CHAPTER 4

RESOURCES AND TRADE:
THE HECKSCHER-OHLIN MODEL

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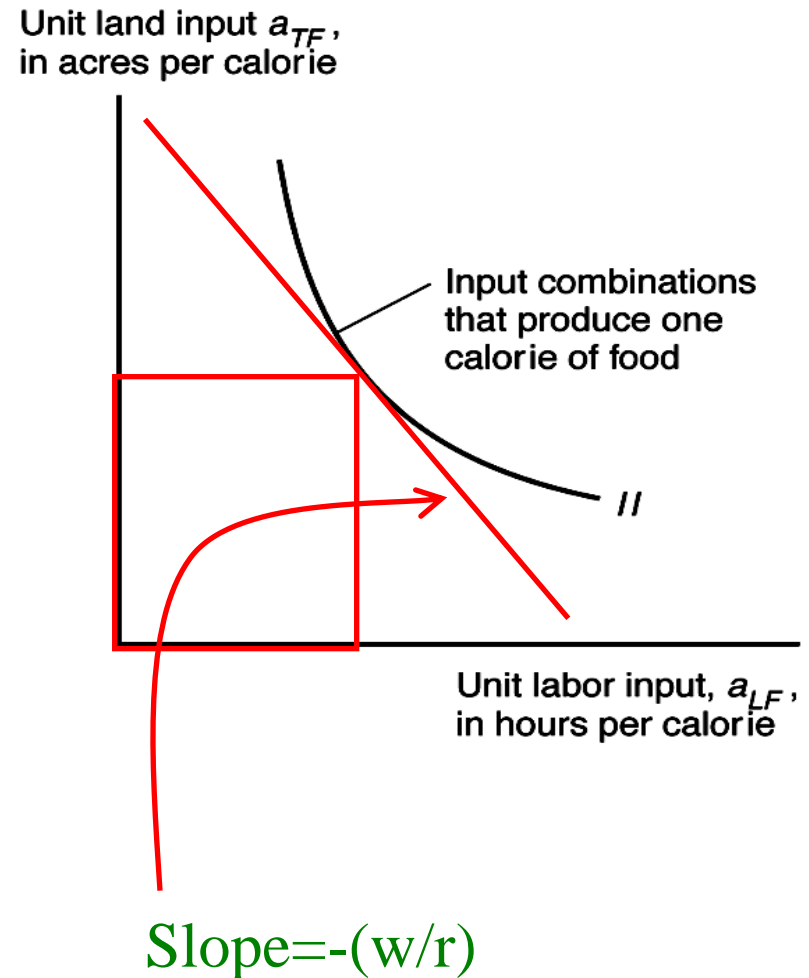
Lessons of SFM

- We saw all the lessons of Ricardian model PLUS
- 1. Pains & gains from trade
- 2. factor endowment differences were ultimate source of trade
  - Relatively K-rich nation exports K-intensive good & relatively L-rich nation exports L-intensive good
- 3. Political economy application & Olsen's asymmetry.
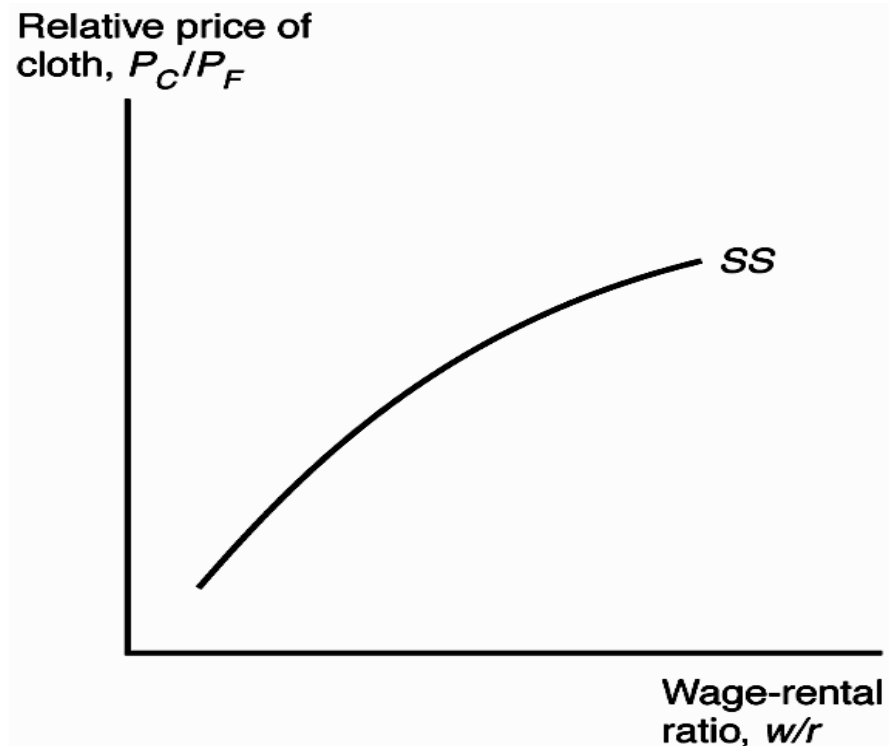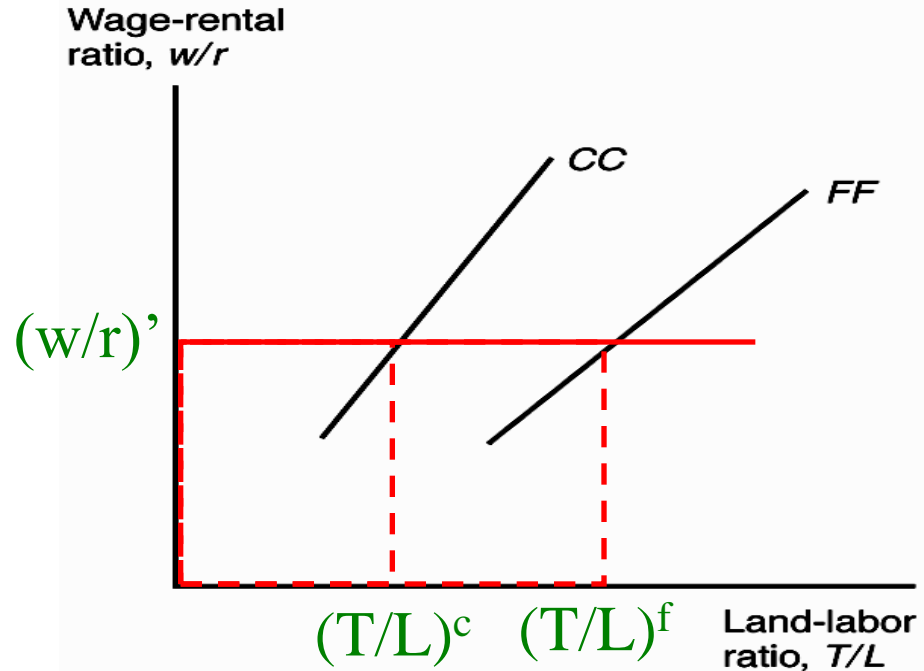
Shortcomings of SFM

- The artificial distinction between specific factors and labour; this might be OK in short run, but not in long run.
  - Losers & Winners from trade: Specific factors clear, mobile factor ambiguous
  - Is this an artefact?
- Heckscher-Ohlin (HO) model avoids this artificial division of factors.
- HO model is very widely referred to in explaining, for example, the impact of trade on wages in US and trade on unemployment in Europe.
- You must know it, if you call yourself a "trade literate".

Basic setup of HO model

- 2 goods (cloth & food), 2 factors (land & labour), 2 nations (postpone).
  - "2x2x2 model"
- Both sectors use both factors.
- Both factors fully mobile between sectors.
- Standard isoquant describes how land and labour produce Food; ditto cloth.
- We assume that cloth is more labour intensive, i.e. uses more L than T than does the food sector at any given w/r.

Unit land input a_{TF}, in acres per calorie

Input combinations that produce one calorie of food

II

Unit labor input, a_{LF}, in hours per calorie

Slope=-(w/r)

- Given factor-intensities:
  - C is L-intense & F is T-intense.
- Relative usage of C and F sectors differs as in top figure.
- Relative intensities also mean that P_c/P_f rises as w/r rises.
  - C sector uses L relatively intensively, so w/r makes C relatively expensive
- THUS bottom figure
  - SS based on intuition, can derive it more carefully (later).

Wage-rental ratio, *w/r*

CC

FF

(w/r)'

$(T/L)^c$ $(T/L)^f$

Land-labor ratio, *T/L*

Relative price of cloth, P_C/P_F

SS

Wage-rental ratio, *w/r*

- Combine panels (trick of flipping bottom one)
- KEY: if we know P_c/P_f we know relative factor demands of both sectors
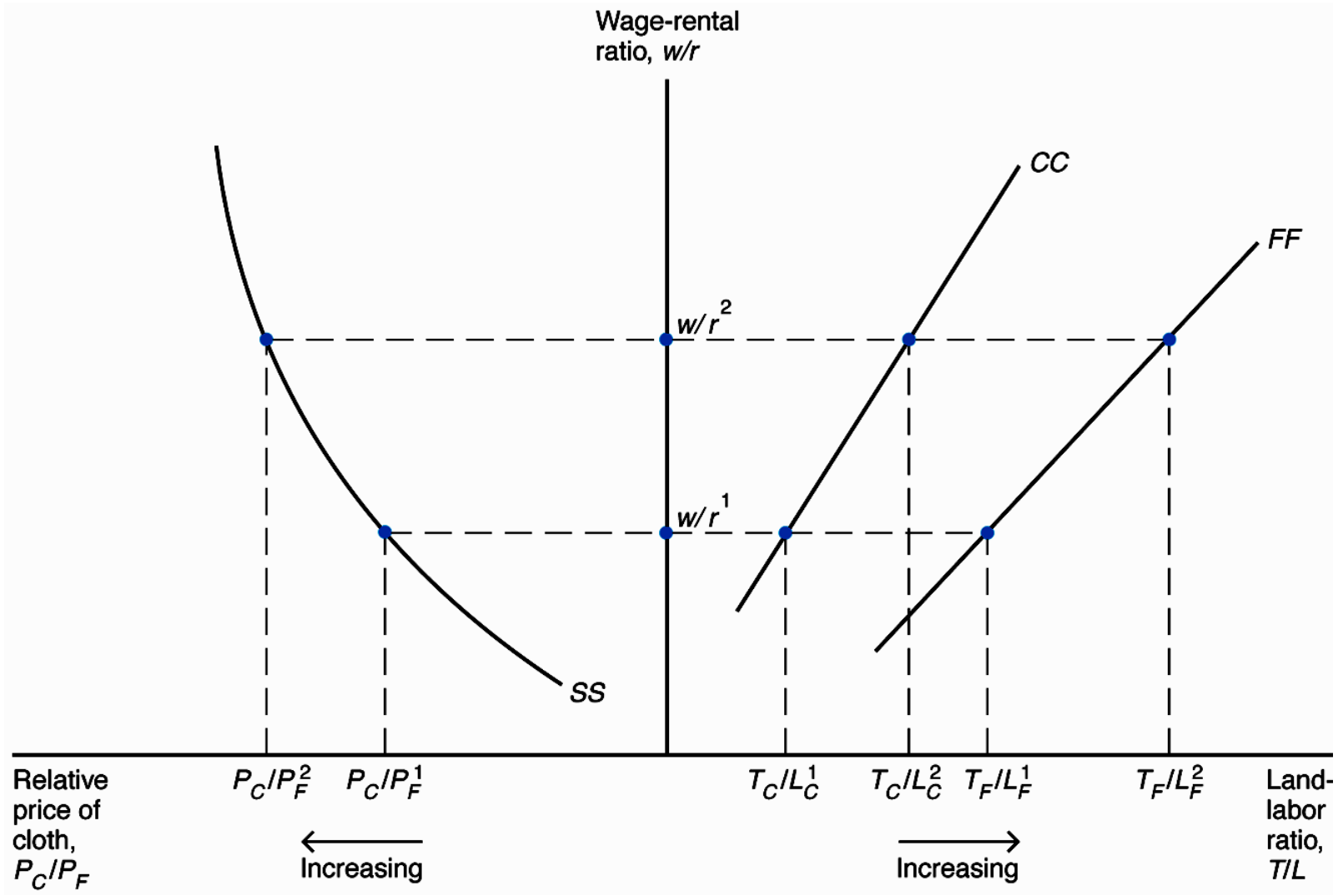
Stolper-Samuelson Thm

- Using the previous diagram, we can see the famous (and very important to globalisation debate) theorem: The Stolper Samuelson Thm.
  - "If the relative price of the labour-intense gd rises, then the reward to labour rises relative to the price of both goods, and the reward to the other factor falls i.t.o. both gds".
  - This is a more specific 'pains from trade'; it identifies who wins and loses from the relative price changes.
- How to see it?
  - Land-to-labour ratio rises in both sectors, so marg'l product of land falls in both sectors and marg'l product of labour rises in both sectors.
   - Factors are paid their marg'l product.

Determining output given prices

- We still need to find how much of each good is produced at this rel. price
- We use another diagram to work that out:
- Edgeworth box with fixed rel. goods prices & thus fixed rel. factor prices & thus fixed input coefficients.
  - i.e. how much labour & land per metre of clothes & same for calorie of food.
    - e.g., a_{LF}.

Study features of box before using it

- Height of box is nation's supply of land (T) & width is supply of labour (L)
- We measure T employed in C going up & T employed in F sector going down.
- Likewise: L used in C from right & L in F from left
- Any point in the box describes an allocation of L & T between the 2 sectors
  - Full employment of T & L are assured
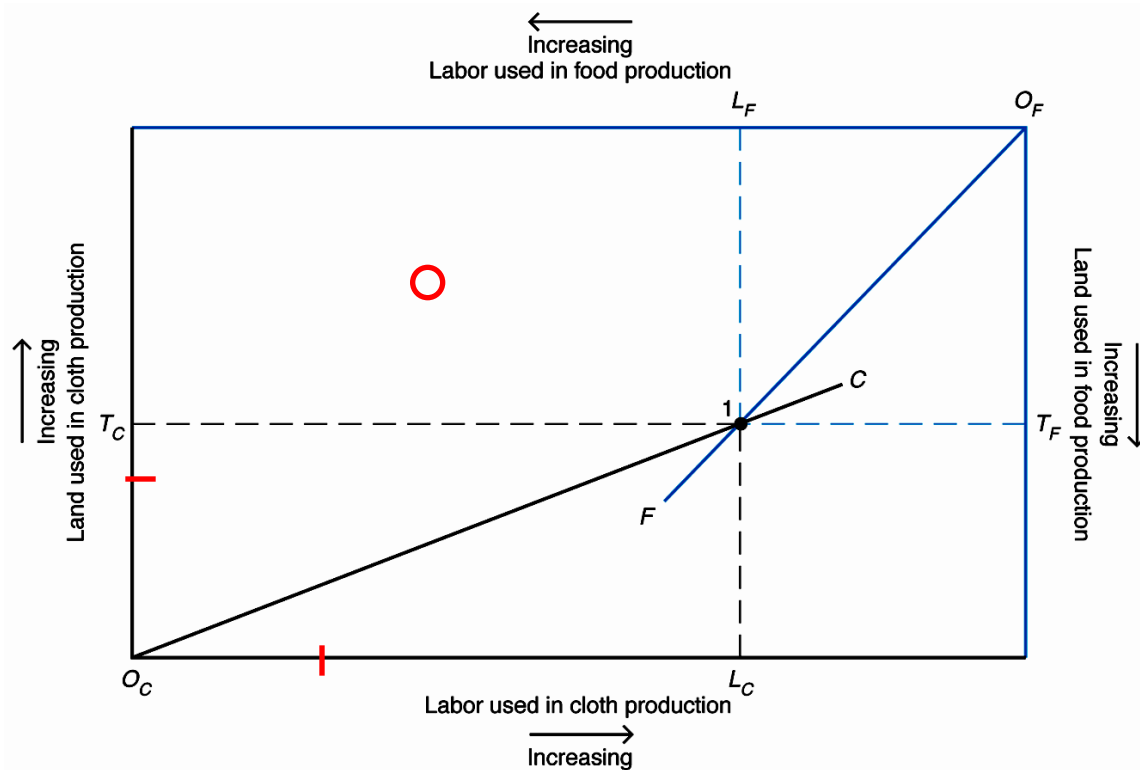
Study features of box before using it

- The 2 lines in the box show the ratio with which L & T are used by the 2 sectors
- Line from O_c shows T/L ratio in C production (at the fixed w/r)
- Line from O_f shows T/L ratio in F production (at the fixed w/r)

How do we know C is L-intense from the slopes of the lines?
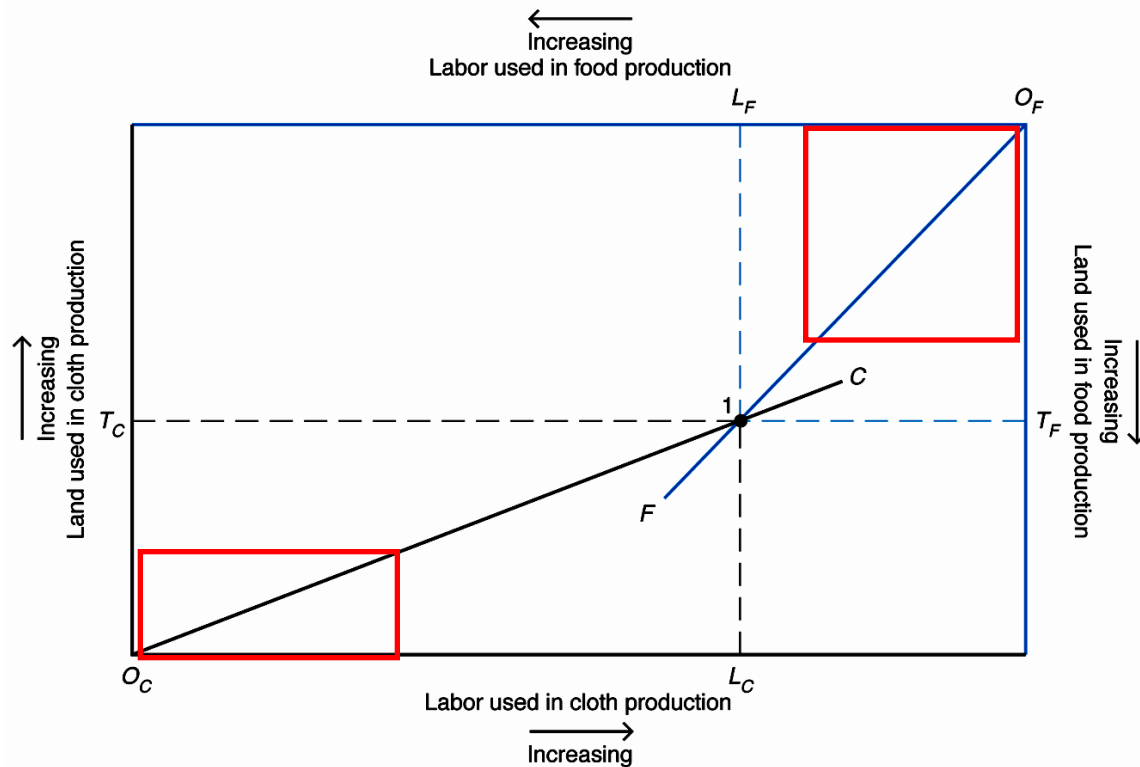
Eq'm allocation of T & L at fixed prices

- Along both lines, sectors are using T & L optimally;
- Where the lines intersect, both sectors are using factors optimally AND all factors are employed.
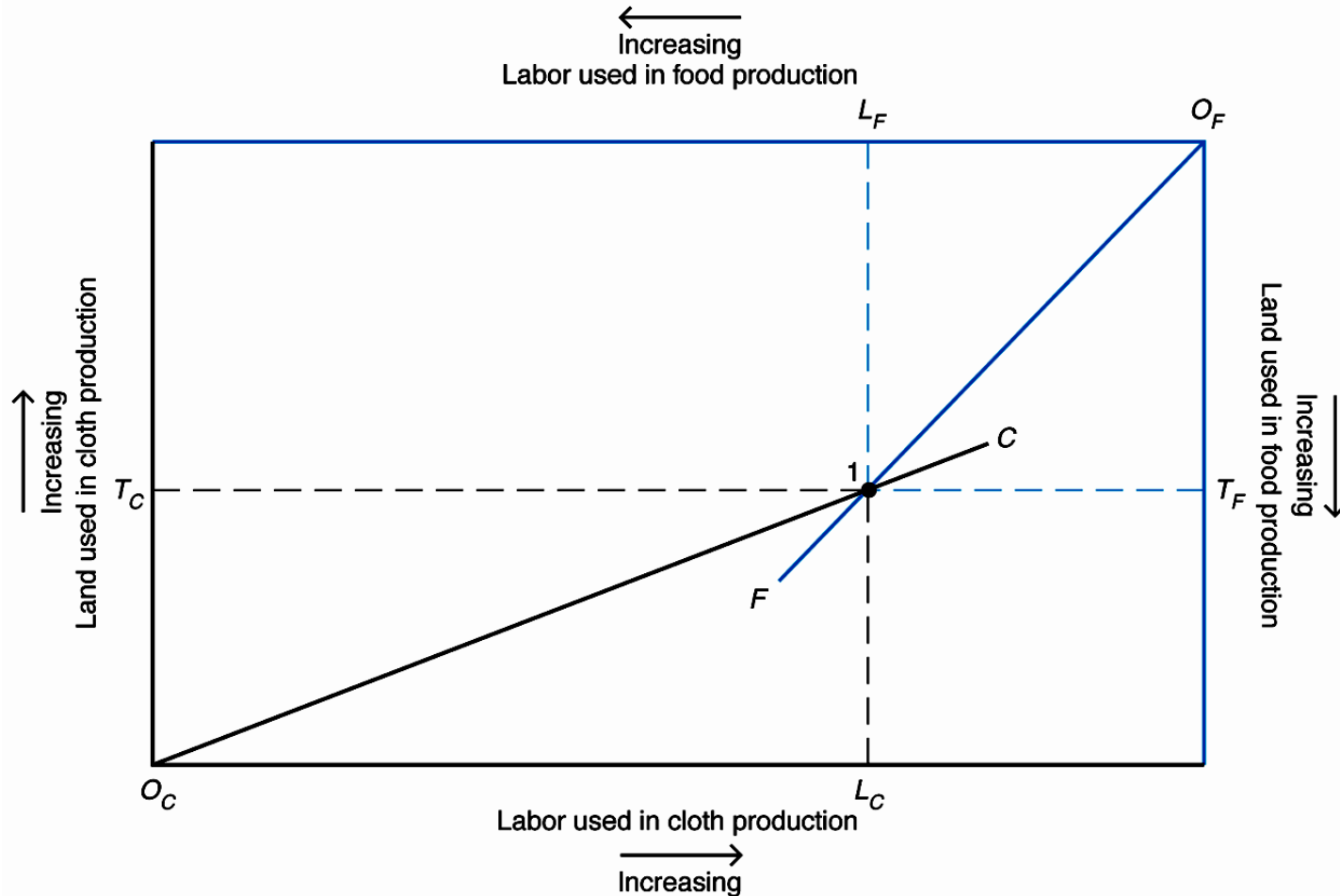
Deriving the PPF for the HO model

- Krugman skips the derivation of the PPF.
- Here we go thru it.
  - This is not mandatory, but useful for those who find economics easy.
- What happens to production of C & F when the relative price of C rises?
  - Intuition from other models suggests that output of C will rise and, since there is only so much L & T, the output of F will have to fall.
  - This intuition is correct.
- If P_c/P_f ↑, w/r ↑ (since C is L-intensive);
- This makes both sectors use relatively less L;
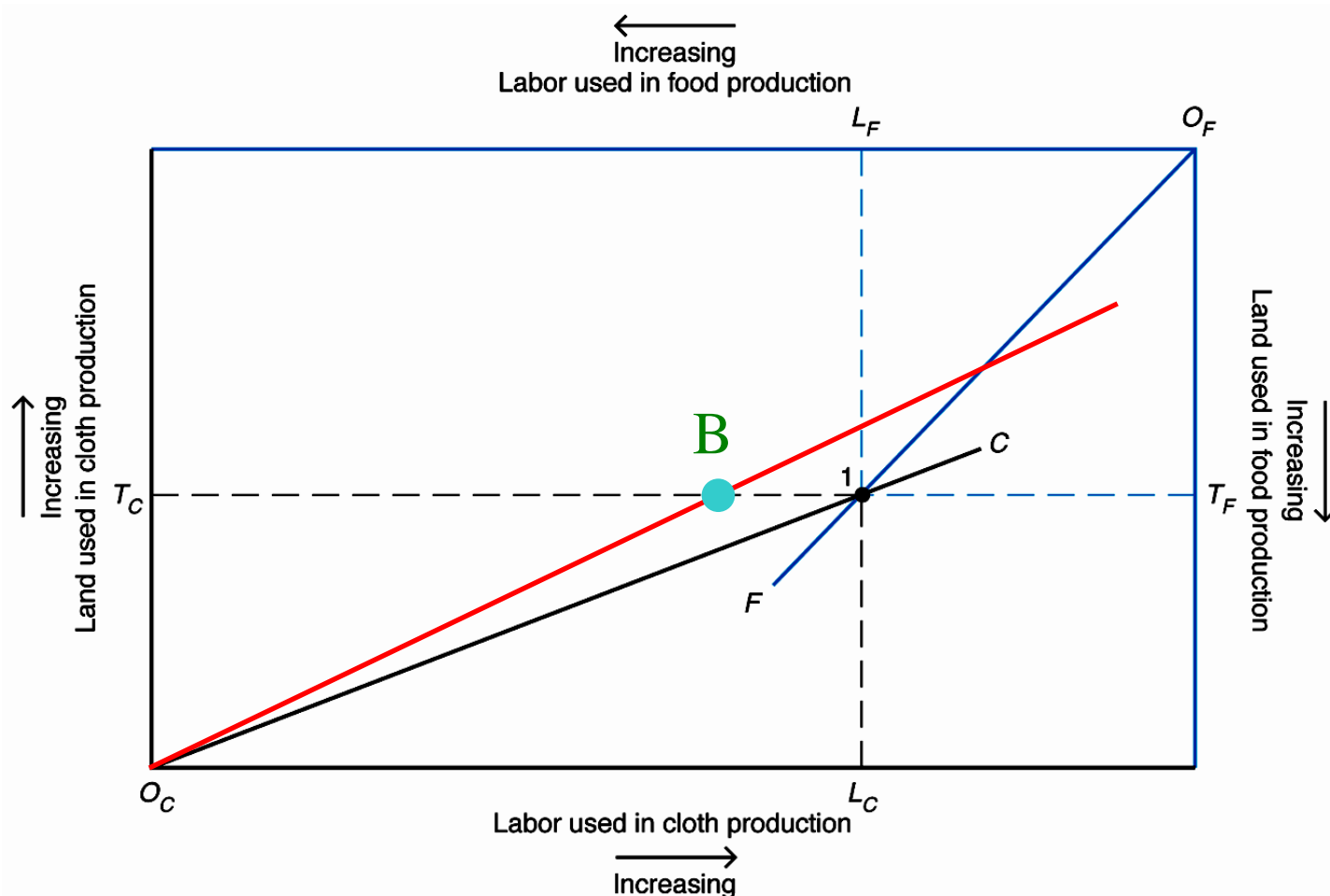- See how this changes the Edgeworth box.

How do rays change with higher w/r?

- For same amount of land, F will use less labour
  - e.g., point 1 shifts to point A
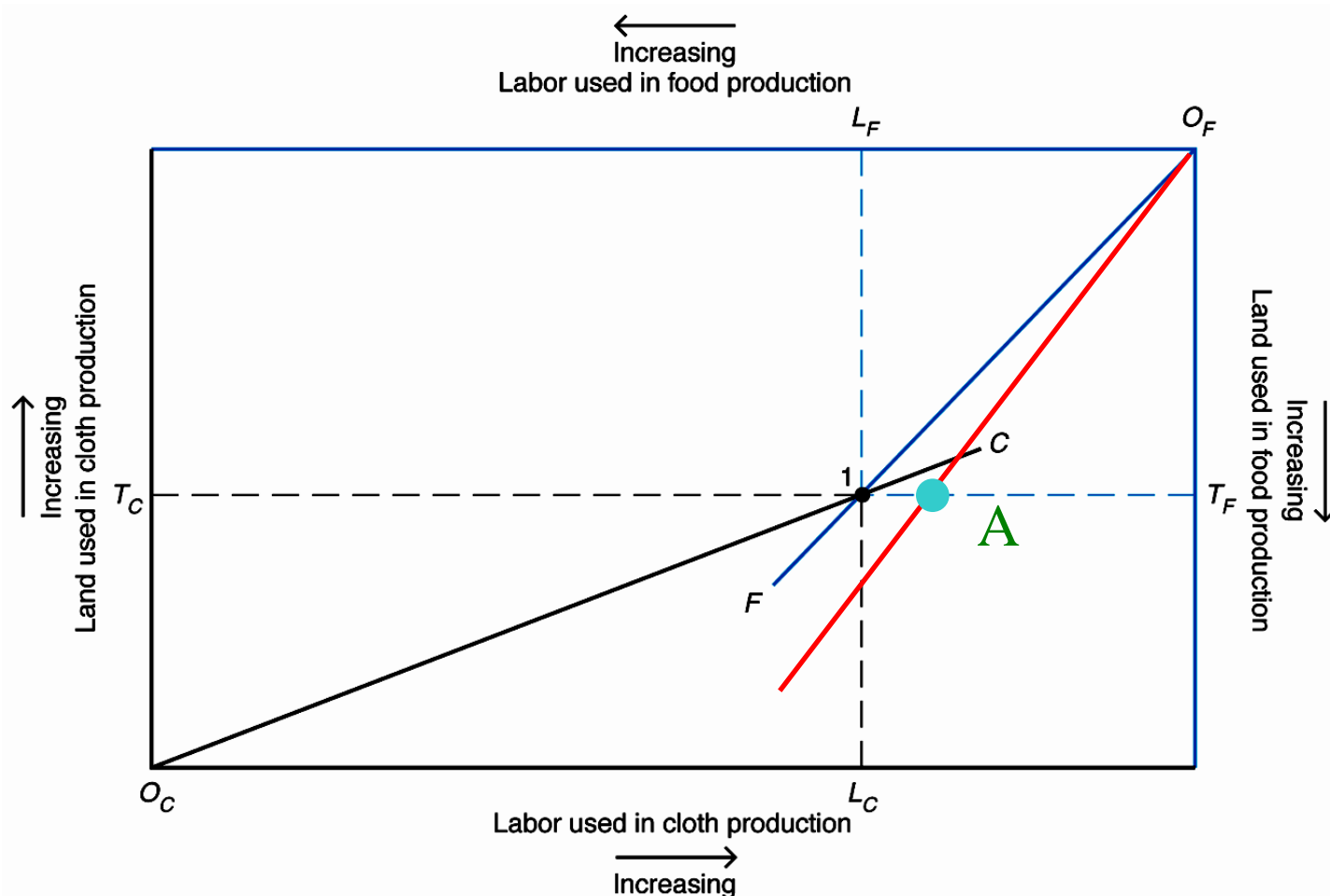
How do rays change with higher w/r?

- For same amount of land, C will use less labour
  - e.g., point 1 shifts to point B

Combining these:
- New allocation of L&T is at point 2
  - C-sector now uses more of both L & T
  - F-sector uses less of both
- We know that output of C $\uparrow$, output F$\downarrow$

Thus the relative supply of C to F rises with relative price of C

- As intuition suggests

Increasing
Labor used in food production

L_F O_F

Increasing
Land used in cloth production

Increasing
Land used in food production

T_C T_F

Increasing
Land used in food production

C

1

2

F

O_C L_C

Labor used in cloth production

Increasing
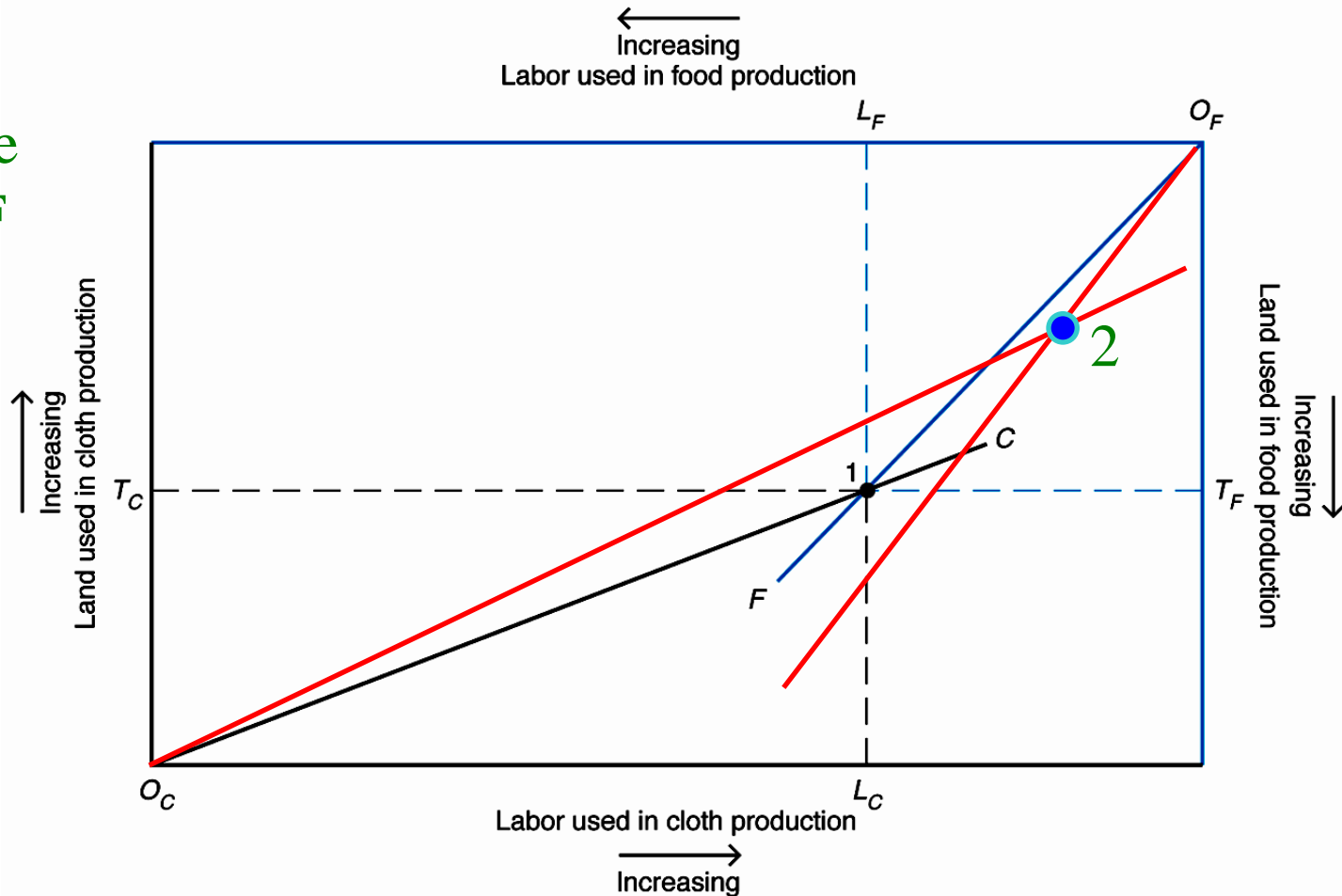
Deriving the PPF for the HO model

- Thinking hard about it, one can see that that reduction in the quantity of F produced for every extra increase in C produce must increase as C production increase.

- This is like diminishing marginal returns in the Ricardo-Viner model, but MUCH trickier since so many things are change (relative factor usage & allocation of both L & T).

- This means the PPF for the HO model is bowed out as in the Ricardo-Viner model.

PPF for the HO model
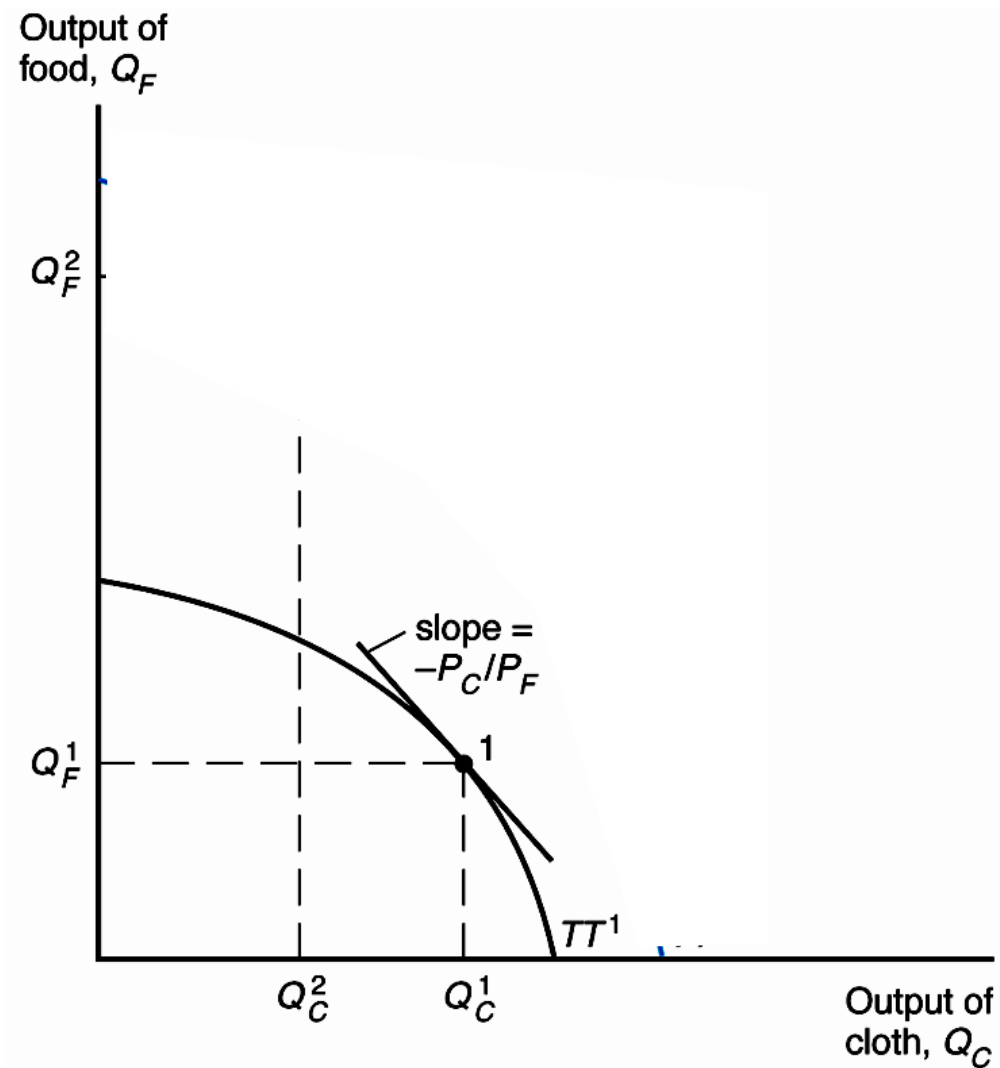
Trade in the HO model

- Next we consider usual auk'y to FT shift between 2 nations
  - Identical nations except for <u>relative</u> factor endowment
  - Viz. same tastes, technology
- To this end, we need to see how change in <u>relative</u> factor endowment changes RS of a nation
- Steps in studying impact of different <u>relative</u> factor endowment
  - 1. We consider impact on allocation of resources for a given set of prices.
  - 2. Show how this affects PPF.
  - 3. Show how this affects the RS

- Take an example
- We increase amount of land (T) without change amount of Labour (L)
- This changes the shape of the Edgeworth box
  - Makes it 'higher'
  - The ray for F sector shifts up
- See this more closely …
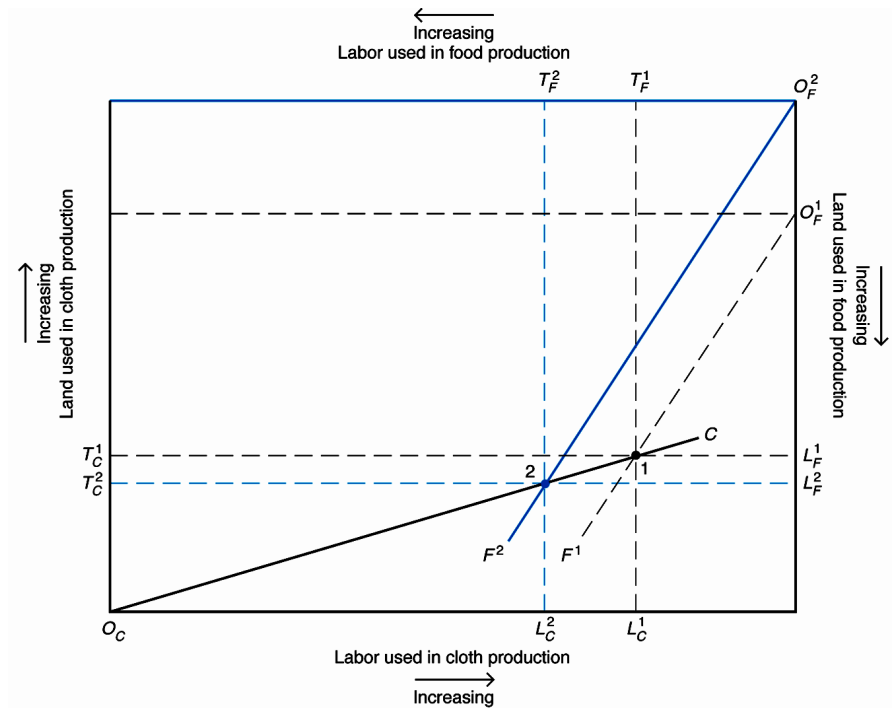
- 1. higher box
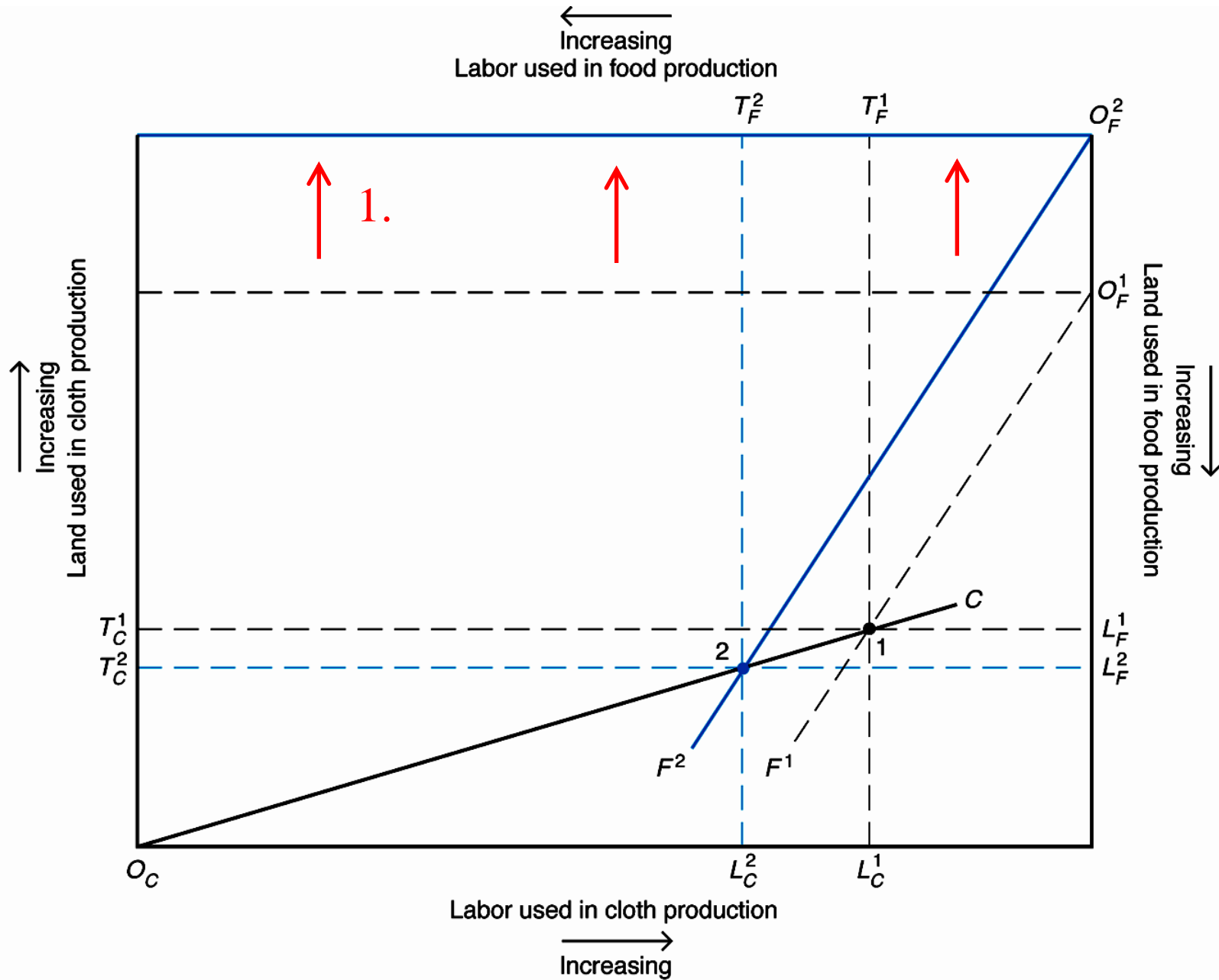
• 2. shifted OF origin & factor intensity ray

NB: slopes of rays don't change (same rel. prices)
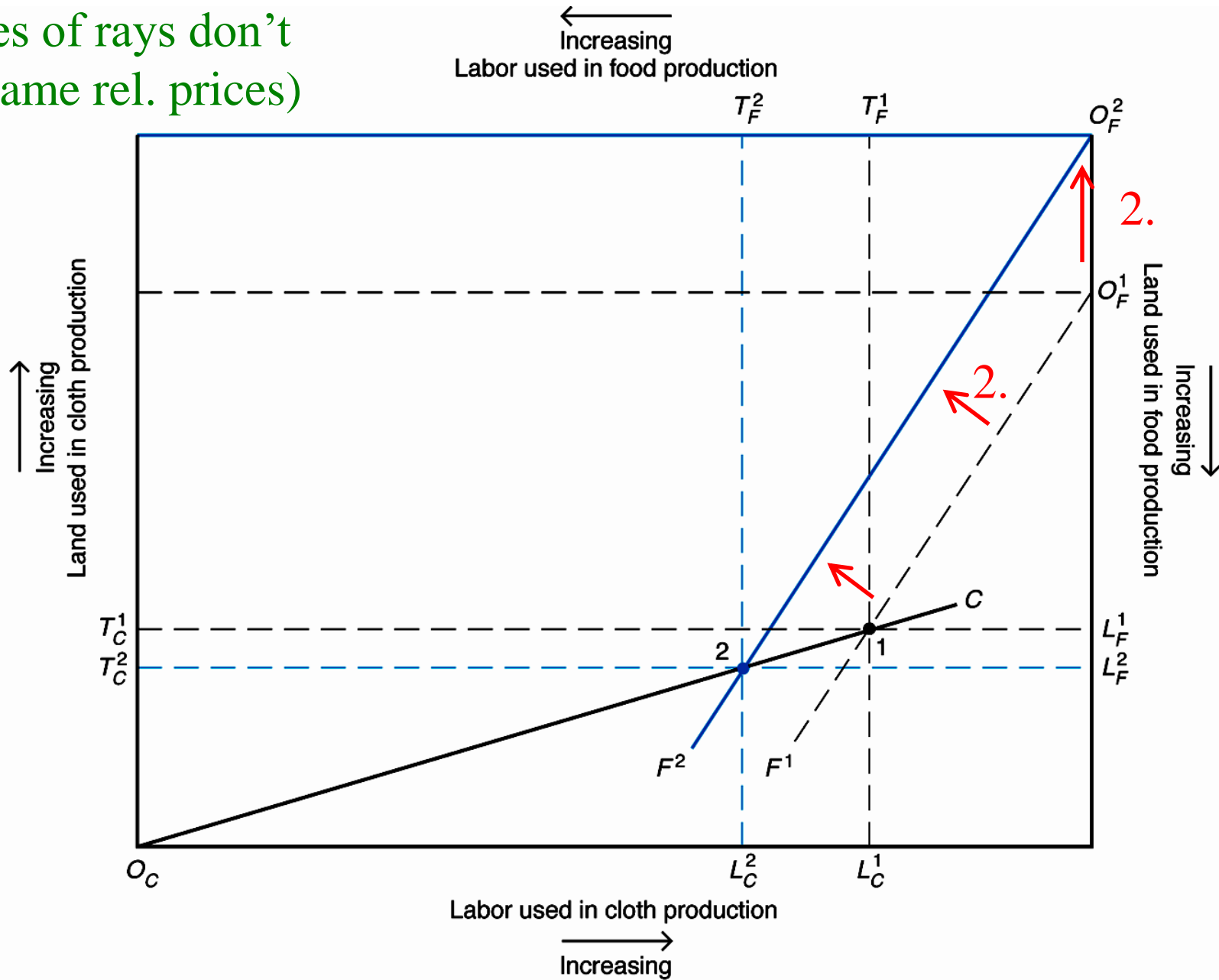
3. New intersection & thus new alloc of T&L
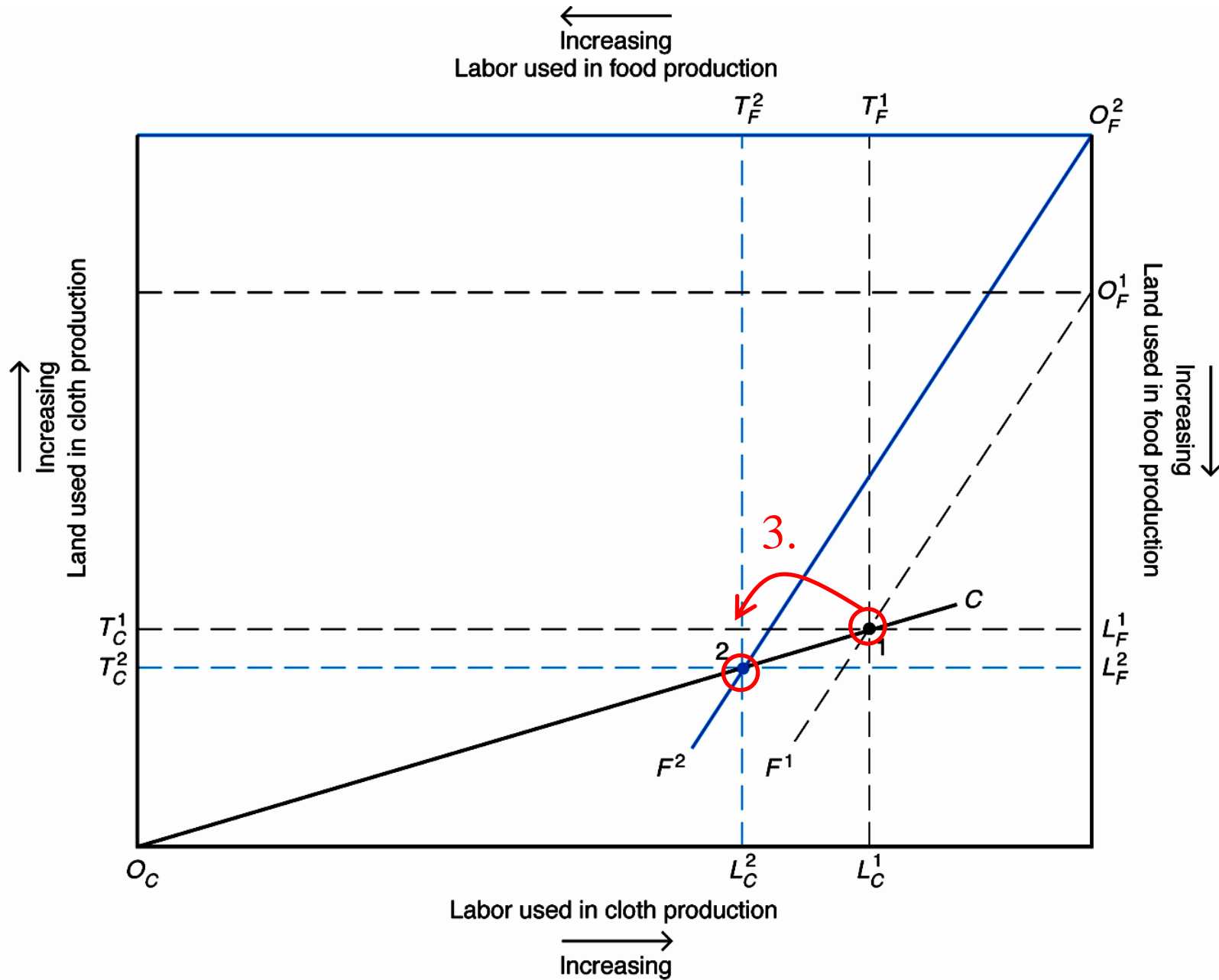
- NB:
  - Less L employed in C (L-intense good)
  - AND less T employed in C
  - More T&L in F (T-intense sector)
  - This means output of T-intense sector ↑
  - Output of L-intense sector ↓
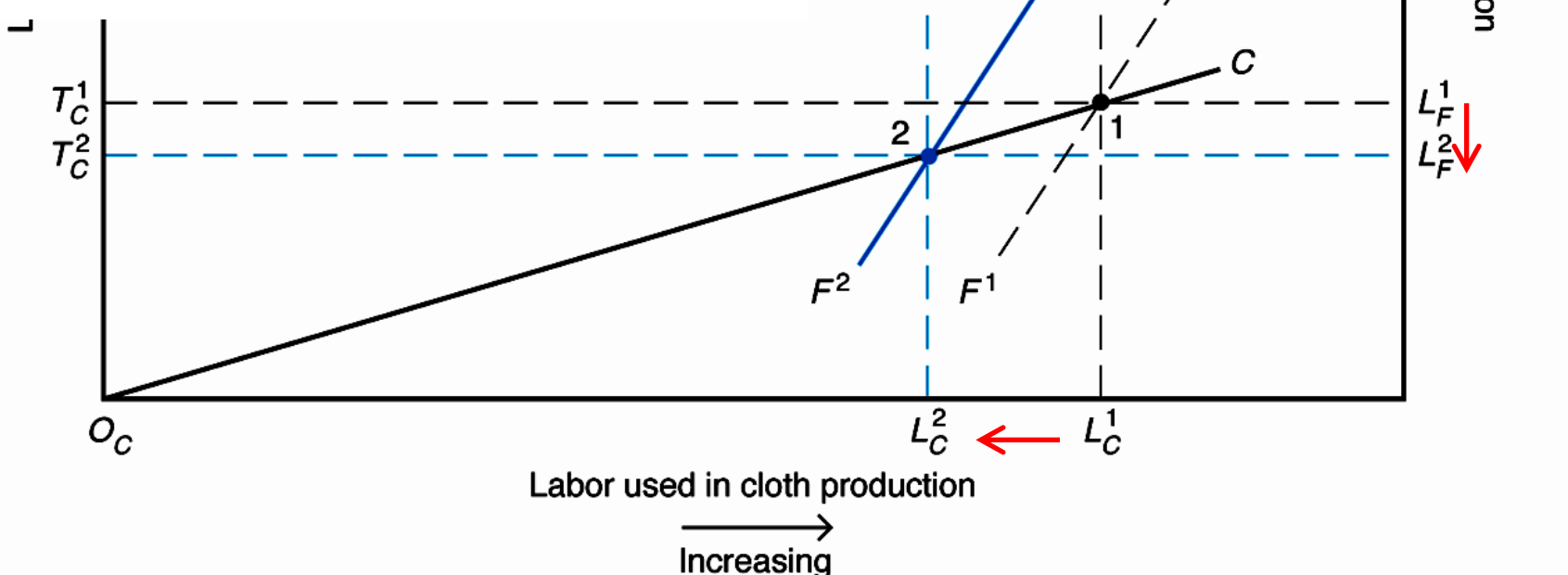
Translate this into PPF shift

- Same relative prices means:
  - Lower C output
  - Higher F output
- THUS, biased shift in the PPF
  - New PPF outside old, but expansion larger in T-intensive sector
- Intuitive results
  - T endowment ↑, possible prod'n of T-intense sector expands more than L-intense sector

Output of food, Q_F

Q_F^2 — 2

slope = $-P_C/P_F$

slope = $-P_C/P_F$

Q_F^1 — 1

TT^1 TT^2

Q_C^2 Q_C^1

Output of cloth, Q_C
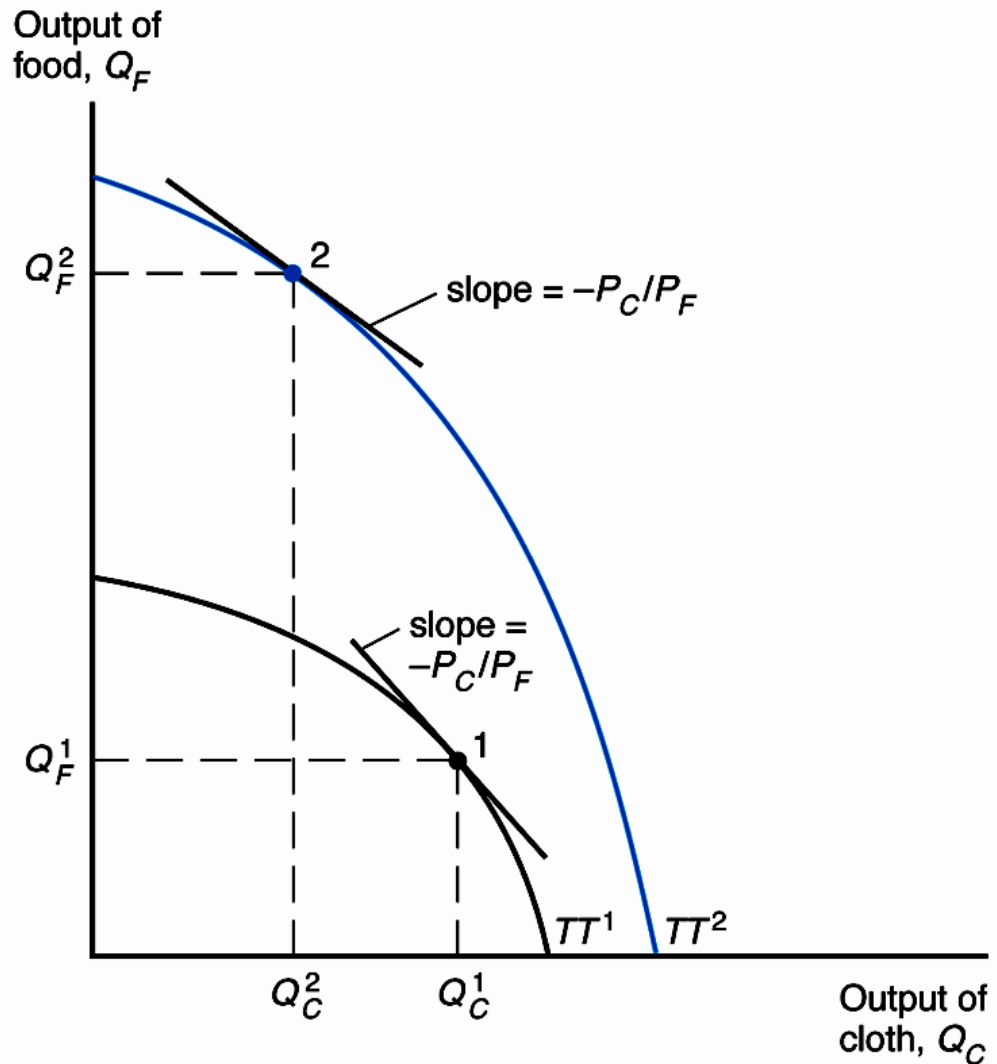
Translate this into RS shift

- This means relative supply of T-intense good rises for any given relative price
- Turn ratio over:
  - Relative supply of L-intense good falls for any given relative price.
- NB: absolute size of endowments irrelevant
  - Relative endowments are what matter

Relative price of cloth, P_C/P_F

RS*

RS

3

2

1

RD

Relative quantity of cloth, $\dfrac{Q_C + Q_C^*}{Q_F + Q_F^*}$
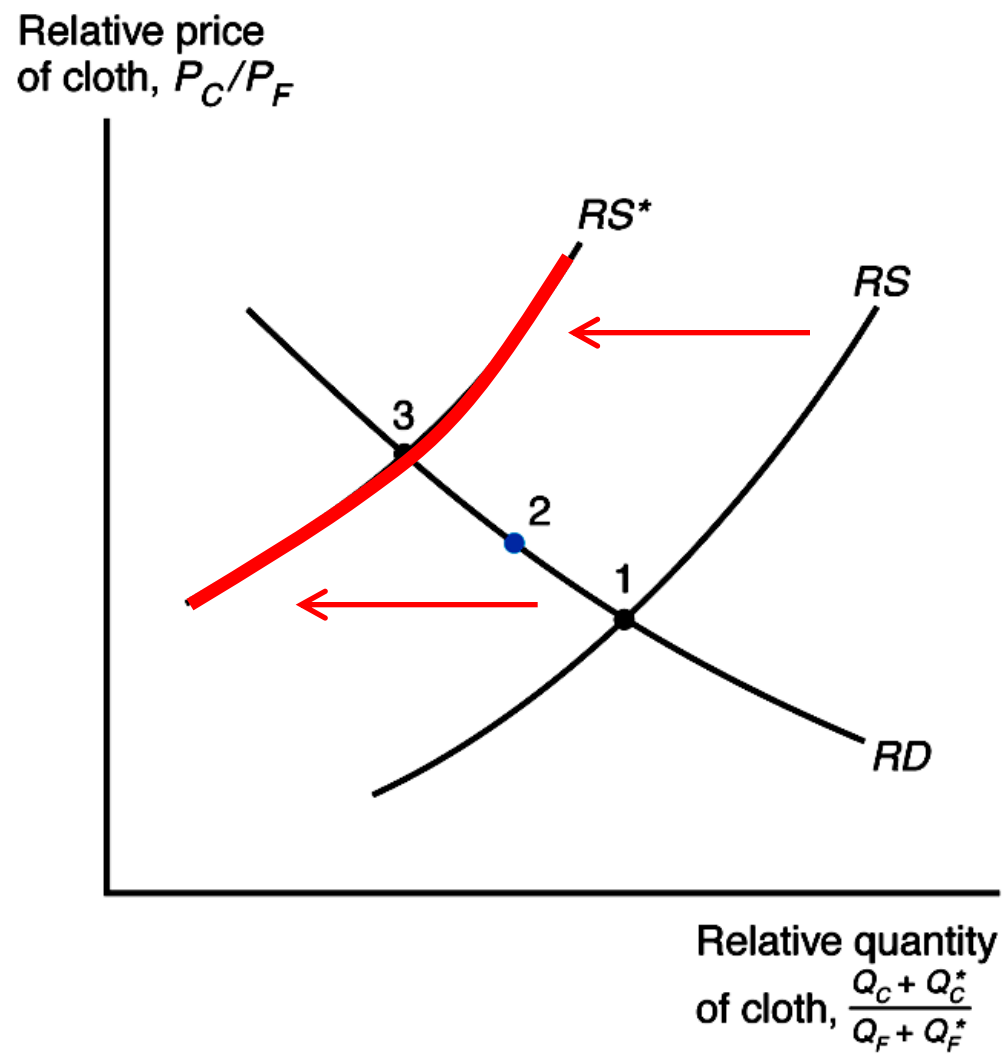
- Ready now to consider trade between nations with different relative endowments.
- Foreign is land-rich compared to Home
  - So Home is L-rich compared to Foreign
- Do 'relative' terminology.

Relative price of cloth, P_C/P_F

RS*

RS

3

2

1

RD
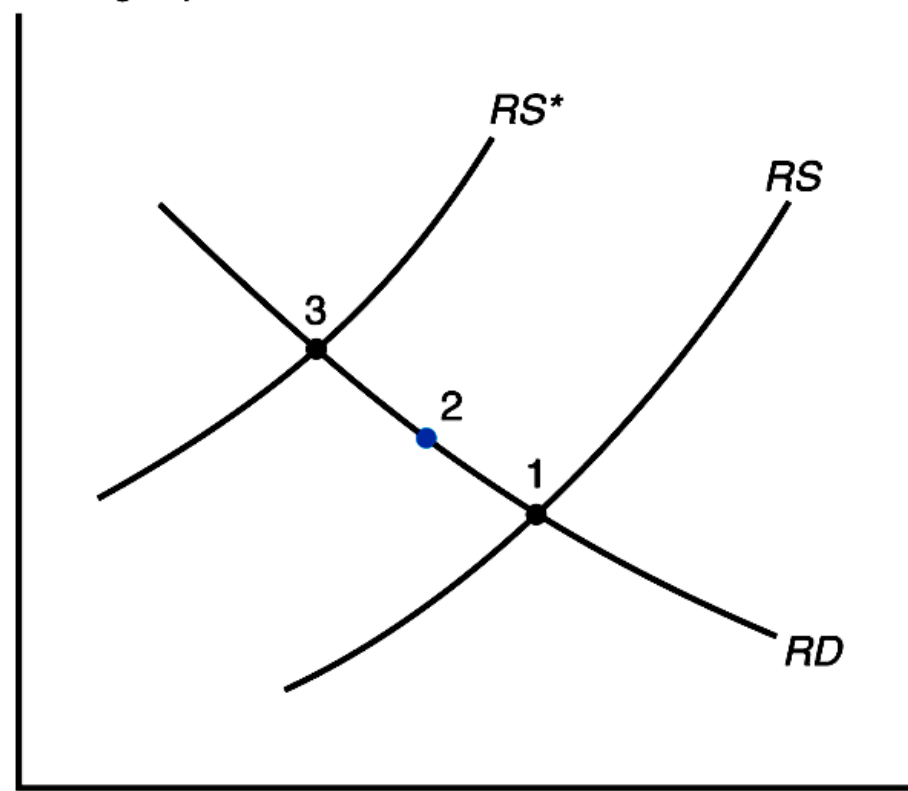
Relative quantity of cloth, $\dfrac{Q_C + Q_C^*}{Q_F + Q_F^*}$

Trade in HO model (cont'd)

- See the 2 auk'y rel.price.
- See the FT rel.price.
- NB:
  - Rel.price of L-intense good ↑ in L-rich nation & ↓ in T-rich nation.
  - Just as in SFM.
- Rel.cons'n of C/F ↓ in L-rich nation & rel.prod'n ↑.
- Opposite in T-rich nation.
- ERGO: T-rich nation exports T-intense good & L-rich nation exports L-intense good.

Relative price of cloth, P_C/P_F

RS*

RS

3

2

1

F^{auky}

FT

H^{auky}

RD

Relative quantity of cloth, $\frac{Q_C + Q_C^*}{Q_F + Q_F^*}$
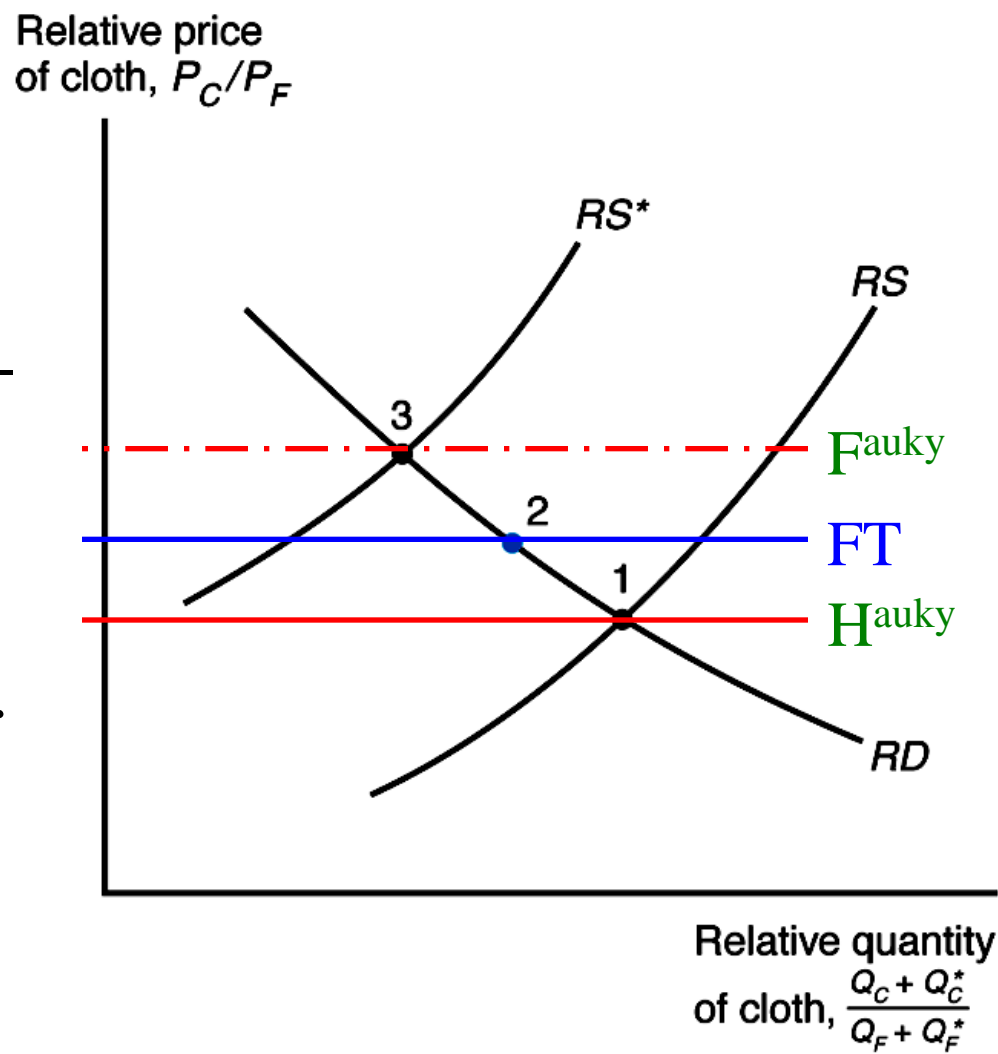
4 key 'theorems' of the HO model

- Must know these & rough intuition
- Proofs aren't important for most students

1. Hecksher-Ohlin Thm

- "Nations tend to export the goods that are relatively intensive in the use of the factors with which they are relative well endowed"
  - Many relatives; know them all. (Just as in SFM.)
- Intuition: trade in goods is a substitute for trade in factors
  - Imagine: no trade in goods, but perfect trade in factors
  - Plainly, Labour would move from L-rich (where L is relatively abundant compared to land) to L-poor nation (where L is relatively scarce compared to land).
  - Trade in HO accomplishes same thing;
    - 'Factor content of trade' approach.
  - This is easy way to remember: (i) trade pattern, (ii) impact on prices and (iii) factor rewards.
- Factor-content approach is the deep fundamentals of HO model.

2. Rybczynski Thm (less useful)

- Biased expansion of a nation's endowment (i.e. change in its relative factor endowment) will result in a biased change in relative output in same direction (holding rel.price constant). Moreover, the sector intensive in use of 'favoured' factor will expand; the other sector will shrink holding rel. goods price constant.
- Can show this with the 'expanded Edgeworth box' diagram.
- Intuition: can't do it in one sentence since involves both full employment conditions and the difference in factor intensity.
  - At least relative prod'n shift is intuitively plausible, even if absolute drop in disfavoured sector is not.
- We showed this when showing how $\uparrow$ in land affected the PPF & RS.

3. Stolper-Samuelson Thm (critical)

- A drop in the rel.price of the L-intense good results in a fall in wage, and a rise in the rental rate (Part 1: direction effect). Moreover, the wage rate fall is more than proportional to the rel.price fall, so landowners gain in consumption terms (i.e. i.t.o. price of both goods) and labour loses i.t.o. the price of both goods. (Part 2: magnification effect)
- Extremely important result.
  - Connects goods prices to factor rewards.
  - Identifies 'pains of trade' with particular factors.
- Used all the time in globalisation debate.

3. Stolper-Samuelson Thm (critical)

- Intuition: can't do it in one sentence since involves both price=marg'l cost conditions and the difference in factor intensity.
  - At least relative factor price shift is intuitively plausible, even if absolute changes are not.
- Good formal intuition: Think about the change in the T/L ratio in both sectors and the impact of this on marginal products and thus factor rewards.
- <u>Rough intuitive on direction</u>: As rel. price of labour-intense gd rises, the demand for labour rises rel. to the demand for land, so the reward to labour rel. to land rises.

SS Thm; diagrammatic proof (not in K&)

1. The price=mc line is flat since F is T-intense, so small drop in 'r' requires bigger rise in 'w' to restore price to 1.

$$1=P_f=wa_{FL}+ra_{FT}$$

2. Steep price=mc line since C is L-intense, so small drop in 'w' requires bigger rise in 'r' to restore price to P_c.

$$P_c=wa_{CL}+ra_{CT}$$

r

r0

w0

w
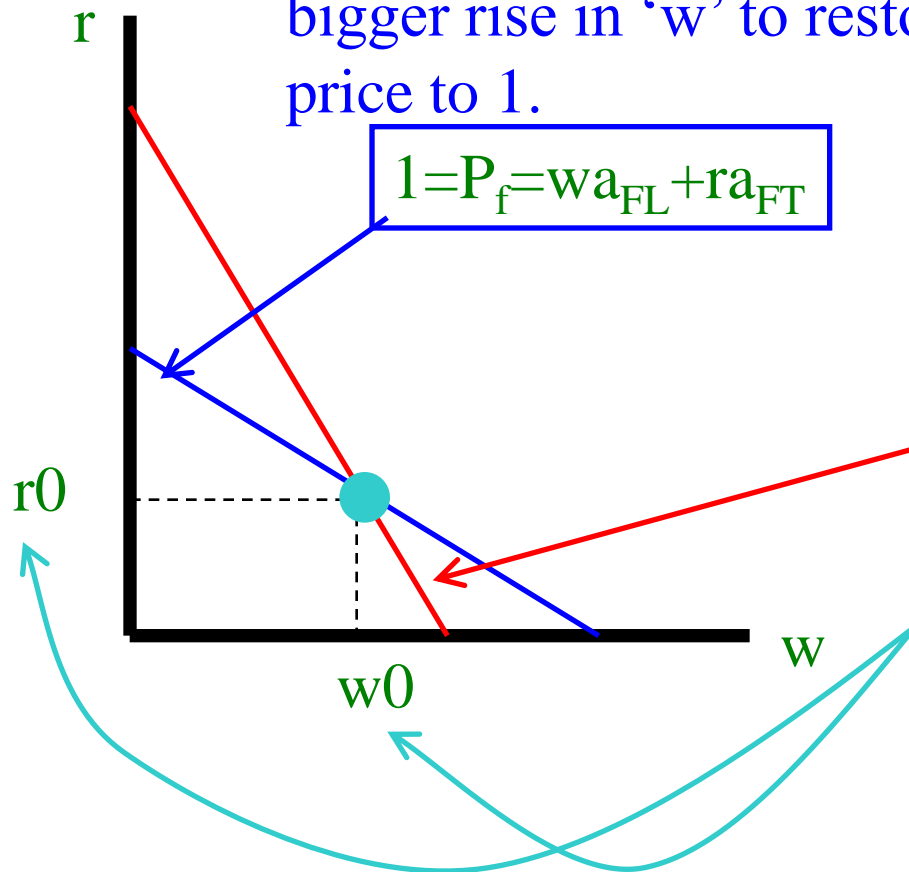
3. At intersection, price=mc for both goods; this is the equilibrium w & r for given prices.

SS Thm; diagrammatic proof

New lower price
$P'_c = wa_{CL} + ra_{CT} < P_c$

No change;
$1 = P_f = wa_{FL} + ra_{FT}$
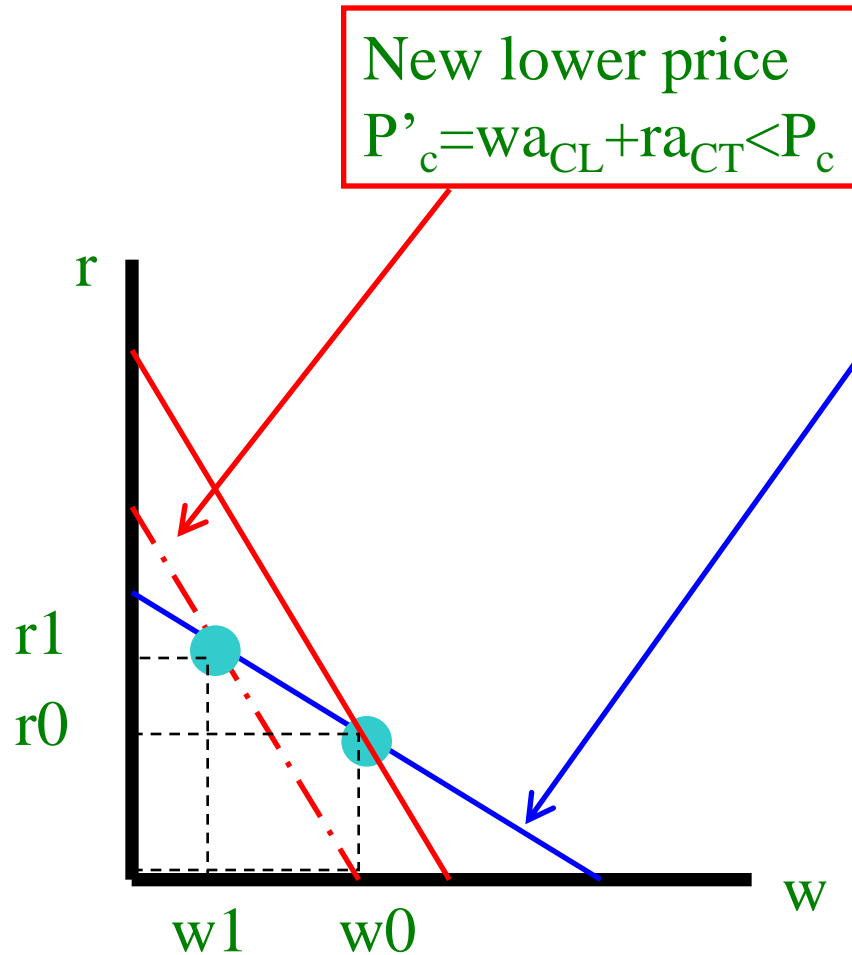
At new intersection, w ↓ &
r ↑.
- NB: biggest impact on
'own factor price', i.e.
"magnification effect", i.e.,
w ↓ more that P_c ↓.

4. Factor Price Equalisation Thm (FPE)

- Important, but absolutely 'wrong'.
  - Factor prices in world are NOT equalised;
  - But, suggests right direction.
  - Often mis-used in globalisation debate.
- More on this later.
- Intuition: If all nations have same technology and same goods prices, then they must have the same factor prices.
- Can show this with the SS curve
  - Plus same technology.
- Can also show with SS thm diagram.

Relative price of cloth, P_C/P_F

SS

Wage-rental ratio, w/r
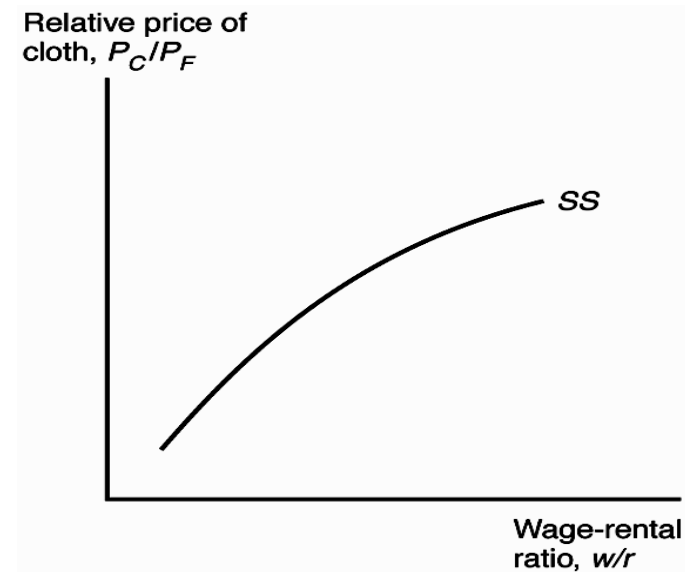
Evidence on HO model

- Read K&O on this. <u>SUMMARY</u>:
- Simplest version is completely rejected by the data.
- More sophisticated versions do better when they allow for:
  - Different technologies across countries (USA vs Bangladesh)
  - Specialisation (not all nations make all goods)
  - Trade costs
- Cannonball & Feather parable; time to consider some 'air resistence'
- Extremely useful for understanding some kinds of trade (Argentina exports beef & imports jets)
- Deeply embedded in the trade discourse, so you must 'know' it if you want to be 'trade literate'.

Application: Trade & Labour

- Read K&O 'case study' on this.
- Received wisdom:
  - Trade is responsible for about 20% of decline in relative wage of unskilled US labour vs. US skilled labour.
  - In Europe, wages don't adjust, so this shows up as higher unemployment rates for unskilled labour.
  - Technology change (e.g. computers) reduce relative demand for unskilled workers (file clerks, typists, etc.)

1. Good X is "labor-intensive" in both nations.
2. Good Y is "capital-intensive" in both nations.

Capital, K

Foreign, K/L high

[Implies (w/r) high]

$[K/L]^F_Y$

Home, K/L low

[Implies (w/r) low]

Capital, K

$[K/L]^H_Y$

2Y

2Y

$[K/L]^F_X$

1Y

1Y

$[K/L]^H_X$

2X

2X

1X

1X

Labor, L

Labor, L

Relative Factor Price, $(w/r)_{Home}$

Relative Factor Price, $(w/r)_{Foreign}$
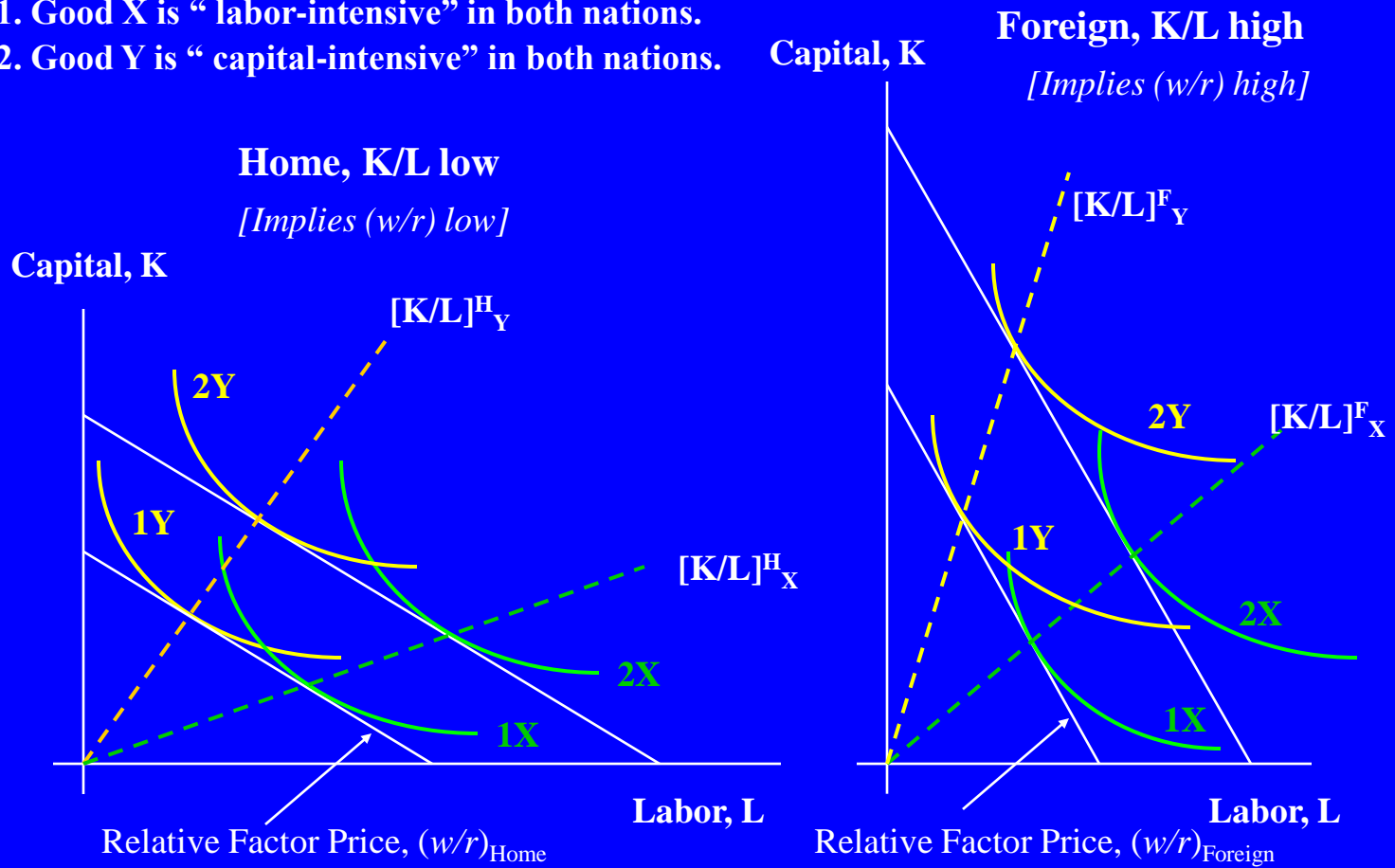
Factor Prices and Input Choices

Wage-rental ratio, *w/r*

Good X

Good Y

Capital-Labor Ratio K/L
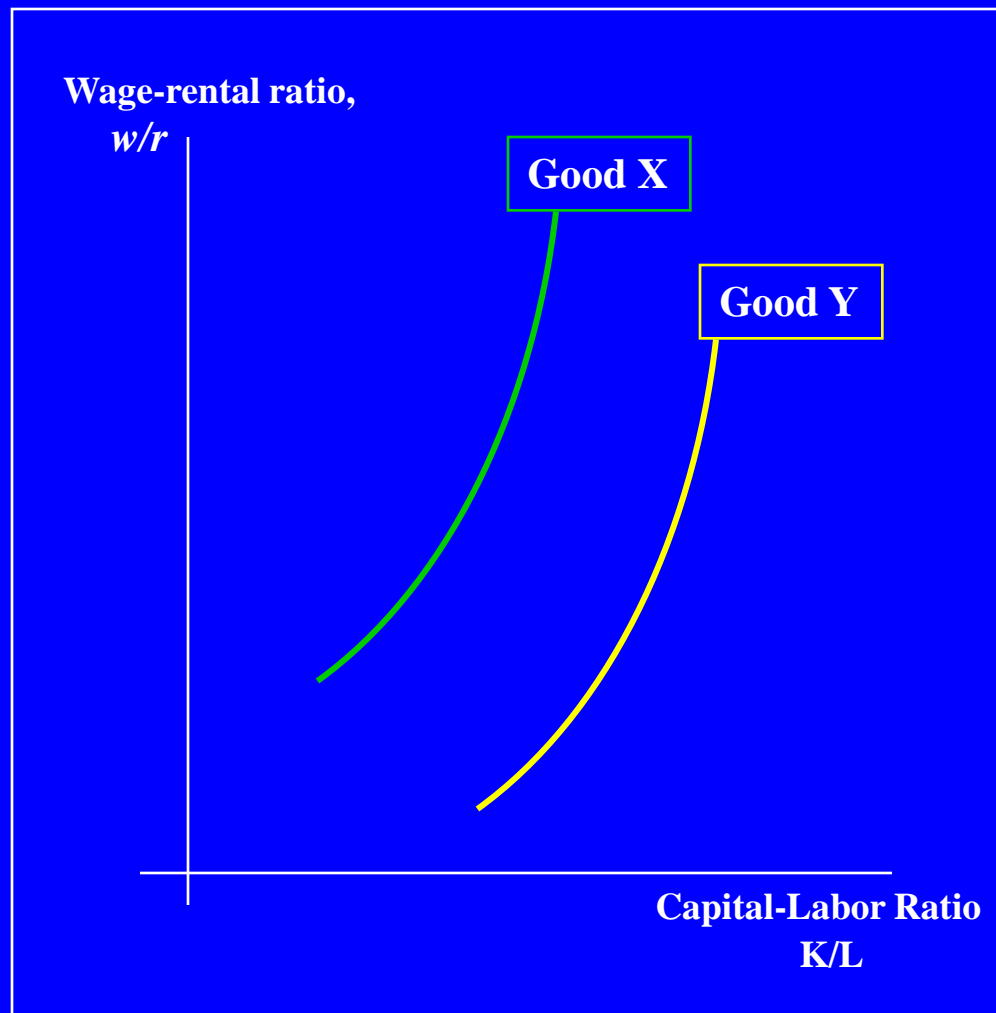
Note from previous slide:

1. As (*w/r*) increases from Home to Foreign, *K/L* ratio used to produce Good X increases. The same is true for Good Y.

2. Implies there is an upward-sloping relation between relative factor price *w/r* and *K/L* used in production of each good.

3. Also, at <u>any</u> level of *(w/r)* Good Y always uses higher *K/L* in prod'n. Thus its relation is <u>below</u> that for Good X.
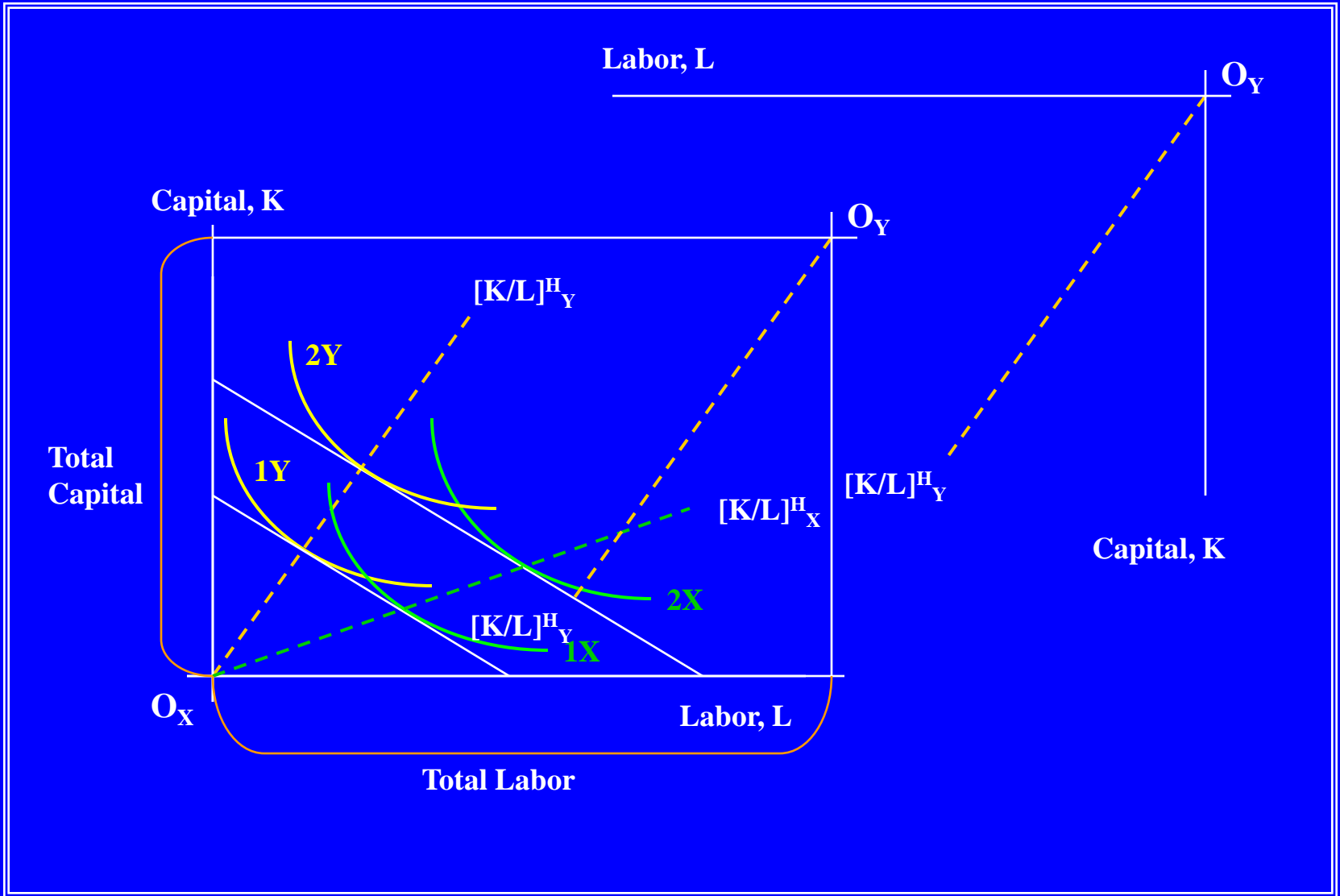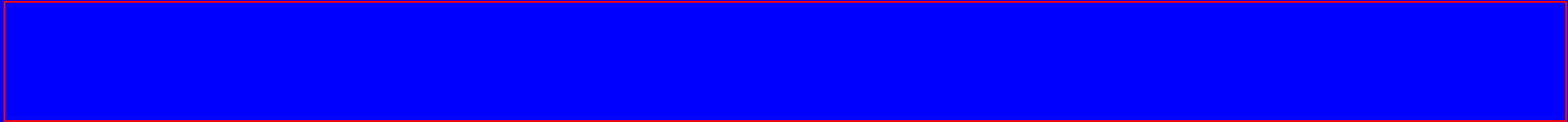
Allocation of Factors & Nation's PPF

1. Box below shows allocation of capital and labor to each good, for a given *w/r* ratio.
2. Implicit in this allocation are prod'n levels of both $Y = Q_Y(K_Y, L_Y)$ and $X = Q_X(K_X, L_X)$.
3. Varying *w/r* picks out different allocations and prod'n points, tracing out PPF.

Y

PPF

B

X

Capital, K

L_Y O_Y

B

$[K/L]^H_X$

K_X K_Y

$[K/L]^H_Y$

O_X L_X Labor, L

- Relative product price (P_X/P_Y) is linked to relative factor returns (w/r) in the H-O model by the mobility of factors between industries within a country.
- Assume relative price of X rises in Home from opening trade.
  - Higher (P_X/P_Y) leads Home producers to raise supply of X relative to Y.
  - Good X is labor-intensive so generates larger increase in demand for labor than labor released by fall in supply of capital-intensive Good Y.
  - Result is increase in demand for labor, driving up real wage, w.
  - Exact opposite result for capital in Home as prod'n shifts to Good X.
  - Higher (P_X/P_Y) thus leads to higher (w/r) as a result of different factor intensities of the Goods combined with labor mobility between industries within Home.
- Diagram on next slide illustrates this relationship between relative product prices and relative factor prices in H-O model.

Relative Factor Prices and Product Prices

Relative Price of X,
P_X/P_Y

SS

Wage-rental ratio
w/r

1. As (P_X/P_Y) increases suppliers switch production from Good Y to Good X.

2. Good Y is capital-intensive, while Good X is labor-intensive.

3. Reducing production of Y increases capital by more than that needed for X. Implies fall in return to capital, r.

4. This also increases labor by less than that needed for X. Implies rise in return to labor, w.

5. Rise in (P_X/P_Y) thus results in rise in (w/r).

- In the Hecksher-Ohlin Model:

    1. For a given set of factor prices, firms choose specific, but different, ratios of factor inputs (K/L) to produce each Good.
    2. A given set of relative product prices (P_X/P_Y) is associated with a given relative factor price (w/r).

- Combining these two results allows us to examine what capital/labor ratios are used in prod'n of each good in each nation before trade.

    – Provide diagrams linking the two results on next slide.

- Will also be able to examine the consequences of the equalization of relative product prices as result of trade for the relative factor prices and capital/labor ratios across countries.

Relative Factor Prices and Product Prices

Wage-rental ratio, *w/r*

1. Assume Home is Labor-abundant, Foreign Capital-abundant

2. Good X is L-intensive, Good Y is K-intensive

SS

Good X

Good Y

$(w/r)_F$

$(w/r)_H$

P_X/P_Y $(P_X/P_Y)_F$ $(P_X/P_Y)_H$ $(K/L)^X_H$ $(K/L)^Y_H$ K/L

$(K/L)^X_F$ $(K/L)^Y_F$
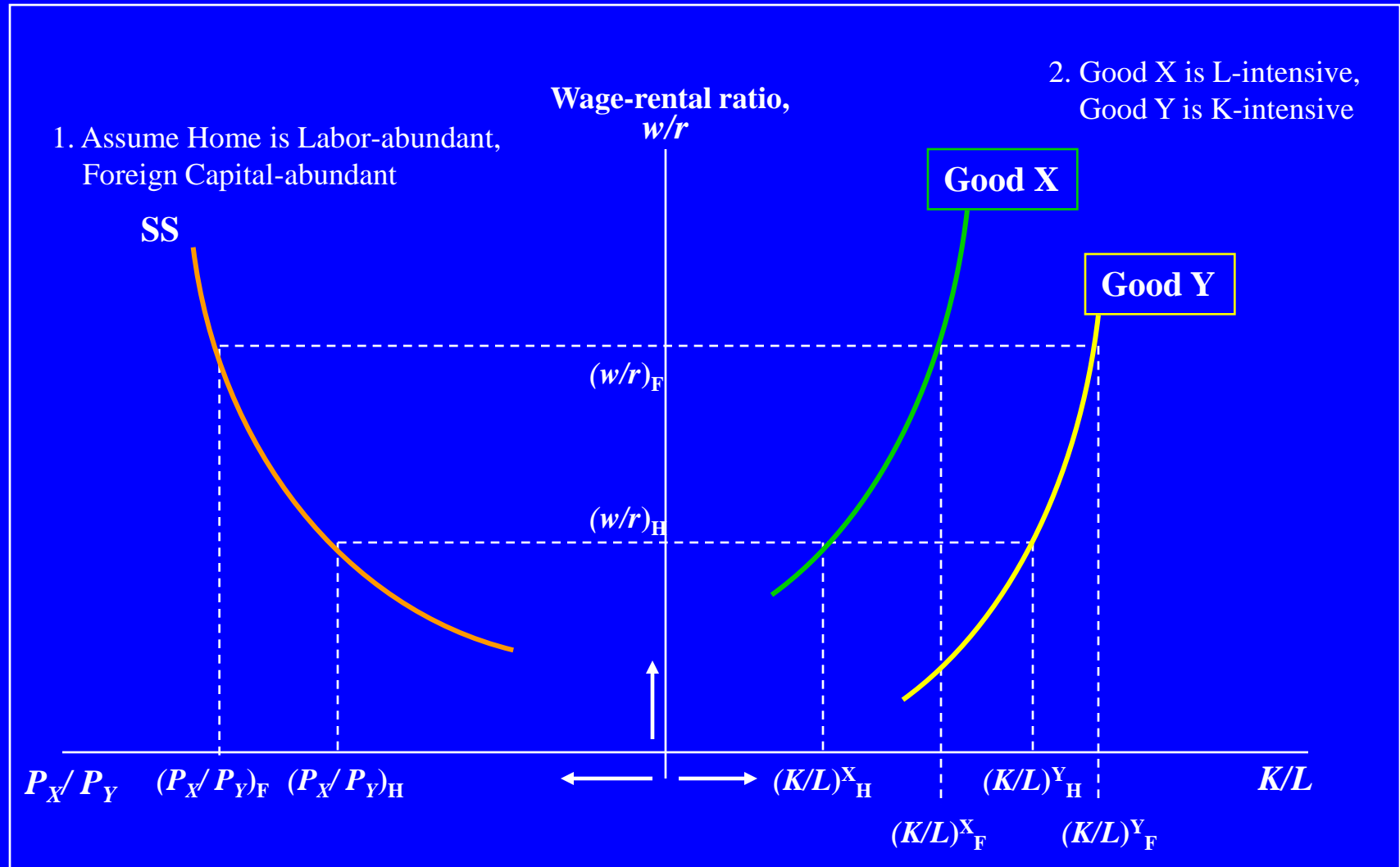
Commodity	SIC Code	K/L ($ per employee)
Dairy Products	202	43,764.54
Grain Mill Products	204	91,328.55
Tobacco Products	21	102,560.98
Textile Mill Products	22	31,067.74
Apparel	23	5,918.62
Paper & Allied Products	26	102,355.57
Petroleum & Coal Products	29	425,090.20
Semiconductors & related devices	3674	70,183.82
Motor Vehicles & equipment	371	54,018.63
Aircraft	3721	27,481.39

Source: U.S. Dept. of Commerce, *Annual Survey of Manufactures*

- **Factor Price Equalization Theorem**
  - International trade will bring about the equalization in the relative and absolute returns to homogenous factors of production across nations.
  - Trade in final goods essentially substitutes for movement of factors between countries to equalize differences in relative factor returns.

- **Stolper-Samuelson Theorem**
  - Free trade will result in an increase in the reward to the abundant factor and a decrease in the reward to the scarce factor, i.e. the relative return earned by the abundant factor will rise with the opening of trade.
  - Assuming full employment before and after trade.

- Do not find complete factor price equalization of H-O theory.
  - May be barriers to adjustment: trade barriers, transportation costs, heterogeneous capital or labor, non-traded goods, imperfect competition, unemployed factors, etc.

Relative Factor Prices and Product Prices

Real Hourly Wage in Manufacturing
(as Percentage of U.S. Wage)

Country	1959	1970	1983	1990
Japan	11	24	51	108
Italy	23	42	62	100
France	27	41	62	101
U.K.	29	35	53	82
Germany	29	56	84	118
Average	24	40	62	102
U.S.	100	100	100	100

Source: IMF, OECD, and US BLS

- At constant product prices, an increase in the endowment of one factor will increase by a <u>greater proportion</u> *(magnification effect)* the output of the good intensive in that factor, and will reduce the output of the other good.

- Intuition:
  - Assume that the supply of capital increases.
  - Constant product prices imply constant relative factor returns, *(w/r)*.
  - But relative factor returns can remain constant only if K/L and productivity of K and L remain constant in prod'n of both goods.
  - To fully employ new capital, while keeping K/L constant in both goods, requires fall in output of labor-intensive Good X to release enough labor to absorb increase in K in prod'n of Good Y.
  - Thus output of capital-intensive Good Y increases while output of labor-intensive Good X falls.

Factor Growth & the Rybczinski Theorem