Two ways to we learn the model…

Graphical Interface:

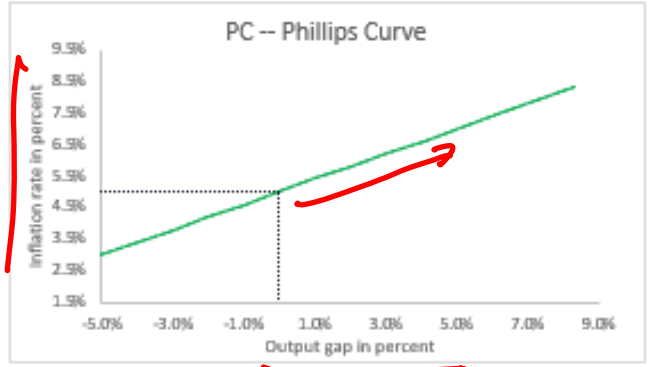
Model Algebra:

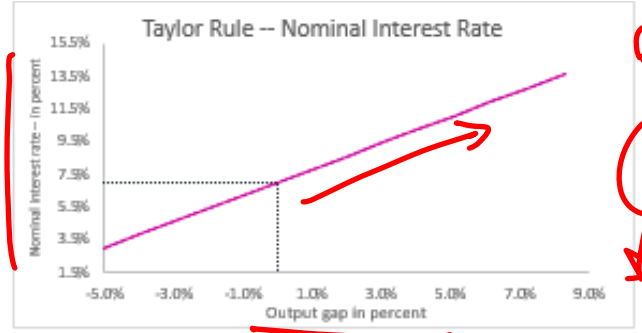
The equation you used in your SPREADSHEET.

→

Corresponding equation in the MODEL.

There are four core relationships in the model: you have already seen three.





$$RER_t = r_t^{EXT} + rp_t - \bar{r}_t + RER_{t+1}^{*}$$

External real interest rate — Risk premium — Expected (or trend) real exchange rate

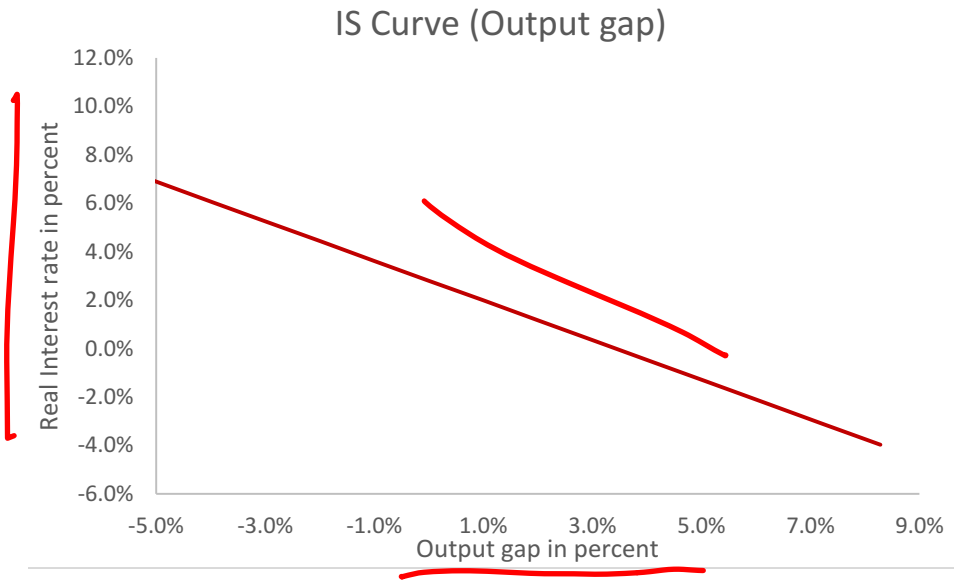
1. An aggregate supply or "**Phillips Curve**" relationship – inflation/output gap, etc.

2. A monetary policy relationship or "**Taylor Rule**," that shows how the central bank sets interest rates.

3. An **interest rate parity equation** that links the real exchange rate to foreign and domestic monetary policies.

The Fourth Core Relationship

Equilibrium in Goods/Services Market – **"IS" (Investment/Savings) Relationship**



The IS curve summarizes equilibrium in the market for goods and services.

Downward slope in output/real interest rate space;

Two channels – an increase in the interest rate:

- Restrains domestic spending.
- Appreciates the currency, discouraging exports, encouraging imports.

Deriving the IS Curve

$$Y = C + I + G + NX$$

X − IM

National Accounting Identity:

What we produce (Y) equals the sum of expenditures on consumption, investment, government, and net exports (exports minus imports).

Next segment: will examine behavioral assumptions behind each of these components – deriving the IS curve from the bottom up.

Domestic Expenditure Elements

$$Y = C + I + G + NX$$

Domestic Expenditures - 1

$$Y = C + I + G + NX$$

The equation you used in your spreadsheet.

$$\Delta\%C_t = \beta_{YC} * \Delta\%Y_t^d$$

Corresponding equation in the model.

$$C_t = a_{C0} + a_{CY} Y_t$$

a_{CY} = *marginal propensity to consume*

Consumption:

Rises with disposable income.

Assumption:

Disposable income rises one-to-one with output.

Domestic Expenditures - 2

$$Y = C + I + G + NX$$

The equation you used in your spreadsheet.

$$\Delta\%I_t = \beta_{IY}\Delta\%Y_t + \beta_{Ir}\Delta r_t$$

Corresponding equation in the model.

$$I_t = a_{I0} + a_{IY} * Y_t + a_{Ir}(r_t - \bar{r})$$

Investment:

Decrease with interest rates (higher cost of funds for firms, fewer profitable projects).

Increases with output (accelerator),

Domestic Expenditures Elements

$$Y = C + I + G + NX$$

In the spreadsheet, you obtained your government spending projection from detailed sector assumptions.

Corresponding equation in the model.

$$G_t = a_{0G} + GP_t$$

Government:

Determined by policy makers (finance ministry).

"Normal level" plus spending expansion or contraction.

External Sector Elements

$$Y = C + I + G + NX$$

Net Exports in the External Sector – 1a

Exports:

Potential output (installed capacity, productivity) – exogenous to the model.

Relative price of exports. – supply curves slope upward (higher prices encourage more production).

$$Y^P$$

$$RPX_t = \left[\frac{S_t * P_t^X}{P_t} \right]$$

Net Exports in the External Sector – 1b

The equation you used in your spreadsheet.

$$\Delta\%X_t = \Delta\%Y_t^P + \varepsilon_{X,RPX}\Delta\%RPX$$

Corresponding equation in the model.

$$X_t = a_{0X} + a_{1X} * rpx_t$$

Real price of exports (deviation from baseline)

Net Exports in the External Sector – 1c

Imports:

Rise with output (income effect)

Decreases with the relative price of imports – demand curves slope downward (higher prices discourage purchases).

$$Y_t$$

$$RPIM_t = \left[\frac{S_t * P_t^{IM}}{P_t} \right]$$

Net Exports in the External Sector – 1d

The equation you used in your spreadsheet.

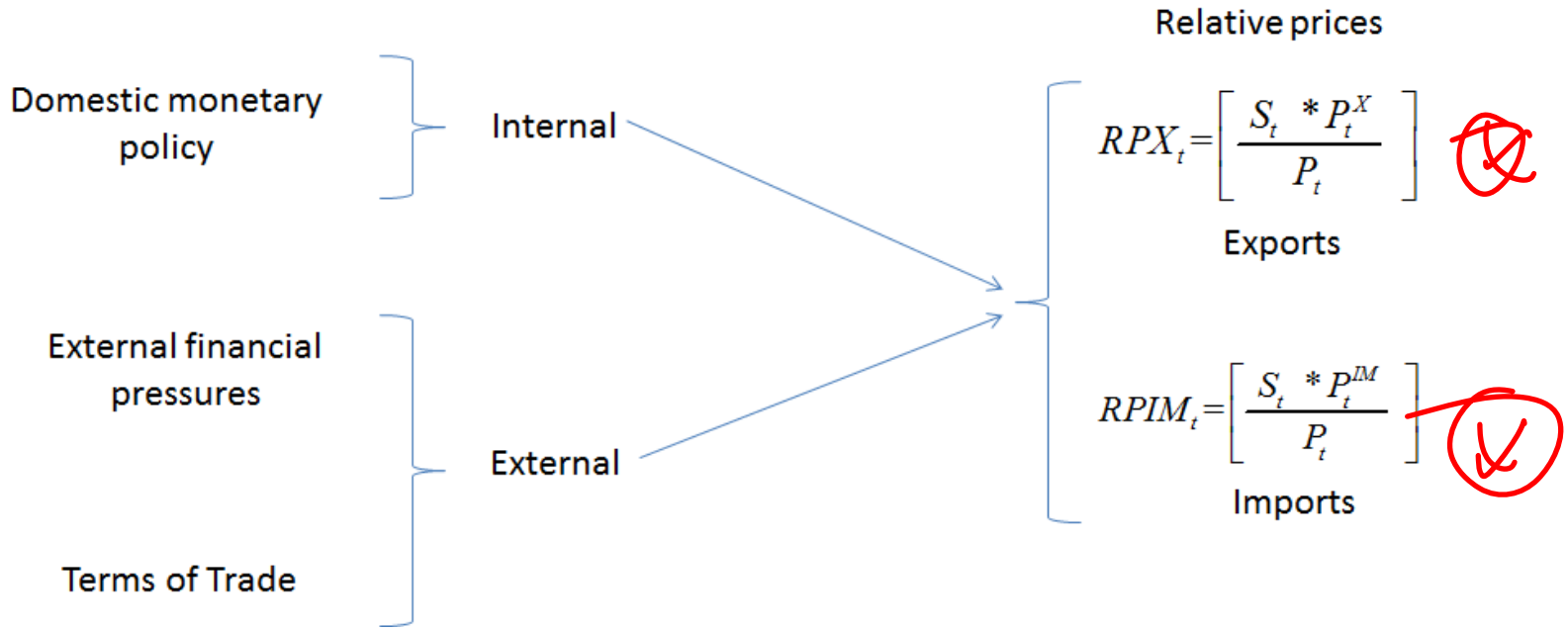
$$\Delta\%IM_t = \varepsilon_{IM,Y}\Delta\%Y_t + \varepsilon_{IM,RPIM}\Delta\%RPIM$$

Corresponding equation in the model.

$$IM_t = a_{0IM} + a_{1IM}Y_t + a_{2IM} * rpim_t$$

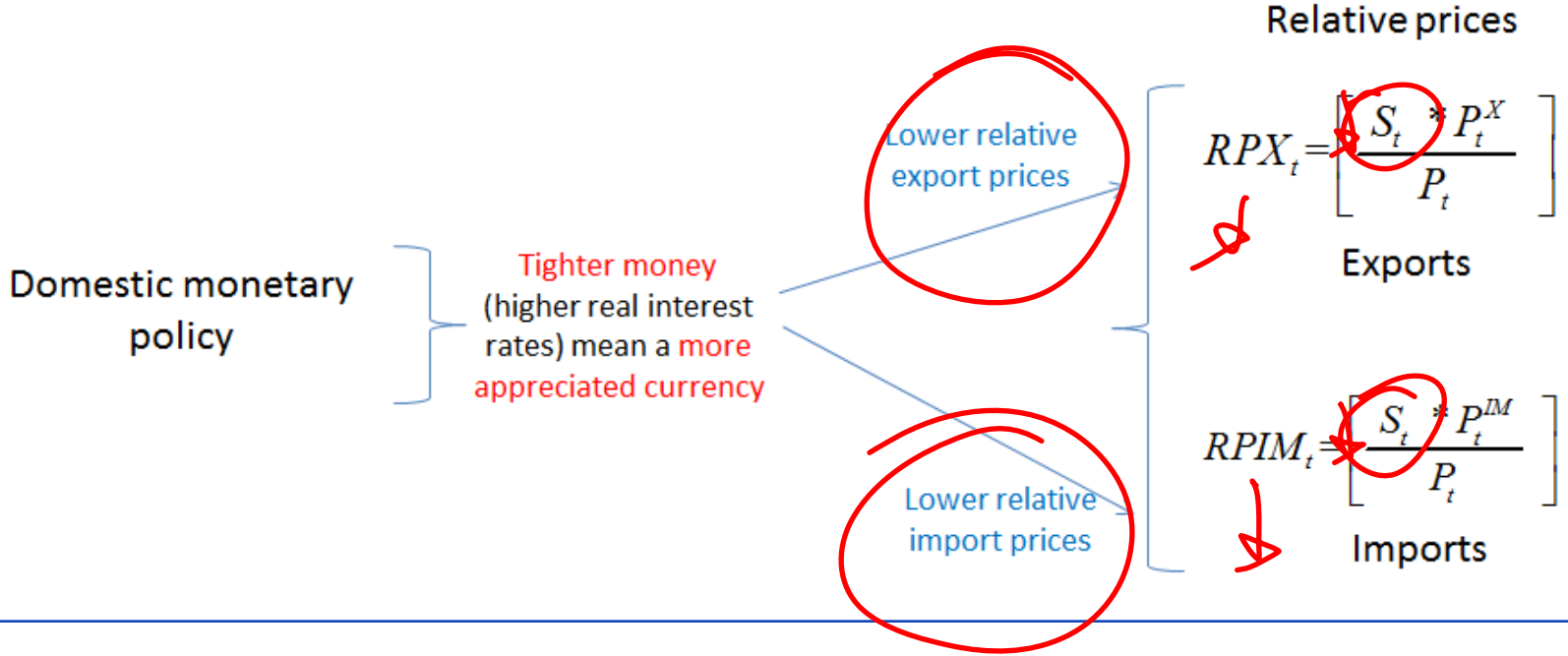
Net Exports in the External Sector – 2a

Both internal and external factors can impact the relative prices of exports and imports:



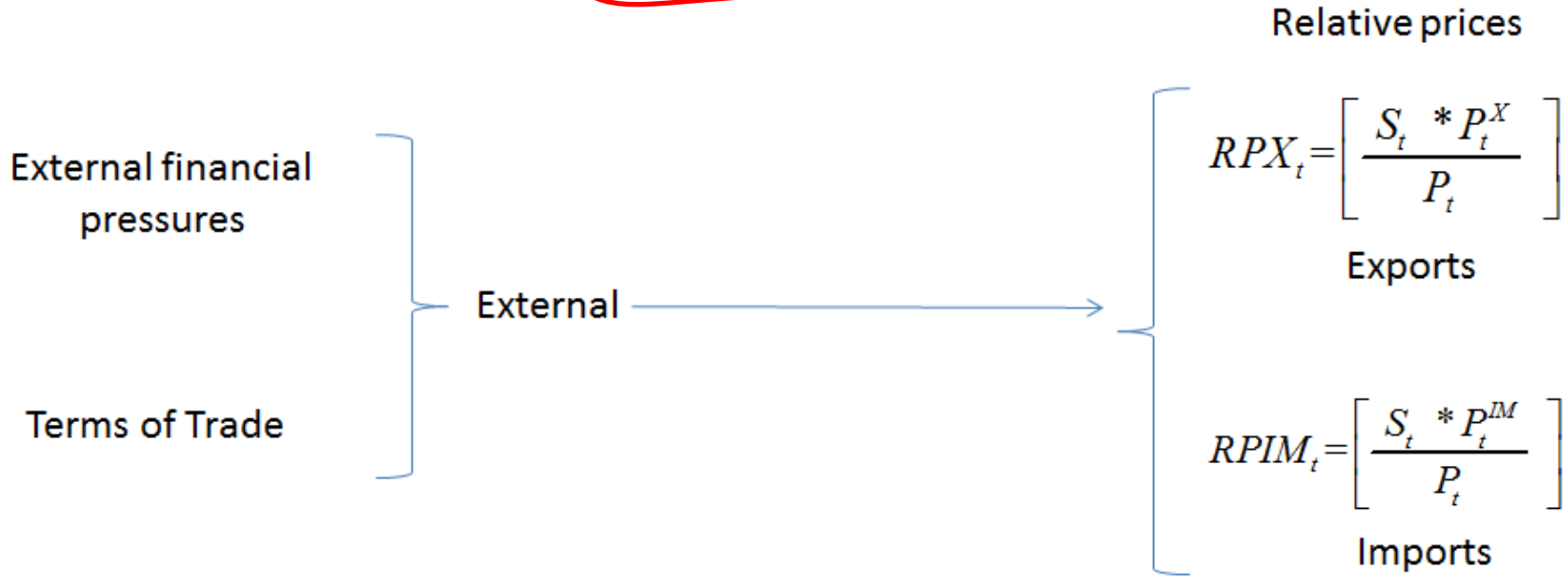
Net Exports in the External Sector – 2b

Internal monetary policy impact the
relative prices of exports and imports through the exchange rate
(reflects interest parity condition).

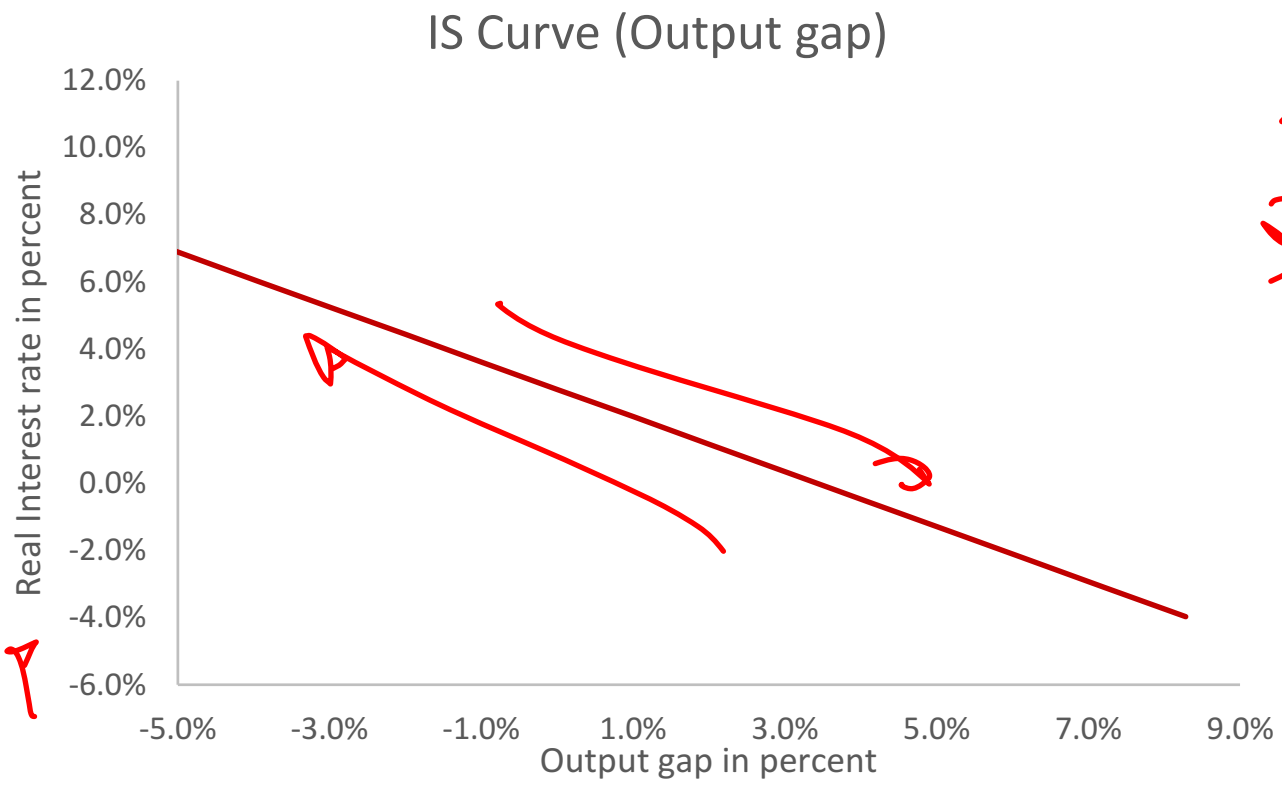


Net Exports in the External Sector – 2c

External factors can also impact the relative prices of exports and imports.
DISCUSSED LATER



The IS Curve and Net Exports



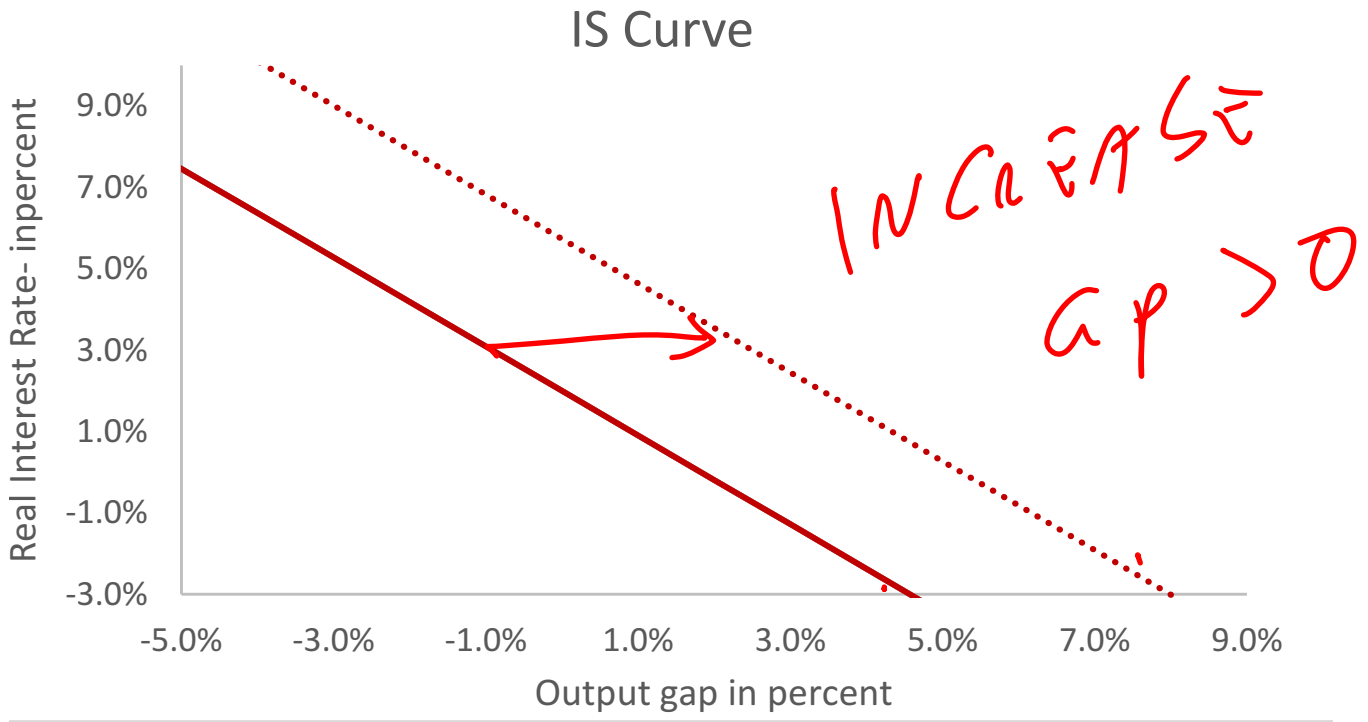
$$Y = C + I + G + NX$$

All else equal, when interest rates rise:

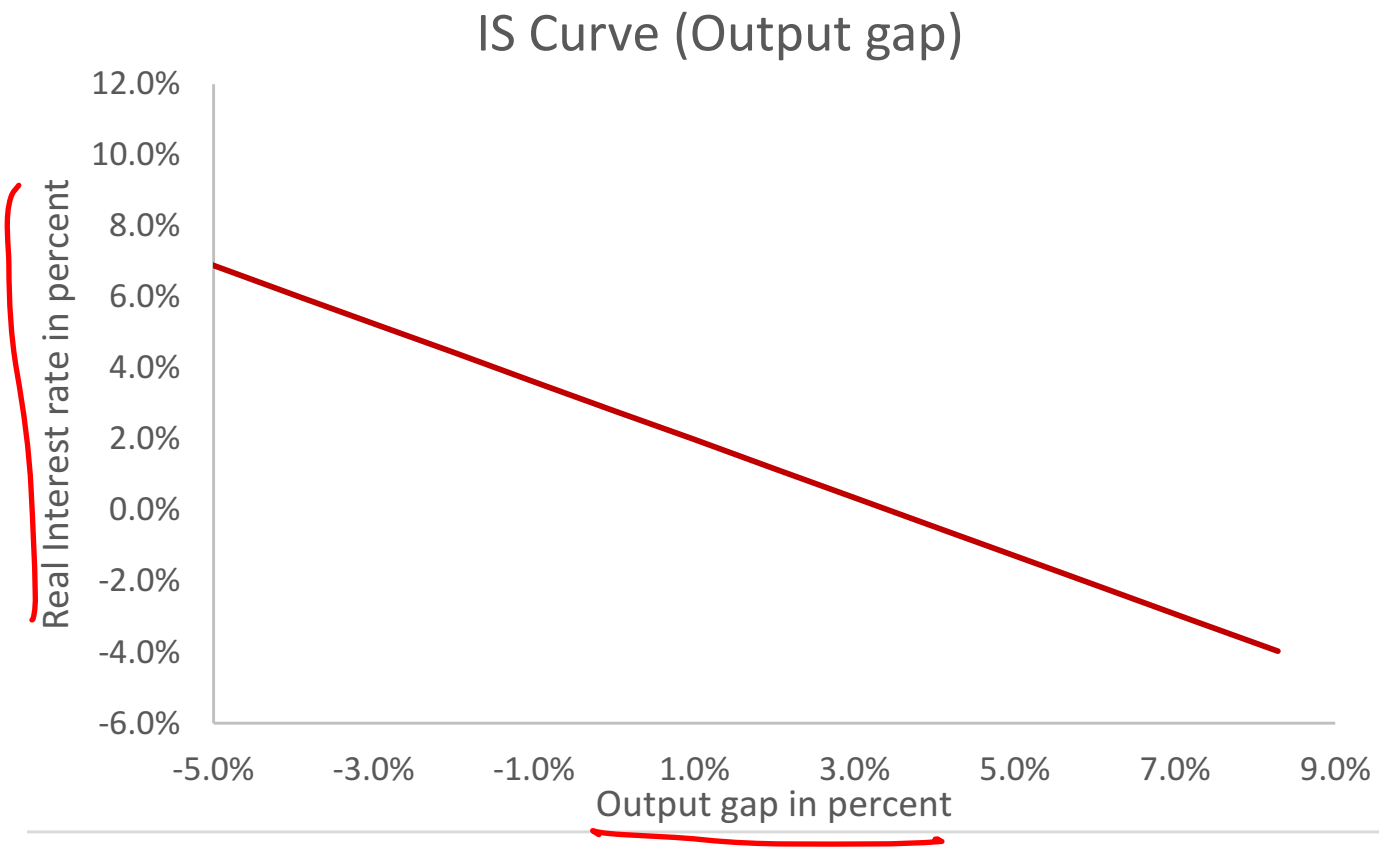
- Less domestic spending.
- External sector: exports discouraged, imports stimulated.

The IS Curve and Output Gap - 1

If we have a change in government spending (or tax policy) the IS curve shifts.



Adding in Monetary Policy



The full equilibrium level of output will be a function of interest rate.

Central Bank Policy Actions

Monetary Policy and Real Interest Rate - 1

A key goal of the central bank is to stabilize the price level.

$$i_t^{TAYLOR} = f[(\pi_t - \pi^*), \ldots]$$

Monetary Policy and Real Interest Rate - 2

According to the Phillips curve, inflation rises when higher demand pushes up the output gap….

$$\pi_t = g(gap_t, \pi^e, \ldots.)$$

Monetary Policy and Real Interest Rate - 3

Thus, the Phillips Curve is a constraint for the central bank.

$$i_t^{TAYLOR} = f[(\pi_t - \pi^*),\ldots]$$

$$\pi_t = g(gap_t, \pi^e, \ldots.)$$

Nominal Interest Rate - 1

$$\pi_t = g(gap_t, \pi^e, ...)$$

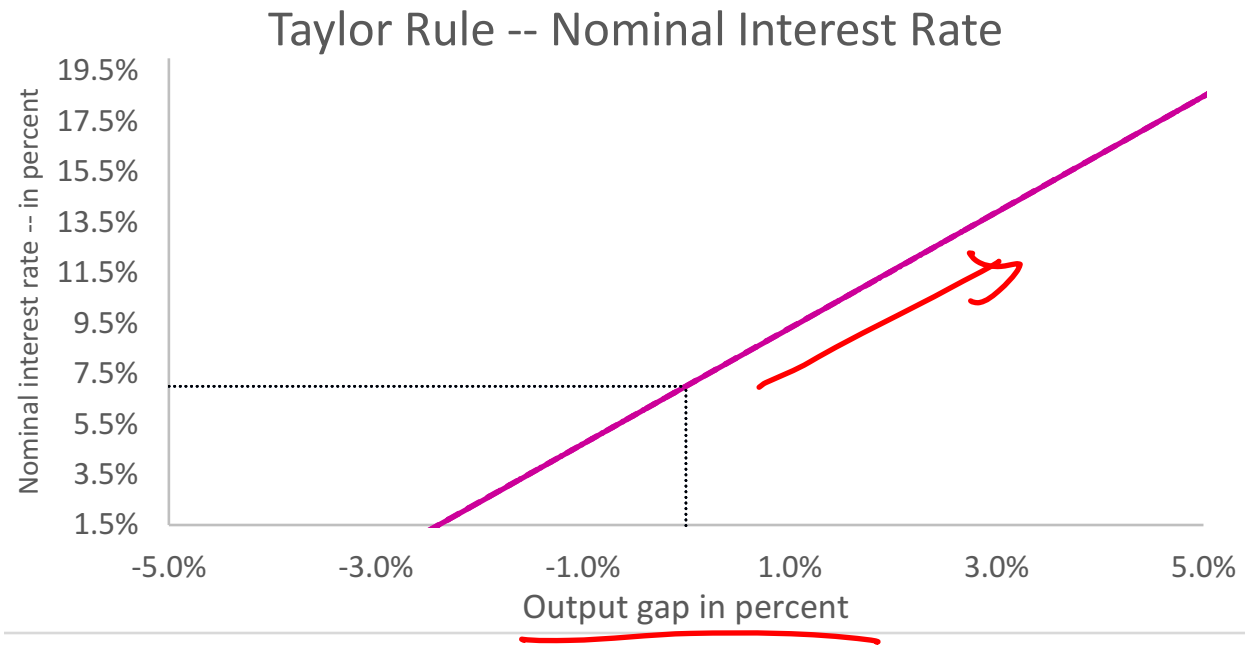
$$i_t^{TAYLOR} = f[(\pi_t - \pi^*), ...]$$

$$i_t^{TAYLOR} = f[(g(gap_t, \pi^e, ...) - \pi^*), ...]$$

Since the PC is a constraint for the Central bank, we can substitute it in to the Taylor Rule.

Intuition: Phillips curve is a constraint for central bank.

Nominal Interest Rate - 2



Result – upward sloping line in output gap and nominal interest rate space.

Intuition – The central bank sets the nominal rate of interest; all else equal an increase in the output gap that reflects more aggregate demand will mean higher inflation (Phillips Curve) -- so central bank raises interest rates.

Real Interest Rate

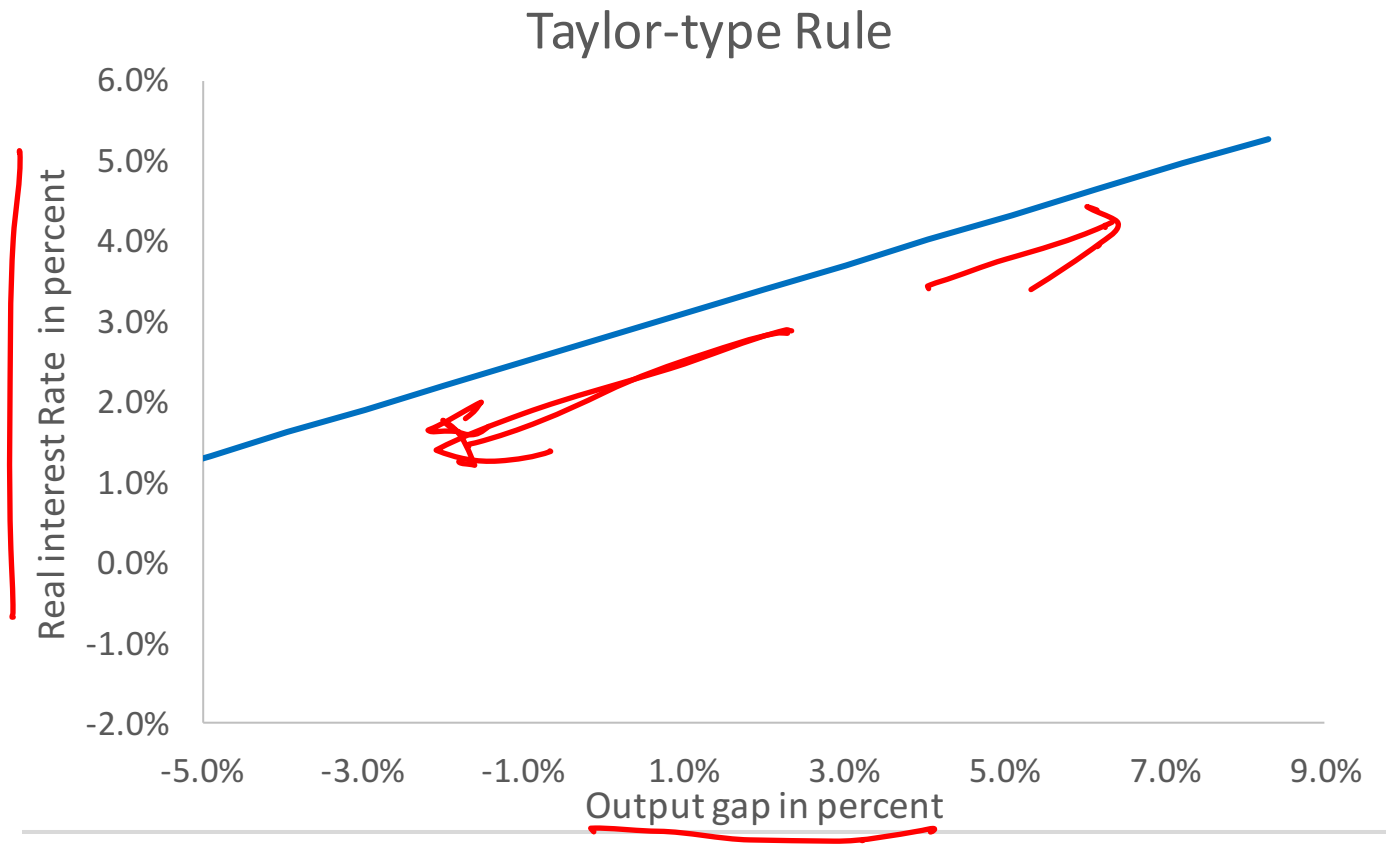
The REAL interest rate that matters for economic decision-making.

To obtain real interest rate… Subtract inflation (Phillips Curve) from nominal interest rate (Taylor rule).

$$r_t = i_t^{TAYLOR} - \pi_t$$

Real interest rate = nominal interest rate minus inflation.

Real Interest Rate



Result – upward sloping line in output gap and REAL interest rate space.

Intuition: when inflation rises, central bank has to increase *nominal* interest rate vigorously enough to also raise the *real* interest rate as well.

Macroeconomic Equilibrium – Graphical Representation

Core macro variables:

- Output gap
- Interest rate

} IS curve and Monetary Policy (Taylor-type rule) ⟵

- Inflation

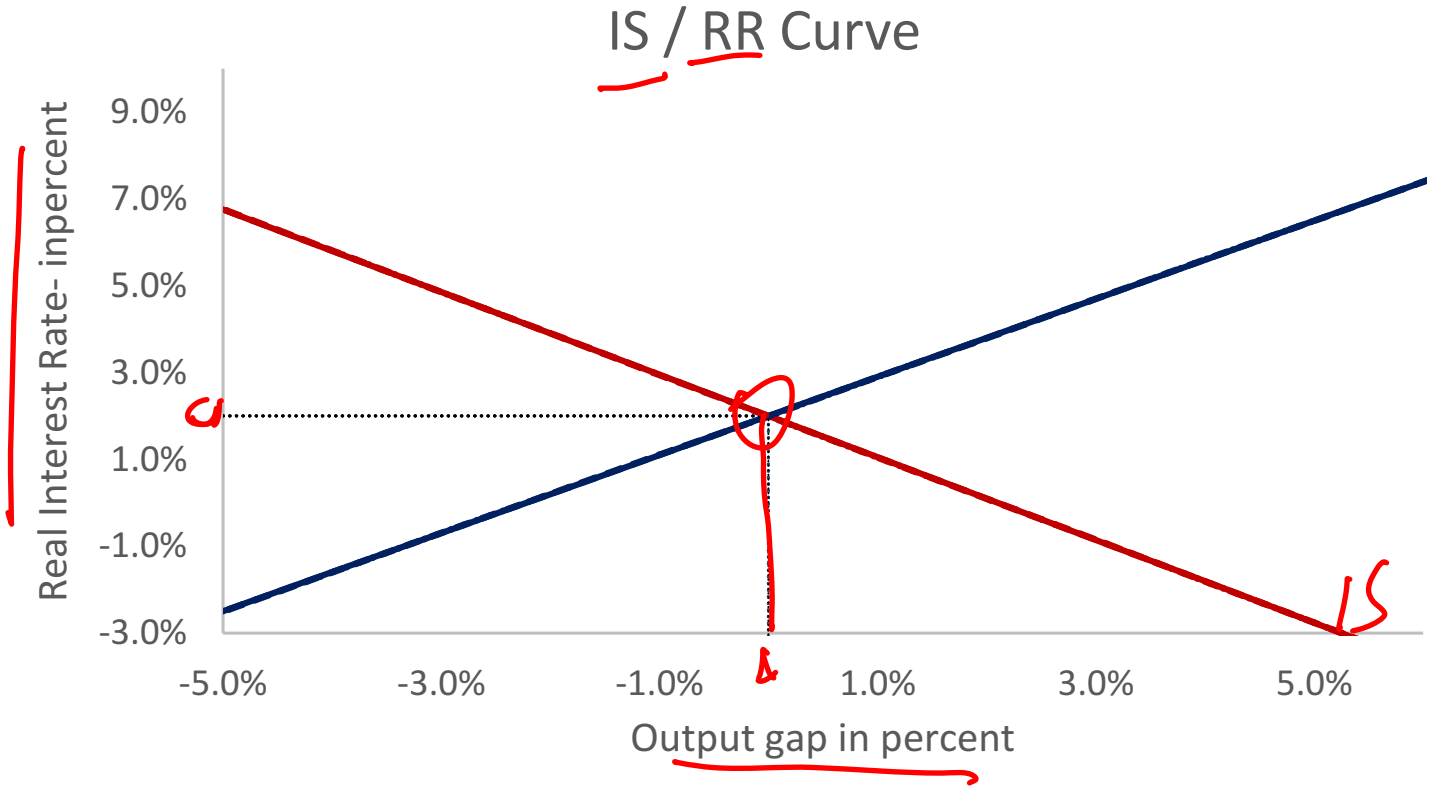
PC

External sector:

- Real exchange rate (relative to trend)
- Net exports

} Parity condition and net export equation.

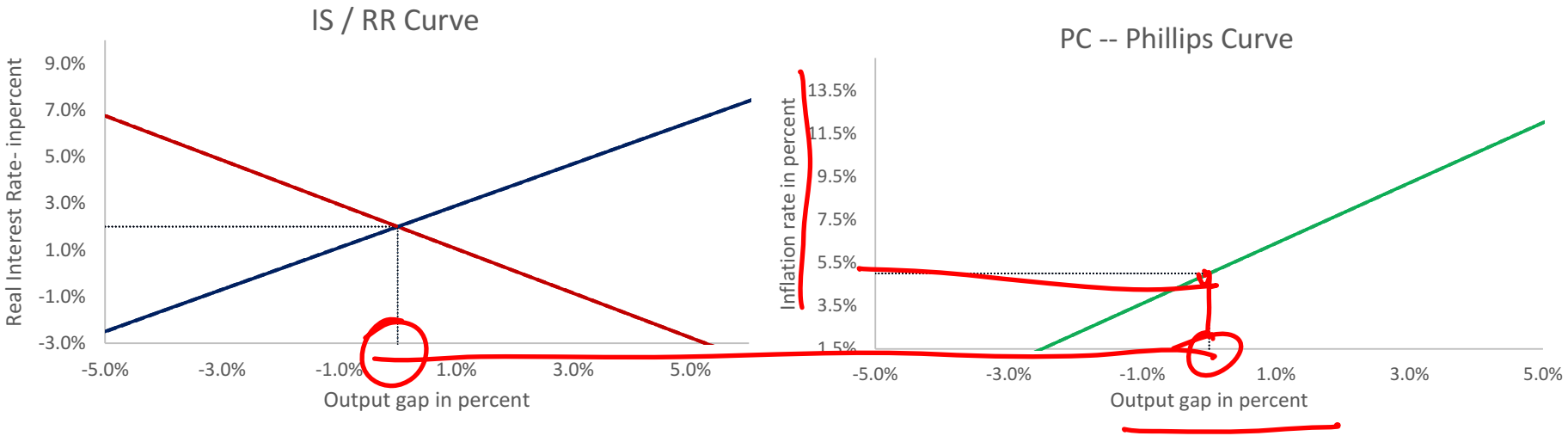
IS and RR



Thus we see an initial macroeconomic equilibrium – output gap and real interest rate – at intersection of IS and RR.

IS, RR, and the Phillips Curve

By adding the Phillips curve – which slopes upward in output gap and inflation rate space – we get the inflation rate!



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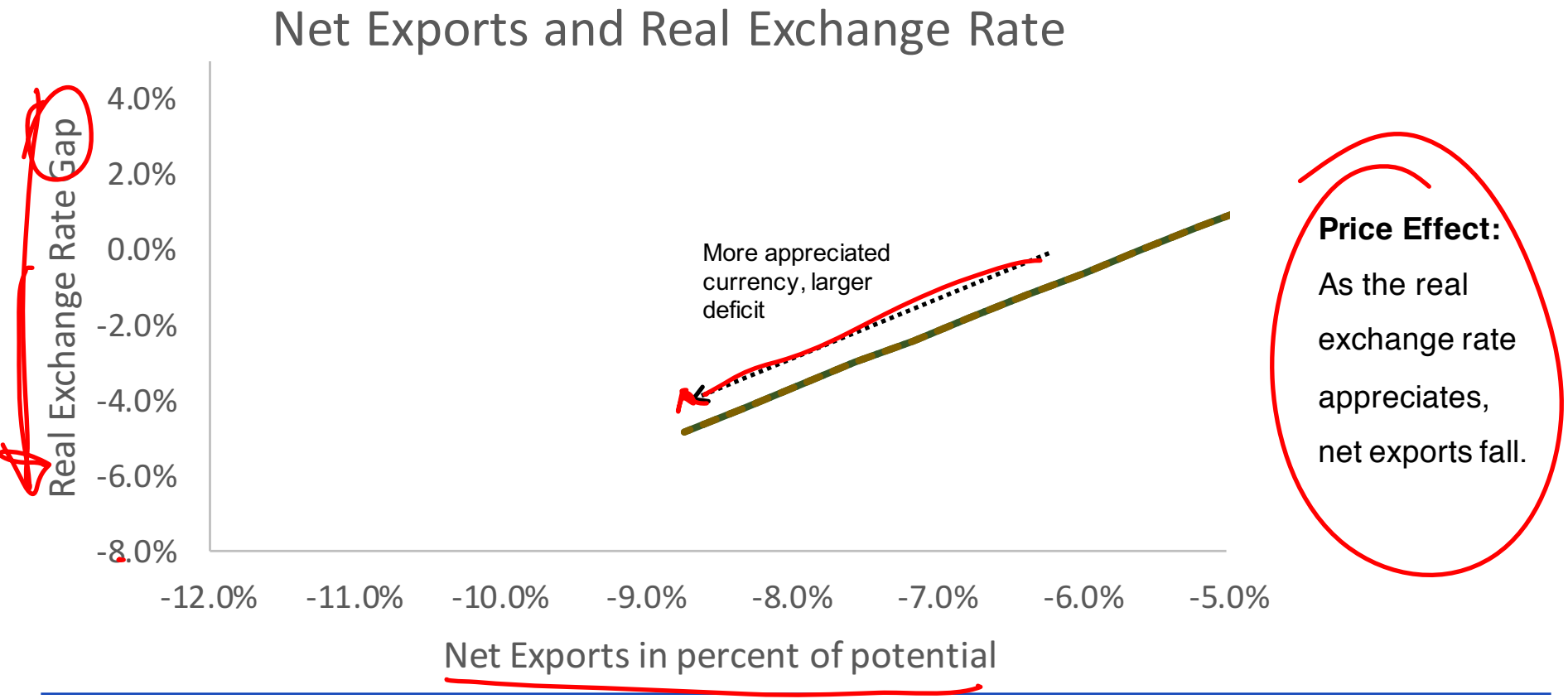
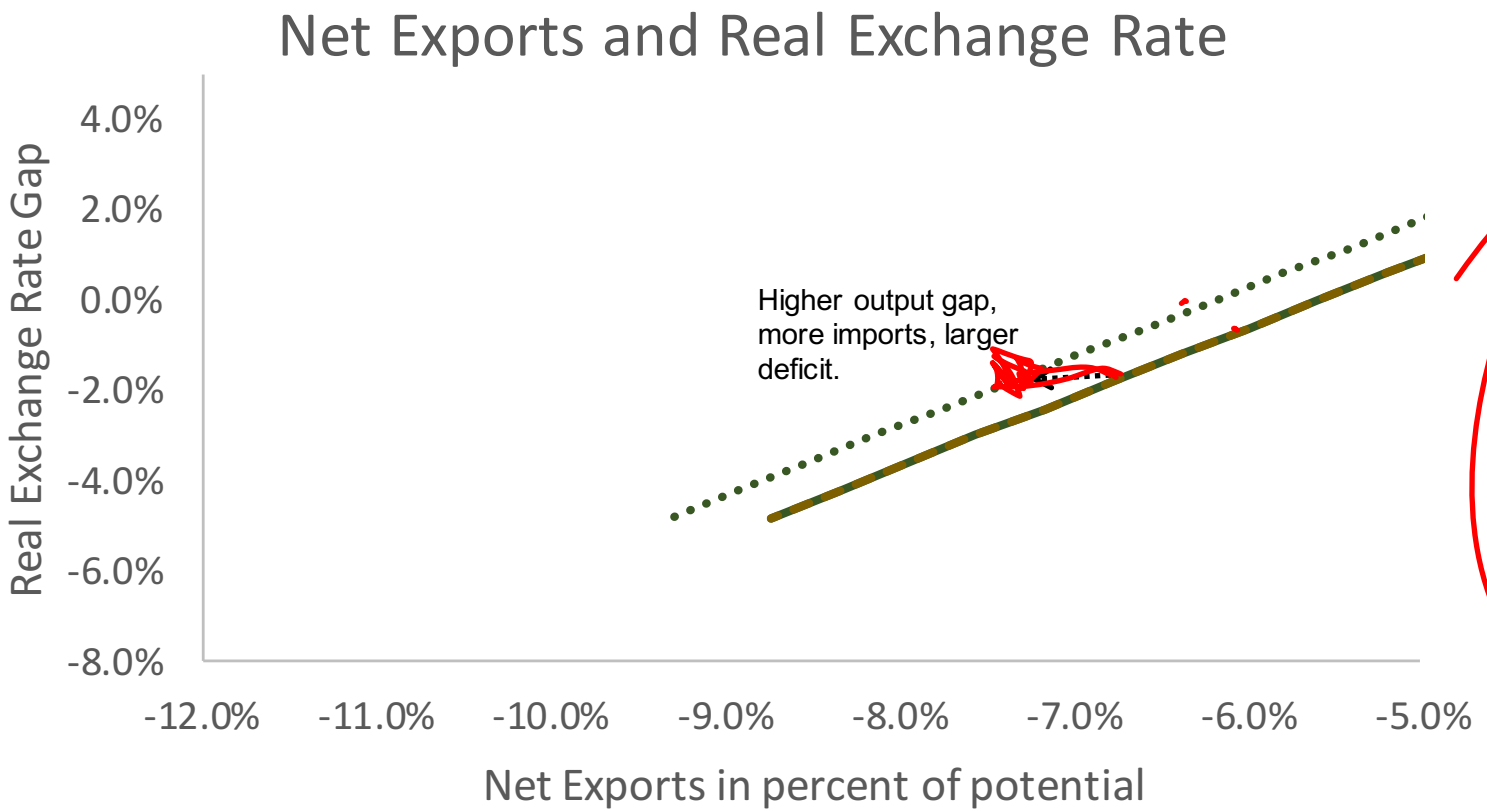
Net Exports and Real Exchange Rate – 1



Price Effect:

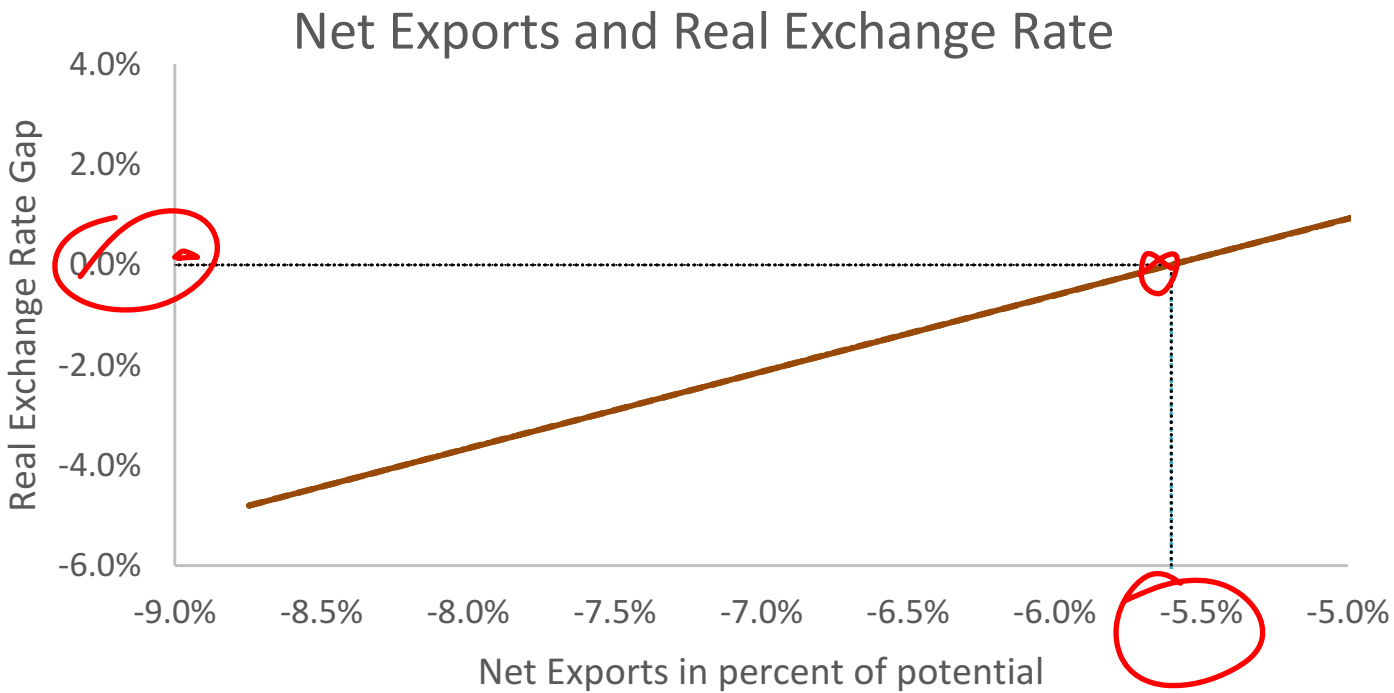
As the real exchange rate appreciates, net exports fall.

Net Exports and Real Exchange Rate – 2



Income Effect: Higher domestic income means more imports, larger deficit on net exports.

Net Exports and Real Exchange Rate – 3



Initial Equilibrium:

With zero output gap with real interest rates at their long-run, real exchange rate at its long run value, net exports are at their long run normal value (ratio to potential output).

Macronia's Risk Assessment

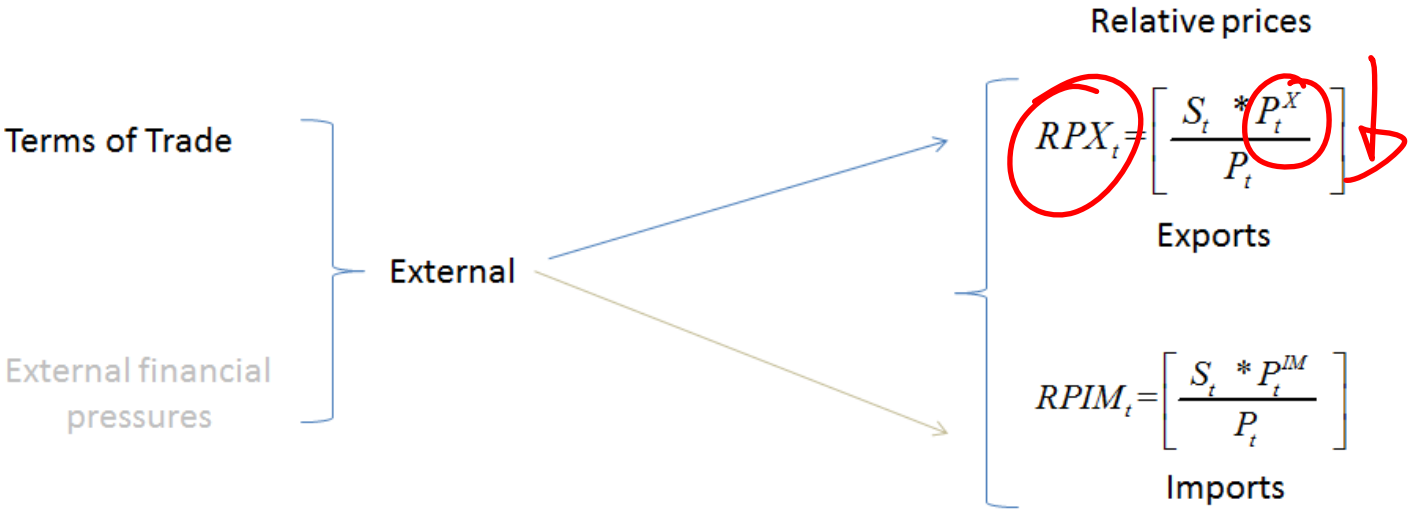
Two risk assessments:

A deterioration of Macronia's terms of trade – a fall in external demand.

Adverse external financial pressures that forces Macronia to reduce its expenditure and improve its net exports.

Macronia's Vulnerabilities: A Risk Assessment – 2

A fall in the world demand for a country's export:
Lower world export prices are transmitted to the domestic economy – through the IS curve.



Primary impact – on exports.

Macronia's External Financial Pressures – 1

$$RER_t = r_t^{EXT} + rp_t - r_t + RER_{t+1}^*$$

External real interest rate — *Risk premium* — *Expected (or trend) real exchange rate*

Tighter money abroad

This can happen with little warning.

Example: The "taper tantrum" of 2013

Macronia's External Financial Pressures – 2

$$RER_t = r_t^{EXT} + rp_t - r_t + RER^*_{t+1}$$

External real interest rate

Risk premium

Expected (or trend) real exchange rate

Investors get a "wake up call"

Sensing that the external situation may become unsustainable, they abandon their position in the country – often suddenly and abruptly!

Macronia's External Financial Pressures – 3

$$RER_t = r_t^{EXT} + rp_t - r_t + RER_{t+1}^*$$

External real interest rate — *Risk premium* — *Expected (or trend) real exchange rate*

In either case, investors now require even more compensation to hold a country's assets – a higher interest rate.

Raising the interest rate will help defend the currency.

But, it will also squeeze out expenditures at home – lower output.

Typically, we do see domestic interest rates rise – but not enough to fully prevent a depreciation of the exchange rate.

Macronia's External Financial Pressures – 4

$$RER_t = r_t^{EXT} + rp_t - r_t + RER_{t+1}^*$$

External real interest rate — *Risk premium* — *Expected (or trend) real exchange rate*

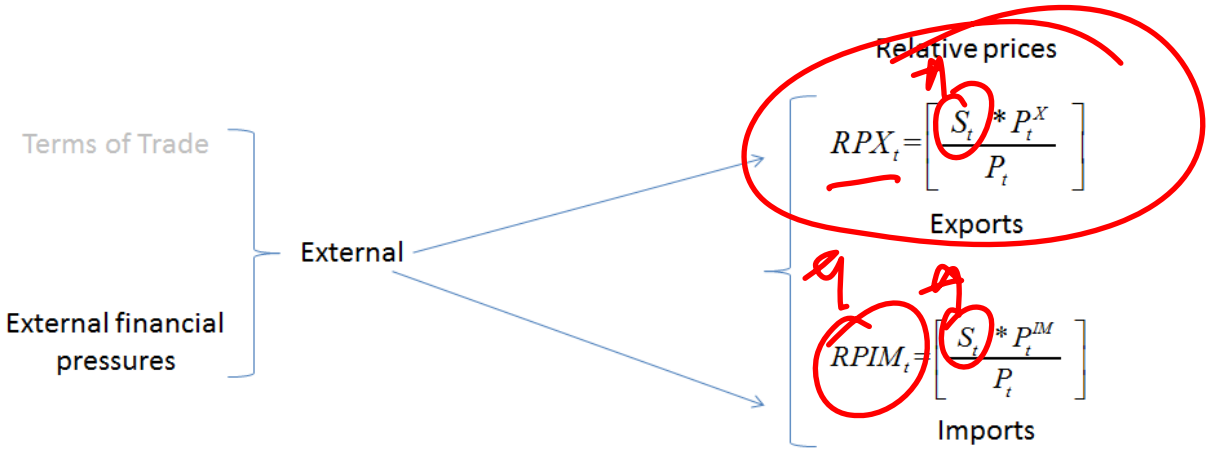
Instead, we will both some interest rate increase and some exchange rate depreciation.

We'll see that markets have forced the country to both rein in its domestic expenditures and to correct its external imbalances – a forced improvement in the net export balance.

Again, such an adjustment is not a happy scenario: it can happen suddenly and its adverse impacts can be severe.

Macronia's External Financial Pressures – 5

Adverse external financial pressures – higher world interest rates or risk premium -- are transmitted to the domestic economy through shifts in both the IS and RR curves



IS curve: exchange rate effects on net exports

RR curve: central bank raises interest rates defends the exchange rate (defense is only partial).