1.8 — The Specific Factors Model

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Outline

Assumptions of the Specific Factors Model

# Assumptions of the Specific Factors Model
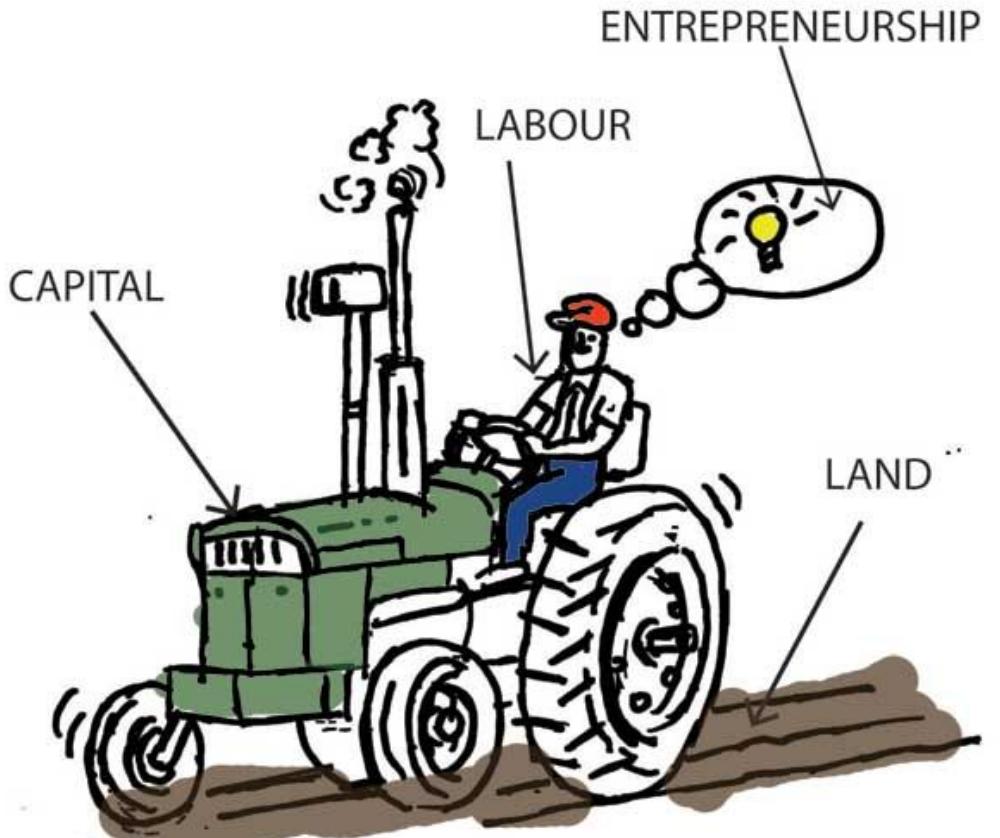
- Until now, we've assumed (within each country), factors are mobile

- But in truth, some factors are **specific** or **immobile**: can only be used for the production of a specific set of goods or industry

  - e.g. programmers can only work in software, not in pro-football
  - e.g. equipment used to make beer barrels cannot switch to producing computer chips

- **Opening up trade will affect the distribution of income between fixed and mobile factors**

Assumptions of the Specific Factors Model

- Imagine 2 countries, Home and Foreign

- Countries have three factors of production:

  - labor (L)
  - capital (K)
  - land (T)

Assumptions of the Specific Factors Model

- Each country has two industries, **manufacturing (M)** and **agriculture (A)**

- **Manufacturing** is produced using *capital* (K) and *labor* (L)

- **Agriculture** is produced using *land* (T) and *labor* (L)

- Land (T) and capital (K) are **specific factors**, only used to produce one good

- Labor (L) is a **mobile factor** that can be used in *either* (or both) sectors

Setting up the Model: Production Function

- An economy's production can be described as a set of production functions for manufacturing (M) and agriculture (A)

$$Q_M = Q_M(K, L_M)$$
$$Q_A = Q_A(T, L_A)$$

- Each country can only allocate its labor force between two industries

$$L_M + L_A = \bar{L}$$
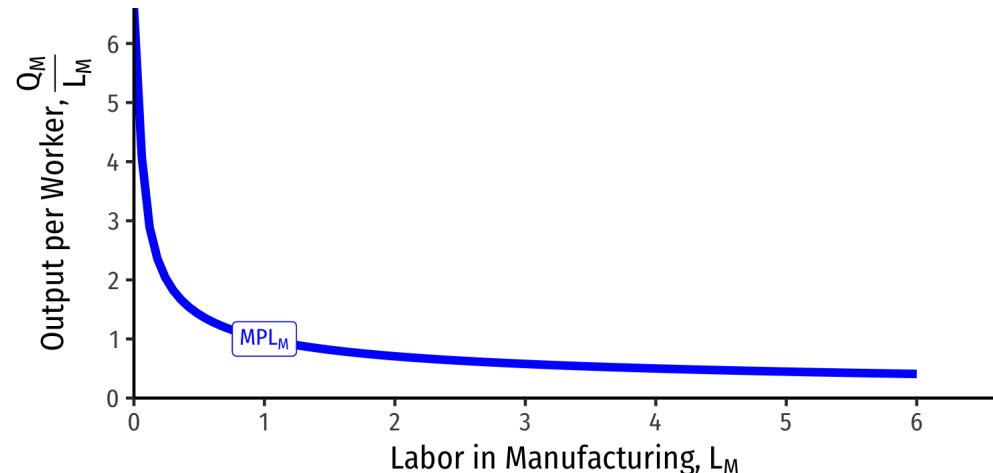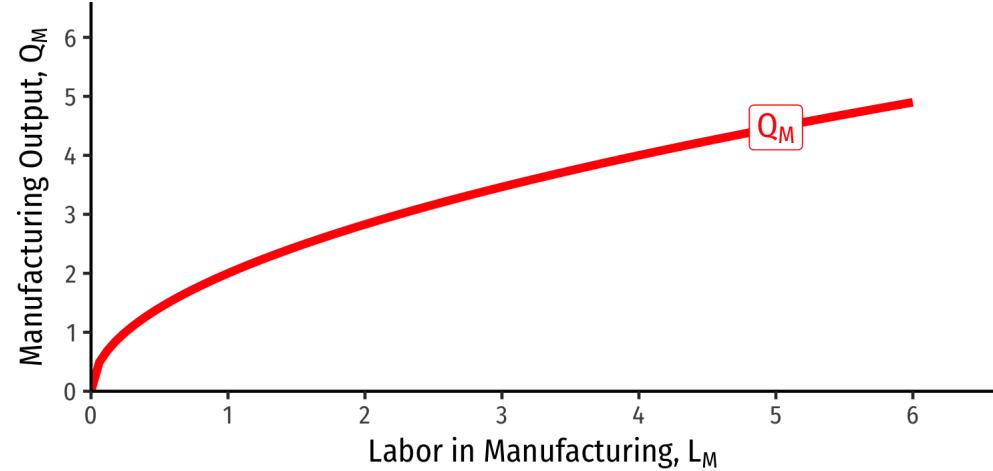
Diminishing Marginal Product of Labor

- Each industry exhibits **diminishing returns to labor**

- **Marginal product of labor in manufacturing** (MPL_M): additional manufacturing output produced by adding one more unit of labor (holding K constant)

$$MPL_M = \frac{\Delta Q_M}{\Delta L_M}$$

- Declines as more L is added to manufacturing production
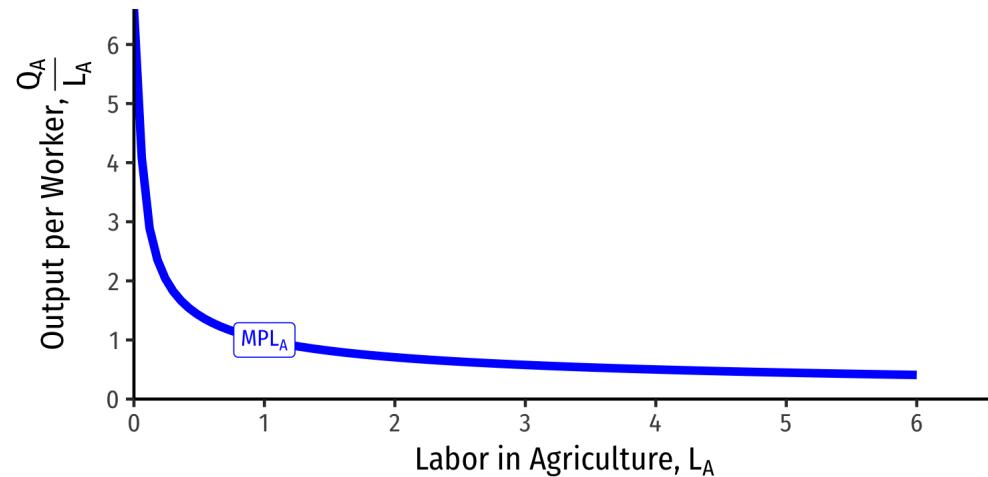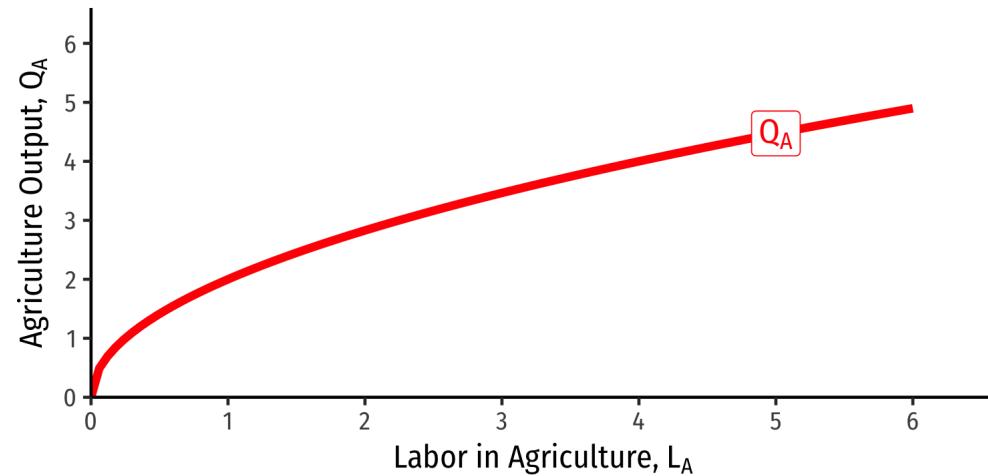
Diminishing Marginal Product of Labor

- Each industry exhibits **diminishing returns to labor**

- **Marginal product of labor in agriculture** (MPL_A): additional agriculture output produced by adding one more unit of labor (holding T constant)
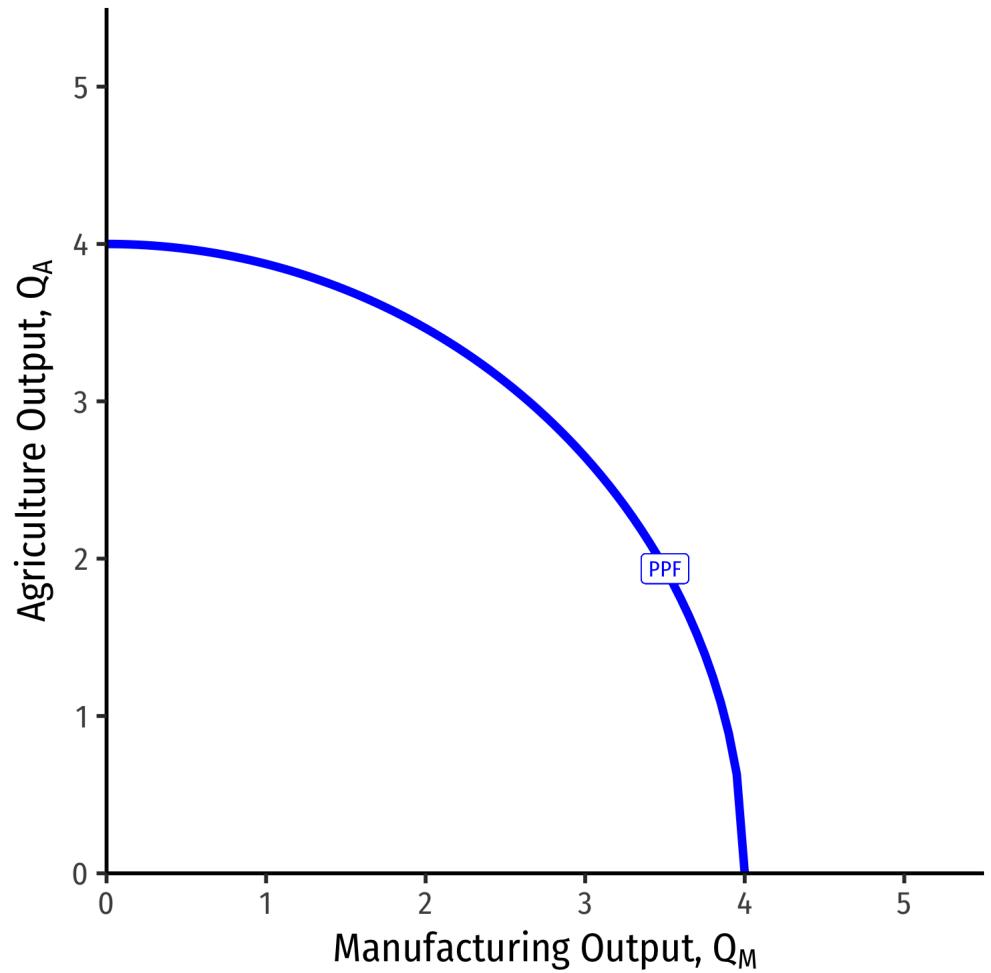
$$MPL_A = \frac{\Delta Q_A}{\Delta L_A}$$

- Declines as more L is added to agriculture production

PPF

- We get a PPF with increasing costs again

- Let's examine more *why*

# Allocating the Mobile Factor (Labor)
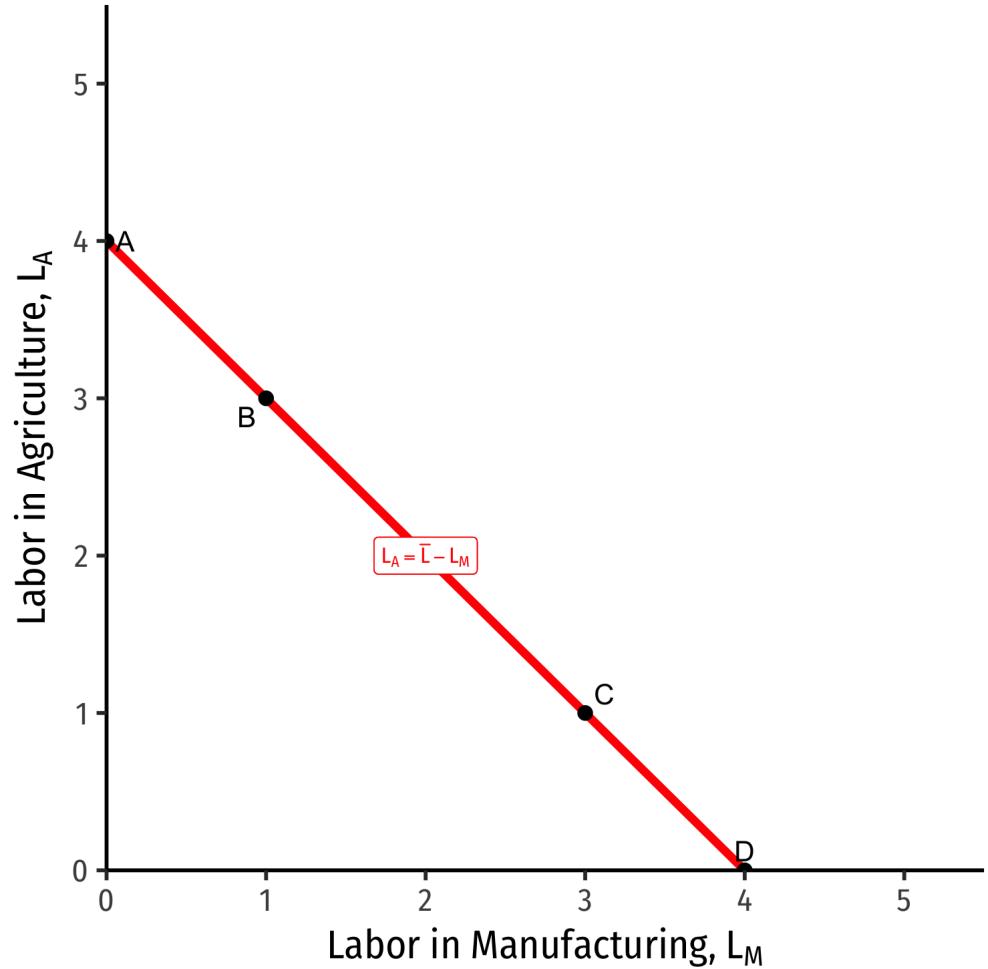
A Note About Labor

- A simple (and very Ricardian) assumption about labor: it is measured in hours, and can equally be applied to each industry

$$\bar{L} = L_M + L_A$$
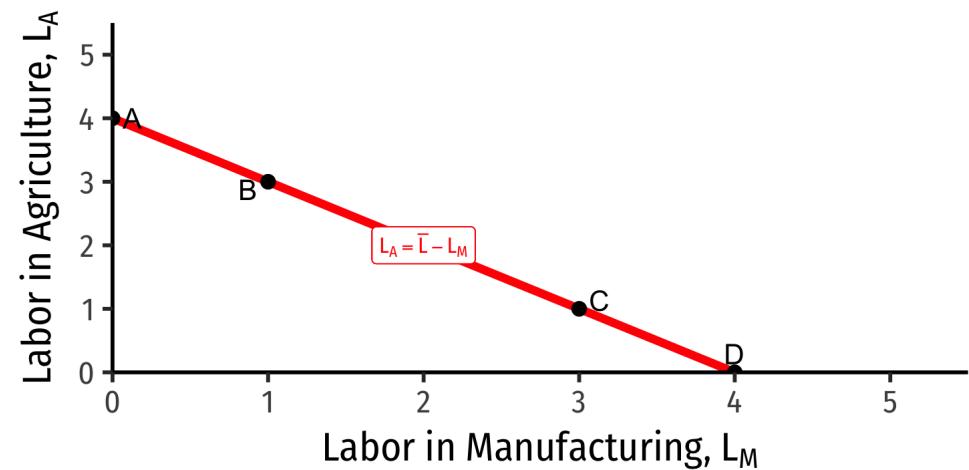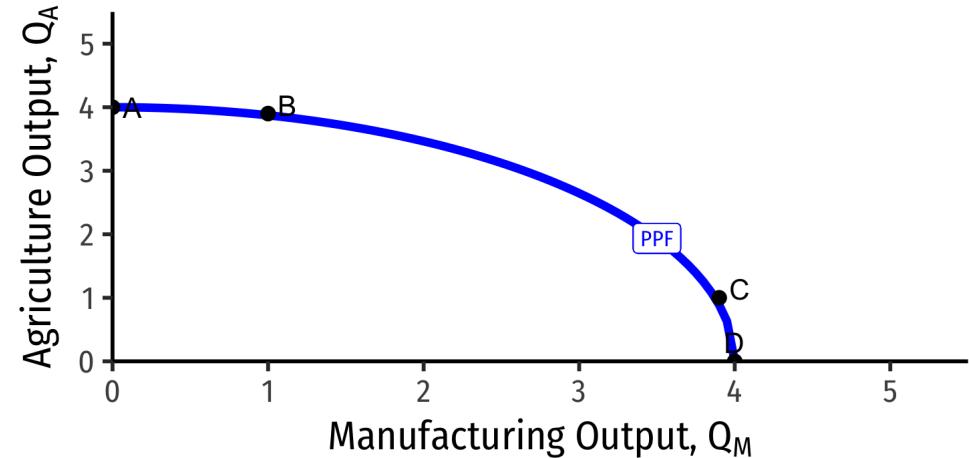
- Every labor hour allocated to agriculture is a labor hour *not* allocated to manufacturing, and vice versa

  - **Opportunity cost of labor**

- Visualize a "labor budget constraint" to understand movements along the PPF

Allocating Labor
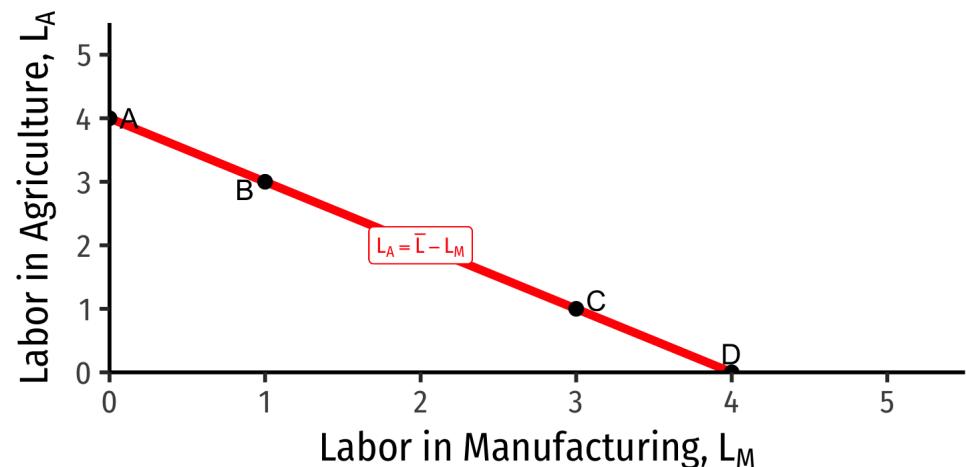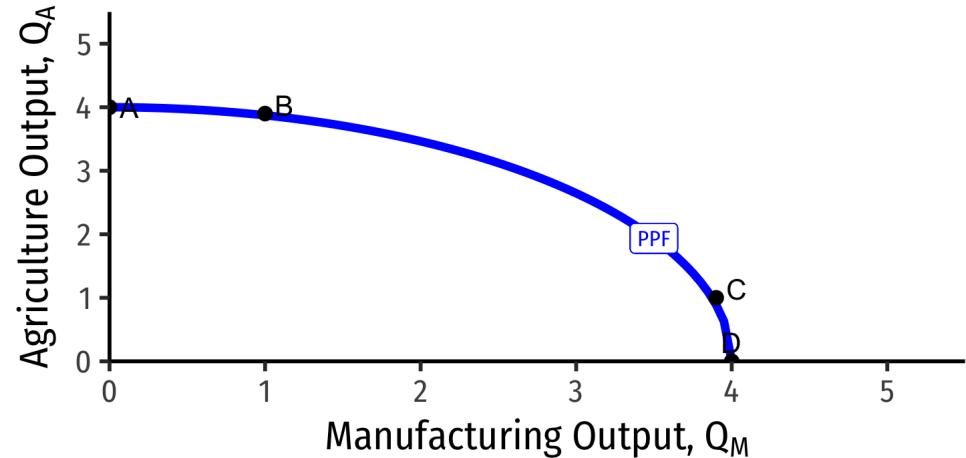
- Shows relationship of moving along PPF $\iff$ reallocating labor across industries

- If all labor in A (point A), country only produces A, no M

- If all labor in M (point D), country only produces M, no A

- Remember, each industry has diminishing returns to labor, and will have a particular MPL depending on how much land or capital there are

  - Hence, a 1 unit $\uparrow\downarrow$ in L in one industry *does not* imply a 1 unit increase in output

Allocating Labor

- As we move to the right of the PPF, we are pulling labor out of agriculture and into manufacturing

- Each single unit of labor we take out of A and put into M will:

    - Lower $\downarrow Q_A$ by MPL_A
    - Raise $\uparrow Q_M$ by MPL_M

- Or to put it inversely, to produce 1 more unit of M:

    - Reallocate $\downarrow L_A$ input by $\dfrac{1}{MPL_A}$
    - Reallocate $\uparrow L_M$ input by $\dfrac{1}{MPL_M}$

Production Possibilities Frontier
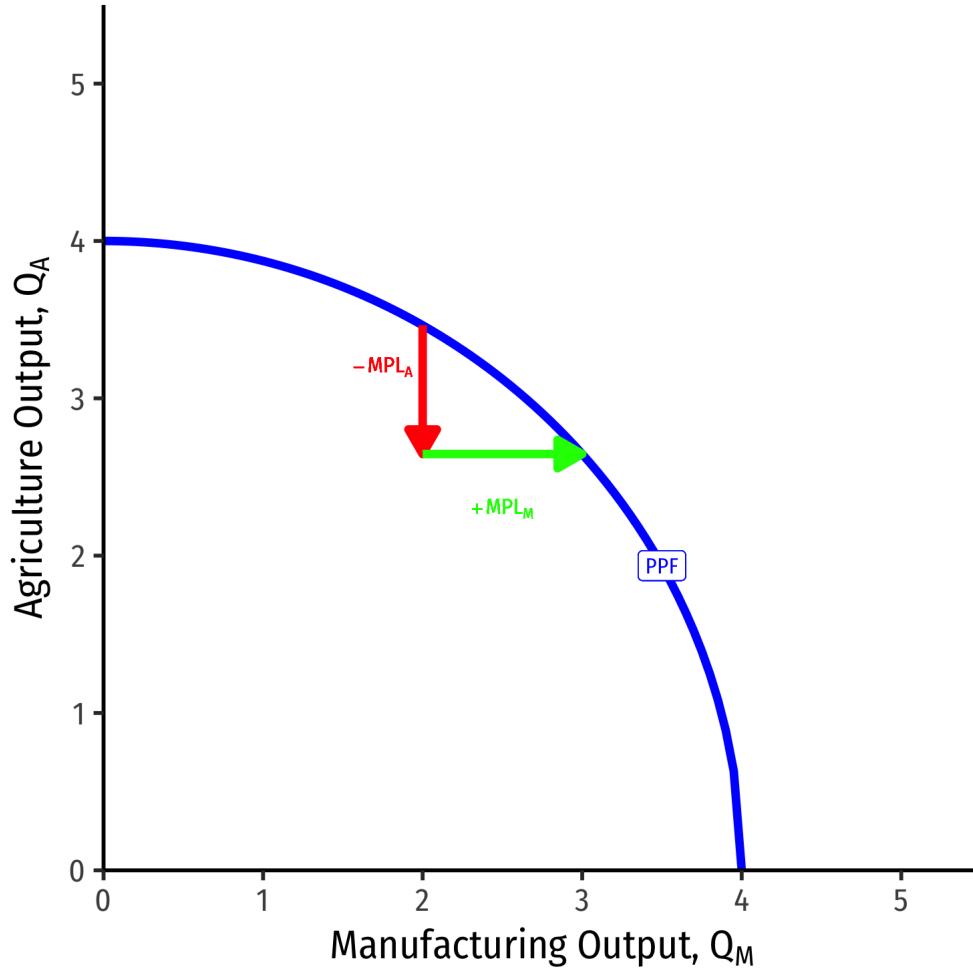
- **Marginal rate of transformation (MRT)** *increases* as we produce more of a good
  - Again: **"slope"**, **"relative price of M"**, **"opportunity cost of M"**
  - Amount of A given up for 1 more M

$$\underbrace{MRT}_{slope} = -\frac{MPL_A}{MPL_M}$$

- Note $A(y)$ on top and $M(x)$ on bottom!
 - if you think in our Ricardian terms,
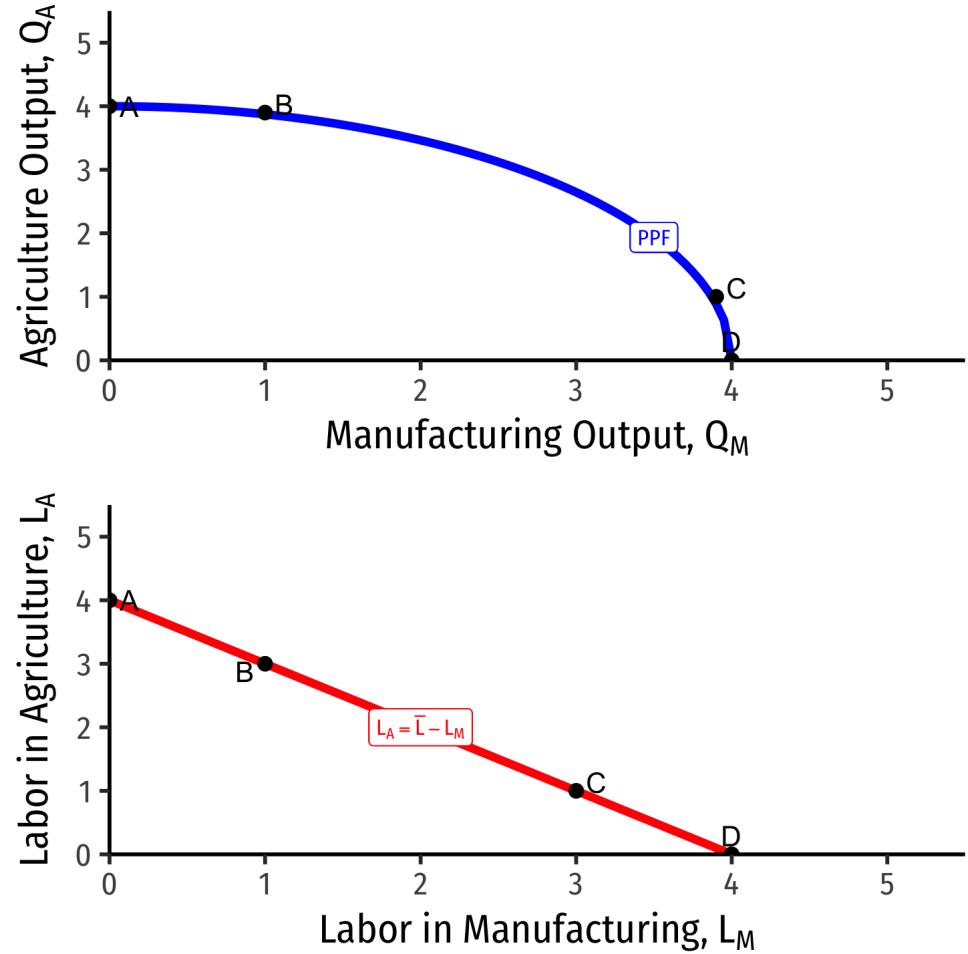
  `\\(l_x=\frac{1}{MPL_x}\\)`

Allocating Labor

- Because of diminishing returns, as we move labor out of A and into M, we lower MPL_M and raise MPL_A

- This is why the PPF has increasing opportunity costs, and is bent inwards the way it is!

- For a given amount of T, K, and L, we can determine the economy's output bundle (Q_M, Q_A) by knowing how much labor is allocated across (L_M, L_A)

- Now let's find how labor is allocated across industries

The Demand for Labor in Competitive Industries

- Profit-maximizing firms in competitive labor markets will hire labor (hours) up to the point where the marginal benefit of hiring labor equals the marginal cost

  - Marginal cost per labor-hour: wage w
  - Marginal benefit per labor-hour: marginal revenue product (marginal product $\times$ price of output)
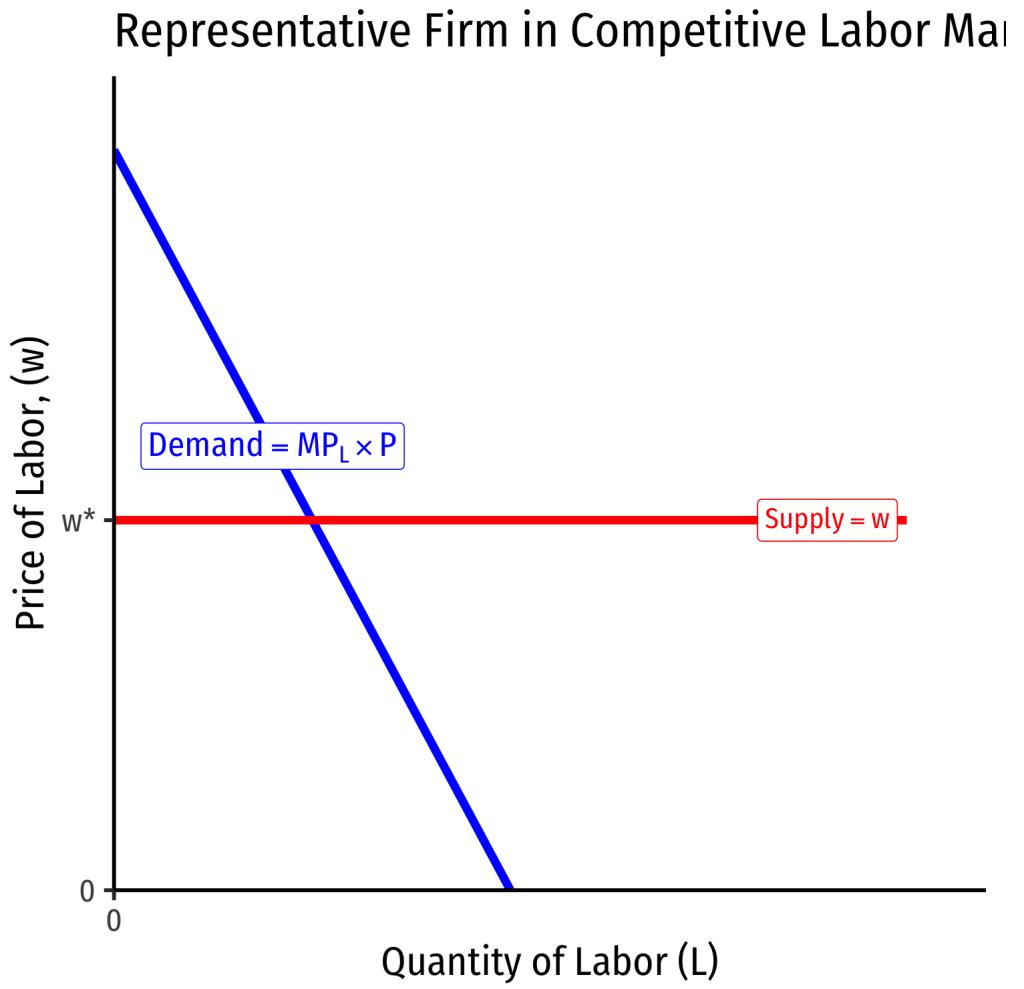
- In manufacturing:

$$w = MPL_M * P_M$$

- In agriculture:

$$w = MPL_A * P_A$$

- Again, if you want to remember why, see my slides on Factor Markets

Representative Firm in Competitive Labor Ma[r]

Demand = $MP_L \times P$

Supply = w

Price of Labor, (w)

w*

0

0

Quantity of Labor (L)

The Demand for Labor in Both Industries

- Because we have assumed **labor is mobile** (and homogenous "labor hours"), workers will always move out of a lower-paying industry and into a higher-paying industry

- Thus, in equilibrium, **wages (w) must equalize across both industries**, with the implication:

$$(w =)MPL_M * P_M = MPL_A * P_A(= w)$$

$$-\frac{MPL_A}{MPL_M} = -\frac{P_M}{P_A}$$
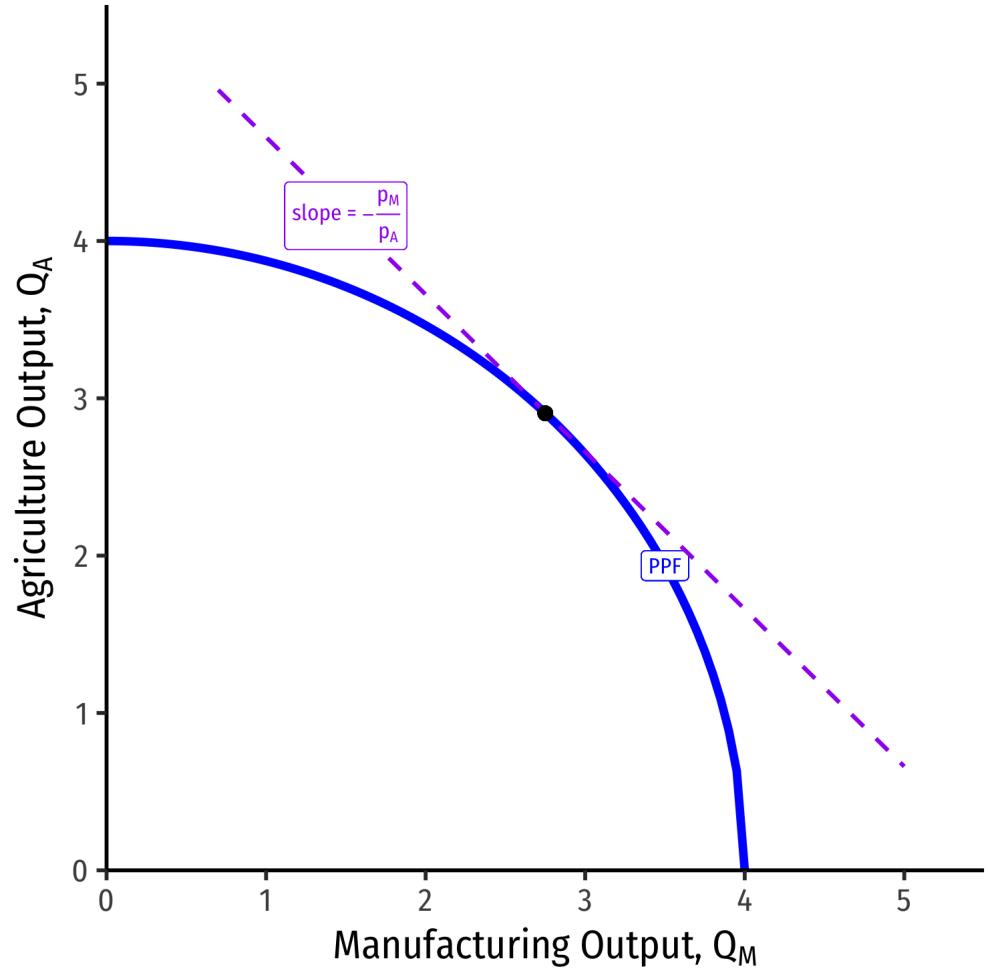
Labor and the PPF

- Thus, we finally see how it is that the slope of the PPF is equivalent to the relative price of M

$$MRT = -\frac{p_M}{p_A}$$
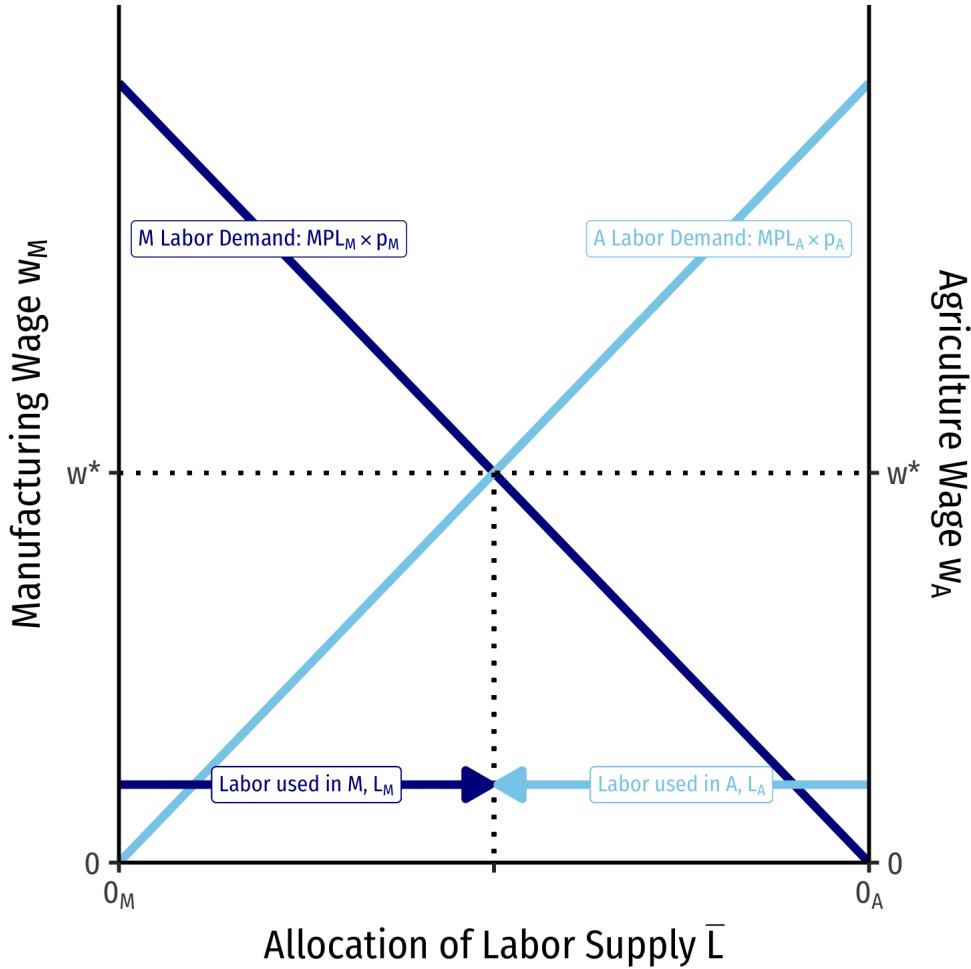
- (Back to x on top, y on bottom!)

- At the optimum production, PPF is tangent to a value line with slope the relative price of M

Labor Allocation
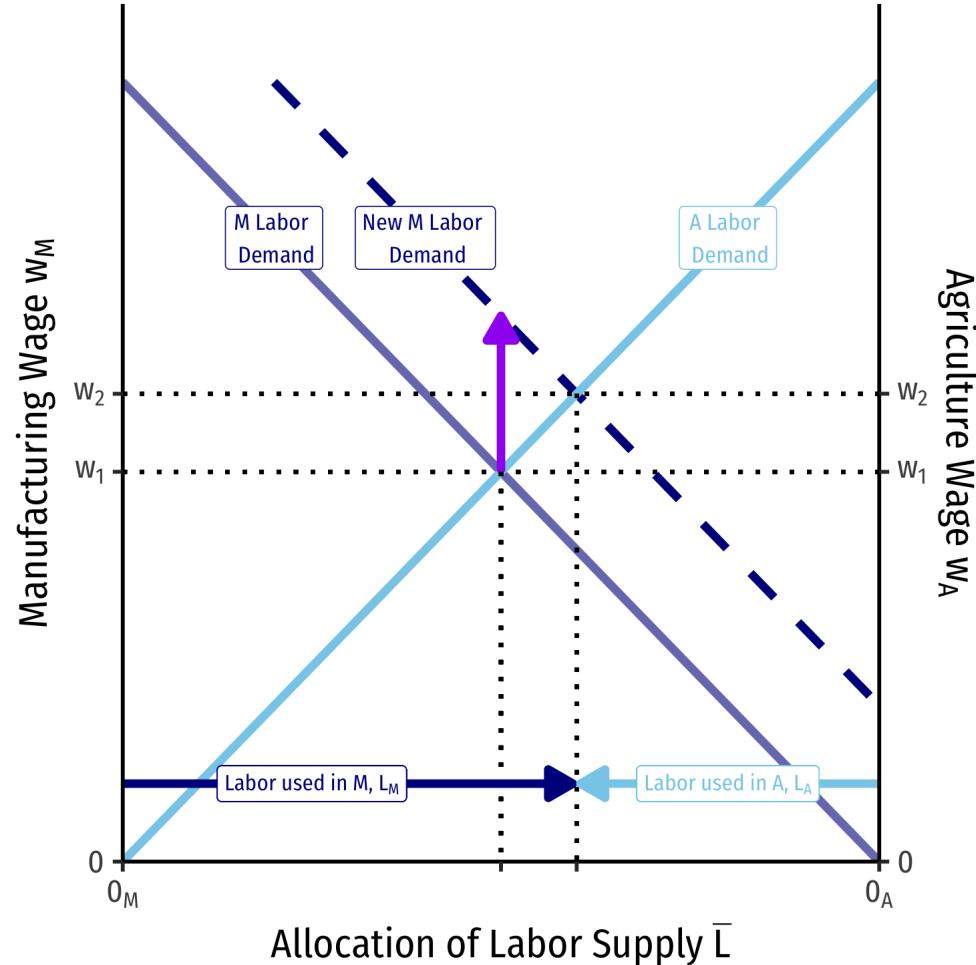
- We can also visualize the allocation of labor in the country

- Recall both industries in equilibrium must charge the same wage
$$w_M = w_A = w^\star$$

- Moving from left to right, labor allocated to manufacturing, L_M

- Moving from right to left, labor allocated to agriculture, L_A

A Change in Relative Prices on Labor Allocation

- An increase in the relative price of manufacturing $\left(\dfrac{p_M}{p_A} \right)$ will increase the demand for labor in manufacturing

- Because both industries have to compete for labor, wages do increase, but not as much as the increase in the relative price of manufacturing

- More labor will be used in manufacturing than in agriculture, and thus, the economy will produce more manufacturing and less agriculture
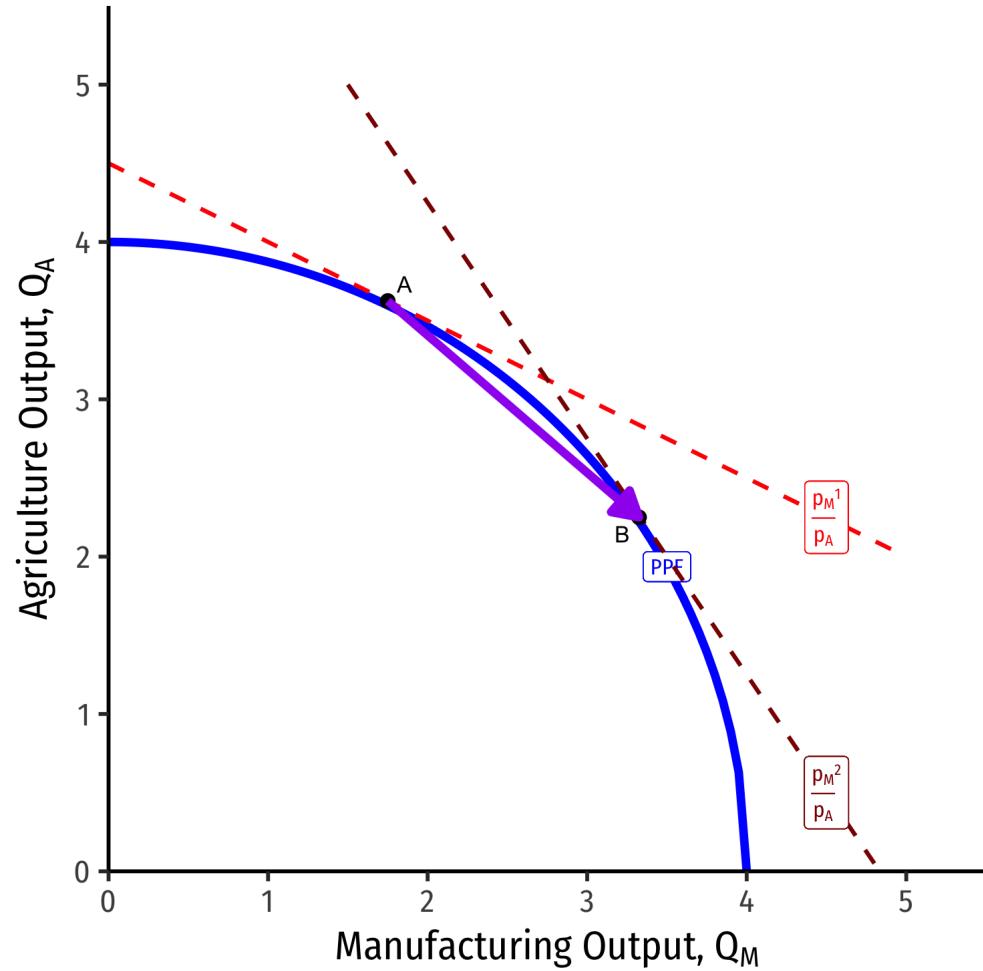
A Change in Relative Prices on PPF

- We can equivalently see this on the PPF

- Increase in the relative price of manufacturing

$$\left(\frac{p_M}{p_A}\right)^1 \rightarrow \left(\frac{p_M}{p_A}\right)^2$$

- Moving from $A \rightarrow B$
  - Slope steepens
 - Country will produce less agriculture, more manufacturing
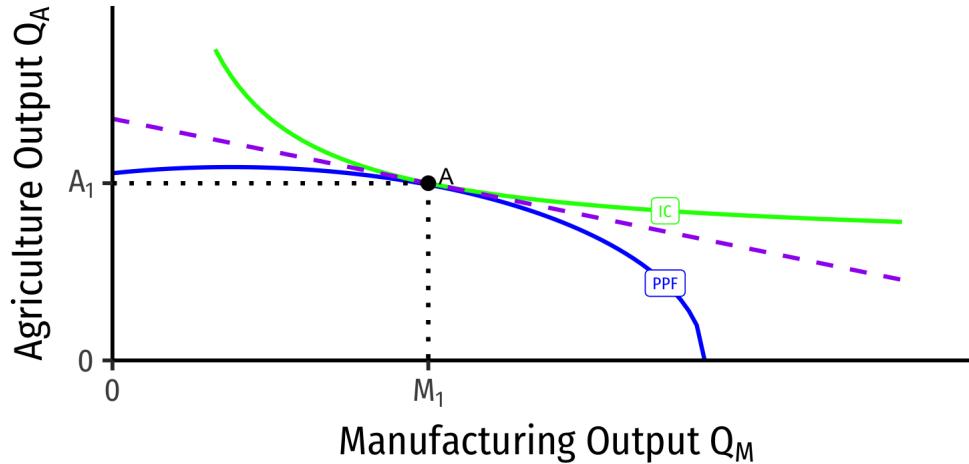
# Distribution Effects Using our Two Country Trade Example
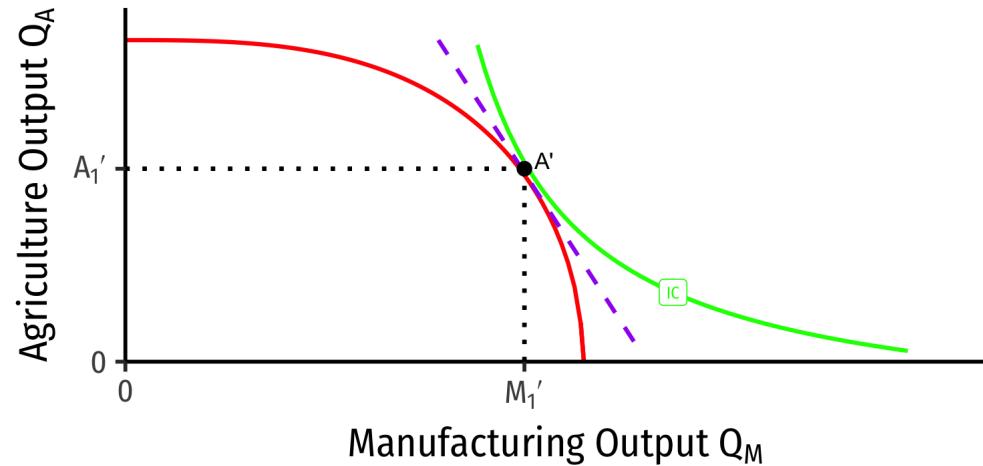
Our Two Country Trade Example: Autarky

Home

Foreign
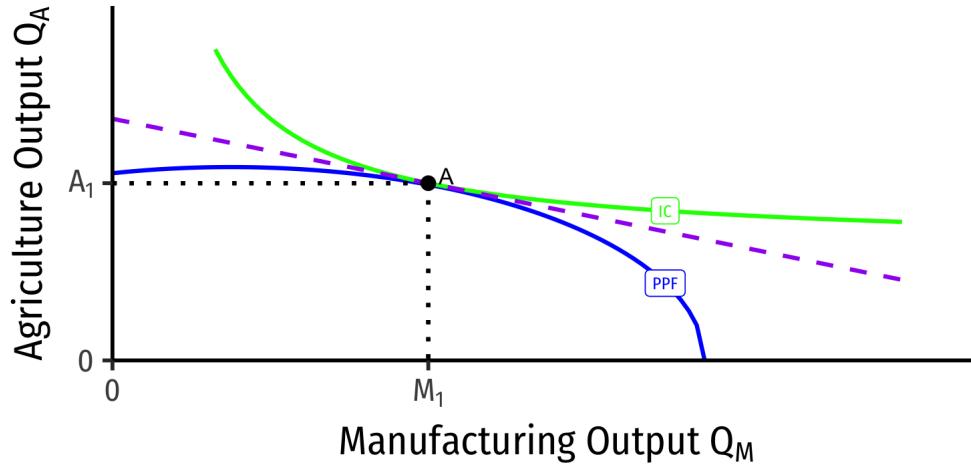

- Countries begin in **autarky** optimum with different relative prices
  - A is optimum for Home
  - A' is optimum for Foreign
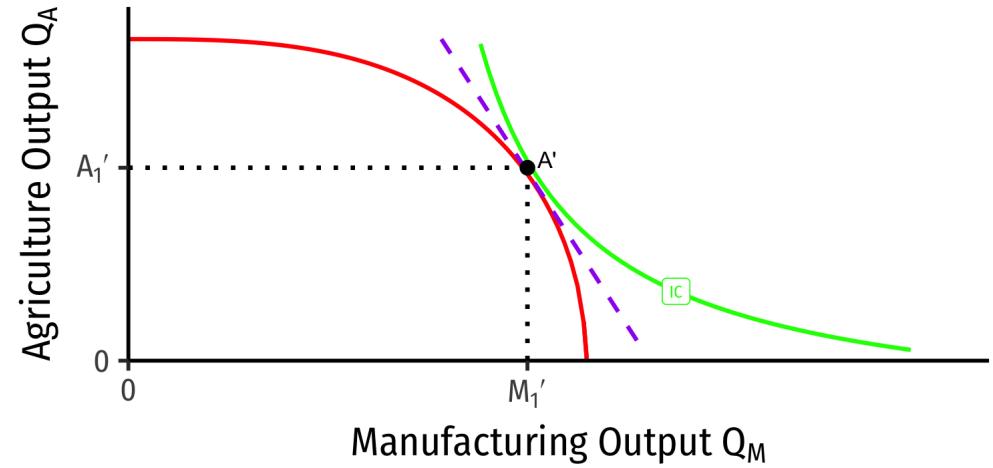
Our Two Country Trade Example: Specialization
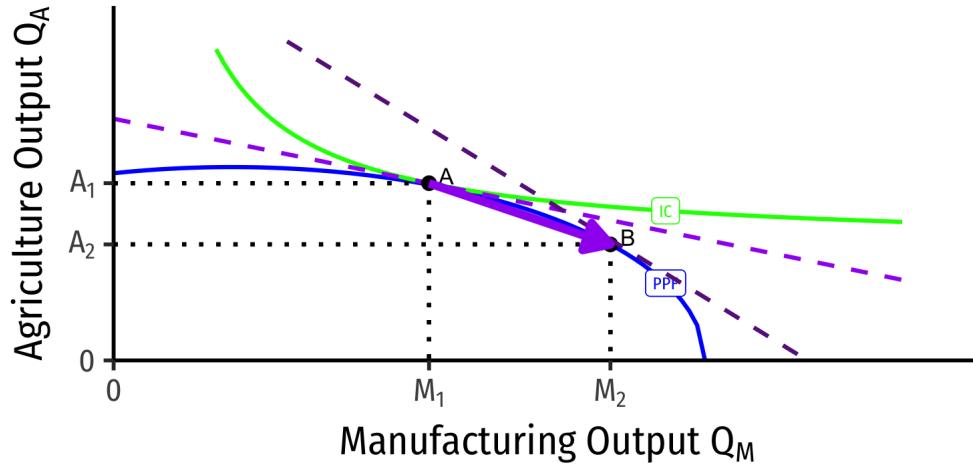
Home

Foreign

- Home has comparative advantage in manufacturing
- Foreign has comparative advantage in agriculture
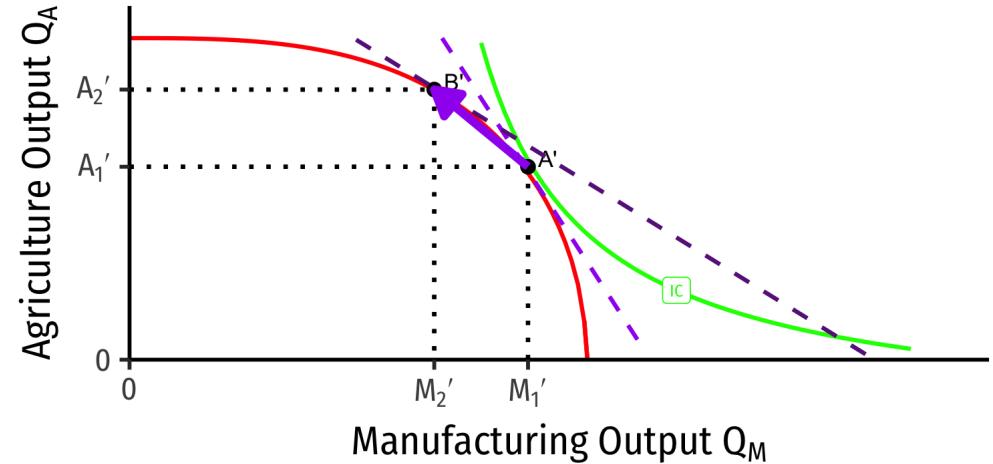
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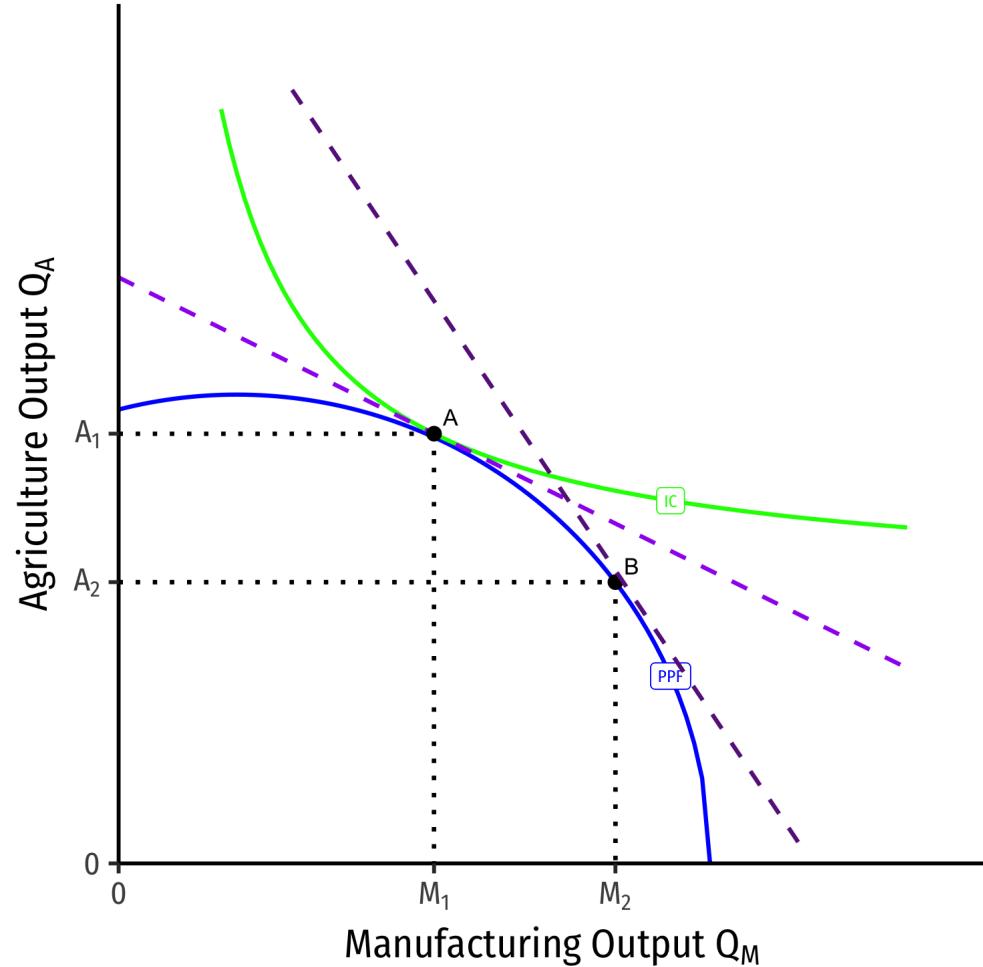
Home

Foreign

- Countries **specialize**: produce *more* of comparative advantaged good, *less* of disadvantaged good
  - Home: A → B: produces more M, less A
  - Foreign: A' → B': produces less M, more A

Relative Price Changes in Home

- Let's look at three groups at Home:

  - Laborers (L)
  - Capitalists (owners of K)
  - Landowners (owners of T)

- Increase in the relative price of manufacturing from trade

  - decrease in relative price of agriculture
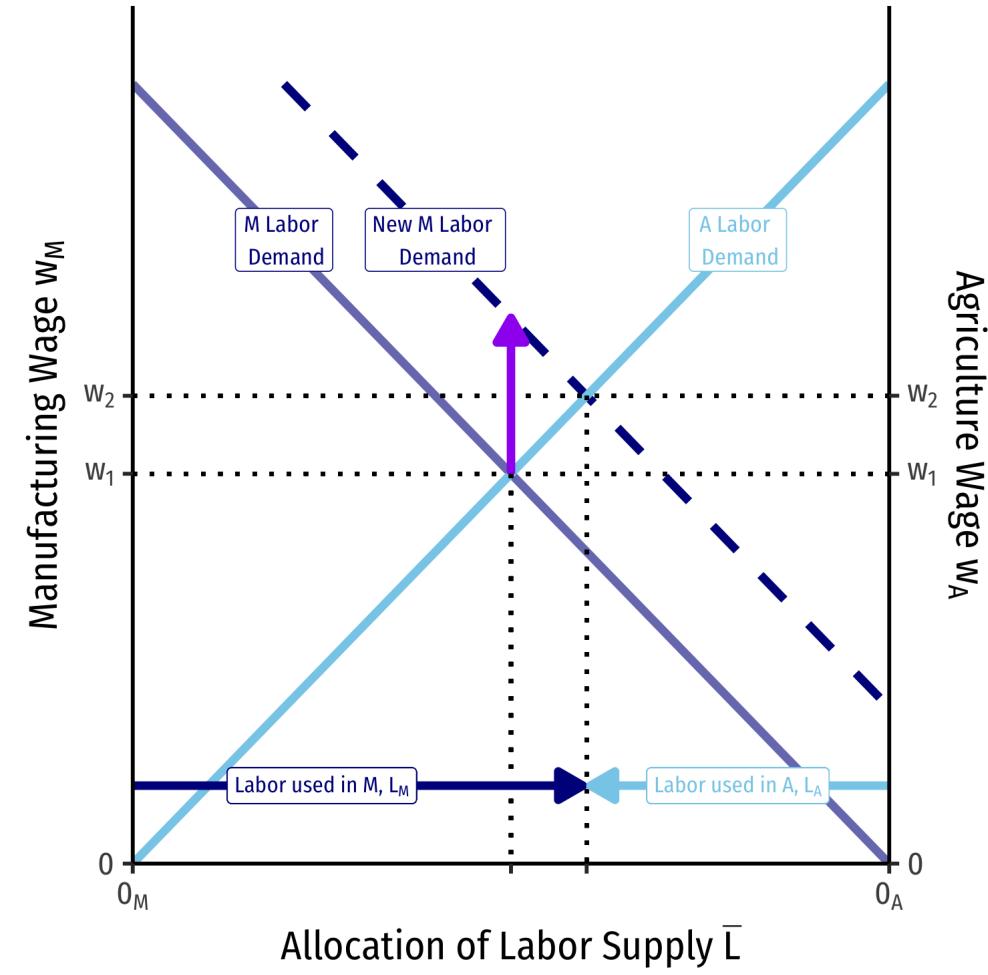
Effects of Trade on Home's Income Distribution: L

- Workers find their wage has increased (but less than increase in relative price of M)

$$\frac{\Delta w}{w_1} < \frac{\Delta \left(\frac{P_M}{P_A} \right)}{\left(\frac{P_M}{P_A} \right)_1}$$

- Amount of manufactures Q_M that can be purchased with wages has *fallen*!

  - **Real wage in terms of manufacturing,** $\downarrow \frac{w}{p_M}$

- Amount of agriculture Q_A that can be purchased with wages has *risen*!

  - **Real wage in terms of agriculture,** $\uparrow \frac{w}{p_A}$

- **Effect on workers is ambiguous**

  - Depends on their consumption preferences between M and A

Manufacturing Wage w_M · Agriculture Wage w_A

M Labor Demand | New M Labor Demand | A Labor Demand

w_2 · w_1

Labor used in M, L_M | Labor used in A, L_A

Allocation of Labor Supply $\bar{L}$

O_M · O_A

Effects of Trade on Home's Income Distribution: K

- What about capital owners?
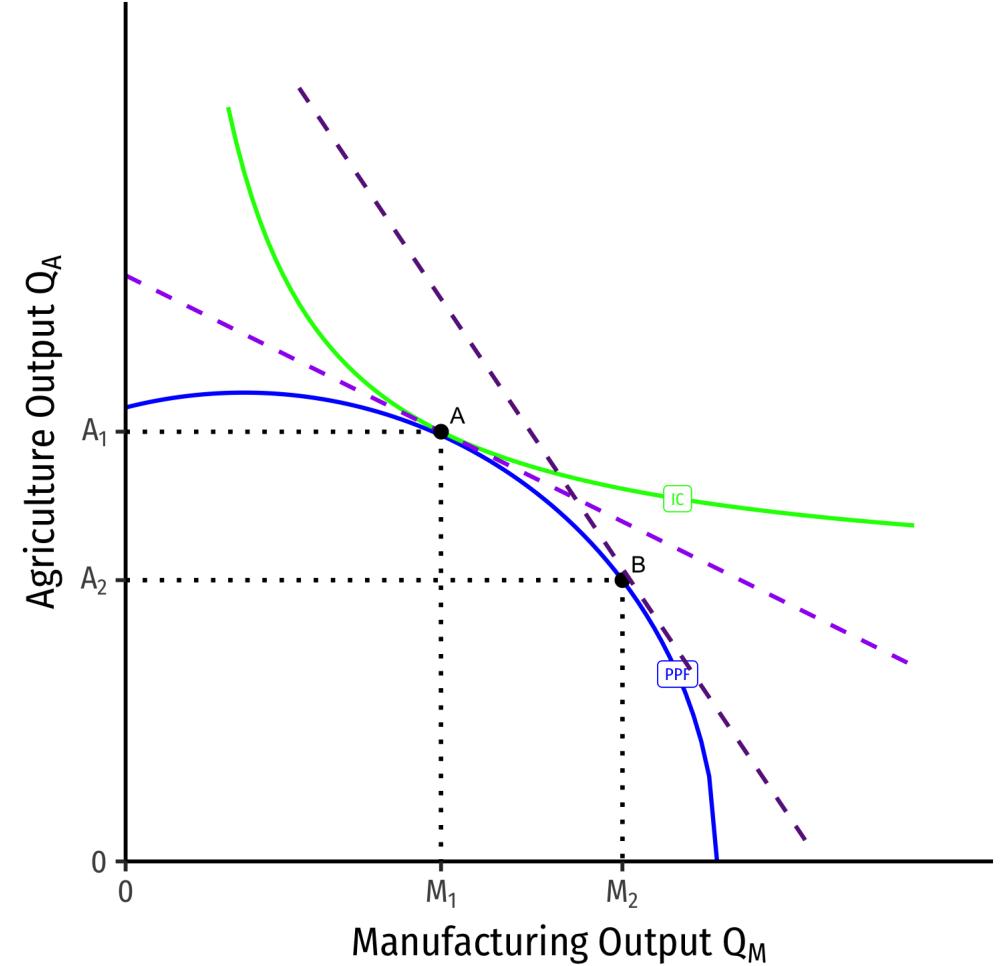
- Total income to capitalists
$$= \underbrace{(P_M * Q_M)}_{\text{Revenues in M}} - \underbrace{(W * L_M)}_{\text{Labor costs}}$$

- As more labor used in manufacturing, $\uparrow MP_K$:
  Each machine has more workers to work it.

- **Capital owners gain**
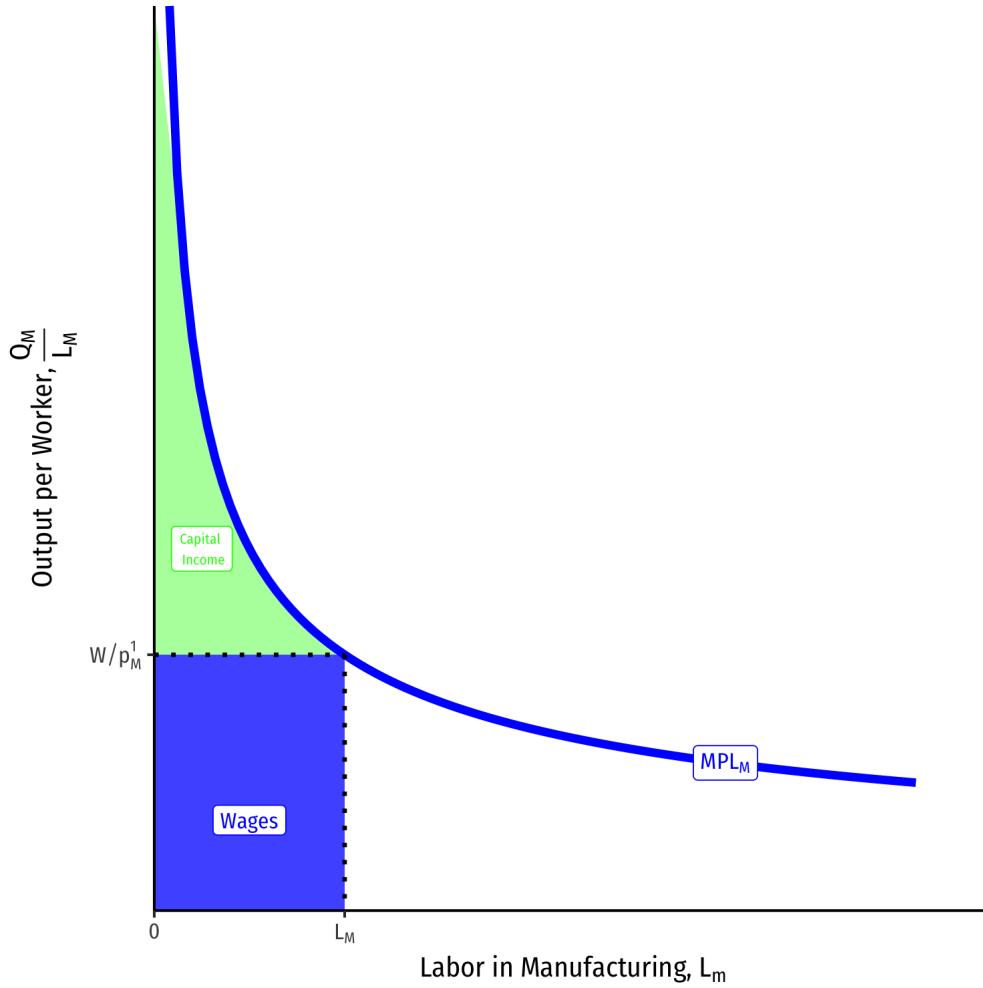
  - We saw (1) $\uparrow$ relative price of manufacturing
    and (2) $\downarrow$ real wage in terms of
    manufacturing
  - Thus, income to capital will rise more than
    proportionately to the rise in relative price
    of manufacturing

Advanced Explanation for Capital
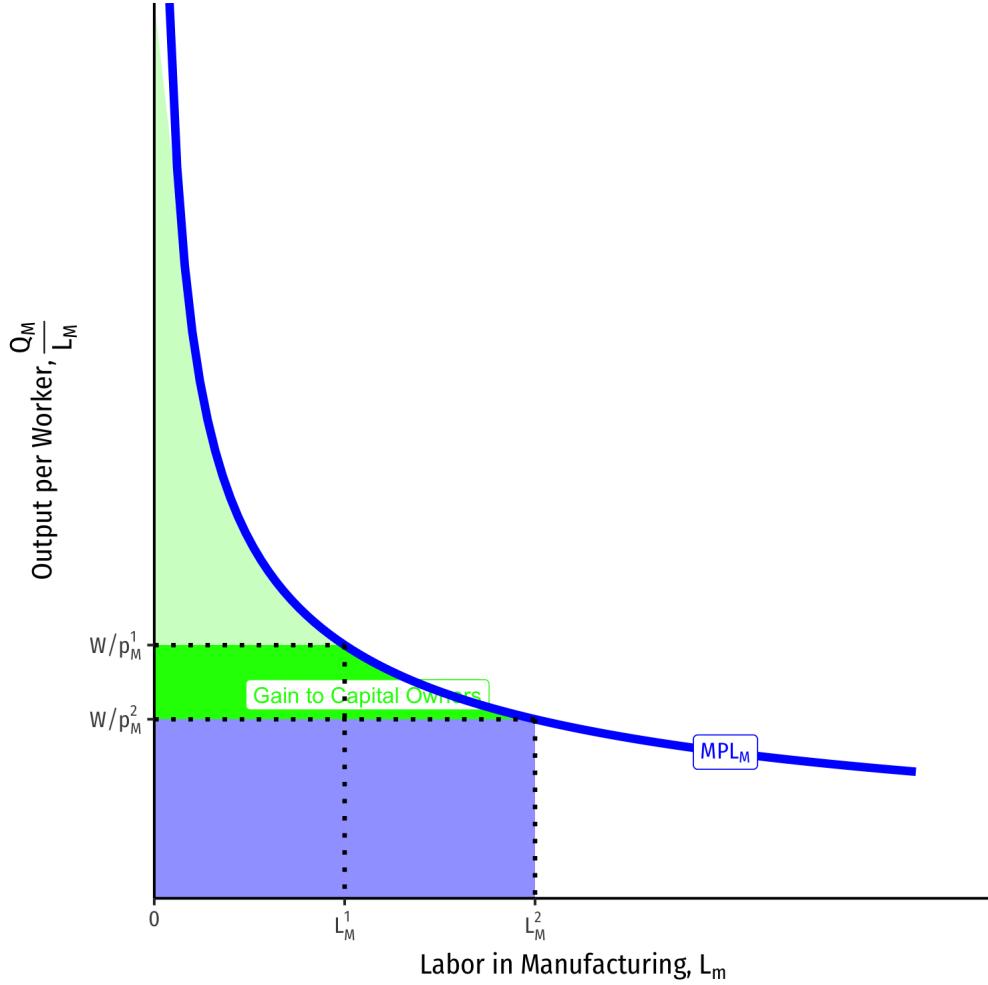
- Manufacturing is produced with capital and labor, $Q_M = Q_M(K, L_M)$

- Total output Q_M using L_M is equal to the area under the MPL_M curve up to L_M

- Labor is paid $w = MPL_M * p_M$

  - Rewrite as real wage (in terms of M): $\frac{w}{P_M}$
  - This times the total number of workers L_M equals the total wages paid

- All residual income goes to capital owners

Advanced Explanation for Capital

- Because trade raises the relative price of manufacturing, $\frac{p_M}{p_A}$, we saw:

  - Increase in labor L_M, and increase in *nominal* wage w, but
  - Decrease in real wage in terms of m, $\frac{w}{p_M}$

- **Capital owners gain**

Effects of Trade on Home's Income Distribution: T
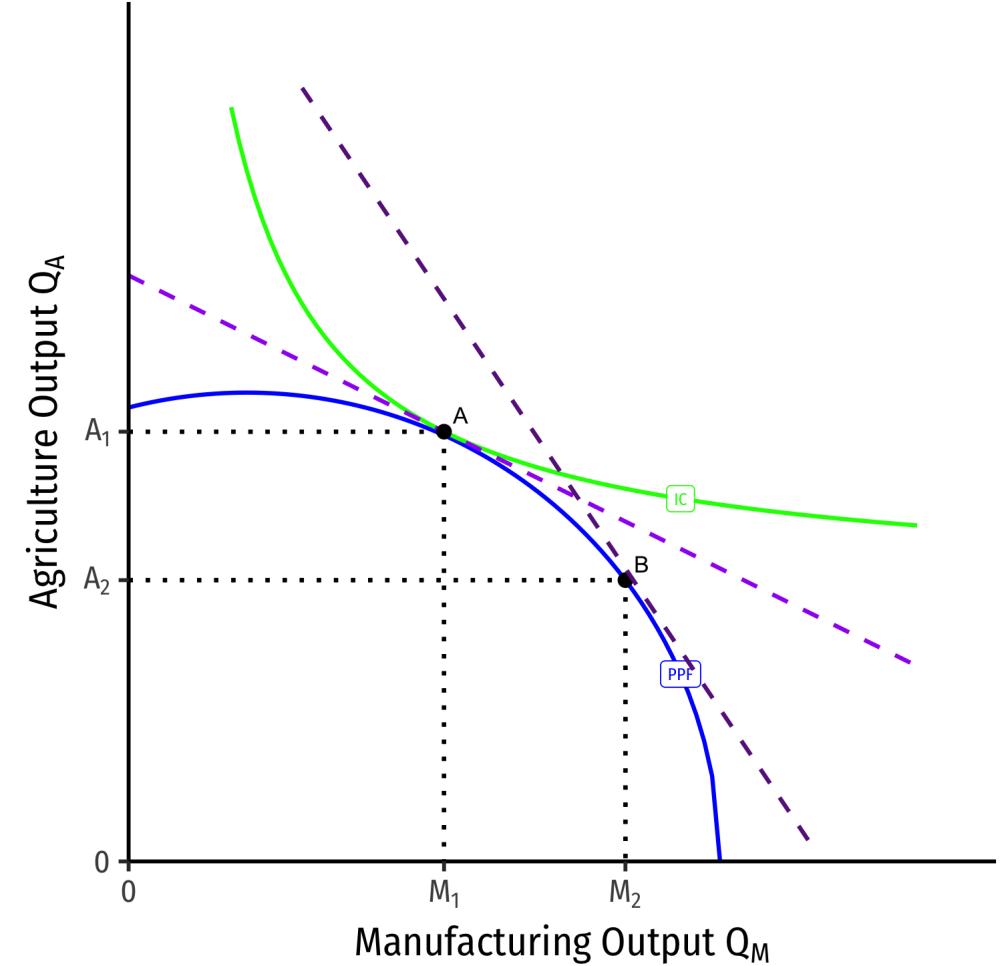
- What about land owners?

- Total income to landowners
$$= \underbrace{(P_A M * Q_A)}_{\text{Revenues in A}} - \underbrace{(W * L_A)}_{\text{Labor costs}}$$

- As less labor used in agriculture, $\downarrow MP_T$: Each piece of land has fewer workers to work it.

- **Land owners lose**
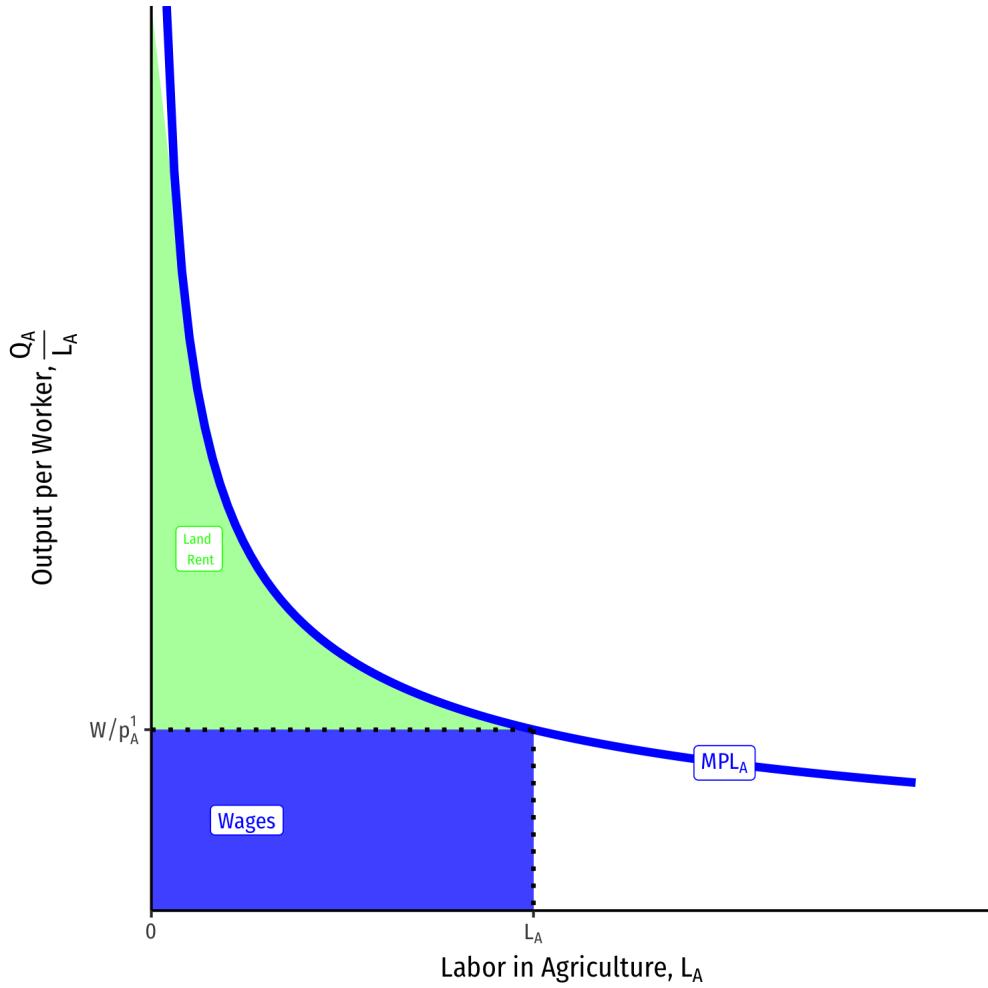
  - We saw (1) $\downarrow$ relative price of agriculture and (2) $\uparrow$ real wage in terms of agriculture
  - Thus, income to landowners will fall more than proportionately to the fall in relative price of agriculture

Advanced Explanation for Land
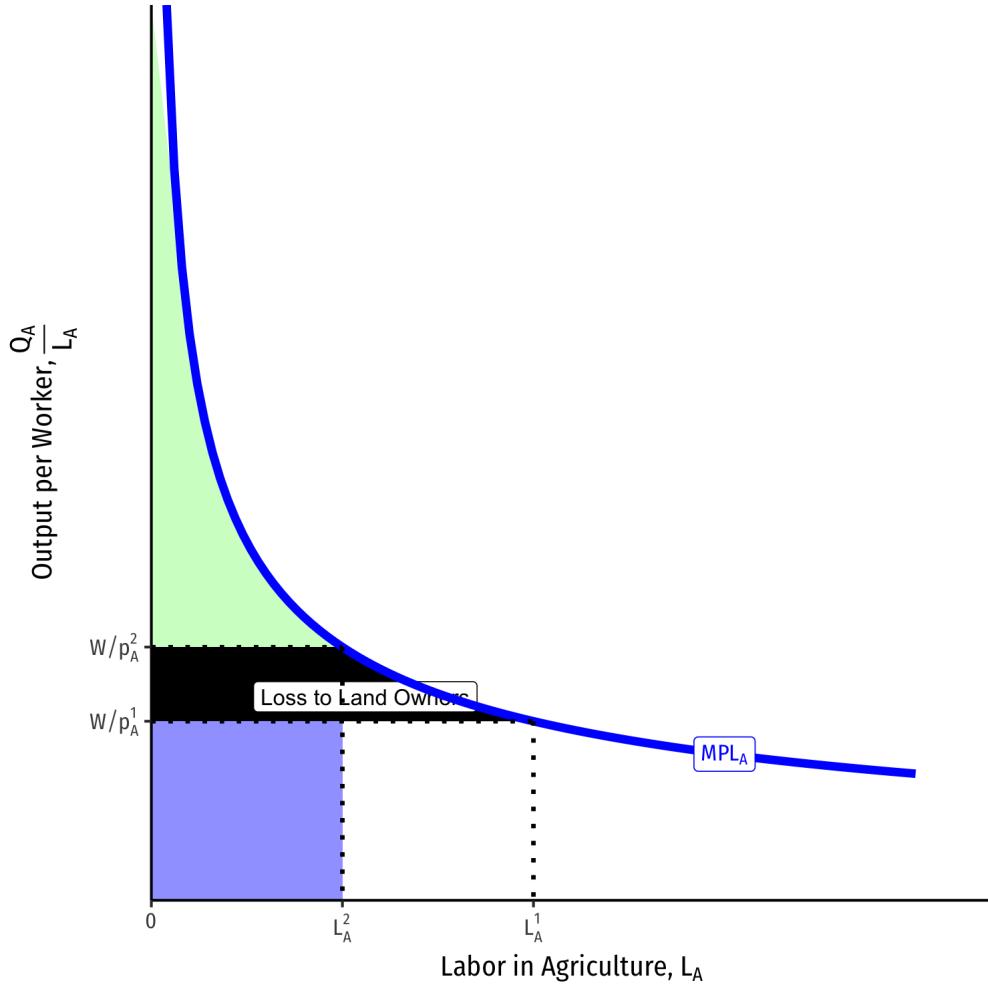
- Agriculture is produced with land and labor,
$$Q_A = Q_A(T, L_A)$$

- Total output Q_A using L_A is equal to the area under the MPL_A curve up to L_A

- Labor is paid $w = MPL_A * p_A$

    - Rewrite as real wage (in terms of A): $\frac{w}{P_A}$
    - This times the total number of workers L_A equals the total wages paid

- All residual income goes to land owners (as rent)

Advanced Explanation for Land

- Because trade lowers the relative price of agriculture, $\frac{p_A}{p_M}$, we saw:

  - Decrease in labor L_A, but increase in *nominal* wage w, so
  - Increase in real wage in terms of A, $\frac{w}{p_A}$

- **Land owners lose**
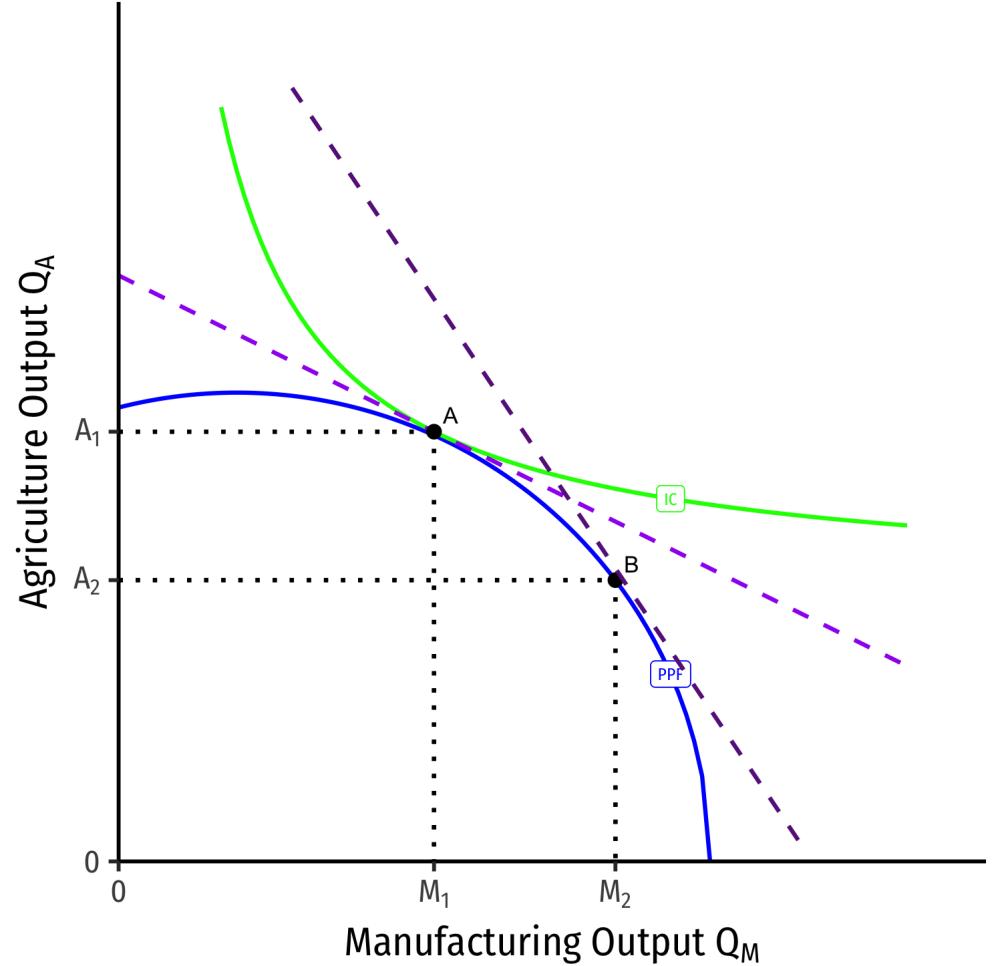
Effects of Trade on Home's Income Distribution

EFfects of trade on Home's:
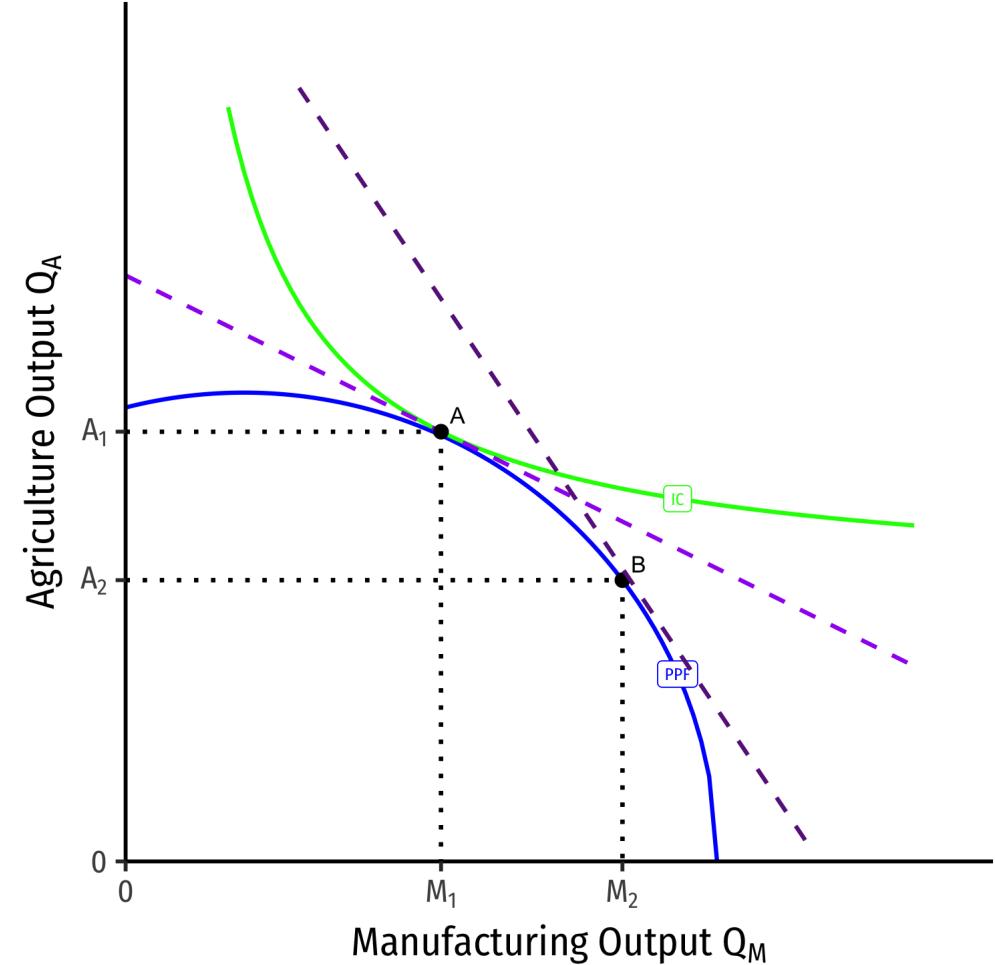
- **Labor**: ambiguous

  - real wage rises in terms of M, falls in terms of A

- **Capital**: income rises more than proportionate to M relative price increase

- **Land**: income falls more than proportionate to A relative price fall

Effects of Trade on Home Income Distribution
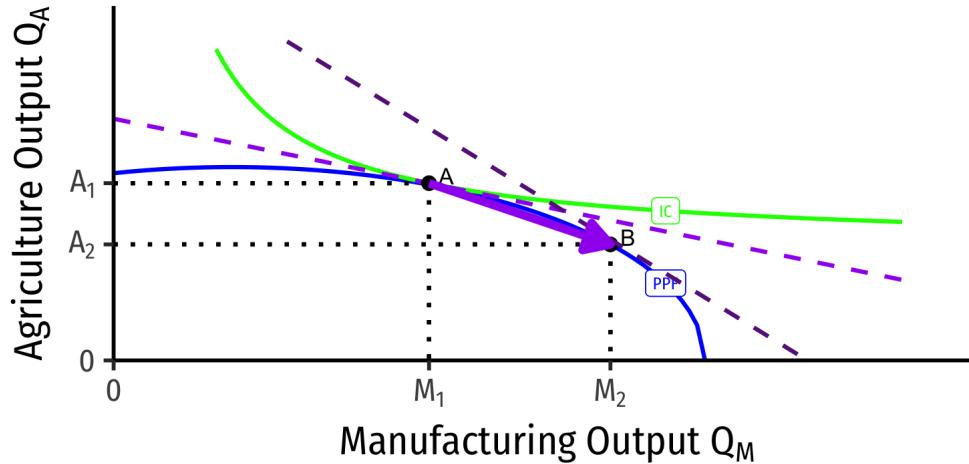
- **Factor specific to the sector whose relative price rises is *better off* with trade**

  - Capital for manufacturing

- **Factor specific to the sector whose relative price falls is *worse off* with trade**

  - Land for agriculture

- **The mobile factor is *not clearly* better or worse off with trade.**

  - Labor
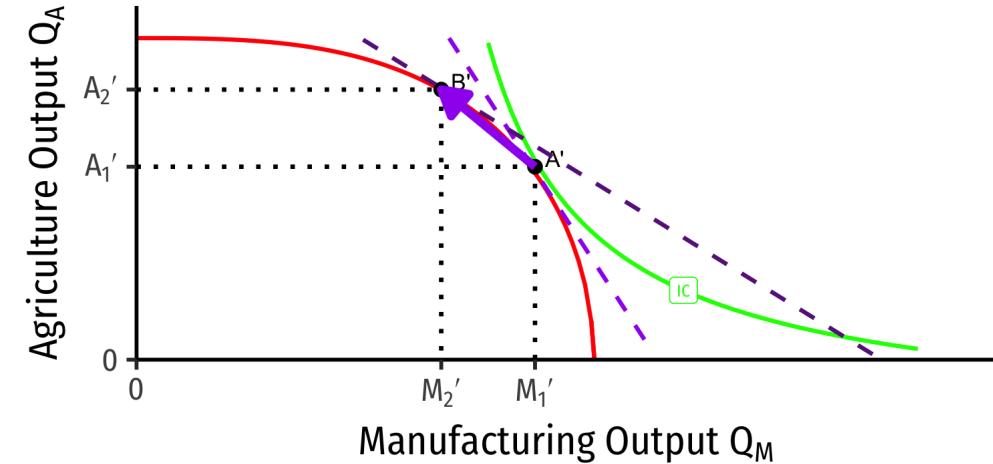
Specialization (Again)

Home

Foreign
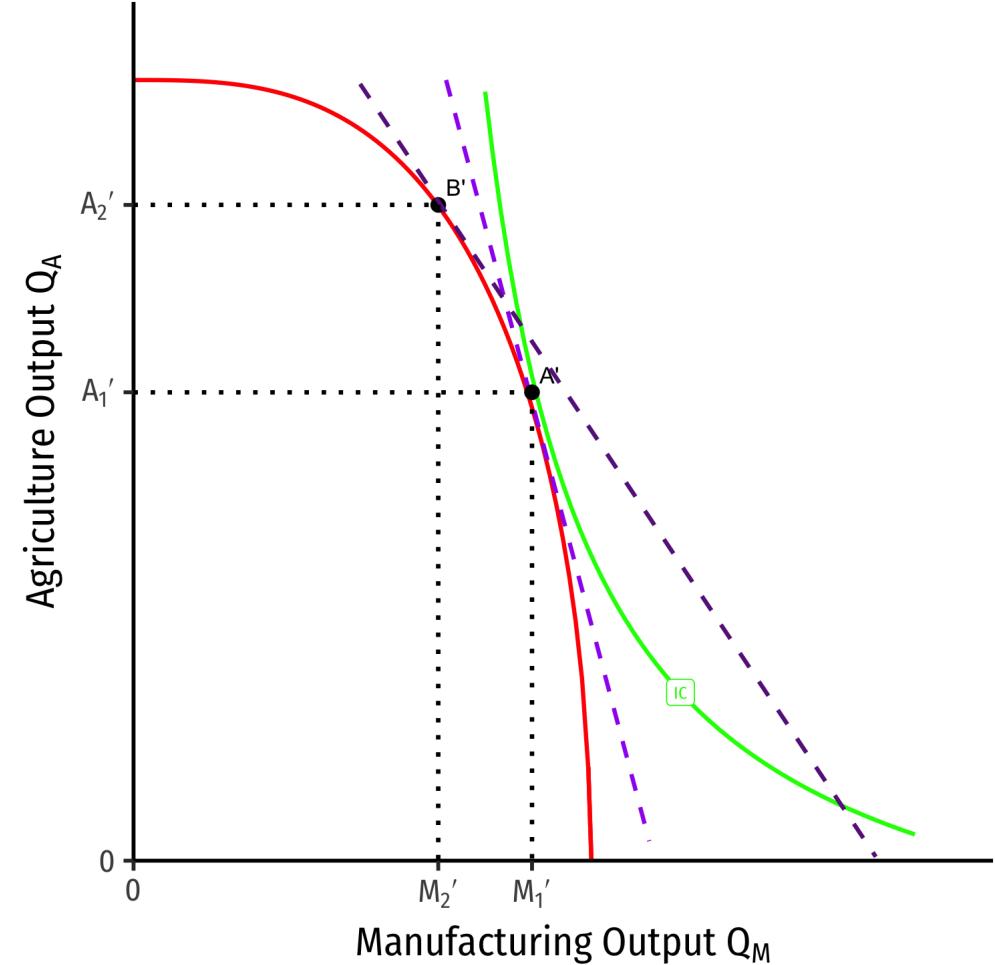
- Countries **specialize**: produce *more* of comparative advantaged good, *less* of disadvantaged good
  - Home: A → B: produces more M, less A
  - Foreign: A' → B': produces less M, more A

Relative Price Changes in Foreign

- Let's look at three groups at Foreign:

  - Laborers (L)
  - Capitalists (owners of K)
  - Landowners (owners of T)

- Decrease in the relative price of manufacturing from trade

  - increase in relative price of agriculture
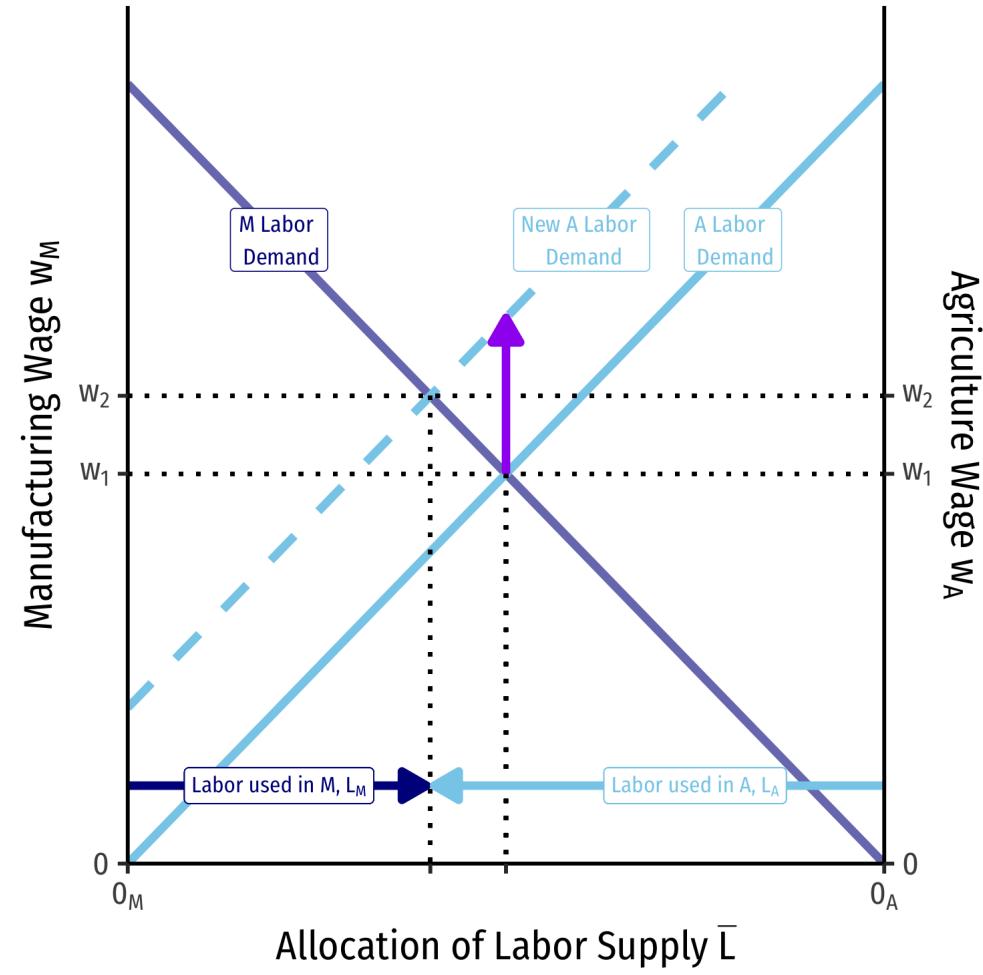
Effects of Trade on Foreign's Income Distribution: L

- Workers find their wage has increased (but less than increase in relative price of A)

$$\frac{\Delta w}{w_1} < \frac{\Delta\left(\frac{P_A}{P_M}\right)}{\left(\frac{P_A}{P_M}\right)_1}$$

- Amount of manufactures Q_M that can be purchased with wages has *risen*!

 - **Real wage in terms of manufacturing,** $\uparrow \frac{w}{p_M}$

- Amount of agriculture Q_A that can be purchased with wages has *fallen*!

  - **Real wage in terms of agriculture,** $\downarrow \frac{w}{p_A}$

- **Effect on workers is ambiguous**

  - Depends on their consumption preferences between *M* and *A*

Allocation of Labor Supply $\bar{L}$

Effects of Trade on Foreign's Income Distribution: K

- What about capital owners?

- Total income to capitalists
$$= \underbrace{(P_M * Q_M)}_{\text{Revenues in M}} - \underbrace{(W * L_M)}_{\text{Labor costs}}$$
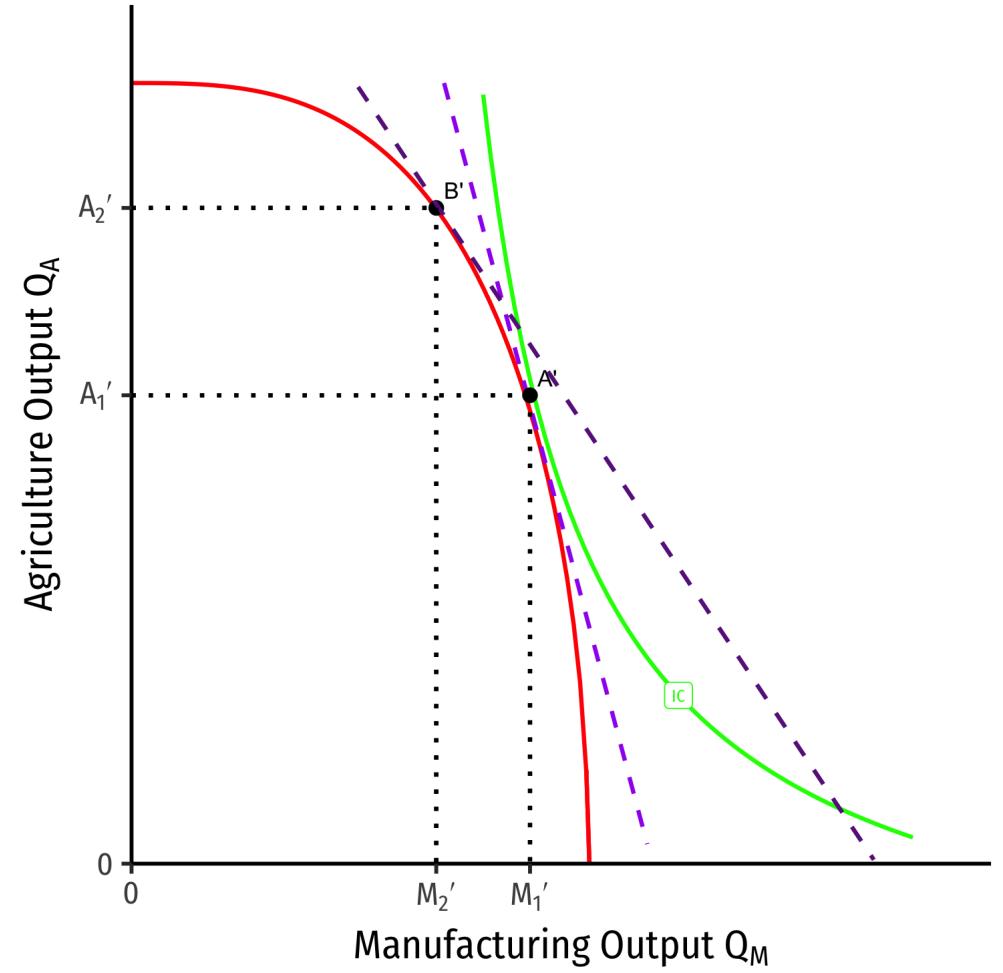
- As less labor used in manufacturing, $\downarrow MP_K$: Each machine has fewer workers to work it.

- **Capital owners lose**

  - We saw (1) $\downarrow$ relative price of manufacturing and (2) $\uparrow$ real wage in terms of manufacturing
  - Thus, income to capital will fall more than proportionately to the fall in relative price of manufacturing

Effects of Trade on Foreign's Income Distribution: T

- What about land owners?
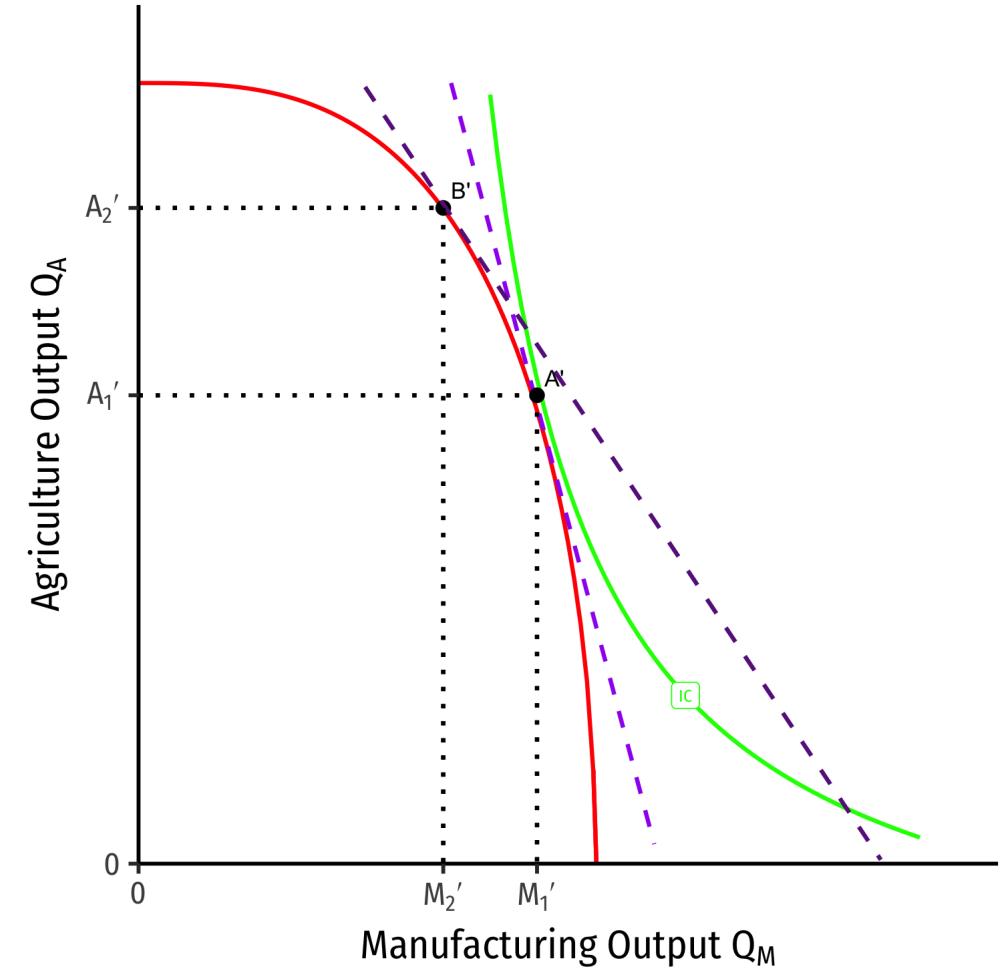
- Total income to landowners
$$= \underbrace{(P_A * Q_A)}_{\text{Revenues in A}} - \underbrace{(W * L_A)}_{\text{Labor costs}}$$

- As more labor used in agriculture, $\uparrow MP_T$: Each piece of land has more workers to work it.

- **Land owners gain**

  - We saw (1) $\uparrow$ relative price of agriculture and (2) $\downarrow$ real wage in terms of agriculture
  - Thus, income to landowners will rise more than proportionately to the rise in relative price of agriculture
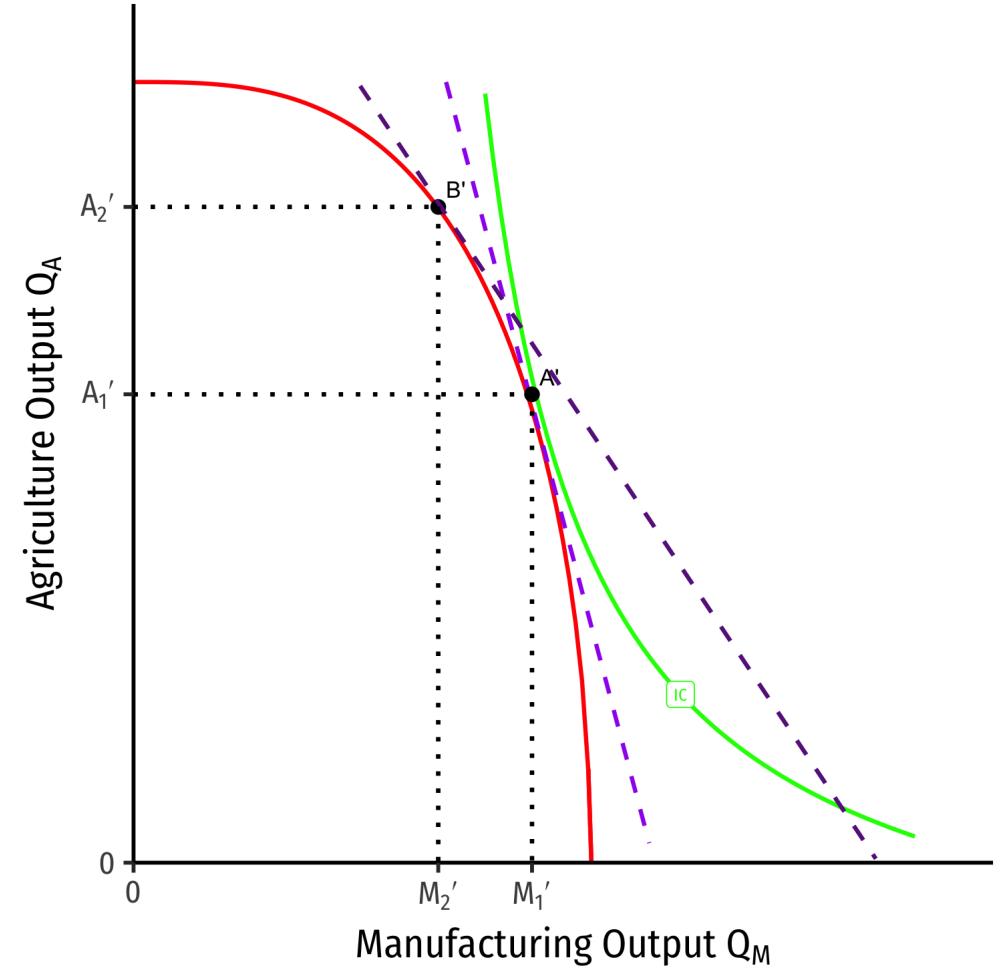
Effects of Trade on Foreign's Income Distribution

EFfects of trade on Foreign's:
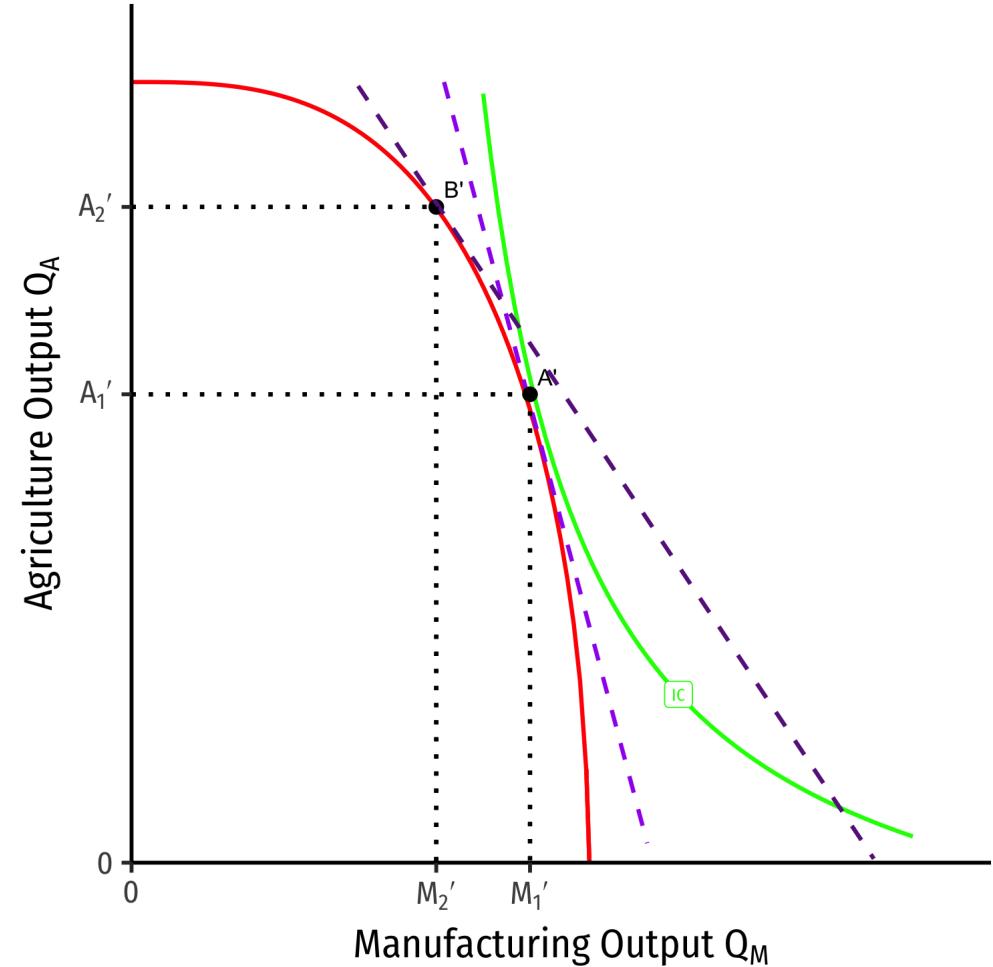
- **Labor**: ambiguous

  - real wage rises in terms of M, falls in terms of A

- **Capital**: income falls more than proportionate to M relative price fall

- **Land**: income rises more than proportionate to A relative price increase

Effects of Trade on Foreign's Income Distribution

- **Factor specific to the sector whose relative price rises is *better off* with trade.**

  - Land for agriculture

- **Factor specific to the sector whose relative price falls is *worse off* with trade.**

  - Capital for manufacturing

- **The mobile factor is *not clearly* better or worse off with trade.**

  - Labor

Takeways from The Specific Factors Model

Takeways from The Specific Factors Model
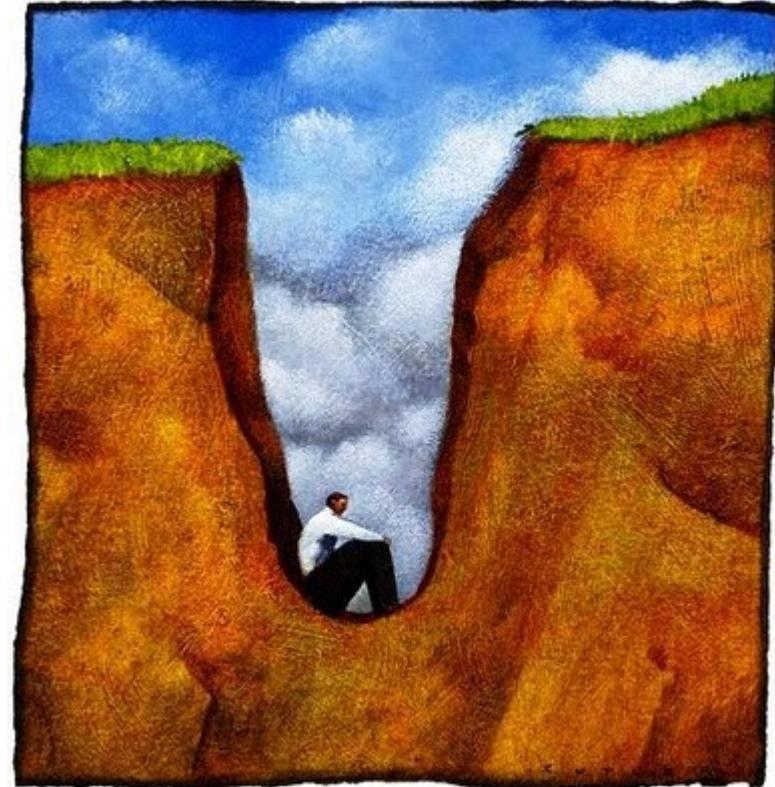
- **Changes in trade fall mainly upon the fixed/specific factors of production**

  - Increase in relative prices (exports) benefit fixed factor producing exports
  - Decrease in relative prices (imports) harm fixed factor competing with imports

- **Mobile factors face ambiguous change**

  - Can move from low-income industries to high-income industries

Takeways from The Specific Factors Model

- Of course, our simple model aggregates labor into a single mobile factor

- In reality, different types of labor, some may be **mobile** and some may be **immoble** and **specific**

- Changes in trade patterns and relative prices will affect specific and mobile factors differently

Example of Mobile vs. Specific Labor

Example: Auto-workers in Detroit in the 1980s were a relatively specific and immobile factor

- Geographically concentrated

- Skills specific to car assembly-lines
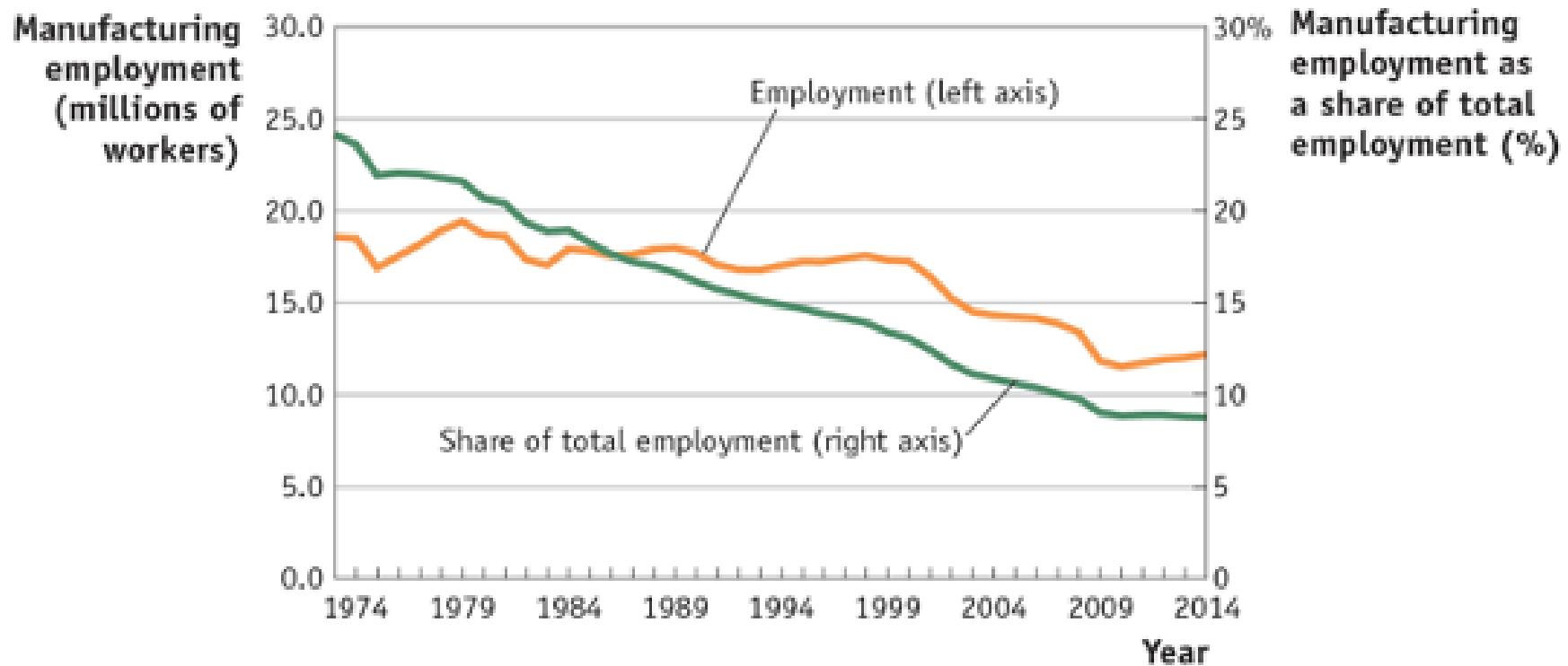
Example of Mobile vs. Specific Labor

- Japan begins exporting cheap cars in 1980s, U.S. consumers import them

- Relative price of cars falls in U.S., U.S. factories produce fewer cars, wages & jobs in U.S. auto manufacturing diminish

- More **mobile** and **nonspecific** workers left Detroit for other industries

  - e.g. maybe they went to Texas to work in booming oil industry

- More **immobile** and **specific** workers lost jobs

  - Maybe geographically stuck in Detroit
  - Skills were too specific to auto industry, not transferrable to other industries

Some More Examples
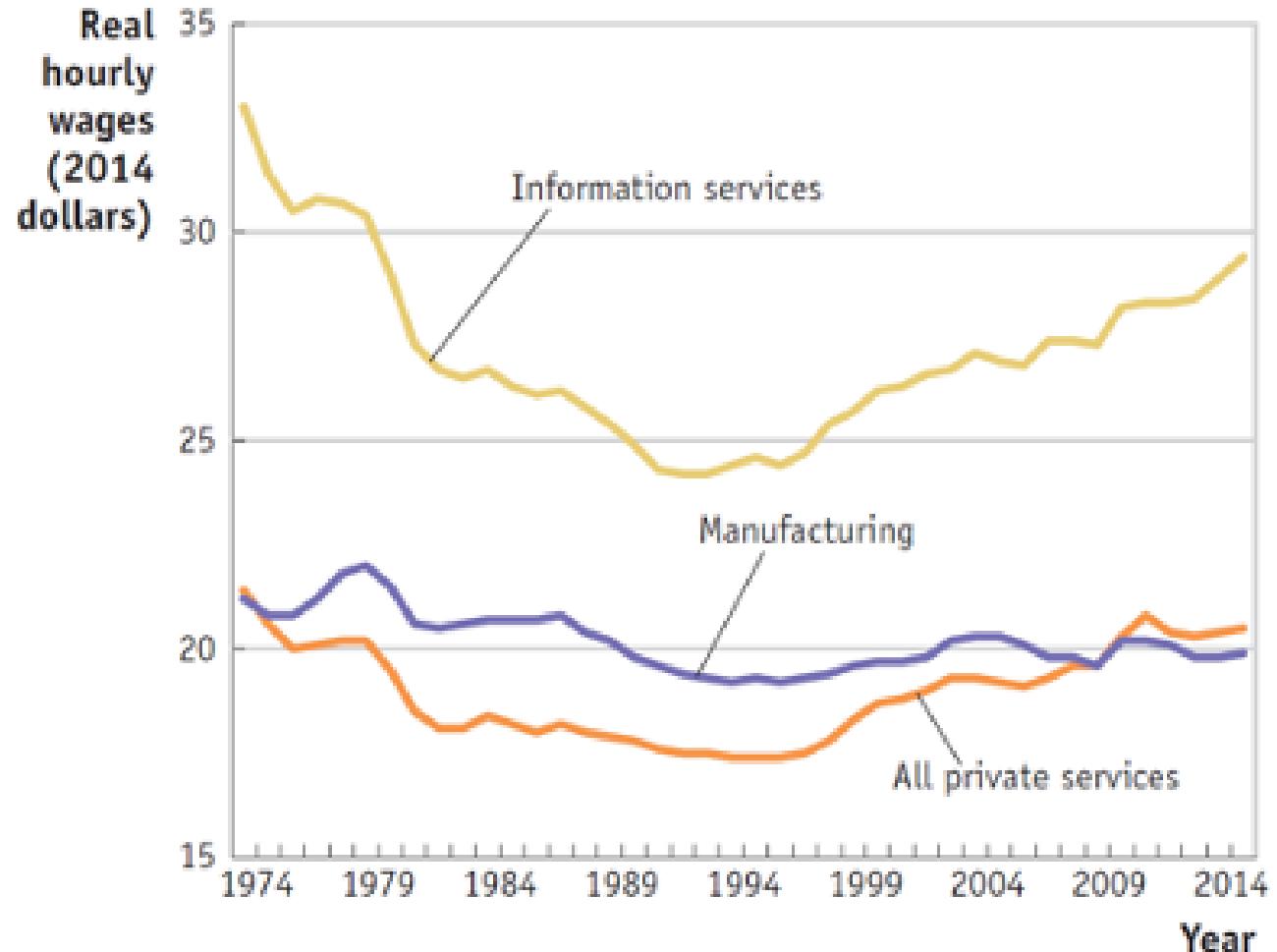
Source: Feenstra & Taylor (2017)

Some More Examples

Source: Feenstra & Taylor (2017)

Some More Examples

Industry	Total Displaced Workers (thousands) Jan 2011–Dec 2013	Workers Reemployed by Jan 2014	PERCENTAGES	
			Of the Workers Reemployed:	
			Earn Less in New Job	Earn Same or More in New Job
Total	4,292	61%	48%	52%
Manufacturing industries	765	59%	57%	43%
Service industries	3,146	62%	72%	28%

Source: Feenstra & Taylor (2017)

Takeways from The Specific Factors Model

- Again, **changes in trade fall mainly upon the fixed/specific factors of production**

  - Increase in relative prices (exports) benefit fixed factor producing exports
  - Decrease in relative prices (imports) harm fixed factor competing with imports

- **Mobile factors face ambiguous change**

  - Can move from low-income industries to high-income industries

- **Policy implication**: if governments wish to protect domestic groups from adverse trade shocks, increase mobility and non-specific skills/uses