

# ECO364: International Trade Theory

## Lecture 5

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- Last Class

- Why does FPE happen in free trade?
- Factor Content Studies

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  - Factor Content Studies
- Today
  - Under what conditions does FPE take place?
  - Specific Factors Model

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  - Factor Content Studies
- Today
  - Under what conditions does FPE take place?
  - Specific Factors Model
- Readings
  - KMO Ch 4

# The Specific Factors Model

- In the Ricardian model, we were not able to say anything about the income distribution (why?)
- But we were able to do this in the Heckscher-Ohlin model
  - Two factors of production
- In a model with more than one factor, we showed that factors could experience a fall in their real returns
  - When the price of a good increases, the factor used intensively in the production of that good experiences an increase in real returns
  - The other good experiences a decrease in real returns
  - Stolper-Samuelson theorem

# The Specific Factors Model

- The HO model is more suitable for studying the long-run effects of trade
  - We assumed each factor can costlessly transfer across industries within a country where the decision to move is based on factor returns
- In the short run, factors could be stuck in their industry
  - Occupation-specific skills: it takes a long time and a lot of money to switch careers
  - Large factories and heavy machinery are difficult to move or convert for other uses
  - Geographic constraints: very high transportation or migration costs could make it difficult for factors to move in locations with industries experiencing growth

# Specific Factors Model: Outline

- Model setup + analysis
- Autarky equilibrium
- Trade equilibrium
  - Countries North and South
- Gains from Trade
- Note: a lot of the ideas here will be similar to what you saw in the HO model, but I will proceed slowly anyway (consider it as a review for the exam!)

# Model Setup

- Two sectors/goods: Food,  $F$ ; Computers,  $C$
- Three factors in production: Labour,  $L$ ; Capital,  $K$ ; Land,  $T$
- Labour is a **mobile factor**: can costlessly move across industries
- Capital and Land are **specific factors**
  - Land is used only in the food sector
  - Capital is used only in the computer sector

# Model Setup

- The production functions for each industry are denoted by

$$Q_C = Q_C(K, L_C)$$

$$Q_F = Q_F(T, L_F)$$

- There's a finite stock of labour,  $\bar{L}$ , in the economy and in optimum

$$L_C + L_F = \bar{L}$$

# Model Setup

- The marginal product of labour are

$$MPL_C = \frac{\partial Q_C(K, L_C)}{\partial L_C}$$

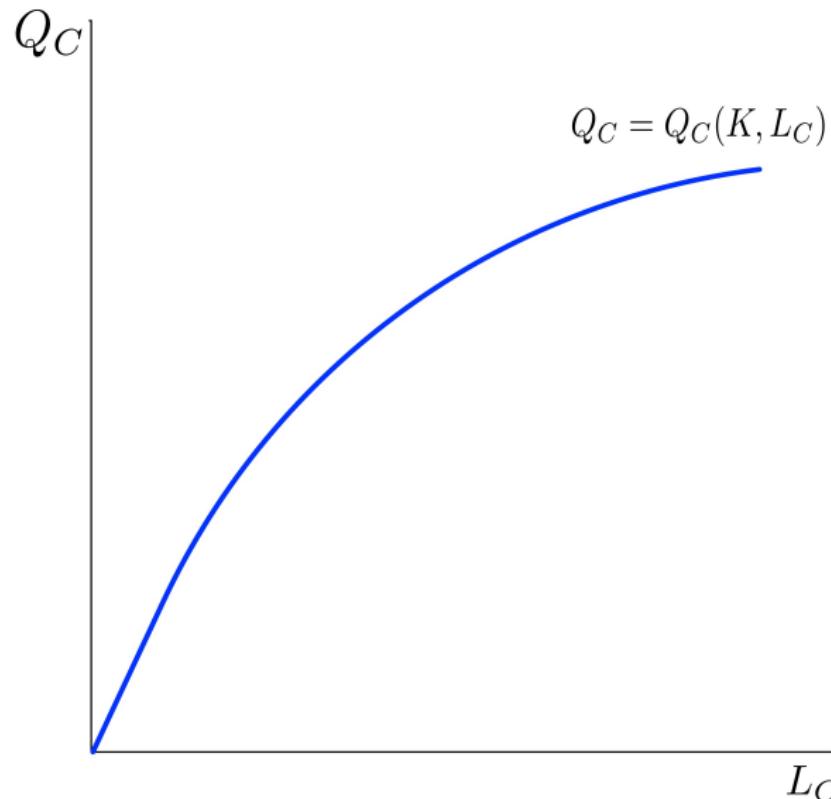
$$MPL_F = \frac{\partial Q_F(T, L_F)}{\partial L_F}$$

- Just as in the HO model, we will assume that the production functions exhibit diminishing returns in each input
- For labour, these are just

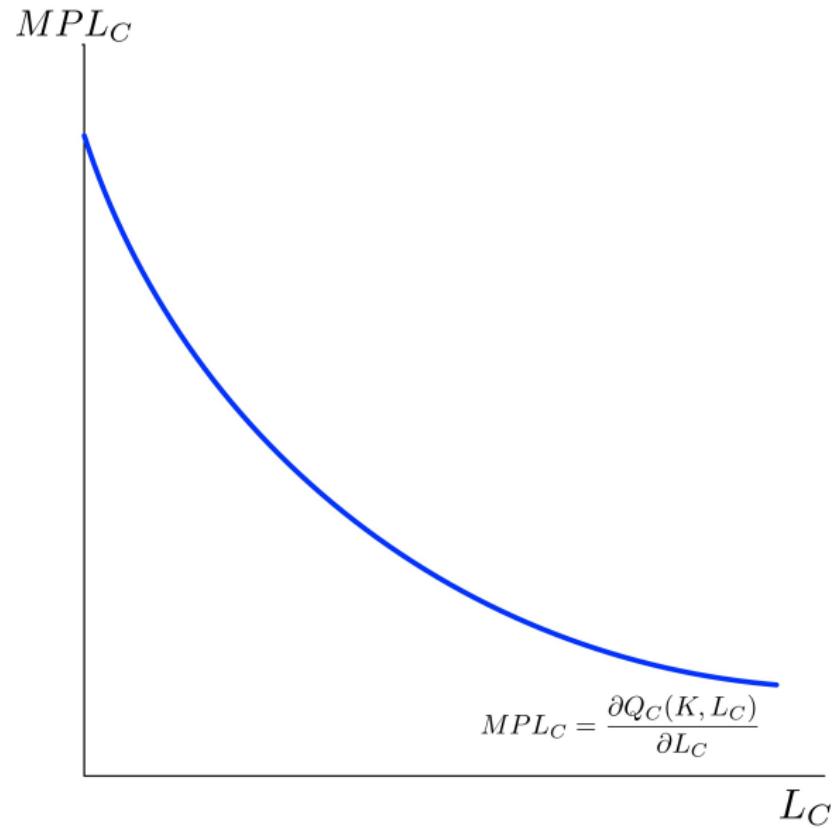
$$\frac{\partial^2 Q_C(K, L_C)}{\partial L_C^2} < 0$$

$$\frac{\partial^2 Q_F(T, L_F)}{\partial L_F^2} < 0$$

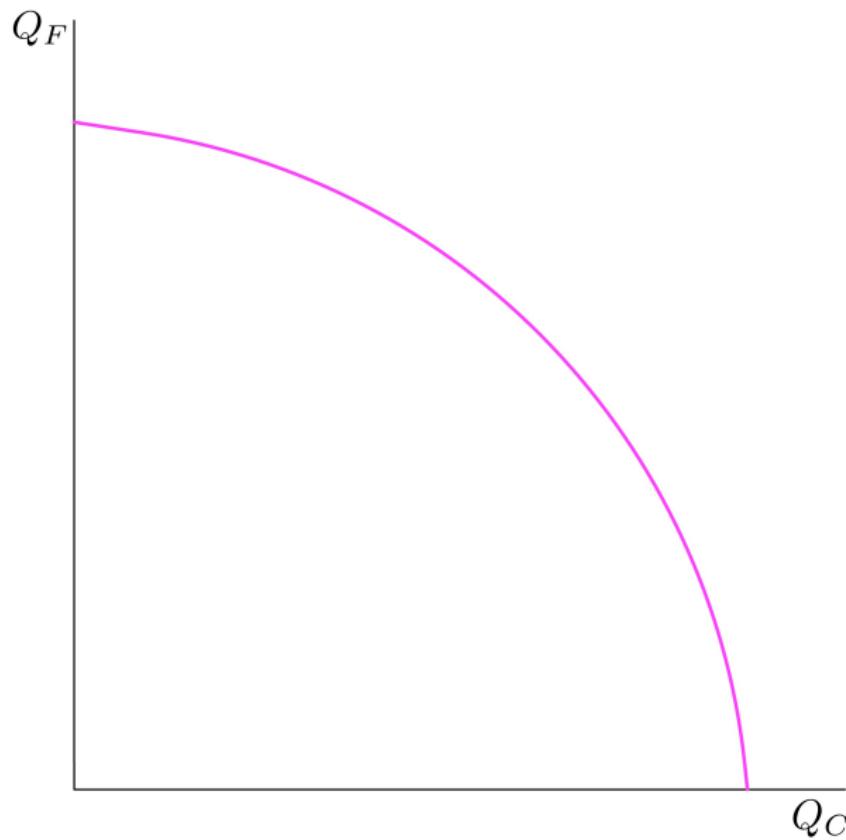
# Production Function and Marginal Product of Labour



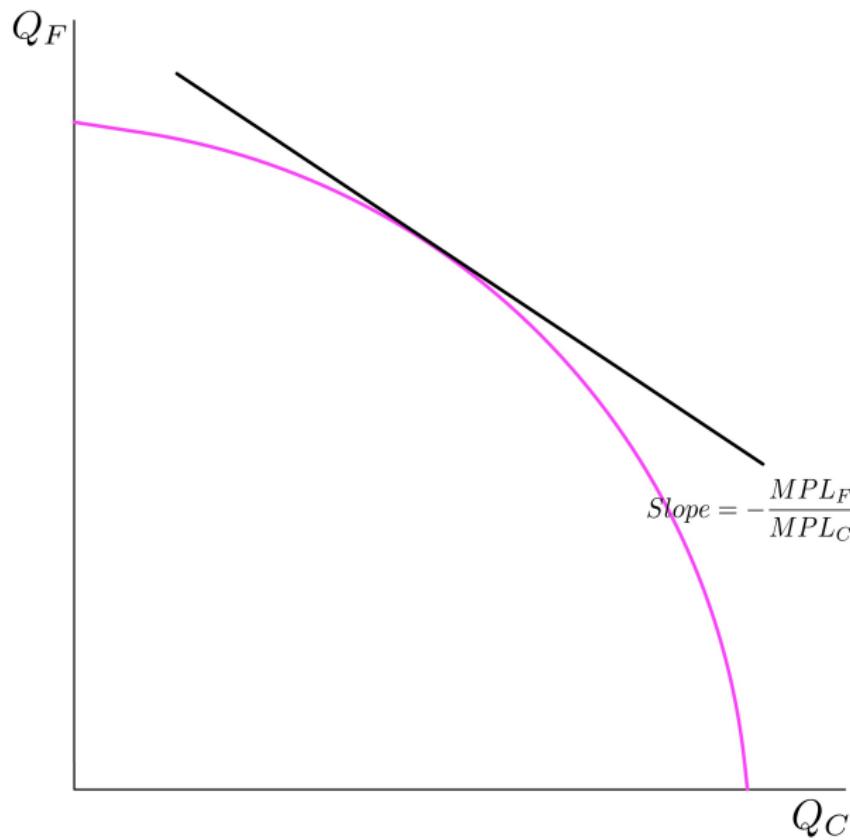
# Production Function and Marginal Product of Labour



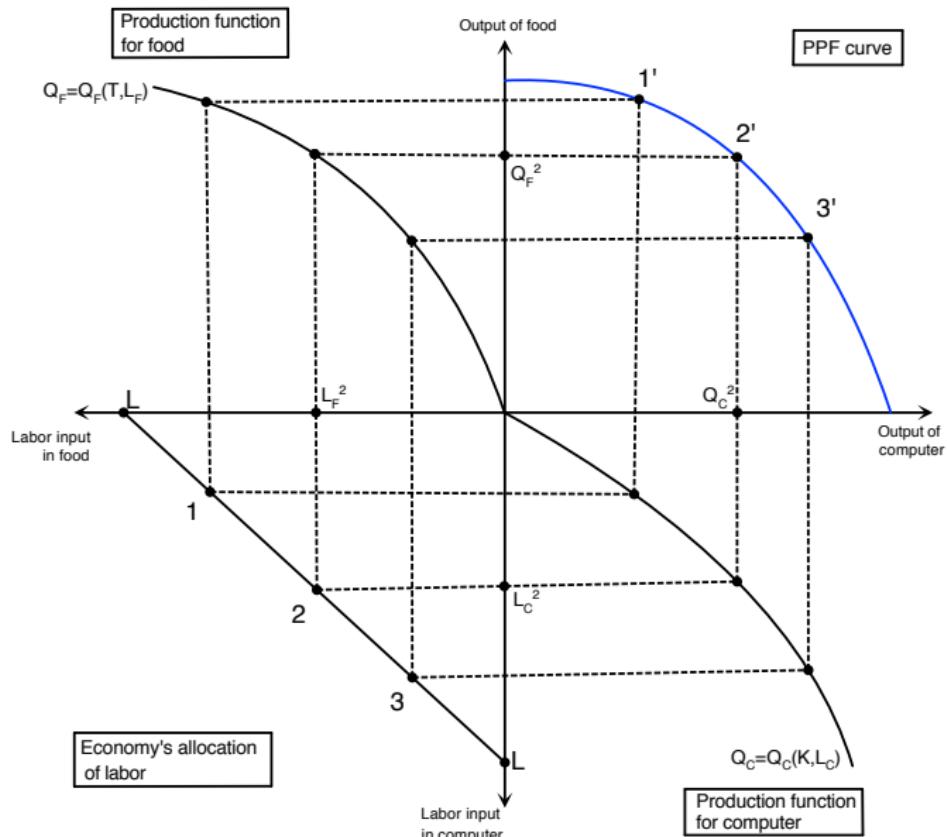
# Diminishing Returns and PPF



# Diminishing Returns and PPF



# How the PPF is constructed



# How the PPF is constructed

- Lower left quadrant
  - Labour allocation in each sector
- Lower right and upper left quadrant
  - Production functions in each sector as a function of labour
  - Conditional on some given amount of their specific factors
- PPF bowed out because of diminishing returns
- How is labour allocated across sectors in this economy?

# How labour is allocated across sectors

- To see how labour is allocated, we need to model the supply and demand for labour in each industry
- The demand for labour in a given sector depends on the price of the good in that sector and the current wages

# Demand for Labour

- Employers (firms) will hire labour until it is not longer worth it for them to do so
  - Hire until the marginal value produced by the hire is greater than the marginal cost of the hire
- Value of a marginal hire is

$$MPL_C P_C$$

- Cost of a marginal hire

$$w$$

# Demand for Labour

- If  $MPL_C P_C > w$ , firm should hire more labour!
  - Value of marginal hire exceeds cost
- If  $MPL_C P_C < w$ , firm hired too much labour
  - Cost of marginal hire exceeds the value they can generate
- $MPL_C P_C = w$  is the optimum
- Recall, diminishing returns in the production function is the reason why for a large value of  $L_C$ ,  $MPL_C P_C$  is small
- These conditions also hold for the food industry

# Demand for Labour

- The optimum condition for labour demand,  $MPL_C P_C = w$ , can be interpreted as the inverse demand function for labour
- For a given  $P_C$ , when nominal wages are too high, firms should hire less labour
  - $MPL_C P_C < w$
- Similarly, when wages are very low, firms should hire more labour
  - $MPL_C P_C > w$

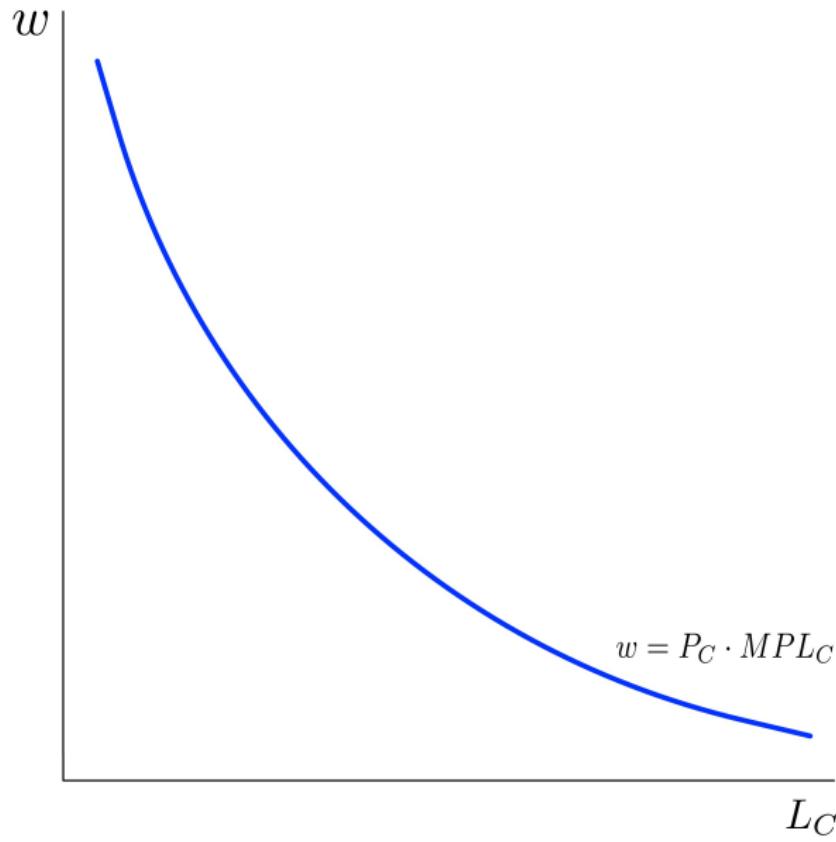
# Demand for Labour

- The demand for labour in the food industry is similar

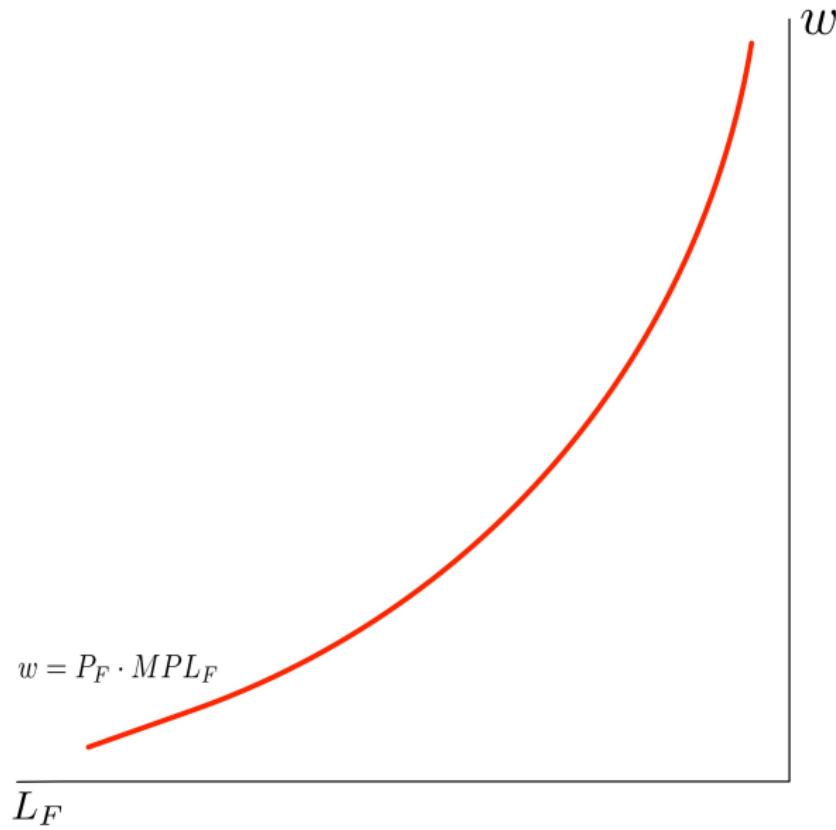
$$MPL_F P_F = w$$

- Because labour can freely move across sectors, wage between the two sector will equalize
- Along with the labour market clearing condition,  $L_C + L_F = \bar{L}$ , we can solve for the equilibrium labour allocation in each industry

# Demand for Labour



# Demand for Labour



# Demand for Labour

- In other words, for some given values of  $P_C$ ,  $P_F$ ,  $K$ ,  $T$ , and  $\bar{L}$ , the equilibrium allocation of labour in each sector,  $L_C^*$  and  $L_T^*$ , satisfies

$$MPL_C(K, L_C^*)P_C = MPL_F(T, L_T^*)P_F$$

- and

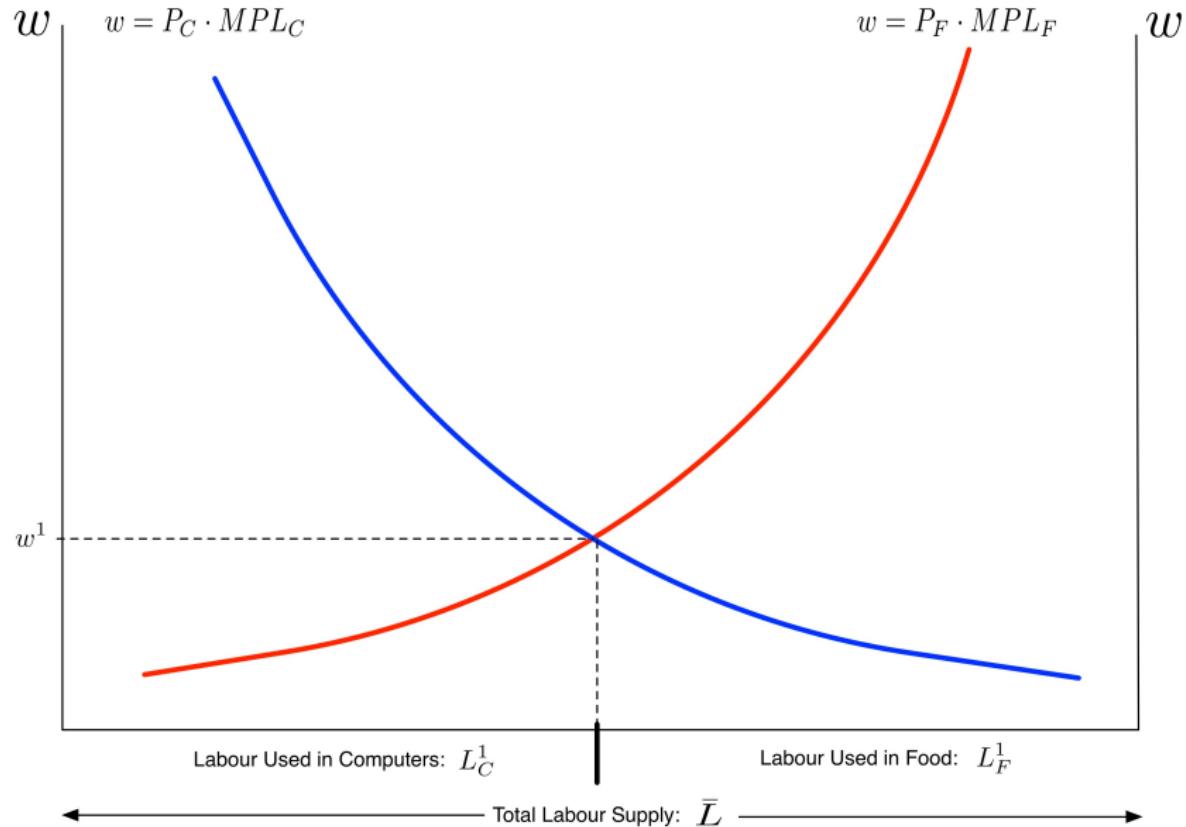
$$L_C^* + L_T^* = \bar{L}$$

- The last condition is just a resource constraint

# Demand for Labour

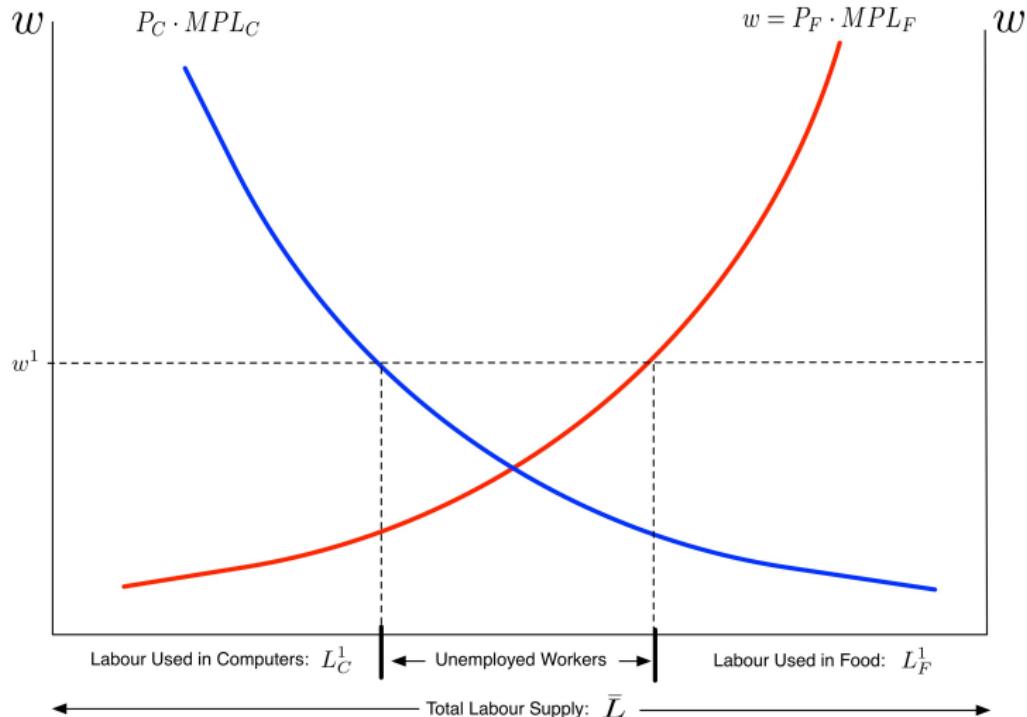
- The equilibrium allocation can be shown in what's called the Scissors Diagram
- This is a diagram where the labour demand curves in both sectors are shown together

# Demand for Labour



# Demand for Labour

Suppose wages is higher than the point where the two demand curves cross...



# Relative Goods Prices and Production Pattern

- From the equilibrium allocation of labour condition, we saw that

$$MPL_C(K, L_C^*)P_C = MPL_F(T, L_F^*)P_F$$

$$\implies \frac{P_C}{P_F} = \frac{MPL_F(T, L_F^*)}{MPL_C(K, L_C^*)}$$

- This takes us back to our PPF, since  $\frac{MPL_F(T, L_F^*)}{MPL_C(K, L_C^*)}$  is just the slope of the PPF at the production output corresponding to the inputs  $T$ ,  $K$ ,  $L_F^*$ , and  $L_C^*$

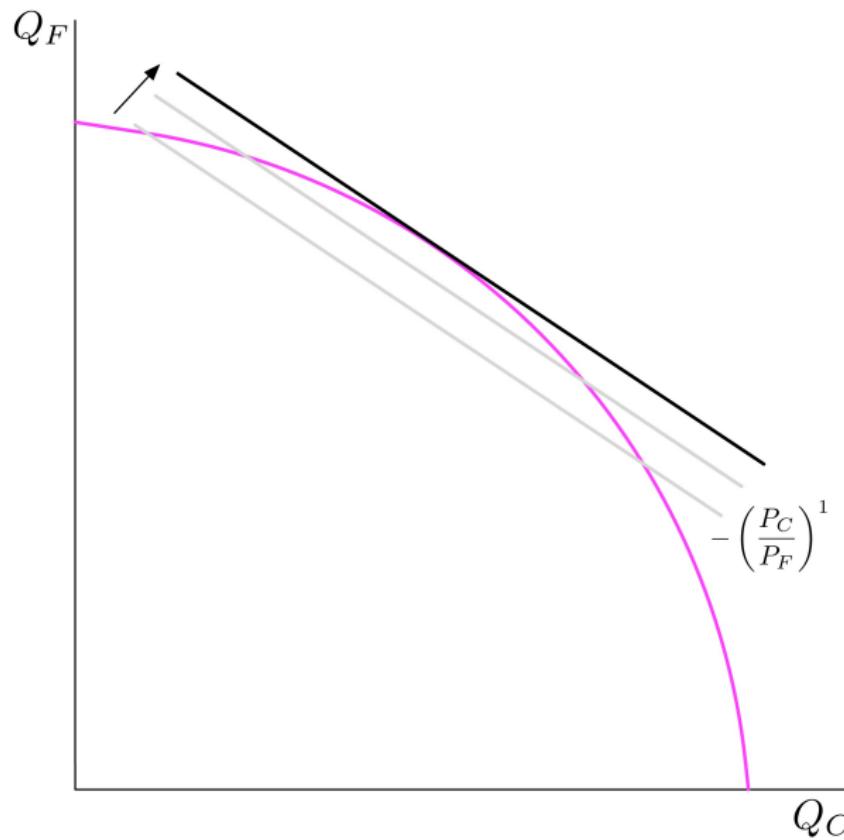
# Relative Goods Prices and Production Pattern

- The economy will produce the output that maximizes the total value of production

$$V = Q_F P_F + Q_C P_C$$

- This is at the point where the line described by the equation  $V$  is tangent with the PPF

# Relative Goods Prices and Production Pattern



# Changes in Prices

- Now that the main elements of the model is complete, we can conduct some thought experiments
- We will consider two types of price changes:
  - The price of both goods rises by the same percentage
  - The price of one good rises while the other stays constant

# Changes in Prices

- For each type of price change, we will answer the following questions
  - What happens to the production of output in each good?
  - What happens to how labour is allocated across industries?
  - Who gains from the price change? Who loses?
- Let's begin

# Equal-Proportion Price Increase: Changes in Output

- Suppose the price of both computers,  $P_C$ , and food,  $P_F$ , increases by 10%
  - Assume everything else stays the same
- $P_C/P_F$  does not change
- Because relative goods prices stay the same, from the PPF, output allocation stays the same

# Equal-Proportion Price Increase: Labour Allocation

- What happens to labour allocation?
- Recall, the inverse labour demand functions were

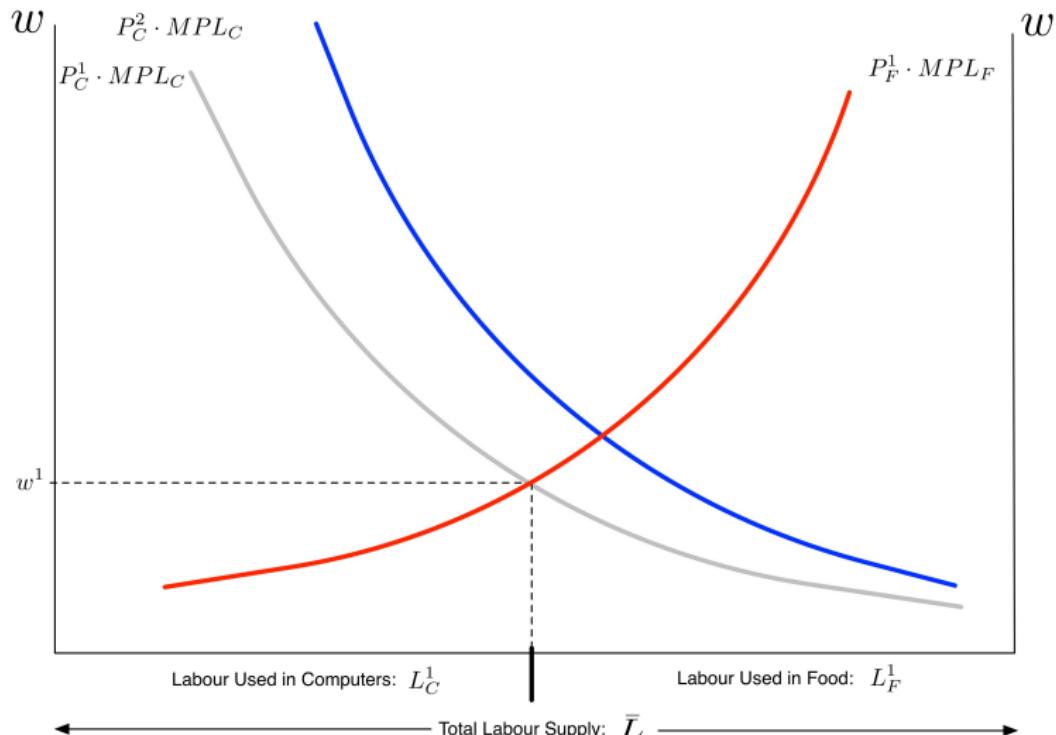
$$w = MPL_C P_C$$

$$w = MPL_F P_F$$

- For some fixed wage, an increase in goods prices causes the value of the marginal product of labour to be higher than before
  - Firms will demand more workers
  - Wages will increase as a consequence

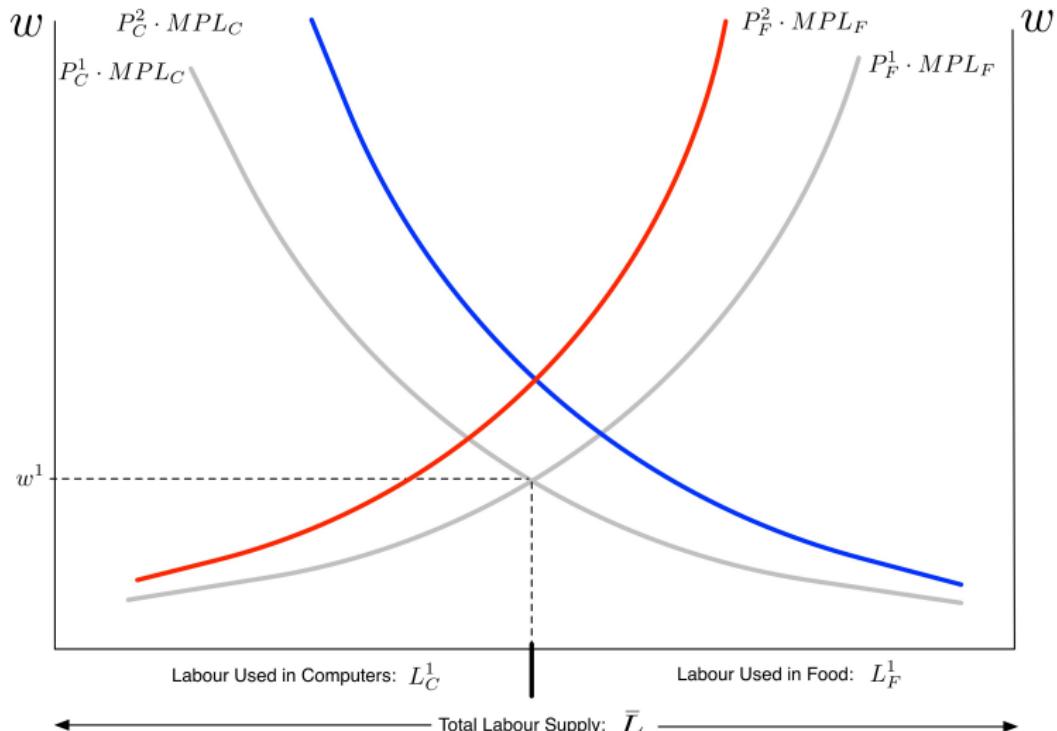
# Equal-Proportion Price Increase: Labour Allocation

$P_C$  increased by 10%



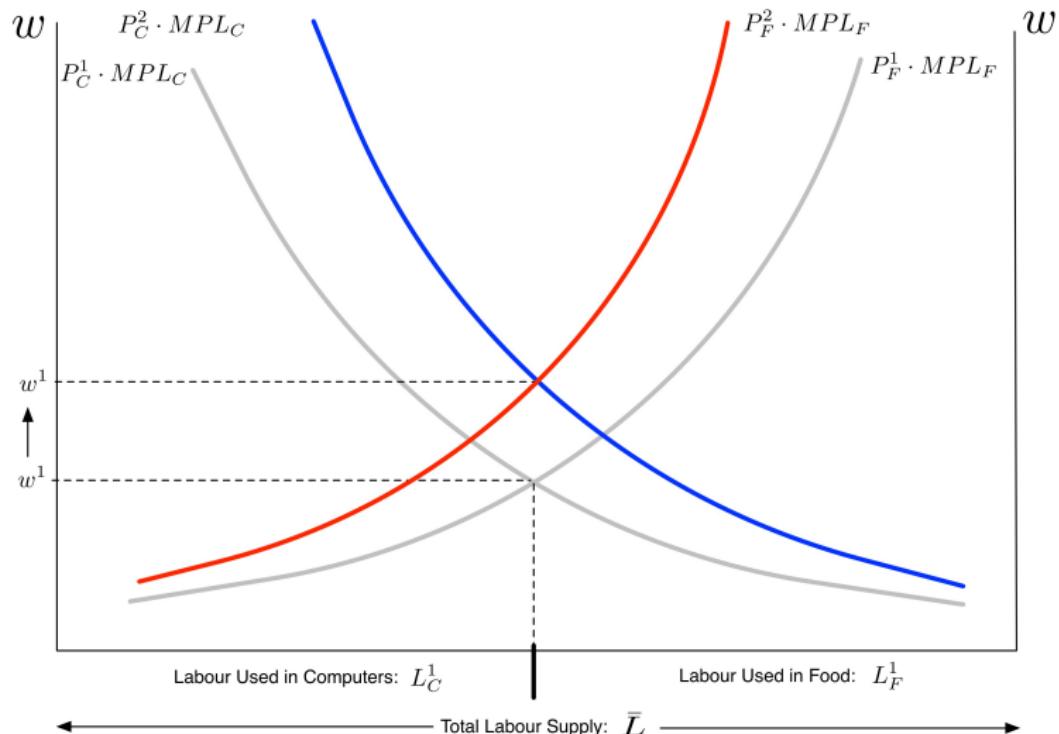
# Equal-Proportion Price Increase: Labour Allocation

But  $P_F$  also increased by 10%



# Equal-Proportion Price Increase: Labour Allocation

$w$  increases



# Equal-Proportion Price Increase: Gains / Losses

- From the scissors diagram, we see that an equal proportion change in goods prices results in no changes in the labour allocation
- For workers, the 10% increase change in price causes a 10% change in real wages
  - This means that wages,  $w/P_C$  and  $w/P_F$  do not change

# Equal-Proportion Price Increase: Gains / Losses

- What about the returns to capital and land owners (owners of the factors specific to their industry)?

# Equal-Proportion Price Increase: Gains / Losses

- Consider the capital owners
- Remember that  $MPK_C = \partial Q_C(K, L_C) / \partial K$ 
  - The marginal product of capital is a function of both capital and labour
- Because  $L_C$  did not change (from scissors diagram),  $MPK_C$  stays the same
- By the marginal revenue = marginal cost condition,  $MPK_C P_C = r$
- Thus, real return to capital in terms of computers does not change
  - $r/P_C = MPK_C$
- Because,  $r/P_C$  is unchanged,  $r$  must have increased by 10%
- This means  $r/P_F$  also did not change (since  $P_F$  increased by 10%)
- Similar argument can be applied to see that the real return to land owners did not change (EXERCISE)

# Equal-Proportion Price Increase: Summary

- In summary, an equal-proportion increase in goods prices results in
  - No changes in relative goods prices
  - No changes in the pattern of production
  - No changes in the labour allocation across industries
  - No changes in the real wage of workers in both industries
  - No changes in the real returns to capital and land owners

# Equal-Proportion Price Increase: Summary

- General principle: if the price of all goods in the economy were to increase by the same percentage point, things will be just like before
  - At least in the long run this is probably true
  - In the real world, there may be institutional frictions that prevent changes in prices to be perfectly passed on to worker wages and capital/land returns
  - Different market structures also have implications (we assumed perfect competition)

# Change in Relative Prices

- Real change is caused by a disproportionate change in prices across goods
  - This causes a change in relative output, as seen from the PPF
  - which, in turn, causes a change in the allocation of labour

# Change in Relative Prices

- Let's consider the case where the price of computers increases but the price of food stays the same
- Suppose the price of computers,  $P_C$ , increases by 7%
- Denote the change from the old relative goods price by  $(P_C/P_F)^1$  and the new relative goods price by  $(P_C/P_F)^2$ 
  - Relative goods prices increases

# Change in Relative Prices

- Let's ask the same questions:
  - What happens to the production of output in each good?
  - What happens to how labour is allocated across industries?
  - Who gains from the price change? Who loses?

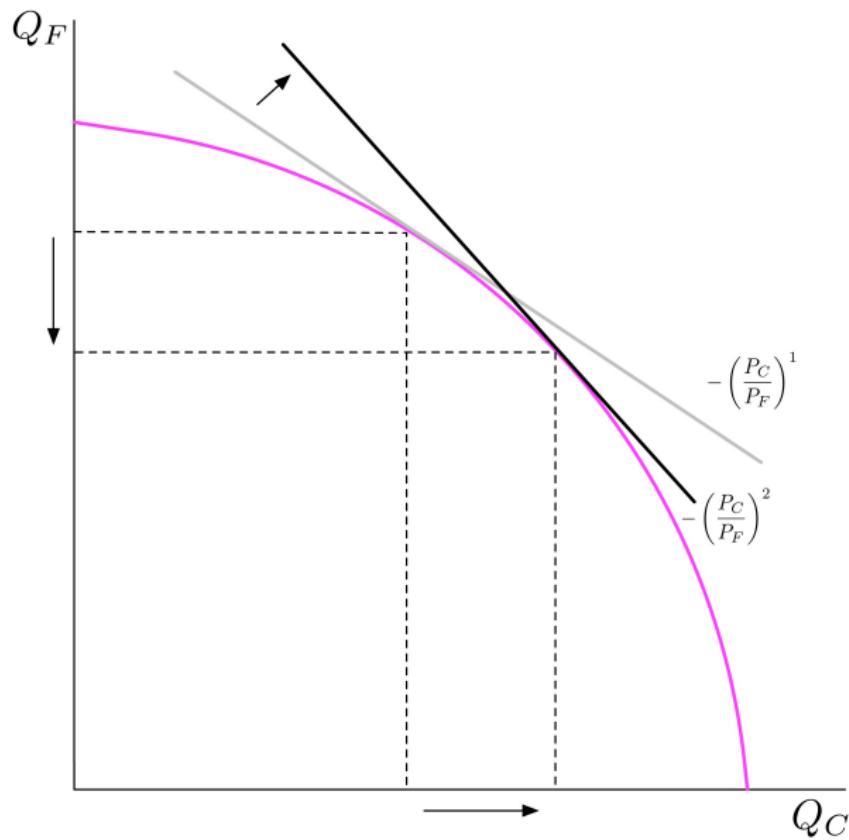
## Change in Relative Prices: Changes in Output

- Change in relative goods prices causes a change in production patterns
- It changes the slope of the isovalue line equation

$$V = P_C Q_C + P_F Q_F$$

- The result is that the output of computers increases while that of food decreases

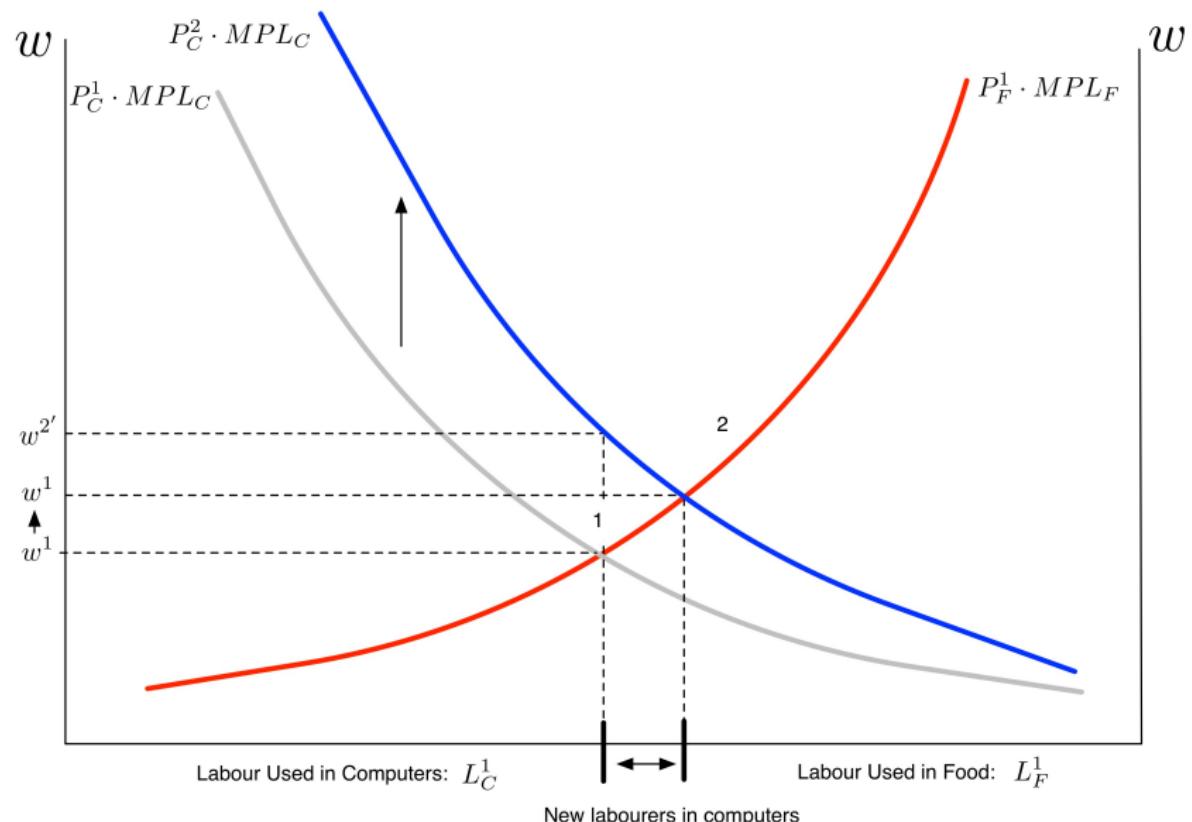
# Change in Relative Prices: Changes in Output



# Change in Relative Prices: Labour Allocation

- What's the effect of the relative price change on the allocation of labour?

# Change in Relative Prices: Labour Allocation



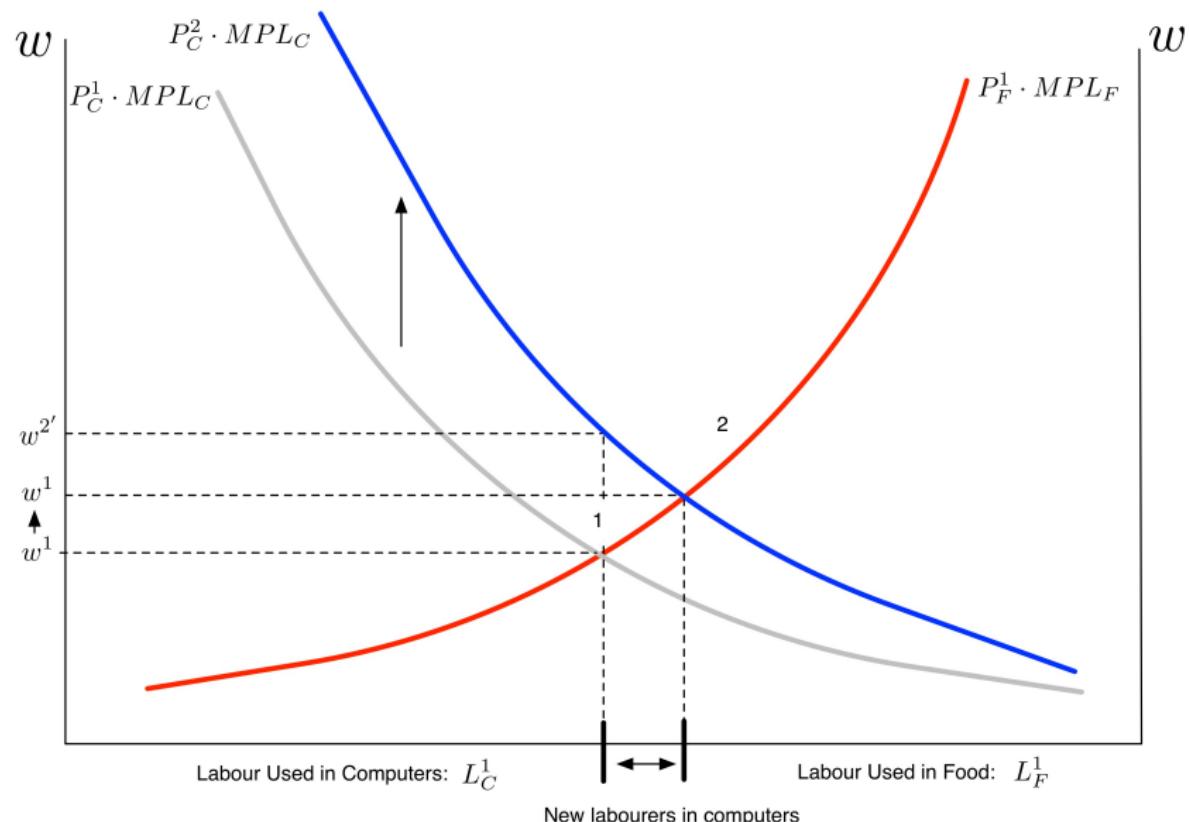
# Change in Relative Prices: Labour Allocation

- The increase in  $P_C$  shifts the labour demand curve up
- Equilibrium changes from point 1 to point 2

# Change in Relative Prices: Labour Allocation

- Two things to note:
  - ① Although  $w$  rises, it rises by less than the increase in the price of computers
    - If it were to increase by the same amount, it would be in  $w^2'$
  - ② Labour shifts from the food sector to the computer sector
    - This increase in labour working in computers decreases the marginal product of labour in computers ( $MPL_C$ )
    - which is the reason why, as noted in note 1., the price of computers,  $P_C$ , increased by more than  $w$  (recall,  $w = P_C \cdot MPL_C$ )
    - We see here that the increase in output is due to more labour being allocated to the computer industry

# Change in Relative Prices: Labour Allocation



# Change in Relative Prices: Gains / Losses

- Who gains and who loses from the change in relative price?

# Change in Relative Prices: Gains / Losses

- Workers

- Not obvious
- $w$  increased, but not by as much as  $P_C$ ; therefore,  $w/P_C$  fell
- Since  $P_F$  did not change,  $w/P_F$  must have increased
- Whether workers gain or lose depend on how much they value each good
- If they value computers more than food, they lose from the price change
- If they value food more than computers, they gain from the price change

# Change in Relative Prices: Gains / Losses

- Capital owners
  - Capital owners gain
  - $MPK_C$  rises because  $L_C$  increased
  - Thus,  $r/P_C = MPK_C$  increases
  - This suggests that  $r$  increased by more than 7%
  - Because  $r$  increased and  $P_F$  stayed constant,  $r/P_F$  increased

# Change in Relative Prices: Gains / Losses

- Capital owners:
  - **Aside:** To convince yourself that  $MPK_C$  increased, here's a production function and take its derivative with respect to  $K$

$$Q_C = K^{2/3} L_C^{1/3}$$

- Intuitively, a machine with 2, 3, or 4 workers on it cannot be less productive than a machine with just 1 worker on it—assuming the depreciation of the machine is constant for any number of workers

# Change in Relative Prices: Gains / Losses

- Landowners
  - Landowners lose
  - $MPT_F$  decreases because labour has moved to the computer industry
  - $r_T/P_F$  decreases, which means  $r_T$  decreased since  $P_F$  did not change
  - $r_T/P_C$  decreases by more than 7% since  $r_T$  fell and  $P_C$  increased

# Change in Relative Prices: Gains / Losses

- EXERCISE: What if the price of food drops while the price of computers remained the same?

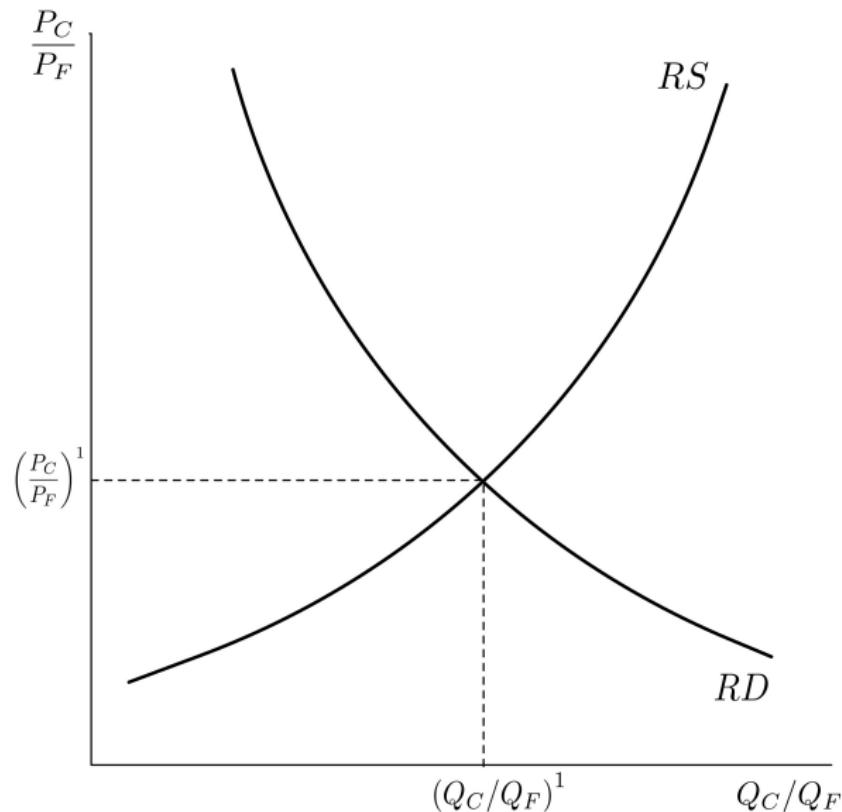
# Change in Relative Prices: Summary

- The factor specific to the sector whose relative price increased (computers) are better off
  - Capital owners
- The factor specific to the sector whose relative price decreased (food) are worse off
  - Landowners
- The change in welfare of the mobile factor is unclear
  - It depends on how much workers value computers over food

# Autarky Equilibrium

- We will now study the source of the price changes in our model
- Just like the Ricardian and Heckscher-Ohlin models, prices come from the intersection of the relative demand (RD) and relative supply (RS) curve
- Relative Demand:
  - Homothetic and identical preferences across countries
- Relative Supply:
  - Comes from the PPF diagram which, itself, is based on factor endowments
- The intersection of the relative demand and relative supply curve gives us the equilibrium relative price and quantity of a country

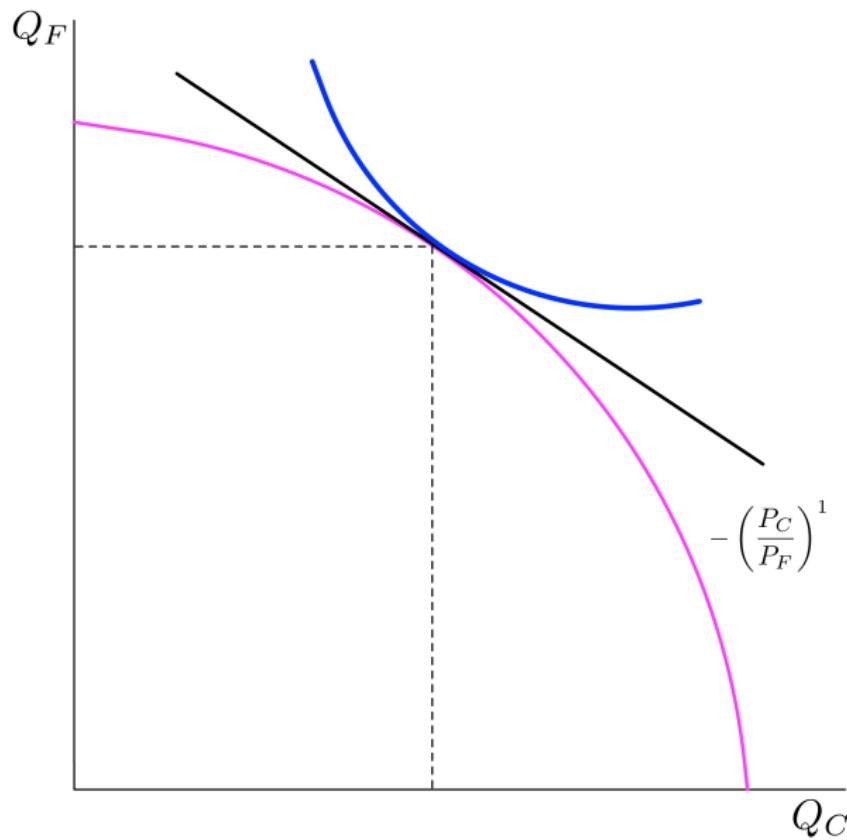
## RS and RD curves



# Equilibrium under Autarky

- Based on the equilibrium relative price pinned down by the intersection of the RD and RS curves, we can derive the optimal level of production of each good
- We do this by going back to the PPF diagram
- The equilibrium is one where the PPF, isovalue line, and the indifference curve are tangent to each other and have the same slope
  - Note that in autarky, consumption is equal to production for all goods

# Equilibrium under Autarky



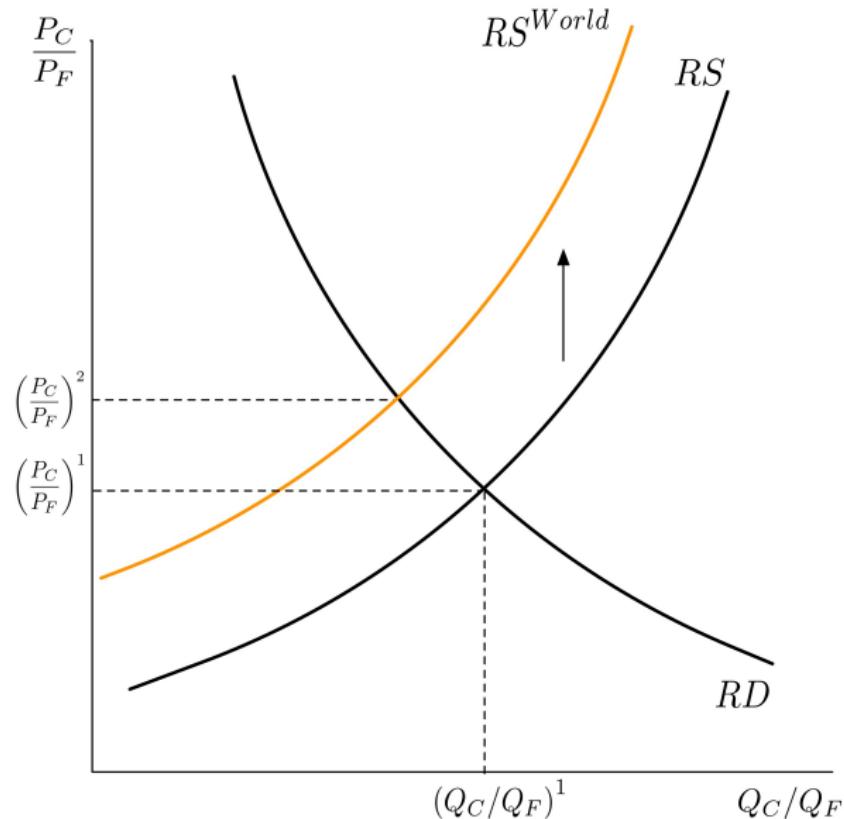
# Trade Equilibrium

- As before, when countries trade, world relative price is determined by the world RD and the world RS curves
- Assume that the country we are analyzing is very good at producing computers
  - or they are relatively capital abundant, which means they have a comparative advantage in computers

# Trade Equilibrium RD / RS

- World RS moves to the left of autarky RS of our country
- The world is relatively less productive at producing food than the South and relatively less productive at producing computers than the North
- World RD is the same as before
  - by the homothetic and identical preferences assumption

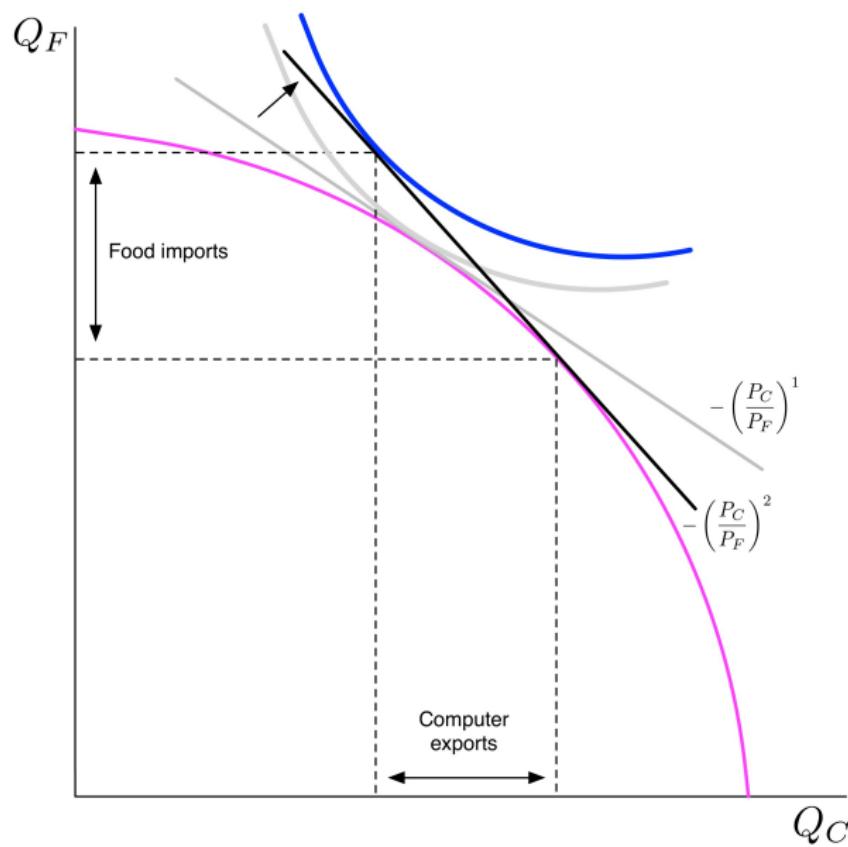
## Trade Equilibrium: RD / RS



# Trade Equilibrium: Equilibrium Quantities

- The trade equilibrium results in relative prices that are higher than relative prices in autarky
- Given these relative goods prices, we can see how production patterns change using the PPF, the isovalue line, and indifference curves

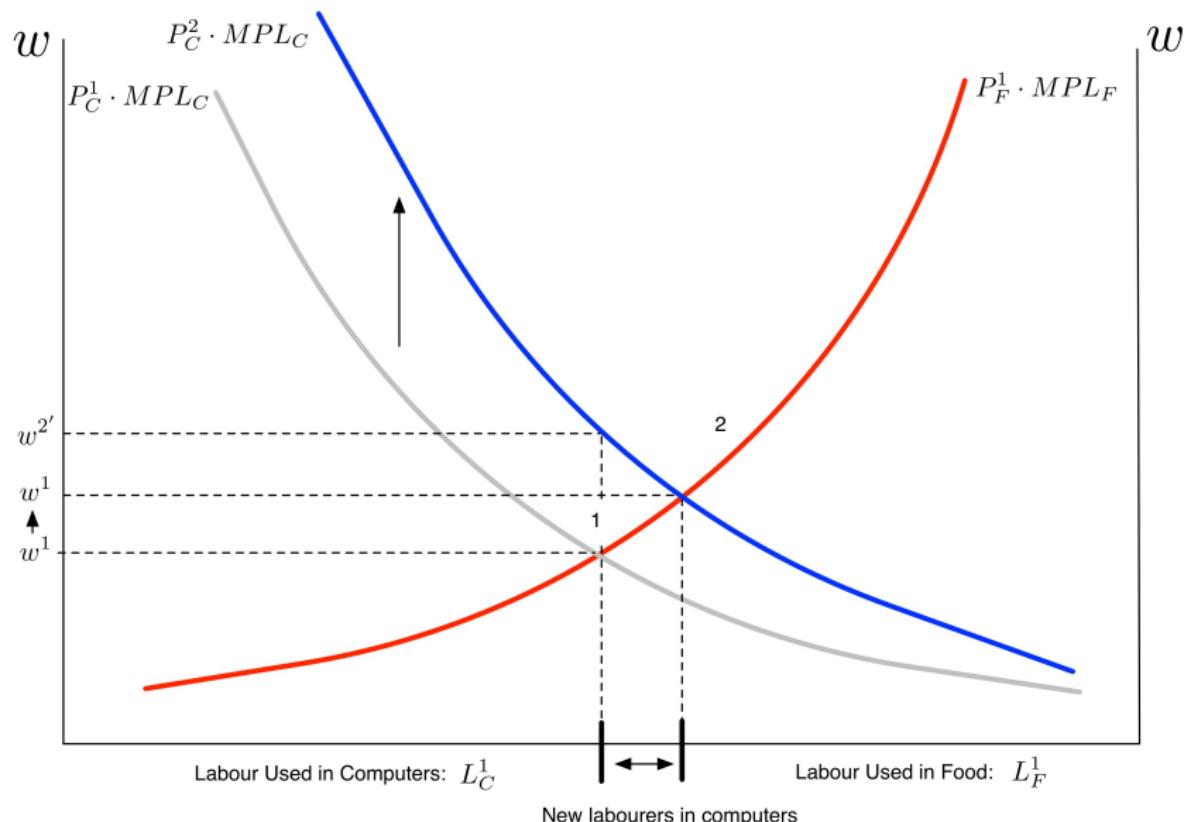
# Trade Equilibrium: Equilibrium Quantities



# Gains from Trade

- In aggregate, our country gains from trade
  - They attain a higher indifference curve in the PPF diagram
- But just like in the HO model, we need to look at real returns to each factor
- We can study real returns by going back to the scissors diagram and examine how—as a result of the price changes because of trade— $w$  and the marginal product of labour in each sector, changed

# Gains from Trade



# Gains from Trade: Real Returns

	Nominal	Real in computers	Real in foods
Worker	$w$	$w/P_C$	$w/P_F$
Capital owner	$r$	$r/P_C$	$r/P_F$
Landowner	$r_T$	$r_T/P_C$	$r_T/P_F$

- Just like before, the welfare analyses involves three factors and six values
- Workers lose in terms of computers, but gain in terms of food
- Capital owners gain in terms of both goods
- Landowners lose in terms of both goods

# Gains from Trade

- Stating these results in terms of how trade affects welfare:
  - Trade benefits the factor that is specific to the export industry (computer) and harms the factor that is specific to the import-competing sector (food)
  - The welfare effect of trade on the mobile factor is ambiguous

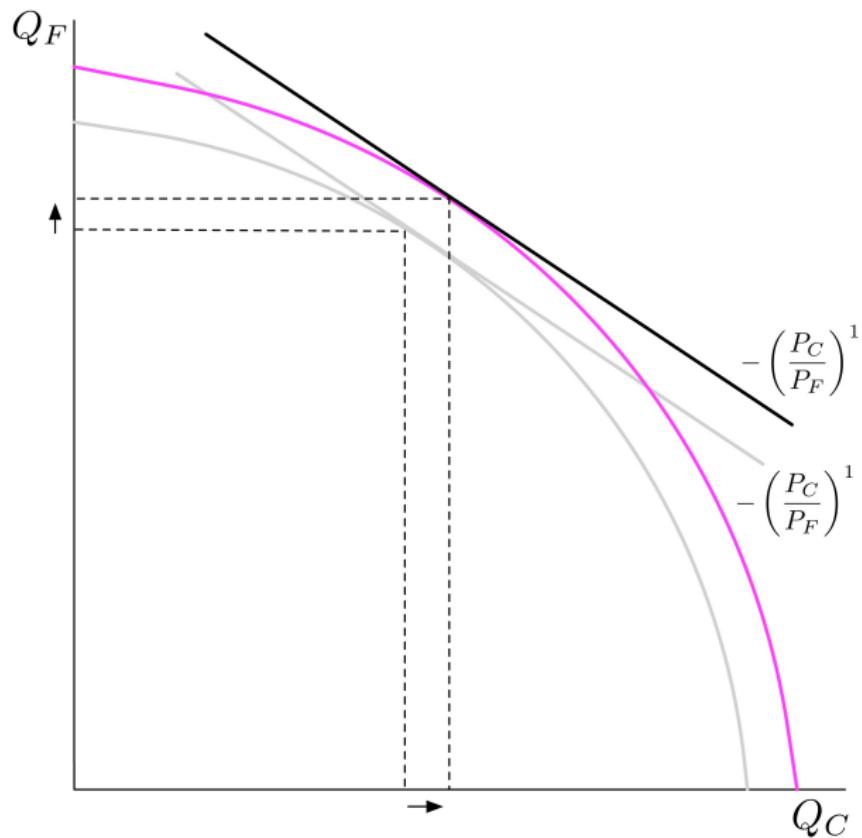
# Questions

- We can use the specific factors model to ask other questions and study its welfare implications
  - What happens if labour stock increases or decreases?
    - immigration, brain drain
  - What happens if capital stock increases?
  - What happens when consumer preference changes?
    - homothetic to non-homothetic
    - different budget allocation between the rich and the poor
  - What if labour cannot move between sectors?
    - occupation-specific skills

# Increase in Labour Stock

- Let's consider the case where labour stock increases
- Suppose our country relaxes its immigration policy and allows labourers from other countries to enter

# Increase in Labour Stock: PPF



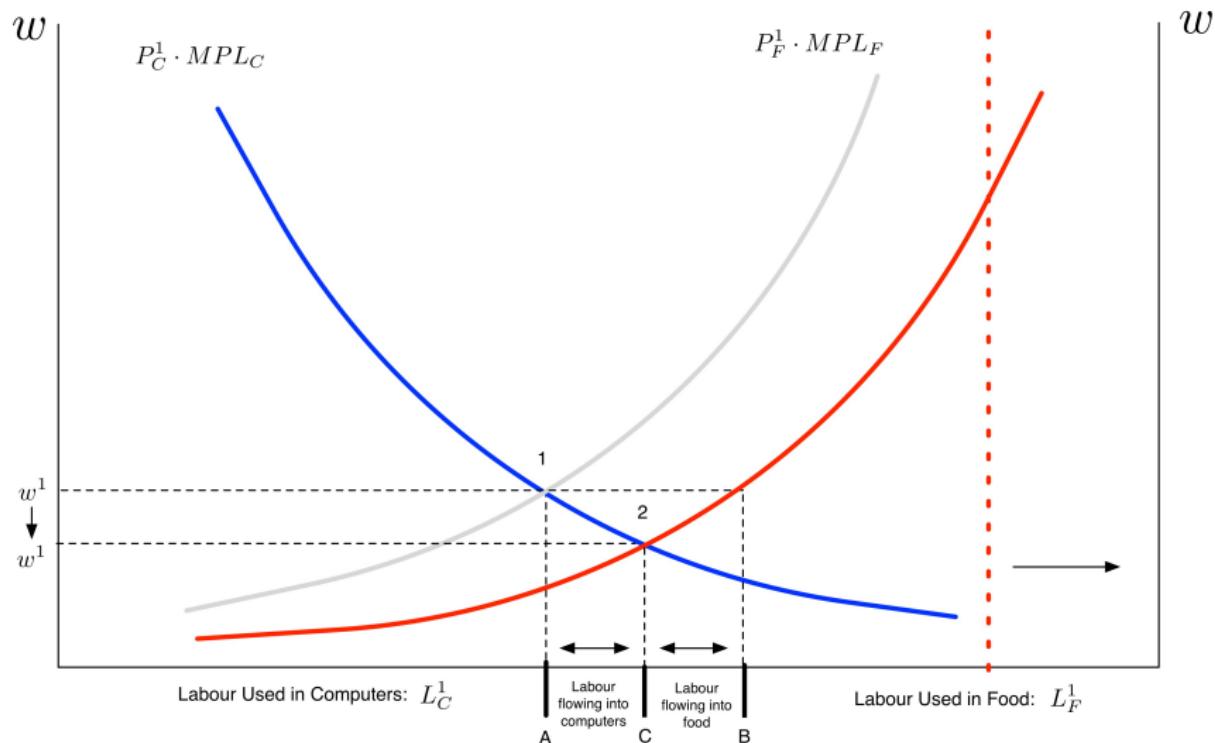
# Increase in Labour Stock: PPF

- More labour in the economy means the PPF expands outward
- Note that labour is just as intensive in computers as it is in food
  - Equal change across all points on the PPF
- Since price levels did not change, production of both goods increases

# Increase in Labour Stock: Scissors Diagram

- Let's see how this increase in labour stock is depicted in the scissors diagram

# Increase in Labour Stock: Scissors Diagram



# Increase in Labour Stock: Scissors Diagram

- As the horizontal axis shifts out, it takes the  $w = P_F MPL_F$  curve with it
  - nothing else changed except the domain of the function
- At the old equilibrium wage  $w^1$ , labour in computer will be at A and labour in food will be at B
  - These are the same labour quantity before the labour stock increase
- Because  $w^1$  is too high for the new labour demand curve, the unemployed workers will bid down the wage
- Nominal wage falls resulting in a move from point 1 to point 2
- Both sectors now have more workers

# Increase in Labour Stock: Gains / Loses

- Workers:
  - $P_C$  and  $P_T$  have not changed, but  $w$  is lower—workers purchasing power have decreased
- Capital owners:
  - $MPK$  rises because there are now more labourers per machine
  - $r/P_C$  rises and since  $P_C$  did not change,  $r$  must have increased
  - This means  $r/P_F$  also increased since  $P_F$  did not change
- Landowners:
  - $MPT$  rises with more labour
  - $r_T/P_F$  increases, which means  $r_T$  increased because  $P_F$  did not change
  - Therefore,  $r_T/P_C$  also increased

# Increase in Labour Stock: Gains / Loses

- These outcomes show that in a model with specific factors, the Rybczynski theorem no longer holds
  - Rybczynski theorem: an increase in the endowment of a factor increases the output of the industry using that factor intensively, and decreases the output of the other industry
- In the specific factors model, an increase in labour endowment increases the output in both industries

# Conclusion

- The specific factors model allows us to study some of the short-run implications of trade
  - We do this by introducing factors that are specific to an industry—perhaps because it is prohibitively expensive to move them
- Just like in the HO model, we were able to study the effects of trade on the income distribution and on aggregate welfare
- Factors experiencing the relative price increase are better off whereas the other factor are worse off
  - Welfare effect on the mobile factor depend on preferences over goods
- Thursday: Last Class!
- No new topics—perhaps we'll do a midterm exam review