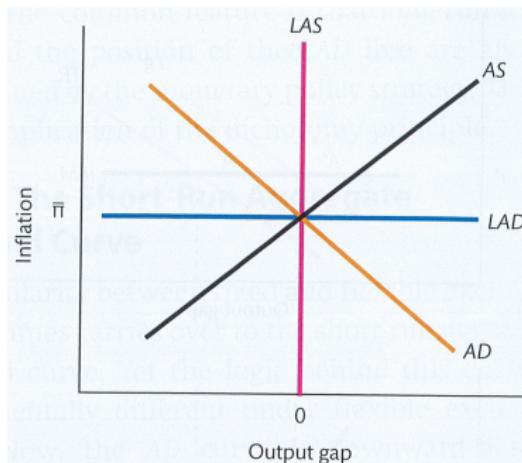
AD-AS model

- ▷ Medium-term movements of output and inflation shaped by both supply and demand
- ▷ **AS** is obtained above
- ▷ **AD** follows immediately from the IS-TR model with full version of TR:

$$i = \bar{i} + \alpha(\pi - \bar{\pi}) + \beta \left(\frac{Y - \bar{Y}}{\bar{Y}} \right)$$

Long-run AD (LAD)

- ▷ In the long run, central bank assumed to set interest such that $\pi = \bar{\pi}$ for whatever Y (which is \bar{Y} in equilibrium)
 - ▷ horizontal **LAD**
 - ▷ will become more relevant in open economy analysis



Source. Burda & Wyplosz (2017), Figure 14.12.

Short run AD

AD & IS-TR:

Assume an increase in π :

- ▷ TR: Central bank raises interest rate
- ▷ Investment decreases, *IS* shifts to the left
- ▷ Equilibrium Y lower for higher π : downward sloping short run **AD**

Shifts in AD

- ▷ IS: any shift in desired demand
- ▷ *TR*: $\bar{Y}, \bar{\pi}$

Policy example: monetary policy

Higher inflation target, $\bar{\pi}' > \bar{\pi}$

Policy example: government spending

Positive fiscal policy shock, $\bar{G}' > \bar{G}$, either permanent or temporary

AS once again

A short-medium run AS relationship $\pi = a(y - \bar{y}) + \tilde{\pi} + s$ arises in **many** models, under different assumptions.

- ▷ We have focused on price-wage-expected price link through **markup** price and wage setting, with **pro-cyclical** markups
 - ▷ Story went like output/unemployment gap → inflation

AS can also go in inflation → output direction:

1. Sticky wages \Rightarrow when $\pi \uparrow$, $\frac{W}{P} \downarrow$, so firms more profitable and $(y - \bar{y}) \uparrow$
2. Multiple goods, incomplete information in firms \Rightarrow when $\pi \uparrow$, firms cannot distinguish **inflation** (e.g. due to monetary policy) from **relative price movements** (e.g. due to changes in preferences) \Rightarrow each firm produces more, since demand might be rising for their particular product only (Lucas, 1972)

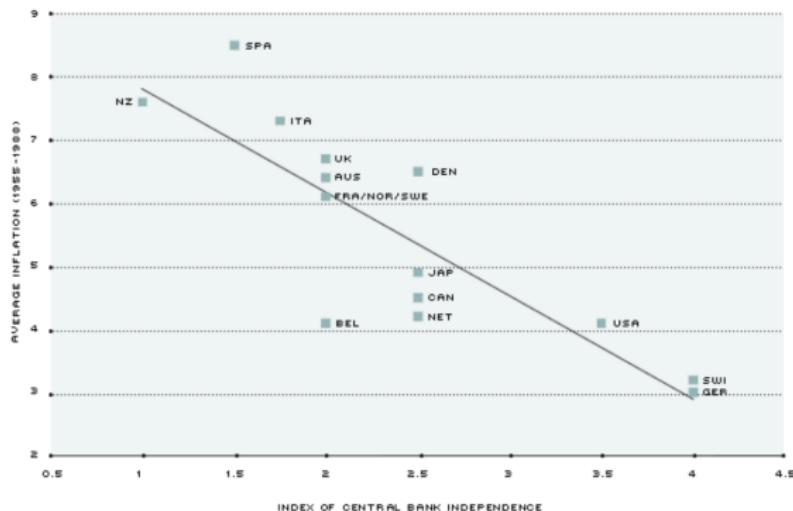
Can rewrite AS to highlight inflation → output:

$$y = \bar{y} + a'(\pi - \tilde{\pi}) + e, \quad \text{where } a' = 1/a, e = -1/a \cdot s$$

Outline

Discretionary policy and time-inconsistency

- ▷ Central banks often independent from political influence.
Why?
- ▷ Negative correlation between measures of central bank independence and inflation:
 - An independent central bank with a focus on price stability is a solution to **time consistency** problems in monetary policy



Time consistency of monetary policy: framework

- ▷ Central bank (CB) cares for both GDP and inflation
 - ▷ influences inflation, but also indirectly GDP through **AS**
- ▷ private agents guess CB's actions and form **inflation expectations**
- ▷ monetary policy can either be **discretionary** (CB free to change policy) or **rule-based**

Main results

1. CB uses inflation to boost GDP \Rightarrow cannot credibly promise low inflation: **time inconsistency** problem
2. Discretionary policy \Rightarrow higher inflation, which is anticipated \Rightarrow no output gain
3. Rules-based policy \Rightarrow can promise lower inflation, but still respond to supply shocks

The model (Barro, Gordon, 1983)

Central bank: maximize utility/minimize cost:

$$\max_{\pi} U(y - \bar{y}, \pi)$$

AS relationship of inflation and output:

$$y = \bar{y} + a(\pi - \pi^e) + e$$

where e supply shock; expected inflation π^e used as **underlying inflation**

Private agents: know CB's preferences, have **rational** inflation expectations π^e

Sequence of events

Timeline very important for understanding the model:

1. Private sector guesses monetary policy based on CB preferences \Rightarrow inflation expectations π^e
2. Supply shock e realizes
3. Monetary policy made: π chosen by CB

Discussion:

- ▷ once π^e formed, CB can “surprise” agents with higher inflation
- ▷ CB can respond to supply shock — stabilization policy

Expansionist CB

$$U(y - \bar{y}, \pi) = \lambda(y - \bar{y}) - \frac{1}{2}\pi^2$$

- ▷ Utility rises in **output gap** (linear relationship) decreases in **inflation** (quadratic)

- ▷ λ – relative preference for expansion vs. price stability

Expansionist CB: results

- ▷ **Discretion:** CB uses inflation to boost medium-run GDP, but effect cancelled by rational expectations
- ▷ inflation larger if CB cares more for expansion
- ▷ **Commitment:** if null inflation commitment feasible, both CB and economy better off

This version of model ignores **stability** of GDP as CB's goal, as in the **TR** equation.

Output-stabilizing CB

CB minimizes cost instead of maximizing utility:

$$\min_{\pi} \frac{1}{2} \lambda (y - \bar{y} - k)^2 + \frac{1}{2} \pi^2$$

- ▷ Cost rises in output gap (quadratic relationship) and in inflation (same)
- ▷ New motive – **output gap stability**: both very high and very low y are bad
- ▷ CB still **expansion biased**: V is minimal when $y - \bar{y} = k > 0$

Output-stabilizing CB: results

- ▷ **Discretion:** optimal inflation depends on:
 1. expected inflation \Rightarrow equilibrium interaction of CB and population
 2. output shock realization: CB counteracts it for stabilization, as in Taylor rule (TR)
- ▷ **Commitment:** a promise of a fixed inflation level not optimal when output shocks matter
 - ▷ introduce commitment to a **rule-based** policy that reacts to output shock, as in TR
 - ▷ optimal rule has null average inflation
 - ▷ again, commitment policy makes everyone better off with respect to discretion