1506
UNIVERSITÀ
DEGLI STUDI
DI URBINO
CARLO BO

Factor endowment

Giovanni Marin
Department of Economics, Society, Politics
Università degli Studi di Urbino 'Carlo Bo'

References for this lecture

- BBVG
  - Paragraphs 3.4, 3.5, 3.6, 3.7, 3.8

- Further suggested readings:
  - World Trade Report 2010, Chapter C, paragraph 5 (page 91): "The natural resource curse"
  - The Economist "What Dutch disease is, and why it's bad", Nov 5th 2014
  - The New Yorker "Venezuela's "Resource Curse" will outlive Hugo Chavez", Mar 6th 2013

Discussion about Ricardo model

- **Differences** in **productivity** across countries were considered as **exogenous**
  - **Why** should EU **productivity** in cloth production **differ** from USA productivity for the same commodity?

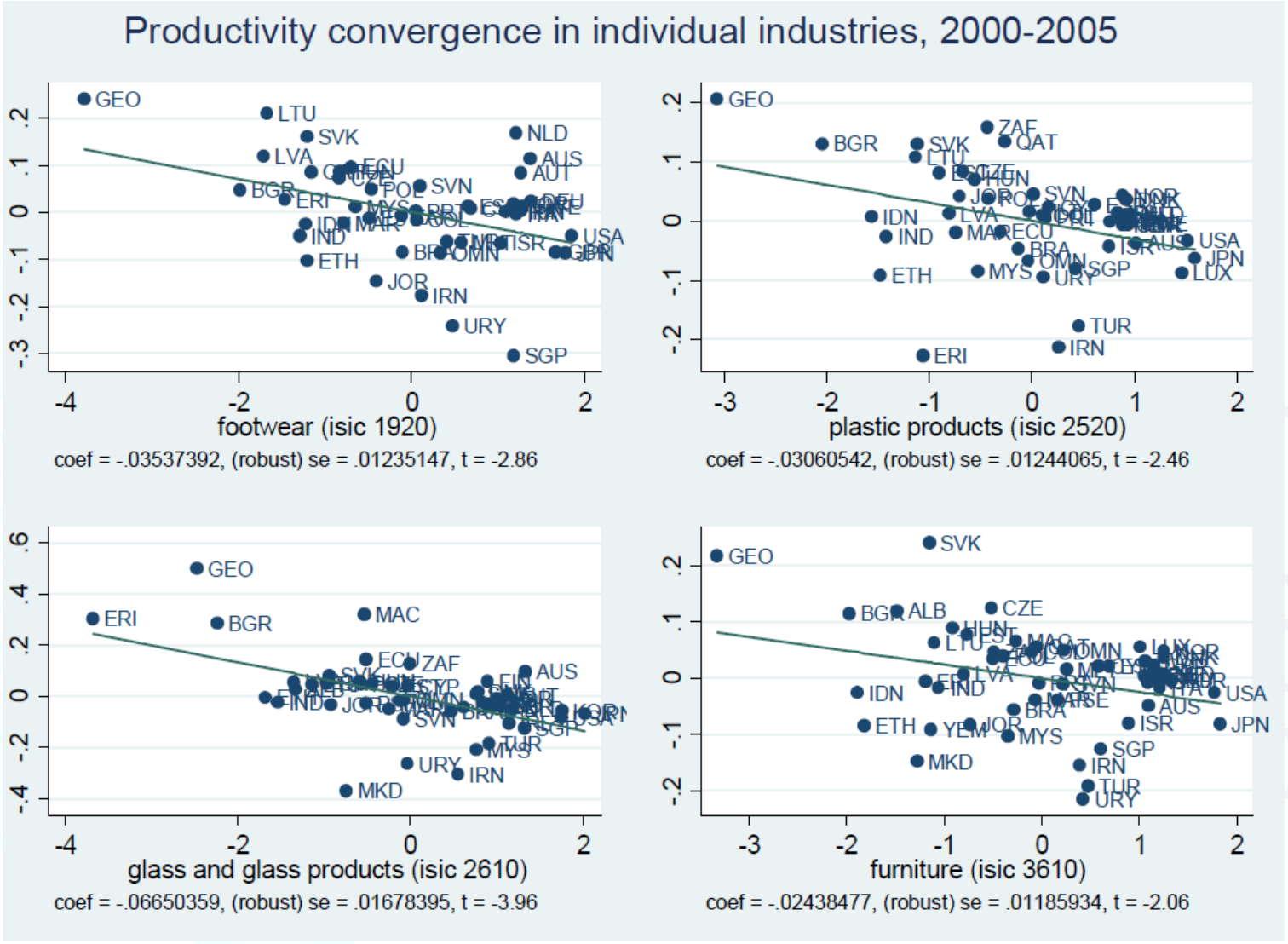
- **Critique** of economists in the **1930s**
  - Improved **communication** and tighter **economic relationships** (trade, FDI, travels) across countries have **reduced barriers** in accessing **knowledge**
  - Countries have access, **potentially**, to the **same technologies**
  - Maybe **technology** was **not that different** across countries…

Diffusion of technologies across countries: knowledge spillovers

- **Knowledge spillovers** ➔ (unintentional) diffusion of knowledge across countries

- New **technologies** are **invented** and developed **in a country**
- **Other countries learn** about these new technologies in many ways:
  - **Scientific publications**
  - Publication of **patents** ➔ the patent 'protects' the technology but **information** on the technology itself is **disclosed** and made publicly available ➔ **imitation**
  - **Technologies** embodied in **FDI**
  - **Trade** of commodities that **embody** new technologies facilitate **imitation** (e.g. reverse engineering)
  - Media, **trade fairs**, etc
  - **Word of mouth**

Is there convergence in productivity?



Source: Rodrik (2012)

Knowledge spillovers and absorptive capacity

- Even though **access to knowledge** has **improved** substantially, technology does **not diffuse immediatly** across countries
  - **R&D** and **patenting** is very much **concentrated** in a few advanced countries
  - To adopt a new technologies, the **recipient** country should be **able to incorporate** these technologies in its economy

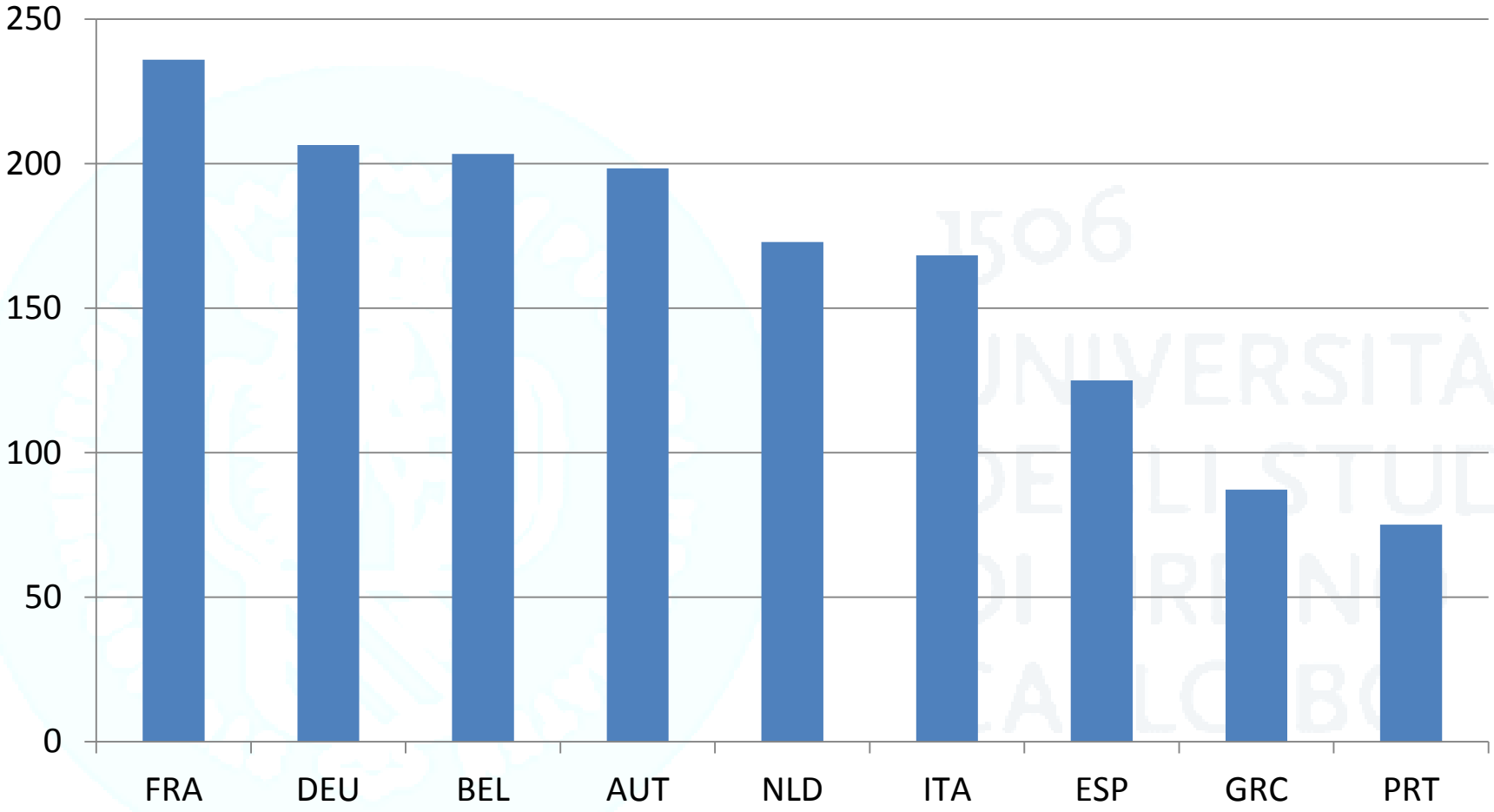
- **Absorptive capacity** → **ability** to **adopt** new technologies (e.g. through knowledge spillovers)
  - Doing **R&D at home** facilitates the adoption of technologies developed abroad
  - **Human capital** also trigger the absorption of foreign knowledge

Heckscher-Ohlin-Samuelson model

- The **Heckscher-Ohlin-Samuelson** (HOS) model **departs** from the **Ricardo** model in two respects
  - **Technology** is now **the same** in all countries
  - **Two inputs** are needed for producing commodities
    - **Labour**
    - **Capital**
- Countries **differ** in the **endowment** of inputs

- **Result** → countries **specialize** in the production of the **commodity** that is **intensive** in the **input** that is **relatively abundant** in the country

K/L ratio in the manufacturing sector of selected EU countries



Source: WIOD
Euro per employee
Year 2007

Framework of the HOS model

- **Two inputs** of production
  - Labour
  - Capital
- **Two** homogenous **commodities**
  - Steel ➔ **capital intensive**
  - Cloth ➔ **labour intensive**
- **Two countries**
  - **Country 1** is relatively well **endowed** with **labour** (wrt country 2)
  - **Country 2** is relatively well **endowed** with **capital** (wrt country 1)

Framework of the HOS model

- **Production functions** for each commodity in the two **countries** are **identical**
  - **Steel** = $f_1(K,L)=f_2(K,L)=f(K,L)$
  - **Cloth** = $g_1(K,L)=g_2(K,L)=g(K,L)$

- **Steel** production is relatively more **capital intensive** than cloth production
  - For a **given** vector of **input prices** (wages [w] and rental price of capital [r]), the **ratio** of **capital** to **labour** is **greater** for **steel** than for cloth production

- **Constant returns to scale** in production

Framework of the HOS model

- The **relative supply** of **capital** and **labour differs** between the two countries
- **Labour** and **capital** are (as labour in Ricardo)
  - **Perfectly mobile** across sectors **within country**
  - Perfectly **immobile between countries ➔ strong assumption** for **capital**!

- Consumers' **preferences** are **identical** in the two countries
  - For **given relative prices** of commodities (p_{Steel}/p_{Cloth}), the **ratio** of steel-to-cloth **consumption** is the **same** in the two countries ➔ $MRUS_1(steel,cloth)=MRUS_2(steel,cloth)$

Framework of the HOS model

- There is **no barrier to trade** (as in the Ricardo model)

- **Markets** of commodities and inputs are **perfectly competitive**
  - Producers, workers, capital holders and consumers in all sectors and countries are **price takers**
  - Perfect competition implies that market prices equal production costs → **zero profits**

HOS with closed economy

- **Before** allowing countries to **trade**, we evaluate what happens when each country is an **autarchy** (no import or export)

- All **commodities produced at home** are **consumed** at **home** (**no export**)
- All **commodities consumed at home** are **produced** at **home** (**no import**)

Closed economy – production costs

- **Production cost (for one unit of output)** ➔ $C_1=a_{L1}w+a_{K1}r$
  - a_{L1} is the **use** (not the requirement!) of **labour** to produce one unit of good 1 (**inverse** of **labour productivity**)
  - a_{K1} is the **use** of **capital** to produce one unit of good 1 (**inverse** of **capital productivity**)

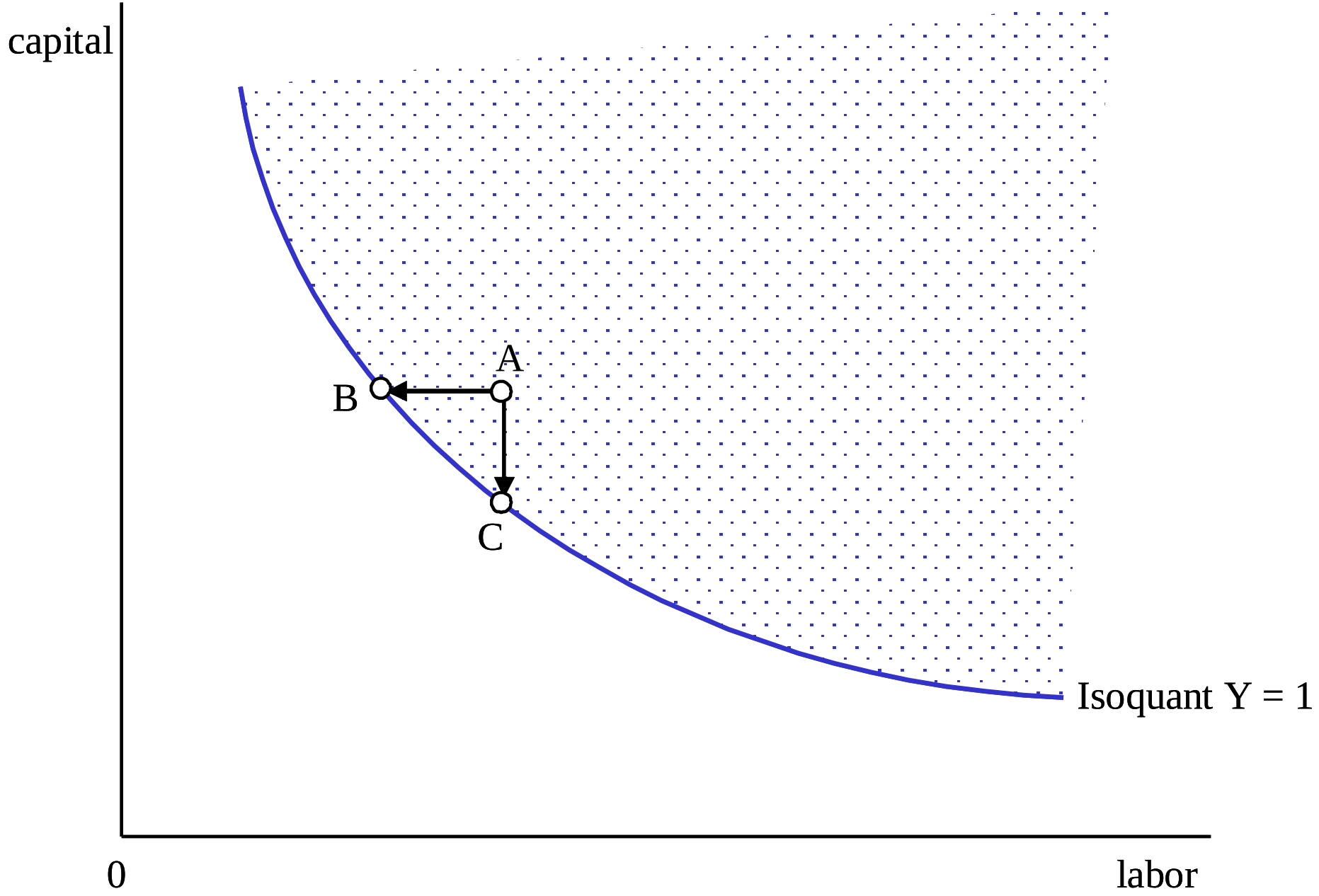
- Why '**use**' and not '**requirement**' ➔ possible **substitution**

- **Isocost** ➔ $K=C_1/r – L*w/r$

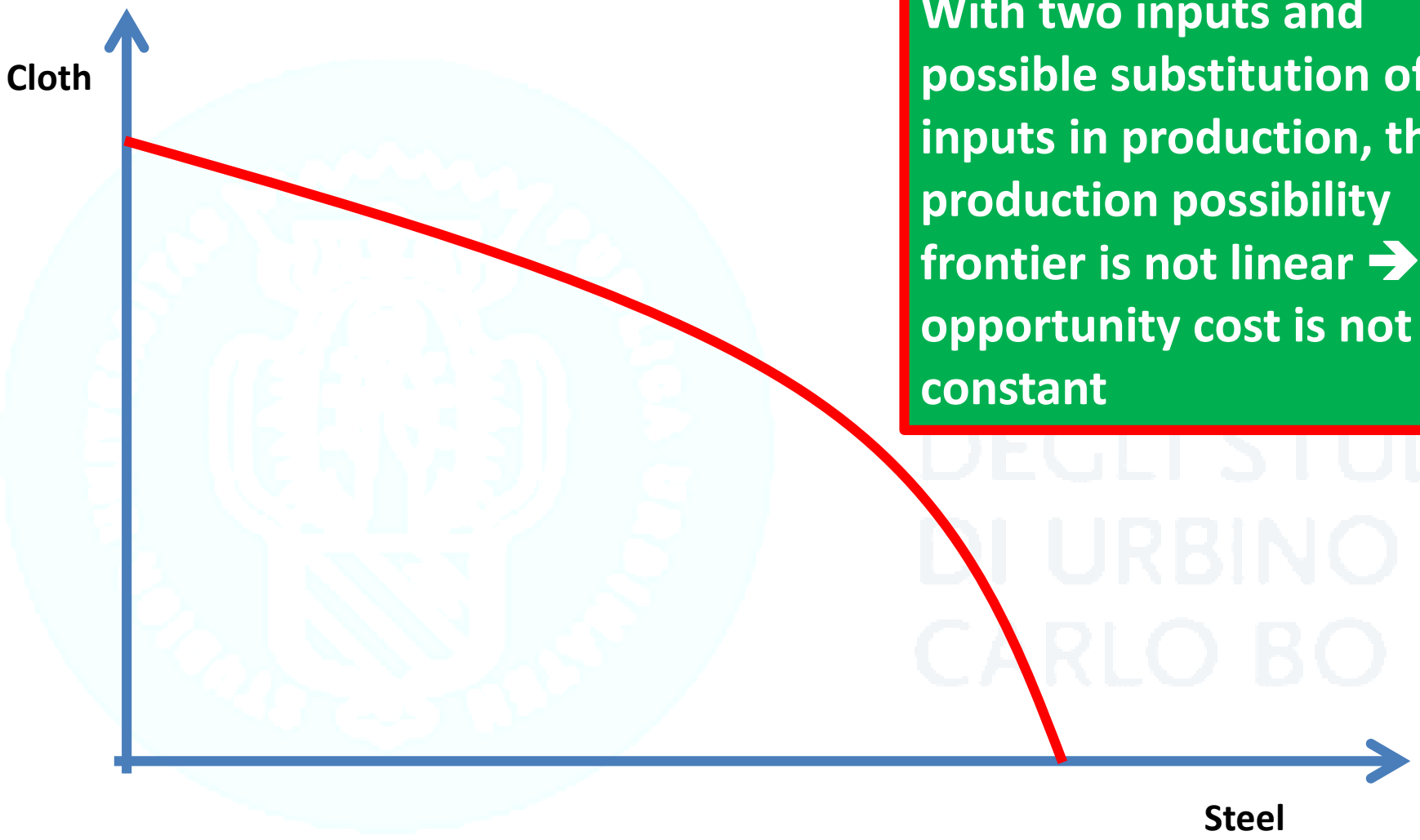
- Producers can **substitute labour** with **capital** (and viceversa) according to the **production function** ➔ **isoquant**

- The **opportunity cost** of steel in terms of cloth is **not constant**!

Figure 3.4 An isoquant



Production possibility frontier



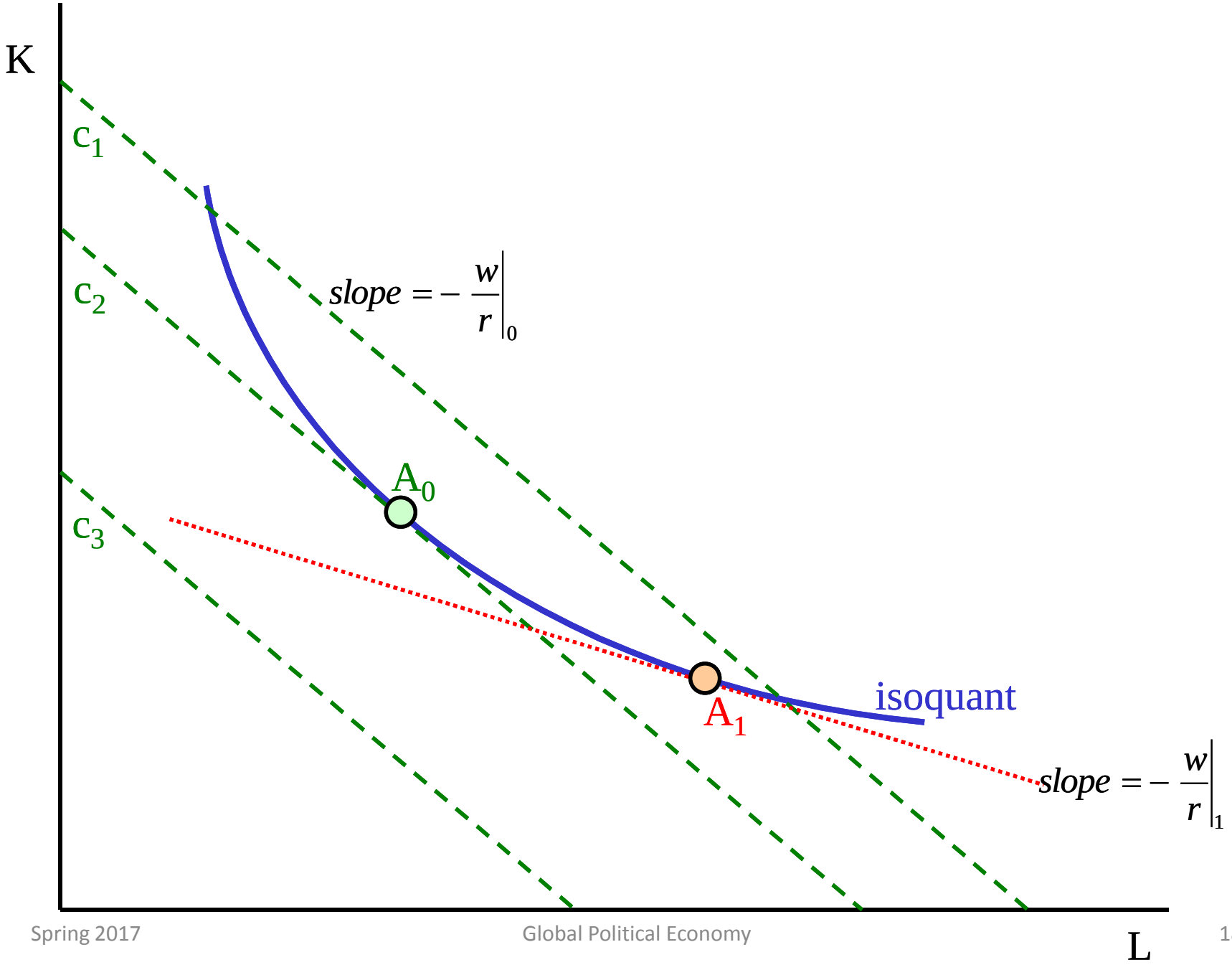
With two inputs and possible substitution of inputs in production, the production possibility frontier is not linear → opportunity cost is not constant

Change in input relative prices

- Changes in **relative input prices** (w/r) determine a **movement** along the **isoquant**
  - If **w/r increases** (i.e. **labour** becomes relatively more **expensive** than capital), **producers** will **substitute** expensive **labour with** cheap **capital**

- **Cross-country differences in w/r** depend on the relative **endowment** of capital and labour
  - If **labour** is relatively (i.e. wrt the other country) more **abundant** than capital, labour will be relatively **cheaper** than capital

Figure 3.5 Cost minimization

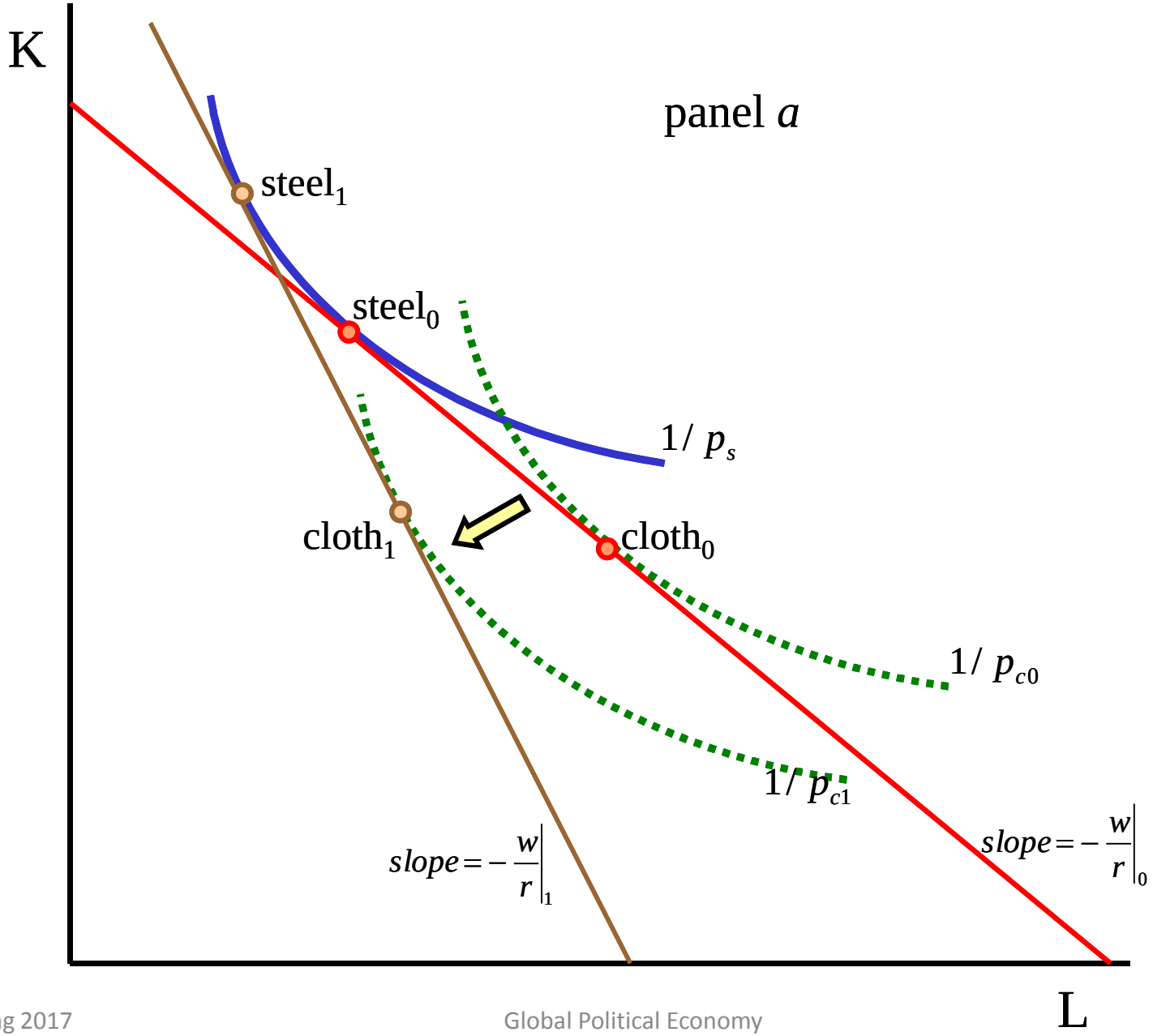


Allocation of factors to producing commodities

- **Input prices** (rental price of capital and wage) are the **same** for **both commodities**

- **<u>Unit value isoquants</u>**
  - They represent the **production** of **each good** that is **worth one dollar** of revenue when sold on the market **→ q=1/p**
  - The unit value isoquant is **inversely related** to the **price** of a commodity **→** the **more expensive** the good, the **fewer units** are needed to get **1 dollar's worth** of revenue

Figure 3.6 Lerner diagram, a goods prices and b factor prices

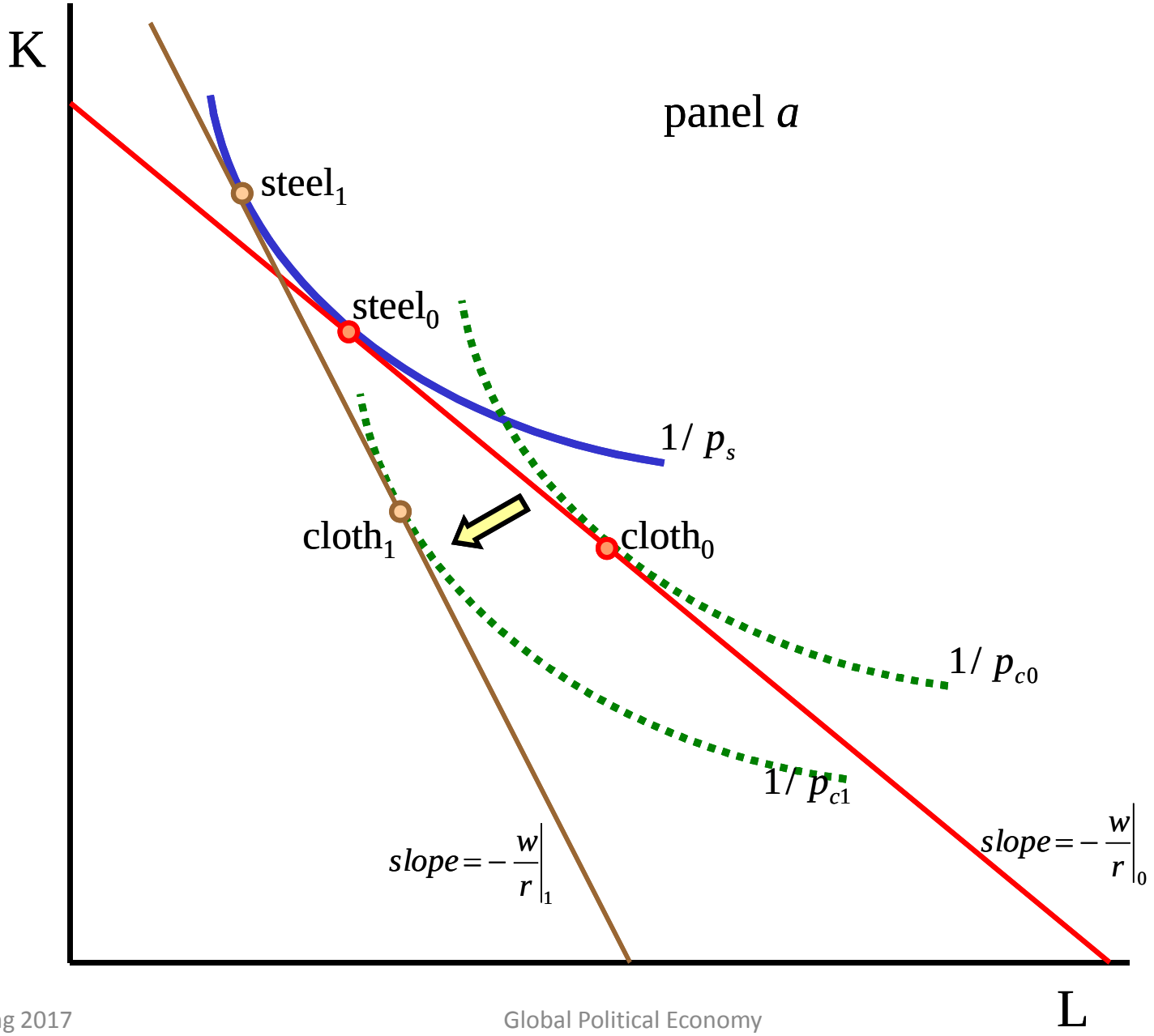


Equilibrium in closed economy

- If both goods are produced in the closed economy, **unit value isoquants** for the two products will be **tangent** to the **unit isocost**
  - **Same input costs** for both commodities ➔ optimal production points must lie on the **same unit isocost** line (where the **unit isocost** line is an isocost with **cost=1 ➔ zero profits**!)

- Relative **factor intensity ➔** in equilibrium, producing **one dollar's worth of steel** requires **more capital** than producing one dollar's worth of **cloth**

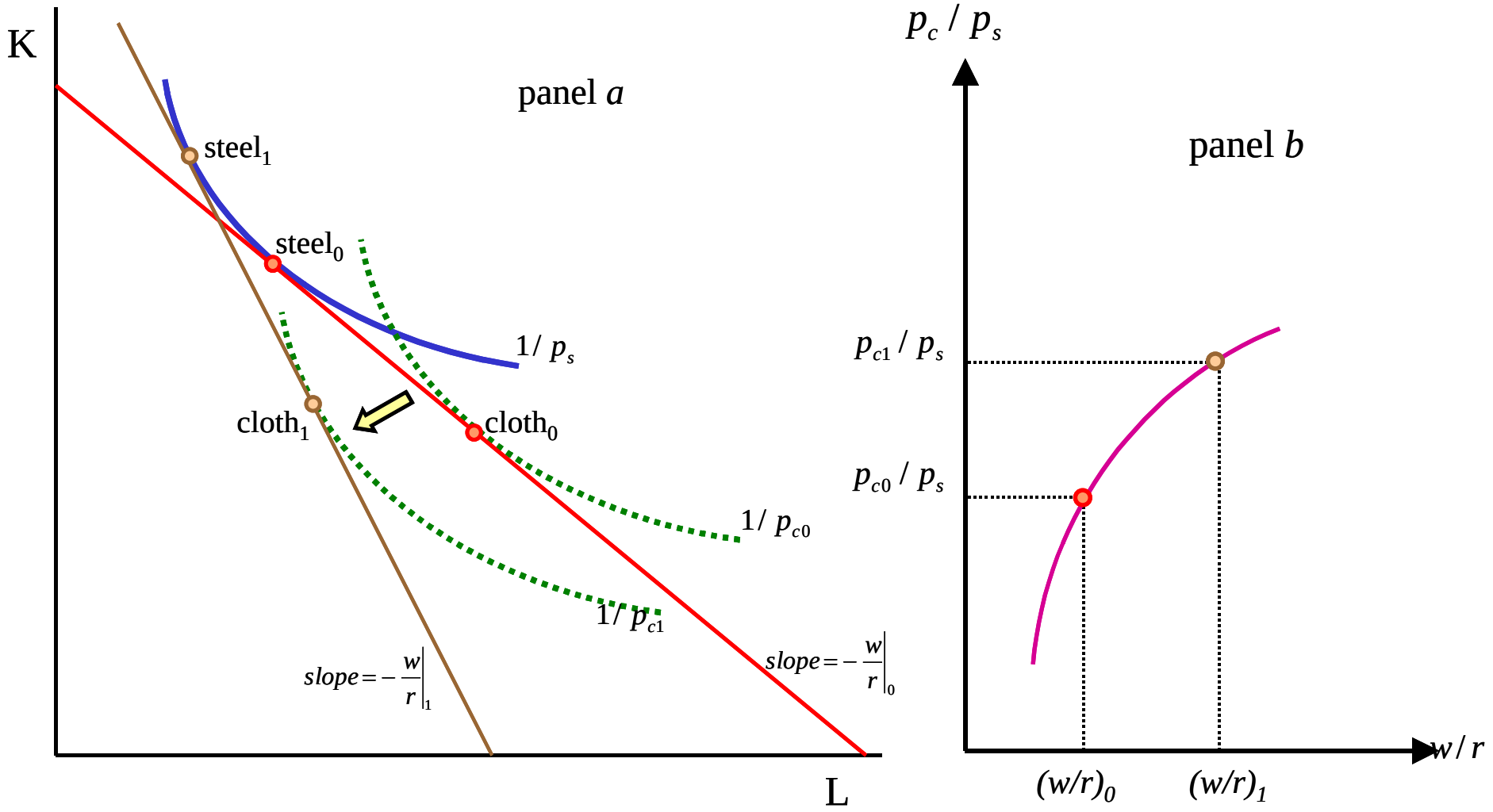
Figure 3.6 Lerner diagram, a goods prices and b factor prices



Simulating a change in output prices

- Example: **price of cloth increases**
- We need **fewer units of cloth** to produce **one dollar's worth** of revenue ➔ **unit value isoquant** of cloth shifts towards the **origin**
- **Unit cost isocost** must **rotate clockwise** to reach a **new equilibrium** in which the **two unit value isoquants** are **tangent** with the unit value **isocost**
- **Wage rate has increased** relative to the rental rate of capital
  - **Cloth** is **labour intensive** ➔ **higher price** of cloth leads to an in**creased demand** of **labour** and thus to **higher wages** (given that **labour** endowment is **fixed**)
  - **Substitution effect** ➔ as labour is more expensive, **cloth production** (but also **steel** production) has become slightly **more capital intensive**
- **Relationship** between **good prices** and **factor prices** ➔ **Lerner diagram**

Figure 3.6 Lerner diagram, a goods prices and b factor prices



Open economy in HOS

- Recall that:
  - **Country 1** is relatively well **endowed** with **labour** (wrt country 2)
  - **Country 2** is relatively well **endowed** with **capital** (wrt country 1)
  - **Technology** (i.e. the production function) is the **same** in the two countries
  - Production **inputs cannot move** across countries

Open economy in HOS

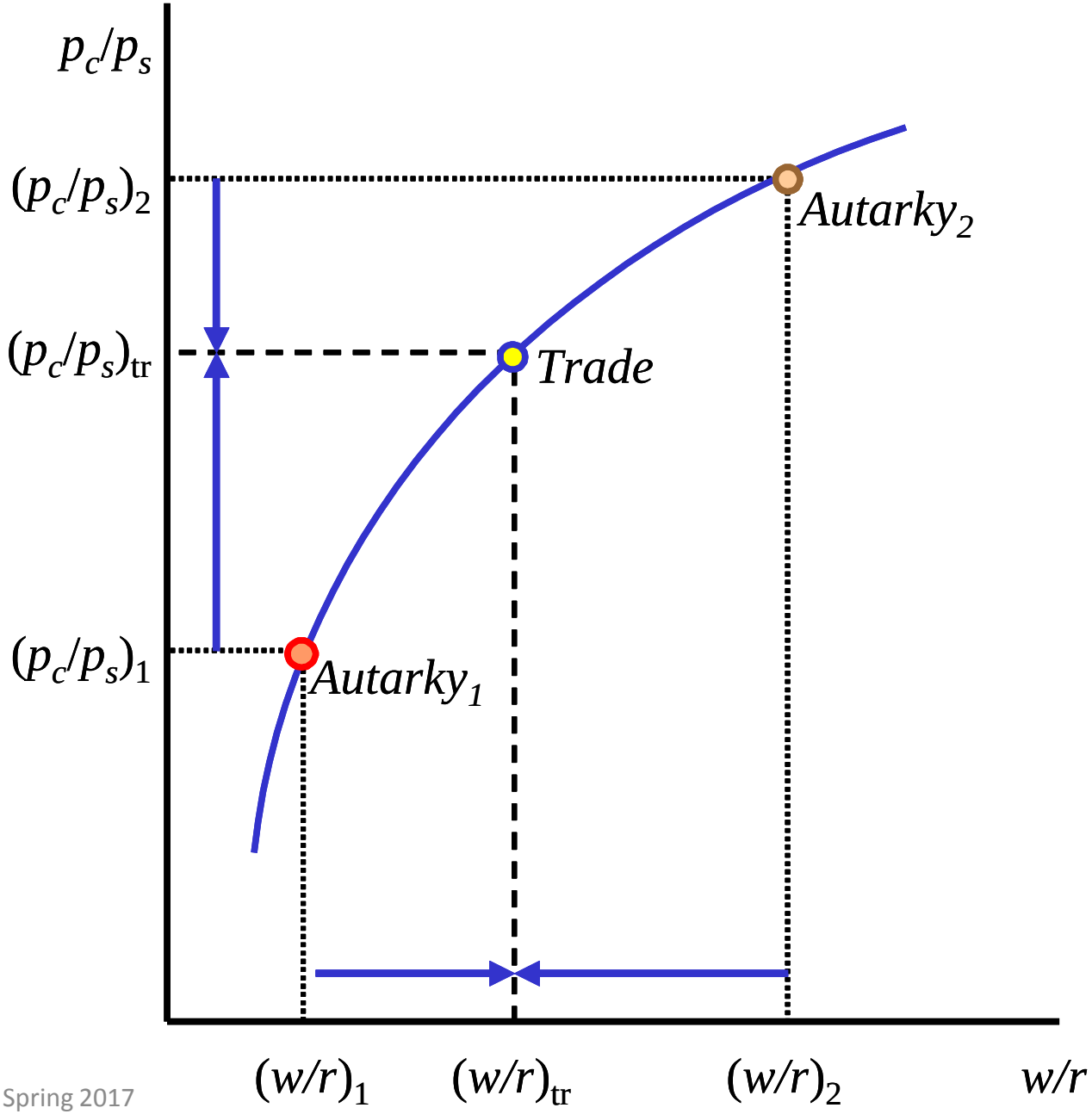
- Same **technology**:
  - **Same Lerner diagram** in both countries
  - Equilibrium in **autarchy** for the two countries is located in **different points** of the (**same**) **Lerner** diagram
  - Different points **reflect** differences in **factors' endowment**

Open economy in HOS

- **Country 1** is relatively well endowed with **labour** while **country 2** is relativey well endowed with **capital**

- In **autarchy w/r** will be **lower** in **country 1** than in country 2

Figure 3.7 The impact of international trade



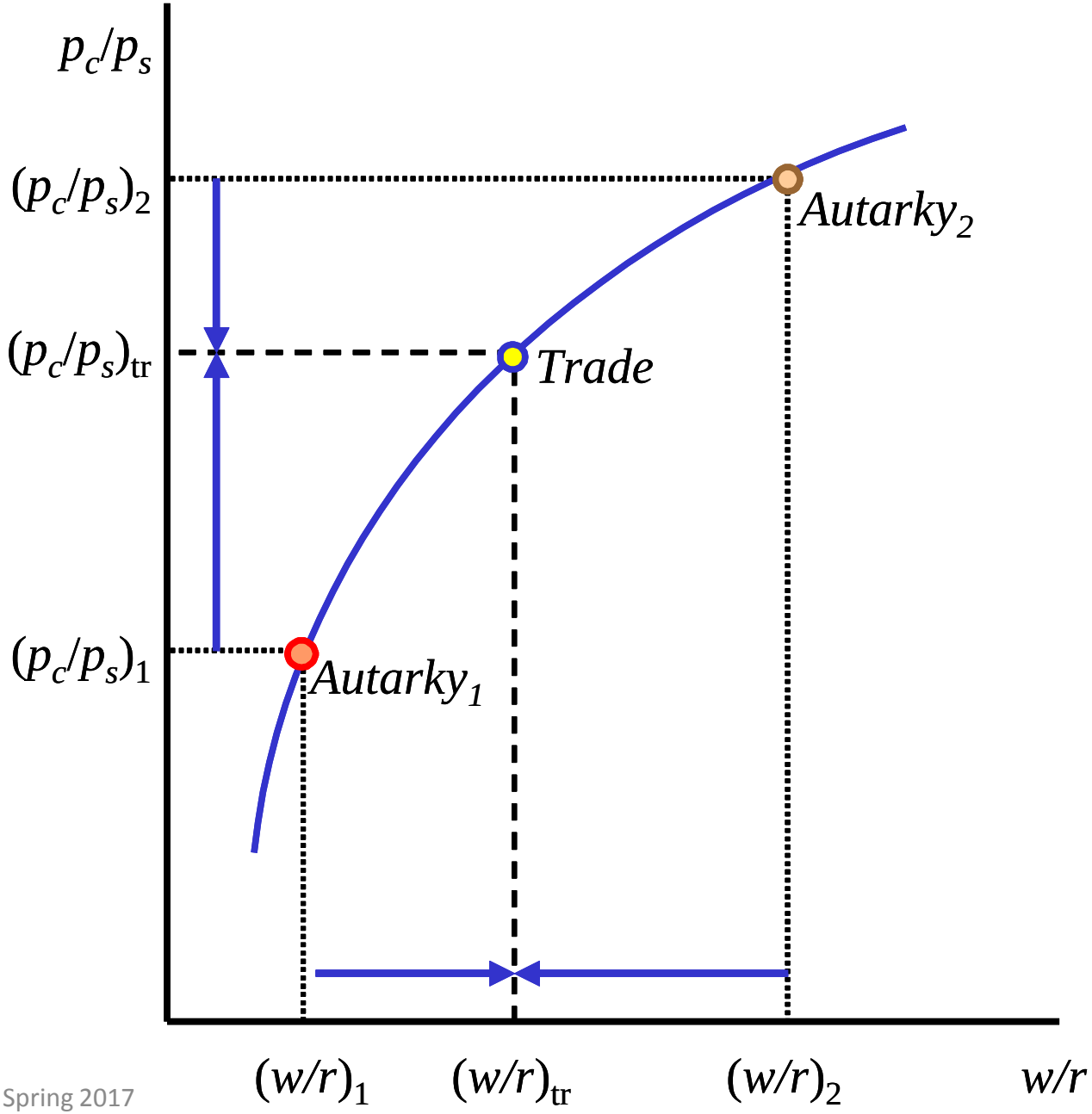
Trade in HOS

- **Trade** is **costless**
- The **price** of each **commodity** will be the **same** in both countries (as in Ricardo)
- This implies that $\mathbf{p_C/p_S}$ will be the **same** worldwide
- In equilibrium, **also w/r** is the same in both countries

Trade in HOS

- Moving **from autarchy to trade**
  - **Consumers** in **country 1** (labour abundant) will **import** the **capital-intensive good** (steel) from country 2 (capital abundant) as it is **cheaper than at home**
  - **Increased demand** for **steel** in **country 2** will **increase** the **demand** for **capital** and will thus increase **its price**
  - Higher cost of capital results in **more costly steel** in **country 2**
  - **Consumers** in **country 2** (capital abundant) will **import** the **labour-intensive good** (cloth) from country 1 (labour abundant) as it is **cheaper than at home**
  - **Increased demand** for **cloth** in **country 1** will **increase** the **demand** for **labour** and will thus increase **its price**
  - Higher cost of labour results in **more costly cloth** in **country 1**

Figure 3.7 The impact of international trade



Trade in HOS

- **Consumers** in **country 1** (labour abundant) will **consume less cloth** than in autarchy (relative **price of cloth** has **increased** at **home**) but **producers** in **country 1 produce more cloth** than in autarchy
- In **autarchy** home **consumption =** home **production**
- In **open** economy ➔ **export** of **cloth** from **country 1** to country 2

- **Consumers** in **country 2** (capital abundant) will **consume less steel** than in autarchy (relative **price of steel** has **increased** at **home**)
- **Producers** in **country 2** produce **more steel** than in autarchy
- **Export** of **steel from country 2** to country 1

Production in HOS

- As a **consequence** of **trade**:
  - **Cloth** production becomes **more capital intensive** in **country 1** because the relative **price** of **labour increases** wrt autarchy
  - There is a **shift** of **labour** and **capital from steel** production **to cloth** production
  - **Steel** production becomes **more labour intensive** in **country 2** because the relative **price** of **capital increases** wrt autarchy
  - There is a **shift** of **labour** and **capital from cloth** production **to steel** production

HOS theorem

A country will **export** the **good** that **intensively uses** its **relatively abundant factor** of production, and it will **import** the commodity that **intensively uses** its relatively **scarce factor** of production

Specialization

- **Differently** from the **Ricardo** model, the HOS model generally results in **partial specialization**

- A country will **export only one commodity**, but will **produce at home both commodities** ➔ still **consistent** with '**inter-industry trade**'

Factor price equalization

- As **technology** (productivity) and **commodity prices** are the **same** in both countries, **also factor prices** are equal in both countries in equilibrium
- This happens **even though** production **factors** are **immobile** (and thus **cannot seek** abroad a greater **reward** than at home)

- **Gains from trade**: compared to autarchy, with trade:
  - The **reward** of the relatively **abundant factor increases**
  - The **reward** of the relatively **scarce factor decreases**

Trade of factors?

- **Specialization** according to factor endwoment can be seen **as** a **trade in production factors**

- The **capital-abundant** country **exports** the **capital-intensive** commodity that **embodies** a large amout of **capital**
- The **importing country imports capital embodied** in imports, partly compensating for the domestic scarcity of capital

Summing up HOS

- Even in presence of **identical technology** and **productivity** in the production of commodities, the model predicts **room** for inter-industry **trade**
- Trade is **driven** by **differences** in the **endowment** of production **factors**
- **Specialization** (and **export**) in the **commodity** that is relatively **intensive** in the relative **abuntant factor**
- Worldwide **equalization** of **commodity** prices and **factor prices**

Empirical test of HOS

- Need to **estimate** the **amount** of a **factor** of production **incorporated** in international **trade** flows
- **Compare** the **relative importance** of factors of production incorporated in **export** with the **actual relative endowment** of factors in the exporting country

- **Relative abundance** of **labour** → a country's **labour endowment** is **higher** than its **GDP equivalent share** of the **world's endowment** of labour

➢ Which is the **share** of '**correctly predicted**' **specialization** according to **factor abundance**?

Table 3.3 Sign tests of factor abundance

Country	Identical technology	Different technology
All countries	0.50	0.62
Bangladesh	0.33	0.78
Indonesia	0.22	0.67
Portugal	0.22	0.78
Greece	0.11	0.56
Ireland	0.67	0.44
Spain	0.22	0.78
Israel	0.67	0.89
Hong Kong	0.67	0.89
New Zealand	0.44	0.22
Netherlands	0.44	0.44
France	0.33	0.33
West Germany	0.56	0.67
UK	0.67	0.78
USA	0.89	0.56

Source: Feenstra (2004, p. 49), who discusses Trefler (1995).

Empirical test of HOS

- Very **poor 'prediction'** of the pure HOS model
- Prediction **improves** when the **assumption** of '**indentical technology**' is **removed → comparative advantage!** (Ricardo)

Factor price equalization?

Country	Hourly Compensation of Production Workers, 2005
United States	100
Germany	140
Japan	92
Spain	75
South Korea	57
Portugal	31
Mexico	11
China*	3

*2004

Source: Bureau of Labor Statistics, *Foreign Labor Statistics Home Page.*

Leontief paradox

- Even though the **US** has an historically **high K/L** ratio, the **capital intensity** of **import** is **larger** than the capital intensity of **export**

TABLE 5-2 **Factor Content of U.S. Exports and Imports for 1962**

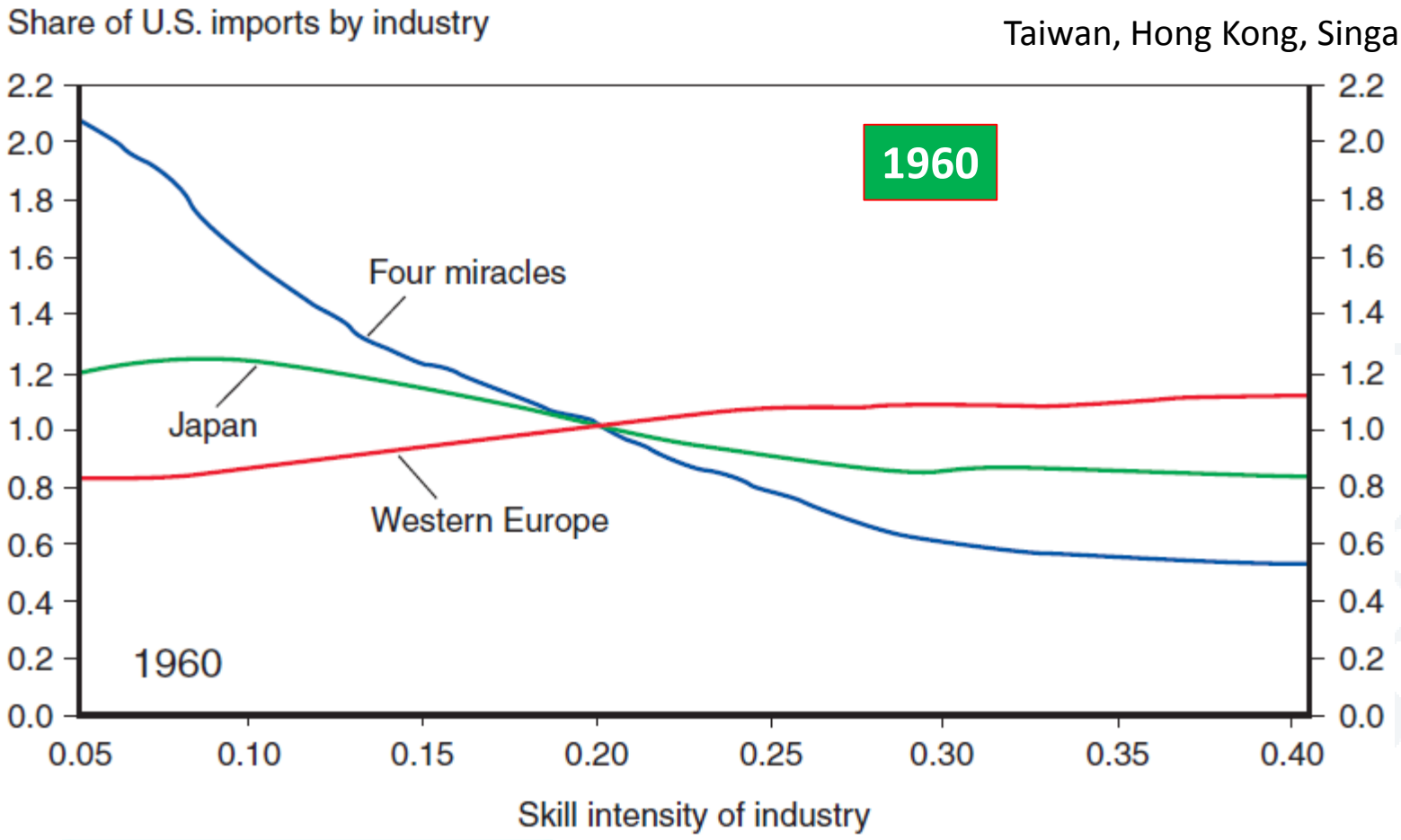
	Imports	Exports
Capital per million dollars	$2,132,000	$1,876,000
Labor (person-years) per million dollars	119	131
Capital-labor ratio (dollars per worker)	$17,916	$14,321
Average years of education per worker	9.9	10.1
Proportion of engineers and scientists in work force	0.0189	0.0255

Source: Robert Baldwin, "Determinants of the Commodity Structure of U.S. Trade," *American Economic Review* 61 (March 1971), pp. 126–145.

- This happens because the US are **even more 'endowed' of high-skill workers** and in high-tech **knowledge**

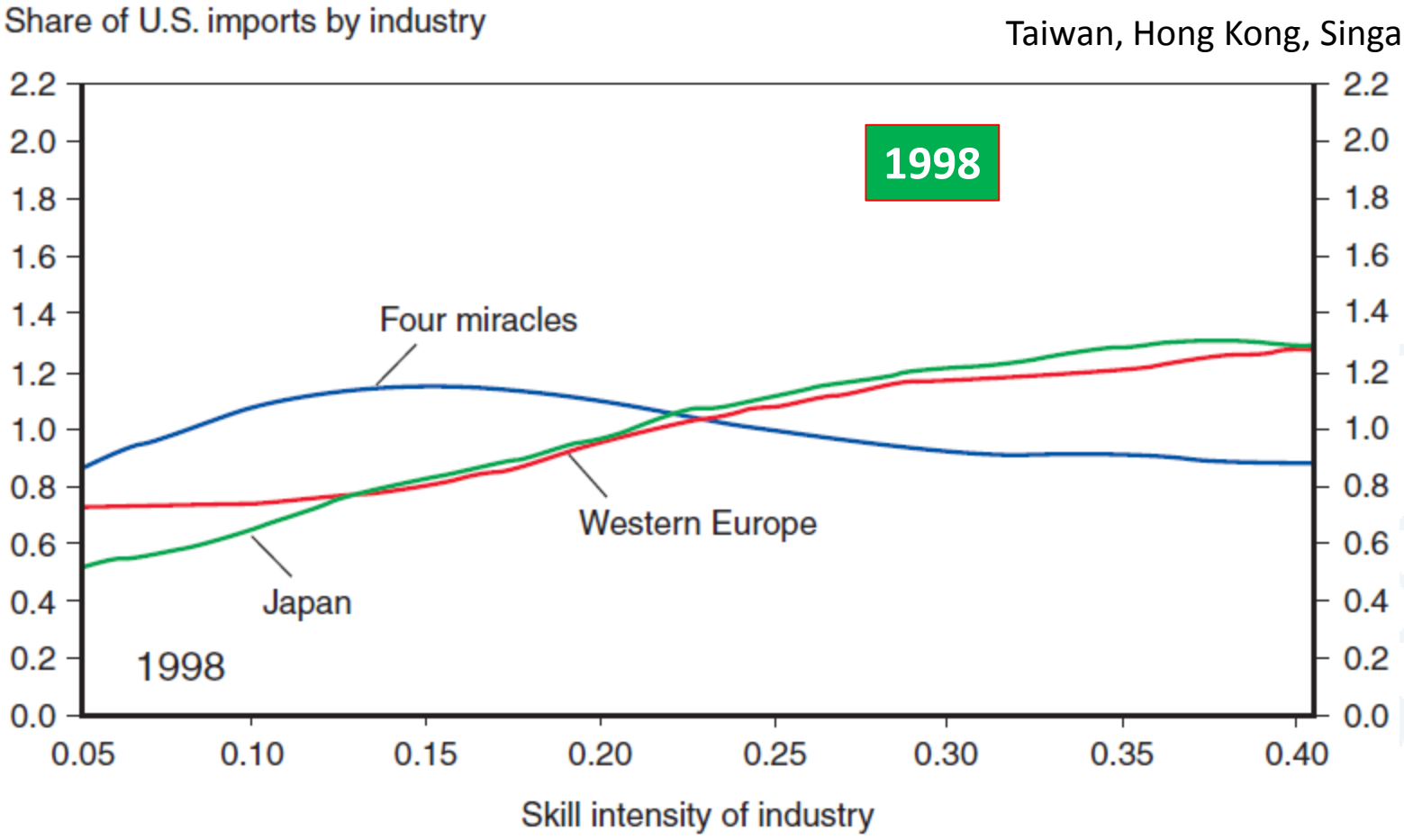
But sometimes HOS works…

*Four miracles: South Korea, Taiwan, Hong Kong, Singapore



But sometimes HOS works…

*Four miracles: South Korea, Taiwan, Hong Kong, Singapore



Trade and income distribution in HOS

- Moving **from autarchy to trade** has relevant **implications** in terms of **income distribution**
- Owners of a country's **abundant factor gain** from trade, but owners of a country's **scarce factor lose**
- These effects are **persistent**

Trade and income distribution in HOS

- The **US** case
  - US is relatively **well endowed** with **capital** and **high-skill** workers
  - This induces a **specialization** in **sectors** that are **intensive** of capital and of high-skill workers
  - Specialization also **increase the remuneration** of these factors and reduces the remuneration of low-skill workers ➔ **politically-sensitive** issue!
  - Trade contributes to **increasing inequalities** (across employees with different skills and between labour and capital)

- Persistent effect ➔ **unemployment subsidies** for **low-skill** workers are **not effective** in the long run

HOS at work: the resource curse

- Consider the case in which **one** of the production **factors** is a **'natural' input** (e.g. oil)
- The **distribution** across **countries** of that input is very much **concentrated** in a few countries
- Countries that are **'naturally' endowed** with that factor will **specialize** in **commodities intensive** in that factor (e.g. gasoline)

- All **other factors** will be '**attracted**' by the **sector** that is **intensive** in the natural resource

Resource curse: why is that a curse?

- **Capital** and **labour** will **not** be employed in **manufacturing** sectors **but** in **activities** that are strictly connected to the **exploitation** of the natural **resource**

- This leads to:
  - **De-industrialization** of the country
  - Shift of **income** to the **owners** of the natural **resource**
    - **Private** owner ➔ high **inequality** in income **distribution**
    - **Public** owner ➔ **corruption** in managing the rents
  - **Dependence** on the availability of a natural resource ➔ **exposed** to fluctuation of **(world) prices** and to **external shocks**
    - **Agricultural** resource ➔ **weather** shock
    - **Mineral** and **fossil** ➔ new **discoveries** abroad, **climate policy**, etc

Comparison Ricardo vs HOS Assumptions

	Ricardo	HOS
Production factors	1	2
Within-country mobility of inputs	Yes	Yes
Between-country mobility of inputs	No	No
Technology / productivity	Heterogeneous	Homogeneous
Relative factors' endowment	-	Heterogeneous
Trade frictions	No	No

Comparison Ricardo vs HOS Predictions of the model

	Ricardo	HOS
Inter-industry trade	Yes	Yes
Intra-industry trade	No	No
Full specialization	Yes	Not necessarily
Commodity price equalization	Yes	Yes
Factor(s) price equalization	No	Yes
Trade is mutually beneficial	Yes	Yes

What do Ricardo and HOS fail to explain?

- The **Ricardo** and **HOS** models **motivate** the existence of **inter-industry trade**
- **Inter-industry trade** → the **range** of **commodities** that a country **exports differs** from the range of commodities that a country **imports**
- **Data** suggest that **intra-industry** trade represents a **relevant component** of total trade

- How to explain **intra-industry trade**
  - **Remove** the assumption of **perfect competition**
  - **Remove** the assumption of **homogeneous commodities**