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GRADUATE COLLEGE

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A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

JAMES V. PINTO

Norman, Oklahoma

1975

BACKGROUND AND DEVELOPMENT OF LOCATION THEORY

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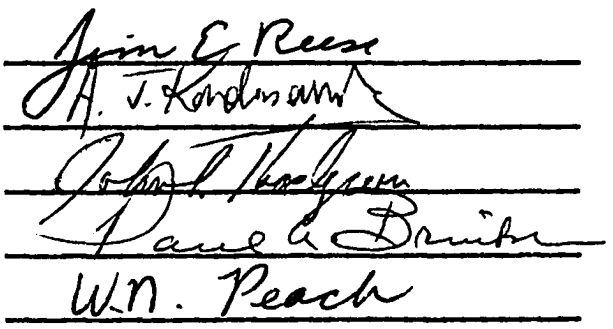

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CHAPTER I

INTRODUCTION

The Nature of Location Theory

Location theory is an interdisciplinary subject. Economics and geography have contributed most to the area. Classical location theory deals primarily with the location of the individual producing unit in a world in which everything else is fixed.[1] The theory has been extended to include the location of individual residences[2] and the location of towns.[3] Hoover has given a definition of location theory.

> Location theory is the attempt to understand how a specified unit or type of economic activity- e.g. a business establishment, a household, and industry- develops and exercises a preference for certain locations and finds a location in reference to other units or types.[4]

---

[1]John Friedman and William Alonso, eds., Regional Development and Planning (Cambridge, Mass.: M. I. T. Press, 1964), p. 75.

[2]Richard Muth, Cities and Housing (Chicago: University of Chicago Press, 1969).

[3]Edwin von Böventer, "Walter Christaller's Central Place Theory in Retrospect," Journal of Regional Science 9 (April 1969): 117-24.

[4]Edgar M. Hoover, "Trends in Location and Location Theory," Center for Regional Economic Studies, Occasional Paper No. 6, University of Pittsburgh, October 1968, p. 1. (Mimeographed.)

A conventional assumption found in "standard" economic theory is that transportation costs are zero.[1] A logically equivalent argument would be that all economic activity takes place on a dimensionless point in space. Time is incorporated in economic analysis only in the most abstract way--usually as a time derivative. Location theory incorporates distance and the costs (measurable in time) of overcoming the space necessary to make economic theory a completely general statement. In fact, location theory can be such a general statement that it has been viewed by some as having as its special case Hicksian general equilibrium analysis.

> We conceive the general theory of location and space-economy to be one which comprehends the economy in its totality. . . . Seen in this perspective, Hicksian general equilibrium is but a very special case of a general theory of location. . . .[2]

The generality of location theory was emphasized by Ohlin in the preface to his Interregional and International Trade while giving the purpose of his study.

> To demonstrate that the theory of international trade is only a part of a general localization theory, wherein the space aspects of pricing are taken into full account, . . .[3]

---

[1] Sidney Weintraub, Price Theory (New York: Pitman Publishing Co., 1949), p. 270. Also see James E. Hibdon, Price and Welfare Theory (New York: McGraw-Hill Book Co., 1969), pp. 320-31.

[2] Walter Isard, Location and Space Economy (Cambridge, Mass.: M. I. T. Press, 1956), pp. 26-27.

[3] Bertil Ohlin, Interregional and International Trade (Cambridge, Mass.: Harvard University Press, 1935), p. vii.

Thus, one can see that another important subtopic in general economics is considered to be a special case of location theory. This is particularly interesting when one considers the fact that most economists consider the theory of international trade and general equilibrium theory to be general in nature when compared to other subtopics in economics.

The Problem, Objectives, and Scope

The problem to be investigated by this research is to find as many of the historical roots of location analysis as possible. The primary intent is to provide a detailed coordination of the historical roots of the various aspects of location theory. Much of the history of location theory is to be found in the translations of major works which until recently were untranslated. Much work remains so that all such accounts will be coordinated.

The general location theories referred to in the last section are taken from a grouping which would compare partial equilibrium location theories against general equilibrium location theories.[1] A second classification system includes household location, agricultural

---

[1]Isard, Location and Space Economy, pp. 24-54.

location, industrial location, and central places.[1] Least-cost location, market area analysis, and locational interdependence is yet another scheme.[2] Finally, location theories may also be grouped into another three categories, (1) those which assume that demand (or population) is concentrated, as in a town, and suppliers are dispersed over space, (2) those which assume that supply is concentrated and demanders are spread over a large (market) area, and (3) theories of interdependence within which suppliers and demanders are dispersed in space. These classification systems are not mutually exclusive. Any one theory very likely can be described by all four systems of classification. For example, the type of location theories found in the works of August Lösch could be described as partial--central place--market area analysis within which it is assumed that suppliers are concentrated and demanders dispersed.[3] Another scheme for model classification can be found in the urban literature. Britton Harris presented

---

[1]For all but agricultural location see Gerald S. Goldstein and Leon Moses, "A Survey of Urban Economics," Journal of Economic Literature 11 (June 1973): 471-515. For agricultural location see Edgar S. Dunn, Jr., The Location of Agricultural Production (Gainsville, Florida: University of Florida Press, 1954).

[2]Robert D. Dean, William H. Leahy, and David L. McKee, eds., Spatial Economic Theory (New York: The Free Press, 1970), pp. v-vi.

[3]August Lösch, "The Nature of Economic Regions," Southern Economic Journal 5 (July 1938): 71-78. The details of Lösch's model will be given in Chapter IX of this work.

the following model dimensions in his 1968 article:

(1) descriptive versus analytic
(2) holistic versus partial
(3) macro versus micro
(4) static versus dynamic
(5) deterministic versus probabilistic
(6) simultaneous versus sequential[1]

An attempt will be made to extend the standard location theory classifications to include the Harris model dimensions for each of the major models studied.

Location theory has at least three historical roots. If one uses the classification system of agricultural location, industrial location, and central places; then one would point to Thünen, Weber, and Christaller, respectively. Johann Heinrich von Thünen published his Isolated State in 1826.[2] Alfred Weber contributed his The Theory of the Location of Industries in 1909.[3] Walter Christaller's Central Places in Southern Germany was released in 1933.[4] Most of the theoretical contributions found in modern location theory literature can be traced

---

[1]Britton Harris, "Quantitative Models of Urban Development: Their Role in Metropolitan Policy-Making," in Harvey S. Perloff and Lowdon Wingo, Jr., eds., Issues in Urban Economics (Baltimore: The John Hopkins Press, 1968), p. 367.

[2]Johann Heinrich von Thünen, Isolated State, trans. Carla Wartenberg, ed. Peter Hall (New York: Pergamon Press, 1966).

[3]Alfred Weber, The Theory of the Location of Industries, trans. Carl J. Freidrich (Chicago: University of Chicago Press, 1929).

[4]Walter Christaller, Central Places in Southern Germany, trans. C. W. Baskin (Englewood Cliffs, N.J.: Prentice-Hall, 1966).

to these three men. There are definite lines of influence in the development of the ideas of these writers. Part of the purpose of this research will be to point to these links.

Another reason for this study is that location theory has recently become popular as a subtopic in urban economics, regional economics, economic geography, urban geography, and regional and city planning. Therefore, an attempt will be made to trace the influence of the three major contributors to location theory to the modern literature.

Unfortunately, writers in the history of economic thought have generally ignored location theory and location theorists. In addition, many writers have ignored (or overlooked) the contributions to location theory by economists who are not considered to be location theorists.[1] One of the objectives of this research will be to trace as many passages and quotes as possible from such well known economists. This attempt will include both efforts to show lines of (possible) influence and in other cases

---

[1]See Mark Blaug, Economic Theory in Retrospect (Homewood, Ill.: Richard D. Irwin, Inc., 1968). Blaug completely ignores Weber, Christaller, and Launhardt (an engineer-economist to be included in the study) and relegates Thünen's location theory to a footnote on page 325. Also see Joseph A. Schumpeter, History of Economic Analysis (New York: Oxford University Press, 1954). Schumpeter ignores Weber and Christaller. He also ignores or places in footnotes the location theory aspects of Launhardt's works, see p. 851, n. 15. The same pattern is repeated in all the major works in the history of economic thought.

merely to point out a passage which, in retrospect, may be considered as dealing with the subject. Descriptive accounts of location written by unknown economists and non-economists will also be reviewed.

From the point of view of the history of thought, with the one possible exception of the contributions to location theory by economists not considered to be location theorists, the objectives stated up to this point could best be described as "eclectic coordination." Most of the historical roots of location theory are known, but no one has attempted to coordinate these various writings.[1] In addition, three new areas will be investigated. They include different aspects of the location theory found in the works of Wilhelm Launhardt, Willard Phillips, and Achille Loria.

This author has discovered a neglected book by Launhardt.[2] The importance of this discovery is that until now it was thought that Launhardt had not been

---

[1]After reviewing dissertations in economics, geography, history, and regional science, only three were found which dealt in any way with the history of location theory. All of the works had objectives other than tracing the history of location theory, and all ignored major writers covered by the others. See Richard O. Been, "A Reconstruction of the Classical Theory of Location" (Ph.D. dissertation, University of California, Berkeley, 1965); Raymond L. Fales, "Location Theory and the Spatial Structure of the 19th Century City" (Ph.D. dissertation, Northwestern University, 1971); and Barclay G. Jones, "The Theory of the Urban Economy" (Ph.D. dissertation, University of North Carolina, 1961).

[2]Wilhelm Launhardt, The Principles of Railway Location, trans. A. Bewley (Madras: L. Asylum Press, 1900-02).

translated from the original German into English.[1] This book is not only in English but also brings his market area analysis and his locational triangle analysis together. Parts of this book were completed 10 years earlier than what had been believed to be his earliest contribution in this field.[2]

An American contribution, generally overlooked by both historians and location theorists, will be given in detail. This contribution is the theory of location presented by Willard Phillips in 1828.[3] This book was published within two years of Thünen's Isolated State (1826). There is a strong resemblance between the two theories. To the best knowledge of this writer, the two theories have yet to be compared and contrasted before this study.

Achille Loria was an Italian economist known primarily for his influence on Frederick Jackson Turner's "frontier thesis." This author discovered an obscure reference to the fact that Loria should be considered the father of the modern theory of industrial location.[4] Upon investigation it was determined that Loria's location

---

[1]Been, "Reconstruction," pp. 38-74.

[2]Schumpeter, History, p. 957, n. 8. Schumpeter listed Launhardt's book as 1885, and he failed to mention Launhardt's 1882 article.

[3]Willard Phillips, A Manual of Political Economy (Boston: Hilliard, Gray, Little, and Wilkins, 1828).

[4]Witold Krzyzanowski, "Review of the Literature of the Location of Industries," Journal of Political Economy XXXV (1927): 279.

theory articles[1] never had been translated from the original Italian into English. One of the major objectives of this research will be to complete such a translation.

Robert Merton has presented a theory of multiple discoveries.[2] Merton contended that all scientific discoveries are in principle multiples, including those that on the surface appear to be singletons.[3] In this theory calendrical time is ignored so that long gaps of time may be allowed.

> Even discoveries far removed from one another in calendrical time may be instructively construed as "simultaneous" or nearly so in social and cultural time, depending upon the accumulated state of knowledge in the several cultures and the structures of the several societies in which theory appear.[4]

One of the major aims of this research is to determine if Merton's theory has application in the field of location theory.

Central place theory is the primary area of location theory which has been developed by geographers. The aim by this researcher is to include central place theory in an analysis of location theory to (1) reflect the fact

---

[1]Please refer to Chapter VII.

[2]Robert K. Merton, "Singletons and Multiples in Scientific Discovery," Proceedings of the American Philosophical Society 105 (1961): 470-86.

[3]Mark Blaug, "Was There a Marginal Revolution?" History of Political Economy 4 (Fall 1972): 270.

[4]Merton, "Singletons and Multiples," p. 486.

that the subject is interdisciplinary in nature, (2) make economists aware of geographers' contributions to a degree approaching geographers' awareness of economic contributions,[1] (3) emphasize a growing movement in the literature of both disciplines to integrate all aspects of location theory, and (4) make explicit the fact that central place theory is a subset of location theory. One of the contributions of this research will be to pull together the economics and geography of the history of location theory.

No attempt will be made to include the history of spatial price theory.[2] Another obvious area not covered is the history of empirical studies of location.[3] Applications of the location models presented by the primary contributors will be traced for their influence on later theory, but the results of and details of the empirical applications of the theory will not be considered. A best

---

[1]Leslie J. King, "Approaches to Location Analysis: An Overview," The East Lakes Geographers 2 (August 1966): 1-16.

[2]See M. L. Greenhut, Microeconomics and the Space Economy (Dallas, Texas: Scott, Foresman and Co., 1963).

[3]For pre-1967 literature see Benjamin H. Stevens and Carolyn A. Brackett, Industrial Location: A Review and Annotated Bibliography of Theoretical, Empirical and Case Studies (Philadelphia: Regional Science Research Institute, 1967). For recent literature see Goldstein and Moses, "Survey of Urban Economics," pp. 495-515. For empirical studies in geography see King, "Approaches to Location Analysis," pp. 1-16 and The Science of Geography, Report of the Ad Hoc Committee on Geography, Earth Sciences Division, National Academy of Sciences, National Research Council (Washington, D.C., Publication 1277, 1965).

effort will be made to not limit the analysis to a mere recount of historical details. In the Schumpeter-Blaug mold, an attempt will be made to present, explain, and critique each of the theories in analytical detail.

Another minor contribution will be in the form of a bibliography of location theory which will incorporate both the literature of economics and geography. Most existing bibliographies have very little overlap.

Methods and Sources

There are two recognized approaches to the history of economic analysis: relativism and absolutism.[1] A relativist views an economic theory as a reflection of contemporary conditions--economic, social, and political. An absolutist is more concerned with the intellectual development of the subject through time.[2] Another approach used independent of (and along with) relativism-absolutism is the topical--great-man--dichotomy. The topical approach presents an account of a particular aspect of a subject as viewed at a point in time or through time by various writers.[3] The great-man approach presents the various views

---

[1]For a discussion of relativism and absolutism see Blaug, Economic Theory, pp. 1-9, and Schumpeter, History, p. 40. For an example of relativism see W. C. Mitchell, Lecture Notes on Types of Economic Theory (New York: A. M. Kelley, 1949). For absolutism see Blaug cited in this footnote.

[2]Blaug, Economic Theory in Retrospect, p. 2.

[3]For examples of the topical approach see Edwin Cannan, A Review of Economic Theory (London: P. S. King and Son, Ltd., 1929), and Edmund Whittaker, A History of Economic Ideas (New York: Lorgmans, Green and Co., 1940).

of a particular writer on the subjects being considered.[1] This research will follow what could be called a great-man absolutist approach. The main part of the work will approach the subject by discussing individuals, and an attempt will be made to classify, critique, compare, and trace the models through time to the modern literature. The relativist approach will not be ignored. Any findings that would tend to support such a view will be reported.

The original source in the literature will be used whenever possible. Such an approach will not always be possible, since a few of the primary works still remain to be translated. Most of the research will rely on English translations and the English language literature dealing with location theory.

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[1]For examples of the great-man approach see Henry W. Spiegal, The Rise of American Economic Thought (New York: Chilton Co., 1960), and Lewis H. Haney, History of Economic Thought (New York: The Macmillan Co., 1921).

CHAPTER II

THE ROOTS OF LOCATION THEORY: THÜNEN

Influences on Thünen

Johann Heinrich von Thünen (1783-1850) was a German economist who has been recognized for many contributions to economic theory other than location theory. Thünen developed the principle of substitution, a theory of marginal productivity, a version of the law of diminishing returns, a theory of profits which included recognition of risks, and the doctrine of "natural" or just wages. He was considered to be both a mathematician and an econometrician. Schumpeter gave him credit for being the first to use calculus in economics.[1]

Thünen's development of location theory was based on practical experience as well as formal education. After receiving practical experience by working on a farm, Thünen enrolled in the Agricultural College at Gross-Flottbeck in 1802. Lukas A. Staudinger, the administrator of the college, became a lifelong friend of Thünen's. Under the influence of Staudinger, Thünen conceived the idea which is foundation for the book Isolated State.

---

[1]Schumpeter, History, p. 466 and p. 955.

> The concept of the Isolated State first came to me in my youth, when I was studying agriculture at Herr Staudinger's Institute at Flottbeck near Hamberg; . . .[1]

In a paper entitled Description of Agriculture in the Village of Gross-Flottbeck written in 1803, Thünen gave the following details of his idea conceived at the age of twenty:

> If one assumed that in a province of 40 miles diameter, a big town lay in the centre, and that this province could only send its products to this town, and that the agriculture in this district had attained the highest level of cultivation, then we could assume that four types of farming systems would exist around this town.[2]

While at Gross-Flottbeck, Thünen attended the lectures of Dr. Albrecht Thaer (1752-1828).[3] Thaer was one of the leading German agricultural writers at that time. From Thaer's lectures, Thünen began to question the established theories of agricultural production, and he began to realize the importance of mathematics to the theoretical study of agriculture.[4]

---

[1]Johann Heinrich von Thünen, Isolated State, trans. Carla Wartenburg, ed. Peter Hall (New York: Pergamon Press, 1966).

[2]Ibid., p. xiii. The biographical material presented here draws heavily from this source. Other material is gathered from the introduction of Thünen's translated Isolated State, pp. xii-xviii. This essay was written by Peter Hall. Also see, Bernard W. Dempsey, The Frontier Wage (Chicago: Loyola University Press, 1960) p. 44. The full text of this paper appears in Thünen-Archivs, Organ fur exaket Wirtschaftforschung, I (1906), p. 122.

[3]Dempsey, The Frontier Wage, p. 43.

[4]Thünen, Isolated State, p. xiv.

In 1803 Thünen went to the University of Gottingen. He studied natural history, chemistry, and economics. After his university training, he married and moved his family to Tellow, an estate, near Mecklenburg. It was at Tellow that Thünen carried out many of his observations and experiments which lead to his Isolated State which was first published in 1826.[1]

In addition to the influences of Thaer and Staudinger, Thünen is known to have studied Adam Smith.[2] As stated by Thünen:

> Adam Smith taught me political economy, Thaer scientific farming. They are the founders of two sciences, and many of their teachings will forever rank among the basic principles of science.[3]

Thünen did not accept Smith's theories without question. In Chapter 5a of his book, he presented a critique of

---

[1]Thünen's book was entitled Der Isolierte Staat in Benziehung auf Lanwritschaft und Nationalokonomie. The book had three volumes, 1st vol. 1826, 2nd vol. 1850-63, and 3rd vol. 1863. All three volumes were placed in the English translation, see Thünen, Isolated State, pp. xviii-xix. The German title translated into English is actually The Isolated State in Relation to Agriculture and National Economy, or Researches into the Influence of Agriculture on the Price of Grain, the Quality of Soil, and the Market. Thünen intended to give his book the title The Ideal State, but his brother convinced him to change it.

[2]Andreas Grotewold, "Von Thünen in Retrospect," Economic Geography 33 (October 1959): 348. Also see John F. Bell, A History of Economic Thought (New York: The Ronald Press, 1953), p. 295.

[3]Thünen, Isolated State, pp. 18-22.

Smith's rent theory.[1] In Thünen's own words, while referring to Smith and Thaer he stated:

> We accept in the writings and the lectures of outstanding men that which appears to be unquestionable, making it part of our own thinking; it ceases to be the object of our own inquiries.
>
> That which, in the teaching of these two great men, appeared to be incomplete, which failed to satisfy my urge for a deeper understanding of the problems and drove me to make my own inquiries, . . .[2]

This writer feels that Thünen could have been influenced by Smith's rent theory despite his critique of Smithian rent theory. The details of this argument are based on the fact that Smith also had a "situation" theory of rent (see Chapter VIII).

Some writers have felt, after reading Isolated State, that one of Thünen's contemporaries, Ricardo, had influenced Thünen's work.[3] It is true that their rent theories are similar,[4] but Thünen himself denied having read Ricardo before the first draft of Isolated State.

> Ricardo, in his work on Political Economy (which I had not read when I wrote the first draft of this work), . . .[5]

---

[1] Ibid.

[2] Ibid., p. 225.

[3] Bell, A History of Economic Thought, p. 295. Bell stated that Thünen used the theories of Smith and Ricardo as points of departure.

[4] This point will be discussed later in this chapter.

[5] Thünen, Isolated State, p. 22.

Thünen did write in the classical[1] tradition, but he arrived at results that are far from those of Ricardo.[2]

Finally, one writer in the history of economic thought felt that another economist, Adam Müller, had an influence on Thünen.

> Thünen could never had written as he did, had not Adam Müller preceeded him. His principle achievement, the theory of agriculture, is really nothing more than a further development of the basic ideas of Adam Müller.[3]

Müller anticipated Thünen by distinguishing between the two main types of agriculture, the intensive and extensive systems.[4]

Perfect Competition, Ceteris Paribus, and Thünen's Method

There are three passages in the book Isolated State which support the contention that Thünen's model approaches what today would be called perfect competition. First,

---

[1]Some authors have classified Thünen as a "classical" economist, see Olof Jonasson, "Agricultural Regions of Europe," Economic Geography I (October 1925): 287. Others have called Thünen "neoclassical," see Richard D. Day and E. H. Tinney, "A Dynamic von Thünen Model," Geographical Analysis 1 (April 1969): 138.

[2]Eduard Heiman, History of Economic Doctrines (New York: Oxford University Press, 1945), p. 112.

[3]Othmar Spann, Types of Economic Theory (London: G. Allen and Urwin, Ltd., 1930 (1912)), p. 185. Müller's ideas are in his Vermische Schriften (Vienna, 1812), republished in Jena, 1921.

[4]Spann, Types of Economic Theory, p. 166, and Thünen, Isolated State, p. 141.

Thünen stated that "we assume throughout that farming is conducted absolutely rationally."[1] Thünen used "rational" in two senses. Hall noted that Thünen used the term in the traditional sense of the English classical economists: an enterprise is conducted rationally when the entrepreneur pursues the maximum profit and when he is possessed of all necessary knowledge to that end.[2] In another sense he used "rational" when referring to both his use of ceteris paribus and his method in general:

> When we consider the manifold and complex nature of the problems we have raised, when we recall that in everything transferred from experience to the Isolated State the condition of rational behavior must be met, we realize that not only the point we have referred to, but virtually every aspect of society must be made the subject of separate inquiry, so that what is rational may be distinguished from what exists; and it becomes obvious that the solution to our problem will not be the work of one man, or even of one generation. It is the work of history itself, which over many generations accumulates what man achieves.[3]

Second, Thünen indicated that the farmer-entrepreneurs were capable of possessing perfect knowledge.

> But in the Isolated State every farmer is as intelligent and as knowledgeable about the various breeds as the next, . . .[4]

Finally, one may infer that Thünen was aware of the relationship between the firm and the industry in what is

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[1]Thünen, Isolated State, p. 8.

[2]Ibid. Also see Day and Tinney, "Dynamic Thünen Model, p. 138.

[3]Thünen, Isolated State, pp. 246-47.

[4]Ibid., p. 156.

now known as perfect competition.

> It follows that the net product of any given farm cannot determine the land rent of this farm even though the land rent springs from the net product. . . .
> The potential net product or net product of a farm run on the customary local lines . . . may serve as the norm for the determination of land rent.
> But we can only discover the results of such an average degree of skill and enterprise from the total product yielded by the efforts of all the farmers of an entire province or country.[1]

The before mentioned relationship between the firm (i.e., ". . . any given farm. . .") and the industry (i.e., ". . . all the farmers of an entire province or country.") could not be clearer, but one can find supporting evidence elsewhere. Thünen indicated that the price of grain was set in the national market, in this case London. In fact, Thünen felt that the price of grain in all of Europe was set in the London market.

> We may also think of this small town with its region as an independent state; in such a small state the grain price is governed wholly by the price obtaining in the central town.
> These small states are related to the central Town in much the same way as are the states of Europe to the wealthy country that can pay the highest price for grain, namely England, and particularly its capital, London.
> Even where they neither import nor export grain, its price in all European countries is governed by the London market, . . .[2]

Most economists give Marshall credit for making this relationship explicit. There is another very important Marshallian concept embedded in the first quote on this page.

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[1] Ibid., p. 212. Emphasis added by this author.

[2] Ibid., pp. 216-17. Emphasis added by this author.

The concept is that of the "representative firm." Could the phrases ". . . a farm run on the customary local lines . . . may serve as a norm . . ." and ". . . the results of such an average degree of skill and enterprise . . ." be mistaken for anything but the representative firm?

This last note restores our faith, Marshall was, after all, as grudging with acknowledgements (at least these) as he has been accused.[1] Are we to believe that he took so much else from Thünen but ignored the analyses dealing with supply and demand, references to what is known as perfect competition, and the ceteris paribus method?

Thünen's use of ceteris paribus was explicit and a major theme in the book Isolated State. While defining his methodology, he made the following statement:

> . . . the result obtained by studying one factor only at a time, holding all others constant, is not a false result, but merely incomplete, and that it will remain so until every other factor has been subjected to a similar inquiry.[2]

This is verbal description of the methodology used in mathematics to take partial derivatives when there are more than one independent variables. Such a method is the ceteris paribus method used in economics and other social sciences.

Thünen then, like Ricardo, studied an imagined state of facts in which all nonessential aspects of the

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[1]Schumpeter, History, p. 474 and p. 839.

[2]Thünen, Isolated State, p. 247.

real case has been eliminated.[1] Several factors normally contributing to a considerable regional diversity of land uses and agricultural production were assumed to be constant or nonexistent. As Grotewold has stated, Thünen's model ". . . reflects the needs of . . . and the state of technology in Macklenburg well over a hundred years ago."[2] So although his model is said to use the "method of idealisation" and an early use of the "as if" method,[3] the model was based on observations in reality. This is another parallel to the method used by Ricardo. In Thünen's words:

> In the discussion of this problem (which is based entirely on real condition (Tellow)), the Isolated State is only a graphic representation, a model to help us see the problem as a whole; but it is a model which we cannot abandon, because it is, as we shall see, so rich in consequences.[4]

Thünen felt that the method he used was similar to those methods used in the physical sciences and mathematics. Again referring to the ceteris paribus aspect of his method:

> This intellectual operation is akin to the experimental method used in physics as well as agriculture:

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[1] Weber, Location of Industries, pp. xix-xx.

[2] Grotewold, "Von Thünen in Retrospect," p. 349. Some writers have felt that Thünen's use of empirical data as a basis for his theoretical work got him into trouble. See Dunn, Location of Agricultural Production, p. 100.

[3] Thünen, Isolated State, pp. xxi-xxii.

[4] Ibid., p. 24.

> only the factor to be determined is raised quantitatively, while all others are held constant.[1]

Thünen addressed himself to criticism that his model did not exist in reality.

> The geometrician works with points without extension and lines that have no width; neither exist in reality. We too may divest an operative factor of all its attendant details and all that is merely fortuitous: for only thus may we hope to discover its influence on the phenomena before us.[2]

He became quite defensive about the possible objections of potential readers. Finally in the preface to the second edition of the first volume, 1842, he felt that readers should be told early in the book. The following quote details his arguments which are surprisingly modern. Such text reminds one of the current debates on the methodology of economics.[3]

> I hope that the reader who is willing to spend some time and attention on my work will not take exception to the imaginary assumptions I made at the beginning because they do not correspond to conditions in reality, and that he will not reject these assumptions as arbitrary and pointless. They are a necessary part of my argument, allowing me to establish the operation of a certain factor, a factor whose operation we see but dimly in reality, where it is in incessant.
>
> This method of analysis has illustrated--and solved--so many problems in my life, and appears to me to be capable of such widespread application, that I regard it as the most important matter contained in all my work.[4]

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[1] Ibid., p. 228.

[2] Ibid., p. 173.

[3] For a good discussion and critique of Friedman vs. Samuelson see Stanley Wong, "The 'F-Twist' and the Methodology of Paul Samuelson," American Economic Review 63 (June 1973): 313-25.

[4] Thünen, Isolated State, pp. 3-4.

But, Thünen never lost sight of the fact that the method was not an end within itself. Much in the character of the philosophy of John Dewey,[1] Thünen stated:

> If observed experience has been throughly and correctly understood and the conclusions drawn from it consistent, this method introduces mathematical certainty into a field where reasoning would give rise to wholly contradictory opinions.
> But the greater the achievements of this method and the more its findings lay claim to certainty, the more rigorous must be the scrutiny and criticism to which it is subjected.[2]

Thünen's Theory of the Location of Agricultural Activities

Location Theory vs. Land Use Models

Thünen has been called, ". . . the first writer to make the distance dimension an explicit part of economic theory."[3] But, one might wonder exactly what branch of economic theory was involved or developed when a passage such as the following is found:

> The ideas developed and expounded by von Thünen do not constitute a theory of location. . . .[4]

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[1]See John Dewey and Arthur Bentley, Knowing and the Known (Boston: Beacon Press, 1949).

[2]Thünen, Isolated State, p. 229. Emphasis added by this author.

[3]Dunn, Location of Agricultural Production, p. 99.

[4]Michael Chisholm, Rural Settlement and Land Use: An Essay on Location (Chicago: Adline Publishing Co., 1962 (1907)), p. 21. Also see Michael Chisholm, "The Relevance of Thünen," Annals of the American Association of Geographers 59 (June 1969): 401.

In general, the conclusion reached by most writers has been that Thünen's theory is one that answers the question "What to produce?" instead of the question "Where to locate?" economic activity.[1] In Thünen's analysis, the general area for the location of "the Town" is given as a starting point. As Greenhut has stated, ". . . the location is given and the type of production is to be determined. . . ."[2] The object of the analysis is the explanation of the geographic pattern of competing agricultural activities. Dunn was correct in giving Thünen credit for being the first to incorporate distance into economic theory, but many writers have been mistaken by believing this use of distance to be a contribution to location theory per se instead of land use theory.[3]

Another common misconception concerns the level of analysis used by Thünen. Böventer set that point straight, and he also addressed the land use question.

> The aim of current as well as Thünen's agricultural location theory, is to determine the most profitable

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[1]Michael J. Webber, Impact of Uncertainty on Location (Cambridge, Mass.: M. I. T. Press, 1972), p. 49.

[2]Melvin L. Greenhut, Plant Location in Theory and Practice (Chapel Hill, N.C.: University of North Carolina Press, 1956), p. 8.

[3]Almost all modern texts on location theory give Thünen as the starting point for location theory. See Isard, Location and Space-Economy, p. 27 who called Thünen ". . . the father of location theorists. . . ." The entire problem may be semantical or definitional. The definitions of "location" and "land use" are too close to be kept completely separate. For the land use point of view see Edgar M. Hoover, "Land-Use Competition," in Readings in Economic Geography, ed. Robert H. T. Smith, Edward J. Taaffe, and Leslie J. King (Chicago: Rand McNally and Co., 1968), pp. 41-43.

> use to which a given piece of land can be put, as a function of its distance from the market . . . the starting point of the analysis has always been the industry level.[1]

In fact, one of the few model characteristics which separates agricultural and land use models from pure (point) theories of location is that ". . . agricultural and land use models have traditionally analysed aggregate location policies."[2] Point location theories are concerned with where the firm will locate, but land use models are interested in the overall location pattern of the industry.

So, an argument can be made that Thünen's theory really constituted what today could properly be called "a branch of location theory," i.e., agricultural and land use theory. In that sense, this writer also gives Thünen credit for being the father of location theory. Further arguments will be made later in this work to substantiate Thünen's claim to this title.

Assumptions and Descriptions of the Isolated State

One is reminded of the first chapter of Keynes' General Theory[3] when one looks at the first two chapters

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[1]Böventer, "Towards a United Theory of Spatial Economic Structure," Papers and Proceedings of the Regional Science Association 10 (1962): 237.

[2]Webber, Impact of Uncertainty on Location, p. 49.

[3]John M. Keynes, The General Theory of Employment, Interest, and Money (London: Macmillan and Co., 1936). Such a comparison applies more to form than to contents.

of Thünen's Isolated State. Each book contains one page chapters. Since this method was used by Thünen, we very efficiently review the assumptions used by Thünen. In Chapter 1, entitled "Hypothesis," one finds:

> Imagine a very large town, at the centre of a fertile plain which is crossed by no navigable river or canal. Throughout the plain the soil is capable of cultivation and of the same fertility. Far from the town, the plain turns into an uncultivated wilderness which cuts off all communication between this State and the outside world.
>
> There are no other towns on the plain. The central town must therefore supply the rural areas with all manufactured products, and in return it will obtain all its privisions from the surrounding countryside.
>
> The mines that provide the State with salt and metals are near the central town which as it is the only one, we shall in future call simply "the Town."[1]

This passage reveals why Thünen has been called ". . . the first regional scientist. . . (because he) . . . postulates the existence of a uniform plain--a birthright of every regional scientist."[2] The assumption of a uniform homogeneous plain was found to be common to all of the models reviewed in this study.

In the next chapter, entitled "The Problem," more assumptions and descriptions are found:

> The problem we want to solve is this: What pattern of cultivation will take shape in these conditions?; and how will the farming system of the different districts be affected by their distance from the Town? We assume throughout that farming is conducted absolutely rationally.

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[1]Thünen, Isolated State, p. 7.

[2]Alexander Melamid, "Some Applications of Thünen's Model in Regional Analysis of Economic Growth," Papers of the Regional Science Association 1 (1955): L-2.

> It is on the whole obvious that near the Town will be grown those products which are heavy or bulky in relation to their value and hence so expensive to transport that the remoter districts are unable to supply them. Here too we shall find the highly perishable products, which must be used very quickly. With increasing distance from the Town, the land will progressively be given up to products cheap to transport in relation to their value.
>
> For this reason alone, fairly sharply differentiated concentric rings or belts will form around the Town, each with its own particular staple product.
>
> From ring to ring the staple product, and with it the entire farming system, will change; and in the various rings we shall find completely different farming systems.[1]

Edwin von Böventer has synthesized the first two chapters of Thünen's book to give the following analysis for the economic variables in the Isolated State:

Givens:
(1) The commodity prices at the center (as well as all input prices),
(2) transportation rates to the center.

Variables:
(1) The distance from the center,
(2) the size of the farm,
(3) the output per acre (or farm),[2]
(4) the input coefficients.

Farmers were assumed to be interested only in maximization of economic rent (the difference between revenues and cost per acre).[3] On the cost side, Thünen felt that

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[1] Thünen, Isolated State, p. 8.

[2] Böventer, "Toward a United Theory," p. 328.

[3] Richard J. Peet, "The Spatial Expansion of Commercial Agriculture in the 19th Century: A Von Thünen Interpretation," Economic Geography 45 (October 1969): 234. Also see Richard J. Peet, "The Present Pertinence of von Thünen Theory," Annals of the American Association of Geographers 57 (December 1957): 810-11. Details of Thünen's concept of rent will be presented later in this chapter.

two factors were of the greatest importance: (1) the cost of transportation, and (2) the size of the farm. On the demand side, he presented an analysis with ". . . the market being assumed to be placed in the middle of the agricultural area."[1] Thünen spelled out the importance of these factors in a list of three propositions.

> I have . . . three propositions which I hold to be of general validity, whose accuracy determines that of my entire inquiry. . . .
>
> First. On the farm itself the value of grains falls with increasing distance from the market.
>
> The greater the distance between farm and market, the more expensive grain is to transport, and the lower, consequently, its value on the farm. . . .
>
> Second. Not all prices of the articles the farmer has to buy are related to the grain price. In other words, the same amount of grain will not pay the farming costs in different parts of the State. . . .
>
> Third. One portion of the costs of grain production depends on the area in cultivation, another on the size of the harvest.[2]

The first proposition will be seen to be the most important factor in determining (1) the total area in the Isolated State, (2) the arrangement of the several agricultural activities, (3) the economic rent, and (4) the intensity of cultivation. The second proposition indicates that Thünen was aware of (1) a cost of living concept, and (2) that the use of capital and labor, particularly in manufactured goods, influences the price of the goods. The third proposition signifies that Thünen was aware of

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[1]Witold Krzyzanowski, "Review of the Literature of Location of Industries," Journal of Political Economy XXXV (1927): 278.

[2]Thünen, Isolated State, pp. 31-2.

fixed costs (i.e., ". . . the area in cultivation") and variable costs (i.e., ". . . the size of the harvest.").

In summary presented in its simplest form, the Thünen Isolated State had the following assumptions:

(1) rational behavior
(2) an isolated state
(3) one central city
(4) a village type settlement
(5) uniform topography
(6) uniform fertility and climate
(7) relatively primative transportation facilities.[1]

Rings and Production

Thünen also assumed that all transportation was by horse-drawn vehicles, and that the horses' feed had to be carried along.[2] It is easy to see Thünen's method of using an "imagined state;" because, although he based his model on observations taken from reality, ". . . to some extent The Isolated State is not a true picture of the Mecklenburg of the period; for Thünen does not allow it in the first place to contain any navigable water, the chief means of transport of his day."[3] He did realize that his model was an abstraction from reality. In this particular case, he did introduce canals, rivers, and highways into the analysis and realized what effect this would have

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[1]Raleigh Barlowe, Land Resource Economics (Englewood Cliffs, N.J.: Prentice-Hall, 1958), p. 250.

[2]Thünen, Isolated State, pp. 12-14, 16. Also see Martin Beckman, Location Theory (New York: Random House, 1968), p. 70.

[3]Thünen, Isolated State, p. xli.

ceteris paribus.

> Here we see the Isolated State crossed by a navigable river.
>
> The diagram rests on the assumption that water freights are one-tenth the cost of land freights.
>
> Here the ring of crop alteration, which . . . occupies only a narrow strip, becomes very much larger, streaching along the river to the state frontier. The ring of stock farming has contracted, and near the river it disappears entirely.
>
> The effect of constructing highways is similar. . . .[1]

With such a modification, Thünen was able to change the strict concentric ring pattern to one which would not necessarily contain rings at all.[2]

The activity yielding the highest rent in the various rings around the Town was assigned to that area. In such a case, it would be possible for some crops to be in several of the rings if the rent function happened to be non-linear.[3] But in general, Thünen's model allowed for a series of rings each having in it the crop which would yield the highest rent.

In the first ring, adjacent to the Town, Thünen assigned the production of perishable vegetables, fruits, and fresh milk. These are products that are heavy or bulky per unit of value. As explained by Thünen, the first

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[1]Ibid., pp. 215-16. Also see Böventer, "Toward a United Theory," p. 329.

[2]Thünen, Isolated State, pp. 216-17. See Figure II (p. 216) which shows both the concentric rings in the Isolated State and in the real world.

[3]Dunn, Location of Agricultural Production, p. 43.

ring contains:

> Delicate horticultural products such as cauliflower, strawberries, lettuce, etc., would not survive long journeys by wagon. . . .
>
> Next to fruit and vegetables, milk is a prime necessity for the Town; and as this is a difficult and costly product to transport and . . . quickly becomes unpalatable. . . .[1]

The people used the Town's manure to raise the fertility level necessary to produce in the area without fallow land:

> The distinctive feature of this ring is that it buys most of the manure it uses from the Town, unlike the remoter areas, which produce their own. . . .
>
> No land in this ring will ever lie in bare fallow. In the first place, the land rent here is far too high to allow any portion of the arable land to remain uncultivated, and secondly, the fertility of the soil may, by the purchase of Town manure, be raised to the point where it yields its maximum output. . . .[2]

One of the major criticisms leveled by Dunn against Thünen was that ". . . he never establishes the principle that determines the boundary between two forms of land use."[3] This statement is not true. Although Thünen did not spell out how the boundaries between every of the rings would be determined, he did explicitly address the problem.

> Buying Town manure is most profitable for the district of the first immediately adjacent to the Town. With growing distance the advantage falls rapidly, since the cost both of fetching the manure and of taking the product to the Town increases. At a

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[1] Thünen, Isolated State, p. 9.

[2] Ibid., p. 10.

[3] Dunn, Location of Agricultural Production, p. 99.

> certain distance from the Town the advantage of buying Town manure begins to look doubtful, and a little farther out it will decidedly be more profitable for a farm to produce its own manure than buy this from the Town. This point marks the boundary of the first and the beginning of the second ring.[1]

Hall has also noted that for every particular crop Thünen studied he estimated that both revenue and cost fall as one moves away from the Town. Revenue falls because the net price received by the farmer is less because the transportation cost rises with distance. The costs are less because with increasing distance from the town more extensive methods of cultivation are used. The point to be made for boundries is that for each crop,

> . . . the costs fall more slowly than grain prices away from the market, and thus there must come a point where the surplus of grain, expressed in money, can no longer meet the fixed money costs.[2]

If there were but one crop in the Isolated State, such reasoning would account for the outside boundary between the State and the uncultivated wilderness. When multiple crops exist, the superimposing of all the rent functions of the various crops on a single diagram relating rent return to distance results in a series of concentric rings similar to those developed by Thünen.[3] Each ring would have a definite boundary marked by the point of intersection

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[1]Thünen, Isolated State, pp. 10-11. Emphasis added by this author.

[2]Ibid., p. xxv.

[3]Ibid., p. 215.

between the rent functions for the crops involved. The size of any one ring would depend on the demand for the particular crop. Under such conditions, it would be possible that some crops (known to exist) would not be produced at all if the demand for those crops were lower than for others.

The second ring would contain a forest to provide lumber and fuel for the first ring and the Town. Thünen reasoned that the forest would always be maintained, so that grain production would never take in the place of the forest.

> The plain of the Isolated State has to provide the Town not merely with food but with all its needs in fuel, building timber, charcoal and so on.
> . . . fuel cannot be brought to the Town from farther than eight miles. . . .
> It follows that the outlying districts cannot supply the Town with wood, which must therefore be produced near the Town.[1]

One can also see within this last quote an explicit calculation of the distance from the Town which would mark the boundary between the second and third rings.

Rings three through five would be used for the production of various types of grains under different intensities of agricultural production. The third ring used the crop alternation system. The fourth ring would take advantage of the improved system. The fifth ring would

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[1]Ibid., 171.

contain the three-field system.[1] The sixth ring was reserved for livestock production. Since livestock could be driven to the market alive, the low transportation cost enabled the activity to take place far from the Town.

The ring configuration has become the most recognizable feature of the Thünian system. This shape has been adopted by researchers independent of the details used by Thünen to develop the concept or the rent theory implicit to the analysis.[2]

Rent and Transportation Cost

In discussing the distinction between location theory and agricultural land use models, it was pointed out that one difference between the two is the level of the analysis. There is a second major difference. In location theory rent is normally considered as an insignificant location factor; in agricultural land use theory the rental payment is the constraining factor which controls production policies.[3]

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[1]For a discussion of the various types of farming methods see Theodor Brinkmann, Economics of the Farm Business, E. T. Benedict, H. H. Stippler, and M. R. Benedict, eds. (Berkeley, Calif.: University of California Press, 1935), pp. 1-7.

[2]For example, an application of the concentric ring concept can be found in the sociology literature. See Ernest W. Burgess, "The Growth of the City: An Introduction to a Research Prospect," Chapter II in Robert E. Park, Earnest W. Burgess, and Roderict D. McKenzie, The City (Chicago: University of Chicago Press, 1925).

[3]Webber, Impact of Uncertainty on Location, p. 49.

Thünen developed a rent theory as the basis for his land use theory. He stated clearly for the first time that the controlling factor in the determination of land use is economic rent.[1] Most writers have emphasized that the rent theory developed by Thünen was a "situation" rent, but Thünen did recognize other sources for rent.

> The land rent of a farm springs from its superiority in soil or location, over the least favoured farm which is still producing for the market.[2]

In fact, Thünen recognized three separate sources for rent. His differential rent could be in the form of a situation rent or a soil quality (fertility) rent. He also developed an "absolute" rent.[3] Chapter 5A in Isolated State is devoted to a discussion of rent. What this writer has called an "absolute" rent is derived from Thünen's definition of land rent.

> We must distinguish between the farm revenue and the pure product of the soil as such.
> Every farm is endowed with buildings, fences, timber and other objects of value which may be separated from the land. It follows that the income of the farm does not entirely derive from land but is in part the interest on the capital invested in these objects.
> That portion of the farm revenue that is left after deduction of the interest on the value of the buildings, timber, fences and all other valuable

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[1]Dunn, Location of Agricultural Production, p. 99.

[2]Thünen, Isolated State, p. 147. Emphasis in the text was dropped and new emphasis added by this author.

[3]Encyclopaedia of the Social Sciences, 1934 ed., s. v. "Johann Heinrich von Thünen," by Edgar Salin, pp. 627-28.

> objects separable from the land, that portion which pertains to the land itself, I shall call land rent.[1]

Thünen was the first to develop the concept of "negative rent" which would ". . . arise whenever the yield derived from a plot of land does not cover the interest charges on the capital invested in the land. . . ."[2]

As stated earlier, Thünen recognized the fact that a differential rent could arise from differences in fertility of the soil. After discussing various propositions concerning the cost of farming, Thünen stated:

> The propositions given above make it possible also to work out the land rent produced by the same soil where it contains less plant food and is consequently at a lower level fertility.[3]

In view of this, it is strange how Thünen has been neglected in the history of rent theory.[4] Thünen recognized a Ricardian theory of a differential rent based on fertility differences, but he concluded that such a theory ". . . is

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[1]Thünen, Isolated State, p. 18. Emphasis is found in the original text.

[2]Salin, "Johann Heinrich von Thünen," p. 627.

[3]Thünen, Isolated State, p. 27.

[4]Michael Chisholm, "Agricultural Production, Location, and Rent," Oxford Economic Papers, N. S., 13 (October 1961): 344. Two major books on the development of rent theory do not mention Thünen at all. See Carl Rollinson Bye, Development and Issues in the Theory of Rent (New York: Columbia University Press, 1940), and Joseph S. Keiper, et al., Theory and Measurement of Rent (New York: Chilton Co., 1961). For a modern discussion of rent theory including Thünen's work and location rent see International Encyclopedia of the Social Sciences, 1968 ed., s. v., "Rent," by Richard F. Muth, pp. 454-61.

neither complete nor exhaustive, . . ."[1]

Bertil Ohlin has presented a statement which could be compared to Jevon's famous statement[2] on Ricardian economics. In discussing the influence of Thünen and Ricardo, Ohlin contended:

> If later writers had followed in von Thünen's path instead of Ricardo's, there can be little doubt that progress in this field of economic science would have been much more rapid that it has actually been.[3]

In a parallel fashion when writing on the need for a general localization theory of pricing, Ohlin stated:

> It seems highly probable that efforts to advance further on these lines during the last century, instead of following in the trail of Ricardo, would have led to the development of a general localization theory and a much fuller consideration of the geographical aspects of pricing.[4]

Thünen's theory of a situation rent was based on the fact that the net price received for a product by a farmer would decline as the increased cost of transportation is paid at increasing distances from the market.

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[1]Thünen, Isolated State, p. 227.

[2]The statement was that ". . . it will be seen that that able but wrong-headed man, David Ricardo, shunted the car of Economic science on to a wrong line--. . . ." See W. Stanley Jevons, The Theory of Political Economy (London: Macmillan and Co., 1879 (1871)), p. li; Schumpeter also wrote of what a ". . . detour Ricardian analysis was." See Schumpeter, History, p. 474; Keynes wrote of how ". . . Ricardo conquered England as completely as the Holy Inquisition conquered Spain." See Keynes, General Theory, p. 32.

[3]Bertil Ohlin, "Some Aspects of the Theory of Rent: Von Thünen vs. Ricardo," in Norman E. Himes, ed., Economics, Sociology, and the Modern World: Essays in Honor of T. N. Carver (Cambridge, Mass.: Harvard University Press, 1935), p. 175.

[4]Ibid., p. 178.

In Thünen's words:

> But grain cannot be as valuable in the rural areas as the Town, because, in order to fetch its market price, it must first be taken to the Town. It follows that the country districts grain is less valuable than in the Town by the cost of its transport.[1]

From the quote above, one could derive a net price function, i.e., net price as a function of the distance from the market. All other costs are subtracted from each net price gives a net rent function, i.e., net rent as a function of distance from the market.[2] As stated above while discussing Thünen's rings, the resulting calculation of situation rent could then be used to determine which products would be produced close to the Town and which would be away from the center.

Intensity and the Theory of Crops

There has been much confusion over Thünen's theories of intensity and crop production. Most of the confusion has come about because some writers have failed to realize

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[1]Thünen, Isolated State, p. 12.

[2]What this author has called the "net rent function," has several names in the literature of location theory. Alonso called it a "rents bid function" or "bid rents," see William Alonso, Location and Land Use: Toward A General Theory of Land Rent (Cambridge, Mass.: Harvard University Press, 1964), p. 38. Hover used "rent surface" in Edgar M. Hoover, Location Theory and the Shoe and Leather Industries (Cambridge, Mass.: Harvard University Press, 1937), p. 23. Dunn used "rent function," see Dunn, Location of Agricultural Production, p. 6.

that there were two theories.[1] A primary example of the confusion is given by Richard Krzymowski's famous article when he said:

> Thünen also discussed the location of forestry with respect to other systems, but in order to make this picture as simple as possible we shall omit discussion of it.[2]

The problem faced by Krzymowski was that while Thünen postulated increasing intensity of cultivation as one moved closer to the Town, the forest was obviously a very extensive form of cultivation existing in the second ring of the Isolated State. Interestingly enough, Krzymowski simply assumed his problem away. He then developed a very unique system of graphs designed to show increasing intensity under various parameter changes. Starting with Thünen's version of the law of diminishing productivity, he deduced that the degree of intensity and the cost of production were one and the same.[3] He then proceeded to show how the degree of intensity could be determined using total curves and differential calculus. Krzymowski was probably inspired by a quote from Thünen like the one below:

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[1]For the best source which separates the two theories see Peet, "The Spatial Expansion," p. 284. Brinkmann, Economics of the Farm Business, p. 14, allowed only for the theory of intensity.

[2]Richard Krzymowski, "Graphical Presentation of Thünen's Theory of Intensity," Journal of Farm Economics, 10 (October 1928): 465.

[3]Ibid., p. 469.

> . . . the effect of a rise in the value of the product. . . . More labourers may be profitably employed; the crop harvested with greater care and threshed more thoroughly; and yield will rise in consequence.[1]

How does one explain the presence of forest so near the Town? The answer is simple. Thünen intended his theory of intensity to apply to only one crop or one crop at a time, ceteris paribus. When more than one land use was involved ". . . competition between crops for the occupancy of land forms the basis of the von Thünen theory of crop location."[2] So, it is not inconsistent to give Thünen credit for developing a theory of intensity and to argue that there were no exceptions to the rule.[3] Thünen discussed single crops in chapters four through twenty-six. But, his general theory for a number of different agricultural products was developed in chapters nineteen through thirty-two. Hall has best stated the warning that the ". . . two subjects must not be confused. There is an intensity theory and a crop theory. It has indeed something to do with intensity; but the main factor is something other."[4] In answer to the question posed earlier, the

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[1]Thünen, p. 256.

[2]Peet, "The Present Pertinence," p. 284.

[3]Robert Sinclair, "Von Thünen and Urban Sprawl," Annals of the American Association of Geographers 57 (March 1967): 75. Also see Peet, "The Present Pertinence," Ronald J. Horvath, "Von Thünen and Urban Sprawl," and Robert Sinclair, "Comment in Reply," all in Annals of the American Association of Geographers 57 (December 1957): 810-15.

[4]Thünen, Isolated State, p. xxiv.

forest is an extensive form of cultivation, but the demand for the products of the forest happened to be greater than the demand for any other more intensively cultivated product in the second ring of the Isolated State.

Summary and Conclusions

Thünen was influenced by his environment in the development of his theories. At the same time, he used an abstract method of analysis employing a ceteris paribus approach. He was fully aware of the strengths and weaknesses of such a methodology.

Many of the contributions usually associated with Alfred Marshall can be found in Thünen's work. These concepts include the "marginal" concept, marginal productivity theory, and the principle of substitution. He is also given credit for developing a theory of profits which includes risk and the "natural" or just wage. Thünen was one of the first to use mathematics in economics.

Thünen is considered to be the father of location theory, but the distinction between location theory and land use theory must be noted. Three forms of rent were postulated by Thünen. His theory of "situation" (or location) rent was the basis for his theories of the intensity of cultivation and crop location. The Thünian system is characterized by a central town surrounded by concentric rings of supportive agricultural production.

His theories can be classified as agricultural land use theories (location theories in the broad sense discussed earlier) within which it is assumed that demand is concentrated at a point (the town) and supply is dispersed over space. Using Britton Harris' model dimensions,[1] this author would classify the simplest of Thünen's models as being analytic, partial, macro, static, deterministic, and simultaneous.

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[1]Harris, "Quantitative Models of Urban Development," p. 367.

CHAPTER III

THE ROOTS OF LOCATION THEORY: WEBER

Introduction

Alfred Weber (1868-1958), German sociologist and economist, was the younger brother of Max Weber (1864-1920).[1] A. Weber died at the age of ninety ". . . the last of the grand old men of the social sciences."[2] He was born in Erfurt and raised in Berlin. Weber was Gustav Schmoller's student at the University of Berlin where he received his doctor's degree in 1895. In 1904 he moved to Prague for a university post, and in 1907 to Heidelberg. He finished his career at Heidelberg in 1933.

Weber started his academic studies in economics and later switched to sociology. His first book, Theory of the Location of Industries, was published in 1909.[3] This study was based on historical research into German data after 1860. It investigated the causes of local

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[1]Salin, "Alfred Weber," p. 491.

[2]Erich Kahler, "Alfred Weber, 1868-1958," Social Research 21 (Autumn 1958): 361.

[3]Alfred Weber, The Theory of the Location of Industries, trans. Carl J. Freidrich (Chicago: University of Chicago Press, 1929).

industrial agglomerations in that period of industrialization. The details of this study will be reviewed later in this chapter.

Alfred and Max

A. Weber's sociology has been called the "sociology of culture."[1] Weber agreed with those who gave his work the designation "synoptic sociology" to be contrasted with brother Max's "systematic" and "rational" approach.[2] A. Weber's work in sociology was reflected in all of his writing including (in a way) the Theory of the Location of Industries. Weber wrote articles for leading German journals.[3] He also had eight books dealing with sociology and politics.[4]

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[1]This phrase is translated from the German Kultursoziologie. He was called a Kathedersozialist, i.e., an academic sociologist without practical experience.

[2]Salin, "Alfred Weber," p. 491. "Synoptic" is used in the sense of a "general view of a whole."

[3]See, Archiv für Sozialwissenschaft und Sozialpolitik 47 (1920): 1-49, and vol. 55 (1928); and, Handwörterbuch der Soziologie (1931).

[4]Deutschland und die europäische Kulturkrise (Jena: Fischer, 1924); Die Krise des modernen Staatgedankens in Europa (Stuttgart: Deutsche Verlags-Austatt, 1925); Das Ende der Demokratie (Berlin: Junke and Dünnhaupt, 1931); Kulturgeschiechte als Kultursoziologie (Munich: Piper, 1950 (1935)); Das Tragische und die Geschichte (Hamberg: Govert, 1943); Farewell to European History: Or the Conquest of Nihilism (New Haven: Yale University Press, 1948), originally published as Abschied von der bisherigen Geschichte: Überwindung des Nihilisms? (London: Routledge, 1941); Prinzipien der Geschichte und Kultursoziologie (Munich: Piper, 1951); and, Der dritte oder der vierte Meusch: Vom Sinn der geschichtlichen Daseins (Munich: Piper, 1955). This list was presented so that one might put into proper reference the relative weight of Weber's work in sociology as compared to economics. This along with other evidence leads this author to conclude that Weber was first a sociologist and second (if at all) an economist.

Weber was the director and editor of a collection of lectures, addresses, and essays in collaboration with some of his students. This work was entitled Einführung in die Soziologie.[1] The details of Weber's sociology are not important for this study. Although this is true, this author contends that Weber was primarily a sociologist and secondarily an economist. His Theory of the Location of Industries is the only one of his works that can be even roughly classified as economics. Due to the nature of this study, Weber's other works will not be reviewed or analyzed.

Since Max Weber was an economist who did work in sociology, it might be of interest to compare both of their approaches to economics. As mentioned earlier, their sociologies were different. There is ample literature in sociology to verify this statement.[2] A proper question for comparing their "systems" of economics might be: Did the Webers really

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[1] Einführung in die Soziologie (Munich: Piper, 1955).

[2] Kahler, "Alfred Weber, 1868-1958," pp. 361-64. After making a superficial review of their sociologies (necessitated by the fact that this observer is not an expert in sociology), it seemed as if the "sociology of culture" developed by A. Weber might apply well to M. Weber's "economic sociology." At the same time Max's "systematic" (or rational) approach to sociology seems to be reflected in brother Alfred's ceteris paribus economics.

study "economics" as it is known today? To answer this rhetorical question, one must consider Schumpeter's concept, "economic sociology."[1] In chapter two of his History of Economic Analysis, Schumpeter delineated those "techniques" necessary to distinguish "scientific" economics from other everyday economics. He listed economic history, statistics, and theory. Taken together these make up what he called "economic analysis." Later in the chapter (without changing the introduction to the chapter to reflect this change), he added to these three a fourth fundamental field, economic sociology. In Schumpeter's words:

> . . . economic analysis deals with the questions how people behave at any time and what the economic effects are they produce by so behaving; economic sociology deals with the question how they came to behave as they do. If we define human behavior widely enough so that it includes not only actions and motives and propensities but also the social institutions that are relevant to economic behavior such as government, property inheritance, contract and so on, that really tells us all we need.[2]

Was Alfred Weber's economic theory of industrial location a part of this "economic sociology?" Was Max Weber's work a part of "economic sociology?" The answer to the first question is probably "no." The answer to the second question is a resounding "yes." This writer does believe that Alfred Weber's life work was mainly sociology. Note should also be taken that in his Theory of the Location of

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[1]Schumpeter, History, pp. 20-21.

[2]Ibid., p. 21.

Industries Weber's work is more "social" in nature than most treatises in economic theory based on the fact that he considers interdependencies, interactions, and agglomerations generally ignored by economics and economists. This point was made by A. Weber's editor, Carl J. Friedrich, when reviewing Weber's use of the deductive method.

> These indirect factors (agglomerating and deglomerating) are not capable of the same deductive analysis as the direct factors discussed before, because they follow from the social nature of production.[1]

But, A. Weber's methodology was "isolation." By using a ceteris paribus method, he held constant social factors which he fatalistically recognized.

> Is it sensible for us to argue about cultural and social motives when perchance we are simply fettered by the iron chains of hard economic forces? It may be that the enormous agglomerations of today are nothing but inevitable results of a certain stage of economic and technical development; or perhaps they are the consequence of the social organization of our economic system.[2]

His plan was to develop the work in two stages: "pure" theory and "realistic" theory. The "pure" laws of industrial location were to be independent of any particular kind of economic system.[3] The term "pure economics" was used as found in the German theoretical literature in an attempt to recapture for economic theory a place in

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[1]Weber, Location of Industries, p. xxvii. Emphasis added by this author.

[2]Ibid., p. 3.

[3]Ibid., p. 10.

economics lost under the influence of the historical school. Friedrich concluded that the assumption of such an abstract ". . . 'pure' system of economics simply marks the return to what would be styled 'economic theory' in England and America."[1]

A. Weber felt that the kind of industrial location which existed at that time could not be explained (entirely) by the "pure" deductive rules of location, because all of the causes were not purely economic.

> The further task of formulating the laws of location under modern capitalism cannot be achieved by simple deduction. . . ., we shall have to show the effects of unexplained causes of a general kind. For these latter we shall have to find the premises which must somehow be due to the particular nature of modern economic or social life.[2]

A further goal of this more "realistic" theory was to introduce those elements of modern capitalism which might effect location. Professor Weber did not work out the details of his realistic theory in the Theory of the Location of Industries.[3] At least one critic felt that he also failed in his attempt to develop a "pure" theory. Edgar Salin

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[1]Ibid., p. 10, footnote 7.

[2]Ibid., p. 11. Emphasis added by this author.

[3]Carl J. Friedrich noted that A. Weber came close to the details of such a realistic theory in his contribution to the Grudriss der Sozialökonomik entitled "Industrielle Standortslehre," see Ibid., p. 12, n. 12. Hoover, Location Theory and the Shoe, p. 70, n. 17 indicated that this article was a "sketch" of the realistic theory.

noted that after establishing certain general conditions of location,

> . . . the theory then develops the concepts of transport orientation and labor orientation, and concludes with an analysis of the laws of agglomeration. According to these laws, the social factors conducive to development may be either economic-rational or social-historical. Clearly, such a theory of location is neither "pure" or "general," since it is too closely tied to particular resources and energy sources which have changed unpredictably in the past and will do so again in the future.[1]

This writer feels that Salin was guilty of a hasty generalization much of the same order as those who have condemned Thünen's work. The same cry was raised, usually by geographers studying Thünen, that since Thünen's system was based on German data of the early part of the 19th century as circumstances changed the theory would be invalidated.[2] Perhaps this problem could be solved if A. Weber's work could be considered as "pure" economics in the same way Max Weber used the concept of an "ideal type."[3] Schumpeter outlined the concept of an "ideal type" as an abbreviated description of an abstract system which has many uses, but ". . . inevitably involved distortion of the facts."[4]

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[1]Salin, "Alfred Weber," p. 491.

[2]Thünen, Isolated State, p. xli. For a geographer who had this view see Richard Harshorne, The Nature of Geography (Lancaster, Penn.: Association of American Geographers, 1939), p. 421.

[3]One should note that Schumpeter felt that M. Weber misused the concept of an "ideal type," see Schumpeter, History, p. 80, n. 4.

[4]Ibid.

> In the social sciences, he (M. Weber) held, we perform operations of a kind entirely foreign to the physical sciences. In the physical sciences explanation never means more than description. In the social sciences explanation involves the understanding of "cultural contents," . . . In order to make headway with the analysis of the latter--and all social phenomena--the observer must understand his subject of research in a sense in which he cannot and need not understand the falling stone (used as an example of a physical science experiment). For this purpose he must create types which, though not necessarily, pure like the economic man, are abstractions in that they possess only essential and lack non-essential properties: they are logical ideals.[1]

An argument has been made that A. Weber does take into account "cultural contents" in the several senses noted above. But, he also hoped to only deal with the "essential" and disregard the "non-essential" through the use of ceteris paribus methodology. As stated by A. Weber:

> By making use of the method of isolating analysis, we may ascertain, if not all, at least some, causal relationships, and prepare for a perfect causal understanding, and even for measurement. . . .
>
> Methodologically we shall always proceed by isolation, not only in the first part dealing with pure theory, but in the second part ("realistic" theory) as well.[2]

So when it came down to the pragmatic choice between a truly "social" theory and a "pure" theory, the ceteris paribus was applied to eliminate social factors. Weber indicated that he wished to apply the same method to the "realistic" or "social" theory, but he did not accomplish this goal. In his own words:

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[1]Ibid., pp. 818-19. All parenthetical material and emphasis added by this author.

[2]Weber, Location of Industries, pp. 9-11, passim.

> To be specific, we shall exclude from the purview of the pure theory all locational factors of a purely social and cultural nature which our analysis of reality reveals.[1]

This writer feels that A. Weber's "pure" theory was meant to be in the same spirit of M. Weber's ideal type. A. Weber fully realized that such an abstract picture was not complete, did not give comprehensive answers, and was only a starting point. As he stated at the end of the introduction: "This book is expected to be a beginning, not an end."[2]

To continue the comparison, one should also note that the two brothers were different as to their beliefs as to whether one should mix scholarly work and political activity.[3] Although Max took part in political debates and made many speeches, he wanted to keep his political activity completely separated from his teaching and scholarly work. Alfred Weber felt that a teacher had the duty to express political convictions and reasoned conclusions to students as a matter of practice. In this sense, Alfred made his <u>teaching</u> more "social"[4] than Max's.

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[1]Ibid., p. 22.

[2]Ibid., p. 15.

[3]Kahler, "Alfred Weber, 1868-1958," p. 364.

[4]For a discussion of what M. Weber meant by the word "social," see Peter L. Berger, <u>Invitation to Sociology: A Humanistic Perspective</u> (Garden City, N.Y.: Anchor Books, 1963), pp. 26-27.

In conclusion to this section, this writer would like to restate the conclusion that while A. Weber's economic analysis was "social" in many respects it could not be considered "economic sociology" as used by Schumpeter and M. Weber. A stronger case can be made for the conclusion that A. Weber's "pure" theory can be compared to M. Weber's "ideal type" with favorable results.

Weber and Thünen

The decision to place Alfred Weber after Thünen was made after due consideration of the fact that Wilhelm Launhardt can be considered as an anticipator of a major Weberian concept, i.e., a convincing argument could be made that Weber and Launhardt should be placed in the same chapter. The final judgment was made based on the observation that Thünen and Weber have been the most popular authors in two complementary areas of location theory--agricultural location and industrial location. Other factors contributed to this decision. The details are presented in the following paragraphs.

As stated in the section of this work dealing with Thünen, his theory is one that answers the question, "What to produce?" instead of the question, "Where to locate?" economic activity. Thünen worked on the aggregate industrial level assuming a "town" (concentration of demand) surrounded by supportive belts of agricultural supply. Weber's theory is concerned with individual manufacturing

firms and individual decisions (most of the time). As stated by Isard, the Weberian school,

> . . . is primarily concerned with the location problem of an individual firm which produces a given product. True, the Weberian doctrine frequently shifts to aggregate analysis when it considers agglomeration economics, the various strata of society, and the like. But this type of aggregative analysis explicitly avoids the problem of the efficient spatial distribution . . . of the various types of industrial production over a given region.[1]

Isard then concluded that the Thünen and Weberian schools had ". . . carved out for themselves separate, non-overlapping areas of inquiry."[2] There is much support in the literature for this "traditional dualism" in location theory. As stated by Greenhut, "Weber's theory of location is procedurally the opposite of von Thünen's."[3] But, Michael Chisholm has indicated that the procedurally different approaches may be a part of a more general scheme within which different variables are allowed to change.

> In the initial von Thünen model, the problem is to determine the optimum production for a farm the location of which is given. In the Weberian case the problem is reversed; given the type of production, what is the optimum location? There is no difference in principle between these two approaches; it is merely that a different factor is allowed to vary.[4]

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[1]Isard, Location and Space-Economy, pp. 92-3. Also see Walter Isard, "Distance Inputs and the Space Economy: The Locational Equilibrium of the Firm," Quarterly Journal of Economics 65 (August 1951): 379-99.

[2]Ibid.

[3]Greenhut, Plant Location in Theory and Practice, p. 8.

[4]Chisholm, Rural Settlement and Land Use, pp. 37-38.

There are many assumptions or characteristics common to both models. In each model the following are given: a homogeneous plain, demand and price (therefore revenue), perfect competition,[1] the location of inputs, and the scale of production. Isard pointed to the relevance of scale to understanding the absence of a dichotomy between the two approaches to the problem of location.[2] If scale of production has no effect on cost and if revenues are given, then profit maximization reduces to a problem of minimization of transportation costs. Based on these conclusions, Isard felt that the transition from one type of analysis to the other for the purpose of the integration of both theories is not as difficult as once believed.[3] That is, transportation costs are very important in both theories. In reference to the common assumption of fixed demand and price, Greenhut placed both theories in the category of "least cost" location theories.[4] In both cases the principle of substitution is used to arrive at

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[1]The assumption of perfect competition as applied to Weber's model will be challenged later in this chapter.

[2]J. W. Birch, "Rural Land Use and Location Theory: A Review," Economic Geography 39 (July 1963): 275. Moses has shown that the scale of production does have an effect on location, see Leon N. Moses, "Location and the Theory of Production," Quarterly Journal of Economics 72 (May 1958): 259-72.

[3]Isard, Location and Space-Economy, p. 189.

[4]Melvin L. Greenhut, "Integrating the Leading Theories of Plant Location," Southern Economic Journal 18 (April 1952): 533.

the profit maximizing least cost location. Thünen substitutes land costs (rents) for transportation cost until the least cost combination is found. Weber's theory involves the substitution between non-transport factors and transport cost factors through the device of isoadpanes. Through such substitutions one may agree with the conclusion that ". . . Alfred Weber and Thünen both point out the fundamental importance of transportation costs for any theoretical understanding of location."[1] The supposed macro-micro dichotomy may not be important if one realizes that Thünen's analysis, while on an aggregate level, ". . . was based on the analysis of individual holdings and his zones represent the sum of the individual choices made regarding types of production."[2] This author does not agree with all of these assumptions as applied to the Weberian system, but discussion will be delayed until the next section which is devoted to the model assumptions.

Weber did recognize Thünen's work. Predöhl seemed to have the correct interpretation of their relationship when he used the term "guided" as found below:

> Guided by Thünen's theory of location of agriculture, Weber noticed the lack of a satisfactory theory of location of manufacturing industries and built up

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[1]Weber, Location of Industries, pp. xxviii-xxix.

[2]Chisholm, Rural Settlement and Land Use, pp. 37-38.

> in juxtaposition to Thünen's work his exhaustive theory on this subject, first published in 1909.[1]

Weber felt that while Thünen's theory was satisfactory, there was room for improvement. Evidence is also revealed to indicate that Weber had read early German location theorists.

> Limiting ourselves thus to the sphere of production, . . . There are good reasons why we should content ourselves with this analysis. We have a theory of the location of agricultural production by Thünen, although it needs, I believe some reshaping, and particularly some developing. But we do not as yet have any theory of the location of industries--we may say that without doing injustice to the work of Roscher and Schaeffle--. . . .[2]

It is interesting that Weber was familiar with the works of Wilhelm Roscher and Albert E. F. Schäffle, but he did not recognize Wilhelm Launhardt or Achille Loria. Launhardt is known to have anticipated Weberian concepts. Loria, an Italian, was not well known for his work in location theory, but he was mentioned by Krzyzanowski in a review article which does not list Launhardt. Loria, like Weber, studied industrial location.[3] There was no evidence discovered by this author to indicate that Weber had (or had not) read Launhardt or Loria. Roscher studied location from the

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[1]Andreas Predöhl, "The Theory of Location and Its Relation to General Economics," Journal of Political Economy xxxvi (1928): 373. Emphasis added by this author.

[2]Weber, Location of Industries, pp. 5-6.

[3]Loria was best known for his work in sociology and income distribution. See Krzyzanowski, "Review of the Literature," pp. 279-80.

historical point of view. He felt that there were natural laws of location. There is evidence that Weber was influenced by Roscher's analysis of raw materials that lose weight in the process of production.[1] Schäffle had very vague ideas about location theory and central place theory. His most interesting contribution was the belief that cities have an attractive force proportional to the square of their size and inversely proportional to the distance between them and factories.[2] This idea reminds one of William J. Reilly's "law of retail gravitation." Reilly's law was that ". . . two cities attract trade from any intermediate city or town in the vicinity of the breaking point (the boundary between their market areas), approximately in direct proportion to the populations of the two cities and in inverse proportion to the squares of the distance of these two cities to the intermediate town."[3] Reilly's law is analogous to the Newtonian law of gravitation. This law states that bodies attract one another in

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[1]Roscher's works dealing with location included Ausichten der Volkswirtschaft aus dem geschichtlichen Stanpunkte, vol. II (Leipsic, 1878), pp. 1-100, and Nationalökonomik des Handels und Gewerbfleisses, 7th ed. (1899), pp. 667-707. Roscher had a working knowledge of Thünen and Schäffle, see Roscher's Principles of Political Economy, vol. II, trans. J. J. Lalor (New York: Henry Holt and Co., 1878), pp. 14-38.

[2]Schäffle's work dealing with location included Bau und Leben des socialen Körpers (Tübingen, 1875), and Gesellschaftliches System der menschlichen Wirtschaft (Tübinger: 1873), vol. II, pp. 265-67.

[3]William J. Reilly, "Methods for the Study of Retail Relationships," University of Texas Bulletin, 2944 (Austin, Texas: 1929), and The Law of Retail Gravitation (New York: Knickerbocker Press, 1931).

proportion to their masses and inversely in proportion to the square of their distance. Hoover has classified such measures (as related to regional economics) as indices of "market access potential."[1] It seems as if Schäffle "misplaced" his square. There is no evidence that this aspect of Schäffle work influenced Weber. Roscher and Schäffle were members of the German historical school. They both could have influenced Weber in as much as his theory has been called "empirical."[2] Weber's theory is based on technical data of the last part of the nineteenth century. But as Predöhl has pointed out, Weber's theory should be considered as "supplementary" empirical theory, i.e., it needs to be supplemented by concrete information.[3] Unfortunately, Weber never finished the details of his "realistic" theory which would have returned us to the data, and there is little evidence to be found that gives the details of how Weber arrived at his original premises. On a casual reading of Weber, one would be more likely to classify the theory as "purely" deductive. An argument was made in the

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[1]Edgar M. Hoover, An Introduction to Regional Economics (New York: Alfred A. Knopf, Inc., 1971), pp. 30-31.

[2]Andreas Predöhl, "The Theory of Location and Its," pp. 389-90. Weber used the term "empirical theory" interchangeably with his "realistic theory." Others have called this an "evolutionary theory," see Isard, Location and the Space-Economy, pp. 28-30. "Evolutionary" is used in the sense of an isolated country "developing" various strata of economic activity with corresponding economic locations.

[3]Isard, Location and the Space-Economy, pp. 36-37, n. 37.

last section of this paper that Weber's work was at least in part a reaction against the German historical school, i.e., with reference to the "pure" abstract theory. This argument along with what one actually finds in his book (not what he planned to place there) places A. Weber on the Austrian-English side of the methodenstreit.

It is interesting to observe that Weber mentioned Thünen six times in the text and footnotes of the present English edition, but in the original German he mentioned Thünen seven times. For some unknown reason, Weber dropped a paragraph and detailed footnote dealing with Thünen's analysis of the relation of the place of production to the place of consumption. If the details of that passage are studied,[1] one is lead to a clue to why it was dropped. Thünen's work at this point involves circular reasoning and is, in general, confused. This writer feels that the reason for the deletion was that Weber could not deduce a positive conclusion from Thünen's analysis. If this were the case, less than "pure" analysis could not find a permanent place in a closely reasoned deductive theory.

In summary, one must go beyond the fact of current popularity in order to justify placing Weber after Thünen particularly in light of the fact that he could have also

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[1]Weber, Location of Industries, p. 215.

been placed in a separate chapter with Launhardt and Loria. This writer found evidence to indicate that both theories may be a part of a more general view of location theory within which there are common assumptions, characteristics, and variables. Within this larger framework the theories may be procedurally the opposite, but each theory only allows a different factor to vary. Both theories are considered to be "least cost theories," and both use the principle of substitution applied to some aspect of transportation cost to maximize profits (or rents).

Alfred Weber's Theory of the Location of Industrial Activity

Assumptions and the Nature of Weber's Economic System

In surveying the location literature dealing with Weber many different assumptions, attributed to Weber, were found. It was of interest to note that Weber's editor-translator, Carl J. Friedrich, contended that Weber had at most four assumptions. While comparing Thünen and Weber, Friedrich stated:

> Like Thünen, he assumed an absolutely even plain and equal transportation rates throughout. But he does not assume one consuming center; he assumes many of them scattered over the plain. Instead of equal fertility throughout, which would correspond to equal amounts of fuel and raw materials at equal cost throughout, Weber assumes only equal cost of fuel and raw materials at all deposits, but retains the uneven distribution of such deposits. These, and these only, are Weber's assumptions.[1]

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[1] Ibid., p. xxiii.

This can be compared to Chapter II, "Simplifying Assumptions," which Weber devoted to the topic. After reviewing the four page chapter, the following three assumptions were found:

> 1. We shall assume the geographical basis of materials as something given. . . .
> 2. The geographical nature of the sphere of consumption also will for the time being be treated as a given phenomenon. The situation and size of the places of consumption will be assumed in the pure theory as a given framework of orientation. . . .
> 3. Finally, we shall not introduce the mobility of the labor basis of industry. . . . We shall further assume that the wages of each branch of industry are "fixed" while the amount of labor available at this price is unlimited.[1]

After stating that other assumptions would be necessary from time to time, Weber concluded that the three simplifying assumptions, listed above, were the only permanent ones needed for his "pure" theory.

In the last section of this paper dealing with the comparison of Weber to Thünen, this writer stated no less than eight assumptions that are believed to be in both systems. Where do these eight come from when Friedrich and Weber listed four and three, respectively? As stated above, Weber warned that other assumptions would be necessary. Other assumptions <u>can</u> be found in his book. For example, he assumed that only weight and distance influenced the cost of transportation and that the railroads were the only means of transportation. Weber used the

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[1]Ibid., pp. 37-38, passim.

phrase "as if" in reference to the latter when he stated that as ". . . a device for simplifying our problem, we shall proceed as if it were the only system existing."[1] Statements of assumptions containing the phrase "as if" were found six times in Weber's text.[2] There is every indication that Weber used the expression in the same sense as Milton Friedman.[3] When trying to justify the use of a simplifying assumption, Weber stated:

> . . ., (it) is only a theoretical aid, an intermediate assumption to which no actual situation ever quite corresponds . . . that neither . . . will ever exist in reality.[4]

Weber also assumed that the transport rate per ton-mile was constant and that the topography consisted of a ". . . mathematically flat plain where the mountains are razed, the valleys filled, and the swamps covered."[5] The latter of these assumptions is one that he held in common with Thünen. Other examples can be found throughout the book to verify the fact that Weber did add to his three basic assumptions.

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[1]Ibid., p. 42. Emphasis added by this author.

[2]In addition to the example sighted above, "as if" statements were found on pages 34, 39, 86, and 110 of Weber's text.

[3]For an example of Friedman's methodology see Milton Friedman, Essays in Positive Economics (Chicago, Ill.: University of Chicago Press, 1953). Of particular interest is the first chapter, "The Methodology of Positive Economics," pp. 3-43.

[4]Weber, Location of Industries, p. 134, passim.

[5]Ibid., p. 45.

Another reason that one can find long lists of Weberian assumptions in some books and articles is that some authors have used deductive reasoning to arrive at new assumptions, implications, and model characteristics based on the original assumptions. For example, one could deduce from the second of Weber's assumptions that demand is given. Such a deduction could lead to the specific implication that demand is perfectly inelastic. From the third of Weber's assumptions, one could deduce that one of the model characteristics is perfect competition in the labor market, i.e., if one ignores labor immobility but presumes that labor is everywhere adequate.

A summary listing of all the assumptions, implications, and model characteristics (not all agreed with by this author) of Weber's theory found in the location literature is as follows:

(1) A homogeneous plain is assumed with uniform climate and technique.

(2) Demand, price, and revenue are given. Only one commodity produced in a single stage of production was considered.

(3) Perfect competition in the input market (with the exception of labor mobility) and perfect competition in the output market are assumed. Rational behavior is postulated.

(4) The location of consumers and the location of

markets are given. Several consuming centers are assumed.

(5) The locations and weight of raw materials and inputs are given. There is a heterogeneous environment, i.e., an uneven distribution of raw materials and inputs, but the same input mix is used by the firm at all locations.

(6) Weber implicitly assumed fixed input coefficients and a linearly homogeneous production function. Scale of production had no effect on cost.

(7) Transportation rates are proportional to weight and distance only. Transport facilities are of the same character (all railroad) and radiate in all directions from all points on the plain.

(8) The supply of labor is unlimited at a fixed wage, but labor is geographically fixed.

Although one would be hard pressed to show a passage in Weber's book when he specifically assumed perfect competition, at least two authors contended that he did.[1] Of course, the term "perfect competition" had not been used in reference to the output market at the time Weber wrote. John Bates Clark in his book, Essentials of Economic Theory, first published in October 1907, used the phrase "perfect competition" twice. Each time the use

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[1]Webber, Impact of Uncertainty on Location, pp. 10, 15. Greenhut, Plant Location in Theory and Practice, p. 22.

referred to the labor market.[1] Clark usually used the term "free competition." In fact, in the two instances just mentioned, he used the terms interchangeably. Frank H. Knight was the first to systematically outline perfect competition as applied to the output market in his book Risk, Profit, and Uncertainty first published in 1921.[2] The concept of perfect competition had been implicit to the works of many writers prior to Knight including the earlier works of J. B. Clark, Alfred Marshall, and the classical economists. Michael J. Webber concluded logically that if Alfred Weber's economic system was characterized by what today is called perfect competition then there were inconsistencies in that system. The reason is that ". . . it can readily be shown that the assumption of perfect competition is incompatible with the postulate of a spatial framework for society."[3] That is, locational specialization is a monopoly advantage and one of the characteristics of monopolistic competition. The works of E. H. Chamberlin[4] in general economic theory and Melvin L. Greenhut in

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[1]John Bates Clark, Essentials of Economic Theory (New York: The Macmillan Co., 1918 (1907)), pp. 143-5.

[2]Frank H. Knight, Risk, Profit, and Uncertainty (Cambridge, Mass.: M. I. T. Press, 1971 (1921)), pp. 76-80. On page 22, footnote 2, Knight referred to Clark's use of perfect competition.

[3]Webber, Impact of Uncertainty on Location, p. 15.

[4]E. H. Chamberlin, The Theory of Monopolistic Competition (Cambridge, Mass.: Harvard University Press, 1933), see appendix C, "Pure Spatial Competition."

spatial price theory have both made this point. As stated by Greenhut while discussing spatial market types:

> Perfect competition does not exist under this alignment of sellers and buyers for the single reason price is functionally related to distance. Clearly, when sellers and buyers are dispersed, each seller in space is, to some extent, a monopolist, and, hence, not a perfect competitor.[1]

This is followed by the argument and conclusion that space can validly enter economic analysis only in forms of imperfect competition. This author agrees fully with those who contend that "space" must enter the price system through forms of imperfect competition. But, Weber specifically abstracted from the price mechanism so that his "pure" theory could apply to any system of economic organization. Weber assumed that demand was given at a point in space. Greenhut concluded that such an assumption enabled ". . . the same type of abstraction from space as has marked the general economic theory."[2] Elsewhere, Greenhut continued to indicate that Weber's system ". . . excludes monopolistic locational advantages as a consequence of his given price (purely competitive) assumption. . . ."[3] These two quotes

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[1]Melvin L. Greenhut, A Theory of the Firm in Economic Space (New York: Appleton-Century-Crofts, 1970), p. 51.

[2]Greenhut, "Integrating the Leading," p. 531.

[3]Greenhut, Plant Location in Theory and Practice, p. 85. Also see Greenhut's A Theory of the Firm, p. 265, where he indicated that in Weber's system there are ". . . no monopoly gains derived from location."

seem to contradict what Greenhut had stated in the spatial price theory text, unless one assumes that the assumption of "given demand" necessarily implies a "given (purely competitive) price." It is easy to see from the last three Greenhut quotes that he did draw such an implication from the "given demand" assumption. It may be true in an absolutist sense that the assumption of perfect or pure competition may be the only assumption that can, in retrospect, be fitted to Weber's model. But from the standpoint of a student of the history of economic thought, there is one definite way to verify what Weber actually assumed (as opposed to what Weberians have ex post deduced). One must look at the actual text.

Weber told us preciously little about the technical details of his economic system. On the microeconomic side, Weber believed that price was composed of the following:

> . . . we get the following elements composing the price . . .: (1) Profit. (2) The interest rates of the fixed and operating capital . . . of the different stages. (3) The rate of amortization of the fixed capital. (4) The cost of securing materials and power. (5) The wages. (6) The cost of transporting: (a) the (raw) materials and power, (b) the finished products. (7) the general expenses.[1]

Weber felt that profits never became location factors because they were not really elements of price but the result of a particular price. They became costs only when

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[1]Weber, Location of Industries, p. 28.

passed on in succeeding stages of production. Weber did separate profit from interest and the wages of management. He kept this clear in order to insure that wages of management and payment for risk could be included as part of the cost of production and not as part of profits.[1] With respect to elements two through six listed above, Weber gave an expanded listing of the factors involved:

> (1) The cost of grounds.
> (2) The cost of buildings, machines, and other fixed capital costs.
> (3) The cost of securing materials, power, and fuel.
> (4) The cost of labor.
> (5) The cost of transportation.
> (6) The interest rates.
> (7) The rate of depreciation of fixed capital.[2]

If Weber's theory of value (if any) were to be classified, it could be called a cost-of-production theory.

> In analyzing the price of industrial products we meet again in the guise of monetary elements all those elements of cost which grow out of the expenditure of goods and labor in the production process.[3]

Weber did recognize the concept of marginal utility, but he never used the term when discussing price.[4] This writer failed to find any passages in Weber's book that would

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[1] Ibid., pp. 28-29, n. 7.

[2] Ibid., pp. 29-30.

[3] Ibid., p. 25.

[4] Ibid., p. 132. Weber used "marginal utility" while discussing land speculation. There is evidence that Weber had read Böhm-Bawerk. Perhaps this was the source of his acquaintance with the term. Weber also agreed with Böhm-Bawerk's concept of interest, see ibid., p. 29, n. 4.

indicate that the price of output was given. The only assumption actually in the book dealing with demand was the second of Weber's assumptions, i.e., that the situation (location) and size of places of consumption were assumed to be given. Without further explanation, this assumption could be used as the source of the assumption of perfect (or pure) competition. But, there is evidence as to what Weber actually meant by this assumption. Near the end of the text, one can find the following:

> In most cases this sphere of consumption is given, not as an indefinite geographical distribution of consumption, but rather as very definite places with very definite magnitudes of consumption.[1]

On the next page, one can find the statement that ". . . we have a system . . . of places of consumption having a given magnitude."[2] The extra information added by these passages is that by "given" Weber apparently meant a fixed or given amount (magnitude) of demand not a "given" demand curve (and price) as one usually thinks of such curves for the firm in perfect competition. This interpretation would imply a perfectly inelastic demand curve with price determined (not given in the sense of data) wholly by supply (i.e., costs).[3]

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[1]Ibid., p. 221. Emphasis added by this author.

[2]Ibid., p. 222.

[3]The inelastic demand curve hypothesis seems to agree with information found in Greenhut, Plant Location in Theory and Practice, p. 15, n. 32. Greenhut indicated that Lösch had given such an interpretation, see August Lösch, Die Räumliche Ordnumg der Wirtschaft (Jena: Verlagvon Gustav Fischer, 1944), pp. 11 and 18.

One possible solution to the problems of different interpretations is that the analyses of Michael J. Webber and Melvin L. Greenhut were on the firm level; the analysis presented by this writer is on the industry level. Regardless of the shape of the demand curve for the industry there would be a "given" price due to a "given" horizontal demand curve for the industry's representative firm. It should be noted that Weber inevitably wrote about the location of "industry" as opposed to the location of a "firm" contrary to the interpretation usually given.[1] This problem could have been solved if Weber would have indicated that the industry being located contained a "large" number of firms. But, there is no indication as to the number of firms in the industry. Weber treated each locational triangle (defined later) as if it were a monopoly with interaction coming by way of agglomerations. Therefore, while this author does not necessarily disagree with M. J. Webber and Greenhut (ex post), there is little evidence in Weber's book to back up their claims that Weber's economic system was characterized by perfect (or pure) competition.[2]

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[1]For example see Webber, Impact of Uncertainty on Location, p. 10, where he stated: "The first, Weberian theory, analyses the location of the individual firm under conditions of perfect competition."

[2]The words "pure competition" can be found at one place in Weber's text, see Weber, Location of Industries, p. 197, where one finds, "It might at first be held that if we are to consider pure competition between agglom-

Note should be taken that in both lists of the elements Weber included in price there is some reference to "fixed" and/or "operating" capital. This classical idea is also supported by Weber's belief that labor is paid by advances from (operating) capital.

> All expenditure of labor and goods which constitute the process becomes monetary advance payment upon the future price of the product. By monetary advance payments we mean that the entrepreneur of each state of production makes advance payments in the form of wages and salaries to his employees, and in the form of prices paid for materials and machines to the entrepreneurs of the previous stage. The monetary outlays of a certain stage of production are nothing but the sum of all these advances which its entrepreneurs must make. It should be remarked, however, that each stage adds two things to its advance payments: the interest on the capital it uses for these advances, and its "profits."[1]

The phrase ". . . the capital it uses for these advances," lends itself to the classical interpretation of the "circulating" fund of capital, i.e., the operating capital.

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locations and labor location we should simply compare the net economies of agglomeration with the net economies of labor." Several points need to be made about this passage: (1) This author feels that Weber was using the word "pure" in the generic sense, i.e., as in "pure" theory. (2) The words "pure competition" were not in the economic literature at the time Weber wrote (although the concept was). (3) Weber was speaking of the competition for positions (locations) of various inputs seeking to substitute for one another in production not of competition in the output market. Only one passage was found in Weber's text where he used the word "competition" and output price in the same sentence, see p. 18, "Competition of price is possible only by disregarding differences in quality." At all other times, the word "competition" was used to describe the interaction of various (competing) inputs or forms of transportation, see pp. 18, 77, 80, 85, 115, and 144-5.

[1]Ibid., p. 26. Emphasis added by this author.

Weber also wrote of a "natural" process of production, but he did not intend to use the term in the sense that the physiocrats and Smith used the phrase "natural order."[1] Rather, Weber used the term to apply to the industrial process before it had been ". . . transformed by the capitalistic economic order."[2] This gives us more insight as to what Weber meant by his "pure" theory. He hoped to develop an economic analysis of industrial location which could apply to any form of economic organization. This fact could account for Weber's popularity in Russia. Weber's hope that the conclusions of his model might be independent of the price mechanism ". . . lends it significance there (Russia) perhaps."[3]

The assumption of perfect competition (as we know it today) in the input markets was doomed to failure from the beginning. There is little doubt that, at least in the labor market, Weber did assume such a competitive position. The third of Weber's simplifying assumptions was quite explicit. Weber assumed that the wages of each branch of industry ". . . are 'fixed' while the amount of labor

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[1]For an example of and explanation of the use of the term "natural order," see Eric Roll, A History of Economic Thought, 3rd ed. (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1953), p. 108.

[2]Weber, Location of Industries, p. 26.

[3]Ibid., p. xxix, n. 45.

available at this price is unlimited."[1] But at the same time, he assumed that labor operated at "geographically defined points."[2] This implies that labor is at least partially immobile. Problems develop in such a system unless another assumption is made, i.e., the system would have been consistent if Weber had assumed that labor was omnipresent and at geographically defined points. Alternatively, he could have assumed perfect mobility for labor, but Weber stated explicitly he would ". . . not introduce the mobility of the labor basis of industry."[3]

In summary, one might state that Weber developed an analytically "pure" system based on ceteris paribus analysis and "as if" methodology using simplifying assumptions. There is no doubt that Weber abstracted from demand and concentrated on supply to develop a "least-cost" theory of industrial location. There is still debate as to whether he assumed perfect competition. This author has tried to document the belief that while perfect competition might be the best type of market structure to apply to Weber's model, in retrospect, there is very little evidence in Weber's book to substantiate the claim that he assumed such a structure explicitly.

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[1]Ibid., p. 38.

[2]Ibid., p. 95.

[3]Ibid., p. 38.

Three Classification Systems

Weber classified his various "locational factors" under three different schemes, but any one factor could be classified under more than one scheme. By "locational factor" Weber meant ". . . an advantage which is gained when an economic activity takes place at a particular point . . . rather than elsewhere. An advantage is a saving in cost. . . ."[1]

Weber believed that all locational factors could be classified as either "general" or "special."[2] General factors were said to be common to all industries. Special factors would only affect particular industries. Examples of general factors included transportation costs and the need for labor. Special factors included the perishability of inputs, climate, and the availability of water.

Superimposed upon this classification scheme was another. Whether general or special, factors could also be classified as either "regional" (i.e., those direct factors which are the primary cause of the regional distribution of industry) or "agglomeration" (i.e., those secondary or indirect factors which can "agglomerate" or "deglomerate" industries <u>within</u> the regional distribution of industries).[3] Weber listed transportation costs, wage

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[1] Ibid., p. 18.

[2] Ibid., p. 20.

[3] Ibid.

rates, and the distribution of mineral resources as "regional" factors. The agglomeration factors included internal and external economics and urbanization economics.

Finally, the third classification was based on whether the factor was natural or technical on the one hand as opposed to social or cultural on the other.[1] It is not difficult to see that any one factor may be classified under several schemes. For example, transportation cost is classified as (1) general, (2) regional, and (3) technical.

Weber's Theory Viewed as New Terminology and New Theoretical Constructs

Alfred Weber introduced many new terms and theoretical aids to the literature of location theory. As an aid to understanding his system, these terms and concepts will be explained pair-wise with each pair adding to the ability to understand the next. "Unpaired" terms and concepts will also be explained. Here are some of the more important of these concepts:

Ubiquities and Localized Materials

Ubiquities are materials that are omnipresent. Examples of ubiquitous materials included water, wind, and air. These inputs have the same price everywhere. Ubiquities can affect location by adding weight to the final product. Localized materials are materials confined

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[1] Ibid., p. 21.

to geographically "fixed" or defined areas. Weber felt that all material inputs could be classified as either localized or ubiquitous, but it was not predetermined for all time whether any industrial material would remain in one category or the other.[1] Localized material inputs would have an obvious affect on location because of the need to either transport the input to the place of production or transport the place of production to the input.

Pure Materials and Gross Materials

Pure materials are localized inputs whose total weight is reflected in the weight of the final product. A characteristic of pure materials is that they can never bind production to their place of deposit, since they enter into production without loss of weight. Gross materials are localized inputs which contribute only part of their weight or no weight to the weight of the final product.[2] Weber felt that all inputs could be classified as either pure or gross. Another name used by Weber (and more popular with later writers) for gross materials was "weight-losing materials."[3] Weight-losing material inputs have

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[1]Stuart Daggett, "The System of Alfred Weber," Readings in Economic Geography, pp. 58-9. Also see Stuart Daggett, Principles of Inland Transportation (New York: Harper and Row, 1928). Also see Weber, Location of Industries, pp. 50-51, 59.

[2]Weber, Location of Industries, p. 61.

[3]Ibid., p. 53.

the unique property of being able to pull production to their site of deposit because of the transportation cost advantage of shipping a finished product (somewhat offset by the fact that it may be more difficult to ship) that weighs less than the sum of the weights of the inputs.

Material Index and Locational Weight

The material index delineates the proportion of the weight of the final product which is composed of localized material inputs. Under such a definition, a product which is made up entirely of pure materials would have a material index of one. The important factor is not the proportion of the weight of materials used, but the proportion of the weight of used localized materials. Weber gave the following description:

> . . . a productive process which for example, uses one ton of localized materials plus half a ton of ubiquities has a material index of one, so also has one which uses a whole ton of ubiquities in addition to one ton of localized material. . . .[1]

The locational weight is the total weight to be moved per unit of product. This measure has a minimum value of one when the material index has a value of zero, i.e., a product made out of ubiquitous inputs only. The value of the locational weight rises in value parallel to the value of the material index so that the value of the locational weight will be two when the material index is one. A low locational weight indicates a small mass of material

[1]Ibid., p. 60.

inputs per ton of product to be transported and vice versa.[1]

Isodapane

An isodapane is a line representing the locus of points of equal (not minimum) transportation costs. Weber introduced the isodapane in order to consider deviations from the minimum transportation cost location that can be accounted for by differences in labor costs and other production cost differentials. They were considered by Palander to be one of Weber's few original contributions to location theory.[2] But in contrast to Palander and E. M. Hoover, Weber used isodapanes in a marginal rather than a total sense. To Weber an isodapane was the locus of points representing the same increases of transport cost over that cost at some minimum transport cost point.[3] "Isodapane" is derived from the Greek words isos, "equal" and dapene, "expenses" or "costs." The locus of equal total transportation costs points found by moving from any one material input point or consumption point (both of these are parts of a locational triangle to be defined later) has been

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[1]Ibid., p. 108.

[2]Tord Palander, Beiträge zur Standortheorie (Uppsala, Sweden: Almquish och Wiksells, 1935), Chapter 8, also see Hoover, Location Theory and the Shoe, p. 42.

[3]Isard, Location and the Space-Economy, p. 130.

called an "isotim."[1] When there are two or more of these points the isotims for each material input point and consumption point will intersect. The points of intersection of the various isotims representing equal total costs are the isodapanes. Beyond this, Weber designated one particular isodapane (for any given situation) as being more important than the others. This was the "critical isodapane." As one moves away from that location of production where transportation costs are minimum out to an isodapane, representing a deviation in transport costs[2] from the minimum point, a point is reached which any economies gained through location at a low labor cost site (a reason for the deviation in the first place) can no longer compensate for the increased transport cost. This is the critical isodapane. In general, one can easily see how Weber's theory involved the substitution of transportation costs for non-transportation costs (and the resulting physical inputs). According to Weber this is an example of ". . . the power of labor location (its ability to substitute

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[1]William Alonso, "Location Theory," Regional Development, p. 91. The isotim and isodapane are constructed in analogy to the term "isotherm" found in geography, see Weber, Location of Industries, p. 102. Weber did not use isotims.

[2]These transport costs are meant to include the cost of bringing inputs to the place of production and the cost of sending the final product to the place of consumption.

'labor orientation' for 'transport orientation'). . . ."[1] This seems to be the principle of substitution. In retrospect, this is yet another common point in comparison of Weber and Thünen. Thünen substituted transportation cost for rents; Weber substituted transfer costs for non-transfer costs.

Location Triangle and Weight Triangle

The location triangle was a pedagogical device used by Weber to illustrate, graphically, how the minimum transportation cost point could be determined. There is evidence that Wilhelm Launhardt used the device before Weber.[2] Böventer called such a development the "Weber-Launhardt model." After discussing the model, he made the following acute observation:

> . . . the industrial location theory as represented by Weber's models and location triangles was first formulated in terms more reminiscent of physical science than of economics, and thus stood quite apart from general economic theory.[3]

It is believed that Pierre Varignon, a mathematician of the eighteenth century, was the first to use the idea to

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[1]Weber, Location of Industries, p. 104. Predöhl, "The Theory of Location and Its," p. 387, stated that the principle used by Weber ". . . though nowhere explicitly discussed, is identical with the principle of substitution. . . ." The quote given above seems to be quite explicit to this author.

[2]Wilhelm Launhardt, "Die Bestimmung des Eweckmaessigsten Standortes einer gewerblichen Anlage," Zeitschrift des Vereines Deutscher Ingenieure 26 (1882): 107.

[3]Böventer, "Towards a United Theory," p. 326.

illustrate the parallelgram of forces as used in physical sciences and mathematics.[1] Weber referred to Varignon several times.[2] Thus, was Dean mistaken in his early study of Weber when he stated that Weber had "invented" this ". . . simplified conceptual device . . ."?[3] This author believes that, at least in one sense, Dean was not mistaken. This could be another example of Robert Merton's multiple discoveries, since calendrical time is ignored by that theory. More properly, this could be an example of multiple "applications" of the same theory. Launhardt and Weber both developed the concept as applied to location theory completely independent of each other.

Although Weber did account for more complicated cases, he usually assumed two material input locations and one point of consumption. The distances between these points modified by the "weights" of the pulls exerted at each of the three points would determine a fourth point--the location of manufacturing production. Weber believed that a corner solution was very likely under these conditions.

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[1]Robert A. Kennelly, "The Location of the Mexican Steel Industry," Readings in Economic Geography, p. 138. Also see Robert A. Kennelly's article in Revista Geografica, tomo XV, no. 41 (1954), pp. 109-129; tomo XVI, no. 42 (1955), pp. 199-213; tomo XVII, no. 43 (1955), pp. 66-67.

[2]Weber, Location of Industries, pp. 64, 55-58, and 227-239.

[3]William H. Dean, Jr., The Theory of Geographic Location of Economic Activities: Selections from the Doctoral Dissertation (Ann Arbor, Michigan: Edward Brothers, Inc., 1938), p. 13.

Production would be located at the place of consumption unless at least some weight-losing materials were used in the production process. In the extreme case, location of production would be at either one weight-losing input point or the other if the weight of that input exceeded the sum of all the other weights, i.e., a "dominant weight." If none of these corner solutions were the result, then a corresponding "weight triangle" could be determined to represent the weights which just offset each other.[1] Weber did not use the terms "location triangle" or "weight triangle." He used the terms "locational figures" and "weight figures" to emphasize the fact that the triangle arrangement is a special case involving three points. Georg Pick, a mathematician who wrote an appendix to Weber's book, did use the "triangle" terminology.[2] Pick's work is quite interesting in several ways. Friedrick stated in the preface to Weber's text that he hoped ". . . the indulgent reader will not feel as did that student who wrote on top of Alfred Marshall's mathematical appendix to his Principles: 'A bad case of appendicitis--cut it out.'"[3] Pick's work is much "purer" than Weber's

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[1]Ibid., p. 16.

[2]Weber, Location of Industries, pp. 228-29. The details of Pick's life are unknown. The enigmatical Pick wrote only one book. The subject of this text was not mathematics but dealt with religion in Germany, see Georg Pick, Die Religion der Freien Deutschen, eine deutung des Weltgeschehens (Berlin: W. Hoffman, 1937).

[3]Weber, Location of Industries, p. viii.

which is surprising given Weber's desires to develop a "pure" theory. Pick's analysis reduces complicated passages containing Weber's "pure" analysis into simple equations and diagrams. The appendix obviously follows Weber's text; but, in the text, Weber consistantly referred to explanatory notes found only in Pick's appendix. The logical conclusion is that Weber inserted references to Pick's appendix before the first edition was issued, because the first edition also contained the notes.[1]

Whatever the solution, corner or otherwise, the place of production represented a point of minimum total transportation costs. From this point of "transportation orientation" deviations could be accounted for through the device of isodapanes by "labor orientation" and "agglomeration."

Agglomerations and Deglomerations

> An agglomeration factor, for purposes of our discussion, is an "advantage" or a cheapening of production or marketing which results from the fact that production is carried on to some considerable extent at one place, while a deglomerative factor is a cheapening of production which results from the decentralization of production (production in more than one place).[2]

Among the factors which Weber listed as agglomerative were (1) enlargement of plant, (2) development of technical equipment, (3) development of labor organization

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[1] Ibid.

[2] Ibid., p. 126.

(management), (4) saving in general overhead costs as production is expanded, and (5) marketing factors including buying and selling on a large scale, the ability to obtain cheaper credit when dealing with large volumes, and the reduced price obtained when purchasing raw materials in large quantities. One cannot help but be reminded of Alfred Marshall's internal and external economies when reading the above list.[1] There is no evidence to indicate that Weber had (or had not) read Marshall.

Weber felt that there was only one "general" type of factor, i.e., he contended that the deglomerative factors could result only from "too much" agglomeration. The only resulting opposing force which Weber allowed was increased land rents due to increased agglomeration. So, a theory of location rent entered Weber's theory through the back door (if only implied) and stayed in the background. It is a fact that industrial location theory has tended to ignore rent. Michael J. Webber listed this as one of the distinguishing differences between agricultural location theories and point location theories (of which Weberian industrial location theory is a part).[2] If the analogy of A. Weber's agglomerative forces to Marshall's

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[1]Alfred Marshall, Principles of Economics, 7th ed. (London: Macmillan and Co., 1916 (1890)), p. 266. Also see the entire chapter x, "Industrial Organization," which will be reviewed in detail below.

[2]Webber, Impact of Uncertainty on Location, p. 49.

economies of scale were totally correct, then one could point to Weber's lack of recognizing internal and external diseconomies as a major deficiency of his theory. Indeed, there are indications in the literature that the analogy to Marshall (while not incorrect) is not enough to explain the meaning of Weber's agglomerations. Hoover has stated that the "least satisfactory" part of Weber's theory and thus the part that reflects "greatest deficiency" is that it combines three distinct influences on production cost: (a) large-scale economies, (b) localization economies, and (c) urbanization economies.[1] One would be hard pressed to show explicit examples of these three categories listed by Hoover, but Hoover contended that this objection is the precise point, i.e., that ". . . all three are inextricably mingled and further analysis is impossible without a preliminary unscrambling."[2]

Weber argued for the existence of an agglomerative force anytime the critical isodapanes of two or more locational figures intersected. Within the zone of intersection of the critical isodapanes, production could be carried out with enough savings to justify moving from least transportation cost points (separate such points for each industry or firm involved) to a new point of "agglomeration

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[1]Hoover, Location Theory and the Shoe, p. 90. Note that Tord Palander also made this point, see Palander, Beiträge, Chapter 8.

[2]Hoover, ibid., p. 91.

orientation." Hoover pointed to Palander's criticism that this analysis implicitly assumed that both producers move simultaneously and with perfect certainly (i.e., they must be absolutely sure that the others will also move) or else the advantage would not be gained. Weber also failed to explain how the exact location in the zone of intersection would be determined.[1]

Recall that Weber felt that agglomerations resulted in part from ". . . the social nature of production which could not be discovered by analyzing an isolated process of production."[2] To this author it seems contradictory that Weber later contended that deviations from the least transportation cost point could be accounted for by an "index of manufacture"[3] (i.e., an index of value added through manufacture) as a measure of agglomerations in a manner analogous to an "index of labor" used to justify the

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[1]There have been many critics of the Weberian system. Some of the more important include: Ohlin, Interregional and International Trade, p. 204; Hans Ritschl, "Reine und historische Dynamik des Standortes der Erzeugungszweige," Schmollers Jahrbuch LI (1927): 824; L. von Bortkiewicz, "Eine geometrische Fundierung der Lehre vom Standort der Industrien," Archiv für Sozialwissenschaft und Sozialpolitik xxx (1910): 767-71; L. von Bortkiewicz, "Letter," Deutsche Literaturzeitung xxxi (1910): 1717-24; Joseph A. Schumpeter, "Letter," Jahrbuch für Gesetzgebung, Verwaltung und Volkswirtschaft xxxiv (1910: 444-47; Predöhl, "Theory of Location and Its," p. 364; Lösch, The Economics of Location, p. 28.

[2]Weber, Location of Industries, p. 125.

[3]Ibid., pp. 164-6.

"labor orientation." For an absolutist point of view, this would be an inconsistency in Weber's model. Weber warned us that we should remember that a lot of assumptions had been made while constructing the index, but this warning is not enough. His "pure" theory simply did not allow one to deduce from given premises (and a method of isolated investigation) factors which are "social" by nature.

Other than the foreshadowing found in Alfred Marshall, this author gives Alfred Weber full credit for sound and original analysis of the economics of agglomeration. Other authors were found in non-economic disciplines who used the word "agglomeration" before Weber. Although some of these used the word in the same spirit as Weber (i.e., in reference to crowded towns, etc.), none of them had actual analysis and no evidence was found to indicate that Weber had read these accounts.[1]

Summary and Conclusions

Alfred Weber's economic analysis was "social" in many aspects. Although it might not be considered "economic sociology" in the sense used by Schumpeter and Max Weber, the work did account for many interactions, interdependencies, and interrelations not usually found in economics. An argument was made to point out the similarity

[1]For exceptions to this statement see Chapter VIII of this thesis. Most of these uses of "agglomeration" were descriptive in nature.

between Alfred Weber's "pure theory" and Max Weber's "ideal type."

Weber and Thünen were compared with favorable results. Evidence was found to indicate that both theories may be a part of a general location theory. Within this larger framework the theories may be procedurally opposite, but each theory only allows a different factor to vary. Both theories are considered to be "least-cost theories" of location. In both theories the principle of substitution applied to some aspect of transportation cost to maximize profits (or rents).

Weber developed an analytically "pure" system based on ceteris paribus analysis and "as if" methodology using simplifying assumptions. Weber abstracted from demand. In retrospect, perfect competition may be the best market structure to apply to his model, but little evidence was found to substantiate the claim that he assumed (even implicitly) such a structure.

The Weberian model had three classification systems for "locational factors." Any one factor could be listed in all three systems, e.g., transportation costs. Weber introduced many new concepts and theoretical constructs. These new terms included ubiquities, localized materials, pure materials, gross (weight-losing) materials, the material index, the locational weight, isodapanes, the locational figure, the weight figure, agglomerations, and deglomerations.

His particular use of the locational figure (triangle) and his development of isodapanes and agglomeration factors are viewed as his most outstanding contributions to location theory.

Using Britton Harris' model dimensions,[1] this author would classify Weber's model as being analytical, partial, micro, static, deterministic, and simultaneous.

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[1]Harris, "Quantitative Models of Urban Development," p. 367.

CHAPTER IV

THE ROOTS OF LOCATION THEORY: CHRISTALLER

Introduction

Walter Christaller (1893-1969) was a German geographer from Bavaria.[1] Few details of Christaller's life and studies were available to scholars until the recent publication of his unusual essay, "How I Discovered the Theory of Central Places."[2] In an autobiographical fashion, Christaller reported the way in which his scientific development carried him to the development of his central place theory. In his youth he was fascinated by atlases and maps. He began his studies of statistics, sociology, geography, and national economy in 1913 at the University of Heidelberg. At Heidelberg Christaller was a student of

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[1]Arthur Getis and Judith Getis, "Christaller's Central Place Theory," Journal of Geography 65 (May 1966): 220. Also see R. G. Putman, F. J. Taylor, and P. G. Kettle, eds., A Geography of Urban Places (Toronto: Methuen, 1970), pp. 68-73.

[2]Walter Christaller, "Wie ich zu der Theorie Der Zentralen orte Gekommen Bin," Geographische Zeitschrift 56 (June 1968): 88-101. For the English translation quoted here, see P. W. English and R. C. Mayfield, eds., Man, Space, and Environment (New York: Oxford Press, 1972), pp. 601-610.

Alfred Weber. Although Christaller was not Weber's student until four years after the publication of Weber's Theory of the Location of Industries, Christaller contended that he ". . . witnessed the efforts of my teacher Alfred Weber in Heidelberg to create an industrial location theory."[1] His studies were interrupted by World War I, marriage, and the need for money. During the break he was associated with Adolf Damaschke's League of German Land Reformers where he studied construction and settlement affairs. He also gained experience in planning while working in Berlin as a city planner. Christaller did not resume his formal studies until 1930 at the University of Erlangen where he studied under Robert Gradmann. Inspired by papers of Hans Mortensen and Hugo Hassinger, Christaller wrote and delivered a paper to Gradmann's seminar entitled, "A Geography of Values." This title reflects Christaller's strong interest in economics that will be noted throughout this thesis. Although Gradmann and Christaller had major differences in methods and approach,[2] Christaller wrote his doctoral thesis under Gradmann on the laws governing the distribution of cities. This thesis was published as

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[1]Christaller, "How I Discovered," p. 602.

[2]Christaller characterized his methodology as "between national economy and geography," whereas Gradmann's methodology was between "geography, botany, and history," see Christaller, "How I Discovered," p. 607.

Christaller's Die Zentralen Orte in Süddentschland.[1] Christaller's personal life effected his academic life. As Gould reported in a popular magazine, ". . . Walter Christaller has lived a penurious existence beyond the walls of German universities."[2] As a distressed young German in the 1920's, he joined the Communist Party. Although in later years his theories were attacked by Soviet geographers, the United States government refused to issue him a visa. So, although he has received honors from the International Geographical Union and the Gold Medal from the King of Sweden (that country's highest geographical award), the Association of American Geographers was forced to present their highest award to him in absentia.[3] In the later years of his life, Christaller worked and lived at Jugenheim, Germany.

Geography and Economics

Although Christaller considered himself to be a geographer,[4] his book uses economic theory and methods in

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[1]Walter Christaller, Die Zentralen Orte in Süddentschland (Jena: Fischer, 1933), trans. Carlisle W. Baskin as Central Places in Southern Germany.

[2]Peter R. Gould, "The New Geography," Harper's Magazine, March 1969, p. 92.

[3]Ibid., p. 94.

[4]Christaller, "How I Discovered," p. 610.

order to solve geographical questions and problems.[1] He considered his "geography of settlements" to be a part of economic geography. One can note an anti-historical school theme in Christaller's text when he justified using an economic geography with a high theoretical content.

> . . . the economic geographer thinks in general that he is able to do without theoretical economic knowledge; he is satisfied with statistics, applied economics, and economic history. When economic geography, with its subdivisions, raises itself from an essentially descriptive discipline (which explains facts only in single cases) to a discipline which strives fundamentally to find laws, it steps up alongside of the disciplines of physical geography.[2]

Central place theory would draw upon economic theory to explain the character and distribution of towns. At the same time, Christaller realized that his approach was so new that it might be misinterpreted.

> Is what we have offered in the present study economic geography or national economics? This question will be posed by many a reader. The geographer will tend to call it national economics; the economist will tend to call it geography.[3]

This confusion might account for the fact that most economists tend to ignore Christaller, but it is interesting that Christaller's book was translated by an economist,

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[1]Harry W. Richardson, Regional Economics (New York: Praeger Publishers, 1969), pp. 156-7.

[2]Christaller, Central Places, p. 201. For a comparison of economics to economic geography, see R. B. McNee, "The Changing Relationships of Economics and Economic Geography," Economic Geography 35 (1959): 189-98.

[3]Christaller, Ibid.

not a geographer.[1] Given economic geography's descriptive bias, most geographers originally considered the book to be too abstract and too theoretical.[2] Many of his basic concepts were ridiculed by geographers.

> My hexagons were laughed at. At some banquet or other, a hexagon was drawn on my placecard. Once, when I was commenting on the numerical series of the hierarchy of central places, their numbers, and their distances, I heard one of the most prominent geographers mutter: "That's just a magic of numbers."[3]

Before the spatial aspects of economics became popular, most economists ignored his work out-of-hand because, (1) it was presumed to be geography or economic geography, and (2) it was written in German and not translated (and published in English) until 1966.

Christaller addressed himself to the specific question as to whether historical research and/or the statistical method could yield a "general" answer to his geographical questions and problems. He concluded that although both forms of research were useful, the use of ". . . economic theory should be brought into play when the organization

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[1]See Carlisle W. Baskin, "A Critique and Translation of Walter Christaller's Die zentralen Orte in Süddeutschland" (Ph.D. dissertation, University of Virginia, 1957). Baskin's translation was originally suggested by Dr. Rutledge Vining (an economist) and was sponsored by the Bureau of Population and Economic Research at the University of Virginia.

[2]Christaller's work has inspired major efforts in theoretical geography. W. Bunge stated that "One man must be championed as the father of theoretical geography--Dr. Walter Christaller." See William Bunge, Theoretical Geography (Lund: C. W. K. Glerrup, 1966), p. vii.

[3]Christaller, "How I Discovered," p. 610.

of the city is to be explained, . . ."[1] That is, when one is seeking valid "laws," one cannot use the historical method and/or statistical method alone. He felt that these methods were best used to verify a theory based on economic laws. Such an argument was based upon the assumption that there are "laws" in economic theory. This was a question that Christaller did not want to face, but he did concede that economic science may be filled with "tendencies" rather than with "natural laws" found in the physical sciences.[2] But abstracting from this concession, he assumed that "special economic-geographical laws" of the geography of settlements could be logically deduced from the laws of economic theory.

Christaller and the Webers

Christaller was Alfred Weber's student at the University of Heidelberg beginning in 1913. There is evidence that Weber's work had a lasting influence on Christaller. Weber's influence is not so much reflected in Christaller's model *per se*, but it can be seen in his constant references to Weber and in his methodology. In fact, Christaller specifically ignored that portion of location theory which he felt belonged to Weber's model.

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[1] Ibid., p. 606.

[2] Christaller, *Central Places*, p. 3.

> Thus, we have disregarded, above all, the entire complex of the determination of urban development through industrialization, which falls more in the scope of the theory of the location of industry as it is discussed by Alfred Weber. . . . We have been satisfied with developing the primary net of central places, on which the phenomena of industrialization may be superimposed.[1]

It is interesting to note that Weber came very close to developing a central place theory as a system of settlements. Such a development occurred when Weber discussed the agglomeration of industries at the intersection of two or more critical isodapanes. Such intersections justified the gathering or agglomerating of industries to gain economies in operation. Weber translated this theory into a discussion of population centers.

> Density of population empirically has two aspects; (1) density of the population of a particular locality = quantity of production of the units of production; (2) number of centers of population = distribution of the individual units of production.[2]

This is as far as Weber took the translation of his theory, but there is evidence that this passage influenced Christaller.[3]

A. Weber's influence on Christaller is quite explicit in the realm of methodology. Christaller's work has been

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[1]Ibid., p. 198.

[2]Weber, Location of Industries, pp. 149-50.

[3]Christaller, Central Places, p. 71. Eric E. Lampard, "The Evolving System of Cities in the U.S.," Issues in Urban Economics, p. 83, stated that Christaller saw his theory as rounding out and complementary to Thünen's and Weber's.

called a "general purely deductive theory."[1] He abandoned the descriptive inductive method usually found in geography for that method emphasized by Weber.

> . . . the usual method of those engaged in geographical investigations will be discarded in the construction of the study under consideration. . . . The work will begin, . . ., not with a descriptive statement of reality, but with a general and purely deductive theory. . . . The theory, . . ., cannot be derived inductively, but only deductively.[2]

Christaller felt that economic theory could be divided into "general" theory and "special" theory. A. Weber's influence can be seen here also. To Christaller, the general theory was concerned with economic relationships which

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[1]Brian J. L. Berry and Allan Pred, "Walter Christaller's Die Zentralen Orte in Süddeutschland--Abstract of Theoretical Parts," in Readings in Economic Geography, p. 65. Also see Brian J. L. Berry and Allan Pred, Central Place Studies--A Bibliography of Theory and Applications (Philadelphia: Regional Science Research Institute, Bibliography Series No. 1, 1961), pp. 15-18. For a contrary opinion see Gunnar Olsson, "Central Place Systems, Spatial Intersection, and Stochastic Process," Papers of the Regional Science Association 18 (1966): 192. Olsson contended that Christaller used "induction" to arrive at his theory (without proof). This point may be separate from the major portion of Christaller's model since (1) Christaller used the complete scientific method, and (2) Olsson was referring only to Christaller's hexagon pattern. M. F. Dacey, "The Geometry of Central Places Theory," Geografiska Annaler, 47B (1965): 112, indicated that Christaller ". . . took the hexagonal lattice as given."

[2]Christaller, Central Places, p. 4. Christaller claimed to be influenced by Sombart on this point. See Werner Sombart, Die drei Nationalökonomien, Geschichte und System der Lehre von der Wirtschaft (Munich and Leipzig: Duncker and Humbolt, 1930). Elsewhere Christaller also agreed with Sombart's assessment that Alfred Weber was too mathematical, see Christaller, Central Places, p. 70, and Werner Sombart, "Einige Anmerkuugen zur Lehre vom Standort der Industrien," Archiv für Sozialwissenschaften und Sozialpolitik 30 (1910: 752.

are effective and exist in every past and future period, for all peoples, and in all countries. The "laws" of general theory would be valid at all times and in all places ". . . regardless of the concrete time and local distinctions of economic systems."[1] He felt that the special theory was different in that it developed rules and laws which were valid only for a specific economic system as determined by time and culture.[2] Christaller hoped that central place theory would be a "general" or "pure" theory in the sense explained here. As stated earlier, this was a new approach for a geographer to take.

> The economic method, in the pure form in which we have applied it here, had not, up to now, been applied in the geography of settlements or, incidently, in economic geography.[3]

In his autobiographical essay, one can also find an extension of Christaller's schema.

> Thus, I first of all, as is said today, developed an abstract economic model. This model is "correct" in itself, even if it is never to be found in the reality of settlement landscape. . . .[4]

Thus, Christaller believed that the "pure" or "general" theory had validity completely independent of what reality

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[1]Christaller, Central Places, p. 133.

[2]Christaller stated specifically that his "special" theory was the same as Alfred Weber's "realistic" theory, and that his "general" theory is the same as Weber's "pure." See Christaller, ibid.

[3]Ibid., p. 198.

[4]Christaller, "How I Discovered," p. 608.

looked like, but only by virtue of its logic and "the sense of adequacy."[1] Here Christaller stated explicitly that this type of methodology, involving a "system or formulation of the question," was the same as Max Weber's "ideal type" or Werner Sombert's "rational scheme."[2] The importance of this statement for this thesis is that it helps verify the contention made by this author (in the chapter dealing with A. Weber) that Alfred Weber's "pure" theory was related to Max Weber's "ideal types." In fact, while discussing aspects of Alfred Weber's work that go beyond (and post-date) his Theory of the Location of Industries (the book in which this author argued that such a relationship existed), Christaller stated:

> When this eo ipso theory is confronted with reality, it becomes clear to what extent reality corresponds to theory, to what extent it is explained by it, and in what respect reality does not correspond with the theory and is, therefore, not explained by it. The unexplained facts must then be clarified by historical and geographical methods, because they involve personal, historical, and naturally conditioned resistances--factors which cause deviations from theory. They have nothing to do with the theory itself, and above all cannot be cited directly as proof against the validity of the theory. Alfred Weber, who followed the same method with great success in his location theory, has termed this method "verification of the theory."[3]

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[1]Christaller, Central Places, p. 4. Also see Max Weber, "Wirtschaft und Gesellschaft," in Grundrib der Sozialökonomie, 2nd ed. (Tübingen: 1925), vol. III, part II.

[2]Christaller, Central Places, p. 9, n. 20. Christaller stated that the correspondence was "approximate."

[3]Ibid., pp. 4-5. Emphasis added.

In this quote the phrase, ". . . this eo ipso theory. . .,"[1] referred to a theory which is true by virtue of its logic and the "sense of adequacy," i.e., a characteristic of "ideal types" according to Christaller's interpretation of Max Weber. The balance of the quote is referring to a "reintroduction of reality" for comparison to the ideal type. Alfred Weber's text is full of short paragraphs within which he attempted (if even in a very abstract way) to discuss such reintroductions.[2] So, in the phrase "Alfred Weber, who followed that method . . .," the word "method" is interpreted as indicating the reintroduction of reality and the eo ipso theory. Such evidence would support the conjecture made by this author.

Christaller made use of Max Weber's "ideal types" elsewhere in the text. When referring to the fact that he did make comparisons to reality, Christaller stated:

> We also made extensive use of the geographical method when we laid out the theoretical pattern of central places over the surface of the globe, and then compared the actual circumstances with the ideal circumstances (the "ideal types" of Max Weber).[3]

That is, Christaller followed the same pattern as Alfred Weber. The "theoretical patterns" or "ideal circumstances"

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[1]The Latin phrase eo ipso translates as "by this very thing itself." Christaller was referring to a "deductively pure" ideal type when he used the phrase.

[2]Recall that a "true" realistic theory was never fully developed by A. Weber.

[3]Christaller, Central Places, p. 200. Parenthetical information shown is found in the original.

were reintroduced into reality by the geographical method (map reading, description, statistics, and inductive reasoning) in order to be compared to the "actual circumstances." Christaller developed an elaborate empirical analysis which followed this pattern to verify his theory.[1] This feature of empirical testing, while planned, was lacking in A. Weber's work.

Although Christaller seemed to draw much from A. Weber, he was not totally satisfied with the Weberian system. As noted above, he agreed with Sombart that Weber's text was too mathematical. He also felt that Weber's use of space was "too abstract." To Christaller, Weber was only interested in whether space is beneficial or restrictive in that, "Its usefulness or injuriousness for the economic man is represented by relatively high or low transportation costs."[2] Such a note from his autobiographical writing helps us to understand the following statement from his text:

> This conception (spatial factors) is lacking in national economics, so that the rational schemes of national economists--as for example those offered by Alfred Weber in relationship to the Theory of Location of Industries--often lack the necessary conception of space and therefore are too denaturalized, as a result of which the value of economic-geographical knowledge is diminished.[3]

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[1]Hirsch has contended that Christaller was the ". . . first to provide a firm empirical base for the observation that cities are distributed in some ordered relationship. . .," see Werner Z. Hirsch, Urban Economic Analysis (New York: McGraw-Hill, 1973), p. 27.

[2]Christaller, "How I Discovered," p. 604.

[3]Christaller, Central Places, p. 201. Emphasis and parenthetical information added by this author.

Christaller did not deny the fact that Weber had used the concept of space (in fact, elsewhere he gave A. Weber and Thünen explicit credit for doing just that),[1] but Weber's use was so abstract and "too denaturalized" to be of use in economic geography. Such reasoning might account for the fact that Weber's location theory has not been popular with geographers.

Christaller and Thünen

Christaller made many references to Thünen throughout his text. He recognized Thünen as the founding father[2] of the analysis necessary to solve problems in economic geography.

> . . . the economist, as well as the geographer, must return to the fundamental and guiding work of von Thünen, The Isolated State, if he wishes to solve economic-geographical problems. . . . His method of isolating and mathematically treating the isolated elements has become indispensable for all investigations into economic theory.[3]

The method of "isolating" was adopted by Christaller. Such a method is represented in Christaller, as in Thünen, by the use of partial ceteris paribus analysis. The outstanding result of using such analysis with space included in the

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[1] Ibid., pp. 6-7.

[2] Johnson stated that "Johann Heinrich von Thünen's Der Isolierte Staat is the first German work in the history of central place theory. . . ." See Hildegard B. Johnson, "A Note on Thünen's Circles," Annals of the Association of American Geographers 52 (June 1962): 213. Emphasis added.

[3] Christaller, Central Places, p. 6.

system has been that Christaller and Thünen both ". . . obtained quite significant results even for the whole space-economy."[1]

The similarities of Thünen's and Christaller's models have been mentioned (but not in detail) in the literature.[2] The essence of the central place theory is that it takes a certain amount of land to support an urban center. The specific difference between the two theories is that in the case of central place theory the supportive land takes the form of "market areas" while in the Thünian location theory that supportive land is in the form of areas of final product (agricultural) supply. The use of Thünen's method of isolation and an explanation of the relationship between the two systems can be seen in the following quote:

> It was clear to me from the very beginning, that I had to develop a theoretical schema for my regional investigation--a schema which, as is customary in national economics, is set up by isolating the essential and operative factors. It was, thus, as in the case of Thünen's Isolated State, abstracted from all natural and geographic factors. . . . I thus followed exactly the opposite procedure that Thünen did; he accepted the central city as already having been furnished, and asked how the agricultural land was utilized in the surrounding area, whereas I accepted the inhabited area as already having been furnished, and subsequently asked where the city must be situated, or, more correctly, where should the cities then be situated.[3]

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[1]Böventer, "Towards a United Theory," p. 327.

[2]Edward L. Ullman, "A Theory of Location of Cities," American Journal of Sociology 6 (May 1941): 853, also see P. K. Hatt and A. J. Reiss, eds., Cities and Society (Glencoe, Ill.: The Free Press, 1957), pp. 227-36.

[3]Christaller, "How I Discovered," pp. 607-8.

It should be noted that while Thünen's analysis has "exactly the opposite procedure" as Christaller's, an argument can be made (as when comparing Thünen to Weber) that both are part of a "larger view" of location theory within which different variables are allowed to change.

Thünen also allowed for more than one "Town" in his system, i.e., he approached a "system" of cities concept even though his model was different. In his famous diagram showing the various rings of agricultural production, he drew in an area for a "small town with its own region."[1] Beyond this, one can find in the section of The Isolated State entitled "Fragments from Inquiries and Plan," a section with the title, "The Order and Distribution of Towns in the Isolated State."[2] Thünen noted that with respect to the number of "Towns" in his system he had made some conflicting assumptions in earlier portions of his book. Most of the time he had assumed that the Isolated State contained only one large town. At other times his system would work better with the assumption that it contained ". . . very many smaller towns, of the same size and equidistant from each other."[3] These inquiries into the reasons for the location and distribution of towns led Thünen into an analysis of the factors influencing industrial location. While

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[1]Thünen, Isolated State, p. 216.

[2]Ibid., pp. 285-91.

[3]Ibid., p. 285.

considering the concentration of industries in large cities, Thünen anticipated some aspects of Weber's analysis of industrial agglomeration. After stating that the two assumptions (a single town or a system of towns equi-distant from each other) were inconsistent and must be abandoned, Thünen listed various reasons why a particular size-distance distribution might be observed. Among the reasons for the population to be located in a large town were:

> (1) Ore, salt, and coal are unevenly distributed. Factories in metals must locate near the deposit. (Thünen assumed that such deposits were only near the Town.)
> (2) The focal center of a country is at the residence of government, offices of administration, army headquarters, schools and colleges, and fine arts.
> (3) Factors listed in reason two (above) attracts scholars, men of the arts (i.e., social attractions and amenities).
> (4) Many people in the artisan and service class are required to cater to the needs of the people assembled in the Town.[1]

Many of these factors will be recognized as "central goods and services" when the details of Christaller's model are given. In addition to these factors, industries would favor the location in the large Town because:

> (1) Only in large-scale industrial plants is it profitable to install labor-saving machinery and equipment.
> (2) The scale of an industrial plant depends on the demand for its products.
> (3) Traffic of buyers and sellers is great.
> (4) Larger plants enable a great division of labor.
> (5) Larger plants enable more specialization of labor.
> (6) The buyers and sellers are more likely to receive the "current price" in a large town.

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[1] Ibid., p. 286. Paraphrased with parenthetical information added.

> (7) Service facilities for industries locate (agglomerate) in large towns.[1]

In opposition to the eleven reasons for central location, Thünen listed three reasons against the location of industries at the center:

> (1) Raw materials are more expensive in the center because of the transportation costs incurred to bring them to the center.
> (2) The manufactured articles (final goods) must be shipped to rural consumers (in market areas) from the center.
> (3) All necessities, especially fuel, are more expensive in the large town. This results in higher rents (deglomerating) at the central location.[2]

In the last two lists, one can find many of the factors that this author discussed while explaining the Weberian system. After analysis of each of these points, Thünen concluded that the weight of the arguments for the location of industries in the country town as opposed to the central "Town" would depend upon the nature of the industry involved. Once again a clear anticipation of Weber can be seen. There is no clear evidence to indicate whether or not Weber had read these "fragments" before he wrote the book Theory of the Location of Industries.

> Factories and workshops processing raw material of little value in relation to their bulk and weight, which need no complicated machinery, no extensive division of labour, and which therefore can supply their products almost as cheaply on a small as on a large scale, belong properly to the provincial towns or even to the countryside itself. . . . All other industries, where the

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[1] Ibid., pp. 287-89, passim. Paraphrased with parenthetical information added.

[2] Ibid., pp. 286-87. Paraphrased with parenthetical information added.

> opposite conditions obtain, have their rightful place in the capital.[1]

Now one can see why Thünen can be considered the true father of location theory independent of any semantical problems with "land use theory" versus "location theory." The seeds of Weber's industrial location theory and Christaller's central place theory can be found in Thünen.

Christaller's Use of Economics

Along with those aspects of economics and the economists referred to up to this point, Christaller made use of many economic tools and theoretical constructs. He was familiar with the works of Adam Smith in addition to Thünen, A. Weber, M. Weber, and Werner Sombart mentioned earlier. Christaller used Smith's concept of economic surplus as a justification for the existence of towns.[2] He also mentioned Smith's use of the division of labor.[3] Christaller was familiar with Gustav Cassel, Friedrich von Wieser, David Ricardo, Carl Menger, and Eugene von Böhn-Bawerk.[4] Christaller gave credit to the "Harms School" for striving ". . . to investigate . . . spatial aspects and to incorporate them

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[1] Ibid., pp. 290-91.

[2] Christaller, Central Places, p. 8, n. 4.

[3] Ibid., p. 48.

[4] Christaller, "How I Discovered," p. 605.

into economic theory."[1] The point to be made is that Christaller had a thorough reading in economics. To emphasize his use of economics, the following quote is given:

> Thanks to my studies of economics, I have now placed the economic points of view of settlement geography into the foreground.[2]

Let us now look at some of the "economic points" used by Christaller. He had a sophisticated understanding of the price mechanism, and he was well aware that if the ". . . price mechanism fails, it creates substitute mechanisms."[3] He used supply and demand analysis throughout the text. He used special terminology such as "elastic" and "inelastic" to describe the shapes of the curves. For example:

> If the demand for a certain type of good (a movie for example) is very elastic, then an increased supply will mean a large increase in consumption. . . . If the demand for a certain good is inelastic (medical care, for example), an increased supply will not bring about a proportionate increase in consumption.[4]

Christaller felt that consumption and demand were not the same, because demands (or wants) were unlimited. He believed that no economic system could exist without the regulater which brings the unlimited wants of man into harmony with

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[1]Ibid., and Bernhard Harms, Volkswirtschaft und Weltwirtschaft, Versuch der Begrüdung einer Weltwirtschaftslehre (Jena: 1912).

[2]Christaller, "How I Discovered," p. 605.

[3]Christaller, Central Places, p. 107.

[4]Ibid., p. 91. Christaller did not mention Alfred Marshall in the text.

the scarcity of goods. In this light, he recognized the "economic principle" of ". . . obtaining the greatest possible satisfaction of wants with the least possible expenditure (least cost). . ."[1]

Throughout his discussion of various types of goods (to be produced at various central places), Christaller maintained a double classification system for reference. He gave the following dichotomies:

> (1) Goods were either of a given quantity (fixed supply) or production could be increased as desired.
> (2) Goods had either a fixed price (by monopoly or by law) or a market price (variable or oscillating).[2]

Christaller made explicit references to profit maximization and competition as rationales for the hexagonal shaped market areas in his system. Others have claimed that such properties were only implicit to Christaller's model.[3]

> . . . the central place at which the highest net revenue is obtained with a certain level of prices and corresponding turnover, and not the central place at which there is merely the greatest turnover will be the central place with the most favorable position. . . .
> . . . this profit margin . . . determines whether or not the one town remains superior to the other in competition. . . . The principle of competition comes fully into play in the case of typical market towns.[4]

Christaller recognized a standard listing of the

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[1]Ibid., p. 134.

[2]Ibid., p. 36. Christaller used the word "monopoly," but he did not refer to "perfect competition."

[3]Böventer," Towards a United Theory," p. 331.

[4]Christaller, Central Places, p. 40.

costs of production. To him these costs included: (1) capital costs (interest), (2) labor costs (wages), (3) revenue costs (profits), and (4) land costs (rent).[1] Interest rates should include a premium for risk and uncertainty according to Christaller. He believed that capital included funds, machines, storage areas, and inventories.[2] His analysis of rent was quite interesting. There were two kinds of rent.

> . . . because it cannot be multiplied or transported, it demands a special position. General rent results from nonreproducibility, and special rent results from nontransportability.[3]

In a short discussion on this topic, Christaller came to two conclusions: (1) The rents of higher order central places are higher than the rents in lower order central places, i.e., that rents are higher in a large town compared to a small town. (2) Rents serve as a brake on centralization, i.e., that rents are deglomerating or decentralizing. One can see the influence of both Thünen and Weber in this analysis. Thünen's analysis was closely related to nonreproducibility and nontransportability with the conclusion that central rents were the highest rent. Weber viewed rents resulting from agglomerations as decentralizing or deglomerative. But once these details were made explicit, Christaller did

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[1]Ibid., p. 95.

[2]Ibid., pp. 95-6.

[3]Ibid., p. 98.

not use rent as an important part of his theory. In this sense, Christaller and Weber used rent in the same way.

This author feels that one of the most important contributions of Walter Christaller was his use of the concept of "economic distance." He gave credit to Hugo Hassinger for an earlier original use of the concept.[1] But, Christaller's analysis can be seen as the basis for much of today's work in urban economics.[2] First of all, he had a basic and clear understanding of what today is called opportunity costs.

> For the farmer . . . who has no fixed working day, the time which he consumes in traveling is always alternative working time. He has to decide whether he will use this time for work or for pleasure. Its value is determined by the value of the quantity of work which he could perform in this time.[3]

Second, he listed "objective" and "subjective" factors which make up economic distance. For example in passenger travel, these factors would include: (1) the cost of transportation, (2) the time required, and (3) the discomforts of travel.[4] The first and second of these factors are objective with the second containing the ideal of opportunity costs.

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[1]Ibid., p. 199. Also see Hugo Hassinger, "Beiträge zur Siedlungs--und Verkehrsgeographie von Wien," in Mitteilunger der Geographischen Gesellschaft 53 (Vienna: 1910), and Hugo Hassinger, "Basel," in Beiträge zur Oberrheinischen Landeskunde, Fred. Metz, ed. (Breslan: 1927).

[2]For example see Alonso, Location and Land Use.

[3]Christaller, Central Places, p. 51.

[4]Ibid., p. 22.

The third of these elements is subjective. Christaller emphasized the various subjective aspects of the central place system.

> . . . because the "pleasurable" trip is valued less than the "unpleasurable" trip. Thus, when we consider the influence of distance on the range of a central good, we must calculate by using a thoroughly subjective element.[1]

Therefore, Christaller made individual subjective calculations at least a part of the basis for his definition of the range[2] of a good. As he stated elsewhere, ". . . the range is not a mathematical but an economic distance."[3] Since the range of a central good will be found to be one of the most important concepts in his system, one might conclude that Christaller's central place theory was not as theoretically exact or "pure" as he claimed.

Christaller's Theory of Central Places

Location Theory and Central Place Theory

Thünen studied the relation of the location of agricultural production to a consuming center. Weber studied the location of manufacturing industry as a function of

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[1] Ibid., p. 51. Emphasis added by this author. Christaller gave an example of traveling to the cinema or to the dentist. The "pleasurable" trip would be valued less than the "unpleasurable" trip in the sense that one would be willing to pay more in order to avoid the disutility associated with the trip to the dentist.

[2] "Range" will be defined later in this chapter.

[3] Ibid., p. 101.

transportation, labor, and agglomeration. Christaller's work attempted to study an entire economic system. In doing so he used political, economic, social, and geographical factors to study a system which was spatially oriented. This is why Beckmann was able to say that,

> . . . some interesting developments occur in location theory at the general equilibrium level under the heading of "central-place theory," a body of theory which has implications for the study of regions that go beyond economics.[1]

Michael J. Webber listed central place theory as the second category under theories of the location of point concentrations.[2] So, one can justify the including of a study of central place theory under a general heading of location theory. Central place theory is a subset of location theory.

The three main writers in "general" location theory can be classified according to the sector of economic activity studied. Thünen's agricultural location theory studied the primary sector. Weber's industrial location theory emphasized the secondary sector. As this section of the thesis will reveal, Christaller's central place theory was based on the distribution of activities that can be classified as

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[1]Beckmann, Location Theory, p. 7.

[2]Webber, Impact of Uncertainty on Location, p. 10. Also see King, "Approaches to Location Analysis," p. 19, for an example of a geographer who places central place theory as a subset of location theory. Also see Peter Haggett, Locational Analysis in Human Geography (London: E. Arnold Pub., Ltd., 1966), pp. 119-25.

the tertiary sector.[1] All three are "general" location theories in the broad sense; all three emphasize a different sector of economic activity.

Central Place Model Assumptions

Christaller's purpose in writing Central Places in Southern Germany was to determine if there were laws influencing the number, sizes, and distribution of towns.

> The truly geographic aim was to be to verify the abstract theory within the reality of a specific landscape, and to show that, in reality, number, size, and distribution of the central places correspond to the theoretical model to a considerable extent.[2]

In order to achieve the abstract theory, Christaller made many simplifying assumptions. These assumptions, model conditions, and model constraints can be outlined as follows:

Assumptions:
(1) An unbounded plain with soil of equal fertility everywhere and an uneven distribution of resources.
(2) An even distribution of population and purchasing power.
(3) A uniform transportation network in all directions, so that all central places of the same type are equally accessible.
(4) A constant range of any one central good, whatever the central place from which it is offered.

Constraints and Conditions:
(1) A maximum number of demands for the goods and services should be satisfied.
(2) The incomes of the people offering the goods and services should be maximized.
(3) Distances moved by consumers to purchase the

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[1]The "tertiary" sector of the economy includes those economic activities dealing with the distribution of goods, the service industries, wholesale-retail, and financing.

[2]Christaller, "How I Discovered," p. 608.

> goods and services should be minimized, i.e., goods are purchased from the closest point.[1]

Other authors have listed assumptions which are said to be implicit to Christaller's system. Böventer stated that at each point on the homogeneous plain ". . . the amount and quantity of the natural resources, the production function, the population density, and the consumer preferences and all other economic and non-economic factors are identical."[2] Parr and Denike have added (1) a system of f.o.b. pricing, i.e., the consumer pays the price at the point of production (the f.o.b. price) plus the cost of transportation to the consumer's location, and (2) no institutional or legal restrictions on the entry of producers into the market.[3] Michael J. Webber added the information that (1) while being a maximum distance apart, the central places are subject to the constraint that their market areas exhaust the plain, and (2) that all central places that provide a function for a particular level (order) also provide the functions of all central places of a lesser order.[4] Dacey has demonstrated

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[1]Getis and Gethis, "Christaller's Central Place Theory," p. 70. M. F. Dacey has reduced these assumptions to mathematical statements, see Dacey, "The Geometry of Central Place Theory," pp. 116-7.

[2]Böventer, "Towards a United Theory," p. 331.

[3]John B. Parr and Kenneth G. Denike, "Theoretical Problems in Central Place Analysis," Economic Geography 46 (July 1970): 568.

[4]Webber, Impact of Uncertainty on Location, p. 26.

that the combination of all the assumptions and constraints listed above implies that central places are located in the center of hexagonal market areas.[1] Lösch also developed a central place theory with hexagonal market areas,[2] but Lösch gave Christaller credit for the earlier development.[3] Christaller was kind to Lösch by stating that Lösch had worked "independently."

> It is interesting that, almost simultaneously, but completely independently from my work, August Lösch in America discovered central place systems similar to mine--my book appeared in 1933, his in 1940. The problem has, thus, "been in the air."[4]

If Christaller's statement were correct, then this could be another example of Robert Merton's multiple discoveries; but, there is too much evidence that Lösch used Christaller as a building block.

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[1]Dacey, "The Geometry of Central Place Theory," p. 117. For a contrary opinion see Edwin S. Mills and Michael R. Lav, "A Model of Market Areas with Free Entry," Journal of Political Economy 72 (June 1964): 278-88. Mills and Lav were critiquing Lösch's hexagonal market area argument, but it is the opinion of most writers that Lösch's is an extension of Christaller's model. Lösch was able to show that Christaller's model was a special case in the Löschian system, see Wolfgang Stopler, "Spatial Order and the Economic Growth of Cities," Economic Development and Cultural Change 3 (January 1955): 139.

[2]Lösch, "The Nature of Economic Regions."

[3]Ibid., p. 77, and August Lösch, The Economics of Location, trans. W. A. Woglom (New Haven: Yale University Press, 1954), p. 114, n. 4. Lösch also noted that Launhardt developed such a pattern, see Wilhelm Launhardt, Mathematische der Volkswirtschaftslehre (Leipzig: B. G. Teubner, 1885), p. 181.

[4]Christaller, "How I Discovered," p. 610.

Dacey contended that Christaller did not develop the central place system from the assumptions of the system (as Dacey did) but ". . . simply stated properties of the system."[1] This observation along with Olsson's statement that Christaller ". . . arrived at this pattern inductively and without proof. . . ,"[2] makes one question just how "purely deductive" Christaller's model was in reality. Once again, Christaller's autobiographical essay helps the researcher to see that perhaps this aspect of his theory was more inductive than deductive.

> In Erlengen, I studied. . . . At the same time, I continued my games with maps: I connected cities of equal size by straight lines, first of all, in order to determine if certain rules were recognizable in the railroad and road network, whether regular traffic networks existed, and, second of all, in order to measure the distances between cities of equal size.
>
> Thereby, the maps filled with triangles (the distances of cities of equal size from each other were thus approximately equal), which then crystallized as six-sided figures (hexagons).[3]

Such a statement seems to indicate induction more than deduction. Christaller was actually using the scientific method of problem solving which is composed of three parts: induction, deduction, and verification. There is nothing wrong with this procedure. The point to be made here is to determine how Christaller actually began the cycle of the

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[1]Dacey, "The Geometry of Central Place Theory," p. 115.

[2]Olsson, "Central Place Systems," p. 192.

[3]Christaller, "How I Discovered," p. 607.

scientific method.[1] Did he begin with particular observations (as in induction)? Or, did he begin with general premises, definitions, and laws (as in deduction)? The first section of his book does use the deductive method. The argument that this deductive section was not based entirely on "purely" deductive processes is also confirmed by the following quote:

> My goal was staked out for me: to find laws, according to which number, size and distribution of cities are determined. The way to accomplish the task still remained, however, to be discovered.[2]

This may seem like a "chicken-and-egg" argument which is resolved by looking at the "large" view of Christaller's system, but one is always interested in extra insights provided by scholars. In this case, the autobiographical insights provided by Christaller seem to contradict other information found in his text.

Three Principles of Location

Christaller presented three guiding principles which could be used to explain the numbers, sizes, and distribution of cities. These principles were the market (or supply) principle, the traffic principle, and the separation

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[1]For evidence that Christaller was using the complete scientific method see R. Roberge, review of Central Places in Southern Germany, by Walter Christaller, in Canadian Geographical Journal 75 (August 1967): v-vi.

[2]Christaller, "How I Discovered," p. 607. Emphasis added by this author.

(or administrative) principle.[1] The first two principles are economic; the last principle is sociopolitical.

The marketing principle was the chief law in Christaller's system involving central functions, central goods, and the range of goods.[2] Central places were determined based on functions performed, not on population counts.

> . . . one can see that central place is not equivalent to town, because it refers to only one important characteristic of a settlement, namely, its possession of a central function.[3]

and,

> This life of a town, that is, its importance, is not necessarily parallel to the number of inhabitants, for it is possible that a surplus of importance exists and that most central places possess such a surplus.[4]

The goods and services necessary to provide central functions (and other functions) were classified into three groups: (1) central goods and services, (2) dispersed goods and services, and (3) indifferent goods and services.[5] The central goods and services used to determine the "importance surplus" of a central place are in the tertiary sector of economic activity. These central goods and services included: (1) trade (the act of exchange),

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[1]Berry and Pred, "Walter Christaller's," p. 66.

[2]Brian J. L. Berry and William L. Garrison, "The Functional Bases of the Central Place Hierarchy," Economic Geography 34 (1958): 145.

[3]Christaller, Central Places, p. 139.

[4]Ibid., p. 18.

[5]Ibid., p. 19.

(2) banking (commerce and finance), (3) handicrafts, (4) state administration, (5) cultural activities, (6) religious activities, (7) educational activities, (8) professional and business organizations (e.g., unions), (9) sanitation facilities, (10) transportation facilities, (11) communication facilities, and (12) other goods and services of social importance.[1]

The region for which a central place is the center of central functions was called "the complementary region."[2] Central places with many central functions (relative to those with fewer such functions) were called "central places of a higher order." The higher the order of the central place, the larger is the complementary region. The ideal complementary region was "ring" in shape with two definite boundaries. This ring determined the "range" of a particular central good or service.

> The lower limit circumscribes the region with the smallest number of sales which must exist in order to offer the central good at a central place in this region, while the upper limit circumscribes that region in which sale of the central good may be possible at all. . . . These range-limits run in closed curves, and are more or less circular, i.e., the curves are isolines.[3]

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[1] Ibid., p. 20 and pp. 140-1.

[2] Ibid., p. 21.

[3] Ibid., p. 60. Berry and Garrison have called the lower limit of the range of a central good or service the "threshold," see Brian J. L. Berry and William L. Garrison, "A Note on Central Place Theory and the Range of a Good," Economic Geography 34 (1958): 304, and Brian J. L. Berry and William L. Garrison, "Recent Developments of Central Place Theory," Papers of the Regional Science Association IV (1958): 107-30.

In isolation the complementary region would define a market area for the central good or service with a circular shape reminiscent of the isolated "Town" and supportive agriculture area found in Thünen's analysis. The hexagonal market area patterns described by Christaller resulted from the necessity to serve the entire region with central goods and services. Without such a shape, the complementary regions would either overlap or leave gaps of market area unserved. For the size classes of central places, Christaller found a constant mathematical ratio following the sequence 1,2,6,18,54,... Since each higher order central place contained the functional characteristics of all lower order centers, the number of complementary regions increased in the ratio 1,3,9,27,81,...[1] Thus, the market principle accounted for the basic pattern of settlements in Christaller's system. In a ceteris paribus fashion, he used the other two principles to account for deviations from the basic hexagonal pattern.

The market principle was a spatial concept. The traffic principle accounted for linear deviations in that spatial system. Depending on the form of the transportation, Christaller believed that there could be opposite effects in the system.

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[1]Richardson, Regional Economics, p. 159, and Christaller, Central Places, p. 65.

> It is rightly said that automobile traffic results in decentralization. Herein lies the most important difference from the effects of the railroad, which, by necessity, preferred the centers and enabled them to gain importance.[1]

The economic traffic principle formally stated was ". . . to satisfy as many demands for transportation as possible with a minimum cost."[2] If the traffic principle were left to work alone, then central places would be in "star-shaped" patterns along straight lines equidistant from each other (i.e., a linear relationship).

The separation principle was an attempt on Christaller's part to account for deviations in the basic pattern that are socio-political in nature. He felt that the "separateness of human communities" was counteracted by an idea of community and the need for defense and protection.[3] Although the attempt on Christaller's part should be praised, his analysis was very limited. By including this aspect of reality, Christaller explicitly recognized that location theory is more than economics alone.

Although he felt that the market principle was the most important principle, it was only through the combination of all three principles that one could arrive at a

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[1]Christaller, ibid., p. 106. Christaller gave credit to Johan G. Kohl for developing the "traffic" principle, see ibid., p. 74, n. 33.

[2]Ibid., p. 74.

[3]Ibid., p. 77.

"compromise location."[1]

> . . . the market, the traffic, and the separation principle determine the distribution, sizes, and number of central places. We may call these principles laws of distribution of central places or laws of settlement which fundamentally and often determine, with astonishing exactness, the location of central places.[2]

In discussing Christaller's contributions to central place theory, this author has been primarily interested in Christaller's use of economics and his methodology. One should also note that there is a body of literature dealing with the various criticisms[3] of his theory which are not emphasized here. In addition, Ullman and Brush have outlined the various works in sociology and agricultural economics which pre-dated and anticipated many aspects of Christaller's system.[4] Along with these developments, note should be taken of the fact that Christaller did, in the last part of his academic career, develop a "theory

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[1]Ibid., p. 116.

[2]Ibid., p. 190.

[3]R. Vining, "A Description of Certain Spatial Aspects of an Economic System," Economic Development and Cultural Change 3 (January 1955): 147-95, and E. M. Hoover's comment pp. 196-98; R. J. Johnson, "Central Places and the Settlement Patterns," Annals of the Association of American Geographers 56 (September 1966): 541-9; Edwin N. Thomas, "Toward an Expanded Central Place Model," Geographical Review 51 (1961): 400-11; Richardson, Regional Economics, pp. 162-5; and Leslie Curry, "Central Place in the Random Spatial Economy," Journal of Regional Science 7 (1967): 217-38.

[4]Ullman, "Theory of the Location of Cities," and John E. Brush, "The Heirarchy of Central Places in Southwestern Wisconsin," Geographical Review 43 (1953): 380-402.

of the periphery."[1]

> . . . I have tried to develop a polar counterpart to the theory of central places--a theory of peripheral places.
> . . . I believe that for this, one cannot set up such an exact model as that of central places.[2]

Not all researchers have shared Christaller's doubts about what has (as an application) come to be called a "theory of tourism." Christaller made the argument that while on vacation people get as far as possible away from their homes and other people. As a result, he argued that this was just the opposite of the principle underlying central place theory, i.e., "a polar counterpart." Böventer has demonstrated that while Christaller's arguments are true there is no necessary inconsistency between the two theories.[3]

> Tourist location theory, just as agricultural and urban location theory, may be thought of as a combination of Thünen elements (a theory of the periphery) and of central place elements. It is both a theory of the periphery and a central place theory. Both aspects were first formulated by Walter Christaller.[4]

Summary and Conclusions

Walter Christaller was a geographer who placed major emphasis on the use of economic theory to solve geographical

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[1]Walter Christaller, "Some Considerations of Tourism in Europe," Papers of the Regional Science Association 12 (1964): 95-106.

[2]Christaller, "How I Discovered," p. 610.

[3]Edwin von Böventer, "Land Values and Spatial Structures," Papers of the Regional Science Association 18 (1965): 240.

[4]Ibid., p. 242.

problems. An argument has been made that the use of economics was a direct result of Christaller's training under Alfred Weber.

Christaller followed the complete scientific method in his inquiries, but he felt that the investigation of the location of central places should begin with "pure deduction." Alfred Weber's methodology was reflected in this analysis. He also used Max Weber's concept of an "ideal type." There was evidence found in Christaller's text to help verify the conjecture made by this author that Alfred Weber's "pure" theory and Max Weber's "ideal types" are related.

Christaller was also influenced by Thünen. He made use of Thünen's ceteris paribus form of analysis. There is an affinity between Christaller's market areas and Thünen's isolated "Town." From an overall view of location theory, the models are very similar with common characteristics and assumptions. Thünen also discussed the distribution of settlements. In doing this, Thünen anticipated Weber's theory of industrial agglomeration. Such observations give Thünen the undisputed claim as being the father of location theory.

Christaller used economics in many different ways. His text is full of supply and demand analysis. He recognized the standard elements of cost of production. His analysis of rent seemed to be influenced by both Thünen and

Weber. Christaller's most important use of economics (in the opinion of this author) was found in his use of "economic distance." Economic distance included "objective" and "subjective" elements. One of the objective factors was an opportunity costs concept dealing with alternative uses of time. The subjective factors relied on utility estimations made by individuals. These subjects have become very important to urban and regional economics today.

Evidence was presented to substantiate the fact that central place theory is a subset of location theory. After the assumptions of central place theory were outlined, the argument was made (1) to show that Christaller's model may have begun the scientific method cycle inductively instead of deductively as is usually claimed, and (2) to show that Lösch's contributions were not independent of Christaller's.

The chapter shows that central place model developed by Christaller used three "general" principles of location. They were the market, traffic, and separation principles. The first two are economic. The last is socio-political. Christaller felt that the market principle was the most important. The market principle utilized the concept of central goods to fulfill tertiary sector economic functions. It also accounted for the hexagonal market area shapes in the theory. The other two principles accounted for deviations from this pattern.

Christaller also developed a "theory of the periphery" as a polar counterpart to central place theory. The combination of both of these theories resulted in a "theory of tourism."

Using Britton Harris' model dimensions,[1] this author would classify Christaller's central place model as being (basically) descriptive, partial, macro, static (with a descriptive attempt to also be dynamic), deterministic, and simultaneous.

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[1]Harris, "Quantitative Models of Urban Development," p. 367.

CHAPTER V

THE CONTRIBUTIONS OF WILLARD PHILLIPS

Introduction

Willard Phillips (1784-1875) was born in Bridgewater, Massachusetts.[1] He was graduated from Harvard in 1811 where he remained for five years as a tutor.[2] Phillips was a lawyer, editor, author, judge, and the president of a life insurance company. He was a fellow of the American Academy of Arts and Sciences. His books included Treatise on the Law of Insurance (1823), Manual of Political Economy (1828), The Law of Patents for Inventions (1837), The Inventor's Guide (1837), and Protection and Free Trade (1850).[3]

Of particular interest to this study is his A Manual of Political Economy with Particular Reference to the Institutions, Resources and Conditions of the United States

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[1]Spiegal, The Rise of American Economic Thought, p. 89.

[2]Joseph Dorfman, The Economic Mind in American Civilization, 1606-1865 vol. II (New York: The Viking Press, 1946), p. 585.

[3]John R. Turner, The Ricardian Rent Theory (New York: New York University Press, 1921), pp. 35-36, n. 43.

published in 1828 in Boston,[1] which has been called ". . . a practical rather than a theoretical work."[2] As practical as the language may be, the basic arguments behind many modern day theories can be found in this work. The following text will cover the contributions and discussions made by Phillips of a non-locational and locational nature. Many of the references are clearly independent of any mention of location theory; but, it will be seen that Phillips managed to bring some aspect of distance, situation, or transportation into nearly every part of his book.

Anti-Ricardian: Other Contemporaries, Say's Law, Savings Is Investment, and Population

Phillips was a well read economist. He was familiar with and quoted the works of Adam Smith, Say, Ricardo, Malthus, Bacon, Franklin, Montesquieu, M'Culloch, Arthur Young, Hume, Lauderdale, Mandeville, Lowe, and Locke. He was anti-Ricardian in the sense of Malthus and Lauderdale, but he was against the theory of population presented by Malthus. Most of the book is devoted to a critique of many of the aspects of Smithian economics. Despite this, Smith did have an influence on Phillips. The works of Thünen are not mentioned in Phillips' book. Such a fact will be

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[1]Willard Phillips, A Manual of Political Economy with Particular Reference to the Institutions, Resources, and Conditions of the United States (Boston: Hilliard, Gray, Little, and Wilkins, 1828).

[2]Turner, The Ricardian Rent Theory, p. 36.

important when arguments are presented on the hypothesis that Phillips and Thünen actually had a "multiple discovery" of some aspects of location theory.

Phillips felt that Smith's distinction between productive and non-productive capital was

> . . . of no great practical importance. The object of all industry is in the first place existance, and in the next, a convenient, agreeable existance, to which various species of unproductive articles contribute, . . .[1]

One cannot help but be reminded of Galbraith's arguments by reading the last quote.[2] Phillips defined the ". . . value of all capital is (as being) estimated by the income derived from it. . . ."[3] He also did not agree with Smith "invisible hand" concept. It is interesting to read how Phillips described Smith's idea:

> A man very naturally engages in a business for which he has the most skill and advantages, and exchanges the products of his labour with the one who will give the most of what he wants in return, whether he lives one mile or one thousand miles off. Of course then, you will say, each member of the community being left free to trade where and for what he pleases, will find out what he can most advantageously produce and sell, and of whom he can most advantageously purchase what he wants, or, in other words, with whom he can most advantageously exchange products, and if each member of the community makes for himself the best exchanges, whether they be

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[1]Phillips, A Manual of Political Economy, p. 99.

[2]John K. Galbraith, New Industrial State 2nd rev. ed. (New York: Houghton Mifflin Co., 1972). Phillips also stated (one time) that a monopolist ". . . fixes his price at such a rate that will yield the greatest profit." See Phillips, A Manual of Political Economy, p. 36. Neither approach is emphasized in the book.

[3]Phillips, A Manual of Political Economy, p. 97.

> at home or abroad, they will be the most advantageous to the community. This is the doctrine promulgated by Adam Smith, and reiterated, sometimes broadly and absolutely, at other times with limitations, by Mr. Ricardo, M. Say, Mr. Malthus, Mr. M'Culloch, and many others.[1]

Note that Phillips managed to use distance (i.e., ". . . whether he lives one mile or one thousand miles off,") when talking about a subject unrelated to location theory. This theme is repeated throughout the book. In a lawyer like fashion, he used the next fifteen pages to list all the reasons why such a statement of the "invisible hand" concept (or the implications of such a statement) could not be true. Later Phillips concluded that without this pillar ". . . then the whole theory of Adam Smith and his followers fails."[2]

Phillips did not accept the contention that supply creates its own demand--Say's Law.[3]

> Mr. Ricardo, M. Say, and I know not how many others, have laid down the doctrine that supply creates demand, and that there cannot be too great a quantity of vendible consumable things produced; and consequently that the general accumulation of stock of all descriptions cannot be excessive.
>
> But, as we have already noticed, common experience contradicts this doctrine. The excited industry of the world so much surpasses the immediate wants, that there may be an excess of all descriptions of stock over what is wanted for immediate consumption. . . .[4]

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[1]Ibid., pp. 165-66. Emphasis added by this author.

[2]Ibid., p. 178.

[3]For a good discussion of Say's Law, Say's Equality, and Say's Identity see Blaug, Economic Theory in Retrospect, pp. 145-79.

[4]Phillips, A Manual of Political Economy, p. 96.

Such a statement lends credence to the contention made earlier that Phillips was anti-Ricardian in the Malthusian sense. It is surprising that Schumpeter did not list Phillips among the anti-Ricardians[1] or anyplace at all. How could an economist be so obscure or inconspicuous as to not be mentioned by Schumpeter?

In the same spirit, Phillips did not support the belief that saving and investment are always identical. One may infer this from the following passage.

> Many passages in the works on economy maintain the doctrine that a capital once accumulated will flow on in some channel or other, promoting industry and production; and if you stop its channels it will find out new ones, as a steam of water dammed up, will seek a new course. But this view of the capital of a community, though in a degree correct, yet gives an erroneous notion. You may stop a given quantity of water, or direct it over a sandy surface, until it is lost by evaporation and adsorption. So capital, though it have a tendency to find a channel, may find none, or one in which it will be lost. Almost every change of fashion, habit, opinion, institutions, or laws, may have some influence, direct or remote, in checking or augmenting production and accumulation.[2]

Although saving is not mentioned directly, if one supposes that ". . . a capital once accumulated" is realized savings seeking an investment opportunity for the ". . . promoting (of) industry and production," then the above interpretation can apply. Without a doubt, such a statement supports an interpretation that not all of "intended" investment is in

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[1]Schumpeter, History, p. 489.

[2]Phillips, A Manual of Political Economy, p. 95, Emphasis added by this author.

fact "realized."

While Phillips seemed to support anti-Ricardianism in the Malthusian sense, he rejected Malthus' theory of population.

> Since the publication of Mr. Malthus's Treatise on Population, it has been customary to repeat, the now hacknied doctrine, that a community will increase in proportion to the quantity of food furnished by its territory, as if no community could permanantly export provisions, though the example of Poland and the districts communicating with the Baltic, the Mediterranean, and the Black Sea, besides the United States, the north of Scotland, and many other places, was a plain demonstrative refutation of such a doctrine. If men had no other earthly wants but that of food, there would be more plausibility in this doctrine, although it would not in that case be practically true. But since the demand of the apetite do not constitute one half of the wants of the civilized community, it is surprising that men should have so generally adopted the doctrine. . . .[1]

Phillips did not anticipate the most popular criticism of the Malthusian population theory, i.e., that advancing technology would more than compensate for diminishing returns to agricultural production. The reasons that Phillips did give are easy to understand. It is not surprising since he contributed to the literature of international trade that he conceived that some communities ". . . could permanently export provisions," to help other communities with a population problem. His other objection was practical and based on common sense. How would a people be made to first starve if only one half of their total consumption was food? Would they not first decrease their consumption of housing,

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[1]Ibid., pp. 75-76. Emphasis added by this author.

shelter, and fuel? Of course, neither of these objections answers the question in the logical extreme. After all possible exports have been made and all non-food consumption cut, would not the Malthusian specter reappear? The point is that while Phillips supported Malthus in anti-Ricardianism, he did not accept Malthusian population theory.[1]

Value, Supply, and Demand

Turner has called Phillips' theory of value "subjective and individualistic" and one that "may or may not correspond to cost."[2] He rejected labor and cost of production theories and realized that while ". . . value is a relative term,"[3] price and value are not identical.

> The expense of rent, stock, and wages, for the production of articles, including interest and profits, together with the expense of transporting the articles to any particular place, determines their general market price and value in that place. But the market price or exchangeable value is not the same . . . with the cost of production. . . .[4]

and,

> Price, in its strict and appropriate sense, is the worth of a thing in money . . . the price is the medium

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[1]Phillips agreed with S. Gray's critique of the Malthusian population theory. See ibid., p. 139. Also see Turner, The Ricardian Rent Theory, pp. 34-35.

[2]Turner, The Ricardian Rent Theory, p. 37. Phillips, A Manual of Political Economy, p. 19, stated that "Value sometimes, but not necessarily and always coincides with cost, and though these are often equivalent, they are not the same."

[3]Phillips, A Manual of Political Economy, p. 18.

[4]Ibid., p. 16. Emphasis added by this author.

> for finding out the comparative value of a thing in the same market; but this does not make price and value the same thing.[1]

The first part of this passage contains the phrase ". . . together with the expense of transporting the articles to any particular place, . . ." This again emphasizes the fact that distance was explicitly recognized by Phillips in all parts of his book.

As just mentioned, Phillips knew that value was a relative term. But in addition to values being relative to each other for different goods, he realized that these values were a function of the "place" and the "time" of exchange. The same goods at different places (at the same time) or different times (at the same place) would have different exchangeable values. So, it was important to Phillips that one should realize that ". . . the prices current afford a scale of comparative values of all commodities in the same place or market at the same time. . . . But a standard or measure of value for different times and places, is a desideratum. . . ."[2] Such a desire lead Phillips to reject the classical convention of using wheat and/or labor as a measure of value. He used gold and silver instead because of their being,

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[1]Ibid., p. 18. Emphasis in the original text.

[2]Ibid., p. 14.

> . . . little liable to decay or become tarnished; their having a great value in a small bulk and weight; the adequate supply, and the certainty and uniformity of quality that can be given to the species of currency.[1]

Phillips emphasized that a good had value ". . . because it can be exchanged for others. . . ."[2] He recognized the cost side (of supply) as reviewed earlier.[3] He also was familiar with the utility side (of demand):

> The desire to obtain any particular thing, gives it its value, and the motives of such desire are as various and numerous as the appetites, tastes, passions, wants, and caprices of mankind.
>
> As value is created by this desire, so it is limited by its strength and intensity.[4]

Phillips seemed to be aware of the results of the interaction of supply and demand as they are known today. In the following quote, one can infer that Phillips was cognizant of excess supply and possibly a crude notion of elasticity.

> The rise or fall of the market value depends on the proportion of the supply to the demand.
>
> When the production of an article begins to exceed the quantity needed for consumption, . . . (the result is) a reduced price. . . .
>
> The prices of most articles thus following the causes of change, are always ebbing and flowing alternatively, while the two parties of buyers and sellers wage their perpetual war with alternate success.
>
> A surplus or deficiency of supply will raise or depress the price in an excessive ratio.[5]

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[1] Ibid., p. 235.

[2] Ibid., p. 14.

[3] Ibid., p. 18.

[4] Ibid., p. 33.

[5] Ibid., pp. 48-9. Parenthetical information added by this author.

The preceding quote also shows that Phillips used a concept of a "moving equilibrium." More explicitly, he stated:

> Though price, where not affected by excess of demand or supply, hovers about the point of average cost of production, it does not become fixed at that point. This point is not itself fixed, but varies in most, at least, if not (with) all articles, either slowly and gradually, or suddenly and irregularly. The market, like the ocean is always tending to a level, at which it never rests.[1]

The word "equilibrium" was used several times in this book.[2] Although it was not emphasized or directly discussed, he used a ceteris paribus methodology. The phrase "all other things equal" can be found several times.[3]

Phillips was aware of several of the parameters which affect supply and demand. He stated that improvements, skill, and inventions tended to lower value. In modern terms, these are factors which would shift a supply curve to the right. Phillips explicitly discussed what today are called "special cases" in price theory. He said that the ". . . extremes of demand and supply are a monopoly on the one hand and a glut on the other."[4] Another special case is that found when supply is fixed so that demand determines price.

> The value of an original picture, or statue, or any thing of which there is only a single one of the kind, is limited to the same manner. The possessor

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[1]Ibid., p. 42.

[2]Ibid., p. 53. The word "equilibrium" is used while referring to the possibility of unemployment in the labor market.

[3]For example, see ibid., p. 87.

[4]Ibid., p. 35.

> has a complete monopoly, but the price is determined by the intensity of the desire of men to obtain the subject of the monopoly.[1]

He recognized that the demand for the factors of production is usually in the form of a derived demand. While discussing labor, he stated that for labor to have value ". . . it must be in demand, that somebody should desire to make it exchange for it, or purchase it, or its products."[2] More explicitly,

> All the instruments and materials used in production, though many of them are not applied directly in the gratification of the wants or tastes of men, have a value, because they are the means by which objects are procured for the gratification of those wants and tastes.[3]

Investment in Human Capital and Present Value

Two areas remain to which Phillips is seen (but generally not recognized) as making seminal contributions. The first area is that of education. Phillips felt that the education of laborers would have ". . . a great influence upon their condition in general, and among other things, upon their rate of wages. . . ."[4] He explicitly stated that education was an investment. Today this is called an investment in human capital.

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[1] Ibid., p. 33.

[2] Ibid., p. 131. Emphasis added by this author.

[3] Ibid., p. 33.

[4] Ibid., pp. 153-54. Phillips may have been influenced by Smith in the area of education, but Phillips was critical of Smith's analysis dealing with apprenticeships.

> If a long course of instruction, and great expense of education be necessary to the practice of any art or profession, the wages are commonly supposed to be higher. . . . This expense of education may justly be considered as an investment of capital on which the party instructed is entitled to a profit by a corresponding enhancement of his wages. . . . it is a capital he is least likely to lose or spend, and though the profits may be smaller than those of other investments, yet they are considered to be more certain.[1]

It is interesting that Thünen has also been given credit for an early development of this concept.[2]

The other area is that of the present value of assets. Phillips stated that the value of land was a direct function of the rent yielded by the land and inversely related to the rate of interest. Such an analysis corresponds to the modern day equation:

$$\text{Present Value} = \frac{\text{Net Return}}{\text{Interest Rate}}$$

One can find such evidence in the following two quotes taken from Phillips:

> And this same variation of the general rate of interest and profits is a reason why the value of land will not always bear the same proportion to rents. . . . as the general rate of interest and profits becomes lower, the price of land yielding the same net rent will rise.[3]

and,

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[1]Ibid., p. 133. Emphasis added by this author.

[2]B. F. Kiker, "Von Thunen on Human Capital," Oxford Economic Papers, N.S., 21 (November 1969): 339-43.

[3]Phillips, A Manual of Political Economy, pp. 114-15.

> . . . for the value of land in the market will rise with the rents. . . .[1]

Situation, Transportation, and Rent

Phillips was also a contributor to the literature of international trade.[2] The influence of his interest in trade problems is reflected in his Manual of Political Economy which contains a chapter on that subject (i.e., Chapter VIII, "Commerce"). In addition to this, nearly every part of the book integrates location, situation, or transportation into the analysis at hand. The influence of international trade thought can be seen in the following:

> That the country has been and still is very prosperous, is true, and it is equally true that this prosperity must arise from some internal or external advantages in situation or territory, or from the character and habits of the population.[3]

The interesting aspect of this passage for location theory is that Phillips added the word "internal" to a statement that would otherwise apply exclusively to international trade. Such internal and external advantages in situation influence the productivity of the factors of production.

> The situation of a country in respect to markets may give the same result; the nearer the places of supply and demand are, to each other, the greater produce will be yielded by the same labour and capital employed with equil skill.[4]

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[1] Ibid., p. 118.

[2] Phillips, Protection and Free Trade.

[3] Phillips, A Manual of Political Economy, p. 71. Emphasis added by this author.

[4] Ibid., p. 88.

Phillips also felt that the productivity of the factors of production could be augmented by better transportation systems. The districts of a territory could thus be brought into communication so that ". . . the economy in transportation might make the same capital and industry more productive. . . . Any facility of transportation by rivers, canals, or good roads, gives a superiority of the same sort. . . ."[1] He linked the advantages of cost saved due to superior transportation systems directly to his definition of rent.

> Rent being the excess of the value of the products over the cost of production and transportation to the market, it will evidently not vary in the proportion of the gross value of the products.[2]

The rent would ". . . not vary in the proportion of the gross value of the products," since,

> Of two pieces of land situated at the same distance from the market, if one yields twice the value of the value of the products of the other, with less than twice the cost of production, as is usually the case, the rent will be more than double that of the less fertile.[3]

From the preceding quote, one can begin to see that Phillips was not in agreement with Ricardo's concept of rent. He called Ricardo's theory of differential rent based on soil fertility ". . . the somewhat metaphysical and now almost exploded theory."[4] Phillips felt that such

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[1]Ibid., p. 87.

[2]Ibid., p. 110. Emphasis added.

[3]Ibid.

[4]Ibid., p. 108.

a theory led to ". . . too many inadmissible consequences."[1] He said that if Ricardo's theory held true then (1) the last grade of fertility brought into cultivation would pay no rent, (2) once the margin is reached any further cultivation would lead to a decline in what today is called GNP, and (3) if all land in a country happened to be of the same fertility no rents would be paid. Turner has noted that Phillips failed to realize that Ricardo's intensive no-rent concept could account for point number one.[2] This writer disagrees; Phillips was looking at Ricardo with a practical eye. He asked the reader to look at the (then) current experience in the United States and Great Britain to prove his points.

A passage was found in Phillips' book which brings together all the spatial aspects of rent developed by Phillips. In this quote Phillips also lists all the other factors which he felt had an influence on rent.

> The circumstances which determine the value of rents are in many particulars the same already enumerated as constituting territorial advantages, variety, excellence and abundance of product, upon or under the surface; good breeds of animals; facility of cultivation; an adequate stock of materials and implements; a race of able bodied skillful labourers; security from destructive insects and vermin, wild beasts, and robbers, and rapacious and lawless officers of the government; and what is no less important than the rest, a population, near or distant, that will afford a certain market for the products. As the territorial advantages of a country depend partly upon its being favourably situated

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[1] Ibid.

[2] Turner, The Ricardian Rent Theory, p. 40.

> for intercourse between its different parts, and with other countries, so some parts of its territory, near the central points of population and trade, will yield an enhanced rent, and be more value for more residence, then the richest part of the territory is for any other purpose. These different circumstances will influence the rents of every part of territory. Land of less fertility, may yield greater rent, by reason of its being nearer a large market, or within reach of better and cheaper transportation, or in a district possessed of better agricultural preparations and skill. . . . A better breed of domestic animals, greater care in rotation of crops, a more judicious choice and preparation of seed, the use of a better plough or threashing mill, or vicinity to a flouring mill, may have the effect of increasing the rents.[1]

Near the last part of the quote (i.e., starting with, "Land of less fertility, may. . ."') one can see that Phillips was in absolute opposition to Ricardo's rent theory. Phillips said that under the right circumstances, land of less fertility could yield greater rent than land of more fertility. That part of passage beginning with ". . . near the central points of population and trade, will yield an enhanced rent . . .," is a good example of how Phillips' theory of rent can be interpreted to imply a theory of location. The nearer one located to a town or market the higher the rent due to being so located.

Location Theory

Henry W. Spiegal in a book of readings which contains three passages from Phillips' Manual of Political Economy noted in the introductory page of the section on

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[1]Phillips, A Manual of Political Economy, pp. 109-10. Emphasis added.

Phillips that Phillips' ". . . location theory, with its 'circles,' has some affinity with that developed in von Thünen's Isolated State. . . ."[1] It is much to Spiegal's credit that he included the words "some affinity." The point in fact is that although Phillips did give economics a theory nearly identical to some statements found in Thünen, the portion of the quote given by Spiegal dealing with Phillips' "circles" has nothing at all to do with Thünen's theory. Thünen's circles were in the nature of circles of supply surrounding a demand point (the Town). Phillips' circles were circles of demand surrounding a point of supply. The following quote (also used by Spiegal) supports this writer's interpretation:

> We perceive that agricultural production accommodates itself in some measure to the distance of the great markets, and in effect reduces the distance in some degree, by supplying surplus articles of a comparatively safe, easy, cheap transportation, and by this diminishing the disadvantages of local position, in respect to the central points of exchange, it equalizes rents, or rather reduces the inequalities which would result from a similar cultivation in all districts of territory. We perceive also that the markets for different products range in circles of very different extents from the points of production of each article. The extent of the circle from the point of production, within which any article may seek a market, is determined by the cost of production and transportation, and the price in the distant markets.[2]

The sentence, "We perceive also that the markets for different products range in circles of very different extents from

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[1] Spiegal, The Rise of American Economic Thought, p. 89. Emphasis added by this author.

[2] Phillips, A Manual of Political Economy, p. 112. Emphasis added by this author.

the points of production of each article," lends to no interpretation excepting one of market area analysis,[1] i.e., points of supply, ". . . the points of production," surrounded by areas of demand, ". . . the markets for different products."

On the next page, Phillips did give an analysis that is unmistakenly Thünian.

> We accordingly see how agriculture, by accommodating itself to the distance to the markets, and gradually changing upon their approach yield the greatest aggregate products to the cultivators, increases the rents, and augments the general productiveness of the combined labour of the distant members of the community.[2]

Here one finds points of demand, i.e., ". . . the markets," surrounded by agriculture of varying degrees of intensity of cultivation ". . . gradually changing on their approach . . ." to the markets, all based on ". . . increases (in) the rents." This is the Thünian system. Spiegal included this paragraph in his selection of readings, but he failed to point out the distinction made here. At least part of this neglect can possibly be explained by the fact that Spiegal's primary intent in his analysis was to give a selection of reading--not to give rigorous analysis.

Other passages can be found some of which support the market area analysis interpretation and others of which support the Thünian system interpretation. The following

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[1]For a discussion of market area analysis see, Isard, Location and Space-Economy, pp. 143-53.

[2]Phillips, A Manual of Political Economy, p. 113. Emphasis added by this author.

passage indicates that Phillips was also familiar with what is called "supply area analysis."[1]

> The manufacture of many materials near the place of production diminishes cost of transportation, and thus extends the limits of the markets; and increases the rents of the land producing the raw materials. . . . A successful manufactory in the neighbourhood of the production of the raw material has the same effect upon the production and also upon the rent of the lands, as a canal or navigable river.[2]

The following statement supports the Thünian interpretation. One is reminded of Thünen's circle of livestock production.

> Some parts of every extensive tract of territory must produce articles for a distant market; and they accordingly produce what costs the least expense of transportation. Much of the beef for the London market is raised in Scotland and fed in Leicestershire, because the lean cattle will transport themselves, at a small expense to the owners, from the highlands of Scotland to Leicestershire.[3]

The passages presented to this point supporting a Thünian interpretation are further upheld by the quote given earlier that, ". . . near the central points of population and trade, will yield an enhanced rent . . .,"[4] and another passage which has that the ". . . reduction of price consequent upon any improvements in production or transportation

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[1]For a discussion of supply area analysis see, Isard, Location and Space-Economy, pp. 154-57. "Supply area" or "purchasing area" is defined as the geographic area from which raw material is furnished to a producer.

[2]Willard Phillips, A Manual of Political Economy, pp. 113-14.

[3]Ibid., p. 110.

[4]Ibid.

is attended with no distress, . . ."[1] Both of these statements contain ideas that are a part of a Thünian system.

Other parts of Phillips' book indicate that he was aware that "weight and bulk" can affect the location of production.

> The article of flax . . . the reasons of cultivating this article at a distance from the principle market, being its security from decay and damage by keeping, and its comparatively great value in a given weight and bulk, and consequent cheapness of transportation.[2]

Thünen made a similar statement. Note that Phillips also addressed himself to the perishability of the good (i.e., ". . . its security from decay . . .") as did Thünen. Correspondingly when ". . . the value is small in comparison to their weight and bulk, . . ." the production should take place near the market.

> The products of diamond, gold, silver, copper, tin, and even an iron mine, may be transported to all parts of the world; and those of the three first especially, are so cheap of transportation, that the mines may almost as well, for their value and usefulness, be situated in a desert as in a populous district. But stone quarries, abundance of building materials, coal mines, and fertility in all heavy raw products of which the value is small in comparison to their weight and bulk, require, to give them their greatest value and utility, an easy access to a numerous population.[3]

Such an analysis is clearly in anticipation of the work of Weber and Hoover. This is the fourth area anticipated by Phillips.

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[1] Ibid., p. 54.

[2] Ibid., p. 111. Emphasis added.

[3] Ibid., p. 106. Emphasis added.

Summary and Conclusions

Willard Phillips was an American economist who contributed to the economics of international trade, law, inventions, and location. He was an anti-Ricardian in the Malthusian tradition, but he did not support Malthus' population theory. Phillips was against Say's Law and the proposition that all savings are converted into capital. His theory of value was based on the interaction of supply and demand to effectuate bilateral exchange.

Evidence has been presented to support the contention that Phillips was an early developer of the concepts of investment in human capital and the present value of an asset. No such insights have been noted by other writers in the histories of economic thought.

Other parts of Phillips' book brought in some aspect of distance, situation, or transportation into the analysis at hand. The analysis dealing with transportation was integrated into his rent theory to provide a spatial interpretation of rent.

This spatially oriented rent theory was the basis for at least one aspect of Phillips' location theory. Four location theories were found. First, there was a theory like ones found in the Thünian system (i.e., a point of demand surrounded by spatially dispersed supply). Second, there was a theory best described as "market area analysis" (i.e., a point of supply surrounded by spatially dispersed

demand). Third, there was a theory of what today is called "supply area analysis" (i.e., a geographic area from which raw material is furnished to a producer). Fourth, there was a theory developed for the location of production based on the weight and bulk of the items produced.

To answer the question stated at the first of this chapter section, yes, Phillips' and Thünen's theories of location might be classified as "multiple discoveries" in the Merton sense. No evidence was found that Phillips had read Thünen. But, the general conclusion of this writer is that although Phillips was not as analytical as Thünen, Phillips developed more "types" of location theories. Thus, in an absolutist sense, Phillips' contributions should be considered superior to Thünen's.

Using some of Britton Harris' model dimensions,[1] this author would classify Phillips' models as descriptive, partial, macro, and quasi-dynamic.[2]

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[1]Harris, "Quantitative Models of Urban Development," p. 367. "Quasi-dynamic" was not used by Harris.

[2]Recall that Phillips allowed for a "moving equilibrium." See Phillips, A Manual of Political Economy, p. 53.

CHAPTER VI

THE CONTRIBUTIONS OF WILHELM LAUNHARDT

Introduction

Carl Friedrich Wilhelm Launhardt (1832-1918) was a professor of engineering science at the Polytechnical College in Hanover, Germany.[1] He received an honorary doctorate in engineering at the Dresden Institute of Technology in 1903 for contributions to the technical and economic problems of transportation. Launhardt made important contributions to welfare economics, public utility pricing policies, transportation-engineering economics, and industrial location and market area analysis.[2] His work in the area of welfare economics is reflected in his study of price theory. His treatment of "repeated exchange" and "exchange with continually changing prices" foreshadows the work of Oskar Morgenstern in demand theory.[3] On questions of capital and interest, Launhardt followed the work of Leon Walras

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[1] International Encyclopedia of the Social Sciences, 1968 ed., s. v. "Wilhelm Launhardt," by Eberhard M. Fels, pp. 48-49.

[2] Launhardt's other books dealing with non-locational/market area problems will be listed in the bibliography.

[3] Oskar Morgenstern, "Demand Theory Reconsidered," Quarterly Journal of Economics 62 (1948): 165-201. Also see Fels, "Wilhelm Launhardt," p. 49.

and Stanley Jevons. His analysis of railroad costing and pricing was also influenced by Walras and Jevons.[1] He opposed the private ownership of railroads, favored marginal cost pricing, and believed that overhead costs should be paid out of revenue from general taxation. Launhardt spent most of his academic life in the field of transportation-engineering economics. He investigated such questions as the influence of gradients and curves on the operating costs of railroads and the location-dependent "rentability" of highways and railroads.[2]

Schumpeter recognized the fact that Launhardt was one of the first to apply mathematics to new fields of inquiry.

> The earliest text, so far as I know, is W. Launhardt's Mathematische Begründung der Volkswirthschaftslehre (1885), which taught the doctrines of Jevons and Walras and in addition some original results of the author, especially on transportation.[3]

But, Schumpeter, like most other historians and economists, relegated mention of Launhardt's location theory to parenthetical information in a footnote.[4] Launhardt's obscurity to economists can be explained by three facts: (1) He was an engineer by profession. (2) He used abstract mathematical and geometrical analysis to deal with problems generally

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[1] Fels, "Wilhelm Launhardt," p. 48.

[2] Ibid., p. 49.

[3] Schumpeter, History, p. 957, n. 8.

[4] Ibid., pp. 850-1, n. 15.

ignored by the economists of his day. (3) He published most of his work in engineering journals.[1]

Launhardt's Two Major Works in Location Theory

Although his major works have not been published in English, location theorists have recognized Launhardt's contributions. A note of his work was made by Bortkiewicz in 1910.[2] But even with this acknowledgement, two other writers (who developed aspects of location theory found earlier in Launhardt) were not aware of Launhardt's work. Alfred Weber (and Georg Pick) used the location triangle and the weight triangle both of which can be found in Launhardt's work.[3] Frank A. Fetter developed a theory of market areas (also found in Launhardt) in his 1924 article.[4] Isard has given Launhardt credit for developing both of these principles, but at the same time ". . . he made no attempt to put them together."[5] Engländer was probably the first to recognize that these two problems were fundamentally the same,

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[1] In fact, Launhardt was the editor of Zeitschrift für architektur und ingenieurwesen from 1872 through 1875.

[2] Bortkiewicz, "Eine geometrische."

[3] This might be partly due to the fact that Weber published in 1909, but it does not explain Weber's lack of review of the German literature.

[4] Frank A. Fetter, "The Economic Law of Market Areas," Quarterly Journal of Economics 38 (May 1924): 520-9.

[5] Isard, "Distance Inputs," in Dean, Leahy, and McKee, Spatial Economic Theory, p. 53, n. 37.

but he also failed to synthesize the two.[1] One must wait for the writings of Palander, Hoover, and Lösch for a more satisfactory synthesis of location theory.

The details of Launhardt's contributions as developed in his two major works have been covered in the location theory literature. His article, "Die Bestimmungdes Eweckmassigsten Standortes einer geweblichen Anlage," dealing with the optimum location of a business enterprise by minimizing total transportation costs, the "pole" method, and the location/weight triangles was reviewed by Robert A. Kennelly in 1954.[2] Launhardt's article was published in 1882. A recent dissertation gave a detailed review of this article and Launhardt's book on the subject, Mathematische Begründung der Volkswirtschaftslehre (1885) which outlines market area analysis.[3]

Discovery of a Neglected Book by Launhardt

In an effort to break new ground in this area, this author conducted an intensive review of the literature with particular emphasis on Launhardt's other books and articles. As a result of this research, a book written by Launhardt was found that was translated into English in 1900-02. The

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[1]O. Engländer, "Kritisches und Positives zu einer allgemeinen reinen Lehr vom Standort," Zeitschift für Volkswirtschaft und Sozialpolitik, n. f., V (1926): 475-79.

[2]Kennelly, "The Location of the Mexican," pp. 140-45.

[3]Been, "Reconstruction," pp. 38-74.

title of this book is The Principles of Railway Location.[1] To the best knowledge of this author, this book is the only one of Launhardt's works translated into English and published. No reference to this work can be found in the location theory literature or in the history of economic thought. In fact, a bibliography of Launhardt's works in the International Encyclopedia of the Social Sciences does not list the work.[2] But, evidence was found to indicate that parts of the work were written at least 10 years earlier to what, until now, was believed to be Launhardt's earliest contribution to the field of location theory. Although the preface was written in 1886, one finds the following in the "Author's Preface" to Part I:

> The present Work treats the Commercial Location of Lines, viz., the location of the trace in its financial aspect.
>
> It was originally published in 1872 as a reprint of an article that appeared in that year in the Zeitschrift

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[1]Wilhelm Launhardt, The Principles of Railway Location trans. A. Bewley (Madras: Lawrence Asylum Press, 1900-02). It should be noted that the first page of the book has the title The Theory of the Trace: Being a Discussion of the Principles of Location. The book has two parts. Part I, The Commercial Trace, was translated in 1900. Part II, The Technical Tracing of Railroads, was translated in 1902. This book was found by looking page by page through The National Union Catalog: Pre-1956 Imprints, vol. 318, p. 325. The discovery was quite serendipitous.

[2]Fels, "Wilhelm Launhardt," p. 49.

> des hannoverschen Architekten--und Ingenieur--Vereins.[1]
> The particular and specialized idea to which I then gave publicity under the expression Commercial Trace[2] has found such a ready and wide acceptance. . . .[3]

To this early work, Launhardt added materials in order to produce the book under review here.

> The scope of my earlier work on Commercial Trace was subsequently extended in Lectures at the Polytecnic, Hanover, and also in various publications. From amongst the latter I may cite an article originally published under the title, "Economic Questions in Railway Engineering," in the Centralblatt der Bau-Vermaltung, 1883: and the Section treating Goods Transport in my Mathematical Basis of the Theory of Political Economy (Leipzig: W. Engelmann, 1885).[4]

In addition to these four sources for the book, the translator noted that additional material found in Part II was taken from Launhardt's Theorie des Trassirens which apparently was never published.[5] The National Union Catalog mistakenly asserts that both parts were taken from the Theorie des Trassirens.[6] The evidence found in the "Author's Preface" to Part I (quoted above) would suggest that Part I

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[1]"Kommercille Tracirung der Werkehrswege," Zeitschrift für architektur und ingenieurwesen, Band XVIII, Heft 4 (1872), pp. 515-34. This article is available from the University of Chicago, Joseph Regentein Library, Department of Photoduplication.

[2]Wilhelm Launhardt, Die Kommerzielle Trassierung der Verkehreswege (Hanover, 1872).

[3]Launhardt, The Principles of Railway Location, Part I, "Author's Preface," no page number.

[4]Ibid.

[5]Ibid., Part II, p. 70 and p. 88.

[6]The National Union Catalog: Pre-1956 Imprints (London: Balding and Mansell, Ltd., 1974), vol. 318, p. 325.

was based on Launhardt's earlier works, not on the Theorie des Trassirens. Part I contains the theoretical aspects of Launhardt's theory. Part II was viewed by Launhardt as an empirical application and verification of the theory found in Part I.

> In Part I of my Theory of the Trace the problem of location was considered solely from the economic standpoint as Commercial Location. We have now to consider in detail the technical conditions which depend on the form and character of the ground and on the type of construction and mode of working. . . .
>
> It is the object of the present Work on the Theory of Location to withdraw the problem of the determination of the trace and of its shape in plan and elevation from the regions of vague guesswork and place it as far as practicable on a mathematical and numerical basis.[1]

The topics covered in Part II are technical in nature. Most of the sections dealt with the operational aspects of railroads. Part I contained the parts of Launhardt's theory which are of interest to us here.

In Chapter 2 of Part I, "The Growth of the Art of Transportation," Launhardt discussed the advantages of a developed system of transportation as reflected in greater accessibility, safety, and rapid travel. In doing so, he gave a numerical example of the savings possible under such a system. The discussion centered on this example indicates that Launhardt had a basic understanding of the opportunity cost concept as applied to transportation.

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[1]Launhardt, The Principles of Railway Location, Part II, "Author's Preface," no page number. This preface was written April 1888.

> . . . many of the requisites of transport may be expressed as a money value. Thus, for example, safety may be represented by the amount of the insurance premium payable. The advantage of great rapidity of travel may be expressed by the saving in interest of the cost of goods, or in the wages of the persons transported by the train. . . .[1]

But at the same time, he felt that the advantages of speed of travel were really "insufficiently estimated." The greater mobility of individuals, the possibility of rapid distribution of goods (thereby avoiding the interest, depreciation, and expenses of warehousing), and the increased distances which perishable goods could be transported were ". . . some of the advantages of increased speed of transportation which cannot be precisely represented by a definite figure."[2] In addition, how could one measure the greater "convenience and comfort" of passenger travel? He concluded that since all of these additional aspects were so difficult to measure that he would use the "cost of transport" as the best approximation.

In Chapter 3, "The General Problem of Location," Launhardt discussed the various parts of the cost of transport. The average costs, k, included; (1) the direct costs of working, f, per transport-unit (ton-km. or passenger-km); plus (2) the interest on the capital costs, A, of the installation. Thus, if the interest rate, i, is given along with the volume of traffic, C, then the average cost per

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[1]Ibid., Part I, p. 6.

[2]Ibid.

transport-unit is:

$$k = f + Ai/C.$$

The problem to be solved is to make the average cost of transport a minimum value. If the direct working-expenses of transportation are dependent on the amount of capital (i.e., $f = F(A)$), then Launhardt found (by differentiating the above equation with respect to A) that average transport cost is at a minimum when:[1]

$$F'(A) + i/c = 0$$

To Launhardt, this solution of the "general problem of location" was ". . . most advantageous politico-economically, i.e., best serving the general, public, or communal interest."[2] He followed that statement with a derivation of the "dividend" desired by the capitalist on his capital investment at the current rate of interest. Then in a numerical example he demonstrated that the interests (general, public, and communal interests) of the general public were best upheld when as high a net return as possible is aimed at; whereas the private speculator desires that the profit yielded per unit of invested capital (i.e., the "dividend") be as large as possible. From this analysis, Launhardt concluded:

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[1] Ibid., p. 6. Launhardt apparently made a mistake when he took the derivative, because at first he showed it to be $F'(A) + Ai/C = 0$. However, later on the same page he used the form given above. This may have been a printer's mistake.

[2] Ibid.

> Now since in railway-working outside competition is practically non-existent and a railway may, up to a certain degree, be worked as a monopoly, it is evident from the above investigation that the most complete development of the railway machine cannot be looked for from private interest alone.[1]

In Chapter 4, "The Market Area," Launhardt developed the theory of market areas which was until now believed to be found only in his book Mathematische Begrüdung der Volkswirtschaftslehre.

> The exchange of commodities between the town-population and the country forms the local or Market traffic, in contrast to the Wholesale or bulk-traffic which is carried on between towns. Each town forms the market-centre or centre of sale, and the area surrounding it is the market-area or area of sale.[2]

Launhardt believed that the "apparent irregularity" of the grouping of the market centers was only apparent and not the result of chance. The sites were originally formed on the basis of the distance of a day's journey, so that it would be possible to make a journey to and from the market from a point half-way between two market centers. It is interesting that Christaller[3] mentioned the same measure as the basis of his time-distance measure of a region. But, Launhardt stated that the ". . . limits of the sale-area are determined by the price of commodities at the neighbouring market-centres

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[1]Ibid., p. 7.

[2]Ibid., p. 9.

[3]Christaller, Central Places, p. 118, n. 5, and pp. 119-20.

or towns."[1] If at market A, a commodity is sold at the price p, and transported at the transport cost rate f, then at the distance x from the market center the cost will be $p + fx$. If at the neighboring market B an equal volume of merchandise is sold at price p_1 and the transport cost rate is f_1, then at the distance y from the market center the cost will be $p_1 + f_1y$. The limits of both market-areas, or sales areas, is given by:[2]

$$p + fx = p_1 + f_1y.$$

The locus of these limits forms a closed curve about the place of the most expensive good (see Figure VI-1).[3] The oval boundary dividing the market area of market A from market B is defined as the locus of all points at which the net prices for the two markets are equal after adjustment for the transport cost. Such a curve was identified by Launhardt as being a fourth degree ellipse of the second order from which one can determine the distance AB between the sources of final goods supply. If the two transport cost rates are equal so that $f = f_1$, then the boundary of the market areas is no longer a closed curve but a hyperbola with its concave side turned towards the market with the

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[1] Launhardt, The Principles of Railway Location, Part I, p. 9.

[2] Ibid., p. 10.

[3] Ibid., opposite p. 6, figure 2. It compares favorably to figure 11 in Launhardt's 1885 book, also see Been, "Reconstruction," p. 59.

Figure VI-1

Launhardt's Market Areas

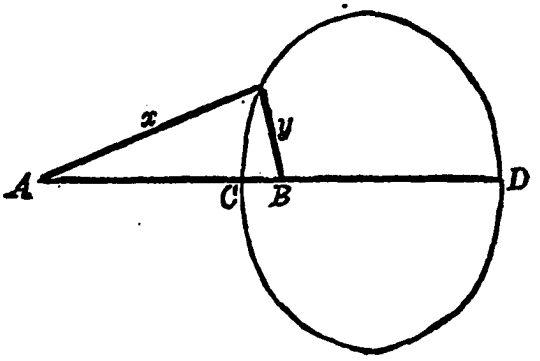


Figure VI-2

Launhardt's Location Triangle

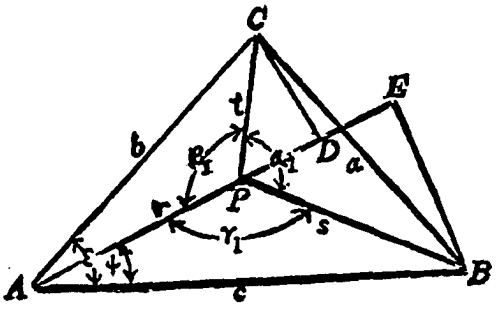
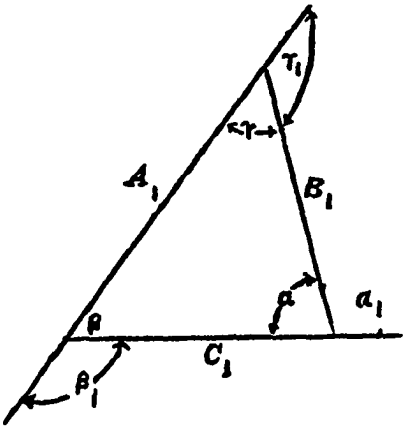


Figure VI-3

Launhardt's Weight Triangle



highest price. Launhardt believed that if the selling prices are equal at the supply sources A and B so that $p = p_1$, then the hyperbola would become a straight line intersecting the line AB at right angles. Been has pointed out that under such circumstances the ellipse actually becomes a circle, but the location of the supply source B is not in the center of the circle.[1] It is only when the two prices and the two transport cost (freight) rates are both equal that the boundary becomes a perpendicular bisector as described by Launhardt.[2] Finally, the market region for a supply source of final goods must compete with other market-areas surrounding it. Under such circumstances Launhardt concluded that the,

> . . . boundary of the market-area forms a polygon of which the number of sides corresponds to the number of the adjacent market-areas and the sides of which are, according to circumstances, elipses of the fourth degree, hyperbolas, or simply straight lines.[3]

Once again one can notice the similarity between Launhardt and Christaller on this point. Christaller felt that the market area pattern would result in a hexagonal shape.[4]

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[1]Been, "Reconstruction," p. 60.

[2]Launhardt made an apparent mistake by stating that if $f = f_1$, then ". . . the two commodities are of equal value. . . ." This was followed by the correct analysis for when $f = f_1$ and $p = p_1$.

[3]Launhardt, The Principles of Railway Location, Part I, p. 10.

[4]Christaller, Central Places, p. 63. For different views as to the shape of market areas and the shape of the boundary between two adjacent market areas see Fetter, "The

In Chapter 8, "The Principle of Nodes," and in Chapter 9, "The Commercial Trace," Launhardt developed what today is called the locational triangle. He accomplished this task by combining what he called a principle of nodes, the pole principle, and what today is called Varignon's Frame.[1] The conclusions to this analysis anticipated the work of Alfred Weber and Georg Pick. The details of this analysis were covered by Been[2] and Kennelly[3] when they reviewed the two other Launhardt works.

An overview of the analysis found in the book The Theory of the Trace includes a discussion of the classical three-point problem which Launhardt solved with what today is called the locational triangle or what he called "the principle of nodes" (see Figure VI-2). This drawing was labeled as Figure 9 in The Theory of the Trace.[4] It is substantially the same as Figure 2 in Launhardt's article of 1882, and it compares favorably with the Weber-Pick

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Economic Law of Market Areas;" C. D. Hyson and W. P. Hyson, "The Economic Law of Market Areas," Quarterly Journal of Economics 64 (1950): 319-24; Melvin L. Greenhut, "The Size and Shape of the Market Area of a Firm," Southern Economic Journal ixx (July 1952): 37-50; Mills and Lav, "A Model of Market Areas with Free Entry;" and Lösch, "The Nature of Economic Regions."

[1]Varignon's Frame will be defined later in this chapter.

[2]Been, "Reconstruction," pp. 42-54.

[3]Kennelly, "The Location of the Mexican," pp. 140-43.

[4]Launhardt, The Principles of Railway Location, Part I, opposite p. 16, figure 9.

Figures 44 and 45 in the appendix of Weber's text.[1] In the case of the "tracing" of the optimal railroad route, the position of the node P is fixed from the minimization of the sum of the construction and working costs, S. Launhardt noted that the ". . . principle of the Node can also be employed to determine the best position of an industrial location--for example, of an iron ore obtained from A, the coal from B, and the pig-iron has to be despatched to C."[2] Using the lettering found in Launhardt, the letters A, B, and C served both as indicators of three fixed points and the tonnage-weight of the annual traffic carried on the railroad when written as A_1, B_1, and C_1. The straight line distances between P and the fixed points A, B, and C were represented by the symbols r, t, and s respectively. Under these conditions, the sum of the construction and working expenses would be:

$$S = A_1r + B_1s + C_1t$$

In Launhardt's analysis of the location of an industry, S represented the total transportation costs. By making trigonometric substitutions into the equation for S, Launhardt was able to differentiate the equation to solve for the actual position of the node P. He concluded that:

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[1]Weber, Location of Industries, p. 228 and p. 230. In Launhardt's 1872 article, this figure appeared as figure 1, see Launhardt, "Kommercielle Tracirung," p. 521.

[2]Launhardt, The Principles of Railway Location, Part I, p. 23.

> At the node there must be equilibrium between the three forces of which the magnitudes are proportional to the kilometric construction--and working-expenses, and acting in the direction of the three rays.[1]

In the case of the railroad analysis, such a calculation determined the position of the "node" through which the railroad must pass in order to minimize total cost; in the case of industrial location analysis, such a calculation determined the best location of the production facility in order to minimize total transportation costs. From the central node, angles α_1, β_1, and γ_1 can be used to form a triangle of the kilometric construction--and working--expenses A_1, B_1, and C_1 using the angles α_1, β_1, and γ_1 as exterior angles on the new triangle (see Figure VI-3). This resulting triangle is what Weber-Pick called the "weight triangle."[2] So, although Launhardt used a different method, he arrived at the same solution as Weber-Pick. Another interesting parallel between Launhardt and Weber-Pick is the mechanical analogy used by both to find the position p. According to Launhardt that position is found by an application of (what Weber called)[3] Varignon's Frame in the following manner:

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[1] Ibid., p. 21.

[2] Weber, Location of Industries, pp. 229-30 and the small triangle in figure 46, ibid., p. 230. Also see Kennelly, "The Location of the Mexican," pp. 141-42. In Launhardt's 1872 article, this figure appeared as the top part of figure 2, see Launhardt "Kommercielle Tracirung," p. 523.

[3] Weber, Location of Industries, p. 64 and pp. 228-29.

> Mechanically--neglecting friction--the best position of the node would be obtained if the position of the three places A,B,C were marked on a horizontal sheet, say, of thin metal holes bored at these points and threads passed through the holes and knotted together on the upper-side, loaded with weights proportional to the kilometric construction and working expenses.[1] The node or knot would then be brought into the correct position under the action simply of three weights.[2]

By combining the locational triangle and weight triangle, Launhardt was able to derive the location of the node P in a different way (see Figure VI-4).[3] This method was called the constructing of a polar point or "pole" of one of the three fixed points of a locational triangle. The steps necessary to construct this pole are as follows: (1) Take the locational triangle A, B, C (as found in Figure VI-2). (2) Place on one side of this locational triangle a weight triangle similar[4] to that constructed from the relative weights of the factors A_1, B_1, and C_1 (as found in Figure VI-3). Call this similar triangle A,B, O. (3) Circumscribe the points A, B, and O with a circle just touching

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[1]When analyzing the location of a firm, Launhardt used weights proportional to the transport cost per mile, see Been,"Reconstruction," p. 44.

[2]Launhardt, The Principles of Railway Location, Part I, p. 21. A similar description specifically applicable to the commercial trace can be found on p. 24.

[3]Launhardt identified this diagram as figure 11, see ibid., opposite p. 21, figure 11. It is substantially the same as Launhardt's figure 3 in his 1882 paper, and it is reproduced from that paper by Been, "Reconstruction," p. 46. In Launhardt's 1872 article, this figure appeared as the bottom part of figure 2, see Launhardt, "Kommercielle Tracirung," p. 523.

[4]"Similar" in the geometric sense.

Figure VI-4

Launhardt's "Pole" Method

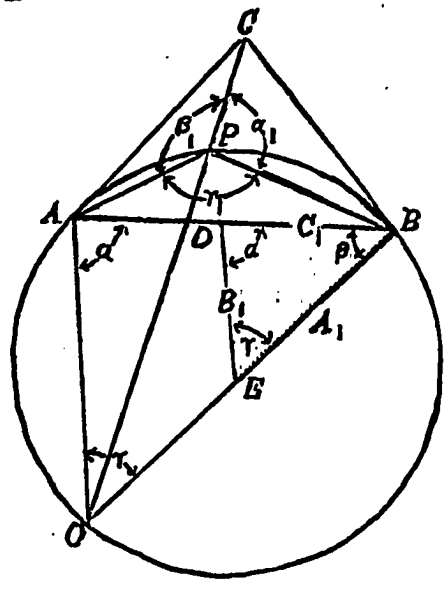
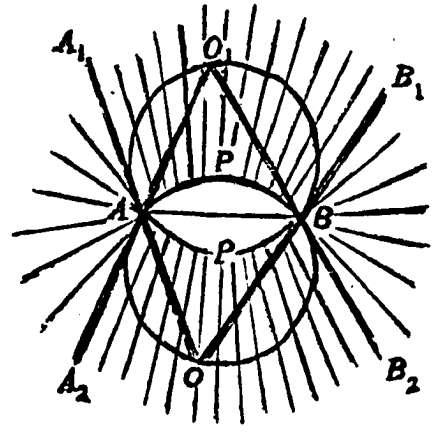


Figure VI-5

Launhardt's Optimal Location Figure



each point. (4) Draw a straight line connecting the point O of the similar weight triangle to the point C of the locational triangle. (5) Call the point of intersection of the circle and the straight line OC point P. (6) Connect point P to points A and B with two straight lines, AP and BP.

By constructing the pole of any one of the fixed points in the locational triangle, the position of the node P is determined (completely) by the position of the other two fixed points. In the case described above, the pole of point C determined the position of node P with information obtained only from the positions of points B and C and the relative weights of the factors. In other words, the similar triangle ABO can be used to determine the node P regardless of the location of the point C. In Figure 12 of Launhardt's work (not reproduced here), he was able to show that once the node P was determined by the combination of a location triangle and a weight triangle, similar constructions on the other sides of the same locational triangle with weight triangles attached in the proper way will give the node P in the same location.[1]

In Launhardt's Figure 13 (see Figure VI-5),[2] he

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[1]Launhardt, The Principles of Railway Location, Part I, opposite p. 21, figure 12.

[2]Ibid., opposite p. 24, figure 13. This diagram is substantially the same as figure 4 in Launhardt's 1882 paper, and it is reproduced from that work by Been, "Reconstruction," p. 48. Also see Hoover, Location Theory and the Shoe, pp. 55-6.

attempted to solve for the optimal location of any third point C given the other two fixed points A and B. In the following quote, the method is applied to the flow of traffic. In the 1882 paper, the location of point C helped determine the optimum location of the producing unit. The analysis is quite complicated and can best be represented in the author's own words.

> So long as the kilometric traffic-expenses remain constant the pole of any two of three places remains unchanged in position; as, for example, the pole O of A and B, wherever the place C may happen to lie, if it lies at all within the angle AOB, so that . . . the traffic from point C--variable according to the position of C within this boundary--will always proceed towards O.
>
> If C lies on the other side of the line AB, then we have a symmetrically-lying pole O_1 to which the traffic from all points lying within the angle AOB will proceed.
>
> If the point C lies within the angle A_1AA_2 there is no node: the traffic then goes from this place direct to A, and thence to B. Similarly, the traffic from all points lying inside the angle B_1BB_2 will proceed directly to B, and thence to A. Also, if the point C lies within the two arcs APB there will be no node, and the traffic will proceed by the line ACB.[1]

It should be noted that in Launhardt's last case, i.e., ". . . C lies within the arcs APB, there will be no node, . . ." the node P will not be formed; but, the optimum location will be <u>at</u> point C, hence the flow of traffic ". . . will proceed by the line ACB."

The last area of interest is found in Chapter 18, "The Effects of Improved Means of Communication."

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[1]Launhardt, <u>The Principles of Railway Location</u>, Part I, p. 22. Been, "Reconstruction," p. 49, outlined this same system as applied to industrial location as taken from Launhardt's 1882 paper.

Launhardt discussed the problems of the agricultural sector as "improved communications" improved transportation facilities and lowered transport costs. In some cases this improved communication would facilitate imports and hurt farmers and in other cases just the opposite. Launhardt cautioned that agriculture must continually adapt itself to these changes. But most important, one can find an elementary understanding of the economics of agglomeration.

> Mercantile profit is increased through the enlarged area of sale which an advantageously situated industry obtains by improved communications, and thereby an impulse is given to the formation of new business enterprises, mutually competing, in the same locality.[1]

To this statement which accounted for the "gathering" of firms in the same industry, the following was added by Launhardt:

> Thus for the different branches of industrial commerce special foci are formed which offer the most advantageous conditions for carrying on the particular business concerned. The local or territorial grouping of classes of industry offers such decided advantages for the improvement of business operations, for the growth of an expert class of workers, and for the transaction of business, etc., that once formed it becomes speedily organized in an increasingly distinct manner.[2]

From this arrangement (obviously an early description of agglomerations) Launhardt concluded that there would be an increased division of labor. The division of labor would support and promote an increased specialization of labor and

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[1]Launhardt, The Principles of Railway Location, Part I, p. 53.

[2]Ibid., emphasis added by this author.

capital. So, instead of having woolen goods firms doing every step of the operation, one could find separate firms operating businesses for combing, spinning,dyeing, weaving, and despatching. After such reasoning Launhardt concluded that:

> In the neighbourhood of the site of any specific industry we find the auxiliary businesses grouped alongside; so that the entire economic character of a district is a consequence of the predominant branches of industry.[1]

Summary and Conclusions

Wilhelm Launhardt was a German engineer-economist who was among the first to apply higher mathematics to economic problems. He made major contributions to many areas in economics including location theory. A very strong case can be made for a double observation of Robert Merton's theory of multiple discovery, when we consider Launhardt's location theory. Weber-Pick discovered the locational/weight triangles developed earlier by Launhardt. Frank A. Fetter developed the market area analysis also found earlier in Launhardt. As far as can be determined, neither Weber-Pick nor Fetter were familiar with Launhardt's work.

Furthermore, this author discovered a neglected book of Launhardt's within which he included both the locational/weight triangles and the market area analysis. There is evidence to indicate that parts of this book were completed

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[1]Ibid., pp. 53-4.

in 1872--ten years earlier than his first article on the subjects. No reference to this book could be found in the location theory literature or in the history of economic though literature. The book contained an application of a combination of locational/weight triangles and market areas to find the "commercial trace" of railroad lines. A passage was found that shows that Launhardt had a basic understanding of agglomerations.

Using the model dimensions developed by Britton Harris,[1] this author would classify Launhardt's models as analytic, partial, micro, static, deterministic, and simultaneous.

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[1]Harris, "Quantitative Models of Urban Development," p. 367.

CHAPTER VII

ANALYSIS AND TRANSLATION OF LORIA

Introduction

Achille Loria (1857-1943) was an Italian economic theorist. He studied under Luigi Cossea at Povia, Angelo Messedaglia at Rome, and Adolf Wagner at Berlin.[1] He had a long and distinguished teaching career which ended at the University of Turin in 1932.[2]

Loria's first book, La Rendita Fondiaria e Le Sua Elisione Naturale (1880),[3] contained an idea which would influence all of Loria's later works: the terra libera--the influence of free land. In fact, Loria has been recognized as providing the major basis for Frederick Jackson Turner's "frontier thesis."[4] This factor will also be seen

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[1]International Encyclopedia of the Social Sciences, 1968 ed., s. v. "Achille Loria," by Shepard B. Clough, pp. 474-75.

[2]Luigi Einaudi, "Achille Loria (1857-1943)," Economic Journal LVI (March 1946): 147. Also see Einaudi's bibliography of Loria's 884 works in La Riforma Sociale (1932).

[3]Achille Loria, La Rendita Fondiaria e La Sua Elisione Naturale (Milano: Ulrico Hoepli, 1880). This work is not yet translated into English.

[4]Lee Benson, Turner and Beard: American Historical Writing Reconsidered (Glencoe, Ill.: The Free Press, 1960 (1950)), p. 21. Also see "Achille Loria's Influence on American Economic Thought," pp. 1-40.

to have been the foundation for his location theory.

None of the surveys of Loria's life and works mentioned the fact that he had written two articles on location theory, but Krzyzanowski did mention these works in his early review article on the location of industries. In fact, Krzyanowski called Loria ". . . the father of the modern theory of industrial location."[1] Upon investigation it was determined[2] that these articles had never been translated from the original Italian into English. The translation of these works is now completed. The contents of these translations are not always clear, so some "guiding through" the works might be helpful. The text of the first article contains many mistakes which Loria corrected in the second article. Since this was the case, the text of the first at some points is confused at best. The translations are presented as an appendix to this chapter.

The First Article

Loria reviewed the problem of location from the standpoint of rent. The first article, "In Reference to the Influence of Rent on the Topographical Distribution of

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[1] Krzyzanowski, "Review of the Literature," p. 279.

[2] The determination of existing translations and rights to translations was accomplished in written communications with the Accademia Nazionale dei Lincei and the Societa Editrice Libraria both of which have published the articles in Italian. This author has received written permission from these organizations to do the translations (see the Appendix to this chapter).

Industries,"[1] dealt with agricultural problems. Here, as elsewhere, one can see the influence of Thünen on Loria's work as he investigated the ordine razionale delle colture,[2] i.e., the rational order of crops. Loria gave Thünen praise for being a great economist, but he did not always agree with Thünen. In general, Loria agreed that there should be an inverse relationship between the cost of transportation and the distance from the market that a crop can be grown,[3] but this is where the agreement ended. Loria was fond of giving special cases of any problem which he was investigating. He would agree with Thünen (as in the case stated above) only under special conditions. For example, at other times the product with the lowest transportation expenses per unit could be located near the market. Loria reached this conclusion by stating that total transportation costs were important. If this were true, then a product with a low per unit transportation cost but with a heavy weight might be located next to the town.

The major counter-example to Thünen's system was given by considering production cost along with transportation cost. Loria believed that the ratio between production cost and transportation cost could, ceteris paribus, be the

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[1]Achille Loria, "Intorno All'influenza della Rendita Fondiaria sulla Distribuzione Topografica delle Industrie," Atti della Reale Accademia dei Lincei, Roma, Rendiconti, Serie IV, no. 2 (1888), pp. 115-26.

[2]Ibid., p. 123.

[3]Ibid., p. 115.

lowest on lands near the market, but the absolute transportation cost in that ratio did not have to be the highest (as Loria claimed was required in the Thünen model).[1] In reading the first article, one must be very careful anytime Loria referred to this ratio. The first several times he mentioned the ratio, he stated that the ratio between transportation cost and production cost should be the highest on the land near the town. Then for some unknown reason he began to give the inverse of this ratio, i.e., that the ratio between production cost and transportation cost should be the lowest on land near the town. The two approaches are, of course, logically equivalent. This author's interpretation of one possible way that Loria could have arrived at these particular ratios is as follows. If rent, R, is the surplus of total revenues, TR, over production cost, P, and transportation costs, T, then when production cost and

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[1]For example, what if the ratio of production cost to transportation cost was 1/5 near the town and 2/9 away from the town. In this case the absolute transportation cost near the town is less than away from the town, i.e., 5 is less than 9. At the same time, when the two fractions are converted to a common base such as 45, it is determined that 1/5 is less than 2/9, i.e., 9/45 is less than 10/45. Loria presented such reasoning as a counter-example to Thünen's model. The reason why the fraction should be lower near the town was not fully explained by Loria. The fraction could also be less near the town if the numerators (production cost) were the same, and if the denominator (transportation cost) of the fraction near the town were greater than the denominator of the fraction away from the town. Loria felt that this last case was very common (see the discussion of "fictitious" transportation cost later in this chapter).

transportation costs are both a function of distance, d, the first order conditions for maximizing rent with respect to distance will give the ratio. Assume that there are only two goods.

(1) Rent Functions

$$R_1 = TR_1 - P_1(d) - T_1(d)$$
$$R_2 = TR_2 - P_2(d) - T_2(d)$$

(2) First Order Conditions

$$-P_1 - T_1 = 0$$
$$-P_2 - T_2 = 0$$

(3) Simplification

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

This procedure would give a maximum rent to the society assuming that it would be possible to arrange for the ratios to be equal. Loria must have implicitly recognized that such an outcome was unlikely, so he reasoned that the crop with the lowest ratio of production cost to transportation cost (and very likely a high value for T) should be produced close to the market. In addition, unless the two crops were produced by the same firm, it would be unlikely that competition among firms could lead to the result given by this author, i.e., that the ratios should be equal. There would be no reason to assume that the firms would cooperate to maximize rent for society. One should also note that the values used by Loria for T in these equations were "fictitious"

or "imaginary." Loria used "fictitious" transportation expenses to represent the potential transportation expenses which would have to be incurred if the goods involved had to be transported from the "border-line" of the trade territory for that good. So, the actual transportation expenses for a good may be reduced to a small number by locating it near the town, but the "fictitious" transportation expenses would be high at such a location. In this sense, it is easy to understand why Loria contended that the transportation expenses in the ratio did not have to be the highest "absolute" expense; that would depend on the goods under consideration and their market areas as compared to the production cost of each good.[1] There is much room for confusion in such analysis and at other points in the first article where Loria used different ratios. This author believes that a conclusion reached in the second article will help to show that Loria himself was confused.

Another modification of Thünian conclusions was given by taking the cost of labor into consideration. Loria

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[1]As in the example given in the preceding footnote, the ratio 1/5 (near the town) is less than 2/9 (away from the town) but the "absolute" transportation expense near the town is not the highest near the town, i.e., 5 is less than 9. At the same time the "fictitious" transportation expenses of transporting the crop near the town from the border-line to the town would be greater than those expenses for a crop away from the town (nearer the border-line of the trade territory) assuming (1) that the weights of the two crops are the same, and (2) that the transport (freight) rates are the same for the two crops. So in this example, the ratio of production cost to transportation cost would be lower near the town no matter if one uses "absolute" or "fictitious" transportation expenses.

contended that the price of labor would rise as one located production nearer the town, because near the town ". . . it is easier for the workers to find a job in the factories."[1] Under such conditions, if the "salary-product" paid to labor rose at the correct rate (in an amount equal to what the rent would have been otherwise) this could result in a system with no distance rent at all. One should also have information on where the crops are grown to feed the laborers. If the production site is located near the town but the crops used by labor is located near the "border-line," then the transportation cost of these goods must also be counted. Loria concluded that the rational producer should pick that location for which the ratio between production cost and transportation cost is lower than the ratio between the salary of the distant land to the increment of the salary added by locating on the land near the town. In such a case, the rational distribution of crops might be ignored. In the second article, Loria admitted that this analysis is not always correct.

Loria sighted examples from history to show that Thünen's circles were sometimes reversed, but he contended that the ". . . actual reversion of Thünen's circles is easily explainable, if we consider the reversion as the result of the owner's struggle to get the highest rent."[2]

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[1]Loria, "Intorno all'influenza," p. 122.

[2]Ibid., p. 125.

That is, if one keeps in mind the various variables included in or excluded from a model's ceteris paribus assumptions, one might realize that under the stated conditions Thünen's principle of "highest rent" applies after all.

At the conclusion of the first article, Loria stated that the law which regulates the logical order of crops also applies to the location of manufacturing industries. So, although the title of the first article might seem to indicate that the entire article was devoted to manufacturing, only the last few paragraphs actually address the subject. During these few paragraphs, Loria made a surprising mistake. This mistake would be corrected 10 years later in the second article. In this section of the first article, Loria gave an explicit definition of a distance rent (location rent). He viewed such a rent as a "value surplus."

> The value surplus in relation to the cost (this surplus is equivalent to the expenses necessary to transport the product from the most distant land) will form the rent of the area on which the industry is established.[1]

But in the same paragraph, he contended that the production of goods with the highest transportation expenses should always be produced on the land nearest to the market and the goods with the lowest transportation expenses on the most distant land. This seems surprising because of all the exceptions to this "Thunian pattern" which Loria had outlined with respect to agricultural products. He did not state that

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[1]Ibid., p. 126.

the "heavier commodities" must be located near to the place of consumption as reported by Krzyzanowski.[1] Loria wrote of high or low transportation cost just as in the early part of the article, but in this case there was no mention of weight at all.

The Second Article

No matter what were the technical details of his mistakes, Loria devoted the entire second article, "Further Inquiries About the Topographical Distribution of Industries,"[2] to correcting the mistakes of the first.

The major variable added in the second article was the location of raw materials production. Thus, Loria presented an analysis similar to Weber's in the sense that there were three types of locations: (1) the raw materials location, (2) the final goods production location, and (3) the center of consumption or town location. Loria's analysis was like Thünen's in the sense that he retained the use of rent. His analysis was unique in combining both types of models.

Loria made use of weight-losing raw materials in his location theory. This use was in clear anticipation

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[1]Krzyzanowski, "Review of the Literature," p. 279.

[2]Achille Loria, "Ricerche Ulteriori sulla Distribuzione Topografica delle Industrie," Reale Accademia dei Lincei, Roma. Classe di Scienze Morali. Rendiconti. Serie V, vol. VII (1898), pp. 235-43.

of Alfred Weber.

> . . . transportation expenses are usually lower for the finished product than for raw material necessary to produce it; and this is for the simple reason that part of the raw materials is consumed during the production process and is not to be found anymore in the finished product.[1]

Under these conditions, the establishing of a firm within a short distance of the raw materials production site would save the transportation expenses for that portion of the raw materials consumed in the production process.

Loria presented his model in three different ways: (1) verbally, (2) symbolically, and (3) numerically. This author will now present a summary of the first method. Secondly, a diagrammatical interpretation (not used by Loria) will be used in an attempt to relate his first method to his second method.

The model may be described verbally in the following way. No matter what exact location is decided upon for the final goods production site, the decision of location will result in two distances being made explicit. The first distance is that from the raw materials production site to the final goods production site. The second distance is that from the final goods production site to the consumption center. Loria stated that a rent area would result around the raw materials production site or around the consumption center depending on the transportation costs associated with

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[1]Ibid., p. 236.

the raw materials and the final goods. If the transportation expenses were lower for the raw materials than for the final goods, then a rent area would be formed around the consumption center. If the transportation expenses for raw materials were higher than those for final goods, then the rent area would be formed around the raw materials production site. If the two costs were equal, then there would be no rent. A diagrammatical view of these variables could help one to understand the subtleties of Loria's arguments. His model is much like one used by Alonso,[1] but the feature of rent was added by Loria. To the best knowledge of this author, Loria is the only writer in the history of location theory to have developed a Thünen-Weber type model combined in this particular way. In Figure VII-1, understand the following symbols (not used by Loria) as:

R = raw materials production site
K = the market or consumption center
P = final product production site
d = distance from R to P
(D-d) = distance from P to K
D = distance from R to K
t_m = cost per mile to transport raw materials
t_p = cost per mile to transport final goods
$t_m(d)$ = raw materials transport cost per unit represented by RY
$t_p(D-d)$ = final goods transport cost per unit represented by KX

From these relationships, one can deduce that total transportation cost, TTC, at any one point would be:

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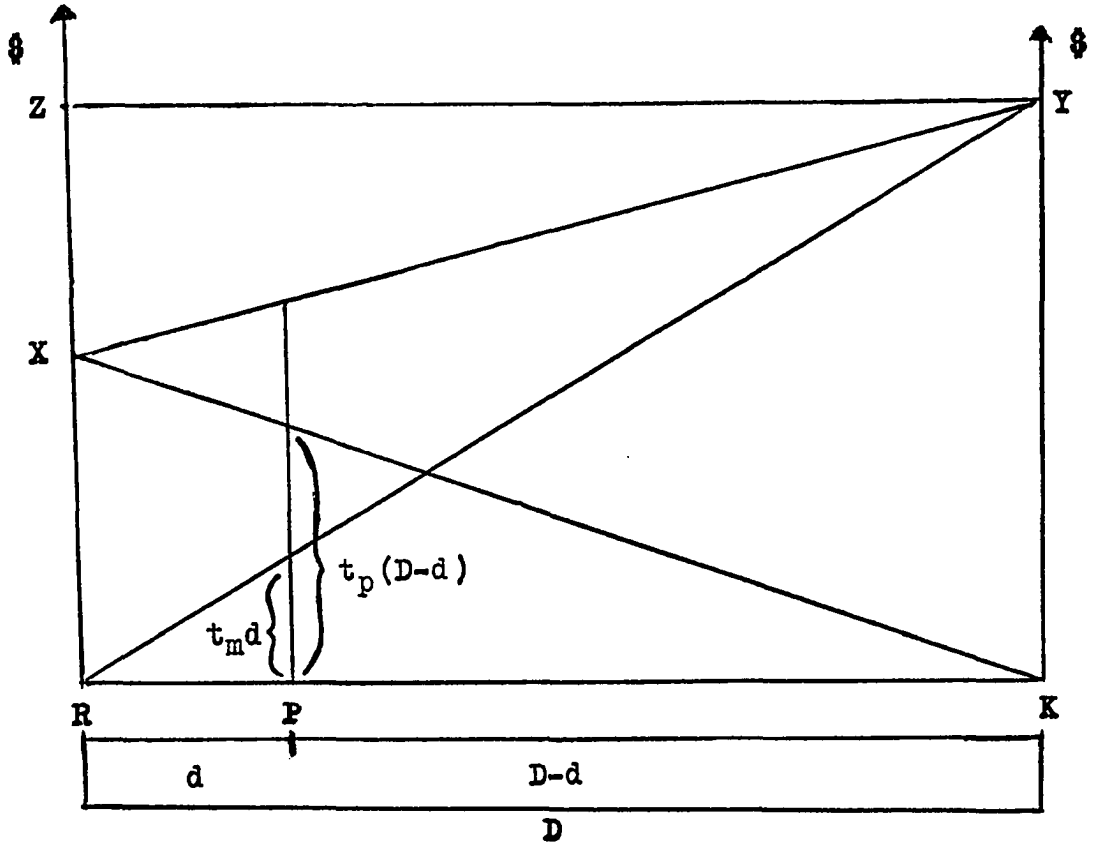
[1]William Alonso, "Location Theory," in Friedman and Alonso, Regional Development, p. 83.

Figure VII-1

A Diagrammatical Interpretation of Loria's Model



$$TTC = t_m(d) + t_p(D-d)$$

In Figure VII-1, TTC is represented by the line XY. Alonso and others have used this relationship to find a value for d such that TTC would be minimized, but at this point in his article Loria ignored the problem of finding the "best" value for d. Instead, he noted (in the case presented in Figure VII-1) that if revenues are just sufficient to cover the maximum TTC, KY, then there will be a rent area formed around the raw materials location, R. At R that rent would be equal to XZ. This rent would decline in value as one moved toward the consumption center, K (where the rent would be exactly zero). If the final goods transportation costs were higher than those for the raw materials (and represented on a diagram similar to Figure VII-1 but with the line KX steeper than the line RY), then the total transportation cost line XY would fall from left to right on the diagram. The final result would be that a rent area would be formed around the consumption center, K. The rent would fall to zero at R. If RX = KY, then there would be no rent at all as Loria stated.

Later in the article, Loria commented that when there are both final goods transportation costs and raw materials transportation costs the rent at any one location would be equal to difference between the transportation expenses of the final goods and the raw materials. This fact can be seen graphically. In the case represented in

Figure VII-1, the rent at R, XZ is equal to the maximum possible raw materials transportation costs, KY, minus the final goods transportation costs, RX. One can arrive at the same conclusion by noting that the equation for total transportation cost can be rearranged into the following form:

$$\begin{aligned} TTC &= t_m(d) + t_p(D-d) \\ &= t_m(d) + t_p(D) - t_p(d) \\ &= (t_m - t_p)d + t_p(D) \end{aligned}$$

If t_m is greater than t_p, then the firm would want to keep d as small as possible, i.e., locate at R. This is as far as Alonso would take the analysis, i.e., Alonso did not extend his analysis to recognize rent. Loria noted that if t_m were greater than t_p then a rent area would be formed around the raw materials location, R. If t_m were less than t_p, then the coefficient for d becomes negative. The firm would like to make d as large as possible under these conditions so that TTC would be as small as possible. This is true when d = RK so that the firm is located at the consumption center. In this case the rent area would be formed around the consumption center, K. If $t_m = t_p$, then the coefficient for d would be zero and the transportation cost would be equal to $t_p(D)$ no matter where the firm located. In this case if revenues just cover costs, then there would be no rent in the system.

The diagram used by Loria in his second article was

unnecessarily cluttered with a fourth point (see point p).[1] If this point is ignored (as even Loria himself instructed), then one can see that his analysis was the same as that presented by this author (note that Loria's S' = NS and S are t_m and t_p, respectively).[2]

The importance of Loria's analysis lies in the fact that one should realize that no matter where the production site for final goods is located there is a good chance that a rent will be forthcoming. The details of Loria's analysis reveals the source of that rent.

After reaching the conclusions of his rent model, Loria reached back into his first article to correct some weak analysis. He admitted that it was not always true that final goods burdened with the highest transportation costs must be produced on lands near the consumption center. There may be some "indirect" burdens that have been overlooked. This would be true when raw materials had to be used in the production process. Loria concluded that the meaning of "rational order of production" should be looked at in this new light.

> More generally, we can say that the rational order of production requires the production near the market of that product procuring the highest savings on transportation expenses. Now, this product is the one

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[1]See the translation of Loria's second article in the appendix to this chapter.

[2]Ibid.

> requiring the highest transportation expenses only when we suppose all other conditions unchanged.[1]

This author believes that such a conclusion should also apply to Loria's use of the various ratios in the first article. The text accompanying these ratios was quite complex and confused, but the message seemed to be the same as in the quote given above--produce at that ratio where savings in costs is the greatest.

Summary and Conclusions

Loria presented a unique model of location based on aspects of Thünen's work. Retaining the element of rent from Thünen's system, Loria built a model which anticipated Alfred Weber's location theory. He used weight-losing raw materials and a model based on three different types of locations: (1) raw materials location, (2) final goods location, and (3) the consumption center.

Using Britton Harris' model dimensions,[2] this author would classify Loria's model as analytic, partial, micro, static, deterministic, and simultaneous.

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[1]Loria, "Ricerche Ulteriori," p. 242.

[2]Harris, "Quantitative Models of Urban Development," p. 367.

APPENDIX

This appendix contains two letters granting this author permission to make English translations of Loria's articles. In addition, it contains the actual translations in order of date published. This natural order is unfortunate in one sense. The second article is much more readable than the first article. As mentioned above, the second article was written by Loria to overcome weaknesses of the first article. In retrospect, one of the major weaknesses of the first article was Loria's "ramblings" which at some points included materials and examples not relevant to the problem at hand. The second article is void of such wanderings. The footnotes associated with these articles have been placed at the end of each article along with the translator's footnotes. In the body of the translations, those footnotes found in Loria's original text have been placed in parentheses.

ACCADEMIA NAZIONALE DEI LINCEI

IL PRESIDENTE

3840/74

190 Roma, 13 novembre 1974

Egregio Sig. James V. PINTO
Adams Hall, Room 306
Department of Economics
University of Oklahoma

NORMAN, Oklahoma 73069
(U.S.A.)

Egregio Signore,

con riferimento alla Sua richiesta del 16 ottobre u.s., mi pregio informarLa che questa Accademia Le concede l'autorizzazione a tradurre le due note di Achille Loria

(1) "Intorno all'influenza della rendita fondiaria sulla distribuzione topografica delle industrie", Atti della Reale Accademia dei Lincei, Roma. Rendiconti. Serie IV, vol. IV, 2 (1888) pp. 115-126.

(2) "Ricerche ulteriori sulla distribuzione topografica delle industrie", Reale Accademia dei Lincei, Roma. Classe di Scienze Morali. Rendiconti. Serie V, vol. VII (1898) pp. 235-243.

Si chiede di voler cortesemente citare la fonte come d'uso e di voler inviare a suo tempo un esemplare della traduzione a stampe alla Biblioteca di questa Accademia.

Per quel che riguarda la Sua richiesta di notizie circa eventuali precedenti traduzioni in inglese dei due suddetti articoli, sono spiacente di informarLa che non mi è possibile fornirLe nessuna precisazione in merito.

Con i migliori saluti.

(Enrico Cerulli)

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Ufficio Editoriale

Mr. JAMES V. PINTO
The University of Oklahoma
Division of Economics
307 West Brooks Street, Room 306
NORMAN, OKLAHOMA 73069
(U.S.A.)

Milano , 15 novembre 1974

Egregio Dottore,

in riscontro alla Sua gentile lettera del 16 ottobre u.s., siamo lieti di autorizzarLa a tradurre in lingua inglese le parti da Lei citate dell'opera di A. Loria "VERSO LA GIUSTIZIA SOCIALE".

Non ci risulta che sia mai stata effettuata una traduzione dell'opera in lingua inglese nè in tutto nè in parte.

L'occasione ci è gradita per inviarLe i nostri più distinti saluti.

Dr. Giorgio Quintavalle

"In Reference to the Influence of Rent[1] on the Topographical Distribution of Industries"*

Many scholars have learned from economists' investigations that rent is a limit to production and interferes with agricultural improvements. They also need to examine another problem of whether or not the rent can affect, obstruct, or hinder this special form of agricultural improvement, that is, the distribution of each crop to a distance from the market at a rate inverse to the cost of transportation of the products acquired. To solve this problem, it is necessary to determine what bearing the rational distribution the crops exercises on the value of the products. We think that this influence has not been deeply pointed out until the present.

Let us suppose that we have three pieces of land, one of these is superior in the production of two products, but the superiority is higher in one production than in the other. For example, in land A they produce G and Q in ten working days; in land B they produce G in twelve days and Q in fifteen; in uncultivated land B' the productivity is B. In this situation it is obvious that every kind of

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*Translation of Achille Loria's article, "Intorno all'influenza della rendita fondiaria sulla distribuzione topografica delle industrie," Atti della Reale Academia dei Lincei, Roma. Rendiconti. Serie IV, vol. IV, no. 2 (1888), pp. 115-126. This article can also be found in Achille Loria's Verso La Giustizia Sociale, vol. I (Milano: Societe Editrice Librarice, 1904), as Part I of Chapter 18, "Studi sulla topografia dell'industria."

product cultivated in A will have the same value as its production cost in B. If the producer of land A refuses to sell his product at a lower value, the consumer is compelled to produce that crop in B or in B', at precisely the same price[2] as when he purchased the product from the owner of land A. Now, the producer of land A takes an advantage[3] by growing that crop which has the highest degree of productivity on his land; how much is the difference between the cost of production of the crop in B and in A? as much as the higher rent of the latter land. So therefore, they will produce Q in A and G in B. They will sell G at the value given by the cost of its production on land B, involving twelve working days; they will sell Q at the value given from the cost of its production on B involving fifteen working days, and so the owner of A will have a rent equivalent to five working days.

This distribution of crops is profitable to the owner, and in the meantime gives the opportunity to obtain the products at the lowest cost. The lower productivity of the second land is reduced to a minimum, because that land is planted to produce a less inferior product[4] and quantity. The rational distribution of crops is really useful to the society as a producer; the society as a consumer gains no advantage, because the value of the products would be the same if they changed the order of the crops or if all the lands were unfruitful. As the value of the product is the

same in A and in B, it is obvious that the quality level of the product in A is totally unimportant to the consumer, since the logical order of the crops in lowering the total cost of production does not reduce its value. This is an agricultural improvement which is limited to the most fruitful land, and it reduces the cost of production on this land without reducing the value of the product. The latter is determined by the cost on the land-limit[5] land the conditions of which are unchanged. Therefore, the consumer has to accomplish the same amount of work[6] as if no agricultural improvement had occurred; but a part of this working quantity goes to the owner of the best land in the form of an increased rent. If they had had no agricultural improvement, this working quantity would have compensated for losses incurred on the best land.

This is the effect of a rational distribution of crops[7] among lands that have a different potential for the production of different crops. We can state the same concept concerning the rational distribution of crops among lands of the same quality but at different distances from the market when the cost to transport is differentiated according to the products transported. For example, given two plots of land, the first being at zero distance and the second at a further distance from the market; we have two products G and Q, the former needs an expense of ten working days and the latter twenty working days in order to be carried from the forest

to the market. It is obvious that the producer of the nearer land will sell any kind of product acquired at the same value (without considering the expenses of production) as the cost of transportation of that product from the land far from the market. The higher the transportation cost of this product the higher is the rent of the land near the town. So on this land they will bear Q because its transportation is more expensive. On the contrary, they will produce G on the most distant land. This distribution of crops is profitable not only for the owner but also for the society as producer. This is because society can get the product cultivated in the most distant land with the lowest transportation cost, that is ten working days. On the contrary, if the crops were reversed the society would have to incur a cost of transportation of twenty working days to acquire the product of the remote land. But the society, as consumer, does not get any advantage from rational distribution of crops, because the products all have the same value as if they were cultivated in the most distant land. All the plots of land are barren and far away for the consumer; the savings in cost because of the nearness or fruitfulness of the land is profitable only for the owner. Therefore, you can deduce that the rent must be favorable which results that kind of agricultural improvement that gives the rational distribution of crops. It is the producer's interest to have this arrangement,[8] because if[9] this

improvement is exclusive to the nearest land then[10] the rent can rise. However the same influence of the rational distribution of crops, providing value to the owners, is excluded[11] if it depresses the value of the agricultural products; so Thünen was in error when he stated that the aim of the rational distribution of crops was to permit the sale of agricultural products at the lowest value. In fact, according to Thünen,(1) the product cultivated in the nearest land has a value (apart from the production cost) equivalent to the rent that these plots would have if they had cultivated the product acquired from the most distant land,--that is, the border-line product.[12] This means that this product has a value corresponding to the transportation cost from the most distant land to the nearest. This implies that as the transportation cost of the border-line product is lower so decreases the rent of the nearest land and consequently of the product acquired. But, the previous statement is also inaccurate; in fact, the owners of the nearest land can raise the value of their product by the whole cost of transportation of the product itself, not of the border-line product from the most distant land. Those consumers who do not want to submit to[13] that price would have to grow those crops in the most distant land and pay the same price they have to pay now. Therefore, we can state that it is not true that a lower transportation cost of the border-line products lowers the value of the products grown on the

nearest land and its rent, as that value and that rent is obtained from the transportation cost of the products raised on all lands. For example, Thünen is right when he states that it is better to produce forests near towns and produce cereals far away in distant zones, because the transportation cost of the latter is cheaper. But the price of wood would not result in the same rent if the land raised cereals instead of trees. Regarding the transportation cost of the cereals from the most distant land to the nearest, the price is equivalent to the transportation expense of the wood itself. We can state that the value of the wood and of the cereals is always the same even if grown in different areas. In addition, even if you change the order of the crops, the wood would have a value similar to its transportation cost from the most distant land. On the contrary, the cereal cultivated on the nearest land would have a value corresponding to the cost of their transportation from the most distant land. Therefore, the rational distribution of crops, even if desirable as it lowers the cost of the product, is less effective than Thünen states.(2)

There are only two cases in which the rent of the near land or the value of the product raised on it is similar to the transportation expenses of the border-line product. You have two products--the one raised on the farthest land has the lowest transportation expenses. Let us imagine that the demand for the product cultivated in the nearest

area becomes lower and that the demand for the other product rises, so that a part of the latter product is cultivated by necessity in the area by the town. In this case the land of the area that halted the cultivation of the product with the higher transportation cost observes[14] its rent becoming lower. For this rent is corresponding to the transportation expenses that are now lower. Therefore, the rent will be different on various lands tilled in the same area, because of the lower or higher transportation expenses of the product grown. This inequality produces an immediate halt to the production of the first crop that has lower transportation expenses, on the land of the first area. Consequently, we have an excessive production of the other crop causing a depreciation in its value. To avoid this depreciation, it is necessary to sell the product cultivated in the first area, that has the higher transportation expenses, at a value not corresponding to its transportation expenses but corresponding to the expenses of the product with the lower transportation cost. This proportionally lowers the rent of all the plots of land in the first area, and it permits the coexisting production of the two crops. This is an example in which the value of the product grown in the first area corresponds to the transportation cost of the product grown in the most distant land. We have a different case when the product raised in the nearest land does not have a demand determined by the value obtained from the transportation

expenses of the border-line product. In this case, if the producers ask for a higher price, the consumers do not start to produce this crop on the most distant land but simply stop production. The conditions in which the owners of the nearest land could require a value corresponding to the transportation cost from the most distant land of the product cultivated on it does not apply.

If the product grown on the nearest land is among the products consumed by the worker this product has a higher value. Therefore, the rate of profit is inferior to what would be expected if the rational order of cultivations lowered the value of the crops--as Thünen states. However, it could happen that the product consumed by the worker is only required when its value is burdened with a rent corresponding to the transportation cost of the border-line product from the most distant land to the nearest. In this case, the value of the product consumed by the worker will be determined by Thünen's statements, the value will be lower as less of the area is cultivated with this product. The part of its value corresponding to the real cost of the transportation to the town will be lower, because this value is burdened by the higher transportation expenses.(3)

It is necessary to notice that the topographical location of the crops does not effect the transportation cost of a unit of weight of the various products,[15] but rather the whole quantity of the various products cultivated in a

stated area. For example, a product m has a lower transportation cost--per unit--than the product n, but the total weight of m when produced in a stated land is much higher than the total weight of n that could be produced on the same land. So, we have total transportation cost of the quantity of m produced higher than the total transportation cost of the quantity of n produced on that land. Under these conditions it will be more useful to produce that crop which has a lower transportation cost per unit on the nearest land, since the transportation cost of the quantity of that produced obtained on a stated extension of land, is higher than the production of the same quantity of the other products. Therefore, the savings in the cost is higher if you produce that crop in the land by the market. For example, industrial plants[16] spoil the land excessively, and this includes vast areas of meadows and pastures. The quantity of these plants produced in a stated area has less weight than other products with a lower unit weight. Therefore, the industrial plants must be produced in the most distant areas.[17]

Until now, we have not as yet considered a relevant element, that of the cost of labor[18] which brings considerable modifications to the preceding results. We have, for example, several crops with the same expenses of production and transportation, and we suppose that the product consumed by the worker is cultivated in the most distant land.

Suppose that 100 working days produce 100 measures of oats in a, which is the near land, and 100 measures of wheat in b, which is the distant land. The transportation cost of both from b to a is 22.2 working days. The salary for 100 working days of labor is 50 measures of oats, and therefore the rate of profit is 100% on land b. If these conditions hold, the producer of land a raises the value of the product in relation to the transportation expenses that his crop would have if cultivated in b; he sells 100 measures of oats at 122.2 working days. But, the producer must pay 50 measures of wheat in salary, and he must get it from land b, that is, at a value of 61.1 working days. So, the profit rate is 61.1/61.1 = 100% in land a; the profit rate is similar on the two pieces of land for which there is no rent. In fact, under these conditions, while the value of the product acquired in a raises corresponding to fictitious[19] transportation expenses (as if the product were transported from the most distant land), the value of the salary raises corresponding to real transportation expenses, and it is in proportion to them. Therefore, the relation between the capital and the product is equal in the two pieces of land, excluding the possibility of a rent.

If we state that the products are grown at the same expense of production and transportation on various pieces of land and that the value of the salary spent on this land rises correspondingly with their nearness to the market,

then there is no distance rent. As regarding the nearest land, the benefit of the closeness of their product to the market is neutralized by the distance of the place in which the salary-goods are produced. We have a different case when the various products have the same transportation cost and different production cost. If, for example, 100 measures of oats are acquired in 80 working days, the producer of land a will sell his product at 102.2 working days of labor; the salary paid by him, which corresponds to 40 measures of wheat, will have a worth of 48.8 working days. The gain will be 53.4, and the rate of profit acquired on land b will be 53.4/48.8, which is more than 100%, and will leave a rent to the owner of a. If the product raised on a needs a quantity of labor[20] less than the product which is consumed by the worker with the same transportation cost, this means that the transportation cost raises the value of the product of land a in a higher proportion than the value of the salary. And this means that the owner of a can raise the value of his product for the fictitious transportation expenses in a higher proportion than if he had to raise the value of the salary for the real transportation expenses. This shows that the correlation between the salary and the product is lower in a than in b and that it leaves a rent to the owner of the first land. Therefore, it is obvious that the owner of the nearest land grows the product with the lowest production expenses to acquire a good rent.

He would not acquire the same rent if the product cultivated by him and the product consumed by the worker had the same production expenses.

The raising of the cost of labor on the nearest land shows a new method for the local distribution of crops. They will raise the crop on the nearest land for which the ratio between the transportation cost and production cost is higher than that of the salary-product, and even when it shows the highest ratio between these two costs. In the case presented, the different products have the same transportation cost, so that the new factor does not introduce any contradiction into the rational distribution and location of the crops based on the transportation expenses of the various products. The result is the same if the imagine the opposite case, that is, if we have the same production cost and different transportation cost of the products grown in a stated area. In this case, the product that has the highest ratio between transportation and production expenses is the one that has the highest absolute transportation expenses. Therefore, the cultivation of that product on the nearest land responds to the rule of the rational distribution of crops.

Let us imagine now that the production cost and transportation cost of the various products are different. We can notice that the product with the highest ratio between transportation and production expenses cannot have

the highest absolute expenses. Therefore, the owner of the nearest land can have an interest in growing a product which is different from that suggested by the rational location of crops. For example, the 100 measures of oats have a production cost of 80 working days and a transportation cost of 20 working days. The other products, wheat, barley, etc., have production expenses of 100 days and transportations of 22 working days. If the owner of a grows barley he gets no rent for he raises the value of his product at the same ratio at which the value of the salary raises. On the contrary, when he grows oats, he raises the value of his product from 80 to 100 working days, that is by ¼, while the value of the salary spent by him rises only from 40 to 48.8 working days, or 11/50. The profit rate is 51.9/48.8, which is higher than the profit of b's owner, because it leaves a rent. It is necessary to note that in this case the rent really contributes to the prevention of the rational location of the crops. The location theory requires[21] that the product with the lowest transportation expenses be grown in the most distant land; the rent, instead, requires that the cultivation of the same product be in the nearest land. For, only in that product do the production expenses have a lower ratio with respect to the transportation expenses, and in regard to the crop consumed by the worker. Because of the rent, we have the cultivation of the crop with the lowest transportation expenses (the oats in our

example) in the nearest land, and the cultivation of the product with the highest transportation expenses (the barley) in the most distant land. The society as producer is burdened with an additional transportation cost which the rational location of the crops could have avoided. The society as consumer is untouched by this change in the location of the crops. As we said, the value of the various products is always correspondent to their cost of transportation from the most distant land. The moving of the production of a crop to the most distant land raises its transportation cost, but it does not change the value. The value of the various products does not change; but, the value of the product acquired in the nearest land is lower than the value of the product assigned by the natural location of crops. In the first product, part of its value representing its fictitious transportation expenses forms a ratio with the part of its value representing the salary made up of real transportation expenses, in a larger proportion (ratio) than in the second product. So, we have an increase in the profit rate on the nearest land which is a special cause for rent to the owner.

The previous statements are true when the crops consumed by the worker are produced only on the land distant from the center of the market. On the contrary, if the product consumed by the worker is raised on each piece of land, there is not higher salary cost in the nearest land

due to the transportation expenses of that product. If the crops consumed by the worker are grown only on the land near the center of the market, these crops have two rent causes: the lower cost of transportation of their products and the non-existent transportation cost for the salary-product. Nevertheless in these last examples, it is also evident that the owners of the nearest land are usually burdened by a higher working cost of labor, due to the particular elevation of the agricultural salaries in the area of the town. This is because it is easier for the workers to find a job in the factories.(4) In this case, it would be in the owner's interest to grow the crop on the nearest land for which the ratio between the production expenses and the transportation expenses is lower than the ratio between the salary of the distant land and the salary increase of the land by the town, and even to grow the crop which has the lowest ratio between production and transportation expenses. The cultivation of this crop on the nearest land implies a reversal in the rational location of crops if that crop does not have the highest absolute transportation cost. That is, if the quantity of that crop produced on a stated area does not show a higher transportation expense than the quantity of each of the other crops produced in the same area.

In conclusion, when the crops consumed by the worker are grown on every piece of land, the transportation expenses effect only the value of the products, but not that of the

salary-value. Under these conditions, that which determines the location of the crops is the absolute transportation expense of the various quantities of the products in a stated area. Therefore, they cultivate on the nearest land that crop which has the highest transportation expenses which gives the highest rent to the owners and the lowest transportation expenses to the society. When, on the contrary, the crops consumed by the worker are produced on the most distant land (because of the special condition of the productiveness of this land, or due to the lower transportation cost of these crops), the transportation cost does not only raise the value of the product but also the value of the salary. So, the product cultivated in the near land gives a rent when its value increases at a higher rate for the fictitious transportation expenses than those values of the salary made up of real transportation expenses. This crop gives the highest rent only when the ratio between its transportation and production expenses have reached the highest degree of superiority when compared with the same ratio for the salary-product. Therefore, in the near land they need not cultivate the product with the highest absolute transportation expenses, instead, they have to cultivate the product with the lowest ratio between production and transportation expenses. The same thing happens when the salary is higher on the land by the town. If this product, which has the lowest ratio between production and

transportation expenses, does not have the highest absolute transportation expenses, its cultivation in the land by the town implies a reversal of the rational location of crops.

The proof of the preceding statements is the inversion of Thünen's circles, that manifests itself in the most diverse periods of the economy. Wheat requires a higher quantity of labor and it has a higher ratio between production and transportation expenses than does livestock; therefore (and still the worker consumes the crop produced in the most distant land), cattle breeding is the kind of production most profitable for the owners of the land by the town. The cattle breeding decreases to a minimum the amount deducted from rents in order to cope with the higher cost of transportation paid to the workers or the supplementary salary.(5) Since livestock is the agricultural product with the lowest absolute transportation expenses, the natural order of cultivation would require that cattle breeding be done in the most distant land, and that wheat cultivation (which requires more transportation expenses) be done on the land by the town. The owner's interest suggest to reverse the location of these cultivations. When the average labor cost is low and its specific increases are not relevant, the owners can support a limited deduction from their rents without changing the cultivation system. But, when the average labor cost is particularly high and its increase remarkable in the areas by the town, the owners

are compelled by the laws of personal profit to prefer the system of cultivation requiri..g the least quantity of labor; therefore, they spread the pastoral economy in the area by the market centers, forcing the most distant land to grow cereals.(6)

The same happens in a slave economy, the owner of the near land is stimulated to practice the pastoral economy leaving the cultivation of wheat to the most distant land. In fact, the slave economy increases, as the average cost of labor, its specific growth in the areas by the town, both for the higher transportation expenses of the slaves and for their higher needs. Therefore, we find the pastoral economy practiced in Attica where cereals are imported from trans-marine lands.(7) We find a prosperous pastoral economy in the Roman Italy. On the contrary, we find wheat production in Sicily, Sardinia, Corsica that furnish the town.(8) Why? Because, we know that the crops consumed by the slaves were raised on the most distant land, and the retribution being higher on the near land, the owners in Attica and Italy suffered a decrease in their rent. This was due to the particularly high cost of the slave labor in those areas. For this reason they were induced to practice the system of cultivation with the lowest ratio between production and transportation expenses. During the 17th and 18th centuries in which an accumulation higher than the population increase there was an increase in the cost of labor, and, therefore,

an additional cost of agricultural work by the town, we had the Thünen cirlces reversed. For example, cattle breeding was practiced in the area by London; on the contrary, wheat cultivation was driven back to Scotland.(9) But, at the present time we can also notice a reversion of Thünen's circles. Europe produced livestock and imports cereals from America, Australia, and India. According to Sax(10) this is due to the improvement of the means of communication, which has lowered the transportation cost of wheat, and the end result is to make profitable the cultivation on the most distant land. This explanation is not acceptable. Firstly, we not only have the improvement of the transportation means for wheat, but also, for livestock and meat.(11) Meanwhile, we have the improvement in the transportation means of wheat and the increasing of their cultivation. The latter raises the quantity of crop which can be produced on a stated land and therefore, it raised the transportation cost of that quantity. An increase of this kind or a proportional one is not noticed in the production of livestock. So, the total quantity of wheat which can be raised on a land always presents a higher transportation cost than the total quantity of livestock producible on land of the same extension. This implies an economy based on producing wheat on the near land.(12) The actual reversion of Thünen's circles is easily explainable, if we consider this reversion as the result of the owner's struggle to get the highest rent.

As the wheat crop is consumed by the worker is produced on the most distant land (America), it is necessary to practice the cultivation of the product (livestock) which presents the lowest ratio between production and transportation expenses in the area of the town. In actuality, the latter product, that needs the lowest transportation expenses, drives back the cultivation of the products (rice and other cereals) that require a higher transportation expense to the most distant lands (India and Australia).

The law which regulates the logical order of crops applies perfectly to manufacturing industries. A hand-made product is always sold in the central market at a value (leaving the production expenses out of consideration) corresponding to the cost of its transportation from the most distant land. If the hand-made product has the lowest transportation expenses, it will be acquired, or the producing industry will be established, in the most distant land. On the contrary, if the product has the highest transportation expense, that industry will be established on the nearest land. The value surplus in relation to the cost (this surplus is equivalent to the expenses necessary to transport the product from the most distant land) will form the rent of the area on which the industry is established. What we have said leaves out the consideration the numerous influences not dependent on distance. These influences tend to make profitable the establishment of industries in

some areas of the territory that from the point of view of the distance would be less profitable.(13) If the hand-made product has lower transportation expenses than the agricultural products and nevertheless, not considering the principle of distance, it has to be produced by the town, it is necessary to burden the value of the hand-made article with a rent corresponding to the transportation expenses of the agricultural product from the land most distant from the town, transportation expenses that are higher. To a greater extent, the special advantages that the nearness to the market gives to industries will probably rise above this limit of the rent in the area by the town, and therefore, the value of the products acquired.

In the nearest land, the rent of the area of buildings not industrially exploited is correspondent to the rent of the same area if cultivated with the product with the highest transportation expenses. That is, the rent is correspondent to the transportation expenses of the product which has the highest expenses from the most distant area. On the contrary, in the most distant lands the rent of the buildings is equal to zero. Therefore, the settlement of crops in the various areas does not effect the value of the products, which is always correspondent to the transportation cost from the border line land. But, the allocation of buildings in different areas has a great effect on the rent which varies from a maximum corresponding to the

expense of the product with the highest transportation expenses to a minimum equal to zero. This applies when the renter of a building in the nearest land is only ready to pay a rent corresponding to the profit that he would receive from this building if used for productive purposes. On the contrary, if the tenant is ready to pay a higher rent, the latter will raise without any limitation other than the economical capacity of the consumer.

Loria's footnotes

(1) Thünen, Der isolirte Staat, Berlin 1875, 321 and pass.--Also see Wolkoff, Precis d'economie rationelle. Paris, 1868, cap. X.--Manara, Concetto e genesi della rendita fondiaria, suci correttivi e sua naturale elisione, Rome 1882, 45-55.

(2) Settegast (Die Lanwirtschaft und ihr Betrich, Breslau 1885, 242-6) states that the owners of the lands by the towns had to cultivate the product with a higher transportation cost to acquire the highest rent. This is true only if you admit that the value of each product is derived from the cost of its transportation from the most distant land, not from the transportation cost of the product raised on this land.

(3) For example, we have 3 pieces of land, a, b, c; a is at zero distance from the market, b and c are at increasing distances; l is a product consumed by the worker; m, another product that requires less transportation cost, is cultivated on c. If the rent corresponds to the transportation cost of the border-line product, then the value of l will be correspondent to the cost of transportation of m from c to b, plus the transportation cost of l from b to a. On the contrary, if l is cultivated only on a, the value of l will be correspondent to the transportation cost of m from c to a, which is a lower cost. But, if the value of l is due to its transportation cost from c to a, reducing its cultivation to land a does not lower the value.

(4) Arthur Young has already noticed that the average agricultural salary per week lowers with distance from Landon. The salary is 10 scellings and 9 pence as far as 20 miles from London; 0.7.8 from 20 to 60 miles; 0.6.6 from 60 to 110 miles; 0.6.3 from 110 to 170. Young comes to the conclusion that "The influence of the capitol (London) in raising the price of labor is prodigious. This influence is unexplainable, as food has the same price in London as in the provinces." (Six weeks tour through the southern countries of England and Wales, Lond. 1772, 342-5).

(5) Moreover, this change in the system of cultivation which reduces the demand for labor, can lower the salary increase typical of the area by the town.

(6) Fraas, Die Ackerbaukrisen und ihre Heilmittel, Leipzig 1886, 180-1; Thünen himself (l. c. I, page 5 and following) points out the influence of the high salary in the areas by the town on changing the system of cultivation.

(7) Wiskemann, Die antike Lanwirthschaft und die v. Thünensche Gesetze, Leipzig 1859, 37, 85, 96, etc.

(8) Robertus, Zur Geschichte der agrarischen Entwicklung Roms, in Jahribücher für N. Oek., 1864, II, 221-2.--Mommsen, Römische Geschichte, Berlin 1858, I, 814 and following.--Roscher, Nationalekonomik des Ackerbaues, Stuttg. 1878,1158.

(9) Rogers, Thornton and all the other historians on British agriculture.

(10) Sax, Die Verkehrsmittel, Wein 1878, II, 34 and following.

(11) We remember the refrigerating apparatus Coleman, which makes the transportation of meat easy and cheap.

(12) Meat, cheese, and butter are worth from 9 pence to 1 schelling and 3 pence per libra. They can support a transportation cost for a longer distance than wheat, which has a worth less than 1 penny per libra. The wheat coming from distant lands has the great disadvantage of a high transportation cost. For this reason from 1872 to 1882, wheat importation only increased by 25%; instead, the importation of more expensive agricultural products increased by 60%. From Caird, "The Price of Wheat," in Times February 10, 1885.

(13) See Roscher, Ueber zweckmässigen Standort der Industriezweige, in Ausichteu der Volkswirthschaft. Leipzig, 1878, II, 1-100--Cossa, "Prime lines di una teoria delle imprese industriale," in Saggi, 1878.

Translator's footnotes

1. "Land income" may be substituted for "rent."

2. "Equal cost" may also be used.

3. "Has interest in" may be substituted.

4. "Produce" may be used here and elsewhere.

5. "Border-line" may also be used.

6. "Use the same amount of labor time" may be used instead of "to accomplish the same amount of work."

7. "Cultivations" may be used here and elsewhere.

8. This phrase actually translated as, "It is in his interest to cause it. . . ."

9. Added by this author.

10. Ibid.

11. "It is not applied. . . ." may be substituted.

12. "Land-limit product" may be used.

13. "Do not agree with . . ." may replace "do not want to submit to . . ."

14. "Sees" may replace "observes."

15. "Individual products" may be substituted for "various products."

16. "Commercial crops" may be substituted.

17. "Most distant zones (or rings)" may also be used.

18. "Working costs" may be substituted.

19. "Imaginary" may also be used. The transportation costs are fictitious in the sense that they are not actually incurred. They are the expenses that would be incurred if the product had to be moved over the distance from their actual location to the border-line.

20. "Working costs" may be substituted.

21. "Requests" may be substituted.

"Further Inquiries About the Topographical Distribution of Industries"*

Pursuing the inquiries we began in the former note,[1] we face the question of whether the distance from the center of production of raw materials has any influence on the topographical distribution of industries.[2] To solve this question, let us suppose the producer has free choice to establish his own factory[3] within a short distance of the place of production of the raw materials, or else to the center of consumption. We wonder which choice he will make, and according to which norms.

If we admit that the cost of transportation is the same for the raw material and for the completed[4] product, we find out right away that for the producer it is exactly the same to establish his production in the first place or in the other one; because, the complete cost of his product will be the same in both cases. Thus, let us say for instance a raw material requiring 100 working days and manufactured by 10 days of manufacturing work, gives 100 units[5] of product a and the transportation cost from the production site of the raw material as for the finished product, the producer of a goods, establishing himself near

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*Translation of Achille Loria's article, "Ricerche ulteriore sulla distribuzione topografica delle industrie," Reale Accademia dei Lincei, Roma. Classe di Scienze Morale. Rendiconti. Serie V, vol. VII (Maggio 1898), pp. 235-43. Also found in Achille Loria's Verso La Giustizia Sociale, vol. I (Milano: Societa Editrice Librarice, 1904), as part II of chapter 18, "Studi sulla topografia dell'industria."

the raw material's production site, is subject to a cost 110 + 10 (a goods transportation expenses) = 120 working days; but also if he is established near the consumption center, his cost is 110 + 10 (raw material transportation expenses) = 120; that is, the complete[6] cost to the producer is the same in both cases.

Actually though,[7] transportation expenses are usually lower for the finished product than for raw material necessary to produce it; and this is for the simple reason that part of the raw materials is consumed during the production process, and is not to be found anymore in the finished product. This is immediately evident when considering auxiliary materials, such as coal, oil for lubricating machines, etc. These materials are totally consumed during the production process and are no longer present in the finished product. And (this is)[8] even more obvious considering fixed capital, no part of which is actually transferred into the finished product. But the same thing is true when regarding[9] raw materials, because only a part of them is transmitted into the finished product, while the residue part is consumed during the production process.(1) Therefore, by establishing finished goods production within a short distance of the raw material's production site, one can spare[10] transportation expenses for all that raw material which is consumed during the production process.(2) From this is originated the tendency to establish factories within

a short distance of the raw material's site (especially when raw material is very heavy), or, if it is imported, within a short distance of the ports of delivery, or near subsidiary factories, or fuel production.(3)

By that it is explained how some countries, which cannot export wheat because of the high transportation cost, can on the other hand explort flour.(4) The point is exactly that the cost of flour is charged with transportation expenses only for that part of the wheat that is turned into flour, and it is not charged with the transportation expenses for all that part which is consumed during grinding. Thus, for instance, if Italian wheat costs 105 working days, and foreign wheat costs 100 working days, and the transportation expenses of foreign wheat from the production country to Italy are 10 working days, it is evident that it will never be possible to import foreign wheat into Italy; but if the transportation expenses of foreign wheat turned into flour are just 5 working days, flour, imported from abroad will cost exactly the same as Italian flour, and therefore it will be easily possible to import foreign flour into Italy. And this will happen every time the transportation costs (for which the foreign country is charged) of wheat turned into flour is the same or lower than the difference between production costs in Italy and abroad.

When it is possible to obtain the entire amount of finished goods, establishing the production, either near the consumption center, or near the raw material's

production site, the problem is not complicated by the element of rent. But let us suppose a given amount of goods, which has to be produced, is such that its[11] production has to be spread over several unevenly distant lands from the raw material's production site (that we suppose coincides with the land-limit[12]) and from the consumption center. In this case, if the transportation expenses are lower for the raw material than for the finished product, the land situated near the consumption center gives a rent,[13] and the most distant does not. In fact, the value of the production is increased[14] by the amount of the transportation expenses of the same product from the land-limit to the town,[15] while its costs, on the land near to the town, is not increased except for the raw material's amount of transportation expenses from the production site to the town.[16] Now, as this second term is smaller than the first one, the product's value is increased more than its cost, and leaves a rent. If transportation expenses are equal[17] for the raw materials and for the finished product, there is no rent, in the given conditions, because; the value of the product obtained near the consumption center is increased the amount of the transportation expenses of the same product from the land-limit to the town, as much as its cost is increased because of the raw material's amount of transportation expenses. Finally, if the transportation cost is higher for the raw materials than for the finished

product, rent is formed, but favoring lands nearer the raw materials production site, and therefore more distant from the consumption center. In fact, the cost of products obtained on lands more distant from the consumption center, is charged[18] by (or with)[19] the raw material's transportation expenses, while the cost of products obtained on lands more distant from the consumption center, is charged by (or with)[20] the finished product transportation expenses, which are lower. Now, the product's value must be equal to the cost of that portion of the requested amount[21] which is obtained in the most unfavorable conditions; so, in our case, it must be such as to compensate the producer charged with the higher transportation cost, that is the most distant one from the site of the production of the raw materials; so that the producer being nearest to them necessarily obtains a rent.

Let us suppose now that transportation expenses are equal for different products and for the raw materials necessary to produce them, but that the different products need a different amount of raw materials. In this case it is evident that the goods needing the lower proportion of raw materials will be produced near the consumption center, and goods needing the higher proportion of raw materials will be produced near the raw material's production site. In this way, in fact, we reduce to the minimum the burden born by the production on the land nearer the town, at the

rate of the raw material's transportation expenses. They are perfectly true here, as the consideration we developed in the previous note, about the seat of industries, that requires different amounts of work, when the worker's products of consumption are not obtained in the same spot as they are working. Indeed, moreover, either we reduce the amount of work (therefore the amount of products consumed by workers) in the lands nearer the town, or we reduce the amount of raw materials, still the result is reducing the goods necessary to the production, hence reducing the complete cost and increasing rent.

Let us suppose finally that the transportation expenses are always lower for all the finished products than for the raw materials, but that some finished products do not need raw materials, or that they are made by raw materials on the spot, while others are made by raw materials producible only in particular parts of the territory. Under such conditions, the first kind of commodities, not burdened by raw material's transportation expenses, will be produced on land near the market center, while the second kind of goods will be produced near the raw material's production site. As a matter of fact, between the lands[22] producing the first kind of commodities, the ones nearer the consumption center will give the maximum rent, while the more and more distant lands will give a lower rent, and the most distant will give no rent at all; the same is true about

the lands producing the second kind of commodities, which will give a higher rent the nearer they are to the site of production of the raw materials. So that two rent areas will come into shape, the first of which will have its maximum near the consumption center, and the second one will have it near the raw material's production site.

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m p s o

So, the first kind of goods, that we will call G, will be produced, as far as possible, near m, while the second kind of goods, that we will call P, will be produced near o.[23] Let us suppose that G goods have to be produced all along the distance[24] m-p, and that P goods all along the distance o-s. It is evident that two rent areas will come into shape; the first will have it maximum at m and zero at p, and the second will have its maximum at o and zero at s. The land's rent at m will be equal to the transportation expenses of G goods from p to m; at o the rent will be equal to the difference between the transportation expenses of the raw material and of the finished product P along the distance o-s.[25] Supposing that the two products G and P have equal transportation expenses which we will call S,[26] and that raw materials have transportation expenses S' = NS, and supposing the distance between m and p is equal to the distance between s and o, we find out that the rent at m is

equal to S x mp, and the rent at o is equal to (NS-S)mp, that is equal to S(N-1)mp. If S' = 2S, the rent at o is equal to S x mp, that is, it is identical to the rent at m.

Let us suppose, for instance, transportation expenses of good P on the distance m-p are 10 lire, and the raw material's transportation expenses on the distance o-s are 20 lire. The value of good P produced[27] at s and sold at m will be burdened (apart from the distance p-s) by a transportation expense of the finished product from p to m equal to 10 lire, + 20 lire of transportation expense of the raw material on the distance o-s; but good P, produced at o, is burdened by the finished product transportation expenses from o to m, that is 20 lire; so that there will be a 10 lire rent for the owner at o. On the other hand, the producer of G goods is burdened by a 10 lire expense for his product's transportation on the distance p-m, while the producer at m is not affected by it; from which (we) have (the) origin (of)[28] a 10 lire rent in favor of the land m. In such a way, rents of the two lands m and o, the nearest one and the most distant one to the consumption center, are equal, and both[29] represent maximum rent.

If the demand of the first of the two products grows and the demand of the second one diminishes, production of the first will be extended, and the production of the second will be reduced; so that rent will grow on land m and on lands nearby, and will diminish on o and

surrounding lands.

Consequently we see that, with conditions in other respects equal, on lands next to the consumption center it is better to produce that commodity that needs no raw material or the lowest quantity of it. But indeed, the transportation expenses might be lower for this commodity than for goods needing a higher quantity of the raw material. Now, whenever this is true, it seems at first sight that the production of such a commodity near the consumption center implies, in any case, an inversion of the natural order of production,[30] which exactly requires the production of commodities having the highest transportation expenses on the lands nearest the market.

Nevertheless, this does not happen. In fact, it is very true that, other conditions being equal, society's interest has it that goods burdened by the highest transportation expenses are produced on the lands nearest the consumption center; but this cannot be true when the production of those goods impose indirectly to the society any burden which is avoidable otherwise. Now that is exactly what happens when goods requiring the highest transportation expenses require the highest quantity of raw material. Because on the one hand,[31] producing near the consumption center the commodity having the highest transportation expenses, we indeed procure to the society a saving equal to the difference between the transportation expenses for those goods and

for the goods having the lowest transportation expenses; but at the same time, society is burdened by the transportation expenses of the highest quantity of raw materials, which are necessary to produce that commodity. Now if the transportation expenses of this differential amount of raw material exceeds the difference between the two goods, evidently the savings we procure to society by producing the commodity having the highest transportation expenses near the consumption center, are lower than the special burden such a production imposes; and therefore, it is in society's interest to produce goods requiring the lowest transportation costs on lands near the consumption center. Well then, everytime owners refuse to produce[32] the commodity having the highest transportation expenses within a short distance of the consumption center, it is precisely because the surplus of transportation expenses of these goods, a surplus constituting their earnings on the production of the first goods, is separated by the burden of the transportation expenses of the differential quantity of raw material. That means that owners decide to produce near the consumption center the commodity needing the lowest transportation expenses, only when this is in the society's interest; that is, such an established production is not at all infringing on the order of rational production, but indeed, it is an exact application of such an order.

These considerations impose a correction to one of

our previous note's conclusions. We said that if the workers' goods for consumption have to be produced on the lands most distant from the consumption center, that the owners of the lands next to the center might have a higher profit by producing the commodity needing the lowest quantity of labor,[33] even when it requires the lowest transportation expenses; we so came to the conclusion that this case would mean an inversion in the rational production order. Now, the former observations teach us that in the case under discussion, about the real inversion of the rational order of production. In fact, if in the case in point, the production of the commodity having the highest transportation expenses is against the interest of the owners of the land next to the consumption center, it is because this commodity's transportation expenses superiority is lower than the transportation expenses of the differential quantity of salary-product required to produce this commodity. Now, the differential transportation expenses burdening that commodity is dissuading society from producing it near the consumption center; the transportation expense of the salary-product's differential quantity is a burden dissuading society from producing that good near the consumption center. So then, in the given case, the said goods' production near the consumption center is burdening society more than favoring it; therefore, leaving out that production brings profit not only to the owners but to the whole society; it is not

an infraction but indeed an application of the rational production order.

More generally, we can say that the rational order of production requires the production near the market of that product procuring the highest savings on transportation expenses. Now, this product is the one requiring the highest transportation expenses only when we suppose all other conditions unchanged. If on the contrary, the commodity requiring the highest transportation expenses requires a higher quantity of a product[34] available only in lands distant from the market, and having high transportation expenses, in that case production of that commodity near the consumption center may easily procure to the society a lower savings on the transportation expenses than if, in the same spot is produced a commodity having lower transportation expenses. In such a case, the rational order of production just requires production of this last commodity within a short distance of the consumption center.

Loria's footnotes

(1) Mr. Jannaccone (Il Costo di Produzione, Torino, 1901, 305) observes that not always does the finished product weight less than the raw material necessary to its production, because manufacturing might indeed make the finished product bulkier and heavier than the amount of raw material necessary to produce it. But manufacturing cannot increase the finished product weight, other than joining to the raw materials some more raw materials; and even supposing that the final product will still weigh less than the mass of the raw materials and of additional materials, it is at the rate of the portion of them that was consumed during the production process.

(2) Ref. Taussig, Tariff History of the United States, New York, 1888, p. 210, and before, Beccaria, Economia pubblica (Custodi), I, 319, which was fought by Melchiorre Gioja, Nuovo prospetto delle scienze economiche, Milano 1815, I, p. 110 ff--Also see Booth, Life and Labour of the People, London, 1897, IX p. 183 ff.

It is true that sometimes duties do not consider the product's weight, but its value; in that case, although manufactured products weigh less than the raw material, it is imposed a higher transportation expense, just because it is worth more. And suppose that, obviously utility of producing the manufactured product near the raw material's production site, disappears, since the saving on the raw material's transportation expenses is lower than the burden of the manufactured product's transportation expenses (Jannaccone, l.c.). Anyway, this does not happen universally. For instance, it does not happen for sugar, in respect to which we notice that the transportation expenses are always remarkably lower for the refined product than for the crude product from which it is extracted.

(3) Matheson, Depreciation of Industries, 2nd ed., London, 1893, p. 124 ff; E. A. Ross, "The Location of Industries," Quarterly Journal of Economics, 1896, p. 251; Kovalewsky, Le regime economique en Russie, Paris 1898, p. 191. And about the middle ages, D'Avenel, Histoire de la propriete, etc., III, pp. 405-6.

(4) Paasche, Die Entwickelung der britischen Landwirtschaft unter dem Druck ausländischer Konkurrenz, in Jahrbucher fur Nat. Oek, 1892, I, p. 14.

Translator's footnotes

1. Both sources give the article in the same form with the exception of the first sentence. Loria rewrote the introductory sentence when the journal article was placed in the book.

2. "Factories" may also be used here and elsewhere.

3. "Industry" may be substituted here and elsewhere.

4. "Finished" may be substituted here and elsewhere.

5. The word "measures" may also be used.

6. The word "aggregate" may be substituted here and elsewhere.

7. "In reality" may be used.

8. Added by this author.

9. "When regarding" may be replaced by "concerning."

10. "Save" may be substituted.

11. "His" refers to the factory's production.

12. "Land limit" means the "border" or the extreme limits of the territory being considered.

13. "Income" may be substituted for "rent" here and elsewhere.

14. "Raised" may also be used.

15. That is, as one locates closer to the town there are less transportation costs to be subtracted from value to give a larger net price.

16. Loria is assuming that of the costs of production, the transportation costs of moving the raw materials, are the only costs fundamentally related to distance. He relaxes this assumption elsewhere.

17. "Even" may be used.

18. "Increased" may be used.

19. Added by this author.

20. Added by this author.

21. "Portion of the requested amount" is the same as the quantity demanded.

22. "Sites" may be used.

23. Do not confuse the good P with the position p on the diagram.

24. "Stretch" may be used here and elsewhere.

25. Recall that position m is that for a finished product, and position o is a location of the production of raw materials.

26. Do not confuse the transportation cost S with the position s on the diagram.

27. Loria used the word "cultivated."

28. Added by this author.

29. "The one and the other" may be substituted.

30. Loria used the word "cultivation."

31. "Side" may be substituted.

32. "Cultivate" may be substituted here and elsewhere.

33. "Work" may also be used.

34. "Input" may be substituted.

CHAPTER VIII

THE UNKNOWNS AND THE KNOWNS

Descriptive Accounts of Location by Relatively Unknown Economists and Non-Economists

Introduction

A survey of the literature reveals the fact that in the late 1800's and early 1900's there was a flurry of descriptive accounts of location. There were contributions by economists, geographers, engineers, and city planners.[1] A representative sample has been drawn from this extensive

[1]Some of the vast literature not covered in this survey include, Charles H. Cooley, "The Theory of Transportation," Publications of the American Economics Association IX (May 1894): 223-371; Adma F. Weber, The Growth of Cities in the Nineteenth Century, ed. the Faculty of Political Science of Columbia University (New York: The Macmillan Co., 1899); John F. Haymore, "What Is the Center of an Area, or the Center of Population," Journal of the American Statistical Association N.S., VIII (June 1902): 47-58; M. T. Copeland, The Cotton Manufacturing Industry of the United States (Cambridge: Harvard University Press, 1912), pp. 27-53; J. R. Smith, Industrial and Commercial Geography (Chicago: H. Holt and Co., 1913), pp. 840-75; P. T. Cherington, The Wool Industry (A. W. Shaw Co., 1916), pp. 142-48; E. L. S. Patterson, "London and New York as Financial Centers," Annals of the American Academy of Political and Social Science XLVIII (1916): 264-77; C. M. Robinson, City Planning (New York: G. P. Putman's Sons, 1916), pp. 175-79; and G. R. Taylor, Satellite Cities (New York: D. Appleton, 1915), pp. 1-14.

literature. Some of the authors reviewed here were covered in a dissertation by Barclay Jones but with a different emphasis.[1] Most of the accounts that follow cannot be classified as "analytical" theory, but they all gave descriptive "models" according to the model dimensions given by Britton Harris.[2] They anticipated many developments to come later in the location theory literature. The different authors discussed in this chapter will be presented in chronological order based on the date of publication of their works.

Arthur T. Hadley

In an article written for Lalor's Cyclopedia of Political Science in 1884,[3] Arthur T. Hadley outlined the history, economic effects, state control, and management of transportation systems. Under section two entitled "Economic Results of Improvement in Means of Transportation,"[4] he delineated the "direct" and "indirect" results of improved transportation methods.

The direct results were an "increase in rapidity"

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[1]Jones, "Theory of the Urban Economy," pp. 83-124. Jones was concerned with population distribution.

[2]Harris, "Quantitative Models of Urban Development," p. 367.

[3]Cyclopedia of Political Science, Political Economy, and of the Political History of the United States, 1884 ed., s. v. "Means of Transportation," by Arthur T. Hadley, pp. 928-32.

[4]Ibid., pp. 928-30.

and a decrease in the expense of transportation. Initially the expense of an improved system might be higher but ". . . then the price begins to diminish, and ultimately may fall below that of the more primitive means of conveyance."[1] He felt that the indirect results were so far reaching that the best he could do would be to just list them. But, one can find the roots of for modern-day location theories in Hadley's descriptive passages.

> The most immediate effect of cheapened transportation is to increase the distance at which it is possible for producer and consumer to deal with one another. To the producer it offers a wider market, and to the consumer more varied sources of supply.[2]

On the whole, Hadley felt that the consumer benefited the most from an improvement, because the producers might become over optimistic and actually over-produce. This would lower the price to the consumer. The final result would be a reduction in the variation of prices between different localities. Before the improved transportation, bulky items would reflect price differences due to expensive transportation between the different localities. After the improvement, the differences in prices would almost disappear.

Hadley also recognized the differences in land rent due to differences in location. Another of the important indirect effects of improved transportation would be the

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[1]Ibid., p. 929.

[2]Ibid.

reduction in the importance of location in determining the rent of "near" land when compared to "far" land.

> And not the least important point where this leveling effect is felt, is in the rent of agricultural land in England, and similarly organized countries. Nearness to market was not long ago a main advantage of high-priced land; now it has to contend on tolerably equal terms with competing land five thousand miles away.[1]

Hadley was obviously influenced by the Thünian literature in the quote above and when he wrote of ". . . successive circles of ground were almost necessarily devoted to different products, according to their different availability for transportation."[2] With the improved transportation system, one would find that it was no longer location which determined the business to be carried on in a particular spot. He argued that the whole system of division of labor could be advanced to a new stage with production in any one spot determined by "natural advantages" more or less independent of location. But almost in contradiction, he concluded that not only was each man employed for what he could do best, but he was given a chance to work in the place where he could do it best.

Hadley also argued that the cheapening of transportation had given a stimulus to the growth of large cities. It enabled them to draw an increased food supply to feed a centralized population, and it enabled business to locate

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[1]Ibid.

[2]Ibid., p. 930.

production near population independent of raw material locations.

J. J. Menzies

In an article which appeared in The Popular Science Monthly in 1890,[1] J. J. Menzies provided a descriptive account of the factors which he felt influenced the (then) present-day location of industries. These descriptive factors included the basic germ of ideas developed later by Alfred Weber.

> The general principles determining the employment of the soil of different countries and localities are tolerably simple. Common, bulky, and perishable articles are naturally produced as near as possible to the places of consumption, though improvement enabling them to be more easily and cheaply transported render them more available for distant markets.[2]

One should notice Menzies' reference to transportation cost in the last quote. He felt that this category of cost influenced ". . . more valuable articles and luxuries . . . (because) the cost of transportation of which is relatively less important. . . ."[3] In addition, one might find these last categories of goods produced far from consumption centers because some localities become "specially adapted" in their production. In this sense, Menzies' article bases part of the factors of location on the specialization of

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[1] J. J. Menzies, "The Location of Industries," The Popular Science Monthly, February 1890, pp. 454-60.

[2] Ibid., pp. 455-6.

[3] Ibid., p. 456. Parenthetical information added.

regions theme found in the literature of international trade theory.

Menzies listed several other factors influencing the location of agricultural activity and manufacturing production. These items included: (1) capital and labor, (2) uncertainty of climate, (3) elevation, (4) resource monopoly, (5) remoteness from other countries, (6) fuel and raw materials, and (7) water.

Edward A. Ross

In an article which appeared in the Quarterly Journal of Economics published in 1896,[1] Edward Ross (1866-1951) presented a descriptive review of the factors influencing the location of industry. In this article, Ross made the basic distinction between those factors which account for localization (or concentration) and those factors which account for location (or migration). To the best knowledge of this author, this is the earliest statement of this distinction. Either of these groups of factors could then be divided into those causes which are "non-rational" (e.g., advantages gained by accident and caprice) or "rational" (e.g., advantages in production or marketing).

Ross gave a clear statement of what has become to be called "agglomerations."

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[1]Edward A. Ross, "The Location of Industries," Quarterly Journal of Economics X (April 1896): 247-68.

> A dispersed industry concentrates in one place, i.e., localizes--because of the economies that result from the dwelling of many enterprises of one kind in the same neighborhood.[1]

Such an arrangement would result in a skilled pool of labor, a fast development of technology, and a supportive infrastructure. This supportive infrastructure included special trade schools, museums, and laboratories. In addition, shops for the building and repairing of machines and subsidiary industries would "spring up." Ross said that these industries filled "industrial chinks" or fissures. As the center becomes larger, there would develop an organization for the production and exchange of all types of raw materials necessary in the production of the various final goods. Ross also allowed for deglomeration of industries when individual industries and firms produce negative externalities.

> An industry may be acted upon repellently rather than attractively. The manufacture of aluminum by the electric process generates gases which kill all vegetation in the neighborhood. If these gases cannot be absorbed, this mode of manufacture will be driven off to unfertile districts, where the damage will be a minimum.[2]

In addition to this force, Ross used a biological analogy to account for the fact that once agglomerations start they do not expand the city without limit.

> . . . one might wonder why the rising centre does not go on killing out its small rivals over larger and larger

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[1]Ibid., p. 262.

[2]Ibid., p. 256.

> areas and appropriating their business. But trees do not grow up into the sky, nor does an industrial centre expand till it absorbes the custom of the globe.[1]

Ross listed two reasons why the analogy should hold true: (1) As the place becomes larger, its original "special advantages" tend to disappear, and (2) as an industry concentrates and grows, the radius of its territory of influence (on labor, raw materials and final products) also grows. This last fact increases the total cost of transportation for labor, raw materials and final products until ". . . its growth neutralizes the economies of further concentration."[2] This last reason is in clear anticipation of Alfred Weber.

Ross listed and discussed many other factors which could account for "localization" or "location." These factors included: (1) fuel supply, (2) auxiliary industry and raw material location, (3) climate, (4) power, (5) labor and capital, (6) nearness to consumers, and (7) "artificial advantages," e.g., taxes and subsidies by government.

A. B. Clark

In an article for Palgrave's Dictionary of Political Economy published in 1900,[3] an English economist by the name of A. B. Clark presented what he felt was a survey of the

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[1]Ibid., p. 263.

[2]Ibid., p. 264.

[3]Dictionary of Political Economy, 1900 ed., s. v. "Localisation of Industry," by A. B. Clark, pp. 628-31.

location theory literature up to that time. Clark contended that the intranational distribution of industries could be explained by the same factors as given by Torrens in his The Economist Refuted (1808). Torrens described the "territorial" division of labor as related to international trade. Clark made reference to Alfred Marshall several times. He gave Marshall credit for accounting for the "physical conditions" which affect location and for developing and expanding the concept of specialization of labor which interacts with Torrens' theory.

The balance of the article is a listing of all the factors Clark had found in his search of the literature. These factors included: (1) the "national character" of the country (i.e., races), (2) physical conditions, (3) the "competitive" climate, (4) the actual climate, (5) geographical position, (6) geological formulations, (7) water communications, (8) the "natural" environment, and (9) the "social and political" environment.

Once the industry was in place, there would be a natural tendency for it to stay fixed. Once established the business would develop a reputation which would help to discourage new firms from entering the area. As the business grows, there would develop a "perfect organization" which would draw upon skilled labor and specialized machinery. As a result of these latter factors, the firm would start to receive "support from the neighborhood" in the form of

(a) supplementary industries and (b) subsidiary industries.[1]

Clark's review of the literature was limited to Englishmen. He failed to mention Thünen, Launhardt, or Loria all of whom preceded him.

Frederick S. Hall

In an article prepared for publication in the twelfth census of the United States (1900),[2] F. S. Hall (1870-1946) presented a listing of the factors affecting the location of manufacturing industries. In addition, he presented an extensive statistical analysis of the influence of each of the factors. His method of analysis influenced later writers on the subject.[3]

Hall listed and discussed seven factors which could give rise to the localization of industries. These factors included: (1) nearness to raw materials, (2) nearness to markets, (3) water power, (4) a favorable climate, (5) a supply of labor, (6) capital available for investment in manufactures, and (7) the momentum of an early start.

While discussing the first two of these categories,

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[1]Ibid., pp. 629-30.

[2]Frederick S. Hall, "The Localization of Industries," Twelfth Census of the United States. Manufacturers. vol. VII (Washington, D.C.: Government Printing Office, 1902), Part 1, pp. cxc-ccxv.

[3]Isaac Lippincott listed the same factors and used the methods developed by Hall, see I. Lippincott, Economic Development of the United States, 2nd ed. (New York: Appleton, 1927), pp. 9-11 and pp. 483-7.

Hall emphasized the importance of transportation cost to the problem of location. In what by now has become a familiar theme in the writings of early location analysis, one can find a "weight/bulk" statement in Hall.

> The industries mentioned above as influenced largely by their market and the source of materials used . . . are those in which the materials or products have a great weight or bulk in comparison with their value, and in which, therefore, freight charges are a very important element of costs.[1]

He felt that all seven factors could be expressed in terms of savings in dollars and cents. The firm would locate where the total costs of operation were the lowest. So although Hall does mention demand (i.e., nearness to markets), his "model" is basically one of cost minimization.

He contended that the original establishment of an industry in a locality was largely a matter of chance. But after the first establishment had succeeded in any one locality, the "main spring" to the real localizing process would begin. This main spring was called the ". . . habit of industrial imitation--a habit as powerful as it is universal. . . ."[2] This habit would lead to a "local bias" toward the original industry to location in an area. This habit would be reflected in three factors: (1) Entrepreneurs chose to operate existing industry rather than establish a new one (i.e., lower risk and uncertainty). (2) The capital

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[1]Hall, "The Localization of Industries," p. ccxi.

[2]Ibid., p. ccxii.

needed to finance the new establishment is easier to obtain if the new establishment is to produce the same line of goods as the one already in existence. (3) The best grade of local labor prefers to have employment in an industry which seems to offer a future rather than in one which seems to be in the nature of an experiment.[1]

Under a subtopic entitled "Economic Advantages of Specialized Centers,"[2] Hall developed an elementary statement of agglomerations. A specialized center would contain specialized machinery and a specialized and skilled labor supply. The specialized community would result in a mutual improvement in manufacturing methods. Laborers would share "shop talk." The manufacturer would be able to notice patented improvements developed by similar firms. Other advantages would include the possibility of subdividing the process of manufacture among several establishments, i.e., a division of labor among employers. Also, subsidiary industries would "spring up" to supply the special tools and machinery required in this specialized "town." He felt that the success of specialization would breed ". . . success in an almost geometrical ratio."[3] This seems to be an early statement of the increasing returns expected under the influence of agglomerations.

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[1]Ibid., p. ccxiii.

[2]Ibid., pp. ccxiii-ccxiv.

[3]Ibid.

H. V. Coes

In an article published in the engineering literature in 1915,[1] H. V. Coes addressed himself to the practical aspects of weighing the various factors of location. He found that the factors governing the location of an industrial plant could be divided into twelve groups. A "weight" was applied to each group based on "an arbitrary scale of values" according to the factors' relative importance to the total factor valuation. The "present location factors" would enter the total factor valuation as a minus (-). The "new location factors" would enter the same factor valuation as a plus (+). If the "new location factors" added to an absolute number greater than the "present location factors" (i.e., if the total valuation turned out to be a positive number), then one should move to the new location. Since Coes' listing seems to be quite complete for an author of his time, his detailed listing of the twelve factors of location will be given here.

1. Proximity of raw-material market (weight 1¼)
   a) Rail service
   b) Water service
   c) Supply
2. Proximity to consumers' market (weight 1½)
   a) Large cities

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[1] H. V. Coes, "The Rehabilitation of Existing Plants as a Factor in Production Costs," The Engineering Magazine XLIX (1915): 357-72 and 560-73. A short passage from this article can also be found in Leon C. Marshall, Business Administration (Chicago: The University of Chicago Press, 1921), pp. 93-6.

b) Rail service
c) Water service
d) Advertising value or influence of plant
e) Competitors

3. Labor Market (weight 2¼)
   a) Character of labor and supply
   b) Percentage of unemployed females (women and girls)
   c) Percentage of unemployed boys (above legal factory age)
   d) Price of labor--cost of living
   e) Specialization of labor
   f) Influence of climate
   g) Associations or unions
4. Power (weight 1)
   a) Price and character of fuel (coal, gas, oil)
   b) Hydro-electric or water power
   c) Central station
5. Influence of climate (weight ¼)
   a) On labor
   b) On product
6. Utilization of waste products (weight ¼)
   a) Disposal of waste products
   b) Market value of waste products
   c) Cost of disposing of same, if unmarketable
7. Perishability (weight ¼)
   a) Raw materials
   b) Finished product
8. Freight rates (weight ¼)
   a) On raw materials
   b) On finished products
9. Legislation, regulation, or ordinances (weight ¼)
   a) State legislation (corporation laws, taxes, employers' liability)
   b) Municipal, town, or county regulations or ordinances (taxes, factory building inspection)
10. Banking facilities (weight 1)
    a) Size of--handling pay rolls, etc.
    b) Credit
    c) General utility
11. Site of real estate (city, suburb, country) (weight 3/4)
    a) Price of
    b) Character of soil
    c) Cost of preparing site
    d) Foundations
    e) Floods
12. Building materials (weight ¼)
    a) Local sand, gravel, etc.
    b) Crushed stone
    c) Brick
    d) Timber

e) Steel
f) Cement[1]

Coes warned that the scale of weights must be varied to suit the industry under study, but he did not give a method to derive the weights.

Henry Clay

In a book first published in 1916,[2] Henry Clay presented a descriptive theory of the location of industries based on the specialization and division of labor. In doing so, he explained what is known as "agglomerations" today.

> Now the simplest way for a firm to make sure that there will be sufficient volume of trade to enable it to adopt these methods of specialization is to establish its works in a district where there are other firms engaged in the same trade.[3]

Clay felt that there were three major influences to be found if the "history" of the location of any one firm were studied. The factors included: (1) cheap power and cheap labor, (2) accessibility to markets, and (3) accessibility to raw materials. The last two of these factors had become particularly important after the introduction of "cheap transport."

He believed that concentrations of firms performing the same business resulted in specialization and division of

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[1]Coes, "The Rehabilitation of Existing Plants," in Marshall, Business Administration, pp. 95-6.

[2]Henry Clay, Economics an Introduction for the General Reader (New York: The Macmillan Co., 1916).

[3]Ibid., p. 27.

labor to give certain other "advantages of localization." In such cases the worker would have a better market for his specialized skills. The industry could command a large number of "special services" the most important of which would be a "specialized market."[1] In addition, special transport facilities would develop. Scientists, lawyers, and accountants would find it worth their while to specialize in the problems of the industries involved. Insurance could be cheaper and credit obtained easier where the risks and conditions of production were known and localized. As an offshoot, subsidiary industries would develop to supply the primary industries with machinery, services, and a market for by-products.

Malcolm Keir

In an article published for political scientists in 1921,[2] Malcolm Keir gave a detailed account of the factors which he felt influenced the location of manufacturers. Keir named six such factors including: (1) raw materials, (2) labor, (3) the market, (4) power or fuel, (5) capital, and (6) transportation. He placed particular stress on the results of lowering transportation cost and upon differential

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[1]Ibid., p. 29.

[2]Malcolm Keir, "Economic Factors in the Location of Manufacturing Industries," Annals of the American Academy of Political and Social Sciences XCVII (September 1921): 83-92.

tariffs.

Keir held the conventional view with respect to raw materials.

> . . . bulky, cheap, fragile, or perishable raw materials have usually limited factories using them to the neighborhood where the material exist.[1]

More originally, Keir concluded that raw materials with the cited characteristics must be turned into more durable products near their origin before shipping. If raw materials could be "concentrated" into a form with high value, then they could be shipped from the source before entering the final product. It might also be possible to substitute one raw material for another so that production would not be bound to an unusually "fixed" raw material.

Skilled labor might also account for the location of a firm requiring that skill. But, Keir concluded that the tendency to replace skilled labor with machines might result in using semi-skilled or even unskilled labor. He argued that either of these last groups of labor have higher mobility than skilled labor since the ". . . unskilled labor has no pride of locality, no roots deeply and intertwined into the community that an employer is bound to respect."[2]

Keir argued that nearness to the consumer market was particularly important for products ". . . that are

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[1]Ibid., p. 83.

[2]Ibid., p. 86.

easily broken, bulky, or are needed for quick convenience. . . ."[1] He felt that this tendency applied to many small manufacturing firms, but he also recognized the decentralizing tendency of some large manufacturing firms with nation markets, e.g., the automobile industry.

While discussing the importance of power and fuel, he gave emphasis to the role of transportation costs to location.

> Fuel is cheapest at points nearest to the coal fields and expensive in proportion to the distance from the mines. There is a final limit to the distance which coal can be carried economically for manufacturers.[2]

That is, Keir recognized the fact that the price of a good (in this case coal) is a function of the transportation costs associated with that good. He felt that the development of new forms of power which could take advantage of low cost transportation systems could liberate manufacturers from these constraints. He gave electricity as an example of such a form of power. He further emphasized transportation by noting that a lack of a good transportation system decentralizes industry. The "tariffs" or rates on railroad's long vs. short hauls were arranged (at that time) to favor long hauls. Such "fixing" of these railroad rates thus contributed to centralization of manufacturing industry on the east coast of the United States. Since the tariff

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[1]Ibid.

[2]Ibid., p. 88.

problem was settled by the courts and since the introduction of the "automobile truck," there has been ". . . a quickening of the decentralization of industry."[1]

Richard Hartshorne

In an article which was originally delivered as a speech to the Association of American Geographers in 1926,[2] Richard Hartshorne presented a listing of the factors of location important to the study of geography. The importance of this work to this study is that Hartshorne gave major emphasis to economic factors of location. After dismissing traditional geographical factors as having an influence but not being decisively important, he concluded that it would be best to turn to a "general method" based on economic theory. But, the problem was that economists had tended to be too descriptive on this point and had failed to develop a general method. On that note, Hartshorne proceeded to outline the elements of his general method since ". . . a brief survey of the literature in economics indicates that this task has been left to someone else--I have presumed to the geographer."[3]

Hartshorne recognized the "marketing advantages of

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[1]Ibid., p. 91.

[2]Richard Hartshorne, "Location as a Factor in Geography," Annals of the Association of American Geographers 17 (1927): 92-9.

[3]Ibid., p. 92.

industrial concentration" and "advertising value of the prestige of certain places," but he emphasized the minimization of total costs when determining the "optimum location," i.e., the point of profit maximization.

> We are concerned almost entirely with the <u>costs</u> of translating raw materials in the place of production into finished products in the place of consumption. The optimum location is that in which the total of these costs is less than the selling price obtainable by the maximum amount.[1]

After listing the "direct" costs (operating costs) and "indirect" costs (overhead costs) that are possible in production, Hartshorne gave an argument to the effect that only certain of the direct costs are affected by different locations. The four major factors of direct costs which usually vary most with location and were therefore most important in determining plant location included: (1) raw materials, (2) power and fuel, (3) marketing expenses, and (4) labor. He felt that the most important of these factors was labor cost.

> Ultimately, in the great majority of cases the problem of plant location may be reduced to differences in labor costs and locus in reference to three sets of places or areas--those of raw materials production, those of power and fuel resources, and those of consuming market.[2]

Hartshorne searched for a method of measuring the relative importance of the factors listed in the preceding

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[1]Ibid., p. 93. Emphasis found in the original text.

[2]Ibid., p. 94.

quote. As a result, he listed four variables to be used to measure the relative influence of these factors on factory location. These measures included: (1) the quantity of commodities handled, (2) their perishability, (3) the unit costs of transporting them, and (4) the extent of concentration of the producing or consuming areas.[1]

Hartshorne allowed for weight-losing production. He concluded that those industries which convert raw materials into a smaller quantity of finished products locate close to or within the raw material's production areas rather than close to the market areas. If either the raw materials or finished products are highly perishable, the final foods will be produced near the consumption market.

The fact that the unit transportation costs on finished products may be higher than the unit transportation costs on raw materials was recognized by Hartshorne. He discussed the importance of transportation costs on all the location factors. He concluded that since transportation costs affect most of the location factors ". . . the initimate and all-important relation of transportation to the location of industries is clear."[2]

Hartshorne did not develop his "general method" any further. He gave us a list of important location factors. Further, he gave four variables which could be used to

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[1]Ibid., p. 95.

[2]Ibid., p. 96.

measure the relative importance of each of these factors. But, he failed to develop an analytical model or even give a numerical (or verbal) example of how the "general method" could be applied. The relationship between Hartshorne's "general method" and Alfred Weber's model should be obvious. Both emphasized at least cost labor location with the minimization of transportation cost to account for deviations from that point. Hartshorne did not mention Alfred Weber.[1]

Conclusions

The nine authors surveyed in this section are representative of approaches to the problem of location found in the literature of economics, geography, engineering, and city planning of about eighty years ago. All of these accounts were descriptive in nature. Among the factors important to the location of firms listed by these writers were raw material location, consumer markets, labor markets, power, climate, perishability of goods and raw materials, freight rates, legislation, taxes, subsidies, financial markets, geography, and geology.

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[1]Hartshorne mentioned only one economist as an example of the economic literature, i.e., Malcolm Keir's text Manufacturing Industries of the United States. Keir's article on the subject (reviewed elsewhere in this chapter) was not mentioned by Hartshorne.

Accounts of Location Found in the Works of Economists Known for Non-location Theory Contributions

Introduction

The purpose of this section is to document the fact that while pre-classical, classical, and neoclassical economists may have not placed emphasis on location theory they did not completely ignore the subject. This review will be limited to the works of Petty, Smith, Marshall, and Hobson. Substantial amounts of descriptions and analyses can be found in the works of each of these writers. Other writers should be noted as having at least touched on the subjects related to this topic. Schumpeter recognized Cantillon, West, Ricardo, Mill, and Edgeworth.[1] One part of Ricardo's work is of particular interest. It shows that even though Ricardo is known for his differential rent theory based on fertility, he also gave "situation" as a possible cause of rent.

> If all land had the same properties, if it were unlimited in quantity, and uniform in quality, no charge could be made for its use, unless where it possessed peculiar advantages of situation. It is only, then, because land is not unlimited in quantity and uniform in quality, and because in the progress of population, land of an inferior quality, or less advantageously situated, is called into cultivation, that rent is ever paid for the use of it.[2]

John Stuart Mill also recognized that fertility and situation

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[1]Schumpeter, History, p. 1246.

[2]David Ricardo, Principles of Political Economy and Taxation (Baltimore: Penguin Books, 1971 (1817)), pp. 93-4.

should be taken together to determine rent.[1] While discussing ground rent, Mill gave the following account of urban rent:

> The ground rent of a building, and the rent of a garden or park attached to it, will not be less than the rent which the same land would afford in agriculture; but may be greater than this to an indefinite amount; the surplus being either in consideration of beauty or of convenience, the convenience often consisting in superior facilities for pecuniary gain. Sites of remarkable beauty are generally limited in supply, and therefore, if in great demand, are at a scarcity value. Sites superior only in convenience are governed as to their value by the ordinary principles of rent. . . . by the amount at which people estimate the superior facilities of money-making in the crowded place.[2]

This writer is not arguing that these authors placed major emphasis on these topics. In most cases, they mentioned the subjects very few times, but the following four economists did devote considerable effort in developing their descriptive accounts of location. As elsewhere in this work, this writer will place emphasis on what the authors under consideration actually said about the subjects. Therefore, liberal references will be made to them and quotations will be cited.

Sir William Petty

Sir William Petty (1623-87) has been called "the founder of political economy."[3] He is known for his development and use of statistics, the conceptual derivation of

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[1]John Stuart Mill, Principles of Political Economy (New York: August M. Kelly, 1969 (1848)), p. 474.

[2]Ibid., pp. 475-6.

[3]Roll, A History of Economic Thought, pp. 99-100.

national income, an implicit use of the multiplier effect through public spending, and his famous statement that "labor is the father and active principle of wealth, as lands are the mother."[1] Schumpeter noted that Petty should be credited with the "discovery of the rent of location."[2] It is surprising that as early as 1938 Eric Roll gave the quotation from Petty which contains locational rent, but he failed to note its similarity to Thünen's work. In fact, even in later editions of his book Roll gave Petty credit for developing the "general principle" of differential rent a hundred and fifty years before Ricardo.[3] In an obvious rebuttal to this statement found in Roll, Schumpeter said that it might be easy to conclude that Petty's "discovery" of location rent as to "imply decreasing returns, and in the end, the whole of the Ricardian theory. Only this would be quite unhistorical."[4] The fact that Petty's discovery was in the spirit of Thünen's theory can also be found in the geography literature. Chisholm stated that the idea of economic rent ". . . particularly von Thünen's version of it, had been

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[1]Sir William Petty, The Economic Writings of Sir William Petty ed. Charles H. Hull (London: Cambridge University Press, 1899), vol. I, p. 68.

[2]Schumpeter, History, p. 214, n. 7.

[3]Roll, A History of Economic Thought, p. 106.

[4]Schumpeter, History, p. 214, n. 7.

briefly stated . . . by Sir William Petty."[1] Finally, one can look to the introductory essay to Petty's works to find evidence that Petty's writings were in the same mold as Thünen's. In addition, one can find the following statement by Charles H. Hull:

> The notion of diminishing returns, forcing recourse to fields of inferior natural and indestructible powers in order to supply the market and thus giving rise to a differential rent, did not occur to him.[2]

Rather, Petty contended that the amount of rent per acre is determined by the density of the population. In other words, the rent of land is dependent on "situation" rather than fertility. Here is the quote from Petty's A Treatise of Taxes and Contributions (1662) which contains this idea:

> For as great need of money heightens exchange, so doth great need of corn raise the price of that likewise, and consequently of the rent of the land that bears corn, and lastly of the land itself; as for example, if the corn feedeth London, or an army, be brought forty miles thither, then the corn growing within a mile of London, or the quarters of such army, shall have added unto its natural price, so much as the charges of bringing it thirty-nine miles doth amount unto.[3]

In an effort to break new ground in this area, this author read and reviewed the entire collection of Petty's works. Many passages were found that prove to be just as interesting as the preceding one. Later in the Treatise,

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[1]Chisholm, Rural Settlement, p. 21. It should be noted that even though Chisholm thought Petty's discovery was "independent" of Ricardo's, Chisholm gave Roll's incorrect interpretation as a reference.

[2]Petty, The Economic Writings, p. LXXIII.

[3]Ibid., pp. 48-9.

Petty displayed a basic understanding of the fact that the price of an agricultural good near the center of a population area would yield more rent than the same good farther from the center. Petty reasoned that the price of all such goods would be set by the price of those goods brought from the fartherest distance.

> For if the said five shires did already produce as much commodity, as by all endeavour was possible; then what is wanting must be brought from a far, and that which is near, advanced in price accordingly . . . then will the rent be as much more advansed. . . .[1]

Petty also recognized the importance of transportation costs and the "hazard" of carriage. In Political Arithmetick he analyzed the advantages of Great Britain as compared to France. Using a "parallelogram figure" to make the islands comparable to France, he reasoned that there was no point on the islands more than twelve miles from cheap transportation (i.e., the sea), whereas some points in France were over seventy miles from a port. Most important he concluded that:

> Upon which grounds it is clear, that England can be supplied, with all gross and bulky commodities of foreign growth and manufacture, at far cheaper rates than France can be. . . .[2]

Petty used the word "situation" to mean location. He felt that situation, trade, and public policy were the most important factors in determining the wealth and strength

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[1]Ibid., p. 52.

[2]Ibid., p. 293.

of a country. Improvements in shipping and water carriage could work with the other factors to improve a country's financial position.[1] Petty was an advocate of public works projects. Among his suggestions for such projects was the ". . . making all highways so broad, firm, and even, as whereby the charge and tedium of traveling and carriages may be greatly lessened."[2] The major result of such projects besides "the pleasure and beauty of them" would be to make commodities "vendible" over a large area.[3]

While discussing the sizes and purposes of "parishes," Petty made some remarks which apply to central place theory. First, in his book Political Anatomy of Ireland (1691), he determined that a parish would contain "the number of people living within a market-days journey."[4] Second, one can find the following in his Treatise:

> . . . the largest parishes I know, being not more capacous then three or four miles square, in which is no difficulty for the people meet once a week at some central place within that scope.[5]

The last quote was found under the title "That five thousand Parishes are enough for England and Wales so as to give unto each but a thousand Parishioners, and so that none need go

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[1]Ibid., pp. 249-67.

[2]Ibid., p. 29.

[3]Ibid., p. 31.

[4]Ibid., pp. 180-1.

[5]Ibid., p. 24. Emphasis added.

two miles to church." This seems to be a crude central place system.

In his book The City of London (1683), Petty presented a short analysis of what is known as "agglomerations" today.

> But the gain which is made by manufacturers, will be greater, as the manufacture it self is greater and better. For in so vast a city manufacture will beget one another, and each manufacture will be divided into as many parts as possible. . . .[1]

Petty gave an example of watch production. One man (or firm) would make the wheels. Another man would make the springs, etc. The final result would be a product ". . . cheaper than if the whole work be put upon any one man."[2] He continued by giving the following statement:

> . . . we also see that in towns, and in the streets of a great town, where all the inhabitants are almost of one trade, the commodity peculiar to those places is made better and cheaper than elsewhere. Moreover, when all sorts of manufacturers are make in one place . . . and shipped off in another, the carriage, postage, and travelling-charges will inhance the price of such manufacture. . . .[3]

All of these developments are in addition to those factors listed at the beginning of this essay which lead Marx, Brentano, Roll, and others to call Petty "the founder of political economy." It seems as if Petty might also be given credit for at least mentioning very important aspects of what has become known as location theory. His accounts

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[1]Ibid., p. 473.

[2]Ibid.

[3]Ibid.

are too vague and sketchy to call him the founder of location theory, but he deserves recognition beyond a mention of his location rent.

Adam Smith

Adam Smith (1723-90) is usually considered to be the founder of classical political economy. Smith devoted much space in his Wealth of Nations[1] to the problems of "situation," i.e., location. Schumpeter has given him credit for developing a theory of rent based on location.[2] But, it is surprising that writers of location theory literature who mentioned Smith have failed to cite one part of the Wealth of Nations dealing with this subject. They have generally cited another portion of his book by giving the following quote:

> The corn which grows within a mile of the town, sells there for the same price with that which comes from twenty miles distance. But the price of the latter must generally, not only pay the expense of raising and bringing it to market, but afford too the ordinary profits of agriculture to the farmer. The proprietors and cultivators of the country, therefore, which lies in the neighbourhood of the town, over and above the ordinary profits of agriculture, gain, in the price of what they sell, the whole value of the carriage of the like produce that is brought from more distant parts, and they save, besides, the whole value of this carriage in the price of what they buy. Compare the cultivation of the lands in the neighbourhood of any considerable town, with that of those which lie at some distance from it, and you

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[1]Adam Smith, The Wealth of Nations (New York: Modern Library, 1937 (1776)).

[2]Schumpeter, History, p. 264.

> will easily satisfy yourself how much the country is benefited by the commerce of the town.[1]

This passage is in clear anticipation of Thünen. It makes one wonder about Thünen's use of Smith, since Thünen devoted a chapter in his book to a critique of Smith's theory of rent without mentioning Smith's theory of location rent.[2] In the Wealth of Nations, Chapter XI, "Of the Rent of Land," Part I, "Of the Produce of Land which always affords Rent," one can find as explicit statement of Smith's location rent.

> The rent of land not only varies with its fertility, whatever be its produce, but with its situation, whatever be its fertility. Land in the neighbourhood of a town gives a greater rent than land equally fertile in a distant part of the country. Though it may cost no more labour to cultivate the one than the other, it must always cost more to bring the produce of the distant land to market.[3]

Smith gave explicit examples of this "situation" rent. In the following quote, he also indicated that (depending on the bulk and the value of the product) transportation costs are important.

> The value of a coal-mine to the proprietor frequently depends as much upon its situation as upon its fertility. That of a metallic mine depends more upon its fertility, and less upon its situation. The coarse, and still more the precious metals, when separated from the ore, are so valuable that they can generally bear the expense of a very long land, and of the most distant

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[1] Jones, "Theory of Urban Economy," p. 43, and Smith, Wealth of Nations, pp. 356-7.

[2] Thünen, Isolated State, pp. 18-22.

[3] Smith, Wealth of Nations, p. 147. The first and second editions read, "The rent of land varies with its fertility, whatever be its produce, and with its situation, whatever be its fertility."

sea carriage.[1]

One of the most interesting quotes found in Smith is one which indicates that Thünen may have been influenced more by Smith than he admitted. While discussing the effect of improved transportation on production, Smith gave the following important statement:

> Good roads, canals, and navigable rivers, by diminishing the expense of carriage put the remote parts of the country more nearly upon a level with those in the neighbourhood of the town. They are upon that account the greatest of all improvements. They encourage the cultivation of the remote, which must always be the most extensive circle of the country. They are advantageous to the town, by breaking down the monopoly of the country in its neighbourhood. They are advantageous even to that part of the country. Though they introduce some rival commodities into the old market, they open many new markets to its produce.[2]

The phrase "the most extensive circle of the country" could have inspired Thünen's circles. Smith discounted attempts to claim that improved transportation would lead to lower rents at central sites. Some people had feared that the extension of turnpike roads from London to the surrounding countryside would enable competitors to sell grass and corn cheaper in the London market than themselves. If such were the case, there would be a reduction in the rents collected in London. But, Smith concluded that such fears were not confirmed by the facts in the case. In retrospect, their rents had risen after such improvements were made.

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[1]Ibid., p. 167, also see pp. 164-5.

[2]Ibid., p. 147. Emphasis added by this author.

In addition, Smith felt that cities existed because of their special relationship to the countryside. The country produced a "surplus" beyond what was necessary to feed the cultivators. In exchange, the city would provide the country with manufactured goods.[1] He also felt that having a central location could affect the development of a city.

> The cities of Italy seem to have been the first in Europe which were raised by commerce to any considerable degree of opulence. Italy lay in the centre of what was at that time the improved and civilized part of the world.[2]

In summary, Smith made an explicit statement of location rent. One can find extensive examples and applications of this theory in his book. He felt that transportation costs and a good transportation system were both important factors in location. Smith explained that the existence of cities depended on a surplus produced in the countryside.

Alfred Marshall

Alfred Marshall (1842-1924) is usually considered to be the first of the neoclassical economists. It is amazing how much work dealing with location theory and spatial economics can be found in his Principles of Economics.[3] This fact might make one wonder why most writers have agreed

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[1]Ibid., p. 357.

[2]Ibid., p. 380.

[3]Alfred Marshall, Principles of Economics, 7th ed. (London: Macmillan and Co., 1916 (1890)).

with the conclusion that the classical and neoclassical economic systems were ". . . wonderland(s) of no dimensions."[1] We have already seen that the preclassical (Petty) and classical (Smith) systems were not as void of this analysis as is usually indicated. But as far as general emphasis in their writings is concerned, this writer would have to agree with the consensus, i.e., that the classical and neoclassical economic systems tended (in the most part) to ignore space. The reasons for both of these apparent lapses can be found in Marshall. As far as the classical system was concerned, Marshall relied on a relativistic argument to explain why producers surplus (economic rent) type analysis found in the writings of English economists tended to ignore the influence of location. He felt that England was so small that goods could be delivered almost anywhere in the country at "no inordinate expense."

> For this reason English economists have ascribed to fertility the first rank among the causes which determine the value of agricultural land; and have treated situation as of secondary importance.[2]

According to Marshall these economists were guilty of committing one of two errors. They did not take the trouble to state explicitly that (1) when comparing two pieces of land they must be located in the same neighbourhood (to get

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[1]Walter Isard, "The General Theory of Location and the Space-Economy," Quarterly Journal of Economics LXIII (1949): 477. Also see William Warntz, Toward a Geography of Price (Philadelphia: University of Pennsylvania Press, 1959), p. 13-27.

[2]Marshall, Principles of Economics, p. 633, n. 1.

the results that they did), or that (2) separate allowance must be made for differences in the expense of marketing. Economists in "new countries" (and this author would argue "larger countries") did not make these mistakes. In such countries the richest land might lie uncultivated, because it did not have good access to markets.

> In their view land on the margin of cultivation, was land far from markets; and, especially, land far from railways that lead to good markets: and the producer's surplus presented itself to them as the excess value of the produce from well situated land over that which equal labour, capital (and skill), would get on the worst situated land; allowance being of course made for differences of fertility, if necessary. . . .[1]

While discussing market supply and demand relationships, Marshall also gave a set of priorities which were adopted by neoclassical and later writers. He felt that markets vary with regard to the period of time which is allowed to let the forces of supply and demand to come into equilibrium. In addition, he argued that the area of influence of these forces also varies. But he concluded that ". . . this element of Time requires more careful attention just now than does that of Space."[2] Unfortunately for the development of location theory and spatial economics, the economics profession paid more heed (at least implicitly) to Marshall's former theme (i.e., the emphasis on "time" rather than "space"). Ironically, Marshall's Principles seems to have contained

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[1]Ibid.

[2]Ibid., p. 330.

much emphasis on "space." Let us now look at some specific examples of this emphasis.

One of the major developments in Marshall's Principles is his internal-external economies analysis. One overlooked point concerning this analysis is that Marshall believed that ". . . the situation of a business nearly always plays a great part in determining the extent to which it can avail itself of external economies. . . ."[1] Marshall used the word "situation" to mean location. A "situation value" was derived from the growth of population, from improved transportation, and from improved communication with existing markets. He reasoned that two producers with otherwise equal facilities except that "one has a more convenient situation than the other" would not have even competition. The one with the best location could buy and sell at "less cost of carriage" and thus gain the advantage. Marshall felt that these advantages of "situation" and other factors (e.g., nearness to a labor market) could be translated into money values. When this translation was accomplished the money value of the advantages of situation of one business over another could be calculated. That monetary measurement of a business' special situation values was called a "special situation rent" which contributed to "site value."[2]

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[1]Ibid., p. 441.

[2]Ibid.

Marshall devoted an entire chapter in book IV of his Principles to the subject of industrial location.[1] He laid special emphasis to "physical conditions" in accounting for the localization of industries. These factors included climate, soil, mines, and easy access by land and water. Such localization would allow for ". . . division of labour in the mechanical arts and in the task of business management."[2] Marshall also listed "patronage of a court" as another chief cause of localization. A court would have many "rich folks" who would (1) make the demand for goods of a "specially high quality," (2) attract skilled workmen, and (3) educate those attracted on the spot. Other advantages of localized industries included the growth of hereditary skills, the growth of subsidiary trades, the use of highly specialized machinery, and a local market for special skills.[2] When an industry had finally chosen a locality for itself, Marshall felt that it was very likely to stay there for a long time. In addition to those factors listed in the last few sentences, he believed that social forces would cooperate with economic forces to help make industries relatively immobile. Friendships would form, and children would ". . . learn the mysteries of trade unconsciously."[3]

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[1]Ibid., Chapter X, "Industrial Organization, Continued. The Concentration of Specialized Industries in Particular Localities," pp. 267-77.

[2]Ibid., p. 271.

[3]Ibid.

Sometimes the localization of an industry would make an extensive demand for a particular kind of labor to the exclusion of all other types of labor. This could result in the unemployment of women and children unless "industries of a supplementary character" appear in the neighborhood to take up the surplus. Such would be the case in isolated rural company towns. Finally, Marshall accounted for the agglomeration of shops which deal in "expensive and choice objects." This gathering was explained by the consumer's need to do comparison shopping for these items.

Friedrich noted in the preface to Alfred Weber's Theory of the Location of Industries that Alfred Marshall gave a certain recognition of Weber's point of view concerning transportation costs.[1] Marshall argued that the "dominant economic fact" of his time was the development of the transportation industries.

> Probably more than three-fourths of the whole benefit she (England) has derived from the progress of manufactures during the nineteenth century has been through its indirect influences in lowering the cost of transport of men and goods, of water and light, of electricity and news: for the dominant economic fact of our own age is the development not of the manufacturing, but of the transport industries.[2]

Marshall argued that every cheapening of the means of communication and transportation between distant places would alter the pattern of localized industries. The lowering of tariffs

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[1]Weber, Location of Industries, p. XXXI.

[2]Marshall, Principles of Economics, pp. 674-5. Parenthetical information added.

or of freight charges on the transport of goods would tend to make each locality buy more from distant places.[1]

Marshall's discussion of market areas contains some of his best work in location theory and spatial economics. He brought f.o.b. pricing into his analysis. If a market were large, then the producers must have allowed for the expenses of delivery of goods to the purchasers. Each purchaser would have ". . . to pay in addition to the market price a special charge on account of delivery."[2] The size of a market area would be a function of the amount of bulk.

> Commodities for which there is a very wide market must also be such as will bear a long carriage: they must be somewhat durable, and their value must be considerable in proportion to their bulk. A thing which is so bulky that its price is necessarily raised very much when it is sold far away from the place in which it is produced, must as a rule have a narrow market.[3]

The most important discussion of market areas is found elsewhere in the text. Marshall gave us a footnote on the subject of the shape of the boundary between market areas at least fifteen years before it was repeated by Frank Fetter.[4]

> If we suppose that two mineral springs A and B supplying exactly the same water are capable of being worked each to an unlimited extent at a constant money cost of production, this cost being, say two pence a bottle at A whatever the amount produced by it, and two pence half-penny at B, then those places to which the cost of carriage per bottle from B is a half-penney less than

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[1]Ibid., pp. 273-6 and p. 325.

[2]Ibid., p. 325.

[3]Ibid., p. 326.

[4]Been, "Reconstruction," pp. 73-4.

> from A, will be the neutral zone for their competition. (If the cost of carriage be proportional to the distance, the neutral zone is a hyperbola of which A and B are foci). A can undersell B for all places on A's side of it, and vice versa; and each of them will be able to derive a monopoly rent from the sale of its produce within its own area. This is a type of a great many fanciful, but not uninstructive, problems which readily suggest themselves. Compare von Thünen's brilliant researches in Der Isolierte Staat.[1]

Of course, Thünen did not have a market area analysis comparable to Marshall's, but this passage reinforces the argument that Marshall was influenced by Thünen. In addition, it shows a level of sophistication in market area analysis developed independent of Launhardt and preceding Fetter.

Marshall was also concerned with the migration of industries and people. He was much ahead of his time by observing that individuals may seek communities which have a proper taxes-expenditures package. This idea was developed later by Charles Tiebout.[2] While discussing the tax rates paid by consumers of local services, Marshall stated:

> The occupier generally regards the rates which are collected from him as forming a single aggregate with his rent; but he makes his reckoning also for the amenities of life which are secured by remunerative local expenditures of rates; that is he tends, other things equal to select districts in which the aggregate of rents and onerous rates is low. . . .[3]

The potential mover would be hindered by personal and

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[1]Marshall, Principles of Economics, p. 442, n. 1.

[2]Charles M. Tiebout, "A Pure Theory of Local Expenditures," Journal of Political Economy LXIV (October 1956): 416-24.

[3]Marshall, Principles of Economics, p. 795.

business ties at his present location. He should also take into consideration the "expenses and trouble of moving." As far as industries are concerned, Marshall anticipated the fact that someday business firms might start to abandon the central city for locations in the suburbs. He blamed high "ground rents" for this migration from central sites.

> . . . the value which the central sites of a large town have for trading purposes, enables them to command much higher ground-rents than the situations are worth for factories, even when account is taken of this combination of advantages: and there is a similar competition for dwelling space between the employees of the trading houses and the factory workers. The result is that factories now congregate in the outskirts of large towns and in manufacturing districts in their neighbourhood rather than in the towns themselves.[1]

In another place in his text, Marshall explained the same type of movement by the fact that as a city grows there is competition for land which increases the price of land. From a microeconomic standpoint, this increased rent is an increase in the "expenses of production" to an individual firm. The firm might "move to another town or into the country" if

> . . . the saving in the cost of land that he will make by moving into the country, together with other advantages of the change, will more than counterbalance its disadvantages. In a discussion as to whether it was worth while to do so, the rental value of the site of his factory would be reckoned among the expenses of production of his cloth, and rightly.[2]

In summary, one might wonder what else could be expected of Marshall. He seems to have had a deep understanding

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[1]Ibid., pp. 272-3.

[2]Ibid., p. 449.

of the basic problems of location theory and spatial economics. He also explained why the subjects had been ignored by most English writers before him, and his analysis of time helps explain why most economists after him have failed to emphasize space. In Marshall's own work external economies were affected by location. He devoted an entire chapter to the subject of the localization of industries and his writings emphasize the importance of transportation costs. Furthermore market area analysis can also be found in his text and he had a general concern for and interest in the migration of people and industries. In conclusion, Marshall should be recognized for his many contributions and discussions of locational-spatial problems.

John A. Hobson

John A. Hobson (1858-1940) is best known for his anti-Marshallian positions and his theory of underconsumption.[1] He had a long list of books including The Evolution of Modern Capitalism.[2] This book contains Hobson's discussions on location theory and spatial economics. He recognized that both time and space should be used to measure a market area's size.

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[1]Schumpeter, History, pp. 832-3, footnote 5.

[2]John A. Hobson, The Evolution of Modern Capitalism (New York: Charles Scribner's Sons, 1894). A. Ross recognized Hobson as early as 1896, see Ross, "The Location of Industries," p. 255.

> Modern methods of production have also brought about a great expansion in the time-area of the market. Competition covers a wider range of time as well as space.[1]

He believed that a market area varied with the nature of the product being considered. The chief qualities which would determine the market area included (1) the extent of demand, (2) portability, and (3) durability.

Hobson argued that the same laws and limitation that applied to the ". . . degree of specialization of countries" also applied to ". . . smaller districts, towns, and streets."[2] Industries producing valuable or durable goods would be subject to a "wide demand," and they would be locally specialized. Those industries producing bulky or perishable goods would have a "narrow demand," and they would be unspecialized (and ubiquitous). The specialization function of a town could be augmented by the location of a large industry. Such industries would require a grouping around them of (a) secondary or auxiliary trades (coordinate trades), (b) dependent or derivative trades, and (c) "parasitic" industries. Within the town the industries related to the "carrying trades" would cluster to provide transport for the firms. Once the central business district becomes recognized as a trade center it is ". . . increasingly important to each new competitor to settle there" to take advantage of "trade

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[1]Hobson, Evolution of Modern Capitalism, p. 99.

[2]Ibid., p. 110.

centralization."[1] Hobson recognized the fact that "effective competition in retail" (trade) sometimes would require centralization and sometimes dispersion, but he placed emphasis on centralization.

Hobson also listed three major determinants of industrial location independent of his market area analysis and specialization analysis. These factors included climate, geographical and geological features, and "national character."[2] Under the category of "national character," he included race characteristics, food supply, density of population, and any other factor which would help determine the "efficiency of labour."

Hobson gave special emphasis to the influence of transportation to the problem of location.

> The space area of competition has been immensely widened, especially for the more durable classes of goods. It is machinery of transport--the transport of goods and news--that is chiefly responsible for this expansion. Cheaper, quicker, safer, and more calculable journeys have shrunk space for competing purposes. Improved means of rapid and reliable information about methods of production, markets, changes in price and trade have practically annihilated the element of distance.[3]

In summary, one can find four major areas of analysis in Hobson's text which apply to location theory and/or spatial economics. These subjects include market areas, specialization, determinants of location, and transportation.

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[1]Ibid., p. 114.

[2]Ibid., pp. 108-9.

[3]Ibid., p. 99.

His contributions are interesting, but they are not profound.

Conclusions

Petty, Smith, Marshall, and Hobson did not give major emphasis to problems of location in their writings, but the extent of their discussions on the subject go beyond what one might expect. All four realized that space could make a difference in basic economic reasoning. Locational rent can be found in Petty, Smith, and Marshall. Some form of market area analysis can be found in Marshall and Hobson. Transportation cost or transportation system improvements were important to all four writers. In conclusion, this author feels that these discussions are too important to ignore. Alfred Marshall should be given special credit for his analysis.

CHAPTER IX

THE INFLUENCE OF EARLY WRITERS ON SELECTED MODERN LITERATURE

Introduction

In this chapter, an attempt will be made to document the influence of Thünen, Weber, and Christaller on modern location theory literature. The procedure will be to present summaries of the modern day models which are reflections (or extensions) of the earlier works.

Thünen and Muth

Alonso, Wingo, Kain, and Muth[1] have presented urban land use models with Thünian features. There are several features common to these models. In urban land use theory, Thünen's isolated town has been replaced with the central business district (CBD). The homogeneous fertile plain without navigable waterways containing rings of agricultural activity surrounded by wilderness found in Thünen's model has been converted to a homogeneous and flat urban area with

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[1]Alonso, Location and Land Use; Lowdon Wingo, Transportation and Urban Land (Washington: Resources for Future, 1961); John Kain, "The Journey to Work as a Determinant of Residential Location," Proceedings of the Regional Science Administration 9 (1962): 137-60; and Muth, Cities and Housing.

land use allocated to residential housing, retailing, or manufacturing. Nevertheless, upon close inspection of Thünen's text, one can find a rather complete description of how an adaption of his model could be made.

> If we want to know the reasons for the disproportionate rise in ground rent with the approach to the town centre, we shall find them in labour economies; in the general convenience of a central situation; in time-savings to be made in trade and business: for one and the same law governs ground as well as land rent.[1]

There are several other Thünian assumptions common to most of the models. The CBD is the point of maximum accessibility. The producers which locate in or near the CBD tend to have lower transportation cost than otherwise; therefore, those producers for whom transportation cost is greatest or for whom the use of space is least important locate near the CBD.[2] Households find employment and purchase goods only within the CBD. So like the producers, those households with large transportation costs or small space needs locate near the CBD.[3] Under these conditions, the difference in land rent of any two locations having the same type of land use is dependent on differences in transportation costs associated with the two locations. All the models noted earlier have this basic pattern. The Muth model will be used to represent all such models.

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[1]Thünen, Isolated State, p. 133.

[2]Muth, Cities and Housing, p. 7.

[3]Hirsch, Urban Economic Analysis, p. 53.

The Muth model employs a partial equilibrium analysis to describe the behavior of a household choosing its housing in urban space.[1] The general problem faced is that of a household maximizing a utility function (which is a function of "housing space" and a composite good including leisure) subject to a budget constraint. Muth assumed that all jobs are located in the CBD. All workers live in residential areas which form concentric rings around the CBD. "Housing space" consists of both land and the structure on the land. The quality of housing is assumed to be the same throughout the city. Muth does not distinguish between owners and renters of housing. The price of housing space declines from the CBD outward. This price is made up of a fixed part and a variable part. The fixed component is the base price of housing space in the CBD. The variable component is due to the fact that the price declines with distance from the CBD. The price of transportation increases from the CBD outward, and it is assumed to be the same in all directions. The price of transportation is a function of two variables. It is a direct function of distance from the CBD. Muth also takes into account the opportunity cost of time spent commuting by making transportation cost a function of wage income. Details of the model are as follows:

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[1]Goldstein and Moses, "A Survey of Urban Economics," p. 476.

(1) Utility Function

$U = U(X,Q)$
U = utility
X = composite good including leisure
Q = housing space

(2) Budget Constraint

$Y = X + P(k)Q + T(k,y)$
Y = income
$P(k)$ = price per unit of housing space
$T(k,y)$ = expenditure on commuting
y = money income

(3) Lagrangian Form ("d" is used for the partial sign)

$$L = U(X,Q) + \lambda(Y-X-P(k)Q-T(k,y))$$

(a) $dL/dX = dU/dX - \lambda = 0$
(b) $dL/dQ = dU/dQ - \lambda P(k) = 0$
(c) $dL/dk = -\lambda((dP/dk)Q + dT/dk) = 0$

(4) Simplification

(a) $(dU/dQ)/(dU/dX) = P(k)$
(b) $-(dP/dk)Q = dT/dk$

Equation 4a can be interpreted as requiring that the marginal rate of substitution between the composite good, X, and housing space, Q, should equal the price of housing space, P(k). Equation 4b relates that the reduction in expenditures on housing space resulting from a small change in commuting distance should equal the increase in commuting cost that results from that move. Under these conditions, that amount which the household would save from a very short move away from the CBD in housing cost would be just offset by an increase in transportation costs. Equation 4b also provides a mechanism to determine the exact location of the household residence. The equilibrium location is at that distance for

which the marginal price function for housing space, $-(dP/dk)Q$, is equal to the marginal commuting cost function, dT/dk. Both of these functions are inversely related to distance. Since the marginal price function is steeper than the marginal commuting cost function, the resulting intersection determines where they are equal (and thus the equilibrium distance of residence, k).

In other words, the constrained maximization solution represents an equilibrium location from which no move in any direction can increase utility. The declining price for housing space (combined with the assumption that construction costs are similar in all parts of the city) results in capital being substituted for land space near the CBD and land intensive construction near the outskirts. Once located, the housing space owner would change location based upon the income elasticity of the demand for housing space as compared to the income elasticity of commuting. If the former is the larger, then an increase in income would move the equilibrium distance farther from the CBD, and vice versa.

Muth has developed extensions of his model which will not be covered in this summary. His major modifications were (1) to allow for employment in places other than the CBD, and (2) to describe the behavior of a profit maximizing firm which is providing the housing services.

Weber and Hoover

Edgar M. Hoover, Jr., Tord Palander, and August Lösch[1] may be considered followers of the "Weber School" in the sense that they have given extensive critiques of the Weberian system. The contributions of Hoover will be reviewed as being representative of this group. Palander has yet to be translated, and most of his analysis was repeated by Hoover. Lösch was a multi-talented writer whose model will be presented in association with Christaller.

In part I of his 1937 text, Hoover presented a review of the theory of location up to that time. He borrowed heavily from Palander's text by duplicating many of Palander's diagrams and discussions. Hoover was quick to give credit to Palander.

> Palander's work has influenced the present book to a much greater extent than it is possible to indicate by specific reference.[2]

Since Palander's theory was an extension (and critique) of Weber's, Hoover's theory is also similar to Weber's. As in Weber's model, Hoover analyzed the problem of location from a cost minimization standpoint, but he also analyzed potential markets and access to suppliers. But despite

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[1]Hoover, Location Theory and the Shoe and Leather Industries; and Edgar M. Hoover, The Location of Economic Activity (New York: McGraw-Hill, 1948); Tord Palander, Beitrage zur Standortschtheorie (Uppsala: Almquish och Wiksells, 1935); and Lösch, The Economics of Location.

[2]Hoover, Location Theory and the Shoe, p. 8, n. 3.

references to demand,[1] Greenhut concluded that the ". . . greatest weakness in Hoover's work is the failure to probe deeply into locational interdependence."[2] Of the major Weberian topics discussed by Hoover, he made major modifications in two areas: (1) transportation rates are investigated in depth, and (2) agglomeration economies and labor costs are analyzed more fully.

A major distinction of Hoover's cost minimization model and Weber's was that Hoover emphasized the difference between processing (of product) cost and transportation cost. The location decision was viewed as a process of substitution between these two catagories of costs in a manner such that they would be minimized. Hoover's adjustment mechanism was fundamentally one of ". . . a little higher transportation cost in exchange for a reduction in processing burdens, or vice versa."[3] However, Hoover also stressed the least-cost transportation expense location, but unlike Weber he believed that transport cost increases were less than proportional compared to distance increases. Such a nonproportionality could account for a widening between isodapanes as distance increases. Hoover also modified Weber's system by giving emphasis to the terminal costs portion of transit costs.

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[1]Hoover, The Location of Economic Activity, pp. 48-65.

[2]Greenhut, Plant Location in Theory and Practice, p. 21

[3]Ibid.

Terminal costs are fixed costs independent of distance, so a shipper will gain greater economies from a long-haul as compared to a short-haul shipment. Such a fact could account for the location of certain firms around ports and railroad interchanges. Hoover found that the least-cost transportation expenses locations were usually at the market or at the source of raw materials, but he also modified Weber's model by allowing for transshipment points and transit junctions. When a firm has several sources of raw materials and several markets to serve, such a transshipment point or transit junction might be the ideal location even though it is an intermediate location. Transportation costs could also account for orientation of a firm close to the raw materials location or close to the market for final goods. Orientation to the raw materials was postulated any time (1) that the transportation costs of raw materials were greater than those for final goods, or (2) that the weights of raw materials and final products were equal, but ". . . the procurement costs per ton-mile are for some reason greater than the distribution cost."[1] Orientation to the market could be accounted for by either ". . . a 'weight-gain' in the process or higher transfer costs per ton-mile on products than on materials."[2] Although Hoover's "weight-gain(ing)" process was an interesting turn on Weber's "weight-losing" materials, one can conclude that

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[1]Hoover, The Location of Economic Activity, p. 32.

[2]Ibid., p. 35.

Hoover's analysis of transportation costs was basically the same as Weber's with the modifications and extensions noted above.

Hoover's analysis of deglomeration and agglomerations was much more detailed than that of Weber's. As stated in the chapter dealing with Weber's work, Hoover believed that agglomerations were actually the combination of three forces: (1) large-scale economies, (2) localization economies, and (3) urbanization economies.[1] More specifically, Hoover included in agglomerations such advantages as better transfer services, a broader more flexible labor market, more advanced banking facilities, better police and fire protection, and lower insurance costs and utility rates.[2] By agglomerating, firms tended to specialize so that special services and certain operations of the firms might be taken over by other (specialized) firms. In addition, interindustry linkages created by agglomerations may provide for the use of other firms' by-products, complementary use of labor, and the ability to maintain low inventories.[3] Although he did not associate rent with deglomerations (like Weber), Hoover did investigate rents extensively. His model of rents was based on differentials in prices of various productive services which result from the difficulty of moving

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[1]Hoover, Location Theory and the Shoe, p. 90.

[2]Hoover, The Location of Economic Activity, p. 120.

[3]Ibid.

factors (lack of mobility) from one location to another. Factor immobility was thus seen as the cause of geographical differences in the cost of production. Such differences in costs accounted for rent formation.[1]

In Weber's system labor costs were considered to be a "general" location factor in that they were common to all industries. Hoover used a more general category called "processing costs" as a location factor. Processing costs included the direct costs of labor, costs of administration, interest, rents and royalties, maintenance and depreciation and taxes.[2] As stated earlier, even though Hoover emphasized transportation costs, his analysis was actually a cost minimization model based on both processing cost and transportation (distribution) cost. If transport costs happened to show little variation in a particular case, then differences in processing costs could be a primary location factor. So, unlike Weber who viewed labor cost as a factor to account for deviations from a least-cost transportation expenses point, Hoover had a model with a continuous trade-off between the two costs. This feature of Hoover's model lead Böventer to label such an application of the substitution principle as the "Hoover Criterion" in finding the optimal size firm in space.[3] This relationship actually included

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[1]Ibid., pp. 67-74.

[2]Ibid., pp. 39-40.

[3]Böventer, "Toward a United Theory," p. 343.

a comparison of internal economies on the one hand to transportation-distribution costs on the other. The optimum size firm would be one for which the internal economies associated with increasing firm size (which would result in lower per unit processing costs) would be just off-set by increased transportation-distribution costs.

The combination of the three costs listed above (the transportation costs of "procuring" raw materials, processing costs, and transportation-distribution costs of final goods) were combined by Hoover to be the basis of what can be considered to be one of his major contributions to location theory. This development was called the "margin line."[1] Margin lines divide a market area of a firm (for a particular product) from other firms' market areas (for the same product). This line represents points served equally well by two or more production centers. The cost of a product at any one market place would be the sum of the three types of costs listed above. In other words, the margin line represents delivered prices at the outer edge of a market region of a firm. The particular pattern of these lines would depend on "transfer costs" (i.e., the raw materials transportation costs and final goods distribution costs) the economies of scale (resulting in lower per unit processing costs) as the firm increases in size. However, Greenhut has voiced criticism of Hoover's analysis of market areas.

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[1]Hoover, Location Theory and the Shoe, p. 16.

He pointed out that in order for Hoover to make this brief journey into the "field of spatial interdependence" it was necessary for him to assume the location of firm.[1]

In conclusion, Hoover developed and extended Weber's model of the location of industries. Despite Greenhut's comments, Hoover did make a significant contribution to market area analysis by linking his three categories of costs to his "margin line" concept.

Christaller and Lösch

In Walter Christaller's autobiographical essay, he noted that August Lösch had developed a central place theory similar to his.

> It is interesting that, almost simultaneously, but completely independently from my work, August Lösch, in America, discovered central place systems similar to mine--my book appeared in 1933, his in 1940.[2]

But as this author noted in the chapter dealing with Christaller, Lösch admitted in both of his major works[3] that he had read and used Christaller. Lösch's development of hexagonally shaped market areas results in a central place system similar to Christaller's, but he wrote on all aspects of location theory. By reading his 1940 text, one will encounter many familiar concepts. For example, one finds Alfred

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[1]Greenhut, Plant Location in Theory and Practice, p. 21.

[2]Christaller, "How I Discovered," p. 610.

[3]Lösch, "The Nature of Economic Regions," and August Lösch, The Economics of Location trans. W. H. Woglom (New Haven: Yale University Press, 1954 (1940)).

Weber's use of weight-losing materials and isodapanes with Lösch insisting that profit maximization rather than cost minimization should be the dominant criterion in location studies. He used Thünen's rings, with descriptions of the effect of central markets on the patterns of agricultural land use, and also Christaller's concepts of central places and hexagonal market areas, which he expanded into a complex model which included the distribution of various types of commodities as well as the location of various types of urban centers.[1] So, the choice of placing of Lösch's model with the central place analysis of Christaller was somewhat arbitrary in the sense that Lösch wrote about more than central places.

Lösch's model was unique in the way the equilibrium conditions of Chamberlin's model of monopolistic competition were brought into the analysis.[2] Chamberlin himself had pointed the way to such adaptations in appendix C of his famous text.[3] Lösch assumed a homogeneous plain with an even distribution of resources, uniform distribution of population, and equal transportation opportunities and rates in all directions. Consumers were assumed to have identical

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[1]Lösch, The Economics of Location, passim. Also see H. H. McCarty, "The Economics of Location," Economic Geography 31 (April 1955): 187.

[2]Lösch, "The Nature of Economic Regions," pp. 71-72.

[3]Chamberlin, The Theory of Monopolistic Competition, appendix C, "Pure Spatial Competition," pp. 260-65.

tastes, and any consumer on the boundary line between two or more market areas would be indifferent as to which market he would travel to in order to minimize total transportation costs. Each firm was assumed to seek maximum advantage by setting marginal cost equal to marginal revenue so as to seek maximum profits. But due to the feature of monopolistic competition which allows for free entry into the market, all profits would be eliminated in equilibrium. Lösch assumed that supply, production, and sales locations would be numerous and as small as possible so that the entire "space" under consideration would be filled without gaps. Under these conditions, there are only three possible regular geometric figures for the market areas which can fulfill these requirements--squares, equilateral triangles, and hexagons. In a market region of a given area, the total demand in a hexagon is 2.4% greater than in a square and 12% greater than in an equilateral triangle.[1] Thus, of the three shapes mentioned, the hexagon is the most efficient shape for a firm's market area. For any one market area alone in abstract economic space, the ideal market area would be in the shape of a circle. Lösch developed the concept of a "demand cone" to account for this shape. He reasoned that at the firm's site of production the price of the product to the consumer would not include transportation costs. As one moved farther away from the production site, the price

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[1]Lösch, The Economics of Location, pp. 111-13.

would have to be raised by the amount of the transportation expenses incurred resulting in a decrease in the quantity demanded. So not only is there an inverse relationship between the price and the quantity demanded but also between the quantity demanded and distance from the production site. In the logical extreme, the quantity demanded would fall to zero at some distance far from the production site. This distance would be the boundary of the market area. Firms would be attracted to the same general area in response to the isolated firm's profits until they became so "crowded" as to force the ideal circles into the shape of hexagons. Once the hexagonal shapes are achieved, a stable equilibrium is reached which corresponds to the demand curve being just tangent to the average cost curve in Chamberlin's model.

Lösch found that he could superimpose the hexagonal maps of several different goods in order to account for economic systems containing more than one good. Once superimposed, he rotated the individual maps until he could recognize "nets" of hexagons. These nets would have various points of common intersection which could represent metropolitan areas or industrial centers. In this way Lösch was able to account for agglomeration (central places).[1] So, points of agglomerations resulted despite the assumptions of evenly distributed resources and uniform population.

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[1]Webber, Impact of Uncertainty on Location, p. 26.

Lösch's model can be viewed as a generalization of Christaller's central place analysis. His analysis verified or extended Christaller's work in the following ways: (1) Demand cones were developed to account for market areas. (2) The hexagonal shaped complementary region was verified as being the most efficient shape. (3) Lösch gave a clear statement of the relation of transportation routes to central places. (4) He presented a more general description of a system containing all possible relationships of evenly-spaced central places. (5) Lösch asserted (but did not prove) that one outcome of his system is a hierarchical class-system of central places.[1]

There are two major differences between Lösch's model and Christaller's. In Christaller's system all towns of a given order provide all the central goods specific to that order and all the central goods also provided by lower order towns. In Lösch's model, the degree to which functions of different orders agglomerate depends on the particular way the individuals maps of market areas are rotated in order to form the "nets" in hexagonal patterns. In such a system, any one central place need not provide the central goods supplied by all lower order central places. This would depend on the specific net resulting from specific rotations of the various maps. Likewise, in Christaller's

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[1]Berry and Garrison, "Recent Developments in Central Place Theory," p. 119.

model the ratio between the order number of the central places and the number of places in the central place system is a constant. In Lösch's system this ratio varies directly with the number of central places resulting in the net formation. Lösch's hierarchy is far less rigid than Christaller's. It yields a continuous sequence of central places as opposed to the distinct plateaus found in Christaller.[1] On a superficial level, one can also note that Lösch wrote of the location of farms and breweries whereas Christaller's model referred to towns or cities. Christaller took the hexagonal pattern as a given. Lösch was more concerned with derivation of the pattern from basic principles. In this sense, Lösch's model was far more general than Christaller's; and, also in another sense, Lösch was able to show that Christaller's model was a special case of his model.[2]

Summary and Conclusion

Thünen, Weber, and Christaller have all presented models of location which have become known as classics in this field of study. Each can be shown to have influenced a considerable body of literature. Thünen's agricultural land use theory has been adapted to apply to the location of different types of economic activities in urban areas. Weber's model inspired Hoover to develop a similar model

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[1] Webber, Impact of Uncertainty on Location, p. 26.

[2] Lösch, The Economics of Location, p. 114, n. 14, and pp. 431-34.

with increased emphasis placed on transfer costs and agglomerations. Lösch's model was found to be a generalization of Christaller's work. One might conclude that such arterial branch development might lead to three separate disciplines, but there is ample evidence in the literature to indicate that there is a synthesis developing.[1]

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[1]Böventer, "Towards a United Theory," passim; Greenhut, Plant Location in Theory and Practice, pp. 251-323; and Isard, Location and Space-Economy, pp. 221-51.

CHAPTER X

SUMMARY AND CONCLUSIONS

Introduction

Location theory, as interpreted by this author, consists of three major branches of study: (1) agricultural land use theory, (2) the theory of the location of industrial activity, and (3) the theory of the location of towns (and people). One major writer was studied and analyzed in each of these areas. Chapters II, III, and IV each have a portion of their titles in common (i.e., "The Roots of Location Theory") to emphasize this trilogy. Johann Heinrich von Thünen represented agricultural land use theory. Alfred Weber's work was studied as representative of the theory of the location of industries. Walter Christaller was found to have offered the first well-known analysis of the location of towns and cities.

Thünen

Thünen's model was based on the "situation rents" of the various crops which could be grown around an isolated town. The transportation costs associated with moving a crop from the most distant site of production to the place

of demand (the town) accounted for a rent accruing to those producers whose production of the same crop was closer to the town. The price for the crop in the town was set by the cost of production plus the transportation cost of the most distant production. Those producers nearer to the town than the most distant producers would enjoy the same market (town) price, but they would not spend as much on transportation costs. For any one crop, a rent gradient could be calculated which would show maximum rent at the town. The rent would decline as one moved away from the town to reflect the increased burden of transportation costs. More than one crop entered the model by allowing land to be allocated to the crop which would yield the maximum rent in any one location. As a final result, the isolated town would be surrounded by rings of agricultural activity.

Thünen can be considered the father of location theory, but one should note the distinction between location theory and land use theory. The conclusion reached by most writers was that Thünen's theory was one that best answered the question "What to produce?" instead of the question "Where to locate?" economic activity. Evidence was found which would indicate that Thünen should be considered the true father of location theory independent of any semantical problems with "land use theory" versus "location theory." This paternity is because the seeds of Weber's industrial location theory and Christaller's central

place theory can also be found in Thünen. So not only was Thünen the first of the three to write (1826), he also mentioned problems which foreshadow the work of the other two. In addition, both Weber and Christaller had read Thünen, and they both referred to him in their own works.

Thünen's work was obviously influenced by his observations of the real world. At the same time, he used an abstract method of ceteris paribus analysis. He made many restrictive assumptions in order to employ this methodology. He was called the "first regional scientist" because of his assumption of a uniform homogeneous plain. Other "givens" in his system included the commodity price at the market and the transportation rates to the market. Thünen assumed "rational behavior" on behalf of the farmers in his system so that each would seek to maximize economic rent. He did recognize rent from other sources, but Thünen emphasized "situation" rent.

One apparent paradox in the Thünian system can be made clear by careful study of the literature. The apparent paradox is that although Thünen called for intensive cultivation near the town and extensive cultivation at distances far from the town, inspection of his text revealed that he allowed for a forest (extensive cultivation) in the second ring near the town. The problem is solved if one realizes that Thünen had two separate theories: (1) a theory of the intensity of cultivation of crops, and (2) a theory of crop

production (and land use). An extensive form of cultivation could exist near the town if the demand for it were so high as to result in a higher rent than that rent for any other crop.

Weber

Alfred Weber developed a theory for the location of industries. He used an analytically "pure" system based on ceteris paribus analysis and "as if" methodology. There was evidence found to indicate that Alfred Weber's "pure theory" was similar to Max Weber's "ideal types." Supporting evidence for this conjecture can be found in Alfred Weber's text and in Walter Christaller's book. Some modern writers have contended that Weber assumed perfect competition. This author documented the fact that no such assumption was made explicit by Weber in his book. In retrospect, perfect competition may be the best market structure to apply to his work, but little evidence could be found to support such claims.

Weber's model was compared to Thünen's to determine whether the "traditional dualism" in location theory actually exists. The traditional dualism is that the two models (Thünen's model and Weber's model) are so different that it would be impossible to find a common framework for them. This author concluded that such a common framework can be found. Although the two models may be procedurally opposite, each can be viewed as a part of a larger model within which

different variables are allowed to change. In addition, both models may be classified as "least-cost" theories, and both used the principle of substitution to allow for a trade-off between transportation costs and some other variables (different in each model) in order to maximize profits or rents. Evidence was also found to indicate that Thünen had anticipated some aspects of Weber's analysis.

Weber introduced many new terms into the location theory vocabulary. Among these terms were ubiquities, localized materials, pure materials, gross (weight-losing) materials, the locational figure (triangle), the weight figure (triangle), agglomerations, deglomerations, and isodapanes. His model allowed for three types of locations: (1) raw materials locations, (2) a production site for final goods, and (3) a consumption center. Weber viewed the location of the production site for final goods as being determined by the relative "weights" or pulls of three points. These points usually included two raw materials locations and one consumption center. Thus, Weber formed a "triangle" to solve what has become to be called the "classical three point problem." Once the production site has been determined, points of equal transportation costs from that point creates what Weber called an "isodapane." One reason for moving from a location triangle determined least-cost-transportation-expenses production point to an isodapane might be due to savings in labor costs at that point. A "critical isodapane"

is reached when the savings in labor costs are just off-set by the increased transportation expenses. Such a move would result in what Weber called "labor orientation." "Agglomeration" was another force in Weber's system to account for deviations from a least-cost-transportation-expenses production point. Weber argued that agglomerations exist anytime the critical isodapanes of two or more locational triangles intersect. Within the zone of intersection of the critical isodapanes, production could be carried out with enough savings to justify each firm moving from least-cost-transportation-expenses points to a new point of "agglomeration orientation."

Weber's economic analysis was "social" in many respects. His work allowed for many interactions and interdependencies not usually found in economics. The balance of his life's work was in the field of sociology.

Christaller

Walter Christaller was a geographer who placed major emphasis on the use of economic theory to solve geographical problems. His use of economics and his methodology were heavily influenced by his training under Alfred Weber. Christaller believed that a scientific investigation should begin with "pure deduction," but evidence was found in his autobiographical essay to indicate that he may have actually developed his model inductively. Christaller used Max Weber's concept of ideal types, and he presented supporting

evidence for this author's claim that Alfred Weber's pure theory was similar to Max Weber's ideal types.

Christaller was also familiar with Thünen's work. He used Thünen's ceteris paribus form of analysis. In retrospect, one should note that ceteris paribus analysis was common to all the models developed by Thünen, Weber, and Christaller. Christaller's market areas were very similar to Thünen's isolated town on a conceptual level, but they were exactly opposite in that Christaller's model had points of supply surrounded by spatially dispersed demand. Thünen anticipated some aspects of Christaller's work when he discussed the distribution of settlements.

The central place model developed by Christaller used three principles of location which he called the market, traffic, and separation principles. The first two are economic. The last is socio-political. He felt that the market principle was the most important. The market principle utilized the concept of "central goods" to fulfill tertiary sector economic functions. Central places were determined based on functions performed, not on population counts. Those places with a large number of central functions (and therefore with a large number of central goods) were called central places of a "high order." The higher the order the larger the "range" of the central place's goods. The area included in this range was called the "complementary region." The ideal shape of a complementary region (market area) would

be a circle. Christaller simply assumed that if the entire area under consideration is to be served then the only logical pattern for these regions is that of a hexagon. This was a major point of difference between Christaller and Lösch. In Lösch's model, one can deduce the hexagonal shape from given premises. Thus, Christaller's basic pattern of market areas was determined by the market principle (price as a function of distance from the market). He used the traffic principle to account for linear deviations found in the basic pattern. The separation principle was introduced in recognition of the fact that economics alone could not account for all of the details of actual locations.

Christaller used the concept of "economic distance" to measure the range of a central good. Economic distance included objective and subjective elements. One of the objective elements was an opportunity cost concept dealing with alternative uses of time. The subjective factor relied on utility estimates made by individuals. These subjects have become very important in urban and regional economics today.

Phillips

Willard Phillips was an American economist who contributed to the economics of international trade, law, inventions, and location. Nearly every part of Phillips' book (1828) included some aspect of distance, situation, or transportation. He integrated transportation costs into his

rent theory to provide a spatial interpretation of rent. This spatially oriented rent theory was the basis for at least one aspect of his location theory. Four different types of location theories were found in this book. To the best knowledge of this author, no one has given credit to Phillips for mentioning these theories. The only reference in the literature which acknowledges the fact that Phillips may have had a location theory was mistaken in its interpretation. First, Phillips developed a theory like that found in the Thünian system. Second, one can find a theory of market area analysis. Third, he contributed an analysis of supply-areas. Fourth, there was a theory of production based on the weight and bulk of the items produced. Although these theories were presented in a descriptive manner, one would have to conclude that this was a significant development for the year 1828.

Launhardt

Wilhelm Launhardt was a German engineer-economist who anticipated two major developments in location theory. Weber-Pick discovered the locational/weight triangles developed earlier by Launhardt. Frank A. Fetter developed the market area analysis found earlier in Launhardt's work. These developments have been common knowledge in the location theory literature for a substantial period of time. His 1882 article and his 1885 book, while still untranslated, have been analyzed in detail. This author discovered a

neglected book of Launhardt's within which he included both the locational/weight triangle analysis and the market area analysis. Evidence was found to indicate that parts of this book were completed in 1872--ten years earlier than until now was believed to be his earliest article on the subjects. More importantly, the book has been translated into English. No reference to this book could be found in the location theory literature or in the history of economic thought literature. In fact, an important bibliography of his works also failed to list it.

Loria

Achille Loria was an Italian economist who based a life time of work on the idea of terra libera--the influence of free (no rent) land. Although Loria was primarily known for the fact that his work influenced Fredrick Jackson Turner's "frontier thesis," he also authored two articles on location theory. These articles were mentioned in only one source in the location theory literature (a 1927 review article), but Krzyzanowski considered them important enough to call Loria the father of the modern theory of industrial location. Upon investigation, this author found that the articles had never been translated from the original Italian into English. A translation has been completed and appears as the appendix to Chapter VII.

The first article by Loria revealed the fact that he was heavily influenced by Thünen. He used almost the

entire article specifying the conditions for which there would be exceptions to the "rational order of crops" as presented in the Thünian system. His major tool for this analysis was the ratio of production costs to transportation costs. He maintained that it was not always true that the crops with the highest absolute transportation costs must be grown near the market. When production costs were also considered, it was only necessary to grow the crops with the lowest ratio near the market. Loria developed the concept of "fictitious" transportation costs to form the denominator of this ratio. Fictitious transportation costs are those costs that would have to be paid if the crop had been actually transported from the most distant land to the market. The "actual" or real transportation costs of locating production near the market may be quite small, but at the same time the fictitious transportation costs could be quite high.

Loria also allowed for the cost of labor in the first article, but in the second article he admitted that his analysis was faulty. At the end of the first article, Loria stated that the law which regulates the rational distribution of crops also applies to the location of manufacturing industries. During these few paragraphs, Loria made a surprising mistake. He contended that the production of goods with the highest transportation expenses should always be produced on the land nearest the market. Such a statement was surprising when one considers all the exceptions

to this pattern which he had outlined with respect to agricultural goods. If the same law applied to both types of activities, why did the special cases noted not also apply?

The key to the answer to the question in the preceding paragraph is that the same law did not apply to both types of activities. In the second article, Loria developed a true industrial location theory to overcome mistakes found in the first article. He added the variable "raw materials" to his model to overcome the mistakes. The resulting analysis is very similar to Weber's theory in that Loria allowed for three types of locations: (1) the raw materials locations, (2) the final goods production location, and (3) the center of consumption. His analysis was like Thünen's in the sense that he retained the use of rent in his model. The resulting analysis is very much like that of Alonso but with rent added. To the best knowledge of this author, Loria is the only writer in the history of location theory to combine the Thünen model with the Weber model in this particular way. Of course, one must remember that Loria's work preceded Weber's. Simply put, Loria's model accounted for the rent accruing to the production site for final goods. Loria's contribution was to give the details of the source of that rent. If the transportation costs of the raw materials is greater than those for the final goods, then a rent area is formed around the raw materials location. If the opposite is true, then the rent area would be generated

around the consumption center. If the costs are equal, then there would be no rent in the system (assuming that revenues are just sufficient to cover costs). With this analysis, Loria was able to correct the mistakes found in the first article. These corrections amounted to the formation of a new "law" or criterion for the location of any type of economic activity--the location of the economic activity should result in the highest savings in transportation expenses.

Loria also anticipated Weber by accounting for weight-losing raw materials in the production process. He concluded that, if weight-losing materials were used, the production site should be located near the raw materials site to save on transportation costs.

The Unknowns

The nine authors surveyed in this section are representative of approaches to the problem of location found in the literature of economics, geography, engineering, and city planning about eighty years ago. All of these accounts were descriptive in nature. Most of the articles were merely a cataloging of important factors in the location of industrial activity. Among the factors listed by these writers were the raw materials location, consumer markets, labor markets, power, climate, perishability of final goods and raw materials, freight rates, legislation, taxes, subsidies, financial markets, geography, and geology. To this author, the most interesting of these articles was that by H. V. Coes.

Coes attempted to assign a numerical weight to each of the locational factors. If the sum of the weights for a new location were larger than those for the old location, then the firm should move to the new location.

The Knowns

Sir William Petty, Adam Smith, Alfred Marshall, and John Hobson did not give major emphasis to the problem of location in their writings, but they did not ignore the subject. All four realized that space could make a difference in basic economic reasoning. Locational rent can be found in Petty, Smith, and Marshall. Market area analysis can be found in Marshall and Hobson. Transportation costs were important to all four writers.

Marshall's analysis was of particular importance, since he developed an analysis of market areas similar to Frank Fetter's (and independent of Launhardt's). In Marshall's work one can find perhaps the best explanation of why most writers in the English-classical tradition tended to ignore the influence of location. Marshall relied on a relativistic argument. He felt that England was so small that goods could be delivered almost anywhere in that country without much notice by the general public or by economists. Economists in larger countries were more likely to give explicit treatment to transportation cost because they would be more important there. Another passage in his text might account for the fact that neo-classical economists

have also tended to ignore space in their analyses. Marshall felt that when one studied the equilibrium system adjustment mechanisms, the element of "time" was more important than the element of "space." Unfortunately for the development of location theory and spatial economics, Marshall may have been correct in his relativistic argument, and he may have unduely influenced later writings with the priority of placing "time" ahead of "space."

Influence of the Early Writers

Thünen, Weber, and Christaller presented models of location which have become known as classics in location theory. Each can be shown to have influenced a considerable body of literature. Thünen's agricultural land use theory has been adapted to apply to the location of different types of economic activities in urban areas. Weber's model inspired Hoover to develop a similar model with increased emphasis placed on transfer costs and agglomerations. Lösch's model was found to be a generalization of Christaller's work. One might conclude that such arterial branch development might lead to three separate disciplines, but there is ample evidence in the literature to indicate that there is a synthesis developing in the field. The biggest problem with the syntheses is that it is necessarily very general in nature. So, one is faced with a trade-off between detailed development of the specific area (which is unrealistic in the sense of the narrowness of individual views) and the development

of synthesis-models which may be more realistic but too general for testing.

Model Classifications and Model Dimensions

Throughout this paper an attempt was made to classify each of the major models. Table X-1 is designed to show a general two-part classification for each of the models in terms of concentrated/dispersed supply and demand. There were three basic patterns found: (1) concentrated demand with dispersed supply, (2) concentrated demand with concentrated supply, and (3) dispersed demand with concentrated supply. Of the models studied, pattern #1 fit five models, pattern #2 fit four models, and pattern #3 also fit four models. Pattern #1 could be called a "Thünian type" pattern. Such a pattern was found in models by Thünen, Loria, Muth, and two in Phillips. Pattern #2 could be labeled a "Weberian type" pattern. Such a pattern was found in models by Weber, Launhardt, Loria, and Hoover. Pattern #3 might be called a "market-area type" pattern. This pattern was found in the analyses of Christaller, Launhardt, Phillips, and Lösch.

In a majority of the models studied, this author also attempted to give various model dimensions as developed by Britton Harris. Of the dimensions used, all of the models were assigned the same label in three categories. All of the models were found to be partial, deterministic, and simultaneous. Only two of the models, Christaller's and

TABLE X-1

CLASSIFICATIONS OF MODELS

	Concentrated Demand	Dispersed Demand	Concentrated Supply	Dispersed Supply
Thünen	X			X
Weber	X		X	
Christaller		X	X	
Launhardt[1]	X		X	
Launhardt[2]		X	X	
Phillips[3]	X			X
Phillips[4]		X	X	
Phillips[5]	X			X
Loria[6]	X			X
Loria[7]	X		X	
Muth	X			X
Hoover	X		X	
Lösch		X	X	

[1]Locational triangle model.
[2]Market area model.
[3]Thünian type model.
[4]Market area model.
[5]Supply area model.
[6]Thunian critique.
[7]Weberian type model.

Phillips', attempted a dynamic analysis; but, both of these models were basically descriptive in nature (the only two models with such a dimension label). Of the six models for which the dimensions were applied, three were considered to be microeconomic and three macroeconomics. The models by Weber, Launhardt, and Loria were labelled as microeconomic. The models by Thünen, Christaller, and Phillips received the macroeconomic label.

Multiple Discoveries

Robert Merton has presented a theory of multiple discoveries. Merton contended that all scientific discoveries are in principle multiples, including those that on the surface appear to be singletons. In this theory calendrical time is ignored so that long gaps of time may be allowed. The important criterion is that the discoveries should be completely independent of each other. The best natural barrier to plagiarism is a language difference.

Willard Phillips' writing on the economics of location theory can be considered a multiple discovery with Thünen. In this case, both authors were writing at almost the same time (Phillips in 1828 and Thünen in 1826) in different countries and in different languages. Phillips developed a Thünian type land use theory based on location or "situation" rent. The Phillips model allows for an isolated town surrounded by rings of agricultural activity just as in Thünen's model. There was no evidence found to

indicate that Phillips had read Thünen. In fact, Phillips' analysis extended beyond that of Thünen in the sense that Phillips developed more types of location models than Thünen. Thünen's model was quite analytic; Phillips' was almost entirely descriptive, but the substance of the two models was the same.

A very strong case for multiple discoveries can be made with reference to Wilhelm Launhardt. Launhardt had two major discoveries repeated in later years by other location theorists and economists. Alfred Weber and Georg Pick developed the same type of locational/weight triangles which can be found earlier in Launhardt's work. Frank A. Fetter and Alfred Marshall had market area analyses which can also be found in Launhardt. For Alfred Weber and Georg Pick there was no language problem, but no evidence was found to indicate that they had used Launhardt. Until this author's discovery of Launhardt's neglected book, there was no recognized (known and published) English translation of Launhardt's location theory. So, there was a language problem in Fetter's lack of knowledge of Launhardt. Marshall was able to read German, but he failed to mention Launhardt in any of his books. In both cases the original discoveries were several years before the rediscoveries. Launhardt wrote his works in 1872, 1882, and 1885. Marshall was published in 1890. Weber's book became available in 1909, and Fetter's article appeared in 1924. In addition to language, there are several other

factors which might help to explain Launhardt's obscurity. He was an engineer by profession. He used abstract mathematical and geometrical analyses to deal with problems generally ignored by the economists of his day. Finally, he published most of his works in engineering journals not economics journals.

The work of Achille Loria may also be considered a multiple discovery with Weber. Loria's analysis contained two features of Weber's system. He allowed for weight-losing raw materials in the production process. Such materials could account for location of production near the raw materials location to save transportation expenses. More importantly, Loria used three types of locations in his model which are also found in Weber's: (1) the raw materials location, (2) the final goods production location, and (3) the consumption center location. These locations helped form the locational triangle in the works of Weber and Launhardt. In Loria's work a locational triangle was not mentioned but the interactions among these locations were discussed in a manner similar to Weber-Launhardt. Of course, one should recall that Loria followed Launhardt and preceded Weber. In addition, the particular way in which Loria analyzed the transportation costs of raw materials and final goods was very similar to a model developed by Alonso.

Multiple uses of transportation costs, location rents, agglomerations, and weight-losing materials were too

numerous to recount here. Chapter VIII, "The Unknowns and the Knowns," recaps these discoveries. Multiple discoveries can be found in all aspects of the development of location theory. It appears that Merton's theory holds true for this field of study.

Final Conclusions

Location theory has a rich and well developed history. All of the major contributions in the field stem from the original works of Thünen. References to Thünen were found in all of the works surveyed here with the exception of Phillips. Thünen influenced Weber; Weber and Thünen influenced Christaller. Thünen and Weber were considered to be "different," because they added "space" to economics. Christaller completed the circle by emphasizing economics in spatially oriented geography.

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