

Extensions of the Ricardian model

Actual trade is characterized by the exchange of a large number of goods (more than 2!). For example, the SITC nomenclature has 3118 5-digit product categories. However, the number of goods actually traded is larger. Some commodities like textiles are well represented (200 entries) but trade classification does not fully account for the degree of product differentiation of many other items (such as bolt, cars, etc.).

Many goods DFS77 model

Now we want to extend the Ricardian model to the case of many goods using the continuum assumption originally developed in the paper by Dornbusch, Fisher and Samuelson (1977), published in the American Economic Review. To simplify the analysis the model assumes a continuous rather than discrete number of goods. The model allows to study the effects of growth, demand shifts and exogenous technological change. In each case the focus of the analysis is to determine:

- i) the dividing line between exported and imported goods,
- ii) the position of the relative wage that assures balanced trade.

SUPPLY SIDE

The model assumes that each good is produced with constant unit labor requirement both at home and abroad. For i -th good, a_i represents the unit labor requirement in the home country, while a_i^* the unit labor requirement in the foreign country.

Goods can be ranked according to the diminishing home country comparative advantage. Hence, if n goods are produced we have:

$$\underbrace{\frac{a_1^*}{a_1}}_{\text{strongest comparative advantage}} > \frac{a_2^*}{a_2} > \dots > \frac{a_i^*}{a_i} > \dots > \underbrace{\frac{a_n^*}{a_n}}_{\text{weakest comparative advantage}}$$

Numerical example with 4 goods: A, B, C & D

Assume that unit labor costs are as follows:

a_{ij}	A	B	C	D
Home (a_{ij})	1	2	3	5
Foreign (a_{ij}^*)	12	18	24	30

And relative wages are equal (w/w^*): 7.

Home country has a comparative advantage in production of goods: A, B, C and Foreign country in production of good D

What happens when relative wages are equal 9?

In working with a continuum of goods we index commodities on an interval, say $[0,1]$, in accordance with diminishing home country comparative advantage. A commodity z is associated with each point on the interval, and for each commodity there are unit labor requirements in both countries: $a(z)$ and $a^*(z)$. Define $A(z) = a^*(z)/a(z)$ as the ratio of foreign to domestic unit labor requirement for commodity z . Assume that $A(z)$ is a smooth, continuous function decreasing in z , i.e. $A'(z) < 0$. The function $A(z)$ can be graphed in Figure 1 as a downward sloping schedule against z varying between 0 and 1.

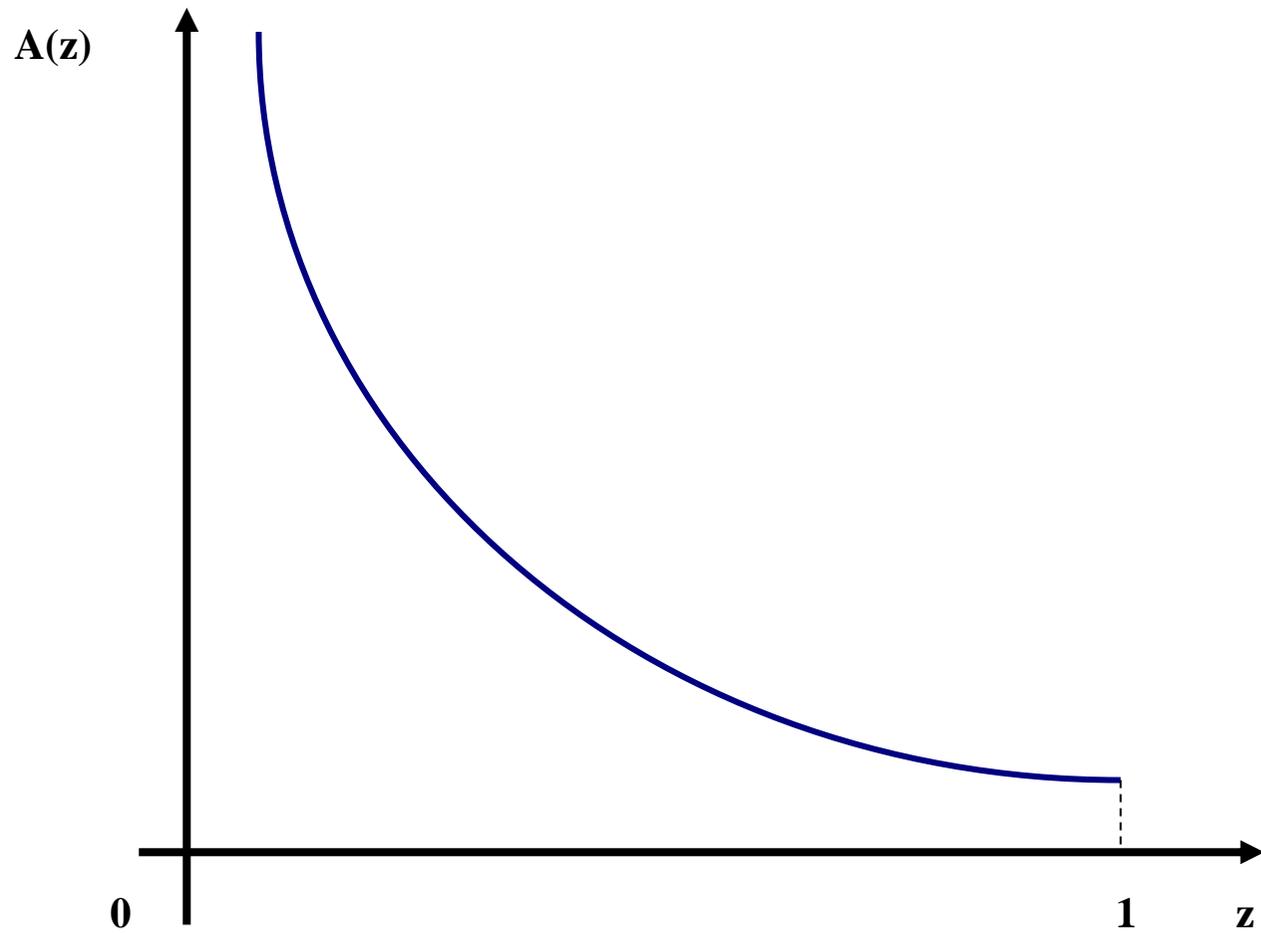


Figure 1. Relative unit requirement function

Now consider the range of goods produced in the home country (and those produced abroad). It will be cheaper to produce the good in the home country if unit production cost is smaller than abroad:

$$a(z)w \leq a^*(z)w^*$$

This is called the efficient specialization condition. If we define relative wage as $w/w^* = \omega$, this condition can be rewritten as:

$$\omega \leq A(z)$$

In other words, the good will be produced in the home country if the relative wage is smaller or equal the relative productivity.

For a given relative wage the home country will produce the range of commodities:

$$0 \leq z \leq \tilde{z}(\omega)$$

while the foreign country will produce the range of commodities:

$$\tilde{z}(\omega) \leq z \leq 1$$

If we know the relative wage ω we can determine the borderline commodity \tilde{z} .

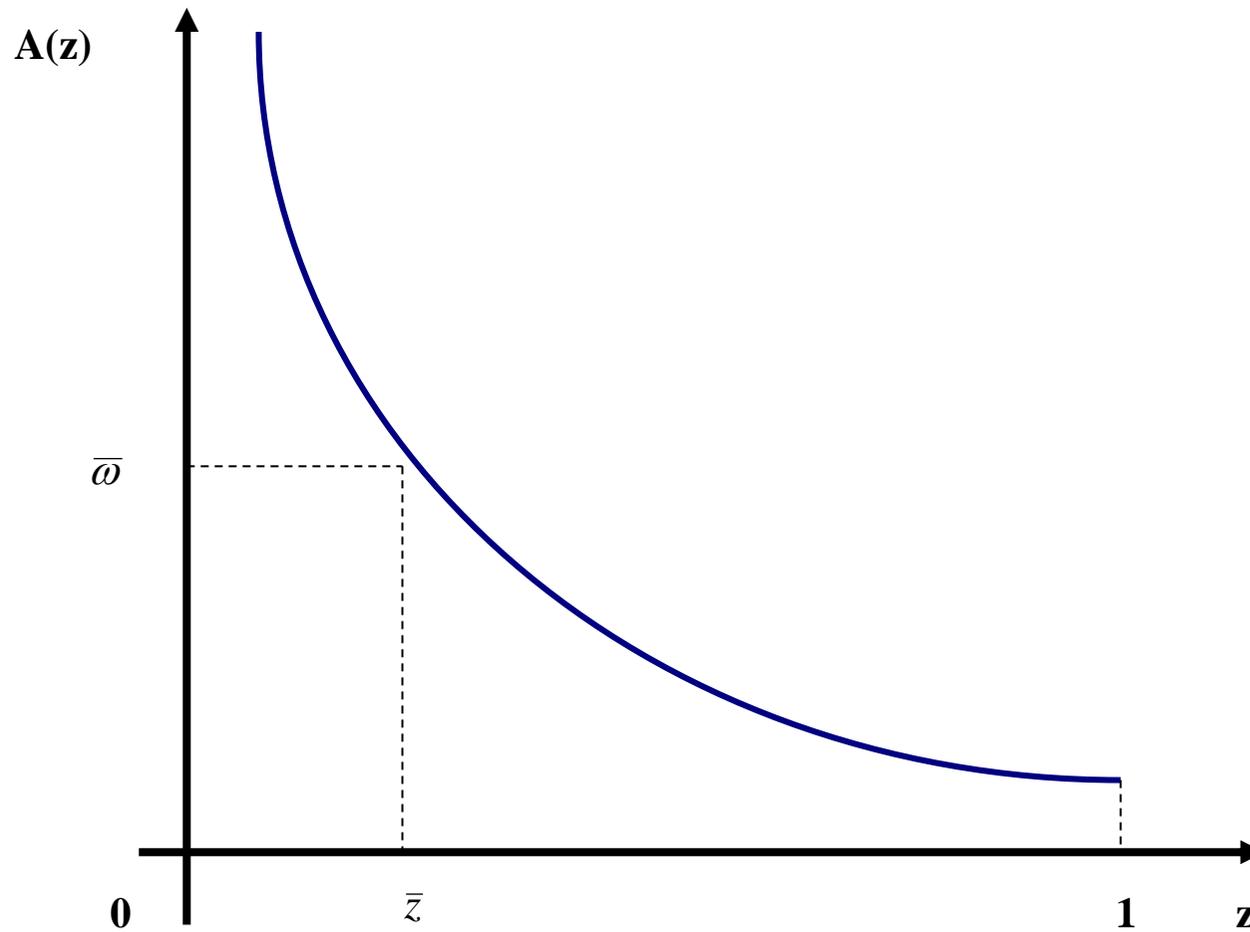


Figure 2. The pattern of international specialization given the state of technology and relative wages.

DEMAND SIDE

On the demand side we assume homothetic and identical consumer preferences in both countries.
In particular, we assume that the demand functions are derived from a Cobb-Douglas utility function.
In the discrete case we would have:

$$\underbrace{b_i}_{\substack{\text{constant} \\ \text{expenditure} \\ \text{share}}} = \frac{p_i c_i}{Y},$$

where: $\sum_{i=1}^n b_i = 1$, and $b_i = b_i^*$

In the continuous case we have:

$$b(z) = \frac{p(z)c(z)}{Y},$$

where: $\int_0^1 b(z) dz = 1$, and $b(z) = b^*(z)$.

and where:

Y – total income

c(z) – consumption demand for good z

p(z) – price of good z

Now, define the fraction of income spent (in both countries) on those goods in which the home country has a comparative advantage.

$$v(\tilde{z}) = \int_0^{\tilde{z}} b(z) dz > 0,$$

where $v'(\tilde{z}) = b(\tilde{z}) > 0$, and $0 \leq v(\tilde{z}) \leq 1$.

In the similar manner the fraction of income spent on foreign goods can be defined as:

$$1 - v(\tilde{z}) = \int_{\tilde{z}}^1 b(z) dz$$

EQUILIBRIUM

We can use the market equilibrium condition to determine relative wage and international specialization in production. Equilibrium in the market for goods produced in the home country requires that the total value of spending on home-made goods equals the domestic labor income (due to the fact that all sales revenue is paid out to the workers, there is no profit by assumption – perfect competition). Hence:

$$\underbrace{v(\tilde{z})}_{\substack{\text{fraction} \\ \text{of} \\ \text{income} \\ \text{spent} \\ \text{on} \\ \text{home-made} \\ \text{goods}}} \underbrace{[wL + w^* L^*]}_{\substack{\text{total} \\ \text{world} \\ \text{income}}} = \underbrace{wL}_{\substack{\text{sales} \\ \text{revenue} \\ \text{(our} \\ \text{income)}}}$$

$\underbrace{\hspace{15em}}_{\substack{\text{total} \\ \text{world} \\ \text{expenditure} \\ \text{on} \\ \text{our} \\ \text{goods}}}$

The above condition associates with each z an value of the relative wage w/w^* . The alternative interpretation of this condition is as follows:

$$\underbrace{[1 - v(\tilde{z})]}_{\substack{\text{share} \\ \text{of} \\ \text{imports} \\ \text{in} \\ \text{our} \\ \text{expenditure}}} \underbrace{wL}_{\substack{\text{our} \\ \text{income} \\ \text{(expenditure)}}} = \underbrace{v(\tilde{z})}_{\substack{\text{share} \\ \text{of} \\ \text{home-made} \\ \text{goods} \\ \text{in} \\ \text{foreign} \\ \text{expenditure}}} \underbrace{w^* L^*}_{\substack{\text{foreign} \\ \text{income} \\ \text{expenditure}}}$$

$\underbrace{\hspace{10em}}_{\text{IMPORTS}} \qquad \underbrace{\hspace{10em}}_{\text{EXPORTS}}$

Hence, the above condition can be interpreted as the balanced trade condition.

This condition can be rewritten as:

$$\omega = \frac{w}{w^*} = \left[\frac{v(\tilde{z})}{1-v(\tilde{z})} \right] \frac{L^*}{L} = B(\tilde{z}, \frac{L^*}{L})$$

B schedule is upward sloping because an increase in the range of commodities produced at home (at constant relative wages) lowers our imports and raises our exports. The resulting trade imbalance has to be eliminated by an increase in our relative wage (that would raise our imports and reduce exports).

The alternative interpretation (home labor market interpretation).

If the number of goods produced at home increases (but wages remain unchanged) then the demand for home labor would increase (with increasing number of goods produced at home) and the demand for foreign labor would decrease. In this case the relative wage has to increase to equate the demand for domestic labor to the existing (fixed) labor supply.

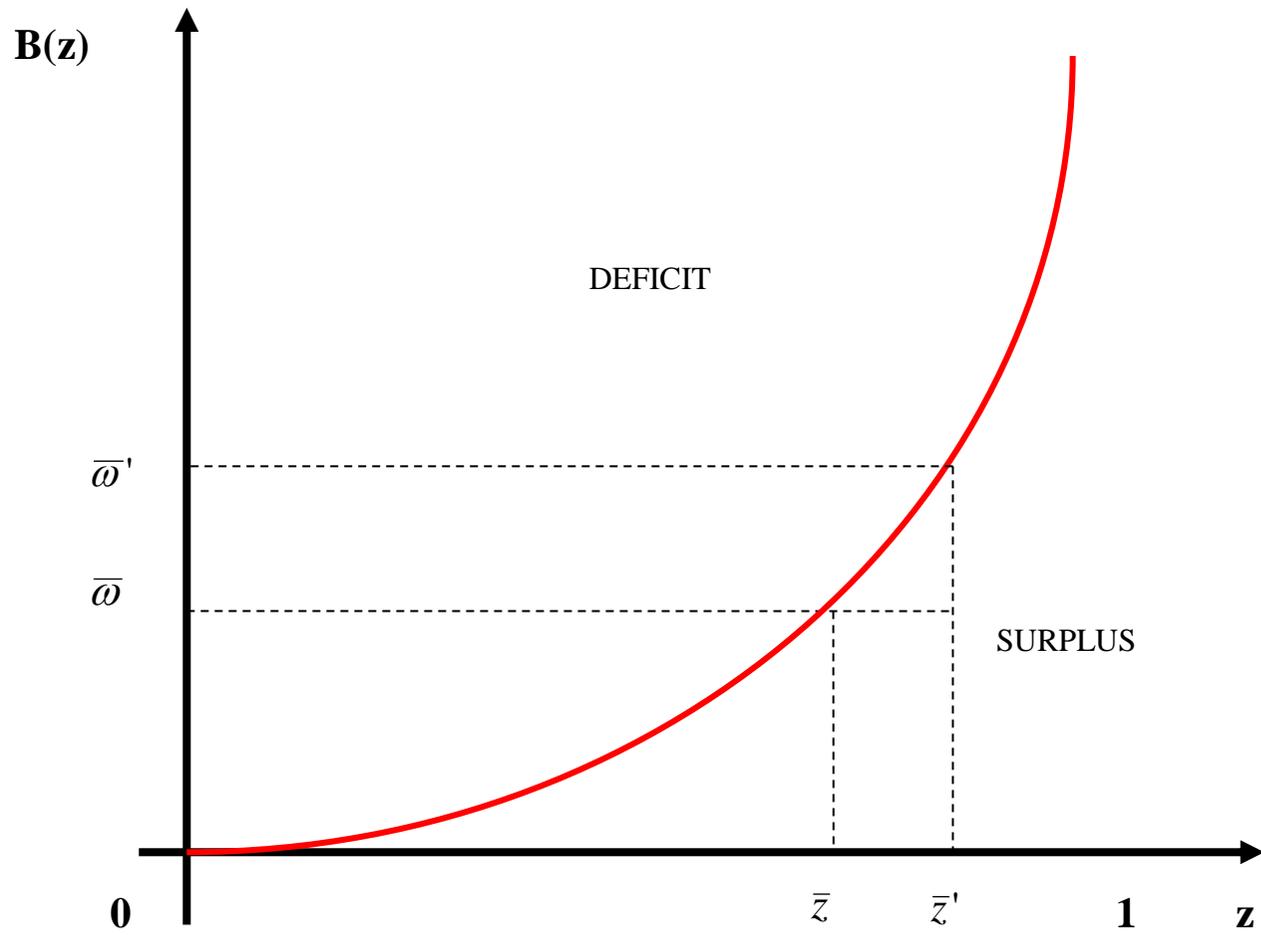
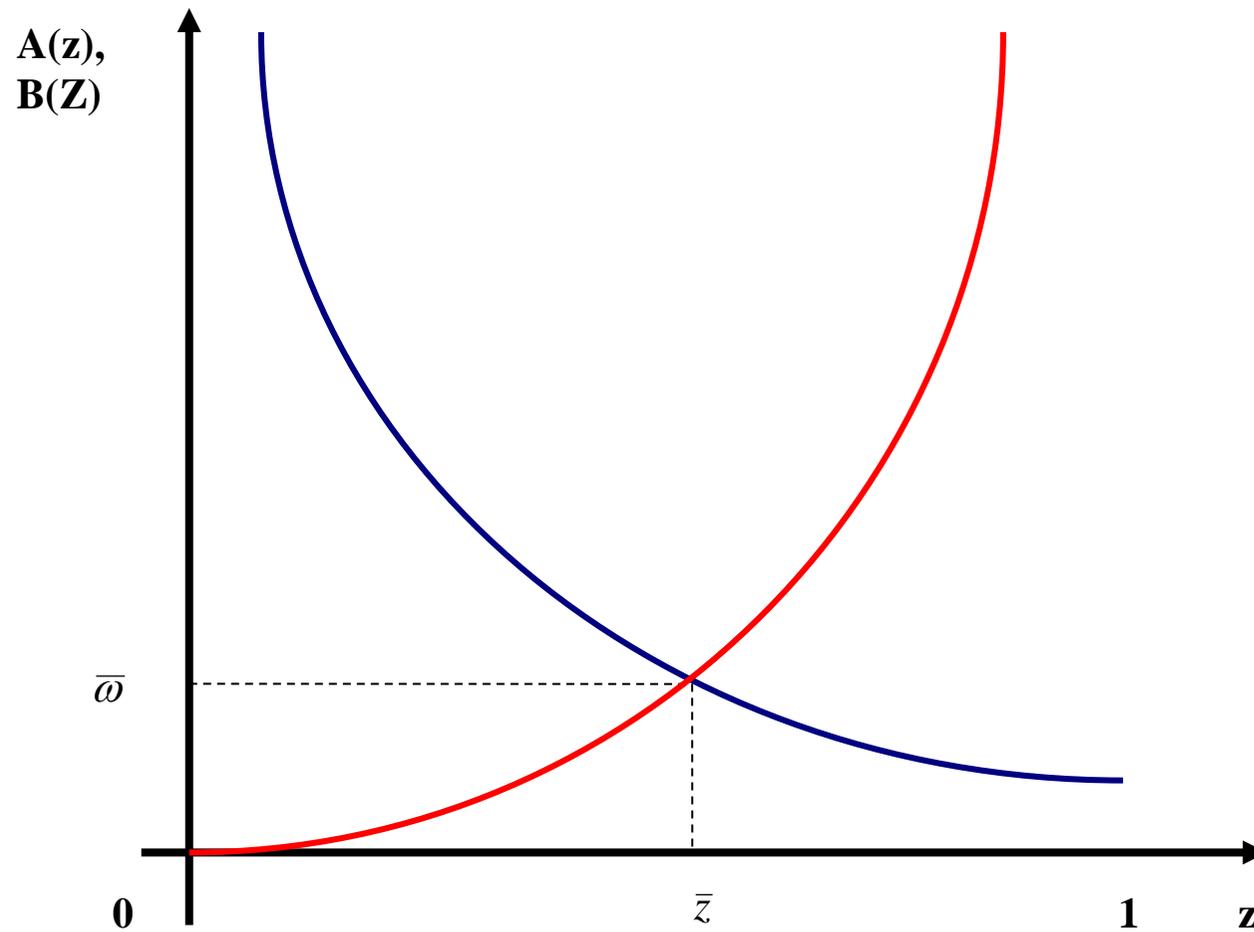
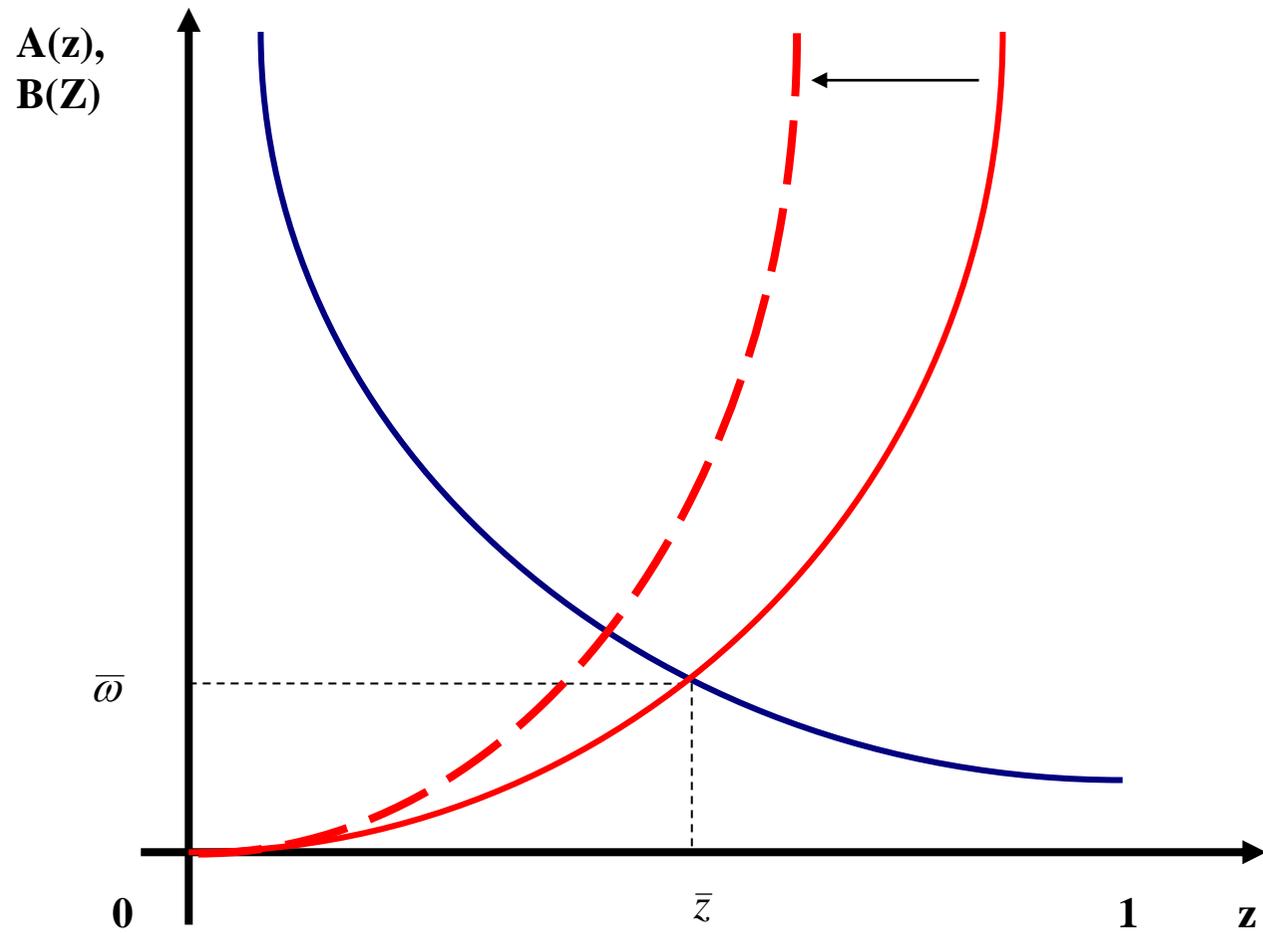


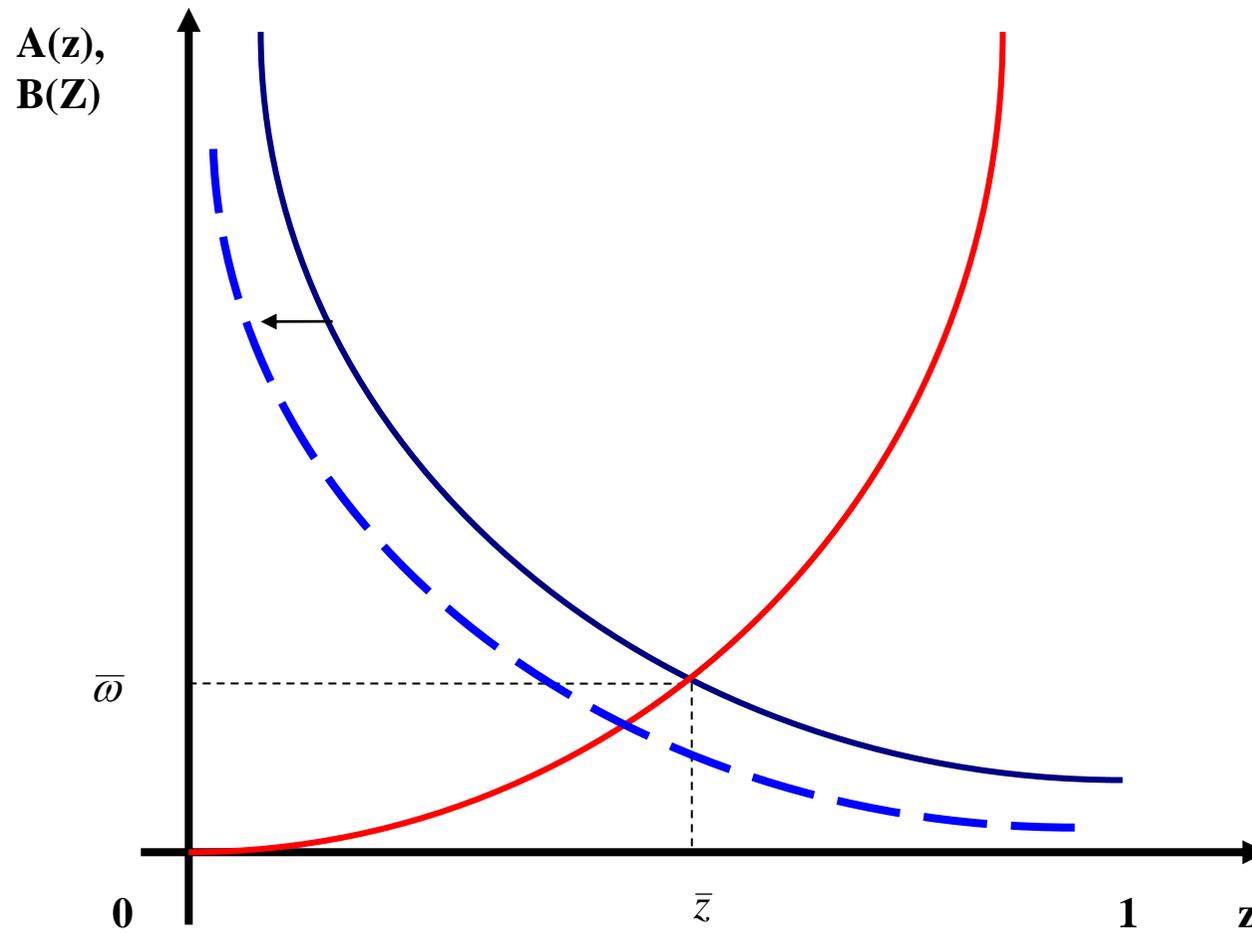
Figure 3. The balanced trade condition.



The final step is to combine the efficient specialization condition and the balanced trade condition.



Effects of increase in relative Foreign country size.



Effects of technological progress in Foreign country.

Empirical tests of Ricardian model

The relationship between trade theory and empirical tests – General remarks

Economists have developed numerous models to explain why international trade takes place. These models make assumptions that embody **STRONG ABSTRACTIONS** (such as perfect competition, one factor of production, etc.) from reality in order to isolate the particular influence of some important variable on the pattern and the volume of trade. (Empirical research obeys a similar rule, in econometric studies we often focus on the variable of interest controlling for the impact of other variables).

Otherwise, undertaking an analysis in the real-world environment of imperfect competition, numerous factors of production, and trade restrictions would be very difficult. These theoretical abstractions allow economists to investigate the implications of different circumstances for trade flows and economic welfare. However, some people claim that all these theories are too abstract to be tested empirically.

It is natural for analysts to wonder how well their theoretical predictions correlate with actual empirical data on international trade. That is why there exists a large body of literature in which economists attempt to test various aspects of the theory of comparative advantage (or to assess the importance of different explanations for trade).

BAD NEWS: There is a large number of problems in the empirical work on international trade a trade analyst must be confronted with.

- It is very difficult to test theories of comparative advantage directly because they rely on statements about differences in autarky relative costs and prices across countries. Autarky is virtually an unobservable situation, and available data would be influenced by international trade. Therefore, economists often use INDIRECT ways of testing trade theories based on observable variables.
- To establish theoretical statements about trade economists make numerous simplifying assumptions that cannot be true under all realistic circumstances. Even in cases where it is possible to translate theories into equations that embody observable variables, these equations cannot be expected to hold literally or without error. Given this constraint, empirical work consists largely of measurement and judgement rather than precise testing. Therefore you should rather ESTIMATE but DO NOT TEST! Since trade theories cannot be tested economists must pose a simpler question: “How closely do actual trade data correspond to the levels predicted by various trade theories?”.
- Various international trade theories should not be seen as competing hypotheses. Each theory tends to focus on a particular aspect of national economies that is expected to induce trade. Each of these influences operates simultaneously both alone and in conjunction with the others to explain the pattern and the volume of trade. The task for an economist is to assess the relative importance of various trade determinants. Therefore, remember that each theory works in its own limited domain for which it was created.

GOOD NEWS: Despite the aforementioned problems economists made great progress in studying the effects of various influences on the patterns of international trade. In particular it is worth examining some of the important work on the determinants of comparative advantage.

Early tests of the Ricardian model

The Ricardian model rests on the assumption of different production technologies in different countries generating varying labor productivities. These labor productivities determine comparative advantage. Tests of the Ricardian model attempt to find relationships between relative labor productivity and international trade flows.

The sharpest prediction of the Ricardian model that countries are completely specialized in the goods they export is rejected in practice. Countries produce also goods they import and a whole range of non-traded goods. Nevertheless, it is interesting to examine how strongly differences in labor efficiency correlate with exports. Therefore, looser versions of the Ricardian model are studied (that allow for, for example, across industry wage variation).

MacDougall (1951) tests

The pioneering empirical work on the Ricardian model was done in the 1950s by G. MacDougall (1951), published in Economic Journal, who computed simple measures of average labor productivity (output per worker) in the United States and the United Kingdom for the year 1937.

MacDougall hypothesized that, given that American wage rate was approximately twice that in the UK, **US firms should have an export advantage in manufacturing sectors for which U.S. labor productivity exceeded twice the level in the UK.**

He tested this hypothesis by calculating the ratios of US exports to UK exports of 25 products to countries other than themselves (because at that time trade barriers greatly influenced bilateral trade between the US and the UK while in other countries exporters from both countries faced largely equivalent market conditions and could compete on an equal footing).

MacDougall test results were very supportive of the Ricardian model. 20 of 25 products satisfied the simple prediction that in cases where US productivity exceeded twice the UK level, the ratio of US exports to UK exports exceeded one (while in other cases the ratio was smaller than unity).

TABLE. US and UK relative unit labor requirements and exports to third countries in 1937

$a_{UK}/a_{US} > 2$ (US output per worker more than twice the UK output)	US exports / UK exports
Wireless sets and valves	8
Pig iron	5
Motor cars	4
Glass containers	3.5
Tin cans	3
Machinery	1.5
Paper	1

1.4 < a_{UK}/a_{US} < 2 (US output per worker less than twice the UK output)	UK exports / US exports
Cigarettes	2
Linoleum	3
Hosiery	3
Leather footwear	3
Coke	5
Rayon weaving	5
Cotton goods	9
Rayon making	11
Beer	18
a_{UK}/a_{US} < 1.4 (US output per worker less than 1.4 the UK output)	UK exports / US exports
Cement	11
Men's/boys' coats	23
Margarine	32
Woolen and worsted	250

Exceptions: US output per worker more than twice UK output per worker but UK exports exceed US exports: electric lamps, rubber tyres, soap, biscuits and matches. These represent about 3% of the value of trade in the commodities listed.

Source: MacDougall (1951, p.698).

Stern (1962) tests

A fuller examination of the Ricardian model was performed by Stern (1962), published in Oxford Economic Papers, who compared American and UK trade in 1950 and 1959. By 1950 average US wages were approximately 3.4 times higher than the average UK wages suggesting that the ratio of American to UK exports would be greater than unity in sectors where the ratio of outputs per worker exceeded 3.4 (and less in other cases).

Of 39 sectors considered 33 conformed to this prediction in 1950 (less in 1959). The results for 1950 data suggested that a 1% increase in the ratio of labor productivities was associated with a 1.27% rise in the export ratio.

PROBLEMS WITH THE EARLY TESTS OF THE RICARDIAN MODEL

The early studies by MacDougall (1951) and Stern (1962) seemed to provide encouraging support for the Ricardian model. In fact, it is surprising that economists have not devoted much additional effort to such analysis in order to verify more conclusively that labor productivity differences constitute an important determinant of international trade.

In interpreting the results of empirical studies we must keep two important caveats in mind:

- The empirical specifications used in these studies were exceedingly simple and did not control for the potential effects of other determinants of trade (such as transport costs, imperfect competition, product differentiation, etc.).
- The results found by MacDougall and Stern are consistent with other trade theories as well. For example, in a world where trade is caused by differences in factor endowments but where factor prices are not equalized the relative productivity of labor will tend to be higher in capital-abundant countries (as more capital intensive production techniques will be used in all industries). Accordingly, the results may have simply captured the effects on trade of American capital abundance and UK labor abundance in that period.

CONCLUDING REMARKS

The Ricardian model seems to raise more questions about the sources of comparative advantage than it answers. The model provides no guide as to how labor productivity and comparative advantage can be expected to evolve since it gives no explanation for differences in labor productivities across countries. This sets on of the tasks for more complex models such as the Heckscher-Ohlin-Samuelson model with two factors of production and the factor specific model with three factors of production.