国际经济学

要素禀赋与国际贸易：赫克歇尔-俄林（HO）模型

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提纲

先哲眼中的 HO insignt

古罗马

上帝没有把所有产品赐予世界所有地方，而是把他的馈赠播撒在不同地区，最终人类或许会培育社会关系，因为一个人可能需要另一个人的帮助。因此，他缔造了商业，以致所有人或许都能共享这个世界的果实，不论它们产自何处。

—里巴尼乌斯 (公元 314—393 年)《演说集》

亚当斯密的老友

造物主赋予不同的国家以不同的才能、气候和土壤，从而为各国的交流通商提供了稳固的基础.....这样固然刺激了出口国的产业，而进口国本身的产业，也由于出售商品进行交换而得到发展。

—大卫 ▪ 休谟《论贸易的猜忌》，1752 年

Motivation

- Romney and Obama provide answers to Candy Crowley′ s question:

  " *What are your plans for bringing manufacturing jobs back to the United States* "

- Dissusion
  - 若你是美国选民，你的票会投给谁？理由是什么？

Motivation

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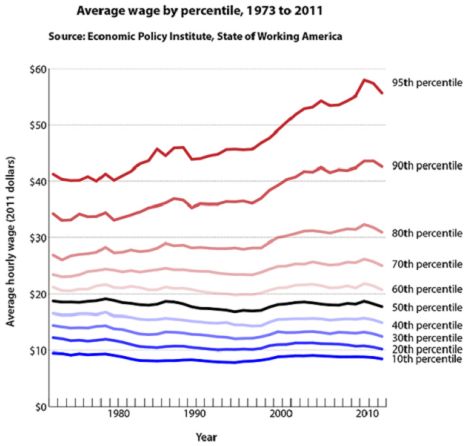
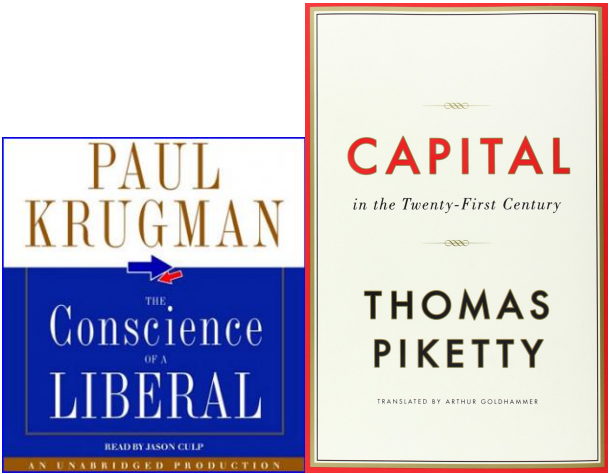
  - 若你是美国选民，你的票会投给谁？理由是什么？
  - 奥巴马（民主党）的言论为何越来越不受待见？如果他是对的，那么将会引上何种危险的结论？

Wage Inequality

- U.S. wage inequality has increased very significantly in the last 40 years
- This is the case in China and most places in the world
- While real wages of the top earners increased by close to 50%, those of bottom earners actually declined
- Is globalization responsible for this?



It is Also the Concerns of Some Bestsellers

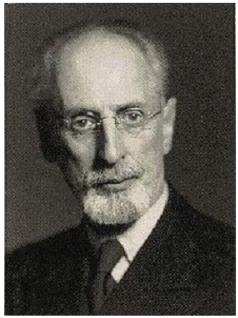


The Role of Factor Endowments

- We next study a model of trade in which all factors of production are flexible **in the long run**
- Trade is explained by cross -country **differences in the endowments** of different types (skills) of labor, physical capital, land and other factors of production
- Model delivers sharp predictions for trade patterns, as in the Ricardian model
- Also sharp predictions for distributional effects from trade, as in Specific Factors Model
- Downsides: model captures only long-run implications of trade and is relatively involved to solve the long-run situation

Intellectual History

- Developed by Eli Heckscher (1879 -1952) and his student Bertil Ohlin (1899 - 1979)
- Paul Samuelson and Ron Jones worked out many of the mathematical details
  - Ohlin (Nobel 1979)
  - Samuelson (Nobel 1970)



Heckscher-Ohlin: Rise of a theory

- From a book by Ohlin published in 1933
- Original point $\rightarrow$ trade and long-run income distribution
- Attractive model
  - Elegant: Can be analyzed graphically
  - Enough complexity to tackle many trade issues
    - Effect of trade liberalization
    - Effect of tariffs
    - Effect of technological change on trade patterns
    - Effect of technological change on income distributions
  - Clear, testable predictions
  - Extremlyg simple: 2+4 is the whole story

Heckscher-Ohlin: Downfall 昔日巨星陨落

- Some quotes:
  - *...the Heckscher-Ohlin model is hopelessly inadequate as an explanation for historical and modern trade patterns, unless we allow for technological differences across countries.*
    -Robert Feenstra, Distinguished Professor of Economics at University of California, Davis, 2004
  - *It is time to declare Stolper-Samuelson [an important result of the HO model] dead. Stolper-Samuelson says that trade liberalization will raise the real income of the abundant (unskilled) labor in poor countries. Stolper-Samuelson, qua theorem, is not wrong, of course. But if we use it, as we so often have, as if it provides a reliable answer to this question of real human significance, then it is worse than wrong - it is dangerous.*
    -Donald Davis, Professor of Economics at Colombia University and Prachi Mishra, Senior Economist, IMF 2007

Heckscher-Ohlin: Why the hate?

- Heckscher-Ohlin is a scientific theory: testable predictions
- Predictions have often not been backed up by data
- Assumptions also seem unusual in the modern world

The point

- Hecksher-Ohlin about long-run effects of trade
- Embodied in the idea that all factors are costlessly mobile

The point

- Famous implications are the four theorems (paraphrase):
  1. *Heckscher-Ohlin*: Countries with relatively more of a resource will export goods for which that resource is more useful in production
     ex: China exports Labor-intensive manufactured goods
  2. *Rybczynski*: If country gets more of a resource, then the output of the good that uses that resource intensively will rise while the output of the other good will fall. ex: if Denmark got more labor, it would increase its production of textiles
  3. *Stolper-Samuelson*: A rise in the price of a final good for which a particular resource is more useful in production will increase the payments to that resource
     ex: if the price of textiles goes up, Chinese workers get higher wages
  4. *Factor-price equalization*: Trade should cause resource prices to converge
     ex: American and Chinese workers should be paid the same wages

Outline

Assumptions of the H -O Model

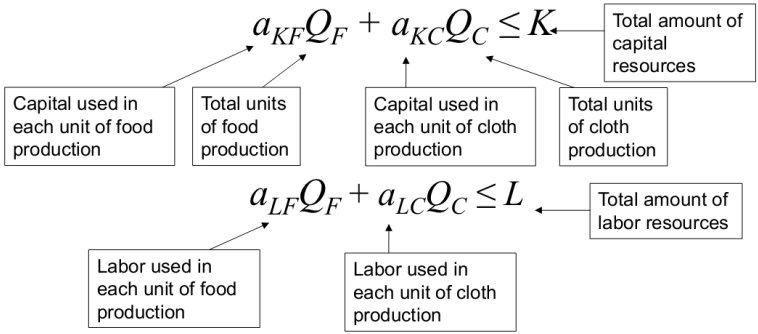
1. **two**- country: Home and Foreign
2. **Two** factors of production: labor and capital
3. Only **two** goods are important for production and consumption: food and cloth
4. The amount of labor and capital is in **fixed supply** but is allowed to **vary across countries**
5. Labor and capital can be **freely relocated across sectors**
6. Food and cloth are produced by combining labor and capital according to a production function featuring **CRS and diminishing marginal products**
7. The technology for producing **food is more capital - intensive** (in a sense to be described) than the technology for producing cloth
8. All markets are **frictionless and competitive**

Discussion of Assumptions

- Indicating two core concepts in H-O model
  - Factor Adundance
  - Factor Intesentiy
- For the specific country, the above two items are fixed
- So The model introduced in our course is a static one. When the above two item changed. We enter the theory of **Dynamic Comparative Advantage**
- both factors can freely move across sectors makes this **a natural model of the long run**
- We will abstract from technology differences and differences in preferences across countries

Production Possibility Frontier

- Formally, we want to characterize the combinations of Q_F and Q_C that satisfy
- 一字之差——"used" 和"required" 有何区别?



No Factor Substitution Case

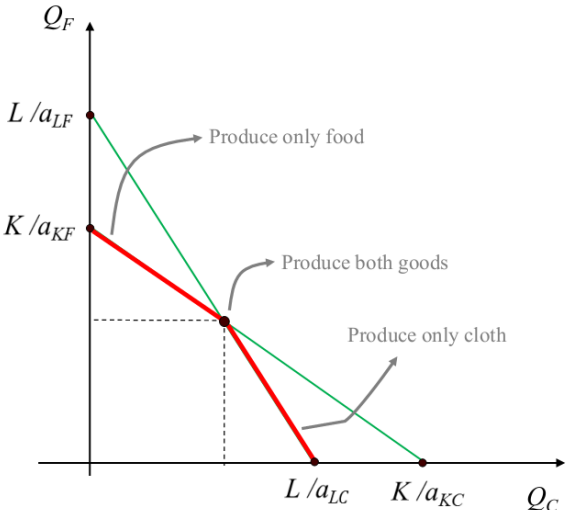
- This corresponds to the case in which unit factor usages are constants
- Capital- Intensity: **Food is capital - intensive relative to clothing** whenever $a_{KF}/a_{LF} > a_{KC}/a_{LC}$
- Note that we can write the resource constraints as 资源约束方程的变形

$$Q_F \leq K/a_{KF} - (a_{KC}/a_{KF})Q_C$$

$$Q_F \leq L/a_{LF} - (a_{LC}/a_{LF})Q_C$$

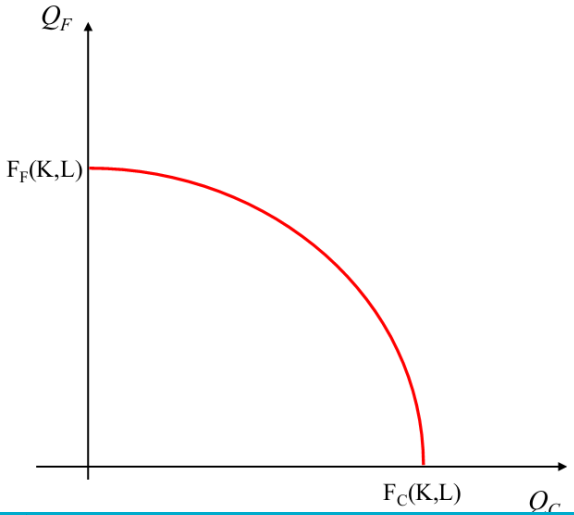
PPF with No Factor Substitution

- The production possibility frontier is then the interior of two factor constraints
- Note that the opportunity cost of producing cloth, in terms of food, is higher when more food is produced
- PPF 的边界：斜率是棉布对粮食的的机会成本，它是可变的



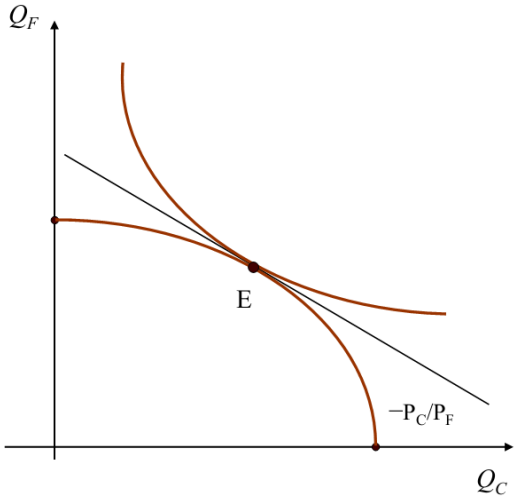
PPF with Factor Substitution

- Factor substitution smoothens out the production possibility frontier
- 那么该国的生产点将在哪里确定呢?
- 产出价值最大化的点



Sketch of General Equilibrium

- The equilibrium autarky relative price P_C/P_F will be such that the slope of the PPF equals the "social" marginal rate of substitution
- For common homothetic preferences across countries, comparative advantage will be determined by differences in the shape of the PPF



Road Map

- I have always said that there **4 theorems** in the framework of HO. All of them can be derived in an Autarky Economy, though HO theory is a stylized trade(open) model. 四大定理
- The key is that trade will change domestic price 贸易的原因是两国存在价格差，也就是说贸易之后会改变初始的国内价格
- Firstly I would discuss the relationship between factor endowment and relative prices under autarky at the cost of some elegance.
- It was induced by the following questions:
  - How do relative factor endowments affect the shape of the PPF and relative prices under autarky?
  - How does international trade affect each of the two factors of production?
- The answer to them is **Rybczynski Theorem**

Outline

Factor Endowments and Output Levels

- Output levels have to be consistent with **factor market clearing**

$$Q_C \cdot a_{KC} + Q_F \cdot a_{KF} = K$$

$$Q_C \cdot a_{LC} + Q_F \cdot a_{LF} = L$$

- We can write this as

$$\frac{a_{KC} + (Q_F/Q_C) \cdot a_{KF}}{a_{LC} + (Q_F/Q_C) \cdot a_{LF}} = \frac{K}{L}$$

- What happens to Q_C and Q_F when K/L increases?
- Suppose first there is no factor substitution（假设不存在要素间的替代）, so that unit factor requirements are constant
- Then note that Q_F/Q_C has to increase (remember $a_{KF}/a_{LF} > a_{KC}/a_{LC}$)

Rybczynski Theorem

定理

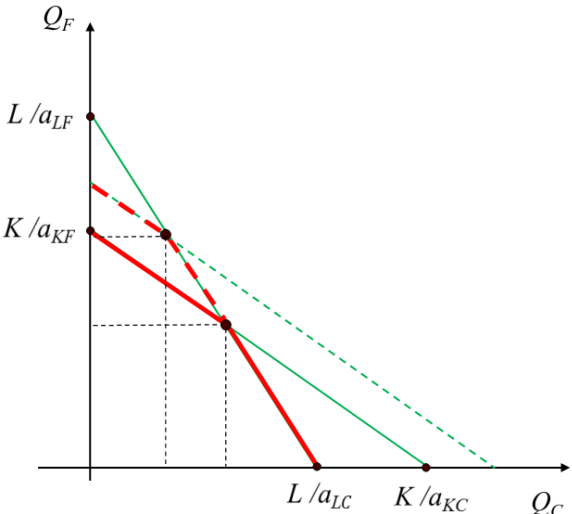
Rybczynski Theorem: *An increase in a factor endowment will increase output in the sector that uses that factor intensively, and will decrease output in the other sector*

推论

Other things equal, a country with a high capital - to - labor ratio will produce a high ratio of food to cloth

Rybczynski Theorem: Graphical Illustration

- An increase in capital increases the production of food but decreases the production of cloth

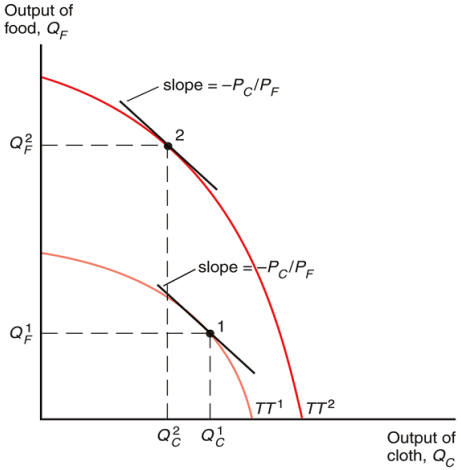


Rybczynski and Factor Substitution 如果要素可以互相替代会怎样?

- The theorem generalizes to the case of factor substitution provided that goods prices are held fixed when changing factor endowments 如果考察要素之间可以替代的情况（PPF 变成平滑曲线），如果产品价格不变，则以上定理仍然成立。因为：
- Rough intuition:
  1. Unit factor usages then depend on factor prices, but if goods' prices are held fixed, factor prices are fixed too (more on this later) 稍后会讲产品价格和要素价格是映射关系
  2. So if goods prices are fixed, so are a_{KF} , a_{LF} , a_{KC}, a_{LC}
  3. Therefore the above derivations still apply
  4. 下面我们通过一个图来证明这一点

Graphical Illustration

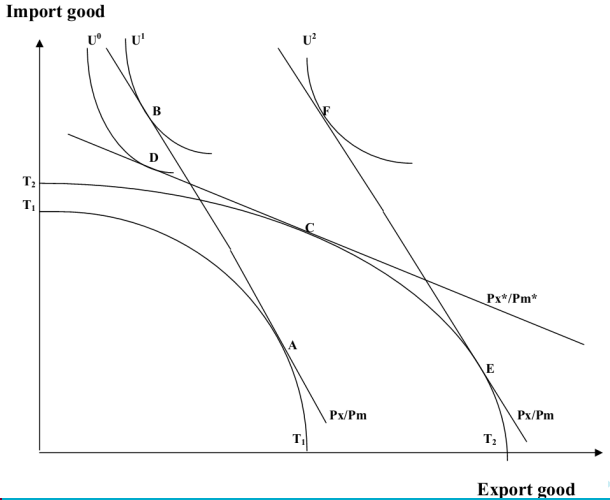
- An increase in capital leads to a disproportionate expansion of the PPF
- In the graph, the price ratio P_C/P_F remains fixed, but changes in relative factor endowments **will affect these prices** in general equilibrium
- Why? Points 1 and 2 cannot both be equilibria with homothetic preferences
- Rybczynski 定理往前一步是深渊



Extension of Rybczyski Theorem: Immiserizing Growth and Dutch Disease

- ***Bhagwati-Prebish immiserizing growth***贫困化增长: If developing countries exporting raw materials have export biased growth while, at the same time, richer countries replace these raw materials by cheaper synthetic products (a decrease in demand), these developing countries could suffer from "immiserizing growth".
- **Dutch disease**荷兰病: the apparent relationship between the increase in the economic development of natural resources and a decline in the manufacturing sector (or agriculture).

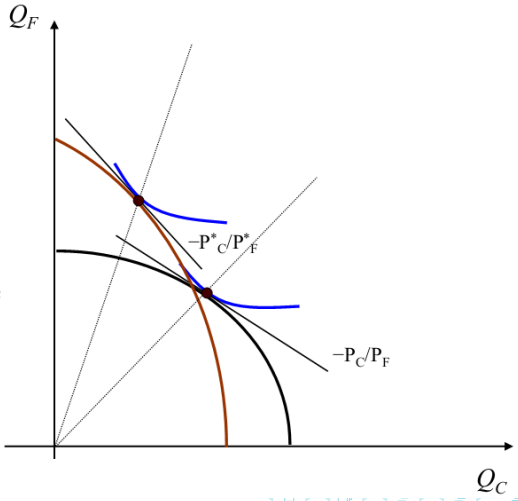
Graphical Illustration



Outline

Autarky Equilibrium

- Assume identical homothetic preferences in both countries
- If Foreign is capital -abundant relative to Home, then Foreign will produce a disproportionate amount of food, and will have a higher relative price of cloth P_C/P_F in autarky



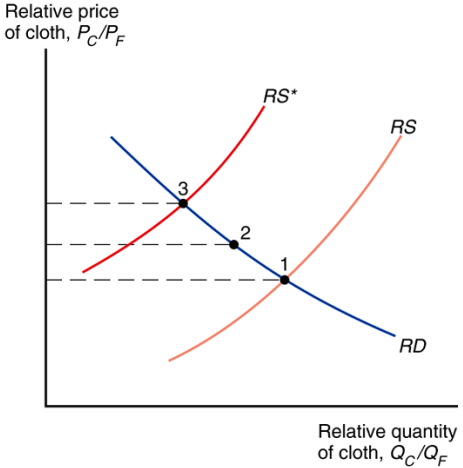
Trade in the Heckscher-Ohlin Model

- Suppose there are two countries in the world: Home and Foreign
- Assume that **Home is relatively abundant in labor and Foreign is relatively abundant in capital**: $L/K > L^*/K^*$
- 根据 Rybczyski 定理的推论：$Q_C/Q_F > Q_C^*/Q_F^*$
- The countries are assumed to have the same technology and same consumer tastes
- we know that the autarky relative price P_C/P_F of cloth (the labor-intensive good) is lower at Home than in Foreign:

$$P_C/P_F < P_C^*/P_F^*$$

Graphical Illustration

- 为什么本国的衣服的相对供给高于外国的，因为本国是劳动力丰裕的，因此劳动力相对便宜，而衣服又密集使用劳动，在同样的衣服（相对）价格下，本国的产量更高
- Note that at a common relative price P_C/P_F , Home would feature a larger relative supply of cloth vs. food
- Trade will lead to a convergence of relative prices (move to point 2 in the graph) 贸易会导致产品价格一致
- So P_C/P_F goes up at Home and falls in Foreign
- Also, at point 2, Home has RS $>$ RD, while Foreign has RS * $<$ RD *



Heckscher-Ohlin Theorem

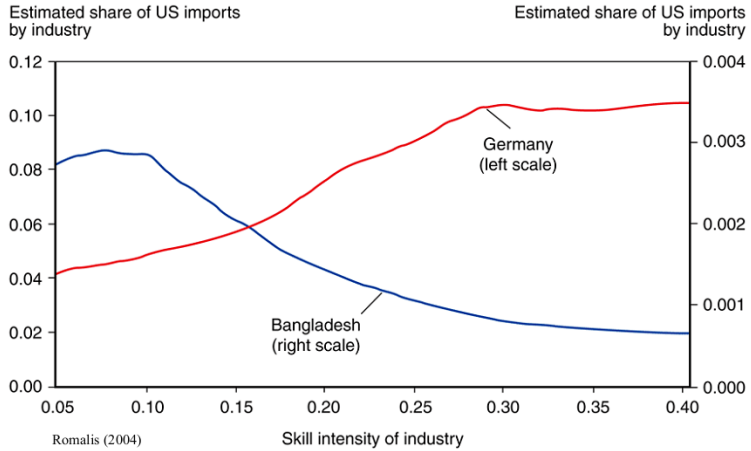
定理

Heckscher-Ohlin Theorem: *an economy will export the good that is intensive in its abundant factor of production and will import the good that is intensive in its scarce factor of production*

- Home (which is labor- abundant) exports the labor -intensive good (cloth) and imports the capital-intensive good (food)
- Foreign (which is capital - abundant) exports the capital - intensive good (food) and imports the labor -intensive good (cloth)

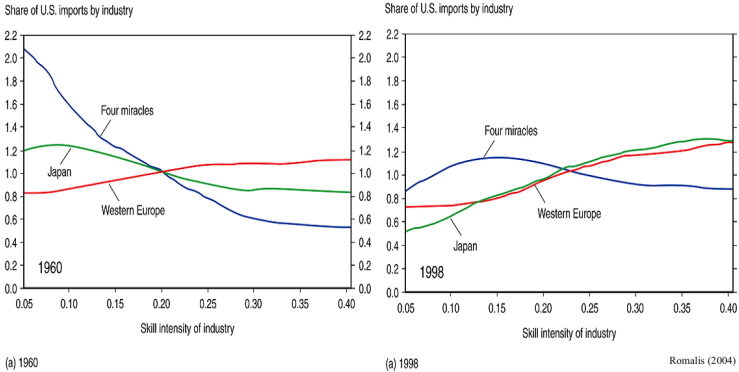
A Heckscher-Ohlin Effect

Skill Intensity and the Pattern of 1998 U.S. Imports from Two Countries



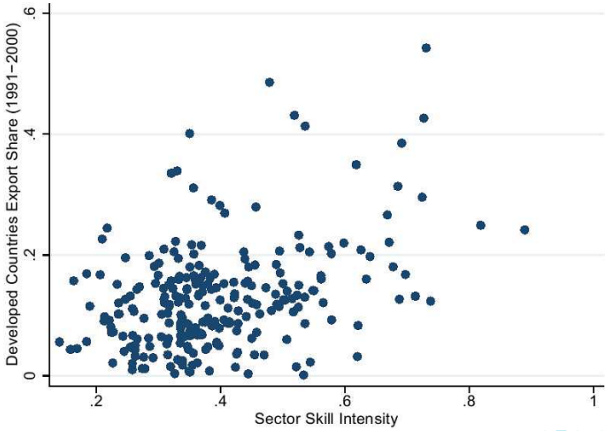
Romalis (2004)

A Rybczynski Effect



Further Evidence on Specialization

- Further Evidence on Specialization



factor content of trade

- the above evidence suggests that countries tend to export disproportionate amounts in industries that use intensively their abundant factor HO 定理的预测基本正确的，但是由于它是建立在两要素基础上的（因为密集度需要两两比较），现实中又有多种要素，HO 定理在多要素多产品情况下是否还准确?
- But the Heckscher- Ohlin theorem does not generalize in a simple way to multi - sector, multi - country setups
- An alternative is to look at the factor content of trade:
  - Compute the value of factor services embodied in the volume of exports and imports

推论

Robust prediction: *a country should be a net exporter of the services of its abundant factor*

Factor Content of Trade Approach

定理 (HOV 定理 (一般了解，不要求掌握))

$$AT^i = V^i - s^i V^w \tag{1}$$

- Perhaps the theory does not offer sharp predictions for exactly which goods (depending on their factor intensity) will a country export
- But if a country is abundantly endowed with, say, physical capital, the average physical capital intensity of its exports should be relatively high
- When computing the capital services embodied in the country′ s exports and imports, the theory predicts that one should then find positive net exports of capital services for that country

Leontief paradox

- Using U.S. data, W. Leontief 诺奖之师 found that US exports were less capital - intensive than US imports, even though the US was the most capital -abundant country in the world
  - Replicated by Baldwin in 1971 for the year 1962
- This is known as the **Leontief paradox**.

TABLE 4-2 Factor Content of U.S. Exports and Imports for 1962

	Imports	Exports
Capital per million dollars	$2,132,000	$1,876,000
Labor (person-years) per million dollars	119	131
Capital-labor ratio (dollars per worker)	$17,916	$14,321
Average years of education per worker	9.9	10.1
Proportion of engineers and scientists in work force	0.0189	0.0255

Source: Robert Baldwin, "Determinants of the Commodity Structure of U.S. Trade," *American Economic Review* 61 (March 1971), pp. 126–145.

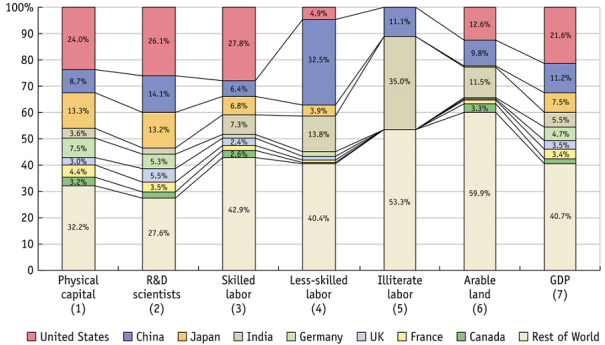
Some Explanation for Leontief Paradox

- Several explanations have been offered for the Leontief paradox:
  1. The Heckscher- Ohlin model is at **odds with the data**
  2. **Human Capital**: Leontief' s numbers suggest that the U.S. might be more skilled - labor abundant than capital abundant
  3. The U.S. was running a large trade surplus at that point; when correcting for it, the paradox disappears
  4. **Natrual Resource**: Leontief just discriminate labor and capital by omitting the other resources, such as land, mineral etc. Probably the contributions of them were combined into labor
  5. **factor-intensity reversals**: the else world use distinct porportion of capital and lobor, rather than the US's
  6. Leontief 使用了美国的 IO 表，即假定国家之间的技术相同，这个问题该如何对待?

Factor Content of Trade Studies: Bowen et. al.'s intelligence

- Bowen, Leamer, Sveikauskas (1987) showed how this test can be extended to multiple factors and countries
- Same idea as the Leontief test but must use a **common benchmark** to compare factor abundance across countries 如何确定一国是否在某种要素上丰裕，需要一个共同的标准。
- If consumers around the world share the same homothetic preferences, then the country′ s share of world income (GDP) is the correct comparison benchmark 选用该国 GDP 占全球比重作为标准。
- For each factor and country, compute that country′ s endowment of the factor as a share of the world endowment
- If that share is greater than the country′ s share of world income, then H -O model predicts that the country will be a net exporter of that factor

Empirical Measures of Factor Abundance



- U.S. and Japan should be large net exporters of capital and R&D scientists, and China and India should be large net exporters of unskilled labor (**but note China abundant in R&D scientists**!)
- 我们把以上问题称为要素禀赋之谜，要想打开这个悖论，就要对要素做生产率调整，这等于是革了 HO 模型的命！我们稍后继续。

Factor Content of Trade Studies (cted)

- Using data for more countries, Bowen, Leamer, and Sveikauskas (1987) found equally devastating results for the model
- Model does not do much better than a coin toss at predicting the sign of net factor exports

TABLE 5-3 Testing the Heckscher-Ohlin Model

Factor of Production	Predictive Success*
Capital	0.52
Labor	0.67
Professional workers	0.78
Managerial workers	0.22
Clerical workers	0.59
Sales workers	0.67
Service workers	0.67
Agricultural workers	0.63
Production workers	0.70
Arable land	0.70
Pasture land	0.52
Forest	0.70

*Fraction of countries for which net exports of factor runs in predicted direction.

Predictions for Trade Volumes

- H -O model predicts that the volume of trade will be larger the bigger are differences between countries in relative factor abundance (holding country size constant) 国家要素禀赋差异越大，则价格差越大，从而引起的双边贸易规模会更大。
- This empirical prediction performs miserably in great part because rich countries with similar factor abundance engage in a high proportion of overall world trade
- Part of the failure also has to do with geography/trade frictions, non-homothetic preferences and, especially, technological differences across countries
- 至此，窟窿被越捅越大

Another Disease: Missing Trade Paradox

- Trefler (1995) showed that the negative results of the factor content of trade studies are not surprising because the observed volumes of net factor trade are very small he labelled this "The Case of the Missing Trade" 消失的贸易之谜
- Trefler' s own explanation for the fact is that technologies are very different across countries
- **Intuition**: labor in rich countries is much more productive than labor in poor countries
- So relative factor endowment differences in "efficiency units" are lower (less room for arbitrage through trade)

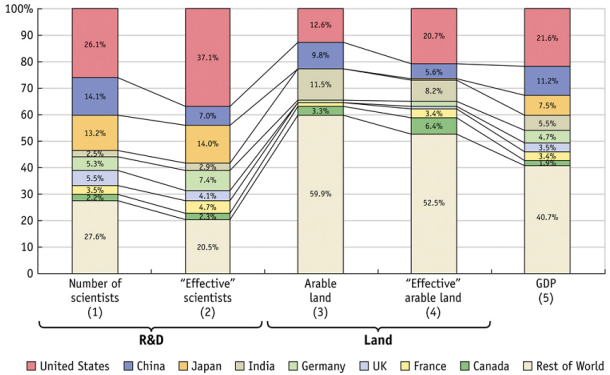
Saving the Model

TABLE 5-4 Estimated Technological Efficiency, 1983 (United States = 1)

Country	
Bangladesh	0.03
Thailand	0.17
Hong Kong	0.40
Japan	0.70
West Germany	0.78

Source: Daniel Trefler, "The Care of the Missing Trade and Other Mysteries," *American Economic Review* 85 (December 1995), pp. 1029–1046.

Efficiency- Adjusted Factor Endowments



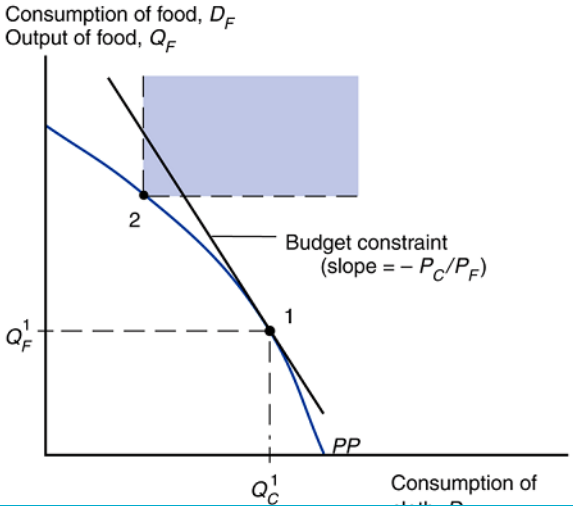
- Now China is no longer abundant in R&D workers, and US is no longer very scarce in Arable Land.

Saving the Model (cont.)

- Trefler (1993) also showed that introducing country -specific (not good- specific) technology differences across countries improves the fit of the model by a lot
- In particular, he repeated the Bowen, Leamer, and Sveikauskas (1987) tests and found much better results
- And introducing country/factor- specific technology, one can ensure that the model fits the data perfectly well!

Gains From Trade

- As in the previous models, if the economy admits a representative consumer...
- ...this consumer is made better off
- Or, in other words, aggregate real income goes up with trade



Outline

Distributional Effects of Trade

- But some agents in the economy may not gain from trade (unless trade opening is accompanied by redistribution)
- Can we **identify** who may lose from trade?
- Under which conditions will some agents lose from trade?
- To answer these questions we need to take a closer look at **the link between factor prices and goods prices**

Factor Prices and Goods Prices

- Under perfect competition, prices equal unit costs:

$$P_C = r \cdot a_{KC} + w \cdot a_{LC}$$

$$P_F = r \cdot a_{KF} + w \cdot a_{LF}$$

- Suppose that P_C/P_F increases. What happens to w and r ?
- It can be shown that w/r increases whenever $a_{KF}/a_{LF} > a_{KC}/a_{LC}$, that is when food is capital intensive relative to cloth
- For the case with no factor substitution, this follows from

$$\frac{P_C}{P_F} = \frac{a_{KC} + (w/r) \cdot a_{LC}}{a_{KF} + (w/r) \cdot a_{LF}}$$

  - and simply note that the right -hand - side increases in w/r whenever $a_{KF}/a_{LF} > a_{KC}/a_{LC}$ (which is true because food is capital - intensive)

Stolper -Samuelson Theorem

- But as in the case of the Rybczynski Theorem, we can actually say more than that w/r increases in P_C/P_F

定理

Stolper-Samuelson Theorem *: An increase in the relative price of a good will increase the real return to the factor used intensively in the production of that good, and will decrease the real return to the other factor*

- Because trade reduces the relative price of the good that uses the scarce factor intensively, owners of the scarce factor necessarily lose from trade

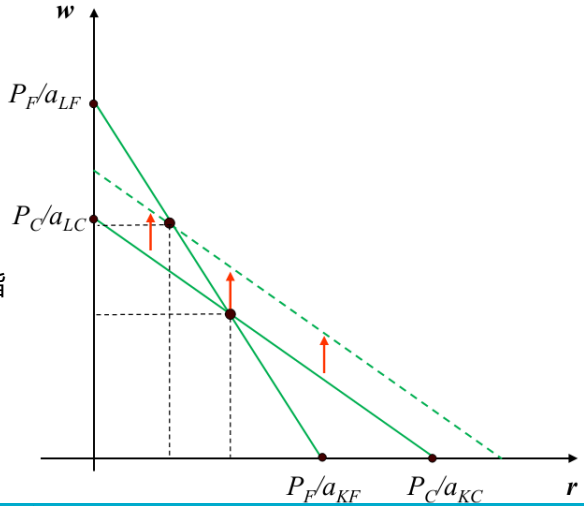
Graphical Illustration

- Note that we can write the zero -profit conditions as:

$$w = P_C/a_{LC} - (a_{KC}/a_{LC})r$$

$$w = P_F/a_{LF} - (a_{KF}/a_{LF})r$$

- Suppose P_C goes up while P_F remains fixed
- Clearly r/P_C and r/P_F both decrease 这两个指标是什么含义?
- Note that not only w/P_F but also w/P_C increases
- 还存在着放大效应，因为工资上升的幅度要大于产品价格上升的幅度



Outline

Factor Price Convergence

- Under autarky, countries have low relative prices for the good that uses intensively their abundant factor
- As a result (remember Stolper- Samuelson), the real return to each country′ s abundant factor is low under autarky but increases with trade
- The converse is true for the real return to the scarce factor
- Goods- price equalization will then tend to bring about convergence in factor prices
  - Trade increases the demand for goods produced by abundant factors, ***indirectly*** increasing the demand for the abundant factors themselves, and thus raising the rewards to these abundant factors

Factor Price Equalization

- Paul Samuelson was the first to notice that the model predicts more than factor price convergence
- When both countries produce both goods and trade is free, both countries will end up with the same factor prices!
- Sketch of proof:

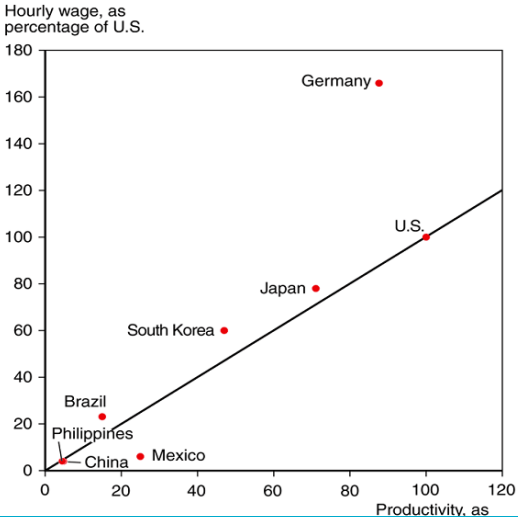
$$P_C = r a_{KC} + w a_{LC}$$

$$P_F = r a_{KF} + w a_{LF}$$

- For common prices P_C and P_F , there is a unique solution for w and r

Factor Price Equalization (cted.)

- Do we see factor price equalization in the real world?
- Of course not! Remember graph from previous Lecture.



Failure of Factor Price Equalization

TABLE 5-1 Comparative International Wage Rates (United States = 100)

Country	Hourly Compensation of Production Workers, 2005
United States	100
Germany	140
Japan	92
Spain	75
South Korea	57
Portugal	31
Mexico	11
China*	3

*2004

Source: Bureau of Labor Statistics, *Foreign Labor Statistics Home Page.*

Potential Reasons for Failure of FPE

- Trade is not free
- There are technological differences across countries
- Factor endowment differences are so large that countries do not produce a common set of goods
- Limited mobility of factors across sectors can also lead to failure of FPE (specific - factors model)

Plan for next week

- Increasing Returns to Scale and Monopolistic Competition.
- Lectures:
  - Increasing Returns (I): Motivating Examples and External Economies of Scale.
  - Increasing Returns (II): Internal Economies of Scale, Imperfect Competition and Trade Structure.
  - Increasing Returns (III): Oligopoly and Reciprocal Dumping
- Readings:
  - K-O-M Chapter 8
  - F-T Chapter 6