J. Tybout

Economics 507a: International Trade
Lecture 1

I. Overview of the course

An introduction to modern trade theory and the empirical evidence on its relevance.

Course mechanics
Pre-requisites, at least one semester of graduate level microeconomics, and one semester of graduate level econometrics. More is better, especially econometrics.

Midterm and final exam 33% each; homework and class participation account for the remaining 33%. I plan to do develop some empirical exercises that develop some basic analytical skills in modeling and estimation.

Class attendance and participation is not optional.

The reading list will evolve as the course progresses—keep an eye on the web site!

Core issues:
How do tastes, technologies and endowments determine trading patterns?

Who are the losers and the winners from trade, presuming no offsetting income re-distribution?

When governments intervene to influence trade patterns, what are the consequences in terms of gains from trade, patterns of trade, and winners and losers?

How do imperfect competition and firm heterogeneity affect our answers to these questions?

Other major issues (more recently emphasized)
How does trade influence the functioning of labor markets?

Similarly, how do trade and multinational investments interact?

How does trade affect innovation?

There is far more on the reading list that one can reasonably hope to master over a 12-week period. I will indicate which papers to study closely, and which are there to indicate what you might read if you wanted to pursue the topic further. Also, I do not expect to cover all of the sections of the reading list this fall. As we get further into the material, we will take up the question of whether to study multinationals or innovation.

Brief tour of the reading list

Section 1: It is not possible to follow the recent literature without first laying a foundation of basic theory. We therefore begin with the traditional neoclassical trade model, which presumes that cross-country differences in factor endowments are the fundamental reason for trade. Some fundamental results emerge from these models that still underpin model theoretical and empirical work.

After developing the theory, we briefly consider the empirical literature on the power of these models to explain trade flows.

Section 2: The models considered in section 1 presume that factors and production technologies are homogeneous across countries. In section 2 we study an alternative type of trade model in which cross-country differences in factor abundance are replaced by cross-country differences in sector-specific productivity levels. The basic idea behind this model was developed by David Ricardo in 1817. It was eclipsed by the neoclassical model of section 1, partly because the model offers no systematic explanation for *why* certain countries are good at producing certain things, and differences in factor stocks seemed to be a good explanation. But the model has made a strong comeback in the past 25 years, perhaps because empirically, factor endowments seem to leave a lot of trade unexplained. It underpins some of the most important recent contributions. We will study the two seminal papers in relative detail—Dornbusch et al, and Eaton and Kortum.

In section 3, we first generalize the basic neoclassical trade model by introducing product differentiation and scale economies. Drawing on the seminal work by Krugman and Helpman we develop several new results: trade allows countries to specialize in the production of certain product varieties, and thereby facilitates scale economy exploitation. It also leads to a larger global menu of available varieties, which is good for variety-loving consumers and (when intermediate inputs are differentiated) for productive efficiency.

Early models of imperfect competition treated all producers as using the same technology. A new generation of models has emerged that treats producers as heterogeneous—some are more efficient than others and/or produce more appealing products. These models are variants on Marc Melitz's seminal paper, which we will study relatively closely. A variant of the Eaton/Kortum model that incorporates plant heterogeneity and imperfect competition will also receive some attention.

At this point we are equipped to analyze the effects of trade on the characteristics of industrial sectors. (Dispersion in technical efficiency, pricing behavior, scale economy exploitation, mix of products produced.) We take stock of the empirical evidence concerning these possible effects of trade

The remainder of the course concerns areas that are currently “hot” .

Section 4 treats models that bring labor markets into trade models in a more serious way than the canonical formulations in sections 1-3. Standard models do a poor job of predicting the effects of trade policy on wage inequality/unemployment, both because they treat all workers as homogeneous, and because they do not allow for labor market frictions. We’ll look at some attempts to do better.

Section 5 focuses on a related issue: global fragmentation of production. Reductions in communication costs, reductions in trade costs, and increased participation in the global economy by countries that were on the fringes have led to a surge in FDI and trade in intermediates. This section treats some of the recent efforts to model and measure these phenomena.

Section 6 concerns the possible effects of trade on innovation and growth. Trade changes the returns to investment in new technologies and can act as a conduit for existing technologies embodied in intermediate or capital goods. This part of the course presents sampling of theories that build on the canonical models from the beginning of the course, then turns to empirical evidence on their relevance.

II. The simple mechanics of the 2 x 2 Hecksher-Ohlin model

A. Preliminaries

Assumptions

- perfect competition
- infinite number of profit maximizing firms
- the same production technologies are available in all countries
- two primary factors (L, K)
- constant returns to scale,

$$X_j = F_j(L_j, K_j) = L_j f(k_j),$$
$$f_j'(k_j) > 0, \quad f_j''(k_j) < 0$$

- two final goods, agricultural and industrial, indexed by $j \in \{1, 2\}$
- homothetic, identical tastes throughout the world; both goods are consumed everywhere.
- no factor intensity reversals

Define:
$A = \begin{bmatrix} a_{L1} & a_{L2} \\ a_{K1} & a_{K2} \end{bmatrix}$ = matrix of input requirements per unit output. (Note that these depend only upon k_j in each sector.)

Factor market clearing condition:
$L = a_{L1}X_1 + a_{L2}X_2$ and $K = a_{K1}X_1 + a_{K2}X_2$,

Competitive output pricing:
$P_1 = a_{L1}w + a_{K1}r$ and $P_2 = a_{L2}w + a_{K2}r$.

Profit maximization:
Competitive firms maximize profits by setting the price of each input equal to the value of its marginal product. Thus:

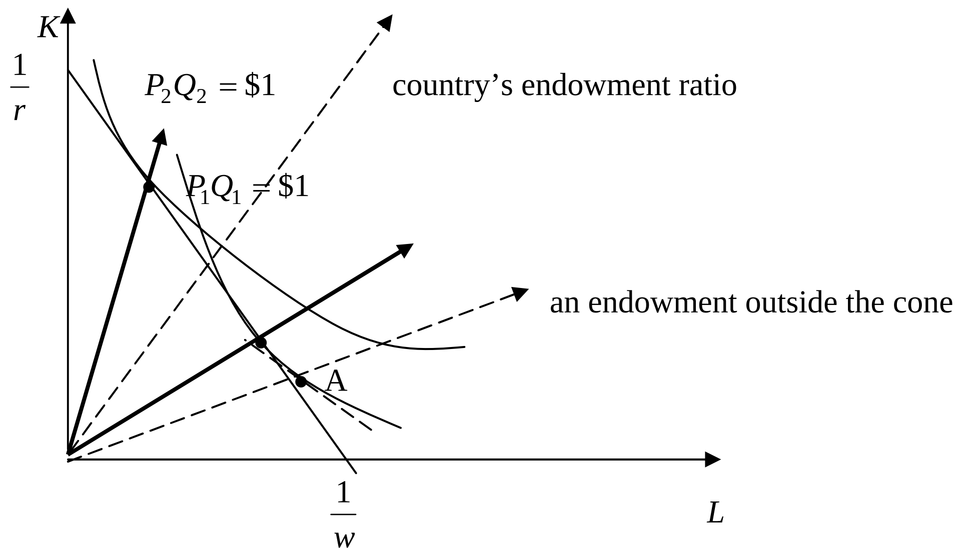
$\frac{w}{r} = \frac{P_j MP_{Lj}}{P_j MP_{Kj}} = \frac{f_j(k_j) - k_j f_j'(k_j)}{f_j'(k_j)}$. The numerator is a monotonic positive function of *k* and the denominator is a monotonic negative function of *k*, given a concave production technology ($f_j''(k_j) < 0$.) Thus the wage-rental ratio uniquely determines the profit-maximizing capital-labor ratio in each sector, $k_j = \frac{a_{Kj}}{a_{Lj}}$, and the factor requirements per unit output:

$a_{Lj} = \frac{L_j}{L_j f(k_j)} = \frac{1}{f(k_j)}$; $a_{kj} = \frac{K_j}{L_j f(k_j)} = \frac{1}{k_j f(k_j)}$, thereby fixing the minimum costs of producing a unit of output: $C_j = a_{Lj}w + a_{Kj}r$

B. The Factor Price Equalization Theorem

The claim:
When a set of countries faces common global prices, and each country produces both goods, identical factor prices will prevail in all countries.

Geometric proof
Under the assumption of no factor intensity reversals, one good is always more intensive in a particular factor (relative to the other good), regardless of factor prices. Let's assume that good 1 is relatively labor intensive, by which we mean $\frac{a_{L1}}{a_{K1}} > \frac{a_{L2}}{a_{K2}}$.



World prices dictate the position of these unit revenue isoquants, and the associated, unique wage-rental ratio that is consistent with zero profits in both sectors. In turn, this factor price ratio implies factor proportions in each sector, as represented by the heavy rays from the origin.

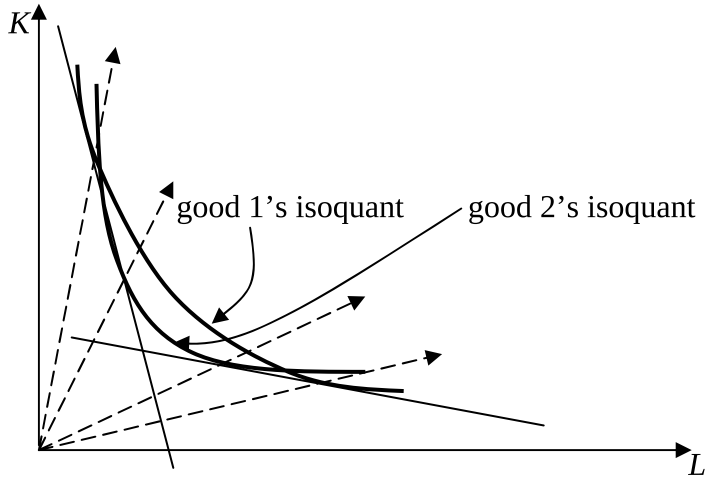
A caveat: If the country only produces one of the goods, its factor prices are not determined by international trade alone. When will it produce only one good? When its factor endowments lie outside the "cone of diversification" defined by the heavy arrows. (Refer to the lower dotted arrow).

Suppose that the country's capital intensity is given by the lower dotted ray. Then at the factor prices implied by global product prices, there is excess demand for capital. To see why, note that the country's factor endowment must be a convex combination of the cone borders if it is to produce both goods:

$$\frac{K}{L} = \left(\frac{L_1}{L}\right)\left(\frac{K_1}{L_1}\right) + \left(\frac{L_2}{L}\right)\left(\frac{K_2}{L_2}\right)$$

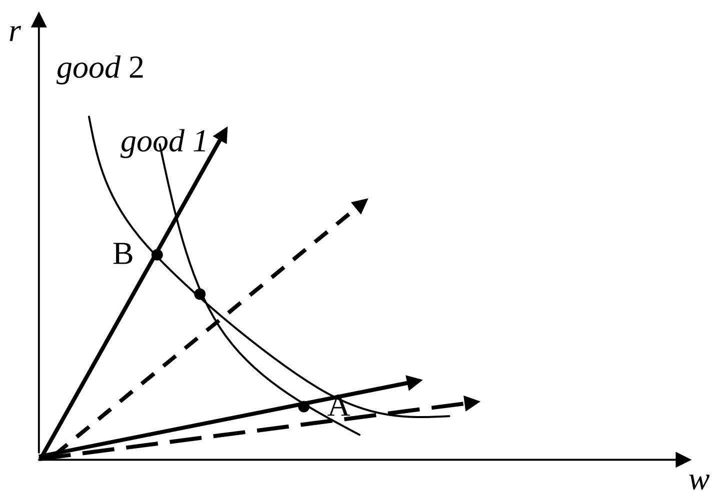
At an endowment like the lower dotted vector, excess demand for capital at the factor price ratio shown will drive up the relative price of capital until production at point A is cheap enough to eliminate losses (refer to the factor price ratio associated with the short dotted line).

As an aside, note that this diagram shows why factor intensity reversals must be ruled out to get factor price equalization. Consider:



At low *w*/*r*, good 1 is capital intensive, but at high *w*/*r*, it is labor intensive. The same global prices are consistent with two different sets of capital intensities. Perhaps this helps to explain the fact that wages are lower in the South than in the north, although both regions produce a pretty large range of goods. (Other things matter too, especially productivity.)

Factor price equalization can also be established using unit cost frontiers. Each curve shows the combinations of the wage rate and the rental rate that imply a unit cost of production equal to the output price of the sector in question.



- Given our assumption that good 1 is labor intensive, changes in the wage rate always have a relatively large effect on good 1's cost, and must be compensated with relatively large changes in *r*. That is, the unit cost curve for good 1 is relatively steep. More formally, the first-order condition for cost minimization is $\frac{w}{r} = \left.\frac{F_L}{F_K}\right|_{Q=1} = \frac{-da_K}{da_L}$ (The second equality follows from the fact that along each unit cost frontier, $Q_j = F_j(a_{Lj}, a_{Kj}) = 1$, so $dQ_j = 0 = F_{jL} da_{Lj} + F_{jK} da_{Kj}$.) Using this result to simplify the condition that costs do not change along either line, $dC_j = 0 = dw \cdot a_{Lj} + w \cdot da_{Lj} + dr \cdot a_{Kj} + r \cdot da_{Kj}$, we obtain $dC_j = 0 = dw \cdot a_{Lj} + dr \cdot a_{Kj}$, or $\frac{dr}{dw} = \frac{-a_{Lj}}{a_{Kj}}$. The labor intensive good (good 1) must always have a steeper unit cost frontier. Further, we have seen that as *r*/*w* increases, capital intensity falls, so the slope of each frontier must become steeper at higher *r*/*w*.

Since there is only one intersection, it follows immediately that countries which face the same output prices will share the same factor prices. (Factor intensity reversals could lead to multiple intersections.)

The cone of diversification can be illustrated with this figure too. Suppose all factors were allocated to sector 1 (food). The (*w*, *r*) combination associated with profit maximization would be point A. Similarly, allocating all factors to sector 2 (manufactured goods), the (*w*, *r*) combination that would emerge is B. If A and B did not bracket the factor price ratio implied by global prices—e.g., if the rays were lower because of abundant capital in this country (see dotted rays)—then regardless of factors are allocated, good 2 producers will be able to pay factors more out of their revenues. Good 1 wouldn't get produced.

Does the factor price equilibrium theorem generalize to more than 2 goods and 2 factors?

- With *n* goods and *n* factors, so long as all countries produce all goods, things still go through. (The A matrix remains invertible.)

- With more goods than factors, it works if all countries can produce all goods at zero profit, but otherwise it does not hold (example).

- With more factors than goods it generally will not hold, even if all countries produce all goods (example).

C. The Stolper-Samuelson Theorem

Stolper-Samuelson theorem

An increase in the relative price of one commodity, say commodity 1, generates a more than proportional increase in the price of the factor that that commodity uses intensively. Thus the owners of the factor used intensively enjoy an

increase in their real purchasing power. The opposite result holds for the owners of the other factor.

Previous diagrams suffice to establish that an increase in the price of good 1 raises wages and reduces the price of capital, holding the price of good 2 constant.

In terms of growth rates,

$$\hat{P}_1 = \hat{w}\theta_{L1} + \hat{r}\theta_{K1} + \hat{a}_{L1}\theta_{L1} + \hat{a}_{K1}\theta_{K1}$$

$$\hat{P}_2 = \hat{w}\theta_{L2} + \hat{r}\theta_{K2} + \hat{a}_{L2}\theta_{L2} + \hat{a}_{K2}\theta_{K2}$$

where θ_{ij} are the share of factor *i* in total earnings of good *j*. These equations simplify because of an Envelope theorem: although the *a*'s adjust to factor price changes, the first-order effects of these adjustments on costs are zero because they are starting from their optimal values.

Each firm takes factor prices as given and adjusts its factor proportions (*a*'s) to minimize cost per unit output. From the first-order conditions, at any cost minimizing point on an isoquant: $\frac{w}{r} = \left.\frac{F_L}{F_K}\right|_{Q=1} = \frac{-da_K}{da_L}$, where the second inequality follows from, $dQ = 0 = F_L da_L + F_K da_K$. Hence $\left(\frac{da_K}{a_K}\right) ra_K + \left(\frac{da_L}{a_L}\right) wa_l = 0$, or $\hat{a}_{Lj}\theta_{Lj} + \hat{a}_{Kj}\theta_{Kj} = 0$.

Substituting $\hat{a}_{Lj}\theta_{Lj} + \hat{a}_{Kj}\theta_{Kj} = 0$ into the price growth equations above yields $\hat{P}_1 = \hat{w}\theta_{L1} + \hat{r}\theta_{K1}$ and $\hat{P}_2 = \hat{w}\theta_{L2} + \hat{r}\theta_{K2}$, which implies that the commodity price changes are convex combinations of the factor price changes. Further, if the two commodity prices move in different directions, the one that increases must move more at a larger rate than the associated price.

$\begin{pmatrix} \hat{P}_1 \\ \hat{P}_2 \end{pmatrix} = \begin{bmatrix} \theta_{L1} & \theta_{K1} \\ \theta_{L2} & \theta_{K2} \end{bmatrix} \begin{pmatrix} \hat{w} \\ \hat{r} \end{pmatrix}$, so solving for factor price growth, we have:

$\begin{pmatrix} \hat{w} \\ \hat{r} \end{pmatrix} = \begin{bmatrix} \theta_{K2} & -\theta_{K1} \\ -\theta_{L2} & \theta_{L1} \end{bmatrix} D^{-1} \begin{pmatrix} \hat{P}_1 \\ \hat{P}_2 \end{pmatrix}$, where $D = \theta_{L1}\theta_{K2} - \theta_{L2}\theta_{K1}$ >0 by our assumption that good 1 is labor intensive. Setting $\hat{P}_2 = 0$ to normalize, the effect of an increase in P_1 on wages is positive and the effect on the return to capital is negative. Further the coefficient $\theta_{K2}D^{-1}$ must be greater than unity because all θ's lie between zero and one.

Implication: if opening to trade drives down the price of the good that uses intensively the factor you supply, you stand to lose. (Lobbying groups should line up according to factor rather than industry.)

Remember for future discussions that both the factor price equalization theorem and the Stolper-Samuelson theorem depend heavily on some special assumptions.

D. The Rybcznski Theorem

Rybcznski theorem
(A dual to the Stolper-Samuelson theorem.) ***Expanding one factor stock while holding output prices constant leads to a more than proportionate expansion in the good that uses that factor intensively, and a contraction in the other good.***

Log-differentiating the factor market clearing conditions, we have:

$$\hat{L} = \hat{a}_{L1}\lambda_{L1} + \hat{a}_{L2}\lambda_{L2} + \lambda_{L1}\hat{X}_1 + \lambda_{L2}\hat{X}_2$$

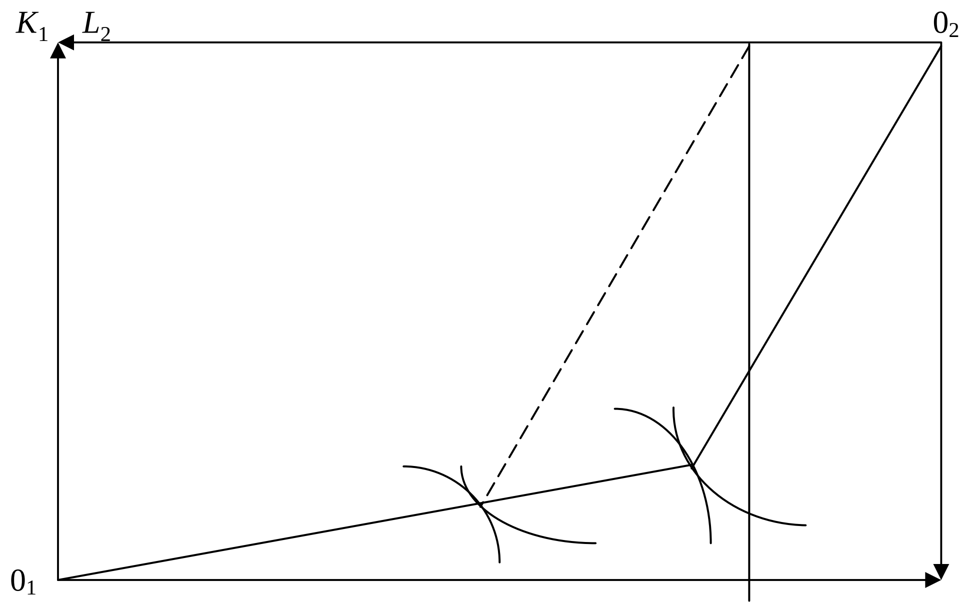
$$\hat{K} = \hat{a}_{K1}\lambda_{K1} + \hat{a}_{K2}\lambda_{K2} + \lambda_{K1}\hat{X}_1 + \lambda_{K2}\hat{X}_2$$

Further, if we assume that the conditions for factor price equalization hold, factor intensities are pinned down by global prices:

$$\hat{L} = \lambda_{L1}\hat{X}_1 + \lambda_{L2}\hat{X}_2$$

$$\hat{K} = \lambda_{K1}\hat{X}_1 + \lambda_{K2}\hat{X}_2$$

Where λ_{ij} the fraction of factor *i* allocated to good *j*. The logic is simple. Suppose the labor force expands, while capital is held fixed. With factor proportions fixed by global prices and factor price equalization, both goods cannot expand. If 2 were to expand and 1 contract, the result would increase demand for capital and reduce demand for labor, exacerbating the disequilibrium. Instead, 1 expands and 2 contracts to free up the necessary capital. (Think of the expansion in *L* as putting incipient downward pressure on the relative price of good 1, attracting a surge of demand for good 1 in global markets.)



To amuse yourself at home, you can do the math to prove the Rybcznski theorem.