CHAPTER 1

INTRODUCTION

The reason for the enduring appeal of the Heckscher-Ohlin-Samuelson\(^1\) model can be summarized in Johnson's words, "the purpose of theory is to abstract from the complexity of the real world a simplified model of the key relationships between the dependent and independent variables, and to explore the positive and normative implications of changes in the "given" of this hypothetical system"\(^2\). Although the truncated 2x2x2 model abstracted from the whole array of issues originally raised by Heckscher and Ohlin, from a theoretical viewpoint it made possible logical deductions between the factor endowments and the pattern of trade\(^3\) on the one hand, and its extension into the factor price equalization theorem\(^4\) on the other. For these relationships to hold irrevocably meant ruling out the other causes of trade—differences in production, consumption and technology. In the factor proportions model this is accomplished through three sets of assumptions—1. Competitive markets, perfect mobility of goods and perfect internal mobility of

\(^3\) Trade refers to the exchange of goods and services between countries.
\(^4\) Factor price equalization theorem is a key result in international trade theory, stating that factor prices will equalize across countries in the long run.
factors. 2. Technological differences are ruled out through the assumption of identical production functions exhibiting constant returns to scale in all trading countries. 3. Differences in consumption cannot cause trade through the assumption of identical demand functions in the trading countries with unit elasticity for all consumption goods.

To the extent that these assumptions are realistic or are at least insignificant, the explanatory power of the hypothesis remains unimpaired. The real test, of course, is that it stand up to empirical verification. In the case of the Heckscher-Ohlin-Samuelson model, questions regarding its validity first appeared following Leontief's study of the structure of U.S. trade pattern. Contrary to the factor proportions hypothesis, his results showed that the U.S. export industries were more labor-intensive than their import-competing counterparts. Similar studies for a host of countries—Japan, Germany and Canada—also gave paradoxical results. Estimates of labor and capital requirements for these countries showed that their exports were capital-intensive despite the fact that the U.S. was their principal trading partner.
More recently, empirical tests of the factor proportions hypothesis by Baldwin\textsuperscript{9}, Branson and Junz\textsuperscript{10} and Hufbauer\textsuperscript{11} confirm Leontief's earlier results. Using 1958 input-output coefficients to estimate the capital-labor requirements for U.S. trade in 1962, Baldwin\textsuperscript{12} shows that the ratio of capital per man is higher in the import-competing industries relative to the exporting industries. Further, his multiple regression results show that although capital-labor ratio explains trade best (among independent variables such as skill, scale, first date of production), it has a negative sign--exports decline with an increase in the capital-labor ratio--that is inconsistent with the predicted pattern. Similarly, Branson and Junz\textsuperscript{13} find a statistically significant negative correlation between physical capital and net U.S. exports in 1964 and in 1967. At a bilateral level, U.S. exports to W. Europe and Japan turn out to be capital-intensive, albeit at statistically insignificant levels. In a broader analysis, Hufbauer\textsuperscript{14} tests the factor proportions theory alongside six other competing trade explanations for 14 countries. His correlation between capital embodied in exports and endowment of fixed capital per man is fairly strong and positive. However, at the disaggregative level, Japan and Germany yield inconsistent results--with Japanese exports relatively capital-intensive and the German exports labor-intensive in production.
These adverse findings have cast varying degrees of doubt on the factor proportions model. In a reexamination of its assumptions one of the areas of major focus has been to include human capital in addition to the two factors, physical capital and 'raw' labor. This approach differs from the original in that labor is not considered a homogeneous mass, but consists of workers with differing productivities depending upon the amount of human capital inhered in them. The total stock of labor therefore includes raw labor (without training) and trained workers whose productivity differences have been appropriately adjusted. Using this argument to contend that American labor is more productive than labor elsewhere, Leontief inflated the U.S. labor supply by a factor of three. With this procedure the U.S. emerges a labor abundant country, hence an exporter of labor-intensive goods. An alternative approach has been to isolate human capital from labor and amalgamate it with physical capital. In this case the U.S. turns out to be both 'capital' (physical plus human capital) abundant and an exporter of capital-intensive goods. Thus, an important aspect of introducing human capital in the factor proportions model is that irrespective of whether it is aggregated with raw labor or physical capital, the paradox is resolved. This has lead to the belief that initial adverse findings do not refute the factor proportions
theory, as many have argued, but call for a restatement of the assumption of the two factors, 'raw' labor and physical capital, to include a third factor, human capital.

SECTION I

HUMAN CAPITAL AND THE STRUCTURE OF TRADE

In the empirical literature where human capital has been explicitly introduced the focus has been on two questions. First, does this procedure help in reversing the earlier paradoxical findings. Secondly, how important is it as an explanatory variable.

In his study Kenen introduces human capital as an additional factor and postulates that wage differentials among occupational categories reflect the returns on varying amounts of capital invested in labor. He estimates the amount of human capital for U.S. exports and import-competing industries by discounting the mean average wage for five occupational categories net of the unskilled wage rate. His results show that the content of human capital in the export industries is greater than the import-competing industries. Further, when human and physical capital are amalgamated the paradox disappears at a 9% rate of return. In a similar study, Kenen and Yudin show
that the paradox is resolved at the 9% and 11% rates of return, but persists at the 12.7% rate.

Rokamp and Mcmeekin are able to reverse the paradox by introducing human capital in the case of West Germany. Using factor incomes instead of physical input of capital and labor, they average the wage rates for 55 industries. Human capital is defined as labor earning excess of a 'minimum' wage rate. When the minimum wage rate is set at the lowest wage, that of untrained labor, then all labor earning more than this level comprises human capital. On the other hand, when the minimum wage is set at the highest wage, then there is no human capital. The authors show that at the lowest minimum wage rate German exports turn out to be capital-intensive (defined as physical plus human capital), while at the highest minimum wage rate they turn out to be labor-intensive indicating that inclusion of human capital affects the results decisively.

In a similar study for India, Bhagwati and Bharadwaj uphold their earlier findings in favor of the factor proportions theory. They use the wage-discount approach to estimate human capital requirements for average Indian exports. After factor intensities are adjusted by adding human and physical capital together, Indian exports continue to be
labor-intensive.

Baldwin estimates several indices such as average earnings, cost of education and the average years of schooling for U.S. exports and import-competing industries in 1962 to capture the effect of human capital on trade pattern. Each of these three indices show higher human capital content in exports compared with competing imports. However, when physical capital and the average cost of schooling are added together as a measure of 'total' capital, its ratio to raw labor is greater in the import-competing industries relative to the exporting industries—upholding Leontief's results. Baldwin ascribes this to the high content of capital-intensive natural resource imports to the U.S. Exclusion of these industries does indeed reverse the paradox.

Using the wage-discount approach to estimate human capital, Branson shows that there exists a positive correlation between human capital and net U.S. exports on the one hand, and between physical and human capital on the other. Thus, industries intensive in physical capital are also intensive in the use of human capital. Although the U.S. is abundant in physical capital it is perhaps even better endowed with human skills, which explains its trading pattern. The importance of human capital in U.S. exports is reinforced by
his regression analysis which uses physical and human
capital as separate factors (alongside other variables
such as scale, and the first date of trade). Human
capital shows a significant positive sign, while
physical capital shows a negative correlation with
exports.\textsuperscript{23}

Keesing\textsuperscript{24} deviates from the single country approach
outlined above, to develop a multicountry framework
to explore the role of occupational skills in
explaining trade in manufactures. Focusing solely on
skills, he posits that a skill abundant country
exports skill-intensive goods and vice versa when skills
are scarce. He divides the labor force into eight
occupational categories\textsuperscript{25} to compute the
percentage requirements of these skills in 46 industries
in the U.S. in 1962. These skill requirements are then
used to derive the occupational distribution of labor in
the export and import-competing industries in 14
countries. Ranking of each country's exports and
imports by the skill-index\textsuperscript{26} gives a symmetric negative
correlation—countries with high skill-index for
exports have a low skill-index for imports. It implies
that countries exporting skill-intensive goods tend
to import less skill-intensive goods. Although
Keesing does not attempt to estimate relative abundance
of skills in these countries, he sees these results as a
confirmation of his skill hypothesis.
Waehrer\textsuperscript{27} extends the skill hypothesis to explain Kravis'\textsuperscript{28} earlier result—that the U.S. export industries tend to pay higher wages than the import-competing industries. She contends that inter-industry differences in skills are the result of differential investment in training, returns to which are reflected in the differences in wages among industries. Hence, the high content of skill in U.S. exports explains their higher wages relative to imports. Her regression results show a positive relation between wages and the occupational index\textsuperscript{29} confirming the first part of her hypothesis. Further, separate regressions of wages and the occupational index with the net trade balance yield a positive relation in both cases, albeit with a higher coefficient and r-square for the occupational index than for wages. Waehrer therefore concludes that skills offer a better explanation of the trade pattern than wages.

In a cross country study Merle Yahr\textsuperscript{30} explains the commodity composition of trade in terms of differences in the endowment of skills among countries. Assuming that skills are abundant in the developed countries and scarce in LDCs, Yahr shows that the latter group of countries choose an output-mix that tends to conserve skills. Developed countries, on the other hand, choose an output-mix that uses skills
intensively. Using Waehrer's result—a positive relationship between wages and skills—she divides a sample of 13 industries into 'high' and 'low' skills on the basis of their national average wages—industries with wages below the national average are classified 'low' while those with wages above the average are classified as 'high'. Using the Harbison index as a proxy for labor quality in each country, Yahr postulates a negative relation between 'low' industries and the labor quality-index and vice versa for 'high' industries. Her cross-country regressions separately of labor quality with skills (ratio of each industry's employees to total labor) and value added (the share of each industry in total output) bear out her hypothesis. Her results show a statistically significant positive relation between 'high' skill industries for both value added and the employment ratio, and a negative relation in the case of 'low' industries.

Baldwin shows that in the U.S. the percentage of labor with higher education and professional expertise is greater in exports than in imports. This is also true for the distribution of labor by years of schooling. For instance, labor with less than 8 years of schooling is greater in the import-competing industries compared with the export industries and vice versa for more than 8 years of
schooling. Similarly, Branson\textsuperscript{33} and Hufbauer\textsuperscript{34} also get results confirming the skill explanation.

\textbf{SECTION II}

\textbf{APPROACH TO INVESTMENT IN HUMAN CAPITAL}

Until the seminal work of Schultz\textsuperscript{35}, Becker\textsuperscript{36} and Mincer\textsuperscript{37} labor was visualized in terms of a homogeneous mass. Each person was considered endowed with an equal capacity to work such that qualitative differences arising from innate or acquired knowledge were disregarded. The important contribution of human capital theory is the establishment of a relationship between training and labor productivity, on the one hand, and between labor productivity and earnings on the other. At the time of entry into the labor force the productivity of labor is equal to his genetic endowment. In the absence of training, this level remains constant\textsuperscript{38} and fetches a constant wage rate competitively determined. On the other hand, investment in training increases labor productivity over time and raises income correspondingly. During the period of investment the individual bears the costs of training which lowers his current income and raises his current expenditures. Therefore, during training his actual consumption is less than his potential consumption. However, it results in an
increase in labor productivity and the future wage rate. The returns to human capital investment therefore manifest themselves through an increase in the future stream of income.

Figure 1 below illustrates the inter-relationship between the investment in human capital and the income profile of an individual. On the horizontal axis is measured the amount of investment defined in terms of the years spent in training. The vertical axis measures income. The income of an untrained worker is equal to the market wage rate of unskilled labor, OU. Since the productivity is assumed constant in the absence of training, earnings remain constant as well.

![Figure 1](image-url)
During training the actual income is below the potential unskilled wage rate by the extent of the cost of training, UT. Starting from an initial point, T, the income increases with labor productivity until, because of declining marginal returns on investment in training, a maximum is reached at R. The decision to invest therefore entails a trade-off of current income for a larger future stream of income. Accordingly, the optimal level of investment is at a point that equates at the margin the discounted value of the future stream of income with current income sacrificed.

Conceptually, the distinctiveness of investment in training arises from the fact that the costs are congealed in the individual and the returns are inseparable from the person. This raises two sets of issues—

**TYPES OF TRAINING**

There is a close relationship between the type of training—general versus specific—and the related question of who invests in training—the individual himself or the firm that employs him. A firm would have an incentive to invest in training its workers so long as it raises its profitability due to higher labor efficiency. It also depends upon the related question as to whether the firm can be certain
of retaining the services of its workers. It would therefore be willing to invest in training that is specific to its operations. During the investment period, the firm incurs direct costs of materials and equipment and the indirect costs associated with the workers' time spent away from work. This means that although during the investment period the firm pays the worker his market wage rate, based on his potential marginal productivity of labor, his actual contribution to output is lower. Subsequently, after training is complete returns to the firm accrue from the difference between the increased marginal productivity of labor due to training and the unchanged wage rate.

The worker, on the other hand, would be willing to invest in general training that could be used equally efficiently in all competing firms. Hence, once the worker's productivity has been enhanced from training, his market wage rate rises concomitantly. Since gains from training are transferred entirely to the worker, there is an incentive for him to bear the costs of training.

Inasmuch as human capital is visualized as a deliberate investment phenomenon—and not as costless learning-by-doing—it entails a decision, on the part of the individual or the firm, about the optimal amount
OPTIMAL INVESTMENT IN HUMAN CAPITAL

The investment decision is dependent upon the inter-relationship between the cost of training and the returns that accrue to it over time. During the investment period, the current income is lower by the extent of the costs of training; future income, however, increases as returns start coming in. In the decision making process the investor seeks to equate at the margin the current expenditures in training with the discounted value of the returns emnating from it.

The cost of training is reckoned in terms of the direct cost such as tuition, expenditures on materials and equipment. It also involves an unobservable foregone cost component measured by the opportunity cost of the time spent in training which could have been spent at work. This is accounted for by the difference between potential income/production and the actual income/production during the investment period.

Assume perfect factor markets--wage rate is equal to the marginal product of labor--and that investment in training is confined to one period only. The relationship between the costs and the returns of
investment in training takes the form:

$$\text{MP}_0' + \sum_{t=1}^{T} \frac{\text{MP}_t}{(1+\rho)^t} = W_0 + C + \sum_{t=1}^{T} \frac{W_t}{(1+\rho)^t}$$

where $\text{MP}_0'$ is the potential marginal product of labor, $W_0$ the wage rate and $C$ the cost of training and $\rho$ the rate of time preference. $\sum \frac{\text{MP}_t}{(1+\rho)^t}$ and $\sum \frac{W_t}{(1+\rho)^t}$ are the discounted values of the marginal product of labor and the wage rate over time respectively.

The difference between the excess of future receipts over outlays measures the return on investment made in the initial period. Thus, if $G = \sum(\text{MP}_{t}-W_t)/(1+\rho)^t$ equation 1 can be rewritten as:

$$\text{MP}_0' + G = W_0 + C$$

where the difference between $G$ and $C$ measures the difference between costs and returns on investment. For $G \geq C$, returns are greater, equal and less than costs indicating an incentive to invest, indifference and disincentive to invest in training respectively.

When investment is confined to one period, the investment decision pertains to choosing between whether or not to invest in training, and if yes, how much to invest. Once the investment is made, assuming no depreciation, there is a uniform increase in the income over the future time period.
When training extends to more than one period, the investment decision becomes complex since it now involves deciding the time period of investment and the amount of investment in each time period. The former decision is constrained by the fact that returns can be recouped within the finite life span and within it, typically, by a declining income. This happens because indirect costs (foregone income) mount at an increasing rate over time. Costs incurred in the first period generate higher income in the second period, hence foregone cost in the second period is higher and so forth for the entire investment period. Secondly, given the finite life-span, the time period within which the individual can recoup costs becomes smaller. The marginal rate of return therefore tends to be negatively related with the length of the investment period\textsuperscript{42}.

The decision on how much to invest in each time period depends upon the production function for human capital. This defines the technological relationship through which the application of various inputs on the innate qualities of labor generates human capital.

Initially, the individual is endowed with his inherent stock of human capital which can be used either to increase his stock of human capital or it can be used in the labor market. The production function with
input time used in training is defined as

\[ H = F( s_T L ) \quad 1 \geq s \geq 0 \]

where \( H \) is the output of human capital, \( L \) is the initial stock of labor and \( s_T \) is the fraction of time spent in training in period \( t \). The range of \( s_T \) varies between 0 and 1---when \( s_T = 0 \) no time is allocated to training. Since time is indispensable for training the production function is undefined at this point. At \( s_T = 1 \) the entire time is used up in training such as in the case of full-time schooling.

The production function is homogeneous of degree \( \eta \) in its input, where \( \eta \) is less than 1. Thus, an increase in the input increases the output of human capital, but at a declining rate. At any point of time a person has a limited absorptive capacity to learn leading to declining returns at the margin. The smaller the value of \( \eta \) the sharper is the decline in the ability to produce human capital and vice versa for a high \( \eta \).

Therefore, the time pattern of investment depends upon the values of \( \eta \) and the rate at which the individual discounts his future income. If \( \eta \) is relatively small, there is greater saving in costs if the investment is postponed to a later date. On the other hand, if the rate of time preference is small, then it is less costly to postpone the benefits associated with
investment in human capital. Thus, given the production function, small values of $\eta$ and the rate of time preference predict an evenly spread out pattern of investment over time.

SECTION III

HUMAN CAPITAL AND TRADE THEORY

The integration of human capital into the standard Heckscher-Ohlin model raises two sets of issues. The first relates to the definition of human capital—whether it should be defined in terms of human capital or in terms of discrete skills associated with different occupations. Analytically, the specification of the trade-investment model differs depending upon the choice of the alternative definitions.

Approach to human capital can follow Leontief's productivity approach on the one hand, and the wage-discount approach on the other. In the former case, labor with differing levels of productivities can be aggregated together into one labor factor through assigning weights. In the wage-discount approach, it is possible to estimate the human capital content by discounting wage differentials. Human capital can then be aggregated with tangible capital to get an estimate of 'total' capital. In either case, the trade model
can be restricted into the familiar two factor framework through aggregation so that the logical deductions of the model remain unchanged.

This procedure, however, raises the related question of production relationships between the three factors—labor, human and physical capital. Aggregation of either labor and human capital or human and tangible capital assumes that they are perfect substitutes in production. This is an issue open to debate.

Under the skill approach, on the other hand, each grade of skill is considered specific and corresponds with a separate factor of production. This, of course, necessitates the use of a multi-factor production function. Accordingly, the deductions of the Heckscher-Ohlin model have to be respecified in terms of more than two factors.

2. Human capital formation is a dynamic phenomenon involving transformation over time. This may happen in one of two ways. There is the Arrowian learning-by-doing where the accumulation of productive experience (as measured by time, cumulative output or gross investment etc.) accounts for skill formation. On the other hand, there is the Becker-Schultz approach (discussed above) which
postulates that past investments in education determine the current amount of human capital. Here, the optimal amount of investment in training is one that maximizes the individual's lifetime income. This dynamic process of human capital formation necessitates the specification of a trade-investment model wherein a change in the stock of human capital affects the factor endowment ratio of a country and hence its pattern of specialization over time.

TRADE AND HUMAN CAPITAL--CONCEPTUAL ISSUES

As discussed in section I above, there is ample empirical evidence that both the wage-discount and the skill approaches are effective in explaining the trade pattern that is consistent with the factor proportions theory. Conceptually, under perfect market conditions both the approaches should give identical results. If investment in training enhances labor productivity, and hence wages, then wage differentials among labor should account for the amount of human capital inhered in labor. It follows then that the high wages associated with professional skills when discounted over the unskilled wage rate should give the human capital content of these skills. The two measures would diverge if due to factor market imperfections there emerged a divergence between wages and labor productivity. In that
case, wage-discount would not be an accurate measure of human capital and the skill-ratio--percentage of professionals in total labor force--would be better.

Branson and Junz test the relative significance of human capital and the skill-index on U.S. exports of manufactured goods in 1964. Their OLS regressions show that physical and human capital fare better (in terms of higher coefficients and t-statistics) compared with physical capital and the skill-index. Further, when the skill-index is introduced as an additional explanatory variable in the original equation (using human and physical capital), the explanatory power of the regression increases only marginally. In addition, the human capital coefficient is significant, but for skill-index it turns out to be insignificant. They therefore concludes that human capital is independently a better explanatory variable than skill.

Hufbauer and Waehrer both find a strong positive correlation between human capital (as approximated by wages) and skills (percentage of professionals in total labor force). Waehrer's correlation between net exports and skills turns out to be stronger than is the case with wages. She therefore concludes that skills are a better explanatory variable than human capital. Hufbauer, on the other hand, gets quite the
opposite result—-with stronger correlation between wages and national attributes as compared with skills.

As opposed to wages, Baldwin uses the cost of education and the number of years spent in schooling as the measure of human capital. His regression results show that both these measures have an inconsistent negative relationship with net U.S. exports, while skills have a significant positive relation. Although Baldwin's results tend to uphold the skill measure, he ascribes the poor relationship of the human capital measure to the fact that it fails to account for learning-by-doing (which would be captured by wage and not cost estimate of human capital).

Therefore, despite enough empirical evidence substantiating the case for both human capital and the skill approaches, the question about their relative efficiency remains unresolved.

PRODUCTION FUNCTIONS

The skill approach yields a multi-factor production function with each category of skill as a separate factor of production. The general production function with n grades of labor takes the form—

23
\[ y = f(K, S_i, L) \quad i = 1, \ldots, n \] - 5

where \( S_i \) is the \( i \)th grade of skilled labor, \( K \) is physical capital and \( L \) raw labor. Assuming that there is only one grade of skill, equation 5 reduces to a three factor case-

\[ y = f(K, S, L) \] - 6

In the case of multiple factors of production, such as in equations 5 and 6, the logical deductions of the Heckscher-Ohlin have to be severely qualified. The concept of relative scarcity of factors and the strong factor intensity conditions have to be redefined. In case the number of commodities exceeds the number of factors, the unique relationship between factor and commodity prices does not hold good. The unit cost functions are now dependent not only on the factor prices, but also their supplies. Insofar as the production relationship between the factors is not defined, the effect of changes in the factor prices on the production coefficients remains indeterminate. Thus, while more than two factors obscures the factor proportions reasoning somewhat, when it is combined with inequality in numbers of factors and commodities the deductions become tenuous indeed.

Keesing\textsuperscript{49}, Waehrer\textsuperscript{50} and others have reduced different
grades of skills by defining a skill/occupational index. While this procedure enables the use of a two factor production model, a strict test of the Heckscher-Ohlin model would need redefinitions of the concepts of relative scarcity, factor intensities and their production relationships would have to be redefined.

In tests of the factor proportions model using human capital the two factor assumption is retained through redefining factors. The wage-discount approach isolates human capital from labor and aggregates it with physical capital to get an estimate of total capital. The productivity approach, on the other hand, reduces different grades of labor into one composite labor factor. Adoption of either one of these approaches depends upon the question of whether human and physical capital or labor and human capital are substitutes in production.

Bhagwati\textsuperscript{51} and Kenen\textsuperscript{52} advocate aggregation of human and physical capital based on the argument that they both require investment hence they should be combined into one man-made resource. Branson and Junz\textsuperscript{53} disagree based on their tests of the production relationships between factors. They postulate that if human and physical capital are substitutes in production then correlation between them would be positive and of
an equal degree of magnitude. However, for 90 3-digit SITC industries in the U.S. regressions for net exports show that the coefficient for human capital has a significant positive sign, while that of physical capital has a significant negative sign. As may be expected in this case, aggregation of human and physical capital into 'total' capital reduces the $r$-square and yields an insignificant $t$-statistic. Branson and Junz contend that the two are not substitutes and hence cannot be aggregated.

The alternative approach is to aggregate raw labor and human capital using the Hicks' composite goods or Leontief's separability theorems. It assumes perfect substitutability among different grades of labor, the justification for which arises from visualizing training as merely labor augmenting a la Becker-Schultz.

If wages remain constant, then labor can be represented as one composite-

$$L = N \cdot E$$  \quad - 7$$

where $L$ is the labor in standard units, $N$ is the number of workers and $E$ is the efficiency factor.

Using equation 7, the standard two factor production function is-
\[
y = f(K, NE)
\]

or simply,
\[
y = f(K, L)
\]

**TRADE/GROWTH MODELS WITH HUMAN CAPITAL**

Kenen\textsuperscript{54} integrates human capital in the Heckscher-Ohlin-Samuelson model by redefining capital as a 'stock in waiting' as against a tangible asset. It consists of a central loan fund that can be borrowed at the market interest rate to generate service flows of otherwise inert factors—land and labor. Optimum investment of this stock of capital on land and labor gives the 'gross factor' ratio of these services for the economy. However, since the replacement of the capital stock uses land and labor services, two other factor ratios are defined. The 'capital ratio' is the amount of land and labor services used in replacing capital and the 'net ratio' is the gross ratio less the capital ratio. Trading pattern reflects the net factor ratio—at which Kenen proves factor price equalization and the Rybczenski theorems. Interestingly, since the net ratio does not take into account capital, differences in the relative scarcity of capital do not directly affect the trading pattern. Further, Kenen proves that when the three ratios are equal then there is continuous saving and investment which produces balanced growth.
Starting with three factors of production, Kenen\textsuperscript{55} postulates a relationship between factors and final goods to draw interesting conclusions. In using this framework, however, his model does not allow for the existence of unskilled labor alongside skilled labor. Further, Kenen does not analyze the effect of changes in the service flows on the pattern of trade.

Hu\textsuperscript{56} provides interesting analytical insights by introducing investment in human and tangible capital in his neoclassical growth model. In a two-period framework, every individual is faced with a consumption-investment decision in order to maximize his life-time earnings. Costs of education are reckoned in terms of foregone income as well as tuition expenditures. This investment yields pecuniary benefits in terms of increased earnings in the subsequent period as well as the subjective utility derived from education. Optimal consumption-investment is at a point that equates the marginal rate of substitution between present and future consumption with the discount rate and the costs of education with the pecuniary and nonpecuniary returns on it. Current income net of investment in training and consumption is saved and invested in tangible capital.

Hu establishes a positive relationship between the
wage rate and the demand for education such that at some minimum wage rate there is no investment in education, while at a maximum wage rate all the current time is devoted to training. In his model the supply of labor in the economy is equal to the fraction of time spent at work by the current untrained generation of workers and the older generation of trained workers. It follows then that the labor supply is positively related with past investment in training, but negatively related with current investment in training. Supply of tangible capital in the economy, on the other hand, depends upon the amount of savings of the older generation of workers. Within this framework Hu investigates the short- and long-run equilibrium properties of growth. Nevertheless, from the standpoint of a trade-investment model his framework provides useful insights.

SECTION IV

AN OVERVIEW

While human capital has become an important focal point of trade explanations, there still remains very little work in incorporating it within trade theory. Forging in this direction, the present model seeks to integrate some aspects of human capital theory within the factor proportions model. This means
stating the conditions for human and physical capital formation at the given factor prices. Further, it establishes the implication of accumulation of factors on their prices within different zones of specialization in the next time period. Through changes in factor supplies the equilibrium relation between the current and future factor prices in the economy is then determined. In steady state factors grow at a constant rate such that factor prices and the pattern of specialization remain unchanged.

In chapter 2, we introduce human capital within the 2x2 factor proportions model by redefining labor as a composite of human capital and 'raw' labor. In a two-period framework, each individual has a choice of investing in human and/or physical capital formation so as to maximize the utility from consumption in his life-time. Returns on these investments depend upon the prevailing factor prices which, in imperfect specialization, are determined from the given commodity prices. Aggregation of the optimal pattern of investment in human and physical capital for each individual determines endogenously the rate of growth of human and physical capital in the economy. 'Raw' labor grows at the natural rate of growth of population. Change in the factor endowment ratio depends upon the rate of accumulation, and determines the pattern of specialization and the
factor prices that will then prevail. Thus, through factor accumulation the relationship between the present and future factor prices is established, and its equilibrium and stability properties are analyzed.

In chapter 3, the effect of a change in the current commodity price ratio on the future factor prices is analyzed in the various zones of specialization. This happens in two ways—through factor price changes emerging from the familiar Stolper-Samuelson theorem. Further, these factor prices affect the investment pattern and induce secondary 'accumulation' effects. The change in the factor price relationship between the current and future time periods is a composite of these two effects.

In chapter 4, the conclusions of the present study are summarized.

Footnotes


4 P. A. Samuelson (op. cit.)


12 R.E. Baldwin (op. cit.)

13 W.H. Branson and H.B. Junz (op. cit.)

14 G.C. Hufbauer (op. cit.)


17 P.B. Kenen (op. cit.)


20 R. Bharadwaj and J.N. Bhagwati (op. cit.)

21 R.E. Baldwin (op. cit.)

22 W.H. Branson and H.B. Junz (op. cit.)

23 An unexpected relationship that raises the question about the production relationship between physical and human capital, see Section II below.


25 Skill classes are I. Scientists and engineers II. Technicians and draftsmen III. Other professionals IV. Managers V. Machinists, electricians, and tool- and diemakers VI. Other skilled manual workers VII. Clerical, sales and service workers VIII. Semi-skilled and unskilled workers.

26 Index computed using the following formula - \[ \frac{2(I+II+III)+V}{VIII} \], where skill categories correspond to those in footnote 27.


29 The occupational index is defined as the percentage of employees in each industry belonging to eight occupational categories.


31 Computed on the basis of pupils currently enrolled in secondary and college-level schools as a percentage of the school age population.

32 R.E. Baldwin (op. cit.)

33 W.H. Branson (op. cit.)

34 G.C. Hufbauer (op. cit.)


38 Human capital theory disregards costless learning by doing as is evident from Mincer's words, "I interpret productivity augmenting experience as an investment phenomenon. The assumption of costless opportunities of augmenting productivity, which is sometimes implied by the notion of learning-by-doing, cannot be descriptive of the labor markets" (op. cit.)

39 G.S. Becker (op. cit), 15-36.

40 Since the worker cannot use the gains from training in other competing firms, labor turnover remains low.

41 G.S. Becker (op. cit)


44 R.E. Baldwin (op. cit)

45 W.H. Branson and H.B. Junz (op. cit.)

46 G.C. Hufbauer (op. cit.)

47 H. Waehrer (op. cit.)

48 R.E. Baldwin (op. cit.)
49 D.B. Keesing (op. cit.)
50 H. Waehrer (op. cit.)
51 J.N. Bhagwati (op. cit.)
52 P.B. Kenen (op. cit.)
53 W.H. Branson and H.B. Junz (op. cit.)