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TRADE THEORY: THE INTUITION, RESULTS AND LIMITATIONS OF MAJOR ECONOMIC FRAMEWORKS^a

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Abstract

This document introduces some of the most influential trade theory models. It requires no advanced economic background and presents the frameworks by means of a descriptive approach. For the ease of the reader, most of the technicalities (equations and graphs) that traditionally describe the models are not reproduced and the focus is put on acquiring a good intuition of the different economic rationales for trade openness.

The Ricardian and Heckscher-Ohlin models explain why trade emerges between countries with different relative technologies or factor endowments, respectively. The Helpman-Krugman model adds product variety and economies of scale to understand why similar countries also trade. The Melitz model lets firms vary in productivity in order to investigate why only a few of them enter the export market. The core-periphery model allows for migration to describe the localization of economic activity. The last section introduces the new paradigm of global value chains.

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1. Introduction

In order to better understand what an economic model is, the analogy between a model and a map is helpful. Just like a map, an economic model is a compromise between simplicity and explaining power. To drive across a country, we use a map that represents cities as points and major roads as lines connecting points. We omit other aspects that are irrelevant for our purpose. For a bike trip however, we will want to focus on a smaller area and add more layers such as the secondary roads and the elevation. Similarly, economic models are used to reshape the complex global economy into a simplified framework that recreates the relevant interactions needed to understand observed stylized facts.

Accordingly, the fact that some of the canonical models explained here use strong assumptions does not make them irrelevant. Indeed, they set paradigms in economic thought and are the foundations on which more sophisticated models were later built. Nevertheless, it is important to understand that the conclusions of a model may be misleading even if just one assumption fails. The road we choose with the first map is probably not optimal for a bike trip. Similarly, we will see that although the effect of trade openness is typically a net gain, this should not be generalized into a “free trade is good for all” type of statement. Losers from trade will be identified in the more sophisticated models, so make sure to read until the end.

The structure of the models is explained as follows. We first state the assumptions defining the world we are looking at. To illustrate our assumptions, values are given to the key variables when necessary. We, then, describe the counterfactual where each country is in complete isolation, the so-called autarky equilibrium. By allowing for cross-border trade, we obtain the free-trade equilibrium and can compare the two extreme situations. Finally, we clearly identify the main limitations of the model, some of which are then answered by “changing the layers of the map” in subsequent models.

The themes addressed in this paper are technological differences with the Ricardian model (section 2), factor endowment with the Heckscher-Ohlin model (section 3), imperfect competition with the Helpman-Krugman model (section 4), heterogeneous firms with a version of the Melitz model that includes comparative advantage (section 5) and agglomeration with the core-periphery model (section 6). Section 7 introduces the new paradigm of global value chains.

2. Technological differences: the Ricardian Model

The theory of comparative advantage was proposed by David Ricardo, an English political economist, in the beginning of the 19th century. It explains the emergence of inter-industry trade – such as bilateral exchanges of manufactured and agricultural goods – between two nations with different technologies.

a. Assumptions

We set up a very simple world with two countries – home (H) and foreign (F) – that both produce only two final goods – manufacture (M) and agriculture (A) – using only one factor of production³ – labour (L).

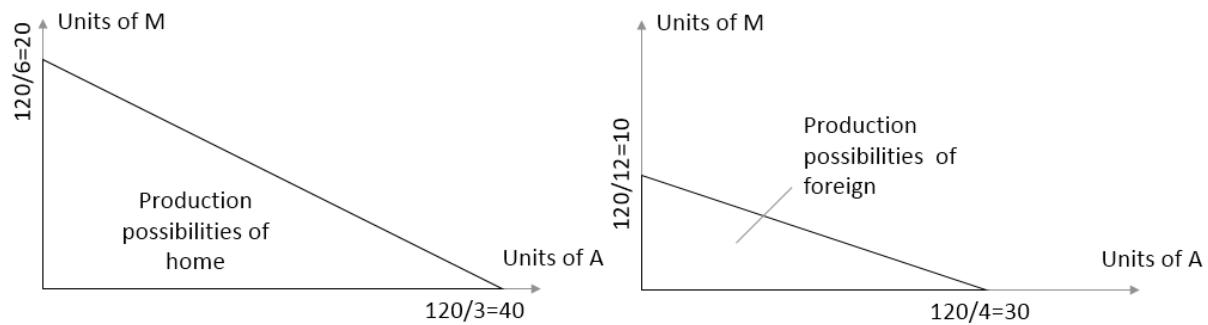
Within the borders of each country, workers are all identical and substitutable. They can freely move across sectors but cannot migrate to the other country. Labour is allocated to the production of M and A so that there is no unemployment.

The two countries may have different productivities and populations but are identical at all other levels. The productivity of a country depends on the technology - in a generic sense - used in the process of production. We take as given that workers in H have more advanced skills or a higher education level that makes them more productive in the production of both goods. In other words, H needs less units of labour to produce one unit of manufactured good than F, and similarly for agriculture (see table below). Formally, H has an *absolute advantage* in both goods. This advantage is disproportionally greater in the production of good M.

For our example we consider countries with similar populations. The case of a large difference in population is also discussed throughout.

	Productivity (a lower value means a higher productivity)		Labour
	Manufacture M	Agriculture A	
Home H	6 workers / unit	3 workers / unit	120 workers
Foreign F	12 workers / unit	4 workers / unit	120 workers

³ The factors of production are the inputs or resources used in the production process of the output (the final good). The most common factors are capital (K), labour (L) and land (N).



The two triangles illustrate all the feasible productions of each country given their productivities and populations. If all labour is assigned to the A sector, the production bundle is the right corner of the triangle. If all labour is assigned to the M sector, the production bundle is the top corner of the triangle. Because we assumed full employment, any production bundle must be on the line connecting those two corners. The larger height and width of the left triangle represent H's absolute advantage in production.

This setting implies that there are constant returns to scale in production, meaning that doubling the number of workers doubles the number of units produced.

It is also useful to assume perfect competition. Firms are small, take the market price as given and enter the markets in each country until profits are zero (total revenues just cover total costs).

b. Autarky equilibrium

We first look at the autarky (without trade) situation. Remember that all workers are identical in a country and can freely move across sectors. For example, think of low-skilled workers during the industrial revolution who choose to either work in M ("screw nuts") or in A ("make hay"). If the M sector offers a higher wage than the A sector, workers have incentives to move to the cities. Firms in M quickly realize the increased labour willing to work in their sector and can lower the wage they pay until it reaches that of the A sector. Hence, wages are equalized across sectors in equilibrium. Because workers cannot emigrate to get paid better abroad, wages however vary across countries.

We can show that in autarky, the relative price of the two goods reflects the relative productivity of the two sectors.

The fact that firms make no profits implies that the price received for a good is fully distributed in wages. In H, the price of M (p_M) is shared between the 6 workers who produced this unit and the price of A (p_A) is shared between 3 workers.

Because wages equalize across sectors, we have for H: $w = \frac{p_M}{6} = \frac{p_A}{3}$, or equivalently

$$\frac{p_M}{p_A} = \frac{6}{3} = 2.$$

The same reasoning for F (identified with an asterisk) yields: $w^* = \frac{p_M^*}{12} = \frac{p_A^*}{4}$, or equivalently

$$\frac{p_M^*}{p_A^*} = \frac{12}{4} = 3$$

In our example, M is twice more expensive than A in country H because the production of M is twice more costly in terms of labour used. M is three times more expensive than A in country F because production of M is three times more costly in terms of labour used. Those differences in input requirements can be defined with an important concept in economics: opportunity cost.

Definition: opportunity cost

When choosing between different options, the opportunity cost is the value of the best dismissed option. In our context, the options are to produce a unit of M or a unit of A and the opportunity cost of this decision is the number of units of the other good we could have produced with the same resources.

Example: by choosing to produce one unit of M, we lose an opportunity to produce 2 units of A in country H or 3 units of A in country F. M needs to be 2 times more expensive than A in H and 3 times more expensive than A in F to justify this choice of production.

Rewriting the table above with the opportunity cost in terms of the other good gives us the following.

	Opportunity cost in terms of the other good	
	Manufacture M	Agriculture A
Home H	2 units of A	$\frac{1}{2}$ unit of M
Foreign F	3 units of A	$\frac{1}{3}$ unit of M

The picture is now different. In absolute terms, H is better than foreign in both goods. In relative terms however, H is better at producing M and F is better at producing A. This is Ricardo's fundamental idea of comparative advantage.

Definition: comparative advantage

Country H has a comparative advantage in M if its opportunity cost of producing M in terms of A is lower than country F.

Example: M is cheaper in terms of A in country H ($2 < 3$) and A is cheaper in terms of M in country F ($\frac{1}{3} < \frac{1}{2}$). H has a comparative advantage in M and F has a comparative advantage in A.

Depending on the consumers' relative preferences for the goods and the relative prices they face, each country produces the quantities of M and A demanded for local consumption. Both countries are diversified and self-sufficient.

c. Free-trade equilibrium

We open trade between the two countries. Consumers can buy from the producers in the other country without any trade barriers and transaction costs.

Remember that until now one unit of M was worth 2 units of A in H and 3 units of A in F:

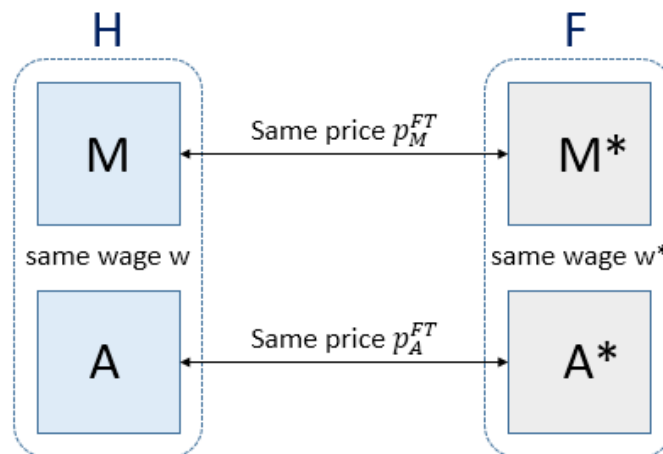
$$\frac{p_M}{p_A} = 2 < \frac{p_M^*}{p_A^*} = 3.$$

As the two goods have exactly the same characteristics in both countries, consumers disregard their origin. Consumers who hold a unit of M could trade it for 2 units of A in H. However, they prefer to exchange it in F instead and obtain 3 units of A. If they then trade those 3 units of A in H, they receive 1.5 units of M, a net gain of 0.5 unit of M without any risk taken. This is called an arbitrage opportunity. Many people want to do this and the price of M relative to A goes up in H and down in F. The process stops when there is a global price of each good, and therefore a common relative price in both countries.

An intuitive way to understand this is that the relative scarcity of the goods is now the same for all because they are pooled in a global market. The free-trade (FT) relative price

$\left(\frac{p_M^{FT}}{p_A^{FT}}\right)$ therefore stands between the two autarky values: $2 \leq \frac{p_M^{FT}}{p_A^{FT}} \leq 3$. A unit of M is worth between 2 and 3 units of A.

With free trade, our world is therefore tied in two ways (see chart). In the same country, *wages* are the same in both sectors (part b). In the same sector, *prices* are the same in both countries (part c).



We first look at the case of strict inequality.

In country H, the price of M increases relative to the price of A. Revenues in M are now higher. In order to maintain zero profit, wages in M have to increase. All workers move to the M sector. H fully specializes in the production of M and imports its consumption of A.

In country F, the price of M decreases relative to the price of A. The wage in M has to decrease relative to wages in A. All workers move to the A sector. F fully specializes in the production of A and imports its consumption of M.

Both countries are fully specialized in the production of the good in which they have a comparative advantage. They export their surplus of production and import their consumption of the other good.

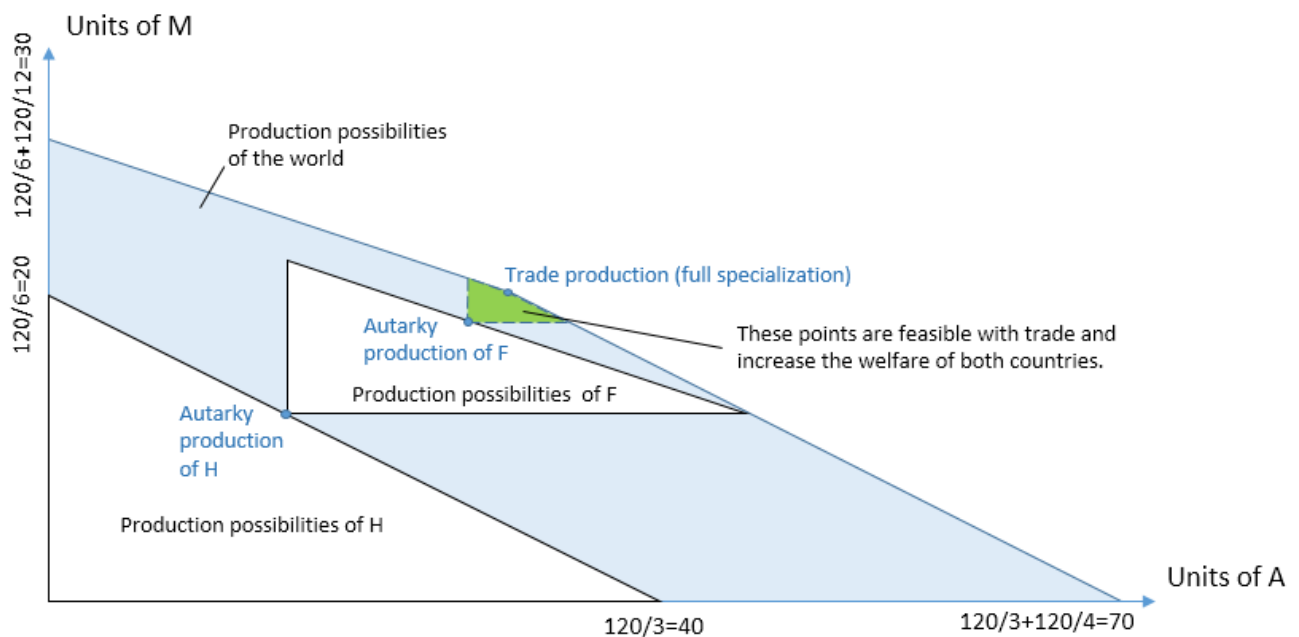
We then look at the case where the free-trade relative price remains at one of the two relative autarky prices. It means that a country is relatively too small to satisfy the world demand of the good in which it has a comparative advantage. The relative world price of the goods is not influenced by the small country and stays at the ratio of the big country. The

small country fully specializes but the large one keeps producing both goods. It can do so because wages remained equal across sectors.

d. Welfare effects

Even though H is better at producing both goods, it can gain from specializing in its relatively more productive sector and importing the other good. Conversely, F can also gain from specializing in the good in which it has a comparative advantage. Taking a case of full specialization, we first show graphically that trade can increase the total world production (the “size of the pie”). We then derive the purchasing power of consumers and conclude that it is greater or equal than in autarky for all.

It is helpful to combine the two graphs of part a) to visualize the efficiency gains from trade.



The two white triangles are all the feasible productions of each country. The top corner of the triangle is specialization in M and the right corner is specialization in A. We place F's triangle on H's triangle to sum the production of the two countries. By sliding it we obtain all the feasible world production bundles (the grey area). Even with full employment, world production does not necessarily sit on the boundaries of the grey area. Two possible autarky productions are represented on the triangles.⁴ In that case we observe that the allocation of

⁴ The production depends on consumers' relative preferences for the goods. In this example, consumers prefer M over A, which compensates for the higher price of M.

labour is inefficient in autarky. Consumers could enjoy more of both goods with specialization and trade. On this figure, it is seen by setting H's production on the top corner, placing F's triangle at the very top and setting F's production on the right corner.

To show that the purchasing power increases for all consumers, we look at the change in real wages. They are obtained by dividing the nominal wage by either the price of A or the price of M. For example, a nominal wage of 100\$ can buy 20 units of a 5\$ soda or 50 units of a 2\$ coffee.

As a preliminary step, we introduce the key notion of *terms of trade*.

Definition: terms of trade

A country's terms of trade is the price of its exports divided by the price of its imports. An improvement in terms of trade means that a country gets more units of the good it imports for every unit of the good it exports.

Example: if H exports M and F exports A, an improvement in H's terms of trade means that $\frac{p_M}{p_A}$ increases so that for every unit of M sold abroad it can buy more units of A from abroad.

Home exports M so its terms of trade are $\frac{p_M^{FT}}{p_A^{FT}}$. Foreign exports A so its terms of trade are $\frac{p_A^{FT}}{p_M^{FT}}$.

The free-trade relative price of the goods is between the two autarky relative prices (part c).

One unit of M is now worth more than 2 units of A ($\frac{p_M^{FT}}{p_A^{FT}} \geq 2$) and one unit of A is worth more than $\frac{1}{3}$ unit of M ($\frac{p_A^{FT}}{p_M^{FT}} \geq \frac{1}{3}$).

We observe that specialization and trade improve the terms of trade of home and foreign.

In autarky (part b), wages in country H were $w = \frac{p_M}{6}$ (six workers share the price of M) and wages in country F were $w^* = \frac{p_A^*}{4}$ (four workers share the price of A).

Real wages in terms of the exported good do not change with trade. Indeed, workers are still paid the equivalent of a sixth of a good M in H and a fourth of a good A in F.

The improvement in terms of trade increases real wages in terms of the imported good for both countries. To see it, we simply divide the wage by the price of the imported good. This measures the number of units of the imported good the wage can buy. We observe that it is proportional to the terms of trade and therefore increases in both countries with trade liberalization.

Home: $\frac{w}{p_A} = \frac{1}{6} \cdot \frac{p_M}{p_A} \leftarrow$ the relative price of M increased in H relative to autarky, so does the real wage in terms of A

Foreign: $\frac{w^*}{p_M^*} = \frac{1}{4} \cdot \frac{p_A^*}{p_M^*} \leftarrow$ the relative price of A increased in F relative to autarky, so does the real wage in terms of M

The purchasing power of consumers in both countries is at least as high as in autarky. In particular, all consumers gain from trade if we observe full specialization.

In the special case where a big country's production remains diversified after trade liberalization, this country does neither gain nor lose from trade. Indeed, the free-trade relative price is the same as the big country's autarky relative price and its terms of trade are unchanged.

e. Conclusion and limitations

The notion of comparative advantage has been very influential as it provides a neat economic rationale for trade liberalization. The bottom line is that trade can increase the size of the pie without making anybody worse off. More specifically, countries that are less productive in all sectors can still be competitive in international markets as long as they have a comparative advantage in production. Indeed, the gain from trade results from specialization and requires countries to be different and complementary. For example, if Switzerland is relatively better at producing watches and Belgium is relatively better at producing beer, trade emerges in those two goods.

Another interesting conclusion for the analysis of free trade agreements is that small countries capture a greater share of the gain in productive efficiency than big countries and therefore have more incentives to liberalize trade.

To be more realistic, the Ricardian model can be extended to more countries and goods.⁵ Nevertheless, several assumptions are likely to fail, in particular the production process

⁵ See for example the Dornbusch-Fischer-Samuelson (1979) model.

(only labour is used), the type of firms (all small and identical) and the factor movement (workers cannot emigrate). Also, the source of the differences in productivity remains a mystery. Finally, this model does not explain the emergence of intra-industry trade, such as why Swiss chocolate is exported to Belgium and Belgian chocolate to Switzerland.

In the following section, we make a few changes to the layer for our map in order to answer some of those limitations.

3. Factor endowment: the Heckscher-Ohlin model

The Heckscher-Ohlin model (H-O model) was proposed by Eli Heckscher and Bertil Ohlin of the Stockholm School of Economics in 1933. It proposes an alternative source of comparative advantage: differences in factor endowment.

a. Assumptions

This model is sometimes called the $2 \times 2 \times 2$ model. Indeed, we stay in a world with two countries (H and F) and two goods (M and A) and build on Ricardo's rather primitive production process to add a second complementary factor of production alongside labour: capital. Capital is any manmade input such as machines, tools, or equipment used in the production of the final goods.

As previously, capital and labour can freely move across sectors but not across countries. In other words, there are full capital controls and no migration. Workers are paid a wage (w) for their effort and owners of capital (capitalists) are paid a rent (r) for the opportunity cost of the money invested.⁶ We remain in a perfectly competitive environment with zero-profits.

Both goods are produced using a combination of labour and capital but they have a different production technology. Good A requires relatively more labour and good M relatively more capital. For example, there are typically more workers per machine in the production of corn than cars. Formally, A is relatively *labour-intensive* and M is relatively *capital-intensive*.

There are still constant returns to scale in production, meaning that doubling the number of workers and machines doubles the output. However, there are diminishing returns to individual inputs, meaning that if one factor is kept constant each additional unit of the other factor increases output by a lower amount.

To illustrate diminishing returns, think of the coffee served at the cafeteria of Graduate Institute. The capital is constant at two coffee machines. One employee has to take the orders, start the correct programs on the machines and collect the money. The output is 1 coffee per minute and there is a long line. A second employee can anticipate the coffee orders in the line and the output increases to 1.5 coffees per minute. A third employee can prepare the sugar and milk and replace others during breaks. The output increases to 1.75

⁶ This is just an example. We could alternatively assume a production process with labour and land where the two types of agent are workers and landlords.

coffees per minute. A fourth employee stands idle. Keeping capital constant, the extra return of each additional unit of labour diminishes.

An important difference with the previous model is that the two countries now have identical productivities. If both countries have the same number of workers and machines, their productions are exactly equal.

For simplicity, the table below describes a technology where inputs are perfect complements.⁷ In the two countries, assembling a car requires 1 worker and 2 machines during a day, whereas harvesting a ton of corn requires 1 worker and 1 machine during a day.

The only difference between the two countries is their endowment in labour and capital. We assume that F is richer in labour and capital than H. However, H has a larger proportion of capital than F. Formally, H is relatively *capital-abundant* and F is relatively *labour-abundant*.

	Worldwide technology		Factor endowment	
	Manufacture M	Agriculture A	Home H	Foreign F
Units of L	1	1	20	40
Units of K	2	1	30	45

M is relatively capital-intensive and A is relatively labour-intensive ($\frac{2}{1} > \frac{1}{1}$).

H is relatively capital-abundant and F is relatively labour-abundant ($\frac{30}{20} > \frac{45}{40}$).

b. Autarky equilibrium

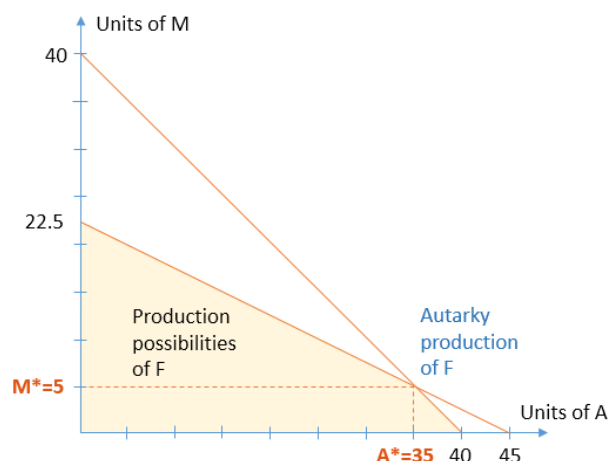
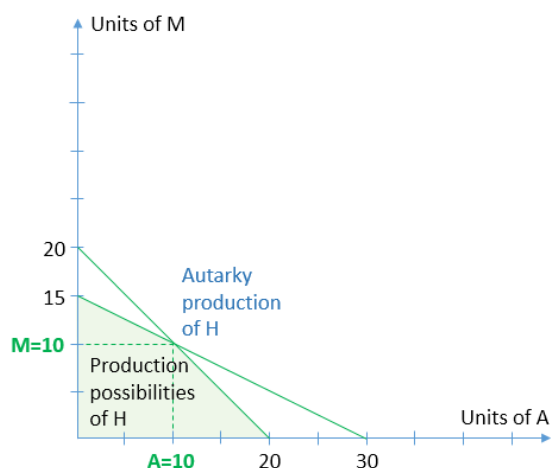
Production and prices

Because the factors are fully employed, the workers (resp. machines) used in the M sector plus the workers (resp. machines) used in the A sector are equal to the factor endowment of the country. Using this condition, we can easily determine the production of each country. We do it algebraically and graphically below.

⁷ Note that this is an extreme example of diminishing returns. Keeping capital constant, adding labour does not change output at all. For a more general production technology with diminishing returns, see for example the Cobb-Douglas production function.

Full-employment conditions:

HOME	$1 \text{ worker} \times M \text{ units} + 1 \text{ worker} \times A \text{ units} = 20 \text{ workers}$ <i>(workers assigned to M + workers assigned to A = population)</i>	Production in H: M = 10 units A = 10 units
	$2 \text{ machines} \times M \text{ units} + 1 \text{ machine} \times A \text{ units} = 30 \text{ machines}$ <i>(machines assigned to M + machines assigned to A = all machines)</i>	
FOREIGN	$1 \text{ worker} \times M^* \text{ units} + 1 \text{ worker} \times A^* \text{ units} = 40 \text{ workers}$ <i>(workers assigned to M* + workers assigned to A* = population)</i>	Production in F: M* = 5 units A* = 35 units
	$2 \text{ machines} \times M^* \text{ units} + 1 \text{ machine} \times A^* \text{ units} = 45 \text{ machines}$ <i>(machines assigned to M* + machines assigned to A* = all machines)</i>	



On both graphs, the steeper line represents all production bundles where labour is fully employed and the flatter line represents all production bundles where capital is fully employed. All bundles in the shaded areas are feasible but the intersection of the two lines is the only one that guarantees full employment of both factors.

We observe that there is a relatively larger production of the capital-intensive good M in the capital-abundant country H ($\frac{10}{10} > \frac{5}{35}$). Conversely, there is a relatively larger production of the labour-intensive good L in the labour-abundant country F ($\frac{35}{5} > \frac{10}{10}$).

With identical consumer preferences in both countries, the relatively rarer good must be relatively more expensive in the autarky equilibrium.

Starting with a different type of comparative advantage from the Ricardian model – relative factor endowment instead of relative productivity – we arrive at the same conclusion that good M is cheaper in terms of good A in country H: $\frac{p_M}{p_A} < \frac{p_M^*}{p_A^*}$.

For example, let's assume that China is labour-abundant, Germany is capital-abundant, corn is labour-intensive and cars are capital-intensive (all in relative terms). In autarky, China produces more tons of corn per car than Germany so cars are relatively rarer in China. A Chinese consumer is willing to give up more corn to get a car than a German consumer. Hence, cars are relatively more expensive in China and corn is relatively more expensive in Germany.

Wages and rents

We now have two types of individuals in the economy: the workers and the capitalists. The interests of each group are embedded in the real wages and rents they receive.

In each country, workers go to the sector that pays the highest wage and capitalists provide their machines to the sector that pays the highest rent. In equilibrium, the factors are allocated so that nobody has incentives to move to the other sector. It means that wages and rents equalize across sectors.

Because there is zero-profit, the price paid for a unit of good (p_M or p_A) is fully distributed to the two factors used in its production. In other words, the revenue per unit is equal to the cost per unit. In our example, the cost of a car is the wage of 1 worker plus the rental cost of 2 machines. The cost of a ton of corn is the wage of 1 worker plus the rental cost of 1 machine.

Zero-profit conditions:

$$\begin{cases} p_A = 1 \text{ worker} \times w + 1 \text{ machine} \times r \\ \text{ (price of A distributed to 1 worker and 1 machine) } \\ p_M = 1 \text{ worker} \times w + 2 \text{ machines} \times r \\ \text{ (price of M distributed to 1 worker and 2 machines) } \end{cases}$$

Solving this simple system for w and r shows that the rent moves in the same direction as the relative price of the capital-intensive good M and the wage moves in the same direction as the relative price of the labour-intensive good A.

$$\begin{cases} r = 1 p_M - 1 p_A \\ w = 2 p_A - 1 p_M \end{cases} \text{ (with } p_A \leq p_M \leq 2p_A \text{ to keep } r \text{ and } w \text{ positive)}$$

	p_M	p_A
r	+	-
w	-	+

Another interesting observation is that the rents and the wages *only* depend on the price of the goods. We showed above that the disproportional endowments of the two countries result in differences in prices. This implies that wages and rents also differ across countries in autarky. The workers in H get a greater share of their national income than the workers in F because they benefit from the scarcity of the labour-intensive good A.

c. Free-trade equilibrium

Production and prices

We allow for cross-border trade between H and F and assume no trade barriers and transaction costs. As in section 2), the origin of the goods is disregarded by consumers and there is a world market for M and A. It means that the scarcity of cars relative to corn is the same for all and prices converge.

The free-trade relative price ($\frac{p_M^{FT}}{p_A^{FT}}$) stands between the autarky relative prices: $\frac{p_M}{p_A} \leq \frac{p_M^{FT}}{p_A^{FT}} \leq \frac{p_M^*}{p_A^*}$.

This means that a car is worth more corn than it was in H and less corn than it was in F. Conversely, corn is worth less cars than it was in H and more cars than it was in F.

Each country now gets a relatively higher price for the good in which it has a comparative advantage. Labour and capital move to this sector to maintain zero-profits and each country specializes in the good that is intensive in its abundant factor. The production in excess of consumption is exported to the other country. In the general case with diminishing returns, the specialization is in most cases only partial, meaning that both countries continue to produce both goods.

Wages and rents

As shown in part b), the wage and rent only depend on the prices of the goods. Because prices are now the same worldwide, wages and rents are also equalized across countries. This important result is called factor price equalization.

Definition: factor price equalization

When countries move to free-trade and the prices of the final goods converge, the factor prices (wage and rent) also equalize across countries without need for international factor mobility (migration and international capital flows).

Example: if the United States and Brazil both produce steel and cotton using the same technology (low-skilled workers and standard machines), opening trade results in a common price of those commodities across countries. As a result, low-skilled workers earn the same wage and owners of standard machines earn the same rent in both countries.

d. Welfare effects

To analyze the change in welfare of the two types of individuals in the two countries, we look at the change in their purchasing power $\left(\frac{w}{p_A}, \frac{w}{p_M}\right)$ and $\left(\frac{r}{p_A}, \frac{r}{p_M}\right)$. By simply dividing the expressions of part b) by the prices, we find that the purchasing power depends on the relative price of the goods $\left(\frac{p_M}{p_A}\right)$. The table below summarizes the effect of the change in relative prices resulting from trade liberalization.

	Purchasing power of workers		Purchasing power of capitalists	
	$\frac{\text{wage}}{p_A}$	$\frac{\text{wage}}{p_M}$	$\frac{\text{rent}}{p_A}$	$\frac{\text{rent}}{p_M}$
Country H: $\frac{p_M}{p_A} \uparrow$	-	-	+	+
Country F: $\frac{p_M}{p_A} \downarrow$	+	+	-	-

This neat result identifies winners and losers from trade. The relatively abundant factor (capital in H and labour in F) gains from trade, whereas the relatively scarce factor loses.

For example, assume that the United States is capital-abundant, Brazil is labour-abundant, steel is capital-intensive and cotton is labour-intensive (all in relative terms) and abstract from all other competitors. The model tells us that the US shall export steel and Brazil shall export cotton. Then free-trade should be promoted by the 'US Companies Lobby' and the 'Brazilian Labour Union'. However, the 'US Labour Union' and the 'Brazilian Companies Lobby' should request protection by means of trade barriers.

Although there is a distributional effect that makes some individuals gain and others lose from trade, the net change in goods consumed remains positive for both countries. This result can be shown with a more general example with diminishing returns. The intuition is similar as in the Ricardian model (section 2). Trade allows factors to be allocated in a more efficient way by having each country focus on its comparative advantage. This makes it possible for the globalized world to consume more of both goods than the sum of individual countries in autarky.

e. Conclusion and limitations

It is helpful to summarize the main results of this model. Remember they rely on our assumptions.

- ✓ Countries tend to export the goods that are intensive in their abundant factors.
- ✓ Trade liberalization tends to equalize wages and rents across countries.
- ✓ Trade makes the abundant factor better-off and the scarce factor worse-off.
- ✓ Trade increases total world production and consumption.

In theory, it is thus possible for the government to put in place a lump-sum transfer from the winners to the losers that makes all individuals gain from trade. This is of course very difficult in practice.

The more sophisticated production process assumed in the H-O model mitigates the economic rationale for trade liberalization and helps explaining why anti-globalization

movements emerge. The model can also be extended to more countries, more goods and more factors.⁸

Nevertheless, this theory is quite poor at explaining the empirical data. A well-known example is the so-called Leontief paradox: in the 50's, the US was exporting labour-intensive goods and importing capital-intensive goods, although it was relatively capital-abundant. This can be explained by the fact that many assumptions of the model fail in the real world. In particular, technologies are far from similar when we analyze trade between developed and emerging countries. The factors in the more productive countries therefore receive a higher payment and factor price equalization does not occur. The other critics stated for the Ricardian model remain.

Those two first maps explained the emergence of inter-industry trade. Their joint consideration is very powerful when it comes to understanding basic international trade patterns and effects.

We now tackle the intra-industry trade puzzle.

⁸ See for example the Heckscher-Ohlin-Vanek (1968) model.

4. Imperfect competition: the Helpman-Krugman model

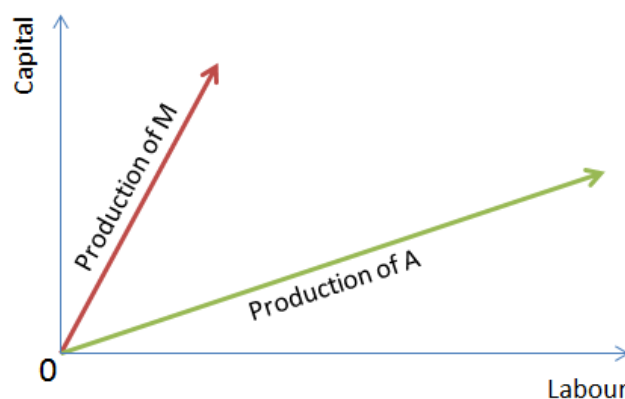
The recent surge of trade in goods with similar factor intensities (say cars) between similar countries (say France and Germany) suggests that comparative advantage is not the only element driving international trade. In the 1960s, less than a quarter of the developed world's international trade was in similar goods, whereas it is over half of it today.⁹ In the least developed regions however, trade remains almost exclusively of the inter-industry type (say cars and corn).

In the late 1970s, Paul Krugman (MIT) publishes two influential models that initiate the new trade theory. Relaxing the assumption of perfect competition, he introduces two new channels that can generate gains from trade: product differentiation and economies of scale.

This section presents the intuition of his theory in the context of the Helpman-Krugman model, proposed jointly with Elhanan Helpman (Tel Aviv University) in 1985, that combines the theory of comparative advantage and the new trade theory into an integrated framework.

a. Assumptions

The map we use is almost identical to that of the H-O model. The two countries H and F receive arbitrary endowments of capital and labour and each similar machine or worker around the world is employed in either M or A. The technology of production is the same everywhere, but the two goods M and A are respectively capital- and labour-intensive. The graph below shows that the production of M follows the direction of the steeper vector (larger share of capital) and the production of A follows the direction of the flatter vector (larger share of labour).



⁹ According to the World Development Report 2009 of the World Bank.

As previously, the agricultural sector produces a homogenous good (say corn) and remains perfectly competitive. We sophisticate the manufacturing sector in two ways: product differentiation and economies of scale.

Product differentiation

Imagine an event organized at a school of international affairs and consider two scenarios: the brown bag seminar and the international potluck. Because there is no free lunch, the participants of the brown bag seminar bring a Tupperware with their preferred meal and eat it individually. At the potluck however, the guests place their food on the table and can freely try different cuisines up to the value of what they contributed.

This example illustrates how international trade widens the range of products accessible to consumers. For example, car dealers propose Japanese, German and American brands; grocery stores have wines from Napa Valley, Bordeaux and Cape Town; libraries have books from Shakespeare, Rousseau and Hemingway.

To model this, we assume that each worker in M is a small entrepreneur who owns a firm. Each firm produces its own variety of the good, which is perceived by consumers as a close substitute to the varieties of other firms. For example, each firm – and therefore each worker employed in M – produces cars of a different colour.

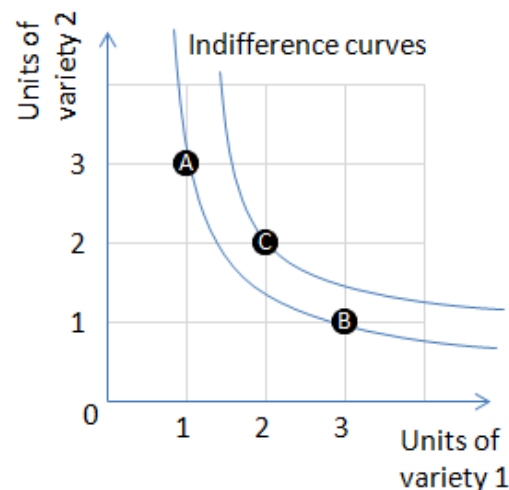
In order to ensure symmetry and simplify the mathematics of the model, Krugman assumes that all varieties use the same technology of production (the steeper vector) and have a comparable quality.

A critical assumption is that consumers enjoy this greater choice. More formally, it states that consumers as a whole prefer to purchase a balanced basket of goods to an extreme one, either because each consumer enjoys variety or because they all have different tastes. This holds empirically. Broda and Weinstein¹⁰ studied the variety of US imports between 1972 and 2001. They show that the number of imported varieties tripled and that consumers value this increased diversity at 2.6% of GDP.

It is in fact a central notion in microeconomics that we shortly present here; taste for variety. Utility is the abstract notion used to measure satisfaction. If we consider the

¹⁰ Broda, C. and Weinstein D.: Globalization and the Gains From Variety, *The Quarterly Journal of Economics* (2006) 121 (2): 541-585.

consumption of two varieties (see graph below), there are different baskets that provide the same level of utility to a representative consumer, for example, 3 apples and 1 pear (point A) or 1 apple and 3 pears (point B). We can draw all the baskets valued equally to obtain indifference curves. They are similar to the contour lines on a topographic map showing elevation. As long as the composition of the basket of goods is on the same curve, utility is constant.



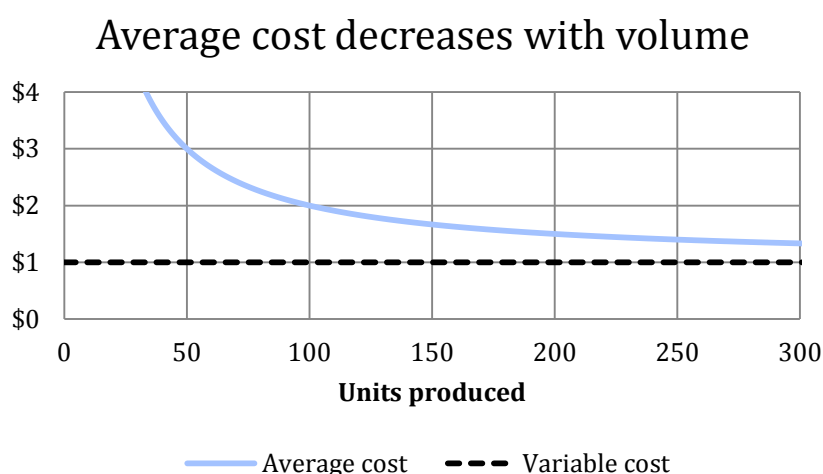
Both the quantity and the variety are valued, which has two implications. First, utility increases when moving to the north-east. Second, indifference curves are convex to the origin. On the graph, points A and B are on the same indifference curve, so provide the same level of utility. Point C also consists of a total of four units (2 apples and 2 pears) but is more balanced and therefore stands on a higher indifference curve. If the three bundles are accessible given the consumer's budget, point C is preferred.

The same idea applies to the many varieties of M. Each new variety made available provides an additional dimension to this graph. The consumers as a whole like each variety equally and rebalance their baskets to include the new variety. An increase in the number of varieties of M provides additional consumer welfare that we consider a potential gain from trade.

Economies of scale

Until now, production technology was assumed to exhibit constant returns to scale, meaning that doubling the number of workers and machines also doubles the output.

In reality, bigger firms are able to take advantage of higher volumes to become more efficient. Companies very often incur a fixed cost that is not related to the number of units produced. Setting up a business, building a plant and providing core support functions are good examples of fixed costs. Once those are paid for, each unit produced adds a variable cost that includes for example the raw materials, the amortization of the machines and the workers on the production line. When production expands the fixed cost is allocated towards more units, which decreases the average cost of a unit.



In this example, the fixed cost of starting a variety is 100\$. Each unit of the variety produced has a variable cost of 1\$. A small firm producing 100 units of its variety has an average cost of $\frac{100\$ + 100 \text{ units} \cdot 1\$}{100 \text{ units}} = 2\$$ per unit. A bigger firm producing 200 units has an average cost of $\frac{100\$ + 200 \text{ units} \cdot 1\$}{200 \text{ units}} = 1.5\$$ per unit.

This is referred to as internal¹¹ economies of scale or increasing returns to scale: doubling the number of workers and machines more than doubles the output. Larger firms are more competitive and can provide goods at a cheaper price. In this context, market size is a requirement for firms' expansion.

Formally, Krugman assumes a setting called monopolistic competition. Firms pay a fixed cost (expressed in units of input) to start their variety and then a variable cost for each unit produced. Because they are monopolists in their variety, they do not take the price as given but set it to maximize profits. Nevertheless, workers have incentives to enter the M industry

¹¹ *Internal* economies of scale refer to a lower average cost due to a *firm's* expansion, whereas *external* economies of scale refer to the synergies benefiting all firms when an *industry* expands.

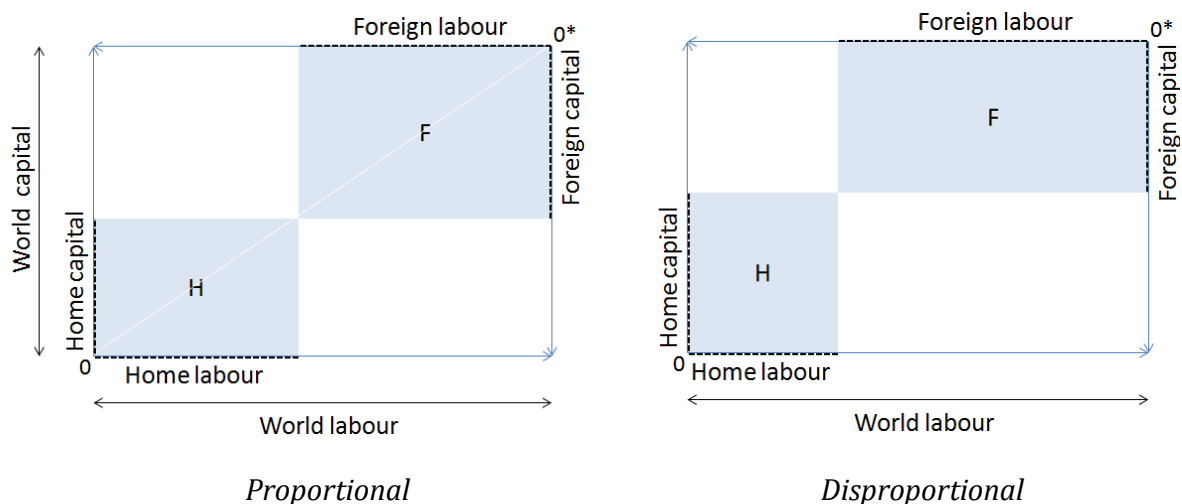
and create their variety until competition drives profits down to zero. It means that the sale price is just enough to cover the fixed and variable costs endured by the firms.

b. Autarky and free-trade equilibrium

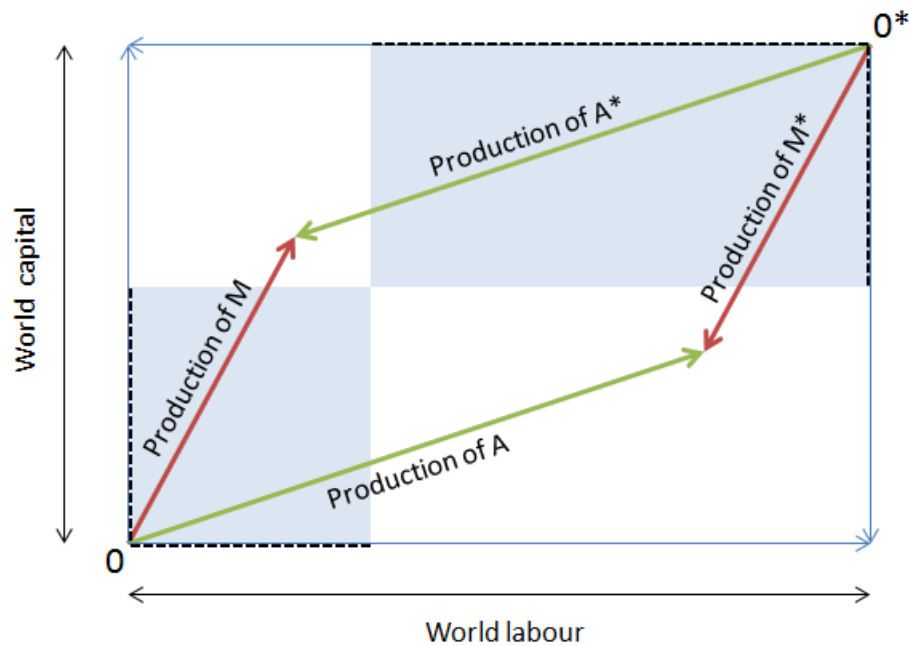
We start by looking at an adapted picture of the H-O model to which we integrate the rationale for intra-industry trade.

Helpman and Krugman propose to represent world resources as a box. The width of the box is the size of the labour force and its height is the size of the capital stock. Cutting the box vertically and horizontally divides the labour force and capital stock into two countries.

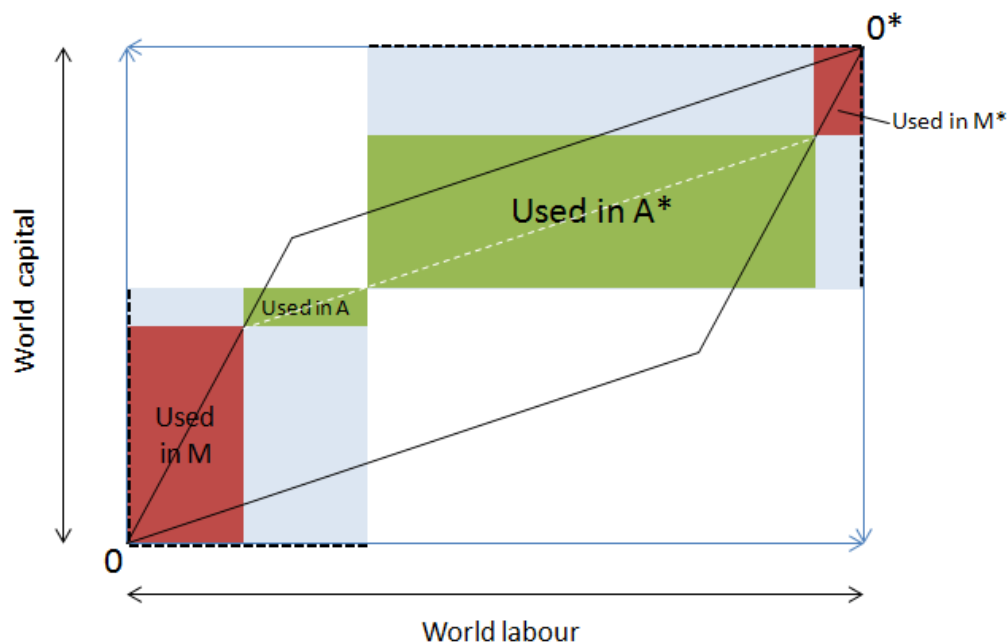
As shown below, we measure the endowment of H from point 0 and the endowment of F from point 0*. The endowments can be proportional (left) or disproportional (right). The former represents similar countries and the latter countries with comparative advantages. Remember that the H-O model concludes that trade will only emerge in the latter case, where H is relatively capital-abundant and F is relatively labour-abundant.



We first look at how labour and capital are allocated to the two sectors M and A in the case of disproportional endowments. The different factor-intensities of the two goods are represented by the direction of the arrows. We obtain a parallelogram because technologies are the same in H and F.



In each country, there is only one possible allocation that guarantees the full employment of factors. It is found by drawing a parallel to one of the technologies of production through the central allocation point. The pattern of specialization is represented by the red (M and M*) and green (A and A*) rectangles.



Source: adapted from Helpman and Krugman (1985)

It is clear from the size of the rectangles that country H produces relatively more M and country F produces relatively more A. Because all consumers have the same preferences, inter-industry trade emerges. Country F is an exporter of good A and country H is a *net* exporter of the varieties of good M.

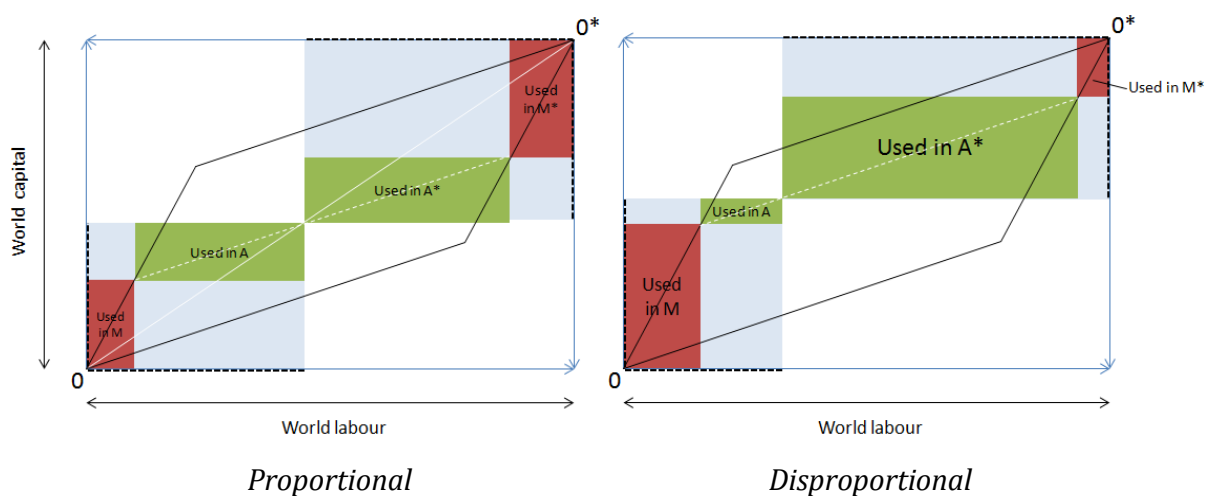
The term *net* is important because another phenomenon occurs simultaneously for the differentiated good M. Remember that each firm produces its own variety. On the demand side, opening trade increases the pool of varieties available to consumers. They want to rebalance their consumption baskets to include the varieties produced in the other country. On the supply side, incumbent firms have access to a wider market to expand production and realize economies of scale. However, they might face an increased competition that makes some firms exit the market.¹²

Each country produces fewer varieties than in autarky but firms produce higher volumes. Because consumers have access to the varieties of foreign firms, their consumption baskets are more diverse than in autarky, although they might include less local varieties.

The consumption of each variety is shared between consumers of H and F, at a proportion equal to the countries' share in world income. Cars are exported from H to F but also from F to H. Overall, H is a *net* exporter of M because of its comparative advantage.

In the free-trade equilibrium, there is both inter-industry trade due to comparative advantage and intra-industry trade in M due to product differentiation and economies of scale. Note that differentiating sector A would lead to a similar result.

Drawing the same graph with a proportional endowment of capital and labour (on the diagonal OO^*) shows that similar countries allocate factors to industries in the same proportions and therefore have no inter-industry trade, as per H-O model. However, they have intra-industry trade in the differentiated good.



¹² This depends on the assumption made. In Krugman's first model, trade increases substitutability between varieties. In his second model however, the elasticity of substitution is constant and competition is unchanged.

In this world, autarky relative prices are not relevant to identify comparative advantage anymore. If two countries have similar relative endowments but one is larger, as in the left graph above, the big country is able to achieve a lower average cost through economies of scale. Its output of M is more than proportionally greater than that of the small country (this is called the “home market effect” and is true as long as there are positive trade costs. We will talk about it in section 6). The autarky relative price of M is thus lower in the big country. When we allow trade, relative prices converge but we only observe intra-industry trade because no country has a comparative advantage over the other. In that special case, opening trade can therefore be seen as creating a larger integrated economy with similar factor proportions as each individual economy.

c. Welfare effects

On the one hand, inter-industry trade driven by comparative advantage does not benefit all factors. We showed in the context of the H-O model that the relatively scarce factor is made worse off by trade liberalization. Cross-border exchanges of M and A hurt workers in H and capitalists in F.

On the other hand, intra-industry trade driven by an increase in the size of the market provides every consumer with a greater variety of products. Cross-border exchanges of varieties of M improve the welfare of both the workers and the capitalists, who are all final consumers, in all countries. For example, this gain has been described in the context of Brazil as “a less tangible, non-economic effect of the trade policy liberalization in the early 1990s.” [...] “Brazil’s isolation in international goods markets was put to an end. The Brazilian consumer was suddenly confronted by much wider product choice and variety. Today products are available – produced by both domestic and foreign establishments – that simply did not exist in the country previously. Trade policies prior to 1990 had effectively cut off Brazil from the world.”¹³

Clearly, the relatively abundant factor gains from trade. The welfare effect of trade on the relatively scarce factor is however ambiguous. The benefits of intra-industry trade are more

¹³ Tyler W. and Costa Gurgel A.: Brazilian Trade Policies: Some Observed and Estimated Effects of the 1990s Liberalization, *Estudos Economicos* 39.1 (2009): 59-88

likely to outweigh the harm to the scarce factor when relative endowments are similar, economies of scale are large and consumers' taste for diversity is strong.

	Abundant factor	Scarce factor	Net effect
Inter-industry trade (M-A)	+	-	?
Intra-industry trade (M-M)	+	+	+
Net effect	+	?	?

Welfare effects of the two types of trade on the two factors of production

d. Conclusion and limitations

This integrated model of international trade provides an intuitive, yet more sophisticated way to think of today's trade flows between any pair of countries. It differentiates two underlying rationales for countries to trade with each other – comparative advantage and imperfect competition – but recognizes that they typically coexist. Trade flows in developing countries, on the one hand, remain mainly driven by comparative advantage such as a cheaper labour force or more abundant natural resources. On the other hand, developed countries accumulated capital, adopted comparable technologies and started exchanging similar products such as manufactured goods. Consistently with the model, this process led to relatively less redistribution problems than traditional North-South exchanges and provides an explanation for the observed large share of intra-industry trade.

This map still simplifies important features of the world as we know it today. Firstly, firms are far from being all identical. In fact, a few multinational corporations produce a highly disproportional share of world exports, while many firms only sell domestically. This point was later addressed by a new type of models called (with little imagination) the “new new” trade theory. Secondly, those models all assume that labour and capital are immobile across countries. In reality, migration and capital flows affect the localization of economic activity and create additional pressures on wages and rents. Krugman answered this limitation in a theory called the new economic geography (section 6) that allows for factor movement across countries.

5. Firm heterogeneity: the Melitz model and comparative advantage

Krugman's assumption that all firms are the same is rather limitative. In fact, firms vary incredibly in size and productivity and are not all impacted similarly by trade liberalization. Some of them export – in most cases the large and productive ones – and others sell in their domestic market only. In order to explain these stylized facts, we need to sophisticate the way firms are described on Krugman's map. This was achieved by Mark Melitz (Harvard, formerly Princeton) with the now-called “new new” trade theory. In this section, we adapt a model by Bernard (Dartmouth), Redding (LSE) and Schott (Yale)¹⁴ that combines Melitz's work with the theory of comparative advantage in the usual 2x2x2 setting used since section 3.

a. Assumptions

We remain in a two-country, two-good and two-factor world. In this model, both M and A are differentiated in the same way as M was in the Helpman-Krugman model (section 4). There is now intra-industry trade in both sectors, but different relative factor endowments and intensities imply that H is a net exporter of the varieties of M and F is a net exporter of the varieties of A, as per the Heckscher-Ohlin model (section 3). Technologies of production and preferences are the same everywhere and factors of production can freely move between industries but not across countries.

The heterogeneity in the productivity of firms is modeled as follows. In order to create a new variety of M or A, an entrepreneur who is part of a competitive fringe (potential entrants) starts up a new firm by paying a given fixed cost similar to that of the previous section. When this is paid, the firm is randomly assigned a productivity level based on a probability distribution. More specifically, firms face different variable costs of production based on luck (or similarly the success of the entrepreneur). Lucky (or successful) entrepreneurs can produce goods at a cheaper cost but they are not yet aware of it at the time they decide to pay the fixed entry cost.

¹⁴ Bernard A., Redding S., Schott P.: Comparative Advantage and Heterogeneous Firms, *The Review of Economic Studies* (2007) 74: 31–66

The zero-profit productivity cut-off

We define the zero-profit productivity cut-off as the minimum productivity level needed for a firm to survive. When firms were all similar, Krugman's setting of monopolistic competition insured that the profit of each firm was exactly covering its fixed cost of entry. This does not hold anymore. The productivity of a company (and therefore its production cost) is determinant for its bottom line. Indeed, consumers like all varieties of an industry equally, which rules out a strategy of increased differentiation. At the equilibrium price, the least productive firms make too little profits to cover their fixed cost of entry and they are forced to exit the market. On a productivity scale, they are all those firms located to the *left* of the zero-profit productivity cut-off.

The export productivity cut-off

We define the export productivity cut-off as the productivity level at which a firm starts exporting part of its production. In this document, describing the autarky and free trade equilibriums allowed us to contrast the two extreme situations and to regard an intermediate openness – such as a non-distortionary tariff – as a mid-way outcome. But in a world where trade is really free, all firms would be exporting regardless of their size or productivity because consumers enjoy variety. Clearly, this is not happening in the real world and regulatory barriers to trade are not the only reasons for this. A fruitful literature in the field of international business strategy explains that a firm willing to export its variety overseas typically faces additional costs and risks. For example, adapting the product to other tastes, cultures, languages or regulations and building networks with foreign stakeholders represents a non-negligible barrier to international expansion. Think of a local example such as the Swiss cheese industry. Despite the fact that different varieties of cheese face similar barriers to trade and that the small sample used here includes three (subjectively) comparable varieties of cheese, annually over 12,000 metric tons of Gruyère are exported to 55 countries (2013)¹⁵, 1,290 metric tons of Tête de Moine are exported to 35 countries (2011)¹⁶ and only a small share of the 1,000 metric tons of Tomme Vaudoise produced is exported to about 7 countries.¹⁷ As trade is costly even in a fully liberalized world, we introduce a fixed cost to export to our model.

¹⁵ <http://www.tdg.ch/economie/gruyere-poursuit-conquete-monde/story/20312415>

¹⁶ <http://www.terrenature.ch/terroir/06102011-0000-dix-ans-daoc-ont-bien-profite-la-tete-de-moine>

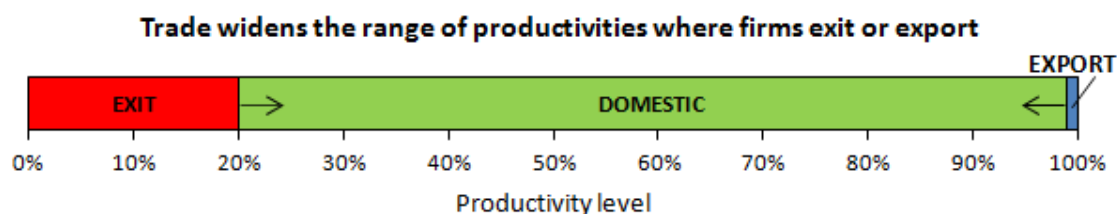
¹⁷ <http://www.laiteries-reunies.ch/lrg/easysite/ValdArve/exportation> and
<http://www.kulinarischeserbe.ch/product.aspx?id=128>

Established firms that already paid the fixed cost to produce and survived are now facing a new decision; can they afford an additional fixed cost to export? On a productivity scale, those firms answering yes and entering the export market are located to the *right* of the export productivity cut-off.

b. Autarky and costly-trade equilibriums

In this part, we contrast the situation of autarky (no trade permitted) to that of costly trade (trade is not regulated but firms incur a fixed cost if they decide to sell abroad). Trade liberalization creates potential export profits that shift the zero-profit and export productivity cut-offs. The shifts are in the same direction in both industries but differ in amplitude.

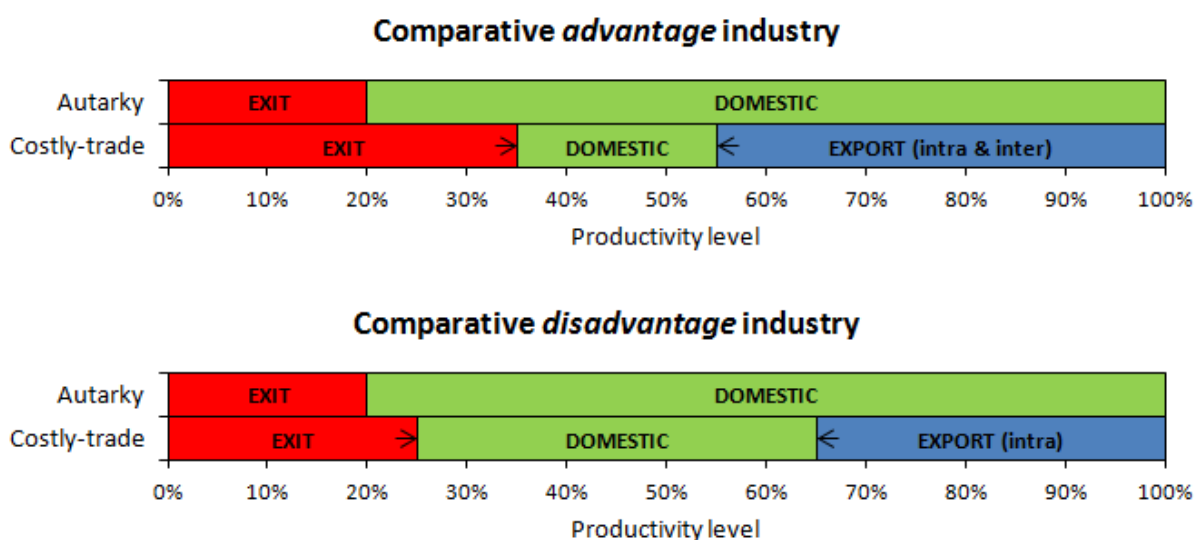
We first look at the direction of the shifts. On the one hand, the new profit opportunities increase the expected value of entering an industry. The competitive fringe has additional incentives to pay the fixed cost and draw a productivity level, hoping that it will be high enough to export. As more firms do so, rising competition makes it more difficult to remain profitable and the zero-profit productivity cut-off increases in both industries. Factors of production are reallocated from defaulting lower-productivity firms (those with productivity between the old and the new cut-offs) to entering higher-productivity firms, creating intra-industry turnover that can be described as a process of “creative destruction”.¹⁸ Consequently, the average productivity level increases in M and A. On the other hand, the export productivity cut-off that was to the far right in autarky (no firm could export regardless of productivity) is decreased to a situation where the high-productivity firms are making profits from exporting despite the fixed cost incurred.



We then compare the relative size of those shifts in the two industries. Recall from section 4 that intra-industry trade takes place in M and A because of product differentiation and increasing returns to scale, but inter-industry trade only emerges between the goods in

¹⁸ In the economics of innovation, creative destruction describes the fact that new ideas make old ideas obsolete. In our case, new productive firms replace less productive incumbent firms.

which each country has a comparative advantage. Thus, trade liberalization has a disproportionate impact on the comparative advantage industry. It increases profit opportunities for the competitive fringe and incumbent firms relatively more in the comparative advantage industry, which gains relatively more productivity and sees a wider range of its productive firms entering the export market. This is summarized on the graph below.



The change in the number of varieties available to consumers in each country is ambiguous. Although they have access to new varieties from the other country, the creative destruction of firms leads to industries with more, larger exporters but a smaller total number of local varieties. For example, this created tensions in the recent negotiation on the Transatlantic Trade and Investment Partnership (TTIP). “Christian Schmidt, Germany’s agriculture minister, said in an interview with Der Spiegel: If we want to seize the opportunities of free trade with the enormous American market then we can’t carry on protecting every sausage and cheese speciality. Food producers, politicians and campaigners against the trade deal seized on his remarks as evidence that the protection of regional brands would be sacrificed to globalization”.¹⁹

In equilibrium, the expected profit of entering an industry (which depends on the probability of exiting and that of exporting) is equal to the fixed cost of entering production. This is a generalization of Krugman’s monopolistic competition setting where the profit of each firm just covered its fixed cost of entering production.

¹⁹ “Sausages at center of EU-US trade row”, Financial Times, 6 January 2015.

c. Welfare effects

At this point, we recognize six channels through which trade liberalization affects the welfare of either individuals or the economy as a whole.

(I) **Efficiency gains from specialization:** world production and aggregate welfare increase because countries specialize in the good in which they have a comparative advantage (see section 2: Ricardian model).

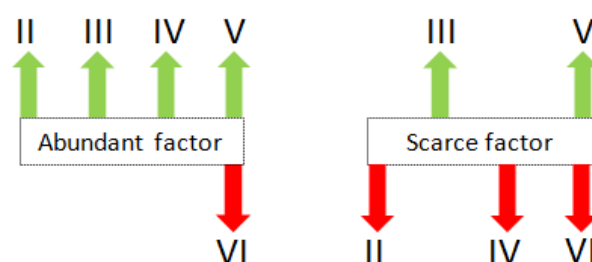
(II) **Reallocation of factors of production between industries:** in the process of specialization, the abundant factor is made better off and the scarce factor worse off (see section 3: Heckscher-Ohlin model).

(III) **Natural selection:** trade makes the industries more competitive and the least productive firms are replaced by more productive ones, which raises the average productivity in all industries. Hence, the average price of a variety falls and the real wage (purchasing power) of all factors rises.

(IV) **Magnification of comparative advantage:** channel (IV) is stronger in the comparative advantage industry of each country, because the opportunities of export profits associated to this industry are higher. The relatively larger increase in efficiency in M for country H and A for country F widens differences across countries and thus channels (I) and (II) are magnified.

(V) **Gain in variety from abroad:** consumers have access to varieties from the other country (see section 4: Helpman-Krugman model). This is still true in this model, although not all varieties are exported.

(VI) **Loss in local variety:** with trade, domestic industries are made of fewer, larger firms. It decreases the number of local varieties available to consumers. The net effect of (III) and (IV) is ambiguous.



Welfare effects of trade liberalization on factors of production according to the model by B-R-S

All in all, Channels (III) and (V) benefit all factors of production (the workers and the capitalists), channels (II) and (IV) benefit the abundant factor but harm the scarce factor and channel (VI) harms all factors. Channel (I) is not represented because its distributional aspect is captured in channel (II).

d. Conclusion and limitations

We started this document with a simple two-good, two-country model, concluding that trade provides aggregate welfare gains. We then followed a process of sophistication by first introducing a second factor of production, then differentiating generic goods into different varieties and finally allowing for firm heterogeneity.

This fine level of disaggregation is extremely useful for current research in international trade. The Melitz model provides a better understanding of the various channels through which trade liberalization affects welfare. While still relatively simple, it reflects different dimensions of the complex world and provides substantial insights for trade policy. Thanks to recently developed firm-level trade datasets, empirical research can be conducted and trade models can be more precisely calibrated. Lucien Cernat, Chief Trade Economist of the European Commission, is unequivocal: “The new firm-level trade datasets that are already publicly available allow researchers to identify and analyse each and every shipment of the 30 million containers trade around the world by carrier, port of departure and destination, countries, description of products and commodities at the most detailed level (e.g. 8 or 10 digit national tariff line level), equipment type, size, weight, value, currency used, shipper and consignee's street, city, zip code, plus any other detail contained in the entire bill of lading. One can also match this information with the most important firm characteristics (e.g. from publicly available balance sheets) that have an impact on export performance. So thanks to the new firm-level trade data ‘revolution’, available trade models come nowadays much closer to business realities.”²⁰

More generally, the model is helpful to understand and assess the trade policy literature, for example this quote from a policy research working paper of the World Bank: “The economic benefits of greater engagement in international trade have a long-established theoretical basis—gains to trade are as much derived from imports as from exports. Increased exports bring both static efficiency gains derived from the exploitation of comparative advantages

²⁰ Cernat, L., “Towards ‘Trade Policy Analysis 2.0’, From National Comparative Advantage to Firm-Level Data”, Chief Economist Note, Issue 4, European Commission, November 2014.

and dynamic gains in the export sector, given productivity gains generated by increased competition, economies of scale, better capacity utilization [...]. Therefore, pursuing greater global integration of the Brazilian economy remains a challenge that, if overcome, should provide significant benefits in the medium and long terms."²¹

Notice that in addition to ignoring the potential harm of trade liberalization (the red arrows), this quote does only mention the medium and long run, like we did throughout this document. Indeed, we assumed that factors of production can freely be reallocated across and within industries, disregarding important short-term implications of trade liberalization. In particular, workers and machines cannot instantly move to another industry or a more productive firm. The growth of the competitive advantage industry at the expense of the other and the important intra-industry turnover are likely to be affected by frictions in the labour and capital markets and cause unemployment and resistance from vested interests. It is also clear that preventing the movement of factors across borders is unrealistic if we want to understand how international trade has been impacting today's globalized world. This last point is the topic of the next section.

²¹ Canuto, O., Cavallari M., Guilherme Reis, J.: Brazilian Exports: Climbing Down a Competitiveness Cliff, Policy Research Working Paper 6302, The World Bank, 2013

6. Agglomeration: new economic geography

New economic geography refers to a new type of models meant at explaining the geographical structure of the economy. In other words, it provides a theory for the uneven localization of economic activity, in particular the agglomeration of industrial activity in clusters, cities or regions. It was initiated with the core-periphery model proposed by Paul Krugman in his 1991 publication “Increasing Returns and Economic Geography” and builds on his earlier work, the new trade theory of section 4. Indeed, the mathematical structure of the model, although not detailed in this document, is very similar to his 1980 publication that was the foundation for the Helpman-Krugman model, with the exception that some workers are now allowed to migrate from one region to the other.

The agglomeration or dispersion forces that influence the localization of firms and consumers are derived from the interaction of economies of scale at the level of the firm, transportation costs and labor mobility across regions. For firms, those counteracting forces can be understood as a trade-off between proximity to consumers and concentration of economic activity. Economies of scale became particularly important during the industrial revolution, leading to the construction of larger plants. This in turn led to the concentration of workers and urbanization. Means of transportation improved in the same period and allowed firms to send goods to the rural periphery and import agricultural goods at lower cost. But this is not only an old story. This domain of research is particularly interesting in light of recent economic integration, for example the free movement of capital and labor in the European Union, which blurs the line between international and regional trade. It also gives a partial explanation for the agglomeration of industries into clusters such as the Silicon Valley or London’s financial center. Finally, it provides some interesting insights to the study of free-trade agreements.

a. Assumptions

Our world is composed of two regions, North and South, which are strictly identical to begin with. The regions are equally open, consumers have the same tastes (they enjoy variety) and firms use the same technology of production.

As usual, there are two sectors. Manufacturing goods (M) are differentiated into many varieties and produced under increasing returns to scale, like in the Helpman-Krugman model. That is, an entrepreneur incurs a fixed cost in terms of labor to start a variety (build a

plant) and the average cost of a unit produced then falls when output increases. Each firm has a monopoly on its variety of M and produces it in one location. As varieties are close substitutes, competition still plays a role and the profit of firms just covers their fixed cost so that there are no profits in aggregate (more detail on page 22).

Transporting goods M to the other region is costly. That is, bringing M to local consumers is costless but in order to sell one unit in the other region, a firm must ship $\tau > 1$ units. This modeling strategy is called iceberg trade cost; part of the shipment “melts” on the way. But this can be understood as a bundle of all the costs that affect trade across regions, such as administrative or regulatory barriers, adaptation and translation costs, custom duties and so forth. As selling domestically causes no transport cost, the size of the domestic market matters.

Agricultural goods (A) are much simpler: they are homogenous (perfectly substitutable), produced under constant returns to scale and costless to transport.

As before there are two factors of production, but this time each is specific to one sector. Industrial workers (H) are only good at producing M and agricultural laborers (L) are specific to A . An important feature of the model, and the key new assumption, is that workers in M are mobile across regions. In other words, they can freely migrate and set up their firm in the region that offers the highest real wage. The location of demand and production is therefore determined by the parameters of the model.²² Laborers in A , however, are assumed to remain in their home region. We start with a situation in which each region has half of the world’s endowment of H and L .

Note that we abstract from comparative advantage in this model. Indeed, each good is produced with one specific factor (M is 100% worker-intensive and A is 100% laborer-intensive), so that differences in initial relative endowments are not a necessary condition for the emergence of specialization, as in previous models. Instead, the country that attracts more workers will be the one that industrializes.

²² The key parameters are transport costs, substitutability between varieties and the relative share of spending on M and A .

b. Autarky and costly-trade equilibria

The short-run equilibrium (before workers get to migrate) can be derived in the same way as in the Krugman model. Not surprisingly, the industrialization and urbanization of each country is symmetrical and represented by the same number of industrial workers and their respective firm and variety. If trade is allowed, intra-industry trade emerges in the varieties of M, but there is no inter-industry trade between M and A.

Now, what happens if one worker from the South migrates to the North and sets up its firm there? The net effect is the sum of three forces.

Market-access effect

The market size increases by one consumer in the North and decreases by one consumer in the South. Because firms incur a transport cost when selling to the other region, they would prefer to be located in the largest market. The larger demand in the North is an incentive for Southern workers to follow their compatriot to the North and set up their firm there. This reinforcing agglomeration force is also called demand-linked circular causality or backward linkages.

Cost-of-living effect

The number of varieties produced increases by one unit in the North and decreases by one unit in the South. Since the consumption basket of consumers in the North now includes more local varieties, and those do not entail a transport cost, the price level decreases in the North and increases in the South. The higher real wage (purchasing power) in the North is an incentive for Southern workers to follow their compatriot to the North, too. This reinforcing agglomeration force is also known as cost-linked circular causality or forward linkages.

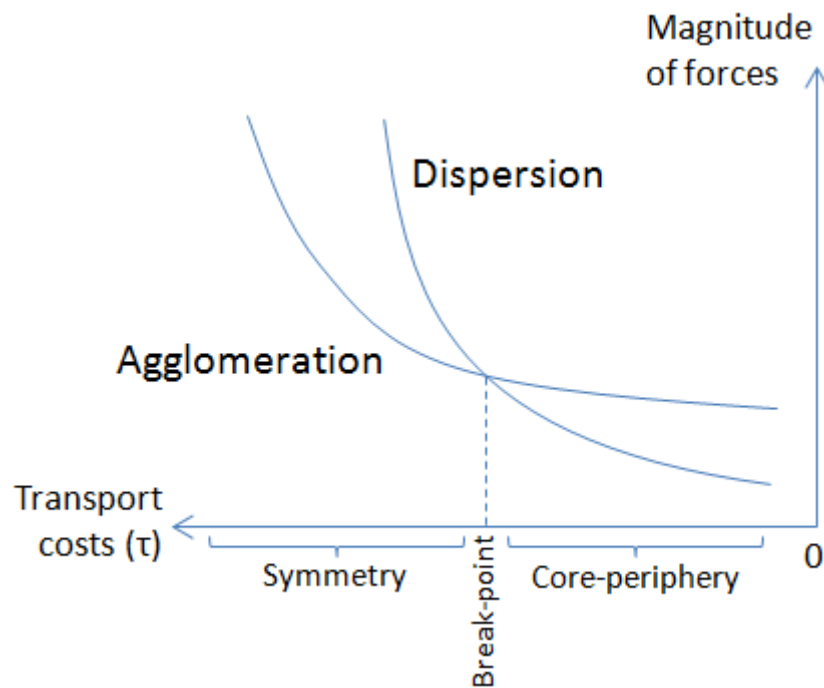
Local-competition effect (or market-crowding effect)

Another consequence of agglomeration is that more firms compete for domestic customers in the North. To realize that, we take a numerical example and imagine a transport cost that is so high that no variety of M is traded across region. Assuming that there are 3 workers and 3 laborers in each region to begin with, three varieties of M compete for 6 customers in each country. Now if one Southern worker migrates, 4 varieties now compete for 7

customers in the North ($4/7=0.57$ varieties per customer) and 2 varieties compete for 5 customers in the South ($2/5=0.40$ varieties per customer). The tougher competition for customers in the North creates downwards pressures on prices and, because there is zero profit, downward pressures on nominal wages, too. The decreasing nominal wage is an incentive for one Northern worker to migrate back to the South. Of course, foreign competition also plays a role if M is traded, but this dispersion force remains for any positive level of transport cost and works against the forward and backward linkages previously mentioned.

All in all, if the agglomeration forces dominate, the first worker is followed by all its footloose compatriots and industrial activity locates in one region. This is a core-periphery equilibrium, with an industrialized “core” and a rural “periphery”. There is inter-industry trade – the “core” exports M and imports A – but no intra-industry trade. If the dispersion force dominates however, the first migrant comes back to its region of origin and the initial symmetric equilibrium remains stable. Only intra-industry trade in the varieties of M takes place.

In order to understand how a stable symmetric equilibrium can suddenly shift to a stable core-periphery equilibrium, we need to consider the impact of a decrease in transport costs similar to the one observed in the real world since the industrial revolution. When this happens, the strength of both agglomeration and dispersion forces falls. Indeed, low transport costs imply that consumers in the other region can be reached cheaply, which decreases the importance of domestic market size. Similarly, the prices paid by consumers are less impacted by the origin of varieties when transport costs are low. Finally, the competition from foreign varieties becomes increasingly similar to that of domestic varieties if they can be transported at low cost. Although the direction of the impact is similar for all forces, its magnitude is different. Simulations show that dispersion forces surpass agglomeration forces for high transport costs, but the latter overtake the former at a given threshold level of trade cost, the “break point”. This is illustrated on the graph below, with the magnitude of agglomeration and dispersion forces as a function of *falling* transport costs (which is why the x-axis is inverted).



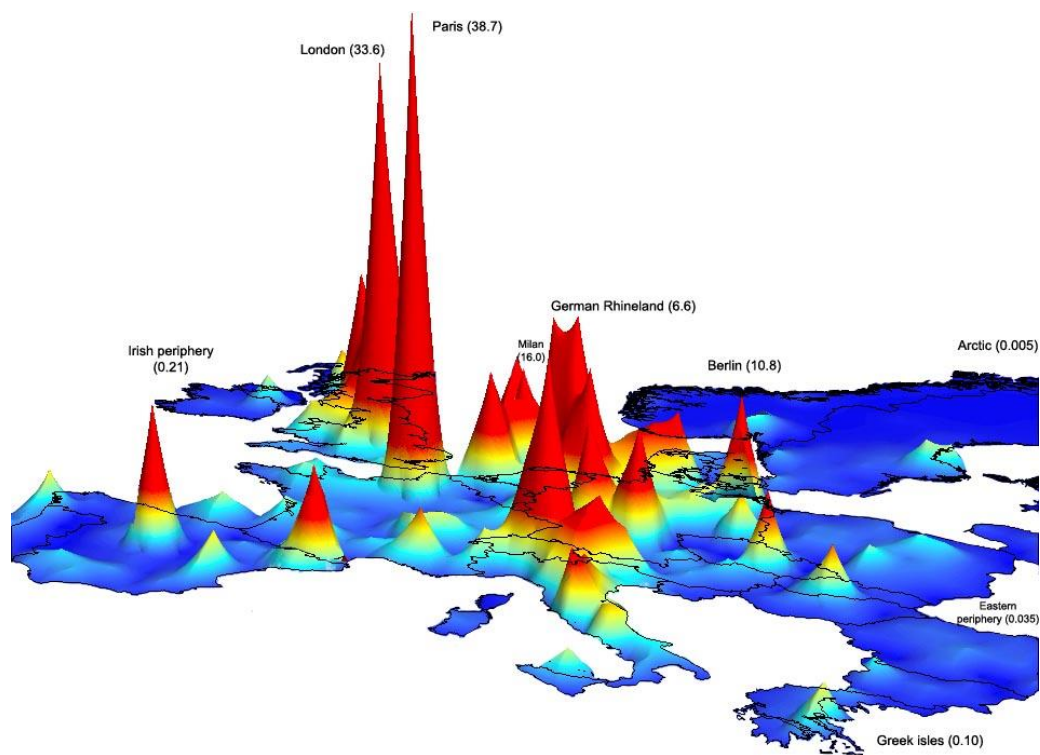
Source: adapted from Baldwin, Forslid, Martin, Ottaviano & Robert-Nicoud (2002), chapter 2, p. 19

As long as transport costs are to the left of the break-point, the dispersion force dominates and the two regions remain in a symmetric equilibrium. However as transport costs fall they end up hitting the break-point. From this moment, agglomeration forces overtake the dispersion force, which pushes workers to migrate to a single region with their firms all at once. This is called catastrophic agglomeration and leads to the core-periphery equilibrium. A symmetric reduction in transport costs between two identical regions can therefore lead to an asymmetric repartition of economic activity.

Before turning to some real-world applications of this model, one of its wonkish specificity is worth mentioning. For an intermediate range of transport costs and other parameters, the long-run equilibrium (“core” in the North, “core” in the South or symmetry) depends on the initial conditions of the model, which is called multiple equilibria in economics. This is when history kicks in. Why did the Silicon Valley develop in the San Francisco Bay area and not in Santa Barbara or Philadelphia? Probably because a few successful entrepreneurs established their high-tech start-up there and this initiated an agglomeration “snowball” effect.

c. Some applications

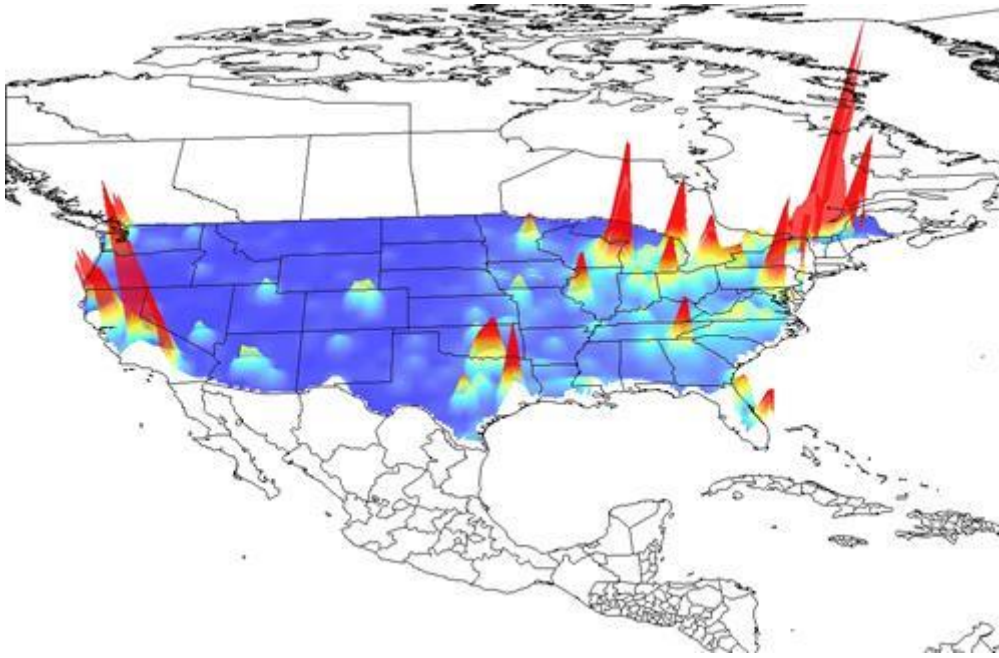
The model can be extended to more than two regions, in which case economic concentration happens in only a few of those regions. This is quite powerful at mimicking the economic geography of the real world. The European “economic contour map” below illustrates the density of GDP and shows that “the world is spiky”.²³ We observe a clear core-periphery structure at the country level, where transport costs are low (Spain and France are the most evident). The core-periphery model indicates that more economic integration in Europe should enhance this pattern at the continental level. Although agglomeration stands out on the “Manchester-Milan axis” (usually called the “blue banana” but this does not fit this map very well), strong transport costs linked to political, cultural or linguistic barriers remain that bring the continent as a whole closer to a symmetric equilibrium.



Source: G-Econ research project, Nordhaus and Chen, <http://gecon.yale.edu/>

The core-periphery equilibrium is clearer in the United States where economic, political and cultural integration is at a much more advanced stage. Three major “cores” stand out: the Boston-Washington Corridor, California and the Great Lakes.

²³ Florida, Richard, “The World is Spiky”, *The Atlantic Monthly*, October 2005.



Source: G-Econ research project, Nordhaus and Chen, <http://gecon.yale.edu/>

The core-periphery model also brings interesting insights relevant to trade liberalization. Its conclusions imply that the creation of a trade bloc between a relatively rural nation and a relatively industrialized nation should have two levels of diversion on firms' investment decisions. On the one hand, the least developed nation may see part of its industrial base migrate to its more industrialized partner as trade costs fall. On the other hand, the free trade agreement (FTA) creates a larger market that has a "gravitational force" on firms from outside the bloc. It therefore gives incentives to those other nations to join the bloc as well. As they do so, the same circular causality of agglomeration that was taking place at the level of individual workers now occurs for individual countries. The larger the bloc, the more costly it is to remain outside of it.

This domino effect, as described by Richard Baldwin (Graduate Institute, Geneva) may help to understand the rapid expansion of the European Union and the motivation of countries in the periphery to maintain their application for membership despite the current difficult circumstances inside the bloc. Another example is the North American Free Trade Agreement (NAFTA): "The idiosyncratic event in the Western Hemisphere was the US-Mexico FTA. Announcement of these talks faced other countries with a *fait accompli*. Mexico-based producers would gain preferential access to the US market, thereby harming third-country exporters and diverting foreign investment to Mexico. Canada-Mexico tariffs were the first dominos to fall. Canada decided that it needed a place at the table to reduce possible

trade and investment diversion (especially in auto parts). Thus Canada found itself lowering barriers that it had previously found optimal (politically) to maintain. More dominos would have fallen, had NAFTA been open to enlargement. Chile, Brazil, Argentina, Uruguay and Paraguay, which had previously found it politically optimal to maintain tariffs against US exports, offered to reciprocally lower their bilateral tariffs to zero (i.e. they requested FTAs with the US)."²⁴

d. Conclusion and limitations

Krugman won the Nobel Prize in Economics in 2008 “for his analysis of trade patterns and location of economic activity”. His two main contributions are cited by the Nobel Committee; the new trade theory (section 4) and the new economic geography (this section): “What are the effects of free trade and globalization? What are the driving forces behind worldwide urbanization? Paul Krugman has formulated a new theory to answer these questions. He has thereby integrated the previously disparate research fields of international trade and economic geography.” When referring to the core-periphery model, the Committee summarizes the impact of this theory as follows: “Economies of scale combined with reduced transport costs also help to explain why an increasingly larger share of the world population lives in cities and why similar economic activities are concentrated in the same locations. Lower transport costs can trigger a self-reinforcing process whereby a growing metropolitan population gives rise to increased large-scale production, higher real wages and a more diversified supply of goods. This, in turn, stimulates further migration to cities. Krugman's theories have shown that the outcome of these processes can well be that regions become divided into a high-technology urbanized core and a less developed ‘periphery’.”²⁵

Although it is not evident from the description above, the level of mathematical complexity makes it impossible to solve the model analytically. Instead, numerical simulations are necessary. Nevertheless, the model simplifies reality in several ways. It does not take into account the free movement of capital across regions, as each good is produced with a single factor, workers or laborers. For the same reason, the other rationale for international trade linked to comparative advantage is omitted. More advanced models adding firm heterogeneity à la Melitz to the core-periphery model have been published, for example by

²⁴ Baldwin, Richard, “The Causes of Regionalism”, *The World Economy*, Volume 20, Issue 7, 2002, p. 880





























²⁵ Press Release for the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2008, available at http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2008/press.html








Baldwin and Okubo²⁶, and show that the most productive firms tend to be the first to migrate to the “core”. New trends in corporate strategy have also significantly altered the way goods are produced, leading to the emergence of global value chains rather than national industries. We touch upon this in the conclusion.

²⁶ Baldwin, Richard and Okubo, Toshihiro, “Heterogeneous firms, agglomeration and economic geography: spatial selection and sorting”, *Journal of Economic Geography*, Oxford University Press, vol. 6(3), pages 323-346, June 2005.

7. Global value chains

The previous sections presented the intuition, results and limitations of five fundamental models of international trade; the Ricardian model, the Heckscher-Ohlin model, the Helpman-Krugman model, the Melitz model and the core-periphery model. It is good at this point to recap the main elements of each “map of the world”. The table below does so by listing, in the following order, the models’ key message, fundamental structure, technology, goods, firms, factor mobility and winners and losers from trade.

2	Ricardo	 Comparative advantage based on technology differences  2 countries, 2 goods, 1 factor  Constant returns to scale  Homogenous goods  Homogenous firms  The factor can move inside but not across countries  Everyone gains from specialization and trade.
3	Heckscher-Ohlin	 Comparative advantage based on factor endowment  2 countries, 2 goods, 2 factors  Constant returns to scale but diminishing returns to individual factors  Homogenous goods  Homogenous firms  Factors can move inside but not across countries  The abundant factor of production gains and the scarce factor loses.
4	Helpman-Krugman	 Intra-industry trade in M between similar countries due to increasing returns to scale and taste for diversity, inter-industry trade between dissimilar countries due to comparative advantage à la Heckscher-Ohlin:  2 countries, 2 goods, 2 factors  Increasing returns to scale in M, constant returns to scale in A  Differentiated good M, homogenous good A  Homogenous firms  Factors can move inside but not across countries  Intra-industry trade benefits both factors, inter-industry trade benefits the abundant factor and harms the scarce factor.
5	Melitz and comparative advantage	 Trade increases competition, least productive firms exit and average productivity is raised. Comparative advantage is magnified.  2 countries, 2 goods, 2 factors  Increasing returns to scale in M, constant returns to scale in A  Differentiated good M, homogenous good A  Firms heterogeneity due to productivity differences  Factors can move inside but not across countries  Intra-industry trade increases average productivity, which benefits both factors, but the change in the number of varieties available is ambiguous. Inter-industry trade benefits the abundant factor and harms the scarce factor both in a magnified way.

6	New economic geography	 Increasing returns to scale and transport costs generate a self-reinforcing agglomeration of industry in one region under a break-point level of transport cost. There is intra-industry trade in the symmetric equilibrium and inter-industry trade in the core-periphery equilibrium.
		 2 regions, 2 goods, 2 factors
		 Increasing returns to scale in M, constant returns to scale in A
		 Differentiated good M, homogenous good A
		 Homogenous firms
		 Interregional factor mobility of workers but not laborers
		 Industrial workers instantly locate in the region with the highest real wage, which is raised by increasing returns to scale but falls with transport costs.

Those models of trade theory represent major refinements and upgrades in economic thinking. They also follow history, as new means of transportation and communication reshaped the structure of international trade and increased its level of sophistication. Recently, economists proposed the addition of a new layer of complexity to the map that would take into account a 21st-century revolution in global trade: the emergence of global (or regional) value chains.²⁷

Richard Baldwin (Graduate Institute, Geneva) distinguishes two episodes in recent history that he calls the great unbundlings.²⁸ In a first phase, the fall in transport costs brought by innovations from the steam engine to air transport allowed for a greater distance between production and consumption and led to the surge of international trade in goods. Until recently, the production stages of a final good were typically collocated inside a single factory and set up in a country strategically based on comparative advantage and/or increasing returns to scale considerations. This is the type of trade we discussed until now, which is why the smallest level of disaggregation we reach is that of the firm.

The second unbundling started in the 1980s with the revolution in telecommunications that permitted cheap and reliable coordination and transfer of information between distant locations. As coordination costs decreased considerably, the benefits stemming from co-locating the management, product design, support services and each step of the manufacturing process in a single location decreased in importance. It became possible to dislocate tasks of different factor intensities and offshore or outsource them strategically to other countries. Whereas comparative advantage played a role at the industry level after the first unbundling, international trade shifted from trade in goods to trade in tasks after the

²⁷ Other terms used in the literature include global production networks, global supply chains, vertical specialization, offshoring, production fragmentation or 21st century trade.

²⁸ Baldwin R., "Globalisation: the great unbundling(s)", prepared for the Economic Council of Finland, September 2006.

second unbundling. The off-shoring of labour-intensive activities such as IT and call center services to India (the “back office” of the world) or manufacturing lines to China (the “factory” of the world) are typical examples of regional specialization in tasks. Those tasks can indeed be performed on behalf of all foreign industries that have them as part of their value chain. As a result, the value of final goods such as a computers or airplanes are now attributed to factors of production in many countries around the globe, rather than a single factory. As corporations seized those cost-saving opportunities, intermediate goods started crossing borders more frequently when travelling between production stages. In fact since 2009, the value of intermediate-goods trade overtook that of final-goods trade.²⁹ To answer this fundamental change, current research in trade theory incorporates tasks offshoring in the models described above.

This section brings together some of the intuition of influential papers³⁰ by Richard Baldwin (Graduate Institute, Geneva) and Anthony Venables (University of Oxford) and describes a version of the core-periphery model (section 6) augmented with comparative advantage as well as trade-in-tasks. The global value chain of the Boeing 787 Dreamliner is used as illustration.

a. Assumptions

Our general framework is quite similar to the core-periphery model of section 6. There are two regions (North and South), two goods (M and A) and two types of labor specific to each good. Firms in M are mobile across regions and a transport cost must be paid to ship to the other side of the border.

Unlike before, we consider that the final good M is produced through a set of stages (“tasks”) that are bundled together by coordination costs. Firms pay a coordination cost analogous to the transport cost if they perform complementary tasks in different regions. This means that we now zoom inside the firm and consider the configuration of the chain of production.

In order to introduce comparative advantage, we assume that North is relatively better at producing M and South is better at producing A (for example because of technological

²⁹ Sturgeon, T., Gereffi, G., Guinn A., Zylberberg E., “Brazil in Global Value Chains: Implications for Trade and Industrial Policy”, article for Funcex Magazine, draft May 21, 2013.

³⁰ Baldwin R. and Venables A., “Spiders and snakes: Offshoring and agglomeration in the global economy”, *Journal of International Economics* 90 (2013) 245–254 and Baldwin R., “Integration of the North American Economy and New-paradigm Globalization”, Government of Canada, Working Paper Series 049, September 2009.

differences or a better access to land). This is true for the bundle of tasks as a whole, but we further assume that some tasks in the M-bundle are performed relatively better in the South.

b. Autarky and costly-trade equilibria

We start in a situation in which production stages are bundled in a factory because of prohibitive coordination costs. Firms therefore locate based on the average balance of agglomeration and dispersion forces across all tasks. When we allow for costly trade, agglomeration forces exceed dispersion forces for the production bundle as a whole, all firms in M migrate to the North and the core-periphery equilibrium is reached.

We then allow for production unbundling. Some exogenous shock such the invention of videoconferencing or enterprise resource planning (ERP) software decreases the coordination cost. As we will see, each task of the value chain of M faces a different balance of dispersion and agglomeration forces and it may become profitable to offshore the production of some but not all stages to the small region. The extent to which the value chain becomes global depends on its configuration and the relative magnitudes of four forces.

Comparative advantage effect

The theory of comparative advantage (sections 2 and 3) explained why international specialization in comparative advantage industries can increase global output in the presence of technological and/or factor endowment differences. The same logic can be applied to intermediate tasks with different input requirements and/or factor intensities. For example, if the comparative advantage of Germany, India and China imply that R&D is relatively cheaper in Germany, call centers relatively cheaper in India and manufacturing relatively cheaper in China, then international specialization can increase the global output of each task. By trading those complementary tasks, a greater quantity of the final good is produced with the same global resources. In the context of our framework, M-tasks requiring less technology will be more likely to migrate to the South because wages are cheaper there. For obvious reasons, comparative advantage is therefore a dispersion force.

Local-competition effect (or market-crowding effect)

This dispersion force is the same as in the core-periphery model of section 6. As we showed with a numerical example, agglomeration implies that more firms compete for domestic

customers in the North. This tougher competition creates downwards pressures on prices and makes the periphery more attractive.

Market-access effect

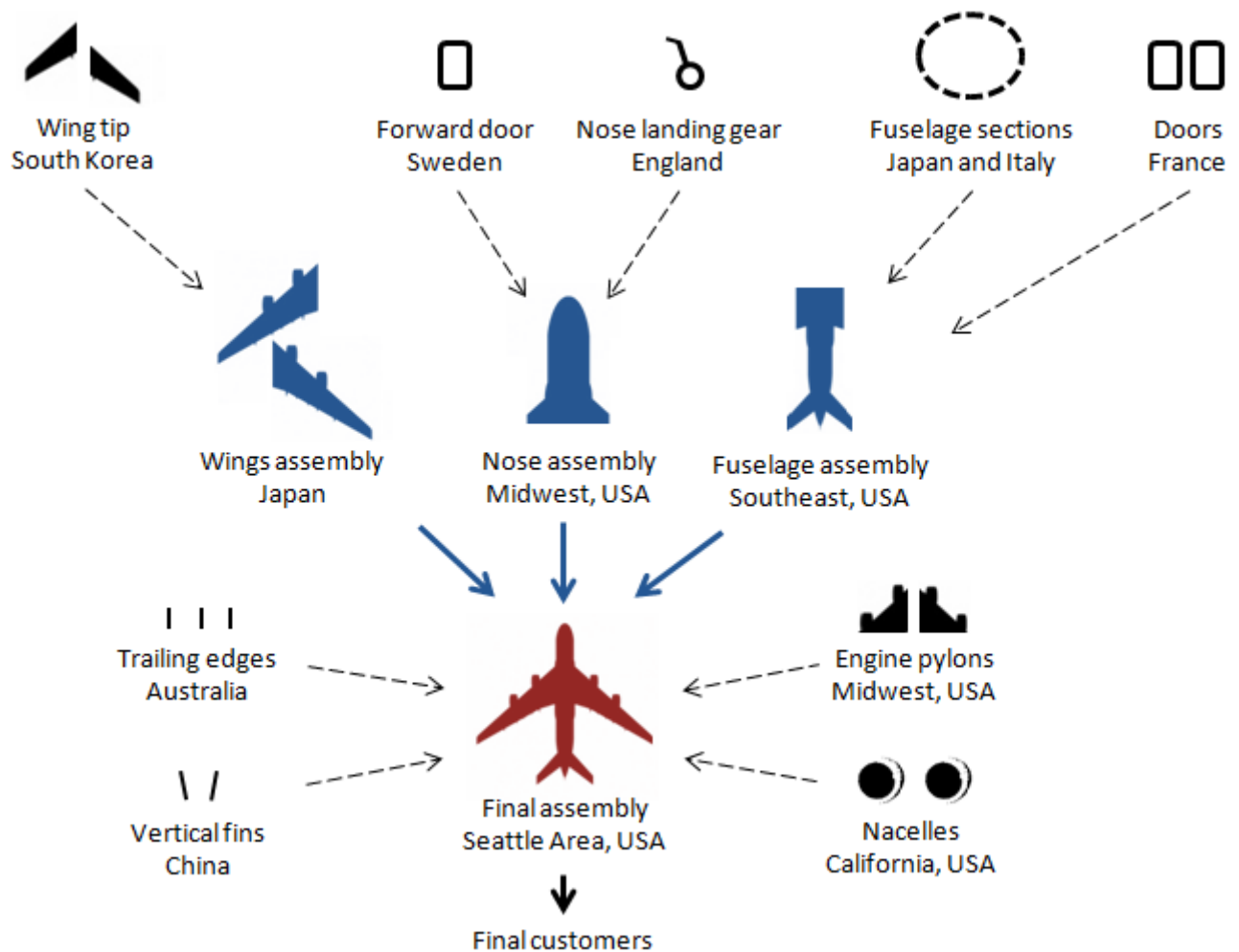
As in the core-periphery model, it is attractive for a firm to be located in the same region as its customers, but those customers are now downstream firms or final consumers. Indeed, selling locally does not entail transport and coordination costs but cross-border trade in tasks does. This reinforcing agglomeration force is also called demand-linked circular causality or demand linkages.

Input-cost effect

The input-cost effect is analogous to the cost-of-living effect in the core-periphery model. But in addition to consumers buying final goods, it includes firms sourcing tasks (for example parts, components or services) from upstream firms. A firm is better off, all else equal, if it locates in the same region as its suppliers because it saves on transport and coordination costs. This reinforcing agglomeration force is also called input cost-linked circular causality or supply linkages.

Out of those four forces, comparative advantage and the input-cost effect are most important when it comes to understanding why some tasks are offshored and others not. Comparative advantage is straightforward, so we turn to understanding why the configuration of the value chain matters.

As an example, we consider a subset of the global value chain of the Boeing 787 Dreamliner. Three types of tasks can be identified: parts (in black), components (in blue) and final assembly (in red). Parts are assembled into components that are in turn combined with other components and parts to produce the final good. The airplane is then sold in the final market.



Mapping based on data from "Building the Dreamliner", Seattle Times, 2010, accessible at <http://seattletimes.com/multimedia/news/business/building-the-dreamliner/boeing-787.html>

The global value chain of the Dreamliner can be sliced into subsets of stages that represent either "snakes" or "spiders". A "snake"-type of process is one in which an intermediate good moves from one step to the other, often across borders, and is upgraded in value over time by use of factors of production. For example, a part (the fuselage sections) manufactured in Japan is then shipped to the Southeast of the USA to be upgraded into a component (the entire fuselage), which is then shipped to the Seattle Area to become a finished product (the airplane). This "snake" is one of the legs of a "spider"-type of process, which creates value by fixing together complementary parts often originating from various countries. In our example, the nose, fuselage and airplane assemblies are spiders.

All stages face demand linkages because firms always sell to another firm or the final consumer (each stage is the origin of an arrow). However, upstream tasks (the parts) are not affected by supply linkages because they require only factors of production but no

intermediate tasks from other firms. Because agglomeration forces are weaker upstream than downstream and the core-periphery equilibrium was sustained for the bundle as a whole, the two dispersion forces are likely to dominate for some parts. In other words, the saving on transport and coordination costs from bundling production may be outweighed by the saving on factor costs from unbundling.

For example, light parts of the Dreamliner such as trailing edges and vertical fins are manufactured in China and Australia, respectively, and shipped to the Seattle area for final assembly. It may be that the production of the engine pylons and nacelles remained in the USA because demand linkages were more important (difficulty to transport, needs for close coordination with final assembly, and so forth) and/or because the USA had a comparative advantage in this technology.

We remember from section 6 that the migration of one firm triggers a self-reinforcing agglomeration force. In the presence of intermediate tasks, the offshoring of a part to the periphery affects the input cost of downstream stages because of the transport and coordination costs entailed when sourcing. This gives further incentives to offshore the production of components to the periphery. If this relocation takes place, it may also shift the production of other parts (the other “legs” of the spider) with it. Where component assembly eventually locates depends on which forces prevail. In other words, components are “stretched” between offshored tasks and the final assembly, which is often tied to the large final market.³¹

For example, it may be that the comparative advantage of South Korea in wing parts and of Japan in wing components made it optimal to offshore both stages to the two neighboring countries and to airlift the wings to the Seattle area. However, the assembling of the aircraft body (nose and fuselage) remained closer to final assembly despite the fact that some of its parts were offshored around the globe (Europe and Japan).

Considering the industry as a whole, similar tasks may be offshored by two or more firms to the same region and/or supplier, which leads to efficiency gains through economies of scales. For example, upstream parts such as aluminum sheets are manufactured in a 2,400-

³¹ This seems to be true for the aerospace industry. Airbus also refers to it on its website: “Airbus’ initial final assembly line was established in Toulouse for the A300/A310. (...) Another final assembly line opened in 2008 at Tianjin, China (...) providing a production site within one of the world’s key future air travel markets. Market proximity was an important element as well in Airbus’ decision to create an A320 Family final assembly line in the United States – to be located in Mobile, Alabama”. It may not be true for final goods with a high value-per-weight ratio (such as electronics).

employee plant in Iowa, USA by the firm Alcoa for all major airplanes including the Airbus A380 and Boeing's 737, 747-8 and 777.³²

c. Welfare effects

After the first unbundling, it was justified to consider the impact of trade liberalization on the welfare of groups of individuals: the factors of production. The second unbundling complicates welfare analysis because the granularity of the map reaches the level of the individual worker, as explained by Richard Baldwin: “Particular workers in particular firms in a given sector could suffer while others in the same firm with the same educational attainment could prosper. New paradigm competition is on a much more individual basis and this has some implications for policy. Policies designed to help sectors may miss globalization’s losers entirely”.³³

d. Conclusion

This model showed that as the cost of coordinating complementary tasks over distant locations falls, firms in M from the North offshore upstream tasks to the South, which might attract further components and some of the parts linked to it. Simulations with different scenarios of interweaved “spiders” and “snakes” show that a linear fall in coordination costs leads to discontinuous relocations. In some cases, parts move away from their comparative advantage country and are “reshored” for even lower coordination costs.

Vertical specialization (i.e. conducting only a subset of the stages needed to obtain a final good) has critical implications for trade liberalization, which explains why GVC-related policy research is currently high on the agenda of most international economic organizations.³⁴ Part of this effort is to adapt trade statistics to measure countries’ added

³² “Alcoa Reaches Supply Pact with Boeing Valued at More Than \$1 Billion”, Wall Street Journal, 11 September 2014.

³³ Baldwin R., “Integration of the North American Economy and New-paradigm Globalization”, Government of Canada, Working Paper Series 049, September 2009, page 17.

³⁴ See for example:

De Backer K. and Miroudot S., “Mapping Global Value Chains”, OECD, May 2014.

Stephenson S., “Global Value Chains: The New Reality of International Trade”, ICTSD, WEF and IDB, December 2013;

Elms D. and Low B., “Global Value Chains in a Changing World”, FGI, NTU and WTO, 2013;

“World Investment Report 2013, Global Value Chains: Investment and Trade for Development”, UNCTAD, 2013;

“The Shifting Geography of Global Value Chains: Implications for Developing Countries and Trade Policy”, WEF, 2012;

value in final goods (i.e. the value of the task performed by a country) rather than the total value of the goods exported that may include imported parts and components.³⁵ It has also been argued that the World Trade Organization, designed for the first unbundling to regulate the international sale of goods (“WTO 1.0”) now needs to be upgraded to encompass the international production of goods through global value chains (“WTO 2.0”).³⁶

While research in the field of trade theory carries on, it seems adequate to conclude this document with a quote from an economist: “It takes considerable knowledge just to realize the extent of your own ignorance” (Thomas Sowell).

“Trade Patterns and Global Value Chains in East Asia: From Trade in Goods to Trade in Tasks”, WTO, 2011;

³⁵ The OECD-WTO joint initiative “Measuring Trade in Value Added” (TiVA) and the World Input-Output Database (WIOD) are the first public global datasets resulting from this endeavor.

³⁶ Baldwin, R., “WTO 2.0: Global governance of supply chain trade”, CEPR, Policy Insight No. 64, December 2012.

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