ECO 442: Quantitative Trade Models

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Trade Costs and Tariffs

So far in our models, international trade has been frictionless

- Instantly teleport goods from one country to another at no cost
- Obviously not true! Prices are not equal everywhere.

Focus on two primary trade costs

- **Iceberg Trade Costs**
- **Tariffs**

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

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

- Effectively the same as lowering productivity for goods sent abroad
- For simplicity, we set domestic iceberg trade costs as $\tau = 1$

Tariffs

Tariffs are a tax imposed on imports (See Tariffs in PE Framework)

- 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, physical output is not directly affected

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

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

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

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

Multi-Good Ricardian Model of Trade

Comparative advantage: countries differ in technology and therefore opportunity costs.

- 2x2 Ricardian Model is simple. Tariffs too high $\Rightarrow$ stop trading.
- Tairffs more interesting with multiple goods (adds middleground between Trade and Autarky)
- We can extend our framework to a large number of goods in a straightforward way

Model Setup

- Two countries, indexed by $i, j = H, F$
- M goods, indexed by m
- Labor $\left(L^i\right)$ is only factor of production, supplied inelastically
- Countries differ in labor productivities for each good:
  - Productivity in country i for producing good m is: $z_{m,i}$

Tariff Trade Costs

Tariffs go on prices rather than in production function

- Let $p_{m,i}^{j}$ be the price firms producing good m in country i charge to consumers in country j, then consumers in country j actually pay

$$\text{Price with Tariff} = \text{Tariff Rate} * \text{Price} = \tau_{m,i}^{j} p_{m,i}^{i}$$

- Where $\tau_{m,i}^{j}$ is the tariff country j charges on imports of good m originating from country i

- What this means, is that the price for consumers in the importing country is $\tau_{m,i}^{i}$ times higher than the price the exporting firm's receive for the good

Tariff Revenue

Tariff Revenue is generated by the importing country and redistributed to consumers in that country.

Let j be the importing country and suppose country i is the other country, then

$$T^j = \sum_{m=1}^{M} \left(\tau_{m,i}^j - 1\right) p_{m,i}^j c_{m,i}^j; \;\; i \neq j$$

- Where $c_{m,i}^j$ is how many units of good m, consumers in country j consume that is produced in country i.

Equilibrium Definition With Tariffs

Equilibrium Definition Summary (Click for Full Definition)

- Wages: w^H, w^F; Prices for each good for each country: $p^j_{m,i}, m = 1, \dots, M; i = H, F$
- Consumption, labor input, and production for each good: $c^j_{m,i}, y^j_{m,i}, l^j_{m,i}, m = 1, \dots, M;\ i, j = H, F$
- Tariff Revenue: $T^j, j = H, F$. **Such that**

1) Given prices and wages, consumers maximize utility subject to budget constraint
2) Firms maximize profit for each good, origin, and destination
3) Markets clear (consumption = output, labor used in production sums to labor endowment)
4) Government B.C. Holds: Tariff Revenue Distributed = Tariff Revenue Collected

Example

Let‘s consider the example from Dornbusch, Fischer, and Samuelson (1979) [Click for more Details]

- Suppose M is very large, so we almost have an infinite number of goods. Say $M = 10^6$

- Let both countries be the same size, and let the tariff rate be symmetric

$$L_H = L_F = L$$

$$\tau_{m,i}^{j} = \tau, \qquad if\ i \neq j\ \ (Note\ \tau_{m,i}^{i} = 1)$$

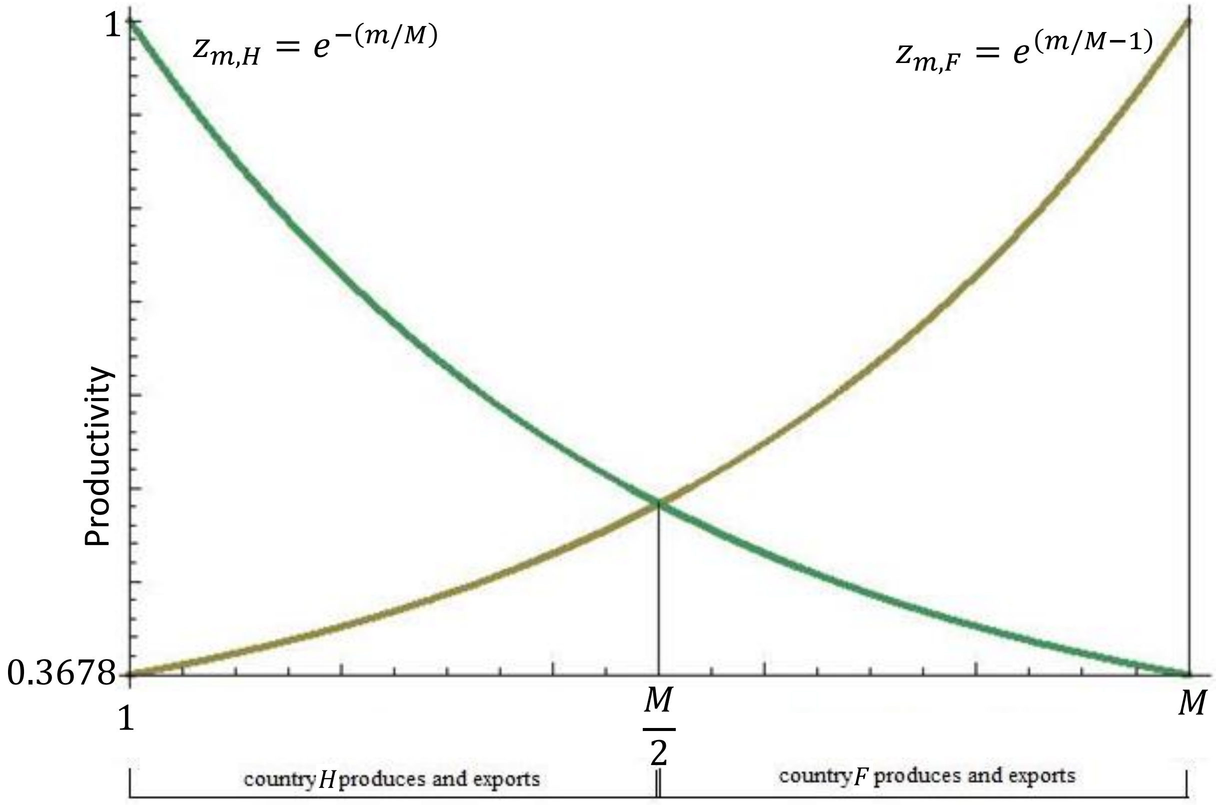
- Suppose the productivity for each good is given by:

$$z_{m,H} = e^{-(m/M)}$$

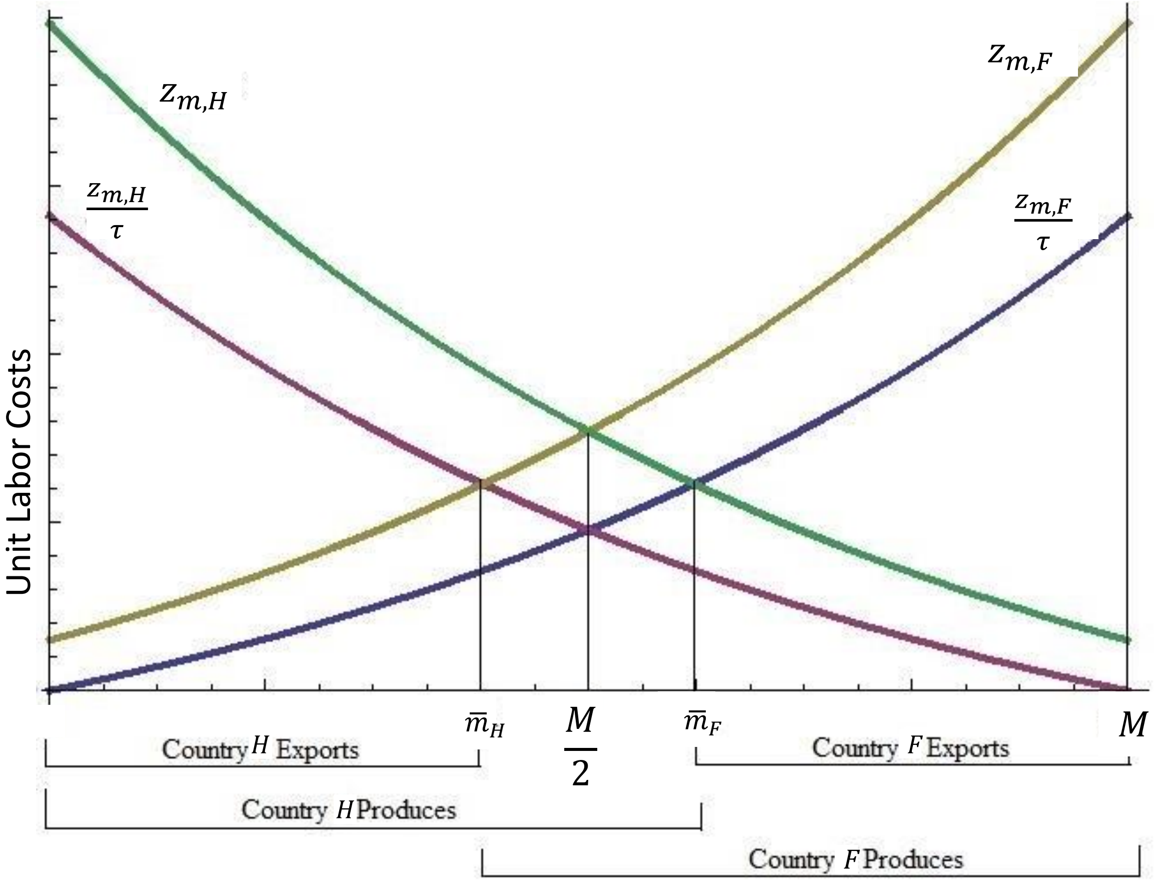
$$z_{m,F} = e^{(m/M-1)}$$

E.g. $z_{1,H} = e^{-\frac{1}{10^6}} \approx 0.9999999,\ z_{1,F} = e^{\frac{1}{10^6}-1} \approx 0.3678,\ z_{M,H} = e^{-1} \approx 0.3678$

Symmetric Equilibrium with Free Trade



Symmetric Equilibrium: Tariff Trade Costs



Summary of DFS

Dornbusch, Fischer, and Samuelson (1979):

- Ricardian model: 2 countries, 1 factor of production, continuum of goods

Strengths:

- Simple and intuitive. Can be used to think about effects of trade policy and trade costs.

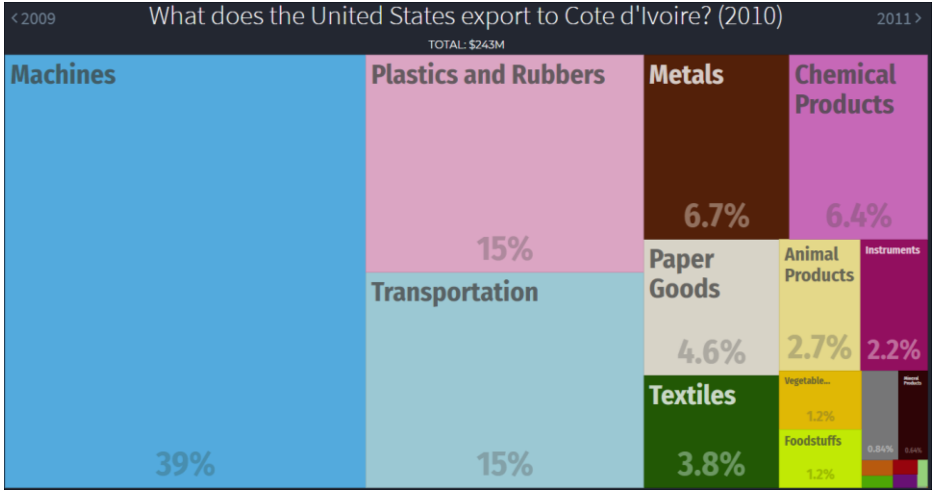
Weaknesses:

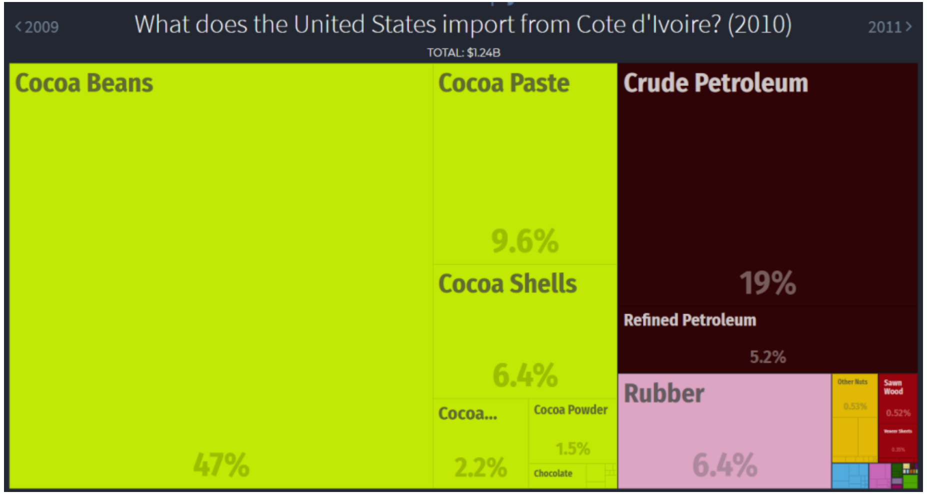
- No explanation for why countries differ in productivity for producing goods

- Not straightforward to extend model to multiple countries

Is Trade Specialized Like a Ricardian Model Would Predict?

For many developing or commodity rich countries: Yes

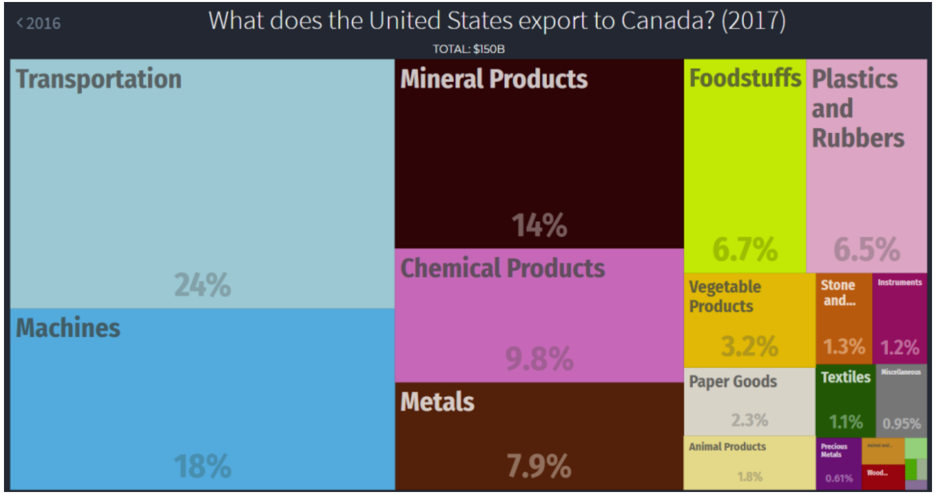


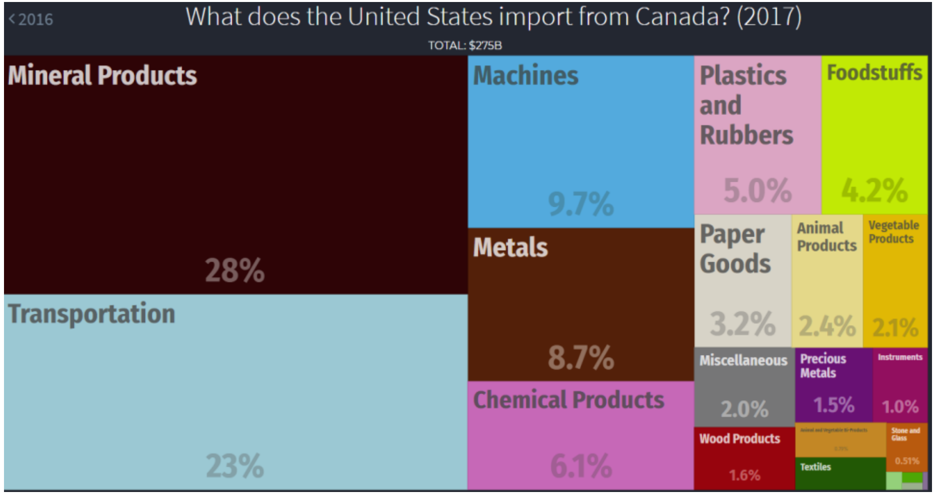


US Trade with the Ivory Coast (From OEC)

Is Trade Specialized Like a Ricardian Model Would Predict?

For Developed Countries: Often Not!





US Trade with Canada ([From OEC]())

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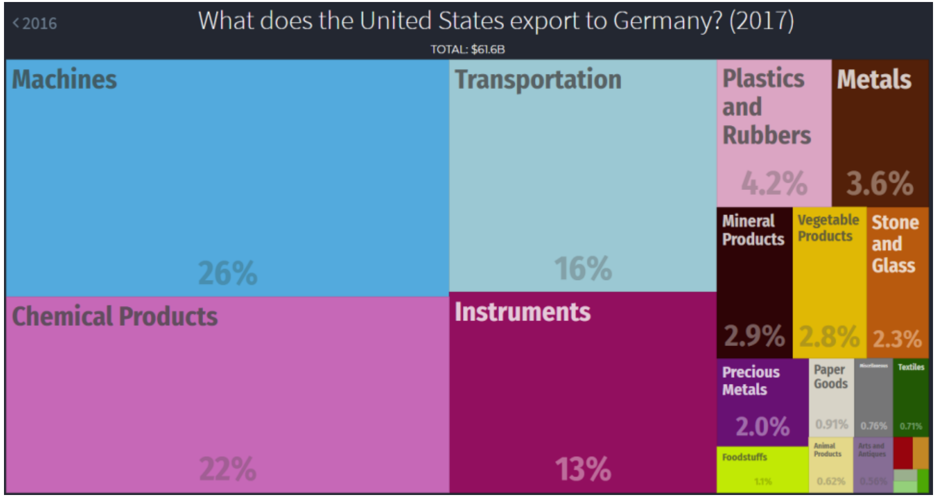

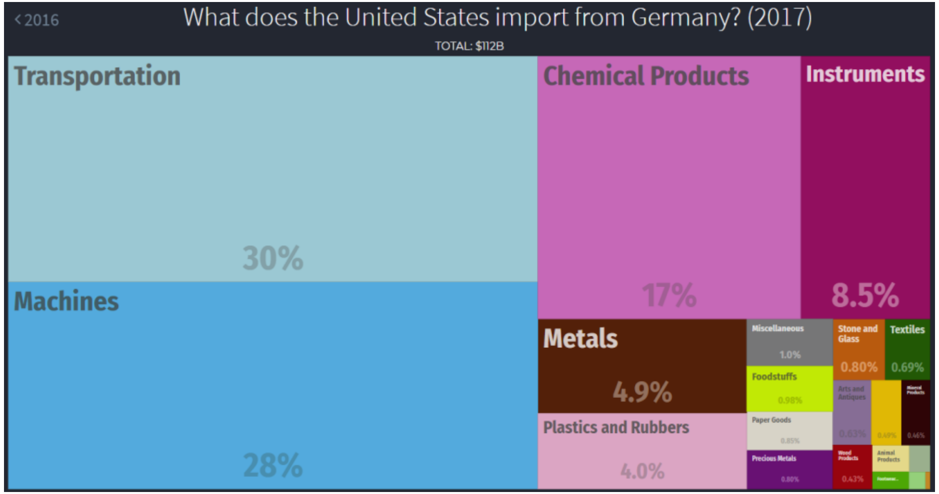

US Trade with Germany ([From OEC]())

Following Slides list the Equilibrium Definition
and more Details of the Example Set-up

1. Consumers problem

Assume Cobb-Douglas Preferences. Given $p^j_{m,i}, w^j$ consumer in country j solve

$$\max \sum_{m=1}^{M} U\left(c^j_{m,H} + c^j_{m,F}\right) = \sum_{m=1}^{M} \theta_m \log\left(c^j_{m,H} + c^j_{m,F}\right)$$

subject to budget constraint (T^i is transfer from tariffs, zero if no tariffs)

$$\sum_{i=H,F} \sum_{m=1}^{M} \tau^j_{m,i} p^j_{m,i} c^j_{m,i} = w^j L^j + T^j$$

$$\text{Non-Negativity: } c^j_{m,i} \geq 0, m = 1, \dots, M, i = H, F$$

Since both goods are inside the log( ), it implies consumers don't care about country of origin

2. Firms Problem

Since we have constant returns to scale, we can separate firm's problem by destination.

Given $p_{m,i}^{j}, w^{i}$ firms in country i maximize profits for good m for destination j

$$\max p_{m,i}^{j} y_{m,i}^{j} - w^{i} l_{m,i}^{j}$$

subject to production technology:

$$y_{m,i}^{j} = z_{m,i} l_{m,i}^{j}$$

Note: No Tariffs! Also, Productivity doesn't depend on destination!

Firm Optimization Yields: $p_{m,i}^{j} = \frac{w^{i}}{z_{m,i}}$ if $y_{m,i}^{j} > 0$

3. Market Clearing and 4. Gov Budget Constraint

Goods market clears for each good. We'll just separate it by origin and destination.

$$c_{m,i}^{j} = y_{m,i}^{j}, \qquad m = 1, \ldots, M; i, j = H, F$$

Labor market clears for each country

$$\sum_{j=H,F} \sum_{m=1}^{M} l_{m,i}^{j} = L_i, \qquad i = H, F$$

4. Government Budget Constraint

$$T^j = \sum_{m=1}^{M} (\tau_{m,i}^{j} - 1)\, p_{m,i}^{j} c_{m,i}^{j}; \; i \neq j$$

Ordering Goods and Equilibrium Cutoff

Order each good by decreasing comparative advantage for country H:

$$\frac{z_1^H}{z_1^F} > \frac{z_2^H}{z_2^F} > \cdots > \frac{z_M^H}{z_M^F}$$

- In equilibrium, there will be a good $\bar{m}$ such that H produces all goods $m = 1,2, \dots, \bar{m}$ and F produces all goods $m = \bar{m} + 1, \dots, M$.
  - This is something you can prove as a theorem, but for our purposes, we can rely on guessing that this is true, finding the cutoff good, and then verifying it's an equilibrium

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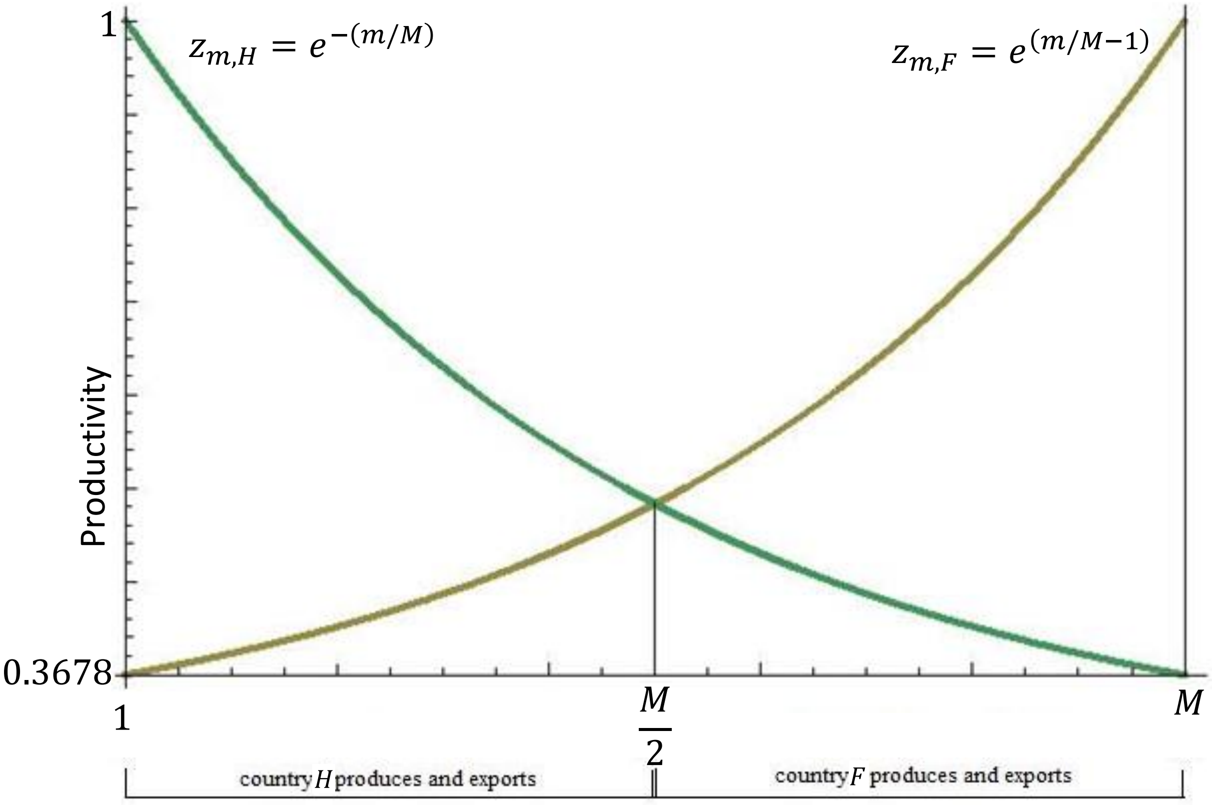
Symmetric Equilibrium with Free Trade

Will have equilibrium with $w^H = w^F$ (relative wages $\frac{w^H}{w^F} = 1$)

Will have cutoff good $\mathrm{\overline{m}} = \frac{\mathrm{M}}{2}$

- Country 1 produces and exports goods in $m = 1, \ldots, \overline{m}$
- Country 2 produces and exports goods in $m = \overline{m} + 1, \overline{m} + 2, \ldots, M$

Graph of Productivities



Tariff Trade Costs: Cutoffs

Will no longer have single cutoff

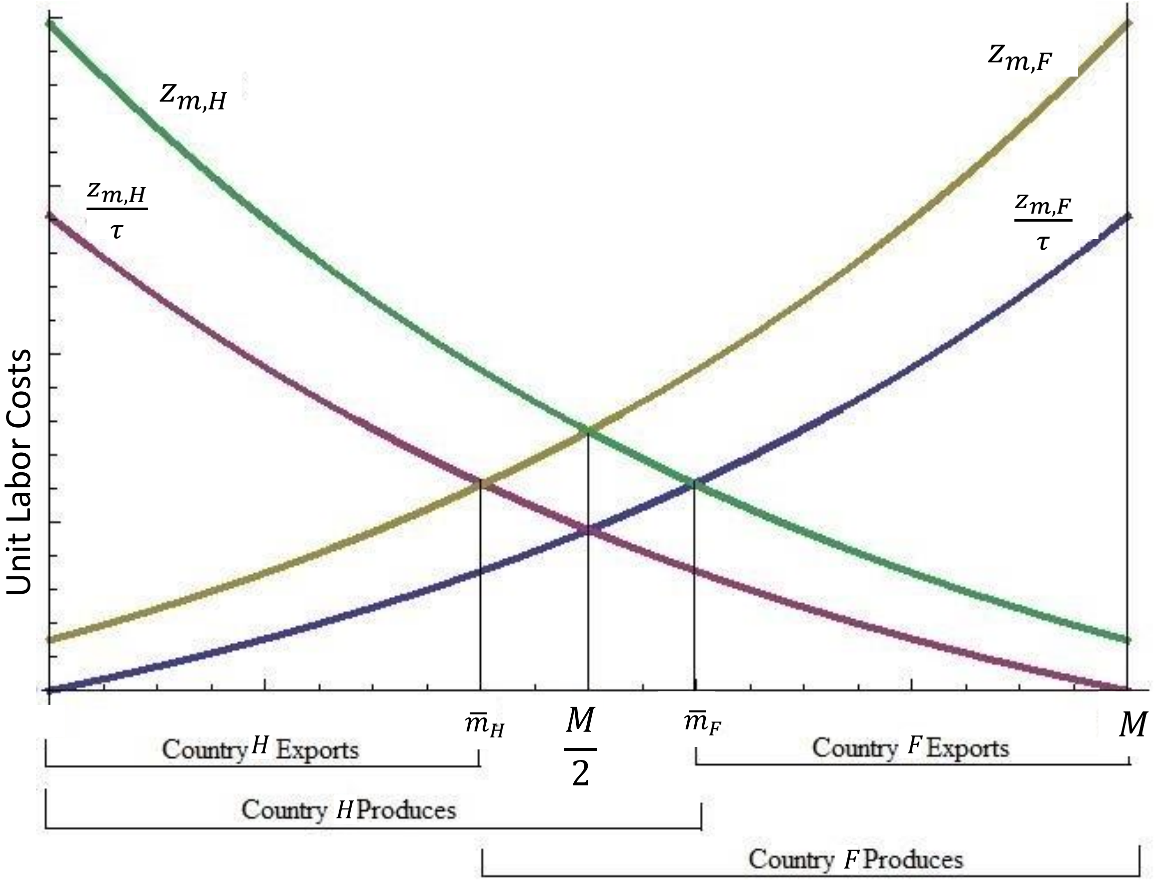
- If $\tau > \max\left\{\frac{z_{m,H}}{z_{m,F}}, \frac{z_{m,F}}{z_{m,H}}\right\}$ then good will not be exported by either country

Two cutoffs $\overline{m}_H$ and $\overline{m}_F$ ($\overline{m}_F > \overline{m}_H$):

- Country 1 produces goods $m = 1, \dots, \overline{m}_F$, exports goods $m = 1, \dots, \overline{m}_H$
- Country 2 produces goods $m = \overline{m}_H, \dots, M$, exports goods $m = \overline{m}_F, \dots, M$

Keep the same symmetric setup, so still have an equilibrium with $w^H = w^F = 1$.

Symmetric Equilibrium: Tariff Trade Costs



Iceberg Trade Costs:

Suppose each country faces an iceberg transportation cost of $\tau > 1$ when exporting:

$$y_{m,i}^{j} = \frac{l_{m,i}^{j}}{\tau z_{m,i}}, \qquad if\ i \neq j$$

Still costless to produce for domestic market: $y_{m,i}^{i} = \frac{l_{m,i}^{i}}{z_{m,i}}$

Comparison Tariff Trade Costs

For both iceberg trade costs and tariffs, will have

$$p_{m,i}^{j} y_{m,i}^{j} = \begin{cases} \dfrac{w^{i} l_{m,i}^{j}}{\tau}, & if\ i \neq j \\ w^{i} l_{m,i}^{j}, & if\ i = j \end{cases}$$

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:

$$Tariffs: \sum_{i=H,F} \sum_{m=1}^{M} \tau_{m,i}^{j} p_{m,i}^{j} c_{m,i}^{j} = w^{j} L^{j} + T^{j}$$

$$Iceberg: \sum_{i=H,F} \sum_{m=1}^{M} p_{m,i}^{j} c_{m,i}^{j} = w^{j} L^{j}$$

Overview of DFS

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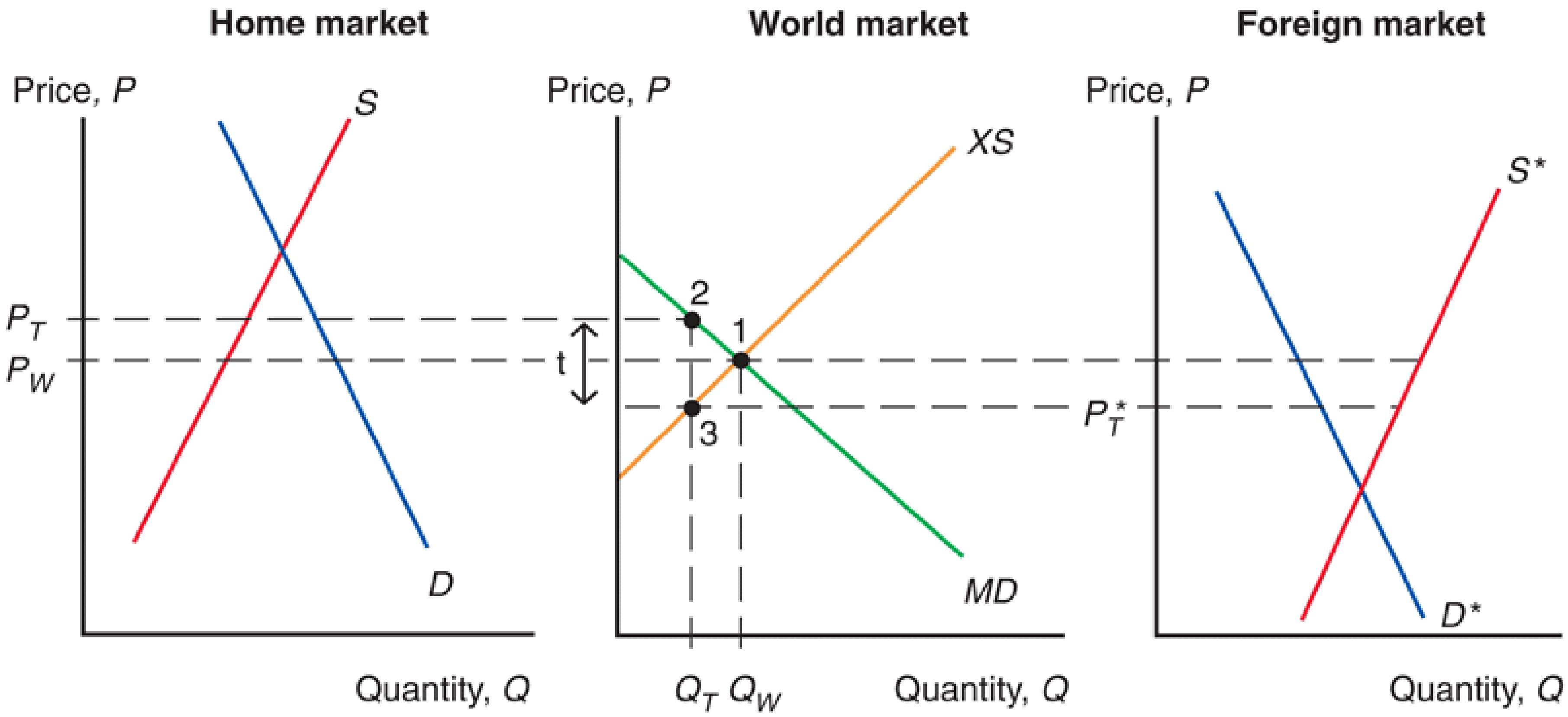
Following Slides briefly show Tariffs in PE Setup

Effects of an Import Tariff



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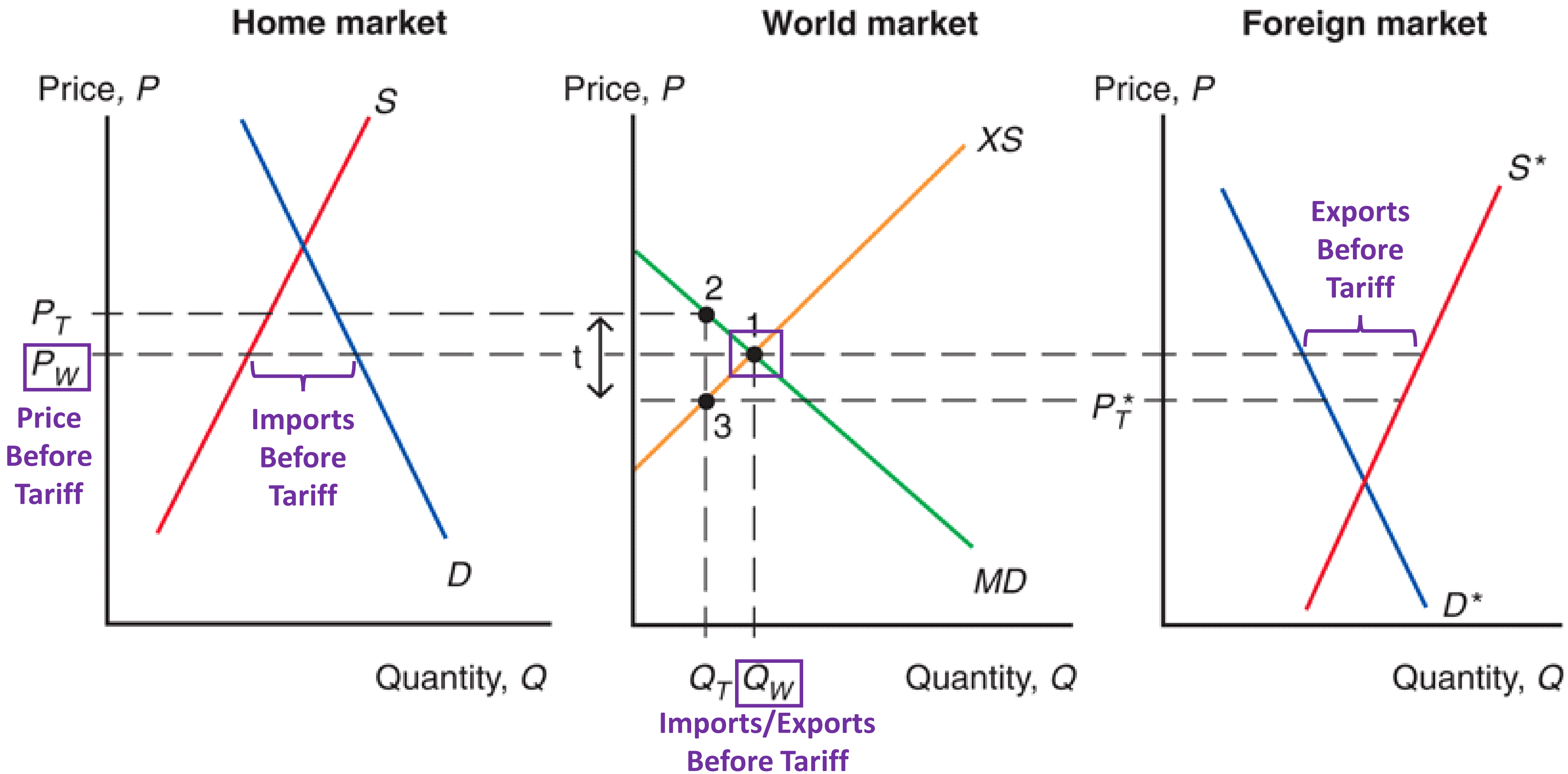

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