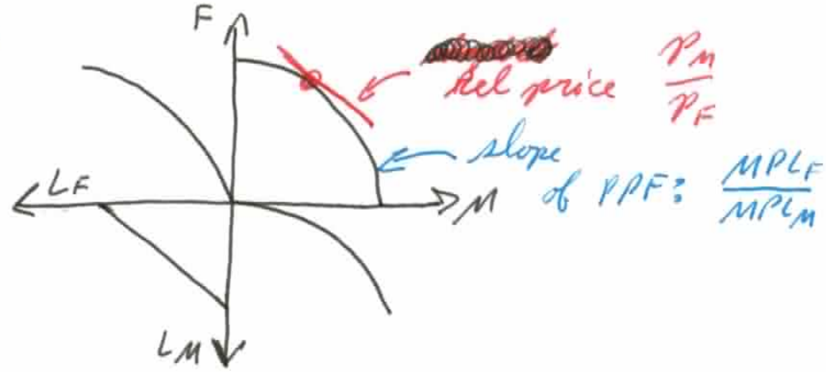
Factor-Price Equalization

→ Recall that in Specific-Factor Model we saw PPF:



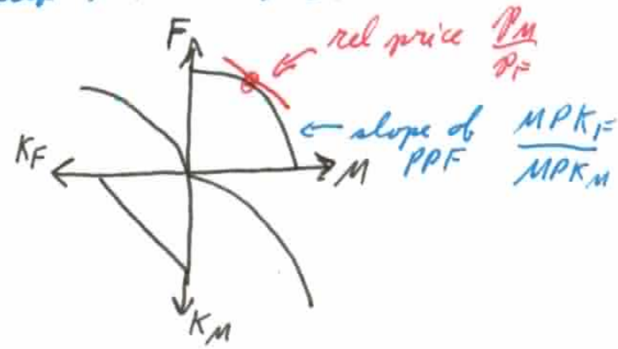
$$\boxed{\frac{P_M}{P_F} = \frac{MPL_F}{MPL_M}}$$

This holds for any quantity of Kapital in Manuf + any quantity of Land in Food

→ Now suppose that Land is simply Kapital that is employed in the Food sector

→ Since Land IS Kapital, Kapital is now free to move between the Manuf + Food sectors

Therefore we can draw:



$$\boxed{\frac{P_M}{P_F} = \frac{MPK_F}{MPK_M}}$$

This holds for any quantity of Labor in Manuf + any quantity of Labor in Food

→ NOTE: This is just another way of saying that the wage W and rental rate r are equalized across sectors.

$W = P_M MPL_M = P_F MPL_F$ and $r = P_M MPK_M = P_F MPK_F$

at an optimum:

$$\boxed{\frac{p_M}{p_F} = \frac{MPL_F}{MPL_M} = \frac{MPK_F}{MPK_M}}$$

cross-multiplying:

$$\frac{MPL_F}{MPK_F} = \frac{MPL_M}{MPK_M}$$ Marginal Rate of Substitution

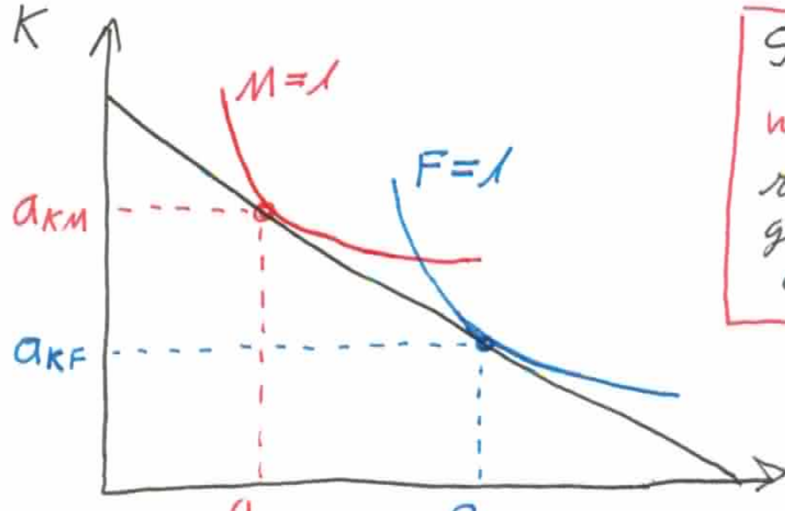
if firms MINIMIZE COSTS

rel wage $\quad \frac{w}{r} = \frac{MPL_F}{MPK_F} = \frac{MPL_M}{MPK_M}$ MRS

Next, let's draw the isoquants for the food + manuf sectors on the same graph + let's also draw the isoquants for a single unit of output so that we can obtain the unit labor + capital req'ts in each sector

Manuf is Kapital intensive

Food is Labor intensive



So at any relative wage w/r the capital-labor ratio in Manuf is greater than the capital-labor ratio in Food

$$\frac{K_M}{L_M} > \frac{K_F}{L_F}$$

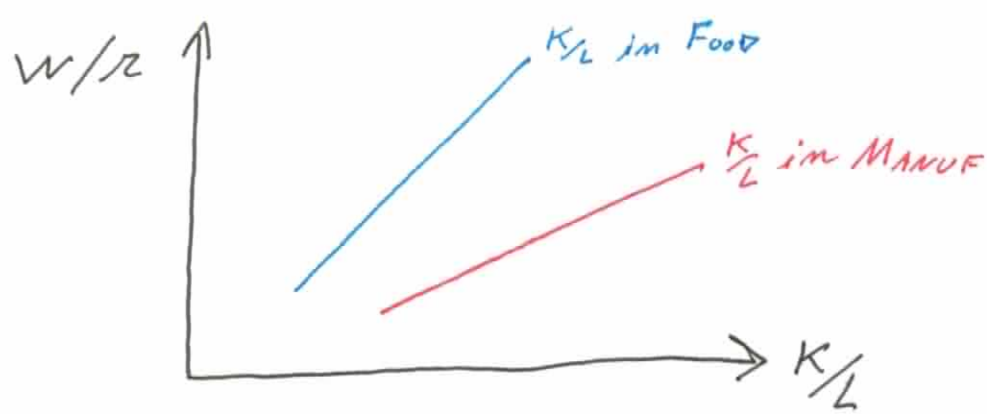
because of CRS

NOTE: The tangencies do NOT have to lie on the same isocost line.

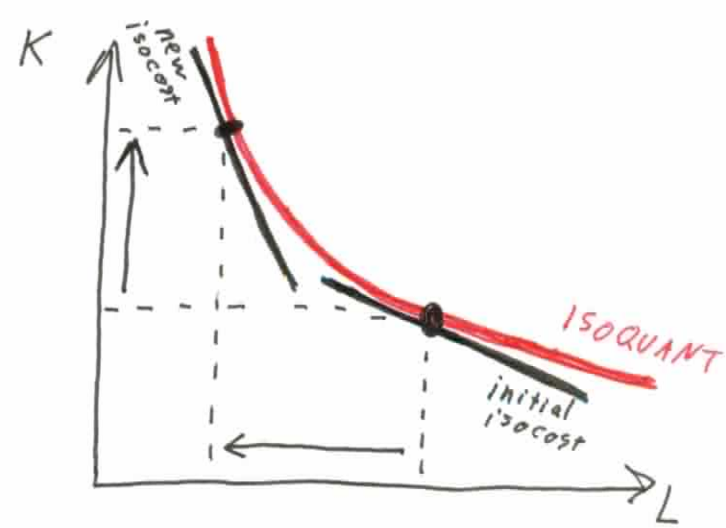
Remember that the assumption of CONSTANT RETURNS to SCALE (CRS) (i.e. linear homogeneity of the production function) means that – for a given relative wage – a cost-minimizing firm that wishes to double its output must double its capital and labor inputs

Therefore, at any relative wage w/r

$$\frac{K_M}{L_M} > \frac{K_F}{L_F}$$



Also note that as relative wage rises, the capital-labor ratio rises in each sector



Notice that we've established the following chain of determination:

$\boxed{\text{relative price of manuf. (or of food)} \xrightarrow{\text{determines}} \text{relative wage} \xrightarrow{\text{determines}} \text{capital-labor ratio in each sector}}$

The only thing we haven't discussed is the relationship between the relative price and the relative wage

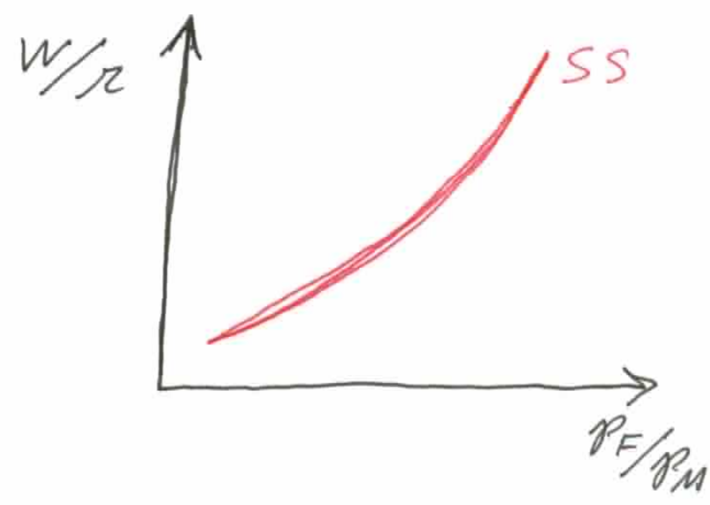
According to the Stolper-Samuelson Theorem

if the percentage of the cost of Food accounted for by Labor is greater than the percentage of the cost of Manuf accounted for by Labor (i.e. Food is Labor-intensive), then an increase in the relative price of Food will raise the relative wage

i.e. $\theta_{LF} > \theta_{LM}$

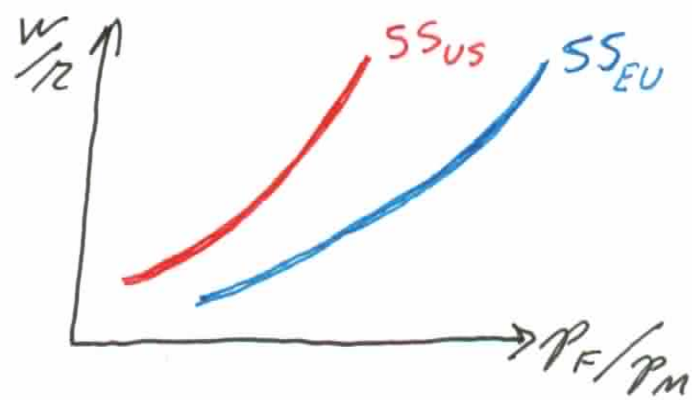
implies that

$\uparrow \dfrac{p_F}{p_M}$ causes $\uparrow \dfrac{w}{r}$



The Stolper-Samuelson Theorem shows that an increase in the relative price of food will raise the relative wage BUT it does **NOT** imply that each country will have the same SS relationship. Factor-price equalization requires that each country has the same SS relationship.

In other words, what prevents a situation like the one depicted to the right?



Suppose that the relative wage is the same in US + EU, could the relative price of food be higher in EU (as depicted in the graph)? **NO!** If the US + EU have the same relative wage AND IF the US + EU share the same technology then the US + EU will have the same unit labor + unit capital requirements in the food and manufacturing sector. Therefore, the cost of producing a unit of food will be the same in both countries and the cost of producing a unit of manufactures will be the same in both countries. Because we assumed zero-profits, the cost of producing a unit of food must equal the price of food and the cost of producing a unit of manufactures must equal the price of manufactures.

notice that the Stolper-Samuelson Theorem does **NOT** imply Factor Price Equalization!
It only implies changes in relative wage as rel price changes
Factor Price Equalization occurs when the capital-labor ratios (in each sector) are the same in both countries

Samuelson (EJ, 1948) provides the following example:

	Labor	Land
America	100	100
Europe	100	55
World	200	155

original factor endowments

Since Labor is relatively scarce in Europe the American wage rate is higher than Europe's so Labor would want to migrate from Europe and to America. Similarly, Land would want to move from America and to Europe

Migration would occur until America and Europe each had the same ~~capital~~ land-labor ratio

	Labor	Land	Labor/Land
America	129	100	1,29
Europe	71	55	1,29

Since they have same Labor-Land ratio FACTOR PRICES EQUALIZED

Since America and Europe would then have the same ratio of labor to land

(and since we've assumed that America and Europe share the same technology and the same demand for clothing and food)

production would be carried on in the same way in both countries and America and Europe would have no need to trade with each other AND wages and rents SAME in Europe + America EQUALIZED

Suppose that the production structure requires a Labor-Land ratio of 1/4 in the Food sector and 4 in the clothing sector

	Labor	Land	Labor/Land
Food input	28	112	1/4
Clothing input	172	43	4
WORLD	200	155	

Now notice that the same Labor-Land ratios can arise WITHOUT migration

	Labor	Land	$\frac{\text{Labor}}{\text{Land}}$
American Food Input	20	80	1/4
American Clothing Input	80	20	4
	100	100	
European Food Input	8	32	1/4
European Clothing Input	92	23	4
	100	55	

Because America and Europe share the same technology (i.e. they have the same isoquants) and because they have the same land-labor ratios in Food + Clothing, they must have the same relative wage

Notice also that the US produces more food than Europe (America is relatively abundant in land) and that Europe produces more clothing than America (Europe is relatively abundant in labor)

So American exports of food + European exports of manufactures allow product prices to equalize which reduces the relative wage in America and raises the relative wage in Europe. Factor prices equalize if the labor-land ratio in Manuf is same in America and Europe and if the labor-land ratio in Food is same in America and Europe.

$$\begin{pmatrix} a_{LM} & a_{LF} \\ 0 & a_{TF} \\ a_{KM} & 0 \end{pmatrix}\begin{pmatrix} M \\ F \end{pmatrix} = \begin{pmatrix} L \\ T \\ K \end{pmatrix}$$

$$a_{TF} = \frac{T}{F}$$

$$a_{KM} = \frac{K}{M}$$

$$a_{LM} = \frac{L_M}{M}$$

$$a_{LF} = \frac{L_F}{F}$$

$$T/L_F = \frac{T}{F} \cdot \frac{F}{L_F} = \frac{a_{TF}}{a_{LF}}$$

$$K/L_M = \qquad = \frac{a_{KM}}{a_{LM}}$$

$$\begin{pmatrix} a_{LM} & 0 & a_{KM} \\ a_{LF} & a_{TF} & 0 \end{pmatrix}\begin{pmatrix} w \\ r_T \\ r_K \end{pmatrix} = \begin{pmatrix} p_M \\ p_F \end{pmatrix}$$

$$\begin{pmatrix} a_{LM} & 0 & a_{LM} \cdot \frac{K}{L_M} \\ a_{LF} & a_{LF}\frac{T}{L_F} & 0 \end{pmatrix}\begin{pmatrix} w \\ r_T \\ r_K \end{pmatrix} = \begin{pmatrix} p_M \\ p_F \end{pmatrix}$$

$$\begin{pmatrix} 1 & 0 & K/L_M \\ 1 & T/L_F & 0 \end{pmatrix}\begin{pmatrix} w \\ r_T \\ r_K \end{pmatrix} = \begin{pmatrix} p_M/a_{LM} \\ p_F/a_{LF} \end{pmatrix} = \begin{pmatrix} p_M M/L_M \\ p_F F/L_F \end{pmatrix}$$

so FPE occurs if K/L_M and T/L_F same in both countries and if a_{LM} and a_{LF} same in both countries

But since we assume CONSTANT RETURNS TO SCALE (i.e. linear homogeneity of the production function):

$$Q = f(K, L)$$

$$\frac{Q}{L} = f\left(\frac{K}{L}, \frac{L}{L}\right) = f(k) \quad \text{where } k \equiv \frac{K}{L}$$

So the average product of labor is a function of the capital-labor ratio

define: $\frac{M}{L_M} = m(k)$ and $\frac{F}{L_F} = f(t)$

where $k \equiv \frac{K}{L_M}$ and $t \equiv \frac{T}{L_F}$

$$\begin{pmatrix} 1 & 0 & k \\ 1 & t & 0 \end{pmatrix} \begin{pmatrix} w \\ r_T \\ r_K \end{pmatrix} = \begin{pmatrix} p_M \cdot m(k) \\ p_F \cdot f(t) \end{pmatrix}$$

So IF both countries share the same technology

IF trade equalizes output prices

and IF K/L_M and T/L_F are the same in both countries

then FACTOR PRICE EQUALIZATION will also occur in the Specific Factors Model

Note however that nothing in the Specific Factors Model requires K/L_M and T/L_F to be same in both countries

$$w = p_M[m(k) - k\,m'(k)] = p_F[f(t) - t\,f'(t)]$$

$$\frac{p_F}{p_M} = \frac{m(k) - k\,m'(k)}{f(t) - t\,f'(t)} = \frac{MPL_M}{MPL_F}$$

NOTE that there is a tendency toward FPE, though not necessarily complete FPE.

ASSUME US & Africa have same L & T but US has more K than Africa.

When US & Africa open to trade, the relative price of food will rise in Africa and fall in the US. Therefore:

US K/L_M will fall   Africa's K/L_M will rise

US T/L_F will rise   Africa's T/L_F will fall

In other words US K/L_M ratio will come closer to Africa's. Similarly US T/L_F ratio will come closer to Africa's.

US capitalists gain   African capitalists lose

US landowners lose   African landowners gain