CHAPTER 1

THE DEVELOPMENT OF LOCATION THEORY

One thing seems to stand out when we consider firm and market organization theories--they work only within the framework of perfect competition--this assumption was made by the classical and neo-classical economists when they developed their theories. Even the few attempts to include location theory within a general framework assumed perfect competition as a basis. Thus the main German attempt at location theory emphasises the need to find the least cost site; this theory states that greater profits arise from plant location at the least cost site than from location by competitor at less fortunate sites, since all are under the effects of the prevailing market price. There are weaknesses in this approach for example it ignores the fact that if there is variation in space demand there will not be a maximum yield of profit at the least cost location, since moving to a new site, with higher unit costs but with greater sales and therefore greater profit, may be preferable. The concept of least total cost in industrial location only seems to apply where there is a constant spatial demand. Failing this, having a low total cost may simply mean that there is a bad location in relation to the market and that the volume of output is low.

Another school of thought developed in order to provide a better theory, namely, the locational interdependence school, sometimes known as the market area school. Palander, Hoover, Losch and other economists interested in various aspects of the theory of imperfect or monopolistic competition belong to this school.

In this theory there is the assumption that all firms have the same production costs and that they sell to a market which is spatially distributed as opposed to being punctiform as Weber assumed. There is variance in the delivered price to the consumer in proportion to the cost of overcoming the distance from the production point. When a seller chooses where to locate, he tries to control the largest possible market area--where this will be and how large it will be is influenced by how the consumer behaves and also by how other firms decide to locate. The section of the market which can be supplied at a lower price than by other competitors will be monopolistically controlled by the manufacturer.

Two factors thus determine the spatial pattern of plant location and market areas: (i) variation (from place to place) in demand, and (ii) locational interdependence of firms. However, the main weak point in this theory is that it pays no regard to changes in spatial cost--a factor which is as unrealistic as the way the least cost school abstracted from the demand principle.

In the present chapter we will attempt to present location theory within a broad theoretical framework. The two approaches mentioned above will be examined briefly and the principal points of the leading theories will be summarized and reviewed.

I Least Cost Location Theory Approach

Since Johan Heinrich Von Thunen was a German agriculturalist, he became best known for his pioneering work on how agricultural location is effected by both transportation and land costs. This was later used in Germany[1] as a model for investigating location theory further.

In Der Isolierte Staat (The Isolated State) he assumes the following:

1. A very large town is centrally located in a fertile plain, the land surface is homogeneous in all aspects except for the distance from the center of consumption.

2. The state is separated from the rest of the world by an impassable wildenness which itself is located quite a long way from the town.

3. This town, the only one in the plain, must provide the state with all manufactured products, while foods-stuffs can only be supplied by the surrounding rural areas.

Also located near to the town are salt and other mines to provide salt and metals for the whole state.

Assuming the above, the question is how will agricultural production develop and if soil cultivation is to be carried out in the most rational way, how will it be affected by the shorter or longer distances from the town? Speaking generally, it seems obvious that

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[1] Johann Heinrich Von Thunen, Der Isoliete Staat in Beziehung auf Londwirt-chaft Und Nationallokonomies (3rd ed. Schumacher-Zarchlin, 1875). Some of this autstanding work has been translated and reprinted in Source Rearing in Economic Thought edited by Phillip C Newman, Arther D. Gayer and Milton Spencer (N.Y.W.W. Norton & Co Inc., 1954).

those crops which have a considerable weight in proportion to their value will be grown near the town, as will crops which have such high transportation costs that it is not feasible to bring them to the town from the more distant regions. Also those goods which are perishable will be produced in vicinity of the town since they require quick consumption. As the distance from the town increases so will the use of land for goods which have lower transportation costs in relation to their value.

Because of this, definite distinct concentric circles arise around the town, each determined by the specific crop which predominates. As long as we assume that producing a certain crop is the main objective of economic activity, it follows that in each of the different circles there will quite different economic arrangements, since the whole character of economic life alters with the cultivation of a different crop.

Thus the problem is presented, and Von Thunen solves it by stating that as we move away from the city there is a decrease in the intensity of production and that production is aimed more towards those items which are non-perishable and yet of enough value to cover transportation costs. Thus, the city will be circumscribed by a series of concentric circles, each concerned mainly with a certain kind of land use. In the first circle we would find items such as green vegetables and dairy products which are difficult to transport and store. As we move outward, we find forestry (to provide material for construction and fuel) extensive farming of different kinds with grain becoming an increasingly important crop, and stock raising in the fourth circle.

The analysis demonstrates how under these conditions agricultural products would be grown in areas which form concentric circles around the city. Products which are heavy in relation to value, and perishable goods, would be produced near the town while lighter and more durable items would be produced further from the center. The returns on the land would become less in proportion to the increasing distance and the effect of such distance on transport costs. Land rent would be zero at a certain distance from the city, exactly how far being a function of price relationships. Also, the ways of cultivating the land would vary if the rent of the land varies i.e. as land becomes less valuable it will be used less intensively.

Alfred Weber, at the turn of the century, used this scheme of agricultural location to derive a theory of industrial location. According to Thunen's model, the establishment of the concentric circles around a city automatically gives rise to the different locational possibilities. As against the assumptions of Thunen, Weber approached the problem by assuming three things so that the complex real world situation would become manageable:

1. The geographical basis of the materials is given (i.e. uneven deposits of fuel and raw material)

2. The situation and size of consumption points are given, the market making up a number of separate points. He implies conditions of perfect competition--each producer has an unlimited market, and the possibility of gaining a monopoly or advantages by choosing a better location does not exist.

3. There are several fixed labour points--labour being immobile and with no limit on supply at a given wage rate.[2]

Three types of cost form the basis of Weber's analysis, and these change as plant location changes. The three types are:

(a) transportation

(b) labour

(c) raw material and fuel.

To simplify the analysis, the third group of factors is merged with the first one. Therefore when the situation arises where either material or fuel cost is higher at one point than another, it is regarded as a more expensive source the further away it is from other alternative sources. This results in there being only two factors which are the determinate of costs, namely, transportation and labour. These are considered as general regional factors. Besides these factors, Weber also included "agglomerating forces" as one more factor which would determine industrial location.[3]

Weber viewed the process of determining location as the outcome of tension between different points because he concentrated on transport cost as a significant factor which affected the location of manufacturing plants. This tension is, in fact between consumption points and row material sources. The problem is to find how the result of this

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[2] Weber, A. Theory of the Location of Industries, trans. by C.J. Friedrich (Chicago: The University of Chicago Press, 1965) pp. 37 - 39.

[3] Ibid., p.

tension is determined. To find the answer, the conflicting pulls are represented by figures (triangle, quadrangles or other more complex forms) representing:

(a) consumption points

(b) raw material sources and fuel to be used

Secondly, Weber determines where lowest transportation costs occur, with respect to the locational figure, at the consumption point, or at one of the raw material or fuel sources, or at an intermediate point. It is at this point that the manufacturing plant should be located.

Before stating his theoretical conclusion, Weber, explains his terminology. The composition of a particular manufacturing item is disaggregated into two quite separate components:

(a) localized materials

(b) ubiquitous materials

Both of these account for the total weight of the product. Since there is no problem in finding the ubiquitous materials, they play no role in forming the locational figure; however, they do have a part in resolving the conflict between the consumption point and the source of localized raw materials, since they make up part of the weight of the finished product. It follows that the proportion of weight caused by using localized materials is of greater importance than the weight of the product; this we call the material index of an industry. That is, if L_m stands for the weight of the localized material which is used in the composition in a product and W_p symbolizes the weight of the final product, then $\frac{Lm}{W_p}$ = M.I. As Weber states, the total weight per unit of the product to be considered for the movement within the locational figure in any kind of productive process apparently depends simply upon this material index of the industry. For this material index indicates how many weight units of localized material have to be moved in the locational figure in addition to the weight of the product. The material index measures the total weight to be moved. This total weight to be moved in a locational figure per unit of product is called the locational weight of the respective industry."[4] In functional terms, Locational Weight = $\frac{Wp + Lm}{W}$, where Wp refers to the weight of the product and Lm refers to localized materials per unit of product.

Three noteworthy principles can be extracted from this framework:

1. If the material index (M.I.) has the value zero and only ubiquitous materials have been used with the value 1, then the locational weight (L.W.) has the minimum value 1. If we suppose that the given ubiquities are constant, the rise in L.W. will be parallel to MI e.g. M.I. = $\frac{2}{3}$, L.W. = $1\frac{2}{3}$, etc.

Therefore, the mathematical conclusion is that: "all industries whose material index is not greater than one and whose locational weight is not greater than two lie at the place of consumption."[5] This conclusion is derived directly from the concept of material index. In general, the greater is M.I., the higher will be L.W. and the more the

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[4]Weber, A. Theory of the Location of Industries, trans. by Friedrich C.J. (Chicago: The University of Chicago Press, 1965), p. 60.

[5]Ibid, p. 61.

industry will be attracted toward the material source, and vice versa.

2. A second conclusion follows from the formulation of M.I.: whenever the weights of weight-losing materials are equal to or are greater than the sum of the weights of the ubiquitous products and the weight of the other localized materials, then production will be attracted to the deposit source of the materials.

In order for this to occur, the material index must be greater than one, and also the weight of weight-losing materials must be equal to or greater than the product's weight plus the weight of the rest of the localized materials.

3. For intermediate cases, when the material index is greater than 1, but where the source of weight-losing materials is not an overriding factor, the weight triangle is useful for solving the locational problem. Suppose a product is made up of two materials which are found in scattered deposits and suppose that the best sources of these two materials relative to a single point of consumption C are shown by M_1, and M_2. This case can be solved geometrically in quite an easy way. However when there are more than two material sources or more than one point of consumption we obtain the result from polygons. With these the net resultant of the different locational attractions can still be found from finding the equilibrium of forces in which relative weights and relative distances are the relevant components, but the solution is most easily obtained by analogies to applied mechanic.[6]

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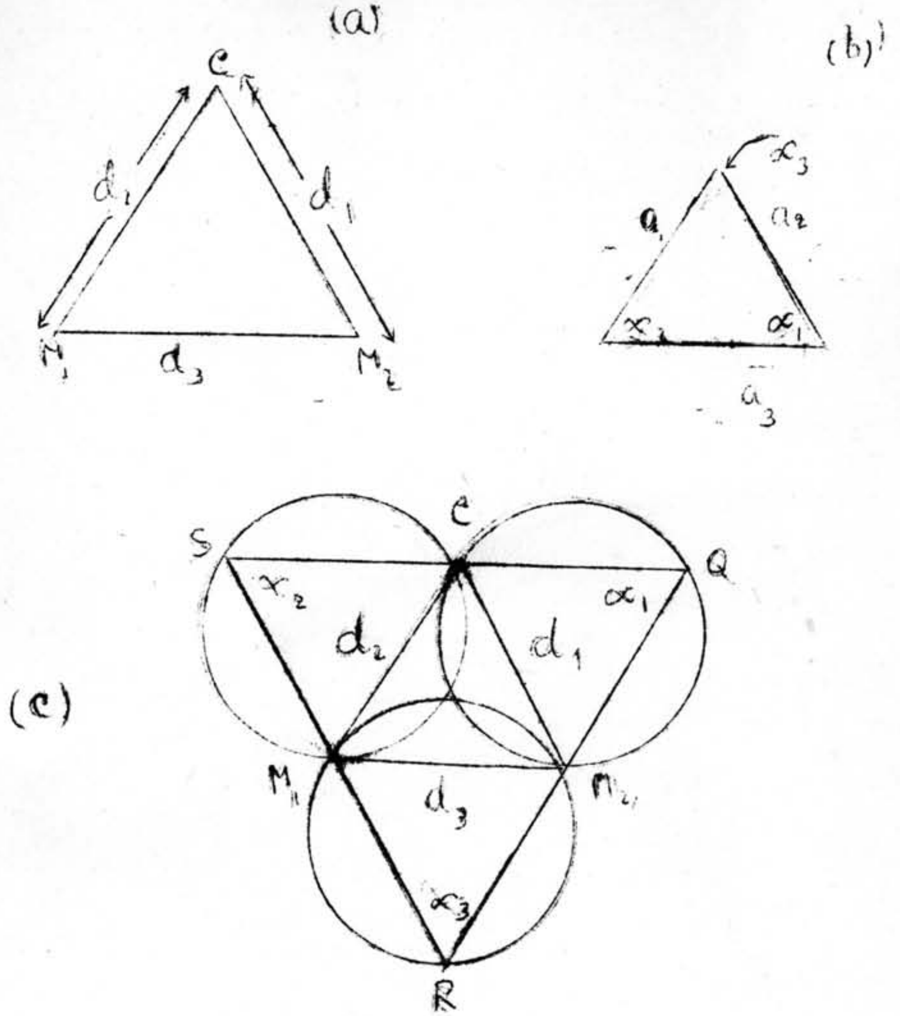
[6] *Ibid.*, pp. 64 - 65.

Figure 1.1



Source Richardson, H.W. Regional Economic (London: Redwood Press Limited, 1969), p. 47.

In figure 1.1 (a) Richardson attempts to show how we can represent locationally three factors: (i) the consumption point (c), (ii) and (iii) sources of raw material (M_1M_2), where d_1, d_2, d_3 represent the relative distances between locations. Next, he employs an expression

$\frac{a_1 + a_2}{a_3}$ where a_1 and a_2 are the respective tons of material produced at M_1 and M_2 needed to make a_3 tons of finished product. This expression will provide us with a material index.

Figure 1.1 (b) is the result of the variables being given certain values. If however, any one of the variables a_1, a_2, a_3 exceeds the sum of the other two, then there will be a direct association between that variable and the locational site. This we term a weight triangle. The angles of this weight triangle are M_1 M_2 M_3. Its weight-distance is determined solely by a_1, a_2 and a_3. The weight triangles are then superimposed on to the locational triangle (as is 1.1 c) with 1 now representing the angle of the quadrilateral C M_1 M_2 Q : ∞_3= angle of quadrilateral C $M_2 M_1$S, etc. Z, the production site, is determined by the point of intersection of minimum transport cost. Z also will be the point of equilibrium of forces from $M_1 M_2$ and C because a_1, a_2 and a_3 are the forces weighted at Z and calculated by distances from M_1, M_2 C respectively. Therefore, $a_1 M_1 Z + a_2 M_2 Z + a_3 C Z$ = Minimum total transport cost per ton of finished product.

However, the fact that the material index is greater than one does not necessarily mean that the location of production cannot be at a corner of the locational triangle or even at a raw material sources which does not lose weight in production. 006718

If these circles around the triangles intersect outside the locational triangle, then the point of equilibrium will also be outside the locational triangle, and this point will no longer be the answer to the locational problem because the costs of transport could always be made less by changing to one of the corners of the locational triangle. This corner is always the point of minimum transport cost. This situation occurs when (a) the weights of the other two corners are small in relation to the third (Figure 1.2 a) or (1.2 b) when the induced corner is near the connecting line of the other two corners (Figure 1.2 b)

Richardson points out that this way of solving the problem geometrically really depends on the assumption that the transport functions are linear. This locational triangle (Polygon) method is inapplicable if the transport rates per unit of distance decrease with distance. Weber himself, suggested that such rate structures could be taken care of by substituting pretended geographical distances which reflected the decreasing transport costs per mile or kilometer. The greater the real distance, the more it would have to be shortened in order to show transport costs geometrically. Unfortunately, the problem is that we do not know how much this shortening should be from any corner of the triangle to the site of production until the production site can be located, and this latter point in turn cannot be ascertained until these distances are known.

Therefore, for realistic transport rate structures we have to depend on mathematical solutions incorporating non-linear transport functions.

After an extensive discussion of the effects of transportation costs on location with the restrictive assumption of equal labour cost throughout, Weber introduced the effect of labour cost on industrial location by looking at varying labour costs at different points. The problem then became one of finding the best overall location when one point was most suitable in terms of labour cost and another was the one at which transportation cost was a minimum. Weber, in dealing with this issue, began by investigating two situations:

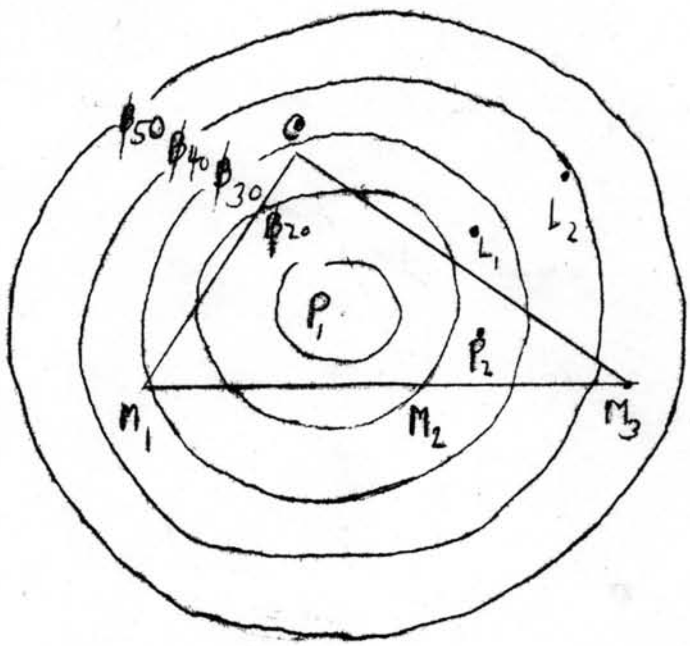
(a) in which circumstances favour the removal of the industry to an attractive labour location

(b) in which circumstances do not favour such a move.

Case (a) occurs if what is saved in labour costs, is greater than the extra transport costs brought about by the move. Analysing this situation requires the use of isodapanes i.e. lines, drawn around the place of least transportation cost, and which join those points which have equal additional transport costs. In Figure 1.3 we see this least-cost location as it relates to the market at C and to the material deposits at M_1 and M_2. Isodapanes are represented by the circles centering on P_1 and these show how transport costs increase as we move further away from P_1. L_1 is the cheap labour source, and by using this site thirty baht per unit of production could be saved on labour costs. Total costs will be lower at L_1, because L_1 is nearer to P_1 than the isodapane representing the 30 baht rise in transport costs. The term critical isodapane is used by Weber for that isodapane which has an equal value to the labour cost saving. If the location of cheap labour is within this critical isodapane then it is a location which is more profitable than the least-transportation cost location, as in L_1; but if it is situated outside this isodapane, as in the case of L_2, then P_1 will still be the most profitable site because the labour saving at L_2 is still only 30 baht.

However more difficulties may arise if the industry moves to a cheap-labour site. One of these may be that deposits of materials which were previously too far from the production point may now be used. Figure 1.3 shows M_3 as a deposit of the same material that is found at M_1; and a factory located at L_1, would obviously prefer to use M_3. M_2M_3C is a new locational triangle and this will bring about a new transport cost situation which will have associated with it a new set of isodapanes. P_2 could therefore possibly be a new least transport cost point which may be at a better location than L_1

Figure 1.3 The effect of a cheap-labour location, illustrated in Weber's isodapane framework



Source Smith, David M. Industrial Location (New York: John Wiley & Sons, Inc. 1971), p. 117.

Weber correlates the two factors as he broadens his analysis to consider the perspective of the whole industry: the more important labour is as a factor of production in any particular industry, the greater will be the possibility of a cheap-labour location.

In order to calculate this importance he makes use of a labour cost indes, which for any particular industry is shown as; i.e.

$$\text{(a) Indes of Labour Cost} = \frac{\text{Total Cost of Product Per Ton}}{\text{Percentage of Labor Compression}}$$

The higher the index the greater will be the industry's susceptibility to move from the point of least-transportation cost. However it was more satisfactory for Weber to evaluate the attraction of labour by calculating the ratio of labour cost per unit of the weight of the product to the total weight of the material and the product to be moved i.e. (b) In functional term, L.C. (labour co-efficient) = $\frac{\text{L.C./Ton}}{\text{L.W.}}$

Thus we set up the principle: (1) what actually decides the most profitable industrial locations is dependent on the ratio of labour cost per unit of production weight to the locational weight. The combination of these two factors is termed the 'labour co-efficient'. (2) One, and only one, condition should bring about the movement from the minimum transportation cost point to a favourable labour location, and that is that the saving in the labour cost at the possible alternative site should be equal to or greater than the additional transportation costs involved.

Up to now, there has been identification and combination of two regional factors, but the result is still not a final conclusion regarding the correct location. Thus Weber, to make this final step, considers in his analysis a third group of factors--'agglomerating forces'.

In Weberian analysis agglomerating forces also include deglomerating forces, although their causes are not the same. According to Weber; "All deglomerative factors are by their very nature nothing but counter-tendencies resulting from agglomeration. But if that is what they are, theory may disregard them as independent factors and treat them as the opposite of agglomeration. For the theory is not concerned with the dynamic interaction of operative tendencies toward agglomeration and the resultant contrary tendencies toward deglomeration, but rather with the final effect of this process, since only this final effect alters the locational situation."[9]

The agglomerating force is handled in quite a different and independent way from the concern with transport or the orientation toward a source of labour. Thus for Weber "pure agglomeration", or technical agglomeration, incorporates only the independent agglomerative tendencies.

Agglomerative tendencies and cheap labour are dealt with in a very similar way--as factors that may cause a production point

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[9] An agglomerative factor is an advantage which results from the fact that production is carried on to some considerable extent at one place, while a deglomesative factor is a cheapening of product which results from the decentrallization of production. <u>Ibid.</u>, p. 126.

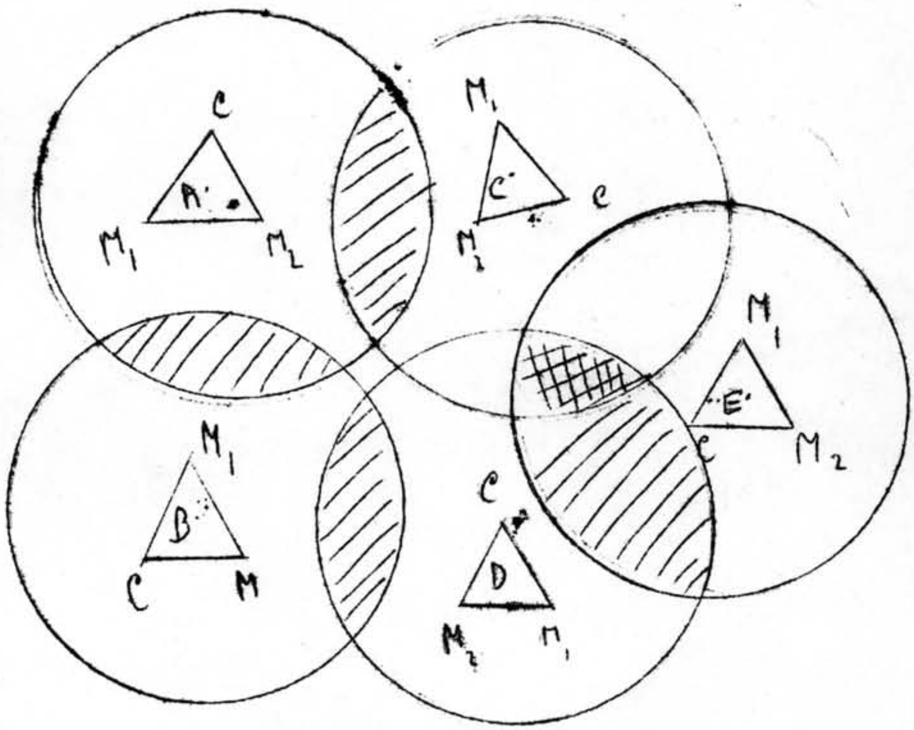
to move from the least-transport cost location.

Figure 1.4 illustrates this. Here five firms A, B, C, D and E have set up business and each unit has it own separate location inside its own location triangle. The businesses see that their production cost could be reduced by twenty baht a unit if at least three of them operate in the same location. By doing this they would take advantage of the economics of agglomeration; but in order to do this, a firm must not suffer an addition of more than twenty baht to its transport cost. The circles in Figure 1.4 represent the critical (twenty baht) isodapanes for each production unit. In the diagram the hatched area shows the only place where three firms (C, D, and E) can locate together and still have extra transport costs of less than twenty baht. It is the region possible for agglomeration to take effect, but neither A nor B will join this agglomeration because it is further than their critical isodapanes. The only circumstances under which they would join would be if costs could be reduced by either obtaining materials from a new source or by supplying their products to a new market. The stippled areas, the intersections of only two isodapanes, are not able to act as agglomeration locations because they cannot satisfy the three-firm minimum requirements. Weber states that two factors determine the setting up of agglomeration centers and the agglomeration of individual units of production at these centers: (a) the attainment of the necessary amounts of production within these areas. (b) the existence of the critical isodapanes' intersections as they relate to the assumed unit of agglomeration. If these two conditions hold there is an agglomeration of the individual units of production and also this concentration

Figure 1.4

Weber's analysis of the operation of

agglomeration tendencies



Source (Based on Weber, Alfred, Theory of Location of Industries, Chicago Press, 1929, page 139).

affects all parts of the production complex.

A mean of measuring the effectiveness of agglomeration tendency is provided by the value added through manufacturing. To do this, we must first examine closely the main features making up this measuring rod.

The first labour cost measured in terms of wage and salaries; the cost of using machinery included interest, amortization of fixed capital, and the cost of power using. Weber called the first as "value added through labour" and the second as "value added through machines." To know the agglomerating force, it is necessary to know what proportion those two factors enter into the index. The initial consideration has been given to the value added through manufactures results from machines. The variation of "value added through machines" due to the increasing use of fuel which means a rising material index of the particular industry. Therefore, the factor of value added through machines is to a large extent paralyzed by a rising material index in the another way round, while the value added through labour is a pure factor of agglomeration. And hence, it is reasonable to take value added through machines of an industry as a second measuring rod of agglomeration which is contained in the material index and locational weight apart from the consideration in value added through labour. Consequently, by this way of consideration lead to relate the notion of the value added through manufacture to that of the locational weight and bring up a connecting concept out of the index of manufacture and of the locational weight that has been previously done.

Hence, we must know the proportions of these two factors individually in the total value added by manufacture and relate these proportional values to that of locational weight. If will then be possible to obtain a more workable measuring rod namely, a coefficient of manufacture.

Weber was thus able to state that high coefficients of manufacture would lead to strong tendencies to agglomerate. Industries with low coefficients of manufacture would show weak tendencies to agglomerate, and these tendencies were inherent in the nature of each industry.[10]

Finally he was able to deduce the following general theoretical conclusion about:

(a) the influences of the determining forces.

(b) regional factors.

(c) locational factors.

"When we apply corporative advantage by looking at the competition between the pure agglomerative deviation and the labour deviation, from the points of minium-transport cost, we can state that the one of the two forces which gets the higher net economies over and above the minimum transport cost will be the more favourable one".[11]

This does not give us a perfect solution however, since both labour orientation and transport are causes of incidental agglomeration. Thus we need to revise the model. Now we need to ask which is more beneficial; the economies of agglomeration under pure and independent agglomeration or the economies of labour plus the economies of accidental agglomeration at the best labour site.[12]

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[10] Ibid., p. 166.

[11] Ibid., pp. 34 - 36.

[12] Ibid., pp. 127 - 131.

To obtain a satisfactory answer, once again the corporative locational advantage is used. Weber remarks that labour location may and in most cases will, itself be an agglomeration point--one of accidental agglomeration. Weber goes on to state that those economies of agglomeration are quite separate from the economies of labour which draw industry towards that particular labour location.

These economies of accidental agglomeration must, therefore, be added to the economies of labour if we really want to know the total amount of economies with which the labour location competes against the purely transport oriented location.[13]

Moreover, further noted that all industries in which accidental agglomeration at labour locations creates units of agglomeration which are equal to or greater than pure and independent agglomeration within the groundwork of transport orientation will retain with their labour orientation. This is so because in such a situation, the economies caused by this accidental agglomeration are greater than those which the transport or labour pulled agglomeration can offer. Only these industries where the accidental agglomeration causes smaller units of agglomeration can have any other possible orientation. However this will occur only when the loss of economies of agglomeration (caused by the unit's smallness) is not compensated for by the economies of labour offered at the labour locations.[14]

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[13] Ibid., 157 - 158.

[14] Ibid.

In conclusion, it may be said that the construction of isodapanes is a useful technical device for testing locational validity when we analyse the whole process of the least cost location. Without this device it is hard to visualize the effect that costs have on the determination of location.

Tord Palander

The Swedish economist Tord Palander was concerned with the difficulty of looking at industrial location within the conventional general equilibrium theory where everything was assumed to occur at one point in space. The first problem he tackled was that of the market. He took a simple case of two firms which manufactured the same product for a linear market, taking the following as:

(i) place of production

(ii) the competitive condition

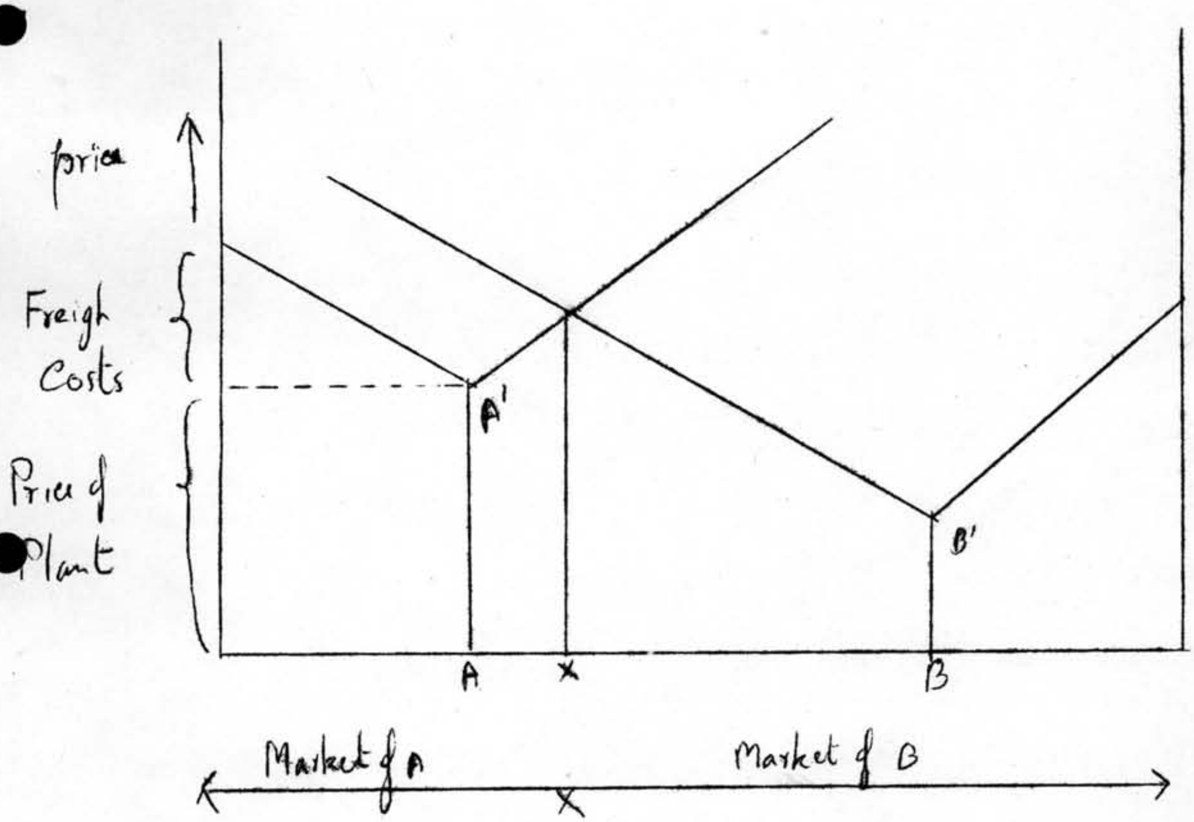
(iii) factory costs

(iv) transport rates

Under such conditions how would the spatial extent in which a producer can sell his goods be effected by price? Assuming the above, Palander showed how the boudary between the two markets could be found.

A and B are two firms serving a market which is distributed along the horizontal axis of the diagram. We can show the plant cost or the price of the product at its source on the vertical distance--AA for firm A and BB for firm B, the latter being slightly lower. The transport cost of items sold away from the plant raises the price the consumer has to pay and this is indicated by the lines which raise in both directions from A and B. Therefore, we can state that, at any point the price which is changed will include two types of cost (i) fixed plant cost,, and, (ii) variable transport cost. The boundary between the two firms' market area is shown by X. A′ this place both producers' delivered prices will be the same, and therefore the customers can purchase from either firm indifferently.

Figure 1.5



(The deviation of a boundary between the market areas of two competition firms. Source: Smith David M, Industrial Location, John Wiles & Sons, 1911, p. 120.)

A number of variations on this situation is shown by Palander. He does so by altering the relative values of the plant prices and the freight charges, both of which affect the boundary between the two market areas. The sizes of these areas will be determined by the level of both plant prices and freight costs. The profit made by any firm will be influenced by the size of its market area.

When we know (i) the cost of production, (ii) profit per unit of output given, and, (iii) sales, related in value to market area size, then the total profit becomes a function of the distance over which a firm's market can be extended.

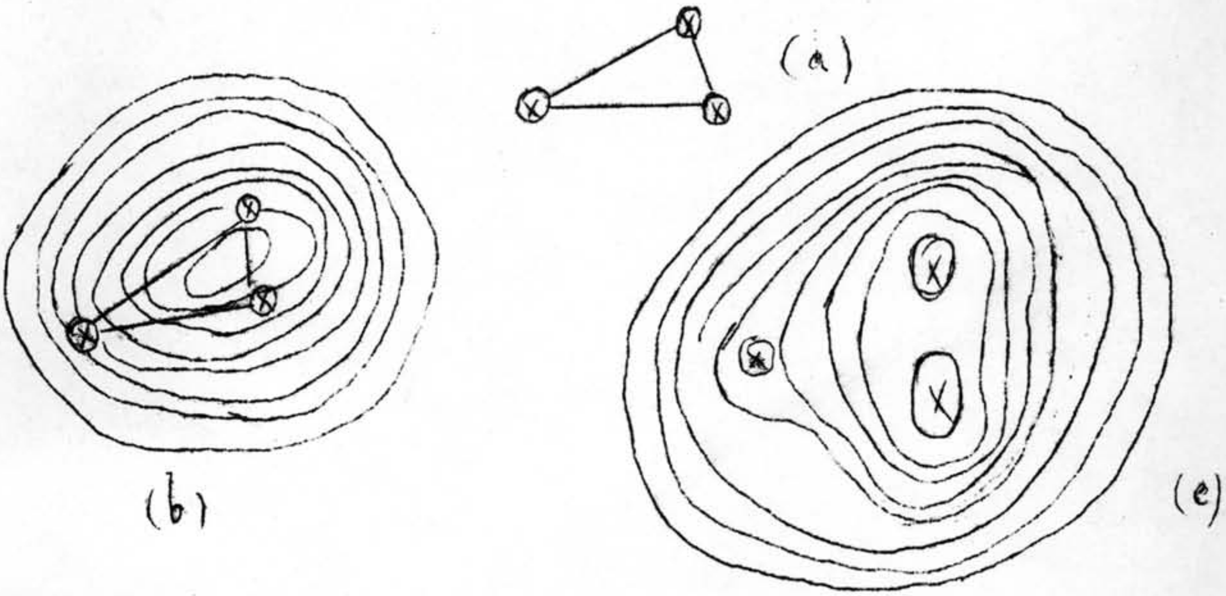
The locational decisions and other actions of competitors will influence a firm's sales area and profits; and Palander, in his case study of two producers, develops a simple theory of spatial duopolistic competition. He takes into consideration how the competing firms plan and utilize prices, and he shows how much these can influence profit and how a state of equilibrium is reached where the firms gain nothing by further competition.

After using spatial competition to work out the analyses of market areas, Palander turns to another major question. If we are given the price, the location of material and the position of the market, where will be the location of production? In answering this Palander utilizes Weber's method of using isodapanes to show how location is influenced by transport costs, rather than by considering the weight of goods to be transported.

Palander's main concern is the effect that friehgt rates has on the pattern of isodapanes. He therefore distinguishes between those rates that have on even rise relative to distance and the more realistic assumption under which the rates decrease according to the distance travelled. The uniform rate will give us a series of isovectors (lines joining these points where the costs of transport for a given item are the same.) around a given point. These isovectors will take the shape of concentric circles regularly spaced, whereas the variable rates produce isovectors which are spaced successively further apart as the cost per unit of distance decreases.

Palander cites a simple case: one source of material and one point of consumption, to demonstrate how, with the uniform rate, the total costs of transport will be equal at any point on the line between the two points, but with variable rates both the source of material and the market have lower costs than at any location inbetween the two points. If a third point is introduced to give us the locational triangle used by Weber and Launhardt (Figure 1.6 a) these is a similar effect. If there is a uniform increase in the costs of transport relative to the distance from each point, then isodapanes are produced which are interpolated from the three sets of isovectors and these isodapanes give us a least-transport cost point inside the triangle (Figure 1.6 b). However with variable freight rates, the locations at the triangle's corners are more attractive (Figure 1.6 c). Thus the general conclusion will be that a least-transport-cost point within a locational triangle is not as likely to occur as Weber suggested. It is much more likely that actual freight rates will cause the best location to be at the market or at a source of material.

Figure 1.6 Patterns of isodapanes for different transport rates
(a) the locational triangle; (b) tariff uniform with distance; (c) tariff



Source: Smith, D.M. Industrial Location (New York: John Wiley & Sons, Inc., 1971), p. 117.

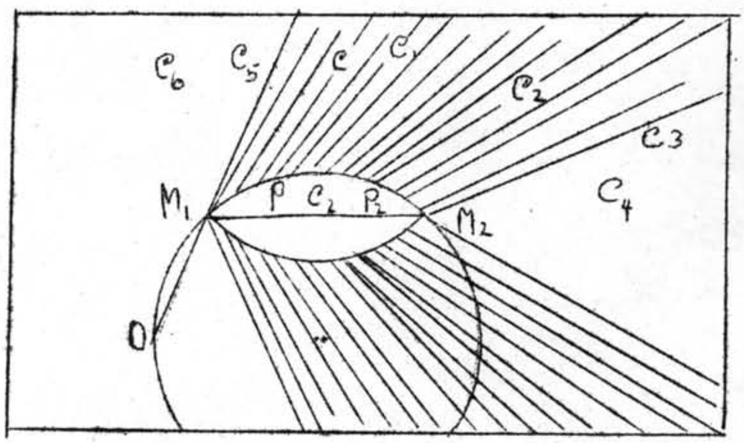
Palander's attempt to introduce market areas into his analysis of transport orientation (following Launhardt) also suggests that the implications of a large number of consumption points, as in a Weber-type situation, should be worked out. His first postulates are therefore (i) the absence of various agglomeration economics and geographic variations in the prices of different inputs and outputs, with the exception of those resulting from the costs of transport on the item and on the two raw materials considered, (ii) uniform transport facilities going in all directions from all points.

The geometric representation of this is as follows:

In Figure 1.7, there are two sources of materials M_1 and M_2. Consumption points are represented at C, C_1, C_2.......C_7. A location triangle M_1, M_2, 0 can be drawn for any point C_1, along with a weight triangle M_1M_2O which will reflect the attractions of the locational triangle corners.

If a circle is circumscribed round the weight triangle and a straight line drawn from the pole O to C, the point of intersection at the circle within the locational triangle is the production point from whioh C_1 should be served in order to bring transport costs to a minimum. Generalizing this situation, with a market which is spatially continuous when the market is represented by an infinite member of points C, it can be demonstrated that M_1 will serve part of the market, M_2 another part and the remaining points along the revelant circumscribed circle (i.e., the two areas M_1, M_2 in Figure 1.7). A factory would serve any consumption point within the two areas, e.g., C_7 in Figure 1.7.

Figure 1.7 The Launhardt-Palander construction



Source: Isard Walter. Location and Space Economy (Massachussets: The M.I.T. Press, 1956) p. 256.

Edgar M. Hoover

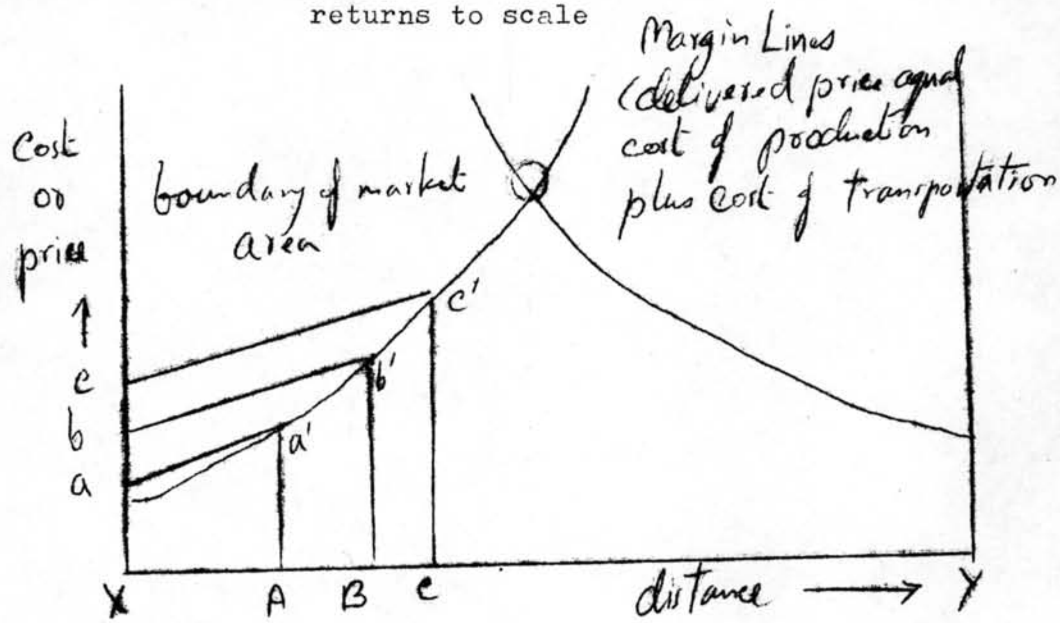
In 1937, Hoover published a study of the shoe leather industries and in 1948, a more general wrok, The Location of Economic Activity. Hoover's first theoretical statement was greatly influenced by Palander, and helped to give wider exposure to some of the ideas first advanced in Palander's work.

Certain factors are taken as assumed or determined in Hoover's former work. A state of (i) perfect competition between buyers and (ii) mobility of the production factors are assumed, while location is determined by costs of (i) transportation and (ii) extraction. Considering extractive industries, a second assumption is the given location of deposits. The area that each point of production will serve is then determined by using these two sets of assumptions. Hoover, like Palander (see Figure 1.5), uses a system of isotems to analyse the delivered price to a particular buyer (cost of extraction plus cost of transport). These isotems connect points of equal delivered prices and radiate from the production point.

The only variable which affects price is transport cost (assuming that extraction cost does not vary with output), but Hoover also feels it is important to include the influence of diminishing returns. He includes this because, with extractive industries, the bigger the market area, the higher the average cost as production increases.

In Figure 1.8 X represents the extraction point of a minieral. The possible market boundaries are represented by A, B, and C. X_a therefore shows the production costs if area XA is supplied, aa' shows what happens when transport costs are added i.e. delivered price will increase the further we go from X. Hoover terms this line aa' the transport gradient. In fact it is simply a cross section through an isotem map. There are similar effectly, as we extend the area to include A B. The "margin line" is the combination of points a', b', c' with the delivered prices at other possible limits to the market area. If we introduce another margin line from Y (a second source of the mineral) we will have a point of intersetion--this will then represent the boundary between the two market areas. At this point the delivered price from X and Y is equal, elsewhere the product will be offered at a lower price from one source than from the other.

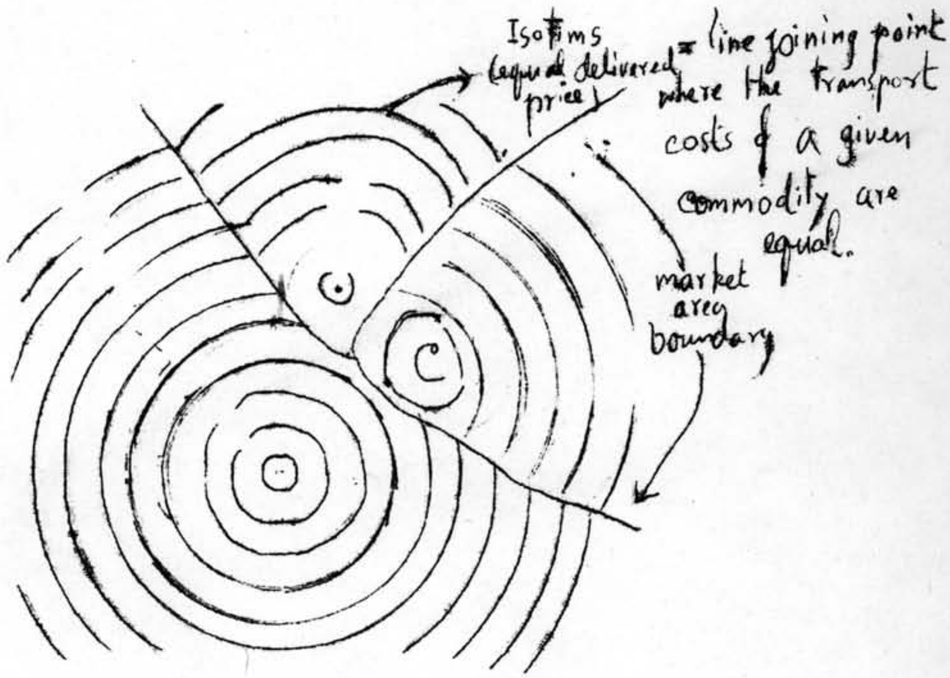
Figure 1.8 The boundary between the market areas of two producers under conditions of diminishing returns to scale



Source: Hoover, A.M, <u>Location Theory and the Shoe and Leather Industries</u> (Massachusetts: MIT Press, 1973), p. 17.

The relationship between the slope of the margin line and the location of plants is handed by Hoover as follows: If the margin lines have a steep gradient from the extraction point, other producers will tend to produce from intermediate areas in order to supply consumers where delivered prices are high. However if there is little difference between delivered price and the production point, a situation arises wherein large market areas are supplied by only a small member of producers. Hoover follows Weber closely when dealing with manufacturing industries. He points out that the best location point will be at the point of minimum transport costs (assuming there are no production cost differences). This location point may be at one of three places; (i) material source, (ii) market, (iii) some intermediate point. This point of minimum transport-cost location is found by finding the points of material source and market and constructing isotems around them. From these points isodapanes are constructed. So far, Hoover followed Weber's model. However he then goes further by showing graphically that different production points will serve different market sectors. This was a point Palander also showed. Figure 1.9 illustrates this principle. There are three points of production A, B, and C, and each has a different production cost. Systems of isotems are constructed around these points and the points of intersection of isotems along the delivered price watersheels give us the respective market areas.

Figure 1.9 Market area boundaries between different producers, arising from areal variations in production costs and delivered prices. (Source: M. Hoover, Jr., Location Theory and the Shoe and Leather Industries, Cambridge, Mass.: Harvard University Press, 1937)



Source: Smith, D.M., Industrial Location (New York: John Wiley & Sons, Inc., 1971), p. 127.

August Losch

There is one outstanding defect that can be attributed to early location theories, namely, that no consideration was given to the problem of demand. Location seemed to stem largely from cost differences. They ignored factors of place variation and sales potential. This failure can even be seen in Hoover's work, for he confined his analysis of the demand factor to showing the relationship between a location site and the market it served without considering the effect of the volume of demand on that location. Competition between firms and the implications which followed were considered by economists in the 1920's and 1950's, Palander (1935) contributing much to this new focus of attention. The first and general theory of location which included demand as a major spatial variable was formulated by August Losch (1940).

Losch's general theory attempted to show that spatial arrangement must be the basis of all economic activity in given circumstances. He assumed the following:

1. Raw materials are evenly distributed over an area which is wide, flat and has an absence of any differentiating characteristics. Transport costs are therefore considered equal in all directions.

2. There is an even distribution of population which is agricultural, homogeneous in taste and technical knowledge, and whose economic opportunities are equal.

3. The area is covered by farms which are self-sufficient and evenly spaced.

When industrial factors are taken into consideration the question arises: if there is a surplus of some commodity from the farms, what arrangement, as far as spatial economics is concerned, will provide a state of equilibrium.

Losch answers this question by stating that certain conditions must first be satisfied. Firstly, both the producer's profit and consumer's gain must be at their maximum and stem from the places of production which are of maximum advantage for each person.

Secondly, the whole area must be used by production units leaving no possibility of new firms finding new source locations. Thirdly, there must be no excessive profit making in those economic activities in which there is open competition, otherwise new firms will compete to gain this excess profit. Next, the only way to ensure that there is a maximum number of firms in an area is to limit the areas of supply, production and sales to a minimum. Lastly, those who live on the boundaries of two adjacent market areas must be unbiased as to which location they are supplied from.

How equilibrium is reached may be demonstrated as follows. If a single farmer decides to produce a surplus of, say, beer for sale, then his sales area will be circular, bounded by a locus of points at which his price becomes too high to sell any beer at all. But if one farmer can produce a surplus, so can the others, therefore, others enter the beer trade. Competition gradually reduces the sizes of sales areas until ultimately they become hexagonal in shape as all space is filled. Of the geometrical forms that could fill all space (hexagons, triangles, and squares), the hexagon most nearly resembles a circle. It has the highest demand per unit of area, and minimizes the total distance from its center to all points within the market area.

This may be illustrated by three stages in the development of a system of hexagonal market areas for one industry. In Figure 1.10, the first stage is a single producer at P operating with a demand curve QF. Price (p) is a function of distance and rises with transport costs along PF, and the vertical distance between PF and QF shows the quantity (q) demanded at any price. When PF is taken as a measure of distance and is rotated about P, the circular market area is formed, bounded by the locus of points F, where the price becomes too high. The total sales are given by the volume of the cone produced by the rotation of PQF. In the second stage a number of firms operate within circular market areas, but they are unable to supply all the potential market. The space between them attracts other producers, and the market areas decrease in size as abnormal profits are competed away, until finally the regular hexagonal grid is formed in the final stage[15]

Losch determines the location of a metropolis and towns or cities by calculating the following: a metropolis will be formed at a center where very commodity is produced. This center is the common point of production of a number of individual systems (i.e. hexagons representing market areas of different products) which are superimposed, one upon the other. Town or city locations are calculated from the points where two or more production points coincide.

Then, Losch shows how concentration of towns will occur in certain parts of the uniform plain. If the individual systems of hexagons

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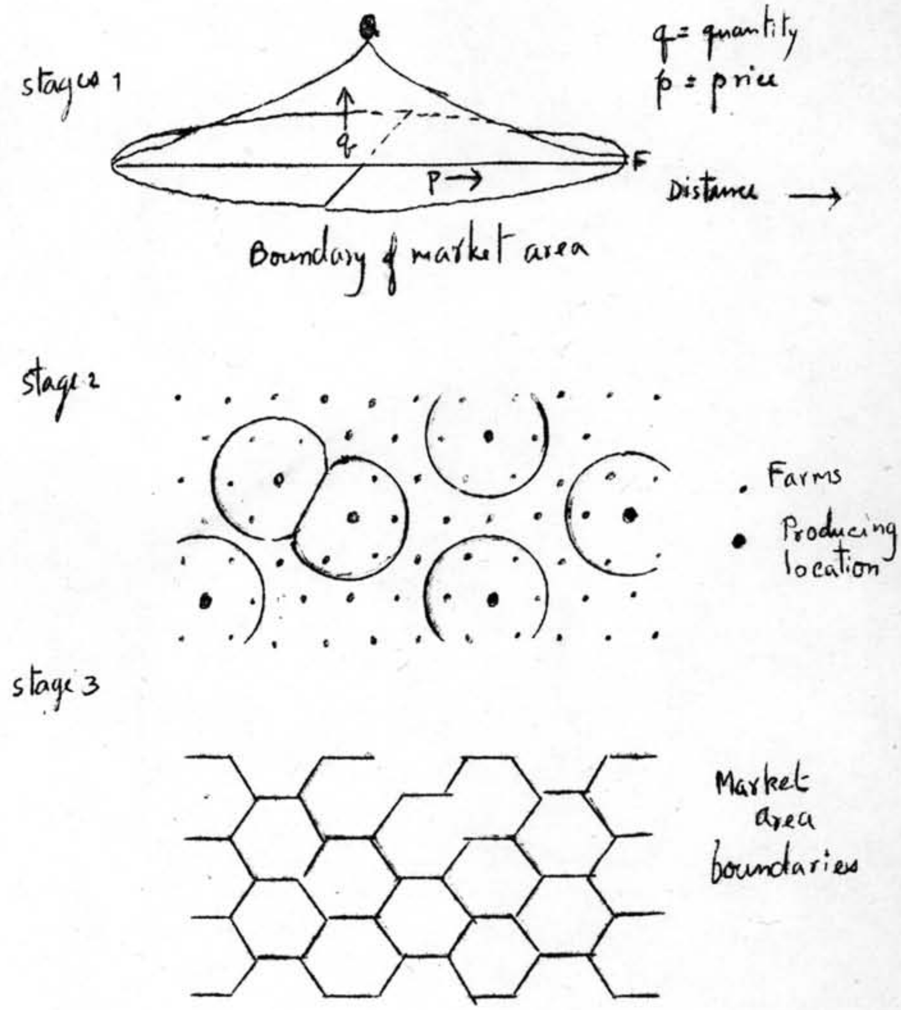
15 *Ibid.*, p. 10.

Figure 1.10

Stages in the derivation of Losch's system of hexagonal market areas



Source: Losch, August, <u>The Economic of Location</u> trans. by Woglom W.H; Stolper W.F. (Massachusetts: Yale University Press, 1954), p. 106, Figure 21 and 23.

are all rotated about the common center of the metropolis, it is found that a pattern can be formed in which there are six sectors with many production sites coinciding, and six intervening sectors in which there are few. In this situation, where the greatest coincidence of production sites exist, the maximum number of purchases can be made locally, and transport costs are minimized. This is the spatial arrangement of economic activity which fulfills the original equilibrium conditions. In Losch words: "First we discovered simple market regions surrounding every center of consumption or production in the form of a regular hexagon. Second, for every group of products a net of these market regions was found. And in the third place, a systematic arrangement of these various nets appeared. This self-sufficient system is the ideal type of an economic landscape, or economic region in the narrow sense. Finally, such landscapes are distributed throughout the world like a network and in accordance with definite laws."[16] The illustration of this pattern is shown in Figure 1.11

In Losch's analysis, an attempt is made to ignore the cost factor by assuring that the land surface has no differentiations. Melvin L. Greenhut found this assumption surprising along with the fact that Losch also did not see that at some locations there would be differing costs.

These cost differences arise from the fact that different products supply different trading areas, and advantages arise from the

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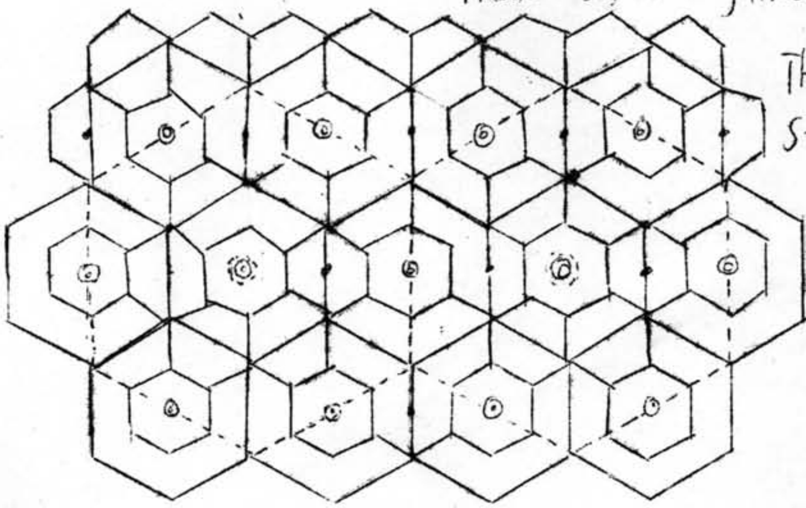
[16] Ibid., p. 137.

Figure 1.11 The spatial arrangement of economic activity which fulfills the original equilibrium conditions. Dashed line circle = product x
" " large hexagon = x's trading area
Heavy line circle = product Y
Medium sized heavy line hexagon = Y's trading area
Thin lined circle = product Z
Small sized light line - hexagon = Z's trading area.



Source: Greenhut, M.L., Plant Location: In Theory and In Practise (Carlifornia: The University of North Carolina Press, 1956), p. 271.

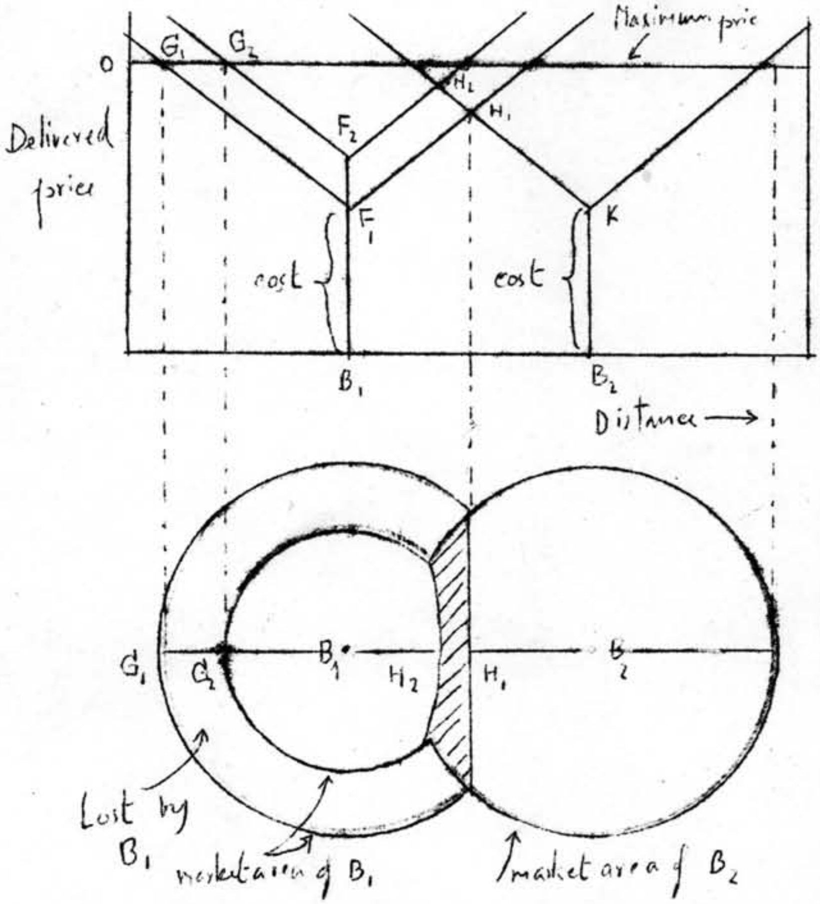
fact that there are different industries in the different market areas. These advantages may have effects within an industry as well as between industries.

Figure 1.11 illustrates the effect of differing costs arising from differing market sizes. Here the two largest hexagons both contain a dashed line circle representing product X. This product X has a trading area which is larger than that of product Y's trading areas. Also Y's trading area is larger than Z's. Thus there must exist agglomerating cost differentials. These differentials, shown by each of the circles, are found at each of the several locations. Even if we had a land surface with no differentiation, concentration would occur within the industry and between industries as well.

To solve the problem regarding the effect of a local price change on the size of a firm's market area, Losch uses a simple but effective diagram. In Figure 1.12, plants are located at B_1 and B_2, with operating costs of F_1 and K, respectively, and with V-shaped delivered price gradients. The market areas of the two plants intersect at H_1 in the cross-section, and their spatial forms are shown below. Notice that except where the two market areas intersect, their limits are determined by a critical price (O) at which sales cease. An increase in the price at B_1 to F_2 has the effect of narrowing the market area, as the limit moves in from G_1 to G_2 on the left and from H_1 to H_2 on the right. The plant at B_2 thus gains customers at the expense of B_1. Losch's discussion of this situation adds a dynamic element to market area analysis, and elsewhere he considers the effect of international trading conditions such as tariff walls on the forms of market areas.

Like any other attempt to theorize on the location of economic activity, Losch's work has its weaknesses. Perhaps the most seriousness is his failuare to consider spatial cost variations, which were eliminated by his assumption of a uniform plain with evenly distributed materials and population. After criticizing the one-sidedness of the least-cost approach, Losch goes to the other extreme and creates an

Figure 1.12 The effect of price inflation on the size of market areas.



Source: Losch August, <u>The Economic of Location</u> trans. by Woglom W.H., Stolper W.F. (Massachusetts: Yale University Press, 1954), p. 268.

idealized space economy in which demand in effect determined the location of producers. "In the equilibrium situation the viable location is one that commands a sales area of a certain size. Cost factors enter the analysis only through transport costs limiting the size of market areas (that is, by their effect on demand) and through the agglomeration advantages implicit in the emergence of Losch's six sectors of many towns--the pattern that maximizes effective demand. Losch has also been criticized on the grounds that his ideal system of location could be brought about only by state direction; in other words, it is irrelevant to a competitive capitalist economy.[18]

II Locational Interdependence School

This approach tries to answer the theoretical question of how equilibrium can be achieved if a situation of imperfect competition exists.

The case can be stated in simplified terms by considering two firms, duopolists, which compete along a linear market. Hotelling used the example of competition between two ice-cream sellers both supplying customers who were evenly distributed (linear market). Figure 1.12 shows this as a section of a three-dimensional situation. Secondly, Hotelling assumed three things: (i) equal production costs everywhere, (ii) for each unit of distance freight rates are equal everywhere, and (iii) the consumer pays transport costs because goods are sold on an   price system. The final assumption is that there is a limit on the demand for the product; i.e. not considering price, one unit of product is bought is one unit of time by each consumer.

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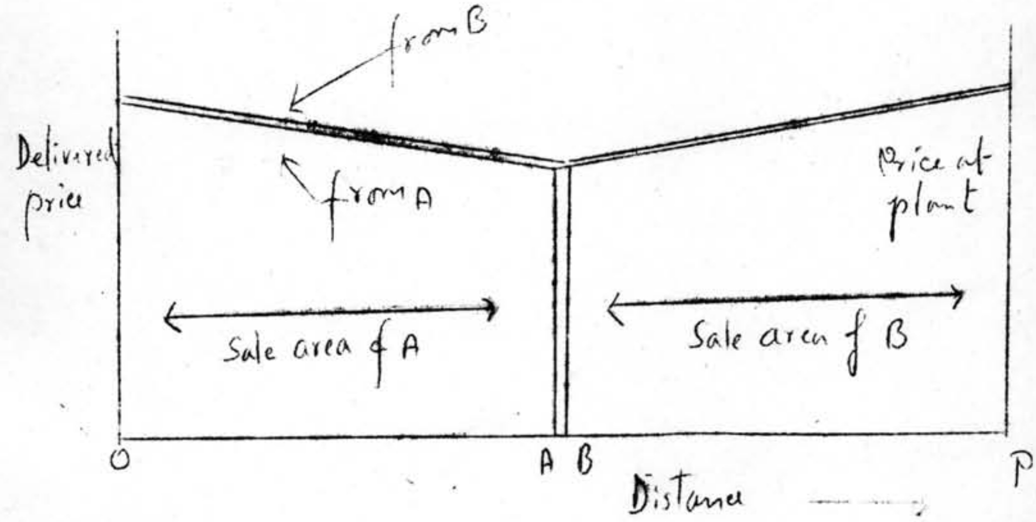
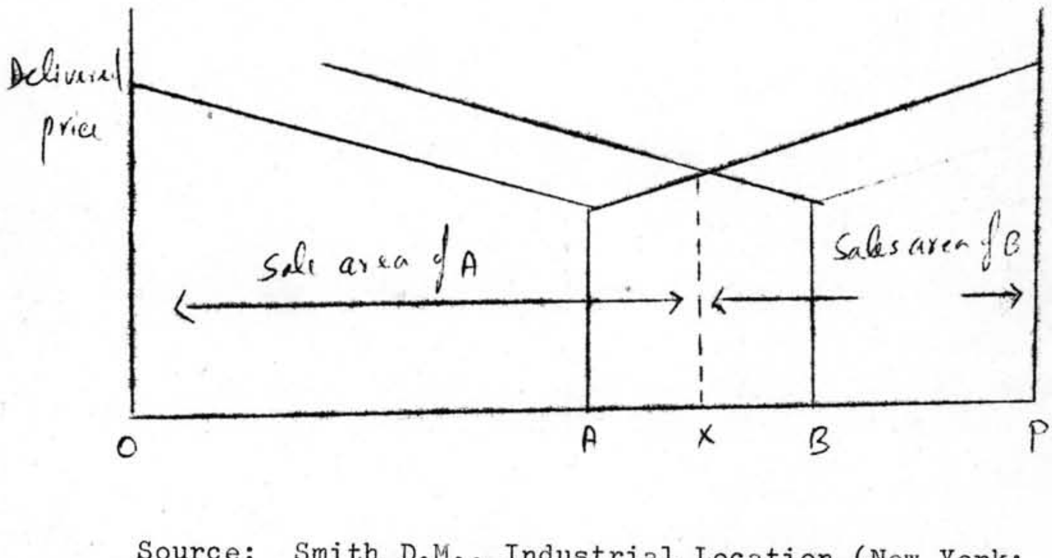
[18] *Ibid.*, pp. 269 - 272.

Figure 1.13 The location of duopolists competing for a linear market in conditions of infinitely inelastic demand, according to Hotelling.

(a)



(b)



Source: Smith D.M., Industrial Location (New York: John Wiley & Sons Inc., 1971), p. 139 figure 8.12.

Figure 1.13 a shows a linear market OP. A is the first producer and sets up his unit in the center of the market (in fact because of the above assumptions any position would supply him with the whole market.) Competition then comes from B who sets up his production unit as near to A as possible, since this is the most advanteous. Therefore A serves the left hand side of the market while B serves the right hand side. Figure 1.13 b shows the result of B's choosing another production location so that the right hand boundary of his market could be served cheaper than from the center--this is shown by the heigth of the two delivered price lines. However he would gain no advantage from this since we are working under the assumption of limited demand.

If B moves his location away from A it means that A has a greater chance of selling at a lower price in the area between the two firms. Therefore the position of B in Figure 1.13 a is the only one which assures his control of as much as half the market.

Hotelling argues that the factor which brings stability into the conditions of duopoly is that each firm monopolistially controls its own share of the market. With this situation, he further claims, if a third firm entered the competition, it would set up its production unit near to A and B but not between them. Other additions would follow this pattern.

The next consideration brings us to an analysis of how duopolists locate their units when there is a varying demand, or in other words what happens when the assumption of limited demand is relaxed. If we allow sales to be affected by price we must then reduce the delivered price at the market boundaries where the price will tend to be at its highest. Figure 1.14 a illustrates what happens when two merged firms locate at the quartile positions along a linear market. Such a situation brings transfer costs to a minimum and sales to a maximum. Such a location would also be of advantage if a given market was showed equally by two firms in competition.

Figure 1.14 b provides a comparison with the central back-to-back location and illustrates that savings on transfer cost at the quartile locations (shaded area) is greater than the savings which the center of the market locations offer. We can also show in a similar way the advantageous position of the quartiles over any other possible alternatives.

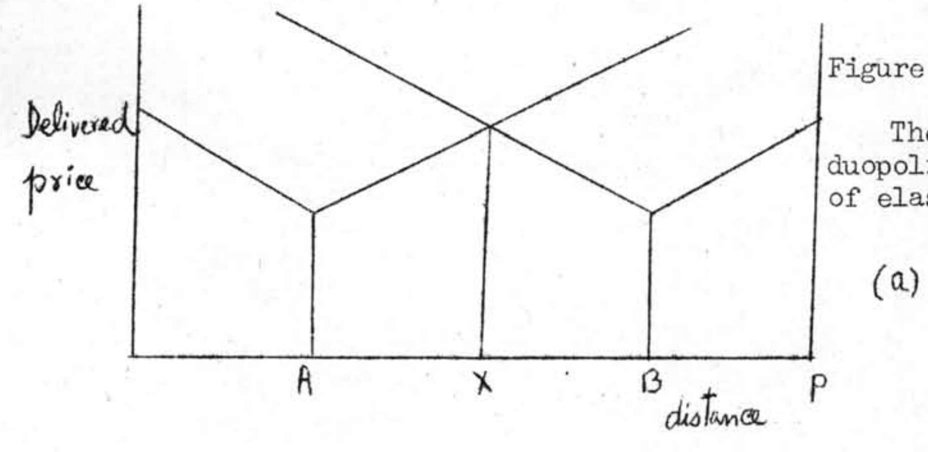
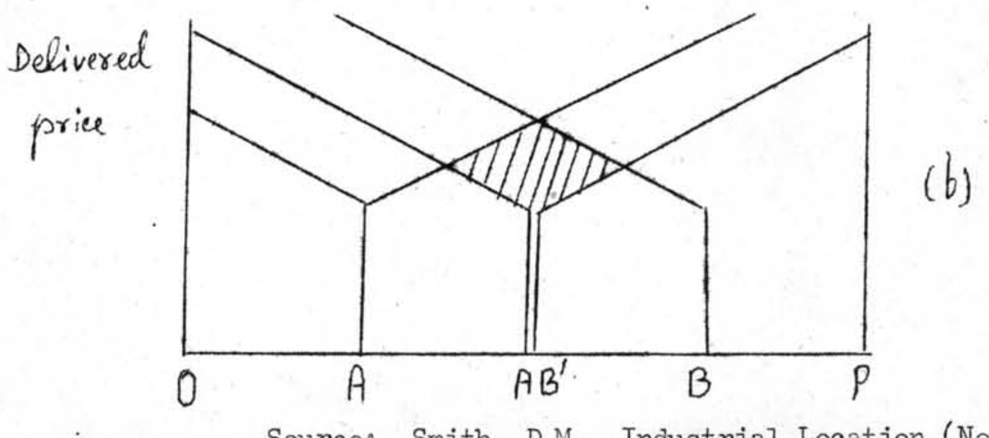


Figure 1.14

The location of duopolists in conditions of elastic demand



Source: Smith, D.M. Industrial Location (New York: John Wiley & Sons, Inc. 1971) p. 141 Figure 8.13.

III. The General Theory of Location

Since the early contributions of classical economists until the present day, a well-developed general theory of location has never appeared. To simply provide a theory which takes into consideration economic activity on a special level is not enough, i.e., it may be easy to point out the important features of such an approach and then to show how these features exist in fluence: but this kind of approach lacks rules by which the integral structure of the theory can be explained. One important thing that general equilibrium analysis can do is to help us develop a determinate theory, but such an analysis does not take account of production, consumption and trade in the spatial. It is therefore, important to have a theory which can account for movement or change with reference to methods, costs, income levels, etc. and to show how these factors have spatial influence on production and as consumption. A theory which is dynamic in nature is thus needed.

What is more, if we include time as well as space factors affecting location, the theory is even less in line with one in which the process of decision-making on a rational basis eventually leads to a position of equilibrium. The addition of the time dimensions also makes the number of possible production sites greater.

Thus, we have a problem: how can we deal with the space and time factors as well as keep the idea of a general theory?

Some economists tried to answer this quite simply by talking of an "inter-regional trade model." Here we find the following:

(i) the spatial structure of the economy is given,

(ii) the locations of production and consumption remain the same,

(iii) the pattern of resource locations and the transportation net work remain the same, and

(iv) technology is unchanging.

So we see that if we want to find how the price and goods patterns flow in equilibrium, there must be no change as far as the spatial, features are concerned. This however does not explain:

(i) the fact of evolution in the spatial set up of the economy,

(ii) how the structure may change in the future.

Because it fails to explain these two important factors we are not really able to class this approach as a general location theory.

However this type of approach is what we find in two major theories:

(i) the Walrasian general equilibrium theory. Here we have no recognition of transport costs; also as far as inputs and outputs are concerned there is no restriction on movement.

(ii) the international trade theory. This also treats transport costs as zero, and assumes no movement as far as production factors go but free trade as far as goods are concerned.

The first set falls in line with a one-point economy; the second set does not allow consideration of distance or transport costs, which is surprising since the theory concerns international economies.

We can look at this situation in two ways. In the first set transport costs are implicitly included in general production costs, and therefore it is justifiable to talk of a one-point economy. An opposing view is one in which transport costs and spatial factors must be considered because of their effects in causing a separation of the points of production and consumption.

If we are right in accepting this latter point, it is necessary to be very clear in explaining how the general spatial model deals with factors of location.

Hence we can assume that the work of a general theory lies in explaining:

(1) production location

(2) the kind of networks which are caused by the mutual dependence of producers are consumers.

This type of theory is possible if we add location factors rather than refusing to consider any inter-regional trade model at all. This latter point, however, has not been included in previous models, which have all been based simply on patterns of production. The reason for this is that there is a limited operational space for each regional industry and this is open to competition. This is only one approach which tries to include both production and trade features--that is Lefeber's theory.

In the search for a general theory we come up against the problem of including location theory in inter-regional trade models. This arises mainly because such theories are not really concerned with a complete equilibrium analysis. For instance, Losch does not consider it necessary to include demand for goods as an interdependent factor. Instead price alone is seen as the determiner of demand. And even for Lefeber there is a predetermining of the price of finished goods, whereas if we had a really general theory such prices would be a result of demand and supply rather than a predetermined factor.

"Thus an ideal general theory would recognize:

(i) differentiated regions

(ii) nodal points and transport channels within each region

(iii) spatial inter-connections between production and consumption among regions.

The space economy would thus have located in it all production and consumption points, inputs and outputs at these production points, intra and inter-regional flows of goods and prices plus the relationship of output and transportation costs to all the other economic activities."[19]

Andreas Predohl

When we begin to see how the general theory of location developed we feel to some extent unsatisfied in that none of the early attempts were at all near the true mark.

In looking at Andreas Predohl's work, we find that he saw a general location theory as another way of viewing a general economy theory i.e. it was an integral part of it. In this he had mainly in mind a general equilibrium theory, as did Walras, Pareto, and Cassel later. In their theories price and quantity were interdependent. Predohl attempted to see how location and price theories were related

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[19] Richardson, H.W., <u>Regional Economic</u> (London: Weidenfeld and Nicolson Press, 1969), p. 104.

or how the economic phenomena of interdependent prices affected local distribution of production.

In Predohl's general theory of interdependence, he makes the mistake of giving the Walrasian-Casselian general equilibrium theory too much scope. He does this because he explains the distribution of factors of production in terms of substition effects (i.e. substitution of production factors such as land, labour and capital). Thus we arrive at a general location theory by applying the substitution theory to the employment of the various factors of production mentioned above. For Predohl, the spatial factor is already part of the analysis.

It is clear that Predohl is dealing with a one-point analysis; transport cost is abstracted and there is no restriction on the movement of production factors and products. In fact, there is a lack of spatial allocation of factors; we are really dealing with the allocation of factors among the different kinds of production. With Isard, we have a reversal of Predohl's conception. With the Walrasian and Casselian general equilibrium analysis we have simply one special case of the general location theory since there may be inequalities in local resource patterns, land, labour, capital and transport which are not negated by using the theory of substitution. The inequalities allow for different modes of production, unlike the case in Thunen's 'homogeneous plain'.

However, basically, these new possibilities of production can be viewed in terms of economic value and as such can also be classed under substitution operation factors.

Predohl begins his analysis from Thunen's 'isolated' state. In this model only one production location is not fixed and as this one moves towards the edges outlays of capital and labour (including transport) are substitued from outlays of land. Naturally, if we move this one movable location towards the center of consumption the opposite takes place. If we apply this substitution theory we will arrive at the minimum cost site in relation to the two extreme positions mentioned.

However, within these two points, yet further substitution points can be found. For example, there is a point of substitution between the outlays for transport and those for local capital and labour: i.e. suppose we have to decide if we should make a change in an item in order to make it lighter or smaller. A point of substitution can also be found in the transport outlay area, a point connected with allocating a fixed amount of input between two transport sources: one in which raw material is brought from the edge of the area, and the other where it is brought from a central consumption point. From this, interdependent points of substitution can be found. These will show where any particular industry should be located.

If we extend this theory, it is possible to include the location of all economic activities in a area by using a general equilibrium analysis.

As far as Predohl is concerned, he tends to convert all spatial and quality differences into differences in 'quantities of use' units. So, if we have any labour, which is not movable, in different places, and if this labour is diversified, it can be changed into units of 'labour use' and so converted into units which are comparable. We can follow this procedure no matter what the resources are. Thus all spatial differences in land, labour and capital are treated as use units of land, labour and capital at any given location.

Within the sphere of location analysis, two types of substitution can be seen:

1) between transport inputs,

2) between outlays, between revenues and between outlay and revenue.

Since there are regularities in cost and price changes over space, it is possible to talk of a logic to location economics. These regular features arise from the fact that the transport cost is a direct function of distance. Economically, it is quite arbitrary how the patterns of consumption centers and of raw material sources are spread over space.

The problem we face now is one of choice. How should the different types of labour, land and transport inputs be arranged: It may be very difficult to choose the right point of substitution between a transport input and a labour input, or between the two groups.

This choice needs to be the result of comparing directly the outlays for different types of labour, or the total labour outlays, and transport outlays etc. Such choices are included in the analysis.

If we want a real locational approach, then substitution analysis as far as outlays and revenues are concerned is not enough. It is necessary to supplement this with a substitution analysis which also includes transportation inputs.

The General Theory of Location According to Losch

The theory of general location equilibrium of Losch assumes certain things:

(i) the distribution of raw materials used for industry is uniform and along with this the possibities for transport are ubiquitous. These two factors give rise to equal costs at any point on his theoretical homogeneous plain.

(ii) this plain is populated with an even distribution of density

(iii) the likes and preferences of the consumers are the same

(iv) there is open competition for production opportunities..

To reach a state of equilibrium two tendencies exist concurrently

(i) producers try to maximise their profits, while consumers try to use the closest market.

(ii) there is competition between production units when units in an industry grow to such a number that they compete spatially, eventually removing excess profits. Only when these profits have been removed can equilibrium be reached. Then, following this, the spatial competition abates and fixed locations can be decided upon.

The following five equations summarize Losch's conditions for equilibrium.

$$\frac{\Delta R_q^m}{\Delta X_q^m} = 0 \; ; \; \frac{\Delta R_q^m}{\Delta Y_q^m} = 0 \quad \ldots\ldots\ldots \quad (1)$$

$$A_1^m + A_2^m + \ldots\ldots\ldots + A_q^m = A \quad \ldots\ldots\ldots \quad (2)$$

$$P^m(Dq) = C^m(Dq) \quad \ldots\ldots\ldots \quad (3)$$

$$\frac{\Delta P_q^m}{\Delta A_q^m} = \frac{\Delta C_q^m}{\Delta A_q^m} \quad \ldots\ldots\ldots \quad (4)$$

$$B_q^m = P_q^m + t_q^m \sqrt{(X - X_q^m)^2 + (Y - Y_q^m)^2} = P_{q-1}^m + t_{q-1}^m \sqrt{(X - X_{q-1}^m)^2 + (Y - Y_{q-1}^m)^2} \quad \ldots\ldots\ldots\ldots (5)$$

where m = number of products 1, 2 .... m

q = number of sites 1, 2 .... q, thus q and q-1 may be regarded as representative locations.

R = profit

X, Y = co-ordinate of location

A = size of entire area, while $A_{1, 2 \ldots\ldots q}$ represent market areas associated with individual sites, 1, 2 .... q

P = factory price

C = average cost

D = demand

B = boundary of market area expressed in money terms (as a delivered price).

t = freight rate

Equation1, which asserts that larger profits will not follow a new location site, states the condition of optimal location for the producer such that each producer has maximum profits (and hence consumer maximum gains), subject to the restrictions in equations 2, 3, and 4.

The second equation demands a high number of units (locations) in order to cover all the space. The following equation, depend on this equation's validity. It shows that, in order for there not to be any excess space and hence possible spatial competition and excess profit making. The market areas of all sites for each good must be exactly equal to the area of the system when multiplied by the number of sites.

Equation 3 states that factory prices must be equal to average costs, both then factors being functions of demand. No excess profits are made under this condition, and all units make normal profit. Thus we have equilibrium (for the consumer the net advantages are equalized).

Equation 4 states that in order to justify a continuation of production the market area must be at a necessary minimum. If it were greater then the minimum, price would be greater then verage cost and thus new firms could enter the industry, compete spatially with the firms already there and reduce their market area until price and average cost were equal. Thus this equation needs to hold in equilibrium.

Another situation could cause spatial competition and a temporary state of disequilibrium; i.e. if a change in the market size occurred as a result of a price change greater than a change in average costs.

However, if the price change was less than the change in average costs the unit would obviously not change the size of its market area. If this happenstance resulted from competition from outside, then eventually the firm would go out of business.

Equation 5 concerns the boundaries of the market areas. At these points consumers from two adjacent locations (e.g. q and q-1) must be indiferent as to which market they buy from. There are therefore 'indifference lines' dividing the market areas which are associated with particular sites. For any point on one of these lines the factor price + freight rate X radius of market area must be same for the consumer which ever market he buys from.

If there was inequality in these values, obviously the consumer would buy from the cheaper delivered price area thus causing the market area of that unit to expand until its delivered price equalled that of the neighbouring unit.

Taking these five conditions along with Losch's initial assumptions, then the following will arise; all firms in a given industry will have:

(i) identical costs, despite location

(ii) constant freight rates over the whole area of the system

(iii) all firms in each industry will have the sam f.o.b. factory price.

The equations allow the estimation of (i) size and limits of market areas, (ii) location of production sites within both each market are and area of the entire system, and (iii) the f.o.b. prices charged for each commodity. Finally, we know that the market areas are represented as hexagons because of the constant freight rates + equations 4 and 5.

In criticising Losch's general theory, H.W. Richardson stated that despite its limitations, its usefulness as a pioneer, insightful theory should be noticed. The simple equations tried for the first time, to describe spatial relations; and also Losch avoided the problem of assuming perfect competition by formulating his model so that it worked under conditions of competition.

The limitations come mainly from the fact that its simple assumptions are very unrealistic, yet without these (e.g. uniform spatial relations, etc.) the analysis would be difficult to cope with.

Because of these assumptions, certain inconsistencies arise. For example, in supposing that the population is uniformly distributed and that economic activities will be arranged hierarchically because of the superimposition of the hexagonal market area nets cover over the whole hexagonal region. The concentrations of these activities will cause population expansion at these centers which in turn will mean that the clusters of buyers thus produced will cause irregularities in the market area shape.

Losch's analysis does not give due attention and importance to agglomeration economies in industrial production, especially in single industries; nor does it completely explain why there are nodal points in the space economy. These only occur for Losch when the market area centers for various goods or services intersect. Since agglomeration economies are not taken into consideration we find his assumption of uniform raw materials is an appropriate one. In other words, the analysis is more orientated to activities with few rar material requirements (e.g. service sectors) than to industrial production requiring localized raw materials.[20]

If we investigate further we find that certain things are lacking in Losch theory; i.e. it is lacking in generality since it assumes that production, sales and prices of individual goods are indipendent, and that the space economy is thus comprised of various independent units

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20 Richardson, H.W. Regional Economics, (London: Weidenfeld and Nicolson, 1969), pp. 107 - 108.

not liked into a whole. So the analysis in fact does not present a true general equilibrium, since both goods and factor markets do not interact through the factors of utility and production. As an example of this point, Losch takes the price of a certain article as a function of its demand.

Another point is that the stability of equilibrium, in order to make sure of maximum space utilization, depends on the existence of market areas which are hexagonal in shape. However, circular areas are the most profitable shape. Against this, Losch argued that because of the pressure of competition the circles would become hexagons. Some industries may be so unprofitable, however, that only market areas circular in shape will allow firms to break even.

There will of necessity be gaps between the boundaries of market areas if they are circular, and these gaps would not allow new firms to enter because the gaps are too small. However the very existence of these gaps interferes with Losch's general concept. Finally a point which obviously conflicts with reality in the space economy is his assumption of uniform costs of production and the following spatial patterns of evenly spaced production units. In reality, firms in the same industry tend to conglomerate together because of either agglomeration economies or locational interdependence. Richardson concludes his criticism by stating that despite its limitations, Losch's work has great value as a pioneering theory.[21]

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[21] *Ibid.*

How can these basic forms be located and how can the great number of market network strata and densities be represented as an empirical Gestalt unit?

In Weigmann's analysis, markets are first categorized accordingly to structure. Labour, capital and land orientation go together to make up each separate commodity market which resists change according to its particular structure. Change differs from market to market, frequently or slowly, actively or inactively. The basic form is comprised of those markets whose nature is (i) relatively permanent (ii) persistenly inactive. The Gestalt is therefore made up of the combined structures of these basic forms; i.e. an integrated overview of the space economy.

Greenhut's general location theory

There is one major difference between the general location theories of Losch & Greenhut: the latter does not abstract from costs. Greenhut tries to find out which conditions will allow locational equilibrium when firms want maximum profits but when there are variations in cost and where the possibility of location interdependence affects demand influences.

Greenhut begins with an economy which is already developed, and then assumes that a new product is brought in at a fixed point in time. Assuming zero costs everywhere plus identical demands, the new firm will locate at the market area center. This innovator will aim at the following--MR = MC = 0; i.e. he will limit his market area to the point where the curve showing marginal revenue in a standard price-cost diagram intersects the horizontal axis. The factory price will be greater than zero over this restricted area, and its height will depend upon the freight rate per distance unit up to the highest price consumers will pay. Continuing with this limiting case, if the population is assumed to be infinite in size, then the profit maximizing price will equal zero plus the smallest increment. As new firms enter the industry they will choose to locate either in areas which were previously not supplied, at a site adjacent to the innovator, or else, depending on the influences of demand at a site for from the innovator.

If we discard the assumption of zero costs, another factor which will influence the final location will be cost differentials. As each new firm enters the industry, since they are all seeing to supply their products at the lowest total cost, it will want to find a location from which it can supply a certain number of buyers. A firm needs to sell to this number in order to gain maximum profits. As competition increases costs and relative demand will change. Location equilibrium will eventually prevail as competitors are sucessful in locating at points where maximum profits will reduce the market areas so much that profits will also be cut. We can describe this equilibrium as follows:

1. marginal revenue = marginal costs
2. average revenue (i.e. the factory price) tangential to the average cost curve.
3. clustering and dispersion of plants in such a way that relocation by even a single plant would produce losses.

Two factors can upset this equilibrium; (i) changes in demand, and (ii) changes in costs. The former changes will affect the number of firms and also will cause direct changes in locations. Therefore it follows from this line of analysis that demand actively determines each location point.

The second type of change can cause multiple disequilibrium and indirectly may effect demand because of interdependence of locational factors. If demand and costs do not change there is still not sufficient cause to continue equilibrium. One factor, ruled out by Greenhut, was changed in psychic income, which may cause different values to be put on cost data and in turn upset the equilibrium.

As for the individual firm, as soon as a site is chosen which maximizes the gap between (R) and (C)--total revenue and total cost--its location is stable. However, general equilibrium will not arise if the maximizing f.o.b. factory price (P) does not equal average cost (not including freight) (Ca). We need both of the following conditions for equilibrium:

(i) R = C; i.e. profits for each firm must be maximized

(ii) P = Ca; i.e. there must be no excess profits by firms in the industry.

Even P = Ca from the beginning, there are still several factors which can upset the equilibrium; e.g. demands could change following changes in taste or price; if new methods of transport are introduced, P can change because the seller's absorption of freight costs is included in the profit maximizing f.o.b. factory price; or Ca could be reduced because of advances in technology.

If U represents sales, generalizing, we may write

$$p_iU_i = p_1U_1 + p_2U_2 + p_3U_3 + \ldots\ldots\ldots p_nU_n \ldots\ldots\ldots (1)$$

and

$$Ca_iU_i = Ca_1U_1 + Ca_2U_2 + Ca_3U_3 + \ldots\ldots\ldots Ca_nU_n \ldots\ldots\ldots (2)$$

In locational equilibrium

$$p_iU_i - Ca_iU_i = 0 \ldots\ldots\ldots (3)$$

This formulation of a general theory of location has a great degree of generality. It permits costs to vary from site to site, and it allows the entry of new firms to alter cost situations. Even more significant, it takes account of alternative locational patterns in an industry consisting of many firms by including the locational interdependence element. Recognition that profit maximization may, because of agglomeration economies and uncertainty about future demand and cost conditions, induce a new firm to locate as close as possible to an existing firm, does not necessarily require the ideal but unrealistic locational pattern of even dispersion of firms producing homogeneous goods as outlined by Losch. The main weakness of Greenhut's attempt at a general theory of location is that transportation was not integrated into his general equilibrium framework, a defect which he had in common with Losch. Thus in the model above, the main variables are the profit-maximising f.o.b. factory price which includes freight absorption but not the overall freight costs, and average costs specifically excluding freight. It is unclear how transportation fits into the picture.

Walter Isard

In his initial formulations Isard combined three frameworks, those of von Thunen, Losch & Weber. From Von Thunen's and Losch's theories he combines the former's system of concentric agricultural sites around a central city with the latter's hexagonal settlement patterns and market areas centering on a major metropolis. When Weber's analysis is also introduced, with its considerations of plant location in conditions of material localization, Von Thunen's & Losch's assumptions of uniform distribution of resources in the homogeneous plain are relaxed. From the Weberian analysis we can deduce new production sites and related cities and then add these to the hierarchy of activities within the concentric models of Thunen and Losch.

Isard's use of the substitution principle brought him to an attempt to combine location theory with other branches of economic theory. The application of this principle was first attempted by Andreas Predohl, The theory can be explained as follows. In other areas of economic theory the substitution principle is applied to the way in which an entrepreneur, combines expenditure on the different production factors. Predohl saw that this principle can be applied in a similar way to location theory. Greenhut summarised this substitution approach as it affects location theory in the following way.

"The theory of plant location is one segment of economic theory. It, too rests on the principle of substitution. The extent to which labour can be substituted for capital or land and vice versa is basically the same problem as the selection of a plant site from among alternative locations. Both decisions attempt to maximize the ends. The objective is accomplished when the scarce means are allocated among competing ends in the optimum manner."[30]

Like most earlier location theorists, Isard gives much attention to the transport factor. He puts transport inputs, previously refered to as distance inputs, on the same level as the four conventionally recognized factors of production (land, labour, capital, and enterprise) as a requirement of the productive process. He does this, not necessarily so that transport is regarded as another factor of production, but simply to emphasize the important role transport inputs play in production and consumption processes.

Isard illustrates the substitution approach for a firm under transport orientation. The framework of his analysis consists of the locational triangle as in Figure 1.15 a.

The first problem is how to find the most beneficial location, assuming certain factors regarding freight rates and amounts of necessary material, for a plant which is located at a fixed distance from one corner of the triangle, perhaps 3 miles from C. Hence the arc TS represents the position of the possible points of location. Next this arc is transposed onto a graph and becomes known as a 'transformation line'. On the graph, distance from M, is plotted against distance from M_2 (Figure 1.15 b).

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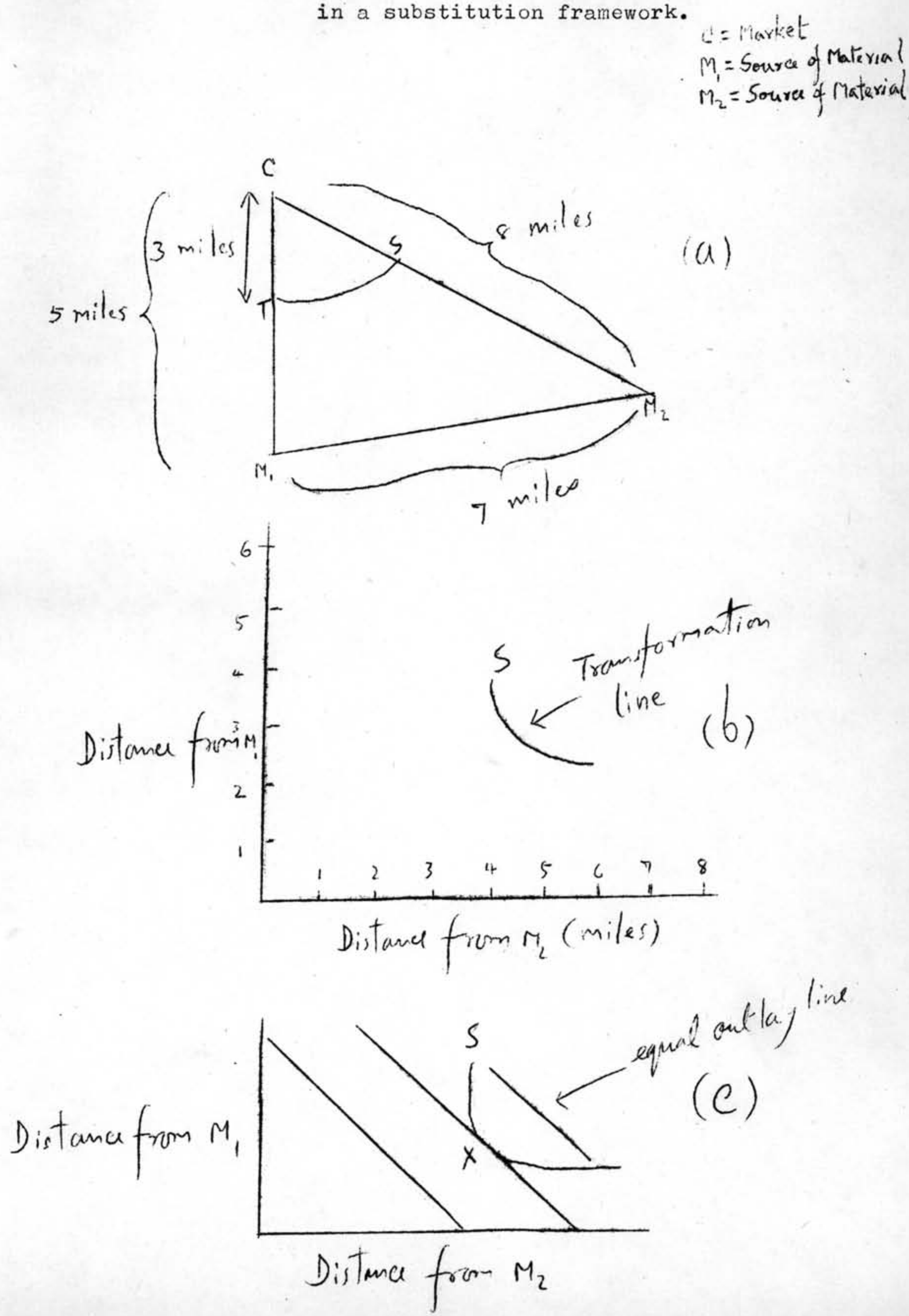
[30] Greenhut, M.L., Plant Location in Theory and Practise (North Carolina: The University of North Carolina Press, 1956), p.4.

Figure 1.15 The locational triangle problem, interpreted in a substitution framework.



As we move along this transformation line from S to T, the distance from M decreases and so the distance from M_2 increases, representing a substitution of transport inputs from one point to the other.

This can be illustrated by assuming one unit of transport inputs ($ x) for each mile of distance. Thus a factory located at S_1 4½ miles from M_1 and 5 miles from M_2 would have transport input cost of $ 4½ x from M_1 and $ 5 x from M_2. If the factory is located at T_1 the costs would be greater from M_2 ($ 7 x) and less from M_1($ 2 x). What has happended is that there has been a substitution of transport inputs from M_1 to M_2.

The problem still exists as to where the optimum, or least cost point will be on ST. To solve this an equal outlay line is added to Figure 1.16 b. This is done by assuming production needs one ton of material from both M_1 and M_2 and transport rates are equal and proportional to distance. On this graph, lines will be drawn to show the costs of moving these materials to points at various combinations of distance from M_1 and M_2.

These lines will be straight and have a negative slope of 1.0 because of the above mentioned assumptions. Figure 1.15 c represents this. The three equal outlay lines represent the different distance combinations from M_1 and M_2. These show what the requisite transport costs will be, relative to the limits of tne outlays represented.

The position of equilibrium, i.e. the most beneficial location, is at x, which is the point on the curve ST tangent to the outlay line of lowest value. This point is at x because any point away from x approaches the next highest equal outlay line. There is great similarity between this analysis and the one in micro-economic theory for determining input combinations. In both cases the optimum is where substitution gains nothing.

Isard's illustration arbitrarily chose the optimum location, i.e. 3 miles from C, and this in fact would not provide us with the real optimum or 'full' equilibrium since to obtain this we need to follow the above process with distances from M_1 and M_2 held constant.

Since Weberian transport orientations depend on substitution between factors, Isard proposed integrating substitution into a production theory by using a framework consisting of transport inputs.

The geometric constructions of Launhardt and Palander and various isodapance techniques all fell short of producing the practical point of locational equilibrium as prescribed by Weber's weight triangle. However, these methods are more direct than Isard's method which uses transformation curves and equal outlay lines. The only advantage of this latter method is conceptual since it involves using the substitution principle to determine the choice of location.

After dealing with transport, Isard examines labour orientation, and shows how cheap-labour sites can be introduced. Again his framework is based on the substitution principle. He considers market and supply areas, following Hoover fairly closely. He reproduces Hoover's illustration of market area boundaries at the intersection of margin lines (see figure 1.8), but interprets the situation in substitution terms; by choosing to purchase from the producer at X rather than Y, consumers are substituting transport inputs from Y, or alternatively they are substituting lower production outlays by the firm at X for higher ones by the firm at Y. Losch's hexagonal net is found to be an acceptable spatial market pattern, which can be described in simple substitution terms. In considering agglomeration, Isard brings Weber's approach into his framework, showing that a move from the least-transport-cost location to an area of agglomeration involves substituting transport outlays for production outlays.

The formal mathematical statement of Isard's general theory follow an earlier paper fairly closely.[22] First, Weber's theory is restated and generalized to incorporate many shipments of materials to production points and of products to many consuming points, and also to recognize market and supply areas. Then the possibility of more than one production site is allowed. Finally the Loschian market area analysis and agricultural location theory based on von Thunen is embraced, to complete the space economy. The equilibrium conditions are stated formally in substitution terms, which are summarized in the basic principle that "the marginal rate of substitution between any two transport inputs or group of transport inputs ...... must equal the reciprocal of the ratio of their transport rates, social surplus less transport cost on all other transport inputs being held constant".[23]

This idea suggests what really lies at the base of location theory and for Isard it is a way to compare location theory with most

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22 Isard, Walter, Location and Space-economy (Massachusetts: The M.I.T. Press, 1968), pp. 221 - 253.

23 Ibid., p. 252.

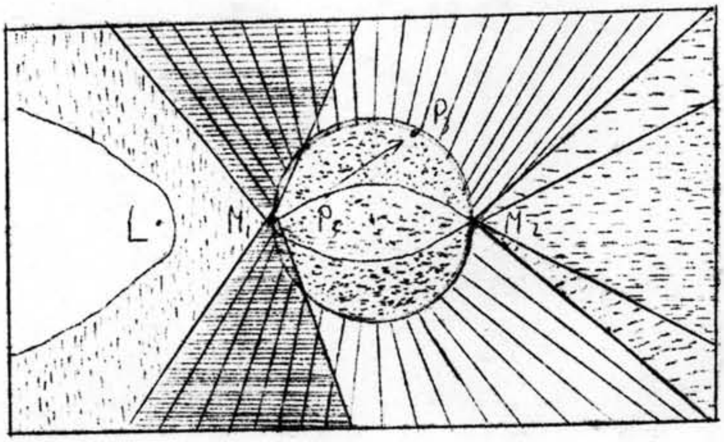
other theories of production--an important asset. Although Isard's synthesis may be abstract, it helped the progress of the theory of industry and general location. It also enabled some kind of relation to be made with other features of economic theory.

Let us examine the following: Isard's theory presents us with industrial patterns: what kind of patterns are these, and given a state of equilibrium how would the space economy look?

He begins by following a method first used by Launhardt and then adapted by Palander, by means of which, still in a Weberian situation the implications of the many consumption points are determined. The description of Palander's analysis shows how the geometrical construction is used to work out this point. This framework is extended by Isard to include locational or other similar orientation factors plus, following Palander, further material sources. This results in a complex subdivision of the market but one which can still be geometrically solved.

If we include labour or other orientation features in the Launhardt-Palander construction we find the following. Figure 1.16 shows a cheap labour point, L. The market area consists of many points and for each one a locational triangle is constructed (see Figure 1.1). A critical isodapane is then constructed around each triangle, each with reference to L. Those locational triangles within whose critical isodapanes L lies are then grouped together. The consumer market served by the cheap-labour location is comprised of these market points, i.e. these locational triangles. The unmarked area around L represents these in Figure 1.16.

Figure 1.16 The effects of a weight change



The position of market points lies on the boundary line between two market areas, the one tributary to L, the other to M_1. These points correspond to the locational triangles whose critical isodapanes pass through L. As the labour cost advantage of L increases, so the consumer market tributary to L expands. At one extreme, therefore, the total area will become tributary to L, while at the other, as the labour cost advantage of L gets less, the consumer market served by L is completely retaken by M_1.

Market area analysis was another phase of location theory which Isard saw was involved in the production site at L. If we are considering the usual Weberian problem where the market is concentrated at one point, then this variable, i.e. market area, does not come into our consideration.

Thus we must determine whether the best production site is at L or not. If there are many market points, the problem of defining a boundary line which cuts across a market area arises in identifying the points to be served by production at L.

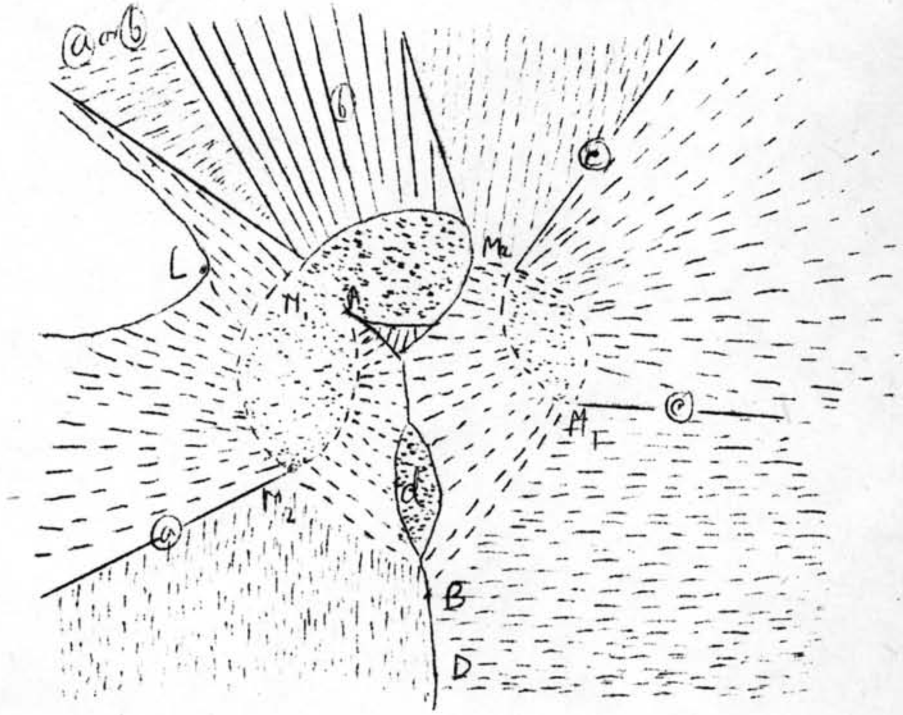
Palander's theory is further followed by including points M_1 and M_2, i.e. more distant raw material points. There are four groups of industrial consumers, as well as the household consumers served from L_1 where respective household consumer districts can be obtained and shown by double weight solid lines. These lines represent loci of equal delivered prices to household consumers. It is not necessary for production in these areas to be market-oriented.

District a, has raw material sources M_1 and M_2 supplying producers which serves households. These same sources also supply goods consumed in L's tributary areas.

There are 3 production points, (i) the source of raw material, (ii) market points and (iii) points which are determined by the intersection of relevant pole lines and the arc of the circle around the relevant weight triangle. District a is partly bounded by district c at the lower right and in district C_1 supply the producers at raw material sources M_1, M_2, market points and intersection points.

District a is also partly bounded by d. Here all producers are market-oriented, with raw materials coming from M_1, M_2. There will be little competition between these two sources of raw material because the distance which separates then is greater than that between any other pair of sources, therefore there will be the greatest restrictions on the household consumer district which is indirectly supplied by this pair of sources. In contrast we can see the pair M_1 and M_2 serving indirectly the largest district of household consumers, since this pair has a closer proximity than the others. At the upper left, we see

Figure 1.17 Spatial production patterns: two sources of each of two raw materials and one labour location



district a bounded by district b. M_1 and M_2 are equidistant from M_1, so they provide the second raw material at the same price. Therefore it makes no difference whether producers at M_1 have alternative raw material sources at either point.

In Figure 1.17, Isard shows how market areas in competition for sources of raw material, will have indirectly assigned to them a market region of household consumers. This will be brought about through the industrial producers. For example, in district C_1 M_1 and M_2 are not supplies of the consumers who may be at the final point of comsumption. As a result we have complex boundary lines, lines showing how the market areas are divided in regard to ultimate consumers. These lines are somewhat more complicated than these in Palander's approach (see Figure 1.7). This occurs since we have a double problem, one about the complex transport situation and the other about the market area. We can apply the substitution principle when the boundary lines one defined by substitution points. These points refer to:

(i) transport inputs for the end of products.

(ii) transport inputs for both the first and second raw materials.

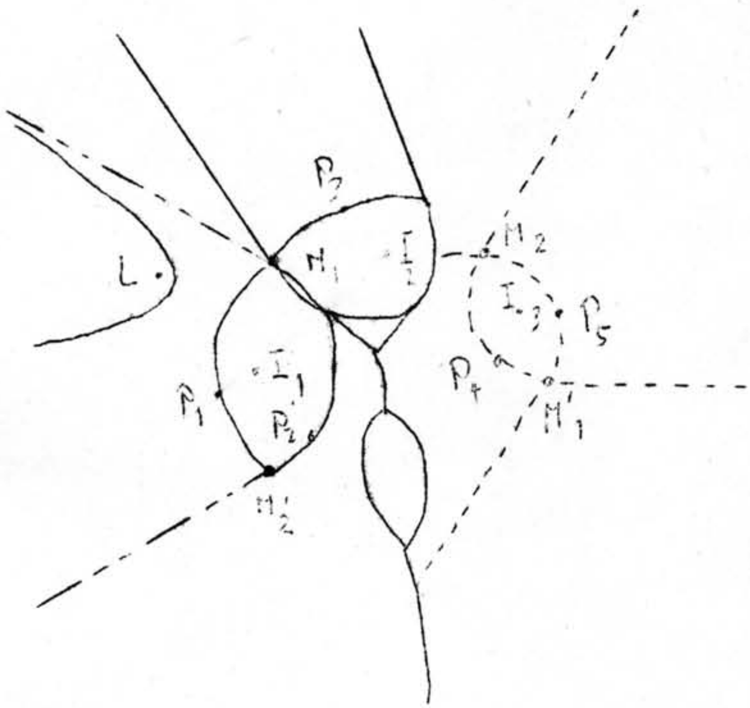
(iii) labour and transport outlays, given a cheap labour site.

Figure 1.`7 illustrates the smallest scales of output possible for market orientated producers. Isard postulated that economies of scale are substantial enough , there will be one central location at which the output of each of the three largest market-oriented production areas will be concentrated; i.e. I_1, I_2 and I_3 in Figure 1.18. Also, Isard made the assumption that at d, the smallest market-oriented production area, there is not sufficient demand to justify a production point within its limits, where economies of scale are present.

In Figure 1.17, there are also other operations at small scale, namely the production points which serve consumers along only one pole line. Isard suggests that where we have significant scale economies, there will be a single point concentration of production along any one arc. This is the case for P_1, P_2, P_3, P_4, P_5 in Figure 1.18. Lastly, the output scale at each raw material point along with the cheap labour point in Figure 1.17, must be large enough for their relation of production points in Figure 1.18 to be justified.

What Figure 1.18 shows, therefore, is that theere will be variability in a situation which reflects the impact of scale. The production pattern in Figure 1.18 is thus much more realistic.

Figure 1.18 Spatial production patterns: scale economies introduced



This pattern will justify location at only a few production points, and each of these will serve a market area. This analysis disregards single market point or single pole line production. However, around any one production point there will be many production sites in competition, thus the boundary line which determines the supplied market area of this point will be a connected series of various kinds of boundary lengths, where each length represents the competitive boundary between the location in question and one other producing site.

Isard now introduces another supposition: if there is a multiplication of the two raw material sources to the extent that practically speaking both materials become ubiquities, then each will be available at all points and at an equal price. If, further, there is an even distribution of consumers of like tastes and an adoption of Losch's various other assumptions and conditions involved in his market area analysis, then we can easily see how the pattern of production sites is uniform in claracter; and it follows logically that the pattern of hexagonally shaped market areas will result. Looking at the problem from this angle, Losch's derivation seems to be a special case of the Launhardt-Palander construction into which has been inserted the additional feature of scale economies.

The opposing pulls of two variables, i.e. scale and transport outlay, are considered in Losch's derivation. This opposition is, in effect, the basic substitution relation between two types of outlays, transport and production. Once we accept Losch's assumption, this derivation, like that of Launhardt and Palander, is suggested by principle governing substitution among the transport inputs.[24]

Isard then goes on to consider a second subset of agglomeration economies--localization economies, which in contrast to internal scale economies of a firm, are external to it. They are contingent upon the spatial patterning of several firms, similar in character. An example

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[24] Ibid., p. 267.

boundary between the location in question and one other producing site.

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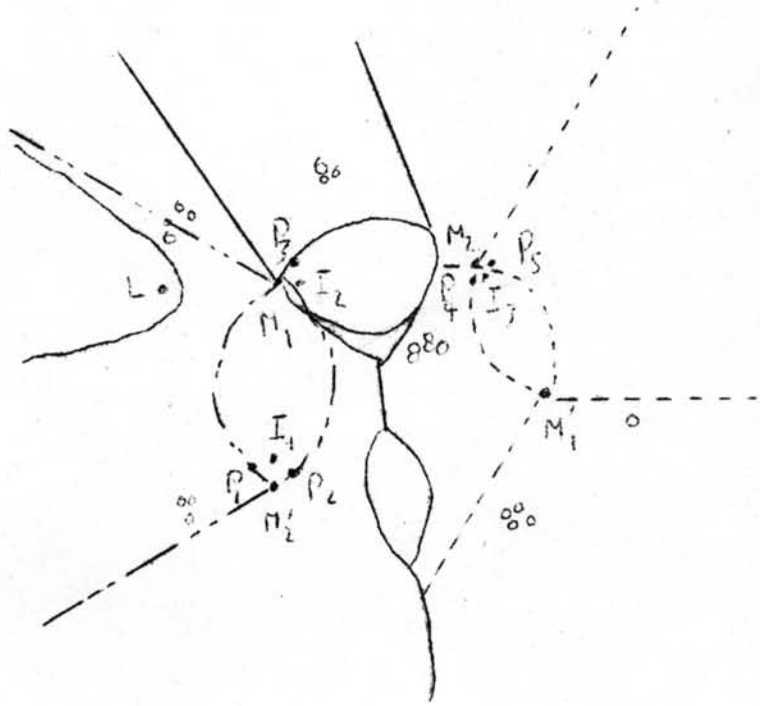
Isard then goes on to consider a second subset of agglomeration economies-localization economies, which in contrast to internal scale economies of a firm, are external to it. They are contingent upon the spatial patterning of several firms, similar in character. An example of these economies would be cheapened service inputs which arises when such a patterning allows an auxilliary to be established more efficiently. Isard makes it clear that if location economies are realized, a physical move along with corrected added transport outlays will be involved, by one firm at least.

It will be profitable for at least one firm to substitute transport outlays for production outlays. The one main factor which will determine which firm or firms will change location and which points will be agglomeration points, is the complex interaction of those forces, historical and institutional, which are concerned with decision-making and rational behaviour by the firm. The observable realization of this interaction has not yet been explained by economists. The clearest explanation of the amount and arrangement of localization and of the necessary specific substitution occurs when economists abstract from these forces and look at the problem of industrial planning for a truly undeveloped area from the viewpoint of social welfare.

To illustrate, Isard, in Figure 1.19, has chosen to analyze just one of many possible situations. Here, in order to bring about location economies, there has been a relocation of firms I_1, P_2 and P_1 around M_2; P_3 and I_2 have relocated around M_1, and P_4, P_5 and I_3 around M_2; while there has been no relocation around M_1 and L.

In Figure 1.19, Isard introduces the third subdivision of agglomeration economies--those forces concerned with urbanization economies, which refer to production outlay savings realisable when there is agglomeration around a point by firms producing various commodities, P.

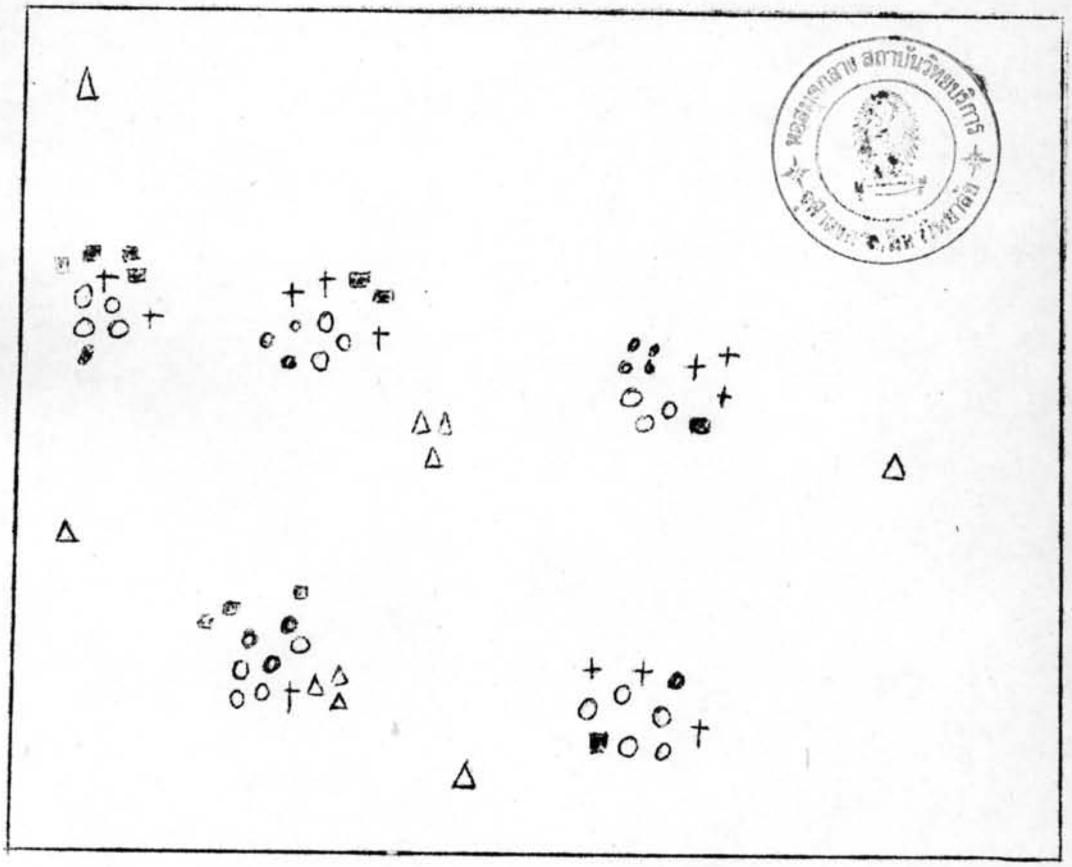
Figure 1.19 Spatial production patterns: localization and scale economies introduced.



There will lead to expansion into a multicommodity situation. As with location economies, urbanization economies reflect a complex interaction of the dual forces of history and institutions. This present analysis does not span the factors which control the specific points at which different degrees of urbanization economies can be found. One other statement which Isard makes is that the advantages of a location at an urban center for many firms, are greater than those of locating in a non-urban situation. The decision to settle in an urban area therefore takes into consideration substitution among different outlays and revenues.[25]

Figure 1.20 presents the impact of urbanization economies which act to unite firms, shown by the small black and white circles.

Figure 1.20 Spatial production patterns: urbanization, localization, and scale economies introduced.



25
Ibid., p. 269.

In Figure 1.19, or 1.20 these circles are separated. In some cases, second commodity producing firms move to a first commodity production center while in other cases the reverse occurs.

Added to these sets of locations in Figure 1.20 are sets of locations of third, fourth and fifth commodity producing firms, represented by small black squares, crosses and white triangles respectively. If urbanization economies were not introduced, there would be a different location for the third and fourth commodity producers. However the fifth commodity producers would not relocate because of the forces of urbanization economies.[26] Also they maintain quite a dispersed pattern sice they are not very sensitive to localization economies either.

Theoretical Conclusion

A. Uses and Limitation of the General Theory of Location and Space Economies.

The purpose of this chapter has been to review the theoretical framework of location theories from the past up to the present state. We are now ready to present a summary and conclusions. The main theoretical conclusions will be summarized and discussed further

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[26] Ibid., p. 270.

where necessary. For brevity, the major conclusions are grouped together below under separate headings.

1) Usefulness of the general theory of location and space-economies.

There were two points which tended to make the general equilibrium analyses of Walras, Pareto, Wicksell and Hicks rather restrictive. Firstly, they all assumed that there was a perfect market situation in which there were no variations in price. Secondly, the assumption which masked the space factor by concentrating or a one point economy, was that costs, including transport, were zero within a given 'market'.

Thus, the German economists Thunen, Weber, Predohl and Weigman felt that they should include both location and space economies in their theories in order to see the economy in its totality.

To make the general theory of location and space economies more closely approximate reality, Tord Palander rejected the zero-cost assumption of earlier general equilibrium models; subsequently, the question of compression into a one point market no longer existed. Lastly, he introduced the time factor into his general theory and regarded it as an economic development process which confirmed itself to analysis of the economic starting point, the adaptation of enterprises and mobility of factors during a time period, and the cencomitant changes in techniques, institutions and consumer tasks.

However, Palander's analysis retained some weakness in the derivation of a general equilibrium theory; he neglected local differences in demand for and supply of factors and commodities by assuming a state of pure competition.

(ii) The most important contribution to a general theory of location and space economies was the Loschian general equilibrium system, which presented, through a set of elementary equations, a highly simplified statis model of a space-economy operationg under conditions of monopolistic competition and encompassing general spatial relations. In all, this is truly a spatial general equilibrium analysis.

(iii) We can attribute the usefulness and workability of this general theory of location and space economy to the Leontief technique, which is concerned with both unput-output and price-cost relations expressed in a set of equations which demonstrate general equilibrium. These include transfer costs plus local differences in the price-cost factor. Together they clearly demonstrate the importance of the space factor.

2) Limitations of the general theory of location and space-economies.

(i) The reason why the basic concepts of the partial equilibrium framework are irrelevant to certain economic activities, despite their applicability to individual decision-making, is that the entire framework is limited in both assumptions and extent, since it focuses on only a small selection of relationships.

Partial equilibrium theories were insufficient in two ways: firstly, they could not be used in considerations of mutual interdependence; and secondly, they did not give full and clear attention to the relationship which should exist between location theory and general and total economic activities.

(ii) The capabilities of a general equilibrium theory of spatial economic relations do not go so far as to include an explanation of the relations among the many forces of social, political or economic natures in real situations. This happens despite the fact that such a theory simultaneously recognises all of the main kinds of spatial interdependence among firms, households and other decision units.

For instance, the theory cannot account for the limilations on the area of economic activity caused by interaction of both cultural and social values and norms, which also render unfeasible any input-outcome vector which might otherwise cause per capita income to be at a maximum, or which might also effect the opportunities for work etc.

B. Isard's Suggestion on the General Theory: Social, Political, Economic and Regional.

By itself, theory has no effectiveness; it is its workability which makes it effective. Among the main weak points of the general theory of location and space economy are its neglect of three factors concerning the different forces in political and socio-economic interrelations; i.e. generalization, comprehensiveness and total action. Until now, no practical general theory has been worked out which aims at allowing the actual location decision to be part of the comprehensive action included in location theory. If we want to reach the point where initial 'total' regional planning is used as a tool for socio-economic development at sub-national levels, then the model of a general theory must include both regional planning and social action.

This is exactly what Dr. Paichitr Uathavikul advocates.[27] Isard also stated that by including another three factors, (i) individual profit, (ii) the exporting unit of different areas, (iii) the results made on the location decision by governmental unit, will reasonably bring this weakness to a minimum and by the same time aim to develop the effectiveness of the general theory to a maximum theoretical workability.

For Isard, location theory becomes part of 'total action' or 'total behavioural' theory, since he has effectively included the location decisions of society in with the 'total action' choices of that society's behaviour units.

He then goes on to explain his 'general dynamic' or 'general evolutionary theory' which he formulated by generalizing his conceptual framework to give explicit consideration to the interdependence of spatial and temporal factors. Finally, Isard suggests, remarkably, that if we want to overcome the world's major social problems a general economic equilibrium theory, which provides a better set of comprehensive operational techniques, is needed.

These techniques would be concerned with interregional linear programming and interregional input-output activities as part of a theory covering both economic and ecologic systems, i.e. a comparative statics theory.

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[27] Phaichitr Uathavikul, "Integrated Social and Economic Development Planning: National and Sub-National Problems and Policy" Thai Journal of Development Administration Vol. XIII No. 1 (January 1973), pp. 23 - 42.