

Increasing returns to scale

Not a comparative advantage trade story

Consider the Chevrolet Impala

Classic American car.

SuperStock



1959 Chevrolet Impala Convertible.



2020 Impala.

Some Chevrolet facts:

- All Impalas are now made at Oshawa, Ontario.
 - Actually a Canadian product!
- Roughly 200, 000 imported into the US per year.
- All Cobalts are made in Lordstown, Ohio (similar but smaller Chevrolet).

Why?

- Comparative advantage?
- Requires Canada to have comparative advantage in Impalas, US to have one in Cobalts.

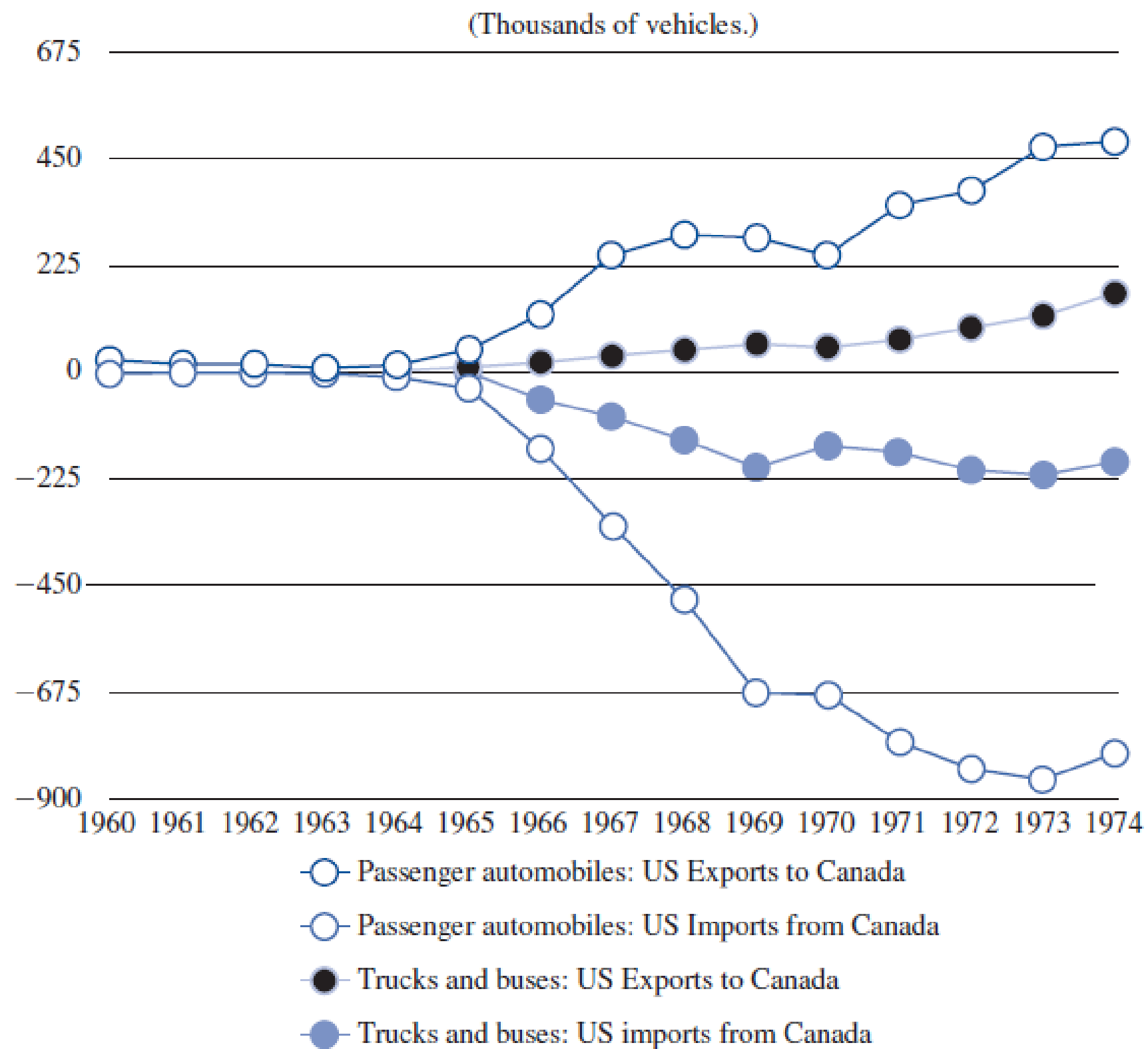
- Comparative advantage doesn't seem to explain US imports of Impalas.
- *Two factors:*
 - I. Canada-US Auto Pact of 1965
 - II. Increasing returns to scale

Canada-US Auto Pact of 1965

- Before 1965, both countries had high tariffs on imported cars and auto parts.
- Result: Big automakers mostly produced in Canada for Canadian market.
- Little trade
- Duplicated assembly lines on both sides of the border.
- Production on smaller scale in Canada: High cost per unit.

- In 1965, two governments eliminated their tariffs against each others' automobile and auto parts exports
- Agreement was grandfathered into NAFTA (1994).
- Some restrictions applied:
 - American automakers to maintain their production of cars and employment in Canada

FIGURE 3.1
US-Canada Automotive
Trade, 1960–74.



Source: USITC (1976, Tables 43, 50, 74 and 76).

Increasing returns to scale

- An industry exhibits *increasing returns to scale (IRS)* if and only if an $x\%$ increase in all inputs increases the output by more than $x\%$.
- Equivalently, an industry has IRS if an $x\%$ increase in output increases cost by less than $x\%$, thus lowering average cost.

Fixed costs and IRS

- Setting up and maintaining an assembly line for one model requires huge fixed costs.
- Induces increasing returns to scale (IRS).
- Suppose cost of producing Q Impalas is equal to $C(Q) = F + waQ$.
- Then cost of producing $2Q$ Impalas is equal to $F + 2waQ$.
- Doubling the output less than doubles the cost!

- Suppose that General Motors needs to produce 11 models.
- Each model:
 - 200,000 units for the US market,
 - 20,000 units for the Canadian market.

- *Pre-Auto Pact.*
- 11 models produced in Canada:
- Cost for each model = $F + 20,000wa$.
- 11 models produce in US;
- Cost for each model = $F + 200,000wa$
- Total cost:

$$22F + 11 \times 220,000wa = 22F + 2,420,000wa$$

- *Post Auto Pact.*
- Now, GM can concentrate production of each model in one location.
- Produce 1 model in Canada, 10 in the US.
- Produce 220,000 units at each plant.
- Now costs are equal to
- $11 \times (F + 220,000wa) = 11F + 2,420,000wa$

- Thus, *GM has saved 11F.*
- Same number of each type of car produced, but costs are lower.
- *Note:* Before, there was no trade in cars.
- Now, every car is traded.
- 200,000 cars exported from Canada to the US.
- 20,000 cars exported from the US to Canada.
- *Intra-industry trade.*

The point:

- IRS *provides a reason for trade*, by creating an incentive to concentrate production of each product in one location.

IRS sheds light on a number of additional topics in trade:

- How to access foreign market: exports versus FDI
- Role of monopolistic competition in trade
- Intra-industry trade and gravity equation
- Why Canadian policy-makers promoted NAFTA

Tackling a foreign market

- You are the CEO of GM.
- You want to break into the European market.
- Two options:
 - produce here and export, or
 - produce over there - FDI

Producing in Europe: FDI Option.

- Set up a plant in Spain.
- Fixed cost: F .
- After that, each unit requires a units of labor.
- Each unit of labor costs w .
- Choose P to maximize $(P - aw)Q(P) - F$.
- This yields maximum profit from FDI option.

Producing here: Export option.

- No *additional* fixed cost (Important!)
- Each unit requires a units of labor.
- Labor costs w per unit.
- Transport cost of $k(d)$ per car, where d is distance to market.
- Tariff of t per car.
- Choose P to maximize $(P-wa-k(d)-t)Q(P)$.

FDI versus exporting

- $(P - aw)Q(P) - F$ versus $(P - wa - k(d) - t)Q(P)$
- FDI option is more likely to be attractive if:
 - t is high;
 - d is high;
 - F is small.

FDI versus exporting

- To summarize:
- We expect to see more FDI relative to exports where
 - *High trade barriers*
 - tariffs and distance
 - *Economies to scale in production are not significant*
 - F is small

GM's strategy in Europe

- Produces in Europe, mostly through its Opel subsidiary
- Within Europe, production is concentrated
- Between the US and Europe: large transport costs and tariffs, GM chooses FDI
- Within Europe: IRS is dominant factor, GM chooses to export

In Class exercise

- Suppose that you are the CEO of an automobile company. Your firm wants to sell its cars in each of several foreign countries, and you must decide whether to do so by exporting or by producing locally for that market through FDI.
- Suppose that in each country the inverse demand for the product is the same, and is given by:
 - $P = 100 - Q$

In Class exercise

- The marginal cost of production in any country is the same, and is equal to \$20 per car.
- Wherever you choose to produce, your firm is a monopolist.
- To produce in a foreign country, your firm must incur a fixed cost equal to \$700.
- On the other hand, to produce in your home country and export to a country that is d miles away requires a transport cost of $d/5,000$ dollars per car shipped.

In Class exercise

- There are two attractive foreign markets:
 - country A which is $d^A=50,000$ miles and
 - country B which is $d^B=200,000$ miles from your home country.

Question : How do you access each market, by exporting or by FDI?

In Class exercise

- First, consider the exporting strategy.
- In country A: $MR=MC$
- Or $100 - 2Q = 20 + d^A/5,000 = 30$
- $Q=35$, $P=100-35=65$, profits $= 35*(65-30)=1225$
- In country B: $MR=MC$
- Or $100 - 2Q = 20 + d^B/5,000 = 60$
- $Q=20$, $P=100-20=80$, profits $= 20*(80-60)=400$

In Class exercise

- Now consider the FDI strategy:
- $MR=MC$, or $100-2Q=20$
- $Q=40$, $P=100-40=60$, $\text{profits}=40*(60-20)-700=900$
- Hence, to access market in country A you should choose an exporting strategy,
- in country B - FDI strategy.

Monopolistic competition

- IRS matter not only for giant firms like GM.
- Pervasive in manufacturing, including small-scale manufacturing.
- E.g., furniture
- A pretty good description of this type of industry: Monopolistic competition.

Trade in Furniture b/w the US and Canada

- 2001:
- The US exported to Canada: \$1.9 billion
- Canada exported to the US: \$3.9 billion
- Trade is dominated by a large number of small and medium-size firms

Example: Baronet and Thos.Moser

- Two medium-sized firms.
- Each has a tiny share of the total furniture market.
- Baronet is Canadian; Moser is American.
- Fixed cost from production and design.
- Distinctive styles.



Baronet Java dining set.



Thos. Moser Hawthorne dining set.

Key features of monopolistic competition:

- Large number of firms; each small compared to the whole market.
- Each produces a unique product; hence, monopoly power.
- Free entry, hence zero profits in equilibrium.

- Baronet set the optimal price P^* as a monopolist
- But it earns zero profit as $P^*=AC$
- If $P^*>AC$, then
 - Other firms would enter
- The number of firms adjusts so that there are zero profits!

- Opening up trade with the US
- Flattens Baronet's demand curve – more elastic
- Raising its price will send some of its customers to a US competitor
- Baronet will price its product closer to marginal cost

- Thus, Baronet now has an incentive to lower its price and sell more dining sets.
- But at the same time *all other firms have the same incentive.*
- All other furniture makers therefore cut their prices, shifting Baronet's demand curve down.

With trade

- Canadian producers sell some of their products to American consumers, and vice versa
- Price of each furniture product is *lower*
 - The market is more competitive now
- Greater number of all firms
- But less firms in each country
 - since the total employment is the same but each firm produces more

With trade

- Owners of firms get zero profit anyway, so no loss from trade
- Consumers benefit from
 - A greater variety of products
 - Lower prices

Implications

- Plenty of trade, even between identical countries.
- Once again, trade results from IRS.
- Trade is *intra-industry* – within industry
- Our previous model explained trade across industries – or *inter-industry* trade

Intra and Inter- industry trade

- $\text{Inter-industry}_{ij} = \text{Net trade}_{ij} / \text{Total trade}_{ij}$
- $\text{Intra-industry}_{ij} = 1 - \text{Inter-industry}_{ij}$

Exercises

- Ex 1: The US exports \$10 billion worth of inorganic chemicals to Germany and imports inorganic chemicals from Germany by the same dollar amount. The measure of the *intra-industry* trade is?
- Ex 2: Japan imports \$1 billion of garments from Indonesia, but does not export any to Indonesia. The measure of the *intra-industry* trade is?

Exercises

- The US exports \$10 billion worth of inorganic chemicals to Germany and imports inorganic chemicals from Germany by the same dollar amount. The measure of the *intra-industry* trade is?
- Answer: 1, or 100%, it is all *intra*-industry trade
- Japan imports \$1 billion of garments from Indonesia, but does not export any to Indonesia. The measure of the *intra-industry* trade is
- Answer: 0 %, it's all *inter*-industry trade!

Index of Intra-Industry Trade for the U.S., 2005

Product	Value of Imports (\$ millions)	Value of Exports (\$ millions)	Index of Intra- industry Trade (%)
Golf clubs	\$305.8	\$318.7	98%
Vaccines	799.1	605.2	86
Small cars	1,199.0	800.9	80
Whiskey	757.7	481.7	78
Mattresses	89.8	32.4	53
Large passenger aircraft	5,988.2	18,821.5	48
Frozen orange juice	223.0	64.0	45
Apples	102.8	492.7	35
Sunglasses	835.4	105.7	22
Natural gas	27,134.5	2,802.8	19
Fax machines	271.8	15.2	11
Men's shorts	701.3	12.1	3

Another Empirical Application: The Gravity Equation

- The **gravity equation for trade** states that countries with larger GDPs or that are close to each other will have more trade between them

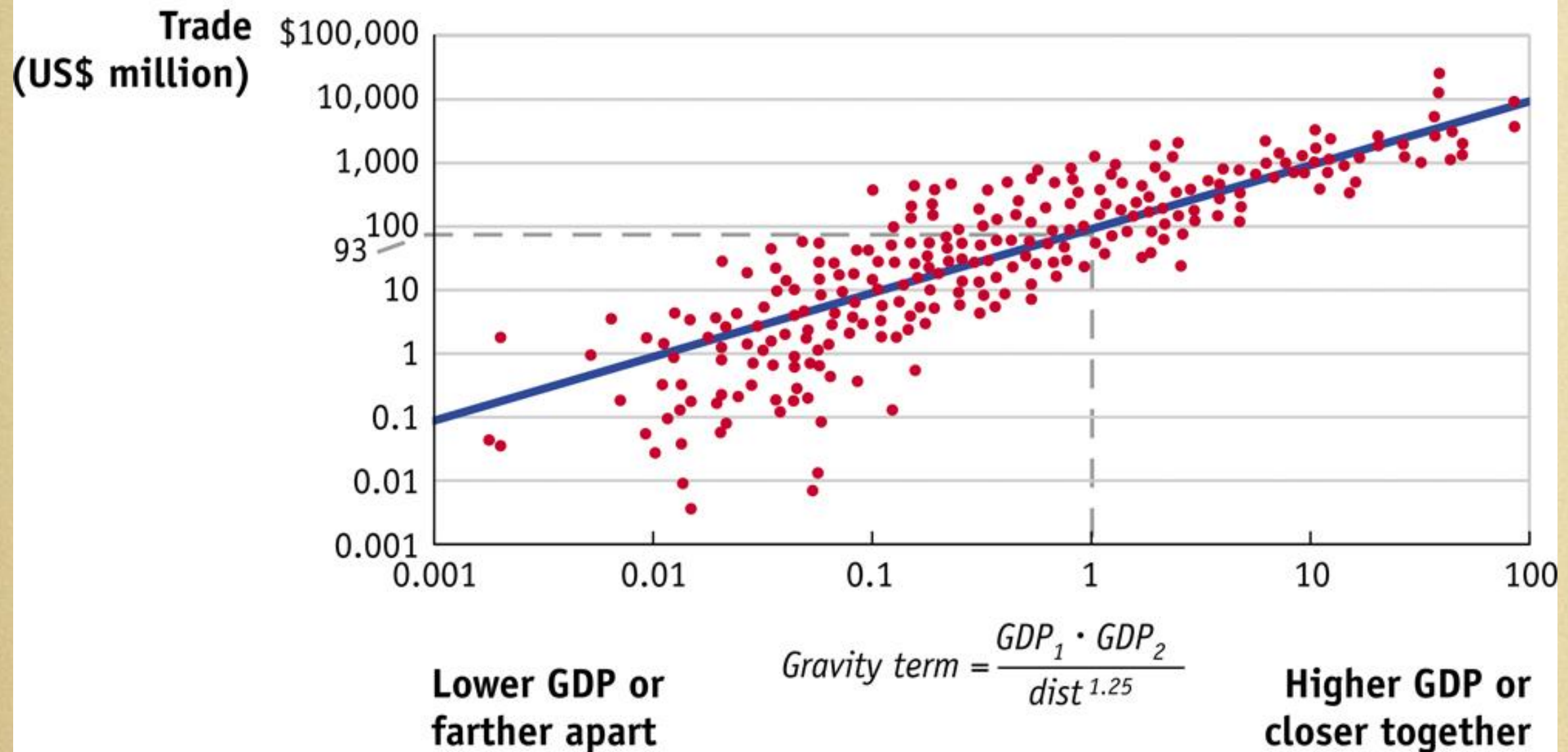
The Gravity Equation

$$Trade = B \frac{GDP_1 GDP_2}{dist^n}$$

The constant term B: summarizes the effects of all other factors

- The Gravity Equation for Canada and the United States
- Data on the value of trade between 10 Canadian provinces and 30 U.S. states in 1993

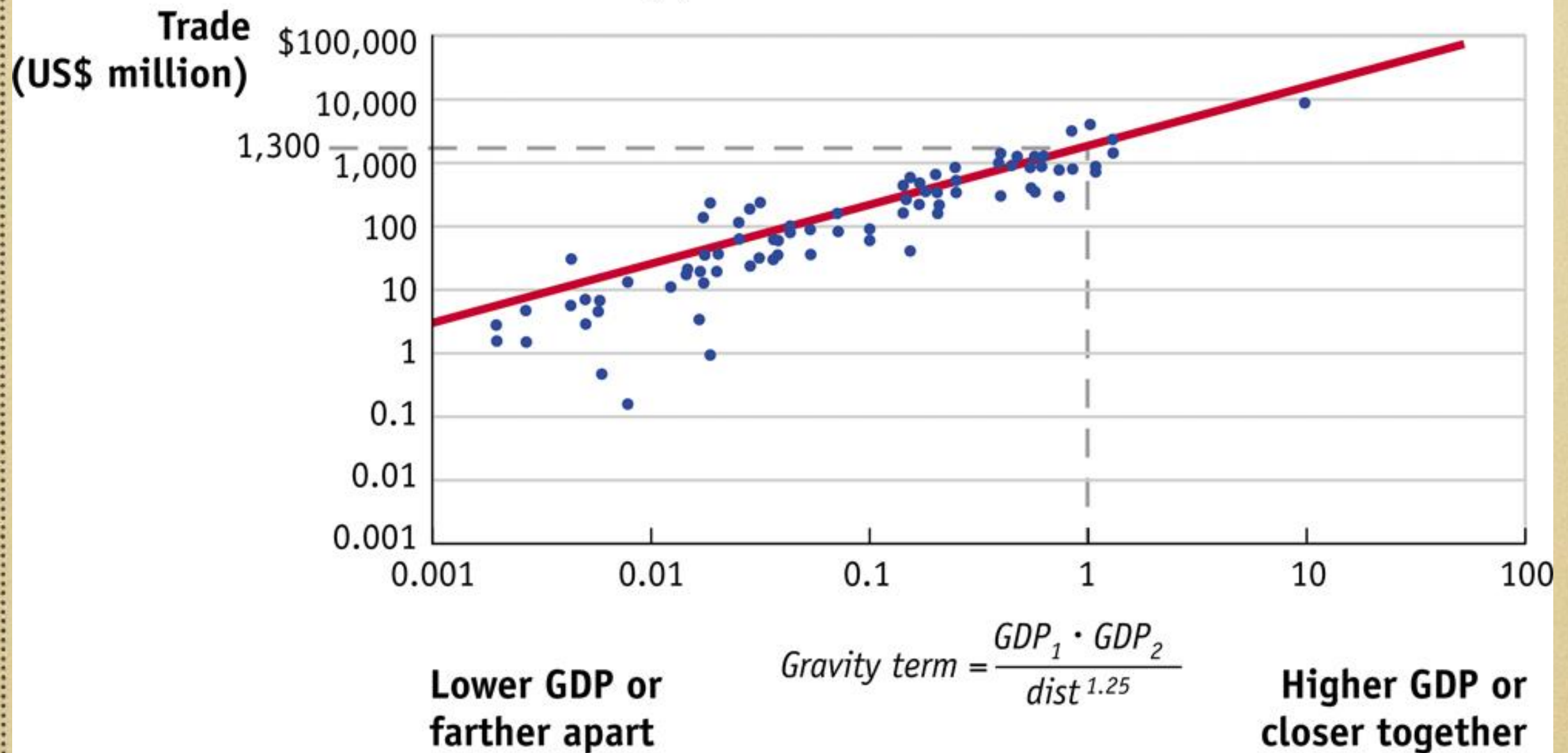
(a) Trade between U.S. States and Canadian Provinces



Trade within Canada

The gravity equation should also work well at predicting trade within a country, or intra-national trade

(b) Trade between Canadian Provinces



Very interesting observation!

- For USA-Canada trade $B=93$
- For trade within Canada $B=1300$
- Taking the ratio of the constant terms ($1300/93 = 14$), means on average there is 14 times more trade within Canada than occurs across the border!

Border Puzzle

- Factors that affect trade between countries are called *border effects* and include
 - Trade policy
 - Administrative rules and regulations
 - Geographic factors
 - Cultural factors
- In the gravity equation, all the factors that influence trade are captured in the constant, B

In class exercise

- Let's try to solve the border puzzle!
- Consider the US and Canada who trade only with each other
- Suppose that $GDP_{US} = 9 \text{ times } GDP_{Canada}$
- First, suppose there is no border effect
- Assume that imports from Canada to the US are proportional to GDP_{US} and to the share of GDP_{Canada} in global GDP
- And similar for imports from the US to Canada

In class exercise

- Now suppose that there is a border effect which reduces trade twice in each country
- By what percentage of domestic GDP is trade being reduced in each country?
- Which country experiences a larger reduction in trade?
- Your conclusion: does border reduce trade more for small country like Canada or for large country like the US?

NAFTA

- Studies in Canada in the 1960s predicted substantial gains from free trade with the U.S.
- Firms would expand their scale of operations to service the larger market and lower their costs
- Studies in the mid-80's influenced Canadian policy makers to proceed with the free trade agreement with the U.S.
- NAFTA
 - 1989 Canada and the US signed FTA
 - 1994 Mexico joined

Was the theory right?

- Was NAFTA indeed good for Canadian economy?
- Daniel Trefler estimated effects of NAFTA on Canada using data for 1988-1996

Trefler's findings

- **Short run:** 100,000 lost jobs (5% of manufacturing employment)
 - Some industries that had very large tariff cuts saw employment fall by as much as 12%
 - Indeed, our theory predicts that some Canadian firms exit the market
- **Long run:** these job losses were more than made up for by creation of new jobs elsewhere in manufacturing
 - Again, consistent with our theory which predict that surviving firms expand their output

- Another finding: *positive effects on productivity*
 - in industries most affected by tariff cuts
 - compound growth of 1.9% per year
 - manufacturing overall
 - compound growth of 0.7% per year
- The difference of 1.2% per year is an estimate of the effect of NAFTA on the productivity of Canadian firms!

- But our theory has no predictions about productivity effect!
- Because we assumed that all firms are equally productive
- Clearly unrealistic assumption

Adding heterogeneity: The Melitz effect.

- Suppose there are high-cost and low-cost producers in the same industry
 - *heterogeneous firms*
- Question was explored in an influential paper by Melitz (2003).

The idea

- Take IRS model
- Make firms heterogenous – each has a different productivity
- Add dynamics – over time, some firms die and replaced by new entrants
- Also, a firm has to pay a fixed cost in order to export

- Suppose that to produce q units of output, a firm must hire $f + q/\Phi$ units of labor.
- The constant f is a fixed labor requirement, and is the same for all firms.
- Therefore, the fixed cost is equal to wf , where w is the wage.

Suppose that to produce q units of output, a firm must hire $f + q/\Phi$ units of labor.

- The parameter Φ is a constant for each firm, but varies from firm to firm.
- More productive firms have higher values of Φ .
- The marginal cost for each firm is equal to w/Φ , where w is the wage.

Autarky equilibrium

- Firms enter until the profits for the marginal firm are equal to zero.
- Only the most efficient firms enter.
- More productive firms (higher Φ) produce more and make higher profits than less productive firms.

Now open up trade.

- If a firm wants to export, it must pay an additional fixed cost (e.g., setting up a distribution network).
- As a result, only the most productive firms choose to export.
- Less productive firms don't benefit from exports and hit by competition
- Therefore, less productive firms produce less and have lower profits than before trade; some drop out.

Result: Effects of trade

- More productive firms benefit from less productive firms dropping out; their output and profits go *up*.
- Market share of less productive firms falls; market share of more productive firms rises.
- Average productivity of industry therefore *rises*.
- Call this the 'Melitz effect.'

Output of firm.

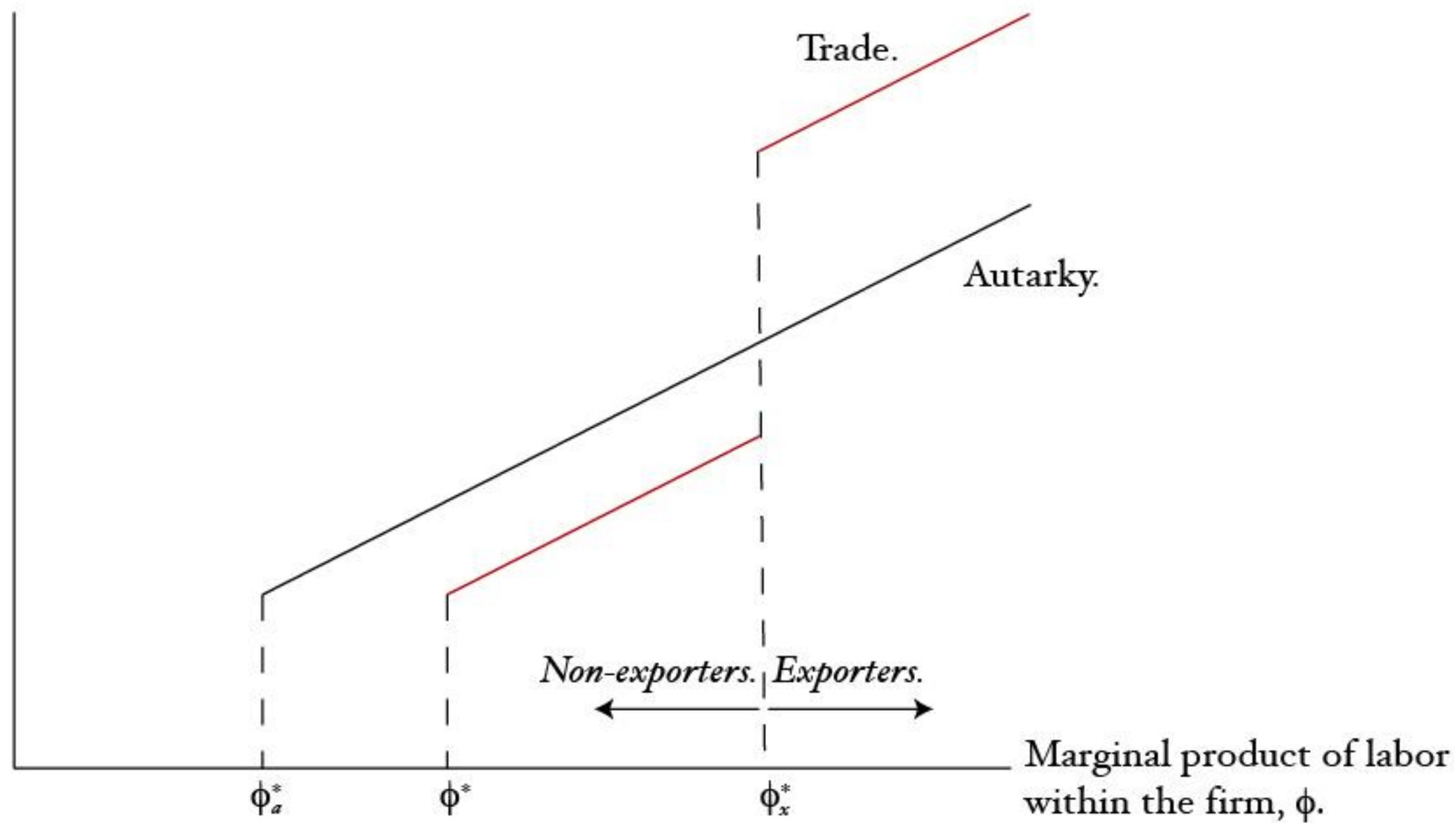
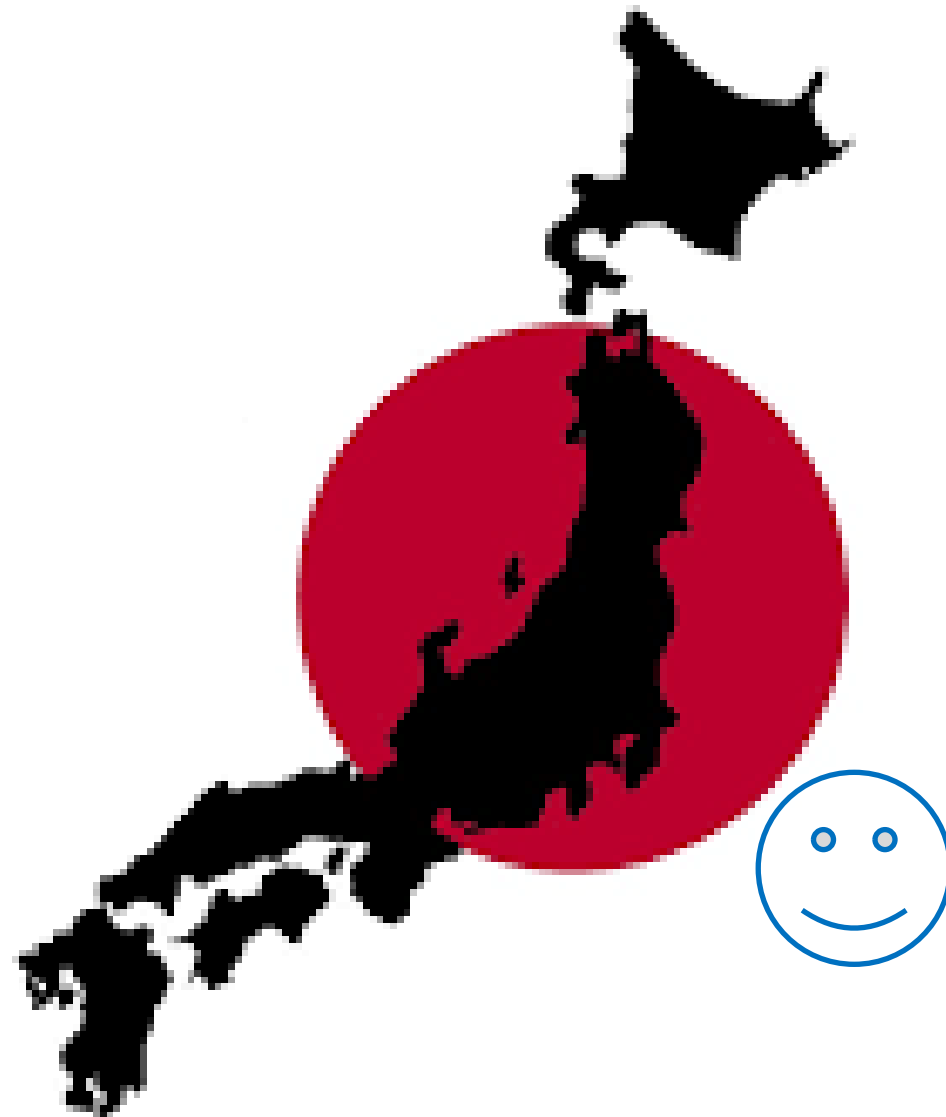


Figure 3.4: The Melitz Effect.

Basic Model: Autarky



Basic Model: Autarky



Basic Model: Open Trade



Basic Model: Open Trade



Basic Model: Open Trade



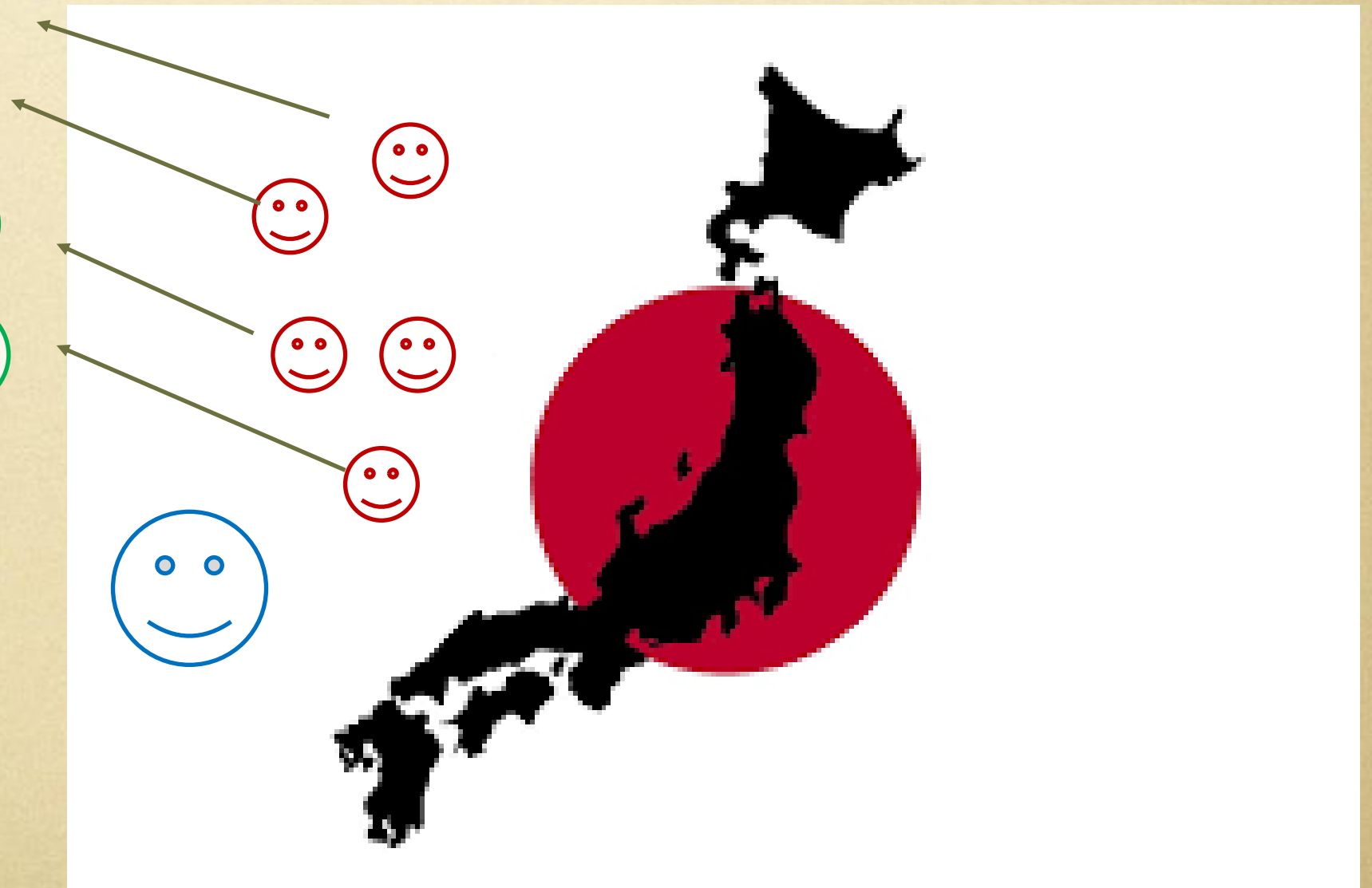
Basic Model: Open Trade



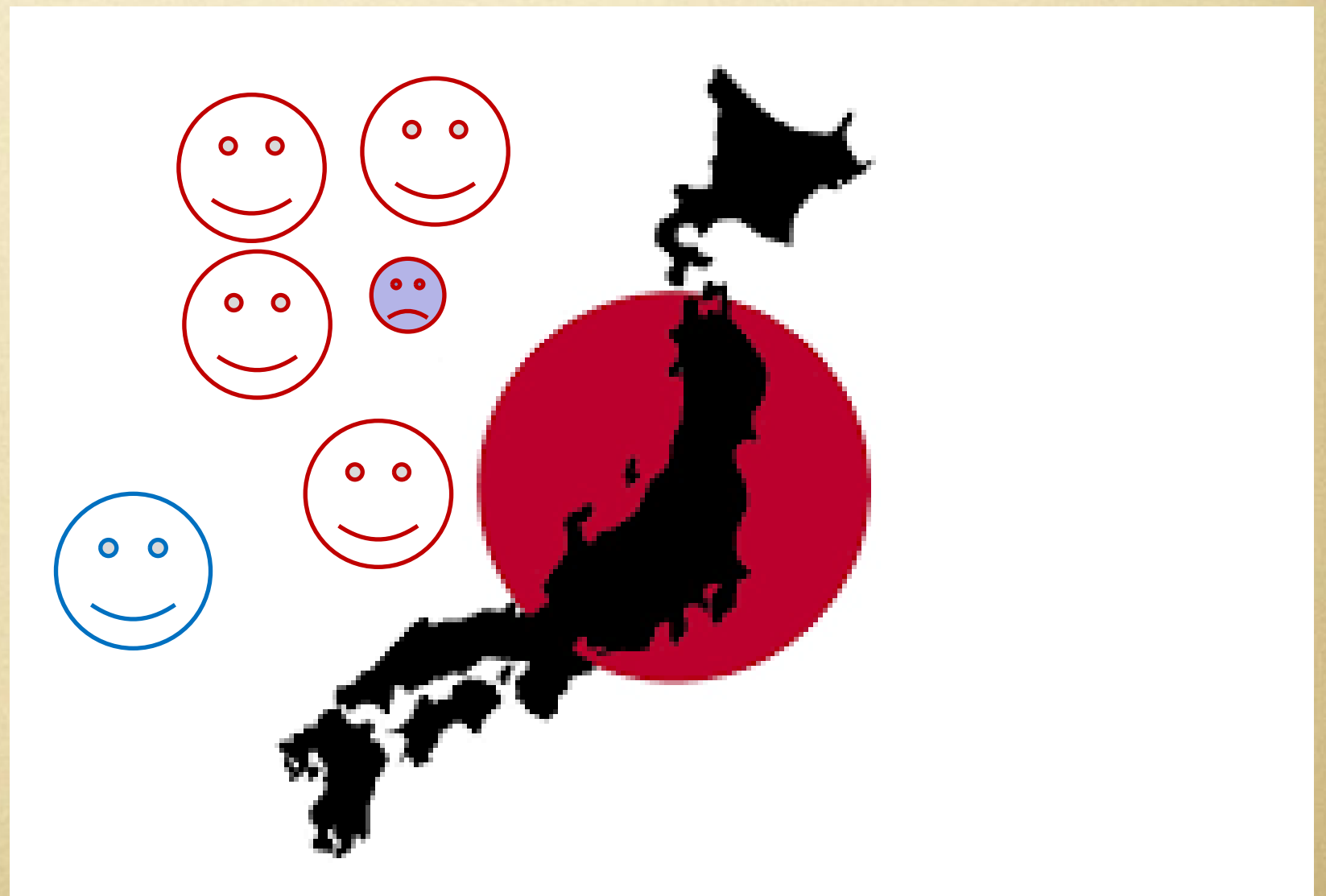
Basic Model: Open Trade



Basic Model: Open Trade



Basic Model: Open Trade



Basic Model: Open Trade



Melitz Model: Autarky



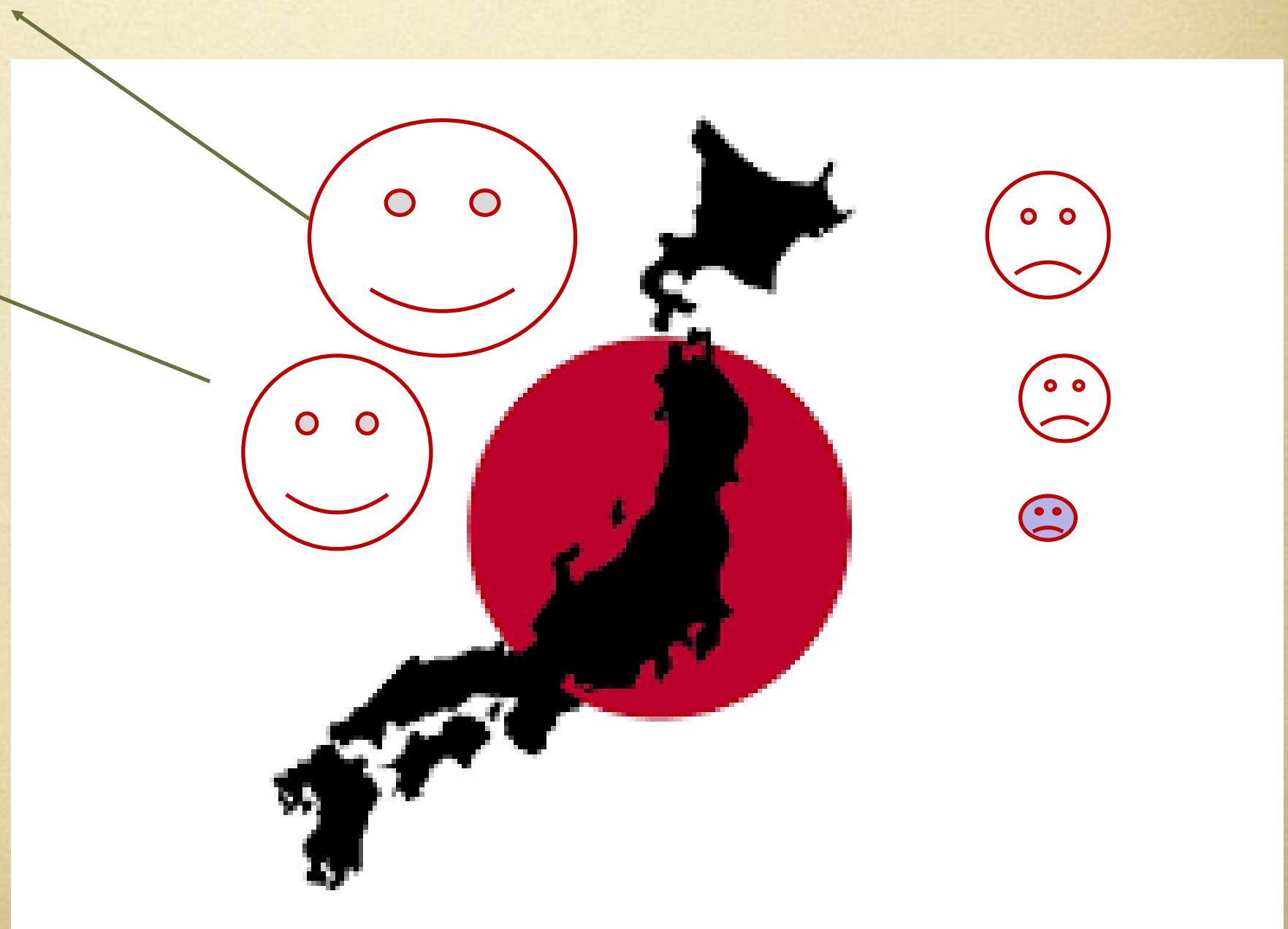
Melitz Model: Open trade



Melitz Model: Open trade



Melitz Model: Open trade



Melitz Model: Open trade

