ECON20001 Intermediate Macroeconomics

Tutorial 6 (Week 7)

Zheng Fan

The University of Melbourne

Introduction

Assign 12 - Sep.

Zheng Fan

- Ph.D student in Economics at Unimelb
- Consultation & Ed discussion board (your first priority)
- Email Dr. David Moreton for all administrative issues
- Consult Stop 1 for special consideration
- Email: fan.z@unimelb.edu.au (last resort!)

Before asking any questions, make sure you have gone through the Ed discussion board, subject guide and Q&A on Canvas!

Slides: github.com/zhengf1/InterMa2022

Last week lectures

t-1 : equilibrium.

Dynamic AS-AD model

DAS: • $\pi_t = \pi_{t-1} + \phi(Y_t - \bar{Y}) + v_t$ ($= \pi^*$)

DAD: • $Y_t = \bar{Y} - \frac{\alpha\theta_\pi}{1+\alpha\theta_Y}(\pi_t - \pi^*) + \frac{1}{1+\alpha\theta_Y}\varepsilon_t$

} $\Rightarrow$ $\pi_t - \pi^*$, $Y_t - \bar{Y}$ at t.

- Endogenous variable: π_t, Y_t; Pre-determined variable: π_{t-1}; State variable π_t, whose evolution links time periods.
- In long-run equilibrium, so lagged inflation equals target $\pi_{t-1} = \pi^*$

Impulse response

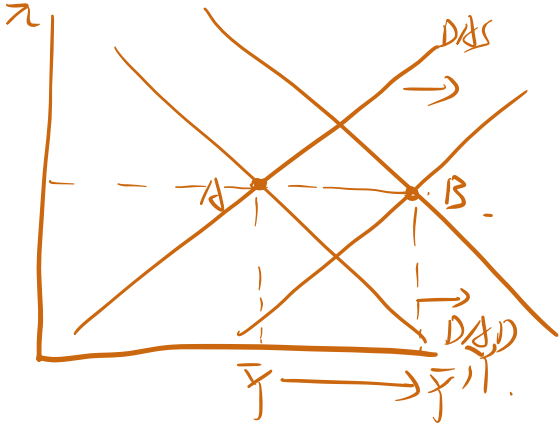
- Given the economy starts from LR equilibrium and $\pi_t - \pi^*$, solve for:

t+1 : (from t)

$$\begin{cases} \pi_{t+1} - \pi^* = (\pi_t - \pi^*) + \phi(Y_{t+1} - \bar{Y}) + v_{t+1} \\ (Y_{t+1} - \bar{Y}) = -\frac{\alpha\theta_\pi}{1+\alpha\theta_Y}(\pi_{t+1} - \pi^*) + \frac{1}{1+\alpha\theta_Y}\varepsilon_{t+1} \end{cases}$$

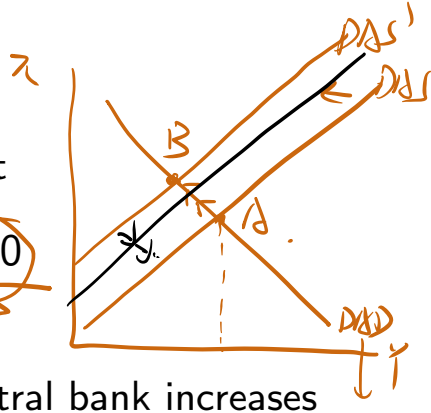
$\rightarrow$ t+2

Last week lectures



Dynamic AS-AD model

1. Permanent increase in aggregate supply, $\bar{Y}$:
   - AS shifts out: productive capacity has increased
   - AD shifts out: income is higher, demand increases
   - No change in inflation, permanent increase in output

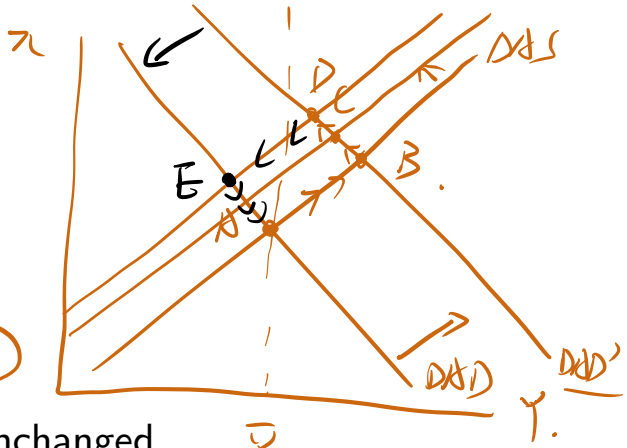


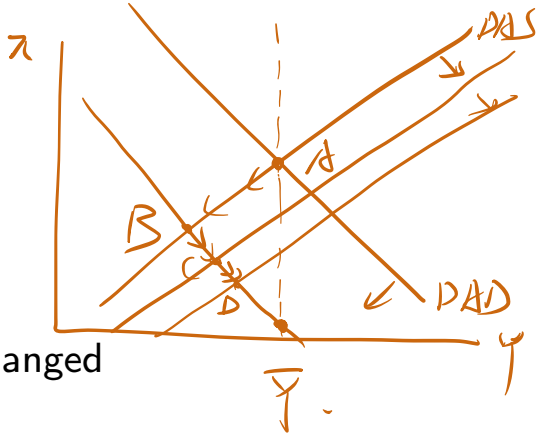
2. Transitory (adverse) shock to aggregate supply, $v_t > 0$
   - On impact: DAS shifts up while DAD unchanged
     $\rightarrow$ higher inflation and lower output due to that central bank increases interest rate
     $\pi \uparrow \rightarrow i, r \uparrow \rightarrow Y \downarrow \rightarrow A \rightarrow B$
   - Shock ends: DAS shifts down gradually until output is back to $\bar{Y}$

Last week lectures

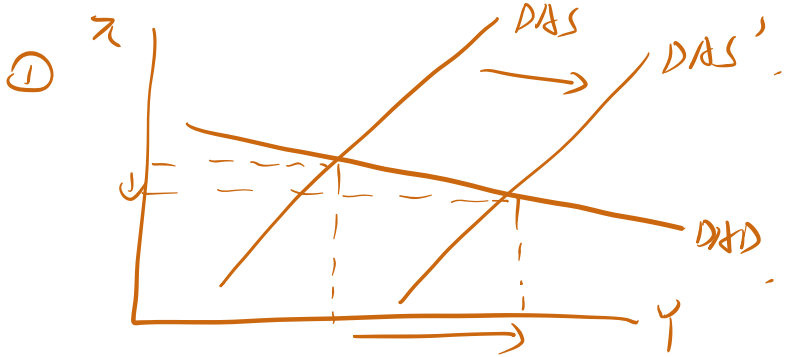
Dynamic AS-AD model

3. Persistent aggregate demand shock $\varepsilon_t > 0$
   - On impact: DAD shifts out while DAS unchanged
   - On shock: DAS shifts up toward $\bar{Y}$
   - Shock ends: DAD shifts back to original
   - DAS shifts down to original
4. Decrease in inflation target, π^*:
   - On impact: DAD shifts in while DAS unchanged
   - DAS shifts down until output is back to $\bar{Y}$
   - Please attempt the pre-tute question!!!



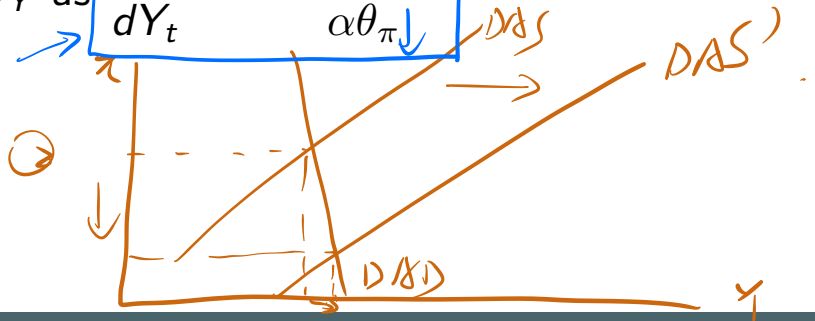


Last week lectures



Tradeoff between output and inflation volatility

- No long-run trade-off between output and inflation levels
- But trade-off between output and inflation volatility
- Flat DAD $\rightarrow$ small change in inflation, large change in output
- Steep DAD $\rightarrow$ large change in inflation, small change in output
- Steep DAD: small θ_π, large θ_Y as $\frac{d\pi_t}{dY_t} = -\frac{1+\alpha\theta_Y}{\alpha\theta_\pi}$



Last week lectures

Tradeoff between output and inflation volatility

- Fed vs ECB
  - Fed's goals: maximum employment, stable prices, and moderate long-term interest rates $\rightarrow \theta_\pi > 0, \theta_Y > 0$ MPR
  - ECB's goals: maintain price stability $\rightarrow \theta_\pi > 0, \theta_Y = 0$
  - In response to GFC, the Fed lowered interest rates much more than the ECB did $\rightarrow$ more variable output and more stable inflation in Europe

Last week lectures

Importance of the Taylor principle

- $\frac{di_t}{d\pi_t} = 1 + \theta_\pi > 1 \quad \Leftrightarrow \quad \theta_\pi > 0$
- Increase in nominal rate will also increase real rate
- Ensures DAD is downward sloping

$$Y_t = \bar{Y} - \frac{\alpha\theta_\pi}{1 + \alpha\theta_Y}(\pi_t - \pi^*) + \frac{1}{1 + \alpha\theta_Y}\varepsilon_t$$

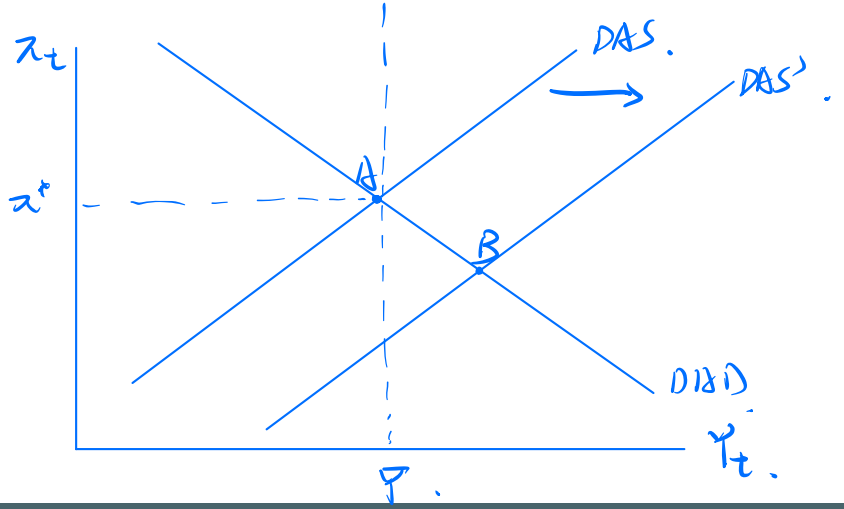
In-tutorial Sheet - Q2

LR equm.

2. Starting at an initial equilibrium where real output is equal to its natural level $\bar{Y}$ and inflation is at target π^*, use a standard dynamic AS-AD model to explain how the macro-economy adjusts following a one-time favourable supply shock, $v_t < 0$ for one period then reverting to zero for all subsequent periods.

$\Delta \downarrow$

(a) Explain how this favourable supply shock affects the DAS and DAD curves on impact.



In-tutorial Sheet - Q2

2. Starting at an initial equilibrium where real output is equal to its natural level $\bar{Y}$ and inflation is at target π^*, use a standard dynamic AS-AD model to explain how the macro-economy adjusts following a one-time favourable supply shock, $v_t < 0$ for one period then reverting to zero for all subsequent periods.

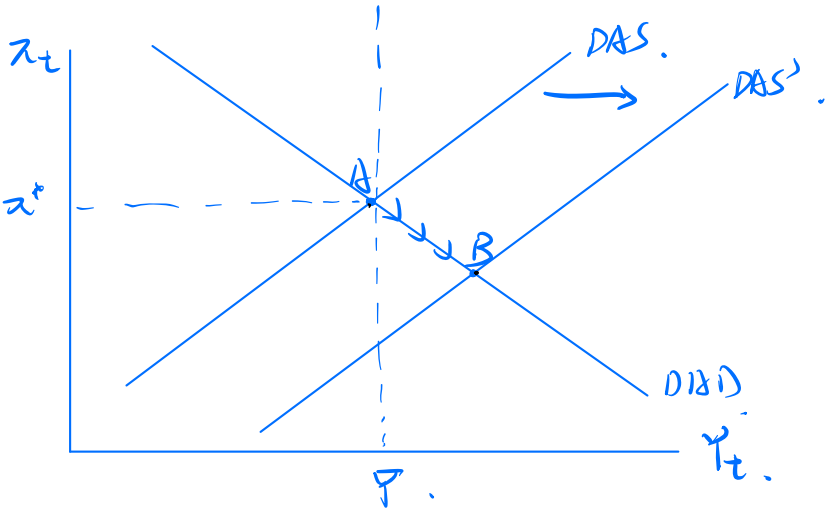
(a) Explain how this favourable supply shock affects the DAS and DAD curves on impact.

The favourable supply shock $v_t < 0$ shifts the DAS curve down on impact, (lower inflation for any level of output).

Since v_t does not enter the DAD curve, the DAD curve is unchanged on impact.

In-tutorial Sheet - Q2

(b) Using your answer from part (a), explain the impact effect of this shock on output, inflation, the nominal and real interest rates.



$\pi \downarrow \xrightarrow{RB} i \downarrow \xrightarrow{\Delta\pi>0} r \downarrow \longrightarrow C, I \uparrow \longrightarrow Y \uparrow$.

In-tutorial Sheet - Q2

(b) Using your answer from part (a), explain the impact effect of this shock on output, inflation, the nominal and real interest rates.

Since the DAS curve shifts **down** along a given DAD curve, on impact inflation falls below target and output rises above its natural level.

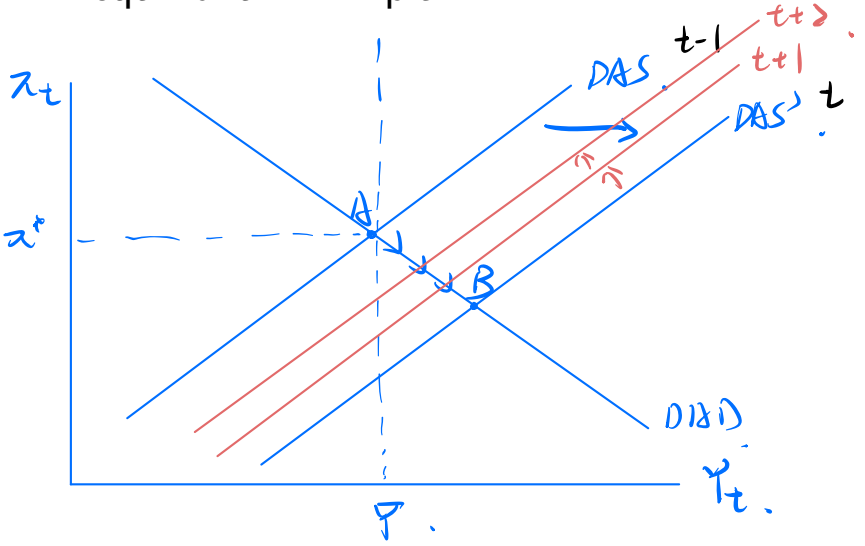
Both nominal and real interest rate fall

$Y_t > \bar{Y} \Rightarrow -\alpha(r_t - \rho) > 0 \Rightarrow r_t < \rho$.

- Since real output is above the natural level, from the output equation $Y_t = \bar{Y} - \alpha(r_t - \rho) + \varepsilon_t$ we know that the real interest rate, r_t, is lower than the natural real rate, ρ, and so falls on impact.
- From the Fisher equation, $r_t = i_t - E_t(\pi_{t+1})$, the nominal interest rate also falls on impact because both inflation and the real interest rate fall.

In-tutorial Sheet - Q2

(c) Explain the dynamic response of output, inflation and interest rates in subsequent periods. Does the economy converge back to the same long-run equilibrium? Explain.



intercept of DAS:

at t: $\pi_{t-1} - \phi\bar{Y} + v_t$.

$t-1$: $\pi^* - \phi\bar{Y}$

t: $\pi^* - \phi\bar{Y} + v_t$ (-ve).

$t+1$: $\pi_t - \phi\bar{Y} + v_{t+1}$

$= \pi_B - \phi\bar{Y}$

B -> A:

$\pi \uparrow \rightarrow \pi \uparrow \rightarrow r \uparrow \rightarrow Y \downarrow$.

t: shock hits.

t+1: shock ends.

In-tutorial Sheet - Q2

(c) Explain the dynamic response of output, inflation and interest rates in subsequent periods. Does the economy converge back to the same long-run equilibrium? Explain.

The DAD curve remains unchanged $\rightarrow$ All the dynamics are given by movements in the DAS curve.

At time $t+1$, the supply shock is back to zero $v_{t+1} = 0$ but the lagged inflation term in the DAS curve is $\pi_t < \pi^*$ because of the impact effect on inflation due to the initial shock.

Hence, even in the absence of further shocks, it will take some time for the economy to converge back to its long-run equilibrium.

- The vertical intercept of the DAS curve at time t is given by $\pi^* - \phi\bar{Y} + v_t$ and at time $t+1$ is $\pi_t - \phi\bar{Y}$ and $\pi_t > \pi^* + v_t$
- It follows that the DAS curve should shift up at time $t+1$.

In-tutorial Sheet - Q2

- Similarly, over time the DAS curve shifts back up along the unchanged DAD curve.

Output is lower than at time t but still more than its natural level $\bar{Y}$.

As inflation rises back towards π^*, both nominal and real interest rates rise, but they remain below their long-run levels $\rho + \pi^*$ and ρ, respectively.

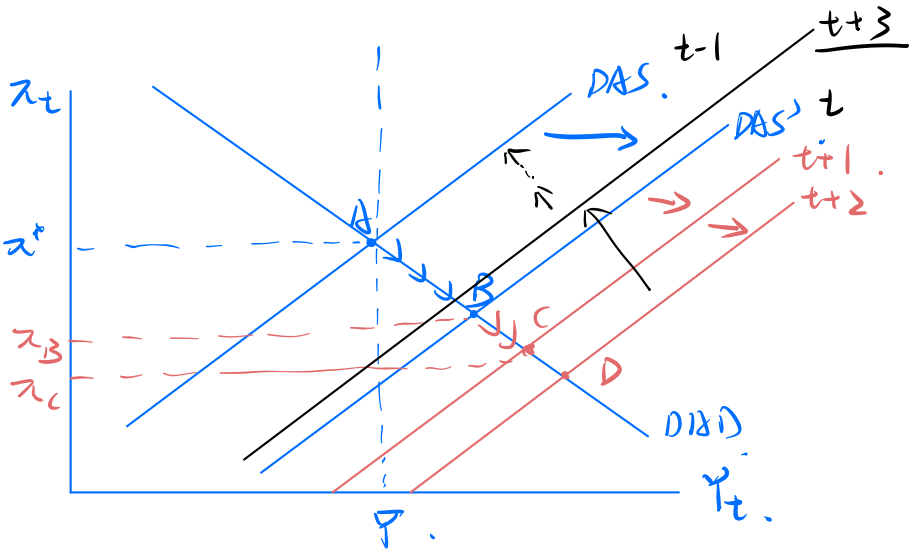
Yes, the economy converges back to the same long-run equilibrium with inflation at target π^* and output at its natural level $\bar{Y}$.

The nominal interest rate converges to $\rho + \pi^*$ and the real interest rate converges to ρ.

The transitory supply shock has no effect on the parameters that pin down the long-run equilibrium.

In-tutorial Sheet - Q2

(d) How, if at all, would your answer to part (c) change if the shock lasted for several periods before reverting back to zero?



t: shock hits.
t+1: shock
t+2: shock.
t+3: shock ends.

intercept of DAS:

at t: $\pi_{t-1} - \phi\bar{Y} + v_t$.

t-1: $\pi^* - \phi\bar{Y}$

t: $\pi^* - \phi\bar{Y} + v_t$ (-ve).

t+1: $\pi_t - \phi\bar{Y} + v_{t+1}$

$= \pi_B - \phi\bar{Y} + v_t$.

t+2: $\pi_C - \phi\bar{Y} + v_t$.

t+3: $\pi_D - \phi\bar{Y}$ → gradually shift back.

In-tutorial Sheet - Q2

(d) How, if at all, would your answer to part (c) change if the shock lasted for several periods before reverting back to zero?

The main difference is that in the first few periods the DAS curve would keep shifting down.

- If the supply shock goes back to zero at $t+1$ then as in part (c), the DAS curve shifts up starting the economy back on its path towards π^*
- If the supply shock is still $v_{t+1} = v_t < 0$ at $t+1$ then the economy keeps moving away from its long-run equilibrium (along the unchanged DAD curve) with output continuing to rise, inflation continuing to fall and interest rates continuing to fall.
- Only when the supply shock finally reverts back to zero will the economy start to respond along the lines sketched in part (c), with inflation eventually rising back to π^* and output falling back to $\bar{Y}$.

In-tutorial Sheet - Q3

$r_t \to \rho$.

3. The text assumes that the natural rate of interest ρ is a constant parameter. Suppose instead that it varies over time, so now it has to be written ρ_t.

(a) How would this change affect the equations for dynamic aggregate demand and dynamic aggregate supply?

In-tutorial Sheet - Q3

3. The text assumes that the natural rate of interest ρ is a constant parameter. Suppose instead that it varies over time, so now it has to be written ρ_t.

(a) How would this change affect the equations for dynamic aggregate demand and dynamic aggregate supply?

The natural rate of interest does not enter the DAS curve, so it will continue to be, using the Phillips curve and adaptive expectations

$$\pi_t = \pi_{t-1} + \phi(Y_t - \bar{Y}_t) + v_t$$

For the DAD curve we now have, starting with the goods market condition

$$Y_t = \bar{Y}_t - \alpha(r_t - \rho_t) + \varepsilon_t$$

(with ρ_t not just a constant ρ). Then using the Fisher equation and adaptive expectations

$$Y_t = \bar{Y}_t - \alpha(i_t - \pi_t - \rho_t) + \varepsilon_t$$

In-tutorial Sheet - Q3

And now supposing a monetary policy rule with *time-dependent* ρ_t

$$i_t = \pi_t + \rho_t + \theta_\pi(\pi_t - \pi_t^*) + \theta_Y(Y_t - \bar{Y}_t)$$

We then have

$$Y_t = \bar{Y}_t - \alpha(\pi_t + \rho_t + \theta_\pi(\pi_t - \pi_t^*) + \theta_Y(Y_t - \bar{Y}_t) - \pi_t - \rho_t) + \varepsilon_t$$

And so solving for Y_t we get the usual DAD curve too

$$Y_t = \bar{Y}_t - \frac{\alpha\theta_\pi}{1 + \alpha\theta_Y}(\pi_t - \pi_t^*) + \frac{1}{1 + \alpha\theta_Y}\varepsilon_t$$

which does not depend on ρ_t either. In short, neither the DAS nor DAD curves are affected.

In-tutorial Sheet - Q3

(b) How would a shock to ρ_t affect output, inflation, the nominal interest rate, and the real interest rate?

In-tutorial Sheet - Q3

(b) How would a shock to ρ_t affect output, inflation, the nominal interest rate, and the real interest rate?

A shock to ρ_t affects neither the DAS nor the DAD curves and so has no effect on inflation or output in either the short run or the long run.

Instead, what happens is that the central bank changes the nominal interest rate i_t one-for-one with the natural rate ρ_t (perfectly accommodating the shock) so that the interest rate gap $r_t - \rho_t$ is zero. With $r_t - \rho_t$ at zero, there will be no change in real output and hence no change in inflation. In equilibrium, the real interest rate will just be

$$r_t = \rho_t$$

and the nominal interest rate will be given by the real rate plus target inflation

$$i_t = r_t + \pi_t^*$$

so that both the nominal and real rates move one-for-one with ρ_t.

In-tutorial Sheet - Q3

(c) Can you see any practical difficulties that a central bank might face if ρ_t varied over time?

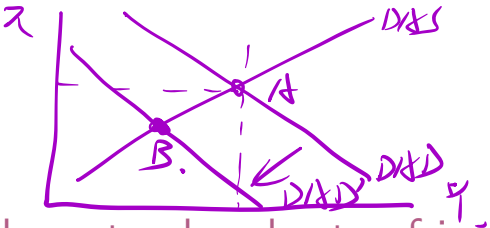
In-tutorial Sheet - Q3

(c) Can you see any practical difficulties that a central bank might face if ρ_t varied over time?

Obviously, this outcome requires the central bank to know perfectly the natural real rate of interest ρ_t so that it can adjust the nominal interest rate one-one-one to fully accommodate any shock to ρ_t.

But if the central bank has imperfect information on ρ_t, as seems plausible, then shocks to ρ_t will shift the DAD curve.

In-tutorial Sheet - Q3



In particular, suppose the central bank believes the natural real rate of interest is ρ'_t so that the monetary policy rule is

$$i_t = \pi_t + \rho'_t + \theta_\pi(\pi_t - \pi^*) + \theta_Y(Y_t - \bar{Y})$$

while the true rate is ρ_t. Then the ρ_t term will not drop out of the DAD curve. Following the usual derivation of the DAD curve, we get

$$Y_t = \bar{Y}_t - \frac{\alpha}{1 + \alpha\theta_Y}\left[(\rho'_t - \rho_t) + \theta_\pi\left(\pi_t - \pi^*_t\right)\right] + \frac{1}{1 + \alpha\theta_Y}\varepsilon_t$$

A shock that makes $\rho'_t - \rho_t > 0$ (a central bank that mistakenly believes the natural rate is higher than it in fact is) will shift the DAD curve down along a given DAS curve, causing both inflation and output to fall on impact.

Notice that a long run equilibrium with $r_t = \rho_t$ cannot be restored until the central bank recognises its initial mistake. $\rho'_t = \rho_t$.

The end

Thanks for your attention! 😄