1.8 — The Specific Factors Model

ECON 324 • International Trade • Fall 2020

Ryan Safner

Assistant Professor of Economics

safner@hood.edu

ryansafner/tradeF20

tradeF20.classes.ryansafner.com

Assumptions of the Specific Factors Model

Allocating the Mobile Factor (Labor)

Distribution Effects Using our Two Country Trade Example

Takeaways from the Specific Factors Model

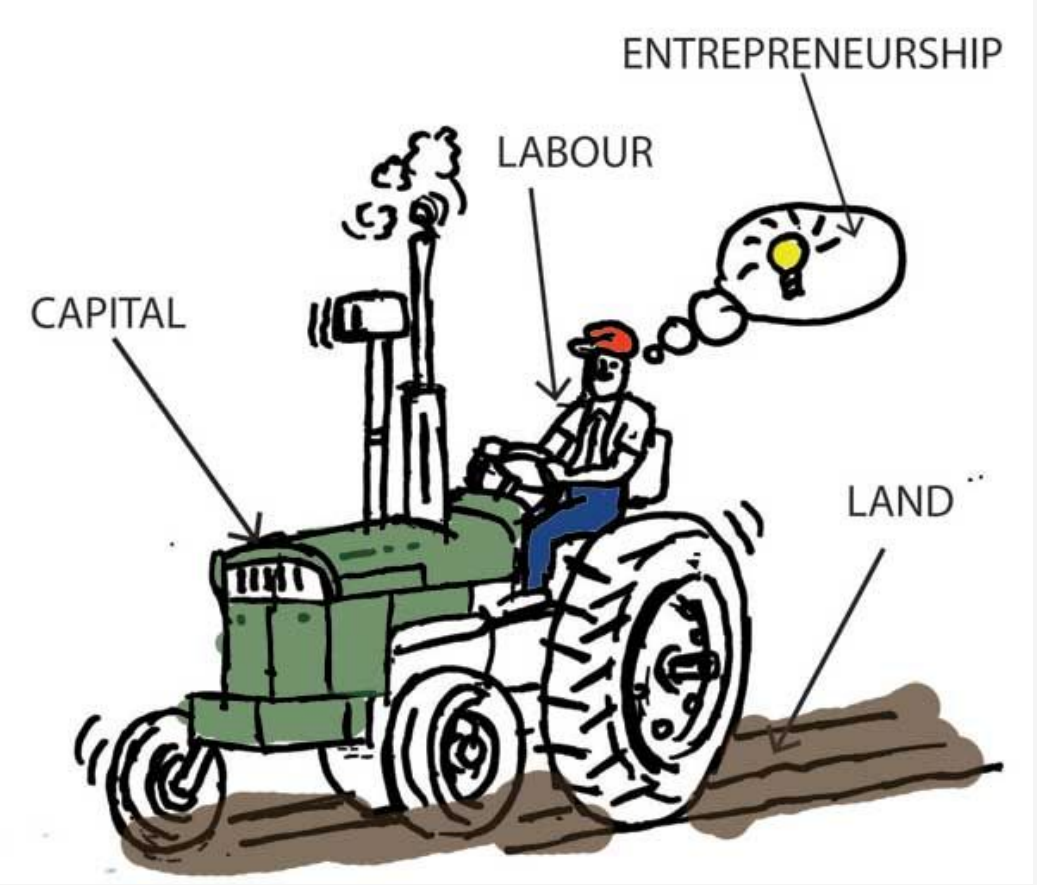
Assumptions of the Specific Factors Model

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

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* and *labor*
- **Agriculture** is produced using *land* and *labor*
- Land and capital are **specific factors**, only used to produce one good
- Labor is the **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

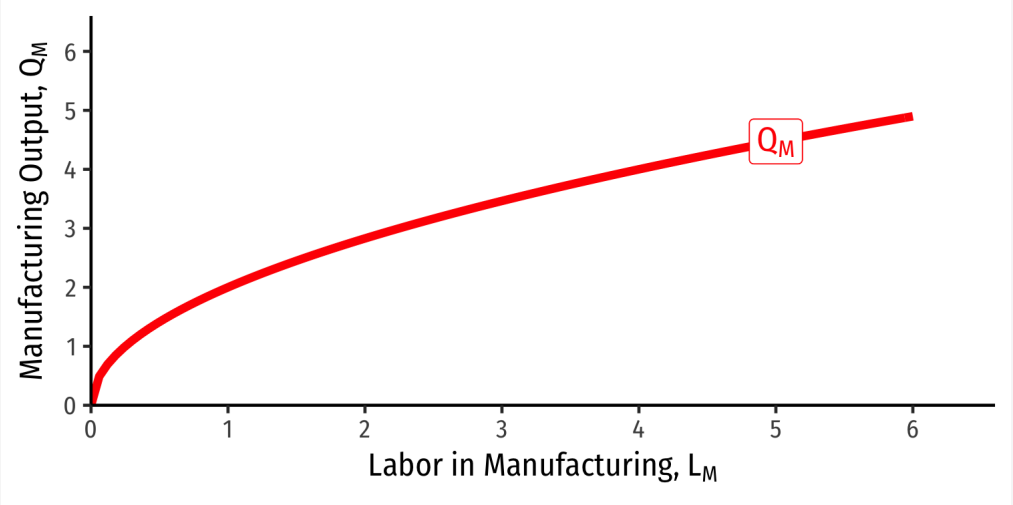
$$L_M + L_A = \bar{L}$$

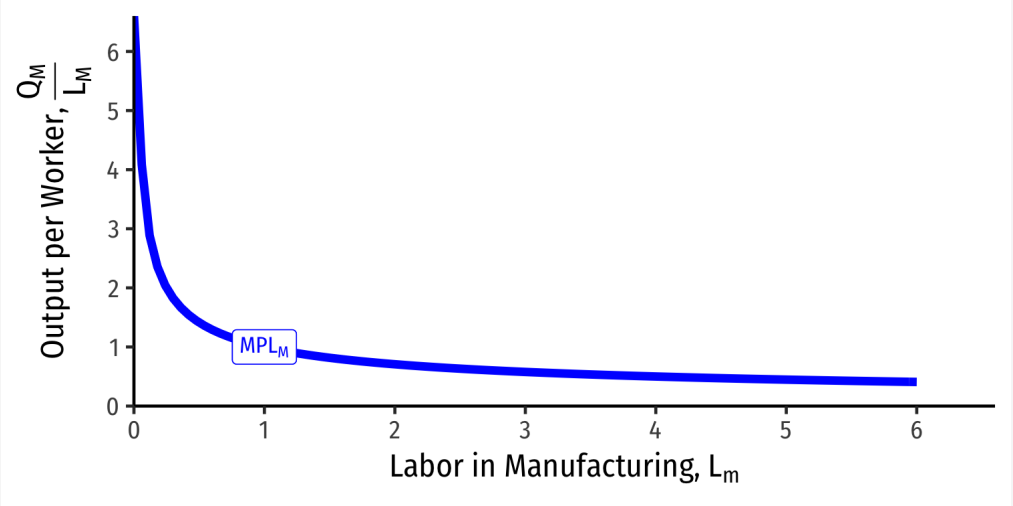
Diminishing Marginal Product of Labor

- 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



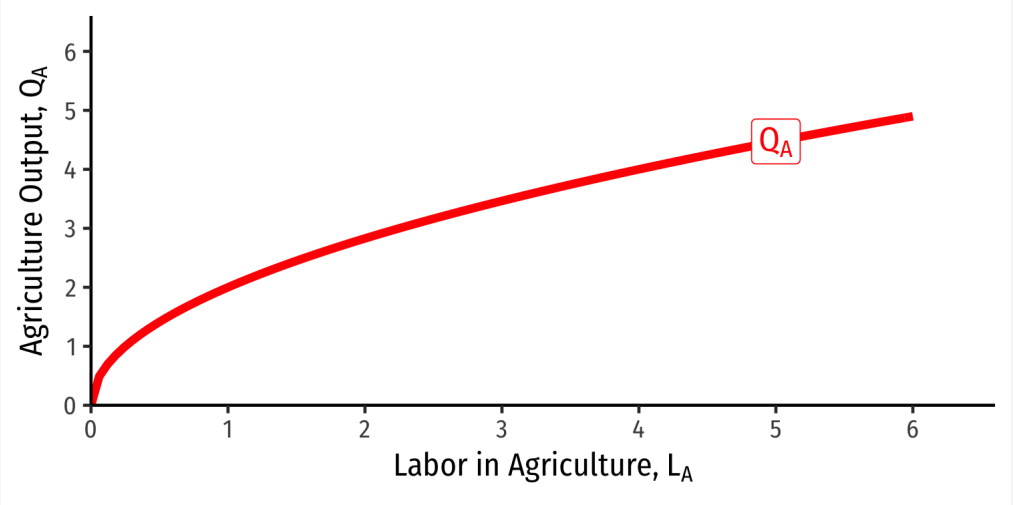


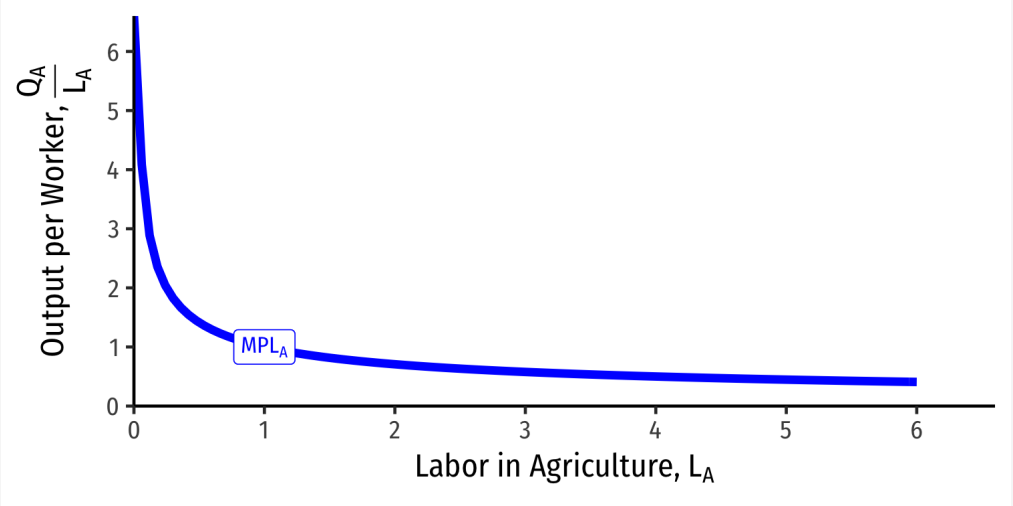
Diminishing Marginal Product of Labor

- 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)

$$MPL_A = \frac{\Delta Q_A}{\Delta L_A}$$

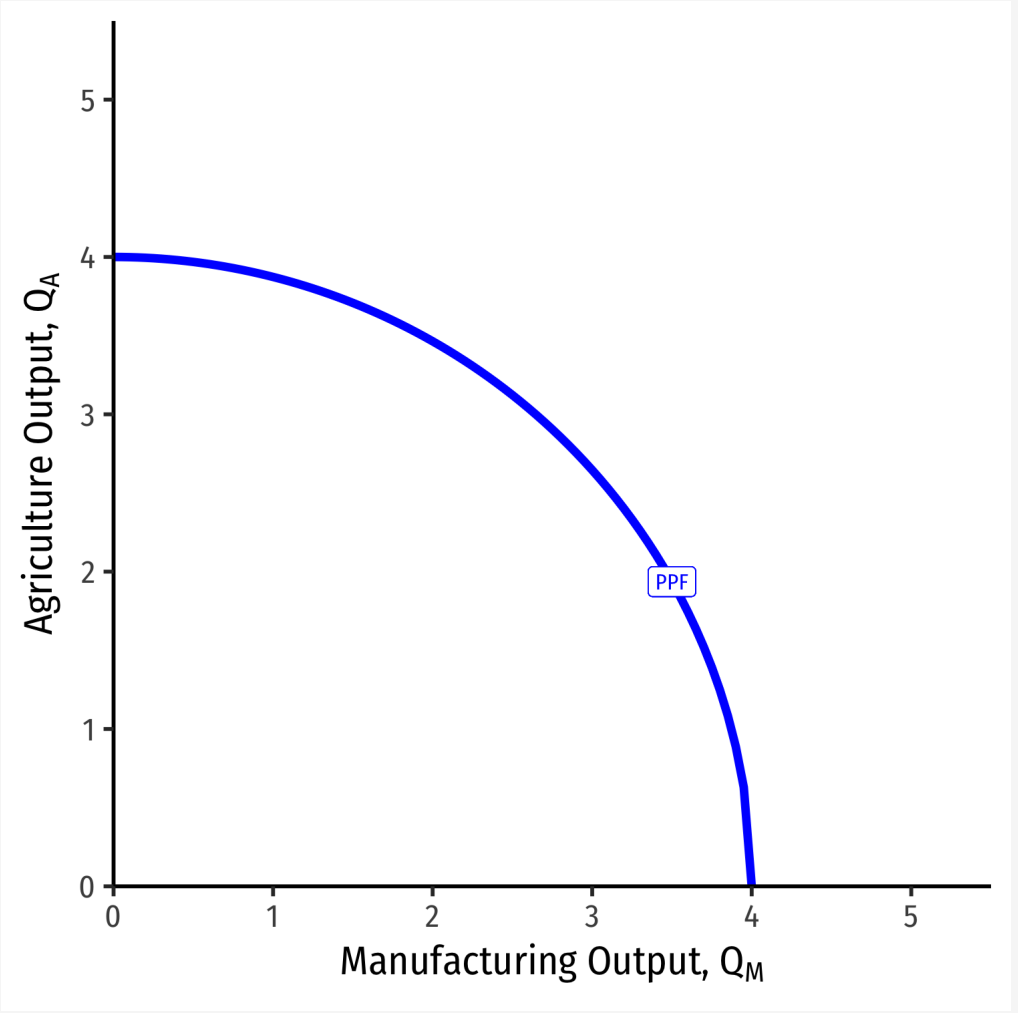
- Declines as more L is added to agriculture production





PPF

- We get a PPF with increasing costs again
- Let's examine more *why*



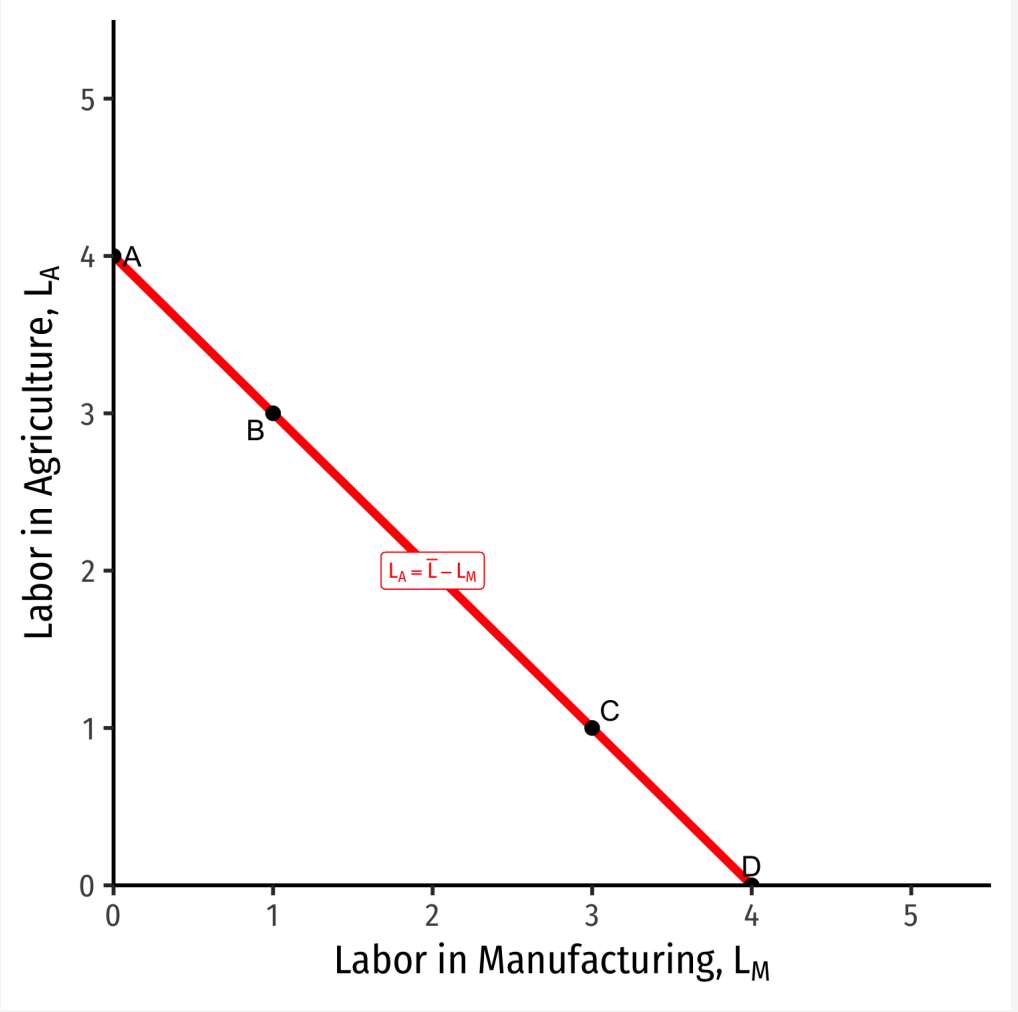
Allocating the Mobile Factor (Labor)

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

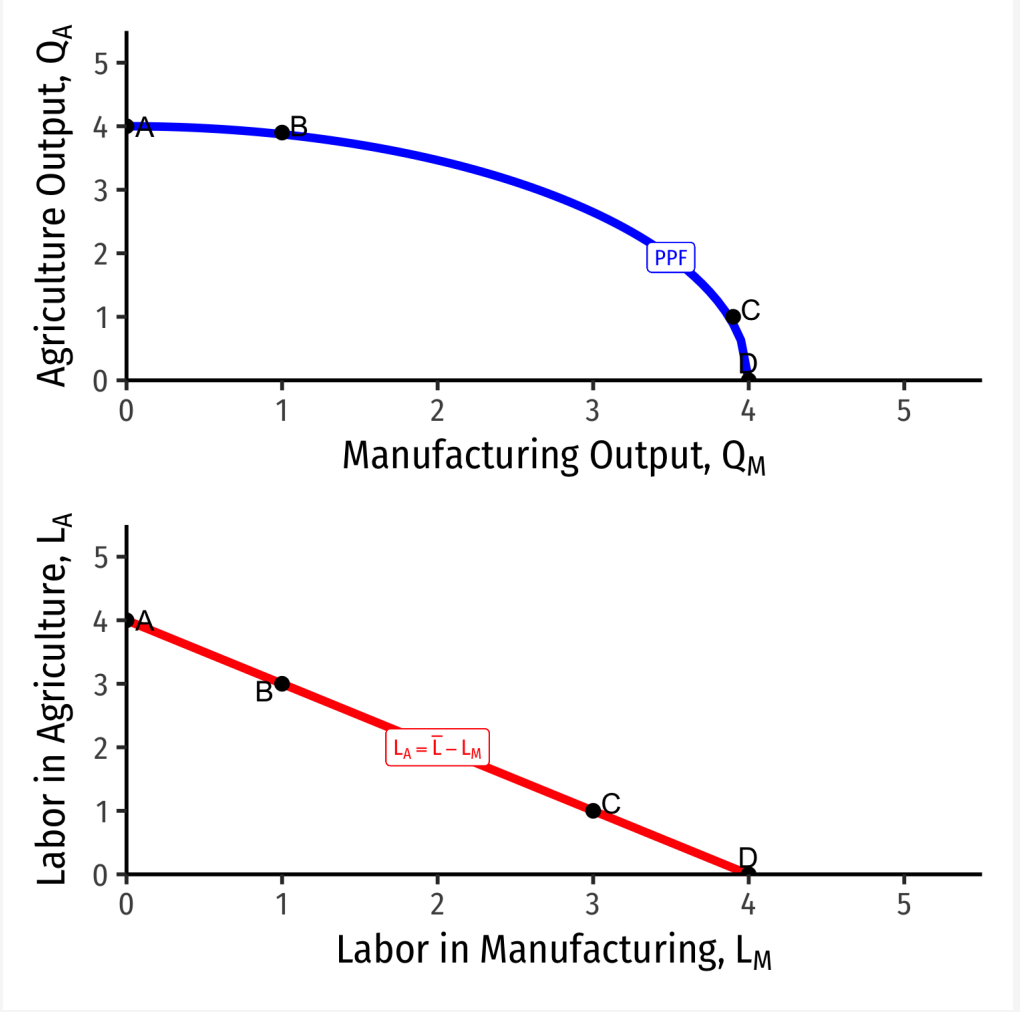
$$\bar{L} = L_M + L_A$$

- 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



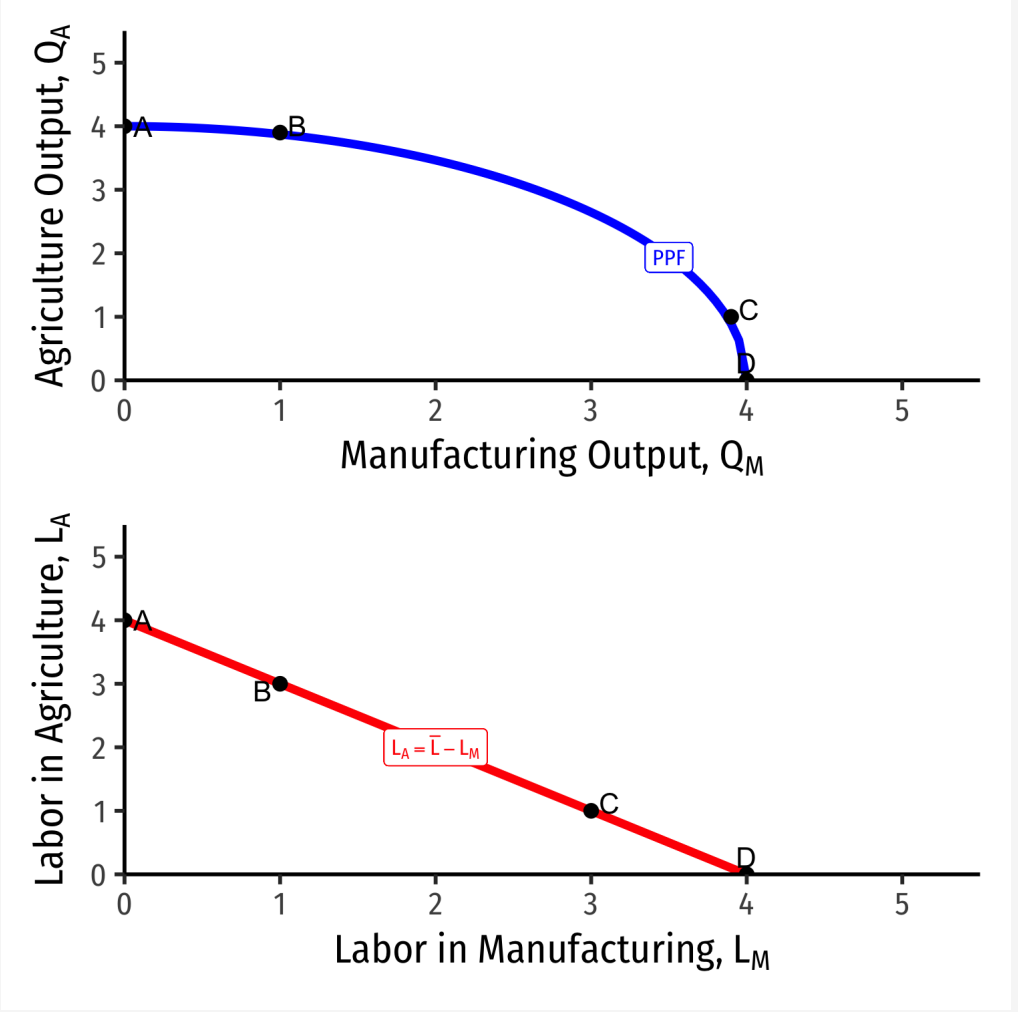
Allocating Labor

- 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



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 $\frac{1}{MPL_A}$
  - Reallocate $\uparrow L_M$ input by $\frac{1}{MPL_M}$

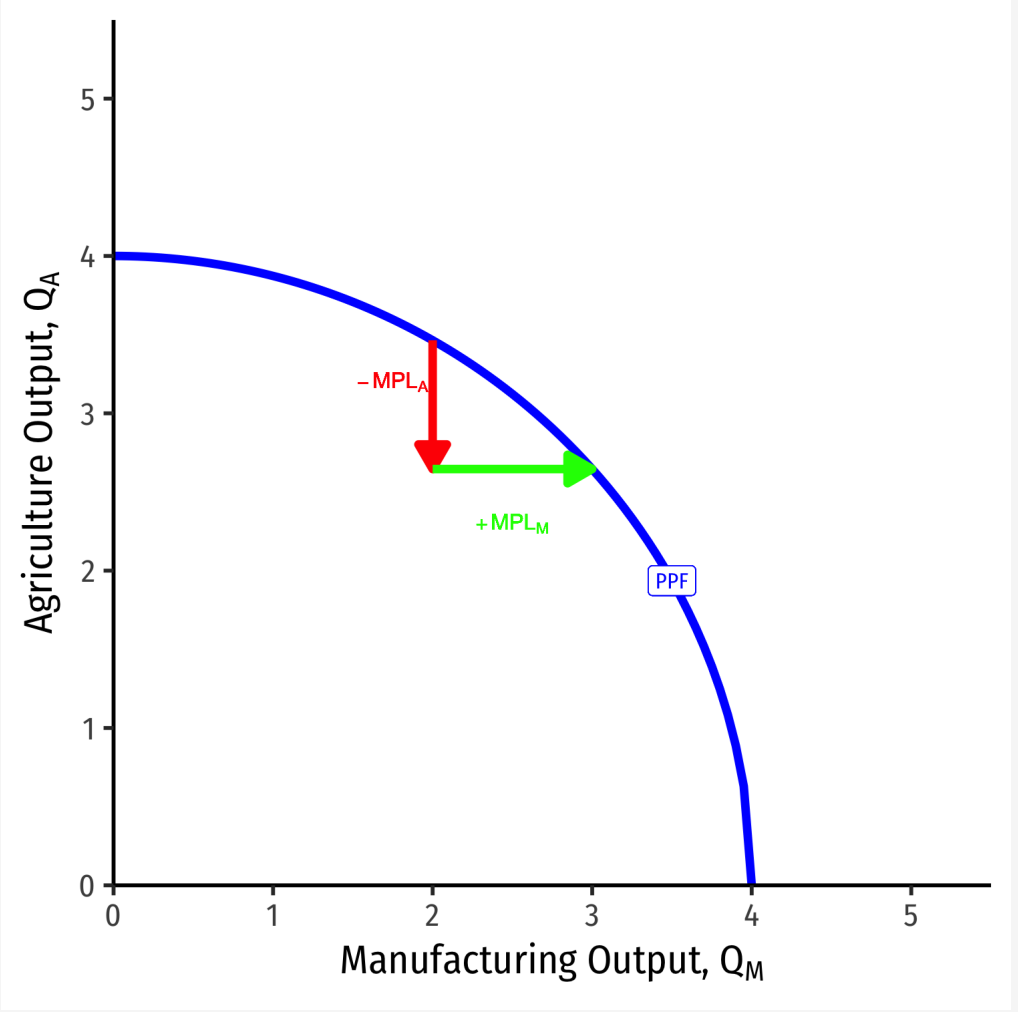


Production Possibilities Frontier

- **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 to get 1 more M

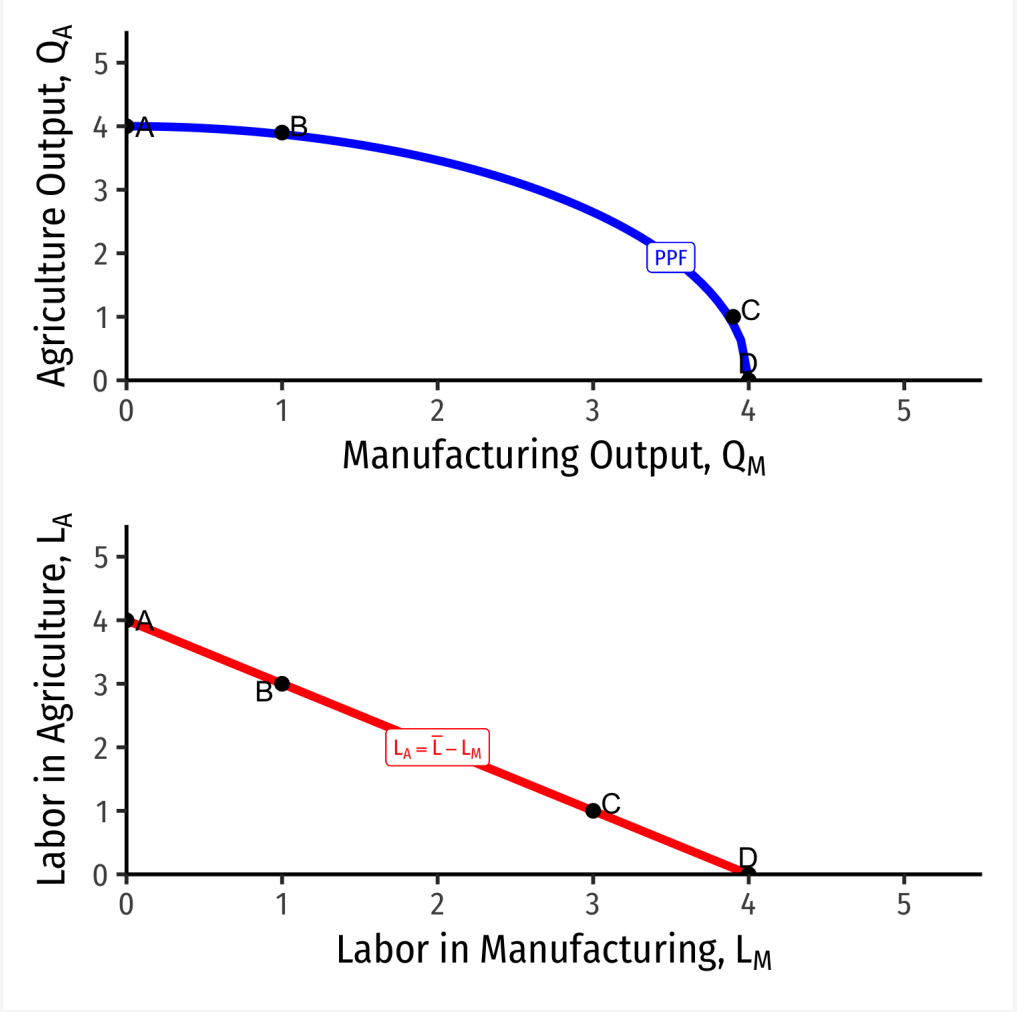
$$\underbrace{MRT}_{slope} = -\frac{MPL_A}{MPL_M}$$

- Note $A(y)$ on top and $M(x)$ on bottom![†]



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 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

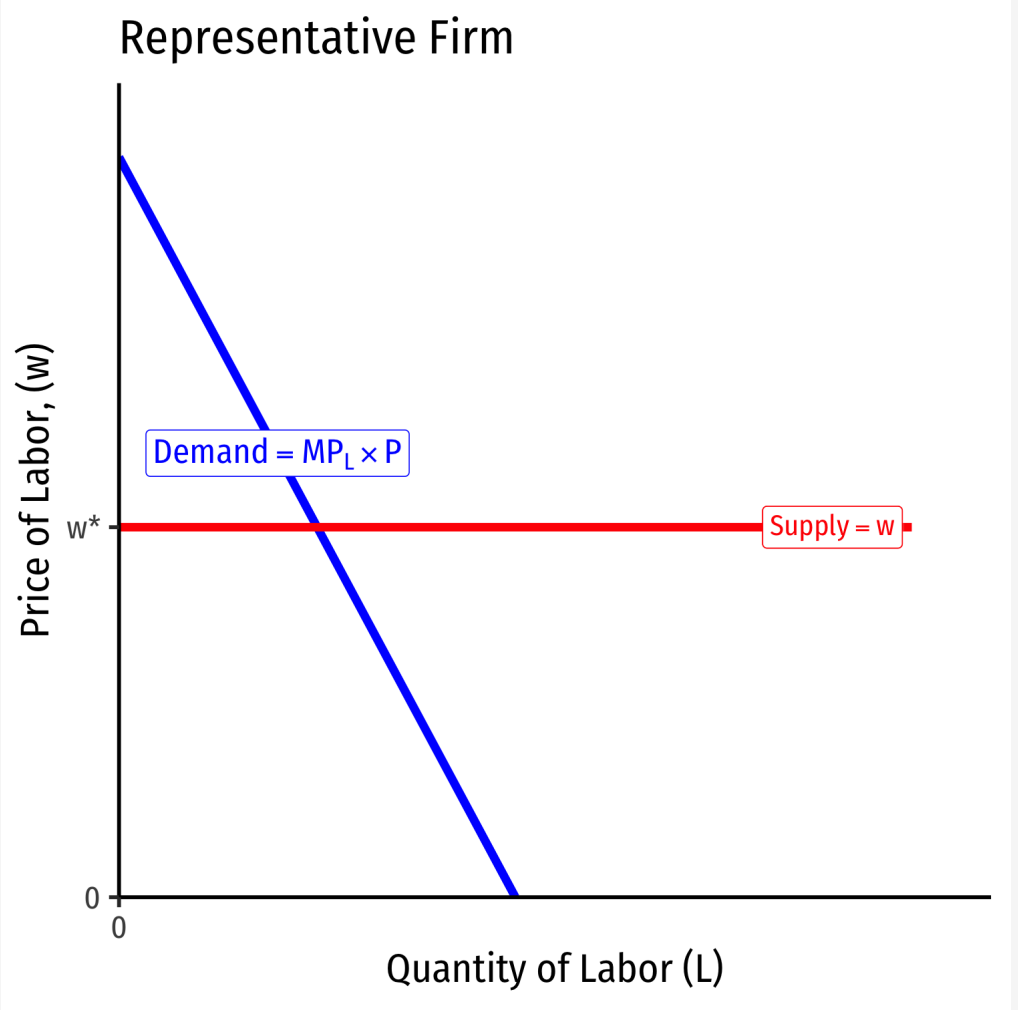
- Profit-maximizing firms will hire labor (hours) up to the point where the marginal benefit of hiring labor equals the marginal cost
    - Marginal cost per labor-hour: wage w
    - Marginal benefit per labor-hour: marginal revenue product (marginal product $\times$ price of output)
- In manufacturing:

$$w = MPL_M * P_M$$

- In agriculture:

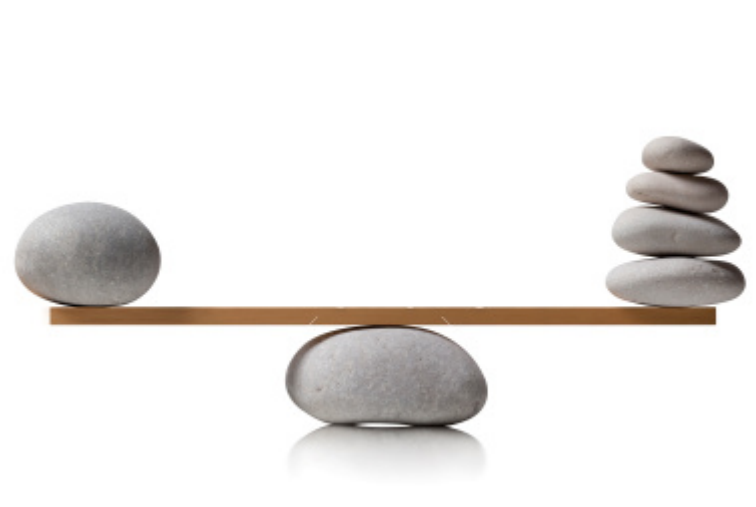
$$w = MPL_A * P_A$$

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



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:

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

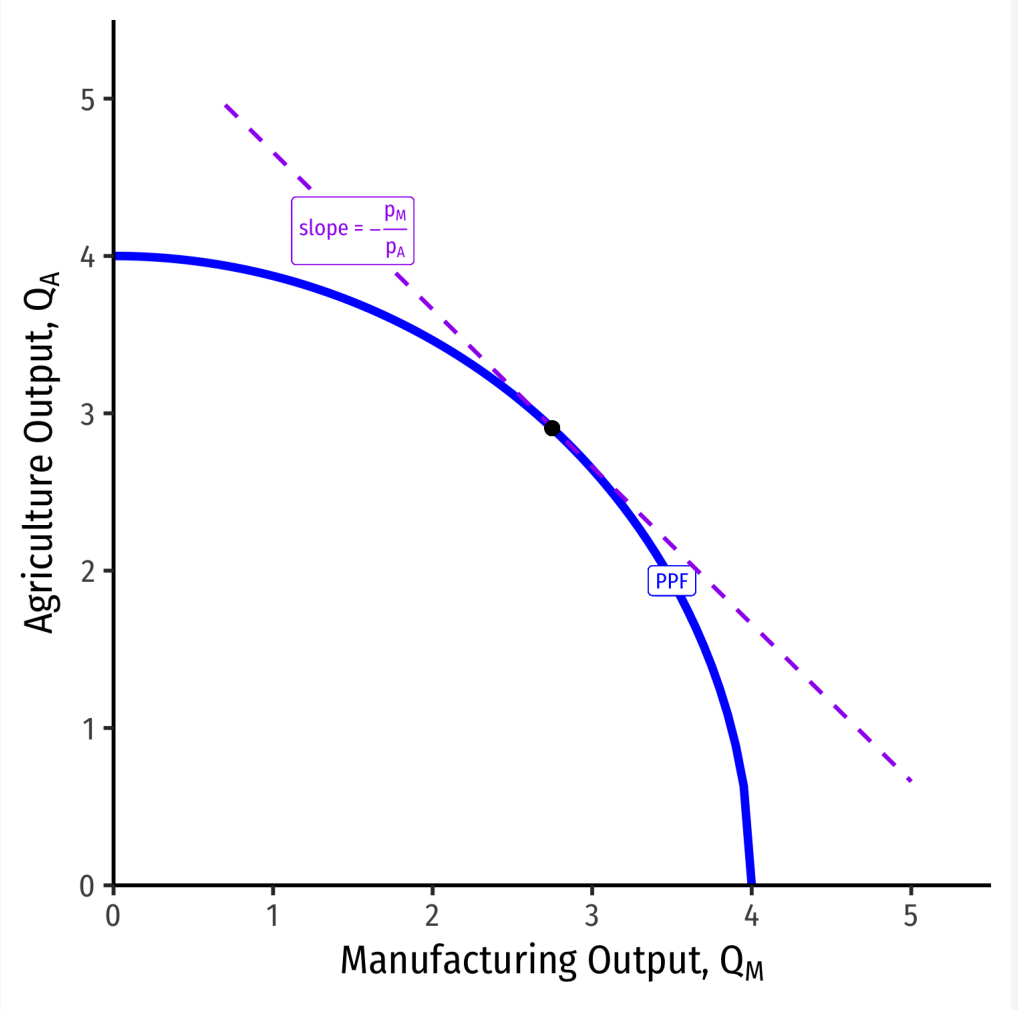
$$-\frac{MPL_A}{MPL_M} = -\frac{P_M}{P_A}$$

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

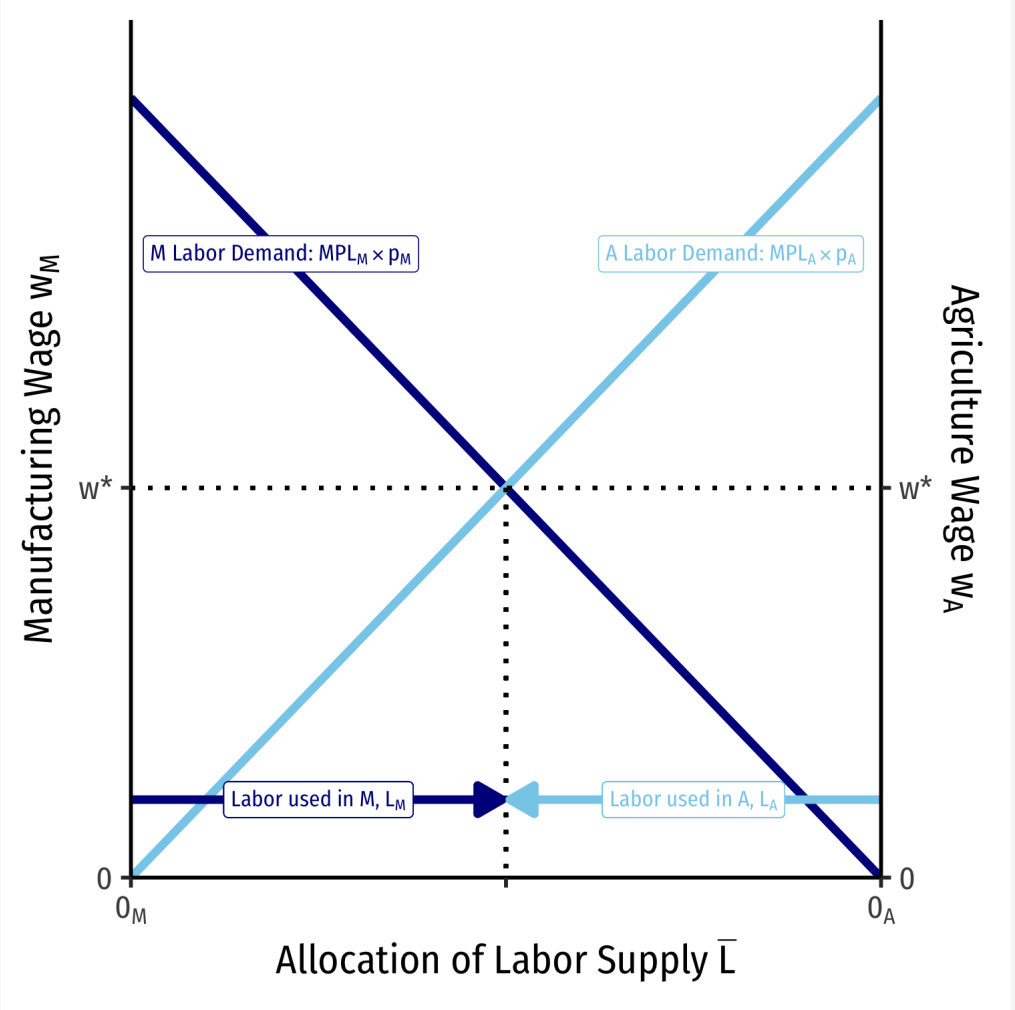
$$MRT = -\frac{p_M}{p_A}$$

- (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



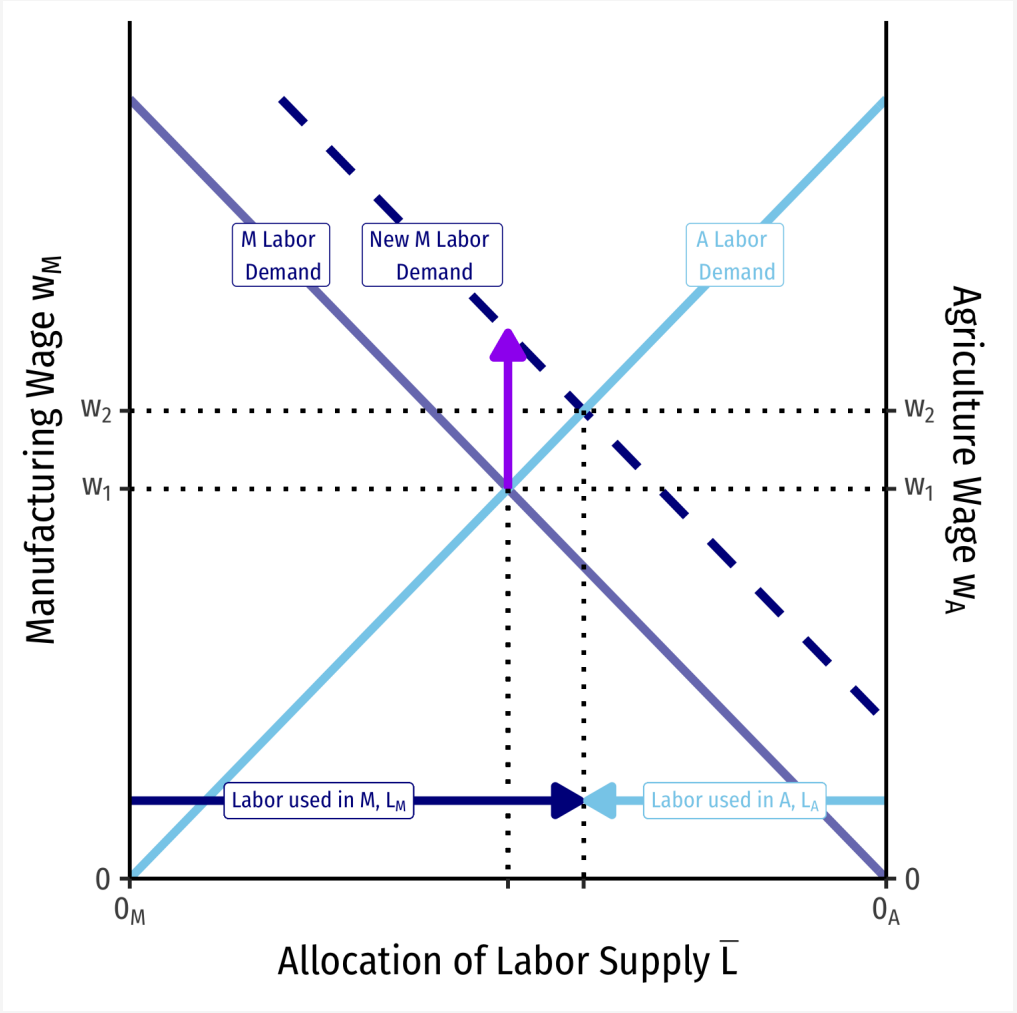
Labor Allocation

- 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 $\left(\frac{p_M}{p_A}\right)$ 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

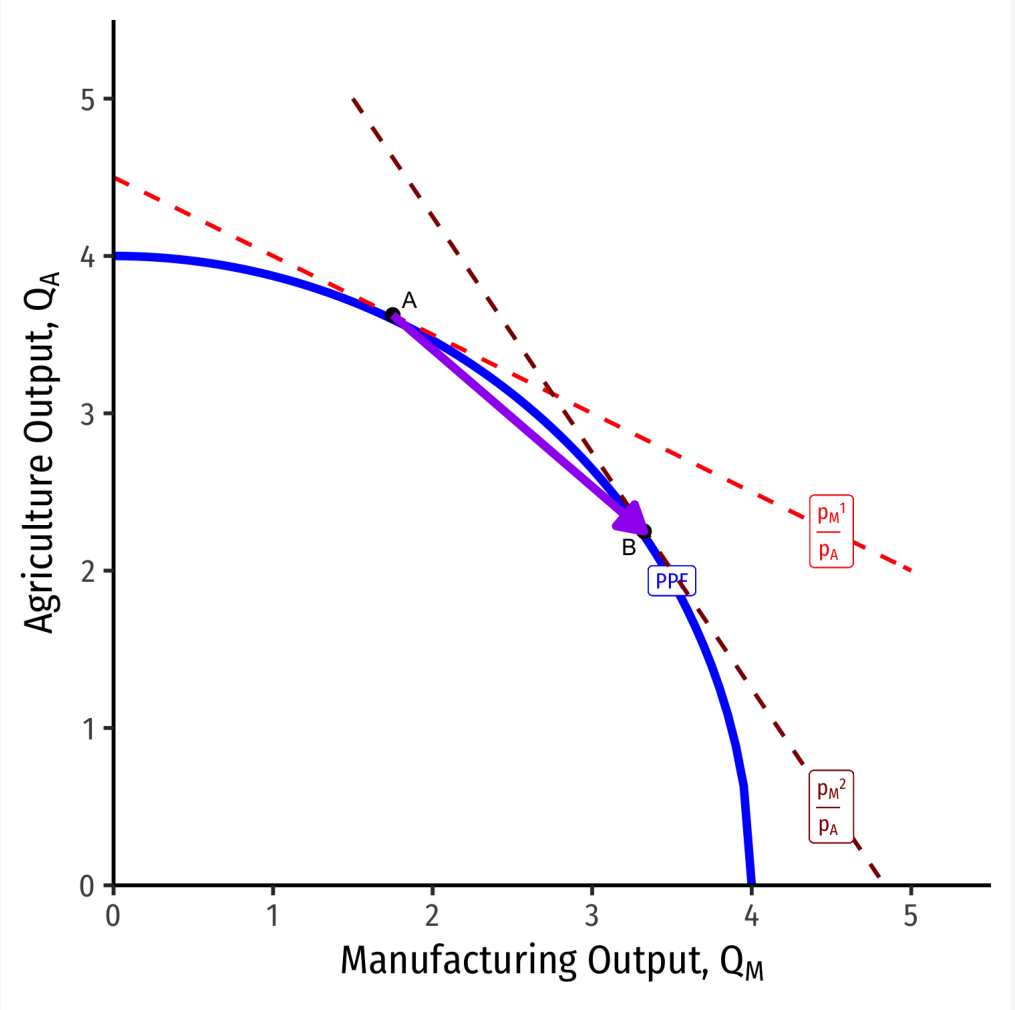


A Change in Relative Prices on PPF

- We can equivalently see this on the PPF
- Increase in the relative price of manufacturing

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

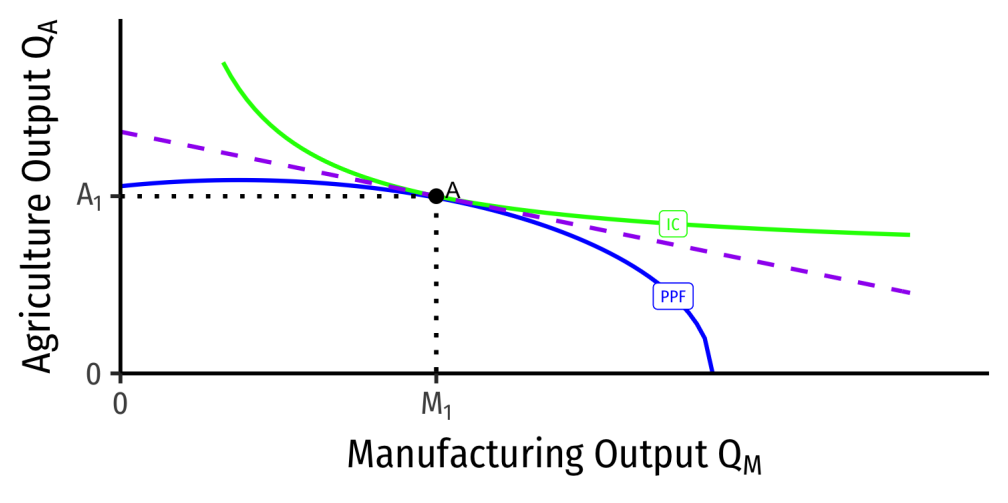
- Moving from $A \rightarrow B$
  - Slope steepens
  - Country will produce less agriculture, more manufacturing



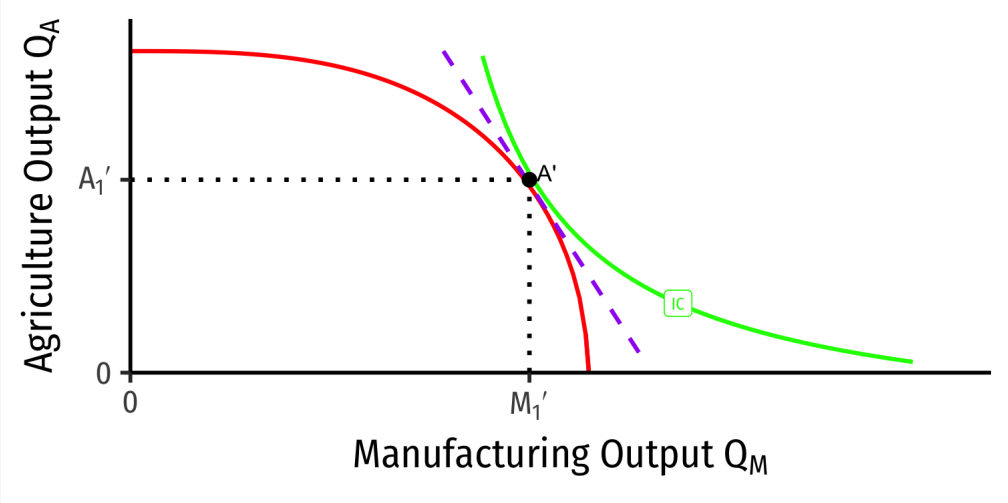
Distribution Effects Using our Two Country Trade Example

Our Two Country Trade Example: Autarky

Home



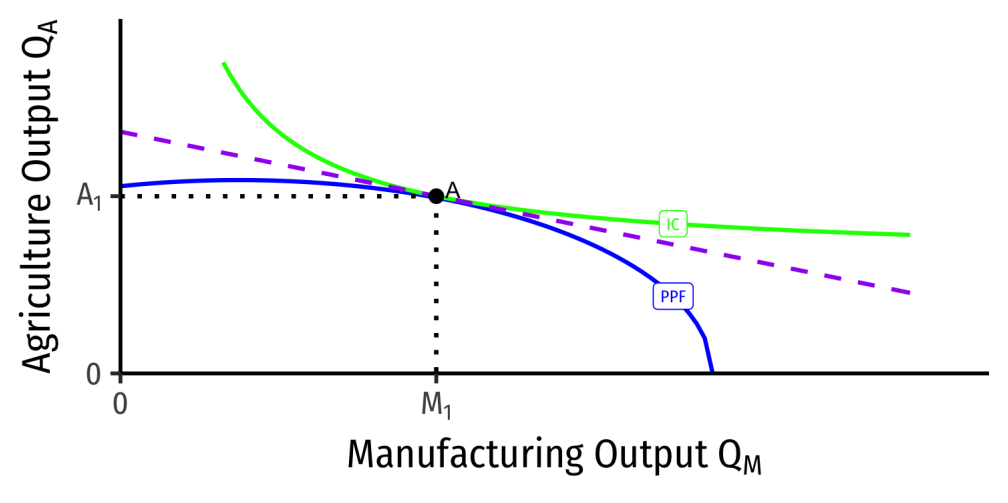
Foreign



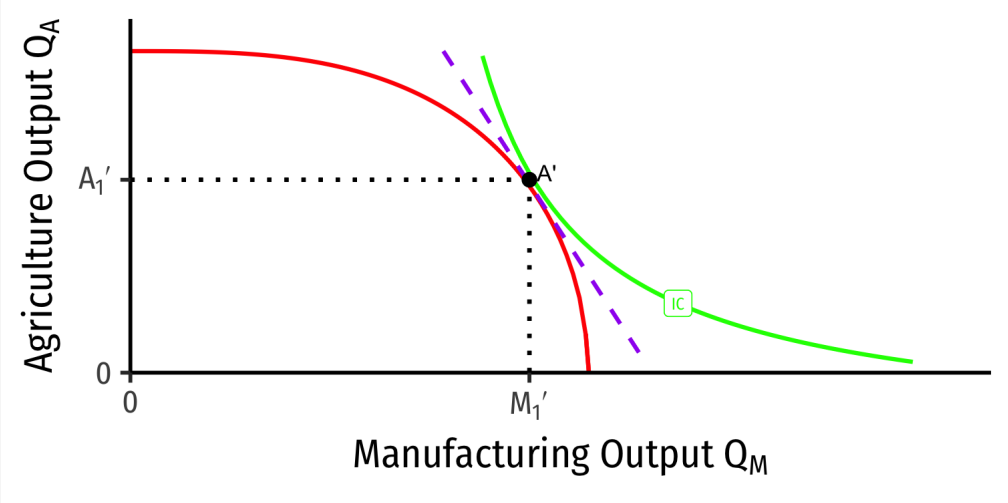
- Countries begin in **autarky** optimum with different relative prices
  - A is optimum for Home
  - A' is optimum for Foreign

Our Two Country Trade Example: Specialization

Home



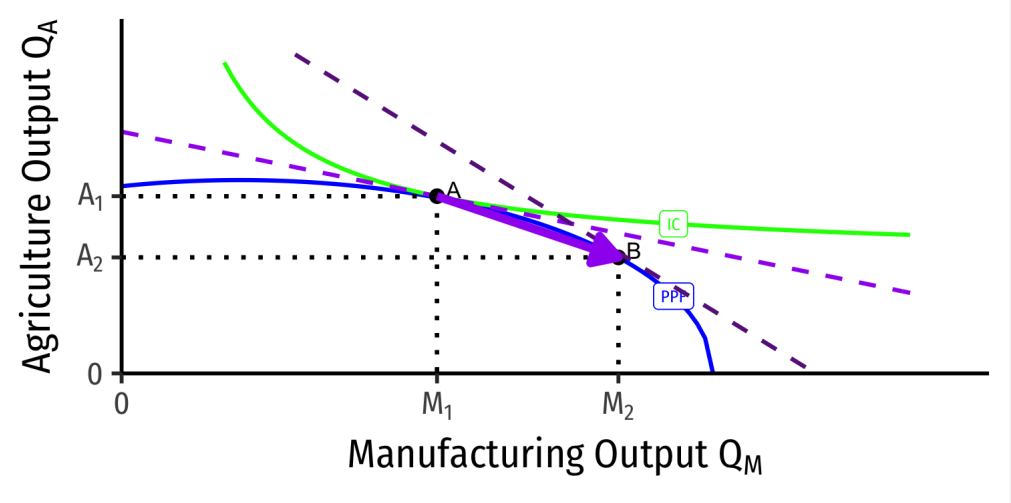
Foreign



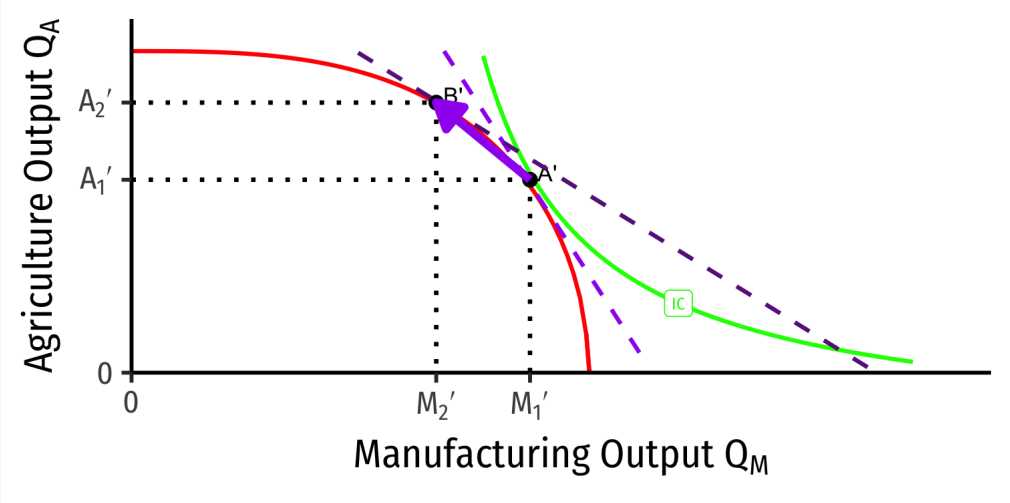
- Home has comparative advantage in manufacturing
- Foreign has comparative advantage in agriculture

Our Two Country Trade Example: Specialization

Home



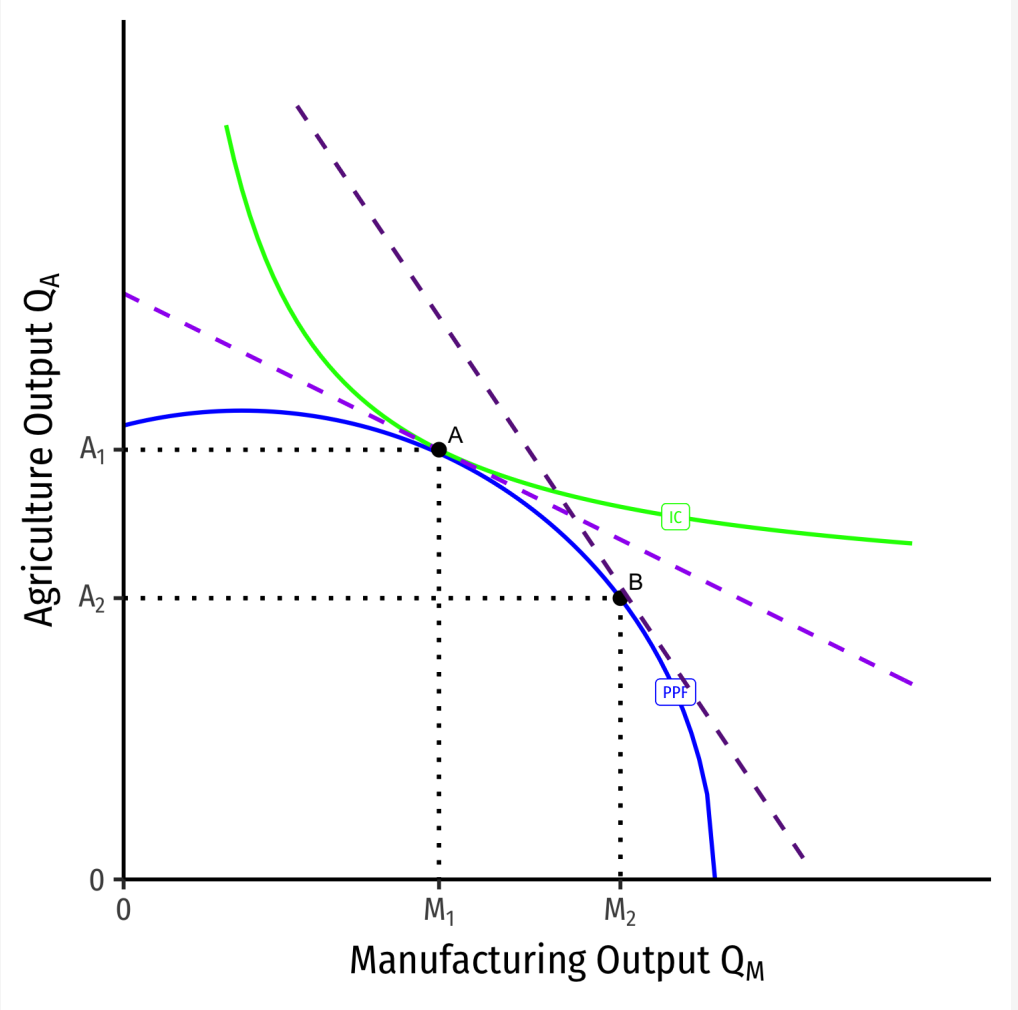
Foreign



- 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

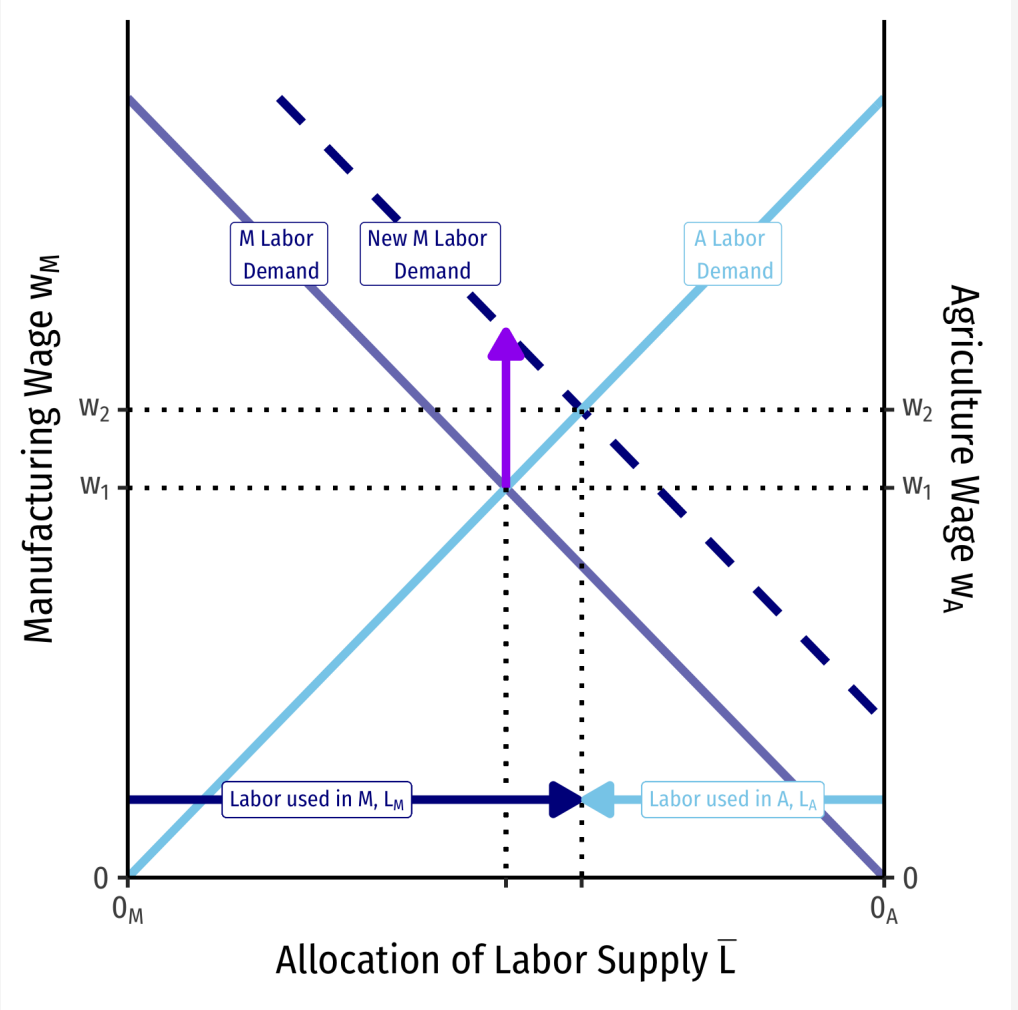


Effects of Trade on Home's Income Distribution: L

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

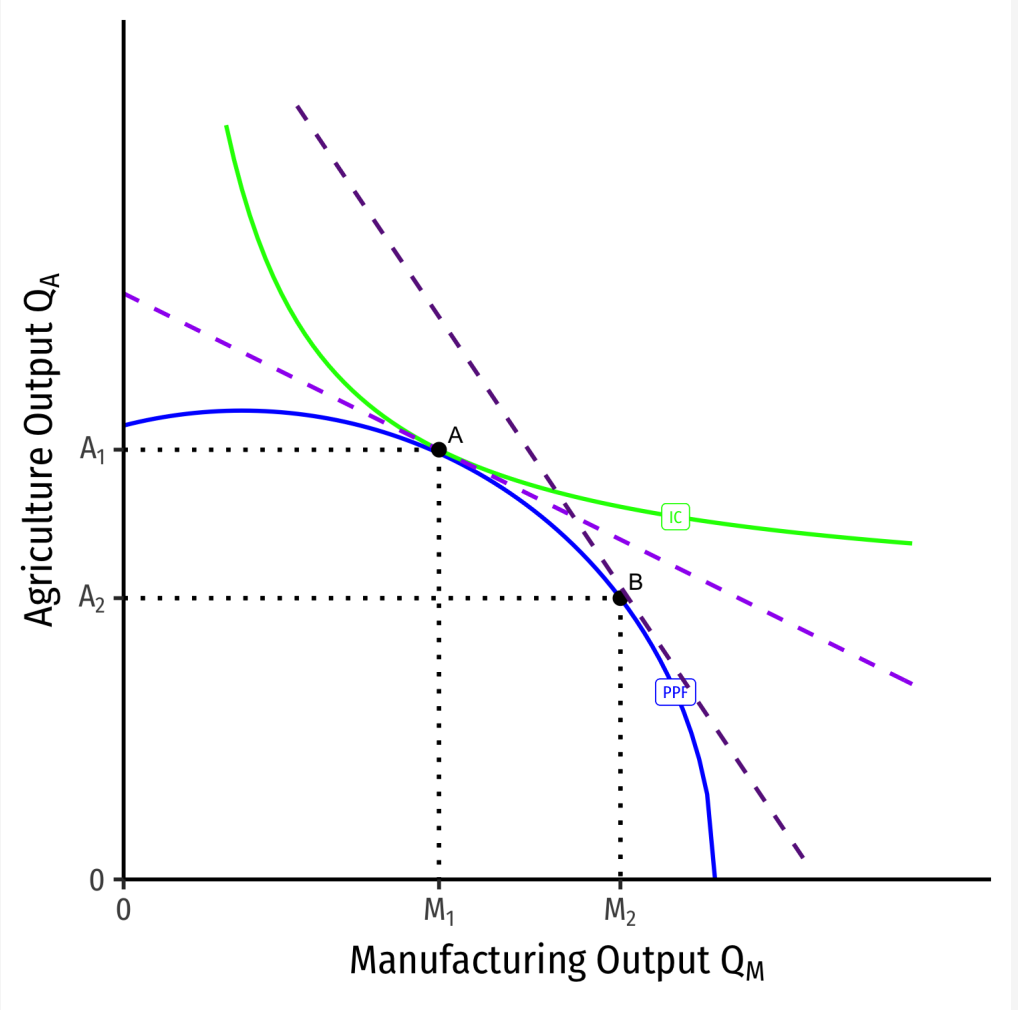
$$\frac{\Delta w}{w_1} < \frac{\Delta\left(\frac{P_M}{P_A}\right)}{\left(\frac{P_M}{P_A}\right)_1}$$

- 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



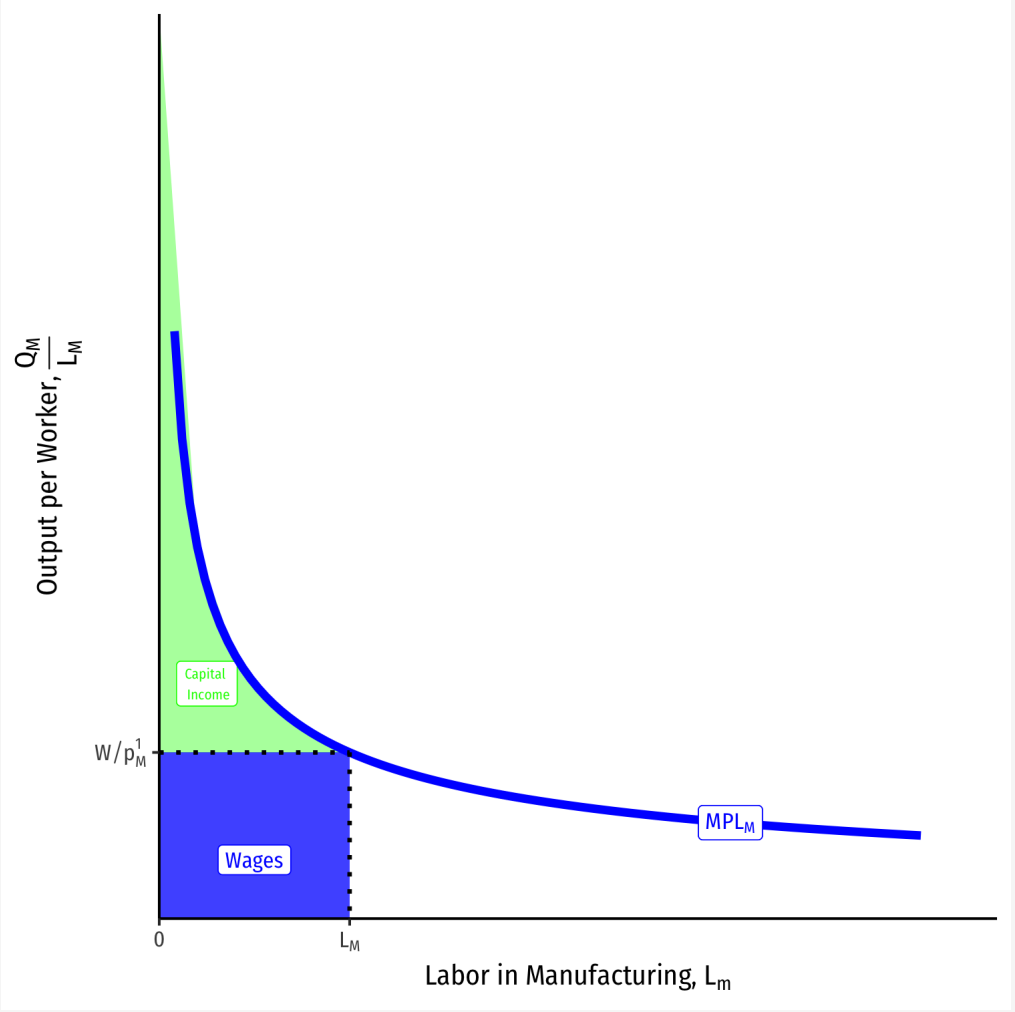
Effects of Trade on Home's Income Distribution: K

- 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) ↑ relative price of manufacturing and (2) ↓ real wage in terms of manufacturing
  - Thus, income to capital will rise more than proportionately to the rise in relative price



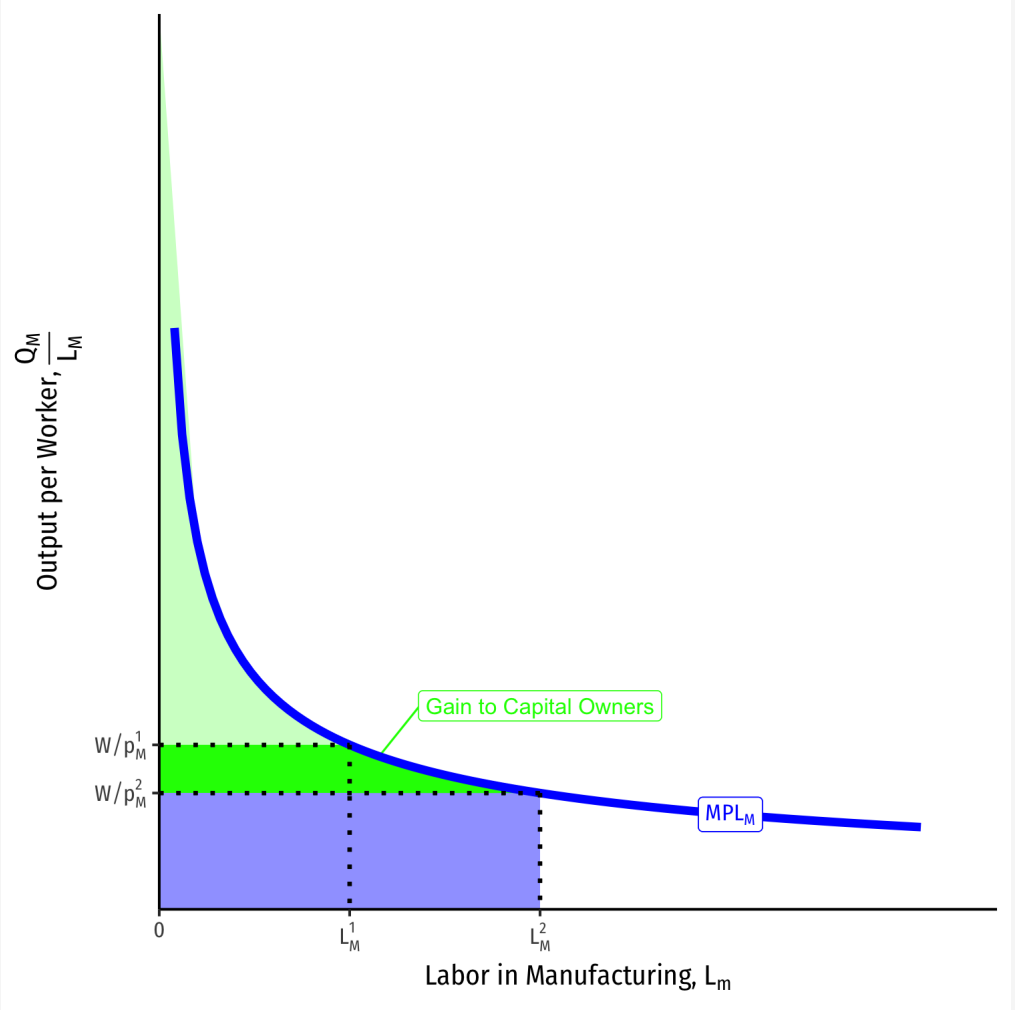
Advanced Explanation for Capital

- 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 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



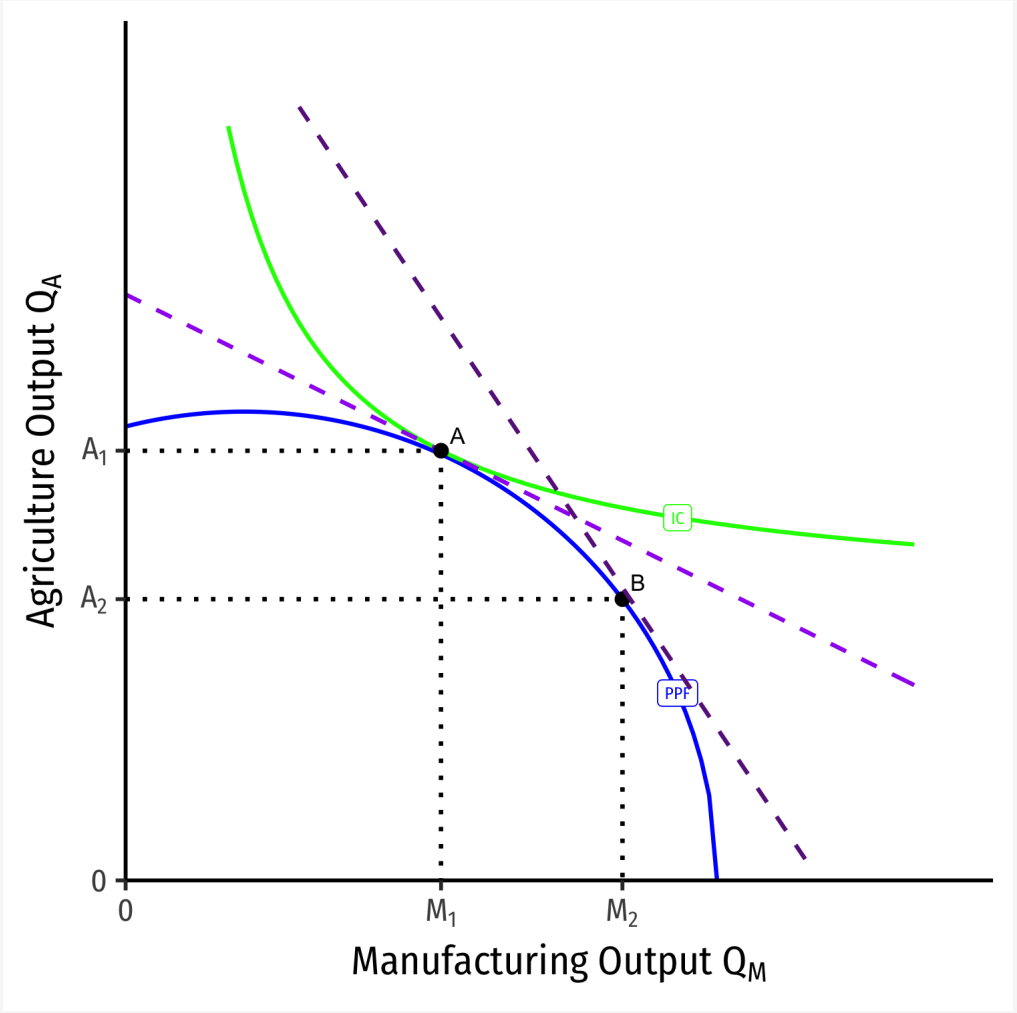
Advanced Explanation for Capital

- 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**



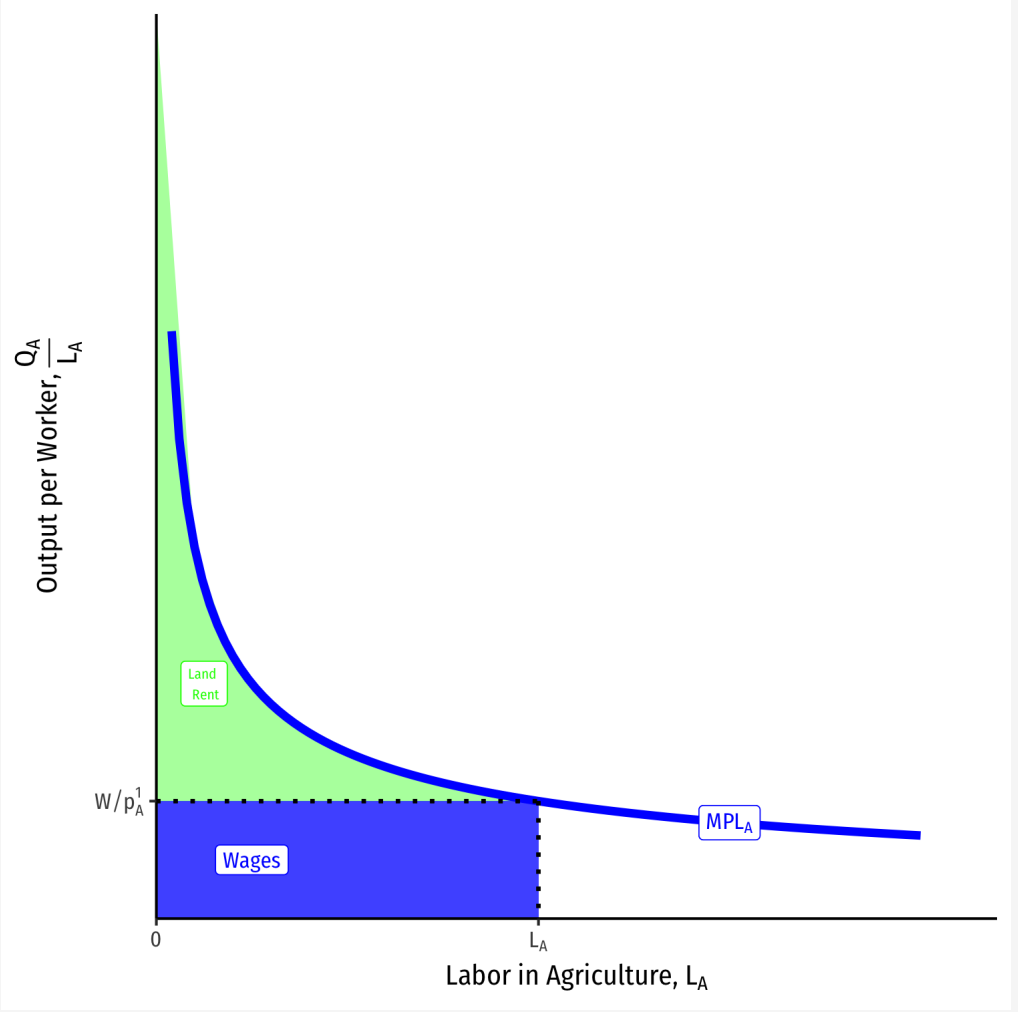
Effects of Trade on Home's Income Distribution: T

- 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



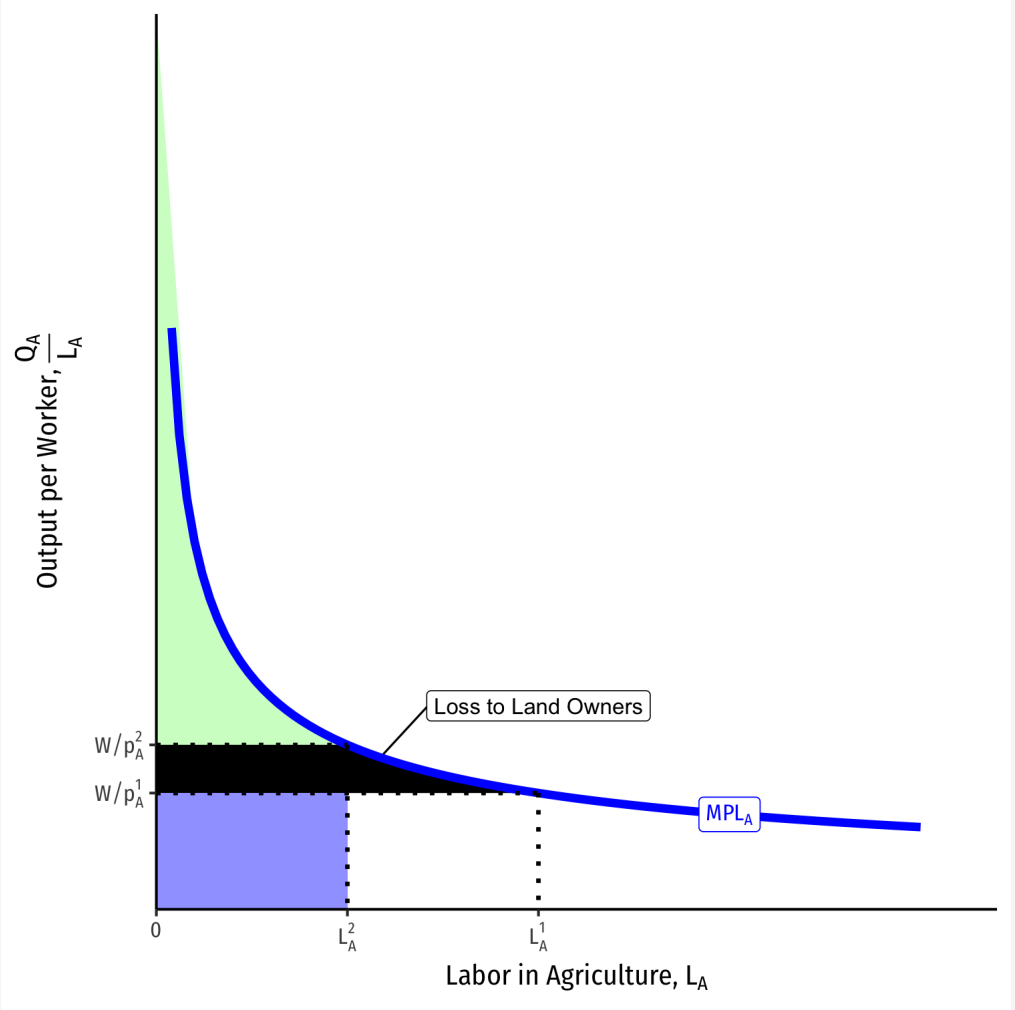
Advanced Explanation for Land

- 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 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

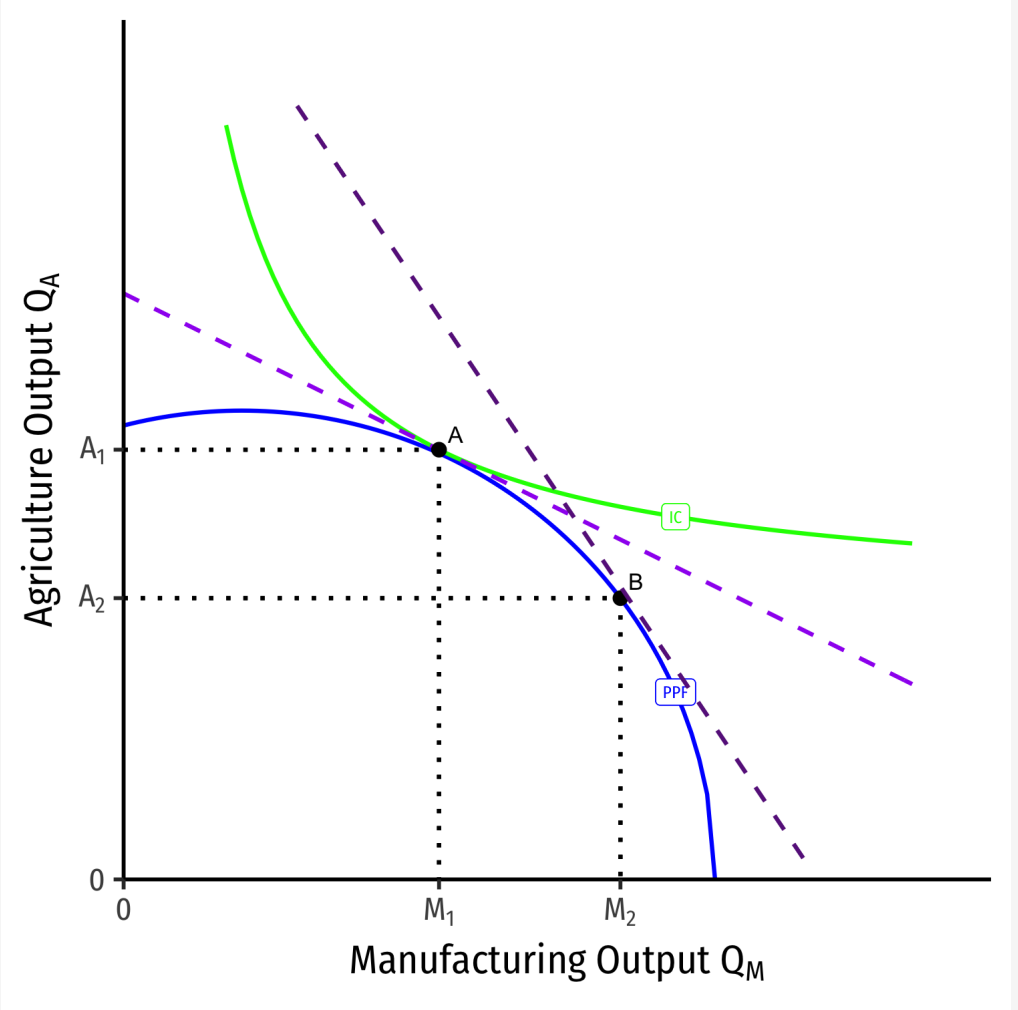
- Because trade lowers the relative price of agriculture, $\frac{p_A}{p_M}$, we saw:
  - Decrease in labor L_A, but increase in *nominal* wage w, so
  - Increase in real wage in terms of A, $\frac{w}{p_A}$
- **Land owners lose**



Effects of Trade on Home's Income Distribution

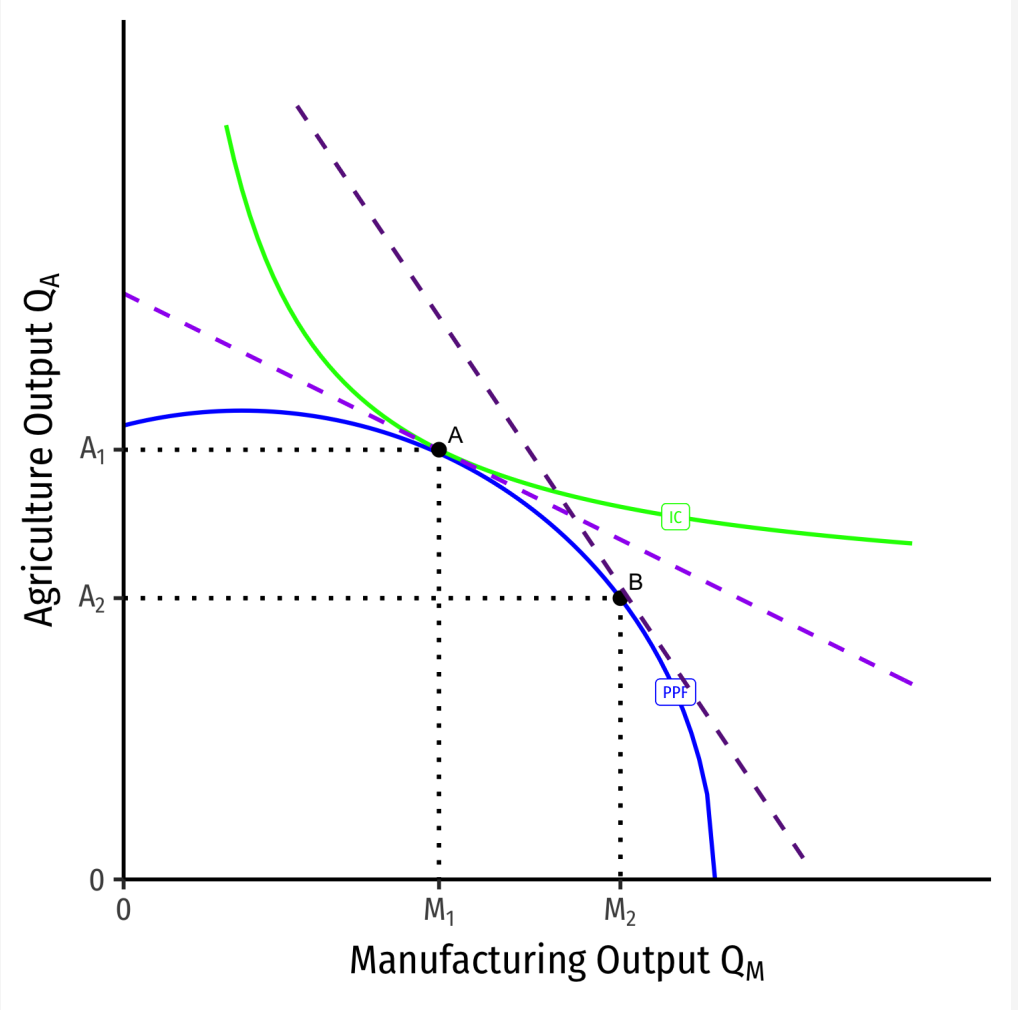
EFfects of trade on Home's:

- **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



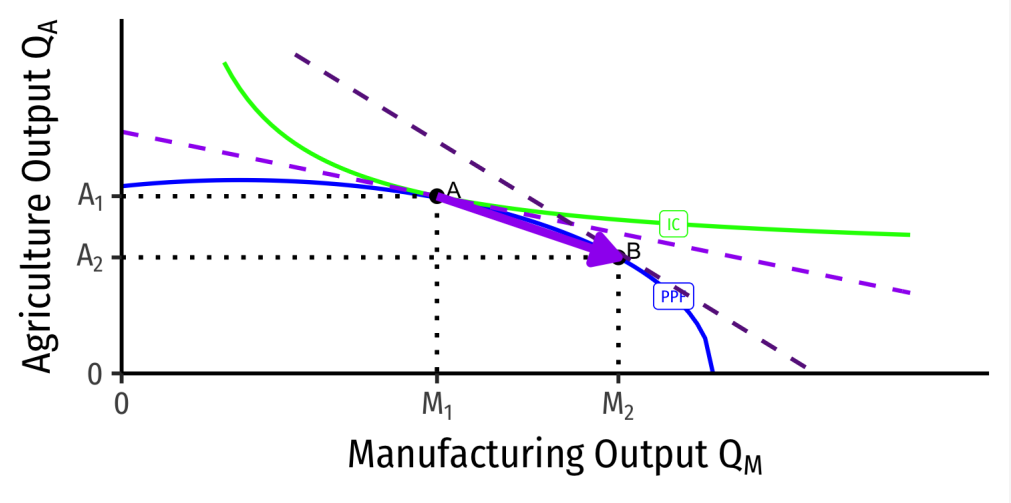
Effects of Trade on Home Income Distribution

- **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

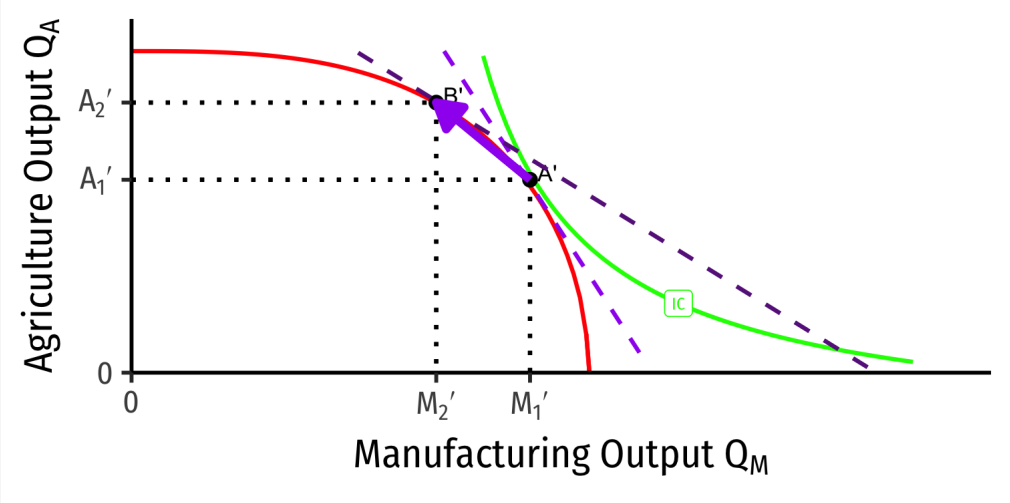


Specialization (Again)

Home



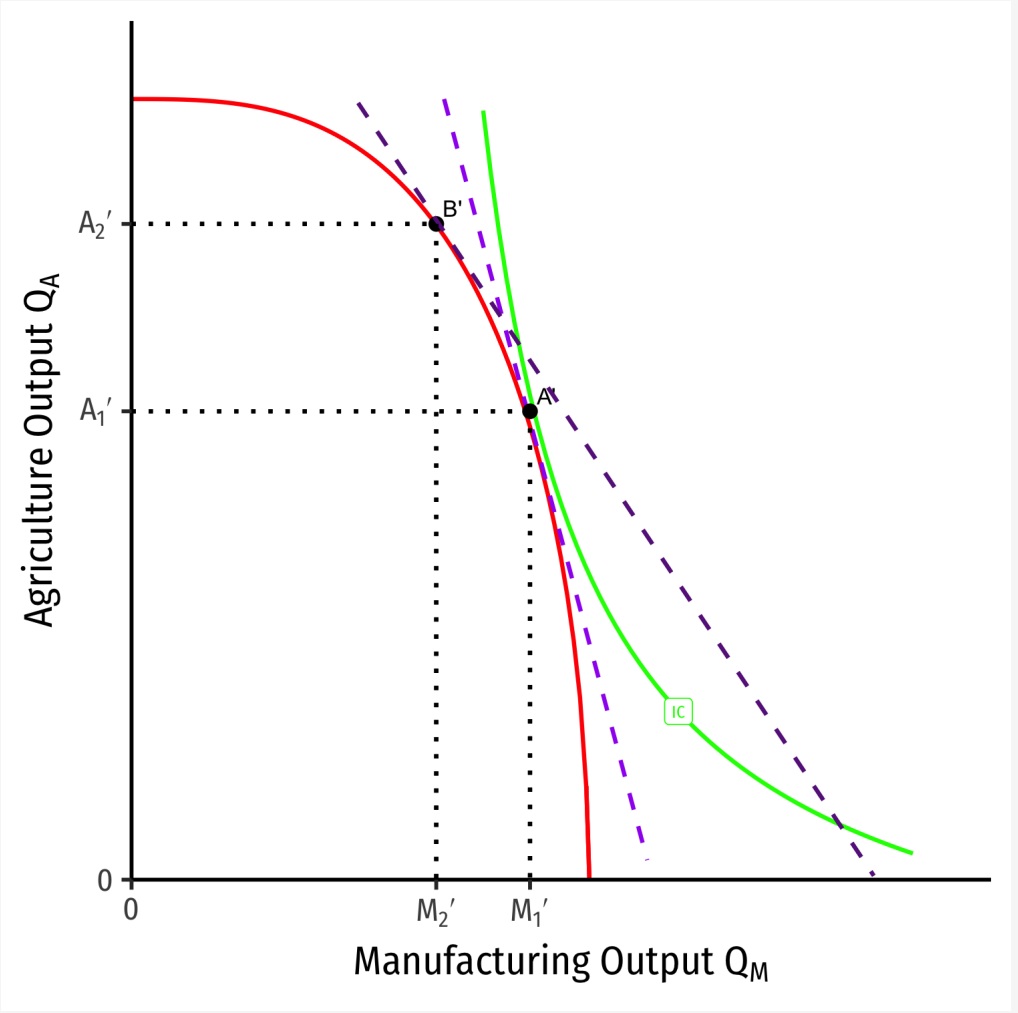
Foreign



- 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

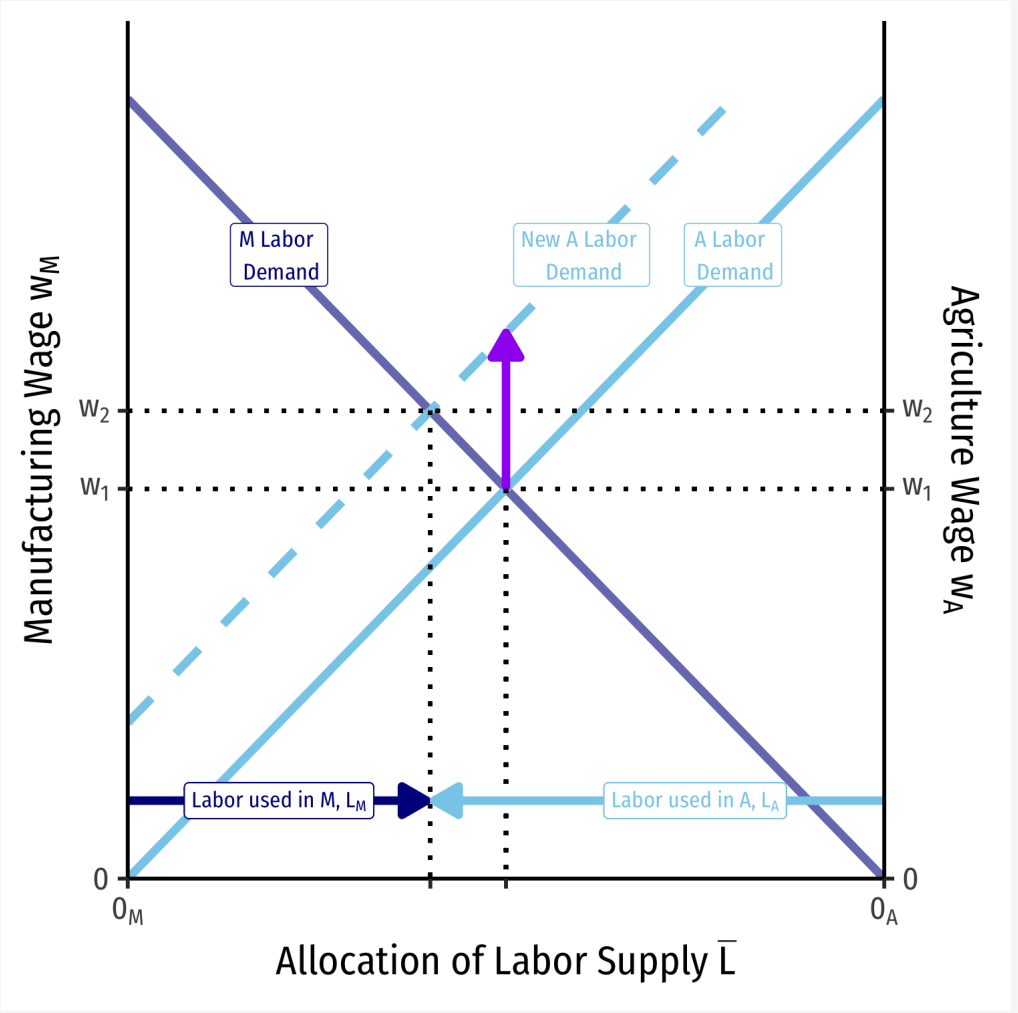


Effects of Trade on Foreign's Income Distribution: L

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

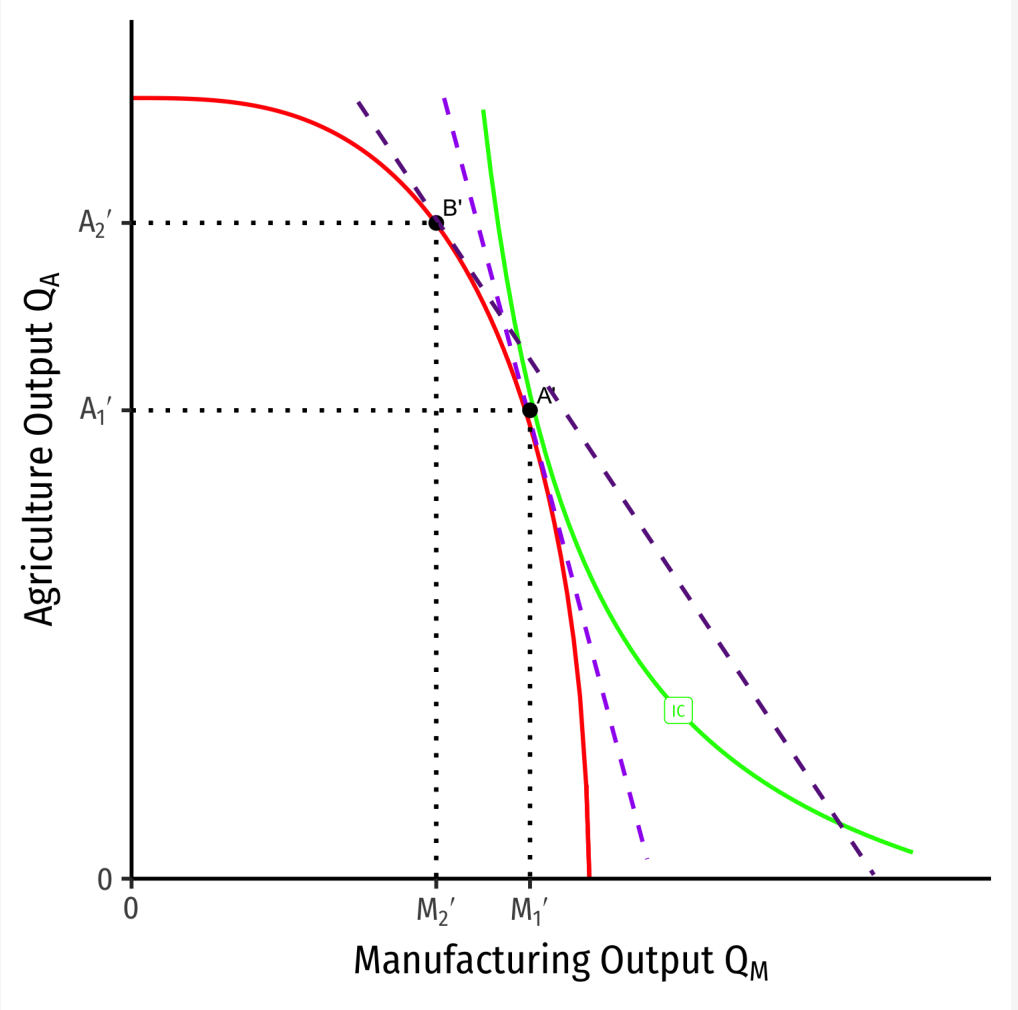
$$\frac{\Delta w}{w_1} < \frac{\Delta\left(\frac{P_A}{P_M}\right)}{\left(\frac{P_A}{P_M}\right)_1}$$

- Amount of manufactures Q_M that can be purchased with wages has *risen*!
  - **Real wage in terms of manufacturing, ↑** $\frac{w}{p_M}$
- Amount of agriculture Q_A that can be purchased with wages has *fallen*!
  - **Real wage in terms of agriculture, ↓** $\frac{w}{p_A}$
- **Effect on workers is ambiguous**
  - Depends on their consumption preferences between M and A



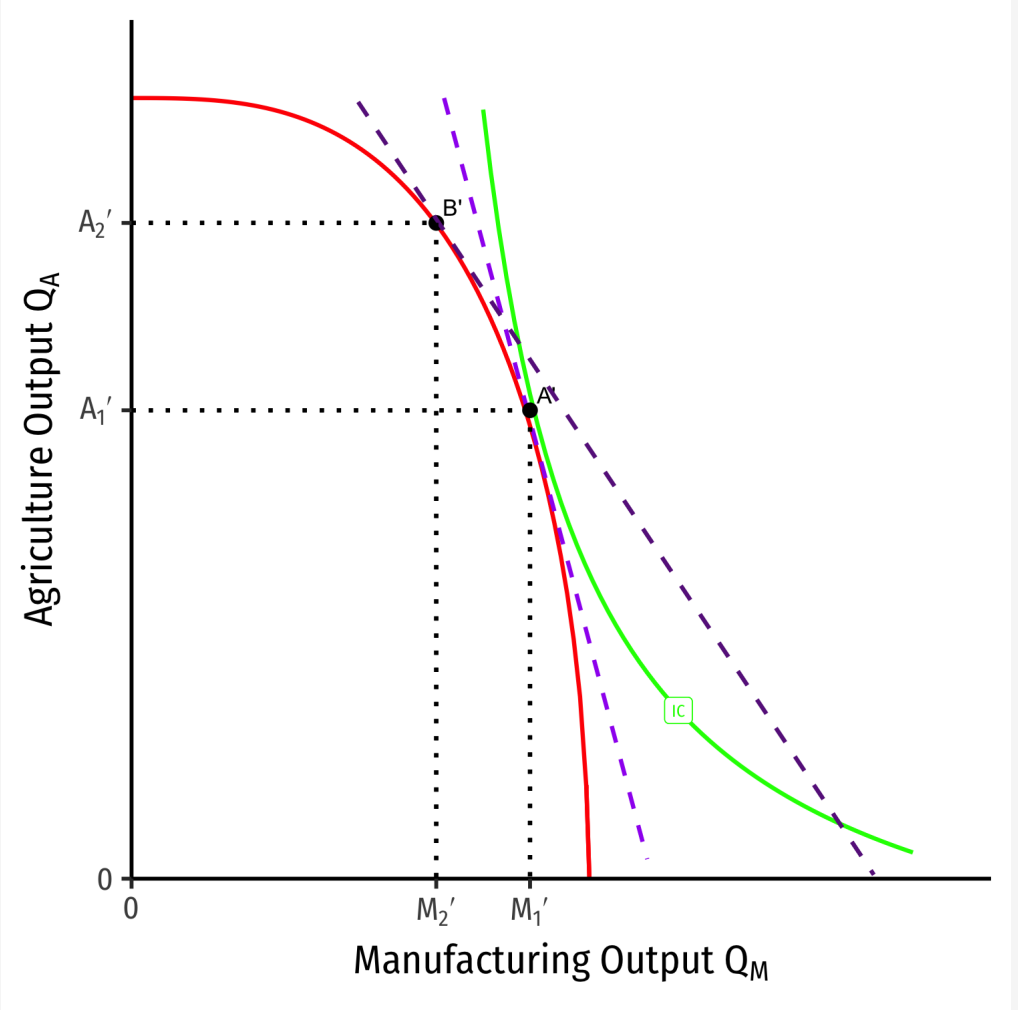
Effects of Trade on Foreign's Income Distribution: K

- 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



Effects of Trade on Foreign's Income Distribution: T

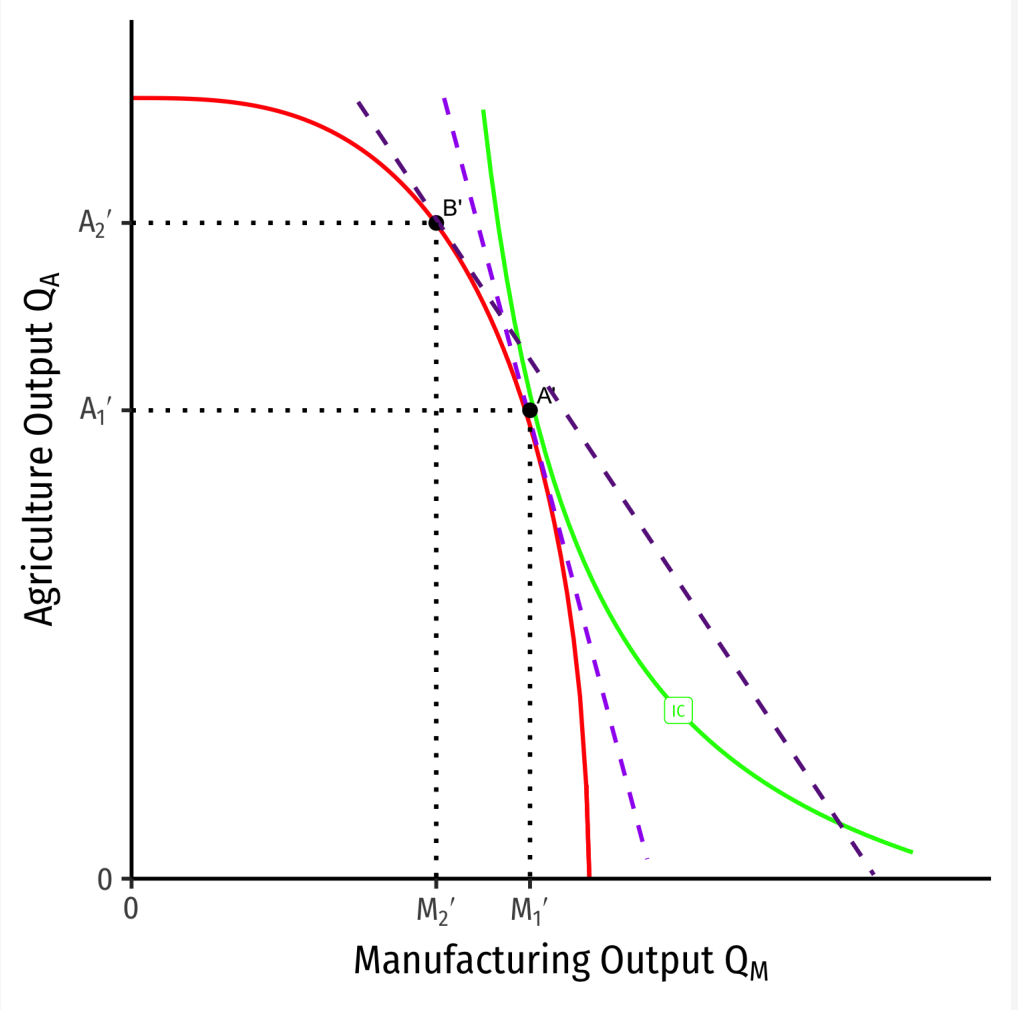
- What about land owners?
- Total income to landowners
  $= \underbrace{(P_A * Q_A)}_{\text{Revenues in A}} - \underbrace{(W * L_A)}_{\text{Labor costs}}$
- As more labor used in agriculture, $\uparrow MP_T$: Each piece of land has more workers to work it.
- **Land owners gain**
  - We saw (1) ↑ relative price of agriculture and (2) ↓ 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

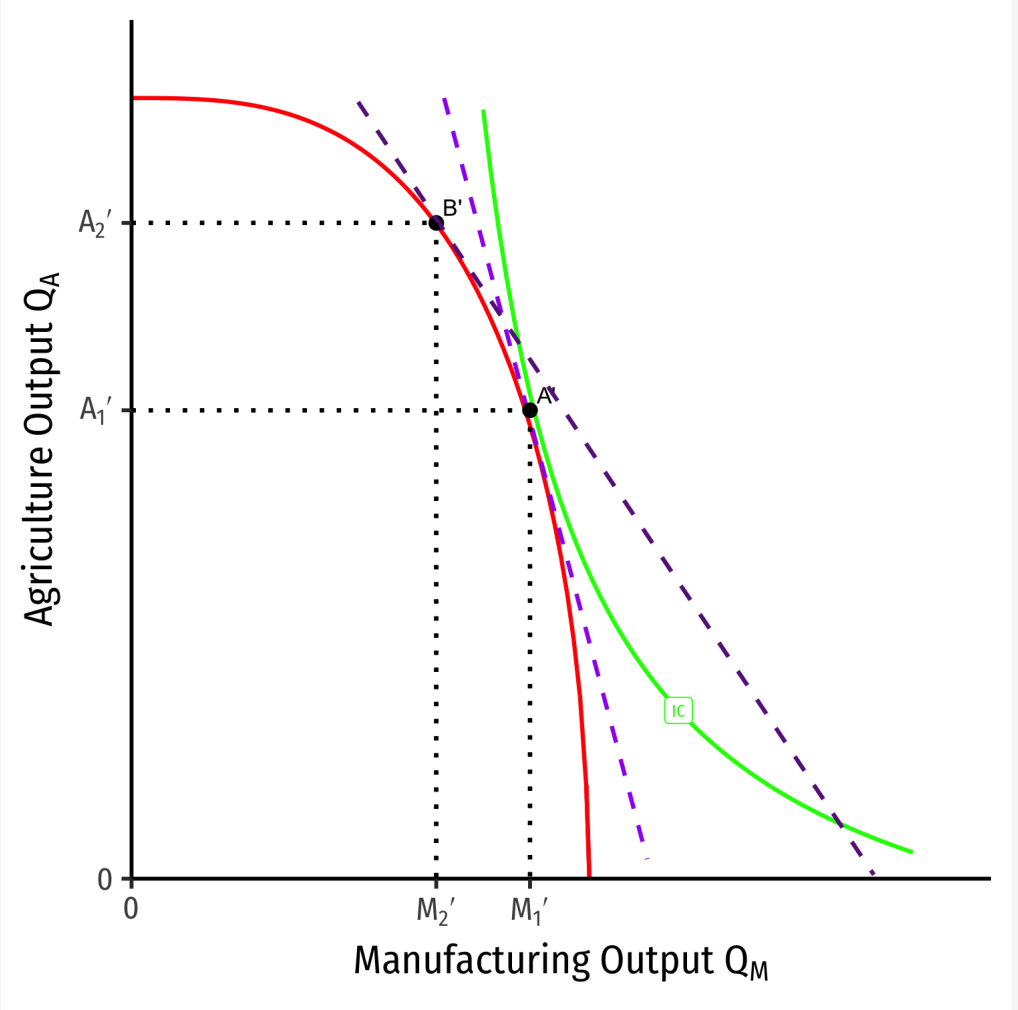
EFfects of trade on Foreign's:

- **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

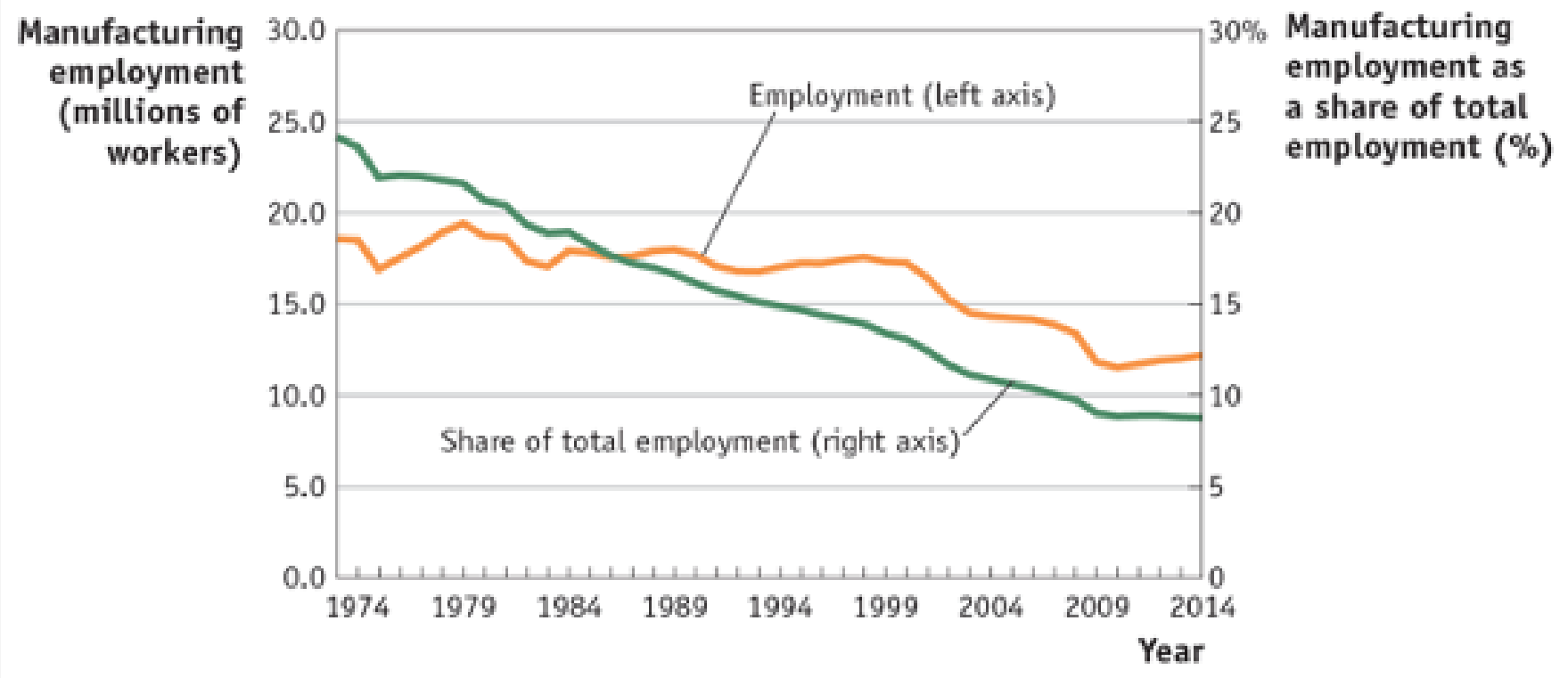
Example: Auto-workers in Detroit in the 1980s were a relatively specific and immobile factor

- Geographically concentrated
- Skills specific to car assembly-lines

Example of Mobile vs. Specific Labor

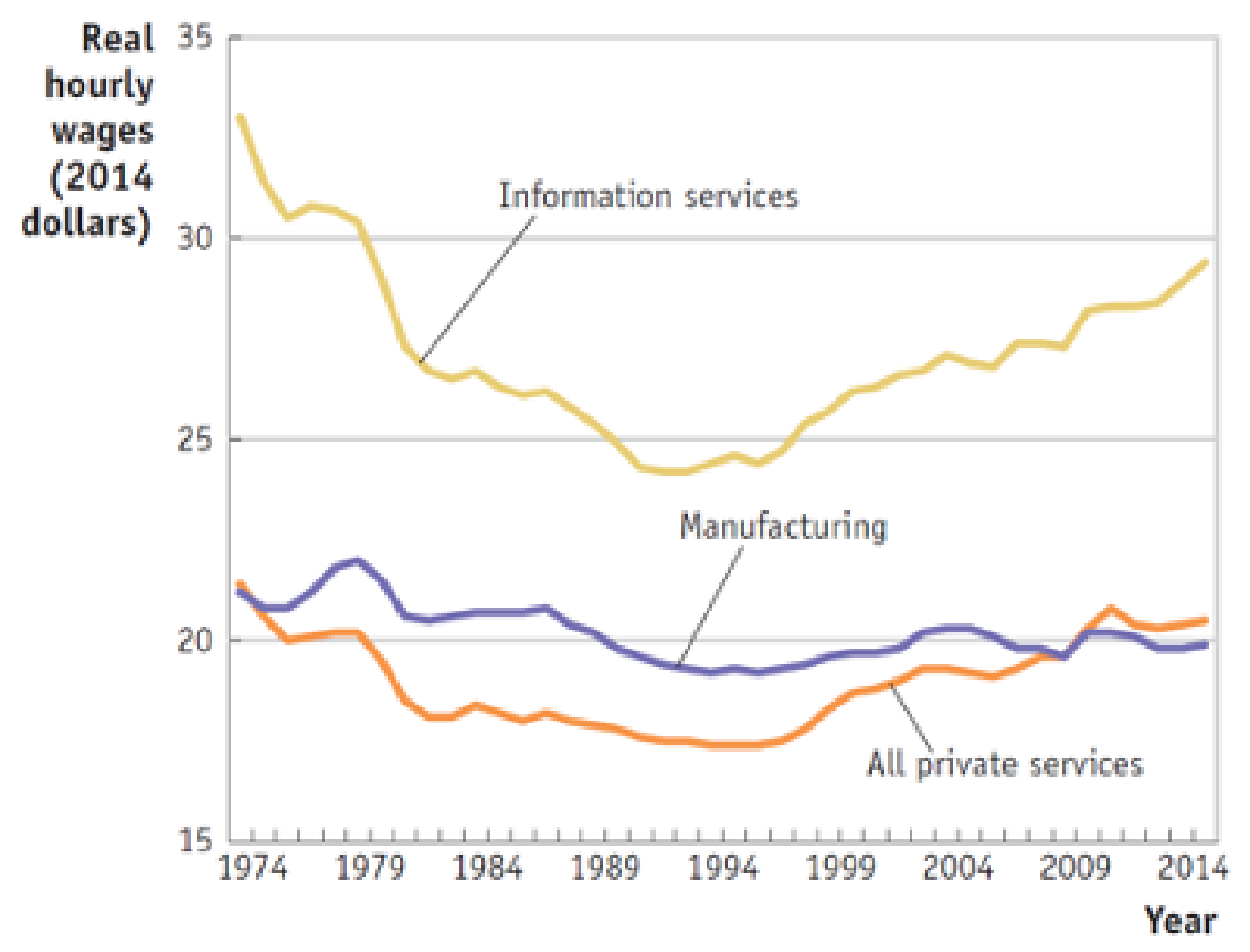
- Japan begins exporting cheap cars in 1980s, U.S. consumers import them
- Relative price of cars falls in U.S., U.S. factories produce fewer cars, wages & jobs in U.S. auto manufacturing diminish
- More **mobile** and **nonspecific** workers left Detroit for other industries
    - e.g. maybe they went to Texas to work in booming oil industry
- More **immobile** and **specific** workers lost jobs
    - Maybe geographically stuck in Detroit

Some More Examples



Source: Feenstra & Taylor (2017)

Some More Examples



Some More Examples

Industry	Total Displaced Workers (thousands) Jan 2011–Dec 2013	PERCENTAGES		
		Workers Reemployed by Jan 2014	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