ECO 445/545: International Trade

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PPFs, Opportunity Cost, and Comparative Advantage

Review: Week 2 Slides; Homework 2; chapter 3

- What the Production Possability Frontier is
- How to find max production of each good on a PPF
- What opportunity cost is, and how to compute it
- What comparative advantage is, how to determine it; how it differs from absolute advantage
- Ricardian gains from trade

Production Possibilities

- The **production possibility frontier** (PPF) of an economy shows the *maximum* amount of a goods that can be produced for a fixed amount of resources.
- The production possibility frontier of the home economy is:

$$a_{LC}Q_C + a_{LW}Q_W \leq L$$

Total amount of labor resources

Labor required for each pound of cheese produced

Total pounds of cheese produced

Labor required for each gallon of wine produced

Total gallons of wine produced

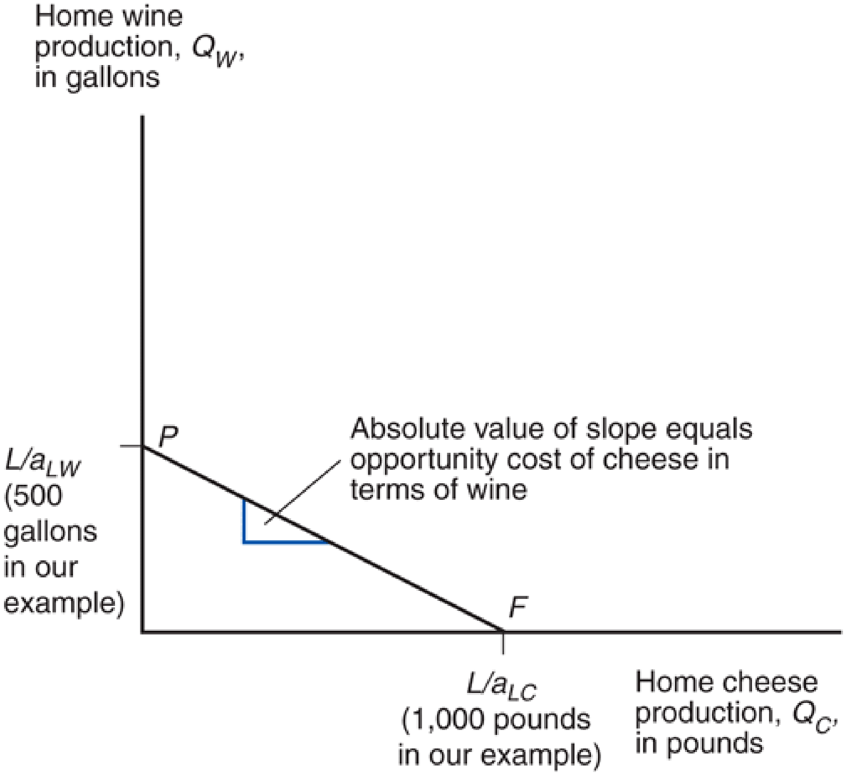
Production Possibilities (cont.)

- Maximum home cheese production is $Q_C = L/a_{LC}$ when $Q_W = 0$.
- Maximum home wine production is $Q_W = L/a_{LW}$ when $Q_C = 0$.

Production Possibilities (cont.)

- For example, suppose that the economy's labor supply is 1,000 hours.
- The PPF equation $a_{LC}Q_C + a_{LW}Q_W \leq L$ becomes $Q_C + 2Q_W \leq 1{,}000$.
- Maximum cheese production is 1,000 pounds.
- Maximum wine production is 500 gallons.

Fig. 3-1: Home's Production Possibility Frontier



Production Possibilities (cont.)

- The opportunity cost of cheese is how many gallons of wine Home must stop producing in order to make one more pound of cheese:

$$a_{LC}/a_{LW}$$

- This cost is constant because the unit labor requirements are both constant.

- The opportunity cost of cheese appears as the absolute value of the slope of the PPF.

$$Q_W = L/a_{LW} - (a_{LC}/a_{LW})Q_C$$

Production Possibilities (cont.)

- Producing an additional pound of cheese requires a_{LC} hours of labor.
- *Each* hour devoted to cheese production could have been used instead to produce an amount of wine equal to

  1 hour/(a_{LW} hours/gallon of wine)

  = (1/a_{LW}) gallons of wine

Production Possibilities (cont.)

- For example, if 1 hour of labor is moved to cheese production, that additional hour could have produced

  1 hour/(2 hours/gallon of wine)

  = ½ gallon of wine.

- Opportunity cost of producing one pound of cheese is ½ gallon of wine not produced.

Homework Review: Comparative Advantage

Q2. Country X can produce 150 units of alpha or 400 units of beta.

Country Y can produce 150 units of alpha or 300 units of beta.

Opportunity Cost of 150 alphas is lower in:

Therefore Country Y should specialize in:

Homework Review: Comparative Advantage

Q2. Country X can produce 150 units of alpha or 400 units of beta.

Country Y can produce 150 units of alpha or 300 units of beta.

Opportunity Cost of 150 alphas is lower in: Country Y (300 units of beta < 400 units of beta)

Therefore Country Y should specialize in:

Homework Review: Comparative Advantage

Q2. Country X can produce 150 units of alpha or 400 units of beta.

Country Y can produce 150 units of alpha or 300 units of beta.

Opportunity Cost of 150 alphas is lower in: Country Y

Therefore Country Y should specialize in: alpha (lower opportunity cost than Country X)

Homework Review: Comparative Advantage

Q2. Country X can produce 150 units of alpha or 400 units of beta.

Country Y can produce 150 units of alpha or 300 units of beta.

Opportunity Cost of 150 alphas is lower in: Country Y

Therefore Country Y should specialize in: alpha

Hypothetical changes in Production

	units of alpha	units of beta
country X	− 150	+ 400
country Y	+ 150	− 300
total	0	+ 100

Homework Review: Comparative Advantage

Q2. Country X can produce 150 units of alpha or 400 units of beta.

Country Y can produce 150 units of alpha or 300 units of beta.

Opportunity Cost of 150 alphas is lower in: Country Y

Therefore Country Y should specialize in: alpha

Hypothetical changes in Production

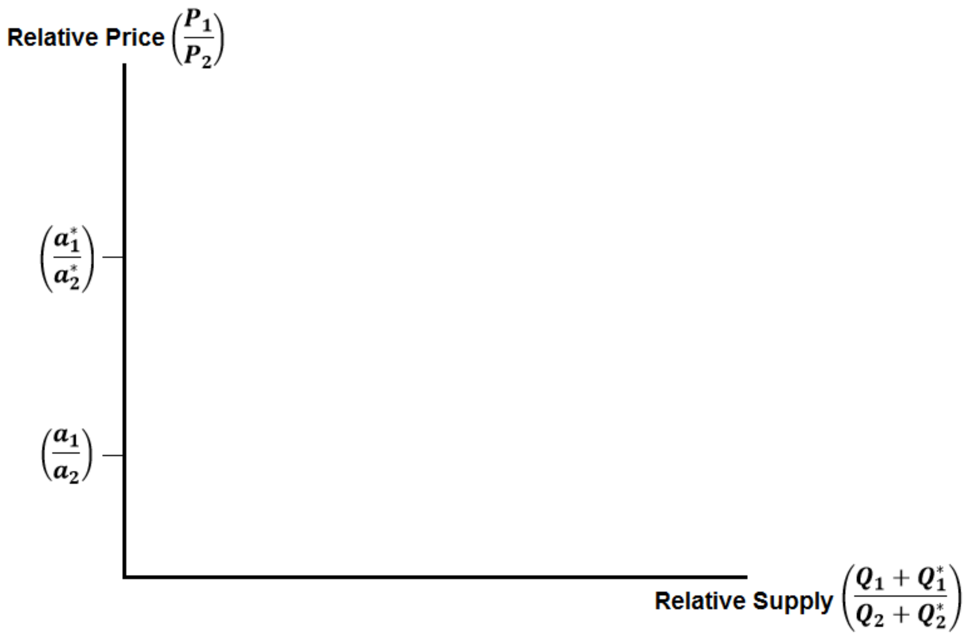
	units of alpha	units of beta
country X	− 150	+ 400
country Y	+ 150	− 300
total	0	+ 100

RS-RD, Relative Prices, Pattern of Specialization

Review: Week 2 Slides; Homework 2

- How relative supply and relative demand determine **pattern of specialization**
- How to use RS-RD graph to find equilibrium
- Pattern of Specialization

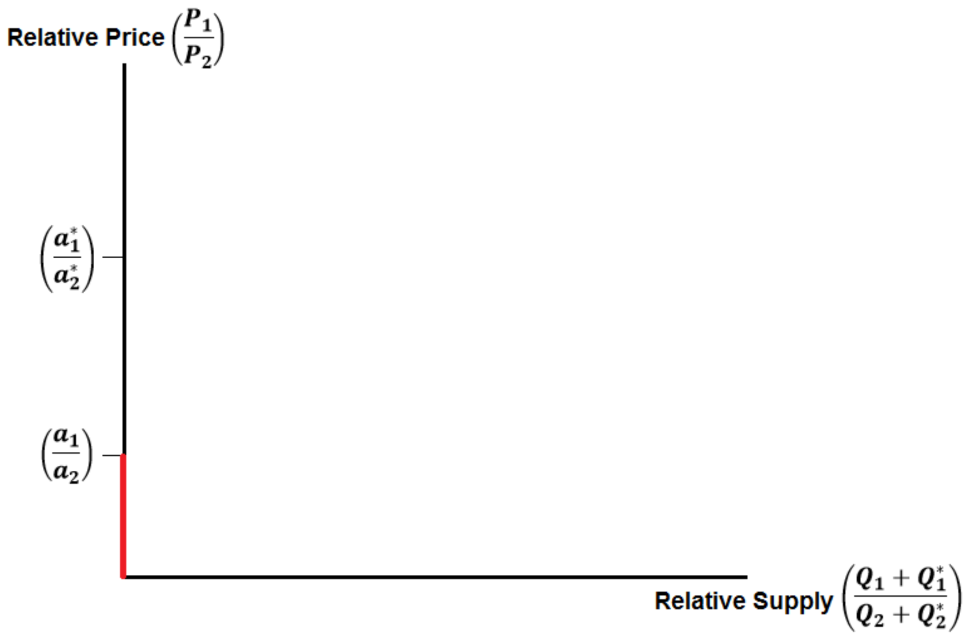
Constructing Relative Supply Graph



a_1 ≡Unit labor cost for producing good 1 in Home; a_2^* ≡Unit labor cost for producing good 2 in Foreign

Assume $\left(\frac{a_1}{a_2}\right) < \left(\frac{a_1^*}{a_2^*}\right)$. Therefore Home has comparative advantage in good 1 (Good 1 has lower opportunity cost in terms of good 2 in Home compared to Foreign).

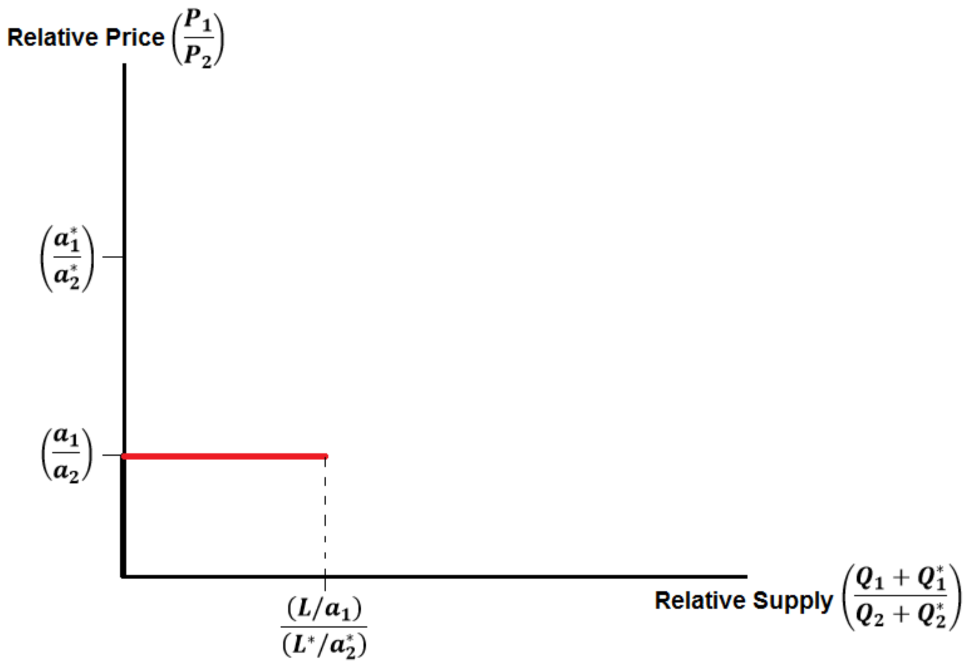
Constructing Relative Supply Graph



Case 1: $\left(\frac{P_1}{P_2}\right) < \left(\frac{a_1}{a_2}\right) < \left(\frac{a_1^*}{a_2^*}\right)$ $\Rightarrow$ Neither country will produce good 1

RS= $\left(\frac{0+0}{Q_2+Q_2^*}\right) = 0$, where $Q_2 = \frac{L}{a_2}$ and $Q_2^* = \frac{L^*}{a_2^*}$

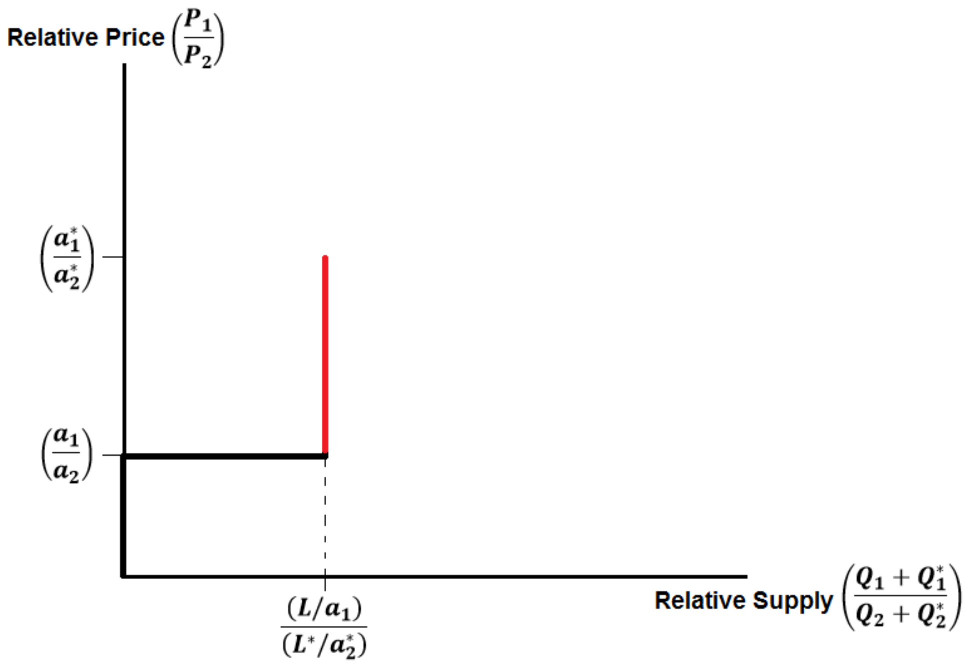
Constructing Relative Supply Graph



Case 2: $\left(\frac{P_1}{P_2}\right) = \left(\frac{a_1}{a_2}\right) < \left(\frac{a_1^*}{a_2^*}\right)$ ⇒ Home indifferent between producing good 1 and 2

RS= $\left(\frac{Q_1+0}{Q_2+Q_2^*}\right)$, where $Q_1 \in \left[0, \frac{L}{a_1}\right]$; $Q_2 = \frac{L-a_1Q_1}{a_2}$ and $Q_2^* = \frac{L^*}{a_2^*}$

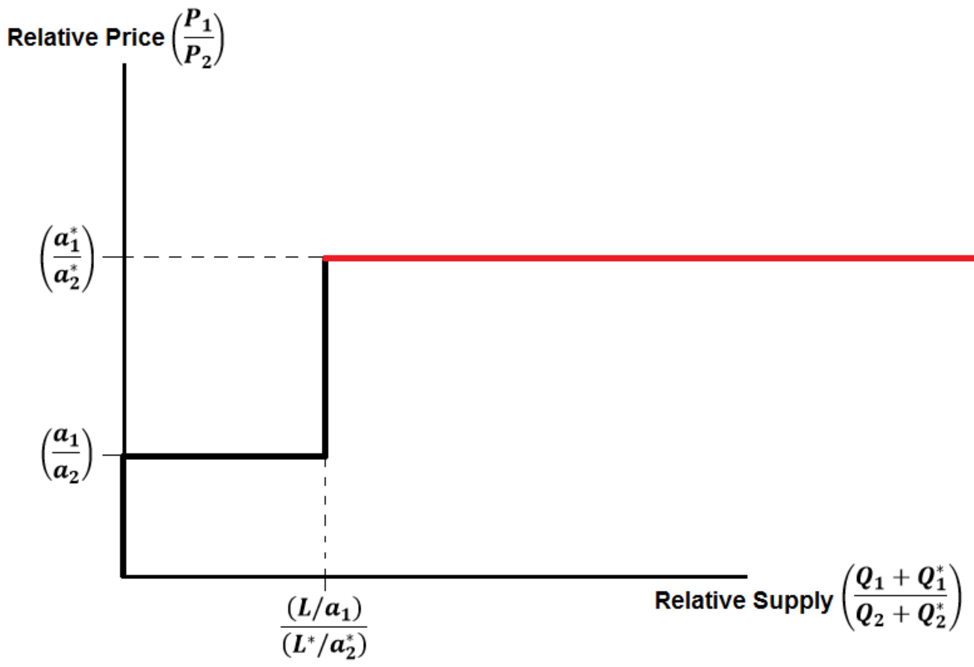
Constructing Relative Supply Graph



Case 3: $\left(\frac{a_1}{a_2}\right) < \left(\frac{P_1}{P_2}\right) < \left(\frac{a_1^*}{a_2^*}\right)$ $\Rightarrow$ Home produces only good 1. Foreign produces only good 2.

RS= $\left(\frac{Q_1+0}{0+Q_2^*}\right)$, where $Q_1 = \frac{L}{a_1}$ and $Q_2^* = \frac{L^*}{a_2^*}$

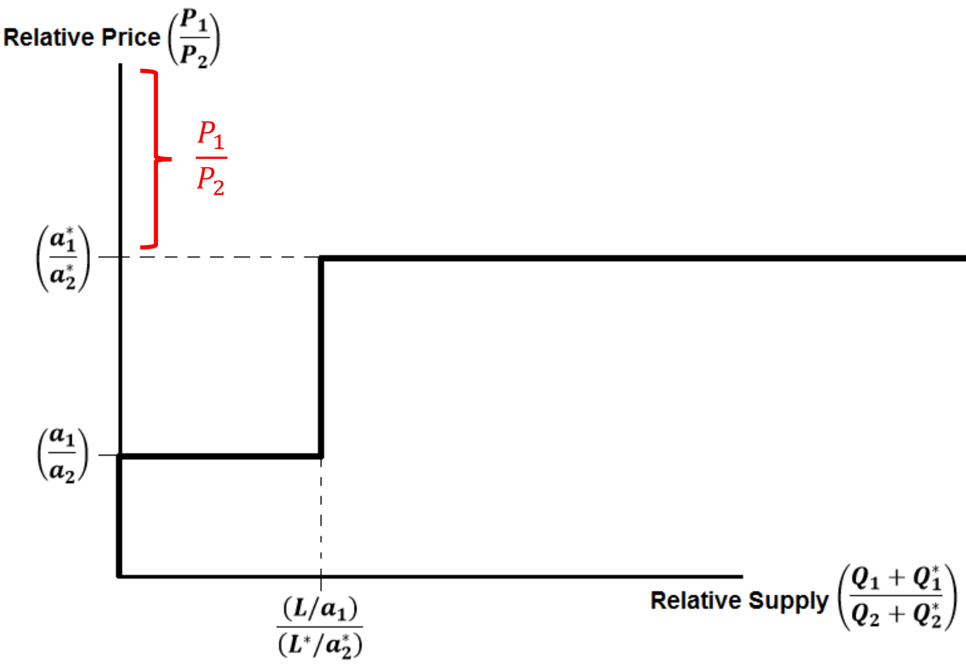
Constructing Relative Supply Graph



Case 4: $\left(\frac{a_1}{a_2}\right) < \left(\frac{a_1^*}{a_2^*}\right) = \left(\frac{P_1}{P_2}\right) \Rightarrow$ Foreign indifferent between producing good 1 and good 2.

RS= $\left(\frac{Q_1+Q_1^*}{0+Q_2^*}\right)$, where $Q_1 = \frac{L}{a_1}$ and $Q_2^* \in \left[0, \frac{L^*}{a_2^*}\right]$; $Q_1^* = \frac{L^*-a_2^* Q_2^*}{a_1^*}$

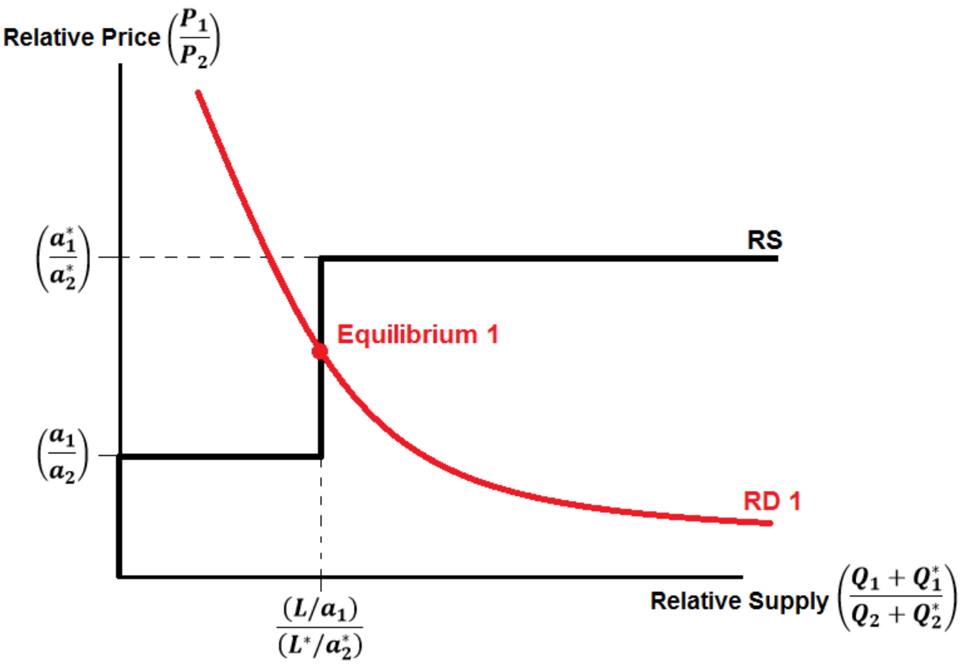
Constructing Relative Supply Graph



Case 5: $\left(\frac{a_1}{a_2}\right) < \left(\frac{a_1^*}{a_2^*}\right) < \left(\frac{P_1}{P_2}\right) \Rightarrow$ Neither country will produce good 2

RS= $\left(\frac{Q_1+Q_1^*}{0+0}\right) = \infty$, where $Q_1 = \frac{L}{a_1}$ and $Q_1^* = \frac{L^*}{a_1^*}$

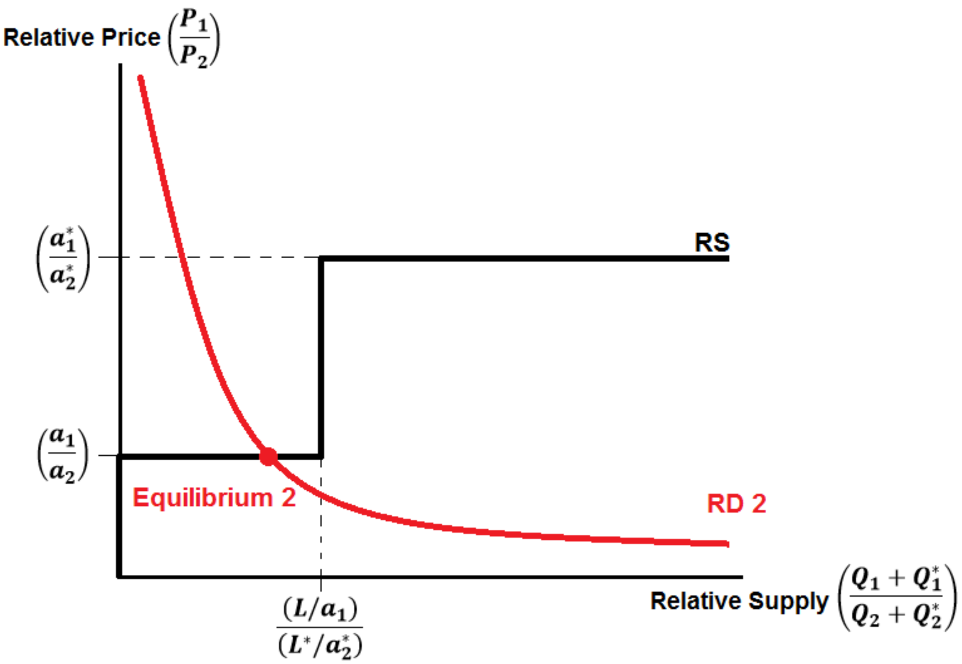
Finding Equilibrium using Relative Demand



Find equilibrium prices where $\text{RD} = \text{RS}$. Happens at the point Equilibrium 1.

Therefore $\left(\frac{a_1}{a_2}\right) < \left(\frac{P_1}{P_2}\right) < \left(\frac{a_1^*}{a_2^*}\right) \Rightarrow$ Home produces only good 1. Foreign produces only good 2.

Finding Equilibrium using Relative Demand



Different RD curves will give different Equilibriums. New RD curve intersects RS at Equilibrium 2

$\Rightarrow \left(\frac{P_1}{P_2}\right) = \left(\frac{a_1}{a_2}\right) < \left(\frac{a_1^*}{a_2^*}\right)$ $\Rightarrow$ Home indifferent & produces both goods. Foreign produces only good 2.

Defining an Equilibrium

Review: Week 3 and 4 Slides, Worksheet 1, HW 3, PS1 Q1

- Endogeneous vs Exogeneous Paramters
- Monotonic transformations on Preferences (OK) vs Production Functions (not OK)
- Basic idea of Walras‘ Law.

How to define a competitive equilibrium

- **Consumer‘s problem** (Max utility subject to Budget Constraint)
- **Firm‘s problem** (Max Profits subject to production technology)
- **Market Clearing for Goods and Labor**

Example of Utility function

Let there be two goods: c_1 is consumption of good 1, c_2 is consumption of good 2.

- Cobb-Douglas Utility Function:

$$U(c_1, c_2) = (c_1)^{\theta_1}(c_2)^{\theta_2}$$

Important: Utility doesn‘t have natural units. Only relative utility matters.

- Transformations that preserve ordering are considered equivalent utility functions.

- Common order preserving transofrmations: Addition, Multiplication, Powers, Logairthms

Example Transformation: Take logarithm

$$\widetilde{U}(c_1, c_2) = \theta_1 \log c_1 + \theta_2 \log c_2$$

$\widetilde{U}(c_1, c_2)$ is the same utility function as $U(c_1, c_2)$ [Note $\log 0 = -\infty$, always consume some of both]

Consumer Problem

Consumer problem will be to maximize utility function, subject to budget constraint

Budget Constraint

- Without a budget constraint, consumers would want an infinite amount of everything
- Budget constraint enforces that consumer expenditures are less than consumer income
- Typically no borrowing or saving in this class (we focus mainly on static models)

Consumption Expenditures: Sum of expenditures (= price * quantity) across all goods.

Income Sources: Labor income (wages * labor supplied).
Other potential sources: rental rates from capital, profits from firms, taxes from government

Firm Problem

For basic Ricardian model we assume firms are **perfectly competitive**.

- This means there are no profits and firms have no market power (they take prices as given)

All firms within a country assumed to have same production technology for a given good

- Typically assume **constant returns to scale (CRS)**: double inputs ⇒ double outputs
- Production technologies vary across products, not firms
- For now, assume single product firms

Market Clearing

Market clearing means total demand equals total supply for each good/input in equilibrium

- Since labor is not mobile, labor used in production must equal labor supplied in each country
- If trade: goods market clearing is at World Level (World Supply = World Demand)
- If no trade: goods market clearing is at Country Level (Country supply = Country demand)

Equilibrium Definition

Equilibrium is prices $\{p_1, p_2\}$, wages, $\{w^H, w^F\}$ and allocations $\left\{c_1^i, c_2^i; l_1^i, l_2^i; y_1^i, y_2^i\right\}_{i \in \{H,F\}}$ s.t.

1. Consumers maximize utility, subject to budget constraint

2. Firms maximize profits, subject to production technology

3. Markets clear

Exogenous vs Endogenous Variables

When working with models, keep in mind what is **Exogenous** vs **Endogenous**

Exogenous variables are parameters that are determined outside of the model

- In our model: productivity parameters, preference parameters, total labor supply

Endogenous variables are parameters that are determined by the model in equilibrium

- In our model: wages and prices, labor and consumption allocations across goods
- Equilibrium outcomes for endogenous variables are affected by exogenous parameters. The opposite is not true.

Things that are exogenous in one model are often endogenous in another. Exogenous also does not mean arbitrary, we can estimate exogenous parameters using data.

Equilibrium Definition

Equilibrium is prices $\{p_1, p_2\}$, wages, $\{w^H, w^F\}$ and allocations $\left\{c_1^i, c_2^i; l_1^i, l_2^i; y_1^i, y_2^i\right\}_{i \in \{H,F\}}$ s.t.

1. Consumers maximize utility, subject to budget constraint
2. Firms maximize profits, subject to production technology
3. Markets clear

Consumer Problem

Suppose $U\left(c_1^i, c_2^i\right) = \theta_1 \log c_1^i + \theta_2 \log c_2^i$ is utility in country i

Given prices $\{p_1, p_2, w^i\}$, consumers in i choose consumption $\{c_1^i, c_2^i\}$ to **Maximize Utility**

$$\max_{\{c_1, c_2\}} \theta_1 \log c_1^i + \theta_2 \log c_2^i$$

Subject to **budget constraint**

$$p_1 c_1^i + p_2 c_2^i \leq w^i L^i$$

Firm Optimization Problem

Assume firms have constant unit labor costs

Firm that produce good m in country i solve:

$$\max_{\{y_m, l_m\}} p_m y_m^i - w^i l_m^i$$

Subject to their production function:

$$y_m^i = \frac{1}{a_m^i} l_m^i$$

Market Clearing Conditions

The last part of the problem is to specify market clearing conditions

Labor Market Clears: labor demand = labor supply in each country

$$l_1^H + l_2^H = L^H$$

$$l_1^F + l_2^F = L^F$$

Goods Market Clears: output of each good = consumption of each good

Important: This condition changes depending on Trade vs Autarky

Market Clearing Conditions

The last part of the problem is to specify market clearing conditions

Labor Market Clears: labor demand = labor supply in each country

$$l_1^H + l_2^H = L^H$$

$$l_1^F + l_2^F = L^F$$

Goods Market Clears: output of each good = consumption of each good

Autarky: Goods market clearing for Home is to consume what is produced at Home

$$c_1^H = y_1^H$$

$$c_2^H = y_2^H$$

(In Autarky, everything that happens in Foreign is irrelevant to equilibrium in Home)

Market Clearing Conditions

The last part of the problem is to specify market clearing conditions

Labor Market Clears: labor demand = labor supply in each country

$$l_1^H + l_2^H = L^H$$

$$l_1^F + l_2^F = L^F$$

Goods Market Clears: output of each good = consumption of each good

Trade: Countries don't need to consume what they produce

$$c_1^H + c_1^F = y_1^H + y_1^F$$

$$c_2^H + c_2^F = y_2^H + y_2^F$$

Tariffs, Trade Costs, and Quotas

Review: Week 5 and Week 6 Slides, HW 4, Chapter 9

- How tariffs and trade costs are defined, how they differ in budget constraint
- How they impact the range of goods produced/exported in many good model
- How tariffs, quotas, and other policies work in partial equilibrium framework
- Prisoner‘s dilemma for protectionism
- What a small open economy is (a country that can‘t influence world prices)

Iceberg Trade Costs

Iceberg Trade Costs are costs associated with transporting goods across countries

- Fuel to ship the goods
- Loss of product due to spoilage
- Additional workers needed to fill out paper work and follow international regulations

Iceberg trade costs means to deliver 1 unit of exports, necessary to ship $\tau > 1$ units

- For simplicity, we set domestic iceberg trade costs as $\tau = 1$

Tariffs

Tariffs are a tax imposed on imports

- Tariffs are redistributed to consumers in the country imposing the tariff

$$\text{Income} = \overbrace{wL}^{\substack{\text{Labor}\\ \text{Income}}} + \overbrace{T}^{\substack{\text{Tariff}\\ \text{Income}}}$$

- Unlike iceberg costs, nothing is physically lost

- Like iceberg costs, the presence of Tariffs distorts the equilibrium vs a frictionless world

- Tariffs are typically ad-valorem (applied proportionally to value). Model as

$$\text{price with tariff} = \text{tariff} \times \text{price without tariff}$$

$$p^{\text{import}} = \tau p^{\text{world}}$$

Tariff Trade Costs in Many Good Model

For both iceberg trade costs and tariffs, will have

$$\hat{p}_i^j(z)y_i^j(z) = \begin{cases} \frac{\widehat{w}_i l_i(z)}{\tau}, & if\ i \neq j \\ \widehat{w}_i l_i(z), & if\ i = j \end{cases}$$

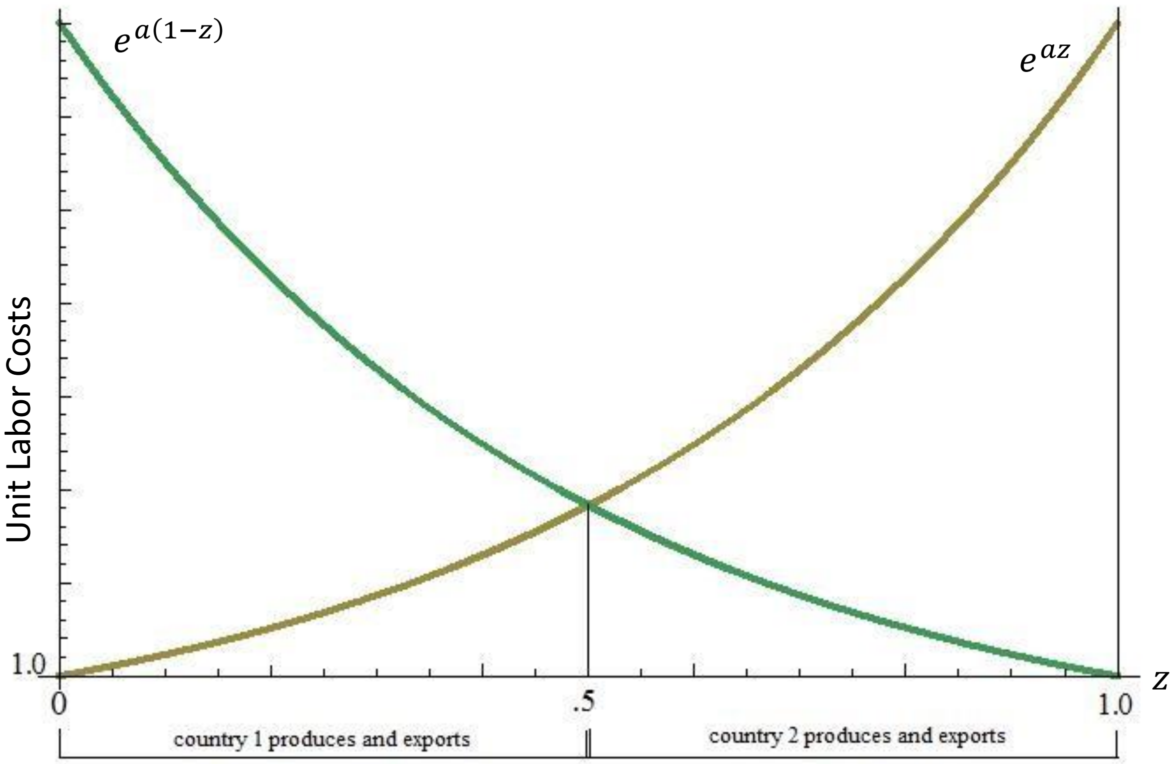
This means it doesn't matter if we put τ on prices or output. Solution to problem is same.

Difference is that **tariffs are rebated back to consumers.** Consumer budget constraint:

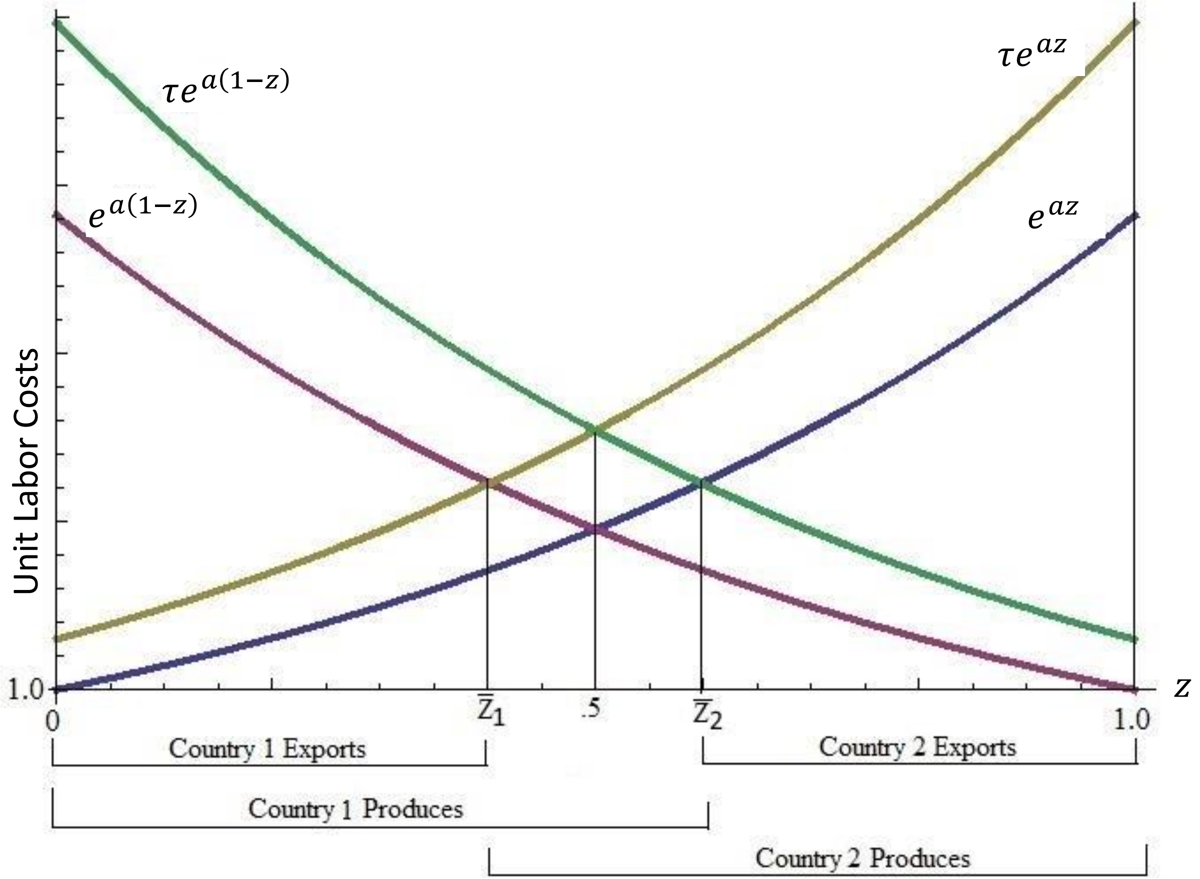
$$\int_0^1 \hat{p}_i(z)c_i(z)dz = \widehat{w}_i L_i + \overbrace{T_i}^{\text{Tariff Revenue}}$$

$$T_i = \int_z (\tau - 1)\hat{p}_j(z)y_j^i(z)dz$$

Symmetric Equilibrium



Symmetric Equilibrium: Iceberg Trade Costs



Instruments of Trade Policy

Many instruments available to affect international trade flows and prices. Non-exhaustive list:

- **Tariffs:** Taxes on Imports. Effect is to increase price of imports, decrease quantity of imports, and collect tariff revenues.

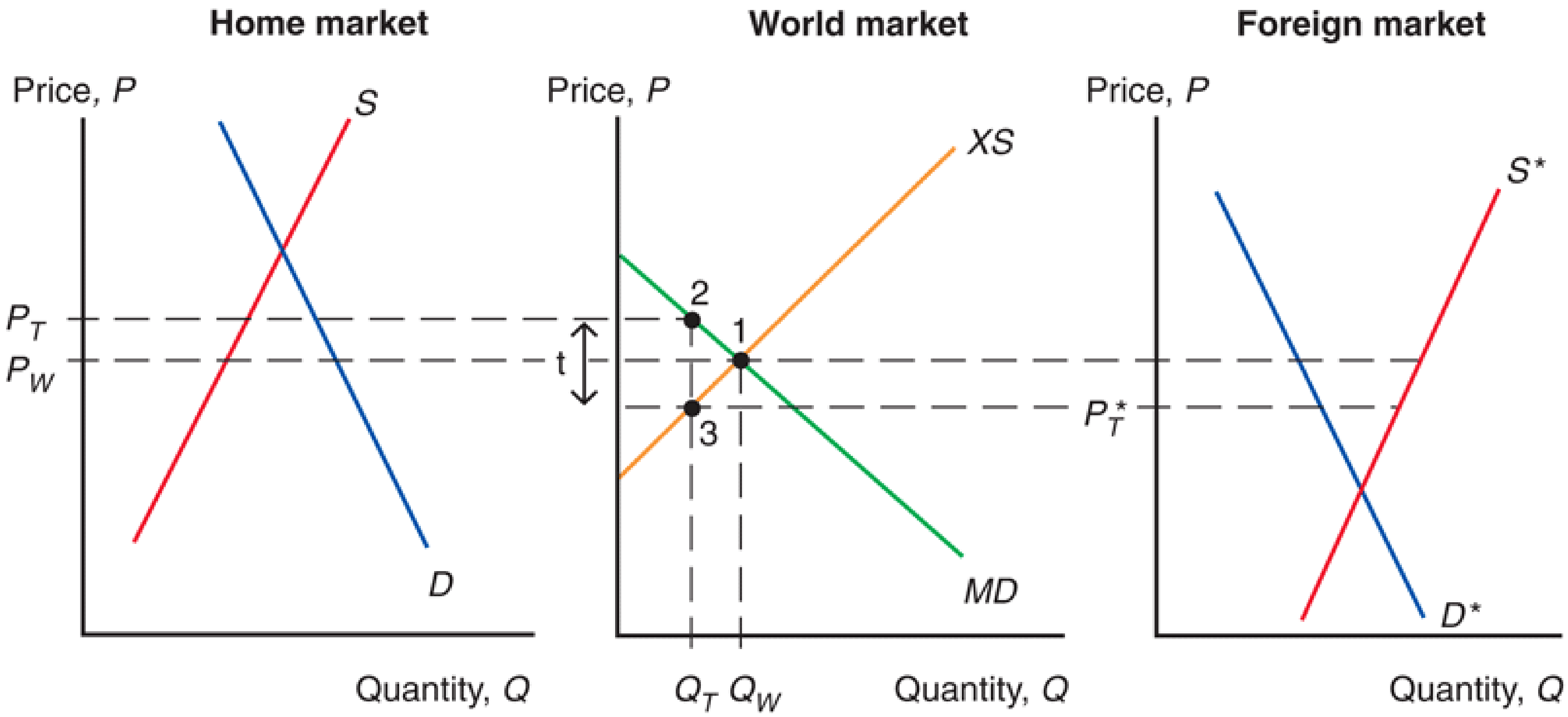
- **Export Subsidies:** Subsidies on exports. Effect is to decrease price of exports and increase quantity of exports. Must be funded by government.

- **Quotas:** Limits on quantity of imports. Effect is to increase price of imports, decrease quantity of imports.

- **Export Restrictions:** Limits on quantity of exports. Effect is to increase price of exports, decrease quantity of exports.

- **Local Content Requirements:** Requirement that a sufficient portion of value added for a good is local. Increases price of imports (due to higher production costs), and decreases quantity.

Effects of an Import Tariff



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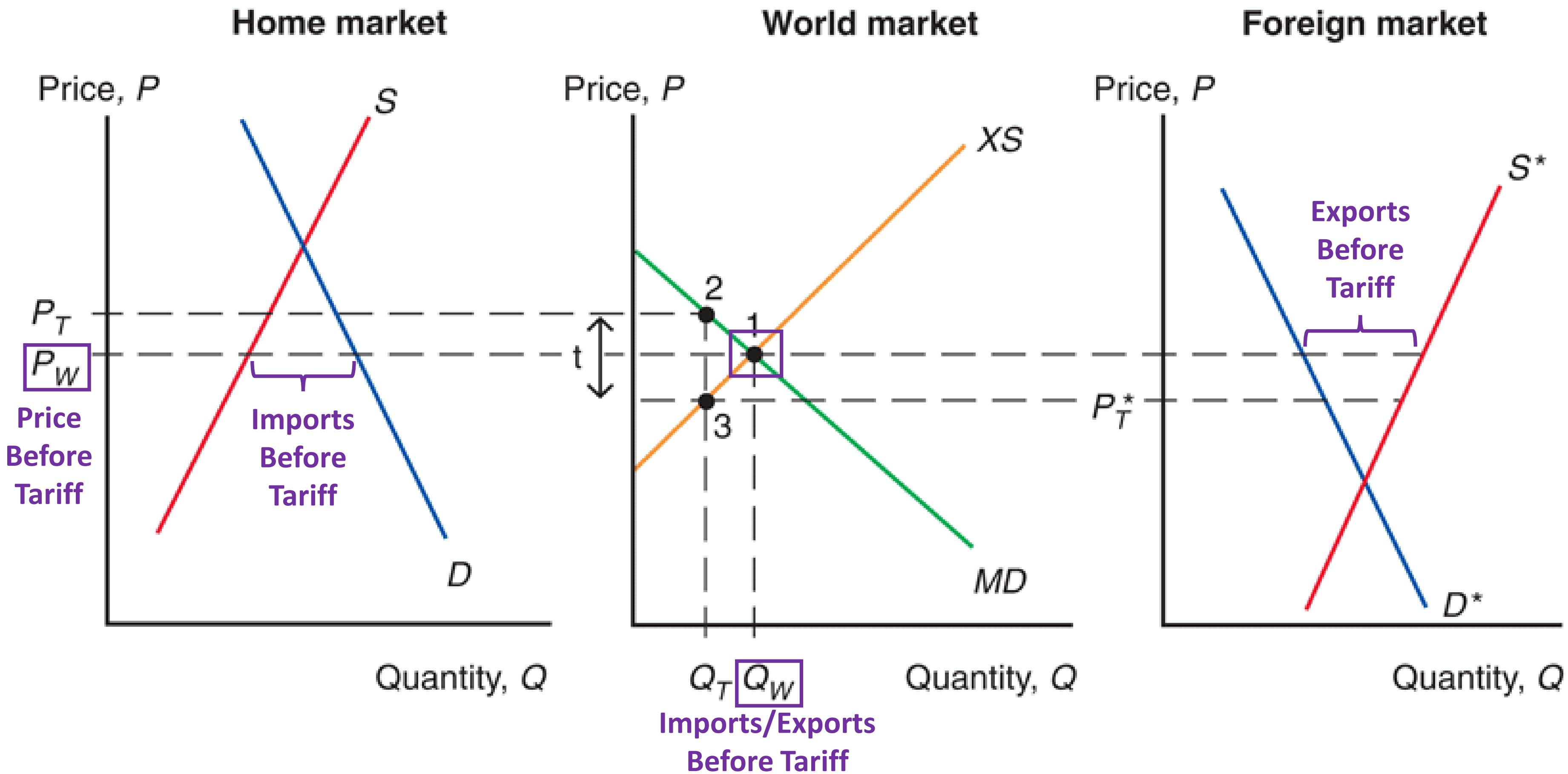

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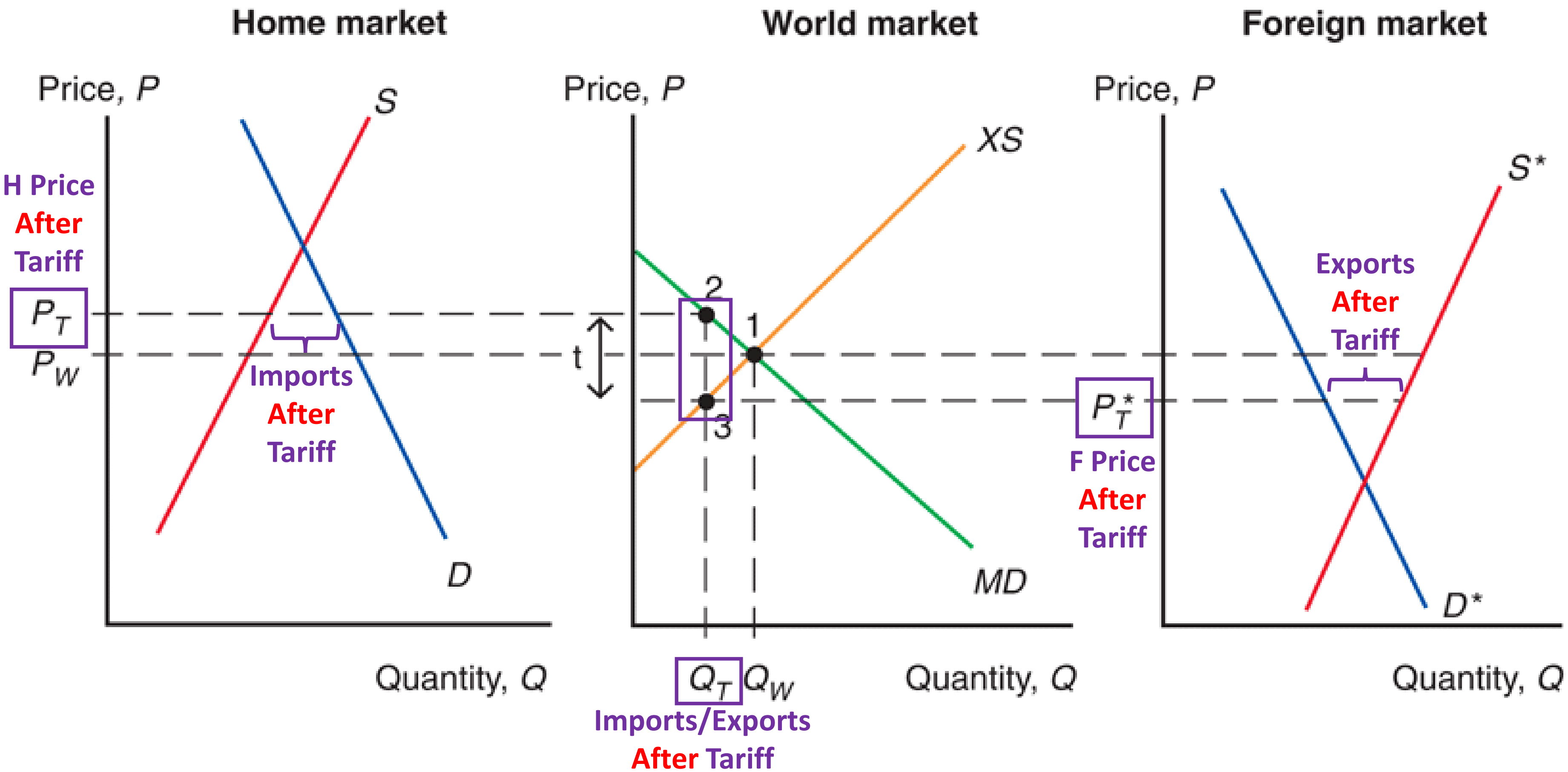
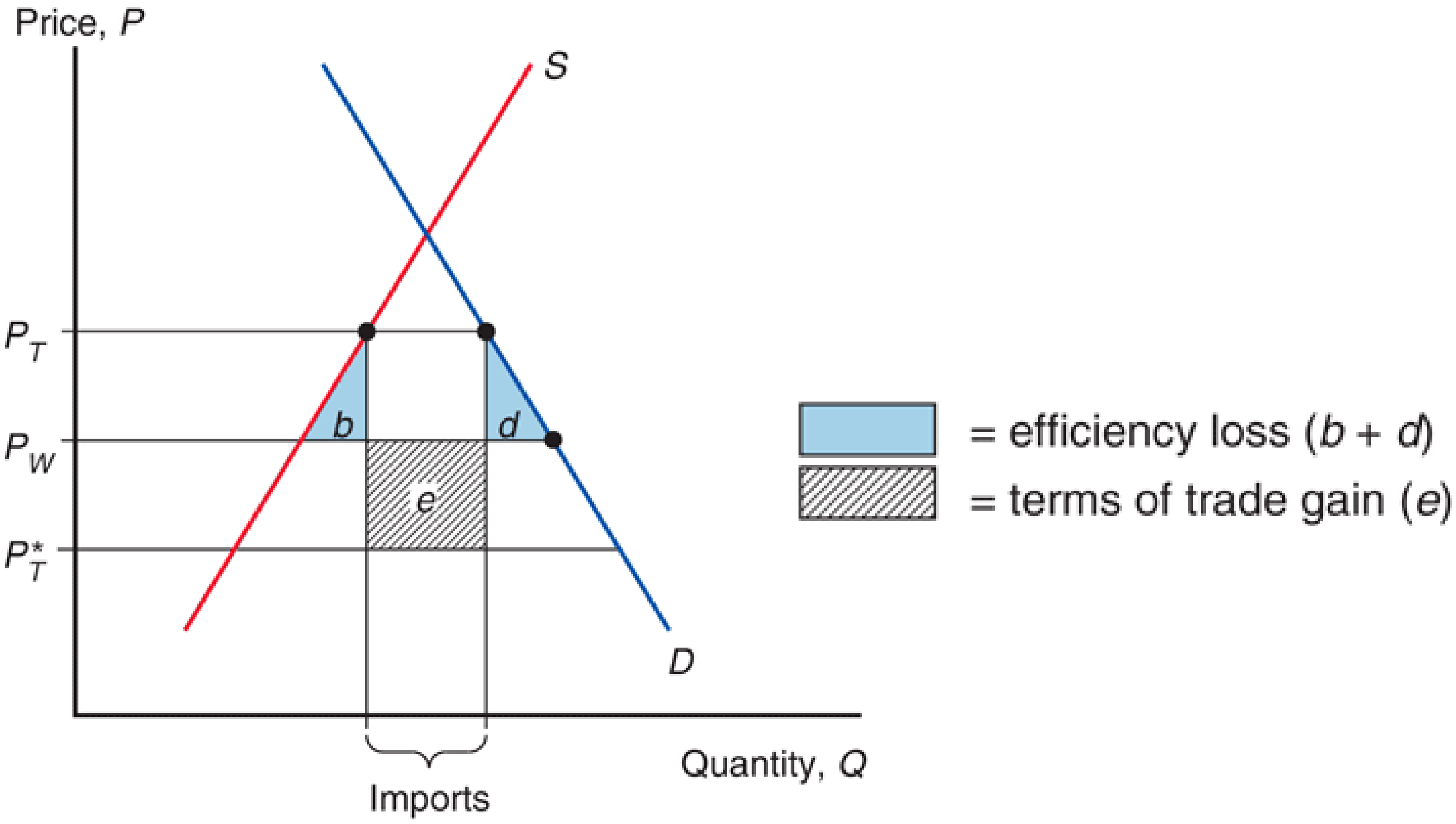


Welfare Effects of Import Tariff in Home (Importing Country)



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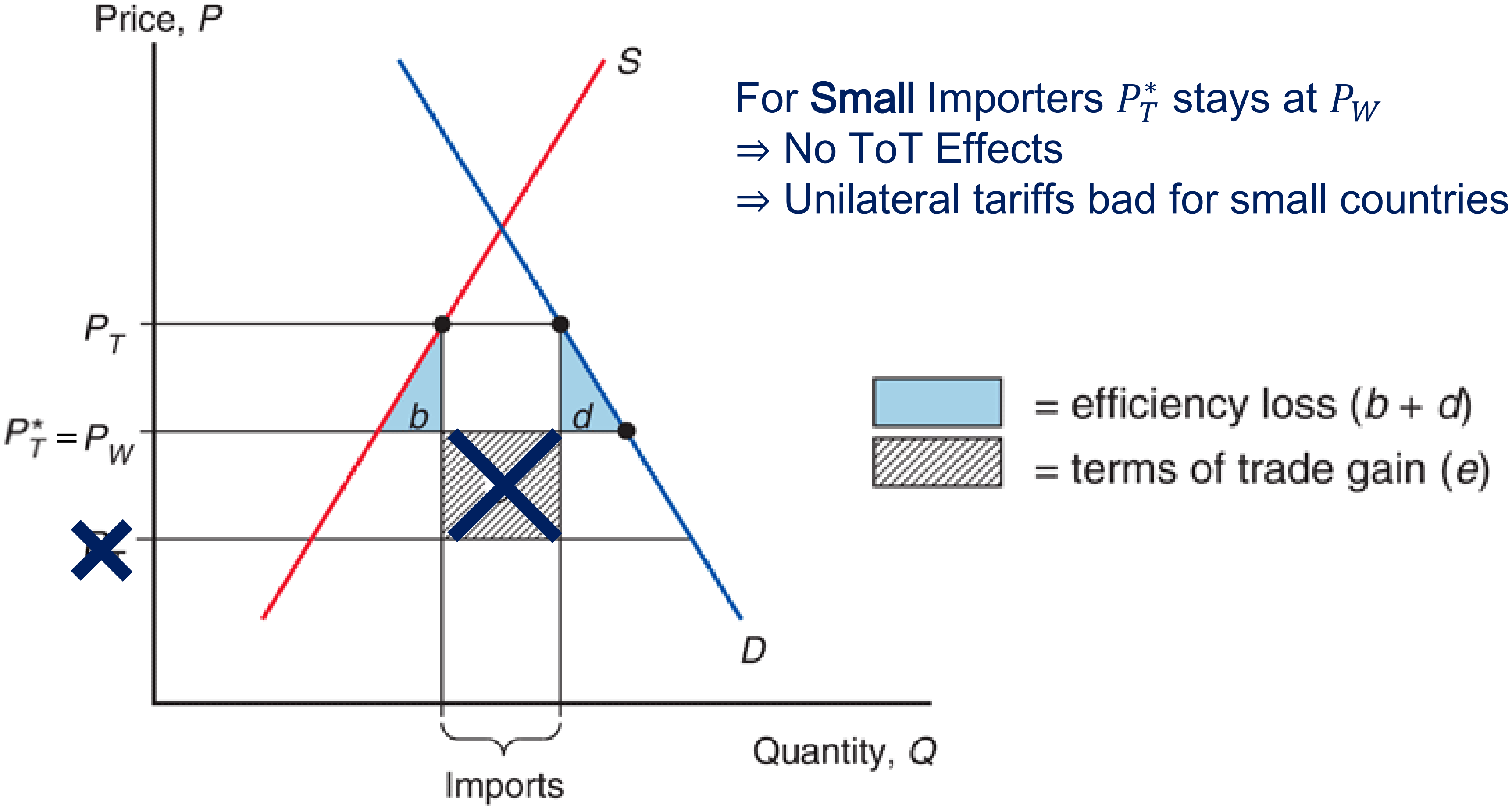

For **Small** Importers P_T^* stays at P_W

⇒ No ToT Effects

⇒ Unilateral tariffs bad for small countries

Effects of an Import Quota

Import Quotas restict quantity of imports

- Quotas typically enforced by issueing licenses to exporters
- Owners of quota licenses have market power, and can earn quota rents
- In practice, Government may choose to sell quota licenses. This allows government to capture quota rents, and the quota then acts like a tariff.

Welfare Effects of Import Quota: Sugar Market in United States