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S. N. Kimaro, 1970

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71-25,002

KIMARO, Sadikiel Ndekiro, 1941-
INTERNATIONAL TRADE THEORY: TREATMENT OF DISTRIBUTION SERVICES.

State University of New York at Binghamton, Ph.D., 1971
Economics, general

University Microfilms, A XEROX Company, Ann Arbor, Michigan

INTERNATIONAL TRADE THEORY: TREATMENT OF DISTRIBUTION SERVICES

A Dissertation Presented

By

SADIKIEL NDEKIRO KIMARO

Submitted to the Graduate School of the State University of New York at Binghamton

DOCTOR OF PHILOSOPHY

May (Month) 1971 (Year)

Major Subject Economics

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no 20

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INTERNATIONAL TRADE THEORY: TREATMENT OF

DISTRIBUTION SERVICES

A Dissertation

By

SADIKIEL NDEKIRO KIMARO

Approved as to style and content by:

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PREFACE

Purpose of the study

The traditional models in the pure theory of international trade, notably those of Ricardo, Graham, and Heckscher-and-Ohlin[1] formally abstract from the actual tasks of distributing economic goods and services from one country to another. This abstraction is generally concretized in the familiar assumptions of factor immobility and negligible transportation costs.

Whatever may be the methodological or analytical merits of such assumptions, it is common knowledge that the actual process of moving an economic good or service between two countries may entail the services of shippers, insurance agents, bankers, merchants, freight-forwarders, mail men, telephone operators, lawyers, commission agents, etc. Such services--henceforth referred to collectively as distribution services--put a claim on scarce economic resources and therefore deserve to be studied by the economist. Unfortunately, in

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[1]David Ricardo, The Principles of Political Economy and Taxation (Dutton: Everyman's Library, 1965), pp. 77-93. Frank D. Graham, The Theory of International Values (Princeton: Princeton University Press, 1948). Eli Heckscher, "The Effect of Foreign Trade on the Distribution of Income," in Readings in the Theory of International Trade (American Economic Association, 1949). Bertil Ohlin, Interregional and International Trade (Cambridge: Harvard University Press, 1967).

the literature on international trade, theoretical or empirical studies on distribution services are rare.

The purpose of the present study is to reduce this weakness largely by

(i) demonstrating a simple way of handling distribution services analytically;

(ii) analysing in a comparative static framework various kinds of important changes which can occur in the industries producing distribution services and final goods;

(iii) interpreting the trade relationship between industrialized and raw material producing countries within an analytical framework which includes distribution services;

(iv) examining possible approaches to empirical studies on international distribution services; and

(v) exploring the problem of deciding which country (or countries) can produce international distribution services most efficiently.

A methodological note

Perhaps any serious work on distribution service in the field of international trade at this point in time is likely to be considered heretical. Distribution services for factors of production can, for example, exist only if factors are mobile. Such mobility may, however, appear dastardly before the traditional models with their methodological assumption of factor immobility. Besides, the circuitous reasoning involved in models which include distribution services has generally compelled the use of simple, Leontief type fixed coefficient production functions. Consequently, in a multi-factor model there arises the possibility of the unemployed factor(s)--again a dastardly possibility before the full-employment assumption in the traditional models on international trade.

For practical purposes the ensuing study will proceed from the assumption that economic goods (pieces of moon rock included) as well as factors of production are not immobile. Besides, fixed factor substitution will be assumed, the possibility of factor unemployment notwithstanding. Neither of these assumptions constitutes a gross violation of "reality" in underdeveloped countries specializing in the production of raw materials. In these countries the presence of foreign capital, management and entrepreneurship, and local factor unemployment (surplus labor) are glaring realities.[1]

For methodological purposes the study is essentially of a short-run character. Existing know-how is assumed to permit only a limited factor substitution. Factors are flowing between countries, and production functions are, at least partly, different among countries because of transitory reasons (e.g., unequal diffusion of technological know-how, institutional rigidities, etc.).

I am very grateful to Dr. R. Leighton, my advisor, for

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[1]"Realism" of assumptions, of course, does not necessarily ensure the usefulness of a model.

assisting and encouraging me at many difficult points in the study. I am also grateful to Dr. J. LaTourette for reading the entire manuscript and advising me on various technical aspects of the study. Finally, I am indebted to the Rockefeller Foundation for financial assistance and to my wife, Young-Hoy Kim, for her invaluable help and encouragement.

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CHAPTER I

PREVIOUS TREATMENT OF "DISTRIBUTION COSTS"

Scope and character of "distribution costs"

The phrases "transport costs," "transfer costs," or "distribution costs" are frequently used to denote costs involved in the actual process of moving commodities from one place to another. The phrase "distribution costs" is preferred in this study.

Traditionally, economists have defined distribution costs to include more than just freight. Cournot, for example, included "insurance premiums and the profits of the merchants, who ought to obtain in his business the interest on the capital employed and a proper return for his industry."[1] Alfred Marshall included interest on trade credit and costs entailed in effecting "communication between buyer and seller."[2] More recently, Professor Kindleberger has maintained that the "notion of transport costs may be broadened to include all costs of transfer, mainly freight, but

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[1]Antoine A. Cournot, Mathematical Principles of the Principles of the Theory of Wealth, trans. by Nathaniel T. Bacon (New York: The Macmillan and Co., 1929), p.117.

[2]Alfred Marshall, Money Credit and Commerce (London: Macmillan and Co., 1923), pp.98-99.

also insurance, handling, freight-forwarder's commission, etc."[1] In the ensuing study, then, the concept of distribution costs will, in keeping with tradition, be used broadly to denote freight and virtually all other costs which might otherwise be classified as marketing costs.

Such a broad view of distribution costs is suited to a general and more abstract concept of "factors of production"--a concept which submerges the peculiar characteristics of various factors.[2] Professor Meade, in contrast, focused on the distribution costs of specific factors namely, labor and capital.[3] He noted, in addition to the more tangible costs associated with the physical movement of factors, other less tangible costs stemming from the fact that owners of factors may suffer some subjective disutility as the factors move across national borders.[4] The overcoming of such disutility entails costs which may also be classified as distribution costs.[5]

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[1]Charles P. Kindleberger, International Economics (Homewood, Ill.: Richard D. Irwin, 1953), p.119.

[2]Cf. Richard E. Caves, Trade and Economic Structure: Models and Methods (Cambridge: Harvard University Press, 1960), pp.120-144.

[3]James E. Meade, Trade and Welfare (London: Oxford University Press, 1955), pp.357-377.

[4]Meade, perhaps more than any other economists to date, went farthest in trying to pin down the elusive concept of distribution costs of capital. See ibid., pp.358-362.

[5]Such costs are actually incurred only if the factor moves across the national boundary.

Occasionally some economists have also commented on the factors which influence distribution costs. Two factors in particular stand out, namely physical distance and the individual characteristics of the good being distributed. Adam Smith, David Ricardo, John Stuart Mill, and Alfred Marshall were, for instance, quite aware of the positive influence of physical distance on distribution costs.[1] Even more interested in the characteristics of distribution costs were Ohlin and Lösch.

Ohlin has disaggregated "distribution costs"--or, to use his own phrase, "costs of transfer" into:[2]

1. Costs of transport determined by supply and demand forces and affected by distance, scarce resources used, scale of transport facilities, and the character of the commodities to be moved as well as that of the transport facilities;

2. costs arising from a reduction in quality and value of goods which are easily spoiled in the

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[1]Adam Smith, The Wealth of Nations (New York: The Modern Library, 1937), pp. 112-113. Smith observed a direct variation between distance and transportation costs and analysed the influence of these costs on the price of grocery goods, bread, and butcher's meat in the towns and villages. Ricardo, Political Economy and Taxation, p. 89. In this passage Ricardo also points to the importance of bulkiness of distribution costs. John Stuart Mill, Principles of Political Economy (New York: Longmans, Green and Co., 1921), p. 582. Marshall, Money Credit and Commerce, pp. 98-99.

[2]Ohlin, Interregional and International Trade, pp. 97-104, 138-139, 145.

process of transportation;

3. costs incurred in trying to overcome "lack of intimate contact with customers, consequent upon great distances from the market";

4. initial marketing expenses, which allegedly can be very large; and

5. export and import duties.

Lösch pushed slightly farther than Ohlin in detailing the constituent parts of distribution costs--or, to use his phraseology--"restriction of market areas." The overcoming of these restrictions, contended Lösch, entails costs most of which can ultimately be reduced to direct functions of physical distance. These costs can be paraphrased as:[1]

1. Costs immediately related to distance, e.g., freight, insurance, and the deterioration of goods in transit;

2. costs immediately associated with the lapse of time--the monetary counterpart of these costs includes such forms as interest on capital tied up in goods in transit, extra charges for quick delivery, high costs necessitated by generally larger inventories where replenishments cannot be effected on short notice, and loss of business if goods are not available at the proper time;

3. selling costs also increasing with distance--reflecting a relative ineffectiveness of promotional effort as the intended market area increases, higher costs of trackling down market development in more distant places, etc.;

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[1]August Lösch, The Economics of Location, trans. by William H. Woglom (New York: John Wiley and Sons, 1952), pp.211-214.

4. costs of overcoming business risks which generally increase with distance including, among other things, the difficulty of obtaining information on distant customers or initiating legal proceedings in case of default;

5. product planning costs also tend to increase with distance since more work may be called for in mastering demand patterns engendered by such diverse factors as climate, habits, income, etc.;

6. entrepreneur's disinclination and incompetence in conducting trade with distant customers. Costs here may take the form of payments to commission agents, factors, inquiry agents, freight-forwarders, etc.;

7. governmental barriers such as taxes;

8. costs associated with the extent of business i.e., costs incident to larger scale of plant operating to the right of long-run minimum average costs as the market area expands spatially.

Lösch, in addition, tried to provide empirical evidence for his observations. Generally he saw the restrictive importance of distance as being corroborated by inverse relationships between proportions of trade into and out of various European countries and their distance from source and destination countries respectively.[1] Additionally, he noted southward and westward spatial increases in interest rates (the discount rate, interest on bank credit, and bond interest) from major financial centers in the United States as reflecting *inter alia* the influence of distance on the transfer costs of capital.

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[1] *Ibid.*, pp.428-430

It would appear from the preceding discussion that distribution costs are substantially influenced by physical distance and the individual qualities of the commodities being distributed. This observation is very important in this study. Instead of viewing distribution services like a homogenious mass of services, it will be assumed that there are two conceptually distinct types or industries of distribution services. The first industry produces distribution services for the factor(s) only, and the other, for the final good(s). Services produced by each industry can be measured by some homogenious standard.[1] Each industry is also capable of undergoing independent technological change.

Previous formal treatment of distribution costs

How have previous economists handled distribution costs in their models? Two distinct approaches can be discerned in the literature. The first approach traceable to Cournot, focuses on monetary variables and tends to emphasize the distribution of final goods more than the distribu-

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[1]For the purpose of concreteness, the standards may be thought of as weight-distance units--say ton-miles--in the Weber-Isard tradition. See Walter Isard, Location and Space-Economy (New York: John Wiley and Sons, 1956), pp.77-90. It is worth emphasizing that a ton-mile of distribution services for a factor is, in this study, conceptually distinct from a ton-mile of distribution services for final goods.

tion of the factors of production.[1]

Cournot, in his Chapter on the "Communication of Markets" considered two spatially separate markets, and formalized mathematically the partial equilibrium conditions of a single traded product under the assumption of perfect competition.[2] His formulation, now common in introductory books on trade theory, simply states that the price of a transportable good in market A equals the price of the good in market B "plus or minus" transportation costs.[3] Subsequently, Cournot's partial equilibrium conditions were depicted graphically by Cunynghame and Barone[4] into the familiar back-to-back construction for demonstrating partial equilibrium in the presence of transport costs or tariffs.[5]

In more recent periods, attempts have been made to extend the Cournotian formulation into more general situations. Enke, using an analogue in electricity, illustrated a partial equilibrium solution for one commodity in a multi-

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[1]The distinction between "consumptive" and "productive" processes of distribution was made by Alfred Weber, Theory of the Location of Industries, trans. by Carl J. Friedrich (Chicago: The University of Chicago Press, 1929), pp.4-5.

[2]Cournot, Theory of Wealth, Chapter X.

[3]"Plus" if the good is transported from B to A, and "minus" if transported from A to B.

[4]Jacob Viner, Studies in the Theory of International Trade (London: George Allen and Urwin, n.d.), pp.98 and 101.

[5]Kindleberger, International Economics, p.119.

market system.[1] Another method of solving Enke's problem was illustrated by Professor Samuelson using a technical concept, "net social payoff," which rests on the Cunynghame-Barone construction.[2] This very construction has also provided a point of departure into the concept of a "surplex" used by Isard in formulating a multi-commodity and multi-market equilibrium system.[3]

The other approach to the handling of distribution costs in economic models focuses on real variables, and emphasizes both the productive and consumptive processes of distribution. This approach, common among theorists interested in location, will be employed in this study. According to this approach, distribution costs are shown explicitly as constituting a claim on economic resources. The central problem is, then, to determine an optimal locational pattern of economic activities given distribution costs, the location of effective demand, the initial location of factors, and some overriding objective such as the maximization of world

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[1]Stephen Enke, "Equilibrium Among Spatially Separated Markets: Solution by Electric Analogue," Econometrica, Vol. XIX (January 1951), pp.40-47.

[2]Paul Samuelson, "Spatial Price Equilibrium and Linear Programming," The American Economic Review, Vol. XLII (June (1952), pp.283-303.

[3]W. Isard, "General Inter-regional Equilibrium," Papers and Proceedings of the Regional Science Association, Vol. III (1957), pp.35-60.

consumption.

Because of their resource-absorbing characteristic, distribution costs can be translated into a production function. In this production function the "thing" being produced is a distribution service. The production of the service, like that of any other commodity, puts a claim on scarce resources. This point was underscored by Ohlin:

> The transfer of commodities from one region to another can be done only by means of certain productive factors; transportation requires the use of such factors as much as does production in a narrow sense.[1]

Nevertheless, Ohlin did not explicitly introduce a production function for distribution services into his analysis.[2]

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[1]Ohlin, Interregional and International Trade, p.98 and Appendix I, pp.297-304.

[2]This is presumably because he was convinced that "no simple formulation of the influence of transfer relations upon location and trade is possible" (ibid., pp. 103-104). In fairness to Ohlin it should be pointed out, however, that he verbalized, following the Cournotian approach, a general interregional equilibrium system which included distribution costs, to wit:

> "...the relation between costs of production at home, and supply price of 'foreign goods,' i.e., costs abroad plus 'transfer' costs, determines whether a given commodity is to be imported, exported, or produced for the home market. It fixes the volume of imports and exports. Similarly, the prices of productive factors determine, through their effect on trade, the amount of 'transfer' services that each region will supply. Such services affect the balance between imports and exports. By means of these relations, a simplified picture of the price system for productive factors, goods and 'transfer' services is obtained."

Ibid., p.99.

Serious attempts to incorporate distribution costs more explicitly began only after Isard forged the concept of a "transport input"--a concept which greatly facilitated the conceptualization of interspatial transformation functions. Isard defined and underlined the concept of a transport input:

> We define a transport input as the movement of a unit of weight over a unit distance; e.g., we may speak of pound-miles, ton-kilometers, etc. In an indirect sense, transport inputs correspond to the exertions of effort and other factor services required to overcome resistance encountered in movement through space where friction is present. In a space-economy we obviously wish to minimize these, ceteris paribus.
>
> It is imperative to think in terms of some such concept as transport inputs if one is to comprehend fully the significance of space in actuality. One cannot ignore transport cost and merely concentrate upon the labor, raw material, and other costs which compose transport cost; nor can one ignore transport inputs and merely concentrate upon the labor, capital, and other inputs which, as we shall presently show, compose transport inputs if he is to understand the full array of dynamic spatial phenomena.[1]

With his concept of a transport input, Isard proceeded to specify

> . . . a general spatial transformation function as
>
> $$(Y_1, Y_2, \ldots, Y_k;\ m_A s_A, m_B s_B, \ldots, m_L s_L;\ X_{k+1}, X_{k+2}, \ldots, X_n) = 0$$
>
> Where the variables $Y_1, Y_2, \ldots, Y_k$ represent quantities of various inputs other than transport inputs; $m_A s_A, m_B s_B, \ldots, m_L s_L$ represent quan-

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[1] Isard, Location and Space-Economy, pp.79-80

> tities of various transport inputs, and X_{k+1}, X_{k+2}, . . . , X_n represent quantities of various outputs. In this formulation, m_A, m_B, . . . , m_L represent the weights of various raw materials and finished products subject to shipment, and s_A, s_B, . . . , s_L represent the distances the respective raw materials and products are moved. By definition, $m_I s_I$ represents transport inputs (say, ton-miles of transportation) involved in the shipment of the raw material I from its source(s) to the site of production, or the product I from this site to the consumption point(s).[1]

Isard's conceptualization of a spatial transformation function, however, had two weaknesses. The function ignored the location of effective demand. In addition, the function failed to indicate whether the transport inputs were to be interpreted as an input or output of the transportation industry.

The two weaknesses were originally spotted and corrected by Lefeber. The location of effective demand was recognized by distinguishing between spatial transformation functions in terms of goods at the place of their production and consumption.[2] The ambiguity regarding the interpretation of transport inputs was resolved in favour of considering transport inputs as an output of the transport industry. The rationale and importance of this interpretation is expressed most briefly by Lefeber himself.

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[1] Ibid., p.222.

[2] Louis Lefeber, Allocation in Space: Production, Transport and Industrial Location (Amsterdam, North-Holland Publishing Co., 1958), pp.4-5.

"Transport inputs" can be inputs in the true sense of the word only if transport services are produced either by the same or by another firm at the cost of sacrificing productive factors. Consequently, a supply relationship must exist equating the output of transport services with its allocation . . . . Further more, the sum total of all ton mileages associated with any given product mix has to correspond to the output variables, even though it may not be a final good . . . . Similarly, productive factors needed to provide transportation services should be included among various factor-input variables . . . .

To view the services of transportation as an input or intermediate product is, of course, legitimate but leads to difficult analytical problems. The implication is that the production function of any good has to vary with the location of the firm and with the markets it supplies, and also with the different sources of raw materials. It is analytically more fruitful to conceive of the output of transportation services as a necessary social sacrifice, in the sense that inputs from the production of final goods have to be drawn into providing it. For general equilibrium analysis, this sacrifice should not be associated with individual goods but rather with the entire bill of final goods delivered to all the markets. Then in the allocation of the total cost of transportation, each productive factor's rent has to be charged, of course, with its proper share of the social burden; this in turn has to be determined for each by the maximizing-mechanism of the general equilibrium framework. Approached in this manner, the production functions of identical goods produced in diverse locations remain invariant with locational changes. A further benefit is the resulting ability to net out the factors consumed by transportation from the spatial transformation curve; thus one obtains a transformation solely among final goods delivered at the market, preserving, of course, all the relevant maximum conditions.[1]

In the ensuing discussion, the treatment of distribution rests on the contributions of Isard and Lefeber. Explicit production functions are introduced for the two distribution

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[1] *Ibid.*, pp.5-6.

industries (i.e., distribution industries for factors and final goods) mentioned earlier. At every step of the analysis, care is taken to distinguish between a world production possibilities frontier in terms of final goods at the countries of production or consumption. In addition, technical coefficients which are analytically analogous to Isard's "transport inputs" are introduced and interpreted in the light of Lefeber's contribution.

Who should produce distribution services?

Thus far, the discussion has reviewed the meaning of distribution costs, and examined both analytical and methodological approaches and problems of incorporating these costs explicitly in theoretical models. Unexplored as yet is the question of where the distribution services themselves should be produced.

The analytical meaning of this question is readily illustrated by Isard's transformation function reproduced and explained above, i.e.:

$$(Y_1, Y_2, \ldots, Y_k;\ m_A s_A, m_B s_B, \ldots, m_L s_L;\ X_{k+1}, X_{k+2}, \ldots, X_n) = 0$$

In this equation, the Y's and X's[1] have a specified location.

[1]Remembering Lefeber's contribution, of course a distinction must be made between X's at the place of production and X's at the place of consumption.

But what is the location of $m_A s_A$, $m_B s_B$, . . . , $m_L s_L$? This is indeed a difficult question to answer. This difficulty was originally spotted by Weber, and attributed to an inherent simultaneity between the processes of production, distribution and consumption.

> The part of distribution, which represents the actual movement of goods is geographically imbedded either between the different parts of production (productive process of distribution) or between production and consumption (consumptive process of distribution). It is impossible to explain the sphere of production locationally without including in this explanation the distribution of material goods in all its aspects. In the theory dealing with the nature of economic processes it may be possible to have production end at the point where the product is sold to a merchant, at least abstractly; but for the purpose of explaining the economic location of production this procedure is impossible. Each part of production orients itself geographically with consumption in mind. The explanation of this orientation--location theory--cannot neglect consideration of the place of consumption. Thus in fact we include the distribution of goods in our theory.
>
> Because of this inevitable interation our theory does not, however, become a complete theory of the location of distribution. We in no way explain the location of the seats of the wholesale merchants, of the agents who direct the actual movement of goods, i.e., the location of the trading centers. The headquarters directing the circulation of the goods and this circulating itself must be disconnected geographically.[1]

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[1]Weber, Location of Industries, pp.4-5. In his synthesized theory of location, he contends that the location of the local tradesmen and functionaries (i.e., "the local organizing stratum") need not be differentiated from the agricultural and primary and secondary industrial strata. As for those in the "central organizing stratum," he contends that "the locational distribution of these elements is something separate and independent."

section it would appear that Weber, at least in one sense, overemphasized the difficulty of accounting for the efficient location of distributors. If production functions for distribution services can be defined--as will be illustrated later--at various geographical points, one can conceived of an efficient locational pattern of distributors.[1] Marshall, no doubt, had this point in mind when, in explaining Britain's continued prominence in entrepot trade, he argued:

> . . . the unrivalled specialization, promptitude and directness of action of her merchants and brokers; the ease and elasticity of her banking system; and the consequent preference for a bill on London over a bill on any place, have tended to strengthen the re-export trade of London.[2]

More recently, Professor Pearce introduced two production functions--one for each country-- in a two-good, two-country model, and illustrated the choice of efficient location of the distributor(s) in a traditional trade model of perfect factor immobility.[3] A more elegant model--and perhaps

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[1]At this point, the author, following the lead of many prominent economists, is confessedly neutral in the continuing technical controversy on the identity of production functions. See Caves, Trade and Economic Structure, pp.145-146. For a more recent and furious criticism of those who still tend to disrespect the identity of production functions, see I. F. Pearce, International Trade (New York: W.W. Norton and Co., 1970), pp.323-328. Additionally, it should be observed that the location of distributors need not be coterminous with their location as consumers.

[2]Marshall, Money Credit and Commerce, p.126.

[3]Pearce, International Trade, pp.290-294.

the only one of its kind--including factor mobility and permitting an efficient choice of the location of distributors was explored in the early fifties by Isard and Peck.[1] Since then little, if any, has been heard on this topic.

The omission of the problem of choosing distributors in recent general works (e.g., those of Isard[2] and Stevens[3]) can, perhaps, be explained by the familiar and, indeed, justifiable preference for clear exposition. The wisdom of such preference is, however, questionable in view of the importance of distribution both within and among countries. Empirical works of students of marketing in the United States, for example, indicated that about one-half of each dollar spent by a consumer is, in fact, spent on distribution services.[4]

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[1]W. Isard and Merton J. Peck, "Location Theory and International and Interregional Trade Theory," Quarterly Journal of Economics, Vol. LXVIII (February 1954), pp.97-114. The authors, using two production functions--one for each country--illustrated the optimization of world output, given factor endowment, non-identical production function, and a Graham-type demand function.

[2]W. Isard, et al., General Theory (Cambridge: The M.I.T. Press, 1969), pp.519-544. Isard, here, imposes his interregional equilibrium conditions in the form of non-resource-using world traders. Hence, barring transportation proper, he has, in fact, neglected all other costs of distribution. For a rationalization of his approach see fn.25 on pp.529-530.

[3]Benjamin H. Stevens, Interregional Linear Programming (unpublished Ph.D. dissertation, M.I.T., 1959).

[4]Reavis Cox, Distribution in a High Level Economy (Englewood Cliffs, N.J.: Prentice-Hall, 1965), pp.118-151. Also see Paul D. Converse, et al., The Elements of Marketing (5th ed.; Englewood Cliffs, N.J.: Prentice-Hall, 1952), p.789.

My own empirical study of costs of international dstribution suggest that these costs are anything but negligible. This study, limited as might be expected by nonavailability of data on international distribution, is summarized in Chapter IV.

These empirical studies suggest that inter-spatial programming techniques, focusing on "production" and ignoring distribution,may be very defective. Efficiency in distribution is, perhaps, just as important as efficiency in production. In an attempt to correct for this defect, the linear programming versions of the problem under study will include an optimal choice of distributors. It will, however, also be seen that many vexing problems remain unanswered.

The influence of distribution costs on international trade

While economists have, on the whole, tended to shy away from the treatment of distribution in their models, they have not hesitated to speculate on the influence of distribution on international trade.[1] Smith, for example, noted

[1]There is a crop of literature by students of marketing and economic development, purposely omitted from the following discussion. The substance of their contributions can be reduced to:

(a) Static, welfare-oriented appraisals of existing marketing services. Included in this category are theoretical and empirical studies and controversies around the Clark-Fisher thesis that approximately normal levels of resource commitments in the distributive sector can be estimated for countries at different stages of economic develop-the influence of relatively cheap transport by waterway on international trade. Such transport, contended Smith, by encouraging trade, increases the wealth of nations by stimulating the division of labor and the "venting" of products in excess of domestic requirements.[1]

On a less general level, Mill observed the influence of "cost of carriage" on the types of goods entering into international trade. More specifically, he, perhaps originally, made the familiar distinction between foreign- and home-trade commodities.[2]

Of all classical economists, perhaps the one most impressed by the influence of distribution costs on international trade was Henry Sidgwick. He, indeed, went so far as to contend that the raison d'etre of a separate theory of

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ment. Also included here are rationalizations of ostensibly large distribution sectors in some underdeveloped countries.

(b) Analyses or indications of the role of distribution in the process of economic development. Common themes include the effect of marketing on decision-making as a scarce resource in economic development; marketing-induced incentives and their effect on the supply curve of effort; marketing as a spawning ground for non-commercial entrepreneurship; and effective distribution as a crucial ingredient in economic regional intergration.

[1]Smith, Wealth of Nations, pp.17-21. As evidenced by Mynt, of course all economists do not agree with Smith. See James D. Theberge, ed., Economics of Trade and Development (New York: John Wiley and Sons, 1968), pp.158-210.

[2]J.S. Mill, Political Economy, p.589. Mill himself did not, however, analyse fully the implications of this distinction.

international trade was "costs of carriage" rather than relative factor immobility.[1] Sidgwick's contention touched off a raging technical debate, ending with his "demise" before the pens of Edgeworth and Marshall.

Marshall, living at a time when breakthroughs in international transportation and communications were constantly making the headlines, was also very interested in the consequences of distribution costs on international trade. An interesting theme maintained by Marshall was that national advantages in manufacturing were inherently superficial and temporary. Ultimately, such advantages were destined to be whittled away by "improved means of communication and increased human plasticity," thus leaving natural advantages as the only determinants of world trade.[2] This trade, he contended, would be characterized by a strengthening of "many weak industrial nations" and an accentuation of north-south world trade governed by climatic conditions.

More recently, a group of models--each claiming at least a part in the crown of explaining international trade--have variously underlined the influence of distribution costs. Notable among these models are those propounded by Seev Hirsch,[3]

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[1]Henry Sidgwick, The Principle of Political Economy (London: Macmillan and Co., 1883), pp.228-230.

[2]Marshall, Money Credit and Commerce, pp.102-106.

[3]Seev Hirsch, Location of Industry and International Competitiveness (Oxford: Claredon Press, 1967), pp.42-61. The essence of his approach is that a product, at various periods

Linder,[1] contemporary location theorists,[2] and proponents of "staple" and "vent for surplus" theories.[3]

Hirsch has, and quite correctly, pointed to marketing costs as one of the main determinants of the scope of goods entering into international trade.[4] Unfortunately, he has no perspective of his own contribution, largely because he is quite unaware of the definitional compatibility between the "marketing function" as conceived by himself and "transportation" as traditionally used in the literature.

Linder's explanation of international trade[5] indi-

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during the life span of its economic production, enjoys different advantages in production and distribution. There is allegedly a way (unspecified) of deciding which products, in a given period of their life span, can be produced with advantage by a country at a certain level of economic development.

[1]Steffan B. Linder, An Essary on Trade and Transformation (Stockholm: Almquist and Wicksell, 1961).

[2]For instance, Lefeber, Allocation in Space, pp.132-133, and Stevens, Interregional Linear Programming, pp.158-160. While Lefeber spells out a way of extending his model into international trade (assuming one factor is perfectly immobile), Stevens, in a Chapter labelled "Alternative Models and Applications" hardly indicates how his model can be extended into international trade.

[3]These theories have been synthesized into an analytical framework by Caves in "'Vent for Surplus' Models of Trade and Growth," in Economics of Trade and Development, ed. by Therberge, pp.211-228.

[4]Hirsch, Location of Industry, pp.42-61.

[5]For an excellent chain of reasoning leading to their central hypothesis see Jagdish Bhagwati, Trade Tariffs and Growth (Cambridge: M.I.T. Press, 1969), pp.37-38.

rectly also underlines the influence of distribution costs. Producers, Linder argues, prefer catering to domestic rather than foreign markets. From the discussion (of Marshall, Ohlin and Lösch) in the first section of this Chapter, it will be clear that the overcoming of this unfamiliarity largely involves costs which can be reduced into distribution costs. In this sense, the Linder spill-over view of international trade represents an attempt at introducing distribution costs in a theory of international trade.

A similar attempt is more explicit in the works of contemporary students of location notably, Lefeber[1] and Stevens.[2] In these models, distribution costs--barring externalities from agglomeration, market imperfections, and other factors giving rise to non-linearities on the supply and demand sides--constitute the central equilibrating mechanism in the location of industry. From this viewpoint, the models of the location theorists share a kinship with the Linder view of international trade.

Yet from a methodological viewpoint, the models of the location theorists differ from the Linder view and the traditional models of international trade (notably those of Ricardo, Graham, and Heckscher-and-Ohlin). The location theorists assume that factors are, at least partly, mobile.

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[1]Lefeber, Allocation in Space.

[2]Stevens, Interregional Linear Programming.

on the other hand, trade theorists[1]--not unaware that factors can be mobile--prefer to assume that factors are perfectly immobile because of "climate" or "atmosphere." (The concepts of "climate" and "atmosphere" as used by economists such as Taussig[2] and Meade,[3] respectively, include not only natural factors such as physical climate and natural resources, but also social aspects such as tenacity to one's flag, birth place, etc.) Thus the two groups--the location theorists and trade theorists--appear to be methodologically at odds.

This methodological conflict is, however, more apparent than real. Suppose it is assumed--as will be done in this study--that all commodities are mobile, and that the only obstacle to this mobility is distribution costs. Then "climatic" or "atmospheric" immobility may translate into prohibitive distribution costs. In this context, the question of whether the models of the proponents of perfect factor immobility are better or worse than the models of the proponents of perfect factor mobility devolves ultimately upon merits in "practical applicability."[4]

The last group of recent models highlighting the

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[1]Joseph Schumpeter, History of Economic Analysis (New York: Oxford University Press, 1955), p.606.

[2]Cf. Caves, Trade and Economic Structure, p.126.

[3]Meade, Trade and Welfare, pp.348-354.

[4]Schumpeter, History of Economic Analysis, p.606.

influence of distribution costs on international trade includes the "staple" and "vent for surplus" theories. In an attempt to formalize these theories into an analytical model, Caves assumes there are two countries--one(I) is old and industrialized; the other(II) is relatively underpopulated and abounds with surplus natural resources. Assuming identical production functions (in terms of labor and capital), diminishing returns, and perfect competition, the operning up of the underpopulated country is triggered by differences in Ricardian rents. At first, the opening up process consists of the exploitation of the abundant natural resources.[1] Subsequently, the location of nonagricultural activities in this country develops according to two propositions:

(a) Services, facing infinite transportation costs, will be started with the establishment of the first export staple. Manufactures, incurring only infinitesimal transport costs, may also become economical claimants for factors of production in II.

(b) Whether or not manufacturing industries are established depends on the relative costs of international movement of goods and factors of produc-

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[1]Caves' synthesis fails to indicate the influence of distribution costs on the pattern of exploitation of the abundant natural resources. Douglass C. North in "Location Theory and Regional Economic Growth," Journal of Political Economy, Vol. LXII (June 1955), has, for instance, underlined the influence of changes in the modes of transportation. In the case of Canada, the monumental works of H. H. Innis suggest that the shift from international trade based on fur and fisheries to wheat, mineral resources, and timber reflects, inter alia, changes in transportation costs.

> tion, since we have assumed no indigenous growth of II's factor endowment. If the costs (however interpreted) of factor movements are small relative to the discounted present value of the costs of transporting II's exports and imports that can be avoided by their migration, as we shall assume, then at least some manufacturing industries . . . will be established in II.[1]

The concept of "the relative costs of international movements of goods and factors of production" used by Caves is a simple and intuitively clear device of assessing the influence of distribution costs on international trade. The concept has, incidentally, been used by others to classify industries from the viewpoint of international trade into supply- or resource-oriented, market-oriented, and foot-loose industries.[2] Excepting the works of Meade and the location theorists (already cited), this vital concept--of relative costs of factors and final goods--has hardly been explored seriously in the theoretical works of trade theorists. A sample of such exploration will be found in Chapter III of this study.

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[1]Caves, "'Vent for Surplus' Models," p.216.

[2]Kindleberger, International Economics, pp.123-127.

CHAPTER II

DISTRIBUTION AT THE FACTOR LEVEL

The objective of this Chapter is to develop the essential elements and analytical relationships of a one-factor, two-good, two-country model, encompassing factor mobility and costly distribution of the factor. This objective is accomplished by:

1) Spelling out the relevant assumptions, concepts, and technological relationships;

2) developing the model, and examining its importance to international economic analysis; and

3) studying the technological relationships in the distribution industry and the final goods industries.

Assumptions, Concepts, and Technological Relationships

The principal model in this Chapter rests upon the following main assumptions:

(i) It is desired to maximize world consumption.

(ii) Distribution costs for final goods are negligible.

(iii) The production of a good utilizes only one production process in each country. However, the production processes for a given good differ between countries.

(iv) There is only one factor of production, considered to be homogenious both within and among countries. (This is, therefore, a full employment model.)

(v) There are only two countries in the world. Therefore, all economic activities including the distribution of economic goods and services must be performed by at least one of the countries.

(vi) There are only two final goods.

(vii) There are two industries producing two distinct types of distribution services. One industry produces distribution services for the factor. The other industry produces distribution services for the final goods. The services produced by each industry constitute a homogeneous commodity, capable of quantification by some standard of measurement.[1]

(viii) Barring distribution services, there are no intermediate goods produced.

(ix) There is no joint production.

(x) Initial factor endowments are given.

(xi) All commodities are considered to be mobile. The only obstacle to international mobility of commodities is distribution costs. Other more superficial obstacles such as tariffs, quotas, blockades, etc., are absent.

(xii) Production and consumption activities in a country are concentrated at one point. Consequently, costs of distributing a commodity within a country are negligible.

(xiii) No distribution services are consumed by that quantity of the factor used in producing distribution services. Stated differently, the distribution industry itself can consume the factor at either country without entailing any distribution

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[1]The rationale for this assumption was discussed in the first section of Chapter I.

costs.[1]

(xiv) There is no "cross-hauling" à la Lefeber.[2] This assumption implies that (a) if, in a given country, the factor is being imported, it cannot, at the same time, be exported; (b) in any given industry, the factor imported from a foreign country is employed only after the factor of domestic origin is fully employed; and (c) the quantity of the factor used in producing distribution services is taken from the bundle of the factor earmarked for shipment.[3]

(xv) Country I is more efficient than Country II in performing the actual task of distributing commodities internationally. This assumption is maintained through most of the study. In Chapter V, however, the assumption is relaxed and the problem of choosing the efficient distributor(s) is explored.

Keeping the above assumptions in mind, the production functions and technical concepts forming the backbone of this Chapter are summarized on Table 1. Rows (1) and (2) on the Table show the production functions of the two final goods mentioned in assumption (vi) above. Rows (3) and (4) show the production functions for the two types of distribution services specified in assumption (vii). Rows (5) - (8) summarize technical coefficients (related to distribution services) which will be explained shortly.

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[1]This is just a simplifying assumption. Including distribution costs for the factor used in producing distribution services will make the presentation considerably more cumbersome without adding significantly to an understanding of the model.

[2]Cf. Lefeber, Allocation in Space, pp.19-32.

[3]It should be noted that this condition is nothing but condition (b) extended to the distribution industries.

Table 1

	Country I	Country II
The Production Function of		
(1) the first final good(X^1)	$X^{11} = \frac{V}{a^{11}}$	$X^{12} = \frac{V}{a^{12}}$
(2) the second final good(X^2)	$X^{21} = \frac{V}{a^{21}}$	$X^{22} = \frac{V}{a^{22}}$
The Distribution service for		
(3) the final goods(X_f^{31})	$X_f^{31} = \frac{V}{\alpha_1}$	-
(4) the factor(X_v^{31})	$X_v^{31} = \frac{V}{\alpha_2}$	-
Distribution Costs (in terms of the factor) per		
(5) unit of the factor	$= \lambda_{vv}$	-
(6) unit of a final good	$= \lambda_{fv}$	-
Input of Distribution Services per		
(7) unit of the factor	$= \beta_v$	-
(8) unit of a final good	$= \beta_f$	-

According to assumption (xv), Country I is more efficient than Country II in distributing goods internationally. Thus the maximization of world production would require that Country I alone undertake all the international distribution of commodities. Consequently, blank spaces are found under Country II on rows (3) - (8).

Referring to row (1) on the Table, the production of the first good, X^1, in Country I, X^{11},[1] is given by the pro-

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[1]To emphasize, the first superscript on the X's denotes the good, the second superscript denotes the country

duction function $X^{11} = \frac{V}{a^{11}}$ where V denotes any positive amount of the factor, and a^{11} is a production coefficient denoting the amount of the factor needed to produce one unit of X^1. The production of X^1 in Country II is given by the production function $X^{12} = \frac{V}{a^{12}}$ where V, again, denotes any positive amount of the factor, and a^{12} is the production coefficient. In keeping with assumption (iii) it should be noted that the two production functions are not identical, that is, $a^{11} \neq a^{12}$. Similarly, the production function of the second good in Country I is $X^{21} = \frac{V}{a^{21}}$ and in Country II is $X^{22} = \frac{V}{a^{22}}$. Again, $a^{21} \neq a^{22}$.

According to assumption (vii), there are two types of distribution services--one for the final goods, and one for the factor of production. The distribution service for the final goods is denoted by X_f^3. The production of this service in Country I, X_f^{31}, is given by the production function $X_f^{31} = \frac{V}{\alpha_1}$ where V is any positive amount of the factor, and α_1 is the production coefficient. Likewise, the production of the distribution service for the factor, X_v^3, in Country I, X_v^{31}, is given by the production function $X_v^{31} = \frac{V}{\alpha_2}$.

All production functions on rows (1) - (4) of Table 1 have now been explained. Still to be explained are the coefficients on rows (5) - (8). On row (5), λ_{vv} is the <u>real cost</u> of distributing a unit of the factor from one country to

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in which the good is produced.

another. This cost is reckoned in terms of units of the factor consumed in the actual process of distribution. Suppose, for example, that $\lambda_{vv} = 2$. This means that to distribute a unit of the factor from one country to another consumes two units of the factor. In a similar manner, λ_{fv} on row (6) refers to the cost (also in terms of the factor) of distributing one unit of any of the two final goods between two countries.

While the coefficients λ_{vv} and λ_{fv} are expressed in terms of the factor, the coefficients on rows (7) and (8) of Table 1 are expressed in terms of units of distribution services. On row (7), β_v refers to the units of the distribution service, X_v^3, consumed in the actual process of distributing a unit of the factor between the two countries. For instance, let $\beta_v = 1$. This means that to distribute a unit of the factor from one country to another consumes one unit of X_v^3. Likewise, β_f on Row (8) refers to units of distribution service, X_f^3, consumed in the actual process of distributing one unit of a final good between the two countries.

Deriving the World Production Possibilities Frontier

How do factor mobility and costly distribution of the factor relate to the world production possibilities frontier? In order to answer this question adequately, a concrete example will be handy. In the Example, V_1 and V_2 denote factor endowments in Countries I and II, respectively. All the coefficients in the Example have just been explained.

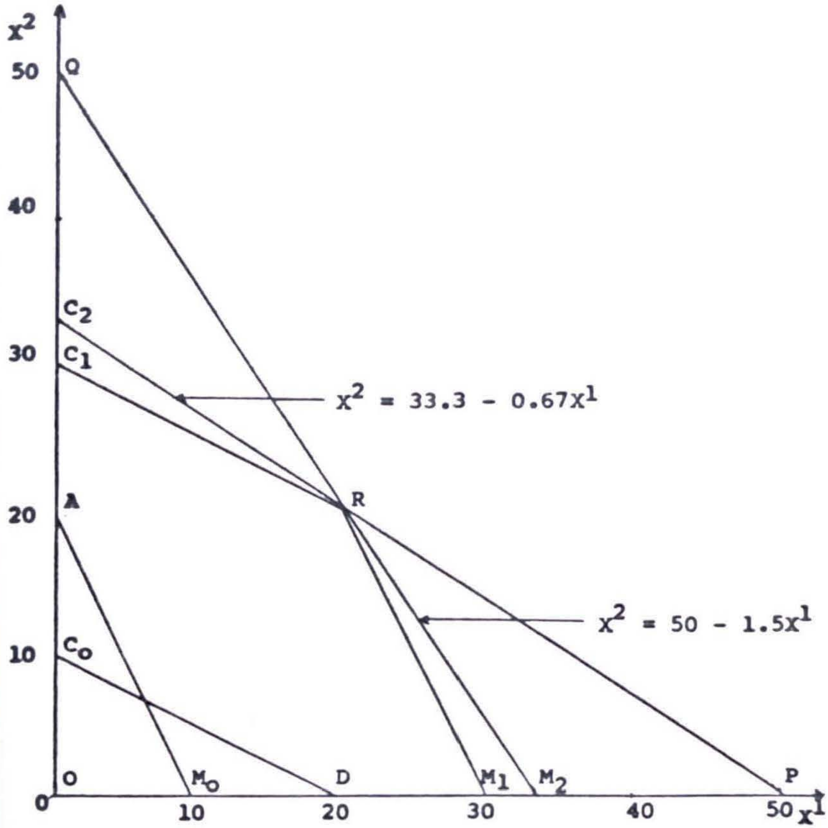
Example I

	Country I	Country II
(1) Factor endowment	$v_1 = 20$	$v_2 = 20$
Factor input per unit output of		
(2) the first final good(X^1)	$a^{11} = 1$	$a^{12} = 2$
(3) the second final good(X^2)	$a^{21} = 2$	$a^{22} = 1$
Distribution costs (in terms of the factor) per		
(4) unit of the factor	$\lambda_{vv} = 1/2$	
(5) unit of a final good	$\lambda_{fv} = 0$	

Assuming--as in the Ricardo-Graham type of models--that the factor is immobile, and that the distribution costs for the factor and the final goods are negligible, rows (1) - (3) contain all the information needed in deriving the world production possibilities frontier. (To avoid cumbersome repetitions, the phrase "world production possibilities frontier" will be denoted by "P/F," for brief.) The P/F is shown on Figure 1.

On the Figure, the two final goods, X^1 and X^2 are shown on the horizontal and vertical axes, respectively. OC_oD is the production block for Country I. The side $OC_o = \frac{v_1}{a^{21}} = \frac{20}{2} = 10$, and the side $OD = \frac{v_1}{a^{11}} = \frac{20}{1} = 20$. For Country II the production block is OAM_o--the side OA being

Figure 1


x^2
50
40
30
20
10
0
Q
C_2
C_1
$x^2 = 33.3 - 0.67x^1$
R
A
$x^2 = 50 - 1.5x^1$
C_o
O
M_o
D
M_1
M_2
P
10
20
30
40
50
x^1

equal to $\frac{V_2}{a^{22}} = \frac{20}{1} = 20$, and the side AM_o being equal to $\frac{V_2}{a^{12}} = \frac{20}{2} = 10$. The P/F OC_1RM_1 is simply obtained by gliding vertically the production block (OAM_o) for Country II down the side C_oD of the production block (OC_oD) for Country I. This is the P/F commonly envisaged in the traditional Ricardo-Graham type of models.[1]

In these models it is immaterial whether the P/F is conceived in terms of final goods at the country of consumption or production. Since distribution costs for final goods are negligible, a good can be distributed more or less freely from one country to another. Hence, the P/F in terms of final goods at the country of production is identical to the P/F in terms of final goods at the country of consumption.

Suppose now it is assumed that the factor is mobile,[2] and that distribution is costly. In particular, let it be assumed, to start with, that the distribution of the factor is costly whereas the distribution of the final goods continues to be free.

So long as the distribution of final goods is free, there is again no need to distinguish the P/F in terms of

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[1]It should be noted that the production block for Country II, i.e., OAM_o, is identical to triangle RDM_1. Also, the production block of Country I, i.e., OC_oD is identical to triangle AC_1R.

[2]Whether this mobility is motivated by the "invisible" hand or by the actions of a centralized world planning organ is beside the point here.

goods at the countries of production from the P/F in terms of goods at the countries of consumption. However, with factor mobility and costly distribution of the factor, a "new" P/F, which is fundamentally different from the P/F in the Ricardo-Graham type of models, is now conceivable.

Of special interest here is whether this new P/F is larger or smaller than the P/F feasible under the assumption of factor immobility, as in the Ricardo-Graham models. If the new P/F is larger, then factor mobility enhances world consumption. Otherwise, if the new P/F is smaller, factor mobility must be eschewed if world consumption is to be maximized.

All the information needed in deriving the new P/F can be found on Example I. According to the Example, Country I has absolute advantage in producing the first final good (i.e., $a^{11} < a^{12}$). On the other hand, Country II has an absolute advantage in producing the second final good (i.e., $a^{22} < a^{21}$). If Country I concentrates on the production of the first good and Country II on the second, it is possible that a redistribution of the factor may increase world production. In order to show the effect of this redistribution on the P/F, attention is first focused to the left of the line DR on Figure 1.

Suppose the amount of the first good, X^1, produced is such that $0 \leq X^1 < OD$. This amount will, as has been argued, be produced in Country I, thus consuming $a^{11}X^1$ of its factor endowment, V_1, and leaving $(V_1 - a^{11}X^1)$ for export to Country II. Not all $(V_1 - a^{11}X^1)$ of the factor exported will reach the destination, however. Some of the factor will be used in the actual process of effecting the export, that is, in producing distribution services. Let the amount of the factor used in the process of exporting a unit of the factor be λ_{vv}, as explained under Table above. If the export of one unit of the factor consumes λ_{vv} units of the factor in the process of distribution, then only $\frac{1}{1 + \lambda_{vv}}$ of each unit of the factor earmarked for export in Country I will reach Country II. Consequently, of the $(V_1 - a^{11}X^1)$ of the factor earmarked for export from Country I, Country II will receive $\frac{1}{1 + \lambda_{vv}}(V_1 - a^{11}X^1)$. Therefore, the maximum amount of X^2 capable of being produced in Country II is given by

$$X^2 = \frac{V_1 + \frac{1}{1 + \lambda_{vv}}(V_1 - a^{11}X^1)}{a^{22}} \quad \ldots\ldots\ldots\ldots\ldots(1)$$

or, simplifying,

$$X^2 = \frac{V_2(1 + \lambda_{vv}) + V_1}{a^{22}(1 + \lambda_{vv})} - \frac{a^{11}}{a^{22}(1 + \lambda_{vv})}X^1 \quad \ldots\ldots(2)$$

To emphasize, equation (2) gives the maximum amount of X^2 which can be produced for all levels of X^1 such that $0 \leq X^1 \leq OD$. In other words, equation (2) describes a portion of a P/F above the segment OD on Figure 1.

Still working with Figure 1, attention is now shifted to the right of the line DR. The maximum amount of X^1 that Country I can produce is $\frac{V_1}{a^{11}}$. Suppose, then, that $X^1 > \frac{V_1}{a^{11}}$. Since all X^1 is, as argued earlier, to be produced in the first country, some amount of the factor must be exported from Country II to meet the production of $(X^1 - \frac{V_1}{a^{11}})$ in Country I. The production of $(X^1 - \frac{V_1}{a^{11}})$ of X^1 in Country I needs $a^{11}(X^1 - \frac{V_1}{a^{11}})$ of the factor. The actual process of exporting $a^{11}(X^1 - \frac{V_1}{a^{11}})$ of the factor from Country II will itself consume $\lambda_{vv}\, a^{11}(X^1 - \frac{V_1}{a^{11}})$ of the factor. Therefore, the maximum amount of X^2 which can be produced in Country II is given by

$$X^2 = \frac{V_2 - a^{11}(X^1 - \frac{V_1}{a^{11}}) + \lambda_{vv}\, a^{11}(X^1 - \frac{V_1}{a^{11}})}{a^{22}} \quad \ldots(3)$$

or, simplifying,

$$X^2 = \frac{a^{11}V_2 + a^{11}V_1 + \lambda_{vv}V_1}{a^{11\,22}} - \frac{a^{11}}{a^{22}}(1 + \lambda_{vv})X^1 \quad \ldots\ldots(4)$$

Equation (4), then, shows the maximum amounts of X^2 which can be produced for all feasible levels of X^2 such that $X^2 > \frac{V_1}{a^{11}}$. Stated differently, equation (4) describes a portion of the P/F above the horizontal axis to the left of the line DR on Figure 1.

The meaning of equations (2) and (4) can be seen more clearly if the numerical values (from Example I) for V_1, V_2,

a^{11}, a^{22}, and λ_{vv} are substituted into the equations. After the substitution, equation (2) becomes

$$X^2 = 33.3 - 0.67X^1 \quad \text{..................(2)'}$$

and equation (4) becomes

$$X^2 = 50 - 1.5X^1 \quad \text{.....................(4)'}$$

These last two equations are, in turn, plotted on Figure 1 where C_2P represents equation (2)', and M_2Q represents equation (4)'. From the explanation given above for equations (2) and (4) it will be obvious that the P/F being sought is OC_2RM_2.

The P/F and changes in distribution costs, λ_{vv}

In deriving the P/F OC_2RM_2 on Figure 1, the numerical value substituted into equations (2) and (4) for λ_{vv} was 1/2. What is the effect, <u>ceteris paribus</u>, of changes in λ_{vv} on the P/F? Suppose the numerical values for V_1, V_2, a^{11}, and a^{22} from Example I are substituted into equations (2) and (4). After this substitution, equation (2) becomes

$$X^2 = \frac{20(2 + \lambda_{vv})}{1 + \lambda_{vv}} - \frac{1}{1 + \lambda_{vv}}X^1 \quad \text{..............(2)''}$$

and equation (4) becomes

$$X^2 = 20(2 + \lambda_{vv}) - (1 + \lambda_{vv})X^1 \quad \text{...........(4)''}$$

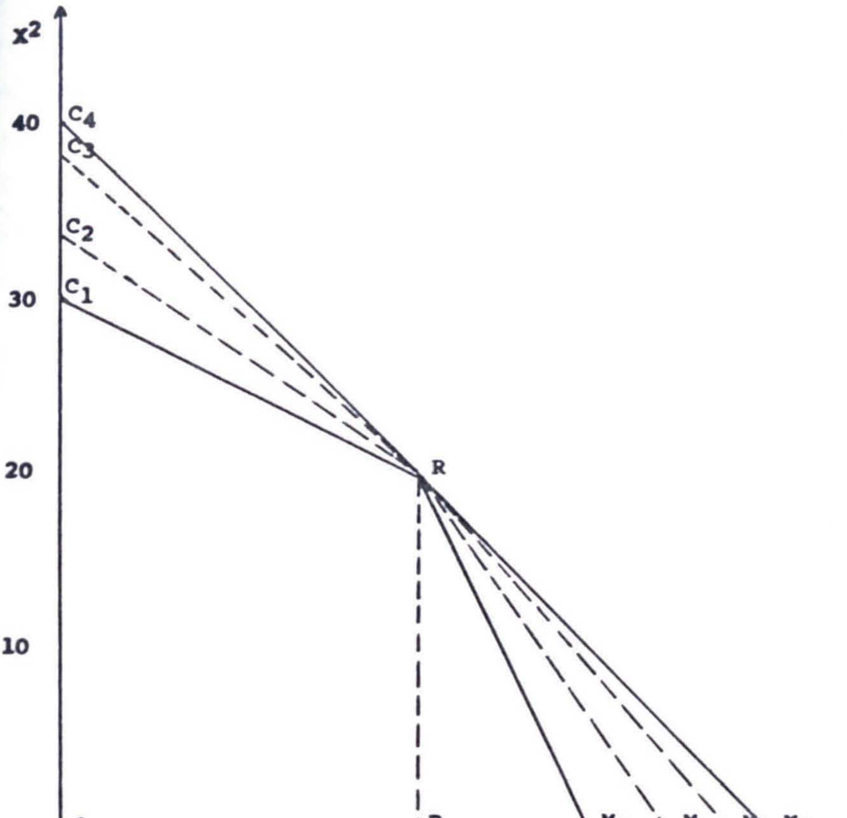
It will be recalled that equations (2) and (4) stand for lines which define the boundaries of the P/F. From equations (2)" and (4)" it can be seen that the intercepts and slopes of these lines are influenced, inter alia, by distribution costs, λ_{vv}. It may, therefore, be suspected that the size and shape of the P/F is partly influenced by distribution costs. In order to see this influence more clearly, various values of λ_{vv} are substituted into equations (2)" and (4)".

Values of λ_{vv}	Equation (2)"	Equation (4)"
1. $\lambda_{vv} = 1$	$x^2 = 30.0 - 0.5x^1$	$x^2 = 60 - 2.0x^1$
2. $\lambda_{vv} = 0.5$	$x^2 = 33.3 - 0.7x^1$	$x^2 = 50 - 1.5x^1$
3. $\lambda_{vv} = 0.1$	$x^2 = 38.2 - 0.9x^1$	$x^2 = 42 - 1.1x^1$
4. $\lambda_{vv} = 0$	$x^2 = 40.0 - 1.0x^1$	$x^2 = 40 - 1.0x^1$

On each row there are two equations which, like equations (2) and (4), define the boundaries of a P/F corresponding to the stipulated numerical value for λ_{vv}. The four P/F's corresponding to the four rows are shown on Figure 2. The P/F for row 1, where $\lambda_{vv} = 1$, is OC_1RM_1. If λ_{vv} drops to 0.5, a larger P/F OC_2RM_2 is obtained. If λ_{vv} drops farther to 0.1, the P/F is OC_3RM_3. Ultimately, if λ_{vv} drops to zero, the P/F is the triangle OC_4M_4.

When $\lambda_{vv} = 1$, the P/F OC_1RM_1(Figure 2) is as large as the similarly labelled P/F on Figure 1. In the latter Figure, however, the P/F was derived on the assumption that

Figure 2



the factor is immobile. Thus when $\lambda_{vv} = 1$, moving the factor cannot (according to Example I) enhance world output beyond the levels attainable under the assumption of factor immobility.. However, as distribution costs, λ_{vv}, drop below unity, factor mobility enhances world consumption. By the same token if λ_{vv} is larger than unity, factor mobility yields a P/F smaller than that which is obtainable under the assumption of factor immobility. Hence, factor movement must, in this case, be eschewed if world consumption is to be maximized.

Marginal conditions for factor movements

Whether the factor movement enhances world consumption depends upon the prevailing absolute level of distribution costs, λ_{vv}, and the differences in the production coefficients. This point can quickly be explained with the help of Figure 1.

In discussing the Figure it was pointed out that for any level of X^1 such that $0 \leq X^1 < \frac{V_1}{a^{11}}$, the unemployed factor in Country I is shipped to Country II, the country with the absolute advantage in the production of X^2. More specifically, for any given X^1 in the designated range, $(V_1 - a^{11}X^1)$ of the factor will be available for export from Country I. After allowing for distribution costs, $\frac{1}{1 + \lambda_{vv}}(V_1 - a^{11}X^1)$ of the factor shipped from Country I will reach Country II. But this shipment will only occur if it results in a higher level of output of X^2 (in Country II) than can be produced in Country I, that is, if:

$$\frac{V_1 - a^{11}X^1}{a^{22}(1 + \lambda_{vv})} > \frac{V_1 - a^{11}X^1}{a^{21}} \quad \text{................(5)}$$

Dividing through by $(V_1 - a^{11}X^1)$, taking reciprocals of both sides, and expressing the result in the form of an equation gives

$$a^{22}(1 + \lambda_{vv}) = a^{21} \quad \text{or}$$

$$a^{22}\lambda_{vv} = a^{21} - a^{22} \quad \text{......................(6)}$$

Before explaining this equation, a corresponding equation for values of X^1 such that $X^1 \geq \frac{V_1}{a^{11}}$, should be derived. When $X^1 \geq \frac{V_1}{a^{11}}$, some of the factor must be shipped from Country II if the production of X^1 is to be carried on in Country I, the country with the absolute advantage in the production of X^1. Again, such shipment will occur only if producing X^1 in Country I rather than Country II results in a larger output. Thus, assume there is a unit of the factor in Country II. By shipping the unit to Country I, $\frac{1}{a^{11}(1 + \lambda_{vv})}$ of X^1 can be produced. If, instead, the unit is used in Country II, $\frac{1}{a^{12}}$ of X^1 can be produced. Consequently, the shipment will occur only if:

$$\frac{1}{a^{11}(1 + \lambda_{vv})} > \frac{1}{a^{12}} \quad \text{......................(7)}$$

Taking reciprocals of both sides, and expressing the result in the form of an equation

$$a^{11}(1 + \lambda_{vv}) = a^{12} \quad \text{or}$$
$$a^{11}\lambda_{vv} = a^{12} - a^{11} \quad \text{....................(8)}$$

Equation (6), then, describes a borderline situation when a shipment of the factor from Country I to Country II neither enhances nor diminishes production of X^2. In this situation, "unit" distribution costs $(a^{22}\lambda_{vv})$ equal the difference in the production coefficients $(a^{21} - a^{22})$. It should be emphasized here that $a^{22}\lambda_{vv}$ is the total distribution costs absorbed in the process of shipping from Country I to Country II as much of the factor as is needed in order to produce a unit of X^2 in Country II. If, instead, $a^{22}\lambda_{vv} > a^{21} - a^{22}$, shipping the factor from Country I to Country II will diminish the production of X^2. Conversely, if $a^{22}\lambda_{vv} < a^{21} - a^{22}$, the shipment will enhance the production of X^2. Equation (8) applies, mutatis mutandis, to the first good, X^1.

Comparison and contrast with the Ricardo-Graham model

Thus far, the derivation of the P/F when the factor is mobile and its distribution is costly has been discussed. What, then, are the analytical implications of the P/F? The question can, perhaps, be answered best by comparing and contrasting this P/F to that which is implied in the Ricardo-Graham type of models.

Two P/F's already shown on Figure 2 namely, OC_1RM_1 and OC_2RM_2, are reproduced separately on Figure 3. On Figure 3(a) is the P/F, OC_1RM_1. This is the P/F which, as discussed before, obtains in the Ricardo-Graham type of models where the factor is mobile and distribution is costless. In contrast, when the factor is mobile and distribution is costly (say $\lambda_{vv} = 1/2$), the obtaining P/F is OC_2RM_2. This P/F is shown on Figure 3(b).

Before continuing with the discussion at hand, a word on the slopes of the line segments defining the boundaries of the P/F's on Figure 3 is in order. These slopes are shown at the bottom of Figure 3. For Figure 3(a) where OC_1RM_1 is the P/F in the Ricardo-Graham type of models, the slope of M_1R (= tan θ_1) represents the opportunity cost of producing the two final goods in Country II, since $\tan \theta_1 = \frac{RD}{M_1D}$[1] $= \frac{V_2}{a^{22}} \Big/ \frac{V_2}{a^{22}} = a^{12} / a^{22}$. Likewise, the slope of C_1R (= tan θ_2) represents the opportunity cost of producing the final goods in Country I because $\tan \theta_2 = \frac{C_1Q}{QR} = \frac{V_1}{a^{21}} \Big/ \frac{V_1}{a^{11}} = a^{11} / a^{21}$. For Figure 3(b) where OC_2RM_2 is the P/F when the factor is mobile and distribution is costly, the algebraic values of the slopes of C_2R and RM_2 have already been derived on equations (2) and (4). From equation (2), the slope of C_2R

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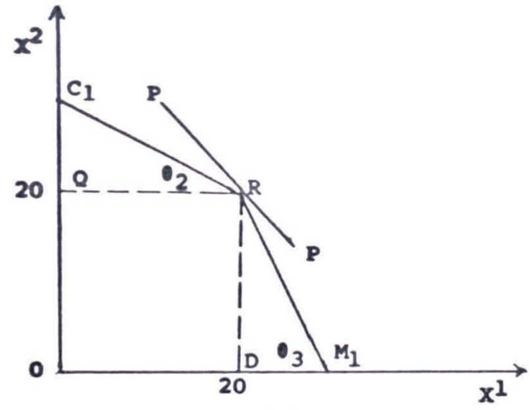
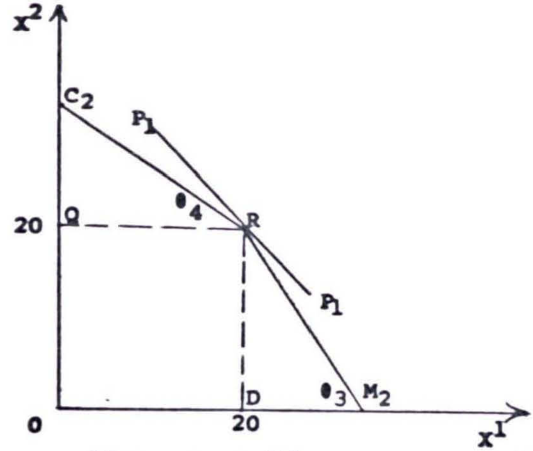
[1]It has already been observed that D's, RDM_1, and C_1QR are identical to the production blocks of Countries II and I, respectively.

Figure 3



(a)

$$\tan\theta_1 = \frac{a^{12}}{a^{22}} \qquad \tan\theta_2 = \frac{a^{11}}{a^{21}}$$



(b)

$$\tan\theta_3 = \frac{a^{11}(1 + \lambda_{vv})}{a^{22}} \qquad \tan\theta_4 = \frac{a^{11}}{a^{22}(1 + \lambda_{vv})}$$

is $\frac{a^{11}}{a^{22}(1 + \lambda_{vv})}$. Similarly, from equation (4) the slope of $RM_2 = \frac{a^{11}(1 + \lambda_{vv})}{a^{22}}$.

Suppose, as shown on Figure 3, PP and P_1P_1 represent international barter terms of trade between the two final goods, X^1 and X^2. Optimum production, then, occurs at the points of tangency between the price lines PP and P_1P_1 and the respective P/F's. On Figure 3(a), production occurs at point R where Country I produces OD of X^1, and Country II produces DR of X^2. In other words, there is complete specialization. Similarly, on Figure 3(b) optimum production is represented by point R. At this point, Country I produces OD of X^1, and Country II produces DR of X^2. Again, there is complete specialization in the traditional sense.[1] As a general observation it can then be seen that introducing factor mobility and costly distribution does not, in this one-factor model, necessarily rule out complete "specialization."[2]

More specifically, complete specialization occurs if the barter terms of trade are, to use Graham's terminology, in the "limbo" region. In the Ricardo-Graham model (on Fig-

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[1]In this case, where (with permissively low distribution costs) each country specializes in the production of a given good at every point on the P/F, the word "specialization" clearly does not carry its traditional meaning. Traditionally, complete specialization--according to this model--would have meant that all the factor endowment in a country is used in the production of one of the goods.

[2]Again, the word "specialization" here is being used in the traditional sense (see footnote immediately above).

ure 3a) the terms of trade are in the limbo region if the slope of the price line PP[1] is larger than the slope of C_1R and smaller than the slope of RM_1 (that is, $\tan\theta_2 < \tan\phi_1 < \tan\theta_1$, or, to use the algebraic values discussed above, $\frac{a^{11}}{a^{21}} < \tan\phi_1 < \frac{a^{12}}{a^{22}}$). When, instead, the factor is mobile and its distribution is costly (Figure 3b), the terms of trade are in the limbo region if the slope of the price line P_1P_1 is larger than the slope of C_2R but smaller than the slope of RM_2 (i.e., $\tan\theta_4 < \tan\phi_2 < \tan\theta_3$ or, $\frac{a^{11}}{a^{22}(1+\lambda_{vv})} < \tan\phi_2 < \frac{a^{11}(1+\lambda_{vv})}{a^{22}}$).

The boundaries of the limbo regions in these two types of models, however, offer interesting contrasts. In the Ricardo-Graham model the boundaries of the limbo region (i.e., $\frac{a^{11}}{a^{21}}$ and $\frac{a^{12}}{a^{22}}$) are simply the national opportunity costs of producing the two final goods. In the model presently being studied, the boundaries (i.e., $\frac{a^{11}}{a^{22}(1+\lambda_{vv})}$ and $\frac{a^{11}(1+\lambda_{vv})}{a^{22}}$) consists of a product of the ratio of the "absolute advantage coefficients," $\frac{a^{11}}{a^{22}}$, and weighted terms ($\frac{1}{1+\lambda_{vv}}$, and $1+\lambda_{vv}$) which reflect distribution costs.

The importance of the boundaries of the limbo region in the Ricardo-Graham model has been noted in various con-

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[1]The slope of the price line PP, of course, represents the barter terms of trade otherwise represented in this case as

$$\frac{\text{" the price of } X^1\text{"}}{\text{" the price of } X^2\text{"}} .$$

texts.[1] Graham himself, for example, contended that

> . . . opportunity cost, rather than demand, is the significant factor in the determination of normal international values.[2]

And

> . . . the (normal) values of internationally traded commodities are not determined by reciprocal national demands.[3]

Stated differently, Graham's contention is that normally the terms of trade (i.e., $\tan \phi_1$) are such that $\tan \phi_1 = \frac{a^{12}}{a^{22}}$ or $\tan \phi_1 = \frac{a^{11}}{a^{21}}$ rather than $\frac{a^{11}}{a^{21}} < \tan \phi_1 < \frac{a^{12}}{a^{22}}$.

Assume, at least for the sake of argument, that Graham's contention is correct[4] and that the production of internationally traded commodities is characterized by factor mobility and costly distribution, as in the model being studied. Graham's contention would, therefore, be changed to read that normally the terms of trade are such that (see Fig-

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[1]In an international linear programming problem aimed at maximizing world production, the coincidence of a price line with a limbo boundary raises problems of indeterminacy.

[2]Frank D. Graham, The Theory of International Values (Princeton; Princeton University Press, 1948), p.17.

[3]Ibid., 16.

[4]A critical evaluation of this contention is outside the purview of the present study. For a serious study of this and other related contentions see Thomas M. Whitin, "Classical Theory, Graham's Theory, and Linear Programming in International Trade," Quarterly Journal of Economics, Vol. LXVII (November 1953), pp.520-532.

ure 3b):

$$\tan \phi_2 = \frac{a^{11}(1 + \lambda_{vv})}{a^{22}} \quad \text{or} \quad \tan \phi_2 = \frac{a^{11}}{a^{22}(1 + \lambda_{vv})}$$

rather than

$$\frac{a^{11}}{a^{22}(1 + \lambda_{vv})} < \tan \phi_2 < \frac{a^{11}(1 + \lambda_{vv})}{a^{22}}.$$

In this case, the "absolute advantage coefficients" (a^{11} and a^{12}) and distribution costs (λ_{vv}) would then constitute the "normal" elements of the terms of trade.

One interesting corollary of interpreting the boundaries of the limbo region in terms of, inter alia, distribution costs can be seen on Figure 2. In discussing this figure, it was pointed out that as λ_{vv} declines from 1.0 to 0.5, 0.1, and 0, the P/F's outer side, C_1RM_1, shifts to C_2RM_2, C_3RM_3, and C_4M_4, respectively. Alongside these shifts is a contraction of the limbo region as evidenced by the decline from the reflex angle C_1RM_1 to reflex angles C_2RM_2, C_3RM_3, and the straight line, C_4M_4. In brief, the lower the distribution costs, the "narrower" the limbo region.

Suppose then, as generally contended, that the past significant improvements in transportation and communication can be translated into declining distribution costs (λ_{vv}). According to this model, the decline would be accompanied by a narrowing of the limbo region, meaning that a small disturbance is now enough to throw the terms of trade outside this region. This, in turn, may mean that

(a) complete specialization in the traditional sense is now less likely than it was when distribution costs were significantly higher; and

(b) the absolute advantage coefficients, a^{11} and a^{12}, are increasingly becoming the normal determinants of the terms of trade. This observation follows from the fact that as λ_{vv} approaches zero, the limits of the boundaries of the limbo region, that is, $a^{11} / a^{22}(1 + \lambda_{vv})$ and $a^{11}(1 + \lambda_{vv}) / a^{22}$, is a^{11} / a^{22}.

The Distribution Industry

Until now, the discussion on the derivation of the P/F and its relevancy for economic analysis has focused on distribution costs in terms of the factor, that is, λ_{vv}. What, then, determines λ_{vv}? In order to answer the question quickly a brief reference to Table 1 is helpful. On the Table, the production function for distribution services (X_v^{31}) is

$$X_v^{31} = \frac{V}{\alpha_2} \quad \text{..............................(9)}$$

Again, on the same Table, β_v was defined as the units of distribution services, X_v^{31}, consumed in the actual process of distributing a unit of the factor between the two countries. Suppose that enough services are produced to distribute <u>only one unit</u> of the factor, that is

$$X_v^{31} = \beta_v \quad \text{..............................(10)}$$

Substituting β_v for X_v^{31} in equation (9) gives

$$\beta_v = \frac{1}{\alpha_2} V^{**} \quad \text{.........................(11)}$$

where $V^{**} = \lambda_{vv}$; and (from equation 9) $\frac{1}{\alpha_2} = \frac{X_v^{31}}{V}$, i.e., $\frac{1}{\alpha_2}$ is the productivity of the factor in the distribution industry. Letting $\frac{1}{\alpha_2} = \gamma_v$, equation (11) can, then, be written as:

$$\beta_v = \gamma_v \lambda_{vv} \quad \text{or}$$

$$\lambda_{vv} = \frac{\beta_v}{\gamma_v} \quad \text{.............................(12)}$$

In other words, distribution costs vary inversely with productivity, γ_v, in the distribution industry, and directly with the input coefficient, β_v, for distribution services.

On Figure 2 it was noted that a decline in distribution costs, λ_{vv}, was accompanied by a increase in the size of the P/F. From equation (12), such a decline in λ_{vv} may be the result of (a) a decline in β_v with γ_v remaining constant, (b) an increase in productivity, γ_v, with the input coefficient β_v remaining constant, or (c) changes in both β_v and γ_v. Any of such changes would, by lowering λ_{vv}, increase the size of the P/F and vary its shape. In order to show directly the influence of β_v and γ_v on the P/F, $\frac{\beta_v}{\gamma_v}$ can be substituted for λ_{vv} in equations (2) and (4)--the equations defining the boundaries of the P/F. After the substitution, equation (2) becomes

$$X^2 = \frac{V_2(1 + \frac{\beta_v}{\gamma_v}) + V_1}{a^{22}(1 + \frac{\beta_v}{\gamma_v})} - \frac{a^{11}}{a^{22}(1 + \frac{\beta_v}{\gamma_v})} X^1$$

and equation (4) becomes

$$X^2 = \frac{a^{11}V_2 + a^{11}V_1 + \frac{\beta_v V_1}{\gamma_v}}{a^{11}a^{22}} - \frac{a^{11}}{a^{22}}(1 + \frac{\beta_v}{\gamma_v})X^1$$

In these equations it can be seen that changes in β_v and/or γ_v, like the changes in λ_{vv} discussed earlier, by influencing both the intercepts and the slopes, will also influence the size and shape of the P/F. Additionally, the slope of the P/F, through its influence on the limbo region, has further implications for international specialization and terms of trade.[1]

Practical implications of
the coefficients β_v and γ_v

Thus far, the influence of the input coefficient (β_v) and productivity (γ_v) on distribution costs (λ_{vv}) and the P/F has been discussed largely from a theoretical viewpoint. It may therefore be doubted whether the discussion has any practical significance. Do the categories β_v and γ_v, for example, have any counterparts in the "real" world? What, in the everyday world, constitutes a change in β_v, or, for that matter, a change in Isard's transport inputs? Can changes in β_v actually be distinguished from changes in γ_v?

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[1]These implications have already been noted. Discussing them again would add little that is new here.

For practical purposes it may be helpful to look at β_v as constituting aggregate inputs of whatever services may be needed in performing the necessary distribution functions, namely[1]

(a) function of buying and selling (including the subfunctions of product planning and development, creating demand, negotiation and drawing up of contracts, planning and product assembling);

(b) functions of physical supply, mainly including transportation and storage; and

(c) facilitating functions which include financing, risk-taking, market information and standardization.

These functions are interrelated. For example, as a product becomes more standardized, inputs (expenditures) on product planning and development, creating demand, and making contacts will, *ceteris paribus*, decline.[2] According to the vocabulary of this study then, as the product becomes more standardized its input coefficient for distribution services will decline. Incidentally, it may, by the same token, be assumed that since raw materials generally have traditionally established markets and are more "mature" and standardized than manufactures, they

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[1]The grouping of these functions is adopted from Rayburn D. Tousley et al., *Principles of Marketing* (New York: The Macmillan and Co., 1962) pp.14-21, 365-539.

[2]This is a popular theme among the "product cycle" theorists cf. Raymond Vernon, "International Investment and International Trade in the Product Cycle," *Quarterly Journal of Economics*, Vol. (May 1966), pp.190-207.

would normally tend to have relatively low input coefficients for distribution services.

The production of the services needed in performing the distribution functions can be visualized with the help of a production function, as explained on Table 1. This production function, much like a production function for a manufacturing sector or national output, defines a relationship between inputs of productive factors and the output of the distribution industry. This output consists of a myriad of commodities such as insurance, storage, transportation, advertising, sorting, and financial services. One can, therefore, reasonably talk of the productivity of a factor employed in the distribution industry (i.e., γ_v) just as one can talk of the productivity of a factor employed in the manufacturing industry.

When viewed in the manner indicated above, β_v and γ_v are quite capable of exhibiting independent changes. Consider, for instance, the following situations illustrating the various possible changes in β_v and γ_v which, according to equation (12), are capable of producing a decline in distribution costs λ_{vv} and hence, an enlargement of the P/F as well as changes in its shape. The possible changes are:

(a) A decline in β_v with γ_v remaining constant.[1]
According to the "product cycle" theorists, as

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[1]To emphasize, equation (12) is $\lambda_{vv} = \beta_v / \gamma_v$. Clearly distribution costs, λ_{vv}, will decline if β_v declines with γ_v remaining constant.

as product "matures" it becomes more standardized and thus its marketing is facilitated.[1] Viewed over its life span, the product may therefore be assumed to have declining input coefficients, β_v, for marketing services. Such a decline can clearly occur without being accompanied by an increase in the productivity of the factors employed in the distribution activities.

(b) An increase in productivity, γ_v, with the input coefficient, β_v, remaining constant: The remarkable breakthroughs in the areas of transportation and communications have, as often alleged, increased considerably the productivity of the factors employed in international distribution. There is, however, no reason to assume that this impressive increase in productivity was accompanied by a comparable change in input coefficients for distribution services. This is perhaps more true with raw materials. The shipment of a ton of sisal or coffee between two points, for example, needs the same volume and energy expenditure on a canoe as on a sail boat or a steam boat. Besides, raw materials, with their traditionally established markets and their high degree of standardization, still continue to use more or less similar marketing channels and facilities (e.g., commodity exchanges, warehousing, etc.).

(c) Changes in both β_v and γ_v (for instance, an increase in β_v and γ_v): Changes such as those discussed under (a) and (b) where only γ_v or β_v change are perhaps rare. A change in γ_v resulting, say from a superior mode of transportation, will most likely influence a marketing function such as warehousing, demand creation, or making contact, thus provoking a change in β_v. Likewise, a change in the input coefficient, β_v, may provoke a change in productivity, γ_v. Consider, for example, a decrease in the carrying capacity of a ship caused by the introduction of an otherwise convenient device such as contenarization. The decline in capacity may be seen as the result of an increase in the input coefficient βv of the load carried by the ship. On the other hand, the introduction of contenarization may, at the same time,

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[1] *Ibid.*

spur an increase in the productivity of the factors employed in the shipping industry.

Changes in Productivity in the Final Goods Industries

Much of the discussion on the derivation of the P/F and its implications for economic analysis was illustrated with Example I. On the Example the stipulated production coefficients are such that with sufficiently low values for distribution costs, λ_{vv}, the maximization of world production requires each country to produce only one of the final good. More specifically, when λ_{vv} is less than unity, world production is maximized if Country I produces X^1, and Country II produces X^2. Suppose now λ_{vv} is held constant (say at $\lambda^*_{vv} = 1/2$) while the production coefficients are allowed to vary. In general, this variation can produce four different types of cases:

Types of Cases	Prerequisite conditions (for the illustrative case)[1]
(i) Each country produces only one of the goods. <u>Illustration</u>: Country I produces X^1 and Country II produces X^2.	$a^{11}\lambda^*_{vv} < a^{12} - a^{11}$ $a^{22}\lambda^*_{vv} < a^{21} - a^{22}$
(ii) Every country produces both goods. <u>Illustration</u>: Assume $a^{11} < a^{12}$ and $a^{22} < a^{21}$.	$a^{11}\lambda^*_{vv} \geq a^{12} - a^{11}$ $a^{22}\lambda^*_{vv} \geq a^{21} - a^{22}$

[1]In this column λ^*_{vv} is used to remind the reader that distribution costs, λ_{vv}, are, by assumption, constant.

(iii) One good is produced by one country while the other good is jointly produced by both countries.
<u>Illustration</u>: X^1 is produced by Country I. X^2 is jointly produced by both countries.

$$a^{11}\lambda^*_{vv} < a^{12} - a^{11}$$
$$a^{22}\lambda^*_{vv} > a^{21} - a^{22}$$

(iv) One country produces both goods.
<u>Illustration</u>: Country I produces both goods.

$$a^{11}\lambda^*_{vv} < a^{12} - a^{11}$$
$$a^{21}\lambda^*_{vv} < a^{22} - a^{21}$$

Type (i) (which includes Example I in the text) refers to cases where the inter-country differences in absolute advantage (in the production of each good) are so large as to warrant factor movements from lower to higher productivity countries. Stated differently, the <u>total unit distribution costs</u> (see discussion of equations 6 and 8) are less than the differences in the production coefficients. Thus in the case where Country I produces X^1 and Country II produces X^2, the prerequisite conditions for factor movements would then be $a^{11}\lambda^*_{vv} < a^{12} - a^{11}$ and $a^{22}\lambda^*_{vv} < a^{21} - a^{22}$.

Type (ii) includes cases where inter-country differences in absolute advantage in the production of all goods are not large enough to warrant advantageous factor movements between the two countries. That is to say, total unit distribution costs are at least equal to the difference in the production coefficients. Hence if it is assumed that $a^{11} < a^{12}$, and $a^{22} < a^{21}$, the conditions $a^{11}\lambda^*_{vv} \geqq a^{12} - a^{11}$ and $a^{22}\lambda^*_{vv} \geqq a^{21} - a^{22}$ prevail. For all cases falling under type (ii) the relevant P/F's are, therefore, identical to to those in the Ricardo-Graham type of models where factor immobility and free distribution are assumed.

Type (III) includes cases where inter-country differences in absolute advantage warrant factor movements in the production of only one of the goods. For example, let Country I have a substantial advantage in the production of X^1 so that $a^{11}\lambda^*_{vv} < a^{12} - a^{11}$. Furthermore, let Country II have only a small advantage in the production of X^2 so that $a^{22}\lambda^*_{vv} \gtreqless a^{21} - a^{22}$. World production here will be maximized if X^1 is produced in Country I while X^2 is produced in Countries I and II. Given V_1 and V_2 as the factor endowments of Countries I and II, respectively, the P/F in this Example can easily be defined.

Suppose the P/F is represented by OCRM as shown on Figure 4(a). For values of X^1 such that $X^1 < \frac{V_1}{a^{11}}$, $(V_1 - a^{11}X^1)$ of V_1 will be used to produce X^2 in Country I while V_2 wil be used to produce X^2 in Country II. Therefore, the line CR can be given by the equation

$$X^2 = \frac{V_1 - a^{11}X^1}{a^{21}} + \frac{V_2}{a^{22}}$$

$$=\left(\frac{V_1}{a^{22}} + \frac{V_2}{a^{22}}\right) - \frac{a^{11}}{a^{21}} X^1 \ \ldots\ldots\ldots\ldots(13)$$

To the left of RD, again on Figure 4(a) where $X^1 > \frac{V_1}{a^{11}}$, Country I produces $\left[X^1 - \frac{V_1}{a^{11}}\right]$ of X^1 with the factor imported from Country II. Since the production of $\left(X^1 - \frac{V_1}{a^{11}}\right)$ of X^1 in Country I needs $a^{11}(X^1 - \frac{V_1}{a^{11}})$ of the factor, and to import this amount consumes $\lambda_{vv}\left[a^{11}(X^1 - \frac{V_1}{a^{11}})\right]$ of the factor in distribution,

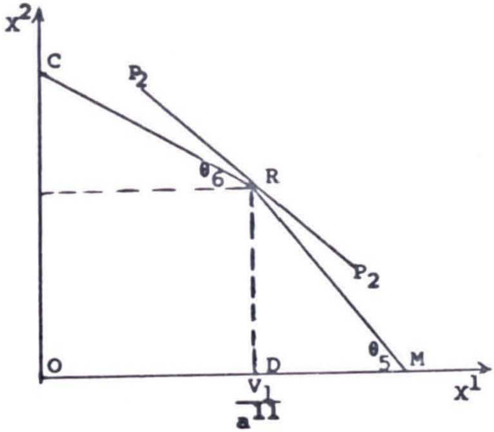
$$X^2 = \frac{V_2 - \left\{a^{11}(X^1 - \frac{V_1}{a^{11}}) + \lambda_{vv}\left[a^{11}(X^1 - \frac{V_1}{a^{11}})\right]\right\}}{a^{22}}$$

which simplifies to

$$X^2 = \frac{V_2 + V_1(1 + \frac{\lambda_{vv}}{a^{11}})}{a^{22}} - \frac{a^{11}(1 + \lambda_{vv})}{a^{22}} X^1 \ \ldots\ldots(14)$$

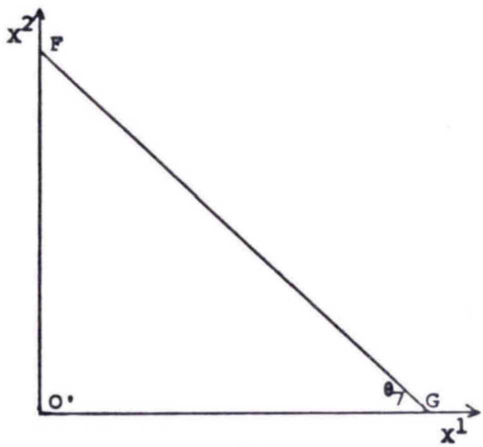
Equation (14) then describes the segment RM of the P/F. The

Figure 4



(a)

$$\tan \theta_5 = \frac{a^{11}}{a^{22}}(1 + \lambda_{vv}), \quad \tan \theta_6 = \frac{a^{11}}{a^{21}}$$



(b)

$$\tan \theta_7 = \frac{a^{11}}{a^{21}}$$

Equation (14) then describes the segment RM of the P/F. The two equations, (13) and (14) together, define the required P/F. Before discussing the analytical implications of this P/F, it will perhaps be helpful first to describe type (iv).

Type (iv) represents cases where one country has a substantial advantage in the production of both commodities. Consequently, the maximization of world production requires that all goods be produced in this country. Assume Country I has a blanket advantage in the production of all goods, in which case $a^{11}\lambda^*_{vv} \quad a^{12} - a^{11}$ and $a^{21}\lambda^*_{vv} \quad a^{22} - a^{21}$. Then Country II has to export all its factor, V_2, to Country I. After allowing for distribution costs, $\frac{1}{1 + \lambda_{vv}}$ of V_2 will actually reach Country I. Therefore, for any given quantity of X^1 produced in Country I,

$$X^2 = \frac{V_1 + \frac{V_2}{1 + \lambda_{vv}} - a^{11}X^1}{a^{21}}$$

$$= \frac{V_2 + V_1(1 + \lambda_{vv})}{a^{21}(1 + \lambda_{vv})} - \frac{a^{11}}{a^{21}}X^1 \quad \text{.............}(15)$$

Thus the P/F for type (iv) is a triangle defined by equation (15). This P/F is shown on Figure 4(b) as O'FG.

Implications for Economic Analysis

In order to see as a whole the analytical implications of the four types of cases specified above, the general equations describing the P/F's for the respective illustrative cases are reproduced together:

Types of Cases	The Equation(s) Describing a P/F for the Indicated Illustrative Cases
(i) Each country produces only one of the goods. Illustration: Country I produces X^1 and Country II produces X^2.	(1) $X^2 = \frac{V_2(1 + \lambda_{vv}) + V_1}{a^{22}(1 + \lambda_{vv})} - \frac{a^{11}}{a^{22}(1 + \lambda_{vv})}X^1$ (2) $X^2 = \frac{a^{11}V_2 - V_1(a^{11} - \lambda_{vv})}{a^{11}a^{22}} - \frac{a^{11}(1 + \lambda_{vv})}{a^{22}}X^1$
(ii) Every country produces both goods. Illustration: Assume $a^{11} < a^{12}$ and $a^{22} < a^{21}$.	(1) $X^2 = \frac{V_2}{a^{22}} + \frac{V_1}{a^{21}} - \frac{a^{11}}{a^{21}}X^1$ (2) $X^2 = \frac{V_2 + a^{12}V_1}{a^{22}a^{11}} - \frac{a^{11}}{a^{22}}X^1$
(iii) One good is produced by one country while the other is jointly produced by both countries. Illustration: X^1 is produced by Country I. X^2 is jointly produced by both countries.	(1) $X^2 = \frac{V_1}{a^{21}} + \frac{V_2}{a^{22}} - \frac{a^{11}}{a^{21}}X^1$ (2) $X^2 = \frac{V_2 + V_1(1 + \frac{\lambda_{vv}}{a^{11}})}{a^{22}} - \frac{a^{11}(1 + \lambda_{vv})}{a^{22}}X^1$

(iv) One country produces both goods.
Illustration: Country I produces both goods.

(i) $$X^2 = \frac{V_2 + V_1(1 + \lambda_{vv})}{a^{22}(1 + \lambda_{vv})} - \frac{a^{11}}{a^{21}}X^1$$

The illustrative case for type (i) (see Figure 3 and its discussion) has already been compared and contrasted with the illustrative case in type (ii). In both cases, if the terms of trade are in the limbo region, that is when

$$\frac{a^{11}}{a^{22}(1 + \lambda_{vv})} = \tan\theta_4 < \tan\phi_2 < \tan\theta_3 = \frac{a^{11}(1 + \lambda_{vv})}{a^{22}},$$

and

$$\frac{a^{11}}{a^{21}} = \tan\theta_2 < \tan\phi_1 < \tan\theta_1 = \frac{a^{12}}{a^{22}},$$

there is complete specialization in the traditional sense. Likewise, in the illustrative case for type (iii) there is complete specialization when

$$\frac{a^{11}}{a^{21}} = \tan\theta_6 < \tan\phi_3 < \tan\theta_5 = \frac{a^{11}}{a^{21}}(1 + \lambda_{vv}).$$[1]

The illustrative case for type (iv) is a triangle, hence there is no limbo region, at least not in the traditional sense as conceived by Graham.

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[1] See Figure 4(a).

Suppose then the terms of trade (i.e., PP and P_1P_1 on Figure 3 and P_2P_2 on Figure 4a) are sufficiently low so as to coincide with the lower boundaries of the limbo regions, that is let

$$\tan \phi_2 = \tan \theta_4 = \frac{a^{11}}{a^{22}(1 + \lambda_{vv})} \qquad \text{(type i)}$$

$$\tan \phi_1 = \tan \theta_2 = \frac{a^{11}}{a^{21}} \qquad \text{(type ii)}$$

$$\tan \phi_3 = \tan \theta_6 = \frac{a^{11}}{a^{21}} \qquad \text{(type iii)}$$

In type (i) the absolute advantage coefficients $\frac{a^{11}}{a^{22}}$, and distribution costs, λ_{vv}, will determine the terms of trade. In types (ii) and (iii) the terms of trade will, as in the Ricardo-Graham type of models, be determined by the opportunity costs of producing the final goods in one of the countries, namely Country I. Here it should be added paranthetically that in type (iv), where one country produces both goods, the terms of trade will simply be determined by opportunity costs in that country. Therefore, if Country I produces both goods, the terms of trade will be $\frac{a^{11}}{a^{21}}$.[1]

On the other hand, suppose the terms of trade are sufficiently high so as to coincide with uppoer boundaries of the limbo region, that is let

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[1]As shown in equation (15), distribution costs influence the intercept. Therefore, on Figure 4(b), changes in λ_{vv} will shift FG in a parallel fashion.

$$\tan \phi_2 = \tan \theta_3 = \frac{a^{11}(1 + \lambda_{vv})}{a^{22}} \qquad \text{(type i)}$$

$$\tan \phi_1 = \tan \theta_1 = \frac{a^{12}}{a^{22}} \qquad \text{(type ii)}$$

$$\tan \phi_3 = \tan \theta_5 = \frac{a^{11}}{a^{21}}(1 + \lambda_{vv}) \qquad \text{(type iii)}$$

Again in type (i) the absolute advantage coefficients, $\frac{a^{11}}{a^{22}}$, and distribution costs will determine the terms of trade. In type (ii) where the P/F's are identical to those in the Ricardo-Graham type of models, the terms of trade are determined by the opportunity costs of producing the two goods in one of the countries, namely Country II. In type (iii) the terms of trade are--in contrast to the preceeding discussion on the lower boundary--no longer determined by factors identical to those in type (ii). Instead, the terms of trade are determined by opportunity costs $(\frac{a^{11}}{a^{21}})$ in Country I, and distribution costs, λ_{vv}. It can therefore be said that if in type (iii) the terms of trade coincide with the lower boundary of the limbo region, changes in the distribution industry which influence distribution costs, λ_{vv}, will not influence the P/F. Conversely, if there is a coincidence of the terms of trade with the upper boundary of the limbo region, changes in λ_{vv} will affect the P/F.[1]

[1]Since λ_{vv} enters into the expressions for the intercept and the slope in equation (14), these changes will affect both the size and shape of the P/F.

CHAPTER III

DISTRIBUTION OF THE FACTOR AND THE FINAL GOODS

Throughout the analysis in the preceeding Chapter, an important simplifying but highly unrealistic assumption was made, namely that the distribution of final goods was free. The objective of this Chapter is to investigate, from the viewpoint of maximizing world consumption, the consequences of relaxing this assumption. The analytical approach will parallel that of Chapter II. The relevant P/F will be derived and analysed; the distribution industries for the factor and the final goods will be studied; and changes in productivity in the final goods industries will be examined.

Deriving the P/F

New assumption and notations

Economic goods have no "use-value" unless they can be placed within the reach of the consumers. Thus in realistically considering the maximization of world consumption, one cannot ignore the location of effective demand.[1]

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[1]The phrase "location of effective demand" is preferred to "location of consumers" because consumption can occur in the absence of the consumer, e.g., the construction of a facility on the account of a resident of a foreign country.

Unfortunately, it is not easy to determine the actual location of effective demand, especially in situations where the factor(s) are also moving between countries. One simple alternative is to assume a definite location of effective demand, and then proceed to maximize world consumption with the help of some programming technique. This approach will yield only a single point on the P/F. The relevancy of this point will, of course, depend upon the accuracy of the assumption on the location of effective demand.

Instead of proceeding with one-point investigation, as in the above mentioned approach, another alternative is to examine all conceivable locations of effective demand. For each conceivable location of effective demand a point, showing maximum world production, is plotted. The locus of all such points is a P/F. This P/F is conceived solely in terms of final goods in the country where they are consumed. It must, therefore, be distinguished from a P/F conceived simply in terms of final goods at the country where they are produced.

This section will illustrate the derivation of the P/F conceived in terms of final goods in the countries of consumption. Virtually all the assumptions ennunciated at the beginning of Chapter II remain intact. The only modifications called for apply to assumptions (ii), (vi) and (xiv).

Instead of assumption (ii) it will be assumed throughout this Chapter that the distribution of final goods is costly. That is, a good can be moved from one country to another only after incurring distribution costs. However, a good in any of the one-point economies can be secured for consumption in the same economy without entailing distribution costs.

From the viewpoint of the consumers in one country then, a good, say X^1, in Country I is not the same as X^1 in Country II. The X^1 in the foreign country can only be obtained for consumption after incurring distribution costs. In brief, instead of one good, X^1, there are, as it were, two goods--X^1 in Country I and X^1 in Country II. Likewise for the other good, X^2, there are two goods--X^2 in Country I and X^2 in Country II. Thus, introducing distribution costs for final goods has the formal effect of transforming a two-good model, such as the one studied in Chapter II, into a four-good model.

In this four-good model, maximum world production can be visualized with a P/F in four dimensions, each standing for good X^1 or X^2 in Country I or II. While the four dimensional P/F is very realistic in the model, the cumbersomeness of dealing in four dimensions prevents clear and penetrating analysis. Therefore, in order to obtain the benefits of such analysis the ensuing discussion will be confined to two dimensions by dropping one of the good, namely X^1. In other words, it will be assumed that there is only one good, X^2, being produced in the world. However, since the distribution of final goods is costly, there are, in fact, two goods in the model--X^2 in Country I and X^2 in Country II. Hence assumption (vi) in the beginning of Chapter II essentially remains intact even though good X^2 has been dropped.

The third and last of the assumptions listed in the preceeding Chapter but needing a modification in the present one is the "no cross-hauling" assumption (i.e., assumption xiv). In this Chapter, assumption (xiv) includes the following conditions:

(a) the factor cannot be exported from and imported into a country at the same time;

(b) the factor originating from a foreign country cannot be used unless the factor of domestic origin is fully employed;

(c) the quantity of the factor used in producing distribution services is taken from the country exporting the factor and the final goods; and

(d) a country cannot export the factor and the final good at the same time.

These conditions ensure that world production is not reduced by inefficient movements of the factor and/or the final good. For instance, violating condition (a) clearly gives rise to unnecessary shipments and, therefore, a needless use of the factor in the process of distribution. Likewise, as violation of condition (b) entails a wasteful use of resource in the process distribution which can otherwise be avoided by using first all the factor of domestic origin. Condition (c) is simply conditions (a) and (b) extended to the distribution industry. Finally, condition (d) asserts, in this one-factor model, that if world production can only be maximized by exporting the factor, then a simultaneous export of the final good must be eschewed. Conversely, where only the shipment of the final good maximizes world production, a parallel shipment of the factor must be avoided.[1]

Finally, a word on four new notations needed to facilitate the exposition: Firstly, $X^2(I)$ and $X^2(II)$ will be used as variables to denote a quantity of good X^2 in Country I and II, respectively. Secondly, subscripts and superscripts will be used along with the factor and the final good (e.g., V_1^2, V_2^1, X_1^2, X_2^1). The subscripts will denote countries of origin, while the superscripts will denote countries of destination. Thus $\bar{\bar{V}}$ is a variable denoting a quantity of the factor from Country I to Country II. Similarly, X_2^1 stands for a quantity of the final good from Country II to Country I. Thirdly, the symbol $\bar{\bar{\bar{V}}}$ will be used to denote the maximum quantity of the factor which can be shipped from one country to another given distribution costs, λ_{VV}. To illustrate, if the factor endowment of a given country is $\bar{\bar{V}}$, then $\bar{\bar{V}} = \frac{1}{1 + \lambda_{VV}}\bar{\bar{V}}$. Finally, the symbols "$\longrightarrow$" and "$\wedge$" will be used with their familiar meaning in logic of "implies" and "and," respectively.

The Derivation of the P/F

The P/F being derived here is, as already argued, two

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[1]A borderline situation in which factor shipment is just as good as the shipment of the final good can arise. This situation, otherwise assumed rare here, will be explored in the next section on the structure of distribution costs.

dimensional, one dimension standing for $X^2(I)$--good X^2 in Country I, and the other standing for $X^2(II)$--good X^2 in Country II. Again, to emphasize, this P/F is solely being conceived in terms of the two goods, $X^2(I)$ and $X^2(II)$, in the countries of consumption.

Since the factor is mobile, the maximization of world consumption may call for factor shipments. But all conceivable quantities of factor shipments are ultimately constrained by factor endowments and distribution costs in this model, that is

$$0 \leqq v_2^1 \leqq v_2^1 \quad \ldots\ldots\ldots\ldots\ldots(16)$$

$$0 \leqq v_1^2 \leqq v_1^2 \quad \ldots\ldots\ldots\ldots\ldots(17)$$

Statements (16) and (17) can, however, be broken down into:

$$0 \leqq v_2^1 \leqq \bar{\bar{v}}_2^1 \longrightarrow \begin{array}{l} \text{(a) } v_2^1 = v_2^1 \\ \text{or} \\ \text{(b) } 0 < v_2^1 < \bar{\bar{v}}_2^1 \\ \text{or} \\ \text{(c) } v_2^1 = 0 \end{array}$$

and

$$0 \leqq v_1^2 \leqq \bar{\bar{v}}_1^2 \longrightarrow \begin{array}{l} \text{(d) } v_1^2 = \bar{\bar{v}}_1^2 \\ \text{or} \\ \text{(e) } 0 < v_1^2 < \bar{\bar{v}}_1^2 \\ \text{or} \\ \text{(f) } v_1^2 = 0 \end{array}$$

In order for both statements (1) and (2) to be true, then

$$0 \leqq v_2^1 \leqq \bar{\bar{v}}_2^1 \wedge 0 \leqq v_1^2 \leqq \bar{\bar{v}}_1^2 \longrightarrow \begin{array}{l} \text{1. (a)} \wedge \text{(d) i.e., } v_2^1 = \bar{\bar{v}}_2^1 \wedge v_1^2 = \bar{\bar{v}}_1^2 \\ \text{or} \\ \text{2. (a)} \wedge \text{(e) i.e., } v_2^1 = v_2^1 \wedge 0 < v_1^2 < \bar{\bar{v}}_1^2 \\ \text{or} \end{array}$$

$$3.\ (a)\wedge(f)\ \text{i.e.,}\ v_2^1 = \bar{\bar{v}}_2^1 \wedge v_1^2 = 0$$
or
$$4.\ (b)\wedge(d)\ \text{i.e.,}\ 0 < v_2^1 < \bar{\bar{v}}_2^1 \wedge v_1^2 = \bar{\bar{v}}_1^2$$
or
$$5.\ (b)\wedge(e)\ \text{i.e.,}\ 0 < v_2^1 < \bar{\bar{v}}_2^1 \wedge 0 < v_1^2 < \bar{\bar{v}}_1^2$$
or
$$6.\ (b)\wedge(f)\ \text{i.e.,}\ 0 < v_2^1 < \bar{\bar{v}}_2^1 \wedge v_1^2 = 0$$
or
$$7.\ (c)\wedge(d)\ \text{i.e.,}\ v_2^1 = 0 \wedge v_1^2 = \bar{\bar{v}}_1^2$$
or
$$8.\ (c)\wedge(e)\ \text{i.e.,}\ v_2^1 = 0 \wedge 0 < v_1^2 < \bar{\bar{v}}_1^2$$
or
$$9.\ (c)\wedge(f)\ \text{i.e.,}\ v_2^1 = 0 \wedge v_1^2 = 0$$

The nine cases listed above exhaust all conceivable patterns of factor shipment in this one-factor, two-country model. The task of deriving the P/F can then be reduced to the problem of finding out which of the nine patterns of factor shipments--singly or collectively--maximizes world consumption.

Before zeroing on the problem some inefficient patterns violating the "no cross-hauling" assumption will be eliminated. Case 1 (i.e., $v_2^1 = \bar{\bar{v}}_2^1 \wedge v_1^2 = \bar{\bar{v}}_1^2$) clearly violates assumption xiv(a) since both countries are exporting and importing the factor at the same time. The same applies to case 2 (i.e., $v_2^1 = \bar{\bar{v}}_2^1 \wedge 0 < v_1^2 < \bar{\bar{v}}_1^2$) and case 4 (i.e., $0 < v_2^1 < \bar{\bar{v}}_2^1 \wedge v_1^2 = \bar{\bar{v}}_1^2$). Assumption xiv(a) is again clearly violated because both countries are simultaneously importing and exporting the factor, Consequently, the problem of determining which of the conceivable pattern(s) of factor shipments maximize(s) world production should then be limited to six cases, namely 3, 5, 6, 7, 8, and 9.[1]

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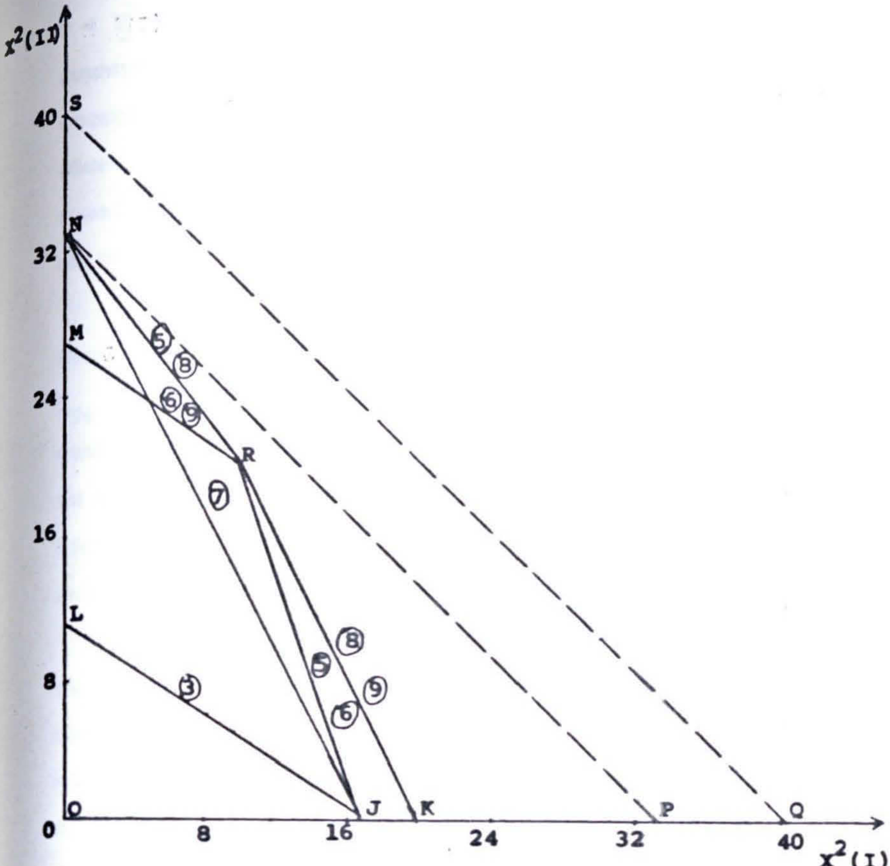
[1]It may appear as though case 5 should also be eliminated. It will soon be clear, however, that this is not correct.

For each of the six cases there corresponds, as will be explained shortly, a P/F which can be derived easily provided factor endowments, distribution costs, and the production coefficients in the final good industry are given. When all such P/F's are plotted on the same figure the P/F being sought in this section can be ascertained. Since the six cases pre-empt all possible factor movements, the P/F will simply be a locus of all points, each representing the largest output that can be produced by any of the six cases. For example, assume for the moment that the P/F's for cases 3, 5, 6, 7, 8, and 9 are OJL, OJRN, OJRM, OJN, OKRN, and OKRM, respectively, as shown on Figure 5. The P/F being sought in this section would, therefore, be quadrangle OKRN.

How then are the P/F's for the six cases to be derived? The derivations follow more or less the same reasoning. Consequently, it would be pointless to expatiate on the derivation of the P/F for each case. Instead, only cases 3 and 5 are explained fully below.

On the basis of the "no cross-hauling condition" stipulating that a country cannot export the factor and the final good at the same time, definite patterns of flows of the factor and the final goods can be inferred for each of the six cases. For example, in case 3 where $V_2^1 = \bar{V}_2^1 \wedge V_1^2 = 0$, the factor is flowing from Country II, meaning that the final good cannot also flow from the same country. In contrast, the factor is not flowing out of Country I, meaning the final good can flow

Figure 5



from there. This information is summarized for convenience on Table 2 under columns (a) and (b) where for case 3 the permissible flows are shown as $\bar{V}_2^1$, and X_1^2. In case 5, where $0 < V_2^1 < \bar{V}_2^1 \wedge 0 < V_1^2 < \bar{V}_1^2$, the factor is flowing from both countries. As a result, the final good cannot flow from both countries. The permissible flows then are V_2^1 and V_1^2, as again shown on Table 2. The permissible flows in the other four remaining cases have been similarly inferred and summarized on Table 2.

Now let $\bar{\bar{V}}_1$ and $\bar{\bar{V}}_2$ stand for factor endowments in Countries I and II, respectively. Furthermore, let λ_{vv} and λ_{fv} stand for distribution costs for the factor and the final good, respectively, as discussed in connection with Table 1 in Chapter II. Finally, let a^{21} and a^{22} represent the production coefficients in the final good industry in Countries I and II, respectively.

The P/F for case 3 can now be derived easily. From the permissible flows, namely $\bar{V}_2^1$ and X_1^2, it will be clear that since Country II is exporting all the factor, $\bar{V}_2^1$, it must also import all the quantities of the final good consumed domestically. In other words, Country I is doing all the manufacturing of the final good, X^2, for the world.

If Country II exports all its factor $\frac{1}{1 + \lambda_{vv}}$ of $\bar{V}_2$ will reach Country I where the total amount of the factor will be $\bar{V} + \frac{\bar{V}_2}{1 + \lambda_{vv}}$. In Country I, $a^{21}X^2(I)$ of the factor will be used to meet domestic demand for the final good, thus leav-

Table 2

Case	Permissible flows for the factor and the final good	Equations defining the P/F's of the six cases
(a)	(b)	(c)
3.	$\bar{v}^1,\ x^2$	$x^2(II) = \frac{\bar{V}_2 + \bar{V}_1(1+\lambda_{vv})}{(1+\lambda_{vv})(a^{21}+\lambda_{vv})} \quad \frac{a^{21}}{a^{21}+\lambda_{vv}}x^2(I)$
5.	$v_2^1,\ v_1^2$	(i) $x^2(II) = \frac{\bar{V}_1 + \bar{V}_2(1+\lambda_{vv})}{a^{22}(1+\lambda_{vv})} - \frac{a^{21}}{a^{22}(1+\lambda_{vv})}x^2(I)$
		(ii) $x^2(II) = \frac{\bar{V}_2 + \bar{V}_1(1+\lambda_{vv})}{a^{22}} - a^{21}(1+\lambda_{vv})x^2(I)$
6.	$v_2^1,\ x_1^2$	(i) $x^2(II) = \frac{\bar{V}_2}{a^{22}} + \frac{\bar{V}_1}{a^{21}+\lambda_{fv}} - \frac{a^{21}}{a^{21}+\lambda_{fv}}x^2(I)$
		(ii) $x^2(II) = \frac{V_2 + V_1(1+\lambda_{vv})}{a^{22}} - \frac{a^{21}(1+\lambda_{vv})}{a^{22}}x^2(I)$
7.	$x^1,\ \bar{v}^2$	$x^2(II) = \frac{\bar{V}_1 + \bar{V}_2(1+\lambda_{vv})}{a^{22}(1+\lambda_{vv})} - \frac{a^{22}+\lambda_{vv}}{a^{22}}x^2(I)$
8.	$x_2^1,\ v_1^2$	(i) $x^2(II) = \frac{\bar{V}_1 + \bar{V}_2(1+\lambda_{vv})}{a^{22}(1+\lambda_{vv})} - \frac{a^{21}}{a^{22}(1+\lambda_{vv})}x^2(I)$
		(ii) $x^2(II) = \frac{a^{21}V_2 + V_1(a^{22}+\lambda_{fv})}{a^{22}a^{21}} \quad \frac{a^{22}+\lambda_{fv}}{a^{22}}x^2(I)$
9.	$x_2^1,\ x_1^2$	(i) $x^2(II) = \frac{\bar{V}_2}{a^{22}} + \frac{\bar{V}_1}{a^{21}+\lambda_{vv}} - \frac{a^{21}}{a^{21}+\lambda_{vv}}x^2(I)$
		(ii) $x^2(II) = \frac{a^{21}\bar{V}_2 + \bar{V}_1(a^{22}+\lambda_{fv})}{a^{22}a^{21}} - \frac{a^{22}+\lambda_{fv}}{a^{22}}x^2(I)$

ing $\bar{V}_1 + \frac{\bar{V}_2}{1 + \lambda_{vv}} - a^{21}X^2(I)$ for purposes of export. The export will, as indicated above, consist of the final good. The final good will, in turn, entail distribution costs. Hence, only $\frac{a^{21}}{a^{21} + \lambda_{fv}}$ of $\bar{V}_1 + \frac{\bar{V}_2}{1 + \lambda_{vv}} - a^{21}X^2(I)$ will actually be used to produce the final good for shipment to Country II. Thus,

$$X^2(II) = \frac{\frac{a^{21}}{a^{21} + \lambda_{vv}}\left(\bar{V}_1 + \frac{\bar{V}_2}{1 + \lambda_{vv}}\right) - a^{21}X^2(I)}{a^{21}}$$

which simplifies to

$$X^2(II) = \frac{\bar{V}_2 + \bar{V}_1(1 + \lambda_{vv})}{(1+\lambda_{vv})(a^{21}+\lambda_{vv})} - \frac{a^{21}}{a^{21} + \lambda_{vv}}X^2(I) \quad ....(18)$$

Equation (18) then defines the P/F for case 3. This equation is shown under column (c) on Table 2. From the equation it should be, in passing, noted that this P/F, which involves movements of the factor and the final good, is influenced by the distribution costs of both the factor, λ_{vv}, and the final good, λ_{fv}.

In case 5, where only factor flows are permissible, each country manufactures the final goods and exports or imports the factor. Thus, for small quantities of $X^2(I)$ Country I will export any of its unused factor. Likewise for small quantities of $X^2(II)$, Country II will export its unused factor. More specifically, for values of $X^2(I)$ such that

$x^2(I) < \frac{\bar{V}_1}{a^{21}}$ Country I will use a $x^2(I)$ of the factor in the manufacture of $x^2(I)$, leaving $\bar{V}_1 - a^{21}x^2(I)$ for export. After allowing for distribution costs, $\frac{1}{1 + \lambda_{vv}}$ of $\bar{V} - a^{21}x^2(I)$ will reach Country II. Therefore,

$$x^2(II) = \frac{\frac{V_1 - a^{21}x^2(I)}{1 + \lambda_{vv}}}{a^{22}}$$

which simplifies

$$x^2(II) = \frac{V_1 + V_2(1 + \lambda_{vv})}{a^{22}(1 + \lambda_{vv})} - \frac{a^{21}}{a^{22}(1 + \lambda_{vv})}x^2(I) \quad \text{......(19)}$$

On the other hand, for values of $x^2(I)$ such that $x^2(I) > \frac{\bar{V}_1}{a^{21}}$, $a^{21}\ x^2(I) - \frac{\bar{V}_1}{a^{21}}$ of the factor will have to be imported. The import will in addition use $\lambda_{vv}\ a^{21}\ x^2(I) - \frac{\bar{V}_1}{a^{21}}$ of the factor in the process of distribution. Therefore,

$$x^2(II) = \frac{\bar{V}_2 - a^{21}\ x^2(I) - \frac{\bar{V}_1}{a^{21}} + \lambda_{vv}\ a^{21}\ a^{21}x^2(I) - \frac{\bar{V}_1}{a^{21}}}{a^{22}}$$

which simplifies to

$$x^2(II) = \frac{\bar{V}_2 + \bar{V}_1(1 + \lambda_{vv})}{a^{22}} - a^{21}(1 + \lambda_{vv})x^2(I) \quad \text{........(21)}$$

Equations (19) and (20) then defines the P/F for case 5. These two equations are shown again on Table 2. From the equations it should be observed that this P/F, which involves only the movements of the factor, is influenced by distribution costs for the factor.

The equations defining the P/F's for the remaining four cases have similarly been derived and summarized on Table 2. From the equations on the Table it can easily be seen that where permissible flows of a case involves the flow of the factor and/or final good, the corresponding P/F will be influenced by distribution costs for the factor and/or the final good. The foregoing discussion can best be illustrated with a concrete example.

Using the data on factor endowments, production coefficients, and distribution costs as shown in Example II below,

Example II

		Country I	Country II
(1)	Factor endowment	$\bar{V}_1 = 20$	$\bar{V}_2 = 20$
(2)	Production coefficients in the X^2-industry	$a^{21} = 2$	$a^{22} = 1$
	Distribution costs (in terms of the factor) per		
(3)	unit of the factor	$\lambda_{vv} = 0.5$	
(4)	unit of the final good	$\lambda_{fv} = 1$	

The equations for the six cases are:

Case	Equation(s)
3.	$X^2(II) = 11.1 - 0.7X^2(I)$

5. (i) $X^2(II) = 33.3 - 1.3X^2(I)$
   (ii) $X^2(II) = 16.7 - 3X^2(I)$

6. (i) $X^2(II) = 26.7 - 0.7X^2(I)$
   (ii) $X^2(II) = 50 - 3X^2(I)$

7. $X^2(II) = 33.3 - 2X^2(I)$

8. (i) $X^2(II) = 33.3 - 1.3X^2(I)$
   (ii) $X^2(II) = 40.0 - 2X^2(I)$

9. (i) $X^2(II) = 26.7 - 0.7X^2(I)$
   (ii) $X^2(II) = 40 - 2X^2(I)$

The lines defined by these equations are plotted on Figure 5, forming P/F's OJL, OJRN, OJRM, OJN, OKRN, and OKRM for cases 3, 5, 6, 7, 8, and 9, respectively. The quadrangle OKRN is, as pointed out before, the desired P/F.

Analytical implications (from Example II)

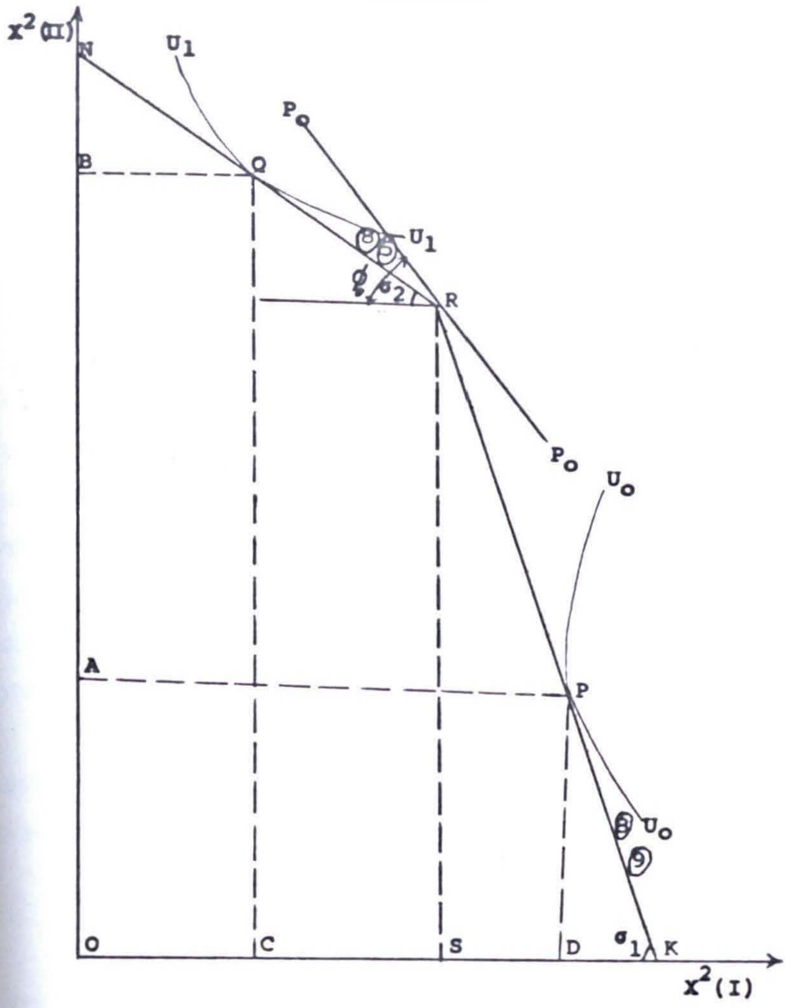
Suppose the distribution of the factor and the final good is free. World production can be maximized by producing all X^2 in Country II where $\frac{\overline{V}_1 + \overline{V}_2}{a^{22}} = \frac{20 + 20}{1} = 40$ units of X^2 can be produced. This output would give the P/F OQS as shown on Figure 5. Suppose next that the distribution of the final good remained free while the distribution of the factor is such that $\lambda_{vv} = 1/2$. Still, world production can be maximized by producing all X^2 in Country II where $\overline{V}_2 + \frac{1}{1 + \lambda_{vv}}\overline{V}_1 =$

$20 + 20\frac{(2)}{} = 33.3$ units of X^2 can be produced. This output would give the P/F OPN as shown on Figure 5. Finally, suppose the distribution of the factor and the final good is such that $\lambda_{vv} = 1/2$ and $\lambda_{fv} = 1$. The P/F will be OKRN as explained earlier. Increasing λ from 0 to 1 while holding λ_{vv} constant at $\lambda_{vv} = 1/2$ then reduces the p/F from (still on Figure 5) OPN to OKRN. In other words, introducing distribution costs for final goods, $\lambda_{fv} = 1$, entails a cost represented by the area KRNP. The P/F OKRN, conceived in terms of final goods at the country of consumption, is clearly quite different from the P/F OPN conceived in terms of final goods at country of production. As a corollary, the oblong shape of the P/F OKRN should be observed. This shape indicates that as more of the final good is placed in Country I, the country with less absolute advantage in the production of X^2, distribution costs claim a larger toll.

The P/F OKRN is reproduced on Figure 6 where the encircled numbers between KR and RN stand for the cases obtaining for every point on the respective line segments. U_oU_o and U_1U_1 are world consumption indifference curves showing levels of satisfaction when different quantities of X^2 are consumed in Countries I and II.[1] When U_oU_o is the prevailing indiffer-

[1]Both the plausibility of derivational possibility of such curves are, admittedly, being assumed here.

Figure 6



ence curve, world consumption is at point P; OD of X^2 is consumed in Country I while OA is consumed in Country II. At P, cases 8 and 9 obtain, meaning--as discussed in the preceeding section--that in order for world consumption to be maximized, each country must produce(manufacture) the final good. Besides Country II must ship the final good to the other country. In contrast, when U_1U_1 is the prevailing indifference curve, OC of X^2 is consumed in Country I while OB is consumed in Country II. Since at Q cases 5 and 8 obtain, world consumption can be maximized if both countries produce(manufacture) the final good. However, Country I must export any of its unused factor to Country II. It should, therefore, be seen that a change in world demand, say between point P and point Q, may call for a shift from the factor movement to the movement of the final good and vice versa if world consumption is to be maximized.

The slope of the "price"[1] line P_oP_o(Figure 6) in this model represents the ratio of the price of X^2 in Country I to the price of X^2 in Country II. That is,

$$\tan \phi = \frac{\text{price of } X^2(\text{I})}{\text{price of } X^2(\text{II})}$$

[1]Alternatively, the slope of P_oP_o may be regarded as a ratio of weights indicating the desirability of the consumption of a unit of X^2 in Countries I and II.

When the ratio is between the slopes of NR and RK (i.e., when $\sigma_2 < \tan \phi_0 < \tan \sigma_1$) maximum world consumption occurs at point R. At this point each country is using all its factor endowment to produce(manufacture) the final good for domestic consumption. Point Q, therefore, represents a situation of global autarky.

Now let the price ratio (i.e., $\tan \phi_0$) decline steadily, say as a result of a persistent increase in the price of X^2(II). Ultimately, the price line will coincide with NR. It will be recalled that over the NR segment of the P/F cases 5 and 8 prevail, and that the slope of NR (as shown by equation i for cases 5 and 8 on Table 2) is $\frac{a^{21}}{a^{22}(1 + \lambda_{vv})}$. Therefore when the price line coincides with NR,

$$\tan \phi_0 = \frac{\text{price of } X^2(I)}{\text{price of } X^2(II)} = \frac{a^{21}}{a^{22}(1 + \lambda_{vv})} \quad ......(21)$$

Similarly, it can be seen from equation (i) for case 8 or 9 on Table 2 that when the price line P_oP_o (on Figure 6) coincides with RK,

$$\tan \phi_0 = \frac{\text{price of } X^2(I)}{\text{price of } X^2(II)} = \frac{a^{22} + \lambda_{fv}}{a^{22}} \quad ....(22)$$

From equation (22) it can be seen that when the world consumption indifference curve is tangental to the P/F at a point such as P on the line segment RK, world consumption is at a maximum when the price ratio equals $\frac{a^{22} + \lambda_{fv}}{a^{22}}$. In this one-factor model, the denominator, a^{22}, is the price of a unit of X^2 produced in Country II. The numerator, $a^{22} + \lambda_{fv}$, is the price of producing a unit of X^2 in Country II and shipping the unit to Country I, that is, $a^{22} + \lambda_{fv}$ is the price of X^2 in Country I. World consumption is then at a maximum when the price of $X^2(I)$ = price of $X^2(II) + \lambda_{fv}$. The cournotian equilibrium condition that price in market A equal price in market B plus or minus transportation costs appears then also to be a necessary condition for the maximization of world consumption when world demand concurs with a point on RK (Figure 6).

In contrast, if world demand concurs with a point on NR, the Cournotian equilibrium condition is modified. From equation (21) the price ratio (when world demand is represented by a point on NR) is $\frac{a^{21}}{a^{22}(1 + \lambda_{vv})}$. The numerator, a^{21}, is the price of producing a unit of X^2 in Country I. The denominator, $a^{22}(1 + \lambda_{vv})$, is the price of producing a unit of X^2 in Country II with the factor imported from Country I. This price consists of units of the factor, a^{22}, needed to produce a unit of X^2 in Country II, plus units of the factor, $a^{22}\lambda_{vv}$, needed in transporting a^2 from Country I to Country II. The Cournotian condition that price of $X^2(I)$ = price of $X^2(II) + \lambda_{fv}$ clearly does not hold here.

The Structure of Distribution Costs

The derivation of the P/F reproduced on Figure 6, and the discussion of the accompanying analytical implications were based on Example II. With a different example--i.e., with different production coefficient or distribution costs for the factor or the final goods-- a P/F resting on other cases with different permissible factor and/or final good flows may result, thus yielding different analytical implications.[1] These implications will not be catalogued here because they can be inferred in the same way as those of Example II. More interesting implications can be obtained by trying to answer the question: under what circumstances will specific cases maximize world consumption?

In order to answer the question it will be assumed, to start with, that the production coefficients, a^{21} and a^{22}, in the final good industry remain constant, and that $a^{21} > a^{22}$. However, the distribution costs for the factor, λ_{vv}, and the final good, λ_{fv}, will be allowed to vary. The problem, then, is to find out how changes in λ_{vv} and/or λ_{fv} relate to the case(s) which maximize world consumption. Graphically the problem can be pictured, as will be illustrated shortly, in the positive quadrant of a two-dimension Eucledian space.

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[1]Varying factor endowments change the size of the P/F but not the slopes. Besides factor endowment does not, in any way, affect the six cases upon which the discussion in the rest of the Chapter and the next relies.

Distribution costs for the final good, λ_{fv}, are plotted on the horizontal axis, while those of the factor, λ_{vv}, are shown on the vertical axis. The problem is to find for each point in the quadrant which of the six cases will maximize world consumption.

The permissible flows (for the factor and the final good) summarized on Table 2 are reproduced below under column (b) on Table 3. It will be remembered that these permissible flows are deduced from the "no cross-hauling" condition that a country cannot export the factor and the final good at the same time.

Table 3

Case	Permissible flows		Implied Statements
(a)	(b)		(c)
3.	$\bar{\bar{V}}_2^1$	$\longrightarrow$	$a^{21} + a^{21}\lambda_{vv} + \lambda_{fv} < a^{21}$
	X_1^2	$\longrightarrow$	$a^{21} + \lambda_{fv} < a^{22} + a^{22}\lambda_{vv}$
5.	V_2^1	$\longrightarrow$	$a^{21} + a^{21}\lambda_{vv} < a^{21} + \lambda_{fv}$
			$a^{22} < a^{21} + a^{21}\lambda_{vv} + \lambda_{fv}$
	V_1^2	$\longrightarrow$	$a^{22} + a^{22}\lambda_{vv} < a^{21} + \lambda_{fv}$
			$a^{21} < a^{22} + a^{22}\lambda_{vv} + \lambda_{fv}$

(Case)	(Permissible flows)	(Implied Statements)
6.	$V_2^1 \longrightarrow$	$a^{21} + a^{21}\lambda_{vv} < a^{22} + \lambda_{fv}$
		$a^{22} < a^{21} + a^{21}\lambda_{vv} + \lambda_{fv}$
	$X_1^2 \longrightarrow$	$a^{21} + \lambda_{fv} < a^{22} + a^{22}\lambda_{vv}$
7.	$X_2^1 \longrightarrow$	$a^{22} + \lambda_{fv} < a^{21} + a^{21}\lambda_{vv}$
	$\bar{\bar{V}}^2 \longrightarrow$	$a^{22} + a^{22}\lambda_{vv} + \lambda_{fv} < a^{21}$
8.	$X_2^1 \longrightarrow$	$a^{22} + \lambda_{fv} < a^{21} + a^{21}\lambda_{vv}$
	$V_1^2 \longrightarrow$	$a^{22} + a^{22}\lambda_{vv} < a^{21} + \lambda_{fv}$
		$a^{21} < a^{22} + a^{22}\lambda_{vv} + \lambda_{fv}$
9.	$X_2^1 \longrightarrow$	$a^{22} + \lambda_{fv} < a^{21} + a^{21}\lambda_{vv}$
	$X_1^2 \longrightarrow$	$a^{21} + \lambda_{fv} < a^{22} + a^{22}\lambda_{vv}$

On the Table there are three types of flows from Country I, namely $\bar{\bar{V}}_1^2$, V_1^2, and X_1^2. Implicit in these types of flows are following conditions

$$\bar{\bar{V}}^2 \longrightarrow a^{22} + a^{22}\lambda_{vv} + \lambda_{fv} < a^{21} \quad \text{..........(23)}$$

$$v_1^2 \text{ ——— } a^{22} + a^{22}\lambda_{vv} < a^{21} + \lambda_{fv}$$

$$a^{21} < a^{22} + a^{22}\lambda_{vv} + \lambda_{fv} \quad .....(24)$$

$$x_1^2 \text{ ——— } a^{21} + \lambda_{fv} < a^{22} + a^{22}\lambda_{vv} \quad .....(25)$$

which must be met if the particular flow is to result in maximum world consumption. Statement (23) simply indicates that Country I will export all its factor if the "unit cost" of exporting the factor and importing the final good (i.e., $a^{22} + a^{22}\lambda_{vv} + \lambda_{fv}$) is less than the cost, a^{21}, of producing the final good domestically. Unit cost here includes a^{22}--the amount of the factor needed to produce one unit of X^2 in Country II, $a^{22}\lambda_{vv}$--the cost of exporting a^{22} of the factor from Country I to Country II, and λ_{fv}--the cost of distributing a unit of the final good from Country II to Country I.

Statement (24) means that the factor will flow from Country I to II if the unit cost of shipping the factor (i.e., $a^{22} + a^{22}\lambda_{vv}$) is less than the unit cost of shipping the final good (i.e., $a^{21} + \lambda_{fv}$). Besides, from the discussion of Table 2 it will be recalled that $V_1^2 > 0$ implies that Country I also produces the final good for domestic consumption. But Country I will produce the final good only if it is cheaper to produce the good at home than to export the factor and import the final good, i.e., $a^{21} < a^{22} + a^{22}\lambda_{vv} + \lambda_{fv}$. Finally, statement (25) indicates that Country I will export the final good if this is cheaper than exporting the factor, that is,

$a^{21} + \lambda_{fv} < a^{22} + a^{22}\lambda_{vv}$.

In Country II as in Country I there are also three types of flows, namely, $\bar{\bar{V}}^1_2$, V^1_2, and X^1_2. Implicit in each flow are conditions analogous to statements (23) - (25) which must also be met if the particular flow is to maximize world consumption. A comprehensive list of all statements for all permissible flows in the six cases appears under column (c) on Table 3. On the Table it will be noted that the compound statements for the various flows are conjugated by " ". This means that in order for the P/F of a given case to maximize world consumption at every point, all statements implied by respective flows must be true.

Suppose now distribution costs λ_{vv} and λ_{fv} on Table 3 are treated as variables while the production coefficients a^{22} and a^{21} remain constant. The result can be clarified by assigning numerical values to the production coefficients. For example, let $a^{22}=1$ and $a^{21}=2$. Substituting these values into the implied statement on Table 3 yields inequalities.

<u>Case</u>	<u>Implied Statements</u>
3.	$\lambda_{vv} < -\frac{1}{2} - \frac{1}{2}\lambda_{fv} \wedge \lambda_{vv} > 1 + \lambda_{fv}$
5.	$\lambda_{vv} < -\frac{1}{2} + \frac{1}{2}\lambda_{fv} \wedge \lambda_{vv} > -\frac{1}{2} - \frac{1}{2}\lambda_{fv}$
	$\lambda_{vv} < 1 + \lambda_{fv} \wedge \lambda_{vv} > 1 - \lambda_{fv}$
6.	$\lambda_{vv} < -\frac{1}{2} + \frac{1}{2}\lambda_{fv} \wedge \lambda_{vv} > -\frac{1}{2} - \frac{1}{2}\lambda_{fv} \wedge \lambda_{vv} < 1 + \lambda_{fv}$

7. $\lambda_{vv} > -\frac{1}{2} + \frac{1}{2}\lambda_{fv} \wedge \lambda_{vv} < 1 - \lambda_{fv}$

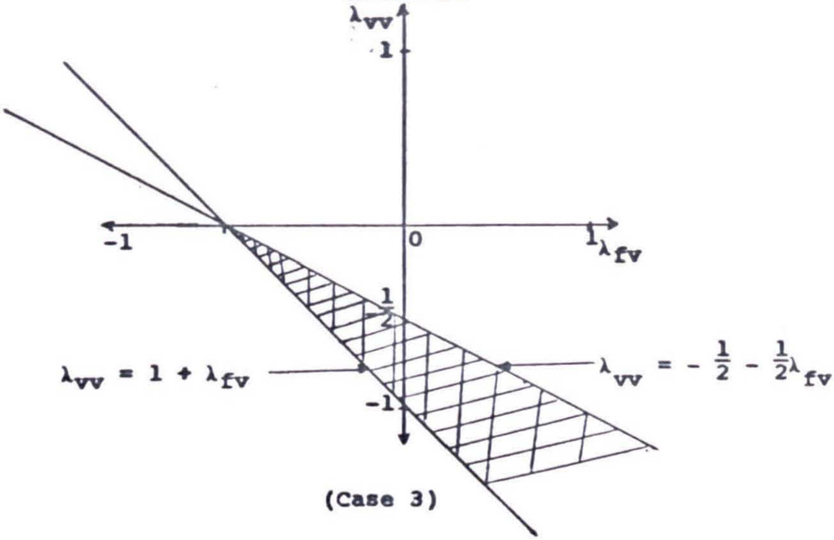
8. $\lambda_{vv} > -\frac{1}{2} - \frac{1}{2}\lambda_{fv} \wedge \lambda_{vv} < 1 + \lambda_{fv} \wedge \lambda_{vv} > 1 - \lambda_{fv}$

9. $\lambda_{vv} > -\frac{1}{2} + \frac{1}{2}\lambda_{fv} \wedge \lambda_{vv} > 1 + \lambda_{fv}$

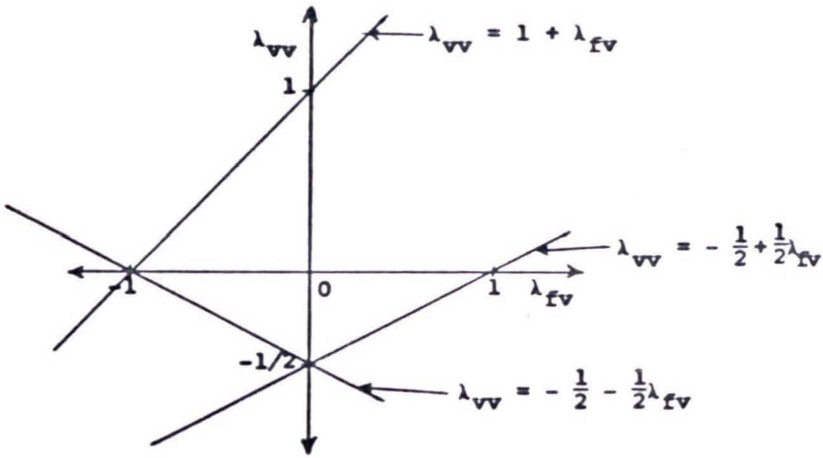
The statements for each case are simple inequalities which can be graphed as open planes. Since for each case all statements must be true, the areas of interest are the intersections of the open planes in each case as shown by the cross-hatched areas on Figure 7. In case 3, for instance, the inequality $\lambda_{vv} < -\frac{1}{2} - \frac{1}{2}\lambda_{fv}$ is the open plane below the line $\lambda_{vv} = -\frac{1}{2} - \frac{1}{2}\lambda_{fv}$ while the inequality $\lambda_{vv} > 1 + \lambda_{fv}$ is the open plane above the line $\lambda_{vv} = 1 + \lambda_{fv}$. The intersection of the two open planes is then shown by the crosshatched area meaning, of course, that the solution space is null since distribution costs λ_{fv} and λ_{vv} cannot be negative. Barring case 6 which also has a null solution space, the remaining four cases have solution spaces which occupy specific areas in the positive quadrant as has been shown more clearly on Figure 8.

It should not, however, be forgotten that Figure is based on the assumption $a^{22} = 1$ and $a^{21} = 2$. With different production coefficients the solution spaces will be different. This point is brought out on the figure by the bracketed expressions above the equations for lines AB, BS, and AT. The expressions are general equations (which can be inferred from Table 3) for the respective lines. To illustrate, the line

Figure 7

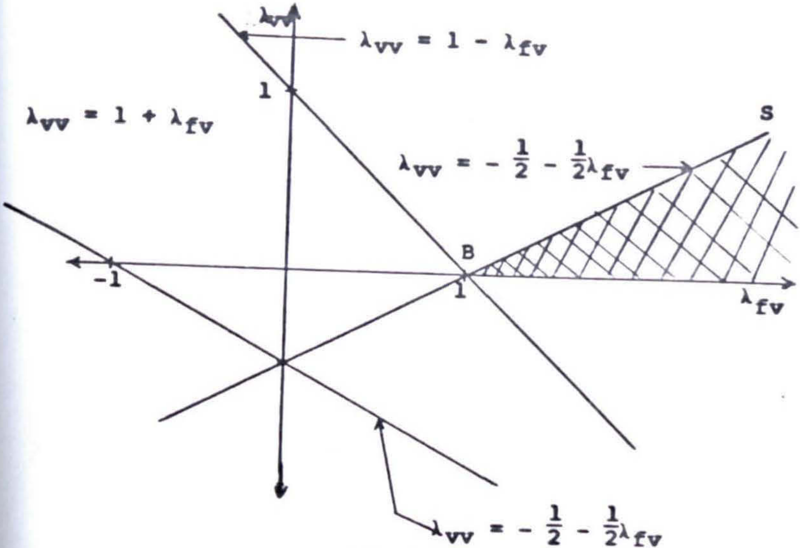


(Case 3)

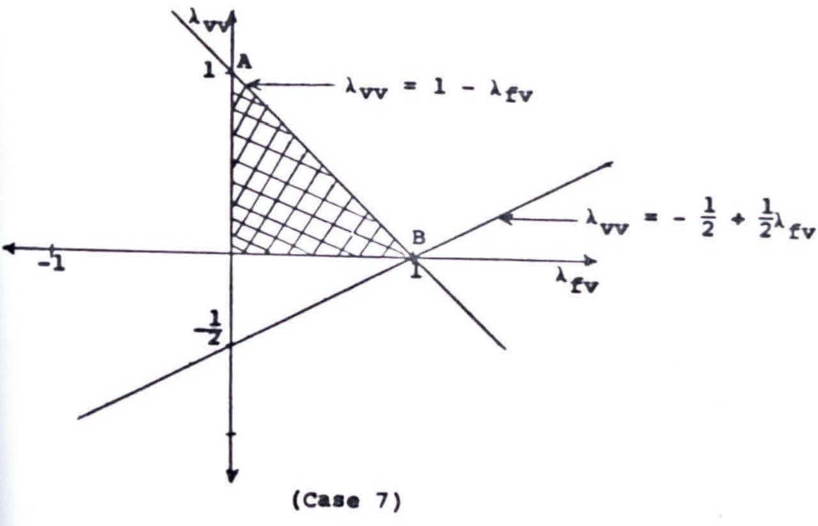


(Case 6)

(Figure 7)

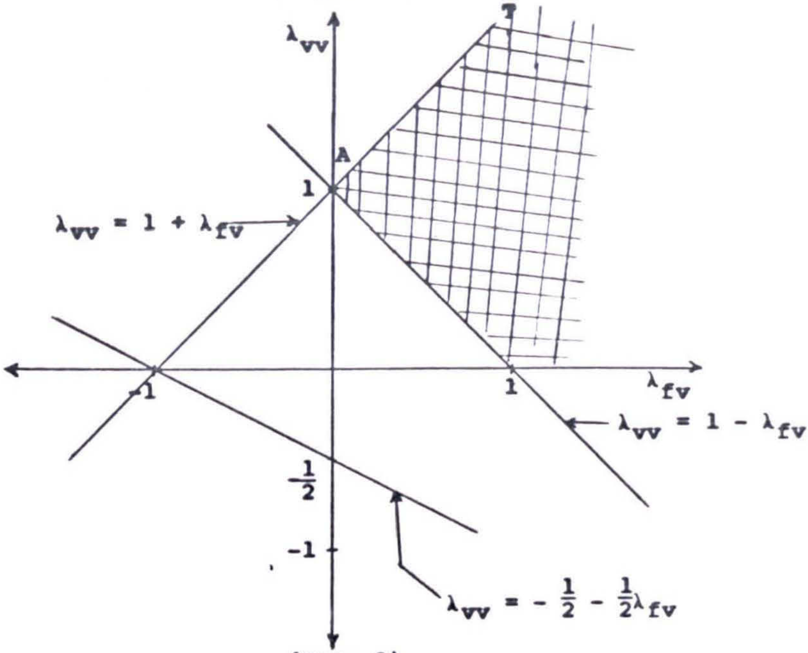


(Case 5)

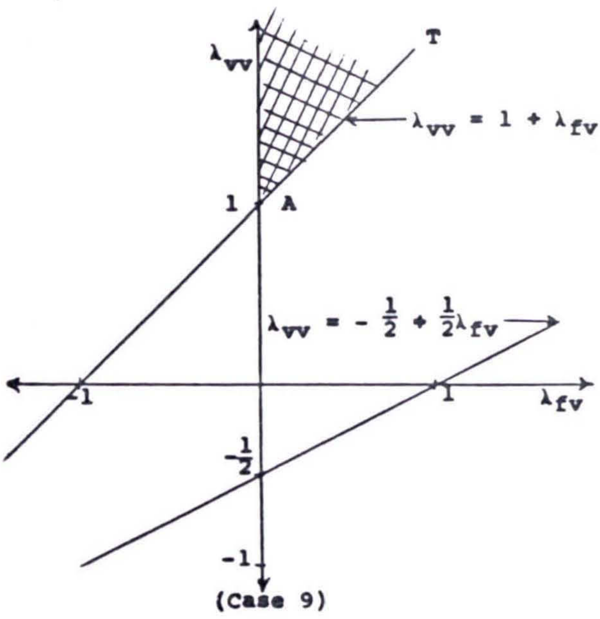


(Case 7)

(Figure 7)

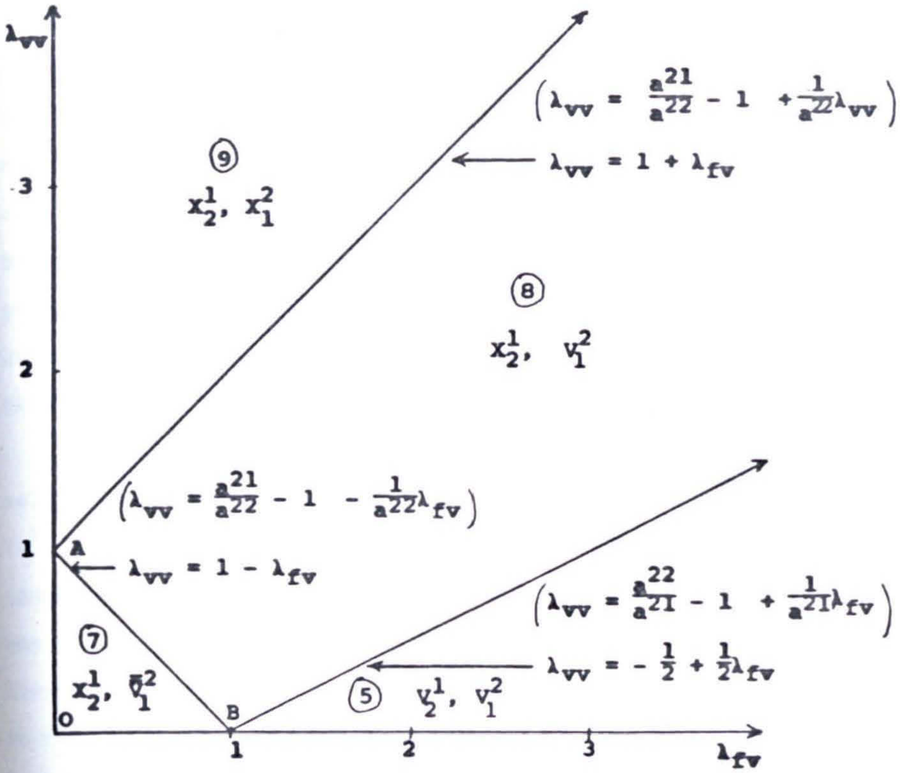


(Case 8)



(Case 9)

<u>Figure 8</u>



λvv
λfv
3
2
1
O
A
B
1
2
3
⑨
x^1_2, x^2_1
⑧
x^1_2, v^2_1
⑦
x^1_2, v^2_1
⑤ v^1_2, v^2_1
(λvv = a21/a22 - 1 + 1/a22 λvv)
λvv = 1 + λfv
(λvv = a21/a22 - 1 - 1/a22 λfv)
λvv = 1 - λfv
(λvv = a22/a21 - 1 + 1/a21 λfv)
λvv = - 1/2 + 1/2 λfv

AB is given by the expression $a^{22} + a^{22}\lambda_{vv} + \lambda_{fv} < a^{21}$ on Table 3. From this expression in turn can be written as $\lambda_{vv} < (\frac{a^{21}}{a^{22}} - 1) - \frac{1}{a^{22}}\lambda_{fv}$, the expression for AB as shown on Figure 8. The other expressions are similarly derived from Table 3.

On Figure 8 it will be seen that with relatively high distribution costs for the factor case 9, which entails only movements of the final good (x_2^1, x_1^2), will maximize world consumption. Case 9 then more or less constitutes, to use Hoover's terminology, a case of material orientation.[1] By producing the final good at the location of the factor (i.e.,in each country), costly distribution of the factor can be averted, thus enabling the maximization of world consumption.

In contrast, when distribution costs for the factor are relatively low, case 5, entailing only movements of the factor (v_2^1, v_1^2), maximizes world consumption. On Figure 8 this situation obtains for all points falling between the line BS and the horizontal axis. Case 5 then constitutes, again to use Hoover's terminology, a case of market orientation.[2] Producing at the point of consumption averts costly distribution of the final good, thus enabling the maximization of world consump-

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[1] Edgar M. Hoover, The Location of Economic Activity (New York: McGraw-Hill Book Company, 1948), pp. 31-35.

[2] Ibid., pp. 35-38.

tion.

So long as one country has an absolute advantage in producing the final good,[1] material orientation and market orientation are, however, only a part of the story. With sufficiently low distribution costs for the final good and the factor, an orientation toward absolute advantage in production is also conceivable. This situation, represented by case 7 below the line AS on Figure 8, requires that only the country with the absolute advantage should produce (manufacture) the final good. Thus with $a^{22}=1$ and $a^{21}=2$, world consumption can be maximized if Country I exports all its factor and imports all the final good needed for her domestic consumption.

Besides material, market, and absolute advantage orientations, an intermediate situation combining market and raw material orientation is also conceivable. This situation is represented by case 8 where, depending upon international location of effective demand, either the factor or the final good may flow internationally.

In summary it should be observed that changes--absolute or relative--in distribution costs λ_{vv} and/or λ_{fv} may call for a shift from one pattern of movements of the factor or the final good to another if world consumption is to be maximized. Besides when there are differences in absolute advantage in production, patterns of movements influenced solely by absolute

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[1]It will be recalled that in the preceeding discussion it was assumed that a^{21} a^{22}.

advantage or the location of effective demand may be called for in addition to the familiar dichotomy of material and market orientation.

The Distribution Industry

Thus far the analysis in this Chapter has focused on distribution costs λ_{vv} and λ_{fv}. Now an attempt will be made to ascertain the determinants of λ_{vv} and λ_{fv}.

In Chapter II it was shown by equation (12)

$$\lambda_{vv} = \frac{\beta_v}{\gamma_v}$$

that the factor distribution costs, λ_{vv}, vary inversely with the productivity, γ_v, of the factor in the distribution industry, and directly with the input coefficient, β_v, for distribution services.

Besides the distribution industry for the factor, there is, in this Chapter, another industry producing distribution services for the final good.[1] The production function for this industry was specified on Table 1 as

$$X_f^{31} = \frac{V}{\alpha_1} \quad \text{...............(26)}$$

Also in connection with Table 1, β_f was defined as the units

[1]See assumption (vii) at the beginning of Chapter II.

of distribution services, X_f^{31}, consumed in the process of distributing one unit of a final good between the two countries. Assume that only enough services are produced to distribute one unit of the final good, X^2, from one country to another, meaning

$$X_f^{31} = \beta_f \quad \text{.................(27)}$$

Substituting β_f for X_f^{31} in equation (26) yields

$$\beta_f = \frac{1}{\alpha_1} V^* \quad \text{..............(28)}$$

where $V^* = \lambda_{fv}$, and from equation (26) $\frac{1}{\alpha_1} = \frac{X_f^{31}}{V}$, that is, $\frac{1}{\alpha_1}$ is the productivity of the factor in the distribution industry for the final good. Letting $\frac{1}{\alpha_1} = \gamma_f$, equation (28) can then be written as:

$$\beta_f = \gamma_f \lambda_{fv} \quad \text{or}$$

$$\lambda_{fv} = \frac{\beta_f}{\gamma_f} \quad \text{................(29)}$$

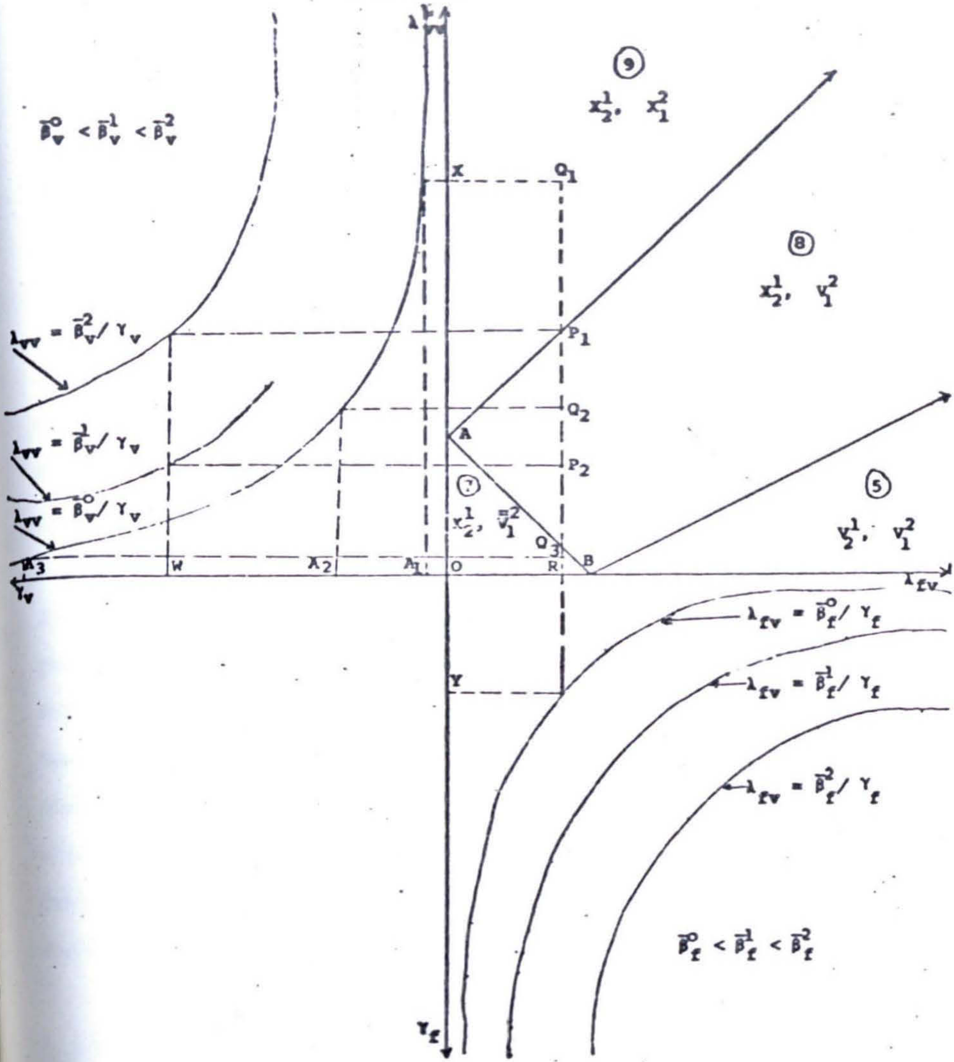
Distribution costs, λ_{fv}, then vary inversely with productivity, γ_f, and directly with the input coefficient, β_f, for distribution services.

Equations (12) and (29), i.e., $\lambda_{vv} = \frac{\beta_v}{\gamma_v}$ and $\lambda_{fv} = \frac{\beta_f}{\gamma_f}$, are helpful in analysing two major implications of changes in β_v and/or γ_v, or β_f and/or γ_f, for the maximization of world consumption. The first implication can be seen with the help of Table 2. Changes in β_v and/or γ_v, or changes in β_f and/or γ_f, by influencing λ_{vv} or λ_{fv} may also affect the size and shape of the P/F. This point can easily be seen by substituting $\frac{\beta_f}{\gamma_f}$ for λ_{fv} and $\frac{\beta_v}{\gamma_v}$ for λ_{vv} in the equations on Table 2.

The second implication can be seen with the help of Figure 9. Through their influence on λ_{fv} or λ_{vv}, changes in β_f and/or γ_f or β_v and/or γ_v may call for a shift from one case of flows to another. This point is brought out more clearly on Figure 9. Let $\bar{\beta}_f$ and $\bar{\beta}_v$ denote given constant values for the input coefficients β_f and β_v. From the equation $\lambda_{vv} = \frac{\bar{\beta}_v}{\gamma_v}$, the graph of λ_{vv} against γ_v is a rectangular hyperbola since $\lambda_{vv}\gamma_v = \bar{\beta}_v$. This graph is shown in the second quadrant on Figure 9 for three different values of $\bar{\beta}_v$ such that $\bar{\beta}_v^0 \quad \bar{\beta}_v^1 \quad \bar{\beta}_v^2$. Simiarly, from the equation $\lambda_{fv} = \frac{\bar{\beta}_f}{\gamma_f}$, the graph of λ_{fv} against γ_f is also a rectangular hyperbola since $\lambda_{fv}\gamma_f = \beta_f$. This graph is shown in the fourth quadrant again for three different values of $\bar{\beta}_f$ such that $\bar{\beta}_f^0 < \bar{\beta}_f^1 < \bar{\beta}_f^2$. Therefore on Figure 9, changes in productivity in the distribution industries are represented by different points on the γ_v- or γ_f-axis while changes in β_v or β_f are represented by different hyperbolas.

Suppose now the input coefficients remain fixed at $\bar{\beta}_v^0$ and $\bar{\beta}_f^0$. Furthermore, suppose productivity in the distribution industry for the final good also remains fixed at $\gamma_{fv} = OY$ meaning, of course, that λ_{fv} also remains fixed at $\lambda_{fv} = OR$. If productivity in the distribution industry for

Figure 9


$\bar{\beta}_v^0 < \bar{\beta}_v^1 < \bar{\beta}_v^2$
$\lambda_{vv} = \bar{\beta}_v^2/\gamma_v$
$\lambda_{vv} = \bar{\beta}_v^1/\gamma_v$
$\lambda_{vv} = \bar{\beta}_v^0/\gamma_v$
9
x_2^1, x_1^2
8
x_2^1, v_1^2
7
$x_2^1, \bar{v}_1^2$
5
v_2^1, v_1^2
X
Q_1
P_1
Q_2
A
P_2
Q_3
B
R
O
A_1
A_2
W
A_3
Y
γ_v
γ_f
λ_{fv}
$\lambda_{fv} = \bar{\beta}_f^0/\gamma_f$
$\lambda_{fv} = \bar{\beta}_f^1/\gamma_f$
$\lambda_{fv} = \bar{\beta}_f^2/\gamma_f$
$\bar{\beta}_f^0 < \bar{\beta}_f^1 < \bar{\beta}_f^2$

the factor increases steadily from zero, a shift from case 9 to case 8 and then to case 7 will progressively be called for if world consumption is to be maximized. For instance, when γ_v = OA meaning λ_{vv} = OX, case 9 will, as indicated by point Q_1, be called for if world consumption is to attain a maximum. With such a low productivity in the distribution industry for the factor, distribution costs, λ_{vv}, are high. Production must be oriented toward the location of the factor in order to maximize world consumption. However, the reasons for such orientation is low productivity rather than high input coefficient, β_v, as suggested by the emphasis on "heaviness" in Hoover's rationalization of material orientation.[1] If γ_v increases from OA_1 to OA_2 case 8 will, as shown by point Q_2, be called for if world consumption is again to reach a maximum. Depending upon the location of effective demand, the factor or the final good may flow. If γ_v increases even further from OA_2 to OA_3, maximizing world consumption will call for case 7 meaning Country I will ship all its factor for production in Country II, the country with the absolute advantage in the production of the final good.

A decline in the input coefficient, β_v, by reducing λ_{vv}, may also call for a shift from one case to another. Let

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[1]Hoover emphasized "a considerable loss of weight through combustion or waste of part of the material" in explaining market orientation. Hoover, Location of Economic Activity, pp. 31-32.

productivity remain constant at γ_f = OY and γ_v = OW. In addition, let the input coefficient in the distribution industry for the final good remain fixed at $\bar{\beta}_f^0$. When $\beta_v = \bar{\beta}_v^2$, case 8 or 9 will, as shown by point P_1, maximize world consumption.[1] If β_v drops from $\bar{\beta}_v^2$ to $\bar{\beta}_v^1$ only case 8 will maximize world consumption. Should β_v drop even further to a value below $\bar{\beta}_v^0$, case 7 may again be called for.

Needless to say, in the real world ceteris paribus changes such as those used in the above illustrations are, perhaps, not the rule. Any configuration of changes in γ_f, γ_v, β_f, and β_v is conceivable. The effect of such changes on the case(s) needed to maximize world consumption can be traced out with the information in quadrants 2 and 4, provided the chart in quadrant 1 remains fixed.[2] In order for the chart (i.e., the positions of lines AB, AT, and BS) to remain fixed, the production coefficients for the final good must, as discussed earlier, also remain fixed. What happens when these coefficients change is the topic of the next section.

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[1]In this case, shipments of the final good X^2 or the factor from Country I result in equal quantities of the final good in Country II.

[2]It will be recalled that the general equations for AB, AT, and BS (the bracketed expressions on Figure 8) are influenced only by the production coefficients of the final good.

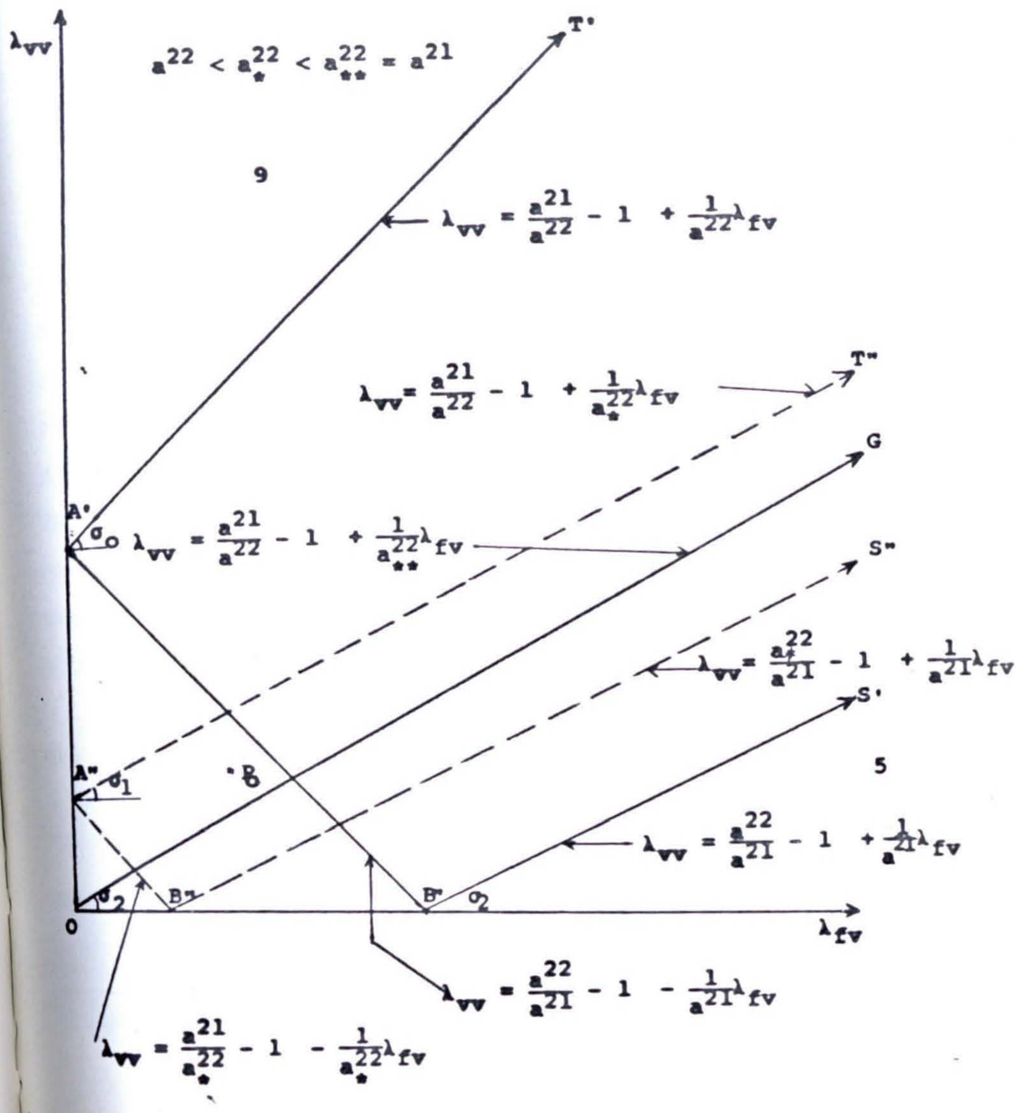
Changes in Productivity in the Final Good Industries

In the preceeding section the effect of changes in the distribution industry were analysed on the assumption that the production coefficients in the final good industries were constant. Now the reverse assumption will be made, namely that conditions in the distribution industry remain fixed while "productivity" in the final good industries changes. (From the production functions for X^2 shown on Table 1, i.e., $X^{21} = \frac{V}{a^{21}}$ and $X^{22} = \frac{V}{a^{22}}$, productivity in Country I is given by $\frac{X^{21}}{V} = \frac{1}{a^{21}}$ and in Country II by $\frac{X^{22}}{V} = \frac{1}{a^{22}}$.)

Changing productivity in the final good industries in Country I or II (i.e., changing $\frac{1}{a^{21}}$ or $\frac{1}{a^{22}}$) can have two different types of implications. Firstly, such changes may influence the size and shape of the P/F. Such influence evidenced by the fact that the coefficients a^{21} and/or a^{22} enter(s) into the intercept and slope expressions of the equations on Table 2.

Secondly, changes in productivity may call for a change from one case (of factor and/or final good flows) to another if world consumption is to be maximized. To illustrate this point, suppose the difference in productivity is reduced by letting $\frac{1}{a^{22}}$--productivity in the X^2-industry in Country II--decline steadily. The results can be seen on Figure 10 where the positions of the lines A'B', A'T', and B'S' reflect some initial value for a^{22} and a^{21}. The equations describing the

Figure 10



λvv
a22 < a*22 < a**22 = a21
T'
9
λvv = a21/a22 - 1 + 1/a22 λfv
T"
λvv= a21/a22 - 1 + 1/a*22 λfv
G
A'
σo
λvv = a21/a22 - 1 + 1/a**22 λfv
S"
λvv= a*22/a21 - 1 + 1/a21 λfv
S'
5
A"
σ1
B
λvv = a22/a21 - 1 + 1/a21 λfv
σ2
B"
B'
σ2
0
λfv
λvv = a22/a21 - 1 - 1/a21 λfv
λvv = a21/a*22 - 1 - 1/a*22 λfv

lines are the bracketed expressions also shown on Figure 8. As with Figure 8, case 9 is between A'T' and the λ_{vv}-axis, case 7 is in the triangle OA'B', case 5 is between B'S' and the λ_{fv}-axis while case 8 occupies the remaining region in the quadrant.

The effect of a decline in productivity in the X^2-industry in Country II (i.e., an increase in a^{22}) can be seen by focusing on the equations describing lines A'B', A'T', and B'S' on Figure 10. Let a^{22} increase first to a_*^{22}. The line A'T' will slide down to the λ_{vv}-axis to A". While sliding down, A'T' will also rotate slowly in a clockwise direction (therefore $\sigma_1 < \sigma_o$). On the other hand, B'S' will slide upward to B"S" but with angle σ_2 remaining constant. If a^{22} continues to increase it will, sooner or later, attain a value a_{**}^{22} equal to a^{21}, and the two lines will merge into a single line OG going through the origin.[1]

That is, when the production functions are identical, the four cases--9, 8, 7, and 5--are reduced to only two cases--9 and 5. In general it can be said that reducing the differ-

[1]It might be interesting to observe here that if a^{22} continues to increase with a^{21} still remaining constant, cases 7 and 8 will change into cases 3 and 6, respectively, because Country I now has an absolute advantage in the production of X^2. Additionally, it will be recalled from the graphs on Figure 7 that cases 3 and 6 had no feasible solution in the positive quadrants.

ence in productivity (i.e., $\frac{1}{a^{22}} - \frac{1}{a^{21}}$)[1] will increase the probability that either case 5 or 9 will maximize world consumption. Conversely, increasing the difference in productivity will increase the probability that case 7 or 8 will maximize world consumption.[2]

In order to illustrate these contentions assume distribution costs λ_{fv} and λ_{vv} remain fixed, as shown by point P_o on Figure 10. Initially at P_o case 7 will maximize world consumption. If the difference in productivity is narrowed by increasing a^{22} to a^{22}_{*}, point P_o will lie between the lines A"B", A"T", and B"S", meaning case 8 now can maximize world consumption. Should a^{22} increase even further until $a^{22} = a^{22}_{**} = a^{21}$, P_o will now be above the line OG implying that case 9 will maximize world consumption. Conversely, decreasing a^{22} steadily from a^{22}_{**} will progressively call for cases 9, 8, and 7, if world consumption is to attain a maximum.

In conclusion it should again be emphasized that the above analysis of changes in productivity in the final good industries was predicated upon the assumption that conditions

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[1]In the above discussion the difference was reduced by decreasing $1/a^{22}$. A similar result might have been achieved by increasing $1/a^{21}$ in the productivity in the X^2-industry in Country I.

[2]If the difference is very large, the probability that case 7 will maximize world consumption will also tend to be very large.

in the distribution industry remain fixed. In the real world changes may occur jointly in the distribution and final good industries. The effect of such joint changes will be explored more fully in the next Chapter where a new synthesis of international trade theory between industrialized and raw-material producing countries is attempted.

CHAPTER IV

TRADE THEORY: VIEWPOINT OF RAW MATERIAL PRODUCERS

A Sketch of the Model

Although the model developed in the previous Chapter is necessarily highly simplified, it can be used cautiously to supplement existing explanations of international trade. The model also gives a new theoretical perspective to existing empirical studies on international trade flows.

Consider a world consisting of non-industrialized Country I and industrialized Country II. Each country, by using factors of local or foreign origin, is capable of generating a flow of a certain raw material.[1] The raw

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[1]The model to be developed below is, therefore, significantly different from the models of Ricardo, Graham and Ohlin, which assume that "what is to be produced and exported by each country is determined by the relative supply of various factors of production which exist within its borders before export production is begun." (Jonathan V. Levin, "The Export Economics," in Trade and Development, ed. by Theberge, p.11.)

Perhaps a more elegant model than the one to be presented below would also include an explanation of why factors (capital, labor, management, entreprenership, etc.,) flow from industrialized to raw material producing countries. Differences in factor returns and distribution costs (interpreted broadly) would, no doubt, constitute part of such a model. In addition, the influence of non-economic factors such as ideology, culture, imperialism, humanitarian ventures, etc., may also have to be included (cf. Harry Richardson, Regional Economics (New York: Praeger Publishers, 1969), pp.287-320).

It should also be observed that the assumption of full employment, common among models applicable to industrialized capitalist countries, is not posited in the ensuing model.

material is used to manufacture a final good consumed in both Countries I and II.

Initially, only Country II can produce the final good. The implications of this point can be shown directly on Figure 10 (in the last Chapter) if the raw material is substituted for the factor so that λ_{vv} is distribution costs[1] for a unit of the raw material while λ_{fv} is distribution costs (in terms of the raw material) for the final good. Since only Country II can produce the final good, any amount of the raw material in Country I cannot produce even a small quantity of the final good. Hence it may be assumed that $a^{21} = \infty$. Substituting $a^{21} = \infty$ into the equations for the lines on Figure 10 will produce a situation where, for any finite level of distribution costs, case 7 will maximize world consumption of the final good. In other words, maximizing world consumption requires that the underdeveloped country export the entire flow of her raw material to the developed country. The requirement that the underdeveloped country be a raw material producer need not depend upon the assumption $a^{21} = \infty$. So long as the productivity of the raw materials remains larger in Country II (i.e., $a^{22} < a^{21}$) the same requirement will hold provided distribution costs are sufficiently low. On Figure 10, one can visualize a decrease in a^{21} which shifts the line A'B' closer and closer to the origin. Thus, so long as the point repre-

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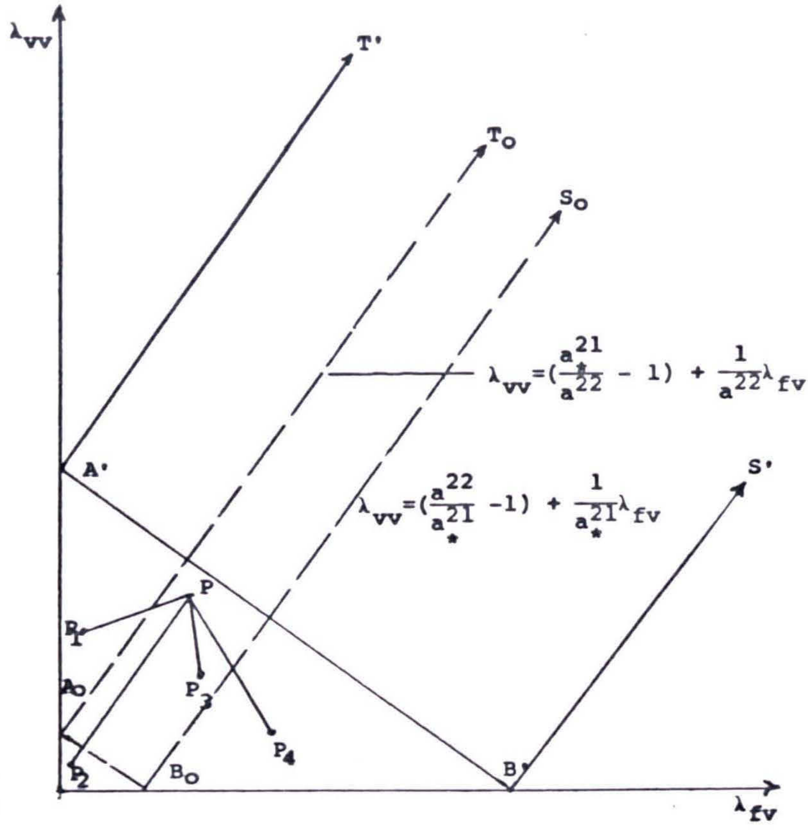
[1] I.e., costs in terms of the raw material.

senting distribution costs lies below the line A'B' the underdeveloped country must continue her role of a raw material producer if world consumption of the final good is to be maximized.

There is no obvious reason, however, to expect that distribution costs will always be so low as to warrant perpetuating the material producing status for the underdeveloped country. For instance, consider Figure 11. The lines A'B', A'T', and B'S' (on Figure 10) are identical to the similarly labelled lines on Figure 11. Suppose the productivity of the factor (i.e., the raw material) increases in the underdeveloped country, as evidenced by a decline from a^{21} to a^{21}_{*}. The decline in a^{21}_{*} will shift B'S' to a position such as B_oS_o, closer to the origin. Likewise, A'T' will shift to position A T , closer to the origin. Meanwhile, it may be assumed that distribution costs remain fixed at a given point, say P. Conversely it may be assumed there is an increase in productivity in the distribution industry producing, in turn, a shift from P to other points like P_1, P_2, P_3, and P_4.

Only if distribution costs drop to a point (e.g., P_2) below A_oB_o, will maximizing world consumption require the underdeveloped country to export her total flow of raw materials. If, instead, distribution costs for the final good drop relatively fast, a point such as P_1 in case 9 will be reached. World consumption will be at a maximum only if both countries trading in the final good in a one-good world will

Figure 11



λvv
T'
To
So
λvv=(a*21/a22 - 1) + 1/a22 λfv
A'
S'
λvv=(a22/a*21 -1) + 1/a*21 λfv
P
P1
Ao
P3
P4
P2
Bo
B'
λfv

be discussed shortly). On the other hand, if distribution costs for the raw material drop relatively fast to points such as P_3 and P_4 in cases 8 and 5, maximizing world consumption will still require each country to produce the final good for domestic consumption. In addition, depending upon the location of effective demand, the underdeveloped country may be required to export the raw material while the developed may be required to export the final good (in case 8) or the factor (in case 5).

From the viewpoint of Country I, international trade will consist largely of an out-flow of raw materials and an in-flow of the manufactured good as well as services of foregn-owned factors. The raw materials are produced by local and, perhaps more importantly, by foreign factors. The crucial role of foreign factors in generating flows of raw materials from the underdeveloped countries has been underlined by Levin who, contending that

> ". . . the labor, capital and entrepreneurship which were to operate most export industries were internationally mobile and could be applied almost anywhere in the overseas world,"

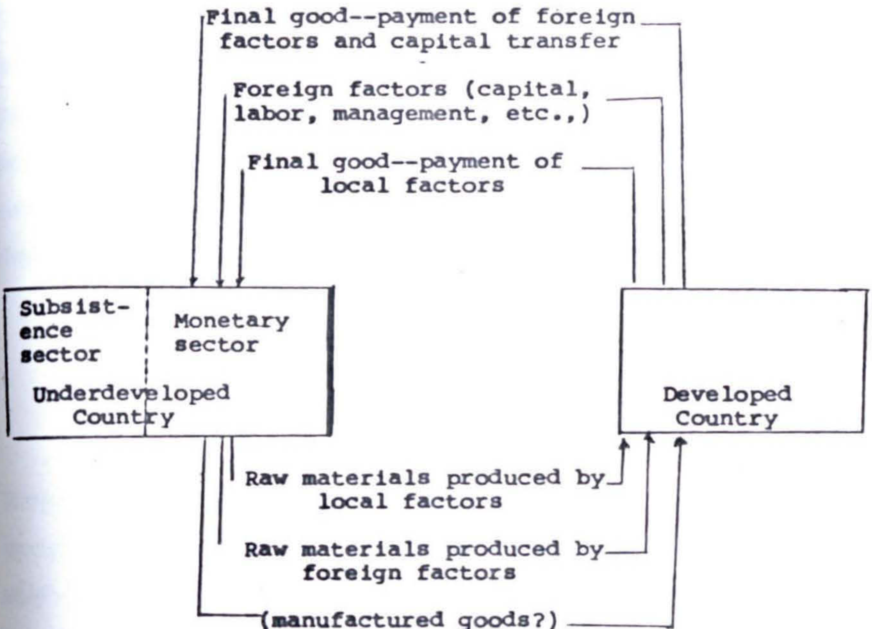
also argues

> "For these industries (i.e., raw material export industries) could not have been established with the existing supply of domestic factors which were inadequate and generally immobile. Indeed it was only through international movement of factors that the raw material export industries were established and

continue to operate.[1]

The raw materials flowing from the underdeveloped country can, therefore, be imputed to local and foreign factors, as shown by the lower loops on Chart 1. The materials are paid for partly by in-flowing final good as shown by two of the upper

Chart 1



[1]Theberge ed., Trade and Development, pp. 12-14. For a nationalistic account of the importance of foreign factors in raw material producing countries see Kwame Nkrumah, Neo-Colonialism, (New York: Internal Publishers, 1965).

loops, again on Chart 1. A fraction of the in-flowing good constitutes payment for local factors. The rest is associated with the in-flow of foreign factors-payment for factors, capital transfer, gifsts, etc.

A considerable part of the payment for foreign factors will also be remitted to the mother country.[1] The remittance will enable the developed country to consume a larger share of the final good, thus locating effective demand on the upper left-hand portion of the P/F's in each of the four cases. To illustrate this point, consider case 7 where all the flow of raw materials, $\bar{V}_1$, is exported to Country II. If all of the materials $(\frac{1}{1 + \lambda_{vv}} V_1)$ reaching the developed country were used to produce and ship the final good back to the underdeveloped country, $X^2(I)$ would be equal to

$$\frac{\frac{a^{22}}{a^{22} + \lambda_{fv}} \frac{1}{1 + \lambda_{vv}} \bar{V}_1}{a^{22}} = \frac{\bar{V}_1}{(a^{22} + \lambda_{fv})(1 + \lambda_{vv})}$$

However, since the foreign factors remit some of their earnings to Country II, the actual consumption of the final good in Country I will be less than $\frac{\bar{V}_1}{(a^{22} + \lambda_{fv})(1 + \lambda_{vv})}$. Therefore world consumption will generally be represented by a point, d, to the left of the line AE on the world P/F for case 7, as shown on Figure 12.

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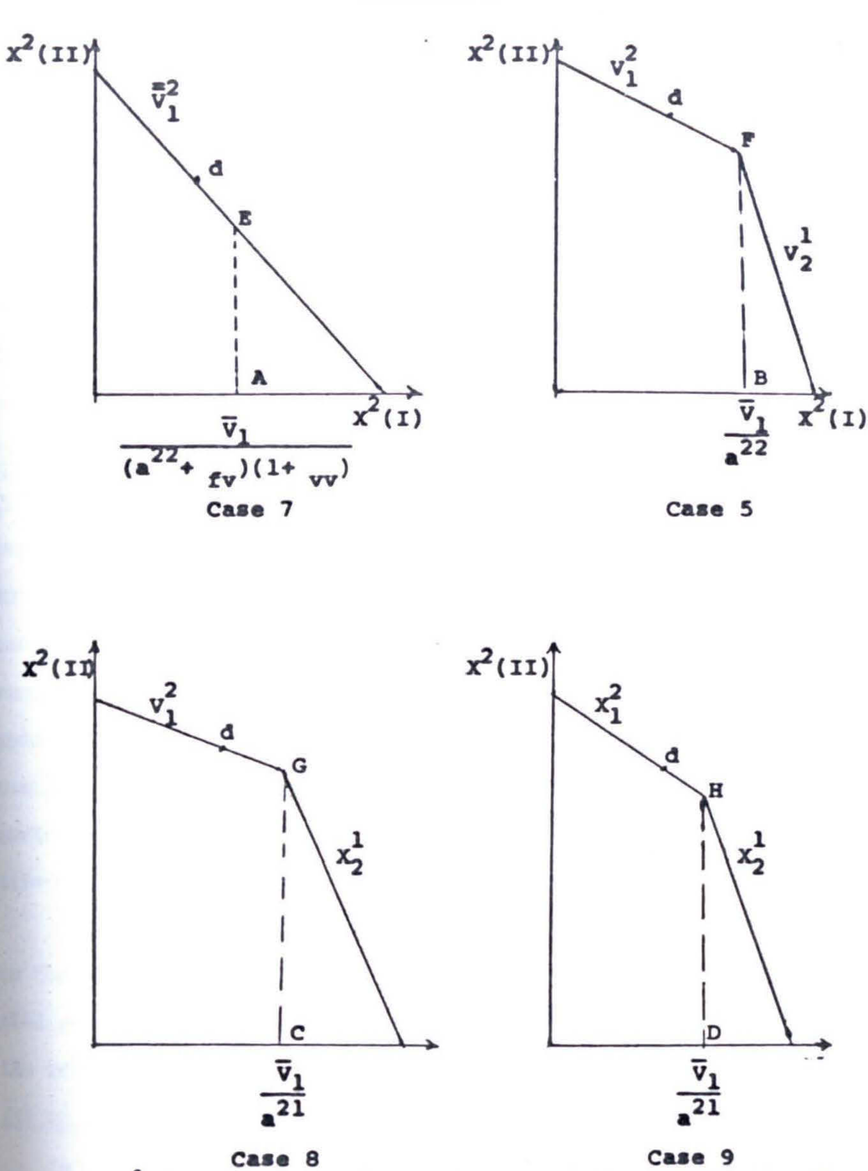
[1] *Ibid.*, pp. 15-19.

Figure 12



[1]Also shown on the perimeter of the P/F is the flow of the factor and/or final good permissible for the cases.

Effective demand is also located on the upper left-hand portion of the world P/F's for cases 5, 8, and 9. In these cases it will be recalled that world consumption is at a maximum when each country is manufacturing the final good for domestic consumption. At first sight it may appear as though the underdeveloped country should use all of her raw material to manufacture $\frac{\overline{V}_1}{a_{2I}}$ of the final good for domestic consumption. However, the raw material $\overline{V}_1$ is produced by both foreign and domestic factors. To the extent foreign factors remit their earnings to their home country, consumption of the final good in the underdeveloped country will be less than $\frac{\overline{V}_1}{a_{2I}}$. Hence world consumption will, as shown on Figure 12, be represented by a point, d, to the left of lines FB, GC, and HD on the P/F's for cases 5, 8, and 9, respectively. In cases 5 and 8, world consumption will be maximized if the remittance is affected by exporting the raw material from the underdeveloped country. Only in case 9, where distribution costs for the final good are relatively low, will maximizing world consumption require that the underdeveloped country effect the remittance by exporting the manufactured good.

In so far as the model sketched above has relevancy to the trading relations between industrialized and raw material producing countries, various generalizations follow from the model.

(1) On the basis of case 7.-Given that

(a) distribution costs for both final goods and the factor are significantly low,

(b) the underdeveloped country is consuming manufactured products which she cannot produce or which she can produce only poorly,[1] and

(c) foreign factors participate in producing the raw materials in Country I,

maximizing world consumption requires an underdeveloped country to export all her raw materials to industrialized countries. The consumption of manufactured products in the underdeveloped will vary (inversely) with the extent to which

(a) foreign factors remit earnings to the industrialized countries, and

(b) foreign factors participate in generating flows of raw materials in the underdeveloped country.

(ii) On the basis of cases 7 and 8. - Given that

(a) distribution costs for raw materials are relatively low (compared to distribution costs for final good),

(b) the underdeveloped country is consuming manufactured products which she can produce fairly efficiently but not as efficiently as the developed country, and

(c) foreign factors participate in generating flows of raw materials in the underdeveloped country,

maximizing world consumption requires that both the developed and underdeveloped countries manufacture their own goods for domestic consumption. Besides, the underdeveloped country must export raw materials in amounts large enough to match the earning remitted by foreign factors. The remittance will again tend to vary (directly) with the share of earnings

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[1] I.e., the productivity of the underdeveloped country is very low.

remitted and the degree of foreign participation in the underdeveloped country.

On the other hand, suppose the axiomatic identity of production functions is a practical reality so that only cases 9 and 5 obtain.[1] It may, however, very well be that distribution costs for manufactured goods are relatively high compared to costs of distributing raw materials. Raw materials, being relatively more standardized, may have lower marketing costs than manufactured goods.[2] Given their heavy weight and bulkiness, one may also surmise that raw materials may have experienced relatively large decline in distribution costs because of the past improvement in transportation. Furthermore, it is probable that raw materials exported to traditional markets flow through long-established marketing channels which have taken steps to improve their efficiency and reduce costs. All these factors, by lowering distribution for raw materials, may place the underdeveloped country in case 5 where she will be exporting raw materials, the identity of production functions notwithstanding.

(iii) On the basis of case 9. - Given that

(a) distribution costs for final goods are relatively

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[1]From earlier discussion on Figure 10 it will be recalled that when $a^{22}=a^{1}$ only cases 9 and 5 remain because lines AT and BS converge into line OG through the origin.

[2]"Product cycle" theorists have, for example, emphasized the fact that manufactured goods, initially unstandardized, may have high marketing costs.

low (compared to distribution costs for raw materials),

(b) the underdeveloped country is manufacturing products which she can produce fairly efficiently, but still not as efficiently as the developed country, and

(c) foreign factors participate in producing raw materials in the underdeveloped country,

maximizing world consumption requires that each country manufacture its own products for domestic consumption. Besides, the underdeveloped country must export manufactured products to match remittance by foreign factors.

Other generalizations are also possible. For example, consider the P/F's for cases 5 and 8 on Figure 12 again. It has already been argued that remittance by foreign factors will reduce the consumption of the final good to the left of the lines FB and GC. Suppose the remittance is very large so that the consumption of the final good in the underdeveloped country is very small (i.e., $X^2(I)$ is very close to the origin). Although maximizing world consumption requires each country to produce the final good, the low level of consumption in the underdeveloped country may not warrant an efficient scale of operation. The country will, therefore, be forced to case 7 where she will export all raw materials. Alternatively, the country may try to preserve manufacturing for domestic consumption by increasing indigenous participation in the production of raw materials, or by deflecting more of the would-be remitted earnings into domestic consumption.

Additionally, the model supports partly the familiar fear that shipping agencies, by colluding to keep the freight rates for raw materials relatively low, may, in fact, perpetuate the raw material producing status of the underdeveloped countries. A shift from case 7 to cases 5, 8, and 9 will probably involve a substantial decline in the volume of shipments, since the underdeveloped country will not longer be exporting all her raw materials and importing all final goods for domestic consumption. It may, at least in the short-run, be in the interest of shipping agencies then to prevent a shift from case 7.

The fear is, however, less warranted in cases 5, 8, and 9. Reducing distribution costs for raw materials may require the underdeveloped country to export the factor (cases 5 and 8) instead of the final good (case 9). It is not, however, clear what shipping agencies will gain by shifting from case 9 to 5 or 8. Neither is it clear, in the absence of relevant empirical studies on international distribution, that the collusion of the shipping agencies will, in fact, produce a shift from case 9 to cases 5 or 8.[1]

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[1]Needless to say, freight rates are only a part of distribution costs as conceived in this study.

A Digression: Empirical Studies

Trade flow analyses

Paucity of data, perhaps more than anything else, accounts for the virtual absence of empirical studies on international distribution costs. A singular exception includes studies on international trade flows. In these studies, distribution costs are assumed to vary directly with geographic distance. This pattern of variation was corroborated by Lösch in am empirical study on international trade between Germany and European countries. He plotted Germany's share in the imports and exports of European countries against distance between Germany and the European countries and obtained a negatively sloped trend--a finding which seemed to confirm the view that "costs of distance" (i.e., distribution costs) do deter international trade flows.

This deterrence has also been empirically observed in more recent studies. Linneman, building on Tinbergen's model,[1]

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[1]Jan Tinbergen, Shaping the World Economy (New York: n.p. 1962). Tinbergen fitted an equation of the form

$$X_{ij} = C_o \ Y_i^{c1} \ Y_j^{c2} \ D_{ij}^{-c2}$$

where: X_{ij} = exports from country i to country j

Y_i and Y_j = GNP's of countries i and j

D_{ij} = geographic distance between the two countries

and C_o, c_1, c_2, and $-c_2$ are positive constants;

employs a gravity model of the form[1]

$$X_{ij} = A_o \; Y_i^{a_1} \; N_i^{-a_2} \; Y_j^{a_3} \; N_j^{-a_4} \; D_{ij}^{-a_5} \; P_{ij}^{a_6} \quad ....(30)$$

where: X_{ij} = exports from country i to j

Y_i and Y_j = income of countries i and j, respectively

N_i and N_j = population of countries i and j, respectively

D_{ij} = distance from country i to j

P_{ij} = preferential trade-factor between countries i and j

A_o, a_1, a_2, a_3, a_4, a_5, and a_6 are positive constants.

Fitting the logarithmic form of equation (30) to the trade flows among countries, Linneman obtained a negative coefficient before the term D_{ij}--a finding which again seems to support the view that physical distance and, by implication, distribution costs obstruct international trade flows.[2]

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and obtained

$$\underset{}{\text{Log } X_{ij}} = \underset{(0.6802)}{-0.6627} + \underset{(0.0270)}{0.0240 \log Y_i} + \underset{(0.0269)}{0.9395 \log Y_j} - \underset{(0.0455)}{0.8919 \log D_{ij}}$$

The negative coefficient for D_{ij}, like the negatively sloped trend in Lösch's study, again shows that geographic distance and, by inference, distribution costs deter international trade flows.

[1]Hans Linneman, An Econometric Study of International Trade Flows (Amsterdam: North-Hall and Publishing Co., 1966).

[2]Ibid., pp. 82-83. Of late, attention has shifted to "trade intensity," that is "departures of actual trade flows from trade flows estimated in gravity model." See Ippei Yamazawa, "Intensity Analysis of World Trade Flows," Hitotsubashi Journal of Economics, Vol. X, February 1970, p. 62.

Given the scarcity of data on international distribution, the Linneman type of studies may have implications for policy purposes if two modifications are introduced. Firstly, the study must be extended to take note of the fact that factor flows from developed to underdeveloped countries constitute an integral part of existing trade between the countries. This extension can be accomplished by adding a term, say $C_{ij}^{a_7}$, to represent factor flows (e.g., long-term capital flows) between the countries. Secondly, the dependent variable should be decomposed into raw materials, ${}^{R}X_{ij}$, and manufactured products, ${}^{M}X_{ij}$. The equations to be fitted will then be[1]

$$ {}^{R}X_{ij} = A_o\, Y_i^{a_1}\, N_i^{a_2}\, Y_j^{a_3}\, N_j^{-a_4}\, D_{ij}^{-a_5}\, P_{ij}^{a_6}\, C_{ij}^{a_7} \qquad .....(31) $$

$$ {}^{M}X_{ij} = A_o\, Y_i^{a_1}\, N_i^{a_2}\, Y_j^{a_3}\, N_j^{-a_4}\, D_{ij}^{-a_5}\, P_{ij}^{a_6}\, D_{ij}^{a_7} \qquad .....(32) $$

Following P. Doysdale, Yamazawa decomposed trade intensity into two components: (a) complementarity, the importance of which "is not only affected by the degree of match of the specialization structures of exports and imports but also by the degree of concentration or diversification in them" and (b) special country bias, which includes "transport costs, discriminatory tariffs, and other import restrictions, product differentiation within commodity classes, and other international economic relations than trade such as capital movements and economic cooperation." (*Ibid.*, pp. 66 and 68.) Distribution costs are, therefore, included in the category "special country bias" in Yamazawa's study.

In a time series study over the period 1955-1967 Yamazawa also found out, *inter alia*, that the special country bias was apparently becoming less and less significant--a finding leaving open the possibility that declines in distribution costs might, at least partly, have been responsible for the decreasing significance of special country bias.

[1]Barring $C_{ij}^{a_7}$, ${}^{R}X_{ij}$ and ${}^{M}X_{ij}$, everything else is as in equation (30).

The coefficient for D_{ij} in equations (31) and (32) will show the influence of distribution costs for raw materials (λ_{vv}) and manufactured goods (λ_{fv}), respectively. In other words, distribution costs needed to effect trade flows between countries will tend to vary directly with the coefficient a_5. Hence a time series study showing specific changes for a_5 in equations (31) and (32) will imply, at least roughly, similar changes in distribution costs for raw materials and manufactured goods. These changes may, in turn, assist raw material producing countries to decide whether to specialize in producing raw materials or to embark on manufacturing for domestic consumption or export, etc.[1]

Although trade-flow approaches to the study of international distribution costs lend themselves easily to data availability, they have their shortcomings. Such studies are very unwieldly. Besides, even though the unwieldliness can be overcome by the economist qua econometrician, the policy implications may not be easily digested by men of affairs.[2] Other approaches to the study of international distribution

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[1]See the discussion on Figure 11. The decision will, as has already been discussed in length, depend upon productivity in the final good industries and the initial position for distribution costs.

[2]The unconvinced reader may want to read through Yamazawa's study which concludes with the claim that a decline in trade intensity (i.e., convergence of I_{ij} toward unity) "will provide valuable implications for policy purposes." What are the implications?

costs should, therefore, be encouraged.

The Channel approach

Students interested in marketing within specific national boundaries have often directed their studies to the question--what share of the dollar spent by a consumer goes toward paying for marketing services?[1] One rough way of answering the question is to subtract the production price of a given good from its retail price and express the difference as a percent of the latter price.[2] Alternatively, where the good flows from the producer through wholesaling and retailing channels, the percentage share is simply given by

$$\frac{\text{wholesale "margin"} + \text{retailing "margin"}}{\text{producer's price} + \text{wholesale "margin"} + \text{retailing "margin"}}.$$

"Margin" in this formular refers to the difference between selling and buying prices.

By putting together various pieces of information published by the United Nations, a rough idea of the margins of some internationally traded agricultural commodities can be obtained from tables summarized below. In international

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[1]Controversies regarding the meaning, content, and policy implications of the answer to such a question fall outside the interest of this study. The interested reader is referred to the works of Converse and Cox, already cited.

[2]The accuracy of the percentage share will, of course, depend upon the extent to which the difference actually reflects marketing costs.

trade the relevant margin may be assumed to include costs incurred while a commodity is in transit between two trading countries. Hence the difference between a commodity's import price in the destination country and the export price in the country of origin may be assumed to constitute the margin. The expression

$$\frac{\text{Import price minus Export price}}{\text{Import price}} \times 100$$

therefore indicates what percentage of every dollar spent on imports is attributable to distribution costs.

The percentages of various commodities are tabulated below. Where only wholesaling prices were available in the exporting or importing country the margins are, instead, represented by "import price minus wholesale price" or "wholesale price minus export price," respectively.[1] For some commodities the tables also show freight rate as (a) a percent of import (or wholesale price), and (b) a percent of the margin.

While definitive statements must await the collection of more information, a few tentative observations are brought out by the available data.

[1]In this case it is assumed, perhaps not too extravagantly, that there is a small difference between export and wholesale prices (in the exporting country) and wholesale and import prices (in the importing country).

(a) The ratio of distribution costs (i.e., the margin) as a per cent of import (or wholesale) price is considerably large and varies widely from commodity to commodity. The percentage is noticeably high for commodities such as bananas, citrus fruits, raisins and dates, perhaps reflecting, among other things, the influence of refrigeration, special handling, and other needs attending shipments of fruits.

(b) The percentages fluctuate considerably from year to year without conforming to one representative trend. Thus, while downtrends are somewhat discernible in barley (from Canada to U.K.), wheat (from Australia to U.K.), and bananas (from Panama to the U.S.), uptrends characterize sago (from Singapore to U.K.), and natural rubber (from Singapore to the U.S.). The percentage of most of the remaining commodities exhibit no definite trends.

(c) The scant data on freight rates convey the impression that a substantial share (say between 40 and 50 per cent) of distribution costs for agricultural products may still be attributed to transport costs proper.

Even without digressing too far, it will be seen that such tables, in so far as they can provide information on changes in distribution costs, may have definite policy implications (see the discussion on Figure 11). Unfortunately, there is as yet no easily accessible source of such information on manufactured goods. It is to be hoped that a source of this kind will soon be developed, at least, with the insistance of UNCTAD.

Other approaches

Thus far, two empirical approaches to the study of costs of international distribution have been cited, namely the "trade flow" and "channel" approaches. Two other empirical approaches may also provide useful insights.

The functional approach. - Here the empirical studies could focus on the costs of those individual bodies, the services of which constitute distribution services in the broad sense. These bodies include financial intermediaries, commodity exchanges, export-import houses, insurance, and shipping agencies, foreign trade branches of business corporations, state trading corporations, etc.[1]

The sectoral approach. - Instead of focusing on individual bodies directly engaged in international trade, one may study a representative sector in one nation, say wholesaling in the United States. This sector, which includes establishments involved in international trade[2] also has data published on a periodical basis.[3] This data may perhaps be used ingeniously to shed some light on the costs of international distribution.

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[1]UNCTAD has mandated the study of state trading, insurance, shipping, etc. In virtually all studies, however, there is hardly any empirical investigation into the costs of international distribution.

[2]E.g., export and import merchants, agents, brokers, etc.

[3]U.S. Department of Commerce, Census of Business Wholesale Trade.

International Distribution Costs:
Agricultural Products[1]

Barley

From Canada to U.K.

Year	Import - Export[1] (as % of Import)	Freight[2] (as % of Export-Import margin)	Freight[2] (as % of Import price)
1955	28.6	50.0	14.3
1956	31.5	52.2	16.4
1957	26.2	50.0	13.1
1958	24.1	42.9	10.3
1959	20.7	50.0	10.3
1960	20.7	50.0	10.3
1961	15.3	66.7	10.2
1962	17.9	41.7	7.5
1963	19.7	50.0	9.8
1964	22.2	42.9	9.5
1965	20.6	50.0	10.3
1966	21.1	40.0	8.5
1967	19.7	46.2	9.1

[1]"Import-Export" is the difference between import price and export price.
Export price: Table 171; No.1 feed, basis in store Fort William - Port Arthur; domestic wholesale and export price.
Import price: Table 171; c.i.f. price of Canadian No.2 feed via St. Lawrence/Atlantic forward shipment.
[2]Freight rate: Table 219.

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[1]All the Tables are derived from Production Yearbook, (Rome: FAO of the U.N., 1968, Vol.22).

Wheat and Sago

Year	Wheat from Australia to U.K. Import - Export[1] (as % of Import)	Wheat from Australia to U.K. Freight[2] (as % of Import price)	Sago from Singapore to U.K. Import - Wholesale[3] (as % of Import)
1955	25.3	24.0	25.8
1956	27.3	31.2	27.7
1957	13.2	23.5	33.3
1958	18.6	12.9	31.1
1959	16.7	16.7	30.4
1960	16.4	16.4	29.4
1961	14.5	15.9	34.2
1962	15.5	14.1	33.8
1963	11.4	17.1	35.1
1964	20.3	14.9	35.6
1965	15.7	18.6	38.9
1966	13.5	14.9	38.7
1967	-	15.1	39.5

[1]Export price: Table 169; Fair average quality, bulk, Australian Wheat Board selling price f.o.b. ports.
Import price: Table 169; c.i.f. price, nearest forward shipment.

[2]Freight rate: Table 219.

[3]"Import - Wholesale" is the difference between import price and wholesale price.
Import price: Table 184; c.i.f. price, Liverpool.
Wholesale price: Table 184; Flour, No.1, Lingga, wholesale price.

Maize

Year	From Argentina to U.K.[1] Import - Export (as % of Import)	From the U.S. to U.K.[2] Import - Export (as % of Import)
1963	16.9	9.8
1964	25.8	8.2
1965	21.1	13.8
1966	29.6	12.3
1967	34.8	22.6

[1]Import price: Table 173; c.i.f. price, nearest forward shipment.
Export price: Table 218; colored, on wagon in port, Buenos Aires, export price.

[2]Import price: Table 173; U.S., yellow, nearest forward shipment, c.i.f.; through 1962 No.2; from 1963 No.3.
Export price: Table 218; corn No.2, yellow, export price, prompt or 30-day shipment f.o.b.

Citrus Fruit: Oranges and Grapefruit

Year	Oranges: From Israel to U.K.[1] Wholesale - Export (as % of Wholesale)	Oranges: From Spain to the Fed. Repub. of Germany[2] Wholesale - Wholesale (as % of Wholesale-Germany)	Grapefruit: From Israel to U.K.[3] Wholesale - Export (as % of Wholesale)
1955	-	-	-
1956	20.9	-	30.7
1957	17.9	-	24.0
1958	32.6	-	21.6
1959	37.0	-	15.8
1960	31.8	42.1	26.6
1961	32.8	46.6	22.0
1962	22.4	64.8	17.4
1963	30.1	56.5	29.4
1964	33.9	68.8	26.2
1965	36.9	48.1	30.0
1966	33.0	32.5	30.7
1967	25.8	49.5	31.7

[1]Wholesale price: Table 188; Auction price, London.
Export price: Table 188; Jaffa export price, f.o.b. Haifa.

[2]"Wholesale - Wholesale" is the difference between wholesale price in the importing country and wholesale price in the exporting country.
Wholesale price (Spain): Table 188; "Blanka" common quality, average wholesale price.
Wholesale price (Germany): Table 188; Auction price, Hamburg.

[3]Wholesale price: Table 188; Net weight, auction price, London.
Export price: Table 188; Average export price f.o.b. Haifa.

Sisal and Soybeans

Year	Sisal from Madagascar to the U.S.[1] Import - Export (as % of Import)	Sisal from Madagascar to U.K.[2] Import - Export (as % of Import)	Soybeans from the U.S. to U.K.[3] Import - Export (as % of Import)
1963	20.0	20.8	7.3
1964	22.1	17.8	0.9
1965	29.6	20.8	3.4
1966	29.2	22.7	12.6
1967	29.1	13.3	9.7

[1]Import price: Table 203; No.1, landed New York.
Export price: Table 218; Fibers not spun, in bales, weighted average of monthly export prices.

[2]Import price: Table 203; c.i.f. price London; through 1960 No.1; from 1961, No.3L.
Export price: Table 218; Fibers not spun, in bales, weighted average of monthly export prices.

[3]Import price: Table 192; American No.2, 3% bulk, nearest forward shipment c.i.f. 1955, 1956 and from 1960, yellow.
Export price: Table 218; No.2, export price basis, prompt or 30-day shipment f.o.b. vessel, Gulf Ports.

Milled Rice and Cane Sugar

Year	Milled Rice from Thailand to U.K. Import - Export[1] (as % of Import)	Cane Sugar from Caribbean Port to U.K. Import - Export[2] (as % of Import)	Freight[3] (as % of Import price)
1955	16.1	-	-
1956	17.9	-	-
1957	17.3	11.6	10.1
1958	9.8	10.5	7.0
1959	13.1	13.3	8.0
1960	15.0	11.5	9.0
1961	13.8	9.9	11.3
1962	12.1	8.3	9.7
1963	10.0	5.1	4.6
1964	10.5	9.2	6.3
1965	11.0	20.3	18.6
1966	9.3	-	-
1967	9.0	-	-

[1]Import price: Table 176; Siam Patna No.2, nearest forward shipment; 1955 through 1962 and 1965 and 1966, c.i.f. London; 1963 and 1964 and from 1967 c and f.
Export price: Table 176; White, 5 - 7% brokens, government standard, f.o.b. Bangkok.

[2]Import price: Table 178; raw 96°, c.i.f. London.
Export price: Table 178; Raw, 96°, bagged, export price, destination other than the U.S.; through 1960, Cuba f.o.b.; from 1961 Caribbean ports including Brazil.

[3]Freight rate: Table 219.

Sorghum

From the U.S. to U.K.

Year	Import - Export[1] (as % of Import)	Freight[2] (as % of Import price)
1963	10.9	12.7
1964	14.3	12.5
1965	14.3	16.1
1966	7.2	12.5
1967	18.3	10.0

[1]Import price: Table 174; c.i.f. price of U.S. Milo, yellow, No.2, nearest forward shipment.
Export price: Table 218; No.2, yellow, export price basis, prompt or 30-day shipment f.o.b. vessel, Gulf Ports.

[2]Freight rate: Table 219.

Cotton and Cattle Hides

Year	Cattle Hides from Argentina to U.K.[1] Import - Export (as % of Import)	Cotton from U.A.R. to U.K.[2] Import - Wholesale (as % of Import)
1959	23.9	- 2.0
1960	14.7	12.6
1961	23.5	3.4
1962	28.3	-11.0
1963	12.9	18.8
1964	19.5	18.3
1965	26.0	20.9
1966	29.5	21.2
1967	39.1	20.3

[1]Import price: Table 205; Argentina, oxen, frigorifico, wet, salted, c. and f. U.K.
Export price: Table 205; Frigorificos, cows, salted, f.o.b. Buenos Aires.

[2]Import price: Table 201; fully good, c.i.f. Liverpool, through 1963, Karnak; from 1964 Menoufi.
Wholesale price: Table 201; through 1962/1963 Karnak, good - fully good, wholesale price Alexandria, from 1963/1964 Menoufi, good - fully good in hydraulic bales, ECC's export sales price minima, spot Alexandria.

Oil

Year	Olive oil from Spain to the U.S.[1] Import - Export (as % of Import)	Palm oil From Singapore to European Ports[2] Import - Wholesale (as % of Import)
1955	12.4	9.2
1956	6.1	7.6
1957	16.0	6.1
1958	10.7	9.0
1959	14.8	10.5
1960	13.8	9.9
1961	18.7	11.5
1962	19.4	9.9
1963	22.4	13.6
1964	17.6	9.9
1965	18.4	1.2
1966	18.6	11.2
1967	18.0	10.7

[1]Import price: Table 193; imported, drums, New York.
Export price: Table 193; Edible, 1% drums, f.o.b.

[2]Import price: Table 193; Sumatra, 5%, bulk, nearest forward shipment.
Wholesale price: Table 193; f.o.b. Singapore.

Bacon and Lard

Year	Bacon: From Poland to U.K.[1] Import - Export (as % of Import)	Bacon: From Denmark to U.K.[2] Import - Export (as % of Import)	Lard: From the U.S. to Fed. Repub. of Germany Import - Export (as % of Import)
1955	-	15.0	9.4
1956	-	14.8	9.4
1957	-	14.3	5.8
1958	-	14.8	5.1
1959	-	15.1	5.4
1960	-	12.5	5.4
1961	-	9.4	7.0
1962	-	7.4	5.8
1963	16.7	6.7	7.1
1964	15.8	6.3	10.7
1965	16.1	6.6	6.9
1966	15.2	6.2	8.8
1967	15.1	6.6	11.8

[1]Import price: Table 209; Selection A, ex quay, London.
Export price: Table 218; Weighted annual average of monthly export prices.

[2]Import price: Table 209; Selection A, ex quay, London.
Export price: Table 209; Export quality, average price, f.o.b. Copenhagen.

[3]Import price: Table 193; prime, steam, import price, c.i.f. Hamburg.
Export price: Table 193; Pure, refined, 37-lb cons, f.a.s. New York.

Abaca

From the Philippines

Year	To European Ports[1] Import - Wholesale (as % of Import)	To the U.S.[2] Import - Wholesale (as % of Import)
1955	3.6	43.7
1956	- 7.5	41.1
1957	-14.4	40.0
1958	0.6	45.0
1959	-11.1	31.7
1960	- 4.1	38.8
1961	-12.3	46.6
1962	14.2	49.1
1963	26.0	46.0
1964	17.3	43.4
1965	4.0	48.3
1966	26.6	58.3
1967	-	-

[1]Import price: Table 203; Philippines Manila J2 (no-Davao), c.i.f.
Wholesale price: Table 203; unmanufactured, wholesale price, Manila.

[2]Import price: Table 203; Davao 1, import price, ex ship, New York.
Wholesale price: Table 203; unmanufactured, wholesale price, Manila.

Bananas

From Panama

Year	To the U.S.[1] Import - Export (as % of Import)	To U.K.[2] Wholesale - Export (as % of Wholesale)
1955	72.7	-
1956	73.7	-
1957	74.6	85.5
1958	72.4	85.1
1959	69.0	83.8
1960	69.2	84.3
1961	64.7	90.1
1962	64.7	83.0
1963	72.6	83.7
1964	65.3	80.5
1965	56.6	74.3
1966	55.2	74.1
1967	-	-

[1]Import price: Table 190; f.o.b. port of entry, Through 1962 from Central America and Equador, first class green steams. From 1963 from Central and South America, in 40-lb boxes, tropical pack.
Export price: Table 190; unit value of exports.
[2]"Wholesale - Export" is the difference between wholesale price in the importing country and export price.
Wholesale price: Table 190; Jamaican, wholesale price, London.
Export price: Table 190; unit value of exports.

Copra

From the Philippines

Year	To the U.S.[1] Import - Export (as % of Import)	To European Ports[2] Import - Export (as % of Import)	Freight (as % of Export-Import margin)	Freight (as % of Import price)
1955	22.3	24.4	47.7	11.7
1956	23.5	26.6	63.8	16.9
1957	18.9	17.4	63.3	11.0
1958	13.0	7.4	73.3	5.4
1959	12.7	7.2	66.7	4.8
1960	16.5	9.9	65.0	6.4
1961	19.7	15.8	46.2	7.3
1962	17.4	15.9	42.3	6.7
1963	18.1	16.3	46.7	7.6
1964	19.2	17.5	44.1	7.7
1965	25.9	26.5	28.3	7.5
1966	23.1	22.7	35.7	8.1
1967	19.4	19.8	42.5	8.4

[1]Import price: Table 192; bulk, c.i.f. Pacific Coast.
Export price: Table 192; Sundried, f.o.b. Manila.
[2]Import price: Table 192; bulk, nearest forward shipment, c. and f.; from 1957 c.i.f.
Export price: Table 192; Sundried, f.o.b. Manila.
Freight rate: Table 219; rate on copra from the Philippines to Antwerp/Hamburg.

Natural Rubber

Year	From Singapore to U.K.[1] Import - Export (as % of Import)
1955	3.6
1956	3.7
1957	4.8
1958	4.6
1959	3.6
1960	3.9
1961	4.5
1962	5.2
1963	5.6
1964	4.9
1965	5.4
1966	6.3
1967	7.5

[1]Import price: Table 204; No.3 R.S.S. c.i.f. London.
Export Price: Table 204; No.3 R.S.S., wholesale price, baled, f.o.b. Singapore.

Year	From Singapore to the U.S.		
	Wholesale - Export[1] (as % of Wholesale)	Wholesale - Export[2] (as % of Wholesale)	Wholesale - Export[3] (as % of Wholesale)
1955	4.8	7.8	6.7
1956	7.6	8.7	7.6
1957	7.1	8.5	8.8
1958	6.8	8.1	9.4
1959	9.7	9.0	10.0
1960	7.6	8.9	8.2
1961	7.4	8.4	11.7
1962	10.8	11.4	13.0
1963	10.0	10.1	-
1964	11.7	11.8	-
1965	11.1	11.2	-
1966	9.6	10.5	-
1967	11.4	14.0	-

[1]Wholesale price: Table 204; No.1 R.S.S., wholesale price, New York.
Export price: Table 204; No.1 R.S.S., wholesale price, baled, f.o.b. Singapore.

[2]Wholesale price: Table 204; No.3 R.S.S., wholesale price, New York.
Export price: Table 204; No.3 R.S.S., wholesale price, baled, f.o.b. Singapore.

[3]Wholesale price: Table 204; No.3 blanket crepe, wholesale price, New York.
Export price: Table 204; No.3 blanket crepe, baled, f.o.b. Singapore.

Currants, Raisins and Dates

Year	Currants From Greece to U.K.[1] Import - Export (as % of Import)	Raisins From Turkey to U.K.[2] Import - Wholesale (as % of Import)	Dates From Iraq to the U.S.[3] Wholesale - Export (as % of Wholesale)
1955	-	-	-
1956	9.6	-	92.2
1957	10.0	-	87.4
1958	8.4	- 6.5	88.9
1959	7.1	37.8	88.3
1960	6.8	23.2	86.7
1961	5.8	37.2	87.6
1962	8.1	35.4	76.6
1963	1.8	27.8	80.1
1964	20.2	33.3	84.6
1965	2.7	32.4	84.0
1966	6.1	31.3	-
1967	7.8	31.6	-

[1]Import price: Table 189; Patras, nearest forward shipment. 1955 through 1961, and from 1964 choicest: 1962 and 1963, selected; 1955 through 1959, c.i.f.; from 1960 c. and f.
Export price: Table 189; average export unit value, f.o.b.

[2]Import price: Table 189; Sultanas No.9, spot price, London; 1957 - 63 ex-store; from 1964 duty paid, ex wharf.
Wholesale price: Table 189; seedless, No.9, wholesale price Izmir.

[3]Wholesale price: Table 189; Sairs, through 1963, selected, good average quality 70's; 1964 GAQ, fancy loose; 1965, pitted fancy loose pack; from 1963 bulk, ex warehouse.
Export price: Table 189; unit value of exports.

CHAPTER V

CHOICE OF DISTRIBUTORS AND ALLOCATION OF PRIMARY FACTORS

The present Chapter has two main purposes. Firstly, the assumption that only one country performs the actual task of distributing commodities internationally will be relaxed.[1] Secondly, the spatial allocation of primary factors will be brought to the foreground. Instead of just asserting, as in the last Chapter, that the foreign factors may be participating in generating flows of raw materials, the allocation of all primary factors will be shown explicitly.

The two purposes can be accomplished by casting the international trade between the industrialized and raw material producing countries in a linear programming frame-work.[2] In brief, the problem is that of maximizing world consump-

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[1]See assumption (xv) at the beginning of Chapter II.

[2]Original expositions of linear programming as a tool in inter-spatial economic analysis can be found in Stevens, Interregional Linear Programming, Lefeber, Allocation in Space, and Isard, "Interregional Linear Programming," Regional Science, Vol.1, Summer 1958. The main problem to be propounded below follows Lefeber's approach of earmarking shipments to specific industries--an approach which, as pointed out by Stevens, entails relatively more constraints and cumbersome solution. This weakness notwithstanding, Lefeber's approach commands a greater clarity in a non-empirical context, such as the one in this Chapter.

tion given:

(i) Country I--a raw material producing country, and Country II--an industrialized country;

(ii) each country is endowed with two primary factors, labor and capital;

(iii) primary factors from one country may be used in the other country to generate a flow of a given raw material, to manufacture a given final good or to produce distribution services;

(iv) the raw material is used to produce the final good;

(v) the final good is consumed in both countries;

(vi) the distribution of primary factors, the raw material, and the final good is costly; and

(vii) the location of effective demand is known.

Before turning to the problem a summary of new notations is in order.

Notation	Explanation
$P_{qg}(q=1,\ g=1,\ 2)$	denote the price of good q consumed in country g. The prices can presumably be established from a priori knowledge on the location of effective demand.[1]
$X^{mn}\begin{pmatrix} n=1,\ 2 \\ m=1,\ 2,\ 3 \end{pmatrix}$	output of good X from industry m in country n. The first industry produces the final good; the second, the raw material; and the third, a homogenious distribution service used to distribute primary factors,

[1]This presumption, in turn, entails other subtle difficulties, for instance, see Isard, "Interregional Linear Programming," Regional Science, pp. 45-50.

the raw material and the final good.[1]

$X_k^{mn}\begin{pmatrix} m=1, 2, 3 \\ n, k=1, 2 \end{pmatrix}$ output of good X from industry m in country n delivered to country k for consumption (in the case of the first good) or for manufacturing the final good (in the case of the raw material).

$V_{jh}^{mn}\begin{pmatrix} j, h, n=1, 2 \\ m=1, 2, 3 \end{pmatrix}$ primary factor number h from country j employed in industry m in country n. Hence all V_{jh}^{mn} ($j \neq n$) are foreign factors which also consume distribution services.

$\bar{V}_{jh}$ $(j, h=1, 2)$ country j's total endowment of primary factor h.

$\beta_{cd}^{rs}\begin{pmatrix} d, c, r, s=1, 2 \\ c \neq r \end{pmatrix}$ units of distribution services needed by country s to transfer a unit of good d from country c to country r. For simplicity it is assumed that distribution services (i.e., good three) are consumed at the country of production.

$b_{ce}^{rs}\begin{pmatrix} e, c, r, s=1, 2 \\ c \neq r \end{pmatrix}$ units of distribution service needed by country s to transfer a unit of primary factor e from country c to country r.

$a_i^{mn}\begin{pmatrix} n=1, 2 \\ m, i=1, 2, 3 \end{pmatrix}$ units of input i needed to produce a unit of X^{mn}. In producing the first good, i.e., the final good, there are three inputs, namely two primary factors and one raw material. The raw material and the distribution services, in turn, use only the primary factors of production.

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[1]This homogeneity is a simplifying assumption which is in contrast to the discussion in Chapters II to IV where distribution services for the final good were distinguished from distribution services for the factor.

The Direct Problem

The objective function. - In the problem only one good, the final good, is being consumed. The amount of the good available in any country for consumption may be imported or produced locally. Thus $(x_1^{11} + x_1^{12})$ and $(x_2^{12} + x_2^{11})$ represent total quantities of the final good consumed in Countries I and II, respectively. Remebering from the above notations that P_{11} and P_{12} represent the prices of good one, the final good in Countries I and II, respectively, the objective function is,

Maximize $Z = P_{11}(x_1^{11} + x_1^{12}) + P_{12}(x_2^{12} + x_2^{11})$[1]

The constraints. - There are five main types of constraints in the direct problem:

(i) Availability constraints:

$$x_1^{11} + x_2^{11} \leqq x^{11} \quad \text{.........(1)}$$

$$x_1^{12} + x_2^{12} \leqq x^{12} \quad \text{.........(2)}$$

$$x_1^{21} + x_2^{21} \leqq x^{21} \quad \text{.........(3)}$$

$$x_1^{22} + x_2^{22} \leqq x^{22} \quad \text{.........(4)}$$

These constrainsts indicate that shipments of the final good

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[1]It should be noted that price discrimination according to the origin of the final good is non-existent.

or the raw material from an industry in a given country cannot exceed total supply. In constraint (1), for instance, x^{11} represents the supply of the first industry in Country I. This supply cannot, therefore, be exceeded by shipments, x_1^{11} and x_2^{11}, to Countries I and II, respectively.[1]

(ii) Input constraints:

$$a_1^{11}x^{11} \leq v_{11}^{11} + v_{21}^{11} \quad \dots\dots\dots\dots\dots\dots(5)$$

$$a_2^{11}x^{11} \leq v_{12}^{11} + v_{22}^{11} \quad \dots\dots\dots\dots\dots\dots(6)$$

$$a_3^{11}x^{11} \leq x_1^{21} + x_1^{22} \quad \dots\dots\dots\dots\dots\dots(7)$$

$$a_1^{12}x^{12} \leq v_{11}^{12} + v_{21}^{12} \quad \dots\dots\dots\dots\dots\dots(8)$$

$$a_2^{12}x^{12} \leq v_{12}^{12} + v_{22}^{12} \quad \dots\dots\dots\dots\dots\dots(9)$$

$$a_3^{12}x^{12} \leq x_2^{21} + x_2^{22} \quad \dots\dots\dots\dots\dots\dots(10)$$

$$a_1^{21}x^{21} \leq v_{11}^{21} + v_{21}^{21} \quad \dots\dots\dots\dots\dots\dots(11)$$

$$a_2^{21}x^{21} \leq v_{12}^{21} + v_{22}^{21} \quad \dots\dots\dots\dots\dots\dots(12)$$

$$a_1^{22}x^{22} \leq v_{11}^{22} + v_{21}^{22} \quad \dots\dots\dots\dots\dots\dots(13)$$

$$a_2^{22}x^{22} \leq v_{12}^{22} + v_{22}^{22} \quad \dots\dots\dots\dots\dots\dots(14)$$

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[1]From the notation described above, it will be clear that constraints (1) and (2) refer to the final good while (3) and (4) refer to the raw material.

$$a_1^{31}X^{31} \leqq V_{11}^{31} + V_{21}^{31} \quad \text{........(15)}$$

$$a_2^{31}X^{31} \leqq V_{12}^{31} + V_{22}^{31} \quad \text{........(16)}$$

$$a_1^{32}X^{32} \leqq V_{11}^{32} + V_{21}^{32} \quad \text{........(17)}$$

$$a_2^{32}X^{32} \leqq V_{12}^{32} + V_{22}^{32} \quad \text{........(18)}$$

The constraints in this group specify that the total of an input (primary factor or raw material) used to produce a good (final good, raw material or distribution service) in a given country cannot exceed input-shipment into the respective industry. For example, $a_1^{11}X^{11}$ in constraint (5) represents the total amount of the first input, i.e., the first primary factor, used in producing the final good in Country I. This amount cannot exceed V_{11}^{11} and V_{21}^{11}, the shipment of the first input into the X^{11}-industry from Countries I and II, respectively. It will be observed (constraints 5 - 10) that the production of the final good in Country I or II uses three inputs, two primary factors and a raw material. The raw material (constraints 11 - 14) and distribution services (constraints 15 - 18), on the other hand, use only two inputs, the primary factors.

(iii) Factor endowment constraints:

$$V_{11}^{11} + V_{11}^{12} + V_{11}^{21} + V_{11}^{22} + V_{11}^{31} + V_{11}^{32} \leqq \bar{V}_{11} \quad \text{...(19)}$$

$$V_{12}^{11} + V_{12}^{12} + V_{12}^{21} + V_{12}^{22} + V_{12}^{31} + V_{12}^{32} \leqq \bar{V}_{12} \quad \text{...(20)}$$

$$V_{21}^{11} + V_{21}^{12} + V_{21}^{21} + V_{21}^{22} + V_{21}^{31} + V_{21}^{32} \leqq \bar{V}_{21} \quad \ldots\ldots(21)$$

$$V_{22}^{11} + V_{22}^{12} + V_{22}^{21} + V_{22}^{22} + V_{22}^{31} + V_{22}^{32} \leqq \bar{V}_{22} \quad \ldots\ldots(22)$$

In this group the constraints signify that total use of a factor originating in a given country cannot exceed the factor endowment in the country. To illustrate, the left side of constraint (19) represents all uses of the first primary factor originating in Country I.[1] The total of the factor in these uses cannot exceed $\bar{V}_{11}$, the factor endowment of Country I.

(iv) Constraints enabling choice of efficient distributors: In a two-country world, such as the one in this problem, one or both countries must perform the actual tasks of distributing commodities between the two countries. An attempt must, then, be made to specify constraints which will permit the maximizing mechanism in the linear programming problem to also choose the efficient distributor-countries.

In order to specify these constraints let

$$\pi_1 = V_{11}^{12} + V_{11}^{22} + V_{11}^{32}$$

$$\pi_2 = V_{12}^{12} + V_{12}^{22} + V_{12}^{32}$$

$$\pi_3 = X_2^{11} + X_2^{21}$$

---

[1]It should be observed that $V_{11}^{11} + V_{11}^{21} + V_{11}^{31}$ of the factor is used domestically. The rest is exported to Country II.

$$\pi_4 = v_{21}^{11} + v_{21}^{21} + v_{21}^{31}$$

$$\pi_5 = v_{22}^{11} + v_{22}^{21} + v_{22}^{31}$$

$$\pi_6 = x_1^{12} + x_1^{22}$$

In the above equations, π_1 and π_2 represent shipments of the first and second primary factors, respectively, from Country I to II. Likewise, π_4 and π_5 represent shipments of the first and second primary factors from Country II to I. Furthermore, π_3 stands for the shipment of the final good, X_2^{11}, and the raw material, X_2^{21}, from Country I to II, while π_6 stands for the shipment of the final good X_1^{12} and the raw material X_1^{22} from Country II to I. The vector $(\pi_1, \pi_2, \ldots, \pi_6)$ then includes, in the two-country world, all the shipments which might consume distribution services.

Suppose Country I undertakes the actual task of distributing all commodities between the two countries. The following constraint, specifying the equality of demand and supply for distribution services, would have to be included in the linear problem:

$$b_{11}^{21}\pi_1 + b_{12}^{21}\pi_2 + \beta_{11}^{21}\pi_3{}^{1} + b_{21}^{11}\pi_4 + b_{22}^{11}\pi_5 + \beta_{21}^{11}\pi_6{}^{1} \leqq X^{31} \ldots (23)$$

The sum of the products on the left side of the equation (23)

---

[1]It is being assumed, solely for ease of exposition in equations (23)-(28), that $\beta_{11}^{21}=\beta_{12}^{21}$; $\beta_{21}^{11}=\beta_{22}^{11}$; $\beta_{11}^{22}=\beta_{12}^{22}$; and $\beta_{21}^{12}=\beta_{22}^{12}$.

constitutes total demand for distribution services. This sum cannot exceed X^{31}, the total distribution services produced by Country I. Alternatively, Country II may undertake the distribution of all commodities, in which case

$$b_{11}^{22}\pi_1 + b_{12}^{22}\pi_2 + \beta_{11}^{22}\pi_3 + b_{21}^{12}\pi_4 + b_{22}^{12}\pi_5 + \beta_{21}^{12}\pi_6 \leqq X^{32} \quad \text{...(24)}$$

Here again, demand for distribution services (the left side) cannot exceed their supply, X^{32}. Unfortunately, equations (23) and (24) do not exhaust all possibilities. One can, for example, visualize situations where each country distributes its own exports:

$$b_{11}^{21}\pi_1 + b_{12}^{21}\pi_2 + \beta_{11}^{21}\pi_3 \leqq X^{31} \quad \text{........(25)}$$

$$b_{21}^{12}\pi_4 + b_{22}^{12}\pi_5 + \beta_{21}^{12}\pi_6 \leqq X^{32}$$

each country distributes its own imports:

$$b_{21}^{11}\pi_4 + b_{22}^{11}\pi_5 + \beta_{21}^{11}\pi_6 \leqq X^{31} \quad \text{.........(26)}$$

$$b_{11}^{22}\pi_1 + b_{12}^{22}\pi_2 + \beta_{11}^{22}\pi_3 \leqq X^{32}$$

each country undertakes the export of its factors and the import of its final goods:

$$b_{11}^{21}\pi_1 + b_{12}^{21}\pi_2 + \beta_{21}^{11}\pi_6 \leqq X^{31} \quad \text{........(27)}$$

$$b_{21}^{12}\pi_4 + b_{22}^{12}\pi_5 + \beta_{11}^{22}\pi_3 \leqq X^{32}$$

each country undertakes the import of factor and the export

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of its final goods:

$$b_{21}^{11}\pi_4 + b_{22}^{11}\pi_5 + \beta_{11}^{21}\pi_3 \leqq X^{31} \quad \text{.........(28)}$$

$$b_{11}^{22}\pi_1 + b_{12}^{22}\pi_2 + \beta_{11}^{12}\pi_6 \leqq X^{32}$$

The list of such constraints (constraints 23-28) can easily be extended if the specification allows for the distribution of each consignment (element) in the vector (V_{11}^{12}, V_{11}^{22}, V_{11}^{32}, V_{12}^{12}, V_{12}^{22}, V_{12}^{32}, V_{21}^{11}, V_{21}^{21}, V_{21}^{31}, V_{22}^{11}, V_{22}^{21}, V_{22}^{31}, X_2^{11} , X_2^{21} , X_1^{12} , X_1^{22}) by each country. Ideally, the maximizing algorithm for the linear programming problem must choose the most efficient distributors from all the possible constraints. This choice may, however, constitute an impossible task, especially in multi-factor, multi-country models. Expediency may, therefore, dictate recourse to more general constraints such as (23)-(28).

(v) Finally, there are 37 constraints, each ensuring a non-negative value for every one of the 37 variables in the problem.

The direct problem is again reproduced on Table 4 where only constraints (1)-(24) are shown. Constraints (23) and (24) will permit an efficient choice of the distributor-nation.[1]

---

[1]It should be observed that this choice is based upon the linearity assumptions (regarding the coefficients in the distribution industry) and upon the ruling prices P_{11} and P_{12} for the final good in Countries I and II, respectively. In so far as changing the prices alters the volume of inter-country

If constraints (25)-(28) are added, the choice of distributors may, as disucssed above, include both nations.[1] The solution values for the variables on top of the table will give

(a) world consumption of the final good, namely $(X_1^{11} + X_1^{12})$ and $(X_2^{11} + X_2^{12})$ in Countries I and II, respectively;

(b) world allocation of primary factors of production (this will be shown by the values for the V's);

(c) the optimal location of the production of the final good (i.e., X^{11} and X^{12}), the raw material (i.e., X^{21} and X^{22}), and distribution services (i.e., X^{31} and X^{32}); and

(d) the optimal trade flows (final good, raw materials, and primary factors) between the two countries.[2]

The Dual Problem

The dual of the direct linear programming problem can also be read from Table 4. The column of $U_1, U_2, \ldots, U_{23}$

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shipments, such change may also affect the choice of distributors if non-linearities exist and characterize the distribution industries in varying degrees from country to country.

[1]The linear programming problem may be solved by including constraints (23)-(28), one at a time, or by including all six constraints at once. The preference for a specific approach will ultimately depend upon the researcher's objectives (cf. Lefeber, Allocation in Space, pp. 133-134. The reader may observe upon second thought that the problem of an efficient choice of distributors shares a kinship with the problem of planning for "optimal transport networks").

[2]More specifically, Country I's exports can be represented by the vector ($V_{11}^{12}, V_{11}^{22}, V_{11}^{32}, V_{12}^{12}, V_{12}^{22}, V_{12}^{32}, X_2^{11}, X_2^{21}$) while Country II's exports will be represented by the vector ($V_{21}^{11}, V_{21}^{21}, V_{21}^{31}, V_{22}^{11}, V_{22}^{21}, V_{22}^{31}, X_1^{12}, X_1^{22}$).

represent shadow prices (to be interpreted shortly); non-negativity constraints for the shadow prices are shown at the bottom of the table; and the direction of the inequality " $>$ " in the direct problem has been reversed, as shown at the bottom of the table.

The objective function in the dual is to minimize the total sum of the location rent of the factor endowments, that is,

$$\text{Minimize } Z' = U_{19}\overline{V}_{11} + U_{20}\overline{V}_{12} + U_{21}\overline{V}_{21} + U_{22}\overline{V}_{22}.$$

The dual constraints (obtained by multiplying the column of U's and a column of each of the variables on the top of the table) are summarized and interpreted below on the assumption that in the choice of distributors, constraint (24) is effective.

<u>Dual Constraints</u>

1. $U_5a_1^{11} + U_6a_2^{11} + U_7a_3^{11} \geqq U_1$

2. $U_8a_1^{12} + U_9a_2^{12} + U_{10}a_3^{12} \geqq U_2$

3. $U_{11}a_1^{21} + U_{12}a_2^{21} \geqq U_3$

4. $U_{13}a_1^{22} + U_{14}a_2^{22} \geqq U_4$

5. $U_{15}a_1^{31} + U_{16}a_2^{31} \geqq U_{23}$

6. $U_1 \geqq P_{11}$

$Max\ Z = P_{11}(x_1^{11} + x_1^{12}) + P_{12}(x_2^{11} + x_2^{12})$

		x^{11}	x^{12}	x^{21}	x^{22}	x_1^{11}	x_2^{11}	x_1^{12}	x_2^{12}	x_1^{21}	x_2^{21}	x_1^{22}	x_2^{22}	x^{21}	x^{22}	V_{11}^{11}	V_{11}^{12}	V_{11}^{21}	V_{11}^{22}	V_{11}^{31}	V_{11}^{32}	V_{12}^{11}	V_{12}^{12}	V_{12}^{21}	V_{12}^{22}	V_{12}^{31}	V_{12}^{32}	V_{21}^{11}	V_{21}^{12}	V_{21}^{21}	V_{21}^{22}	V_{21}^{31}	V_{21}^{32}	V_{22}^{11}	V_{22}^{12}	V_{22}^{21}	V_{22}^{22}	V_{22}^{31}	V_{22}^{32}		
1	U_1	-1				1	1																																		0
2	U_2		-1					1	1																																0
3	U_3			-1						1	1																														0
4	U_4				-1							1	1																												0
5	U_5	a_1^{11}														-1												-1													0
6	U_6	a_0^{11}																				-1												-1							0
7	U_7	a_3^{11}								-1		-1																													0
8	U_8		a_1^{12}														-1												-1												0
9	U_9		a_0^{12}																				-1												-1						0
10	U_{10}		a_3^{12}								-1		-1																												0
11	U_{11}			a_1^{21}														-1												-1										≤	0
12	U_{12}			a_0^{21}																				-1												-1					0
13	U_{13}				a_1^{22}														-1												-1										0
14	U_{14}				a_0^{22}																				-1												-1				0
15	U_{15}													a_1^{21}						-1												-1									0
16	U_{16}													a_0^{21}												-1												-1			0
17	U_{17}														a_1^{22}						-1												-1								0
18	U_{18}														a_0^{22}												-1												-1		0
19	U_{19}															1	1	1	1	1	1																				$\bar{V}_{11}$
20	U_{20}																					1	1	1	1	1	1														$\bar{V}_{12}$
21	U_{21}																											1	1	1	1	1	1								$\bar{V}_{21}$
22	U_{22}																																	1	1	1	1	1	1		$\bar{V}_{22}$
23	U_{23}						β_{11}^{21}	β_{21}^{11}			β_{12}^{21}	β_{22}^{11}		-1			b_{11}^{21}		b_{11}^{21}		b_{11}^{21}		b_{12}^{21}		b_{12}^{21}		b_{12}^{21}	b_{21}^{11}		b_{21}^{11}		b_{21}^{11}		b_{22}^{11}		b_{22}^{11}		b_{22}^{11}			0
24	U_{24}						β_{11}^{22}	β_{21}^{12}			β_{12}^{22}	β_{22}^{12}			-1		b_{11}^{22}		b_{11}^{22}		b_{11}^{22}		b_{12}^{22}		b_{12}^{22}		b_{12}^{22}	b_{21}^{12}		b_{21}^{12}		b_{21}^{12}		b_{22}^{12}		b_{22}^{12}		b_{22}^{12}			0
																		≥																							
		0	0	0	0	P_0	P_{10}	P_{11}	P_{12}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

$x^{11} \geq 0,\ x^{12} \geq 0;\ \ldots;\ V_{22}^{32} \geq 0;\ U_1 \geq 0,\ U_2 \geq 0;\ \ldots;\ U_{24} \geq 0$

$Min\ Z' = U_{19}\bar{V}_{11} + U_{20}\bar{V}_{12} + U_{21}\bar{V}_{21} + U_{22}\bar{V}_{22}$

Table 4

7. $U_2 \geqq P_{12}$

8. $U_1 + U_{21}\beta_{11}^{21} \geqq P_{12}$

9. $U_2 + U_{23}\beta_{11}^{21} \geqq P_{11}$

10. $U_3 \geqq U_7$

11. $U_4 \geqq U_{10}$

12. $U_{19} \geqq U_5$

13. $U_{19} \geqq U_{11}$

14. $U_{19} \geqq U_{15}$

15. $U_{20} \geqq U_6$

16. $U_{20} \geqq U_{12}$

17. $U_{20} \geqq U_{16}$

18. $U_{21} \geqq U_8$

19. $U_{21} \geqq U_{13}$

20. $U_{21} \geqq U_{17}$

21. $U_{22} \geqq U_9$

22. $U_{22} \geqq U_{14}$

23. $U_{22} \geqq U_{18}$

24. $U_3 + U_{23}\beta_{12}^{21} \geqq U_{10}$

25. $U_4 + U_{23}\beta_{22}^{11} \geqq U$

26. $U_{19} + U_{23}b_{11}^{21} \geqq U_8$

27. $U_{19} + U_{23}b_{11}^{21} \geqq U_{13}$

28. $U_{19} + U_{23}b_{11}^{21} \geqq U_{17}$

29. $U_{20} + U_{23}b_{12}^{21} \geqq U_9$

30. $U_{20} + U_{23}b_{12}^{21} \geqq U_{14}$

31. $U_{20} + U_{23}b_{12}^{21} \geqq U_{18}$

32. $U_{21} + U_{23}b_{21}^{11} \geqq U_5$

33. $U_{21} + U_{23}b_{21}^{11} \geqq U_{11}$

34. $U_{21} + U_{23}b_{21}^{11} \geqq U_{15}$

35. $U_{22} + U_{23}b_{22}^{11} \geqq U_6$

36. $U_{22} + U_{23}b_{22}^{11} \geqq U_{12}$

37. $U_{22} + U_{23}b_{22}^{11} \geqq U_{16}$

Group of Constraints	Interpretation
1 - 5	The total "shadow value" of all factors used in producing a particular good (the final good, raw material, and distribution services) in a given country is at least equal to the shadow price of the good in the country.
6 - 7	The shadow price of the final good in a given

(Group of Constraints)	(Interpretation)
	country plus the cost of distributing the good to another country is at least equal to the price of the good in the other country.
8 - 9	The shadow price of the final good in a given country plus the cost of distributing the good to another country is at least equal to the price of the good in the other country.
10 - 24	The "location" rent of a particular factor in a given country is at least equal to the shadow price of the factor in any industry of employment in the country.[1]
25 - 37	The "location" rent of a particular factor in a given country plus the cost of distributing the factor to another country is at least equal to the shadow price of the factor in any industry of employment in the other country.[1]

[1]In the case of the raw material, the location rent is simply the "shadow value" of all factors used in its production in a given country.

CHAPTER VI

DISTRIBUTION COSTS IN TWO-GOOD TWO-FACTOR MODELS

Until now distribution costs have been investigated in a one-factor two-good model, one-factor(input) one-good model, or two-factor one-good model. The present Chapter will investigate distribution costs in a two-good two-factor model--a model more akin to that of Heckscher and Ohlin.

Barring assumption (iv)--that there is only one homogenious factor--the fifteen assumptions spelled out at the beginning of Chapter II will still continue to hold. Instead of assumption (iv) it will be assumed that there are two homogenious factors of production, say labor(L) and capital (K).

Identical Production Functions and Free Distribution of Final Goods

Complementary surpluses

Consider a situation where throughout the world identical commodities have identical production functions. Different commodities, however, have different production functions. Given that factor endowments and, assuming momentarily, that there is no inter-country factor mobility the P/F of a country may be represented by a triangle or quadrangle.[1] Thus suppose on Figure 13 OAB and OCDE are the P/F's for Countries I and II, respectively. On the same figure, OFGH is the world P/F obtained by sliding Country I's P/F down the side OCDE of Country II's P/F.[2]

Along AB only one factor, say L, is constraining output in Country I. Likewise, along CD and DE only one factor, say L and K, respectively, are constraining output in Country II. In other words, along the line segment AB there is a capital surplus in Country I indicated by "$K_1 > 0$" on the Figure. The surpluses in Country II are also indicated on their respective line segments.

Suppose now world demand were represented by point D_1. Maximizing world consumption would require Country I to produce CY of X^1 and YD_1 of X^2, and Country II to specialize completely in the production of X^2. Even if factor mobility were allowed moving factors from one country to another could not enhance world output since each country would be having a surplus of capital.

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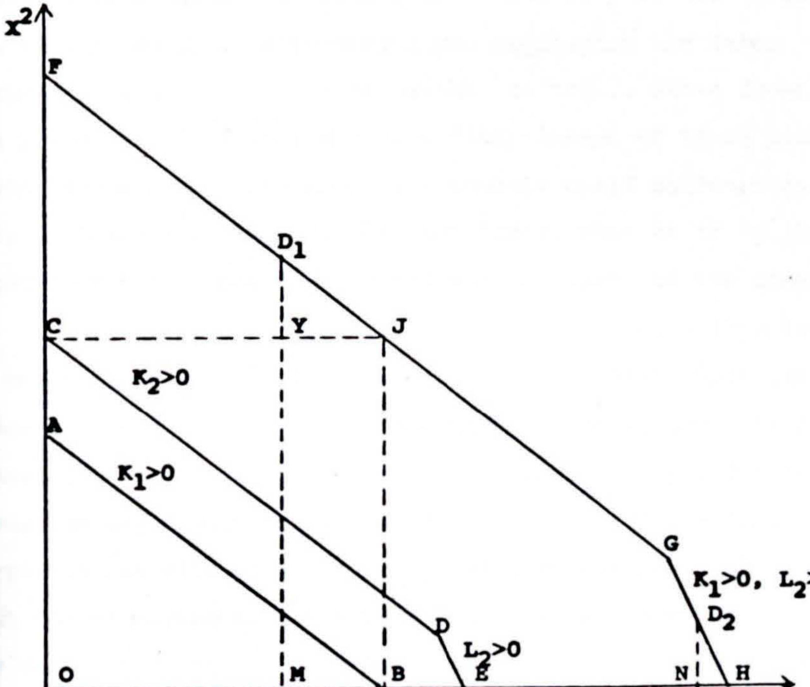
[1]It should, therefore, be noted that it is incorrect to claim that "With constant returns to scale and a single process . . . the transformation curve for outputs would exhibit constant opportunity over the whole range only if intensities were the same in both industries." See M. Clement, et al., Theoretical Issues in International Economics (Boston: Houghton Miffin Company, 1967), p. 89.

[2]The sliding is done with sides OA and OB constantly parallel to the X^2- and X^1-axis. It should also be noted that CFJ and BJGH are identical to the P/F's for countries I and II, respectively.

Figure 13



In contrast, if world demand were represented by point D_2, Country I would specialize completely in the production of X^1 and Country II would produce BN of X^1 and ND_2 of X^2. However, with factor mobility, world consumption might be improved beyond point D_2. Such improvement is possible because the capital surplus in Country I can <u>complement</u> the labor surplus in Country II or vice versa. In brief, given identical production functions and free distribution of final goods, factor movements in the model can enhance world consumption only if there are complementary surpluses, that is if furplus capital exists in one country and surplus labor in the other.

Complementary surpluses, however, need not only exist on one particular end of the world P/F. Depending upon factor endowments and technological conditions in prduction, the surpluses can also occur on the X^1- or X^2-end, meaning factor movements may enhance world output in only one direction. The surpluses can also occur at every point on the P/F, implying that factor movements may extend the whole P/F outward. On the other hand, if the complementary surpluses are absent at every point on the perimeter of the P/F, factor movements cannot, of course, enhance world output.

General influence of complementary surpluses

So long as the distribution of final goods is free, basic model in this study may not be fundamentally different from the Heckscher-Ohlin model.[1] This is clearly so if complementary surpluses are absent over the entire perimeter of the "autarkic world P/F," that is the world P/F obtaining under perfect factor immobility. Maximizing world consumption in this case simply requires that world production of apportioned according to the principle of comparative advantage. The capital-intensive country will tend to specialize in the capital-intensive good and the labor-intensive country will tend to specialize in the labor-intensive good. However, the presence of complementary surpluses may modify the generalizations of the Heckscher-Ohlin model. For example, consider a situation shown on Figure 14 for two goods, X^1 and X^2 which

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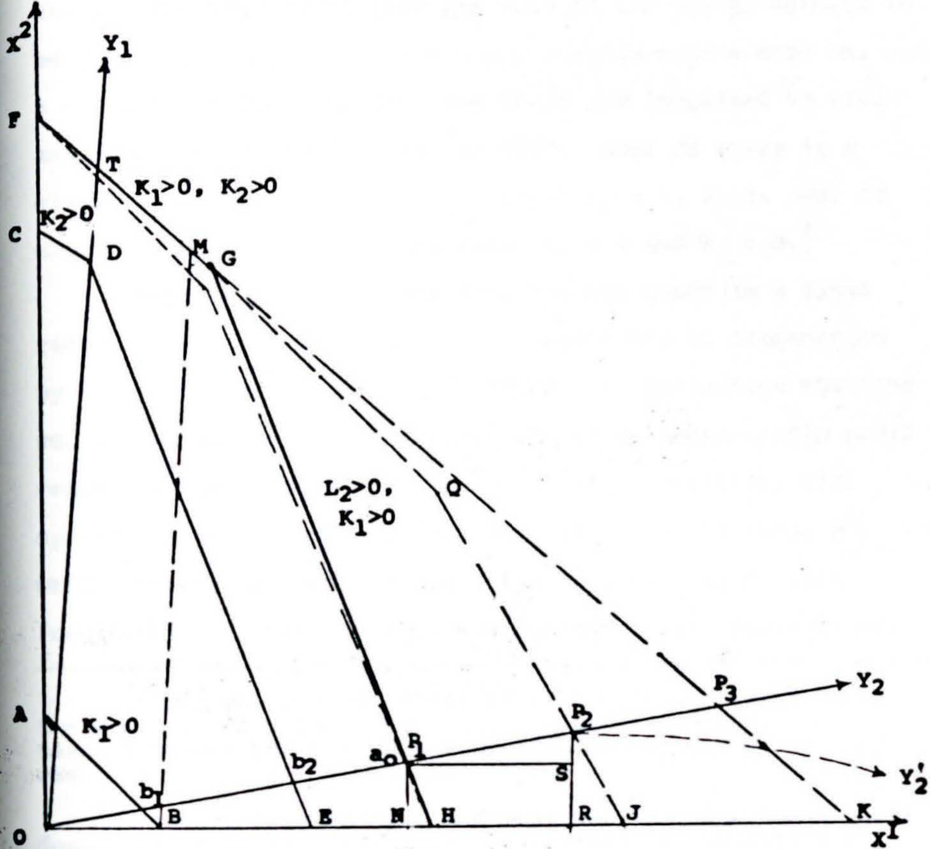
[1]Of course one may still want to raise the Valvanis-Vail type of objection that fixed coefficient production functions, in so far as they may entail factor unemployment, are incompatible with the traditional assumption of full employment common among Western trade theorists. See Stephan Valvanis-Vail, "Leontief's Scarce Factor Paradox," Journal of Political Economy, Vol. LXII, December 1954, pp. 523-538. For a rebuttal see Caves, Trade and Economic Structure, p. 279. Additionally, it should be added that, for purposes of explaining trade between developed and underdeveloped countries, limited factor substitution may very well offer a better approximation to "reality" in view of the fact the foreign trade sectors of underdeveloped countries are probably characterized by limited substitution (cf. Richard S. Eckaus, "The Factor Proportions Problem in Underdeveloped Areas," The American Economic Review, Vol. XLV, September 1955). Fixed substitution in underdeveloped countries can also be supported by the "product-cycle theories." Underdeveloped countries exporting manufactured products will presumably be exporting "mature" products with established methods of production permitting, at best, only a limited factor substitution (cf. Hirsch, Location of Industry and International Competitiveness). In the following discussion limited substitution may, therefore, be assumed to the principal cause of "labor surpluses" in Country II, i.e., the rest of the world.

Figure 14


x^2
Y_1
F
T
$K_1>0$, $K_2>0$
$K_2>0$
C
D
M
G
$L_2>0$,
$K_1>0$
Q
Y_2
P_3
A
$K_1>0$
P_2
b_2
a_0
P_1
S
Y_2'
b_1
B
E
N
H
R
J
K
0
X^1

are capital-intensive, respectively. On the Figure, OAB is the autarkic P/F in Country I (say the United States) where there is an abundance of capital so that labor alone is constraining output (hence, $K_1 > 0$ along AB). Likewise, OCDE is the P/F for Country II (say the rest of the world) assumed to be labor-intensive so that a labor surplus exists over DE, and a capital surplus over CD. The world P/F (obtained by gliding OCDE vertically down AB) is OFGH. Over FG there is a global surplus of capital, $K_1 > 0$ and $K_2 > 0$, while over GH there are complementary surpluses, $L_2 > 0$ and $K_1 > 0$.[1]

Suppose the world consumes the two goods in a fixed ratio $X^1; X^2$, in which case world demand may be represented by a ray such as OY_1 or OY_2.[2] If the ray intersects the line FG, say at M, the generalization of the Heckscher-Ohlin model remains intact. Country I, being capital-intensive, will specialize (completely) in the capital-intensive good, X^1, while Country II, being labor-intensive, will specialize (completely) in the labor-intensive good, X^2.[3] Furthermore,

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[1]Both the precise shape of the P/F's and the position of the complementary surpluses will, of course, depend upon the assumed values for factor endowment and the production coefficient.

[2]More realistically, one may want to visualize a curved demand ray such as OP_1Y_2--indicating that for larger levels of world income, more of the capital intensive good, X^1, will be consumed.

[3]It will, of course, be clear that if world demand is represented by a ray to the left of ODY_1, the gain from world specialization in production is zero.

since in this model the movement of factors is assumed to be costly, a global factor immobility will have to be observed if world consumption is to be maximized.

In contrast, let the "demand-ray" (on Figure 14) intersect GH at a point such as P_1. To start with, it can be asserted that maximizing world consumption will require Country I to produce <u>at least</u> OB of X^1, and Country II to produce <u>at least</u> BN of X^1 and NP_1 of X^2. Because of the complementary surpluses existing at P_1, however, world consumption can be augmented even further by factor mobility.

More specifically, assume distribution costs[1]--the only obstacle to factor movements in the model--for capital are considerably less than the distribution costs of labor and, as a result, maximizing world consumption entails only the movement of capital. On the Figure, FGP_3K is the outermost boundary of the world P/F assuming distribution costs are zero, and that the capital surplus in Country I is large enough to permit full employment (of the labor) in Country II. Depending upon the level of distribution costs, world consumption will then be represented by a point, P_2, between P_1 and P_3 on ray OY_2.[2] At P_2 Country I, the capital-intensive country, is

[1]Distribution costs in this two-factor model are simply the opportunity cost of the factors employed in producing distribution services.

[2]GP_2J is the outermost boundary of the world P/F for a <u>given</u> level of non-zero distribution costs still on the assumption that the capital surplus in Country I is large enough to permit full employment in Country II.

still completely specializing in the production of X^1, the capital-intensive good. Country II, on the other hand, is producing an <u>extra</u> NR of X^1 and SP_2 of X^2. As a general observation it can therefore be said that given the "demand-ray" the country with the more mobile surplus factor (i.e., Country I) will tend to produce in "conformity" with the Heckscher-Ohlin model even after the introduction of (costly) factor mobility.[1] In the other country with less mobile surplus factor, the conformity will be less pronounced because of the increased production made possible by factor movements.

General influence of distribution costs

From the discussions in Chapter II it will also be clear that the slope of GP_2J (Figure 14) is influenced by the distribution costs of the mobile factor, capital.[2] Increasing these costs will rotate GP_2J in a clockwise direction closer to GH, thus increasing Country II's conformity to the Heckscher-Ohlin model. Conversely, decreasing distribution costs will, by permitting larger volumes of capital movement to Country II,

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[1]The word "conformity" as used here refers more to the absolute quantities of the two goods, X^1 and X^2.

[2]In the equation describing the line GJ, distribution costs will again influence the expressions for the intercept and the slope. In the above two-factor model, distribution costs will, of course, be measured by units of distribution services or units of the globally scarce factor, labor. Again, maximizing world consumption will require eschewing unnecessary shipments and using, where possible, only factors of least opportunity cost in producing the distribution services.

produce results which differ increasingly from those in the Heckscher-Ohlin model.

Regarding the influence of distribution costs in the slope of the P/F, it should also be observed that <u>ceteris paribus</u> changes in the locations of production may affect the slope of the P/F, even if the level of distribution costs remains the same. Such a change occurs at point Q on Figure 14. If the demand-ray intersects the P/F along GQ, all the capital-intensive good can be produced in either Country I or II without entailing a factor shipment. Some of the labor-intensive good, X^2, however, can only be produced by exporting capital from Country I to Country II. On the other hand, if the demand-ray intersects the P/F along QJ, a part of each of the two goods must be produced in Country II by exporting capital from Country I. Since X^1 is capital-intensive relatively more capital (entailing more distribution costs) will have to be exported from Country I; hence, the decline in the opportunity cost of X^2 for X^1, as evidenced by the steep slope of QJ.[1]

"Gains" from trade

The traditional models of international trade have tended to emphasize gains from comparative advantage almost to

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[1]Additionally, changing the origin of factors employed in the distribution industry may also change the slope of the world P/F (cf. Lefeber, <u>Allocation in Space</u>).

complete neglect of gains from factor mobility.[1] On Figure 14 the gain from comparative advantage is represented by the area between TGH and the dotted line TH--representing a radial addition of P/F's OAB and OCDE. Depending upon the level of distribution costs and the available quantities of the mobile surplus factor, this area may be larger or smaller than HGQJ, the area representing the gain from factor mobility.

The gain from factor mobility, like the gain from comparative advantage, depends upon the structure of international demand. Consider, for example, a situation where substantially more of the labor-intensive good, X^2, is consumed so that the demand-ray intersects the P/F along FT. Both gains from comparative advantage and from factor mobility are absent in this region. With a relative increase in the consumption of the capital-intensive good, the demand-ray will, at first, intersect the P/F along TG where only gains from comparative advantage are realized. If the increase continues, intersections will occur along GQJ and gains from both comparative advantage and factor mobility will be realized. From Figure 15 it would also appear that the greater the world con-

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[1]Economists have not, of course, been unaware of possible gains from factor mobility. For example, Taussig observed that labor movements will increase incomes in the host country, while Ohlin noted that "the redistribution of productive factors will increase the real income of both regions taken together--in terms of commocities--and that this condition, ceteris paribus, tends to increase trade" (Ohlin, Interregional and International Trade, pp. 170-171).

of the capital-intensive good, the greater the gain from factor mobility.[1] Parenthetically, it should be observed that the presence of gains from trade, of course, says nothing about their distribution among the countries. It is common knowledge that the distribution of gains from comparative advantage depends upon the intensities of reciprocal demand. By contrast, the distribution of gains from factor mobility will depend not only upon the intensity of reciprocal demand but also upon the relative income shares of foreign and indigenous factors of production and income remittances by foreign factors.[2]

Different Production Functions and Free Distribution of Final Goods

In the previous section it was observed that the sole raison d'etre of factor movements when production functions are identical was the presence of complementary surpluses. With non-identical production functions, however, factor movements depend not only upon the presence of complementary surpluses but also upon the possibilities of superior inter-country process selection.

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[1]This observation follows from the not too unrealistic an assumption that capital is more mobile than labor.

[2]It is being assumed here that migrated factors of production are not assimilated into the host economy, in which case the effect of the migration cannot be assumed to constitute only a change in factor endowments (cf., J.V. Levin, "The Export Economics," in Trade and Development, ed. by Theberge, pp. 15-19).

Assuming that one factor--labor--is immobile,[1] one can visualize cases of factor endowments, production coefficients, and levels of distribution costs so that maximizing world consumption would require

(a) one country to produce all goods;

(b) each country to produce only one good;

(c) one country to produce one good and the other country to produce both goods; and

(d) each country to produce both goods.

Unfortunately, a detailed discussion of these cases, already studied by the author, cannot be included in this study because of shortage of space and time. It will suffice here to point out that the P/F in each case is influenced not only by the level of distribution costs but also by the location of production and the origin of factors employed in the distribution industry.

Costly Distribution of Final Goods

Deriving the P/F

The last two sections were predicated on the assumption that the distribution of the final goods was free. Consequently, maximizing output at the countries of production

[1]This assumption is required as a methodological devise of ensuring "climatic" immobility much as in the classical theory of international trade.

also ensured the maximization of world consumption. Introducing costly distribution of final goods however requires, as discussed earlier, distinguishing a final good according to its location (at the country of production or consumption). Hence maximum world consumption in this two-good model can be represented by a four-dimension P/F--each dimension standing for one good for consumption in a given country.

This P/F can be derived with the help of the linear programming problem on Chapter V. However, the problem must be modified slightly to take cognizance of the fact that:

(a) two final goods are now being consumed;

(b) there is not a raw material; and

(c) distribution costs for one factor are so high as to preclude its mobility.

Before presenting the problem, a slight revision of the notation in Chapter V is needed.

Revised Notation	Explanation
P_{qj} (q, j=1, 2)	denote the price of good q consumed in country j. The prices can presumably be established from a priori knowledge on the location of effective demand.
$X^{mn}\begin{pmatrix} m=1, 2, 3 \\ n=1, 2 \end{pmatrix}$	output of good X from industry m in country n. The first and second industries produce the final good, and the third, a homogenious distribution service used to distribute primary factors and the final goods.

X_k^{mn} (m, n, k=1, 2) — output of good X from country n delivered to country k for consumption.

V_{jh}^{mn} $\begin{pmatrix} h=1 \\ j,\ n=1,\ 2 \\ m=1,\ 2,\ 3 \end{pmatrix}$ — primary factor number h from country j, employed in industry m in country n. Hence all $V_{jh}^{mn}(j \neq n)$ are foreign factors which also consume distribution services.

$\bar{V}_{jh}$ (j, h=1, 2) — country j's total endowment of primary factor h.

β_{cd}^{rs} $\begin{pmatrix} d,\ c,\ r,\ s=1,\ 2 \\ c \neq r \end{pmatrix}$ — units of distribution services needed by country s to transfer a unit of good d from country c to country r. For simplicity it is assumed that distribution services (i.e., good three) are consumed at the country of production.

b_{ce}^{rs} $\begin{pmatrix} e,\ c,\ r,\ s=1,\ 2 \\ c \neq r \end{pmatrix}$ — units of distribution service needed by country s to transfer a unit of primary factor e from country c to country r.

a_i^{mn} $\begin{pmatrix} n,\ i=1,\ 2 \\ m=1,\ 2,\ 3 \end{pmatrix}$ — units of input i needed to produce a unit of X^{mn}(identical production functions of the Heckscher-Ohlin type are also included).

The objective function. - The amount of each of the two goods available in any country for consumption may be imported or produced at home. Hence the quantities of the first and second final good consumed in Country I is $(X_1^{11} + X_1^{12})$ and $(X_1^{21} + X_1^{22})$, and in Country II is $(X_2^{11} + X_2^{12})$ and $(X_2^{21} + X_2^{22})$, respectively. Recalling that P_{qg} denotes the price of good in country g, the objective function is

$$\text{Maximize } Z = P_{11}(X_1^{11} + X_1^{12}) + P_{21}(X_1^{21} + X_1^{22}) + P_{12}(X_2^{11} + X_2^{12}) + P_{22}(X_2^{21} + X_2^{22})$$

The constraints. - The primal will again have five main types of constraints.

(i) The availability constraints remain as specified in Chapter V:

$$x_1^{11} + x_2^{11} \leqq x^{11} \quad \text{.....................(1)}$$

$$x_1^{12} + x_2^{12} \leqq x^{12} \quad \text{.....................(2)}$$

$$x_1^{21} + x_2^{21} \leqq x^{21} \quad \text{.....................(3)}$$

$$x_1^{22} + x_2^{22} \leqq x^{22} \quad \text{.....................(4)}$$

(ii) For the input constraints it will now be assumed that distribution costs for the second factor (labor) are so high as to preclude its mobility. Besides there are only two inputs--the primary factors of production. Hence,

$$a_1^{11}x^{11} \leqq v_{11}^{11} + v_{21}^{11} \quad \text{..................(5)}$$

$$a_2^{11}x^{11} \leqq v_{12}^{11} \quad \text{........................(6)}$$

$$a_1^{12}x^{12} \leqq v_{11}^{12} + v_{21}^{12} \quad \text{..................(7)}$$

$$a_2^{12}x^{12} \leqq v_{22}^{12} \quad \text{........................(8)}$$

$$a_1^{21}x^{21} \leqq v_{11}^{21} + v_{21}^{21} \quad \text{..................(9)}$$

$$a_2^{21}x^{21} \leqq v_{12}^{21} \quad \text{........................(10)}$$

$$a_1^{22}x^{22} \leqq v_{11}^{22} + v_{21}^{22} \quad \text{..................(11)}$$

$$a_2^{22}x^{22} \leqq v_{22}^{22} \quad \text{........................(12)}$$

$$a_1^{31}x^{31} \leqq v_{11}^{31} + v_{21}^{31} \quad \text{..................(13)}$$

$$a_2^{31}x^{31} \leqq v_{12}^{31} \quad \text{.........................(14)}$$

$$a_1^{32}x^{32} \leqq v_{11}^{32} + v_{21}^{32} \quad \text{...................(15)}$$

$$a_2^{32}x^{32} \leqq v_{22}^{32} \quad \text{.........................(16)}$$

(iii) The factor endowment constraints must also show the fact that only the first factor is mobile:

$$v_{11}^{11} + v_{11}^{12} + v_{11}^{21} + v_{11}^{22} + v_{11}^{31} + v_{11}^{32} \leqq \bar{v}_{11} \quad \text{.....(17)}$$

$$v_{12}^{11} + v_{12}^{21} + v_{12}^{31} \leqq \bar{v}_{12} \quad \text{.......................(18)}$$

$$v_{21}^{11} + v_{21}^{12} + v_{21}^{21} + v_{21}^{22} + v_{21}^{31} + v_{21}^{32} \leqq \bar{v}_{21} \quad \text{.....(19)}$$

$$v_{22}^{12} + v_{22}^{22} + v_{22}^{32} \leqq \bar{v}_{22} \quad \text{.......................(20)}$$

(iv) The constraints for choosing distributors remain as specified in Chapter V. However, the constraints must also reflect the fact that the second factor is immobile, i.e., $v_{12}^{12} = v_{12}^{22} = v_{12}^{32} = v_{22}^{11} = v_{22}^{21} = v_{22}^{31} = 0$.

(v) Finally, there are 32 non-negativity constraints.

The direct problem is summarized on Table 5 for only 22 constraints. Constraints (1)-(20) are as discussed above while (21) and (22), the modified equivalents of constraints (22) and (23) in Chapter V, are the constraints which permit an efficient choice of the distributor-nation. Solving the problem on Table 5 will give:

(a) a country-by-country maximum consumption of the final goods;

(b) optimal world allocation of primary factors of production;

(c) optimal location of the production of the two final goods; and

(d) optimal trade flows between the two countries.

In order to derive the P/F, the price hyperplane can be tilted to all possible (tangency) positions.[1] At each position there will be a point or a set of points[2] showing four values for the country-by-country maximum consumption of the final goods, i.e., $(X_1^{11} + X_1^{12})$, $(X_1^{21} + X_1^{22})$, $(X_2^{11} + X_2^{12})$, and $(X_2^{21} + X_2^{22})$. The locus of all such points for all possible positions of the hyperplane is the P/F in terms of final goods at the countries of consumption--the current object of inquiry.

Other side-constraints. - Depending upon factor endowments, the production functions and distribution costs for final goods and factors of production, maximizing world consumption may over-concentrate production in only one country. Such concentration may raise nationalistic, military, or other non-economic objections. To forestall these objections it may be necessary to add conscraints which ensure a more bal-

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[1]At every position, each element in the price vector $(P_{11}, P_{12}, P_{21}, P_{22})$ will have a certain non-negative value. Consequently, tilting the hyperplane to a different position is equivalent to writing out a different price vector.

[2]A set of points will occur in the case of multiple of solutions.

Max $z = \rho_{11}(x_1^{11} + x_1^{12}) + \rho_{12}(x_2^{11} + x_2^{12}) + \rho_{21}(x_1^{21} + x_1^{22}) + \rho_{22}(x_2^{21} + x_2^{22})$

		x^{11}	x^{12}	x^{21}	x^{22}	x_1^{11}	x_2^{11}	x_1^{12}	x_2^{12}	x_1^{21}	x_2^{21}	x_1^{22}	x_2^{22}	x^{31}	x^{32}	v_{11}^{11}	v_{11}^{12}	v_{11}^{21}	v_{11}^{22}	v_{11}^{31}	v_{11}^{32}	v_{12}^{11}	v_{12}^{21}	v_{12}^{31}	v_{21}^{11}	v_{21}^{12}	v_{21}^{21}	v_{21}^{22}	v_{21}^{31}	v_{21}^{32}	v_{22}^{11}	v_{22}^{21}	v_{22}^{31}		
1.	u_1	-1				1	1																												0
2.	u_2		-1					1	1																										0
3.	u_3			-1						1	1																								0
4.	u_4				-1							1	1																						0
5.	u_5	a_1^{11}														-1									-1										0
6.	u_6	a_2^{11}																				-1													0
7	u_7		a_1^{12}														-1									-1									0
8.	u_8		a_2^{12}																												-1				0
9.	u_9			a_1^{21}														-1									-1								0
10.	u_{10}			a_2^{21}																			-1											≤	0
11.	u_{11}				a_1^{22}														-1									-1							0
12.	u_{12}				a_2^{22}																											-1			0
13.	u_{13}													a_1^{31}						-1									-1						0
14.	u_{14}													a_2^{31}										-1											0
15.	u_{15}														a_1^{32}						-1									-1					0
16.	u_{16}														a_2^{32}																		-1		0
17.	u_{17}															1	1	1	1	1	1														$\bar V_{11}$
18.	u_{18}																					1	1	1											$\bar V_{12}$
19.	u_{19}																								1	1	1	1	1	1					$\bar V_{21}$
20.	u_{20}																														1	1	1		$\bar V_{22}$
21.	u_{21}						β_{21}^{31}	β_{21}^{11}			β_{11}^{31}	β_{22}^{11}		-1			b_{11}^{21}		b_{11}^{31}		b_{11}^{31}				b_{21}^{11}		b_{21}^{11}		b_{21}^{11}						0
22.	u_{22}						β_{2}^{32}	β_{21}^{12}			β_{12}^{32}	β_{22}^{12}			-1		b_{11}^{22}		b_{11}^{22}		b_{11}^{22}				b_{21}^{12}		b_{21}^{12}		b_{21}^{12}						0
		≥																																	
		0	0	0	0	ρ_{11}	ρ_{12}	ρ_{11}	ρ_{12}	ρ_{21}	ρ_{22}	ρ_{21}	ρ_{22}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

Min $z' = u_{17}\bar V_{11} + u_{18}\bar V_{12} + u_{19}\bar V_{21} + u_{20}\bar V_{22}$

$x^{11} \ge 0,\ x^{12} \ge 0,\ \ldots\ldots v_{22}^{31} \ge 0;\ u_1 \ge 0,\ u_2 \ge 0,\ \ldots\ u_{22} \ge 0$

- Table 5 -

anced distribution of production.[1] The constraints may, for instance, require that one country's production of certain good be at least equal to a certain multiple of the other country's:

$$\frac{x^{11}}{x^{12}} \geqq c \quad \ldots\ldots\ldots\ldots\ldots\ldots(29)$$

$$\frac{x^{21}}{x^{22}} \geqq d \quad \ldots\ldots\ldots\ldots\ldots\ldots(30)$$

The two constraints can be simplified to

$$- x^{11} + cx^{12} \leqq 0 \quad \ldots\ldots\ldots(31)$$

$$- x^{21} + dx^{22} \leqq 0 \quad \ldots\ldots\ldots(32)$$

These constraints (31 and 32) will then be considered as part of the linear programming problem.

The dual problem. - Before concluding the Chapter, a word on the dual problem is again in order. The objective is, as in Chapter V, the minimization of the total sum of the location rents of all primary factors of production, i.e.,

$$\text{Minimize } Z' = U_{17}\overline{V}_{11} + U_{18}\overline{V}_{12} + U_{18}\overline{V}_{21} + U_{20}\overline{V}_{22}$$

Assuming constraint (21) is effective, the 31 dual constraints

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[1]Alternatively, it may be desirable to ensure certain minimum consumption level in which case "availability constraints" a la Isard will be desirable (Isard, "Interregional Linear Programming," Regional Science, pp. 49-50.

summarized below can again be regrouped into five categories, each with a different interpretation:[1]

Summary of Constraints

1. $a_1^{11}U_5 + a_2^{11}U_6 \geqq U_1$

2. $a_1^{12}U_7 + a_2^{12}U_8 \geqq U_2$

3. $a_1^{21}U_9 + a_2^{21}U_{10} \geqq U_3$

4. $a_1^{22}U_{11} + a_2^{22}U_{12} \geqq U_4$

5. $a_1^{31}U_{13} + a^{31}U_{14} \geqq U_{21}$

6. $U_1 \geqq P_{11}$

7. $U_2 \geqq P_{12}$

8. $U_3 \geqq P_{21}$

9. $U_4 \geqq P_{22}$

10. $U_1 + \beta_{11}^{21}U_{21} \geqq P_{12}$

11. $U_2 + \beta_{21}^{11}U_{21} \geqq P_{11}$

12. $U_3 + \beta_{12}^{21}U_{21} \geqq P_{22}$

13. $U_4 + \beta_{22}^{11}U_{21} \geqq P_{21}$

---

[1] If constraints (31) and (32) in the text are included on Table 5 as constraints (23) and (24), respectively, the interpretation of dual constraints (1)-(4) will, of course, need to be modified.

14. $U_{17} \geq U_5$

15. $U_{17} \geq U_9$

16. $U_{17} \geq U_{13}$

17. $U_{18} \geq U_6$

18. $U_{18} \geq U_{10}$

19. $U_{18} \geq U_{14}$

20. $U_{19} \geq U_7$

21. $U_{19} \geq U_{11}$

22. $U_{19} \geq U_{15}$

23. $U_{20} \geq U_8$

24. $U_{20} \geq U_{12}$

25. $U_{20} \geq U_{16}$

26. $U_{17} + b_{11}^{21}U_{21} \geq U_7$

27. $U_{17} + b_{11}^{21}U_{21} \geq U_{11}$

28. $U_{17} + b_{11}^{21}U_{21} \geq U_{15}$

29. $U_{19} + b_{21}^{11}U_{21} \geq U_5$

30. $U_{19} + b_{21}^{11}U_{21} \geq U_9$

31. $U_{19} + b_{21}^{11}U_{21} \geq U_{13}$

Group of Constraints	Interpretation
1 - 5	The total "shadow value" of all factors used in producing a particular good in a given country is at least equal to the shadow price of the good in the country.
6 - 9	The shadow price of a particular good in a given country is at least equal to the price of the good in the country.
10 - 13	The shadow price of a particular good in a given country plus the cost of distributing the good to another country is at least equal to the price of the good in the other country.
14 - 25	The location rent of a particular factor in a given country is at least equal to the shadow price of the factor in any industry of employment in the country.
26 - 31	The location rent of a particular factor in a given country plus the cost of distributing the factor to another country is at least equal to the shadow price of the factor in any industry of employment in the other country.

It will be observed (from constraints 14-16, 20-22, and 26-31) that location rents of the mobile factor are interrelated through inter-country costs of distribution. There is, however, no such relationship in the case of the immobile factor.

CONCLUSION

This study--spurred partly by the virtual absence of theoretical and empirical studies on international distribution services--was aimed at:

(a) demonstrating a simple way of treating distribution services analytically;

(b) analysing, in a comparative static framework, various kinds of technological changes which occur in industries producing distribution services or final goods;

(c) interpreting the trade relationship between industrialized and raw material producing countries within an analytical framework which includes distribution services;

(d) examining the problem of choosing the country (or countries) which efficiently perform the actual tasks of distributing commodities internationally.

In conclusion, it may be refreshing to summarize briefly how each objective was accomplished and note the broader implications arrived at in the course of the study.

Analytical Treatment of Distribution Services: A Static View

The one factor model (Chapters II and III)

International distribution services were explored in a model which was organized around a declared objective--maximising world consumption. Both production and international distribution of commodities were assumed to be costly (that is, both production and distribution consumed economic resources). The model developed in the study, therefore, contrasts with the traditional models (e.g., those of Ricardo, Graham, Ohlin, etc.) which formally ignore distribution costs through the assumptions of factor immobility and negligible distribution costs.

In order to find maximum world consumption (i.e., in order to derive the world production possibilities frontier) it was, inter alia, necessary to reduce the myriad of services involved in the actual processes of distribution into a concept amenable to analytical treatment. Consequently, the services were assumed to constitute two homogeneous goods: one representing distribution services for the factors of production, and the other representing distribution services for the final goods. With this assumption, international distribution services were explicitly incorporated into the model by showing that (a) the actual process of moving commodities from one country to another consumes the homogeneous goods standing for distribution services, and (b) the production of these goods puts a claim on scarce resources.

The resulting world production possibilities frontier (the P/F) was naturally influenced by factor endowments and productivity in the final goods industries in the various countries. In addition, depending upon the location of effective demand and technological interrelationships in the distribution and final goods industries, the P/F was found to be influenced by distribution costs.

More specifically, the world opportunity cost in producing the final goods in this model is not (in contrast to the traditional models) identical to the national opportunity costs. Instead, the world opportunity cost tends to reflect the influence of absolute advantage and distribution costs. Moreover, where the world opportunity cost was influenced by the distribution costs of the factor it was found that maximizing world consumption does not necessarily concur with the Cournotian partial equilibrium condition (that price in one market is equal to price in the other market plus or minus distribution costs).

The two factor model (Chapter VI)

International distribution services were also explicitly introduced into a two-factor model under simplifying assumptions more or less identical to those in the one-factor model. It was shown that the P/F, when the distribution of factors and final goods is costly, can be found by translating the maximization of world consumption into an interspatial linear programming problem. In such a problem the P/F is the locus of all tangency points obtained by tilting the price-hyperplane in all possible directions.

From the specification of the linear programming problem the P/F thus derived is influenced by factor endowments and technological conditions in the distribution and final goods industries. Besides, there is no a priori basis for assuming that the world opportunity cost will reflect the influence of national opportunity costs rather than the influence of absolute advantage or distribution costs.

Further insights into the two-factor model was obtained by assuming that production functions are identical (à la Ohlin) and that the distribution of final goods (but not the factors) was free. Under the assumptions it was found that when "complementary surpluses" exist (i.e., where unemployed labor exists in one country and unemployed capital in the other), the world opportunity cost is inter alia influenced by distribution costs (for the factor) and changes in the location of production.

Comparative Static Changes

The one-factor model (Chapters II and III)

In general two types of changes were analysed, each under ceteris paribus assumptions:

(a) changes in the productivity of the factors in the final goods industries in the various countries; and

(b) changes in the distribution industry for the factor and/or the final good(s). These changes were discussed either directly in terms of distribution costs, or indirectly in terms of the input coefficients and/or the productivity of the factor in the distribution industries.

The changes cited above were found to have two broad and conceptually distinct kinds of implications.

Firstly, the changes can influence the world opportunity cost without altering the pre-existing pattern of international factor and/or final good flows. This influence was in turn found to have more detailed implications. For example, it was shown in Chapter II that a decline in distribution costs for the factor by narrowing the "limbo" region decreased the likelihood of complete specialization and accentuated the influence of absolute advantage on the world opportunity cost.

Secondly, the changes can influence the world opportunity cost, and also alter the pre-existing patterns of international and/or final good flows. Various alterations were noted in the simpler model in Chapter II, as well as in the more elaborate model in Chapter III. In the latter Chapter, for instance, the alterations were shown to include situations reminiscent of the traditional dichotomy between market and material orientations. In addition, other orientations conditioned by absolute advantage or the location of effective demand were noted.

The two-factor model (Chapter VI)

The "unwieldliness" of the interspatial linear programming problem for deriving the P/F prevented a study of comparative static changes when both the distribution of the factor and the final goods are costly. However, under the simplifying assumptions that (a) the distribution of final goods is free, (b) production functions are identical, and (c) complementary surpluses exist, it was found that increasing (decreasing) distribution costs for the factor decreases (increases) conformity with the Heckscher-Ohlin model.

Explaining Trade between Industrialized and Raw Material Producing Countries (Chapter IV)

By substituting the raw material for the factor, the analytical framework developed in Chapters II and III was used to idealize (or explain) trade between an industrialized and a raw material producing country. This idealization was based upon two assumptions:

(i) There is one manufactured good consumed in both countries. The good, though capable of being produced in any country, is presently being produced more efficiently in the industrialized country.

(ii) There is one raw material, the only input used to produce the manufactured good. The raw material can be produced in either country with local and/or foreign factors of production. In particular, it was assumed that factors from industrialized country are involved in generating flows of the raw material in the other country.

In order to maximize world consumption, trade flow from the industrialized country was seen to consist largely of final goods and factors of production while the reverse flow more probably consisted of raw materials. Underlying these flows were (a) distribution costs for raw materials and the final good, (b) the influence of absolute advantage in the production of the final good, (c) the influence of foreign factors, and (d) availability (this was the case when the raw material producing country could not manufacture the final good).

More specifically, the following were some of the major conclusions derived from the attempted explanation of trade between the industrialized and the raw material producing country:

(i) Given that

(a) distribution costs for both final goods and the raw material are significantly low,

(b) the raw material producing country is consuming manufactured products which she cannot produce or which she can produce only poorly, and

(c) foreign factors participate in producing the raw materials in the raw material producing country,

maximizing world consumption requires the raw material producing country to export all the raw materials to the industrialized country which, in turn, should manufacture the whole amount of the final good consumed in the world.

(ii) Given that

(a) distribution costs for raw materials are relatively low (compared to distribution costs for the final good),

(b) the raw material producing country is consuming manufactured products which she can produce fairly efficiently but not as efficiently as the developed country, and

(c) foreign factors participate in generating flows of raw materials in the underdeveloped country.

maximizing world consumption requires that both the industrialized and the raw material producing countries manufacture their own goods for domestic consumption. Besides, the latter country must export raw materials in amounts large enough to match the earning remitted by foreign factors.

(ii) Given that

(a) distribution costs for final goods are relatively low (compared to distribution costs for raw materials),

(b) the raw material producing country is manufacturing products which she can produce fairly efficiently but still not as efficiently as the industrialized country, and

(c) foreign factors participate in producing raw materials in the raw material producing country,

maximizing world consumption requires that each country manufacture its own products for domestic consumption. Besides, the raw material producing country must export manufactured products to match remittance by foreign factors.

It is worth emphasizing that the model sketched in Chapter IV is a theoretical device of idealizing the international trade relationship between an industrialized and a predominantly raw material producing country. The model cannot, therefore, be expected to offer a detailed account of international trade any more so than can Ricardo's or Ohlin's.

Approaches to Empirical Study of International Distribution Services (Chapter IV)

Given productivity in the final good industries, the analytical framework used to explain trade in Chapter IV can be used to ascertain the implications of given levels and changes of distribution costs on the maximization of world consumption. With a view to this end, four different approaches to empirical studies on international distribution services were suggested.

1, Trade-flow approach. - This approach, relying in one form or another upon gravity type of models, can be used to provide at least rough indications of the importance of costs of international distribution. Studies based upon this approach stand to gain from data availability. However, such studies are both unwieldly and of relatively little direct "content" for policy purposes.

2. Channel approach. - Here the emphasis is one establishing what share (margin) of a dollar spent on an imported good goes toward paying for distribution services. An empirical study on some agricultural products found that (a) the margin as a whole was considerable, (b) the margin fluctuated considerably from year to year without conforming to any representative trend, (c) the margin varies widely from commodity to commodity, and (d) a substantial share (perhaps between 40 and 50 per cent) of distribution costs for agricultural products may still be attributed to transport costs proper.

Unfortunately, comparable data for manufactured goods does not exist. It is hoped that this study will furnish the incentive and theoretical framework for organizing the compilation of such data.

3. Functional approach. - Here it was suggested that research energies be directed toward financial intermediaries, international commodity exchanges, export-import houses, state trading corporations, shipping agencies and other bodies involved in the processes of international distribution. Although generalizations (on distribution services) based upon such individualized studies will inevitably be tenuous, the "half a slice" may temporarily be enough.

4. Sectoral approach. - Instead of studying individual bodies engaged in international trade, studies of sectors including such bodies may also shed new light on international distribution services.

Choice of the Distributor-nation(s) (Chapters V and VI)

The fifth and last objective earmarked for the study pertained to the problem of deciding which country (or countries) can produce international distribution services most efficiently. This problem--resembling the problem of an optimal choice of transportation networks--was tackled with the help of an interspatial linear programming problem.

Specific constraints enabling the choice of "distributor-nations" were defined and included in the linear programming problems. Unfortunately, in a multi-factor, multi-country world, the list of all possible constraints may be prohibitively long. In such situations it was suggested, for purposes of expediency, to confine attention only to the more general constraints.

This method of choosing "distributor-nations" has its limitations. The choice is, for example, based on a specific point on the P/F and, depending upon the "mix" of shipments, may or may not be relevant for other points. Besides, in the real world, non-linearities in the distribution and/or final goods industries may call for various distributor-nations at different points on the P/F.

Suggestions for Future Research

In a field as virgin as this it would be pretentious to single out areas deserving the attention of scholars. Virtually every aspect discussed can be refined, elaborated, or illustrated in a commendable way. The author only hopes that economists, more able than himself, will consider international distribution services a topic worth their time and other resources.

The present study, however, has various limitations calling for more research. Firstly, the assumption of limited factor substitution, though adequate for the one-factor model developed in Chapters II and III, is inadequate for a multi-factor, long-run model. Such a model must introduce unlimited (continuous?) factor substitution--a challenge left untouched.

Secondly, the explanation of trade between industrialized and raw material producing countries omitted an explicit treatment of primary factors of production. A more elaborate model, especially a long-run model, should include explicitly at least a partial explanation of inter-country factor allocation and/or movements.

Finally, the efficient choice of distributor-nations was discussed purely on a theoretical level. The linear programming framework suggested for such choice appears too unwieldly for empirical and day-to-day policy purposes. Perhaps there is a simpler approach to the choice of distributor-nations.

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