Microeconomics II: Trade
Program in Economic Policy Management U4613
Lecture Notes

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Chapter 1

The Ricardian Model

1.1. Introduction

1.1.1. Quiz

There are two countries, STRONG and WEAK. They have the following endowments and production capacities:

<table>
<thead>
<tr>
<th>Country</th>
<th>STRONG</th>
<th>WEAK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Labor Units</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>number of each good that can be produced with 1 unit of labor</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>bread (slices)</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>wine (glasses)</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

1. Which country has more resources?
• **STRONG**

2. Which country is more efficient at producing bread?

• **STRONG**

3. Which country is more efficient at producing wine?

• **STRONG**

4. Assume that units of labor cannot be split – you cannot use 1.5 units of labor, only 1 or 2, for example. List all possible outputs for STRONG and WEAK. Put your answer in the table below where each row represents a possible combination of units of bread and wine. [There is no trade.]

<table>
<thead>
<tr>
<th>STRONG</th>
<th>WEAK</th>
</tr>
</thead>
<tbody>
<tr>
<td>bread</td>
<td>wine</td>
</tr>
<tr>
<td>labor</td>
<td>output</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

5. Assume that each country gets utility from consuming bread and wine and that they prefer to consume them in combination than to consume them alone. Bread tastes better with wine, and wine tastes better with bread. Utility is the product of bread and wine. Thus 4 units of bread and 2 units of wine has a utility of 8. [There is no trade.]

Show all possible utilities for STRONG and WEAK.
6. Now we will allow STRONG and WEAK to trade with each other. Assume that STRONG chooses to produce at the point where its utility was maximized when there was no trade. If WEAK chooses to produce only bread is there any offer of trade that she can make to STRONG which will make both WEAK and STRONG better off (in terms of utility) than at any other possible production point? If so, what trade is this (assume that only whole units of any good can be traded) and what is the resulting utility for both STRONG and WEAK?

- STRONG starts at 8 slices of bread and 6 glasses of wine for a utility of 48. WEAK starts at 9 slices of bread and no glasses of wine. If WEAK offers STRONG 2 slices of bread for 1 glass of wine, WEAK ends up with 7 and 1 for a utility of 7, which is higher utility than for any other combination of production without trade.

- Will STRONG accept? STRONG ends up with 10 slices of bread and 5 glasses of wine, for a utility of 50. STRONG is better off than with any other non-trade form of production. STRONG will accept.

7. Again assume that STRONG produces at the point where its utility was maximized before trade. Now assume that WEAK produces only wine. Is there any offer of trade that she can make to STRONG which will make both WEAK and STRONG better off (in terms of utility) than at any other possible production point? If so, what trade is this?

<table>
<thead>
<tr>
<th>STRONG</th>
<th></th>
<th>WEAK</th>
</tr>
</thead>
<tbody>
<tr>
<td>bread</td>
<td>wine</td>
<td>utility</td>
</tr>
<tr>
<td>16</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>36</td>
</tr>
<tr>
<td>8</td>
<td>6</td>
<td>48</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>36</td>
</tr>
<tr>
<td>0</td>
<td>12</td>
<td>0</td>
</tr>
</tbody>
</table>
and what is the resulting utility for both STRONG and WEAK?

- **WEAK** produces no bread and 3 glasses of wine. **WEAK** could trade 1 glass for 1 slice, 1 glass for 2 slices, 1 glass for 3 slices or 1 glass for 4 slices. What can these trades do?

<table>
<thead>
<tr>
<th>trade</th>
<th>total</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>bread</td>
<td>wine</td>
<td>bread</td>
<td>wine</td>
<td>utility</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>

- Only the last of these trades makes **WEAK** better off. Would **STRONG** accept this trade? If **STRONG** gives up 4 slices of bread for 1 glass of wine **STRONG** ends up with 4 and 7 for a utility of 28. **STRONG** would not accept this trade. Would **STRONG** accept the next best trade (which wouldn’t make **WEAK** better off, but wouldn’t make **WEAK** worse off either)? Here **STRONG** would end up with 5 and 7 for a utility of 35. **STRONG** would not accept this either.

### 1.1.1. What do we learn from this exercise?

The titles **STRONG** and **WEAK** were deliberately chosen because they have meaning in this exercise. **WEAK** has less resources and is less efficient.

- The existence of gains from trade does not depend on equality of resources or the ability of a country to produce goods more efficiently than another. (If we generalize from **WEAK** to a country that is not more efficient than any other country at producing anything, we can still get gains from trade).

- Although trade is advantageous both nations, only a particular type of trade is advantageous. In particular **WEAK** does not gain by trading wine for bread, only by trading
bread for wine.

- We will use the term absolute advantage to capture the fact that STRONG is more efficient than WEAK at producing both wine and bread. [STRONG has an absolute advantage in the production of both wine and bread.]

- We will use the term comparative advantage to capture the fact that WEAK appears to be better off if it produces some bread to trade with STRONG for wine. [WEAK has a comparative advantage in the production of bread.]

1.2. One country, two goods, one factor

We will now generalize from these results, and allow continuous allocation of labor. There is one country, WEAK, with the following endowments and production capacities:

<table>
<thead>
<tr>
<th>Country</th>
<th>WEAK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Labor Units</td>
<td>10</td>
</tr>
<tr>
<td>number of each good that can be produced with 1 unit of labor</td>
<td></td>
</tr>
<tr>
<td>bread (slices)</td>
<td>3</td>
</tr>
<tr>
<td>wine (glasses)</td>
<td>1</td>
</tr>
</tbody>
</table>

**Definition 1** \( a_{LB} \) is the number of units of labor required to make 1 slice of bread [productivity of labor per unit of bread].

**Definition 2** \( a_{LW} \) is the number of units of labor required to make 1 glass of wine [productivity of labor per unit of wine].

Figure 1.1 tells us what can be physically produced in the WEAK economy; the production possibility frontier. In order to know what will actually be produced we need to know
something about prices, or actually relative prices. As you might suspect, how much of each good is actually produced does not depend on the actual prices, but the ratio of prices. If bread is three times as expensive as wine, that is enough information to tell us what should be produced, we do not need to know the actual price of bread.

In Figure 1.2 we draw the production possibility frontier and two hypothetical price ratio. In fact, the price ratio only tells us the slope of the price line, it does not tell us the intercept. The slope is the negative of the price of wine over the price of bread. All the slopes that we discuss are in fact negative slopes (they point down when viewed from left to right), but this is confusing notation. We will talk about slopes as if they were positive (omitting the negative sign and if the slope is steeper we will say the slope is larger.) This is the equivalent of talking only about the absolute value of the slope.

We choose the intercept for each price line by making sure that the price line touches at least part of the production possibility frontier. In this way we use the price ratio to construct a budget constraint. Any point along or inside of the production possibility frontier represents a possible output of the economy. The budget constraint represents all
the points that are possible with trade. If you can produce at any point along a price line, with trade you can consume at any other point along the price line. Thus, prices allow us to examine both the production possibility frontier and what I will call the “trade–augmented production possibility frontier”.

![Diagram of production possibility frontier](image)

Figure 1.2: PPF with two hypothetical relative prices

If \( \frac{P_B}{P_W} > \frac{a_{LB}}{a_{LW}} \), then the economy will specialize in the production of bread. To see this look at the total earnings of the economy when it produces only bread,
we introduce a new variable, $x$ which is the units of labor devoted to the production of wine.

Revenue $R = \frac{L - x}{a_{LB}} \cdot P_B + \frac{x}{a_{LW}} \cdot P_W$

$$\frac{\partial R}{\partial x} = \frac{-P_B}{a_{LB}} + \frac{P_W}{a_{LW}}$$

$$\frac{\partial R}{\partial x} < 0 \quad \text{if} \quad \frac{P_B}{a_{LB}} > \frac{P_W}{a_{LW}}$$

or $$\frac{\partial R}{\delta x} < 0 \quad \text{if} \quad \frac{P_B}{P_W} > \frac{a_{LB}}{a_{LW}}$$

When the derivative of revenues with respect to $x$ is negative, revenues are increased by decreasing production of wine, in this case producing zero glasses of wine.

If $\frac{P_B}{P_W} < \frac{a_{LB}}{a_{LW}}$, then the economy will specialize in the production of wine. Follow the same exercise as above to show this.

### 1.2.1. Determination of Prices

When we are looking at only one country (in this case weak), it doesn’t make much sense to just declare a set of prices. They have to come from somewhere. Prices in a closed economy reflect the preferences of the individuals in that economy for the goods being produced. In order to determine the prices in a closed economy, we usually need to know the demand as well as the supply. Demand in this case is represented by a utility map. The usual representation of the determination of prices is shown in Figure 1.3.

The combination of the production possibility frontier and utility gives us a unique set of relative prices for this closed economy. Note that if the production possibility frontier is flat then all possible utility functions (non-trivial and convex) give the same set of prices. The line\(^1\) that separates the production possibility frontier and the highest obtainable iso-

---

\(^1\)Or, in the case of more than two goods, the hyperplane.
utility curve has exactly the same slope as the production possibility frontier at the point of contact, and when the slope of the production possibility frontier is the same over the whole set, then we automatically know the ratio of prices.

2.1.1. Note on the shape of the PPF

Note that in Figure 1.3 the production possibility frontier is bowed outward or concave.

**Question 1** Why do we usually represent the production possibility frontier as concave? This is basically the result of diminishing returns to any given factor.

In the case of only one input, concavity may be the result of differentiation in units of input. If there is one unit of the productive input that is more efficient at producing one input than any of the other inputs (one unit of labor that is really good at producing bread, or one plot of land that is very productive), then when we pass this unit from wine to bread, we get a flatter slope than for the rest of the production possibility frontier (see Figure 1.4).
In the case of multiple inputs, this intuition still holds. There are some units of any
given factor that are just better suited to producing certain types of goods. When we shift
these last factors over we get less.

![Graph](image)

**Figure 1.4:** PPF with one specialized unit of Labor

**Question 2** Why do we usually represent the iso-utility graph as **convex**?
Convexity in iso-utility curves is the result of preferences for bundles over extremes. This
is easy to visualize with the definition of a convex set. If we choose any two points on the
iso-utility graph we can see that any combination of these points (any point along a line
drawn between the points) give higher utility than either of the two points: combinations are
preferred over extremes).
1.2.2. Small country facing world prices

Figure 1.5 shows the same small country as in Figure 1.3, except that in this case there is a set of world prices, as well as the domestic prices. We assume that weak is so small that its decision to trade does not affect world prices. Clearly weak benefits by using the trade–augmented PPF to obtain higher levels of utility than would be possible without trade.

When the PPF is flat, exposure to world prices leads to specialization. Whereas in Figure 1.5 the representative country continues to produce both Good A and Good B, in the case represented in Figure 1.2 (except in the case that world prices had the same ratio as the slope of the PPF), weak would specialize entirely in one good or another.
1.3. Two countries, two goods, one factor

In this case we examine the case in which the representative country is large enough to affect the world prices of the goods in which it trades. Figure 1.6 is similar to Figure 1.5 except that we show the domestic price ratio and two sets of world price ratios.

Essentially we are deriving an offer curve. We show three representative price ratios and examine the level of exports at each of these price ratios. As the price of good A is increasing relative to the price of good B (moving from price ratio 1 to 2 to 3) we see the level of exports increasing. There are two impacts of an increase in the relative price. First there is increased production of good A and second there is decreased demand of good A. If A is a luxury good then it is possible that the consumption of good A would increase or remains stable as its prices increases because the export of Good A is making this country relatively better off. However, the more general case is that demand will fall. Figure 1.7 shows the resulting export supply curve.

An import demand curve for Good A could be similarly derived by doing the same exercise for the second country in this representative economy. Once we have found the supply and demand we can establish the equilibrium relative price.
Figure 1.6: Derivation of the Export Supply Curve: I
Figure 1.7: Derivation of the Export Supply Curve: II
1.3.1. Flat production possibility frontier

The exercise that we have been doing with the concave production possibility frontier is more realistic than using a flat production possibility frontier, but is not as easy to represent in simple math. So now we return to the model with which we began, with the flat production possibility frontier.

<table>
<thead>
<tr>
<th>Country</th>
<th>STRONG</th>
<th>WEAK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Labor Units</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>number of each good that can be produced with 1 unit of labor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bread (slices)</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>wine (glasses)</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 1.1: Endowments and Productivities for WEAK and STRONG

Figure 1.8 represents the production possibility frontier of both WEAK and STRONG. Clearly STRONG has greater productive capacity. However, note that the slopes of the two frontiers are not identical, and that the slope of the production possibility frontier for STRONG is steeper than that of WEAK. We can derive the supply curve (world supply now, not export supply) by following the same exercise as in the previous section. We will examine a set of price ratios and see how much is supplied for each ratio. Table 1.2 shows the production of wine and bread by both WEAK and STRONG for a series of price ratios. The table represents a discontinuity in the supply. For all price ratios where \( \frac{P_B}{P_W} < \frac{a_{LB}}{a_{LW}} \) the supply is the same, for example. Re-examine Figure 1.2 to understand why.

We know from Table 1.1 that \( \frac{a_{LB}}{a_{LW}} = \frac{1}{3} \) and \( \frac{a_{LB}}{a_{LW}} = \frac{3}{4} \) and thus we obtain Figure 1.9 example.

01/18/01↑
Figure 1.8: PPF of weak and strong

Table 1.2: Derivation of world supply of wine and bread

<table>
<thead>
<tr>
<th>Price Ratio</th>
<th>Wine</th>
<th>Bread</th>
<th>Wine</th>
<th>Bread</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_B &lt; \frac{a_{LB}}{a_{LW}}$</td>
<td>10</td>
<td>0</td>
<td>48</td>
<td>0</td>
</tr>
<tr>
<td>$P_W \leq \frac{a_{LB}}{a_{LW}}$</td>
<td>any point on PPF</td>
<td>48</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>$\frac{a_{LB}}{a_{LW}} &lt; \frac{P_B}{P_W} &lt; \frac{a_{LB}^<em>}{a_{LW}^</em>}$</td>
<td>0</td>
<td>30</td>
<td>48</td>
<td>0</td>
</tr>
<tr>
<td>$P_B = \frac{a_{LB}^<em>}{a_{LW}^</em>}$</td>
<td>0</td>
<td>30</td>
<td>any point on PPF</td>
<td>0</td>
</tr>
<tr>
<td>$P_W = \frac{a_{LB}}{a_{LW}}$</td>
<td>0</td>
<td>30</td>
<td>0</td>
<td>64</td>
</tr>
<tr>
<td>$P_B &gt; \frac{a_{LB}^<em>}{a_{LW}^</em>}$</td>
<td>0</td>
<td>30</td>
<td>0</td>
<td>64</td>
</tr>
</tbody>
</table>
Figure 1.9: World Supply of Bread
1.3.2. Wages

Since there is no other factor, and we will assume therefore, that there are no profits, workers earn the value of their labor. Let us say the demand is such that the equilibrium price of bread and wine is 2 thirds \( \frac{P_B}{P_W} = \frac{2}{3} \). To make this math easy we will assume that the price of bread is $2 a slice and the price of wine is $3 a glass. Since it takes one third of a unit of labor to produce one slice of bread, each unit of labor in weak earns $6. Each unit of labor in strong earns $12. Note that strong is 1 and 1/3 as productive as weak in bread and 3 times as productive as weak in wine, and it wages end up, in between, at 2 times as large as the wages in weak.

Note, that at these prices the cost to weak of producing bread is $2 a slice (given by the prices), the cost of producing wine would be $6, the cost to strong of producing wine is $3 (given by prices) and the cost of producing bread would be $4. It appears therefore, that each country sells the good that it can produce the cheapest. This is, of course true, but is the result of trade, not the cause of it. The relative wages between the counties is a product of trade.

This is the Ricardian Trade Model.

1.3.3. False Views of Trade

- Free Trade is beneficial only if your country is strong enough to stand up to foreign competition [mistaking absolute advantage.] for comparative advantage.

- Foreign Competition is unfair and hurts labor in countries with higher wages when it is based on low wages. (US is hurt in US/Mexico trade, for example.)[Ans: It is cheaper to produce the good of your speciality and trade it for the other.]

- Trade exploits a country and makes it worse off if its workers receive much lower wages than workers in other nations. (Mexico is hurt in US/Mexico trade) [strong gains more than weak, but weak gains compared to no trade.]
Chapter 2

Specific Factors Model

2.1. Introduction

The Ricardian model of trade is a nice simple model for showing the gains to trade and even the affect of trade on relative wages between participating countries. We know, however, that the gains from trade are not distributed evenly among all owners of factors in an economy (where owners of factors might include owners of labor, land or capital). This has very important implications for the political economy of trade. In this section we develop a model of production and trade in which there are three factors in the economy. The model of trade is essentially identical to that in the previous section where we had a concave production possibility frontier. However, we will be able to trace backwards the impact of trade on the relative wages of all factors in the economy.
2.2. Graphical Representation

We begin with an economy in which there is labor \((L)\), capital \((K)\) and land \((T)\) (think of territory\([T]\)). Two goods are produced; Manufactures and Food. Manufactures requires labor and capital and food requires labor and land. It should be clear that the result of absolute specialization that we obtained with the Ricardian is unlikely to occur with this model because specialization in one product would leave either land or capital entirely unused.

The essential addition of this model is that capital cannot be used to produce food and land cannot be used to produce manufactures. Labor can be used in either allocation. There is a fixed supply of labor, capital and land, however all land will be used in food and all capital in manufactures.

\[
Q_M = Q_M(K, L_M) \quad (2.1)
\]

\[
Q_F = Q_F(T, L_F) \quad (2.2)
\]

\[
L_M + L_F = L \quad (2.3)
\]

Figure 2.1 introduces the 4 quadrant diagram and shows the constraint for the allocation of labor. The labor allocation frontier is very simple, there is a one for one trade-off between sectors in the allocation of labor.

Figure 2.2 introduces the production functions \(Q_M = Q_M(K, L_M)\) and \(Q_F = Q_F(T, L_F)\) in quadrant IV and II respectively. The functions represent the diminishing marginal productivity of labor (diminishing returns to labor) in each sector.

**Question 3** Why does the curve representing the function \(Q_F = Q_F(T, L_F)\) represent declining marginal productivity of labor?

Now we can find the quantity of food and manufactures produced for any point along the labor allocation frontier. Plotting these quantities in the first quadrant gives us the points from which we will draw the production possibility frontier (see Figure 2.2.)
The quantity of food and manufactures actually produced will depend on the prices faced by the economy. This is exactly the same exercise as that shown in Figure 1.3. We assume a particular ratio of prices and represent this as \( \frac{P_M}{P_F} \). This gives us the quantity of food and manufactures and we can trace this back to the labor allocation frontier to see how much labor is used in each sector.

Alternatively, we can obtain the same result by saying that labor moves between sectors until the wage rate is the same in each sector. The wage in any sector will be equal to the marginal physical product of labor times the price of the good being produced. Note that the marginal physical product of labor is very often called simply the marginal product of labor. I use the term “physical” to remind us that this is a measurement in units of output, not value. The marginal value product of labor is the marginal physical product times the price. Hereafter, the term MPL refers to the marginal physical product of labor, and I will sometimes refer to this as simply the marginal product of labor.

\[
\begin{align*}
  w &= MPL_F \times P_F \\
  w &= MPL_M \times P_M \\
  MPL_F \times P_F &= MPL_M \times P_M \\
  \frac{MPL_F}{MPL_M} &= \frac{P_M}{P_F}
\end{align*}
\]

This just means that the slope of the production possibility frontier must be equal to the slope of the price ratio, which is exactly the condition we discussed above. The slope of the production possibility frontier (at any point) is equal to \( -\frac{MPL_F}{MPL_M} \). We can see this by asking, at any point along the production possibility frontier, what happens if we move one unit of labor from one sector to the other. We cannot see units of labor on the production possibility frontier, but if we remove a unit of labor from manufacturing we loose the marginal physical product of labor in manufacturing \( MPL_F \) units of manufacturing. If we move this unit to food well will gain the marginal physical product of labor in food \( MPL_F \) units of food. The rise is \(-MPL_F\) and the run is \( MPL_M \), thus the slope is \(-\frac{MPL_F}{MPL_M}\).
If, $MPL_F * P_F > MPL_M * P_M$ then the wage rate in the food sector is higher than the wage rate in the manufactures sector and labor will leave the food sector and migrate to the manufactures sector.

**Question 4** *As labor leaves a sector the marginal physical product of labor rises or falls?*

As labor leaves a sector the marginal physical product of labor in that sector will rise (the definition of diminishing returns to labor) and it will fall in the sector which is attracting labor. So this migration will equalize the wages.

### 2.3. Changes in the Price Ratio

#### 2.3.1. Equi-proportional changes in prices

**Question 5** *What happens to this equilibrium when the price of both food and manufactures increases by 10%*

- The price ratio is unchanged so the equilibrium allocation of labor cannot change
- But what about wages?
- Even though nominal wages will rise, the real wage is unaffected, in this model with only two goods. This does not depend on any qualities of the income effect.
- If there was a third good whose price did not change, then we could have an income effect.
2.3.2. Differential changes in prices

As the previous exercise demonstrates, it is important to examine, not just the changes in wages, but the changes in the purchasing power of these wages. Thus we are not concerned with nominal wages but real wages. To do this we will examine the wage in terms of the number of units of both food and manufacture that can be purchased with the wage. If we observe that the wage of labor can purchase both more manufactures and more food (if it is used to buy only one or the other good) then it is clear that laborers are better off.

3.2.1. Earnings of Capital

We start with what should be a clear cut situation. If the price of manufactures rises and the price of food remains the same we would be surprised if the owners of capital were not better off absolutely. What are the earnings of capital? We will call the profits of capitalists \( \pi_K \), the wage paid per unit labor \( w \) and the profits of landowners \( \pi_T \).

\[
\pi_K = P_M Q_M - L_M w \quad \text{Revenues - Wages paid} \tag{2.8a}
\]
\[
\pi_K = P_M Q_M - L_M MPL_M P_M \quad \text{From determination of wages} \tag{2.8b}
\]
\[
\frac{\pi_K}{P_M} = Q_M - L_M MPL_M \quad \text{Profits in units of manufacturing} \tag{2.8c}
\]
\[
\frac{\pi_k}{P_M} = L_M \left( \frac{Q_M}{L_M} - MPL_M \right) \quad \text{Algebraic manipulation} \tag{2.8d}
\]
\[
\frac{\pi_k}{P_M} = L_M (APL_M - MPL_M) \tag{2.8e}
\]

The profits of the capitalist (in terms of the number of units of manufacturing that he could buy with his profits) can be represented as the quantity of labor used times the difference between the average product of labor and the marginal physical product of labor. This makes intuitive sense because the marginal product of labor determines the wage that must
be paid to the last worker hired (and therefore to all the workers) and the average product of labor determines the productivity of the work force as a whole. The capitalist only makes profits if the $APL_M$ is greater than the $MPL_M$. When is this true? Here it helps to examine the production function for manufactures again.

Figure 2.4 shows how one would graphically determine the $APL_M$ and the $MPL_M$ with a standard production function. Convince yourself that the slope of the marginal product will always be less than the slope of the average product. We therefore obtain the values of $APL_M$ and $MPL_M$ shown in Figure 2.5.

Figure 2.5 shows that the average product is greater than the marginal product, and therefore the capitalist earns profits. Additionally, as the use of labor increases, the difference between the average and marginal product increases. Thus as the use of labor increases the profits of the capitalist increase. We know that the impact of a change in prices favoring the manufacturing sector is that labor shifts from the food sector to the manufacturing sector. Returning to Equation 2.8e we can see that as $L_M$ increases, the profits in terms of units of manufacturing is increasing both because $L_M$ increases and because $APL_M - MPL_M$ is increasing. To show that the capitalist is absolutely better off we need to show that he can also purchase more food with his profits. To do this we take his profits measured in terms of units of manufacturing, multiply by the price of manufactured goods (to get a money measure) and divide by the price of food (to get the number of units of food).

$$\frac{\pi_k}{P_F} = L_M \frac{P_M}{P_F} (APL_M - MPL_M) \quad (2.9)$$

Equation 2.9 represents the units of food the capitalist could purchase with the profits earned in manufacturing. As the price of manufacturing rises relative to food this amount goes up by even more than the profits measured in terms of manufacturing. Thus the capitalist can buy more of everything when the relative price of manufacturing increases.
2.1.1. Earnings of Landowners  It should be clear that the owners of land will do worse. We pick up the from Equation 2.8e and represent the number of units of food that the profits of landowners can purchase as seen in Equation 2.10.

\[
\frac{\pi_T}{P_F} = L_F (APL_F - MPL_F) \quad (2.10)
\]

We know that labor is shifting away from the food sector when the price of manufacturing increases. Thus \( L_T \) and \( APL_T - MPL_T \) are both falling and the profits of the landowners is clearly falling. If it is falling in terms of food (which has become relatively cheaper) then it must be falling in terms of manufacturing (which has become relatively more expensive).

2.1.2. Earnings of Labor  The earnings of each laborer is just his wage. The number of units of manufacturing that can be purchased with that wage is the marginal physical product of labor in manufacturing, and the number of units of food that can be purchased is the marginal physical product of labor in food production.

\[
w = MPL_M P_M \quad (2.11)
\]

\[
\frac{w}{P_M} = MPL_M \quad (2.12)
\]

\[
w = MPL_F P_F \quad (2.13)
\]

\[
\frac{w}{P_F} = MPL_F \quad (2.14)
\]

Since labor is moving from the food to the manufacturing sector the marginal products are changing.

**Question 6**  Why does labor migrate from food to manufacturing when the price ratio changes, and why do the marginal products change?

The marginal product of labor in the manufacturing sector is falling and the marginal product of labor in the food sector is rising. Thus labor can purchase less manufactures and
more food. We don’t know if they are better or worse off. This depends on how much they like manufacturing compared to food.

### 2.3.3. Graphical Representation of Changes in Wages

Figure 2.6 shows a graphical representation of the determination of the equilibrium wage rate. As labor is shifted from one industry to another the marginal physical products of labor are changing. The equilibrium allocation of labor is achieved where the wage rates are the same across industries.

Figure 2.7 represents the determination of a new equilibrium when the price of manufactures rises. When the price of manufactures rises this causes the marginal value product curve to shift upwards. Note that it does not shift upwards uniformly because the change in prices causes a larger shift when the marginal physical product of labor is larger. It is a multiplicative upwards shift, not an additive upwards shift. If there was no reallocation of labor the new wage would be the intersection shown by the intersection of $L_M$ and $w^*$. However, with reallocation of labor we get an intersection at $L_M^2$ and $w^2$. Note that the reallocation cause the wage in manufacturing to fall and the wage in food to rise.

Figure 2.8 shows that capital income can be represented on the marginal product of labor curve. It is the area above the marginal product of labor and below the curve. As labor shifts out this area unambiguously increases, as labor shifts in this area unambiguously decreases. Note that we cannot make conclusions about wages because the area shown is the total wage bill, not the actual wage.

### 2.4. Implication of the Model

Trade benefits the factor that is specific to the export sector of each country but hurts the factor specific to the import-competiting sectors with ambiguous effects on mobile factors.
Figure 2.1: PPF with Specific Factors: Labor Allocation
Figure 2.2: PPF with Specific Factors: Deriving the PPF
Figure 2.3: PPF with Specific Factors: Distribution of Labor
Figure 2.4: Finding the $APL_M$ and $MPL_M$ with diminishing returns to labor
Figure 2.5: $APL_M$ and $MPL_M$ with diminishing returns to labor
Figure 2.6: Graphical Representation of Equilibrium in Wages

Figure 2.7: Graphical Representation of Change in Relative prices
Income of capitalists

Wages

Increase in capitalist income

Figure 2.8: Graphical Representation of Capitalist Income
2.5. Political Economy Considerations

**Question 7** The textbook states that there are three main reasons why economists do not stress the income distribution effects of trade. What are these?

- Income distribution effects are not specific to international trade.
- It is always better to allow trade and compensate those who are hurt than to prohibit trade.
- Those who stand to lose from increased trade are typically better organized than those who stand to gain.
Chapter 3

Factor Proportions Model (Heckscher–Ohlin Model)

3.1. Introduction

In this model all factors are mobile but specialization comes from the relative proportion of factors in the economy. Two goods are produced and each is relatively intensive in its use of one of two factors in the economy.

We will be considering an economy that produces food ($F$) and cloth ($C$) with land ($T$) and labor ($L$). We assume that cloth is labor intensive and that food is land intensive. This does not mean that food production does not require labor, but that it requires proportionately more land than does cloth production.
3.2. Fixed Coefficients Model

In this simplified view of the economy food and cloth are produced with fixed ratios of the two inputs.

The fixed coefficients are defined as follows:
- $a_{TC}$ Units of land required to produce one unit of cloth
- $a_{LC}$ Units of labor required to produce one unit of cloth
- $a_{TF}$ Units of land required to produce one unit of food
- $a_{LF}$ Units of labor required to produce one unit of food

The assumption of factor intensity is represented by the inequality in Equation 3.1

$$\frac{a_{LC}}{a_{TC}} > \frac{a_{LF}}{a_{TF}} \quad (3.1)$$

Or equivalently

$$\frac{a_{LC}}{a_{LF}} > \frac{a_{TC}}{a_{TF}} \quad (3.2)$$

We know that the total amount of labor or land used in the economy cannot exceed $L$ or $T$, the endowment of labor and land. Note that $a_{LC}Q_C$ (where $Q_C$ is the quantity of cloth) is just $L_C$, and we obtain Equation 3.4 and Equation 3.3.

$$a_{LC}Q_C + a_{LF}Q_F \leq L \quad (3.3)$$
$$a_{TC}Q_C + a_{TF}Q_F \leq T \quad (3.4)$$

These can be rewritten as:

$$Q_F \leq \frac{L}{a_{LF}} - \left( \frac{a_{LC}}{a_{LF}} \right) Q_C \quad (3.5)$$
$$Q_F \leq \frac{T}{a_{TF}} - \left( \frac{a_{TC}}{a_{TF}} \right) Q_C \quad (3.6)$$
These rewritten equations can in turn be graphed in $Q_C$ and $Q_F$ space to create the production possibility frontier of this economy.

The labor constraint represented in Figure 3.1 is Equation 3.5 and the land constraint is Equation 3.6. Note that the slopes of the two constraints are $\frac{a_{L}}{a_{LF}}$ and $\frac{a_{T}}{a_{TF}}$ for labor and land respectively. We know from the assumption on factor intensity as seen in Equation 3.2 that the slope of the labor constraint is steeper than the slope of the land constraint.

The Labor constraint, for example, represents the set of points for which all labor is allocated to the production of either cloth or food. Every point below the constraint is possible, but leave labor idle. Points above the constraint are not possible. Thus, point 1 in Figure 3.1 represents the set of cloth, food output combinations that leave both land and
labor idle. Point 2 represents outputs for which labor would be idle, but there is insufficient land, and point 3 points for which land is idle but there is insufficient labor. Point 2 and 3 are therefore not possible. Clearly point 4 is not possible. The production possibility frontier is therefore defined by the area interior to both the labor and land constraint.

We chose the intercepts for both lines so that there would be an intersection. This is not a necessary outcome of the assumptions that we have made so far. However, if this were not true we would return to the Ricardian model of chapter 1. Let us examine the impact of increasing the quantity of labor available for production in this economy.

![Figure 3.2: Fixed Coefficients PPF, increasing Labor Supply](image)

Figure 3.2 shows the effect of an increase in labor supply on the production possibility frontier. The intercepts for the labor constraint shift out, though the slope does not
change. This pushes the production possibility frontier outwards, but only in the direction of increased cloth. It is possible that the labor constraint would shift out so much that it would no longer be a binding constraint. In this case the land constraint would be the only effective constraint. This problem returns to the Ricardian model of chapter 1.

3.2.1. Impact of Prices

With the Ricardian model Again we start with a small country assumption, where the country accepts a set of prices given exogenously from outside. The impact wide ranges of prices caused no changes in the production decisions of the economy. In this model we have a similar impact. When the slope of the price line is flatter than the slope of the labor constraint we observe production of food only (for example, price ratio 1 in Figure 3.3). For all slopes that are steeper than the labor constraint but flatter than the land constraint we observe exactly the same output (C and F in Figure 3.3.) Price ratios 2 and 3 are examples of price ratios that give this intermediate income. When the slope of the price ratio is steeper than the land constraint we observe production of only cloth (price ratio 4 in Figure 3.3.)

Thus, for a wide range of prices we observe no change in the productive output of the economy. Since outputs are not changing, neither is the allocation of land and labor in the economy. Thus it would appear that prices (so long as they are within the intermediate range) have no impact on the economy.

3.2.2. Prices and Factor Incomes

In fact, prices have a very important impact on the economy and this is seen in the income of the two factors land and labor. We reintroduce the following notation: \( P_C \) is the price of cloth; \( P_F \) is the price of food; \( w \) is the wage of labor and \( r \) is the rental for land.

We assume perfect competition in the supply of each factor and therefore that there are not profits in the production of either good. Anything earned in the production of either good is paid to labor and land. This gives us Equation 3.7 and Equation 3.8.
Equation 3.7 and Equation 3.8 state that all the proceeds the sale of cloth and food respectively are consumed by the wage and rent paid to the labor and land used in production.

These equations can be rewritten so that they can be graphed in $r,w$ space as in Figure 3.3.

Verify for yourself that the slope of the perfect competition in the production of cloth restriction (Equation 3.7) is steeper than the slope of the perfect competition in food restriction (Equation 3.8).

All points above the perfect competition in cloth restriction represent points where the final price of a unit of cloth is less than the cost of production. Points below the restriction
Figure 3.4: Equilibrium in the wage and rental market for factors

represent points where the final price is less than cost of the inputs.

Production in both food and cloth must be along the perfect competition restriction and therefore the equilibrium in this economy is the point where wages are $w^*$ and the rent is $r^*$. [include a note eventually about how the economy moves towards equilibrium if it starts away from the equilibrium].

02/05/01 The importance of prices is shown in Figure 3.5.

When the price of cloth increases we observe a new equilibrium. The wage shifts from $w^1$ to $w^2$ and the rent shifts from $r^1$ to $r^2$. While the wage increases the rent falls. This is because cloth is labor intensive. Thus prices have a very important impact for owners of the factors of production.

02/01/01 This result is suggestive of the Stolper–Samuelson Theorem which states that:

**Theorem 1 (Stolper-Samuelson Theorem)** A rise in the relative price of a good will
lead to a more than proportional rise in the return of the factor used intensively in the favored sector, and a decline in the return to the other factor

3.3. Numerical Example, Magnification Effect in the Stolper–Samuelson Theorem

We will work with the case of fixed coefficients, a result of Leontief production functions in the two sectors (which we will call $X$ and $Y$). We have two factors, skilled and unskilled labor (denoted by $H$ and $L$, respectively), which are used in different ratios in the two sectors. Assume that prices are exogenous. We can then calculate the wages (for skilled and unskilled labor) that would have to result if zero-profit conditions were to be maintained.
Assume that we have the following conditions:

\[ P_X = 4 \quad \text{and} \quad P_Y = 8 \]
\[ a_{HX} = 4 \quad \text{and} \quad a_{HY} = 4 \]
\[ a_{LX} = 2 \quad \text{and} \quad a_{LY} = 8 \]

In addition to prices, we also know the number of units of factor (H or L) required to produce one unit of a good (X or Y). The value of \( a_{HX} \), for example, tells us the number of units of skilled labor required to produce a unit of good \( X \) (the answer, in this case, being 4).

We can verify that sector \( X \) is the skill-intensive sector. Note that the ratio of skilled-to-unskilled labor in sector \( X \) is higher than that in sector \( Y \).

\[ \frac{a_{HX}}{a_{LX}} = \frac{4}{2} = 2 \quad \text{and} \quad \frac{a_{HY}}{a_{LY}} = \frac{4}{8} = \frac{1}{2} \]

Perfect competition implies that we have zero profits in both sectors. The value of the output in each sector has to be completely exhausted by payments made to different factors of production. Since we have two factors, skilled and unskilled labor, with wages \( (w_H \text{ and } w_L) \) being their costs of use, we get the following zero-profit conditions:

for sector \( X \) :  \[ P_X = w_H a_{HX} + w_L a_{LX} \]
for sector \( Y \) :  \[ P_Y = w_H a_{HY} + w_L a_{LY} \]

Rewriting these equations, we get:

for sector \( X \) :  \[ w_H = \left( \frac{1}{a_{HX}} \right) P_X - \left( \frac{a_{LX}}{a_{HX}} \right) w_L \]
for sector \( Y \) :  \[ w_H = \left( \frac{1}{a_{HY}} \right) P_Y - \left( \frac{a_{LY}}{a_{HY}} \right) w_L \]
Now, fill in what we know about the variables:

for sector $X$ : $w_H = \left(\frac{1}{4}\right)4 - \left(\frac{2}{4}\right)w_L = 1 - \left(\frac{1}{2}\right)w_L$

for sector $Y$ : $w_H = \left(\frac{1}{4}\right)8 - \left(\frac{8}{4}\right)w_L = 2 - 2w_L$

We now have two equations with two unknowns, $w_H$ and $w_L$. We can easily solve this system of equations:

\[
\begin{align*}
1 - \left(\frac{1}{2}\right)w_L &= 2 - 2w_L \\
\left(\frac{3}{2}\right)w_L &= 1
\end{align*}
\]

$\implies w_L = \frac{2}{3}$

and

$w_H = 1 - \left(\frac{1}{2}\right)\left(\frac{2}{3}\right) = 1 - \frac{1}{3} = \frac{2}{3}$

Now suppose that the price of the unskilled labor intensive good, $Y$, declines from $8$ to $6$. An immediate effect of this is the change in the zero-profit condition for sector $Y$ (since the value of the output has gone down, the right hand side in the zero-profit condition above also has to go down for given technology coefficients to maintain equality). Since price of the other good, $X$, hasn’t changed, the zero-profit relation in that sector does not change. So, we have:

for sector $X$ : $w_H = 1 - \left(\frac{1}{2}\right)w_L$

for sector $Y$ : $w_H = \left(\frac{1}{a_{HY}}\right)P_Y - \left(\frac{a_{LY}}{a_{HY}}\right)w_L = \left(\frac{1}{4}\right)6 - \left(\frac{8}{4}\right)w_L = \left(\frac{3}{2}\right) - 2w_L$
Once again, we equate the two zero-profit conditions and get the following:

\[
1 - \left( \frac{1}{2} \right) w_L = \frac{3}{2} - 2 w_L \\
(2 - \frac{1}{2}) w_L = \frac{3}{2} - 1 \\
\left( \frac{3}{2} \right) w_L = \frac{1}{2} \\
\implies w_L = \frac{1}{3}
\]

and \( w_H = 1 - \left( \frac{1}{2} \right) \left( \frac{1}{3} \right) = 1 - \frac{1}{6} = \frac{5}{6} \)

Let us summarize the changes:

- The price of good \( Y \) declined from $8 to $6. Since \( P_X \) hasn’t changed, we now have a decrease in the relative price of \( Y, \ (\frac{P_Y}{P_X}), \) from (2) to (\( \frac{3}{2} \)). This is a decrease of 25 percent.

- The return to unskilled labor, \( w_L \), declined from \( \frac{2}{3} \) to \( \frac{1}{3} \) (a decline of 50 percent). The return to skilled labor, \( w_H \), increased from \( \frac{2}{3} \) to \( \frac{5}{6} \). Note that the percentage fall in the wages of unskilled labor is higher than the percentage fall in the price of the unskilled labor-intensive good.

This confirms the Stolper-Samuelson Theorem

### 3.4. Variable Coefficients

Here we will examine an economy that produces two goods \( X \) and \( Y \) using labor \( (L) \) and capital \( (K) \).
The marginal rate of technical substitution (MRTS) which is occasionally referred to as the rate of technical substitution (RTS) is the units of labor (for example) required to compensate for the loss of a unit of capital holding output constant.

**Question 8** Why is the isoquant convex to the origin?

Diminishing marginal rate of technical substitution. Think of preference of bundles over extremes.

We will refer to the capital labor ratio as $k$, and this can be represented as a ray from the origin.

Constant returns to scale (CRS) justifies looking at the unit isoquant and ignoring issues of scale.

The isocost frontier is a collection of points which represents exactly the same total input cost. The slope of this frontier is defined by the ratio of the wage to the rental rate ($r$ is the
MRTS is constant as output expands

Figure 3.7: Isoquants and Constant Returns to Scale

per unit cost of capital, referred to as the rental rate). In other words, this is the market exchange of a unit of capital for a unit of labor.

We want to produce a unit of output at the lowest cost, so we search for the lowest isocost frontier that will achieve a unit of output. This is obtained where the slope of the marginal rate of technical substitution is equal to the ratio of factor costs. This then defines the capital labor ratio \((k)\) for the production of that good. Because of our assumption about constant returns to scale this ratio will hold for any given wage rent ratio no matter what the scale of production.

**Definition 3 (Strong Factor Intensity)** In a two factor, two good economy strong factor intensity implies that for all wage rent ratios, the ratio of capital to labor used in the production of \(X\) is greater than the ratio of capital to labor used in the production of \(Y\). In
Note that the constant returns to scale is not enough to guarantee strong factor intensity. We can see strong factor intensity in Figure 3.10.

3.4.1. Lerner Diagram

Now the Lerner diagram shown in Figure 3.11 represents an equilibrium. The ratio of the price of good $X$ to the price of good $Y$ is exactly the right amount to insure that the cost of producing $Q_X$ and $Q_Y^* = Q_X \cdot \frac{P_X}{P_Y}$ is exactly the same. But we can see why this was true by assuming one or the other.
3.4.1.1. Fix factor prices, derive goods prices

Find the unit isoquant for good $X$ (where quantity of $X$ is $Q^1_X$) and its tangency with the isocost frontier. Then find the greatest isoquant for the production of $Y$ that touches that unit isoquant. This gives us the number of units of $Y$ that can be exchanged for one unit of $X$ when the costs of production are identical, and therefore sets the price ratio.

1.1.1. Fix goods prices, derive factor prices  If we know the price ratio we know both $Q_X$ and $Q^*_Y = Q_X \cdot \frac{P_X}{P_Y}$. Graph both isoquants and find the unique wage rent ratio isocost frontier that is tangent to both lines. This fixes the $\frac{w}{r}$. 

Figure 3.9: Wage, rent ratios and the capital-labor ratio
### 3.4.2. Impact of Changing Prices

Impact of change in prices (moving from points 0 to points 1). The relative price of $Y$ increases. This is the labor intensive good. This lead to an increase in the wage compared to the rent. This in turn leads to an increase in the capital labor ratio for both $X$ and $Y$.

The wage increases relative to the rent, but are laborers better off? Recall that in the Specific Factors Model the owner of the favored fixed factor gained unambiguously but the owner of the other factor lost unambiguously. This seems like an extreme result and we would not necessarily expect such result when both factors are mobile. However, this is exactly what we get.

The important thing to note is that the capital labor ratio has changed in each sector. We are assuming, as we did in the specific factor model, that workers are paid the marginal
product of their labor and that capital is paid the marginal product of capital. This is just an equilibrium condition.

**Question 9** What is the difference between the statement: “factors are paid their marginal value product”, and “workers are paid a fair wage,” or workers are paid what they are worth?”

When the capital labor ratio changes this changes the marginal physical product of labor and capital. When less workers are working with more machines, the additional product of the marginal laborer increases. (We expect his average product to increase as well.) In addition, the marginal physical product of capital should fall. This is all we need.

We examine the number of units of output that workers can buy with their wages. For $Y$ this will be $MPL_Y$ and for $X$ it will be $MPL_X$. This comes from the definition of the wage (see subsection 2.3.2.) Since changes in the capital labor ratio lead to changes in the
marginal physical product we know immediately that labor can purchase more of both $Y$ and $X$, and capital can only purchase less of $Y$ and $X$. Thus we get the same results as with the Specific Factors Model and the same basic political economy considerations without assuming factors are fixed.

### 3.4.3. More on the Relationship between goods prices and factor prices

What is the relationship between the change in goods prices and the change in factor prices. We have, in essence already answered this question. Let us represent the wage as $w = MPL_Y \cdot P_Y$ and the rent as $r = MPK_X \cdot P_X$, (MPK is marginal physical product of capital) both of which are true. This gives us Equation 3.10
Figure 3.13: The relationship between goods price ratios and factor price ratios

\[ \frac{w}{r} = \frac{MPL_Y \cdot P_Y}{MPL_X \cdot P_X} \quad (3.9) \]

Or equivalently

\[ \frac{w}{r} = \left( \frac{MPL_Y}{MPK_X} \right) \cdot \left( \frac{P_Y}{P_X} \right) \quad (3.10) \]

We know that \( \frac{P_Y}{P_X} \) is increasing, furthermore we know that \( \frac{MPL_Y}{MPK_X} \) is also increasing since the marginal product of labor is rising in both sectors and the marginal physical product of capital is falling in both sectors. Thus the increase in \( \frac{w}{r} \) is proportionately greater than the increase in \( \frac{P_Y}{P_X} \).
3.5. Stolper–Samuelson

Theorem 2 (Stolper-Samuelson Theorem) A rise in the relative price of a good will lead to a more than proportional rise in the return of the factor used intensively in the favored sector, and a decline in the return to the other factor.

3.6. Capital-Labor Ratio and Specialization

If we look at the case where the capital labor ratio is given in the economy we can see some interesting patterns already. In Figure 3.15 the capital labor ratio in the economy is given. This gives us a range of goods prices (A to B) for which the economy will produce some of...
each good.

Figure 3.15: Prices, wage-rent ratios and capital labor ratios

3.7. Allocation of Resources to Production

When the supply of capital increases in the economy we get a very strong result. Figure 3.17 shows the impact of an increase in the supply of capital. The y axis shifts upwards and we draw a new capital labor ratio from the point of view of the production of $X$.

Note that the use of capital in the production of $X$ increases. This is not surprising since $X$ is the capital intensive good. However, note that the increase in the use of capital
Figure 3.16: Allocation of resources in Heckscher–Ohlin economy

$X$ is greater than the additional capital added to the economy. In addition the use of labor expands. $X$ gets more than its share of capital and uses additional labor as well.

**Theorem 3 (Rybczynski Theorem)** At constant relative goods prices, a rise in the aggregate endowment of one factor will lead to a more than proportional expansion of the output in the sector which uses that factor intensively, and an absolute decline of the other good. [as long as the economy continues to be incompletely specialized as its factor endowments change].
$$\bar{K} \over \bar{L} = \frac{K_X + K_Y}{L}$$

$$= \frac{K_X \cdot \frac{L_X}{L} + K_Y \cdot \frac{L_Y}{L}}{L}$$

$$= k_X \left( \frac{L_X}{L} \right) + k_Y \left( \frac{L_Y}{L} \right)$$

$$= k_X \left( \frac{L_X}{L} \right) + k_Y \left( \frac{\bar{L} - L_X}{L} \right)$$

$$= k_X \left( \frac{L_X}{L} \right) + k_Y - k_Y \left( \frac{L_X}{L} \right)$$

$$\bar{K} \over \bar{L} = (k_X - k_Y) \left( \frac{L_X}{L} \right) + k_Y \quad (3.11)$$

If the capital labor endowment ratio increases, the only way to balance Equation 3.11 is to increase the use of labor in the factor that uses capital more intensively.

3.8. Biased Expansion of the PPF

The Rybczynski theorem can also be seen in what we call the biased expansion of the production possibility frontier. Here we start with the production possibility frontier and show what happens if we increase the quantity of one factor or another.

In Figure 3.18 we generate an expanded production possibility frontier on the basis of the following. First, as seen in Figure 3.17, when the supply of capital increases and the price of the final goods stay the same we get more $X$ produced and less $Y$. We draw this on Figure 3.18 by showing that the point on the new production possibility frontier that is tangent to the old price line is to the right and below the previous point.
This process (repeated for each possible price) gives us the production possibility frontier shown in Figure 3.19. Note that this production possibility frontier is biased towards the production of X (because X is the capital intensive good and we have more capital than before).

**Theorem 4 (Heckscher–Ohlin Theorem)** A country has a production bias towards, and hence will tend to export, that good which uses intensively the factor that is relatively abundant in that country.

Figure 3.20 begins with two identical countries. They each have the same PPF and consumer preferences so they produce at exactly the same point, consume at exactly the same point and there is no trade. We add a small amount of capital to economy A. This causes a biased expansion in the PPF of country A. We know this will cause country A to produce more X and less Y (X is the capital intensive good) at the same set of world prices.

However, the change in production will change the equilibrium set of prices. The new set of prices will be a little flatter than the previous set of prices since we are producing a little more X and a little less Y, but preferences have not changed. This gives a new price ratio and two new tangencies with the production frontiers of A and B. The small infusion of capital has caused A to shift towards the production of X and B to shift towards the production of Y as shown in Figure 3.21.

**Theorem 5 (Factor Price Equalization)** when there is incomplete specialization and identical technologies, trade in goods is sufficient to replicate the outcome in a world in which both goods and factors move freely. Real factor prices are equalized.

This is just an extension of the fact that world prices technologically determine factor prices and if technologies are the same then factor prices have to be the same.
Figure 3.17: Increase in supply of capital
Figure 3.18: Biased Expansion of the PPF: I
Figure 3.19: Biased Expansion of the PPF: II
Figure 3.20: Two countries begin identical: Add small amount of capital to A’s resources: I
Figure 3.21: Two countries begin identical: Add small amount of capital to A’s resources: II
Questions from Magee (1989). Note; think of the Ricardo–Viner–Cairnes model, not as the one–factor Ricardian model that we discussed but as the specific factors model in which both labor and capital are specific factors in each sector. (The third, mobile factor does not matter, it can be anything.) Thus labor in one sector does not move into another sector.

1. Assume trade hurts sector B and benefits sector A. Sector B is labor intensive and sector A is capital intensive. Thus there are two sectors and 2 factors in the Stolper–Samuelson setup, but 4 factors (labor A, labor B, capital A and capital B) in the Ricardo–Viner–Cairnes setup.

(a) What coalition does Stolper–Samuelson suggest will form to support trade?
(b) What coalition does Stolper–Samuelson suggest will form to oppose trade?
(c) What coalition does Ricardo–Viner–Cairnes suggest will form to support trade?
(d) What coalition does Ricardo–Viner–Cairnes suggest will form to oppose trade?

2. Which of these two theories does the empirical evidence support?

3. Does the fact that trade negotiations (at the time of this paper) are always short term, impact the expectation as to which theory is most likely to hold?

4. What impact, if any, could we expect from the transformation of trade negotiations from short to long term (which is how it is done now as opposed to when this paper was written)?

Questions from Wood (1997).

1. What is the puzzle that this paper posits and seeks to explain?
2. The paper states “Half the world’s population, and an even higher proportion of the world’s unskilled workers, live in five low-income Asian countries: Bangladesh, China, India, Indonesia and Pakistan. In the 1960’s and 1970’s, all five countries were largely closed to trade, and thus their workers did not form part of the effective world labor supply. By the mid–1980’s, these countries were all opening to trade, led by Indonesia and China, with the South Asian countries also making some progress.”

(a) What does this fact have to do with comparing the wage differentials and the impact of trade in Latin American and East Asia?

3. The paper suggests that a Heckscher–Ohlin model with the addition of a third factor such as land could explain the widening of the wage differential in Latin America and its narrowing in East Asia.

(a) What are the key assumptions that would make the addition of this factor have this impact?

(b) Does this appear to be likely?

4. What is the theory of skill-biased technical progress, or “skill-enhancing trade”?

(a) In what way does it violate the core assumptions of Heckscher–Ohlin?

(b) What evidence exists to back up this theory?

(c) What evidence exists to refute the theory?

3.9. Conclusions

- Trade is driven by differences in resource endowments
- Abundance of factors is relative, not absolute
• There are strong income distribution effects and strong predictions about the direction of these impacts

• Benefits to factors do not depend on the sector in which a factor is employed

• The good that uses the relatively abundant factor intensively is traded and that factor benefits.

• The good that uses the less abundant factor more intensively competes with imports and that factor looses from trade.
Chapter 4

Basic Trade Policy and Welfare Analysis

4.1. Introduction

This chapter is covered in the textbook

4.2. Rent seeking activities with quotas and import licenses

Consider first the results of an import-licensing mechanism when licenses for imports of intermediate goods are allocated in proportion to firms’ capacities. . . By investing in additional capacity, entrepreneurs devote resources to compete for import licenses (Krueger, 1974, p. 292).

[L]icenses are allocated *pro rata* in proportion to the applications for those licenses from importers-wholesalers. . . In this case, competition for rents occurs
through entry into the industry with smaller-than-optimally sized firms, and resources are used in that the same volume of imports could be efficiently distributed with fewer inputs if firms were of optimal size (Krueger, 1974, p. 292).

A third sort of licensing mechanism is less systematic in that government officials decide on license allocations. Competition occurs to some extent through both mechanisms already mentioned as businessmen base their decisions on expected values. But, in addition, competition can also occur through allocating resources to influencing the probability, or expected size, of license allocations. Some means of influencing the expected allocation — trips to the capital city, locating the firm in the capital, and so on — are straightforward. Others, including bribery, hiring relative of officials or employing the officials themselves upon retirement, are less so. In the former case, competition occurs through choice of travel, and so on. In the latter case, government officials themselves receive part of the bribes (Krueger, 1974, p. 292).

The above results are sufficient to indicate that, for any given level of import restrictions, competitions among rent seekers is clearly inferior to the tariff equivalent of the restrictions, in that there could be more food consumed with no fewer imports under the latter case than the former. To the extent that rent seeking is competitive, the welfare cost of import restrictions is equal to the welfare cost of the tariff equivalent plus the additional cost of rent-seeking activities (Krueger, 1974, p. 299).
Chapter 5

Import Substituting Industrialization

5.1. Introduction

There are some alternative views of trade other than the various neo-classical models produced here. The one that has, at various times held the most sway in policy circles in that of Import Substituting Industrialization (ISI).

We begin by looking at the Prebisch–Singer Thesis. For this we define the terms of trade as the price of the goods that you export divided by the price of the goods that you import. \( \frac{P_X}{P_M} \). If we look at the majority of developing countries we can see that they tend to export agricultural and raw commodities and import manufactured or industrial commodities. This was especially true in the 50’s when this hypothesis was first advanced. Add to this the fact that the price of agricultural goods tends to fall over time compared to the price of industrial goods and we have the source of the problem. When the price of the good you export is falling compared to the price of the good you import then you have worsening terms of trade. The Prebisch–Singer observation is that countries should take this change in prices as a given and think about the terms of trade that they face in the long run, not
just in the short run.

![Commodity Terms of Trade Index](chart.png)

Figure 5.1: Real Non-Oil Commodity Terms of Trade, 1977-1992

Why should this be true?

**Demand Elasticity** Agricultural products are not consumed in greater proportions as wealth increases, but industrial products are. As the world budget increases the share of the budget spent on agricultural products will fall.

**Technology** Technology in increasingly substituting for raw materials.

**Linkages** Industrial products, by their nature, create backward and forward linkages with other industrial products. Agriculture does not link well with agriculture nor does it link with industry.
5.2. The policy of Import Substituting Industrialization and Infant Industry Protection

The policy of Import Substituting Industrialization (ISI) is simply that import tariffs (or other trade barriers) are placed on a particular good which was previously imported in order to allow a new industry to grow.

The essential point stressed by infant-industry proponents . . . is that production costs for newly established industries within a country are likely to be initially higher than for well-established foreign producers of the same line, who have
greater experience and higher skill levels. However, over a period of time new producers become “educated to the level of those with whom the processes are traditional;” and their costs curves decline. The infant-industry argument states that during the temporary period when domestic costs in an industry are above the product’s import price, a tariff is a socially desirable method of financing the investment in human resources needed to compete with foreign producers (Baldwin, 1969, p. 297).

The following are necessary criterion for this to make sense as a policy:

1. “that the cost of a new activity may initially be higher. Reasons put forth as to why them might be high include learning by doing and the possibility that there may be linkages between industries.”

2. “While costs will decline, they will do so in a way that individuals initially starting the activity will not reap the fully rewards.”

3. “The losses associated with an initial period of high costs must be recovered (with interest) at a later date, although not by the individual entrepreneur starting up the activity.” (Krueger and Tuncer, 1982)

5.3. An example of ISI with declining costs

Figure 5.3 shows a domestic industry that does not produce any goods; the industry does not exist. All demand for the good is met by imports at the world price. But let us assume that for some reason, if there was supply of $Q_1$ units of the good in period one then the costs of production would fall in period two so that there was a new supply curve (shown by $S’$). In the second time period there would be domestic supply and in fact very little imports. We have not said why yet but, let us assume for the time being that this is true.
5.3.1. Government Intervention

The government can insure that the new industry will be created by having an import tariff in period one and then no import tariff in period two. The tariff \( t \) is chosen to insure that domestic production is equal to \( Q^1 \) in period one and then in period two production will be equal to \( Q^2 \). Note that in the absence of intervention we assume production would have been zero in both time periods.

In the first time period there is a loss of consumer surplus and a gain in producer surplus, revenue and efficiency loss. The change in consumer surplus (\( \Delta CS \)) is \(-[acdh]\), the change in producer surplus (\( \Delta PS \)) is \([abh]\), the revenue is \([bcfg]\) and the net efficiency loss is \([hbg]\).
Figure 5.4: Production and consumption for import competing good with Tariff $+ [cdf]$. Consumer surplus, producer surplus and revenue cancel each other out and only the efficiency loss remains. This is the cost of the government policy. Clearly if we examine only the first time period we can see the policy is wasteful.

However in the second time period we have a net producer surplus of $[hei]$ and no inefficiencies (since there is no tariff any more). If $[hei]$ is greater than $[hbg] + [cdf]$ then the policy is beneficial. Note that we are assuming there are only two time periods and that there is no discounting of the future, but these could be added to the model and wouldn’t add any new intuition.
5.3.2. Private Market reactions to Declining Costs

The simple presence of declining costs is insufficient to justify government intervention. Any firm, or even collection of firms would be able to benefit by simply absorbing the losses in the first period and then reaping the benefits in the second period.

![Diagram of production and consumption for import competing good with Forward–Looking company](image)

Figure 5.5: Production and consumption for import competing good with Forward–Looking company

Losses in the first period are $[hbg]$ and gains in the second period are $[hei]$. If $[hei]$ is greater than $[hbg] + [cdf]$ then it must be greater than $[hbg]$. Thus the government does not need to intervene because forward looking firms would do so anyway.
5.4. Externalities

However, there cases in which firms do not choose to enter the industry and reap profits later and we need to look at these cases and see whether government intervention in the form of Import Substituting Industrialization would be beneficial.

Four principal infant-industry cases will be considered in the following sections. Part II examines the case for protection based upon the point that the acquisition of knowledge involves costs, yet that knowledge is not appropriable by the individual firm. The familiar argument that infant-industry protection is needed because costs associated with on-the-job training cannot be recouped by the training firm is evaluated in Part III. The existence of static and reversible externalities as a justification for temporary protection is discussed in Part IV. This part also considers the argument for protection that imperfect information leads to systematic overestimates of investment risks or of the unpleasantness of working in particular industries. In all four cases I conclude that temporary protection by means of an import duty on the product of the industry is not likely to achieve the goal of a more efficient allocation of resources in production (Baldwin, 1969, p. 296).

Thus we have

- Appropriable Technology
- On the job training
- Static Externalities
- Imperfect Information about risks and benefits
5.4.1. Appropriable Technology

Industrialization is here at first wholly a matter of imitation and importation of tried and tested processes (Hirschman, 1968, p. 7).

Here industrialization is a process of imitation not creation. New technologies are not being created, old ones are being followed. In many of the industries, intermediate goods are imported at the early stage. Note that this suggests that the Heckscher–Ohlin model is a good way to describe economies in this stage at least in a static sense.

4.1.1. Example of Spillovers from Investment in Technology

[This example is attributed to J. McLaren’s lecture notes] Consider an economy with a large number of identical farmers. Each farmer enjoys leisure and food, and must divide her time between leisure time and work on her farm. For simplicity, we will assume that all of the time each farmer spends working is devoted to researching new techniques. (All of the routine business of planting, hoeing, and so forth could be added and would simply add complication without changing the point.) The production possibilities of a particular farmer, holding the actions of all other farmers constant, are indicated by the heavy curve in Figure 5.6. We will call this the “private production possibility frontier.” The more time the farmer spends on research and experimentation, the more effective the farm will be and thus the more output she will receive. The farmer’s preferences are indicated by the lighter, convex curve in Figure 5.6. She chooses the level of research effort that maximizes her utility, given the environment, and that optimum is given by point A.

The private PPF shows how much additional output a particular farmer would receive if she alone worked an extra hour. However, suppose that some portion of the knowledge generated by a farmer as part of that farmer’s research effort can be used by other farmers who observe or hear about that farmer’s discovery and apply it to their own farms. Call this the “spillover” assumption. In that case, if every farmer worked an extra hour, the additional output any one farmer would receive would be greater than the additional output
Figure 5.6: Private PPF for farmer engaged in research

that farmer would have received if she alone was putting in the extra hour, because aside from benefiting directly from her own efforts she would benefit indirectly from the ideas of others. This is represented by the light concave curve in Figure 5.7, which plots the output each farmer would receive for any given level of research effort, if that level of effort was put in by all farmers together. Thus, as we move along the light concave curve, we vary the work effort of every single farmer in the economy by the same amount. We call this curve the “social production possibility frontier” and note that because of the spillover assumption it is strictly steeper than the private PPF.\(^1\)

\(^1\)We have designed the social PPF so that it intersects with the private PPF at point A from Figure 5.6.
Because the social $\text{PPF}$ is steeper than the private $\text{PPF}$, we see immediately that all farmers would be made better off if all of them together could be induced to work a little bit harder; this would allow each farmer to move from $A$ to $B$ in Figure 5.7, which is on a higher indifference curve and therefore preferred. This could be brought about, for example, by a subsidy to research effort, financed by a lump sum tax, so that each farmer would have to give up $x$ bags of grain to the government, but could then get $y$ bags of grain back per unit of output. If things were designed just right, in equilibrium each farmer would get back exactly the amount of the lump-sum tax and the only effect would be to encourage additional research effort, thus moving the economy from $A$ to $B$. On the other hand, Figure 5.8 shows that point $B$ cannot be brought about without government intervention or some similar mechanism, and certainly not by mere moral persuasion. The reason is that if everyone was expected to do the amount of work corresponding to point $B$, then an individual farmer’s private $\text{PPF}$ would look like the flatter of the two light concave curves running through point $B$; again because of the spillover assumption, the private $\text{PPF}$ is always flatter than the social $\text{PPF}$. Thus, any individual farmer expecting everyone else to work hard as in $B$ will do better for herself to relax and enjoy extra leisure, as at point $C$. But this is true of every single farmer, so that the assumption that every farmer is expected to produce at point $B$ voluntarily leads to a contradiction. This is the “free rider” problem.

### 5.4.2. On-the-job training

Another frequently cited example of a technological spillover that creates a divergence between the private and social rates of return on investment concerns on-the-job training. If —so the argument goes— a firm could count on its workers to remain with it after they have been provided with on-the-job training, the firm could incur the costs of training and recoup them later by paying the work-

This is deliberate, so that the analysis is interesting, but we could have drawn a series of social $\text{PPF}$ curves with different intersections.
ers wages just enough below their subsequently higher marginal productivity to cover these costs. However, workers in a free market economy are not slaves, and they will be bid away by new firms after their training period if they receive less than their marginal productivity. Because of this ownership “externality” it is argued that temporary protection is justified (Baldwin, 1969, p. 300).

However, this is not true if

- Learning is internal or specific (firms will pay)
- Otherwise workers should pay
- Or they should share,
- Even if workers cannot pay, tariffs will not invoke changes. You are still forced to pay the marginal product of a worker even with tariffs. If a firm can produce without training, it will.

### 5.4.3. Static Externalities

Static externalities do not require temporary tariffs as a solution, but rather permanent subsidies. Honey and Apples example.

### 5.4.4. Imperfect Information

If it is hard to know whether or not an industry is competitive it is hard to imagine that producing in a tariff protected environment will really answer that question. If you can see that it is profitable with tariffs, but cannot see that it is profitable without them, how will producing with tariffs teach you that it is profitable?
5.5. Backward Linkages

The tuner example. Basic idea is that there is nothing obvious about backwards linkages being created and that the forwards industry might lose considerably if the backward industry gets protected.

5.6. Latin American Experience

Three principal accusations have been leveled against the industrialization process as it has appeared in Latin America:

1. Import Substituting Industrialization is apt to get “stuck” after its first successes, due to the “exhaustion of easy import substitution opportunities”; it leave the economy with a few relatively high-cost industrial establishments an with a far more vulnerable balance of payments since import consist now of semifinished materials, spare parts and machinery indispensable required for maintaining and increasing production and employment.

2. Import substituting industry is affected by seemingly congenital ability to move into export markets.

3. The new industries are making an inadequate contribution to the solution of the unemployment problem.

Hirschman (1968, p. 13)
Figure 5.7: Social and Private PPF for farmer engaged in research
Figure 5.8: Free Riding with spillovers
Chapter 6

Monopolistic Competition and World Trade Patterns

6.1. Introduction

We have been considering the case, so far, of choosing between free trade and no trade. In the case of Import Substituting Industrialization the choice was a bit more complex; that of choosing between free trade and protection for a given good. In fact the choices on trade are often more complex than this. The United States is an excellent example of the degrees of free trade or protectionism that can be exhibited. The U.S. is a champion of General Agreement on Tariffs and Trade (GATT) and now the World Trade Organization (WTO). We push free trade throughout the world. Yet some of our industries have been, and remain, highly protected from foreign competition. And at the same time we are engaged in a very significant free trade area with Canada and Mexico, NAFTA, and are in talks with other nations about the possible expansion of the Free Trade Area of the Americas (FTAA).

Whenever the U.S. restricts imports from foreign countries it hurts domestic consumers
of those goods by raising the price they have to pay for them. Although it benefits domestic producers, we know that there are net efficiency losses for the welfare of the United States. When the trade barriers are in the form of quotas then it is very likely that there are large transfers of quota rents to overseas producers of the goods in question. These transfers can be thought of as net loses, or the U.S. could consider these transfers as a form of foreign aid. When the quota is on the importation of Japanese automobiles, it is very hard to see that domestic policy makers might want to transfer funds from U.S. consumers to Japanese automobile producers; this policy is most likely an underhanded way to transfer funds to domestic automobile producers.

However when we examine trade regimes such as the Multi-Fiber Arrangement (MFA) we see that the U.S. might deliberately be handing rents to foreign countries as a type of aid. It helps domestic textile manufacturers, but it also helps foreign importers. To help in our analysis of the impact of these patterns we look at the model of monopolistic competition.

6.2. Monopolistic Competition

We know that a monopolist does not take the price at which he sells goods as given, but rather that a monopolist understands the impact that his quantity decisions can have on the price. The monopolist seeks to maximize profits and this leads him to set the marginal cost equal to the marginal revenue.

In the setting of monopolistic competition this is also true. However the demand curve faced by the monopolist will be a function of the decisions made by other players in the market. None the less if there are enough players in the market (we are not in a duopoly or oligopoly situation) the player will take his demand curve as given and seek to maximize profits. If there are profits in the industry then this can attract other entrants (since they believe they could also make profits). An increase in the supply of the good will lead to a change in the demand curve faced by every remaining player in the market. Equilibrium will be achieved when every player is maximizing its profits but profits are equal to zero (or
profits for the next entrant would be either zero or negative). This situation is represented in Figure 6.1.

![Graph of Monopolistic Competition](image)

Figure 6.1: Profits driven to zero in Monopolistic Competition

We will assume that each firm faces a demand function as shown in Equation 6.1.

$$q = Q \cdot \left(\frac{1}{n} - b(p - \bar{p})\right)$$  \hspace{1cm} (6.1)

We assume a simple cost structure for the firm as shown in Equation 6.2

$$C = F + c \cdot q$$  \hspace{1cm} (6.2)
### Variable and Definitions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$q$</td>
<td>firm quantity</td>
</tr>
<tr>
<td>$Q$</td>
<td>Industry Quantity</td>
</tr>
<tr>
<td>$n$</td>
<td>number of firms</td>
</tr>
<tr>
<td>$b$</td>
<td>responsiveness of sales to firm price</td>
</tr>
<tr>
<td>$p$</td>
<td>firm price</td>
</tr>
<tr>
<td>$\bar{p}$</td>
<td>industry average price</td>
</tr>
<tr>
<td>$c$</td>
<td>marginal cost</td>
</tr>
<tr>
<td>$F$</td>
<td>Fixed cost</td>
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</tbody>
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Thus the average cost is $\frac{F}{q} + c$ and is declining in quantity produced. There are economies of scale in production.

We want to know what the number of firms will be in a monopolistically competitive industry. We use the above model and assume that there is an infinite supply of identical firms that could enter the industry. How many would enter? On the one hand as more and more firms enter the industry the average cost for the remaining firms will go up, suggesting that if the price of the good is high, more firms will enter. On the other hand, as more and more firms enter the industry the price earned by the firms in the industry must fall since they face more and more competition. If we think of the first effect as a type of supply of firms (increasing in price) and the second as a type of demand for firms (decreasing in price) we can find the equilibrium in the market where both of these forces are in equilibrium.

#### 6.2.1. Costs and number of firms

If each firm is identical then each firm will end up charging exactly the same final price, since they all must have the same process for deciding on a price. If all prices are identical then $p = \bar{p}$ and we can see from Equation 6.1 that each firm will end up supply the same
quantity, \( q = \frac{Q}{n} \). Therefore the average cost of providing each good will be,

\[
AC = n \cdot \frac{F}{Q} + c
\]  

(6.3)

Since we know that firms will enter until profits are equal to zero we know that the price received by each firm will be equal to the average cost of production and that,

\[
p = n \cdot \frac{F}{Q} + c
\]

(6.4)

The price is an increasing function of \( n \) the number of firms.

### 6.2.2. Firm level profit maximization and number of firms

Now we examine the choice of each firm to maximize its profits.

\[
\pi = qp - C
\]

(6.5)

\[
q = \frac{Q}{n} - Qbp + Qb\bar{p}
\]

(6.6)

\[
\pi = \frac{Q}{n} p - Qbp^2 - Qbp\bar{p} - \frac{Q}{n} c + Qbpc - Qb\bar{p}c
\]

(6.7)

\[
\frac{\partial \pi}{\partial p} = \frac{Q}{n} - 2Qbp + Qb\bar{p} + Qbc = 0
\]

(6.8)

\[
Q \left( \frac{1}{n} - 2bp + b\bar{p} + bc \right) = 0
\]

(6.9)

\[
\frac{1}{n} - 2bp + b\bar{p} + bc = 0
\]

(6.10)

\[
p = \left( c + \bar{p} + \frac{1}{nb} \right) \frac{1}{2}
\]

(6.11)
But if every firm is identical then we know that $p = \bar{p}$. Note that we could not have entered this at the beginning of the math or else we would have been allowing one firm to choose the industry price, instead we are assuming each firm chooses their own price (holding industry price fixed), but this turns out to be the industry price. Thus Equation 6.11 becomes Equation 6.12.

$$p = c + \frac{1}{nb}$$  \hspace{1cm} (6.12)

Thus the price charged by each firm is a decreasing function of the number of other firms and the responsiveness of that firms quantity to its price, but an increasing function of its marginal cost. This makes sense. The more other firms there are, and the closer the products they make are to the product that you sell, the lower your price. Note that price cannot be lower than the marginal cost because both $b$ and $n$ are positive.

### 6.2.3. Equilibrium

We now have two equations (Equation 6.4 and Equation 6.12) in two unknowns ($p$ and $n$) and we can solve for both.

$$p = c + \frac{1}{nb} = n \frac{F}{Q} + c$$  \hspace{1cm} (6.13)

$$\frac{1}{nb} = n \frac{F}{Q}$$  \hspace{1cm} (6.14)

$$n = \sqrt{\frac{Q}{Fb}}$$  \hspace{1cm} (6.15)

$$p = \sqrt{\frac{F}{Fb}} + c$$  \hspace{1cm} (6.16)

$$q = \sqrt{QbF}$$  \hspace{1cm} (6.17)
Thus we can see that the number of firms is increasing in the total demand and decreasing in the fixed cost and substitutability of goods. The price is equal to the marginal cost plus a function which in increasing in fixed costs, decreasing in quantity and substitutability.

6.2.4. Numerical Example of Monopolistic Competition

Assume two countries that each produce automobiles but do not trade at first. The cost of automobile production in each country (and for each producer in each country) is the same but the initial demand is not the same:

<table>
<thead>
<tr>
<th>variable</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F$</td>
<td>750,000,000</td>
</tr>
<tr>
<td>$c$</td>
<td>5,000</td>
</tr>
<tr>
<td>$b$</td>
<td>$\frac{1}{30,000}$</td>
</tr>
<tr>
<td>$Q^A$</td>
<td>900,000</td>
</tr>
<tr>
<td>$Q^B$</td>
<td>1,600,000</td>
</tr>
</tbody>
</table>

We can do the math and we get the following values

<table>
<thead>
<tr>
<th>variable</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$n^A$</td>
<td>6</td>
</tr>
<tr>
<td>$n^B$</td>
<td>8</td>
</tr>
<tr>
<td>$p^A$</td>
<td>10,000</td>
</tr>
<tr>
<td>$p^B$</td>
<td>8,750</td>
</tr>
<tr>
<td>$Q^A$</td>
<td>150,000</td>
</tr>
<tr>
<td>$Q^B$</td>
<td>200,000</td>
</tr>
</tbody>
</table>

Now we allow the two countries to trade with each other and thereby allow each country to face a total market demand of 2.5 million cars. Now we end up with 10 firms each selling 250,000 cars at a price of $8,000. Note that there is no comparative advantage and no relative abundance, and yet we will end up with trade between these two countries that is beneficial to consumers. The total number of producers has fallen from $8 + 6 = 14$ to 10, but the price has fallen, and since there were no profits in either case, producers cannot have
lost. Each firm has a larger supply.
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C

concave A set is said to be convex if the line joining any two points of the set lies entirely within the set. A function is concave on a the convex set $D$ if the set defined by $x, x \in D$ and all points less than $f(x)$ form a convex set. A function is convex on the convex set $D$ if the set defined by $x, x \in D$ and all points greater than $f(x)$ form a convex set. In simpler language, on a two dimensional graph, all the points on and below a concave function form a convex set, and all the points on and above a convex function form a convex set.

convex See the definition of concave.

G

General Agreement on Tariffs and Trade (GATT) The General Agreement on Tariffs and Trade was established in 1947 and is headquartered in Geneva. The Uruguay Round is the most recent change in GATT. It is the eight round of negotiations and it began in Punta del Esta, Uruguay in 1986 and was completed with a signing in Marrakesh, Morocco in 1994. The secretariat of GATT was replaced by the World Trade Organization (WTO) as a result of the Uruguay Round treaties.
I

**Import Substituting Industrialization (ISI)**  A deliberate government policy shielding “infant” industries from international competition, usually accomplished through high import tariffs or other trade barriers.

**isouquant**  The locus of alternative combinations of productive inputs that can be used to produce a given level of output.

M

**marginal rate of technical substitution (MRTS)**  The rate at which one input may be traded off against another in the productive process while holding output constant. The RTS is the absolute value of the slope of the isouquant.

P

**production possibility frontier (PPF)**  The locus of all the alternative quantities of several outputs that can be produced with fixed amounts of productive inputs.

T

**terms of trade**  The price of a countries exports divided by the price of its imports. $\frac{P_X}{P_M}$.

**trade–augmented production possibility frontier (trade–augmented PPF)**  The locus of all the alternative quantities of several outputs that can be consumed given domestic production and world prices.
World Trade Organization (WTO)  The World Trade Organization is a new name applied to the secretariat of the General Agreement on Trade and Tariffs.