International Trade: Lecture 3

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The Krugman model (Krugman 1980)

- Krugman 1980: "Scale Economies, Product Differentiation, and the Pattern of Trade"
- The H-O model explains trade patterns between countries with different factor endowments
- The Ricardian model: trade patterns between countries with different technologies
- **However!** None of these models explains trade between the industrial (developed) countries with similar technologies and factor endowments. Moreover, trade between developed countries is basically two-way exchange of differentiated products (intra-industry trade).

A new framework is needed! $\Longrightarrow$ *New Trade Theory*

The Krugman model

The main elements:

- Economies of scale (increasing return to scale)
- The possibility of product differentiation: firms can *costlessly* differentiate their products (each product is a new one) $\Longrightarrow$ monopoly power
- Imperfect competition (monopolistic competition): each firm is small enough to affect aggregate variables
- Free entry

$\Longrightarrow$ Trade between economies with similar factor endowments, the role of a home market in determining trade patterns.

The Krugman model: Assumptions

- A large number of potential goods (in fact, a continuum of potential goods)
- The utility function is given by

$$U = \sum_{i=1}^{n} c_i^{\theta}$$

  where $0 < \theta < 1$ and c_i is consumption of good (variety) i.
- The number of goods actually produced is n.

The Krugman model: Assumptions

- The only factor of production is labor.
- The cost function (labor requirements):

$$l_i = \alpha + \beta x_i$$

  where x_i output of good i.

- That is, there are a fixed costs of production and constant marginal costs.
- Increasing returns to scale: $\frac{l_i}{x_i} = \frac{\alpha}{x_i} + \beta$ is decreasing in x_i. Therefore, it is profitable for firms to produce a new variety than to compete with other firms (higher share of the market).

The Krugman model: Assumptions

- We identify consumers with workers:

$$x_i = Lc_i$$

  where L is the number of workers in the economy.

- Full employment (labor market clearing condition):

$$L = \sum_{i=1}^{n} (\alpha + \beta x_i).$$

- Firms maximize their profits.
- Free entry: equilibrium profits are always zero.

The Krugman model: Equilibrium in Closed Economy

Consumer Behavior:

Consumers maximize

$$U = \sum_{i=1}^{n} c_i^{\theta}$$

subject to

$$\sum_{i=1}^{n} p_i c_i = w$$

where w is the wage level.

The Krugman model: Equilibrium in Closed Economy

Consumer Behavior:

This implies that individual demand for good i is given by

$$c_i = \left(\frac{\lambda}{\theta}\right)^{\frac{1}{\theta-1}} p_i^{\frac{1}{\theta-1}}$$

where λ is the Lagrangian multiplier (the marginal utility of income) and given by

$$\lambda = \theta \left(\frac{\sum_i p_i^{\frac{\theta}{\theta-1}}}{w}\right)^{1-\theta}.$$

The Krugman model: Indirect Utility

Let us calculate the indirect utility function when the prices are identical.

Specifically,

$$U = \sum_i c_i^\theta \iff$$
$$U = n^{1-\theta}\left(\frac{w}{p}\right)^\theta$$

Hence, there is a variety effect (represented by n) the traditional income effect, $\frac{w}{p}$.

The Krugman model: Equilibrium in Closed Economy

Firms:

- Firms profits are given by

$$\pi_i = (p_i - w\beta)\, x_i - w\alpha,$$

- Recall that

$$x_i = Lc_i = L\left(\frac{\lambda}{\theta}\right)^{\frac{1}{\theta-1}} p_i^{\frac{1}{\theta-1}}.$$

- Therefore, firms maximize (each firm ignores the effect of its actions on other firms, λ is taken as given)

$$\pi_i = (p_i - w\beta)\, L\left(\frac{\lambda}{\theta}\right)^{\frac{1}{\theta-1}} p_i^{\frac{1}{\theta-1}} - w\alpha$$

with respect to price.

The Krugman model: Equilibrium in Closed Economy

Firms:

The optimal price level is given by

$$p_i = p = \frac{\beta w}{\theta}$$

- Prices are the same for all goods (symmetry).
- The price does not depend on output (the property of the utility function)
- Given the price:

$$\pi_i = \frac{1-\theta}{\theta} w \beta x_i - w\alpha$$

The Krugman model: Equilibrium in Closed Economy

Free entry condition:

Because of free entry, firms profits are equal to zero in the equilibrium. Therefore,

$$\begin{aligned} \pi_i &= 0 \iff \\ x_i &= \frac{\alpha\theta}{\beta(1-\theta)}. \end{aligned}$$

Production of each firm is constant and does not depend on the characteristics of the economy: the size, the number of firms, etc.

The Krugman model: Equilibrium in Closed Economy

The number of firms:

Labor market clearing condition implies that

$$\begin{aligned} L &= nl_i = n(\alpha + \beta x_i) \\ &= n\frac{\alpha}{1-\theta} \end{aligned}$$

Therefore,

$$n = \frac{(1-\theta)L}{\alpha}.$$

The model is closed! We know n, p, x.

The Krugman model: Effects of Free Trade

- Suppose now there are two countries.
- Countries have same technologies and preferences
- One factor of production $\Longrightarrow$ no differences in relative factor endowments
- No conventional reasons for trade: the Ricardian and H-O models predict no trade!

Trade occurs because, in the presence of increasing returns, each good will be produced in only one country and only by one firm!

The Krugman model: Effects of Free Trade

The trade equilibrium:

- The symmetry and the absence of transport costs imply that the countries have the same wages (FPE).
- Demand for a certain variety does not change $\Longrightarrow$
$$p = \frac{\beta w}{\theta}.$$
- Therefore, the output of each firm does not change compare to the autarky equilibrium.
- The only thing that changes is the number of varieties:
$$U = \sum_i c_i^\theta + \sum_j \left(c_j^*\right)^\theta.$$
- Individuals distribute their expenditure over both the n goods produced at home and the n^* goods produced in the foreign country.

The Krugman model: Effects of Free Trade

The trade equilibrium:

n and n^* can be found from the labor markets clearing conditions:

$$n = \frac{(1-\theta)L}{\alpha}$$
$$n^* = \frac{(1-\theta)L^*}{\alpha}$$

Gains from trade: $\frac{w}{p}$ does not change. The variety effect only works. Consumers gains because of higher number of available varieties:

$$U = (n + n^*)^{1-\theta} \left(\frac{w}{p}\right)^{\theta}.$$

Gains from trade come solely through increased product diversity.

The Krugman model: Effects of Free Trade

Trade volumes:

Consider the value of exports from the home country to the foreign:

$$Exports = npc^* L^*$$

where c^* is the demand for a certain variety of an individual in the foreign country.

It can be shown (see the class presentation) that

$$c^* = \frac{w^*}{(n + n^*)p}$$

Therefore,

$$EX = \frac{w^* n L^*}{n + n^*}.$$

The Krugman model: Effects of Free Trade

Trade balanced condition:

- The trade balanced condition states that imports should be equal to exports. In our case, it holds.
- It confirms our assumption about same wage rate in the countries. In general, we want to have

$$\frac{w^* n L^*}{n+n^*} = \frac{w n^* L}{n+n^*} \iff w = w^*.$$

The Krugman model: Transport Costs

- Now suppose there are trade costs represented by the "iceberg" transport cost, τ
- An individual has a choice over n domestic products and n^* products produced abroad.
- Because of trade costs, foreign products will cost more than the producer price. That is, if p^* is the producer price of a foreign variety, than the price of this product in the home country is τp^*.
- In other words, domestic consumers pay τp^*, while foreign consumers pay only p^*.

The Krugman model: Transport Costs

Equilibrium:

- "Bad news!" Because of trade costs, wage rates are different in the countries.
- But! Demand for a certain variety still has the same elasticity

$$p = w\beta/\theta$$
$$p^* = w^*\beta/\theta.$$

- In the same manner,

$$x = x^* = \frac{\alpha\theta}{\beta(1-\theta)}$$

- Finally,

$$n = \frac{(1-\theta)L}{\alpha}$$
$$n^* = \frac{(1-\theta)L^*}{\alpha}$$

The Krugman model: Transport Costs

Equilibrium:

- Hence, we need to find only wages or, in fact, the relative wage given by $\omega = \frac{w}{w^*}$.
- We will use the trade balanced condition: the total value of exports should be equal to the total value of imports.
- Exports of the home country are given by

$$EX = np\tau c^* L^*,$$

where c^* is the foreign demand for domestic variety.
- It can be shown that

$$c^* = \frac{w^*}{p\tau} \frac{1}{n^* \left(\frac{p^*}{p\tau}\right)^{\frac{\theta}{\theta-1}} + n}$$

The Krugman model: Transport Costs

Equilibrium:

- Therefore, total exports are given by

$$EX = \frac{w^* n L^*}{n^* \left(\frac{p^*}{p\tau}\right)^{\frac{\theta}{\theta-1}} + n}$$

- By analogy, total imports (total exports of the foreign country) are given by

$$IM = \frac{w n^* L}{n \left(\frac{p}{p^*\tau}\right)^{\frac{\theta}{\theta-1}} + n^*}$$

The Krugman model: Transport Costs

Equilibrium:

- In equilibrium:

$$EX = IM \iff$$

$$\frac{w}{w^*} = \frac{L^* + \left(\frac{w}{w^*}\right)^{\frac{\theta}{\theta-1}} L\tau^{\frac{\theta}{1-\theta}}}{L + \left(\frac{w}{w^*}\right)^{\frac{\theta}{1-\theta}} L^*\tau^{\frac{\theta}{1-\theta}}}.$$

From this equation, we can find $\frac{w}{w^*}$ (see the picture in the class note).

The Krugman model: Transport Costs

Analysis of the equilibrium:

- First, if $\tau = 1$, then $\frac{w}{w^*} = 1$
- Second, assume that $L^* > L$, then $\frac{w}{w^*} < 1$, That is, *the larger country has the higher wage*.
  - Intuition: if production costs were the same in both countries (this is the case when wages are the same), **it would be always profitable to produce near the larger market (to save on transport cost)**. Therefore, to keep labor employed in both countries, this advantage must be offset by a wage differential.

The Krugman model: The Home Market Effect

Main idea: *countries will tend to export those kinds of products for which they have relatively large domestic demand.*

- Two industries with many differentiated products within each of them.
- We want to show:

Countries will be a net exporter in the industry for whose products it has the relatively larger demand.

The Krugman model: The Home Market Effect

Setup:

- Two classes of products: *alpha* and *beta*
- Consumption in one class is c_i and in the other class is $\tilde{c}_i$
- Two population groups: one group of size L likes only *alpha* products, while the other group of size $\tilde{L}$ likes only *beta* products. That is,

$$U = \sum_i c_i^\theta \quad \text{and} \quad \tilde{U} = \sum_i \tilde{c}_i^\theta$$

- The technology of production is the same for both industries

$$\begin{aligned} l_i &= \alpha + \beta x_i \\ \tilde{l}_j &= \alpha + \beta \tilde{x}_j \end{aligned}$$

The Krugman model: The Home Market Effect

- There are two countries and transport cost of the "iceberg form".
- We assume that

$$L + \tilde{L} = L^* + \tilde{L}^* = \bar{L},$$

  meaning that $w = w^*$.
- However,

$$\begin{aligned} L &= f\bar{L} \\ L^* &= (1-f)\bar{L} \end{aligned}$$

  where $f \in (0, 1)$. That is, in terms of demand, the foreign country is a *mirror* image of the home country.
- If $f > 0.5$, then the home country has the large domestic market for the *alpha* products and vice versa.

The Krugman model: The Home Market Effect

Theorem

The home country will be a net exporter of the first industry's products (alpha products) if $f > 0.5$.

The Krugman model: Testing The Home Market Effect

Davis and Weinstein (2003) "Market access, economic geography and comparative advantage: an empirical test," Journal of International Economics

The traditional H-O model:

Consider a positive shock to the home demand structure for a good. If the production set is strictly convex, the demand shock causes the relative price of the good to rise. This in turn increases the production of good in both countries. Therefore, the idiosyncratic demand will be partly met additional local supply and *partly* by higher imports.

Local supply moves less than one-for-one with the idiosyncratic demand.

The Krugman model: Testing The Home Market Effect

Davis and Weinstein (2003)

The Krugman model:

A rise in the home demand for alpha products (a rise in L): more home firms enter the industry. These firms sell in both home and foreign markets (exports).

As a result, production in the alpha industry increases by more than unity!

The Krugman model: Testing The Home Market Effect

Davis and Weinstein (2003)

- Hence, there is a key difference between two types of models: the elasticity of production subject to idiosyncratic demand.
- An equivalent formulation (Davis and Weinstein (2003)): idiosyncratic demand patterns have a *magnified* impact on production patterns. The elasticity is greater then one in the Krugman model, but less than one in the classical theory.
- In the data (OECD countries in 1985): elasticity appeared to be greater than one!

The Krugman model: Testing The Home Market Effect

Costinot et al. (2016) "THE MORE WE DIE, THE MORE WE SELL? A SIMPLE TEST OF THE HOME-MARKET EFFECT," NBER Working paper 22538.

- They used *variation in disease burdens* across countries as a way to address the empirical challenge of testing the home market effect.
  - countries whose populations are more likely to die from particular diseases, because of exogenous demographic characteristics, are also more likely to demand pharmaceutical treatments that target those diseases
  - one can test for the existence of the home-market effect by estimating
    - whether higher disease burdens at home tend to increase the sales of domestic drugs (treating those diseases) abroad (the weak home-market effect)
    - and if so, whether they tend to increase them by more than the sales of foreign drugs at home (the strong **("theoretical")** home-market effect)

The Krugman model: Testing The Home Market Effect

Costinot et al. (2016)

- The drug famotidine—used to treat peptic ulcers and gastro-esophageal reflex—was discovered in Japan (Hara, 2003), a country known for particularly high incidence rates of peptic ulcers.
- In the data, individuals in Japan are nearly twice as likely to die from digestive disorders than are individuals in the rest of the world
    - 0.243 deaths per 1,000 population annually in Japan, relative to 0.130 on average in other countries.

The Krugman model: Testing The Home Market Effect

Costinot et al. (2016)

- The data: sales of Japanese drugs targeting peptic ulcers and gastro-esophageal reflux diseases outside Japan account for 10.35% of world sales, compared to an average of 4.54% for all other disease categories.
- This paper uses this type of variation—extended to exploit demographic-driven components—in order to test for the home-market effect in a dataset with near-global coverage of drug sales and disease burdens.

The Krugman model: Testing The Home Market Effect

Costinot et al. (2016)

- The paper documents sales in 56 countries of more than 20,000 molecules by roughly 2,650 firms, which we convert to a dataset of bilateral sales at the disease level, by matching each firm to the country in which it is headquartered and each molecule to the disease that it targets.
- It also documents the demographic composition and disease burdens in the same 56 countries.

The Krugman model: Testing The Home Market Effect

Costinot et al. (2016)

The authors document:

- countries tend to sell relatively more of the drugs for which they have higher disease burdens
  - in line with the existence of a weak home-market effect
- the elasticity of sales towards foreign countries tends to be higher than the elasticity of purchases from foreign countries
  - which is consistent with the existence of a strong home-market effect