Aalto University
School of Business

31E2300
MACROECONOMICS: POLICY

THE THREE EQUATION MODEL FOR OPEN ECONOMIES

NEXT TWO CLASSES:

- Open Economy Version of the 3-Equation Model
- Uncovered Interest Parity (UIP) Condition
- The AD-ERU Model
- CB Stabilization in the Open Economy and the RX Curve.
- Exchange Rate Overshooting/Volatility and Its Causes.

PRELIMINARIES

- To “open” the economy, we’ll first focus on a forex market with forward-looking traders who attempt to profit from arbitrage opportunities.

- Home’s nominal exchange rate: $e \equiv \frac{no.\,units\ of\ home\ currency}{1\ unit\ of\ foreign\ currency}$

  A rise in e is a depreciation of the home currency.

- Home’s real exchange rate (RER):

  $$Q \equiv \frac{price\ of\ foreign\ goods\ in\ terms\ of\ home\ curr.}{price\ of\ home\ goods} = \frac{P^* e}{P}$$

  A rise in Q is a real depreciation of the home currency.

PRELIMINARIES

- **We now have two stabilization channels under flexible exchange rates,** an interest rate channel and an exchange r**ate channel**

  E.g. Shock $\rightarrow \pi > \pi^T \rightarrow$ *CB raises* $i \rightarrow$ *negative* y*-gap* $\rightarrow \pi \downarrow$ *(1);*

  Also, forex mkt expects $i \uparrow \rightarrow$ *returns to home bonds* $\uparrow$ *(arbitrage opportunity)* $\rightarrow$ *currency appreciates* $\rightarrow$ *Exports & AD* $\downarrow \rightarrow \pi \downarrow$ *(2)*

- In addition to the int. rate channel (1), we have the exchange rate channel (2) $\rightarrow$ CB raises i by less than the closed economy case

- We'll assume that CB and forex market form expectations rationally, even if …

- … there is lots of **evidence thaty forex markets are** prone to fads and manias.

HOW IS THE OPEN ECONOMY EMBODIED IN THE 3-EQUATION MODEL?

- **IS relation**: Include imports and exports; lower multiplier as some of the increase in income leaks abroad.

- **PC**: Domestic π^E is used to set W. This is the same as Chapter 2, and is a modeling choice. (One can make other choices …)

- **MR**: CB may target domestic or CPI inflation (includes $\Delta P_{imports}$) ; Assume the former, so CB behaves as in Ch. 3

- Before era of higher international capital mobility, forex driven by trade; now, the forex market is dominated by international financial markets:

  Purchase and sale of currencies to trade in (public) bonds of different countries → Key determinant of exchange rate fluctuations.

SIMPLIFYING ASSUMPTIONS AND UIP

Simplifying assumptions:

1. Perfect int'l capital mobility (home can trade unlimited foreign bonds @)
2. Small home country (cannot affect world int. rates)
3. Households can hold 2 assets: Bonds (home & foreign) and money.
4. Perfect substitutability between home and foreign bonds (only difference is expected return; same default risk)

    1. If we modify our understanding of "the" interest rate, we can incorporate dafault risk.

The Uncovered Interest Parity (UIP) Condition:

- Explains how forex traders respond to int. rate differences.
- Under 4. above, bonds only differ by expected returns depending on:

    1) Expected differences in interest rates across a given time horizon
    2) Expected development of the exchange rate over same time horizon.

- In what follows, we call the UK the 'home' (H) economy and the US the 'foreign' (F) economy.

VISUAL REPRESENTATION

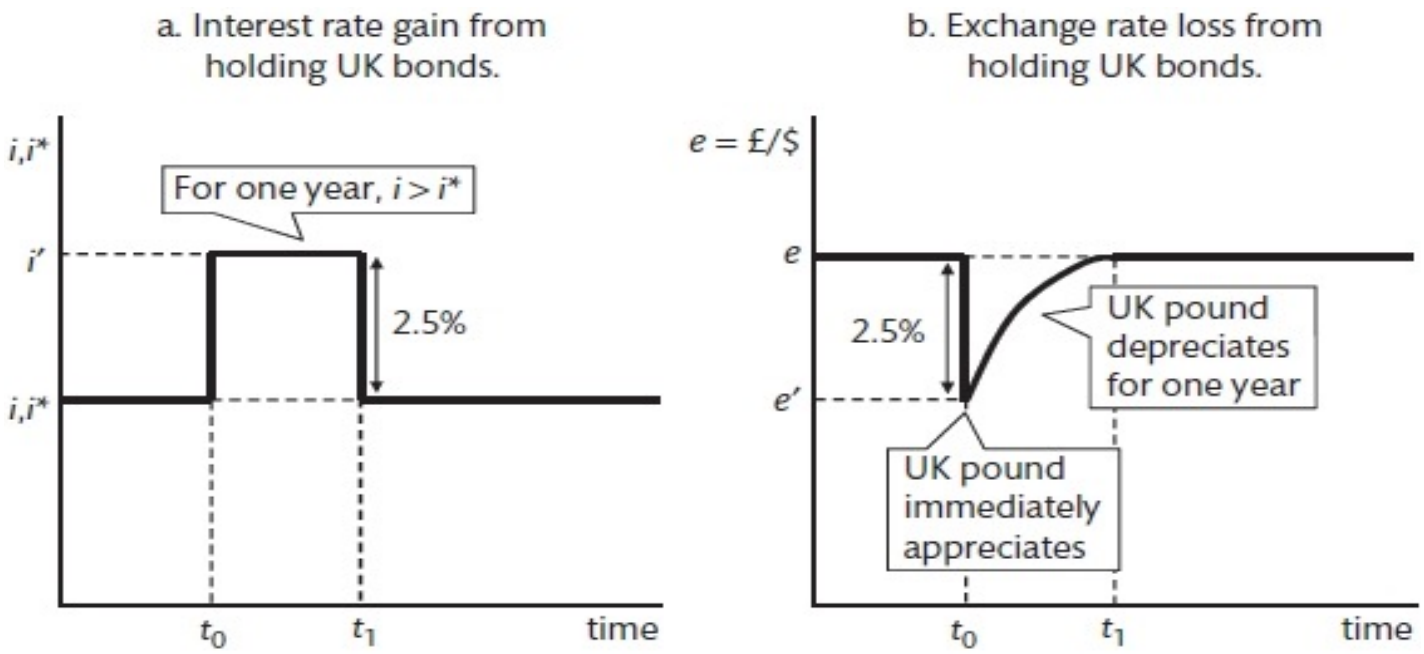


Figure 9.2 Arbitrage in the international bond market.

From t_0 to t_1, i (UK) ↑ by 2.5% above i^* (US) → UK bonds more attractive → Sell USD to buy GBP → USD depreciates while GBP appreciates (e ↓) right away.

Arbitrage: GBP appreciates by exactly 2.5% s.t. the expected returns of UK and US bonds are equal.

Assume: e' expected to reverts to *normal* level e (GBP depreciates) and this represents a 2.5% loss in holding UK bonds.

∴ *The UIP condition*:

*"**Interest gain** from holding H rather than F bonds*
*= **Loss** from expected H currency depreciation against F's "*

FORMALIZING UIP

- The UIP Condition is $i_t - i^* = \frac{e^E_{t+1} - e_t}{e_t}$, and taking a log-approximation: $i_t - i^* = \log e^E_{t+1} - \log e_t$, i.e.
  Interest gain = Expected depreciation

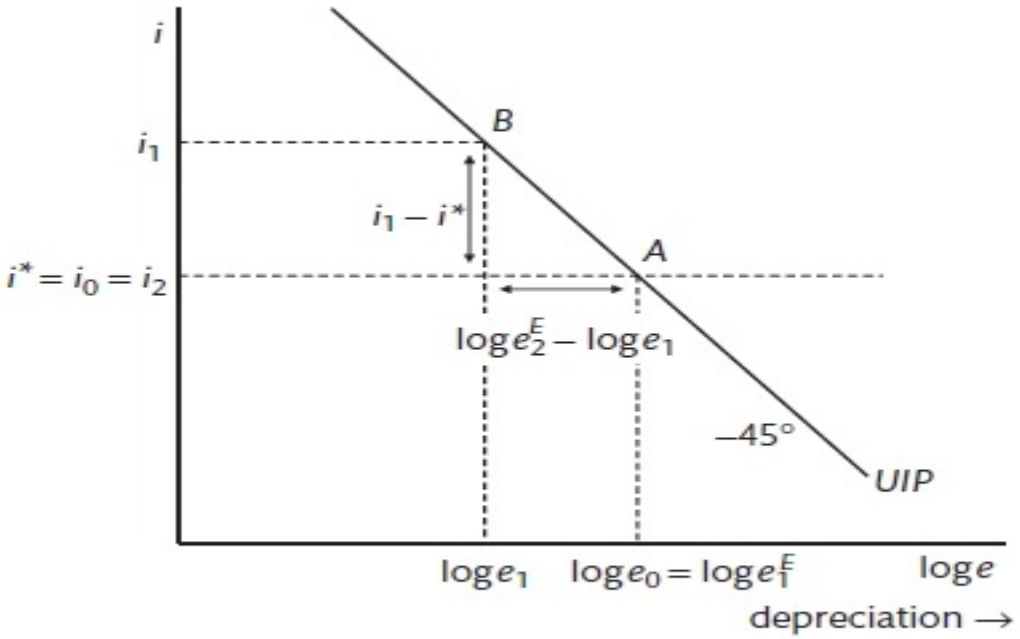


Figure 9.3 The uncovered interest parity condition: $i_t - i^* = \log e^E_{t+1} - \log e_t$.

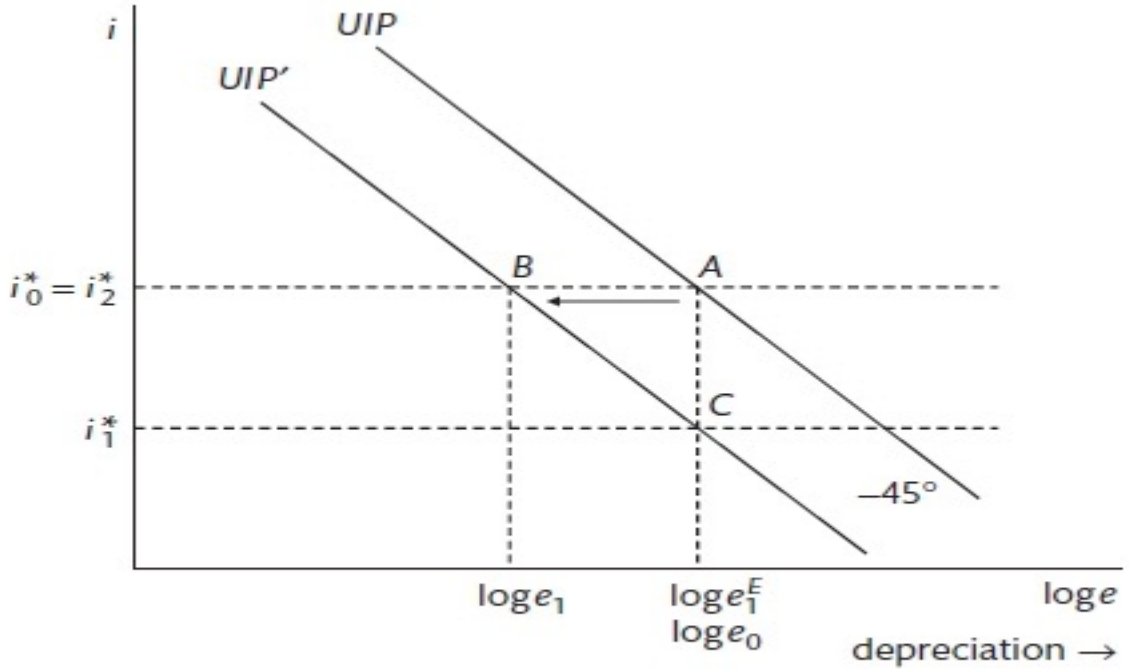
'A': Home int. rate equals world's $(\mathrm{i_t} = \mathrm{i^*})$ and exchange rate expectations are fulfilled $(\log \mathrm{e}^{\mathrm{E}}_1 - \log \mathrm{e}_0)$.

'B': Home sets $\mathrm{i}_1 > \mathrm{i}^*$ for one year, and exch. rate expectation remains at $\log \mathrm{e}^{\mathrm{E}}_{\mathrm{t+1}}$ → exch. rate appreciates immediately to $\log \mathrm{e}_1$ s.t expected depreciation over the year equals the int. rate differential: $i_1 - i^* = \log e^E_2 - \log e_1$

THE UIP DIAGRAM

1) Slope of -45 º, goes through ($\log e^E$, i^*); 2) Δ i → Movement along curve 3) Given $\log e^E$, Δ i^*→ Curve shifts; 4) Given i^*, Δ $\log e^E$→ Curve shifts

- E.g. *One period fall in* i^* → *UIP shifts down ('B')* → $\log e \downarrow$ → *Next period,* i^* *and UIP revert back* → *No int. differential* → $\log e$ *reverts back as well*



Assumption: Expected exch. rate is constant

Also: No fall in $\log e$ *if the CB immediately cuts* i *to* i_1^* *(simply, 'A' → 'C').*

Figure 9.4 The uncovered interest parity condition: a fall in the world interest rate leads to an immediate appreciation of the home exchange rate.

MEDIUM RUN EQUILIBRIUM: THE AD-ERU FRAMEWORK

- Medium-run equilibrium (MRE): WS-PS intersection pins down the equilibrium rate of unemployment (ERU) at constant inflation.
- **ERU**: Supply side in equilibrium, inflation is constant.
- **AD**: Goods market in equilibrium, int. rate equals world level ($i = i^*$). NOTE: THERE IS NO REQUIREMENT, THEN, THAT ECONOMY "BE ON" THE AD SCHEDULE IN THE SHORT RUN. ALSO, THIS IS *NOT* THE USUAL – OR INDEED, ANY SORT – OF "AGGREGATE DEMAND" SCHEDULE.

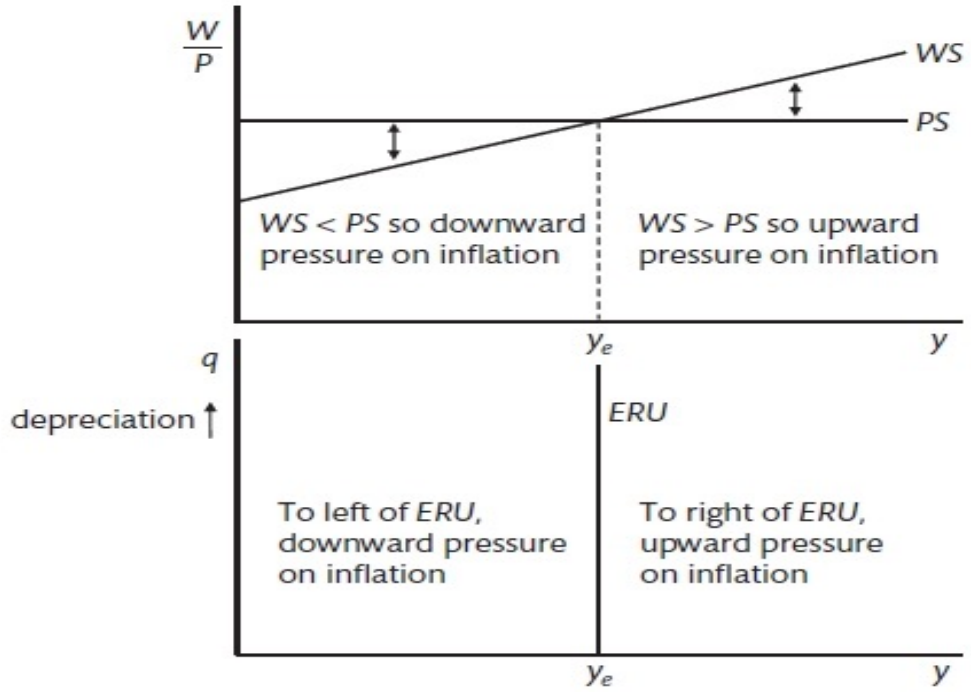


Figure 9.5 Supply-side equilibrium and the *ERU* curve.

<u>Supply-side Equilibrium (Ch. 2):</u>

ERU curve: combinations of RER (q) and y at which $w^{PS} = w^{WS}$.

Note: q is log of RER: $q \equiv \log Q$

BUILDING THE OPEN ECONOMY MODEL

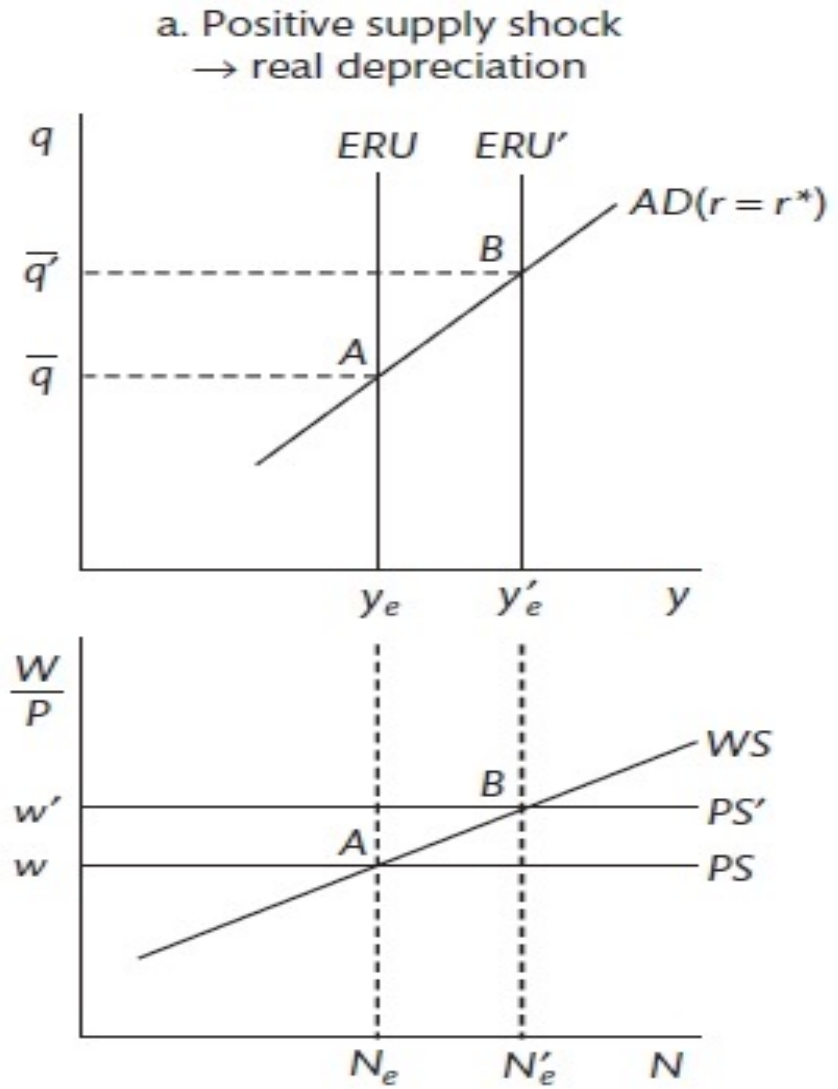
- Open economy IS curve: $y_t = A_t - ar_{t-1} + bq_{t-1}$.
- $r = r^*$ in MRE b/C under the *real* UIP condition: $r_t - r^* = q^E_{t+1} - q_t$, $r = r^*$ is necessary for a constant RER.
- Open economy AD curve: $y = A - ar^* + bq$ (depreciated RER → y ↑)
- AD curve: Medium-run combinations of real exchange rate and output where the goods market is in equilibrium and $r = r^*$.

<u>The basic medium-run AD-ERU model:</u>

1. **AD** curve: Demand side, $y = y^{AD}$ (GME), $r = r^*$.
2. **ERU** curve: Supply side, $y = y_e$, constant inflation.
3. **MRE**: AD intersects wt. ERU; $r = r^* \rightarrow q = \bar{q}$; $y = y_e \rightarrow$ π constant.

- Closed economy: New stabilizing r_S at the medium run after a shock.
- Small open economy: Medium run r pinned down by r^* ($r = r^*$), therefore it is q that moves in response to a shock.

EXAMPLE



↑ depreciation

Example:

a. +ve supply Shock

→ PS shifts up

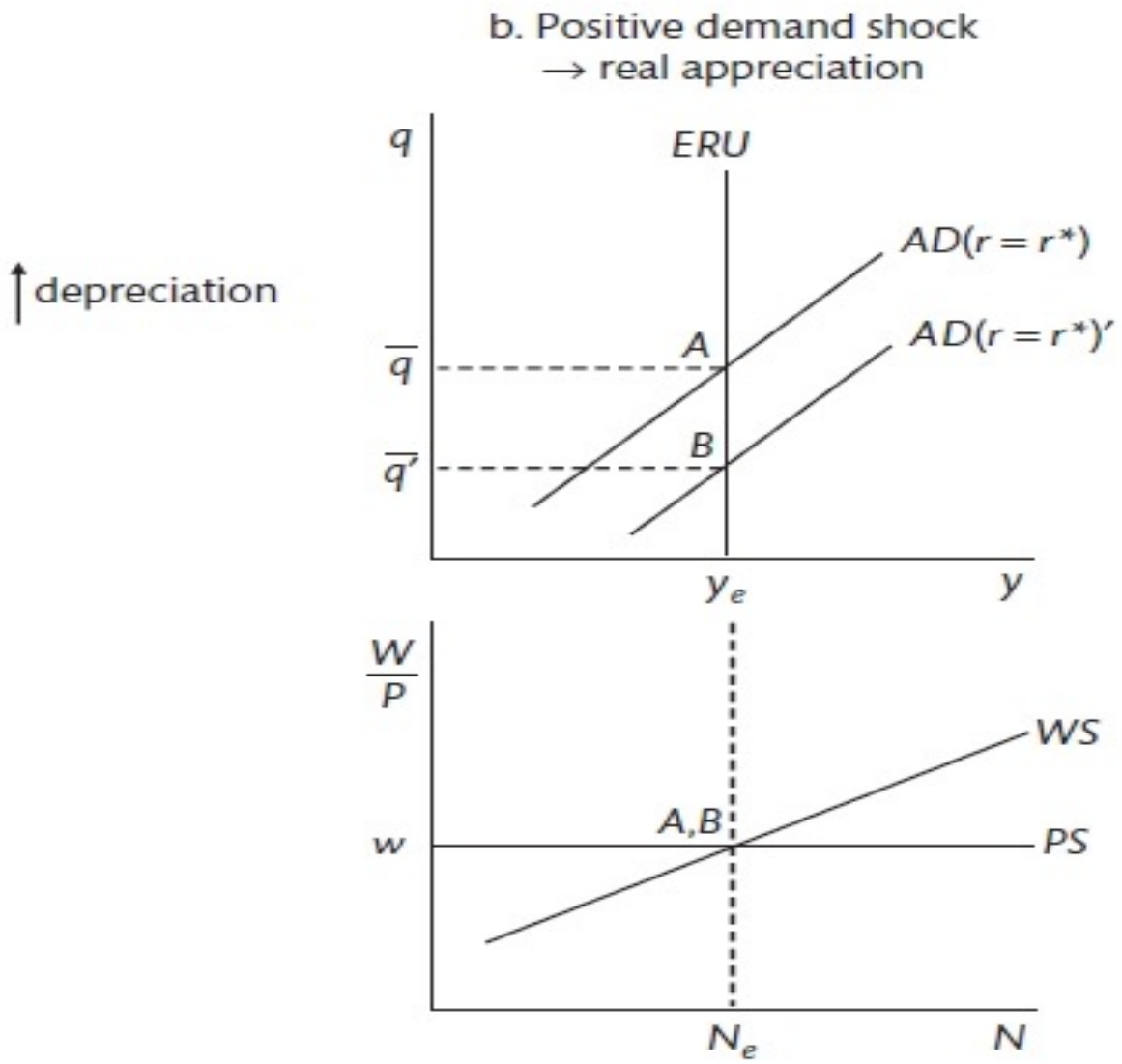
→ ERU shifts right

→ New equilibrium $\bar{q}' \uparrow$ (depreciation)

& $y_e \uparrow$

→ For $y_{AD} = y_e{}'$, need $q \uparrow$.

EXAMPLE



Example:

b. +ve AD Shock

→ AD shifts rightwards

→ New equilibrium $\bar{q}' \downarrow$ (appreciation)

& y_e costant.

→ r is fixed at r^*, so need $q \downarrow$ for $y_{AD} = y_e$.

EFFECTS OF SHOCKS ON MEDIUM RUN EQUILIBRIUM

Quick Summary: *Shock implications for the med-run equilibrium*

Table 9.1 Supply and demand shocks: implications for medium-run equilibrium.

	Shock		
	Rise in productivity	**Fall in union bargaining power**	**Increase in autonomous consumption**
Equilibrium unemployment	↓	↓	no change
Real exchange rate	depreciation	depreciation	appreciation
Real wage	↑	no change	no change

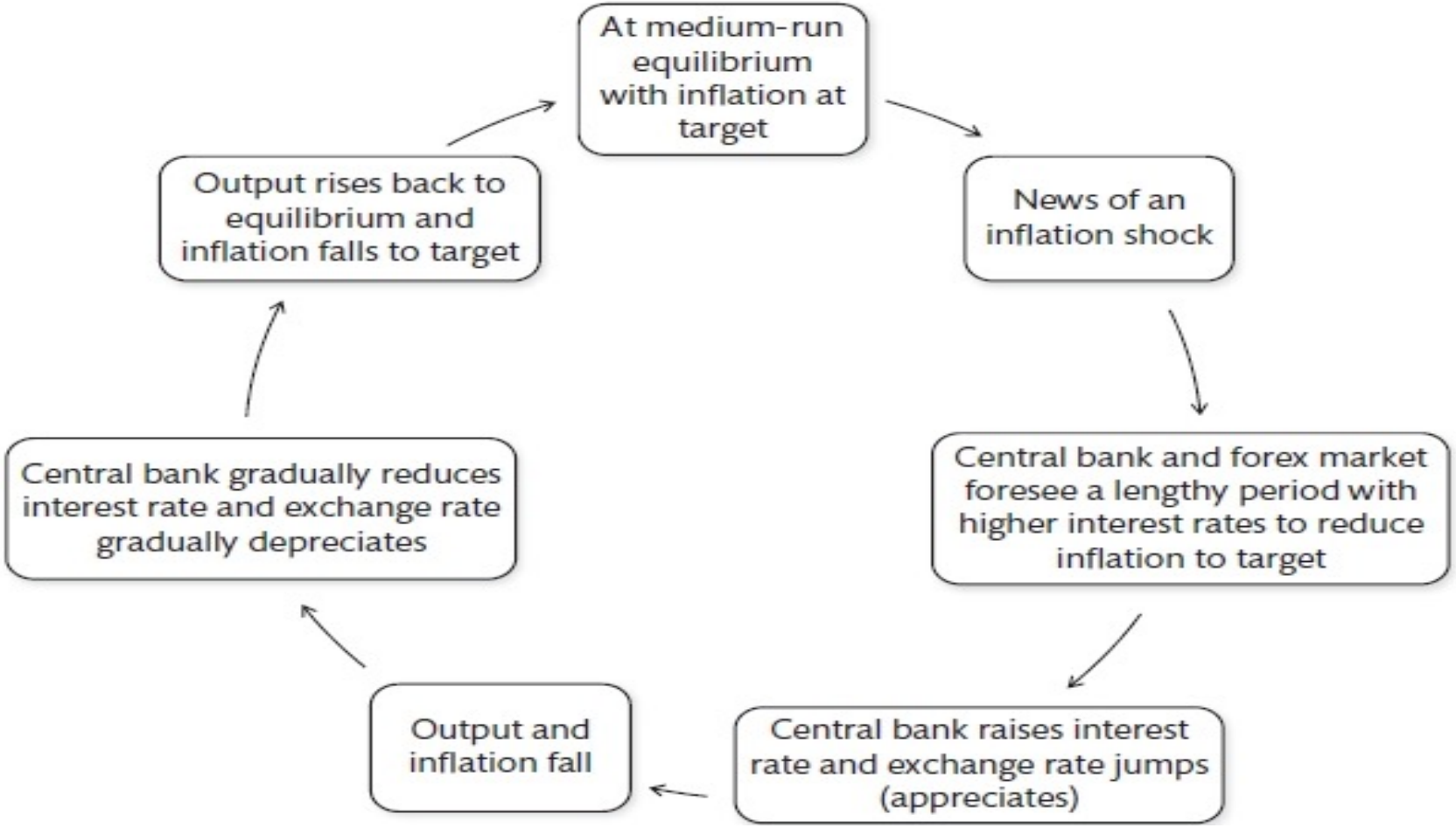
Note: ↑ means the variable is higher in the new medium-run equilibrium, ↓ means it is lower and 'no change' means it is unchanged. We assume a flat PS curve throughout.

STABILIZATION IN THE SHORT RUN: THE RX CURVE UNDER FLEXIBLE EXCHANGE RATES

- RX curve in the 3-eqn model: Shows the CB's best r —response taking into account forex market reactions.
- Assume the CB targets domestic π (excl. imports) and factors in:
  - *Forward-looking forex market behaviour*
  - *The effect of q on y.*
- As before, the CB minimizes its loss function subject to the PC, which yields the MR curve showing the desired y-gap.
- The desired y-gap is now implemented through the choice of r:
  - *using the open economy IS curve, and …*
  - *… factoring in the reaction of the forward-looking forex market.*
- Instead of adjusting back to equilibrium on the IS, the CB adjusts along the flatter RX curve (smaller Δr needed since q moves too).

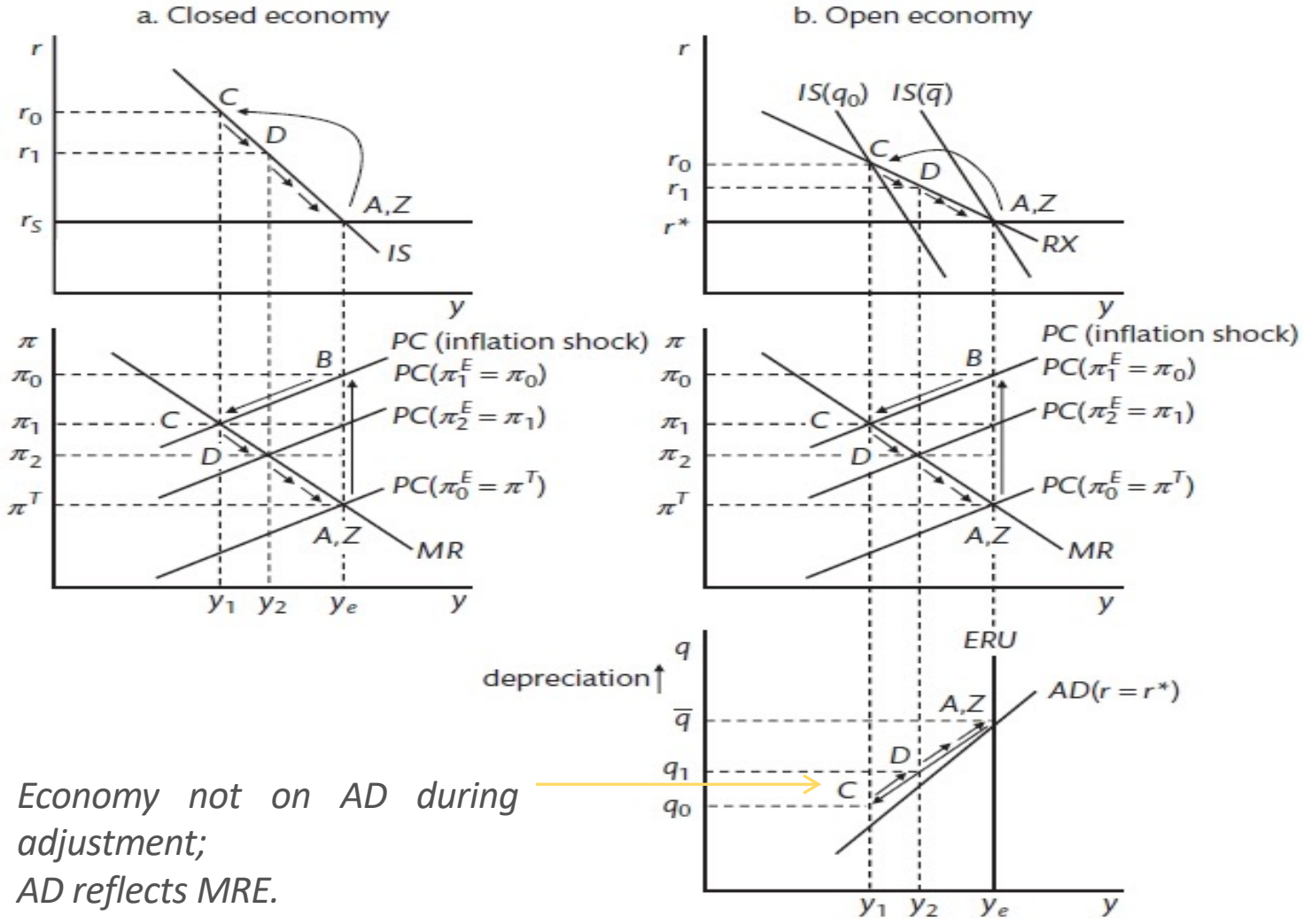
VISUAL REPRESENTATION

Fig 9.7: Dynamic adjustment to an inflation shock under flexible exchange rates and π- targeting



CLOSED V OPEN ECONOMIES: INFLATION SHOCK

Inflation shock: Closed vs Open economies



Economy not on AD during adjustment;
AD reflects MRE.

- Closed economy (Ch. 3)
- Open economy

Shock → Forex mkt foresees $r > r^*$ for some periods → via UIP: q ↓ immediately → to get economy on MR, CB sets r_0 on RX at 'C', which factors in the new $IS(q_0)$.

*Higher r_0 and appreciated q reduces y next period (lag) → y ↓ & π ↓ → PC shifts down & CB desires pt. 'D' now→ ** CB knows that lower r means ↑ q → IS predicted to shift right → As before, CB sets r_1 on RX.*

Process repeats until MRE 'Z' is reached.

CLOSED V OPEN ECONOMY ADJUSTMENT (CONTINUED)

1. Initial rate hike after π shock (to r_0) is greater in closed economy, q appreciation shoulders the burden.
2. IS shifts each period in the open economy as the change in q also changes y due to net exports.
3. The closed economy moves along IS to equilibrium; the open economy moves along the flatter RX back to equilibrium

<u>Key features of the RX:</u>

1. Goes through the intersection of r^* and y_e; RX shifts iff these shift.
2. Slope reflects (i) int. rate and exchange rate sensitivity of AD, (ii) the CB's preference and (iii) the PC's slope:
   a. *Flatter than the IS: RX is flatter if IS is flatter (ie. higher r or q sensitivity)*
   b. *Flatter if the MR is steeper (i.e. flatter PC or CB is less π averse)*

Note: Flatter RX means CB raises int. rate by less.

CLOSED V OPEN ECONOMIES (INFLATION SHOCK)

Impulse Responses from an inflation shock

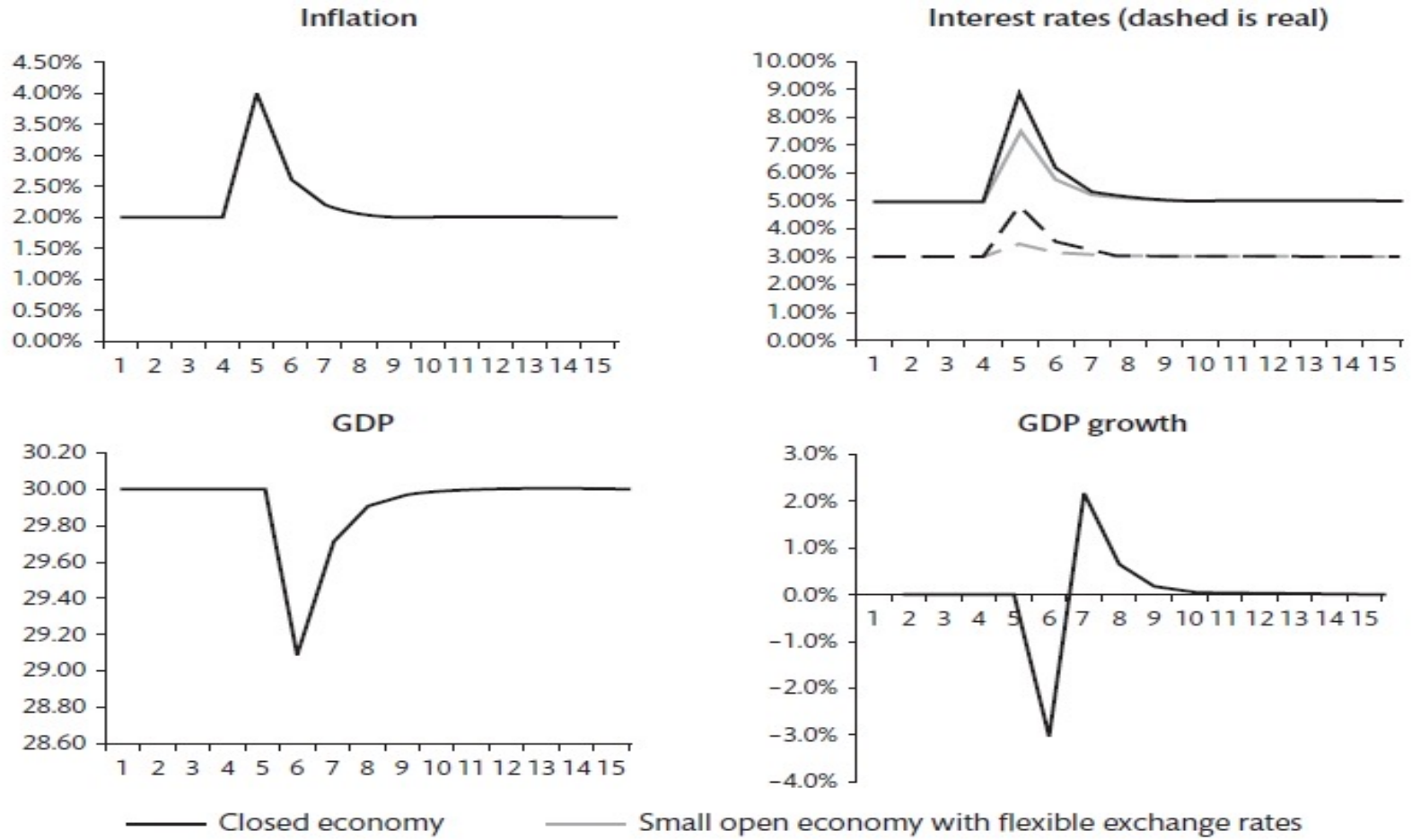


Figure 9.9 Macroeconomic simulator example—Impulse response functions after an inflation shock (in period 5) in a closed economy and a small open economy with flexible exchange rates.

** *Key difference in the interest rate response.*

Source: Macroeconomic Simulator from the Carlin and Soskice webpage