ECON1002 Intro. Macro.

Tutorial 11

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THE UNIVERSITY OF SYDNEY

Plan of Today

1. Concept Review
2. Tutorial Questions
3. Essay Task

   More info on FAQs

   Due: May 11th

Concept Review

Solow Swan Model – Production Function

<u>Production function</u>

$$Y = A \cdot F(K, L)$$

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Constant return to increase in both variables

Diminishing return to increase in single variable

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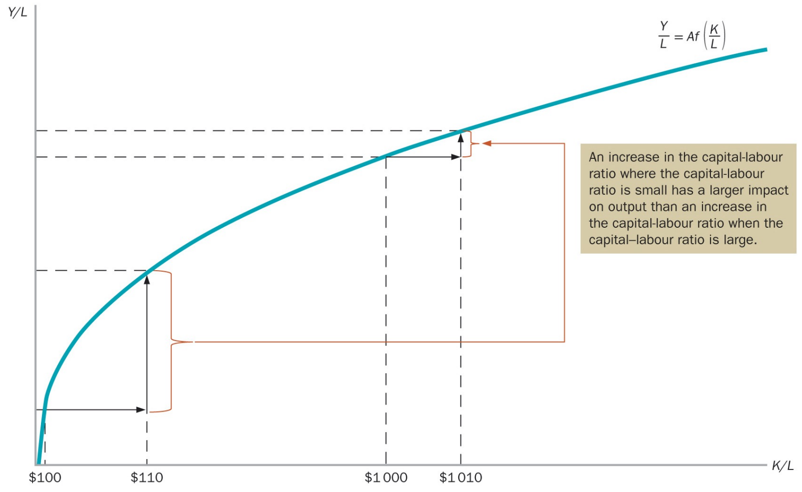

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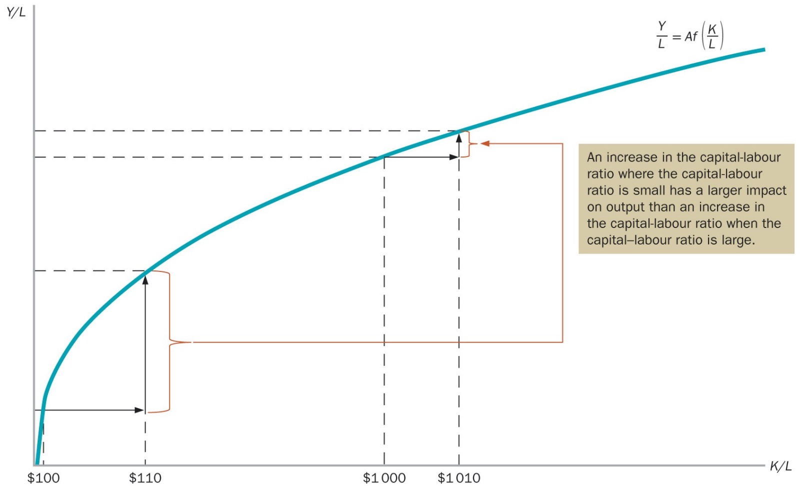

Cobb-Douglas example

$$Y = A \cdot K^{\alpha} \cdot L^{1-\alpha}$$

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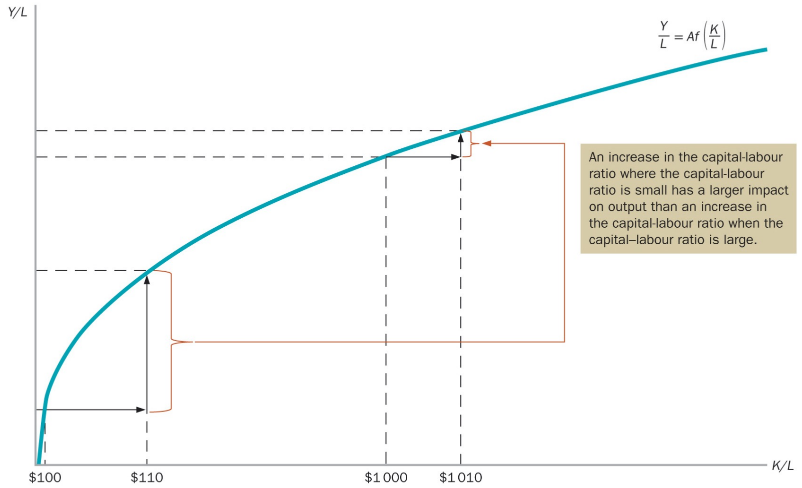

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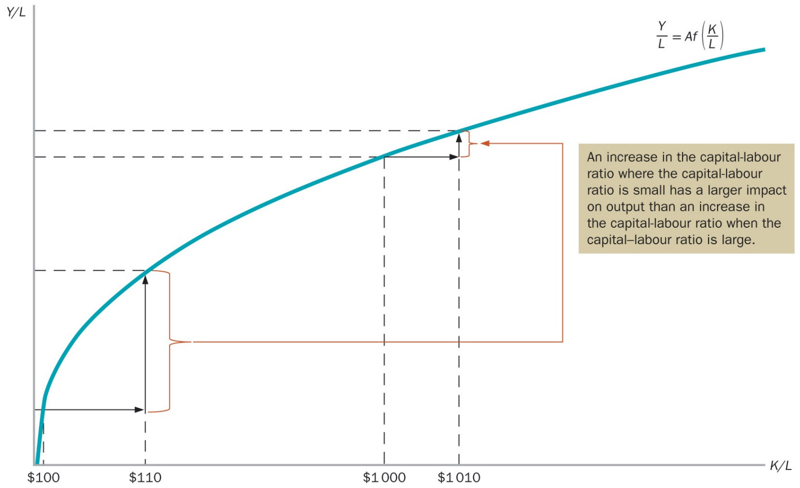

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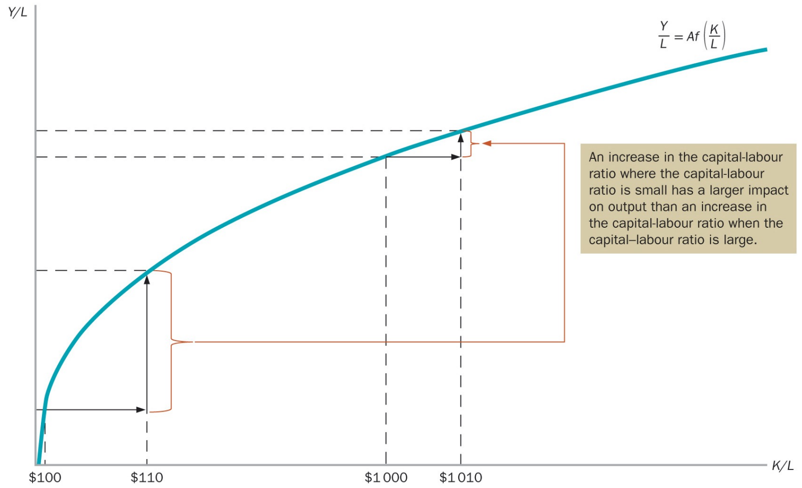

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$$Y = A \cdot K^{\alpha} \cdot L^{1-\alpha} \rightarrow \frac{Y}{L} = A \cdot K^{\alpha} \cdot L^{-\alpha}$$

$$\frac{Y}{L} = A \cdot \left(\frac{K}{L}\right)^{\alpha} \leftrightarrow \boxed{y = A \cdot k^{\alpha}}$$

Capital Accumulation

$$\Delta K = I - \delta K$$

Notation

K= capital

L= labor

I = investment

s = saving rate

δ = depreciation rate

n = population growth rate

Capital Accumulation

$$\Delta K = I - \delta K$$

$$I = s \cdot Y$$

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To prove this, we need calculus and time variable capital: $K(t)$

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$$\mathrm{K}_{\mathrm{t+1}} = \mathrm{sY}_{\mathrm{t+1}} + (1-\delta)K_t$$

$$\frac{\mathrm{K}_{\mathrm{t+1}}}{\mathrm{L}_{\mathrm{t+1}}} = \mathrm{s}\frac{\mathrm{Y}_{\mathrm{t+1}}}{\mathrm{L}_{\mathrm{t+1}}} + (1-\delta)\frac{K_t}{L_{t+1}}$$

$$k_{t+1} = \mathrm{s}\cdot\mathrm{y}_{\mathrm{t+1}} + (1-\delta)\frac{K_t}{(1+n)L_t}$$

$$k_{t+1} = \mathrm{s}\cdot\mathrm{y}_{\mathrm{t+1}} + (1-\delta)(1-n)\frac{K_t}{L_t}$$

$$k_{t+1} = \mathrm{s}\cdot\mathrm{y}_{\mathrm{t+1}} + (1-n-\delta-\delta n)k_t$$

$$k_{t+1} = \mathrm{s}\cdot\mathrm{y}_{\mathrm{t+1}} + k_t + (-n-\delta)k_t$$

$$k_{t+1} - k_t = \mathrm{s}\cdot\mathrm{y}_{\mathrm{t+1}} + (-n-\delta)k_t$$

$$\boxed{\Delta k_{t+1} = sy_{t+1} - (\delta+n)k_t}$$

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$$\Delta K = I - \delta K$$

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$$\Delta K = sY - \delta K$$

$$\Delta \frac{K}{L} = s \frac{Y}{L} - (\delta + n) \frac{K}{L}$$

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$$\boxed{\Delta k = sA \cdot k^{\alpha} - (\delta + n)k}$$

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Solow Swan Model – Solution

Cobb-Douglas production function

$$Y = A \cdot K^{\alpha} \cdot L^{1-\alpha}$$

$$\boxed{y = A \cdot k^{\alpha}}$$

Capital accumulation

$$\boxed{\Delta k = s \cdot A \cdot k^{\alpha} - (\delta + n)k}$$

Notation

A= tech (TFP)

K= capital

L= labor

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Steady state $(\Delta k = 0)$

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Steady state capital

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Steady state output

$$\boxed{y^{*} = A\left(\frac{sA}{\delta + n}\right)^{\frac{\alpha}{1-\alpha}}}$$

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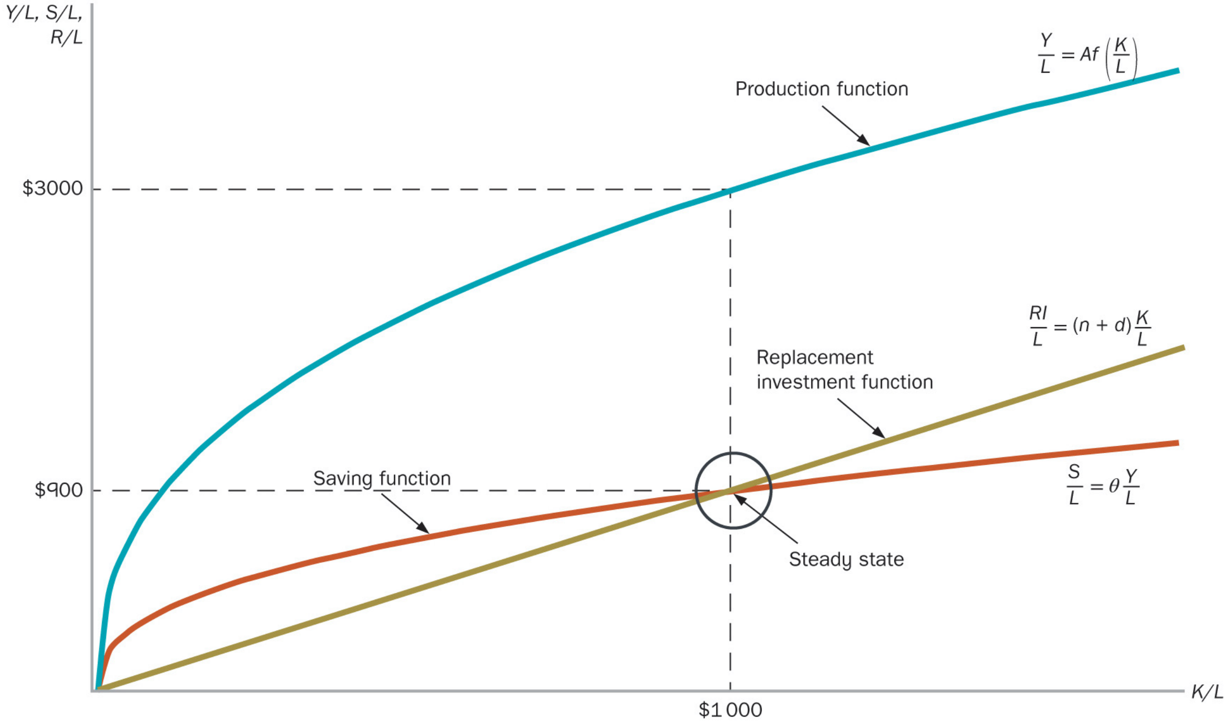
Solow Swan Model - Diagram



Tutorial Questions

Question 2 (Last week)

Richland's real GDP per person is $10,000, and Poorland's real GDP per person is $5000. However, Richland's real GDP is growing at 1% per year and Poorland's is growing at 3 per cent per year. Compare real GDP per person in the two countries after 10 years and after 0 years. Approximately how many years will it take Poorland to catch up with Richland?

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Catch up

$$10000 \times 1.01^t = 5000 \times 1.03^t$$

$$t = -\frac{\ln(2)}{\ln(101) - \ln(103)} \approx 35.3493$$

Question 1

How would you respond to the following argument: ‘Economic theory makes no sense. For example, poor countries have very little capital. But capital has diminishing marginal productivity. So, in poor countries, the marginal productivity of capital must be high. But then if capital is so productive in those countries, why is everyone not there rich?’

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High MPK attracts more investment, increases K in the long-run, thus higher living standard in the long-run

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The Swan-Solow neoclassical growth model can be represented by the following equation, $\Delta k_{t+1} = sf(k) - (\delta + n)k$

a. What do you understand by the above equation? List all the assumptions used to derive the above equation. Represent it graphically

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Saving

Depreciation + increase in population

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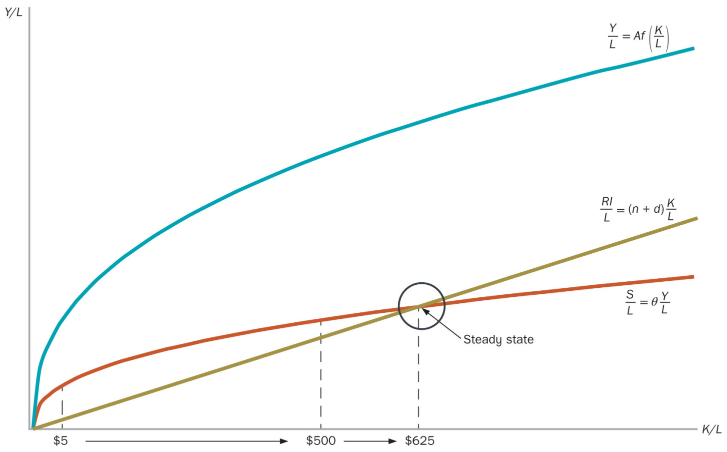

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The economy stops at the steady state

$$\boxed{k^* = \left(\frac{sA}{\delta + n}\right)^{\frac{1}{1-\alpha}}} \longrightarrow \boxed{y^* = A\left(\frac{sA}{\delta + n}\right)^{\frac{\alpha}{1-\alpha}}}$$

Only TFP can change long-run output & growth

Question 3

Show, using diagrams, the effects on output of an increase in the marginal propensity to save in the (i) basic Keynesian model (the 45-degree diagram) and (ii) the Solow-Swan model. Explain any differences

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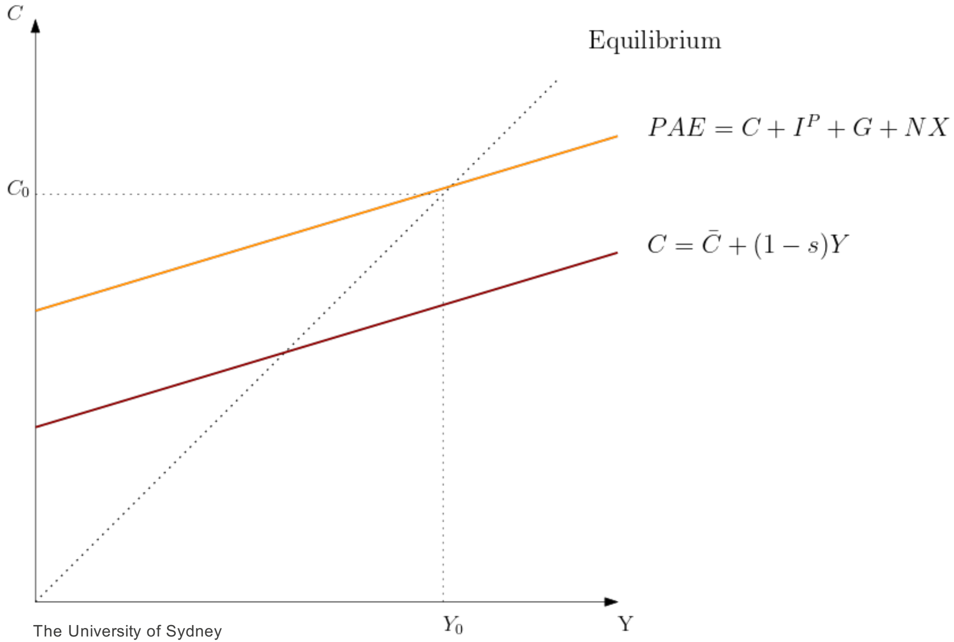

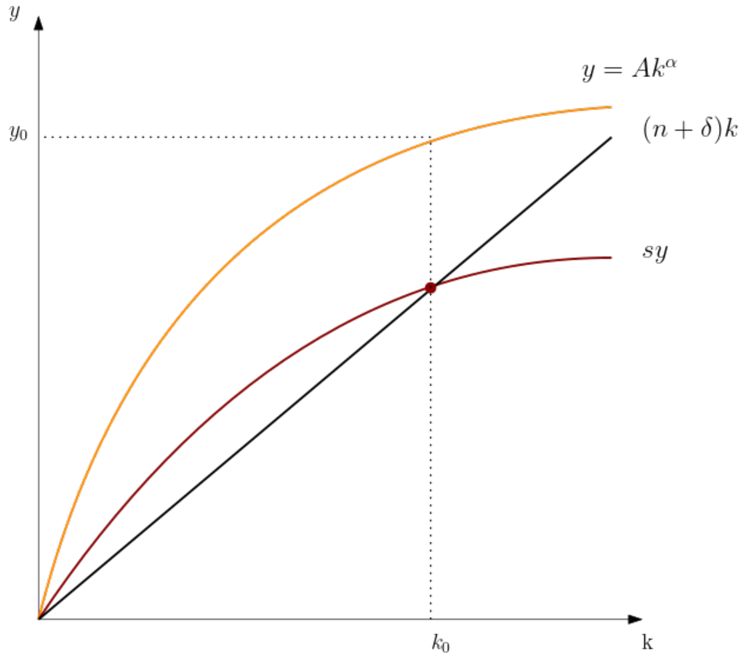

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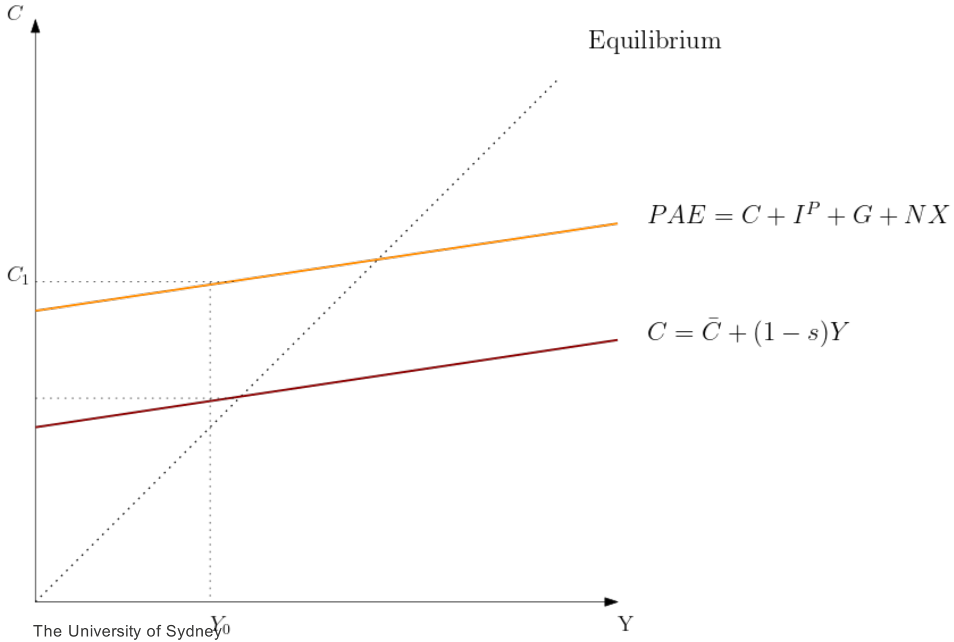

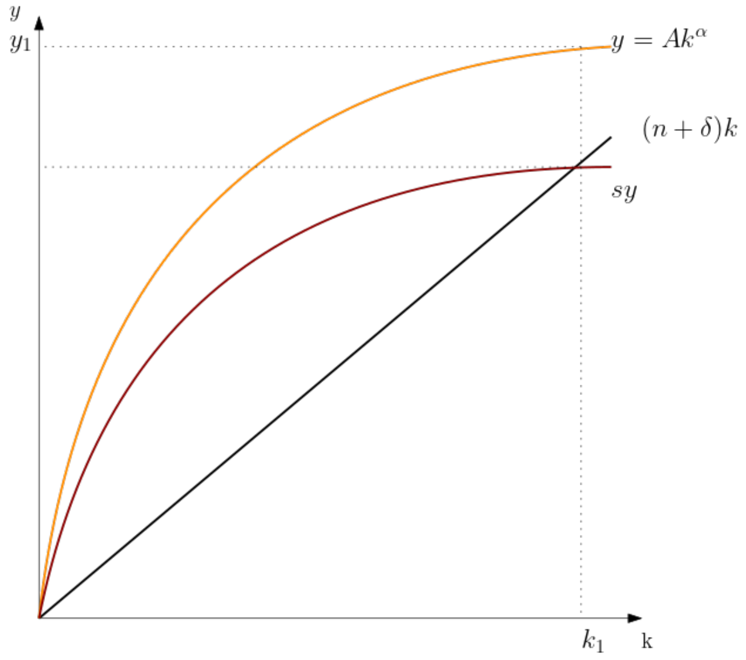

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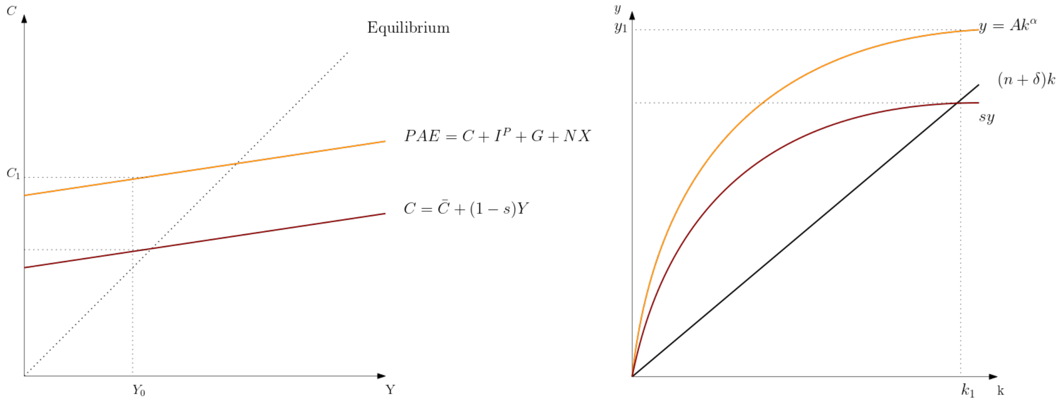

Why so different?

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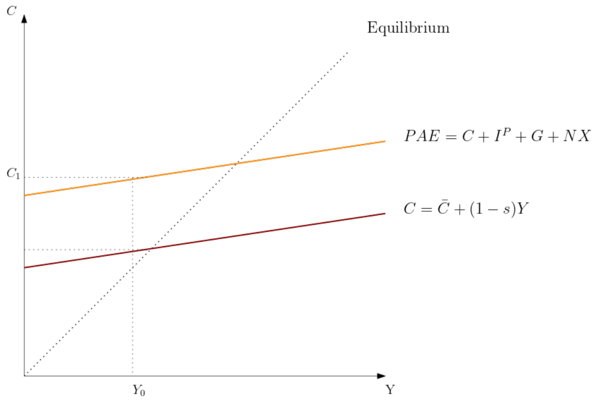

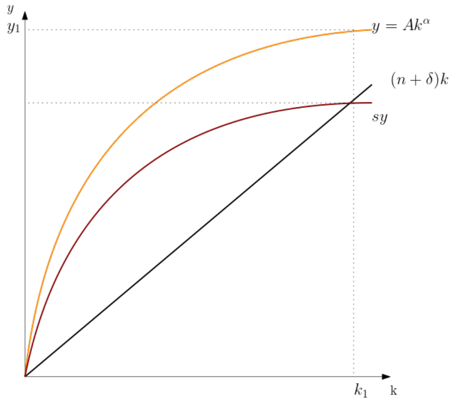

Why so different?

Short vs. Long-run

Question 4

Consider two countries ‘Milkie’ and ‘Cookie’. The two countries have identical per capita production function, $y = Ak^{0.5}$, with initially the same level of technology, $A = 1$.Also, assume that the saving rate is $s = 0.2$ for ‘Milkie’ and $s = 0.3$ for ‘Cookie’, respectively, while the two countries have identical population growth and depreciation rates both equal to 0.1.

a. Which country has a higher steady state income per capita?
Determine the steady state income per capita for each country.
Which country has a higher steady state growth rate in per capita income? Why?

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a. Which country has a higher steady state income per capita? Determine the steady state income per capita for each country. Which country has a higher steady state growth rate in per capita income? Why?

$$\boxed{k^* = \left(\frac{sA}{\delta + n}\right)^{\frac{1}{1-\alpha}}}$$

$$n = 0.1, \delta = 0.1, A = 1$$
$$s_M = 0.2, s_C = 0.3,$$

$$\boxed{y^* = A\left(\frac{sA}{\delta + n}\right)^{\frac{\alpha}{1-\alpha}}}$$

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Consider two countries ‘Milkie’ and ‘Cookie’. The two countries have identical per capita production function, $y = Ak^{0.5}$, with initially the same level of technology, $A = 1$.Also, assume that the saving rate is $s = 0.2$ for ‘Milkie’ and $s = 0.3$ for ‘Cookie’, respectively, while the two countries have identical population growth and depreciation rates both equal to 0.1.

a. Which country has a higher steady state income per capita? Determine the steady state income per capita for each country. Which country has a higher steady state growth rate in per capita income? Why?

$$\boxed{k^* = \left(\frac{sA}{\delta + n}\right)^{\frac{1}{1-\alpha}}}$$

$$\boxed{y^* = A\left(\frac{sA}{\delta + n}\right)^{\frac{\alpha}{1-\alpha}}}$$

$$n = 0.1, \delta = 0.1, A = 1$$
$$s_M = 0.2, s_C = 0.3,$$

$$k_M^* = \left(\frac{0.2}{0.1 + 0.1}\right)^{\frac{1}{1-0.5}} = 1$$

$$y = 1$$

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$$y = 1 \qquad y = \frac{3}{2}$$

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More saving → More capital → Higher Output

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b. Assume now that ‘Milkie’ experiences a productivity boom facing a higher value for A, $A = 2$ now for this country. All else remaining the same, how would it affect the steady state income for ‘Milkie’? Determine the new steady state income per capita for ‘Milkie’.

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$$k_M^* = \left(\frac{0.2 * 2}{0.1 + 0.1}\right)^{\frac{1}{1-0.5}} = 4$$

$$\boxed{y^* = A\left(\frac{sA}{\delta + n}\right)^{\frac{\alpha}{1-\alpha}}}$$

$$y = 4$$

Question 5

Consider the following table, showing population projections for Australia

Years	average pop. growth rate
2001/02 - 2009/10	1.023495299
2010/11 - 2019/20	0.839495726
2021/22 - 2029/30	0.666488749

(Source: ABS 3222.0 – Population Projections 2002 – 2051, Series B)

Using the Solow-Swan diagram, and assuming everything else is held constant, what will be the effect on the economy's steady-state level of per capita GDP of the trend displayed in the table? Does this finding have any implications for other countries in our region – discuss.

Question 5

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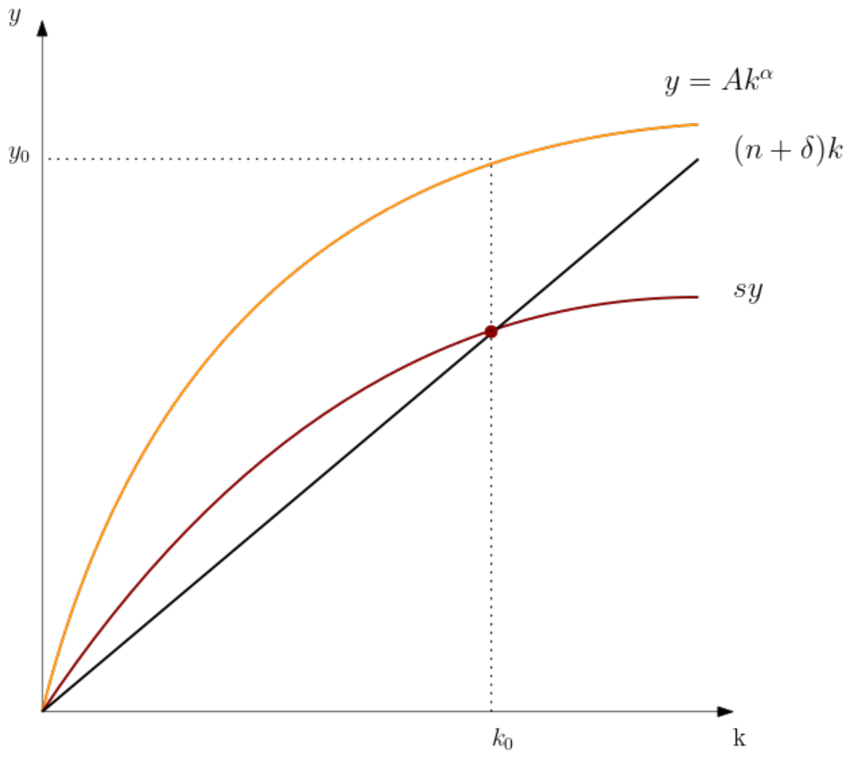

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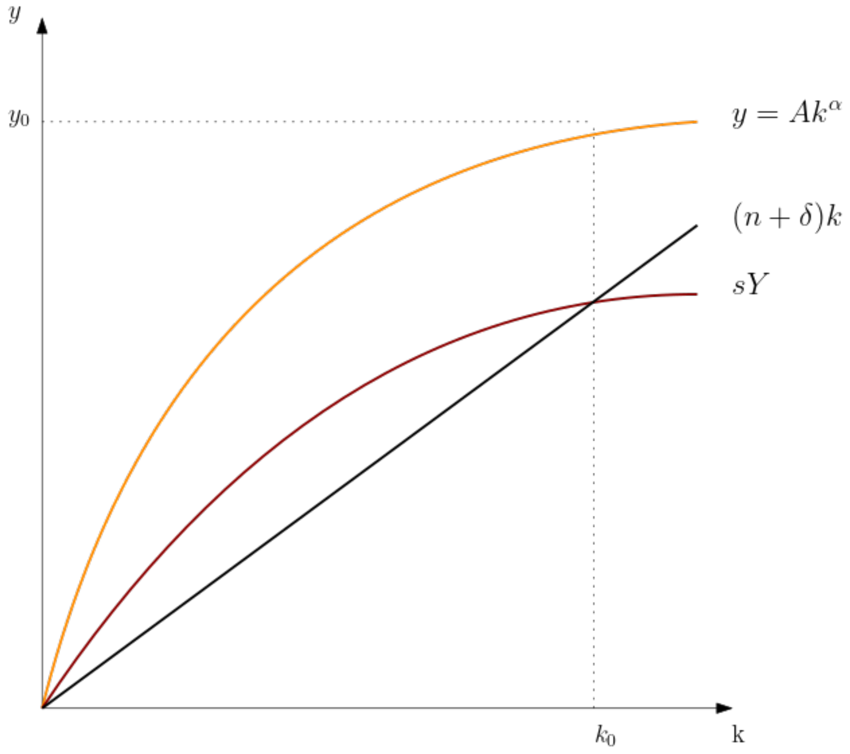

Question 6

Consider the following table. Using a Solow-Swan diagram, choose any one European country and any one Asian country and compare and contrast the factors that have contributed to growth.

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$$\boxed{y^* = A\left(\frac{sA}{\delta + n}\right)^{\frac{\alpha}{1-\alpha}}}$$

	Total Output	*Capital*	*Labor*	*TFP*
Golden Age 1950-73				
France	5.0%	1.6%	0.3%	3.1%
UK	3.0%	1.6%	0.2%	1.2%
W. Germany	6.0%	2.2%	0.5%	3.3%
Asian Miracle 1960-94				
China	6.8%	2.3%	1.9%	2.6%
Hong Kong	7.3%	2.8%	2.1%	2.4%
Indonesia	5.6%	2.9%	1.9%	0.8%
Korea	8.3%	4.3%	2.5%	1.5%
Thailand	7.5%	3.7%	2.0%	1.8%
Singapore	8.5%	4.4%	2.2%	1.5%

Question 6

Consider the following table. Using a Solow-Swan diagram, choose any one European country and any one Asian country and compare and contrast the factors that have contributed to growth.

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Europe: Higher TFP growth (upwards movement on the production function)

Asia: Higher capital growth (movement along a given production function)

Questions?

THE UNIVERSITY OF SYDNEY