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An Empirical Studies of the Heckscher-Ohlin Model

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Abstract:

Eli Heckscher (1919) and Bertil Ohlin (1933) found the basis for crucial and substantial theoretical developments of international trade by emphasizing the relationships between the composition of countries' factor endowments and commodity trade patterns. The Heckscher-Ohlin (H-O) theory is the simplest explanation for why countries involve in trade of goods and services with other countries. Heckscher-Ohlin model, which is the general equilibrium mathematical model of international trade theory, is built on the Ricardian theory of comparative advantage by making prediction on trade patterns and production of goods based on the factor endowments of nations (Learner 1995).

Keywords

International Trade, Comparative Advantage, Equilibrium, Factor Endowments, goods and services.

Introduction

The structure of the modern theory of international trade rests fundamentally upon the theory developed by Eli Heckscher and Bertil Ohlin. This theory has almost completely replaced the classical and neo-classical theories related to international trade. But it does not mean that there is some real conflict between the Hecksher-Ohlin approach and the comparative costs approach or that the former, in any way, invalidates the latter.

In fact, the Heckscher-Ohlin approach supplements the traditional approach in a powerful manner. It goes behind the comparative costs doctrine to investigate the basic cause of the relative differences in costs. Heckscher and Ohlin have traced the cause of cost differences to relative factor endowments and relative factor intensities. That is why this theory is also known as Factor- Proportions-Factor-Intensity Theory. According to this theory, countries which are rich in labour will export labour-intensive goods and those rich in capital will export capital-intensive goods.

Assumptions of the Heckscher- Ohlin Model

The following assumptions pertain to the 2*2 model of Heckscher-Ohlin. It is assumed that there are only two nations (1 and 2) with two goods for trade (X and Y) and two factors of production (capital and labour). For producing the goods, both nations use the same technology and they use uniform factors of production. In both countries, good X is labour intensive and Y is capital intensive. The tastes and preferences of both nations are the same (both countries can be represented in the same indifference curve). In both nations, the assumption of constant returns to scale is applicable for the production of goods X and Y. In both nations, specialization in production is not complete. Goods and factor markets in both nations are perfectly competitive. There exists perfect mobility of factors of production within each country though international mobility is not possible. There are no restrictions or limitations to the free flow of international trade. That is, there exist no transportation costs, tariffs, or like other obstructions either to control or to restrict the exports or imports.

It is assumed that there exists full employment of all resources in both nations. That is, there will not be any under employed resource in either nation. The exports and imports between the nations are balanced. It means that the total value of the exports will be equal to the total value of imports in both nations.

Implications of the Assumptions

The assumptions are made in order to depict the theory in a two-dimensional figure. It is also implied that both countries have access to and use the same general production techniques. The labour-capital ratio (L/K) of commodity X is higher than that of Y in both countries with the same relative prices of factors. As constant returns to scale is assumed, increase in the amount of labour and capital will result in the proportionate increase in the output also. Another implication is that though free international trade exists, both of the countries produce both commodities and it can be presumed that both

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countries are not small in size. As the tastes and preferences related to demand are identical in both countries, if the relative prices of the goods are equal, the consumption of goods X and Y will be in the same proportion in both countries. Likewise, in both countries producers, traders and consumers are too small to affect the commodity prices. Mobility of factors of production implies that capital and labour are free to move from areas or industries of lower prices (earnings) to those of higher prices (earnings) until earnings become same equal in all areas or industries. That is, price equalization theory is implied here. International differences in the earnings exist because of the factor immobility in the absence of international trade. The assumption of incomplete production specialization implies that the process of specialization in production continues until the commodity prices (either relative or absolute) prices are the same in both countries. Again, if the transportation costs, tariffs or any other restriction are allowed, specialization will continue only until price differences by less than or equal to the costs or tariffs.

The Heckscher-Ohlin Model

Heckscher-Ohlin model is generally described as two countries, two goods and two factors model (2x2x2 model). This formulation of HO model was mathematically developed by Paul Samuelson. The goal of the model is to predict the pattern of international trade in commodities between the two countries on the basis of differences in factor endowments in both the countries.

Definition: A nation exports the commodities which are produced out of its relatively abundant and cheap factors or resources and imports the commodity which is produced out of relatively scarce factors or resources. In another words, relatively labour abundant country exports relatively labour intensive commodity and imports the relatively capital-intensive commodity. Country 1 exports commodity X because X is the Labor (L) intensive commodity and L is relatively cheap and abundant factor in country 1. Country 2 exports commodity Y because Y is the Capital (K) intensive commodity and K is relatively cheap and abundant factor in country 2.

The theory implicates two things: first, different supply conditions in terms of resource endowments explain comparative advantage and second, countries export goods that use abundant and cheap factors of production and import goods that use scarce and expensive factors.

According to Heckscher-Ohlin theory, international and interregional differences in production costs occur due to the differences in the supply of factors of production. Under free trade, countries export the commodities whose production requires intensive use of abundant factors and import the commodities whose production requires the scarce factors. Hence, international trade compensates for the uneven geographic distribution of factors of production. The theory gives insight to the fact that commodities are the bundles of factors (land, labour and capital). Thus, the exchange of commodities is indirect arbitrage of factors of production and the transfer of services of otherwise immobile factors from regions where factors are abundant to regions where they are scarce.

The H-O theorem identifies the basic reason for comparative advantage and international trade as the different factor abundance or factor endowments among nations. Because of this particular reason, the theory is known as factor proportions or factor endowment theory. The theory postulates that the difference in relative factor endowment and prices is the main reason for the difference in relative commodity prices between two countries.

Factor Endowments

Factor endowment can be defined as the ratio of capital to labour (K/L). If the capital – labour ratio in country 1 is greater than in country 2, then country 1 is said to be relatively capital-abundant (and labour-scarce) while country 2 is labour abundant (and capital scarce). Symbolically, this can be represented as:

(K/L) 1 > (K/L) 2

Important implication of different factor endowments is for autarky prices of factors of production (the autarky prices are implied in the figure represented below).

For two countries with same demand patterns, relative factor prices leads to relative factor scarcities. Country 2 will have relatively inexpensive labour and country 1 is in a position to provide relatively inexpensive (abundant) capital.

Factor Intensities, Factor Abundance and Production Frontiers under H-O Model

Factor Intensity

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Commodity Y is said to be relative capital intensive and commodity X is relatively labour intensive if the capital labour ratio used in the production of Y is higher than that of the production of commodity X.

That is,

(K/L) y > (K/L) x

If the for the production of commodity Y, the country use 2K and 2L, then K/L = 1 and if the production of commodity X requires 1K and 4L, K/L=1/4. In this case, it can be said that commodity Y is capital intensity and commodity X is labour intensive. Factor intensity depends on K/L rather than the absolute amount of K and L.

At the equilibrium points, for producing the commodities, both countries choose capital-labour ration that minimize the factor costs at the prevailing relative factor prices.

The relative factor prices are represented as W=w/r where w is the price of labour and r is the price of capital. Though in principle, the factor intensities can be reversed when factor prices change. But it is assumed that this does not exist in H-O model. There is no factor intensity reversal.

Factor Abundance

Factor abundance can be defined in terms of two ways:
1) Physical Units and
2) Relative Prices of factors.

In terms of physical units, the overall amount of capital and labour available to each country is taken into consideration (that is, TK and TL). As per this definition, country 2 is capital abundant if the ratio of total amount of capital (TK) to total amount of labour available in country 2 will be greater than that in country 1. The ratio of TK/TL is important rather than total absolute amount of K and L of the countries.

Country 2 may have less capital than country 2 and still there may be the capital abundant country if TK/TL in country 2 exceeds TK/TL in country 1.

In terms of relative factor prices, country 2 is capital abundant if PK/PL is lower in country 2 than in country 1. As the price of capital is taken to be the interest rate, r and the price of labour is wage, w, then PK/PL= r/w. The ratio of r/w is important, not the absolute level of r or w, in determining whether a country is capital abundant or labour abundant. The first definition takes only the supply of factors into consideration, while the second considers both supply and demand factors.

Factor Endowments and Production Frontiers

When country 2 is capital abundant and the commodity Y is capital intensive, country 2 can produce relatively more of commodity Y than in country 1. Similarly, if country 1 is labour abundant and commodity X is labour intensive, country 1 can produce relatively more of commodity X than country 2. This situation gives a relatively flatter and wider production frontier curve for country 1 than country 2.

Diagrammatic Representation of H-O Model

The following figure represents the Heckscher-Ohlin model diagrammatically. As it is assumed, two countries have same tastes and preferences for demand, both the countries are represented in the same indifference map.

I is the highest indifference curve that country 1 and country 2 can achieve separately in the absence of international trade. The points A and A/ represent equality of production and consumption of both countries in the absence of trade. The tangency points of A and A/ determine the no-trade equilibrium prices of PA and PA/ in country 1 and country 2 respectively.

When PA < PA/,

Country 1 has comparative advantage in the production of commodity X and country 2 has comparative advantage in commodity Y.

The right side of the figure shows that country 1 specializes in commodity X and Country 2 in commodity Y when both countries involve in international trade.

Specialization proceeds at point where country 1 achieves the point B and country 2 reaches at point B/. At these points transformation curves are tangent to the common relative price line of PB.

Country 1 exports commodity X in exchange for commodity Y and consumes at point E on the second indifference curve (IC II). Likewise, country 2

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exports commodity Y in exchange for commodity X and the relative equilibrium point of country 2 is point E/ which coincides with point E.

In this context, it is important to note that country 1's exports of commodity X equal country 2's imports of commodity X (that is, BC=C/B/). Similarly, country 2's exports of commodity Y equal country 1's imports of commodity Y (that is, B/C/= CE).

When,

PX/PY>PB,

Country 1 wants to export more of commodity X than country 2 is able to import at this high relative price, and PX/PY tends to diminish to PB, which is equilibrium and normal price. Likewise, when PX/PY< PB, country 1 is in a position to export less of commodity X than country 2 desires to import at this low relative price and gradually, PX/PY tends to rise towards PB.

At point E, more of commodity Y and less of commodity X than at the point A are involved. However, country 1 will gain from international trade because E lies on higher indifference curve (IC II). Similarly, though at E/ more commodity of X and less commodity of Y are involved compared to the point of A/, country 2 gains from the trade because E/ lies on higher indifference curve, IC II.

Propositions of H-O theorem and other empirical Studies

As a connotation of H-O theorem, three other prepositions or theorems are associated:

1) Factor price equalization theorem
2) 2) Stopler-Samuelson theorem and
3) 3) the Rybcsynski Theorem (Jone 2002).

The Factor Price Equalization Theorem

Even though the national frontiers rule out the international mobility of factors, free trade in commodities leads to reduce the disparities in demand relative to supply of factor and thus to decrease the disparities in factor returns among different countries. International free trade leads to sharing of same technology by different countries and bringing of equality of factor returns if the factor endowments are similar and sufficient quantity of commodities are produced commonly (Samuelson 1992).

The Stolper- Samuelson Theorem

Changes in relative commodity prices as brought by free international trade have strong effects on the factor prices or rewards. If there is no joint production, some factors may raise their rewards uncontrollably and other rewards may be lowered unambiguously. If the number of factors equals the number of commodities and production is non-joint, the relative changes in commodity prices will raise the price of any particular factor (Uekawa, 1971).

The Rybczynski Theorem

If there is unbalanced growth in factor supplies, it may lead to stronger asymmetric changes in outputs also. If the quantity of factors of production and commodities are evenly matched and production is non-joint, this pattern of asymmetry may pertain to growth in some factors of production (if there is given commodity prices) and may lead to the reduction of outputs.

Empirical Legitimacy and Leontief's Investigation

Leontief (1953) was the first to confront the Heckscher-Ohlin model with empirical investigation. He had developed a set of data in the frame of input-output accounts for the U.S economy and he computed the amounts of labour and capital used in each industry for 1947. Likewise, he made use of U S trade data for the same year to compute the factors of production (labour and capital) used in the production of $1 million of US exports and imports.

Table 1
Leontief Test (1953)

Capital ($million)	Labor (Person-years)	Capital/labour ($/person)
$2.5	182	$13,700
$3.1	170	$18,200

Each column of the table shows the amount of labour and capital required to occur $1 million worth of international trade (exports or imports) to United States in the year 1947.

Firstly Leontief measured the capital and labour required for the exports from US. This estimation required the labour and capital used in each and every exporting industry and from the first row of the table, it is seen that $2.5 worth of capital was used to

export worth of $1million. For labour, 182 person-years were used to produce the same exports.

Taking the ratio of labour and capital, it can be said as in the third row of the table, each labourer is working with $13,700 worth of capital. Turning to the import side of the calculation, there emerged a problem non-availability of data on foreign technology. Still Leontif managed to estimate the model assuming that same technology of US used in imports. The estimation on imports (i.e., $3.1 million of capital, 170 person- years and capital-labour ratio as $18,000) indicates that capital labour ratio of imports is higher than that of US exports. But US economy is found in 1956 as capital-abundant and this appears to contradict the H-O theorem. Thus the findings of Leontief came to be called as "Leontief Paradox" (Learner 1995).

Under the framework of H-O theorem, many explanations have been proposed for the existence of this paradox.

U S and foreign technologies are not same unlike the assumption of H-O theorem.

The year 1947 was not usual year as World War II has just ended

As H-O model assumes, the U S was not engaged in free trade.

Other Empirical Estimations of H-O model

By examining the limitations of Leontief 's estimation, Bowen, Leamer and Sveikauskas (1987) estimated the H-O model by using data on a large number of countries. It was estimated to check whether countries are net exporters of the factors of production (which are relatively abundant) as factors of production are indirectly embodied in the trade. Cline (1997) suggested a more generalized H-O model by taking into account more and disaggregated factors of production. It was recognized that factor endowments change over a period of time as the investment and technological advances occur.

Concluding Remarks

H-O theorem has been vehemently criticized on many grounds including in terms of its basic assumptions. Some empirical studies even questioned the validity of the theory. Despite of the many criticisms and drawbacks, H-O theory has its own merits and contributions in the theoretical history of international trade.

By taking both commodity and factor prices into consideration, H-O theory provides a more and satisfactory explanation of international trade.

In comparative cost theory of David Ricardo, it was pointed that comparative cost difference is the basis for international trade. But H-O theorem better explains the reasons for these cost differences in terms of factor endowments. The price equalization principle, a concomitant of H-O theorem comprehensively explains the situation which is of course, superior to the previous theories of international trade.

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