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"GEOGRAPHY AND THE PROPERTIES OF SURFACES" SERIES

Paper Number Twelve

"LOCATION AND REGIONS: AGRICULTURAL LAND USE IN AN INTEGRATED ECONOMY"

by Eduardo E. Lozano
Graduate Student
Graduate School of Arts and Sciences
Harvard University
Cambridge, Massachusetts

HARVARD PAPERS IN THEORETICAL GEOGRAPHY

Laboratory for Computer Graphics

Department of City and Regional Planning
Graduate School of Design
Harvard University, Cambridge, Mass.

7 February 1968

Twelfth Technical Report -- Office of Naval Research
Contract No. 00014-67A-0298-0004

Task Order NR 389-147
Principal Investigator: W. Warntz

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PREFACE

In paper number 10 the geographical variation in the value of land used for agriculture in the United States was a matter of concern. Its relationship to sets of distances from points within the United States was treated in a light-hearted, preliminary, though perhaps, not uninteresting, kind of way. Suggestions were made concerning the patterns revealed and their "explanations" in terms of macrogeographic concepts relating the roles of space and time as dimensions of an economic system.

Thorough investigation of these matters has been undertaken by Mr. Eduardo Lozano and his results are offered in the following paper. Mr. Lozano presents us with a stimulating variety of inter-relationships observable within a simple space-time framework. He has moved freely and naturally between theory and observation. Among his special contributions of interest to geographers are his crop typology and his regional typology, based not on arbitrary descriptive classifications, but demonstrated functional relationships, and,of course, his exciting mappings.

It is true that Mr. Lozano has assumed constant production costs in his attempts to determine the rationale of regional locations for various agricultural land uses in an integrated economy and that he has ignored external economies and diseconomies and their impacts on spatial concentration and dispersion and the localization of activity. Moreover, many of the remaining residuals from regression still evidence strong systematic influences (perhaps relatable to the above). But, these are items to be investigated subsequently and doubtless with profit, adding to rather than destroying Lozano's findings.

It is indeed a pleasure to make available this scholarly work.

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Andover, Massachusetts
7 February 1968

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CHAPTER I

THE INTEGRATED ECONOMIC SPACE: LOCATIONAL VARIABLES

1. Introduction

The spatial distribution of the human population can be well expressed as the location of the activities of this population. Among these, economic activities play a most important role as determinants of and determined by population distribution. It is not surprising that the location of economic activities is a prime factor in many of the most relevant theories: the Agricultural Land Rent Theory of von Thunen, the Economic Regions Theory of Losch, the Industrial Location Theory of Weber, and the Theory of the Urban Land Rent of Alonso (the last only in reference to the Location of the Urban Firm). Useful as these theories may be, their explanatory power cannot extend beyond the constraints of the set of assumptions under which each hypothesis is postulated. In other words, a theory is as useful as its basic assumptions are acceptable. Some of these, especially the "regional" theories assume an environment that is increasingly unreal in the second half of the twentieth century.[1]

The intention of the present study is to revise the theories explaining locational distribution of economic activities, by adjusting

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[1]A more detailed historical revision of the theories of location is not necessary here, as William Alonso has written a very good summary of them--starting with Ricardo--in his Location and Land Use, (Cambridge: Harvard University Press), 1964.

their assumptions to the characteristics of the contemporary environment, with the purpose of selecting the most important variables rather than augmenting their number. The present research is concerned only with agricultural production and land use and the effects that emerging locational distributions of the agricultural system may have on the regional structure of the country.

The research is organized to present in each chapter first a theoretical elaboration and then the corroborative empirical studies. For case study, the U.S.A. is the almost logical selection, first because it presents the characteristics of the economic space in the second half of the century, as it is defined in the next section; and secondly, because of the availability of data to the author.

The remainder of the first chapter is devoted to studying this emerging economic space and its regional variables which constitute the new set of hypothetical assumptions. The second chapter analyzes the existing distribution of agricultural production and land use. The third chapter develops a theory of agricultural location, interpreted as extension of the "classical theory" of von Thunen. The fourth chapter analyzes the distribution of specialized agricultural production and the resulting land use. The fifth chapter explores a theory of regional specialization considered as a result of the economic space characteristics and the location process; and this is interpreted as partly connected with the Theories of Regional Economic Growth and of Economic Base.

2. The Integrated Economic Space

The "space" where locational processes take place is the first important element to be defined. Location takes place on a part of the geographical plane, but it is strongly conditioned by other sets of "universes," especially the economic system, in terms of employment, income level, consumers' prices, etc. in a macro (regional) level. Few people can choose a place to live by the criteria only of a mild climate and a pleasant natural environment, and even of those few, almost all settle where there is an economic layer, including urban and social services. Thus it is necessary to integrate the existing economic system with the mathematical description of the national (regional) plane and the physical characteristics--resources and climate--to obtain a valid description of the "locus of possible locations." This is called the "economic space."[2]

The fundamental variables of the economic space are distance and time, as has been pointed out by William Warntz.[3] It must be clarified that the relevant distance is the "economic distance," that is the cost of friction over space, rather than the geometric distance in miles.

The profound effects on the concept of economic space exerted by the technological, political and social developments of this century may

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[2]The first elaboration of this concept was from Francois Perroux; see his "Economic Space: Theory and Applications," Regional Development and Planning, Friedman and Alonso, (eds.), (Cambridge: M.I.T. Press), 1964

[3]William Warntz, Toward a Geography of Price, (Philadelphia: University of Pennsylvania Press), 1959.

be illustrated by comparison with Von Thunen's important work "Der Isolierte Staat"[4] in which he postulated his Theory of Agricultural Land Rent. Von Thunen assumed an isolated region centered around a single urban place that would be a punctual market. No meaningful economic relation subsisted between the isolated region and surrounding areas, comprising a real case of self-sufficiency. At the same time, the size of the region was not more than the market area of a medium size town--40 miles radius--, far removed from the size of a continental area such as the U.S.A.--or the European Community or the U.S.S.R.--where the developed internal demand and supply structures comprises a rather self-sustained economy. It is against the background of the hypothetical model of Von Thunen--valid for his time--that the contemporary economic space must be studied.

The differentiated elements in the contemporary economic space can be summarized in the so-called "economic development," a commonplace to define the process of the last decades in many countries. It may indeed be useful to analyze the process of development in a hypothetical region, in order to focus on its essential characteristics. There are actually two possibilities for the development of any given area: one is what we may call "polystathmic" development--whose model is the Theory of Regional Growth--and the other is the "monostathmic" development--or more clearly

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[4]There is an English translation: Von Thunen's Isolated State, Peter Hall (ed.), (London: Pergamon Press), 1966.

a case of colonialism.[5] The model of monostathmic development could occur within the political boundaries of a large country, and in this case there is collusion with the last stages of polystathmic development, as it is shown below.

The process of polystathmic development may be summarized as follows: assumed a given national entity, with population and resources distributed over the geometric plane. At the beginning, there is a relatively large number of small "regions" of a self-sufficient type. The population is distributed according to the physical characteristics of the area--climate and resources--and is based on an agricultural production oriented to the local market, that is to the autonomous region's demand. Clearly, the transportation system is primitive and costly, as this is the primary "raison d'être" of an isolated economic system. (This stage is formally expressed in the study of the land allocation model, in Chapter III, section 3, when the aggregate demand is assumed evenly distributed and the only real variable is the climatic condition.)

A second stage is reached by improvement of the transportation system, in terms of both cost and technology. Actually, as H.E. Moore has said, "freight rates are to regions and cities what tariffs are to nations," and it is very clear that the immediate effects of a reduction of tariffs are an increase of trade and an incipient locational specialization. Thus

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[5]The names of the two types of regional developments are based on the Greek word "stathmos," that is stages in a journey; plus "poly" and "mono," i.e., multiple and single, to convey the concept of a multistage or single stage process.

betterment of the transportation system brings a corresponding increase in trade and specialization, plus the opportunity for the creation of the first "nodes of concentration." Agriculture production would then begin to show some differentiation, at least in gross terms of cereals, vegetables, etc. The reduction of transfer costs would tend to favor concentration and to enlarge the size of each market area.[6]

The effects of the improvement in the transportation system have been discussed in several studies.[7]

The next stages in the polystathmic regional development start dealing with industrial development, while maintaining the same reliance on the

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[6]This hypothesis being easily corroborated if variable freight costs are introduced to Losch's Theory of Economic Regions; as the market areas would increase with a corresponding decrease of transfer costs, and at the same time there would be a smaller number of relatively larger centers of concentration.

[7]Estall and Buchanan, in their Industrial Activity and Economic Geography, (London: Hutchinson University Library), 1961, state that "little advantage can be made toward functional and areal specialization on a commercial scale until an efficient transportation system is developed." Walter Isard noted that the reduction of transfer costs leads from a scattered ubiquitous pattern of production to an increasingly concentrated one, and to the progressive differentiation and selection between sites according to resources and trade routes. (In the proposed model of land allocation, in Chapter III, "trade routes" would be formally expressed as "accessibility" to the national market, through the use of the aggregate demand model; and Isard's resources, as far as agriculture is concerned would be expressed as "climatic" conditions, through the use of the climate model; assuming that soil fertility might not be really an immobile resource, but subject to improvements after trade-offs with capital investment.) Bela Balassa, in the Theory of Economic Integrations, (Homewood, Ill.: Irwin), 1961, again emphasized that the shorter the economic distance, the greater the potential of economic intercourse, and clearly the only way of reducing economic distance is through cost-reducing improvements of the transportation systems.

effects of the reduction of transfer costs and the trend toward concentration of certain types of industry.[8]

As was mentioned, the monostathmic type of development could occur within a given political boundary or it could involve national entities separated by political divisions; the first case is the traditional "expansion" of a country, such as the U.S.A. expansion to the West, or the U.S.S.R. expansion to the asiatic lands: while the second is simply the case of international colonial exploitation. The reason for this distinction is that the mobility of the factors of production between the old regions and the "frontier" lands could lead to an equalization of incomes, through an equalization of the prices of the factors of production although there is a wide controversy about the feasible levels and even about possible perverse shifts of capital. To summarize the present state of the debate, it appears that in developing countries there is an increasing gap between the income levels of the rich and the poor regions, while in fully developed ones, there is a trend to close this gap.[9] Of course, the advantage of an absence of political boundaries is not only the price equalization of the factors of production, but furthermore, that migration from

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[8]The territorial division of labor is one mainspring of national growth, as Perloff, et al, in Regions, Resources and Economic Growth (Baltimore: R.F.F.), 1960, have recognized; or as Sargant Florence put it in Economics and Sociology of Industry, (London: Watts), 1964, one trend of economic development is the localization of particular economic activities as between countries or regions within countries.

[9]The equalization trend in the U.S.A. has been noticed by some authors, such as William Warntz in Macrogeography and Income Fronts, (Philadelphia: Regional Science Research Institute), 1965, Perloff, et al, in Op.cit. and Williamson in "Regional Inequalities and Process of National Development," Economic Development and Cultural Change (Chicago) Vol.III

from poor to rich areas tends to level per capita income. Often in underdeveloped countries, the first stage of the polystathmic model--that is autonomous units evenly distributed with an economy of subsistence--exists side by side with a foreign-oriented sector--corresponding to the colonial model--or with more advanced stages of national development, in a kind of "dual" economy, as Friedmann calls it.[10]

The important concern here is to establish the relationship between the two models of regional development, the polystathmic and the monostathmic, this problem being the heart of the polemical articles of Douglass North and Charles Tiebout in the reader Regional Development and Planning.[11] The only case that cannot be related is the model of international colonial exploitation; instead the monostathmic model of national expansion is actually only avoiding the first stages of the slower model of polystathmic development. The colonization of "frontier" lands within a country occurs at a period when reasonably efficient transportation systems are available and when the production of the new land is oriented to the existing national market of the older regions, thus establishing from the beginning the characteristics of a third stage in the polystathmic model. This

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No. 4(ii), July 1965. The phenomenon of the widening of the income level gap in the developing countries has been observed by Chennery in "Development Policies for Southern Italy", Regional Development and Planning, Hirschman in Journeys Toward Progress (New York: Anchor Books), 1965, and Williamson in Op.cit.; a fact which led Perroux to state that economic integration may result in increasing regional disparities.

[10]See his "Regional Planning: A Problem in Spatial Integration," Papers and Proceedings of the Regional Science Association, Vol.V, 1959.

[11]Op.cit.

process would eliminate a substratum of autonomous areas and begin development directly with a region based on trade and locational specialization, tightly integrated to the national market (and to national producers of industrial output). This concept of the mergin of the two national models of development offers area of contact between the Theory of Regional Growth and the Theory of Economic Base--the last strongly relying on the export surplus of the region as explanation for development. It is safe to assume that underdeveloped countries will rarely pass through the complete set of stages of the polystathmic model in developing their backward regions, but they would try to avoid earlier steps, resembling the monostathmic model of national expansion.

As a result of the analysis of the process of regional development it is possible to clarify the characteristics of the emerging economic space. A new characteristic of integration (as opposed to local isolation) is changing the concept of the demand market--and eventually of the supply structure also-- by shaping an aggregate national market (as opposed to an isolated local market), distributed over the national space.

A new characteristic of size (as opposed to small areas) introduces the variable of diversity in the **physical** characteristics of the set of regions, that for the agricultural study is essentially a climatic variable (in contrast with the previous homogeneous environment).

These two characteristics of the economic space will be formally incorporated as assumptions in the model of the proposed theory.

The result of a large and integrated economic space is postulated to be the emergence of specialized regions, producing a common crop (or a non-agricultural product also) oriented to the national market. This postulate will be developed theoretically and tested empirically in the last chapter. It is necessary now to discuss briefly each of the new concepts and, of course, to find suitable models for the variables of national demand and climate in order to develop a theory of land allocation in an integrated economic space.

Integration

The process of integration, in a supranational context, is the abolition or reduction of discrimination between economic units belonging to different national states.[12] If the variable of discriminatory tariffs is replaced by the variable of transfer costs, then integration is the progressive reduction of inhibitory transfer costs--and technological improvements of transportation--among autonomous units belonging to the same national state, resulting in a corresponding increase of trade between those units--that is the elimination of self-sufficiency. For any productive activity, minimization of distance-cost inputs would, in general, maximize accessibility to the market, bringing at last the national market to a level of possibility for the producers.

On the international scale, the formal steps of integration resemble the national stages: first a Free-Trade area--abolishing mutual tariffs--parallel to the reduction of transfer costs, then a Customs Union, equalizing all tariffs; after that a Common Market, with no restrictions on the factors' movements--resembling the free movement of factors

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[12]Bela Balassa, Op.cit.

of production within a country; then Economic Union, with harmonization of the nationals' economic policies--that is the equivalent of an effective national administration; and finally, Complete Economic Integration, with unification of monetary, fiscal, social, countercyclical policies--becoming really a new federal entity composed by the former national states.[13]

<u>Size</u>

The process of economic development may regionalize on a continental or subcontinental scale.[14] The constant reduction of transfer costs tends to increase the market area for each production; while the process of economic integration tends to break the isolation of contiguous regions and to form a new total economic space. It is logical that the result of such factors is the increase in size of one economic space--the increase of integrated demand markets and the increase of size in area, being two differentiated components. A number of authors, Tinbergen, Viner, Meade, have found that the larger the size of the integrated economy, the greater the positive production effects will be, through the increasing potential possibilities of the internal division of labor--both sectorial and regional. At the same time, it is interesting to notice how the increase in size diminishes the relative importance of Exports for the total integrated economy, though obviously it would increase the importance of the internal export of surplus among the specialized regions. This trend toward conti-

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[13]The stages in international integration are taken from Bela Balassa, <u>Op.cit</u>.

[14]Brian Berry, in <u>Atlas of Economic Development</u>, Norton Ginsburgh (ed.) (Chicago: University of Chicago Press), 1961.

nental or subcontinental integrated economies is very clear in the contemporary world, where the "autonomous centers of decision" are no longer powers on the conventional scale, but subcontinents: the U.S.A., the U.S.S.R., the European Community, China, India, and eventually Latin America, the South-of-the-Sahara Africa and Indonesia.[15]

Specialization

The division and subdivision of labor is cause and result of the process of economic development. Eric Lampard discussed some time ago such problems,[16] when he stated that regional specialization is the link between the technological and the spatial conditions of economic development; that it is related to the extension of the market--and in turn creates wider markets; that it raises the production potentiality of the integrated community; that it generates an efficient pattern of land use and that it results in greater savings of time, effort and resources. From these comments, it would appear that specialization contributes to the growth of demand and that it reduces the input coefficients on the production side. Actually, specialization appears to be not only convenient, but necessary as well, for an advanced society.

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[15]This phenomenon in which old nationalities are submerged in subcontinental entities has been noticed by Giersch, in his comment that economic integration weakens the tendency to (small) national agglomeration and intensifies (supranational) regional agglomeration; in his "Economic Union between Nations and the Location of Industry", Review of Economic Studies, No.2 (49-50).

[16]See his "History of Cities in the Economically Advanced Areas," Economic Development and Cultural Change, (Chicago: University of Chicago Press), 1955:3.

A parallel phenomenon to regional specialization is obviously regional interdependence, expressed in increasing trade of the surplus from each specialized region to the others.[17]

A special comment is necessary regarding the meaning of "efficiency" in land use, understood by Lampard as a minimization of distance and total land values (i.e., rent). Instead, it is postulated that efficiency would result in a maximization of rents, as an expression of the land being put at its best and highest-paid use.[18]

Finally, it is necessary to answer the objection that the process of economic development will eventually mean the elimination of "regionalism," understanding by this word an economic space structured by discrete units called regions. While the process of economic development tends to eliminate "localism," that is regions at a small self-sufficient level, it tends to generate regions at a larger scale, with clear specialization and close interrelationship among them.

3. Regional Locational Variables for Agricultural Land Use

Under the assumption of producers locating in an integrated economic space, it is important to clarify which variables of the region are relevant

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[17]This has been recognized also by Perloff, et al, Op.cit.; and by Lampard in the article mentioned above where he interpreted interdependence as a centripetal force that tightens the integration process.

[18]See Chapter V-2 and 2b- for a theoretical and empirical proof of this postulate.

for the agricultural producer in contrast with the business firm. To begin with, the difference supporting the primary classification of agricultural producer and non-agricultural firm is that for the former the land has two functions: location plus input in the production process; while for the latter, land performs essentially one function: location. Furthermore, in the non-agricultural firm the quantity of land is subject to trade-off with location, resulting in a balance between total rent and total transfer costs at the site where profits are maximized. On the other hand, the agricultural producer is assumed to be indifferent within the area of positive rent--according to the classical rent theory--and his output is a function of the quantity of land and intensity of production.[19]

Within the basic classification of agricultural producer and non-agricultural firm, it is necessary to select the regional locational variables, in order to study their relevance in each of both cases. In the previous section (I.2), the analysis of the economic space leads to the recognition of two key characteristics, that are integration and size.

The process of integration affects mainly two regional variables: the effective demand and the effective supply structure. The phenomenon of increase size makes possible the appearance of two other regional variables: climate and natural resources.

Assuming then a subcontinental integrated space, we find that the national demand and supply structures and the climate and natural resources are the relevant regional variables.

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[19]Empirical studies by Stewart and Warntz indicate that quantity of land vary inversely and intensity of production vary directly with nearness to the demand market.

The criteria used in selecting variables is aimed at building relatively simple models in terms of number of variables, because the nature of the variables in the integrated space could result in complex dimensions in themselves; and also if the model reaches a reasonable explanatory power with a few selected variables of pervasive influence, it could claim a degree of universality applicable to situations other than the case study for a certain time period.

The analysis of the relevance of the four selected regional variables in the two basic cases, is developed in the following table:

TABLE T.1 (I)

REGIONAL LOCATIONAL VARIABLES FOR AGRICULTURE
AND THE BUSINESS FIRM

Variable	Agriculture	Business Firm
Economic : Demand	Relevant, as one determinant of the area of positive rent (i.e. locus of possibilities	Relevant, as one determinant of the price level and the volume of potential output.
Supply	Not relevant, except for the case of "monopolistic" location. (see Chapter III.2 and 2b.)	Relevant, as one determinant of the price level and indication of the level of competition.
physical : Climate	Relevant, influencing the type and yields of crops.	Not relevant.
Natural Resources	Not relevant.	Relevant, specially for extra active activities but declining in importance for others.

It must be noticed that the relevance of each variable is judged on a broad base of criteria, and on the analysis of the land allocation process for agricultural land use, other secondary influences will be commented on.

The regional variables in the allocation of land relevant to the agricultural production are: the effective demand market (economic) and the climate (physical). The supply structure, that is the location of other producers has some secondary effects, that will be discussed fully in Chapter III.2 and 2b; all other factors, such as fertility, labor wages, etc., are assumed to be constant in this model. It must be noticed that one effect of the integrated space is the tendency to equalize wages --as discussed in section 2--, and that fertility is increasingly subject to trade-offs with capital investment. In summary, national demand and climatic conditions are considered the relevant regional variables for the agricultural location theory. It is necessary now to build the models of each of the two variables.

A final comment is to stress that those variables studied in the present section are "regional," and thus are not intended to include "crop" variables such as price at the market and transfer rates; because this Chapter I is directly oriented toward the new hypothetical environment.

4. The Aggregate Demand

The national market is assumed to be distributed over the country, constituting a spatial variable, as its value can and does change from one unit area to another. A first model describing this distribution could be a density model, explaining the value of the demand market at any given unit area of the country. This is a model that, though valid for some purposes, has little relevance to explain the total effects of the variable national demand on the individual producer, because the data provided are the levels of demand within the unit areas. Obviously, the producer is not interested only in his immediate surroundings, but in the maximum market that it is possible for him to reach. In other words, it is important to interrelate the value of each of the unit markets with the economic distance to the location of the producer.

The model of demand then must explain the aggregate demand of the country, that is the effect of the total demand structure, and it is clear that it should formalize the relations of the different unit markets in the space, as the distance factor directly affects the value of the effective market. The same concept can be explained as follows: the model of the aggregate demand must describe the relative accessibility of each producer to the national market. This model showing accessibility to the market is equivalent to the simple distance variable in the classical rent theory.

Potential Model

The suitable model to describe the effects of the density distribution and of accessibility to it is the Potential model, that has the dimensions of a "field quantity." It must be stressed that it provides the total and interrelated effects of the "universe" system on all and each point of a plane.

The potential model has been studied and used for some time, being originated in the parallel that J.Q. Stewart made of physical science models into social science phenomena, and in the subsequent development by William Warntz.[20] Essentially, the potential value at a given point is the integral of the density of each of the differential areas times the area of the differential over the distance from each differential area to the point that has to be evaluated. The multiplication of the density times the area of the "unit" is the "mass" of the "unit," and the ratio of this mass over the distance from this unit to the point under consideration introduces the effect of distance. Of course, the integration is intended to bring together the effects of all the areal units in the plane.

Formally:

$$ {}_iV = \int \frac{D \cdot dA}{{}_ir} $$

where: ${}_iV$ = potential value at point $\underline{i}$

D = density at each and every differential area

dA = differential area

${}_ir$ = distance from $\underline{i}$ to each and all differential areas.

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[20] See specially: J.Q. Stewart and W. Warntz, "Physics of Population Distribution," Journal of Regional Science, I:I, Summer 1958; W. Warntz, "The Topology of a Socio-Economic Terrain and Spatial Flows," Regional Science Association Papers, Nov. 1965; and also Walter Isard, Methods of Regional Analysis, (Cambridge: M.I.T. Press), 1960, Chapter 11.

This potential model fulfills the criteria for description of the aggregate demand market when the density is the demand market variable. The only problem is the impracticality of manipulating the form of the model shown above. Simplicity could be achieved, at the expense of mathematical correctness, by replacing the differential area dA by finite and relatively small areas, that could easily lead to the summation of the masses. The change in the formal model is then as follows:

$$_{i}V = \sum_{j=1}^{n} \frac{D \cdot A}{_{i}r_{j}}$$

where: $_{i}V$ = potential value at area i

D = density at each and every finite area j, from 1 to n

A = area of each and every finite area j, from 1 to n

$_{i}r_{j}$ = distance from area i to each and every area j, from 1 to n

Though there might be some slight difference from the strict mathematical model, this additive model is more than accurate for the purposes of the social sciences, and its simplicity makes it accessible to many purposes.

The next step is to pass from the potential value at one area to the estimation of the potentials at all the areas in which the country has been divided. Then, it is possible to map those values and to link with contour lines all points of equal potential value resulting in a family of isopotential curves. The mapping obtained is a three dimensional terrain: the potential surface.

In terms of dimensions, mass is expressed in the units of the "universe" selected--population, dollars, etc.--as it is the result of multiplying density (universe over area) times area. The ratio is then universe units over distance units, so that summatory or potential value is given for example in people per mile, or dollars per mile. Clearly, the selection of the "universe" units is an important step.

Two basic alternatives of units exist to describe the demand market, one is simply population; the other is population times income per capita, that is regional income. It is clear that the effective market in a country is better described if the income per capita levels are included.[21] Though food consumption tends to be less elastic than that of other products, still food consumption varies positively with effective demand; and besides, agriculture is not only food oriented but also produces industrial fibers, tobacco, and similar crops.

Density is expressed then, in population density times income per capita, that is persons per square miles times dollars per person, resulting in dollars per square mile, an income density index. Mass is given in dollars per square mile times square miles, that is dollars. Potential, as the sum of the ratios of mass over distance, is given in dollars per mile.

Formally:

$$\text{Density} = \frac{\text{People}}{\text{Sq.Mile}} \cdot \frac{\$}{\text{People}} = \frac{\$}{\text{Sq.Mile}}$$

$$\text{Mass} = \frac{\$}{\text{Sq.Mile}} \cdot \text{Sq.Mile} = \$$$

[21]For example, the largest country in terms of population in South America, that is Brazil, is comparable only with the smallest European countries, such as Belgium or Netherland, from the point of view of effective market capacity.

$$\text{Potential} = \frac{\$}{\text{mile}}$$

Some comments now on shortcomings or problems of the units selected. As is usual with this type of model, its empirical adjustment to the real world observations seems to have forced some authors to qualify the density or mass or distance with factors or exponentials. One of the proposed improvements is the selection of a factor called by Isard of "agglomerative economies,"[22] that would affect the mass exponentially, as a function of the mass itself; implying then that changes in the mass affect the potentials more than proportionally. The reasons for this are various; among them that there are minimum demand thresholds for specific sectors such that below this critical market level there is no production of the given sector at all. This argument is hardly of relevance to agricultural production, especially in the U.S.A..

The distance factor is more problematic, for two reasons. In the first place, it was mentioned before that the interest lies in economic distance and not in air-mile distance. Though this is still valid in the case study of the U.S.A., the transportation system appears to be equally reaching most of the national population, at a level enough to eliminate the burdensome complication of affecting each distance by its relative average transfer costs. The second argument is based on the empirical adjustment of the effect of distance of interaction: and as the consensus is that increases of distance tend to decrease the level of interaction

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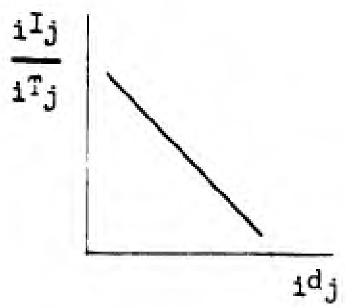
[22]See his Op.cit., Chapter 11.

more than proportionally, there has been a set of exponents for distance proposed in different studies, from 0.7 through 1 (the one used in our potential model) to 1.3, 1.6, 1.7, 1.8, 2.0, 2.6, 3.0 ; a series that includes the conclusions of Stewart, Isard, and others. Among the relevant studies are the set of analyses regarding the difficulty faced in overcoming the friction of distance by Walter Isard.[23] There, a comparative analysis of the Class I Railroad shipments, by 25 mile zones, covering from 70 to 1,400 miles shows that there is a decline of shipment with distance, and that this decline varies significantly with the product shipped --agricultural products appeared to be among the more constant ones. Those results have been formalized so to obtain an exponential to affect distance.[24] If on a cartesian diagram, the y-axis is assigned the ratio of the observed interaction between two places (trips, for example) to the estimated interaction based only on the pure relationship of the two populations--without consideration of distance--and the x-axis is assigned the distances between pairs of centers, the result is a decreasing function.



in log paper

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[23]See his "Locational Theory and International and Interregional Trade Theory," Quarterly Journal of Economics, February 1954.

[24]See his Methods of Regional Analysis, Chapter 11.

where: $_id_j$ = distance between i and j

$_iI_j$ = observed interaction between i and j

$_iT_j$ = hypothetical interaction between i and j

$= k \frac{Pi \cdot Pj}{P}$, where

P = population

k = average trips per person

The equation in log paper of the least squares regression line of all the observation points is:

$$\log \frac{iIj}{iTj} = a - b \log {}_id_j$$

where b is the slope of the correlation line and also the exponent of the distance variable in the potential model. If the line is at 45º, then the exponent b = 1.

In summary, since no theoretical consideration exists to justify the selection of an exponent, but only empirical adjustments to particular situations, it is preferable to choose the distance at the first power. Interestingly enough, the possibility of changing the exponential of distance does not basically affect the potential surface, but it results in models with more or fewer "details." The squared distance would tend to show more of the local market influence of cities over the national surface, that is more local "peaks," than simple distance. This is due, of course, to the fact that since distance is a stronger factor when raised to the second power, there is a quicker reduction of the national potential and opportunity for local influence to appear. Furthermore, if the squared distance is used, potentials are given in $/Sq.mile, that is in the same units of density. The simple distance model would result in less steeper and more unified surfaces, with fewer local peaks, being in general more adapted to the purposes of analysing an integrated economy, where the trend toward reductions of the transfer costs would mean a reduction of higher exponentials affecting distance. In this case it is the "gradient" of the surface that is given in $/Sq.mile, comparative to the density units, and this proves to be important, because the condition for emergence of a local peak is that the local density value be higher than the gradient value of the potential surface at this location.

A final comment regarding the potential model is the inclusion of the influence of its own region for every location under study. If the differential version of the model presents no problem, the summatory version does, because the distance from the area to itself is zero and the value of the potential results infinite. The method used to solve this contingency[25] is approximate and consists in the assimilation of the area to be included, to a circle or to an ellipse, because it is possible to estimate the potential for those two geometrical figures. The potential value for a circle at the center is $V = \frac{2P}{r}$, where V = potential; P = population; and r = radius. In the case of the ellipse, the potential at the center is $V = \frac{2P}{rf}$, where r = radius of the circle of equivalent area, and f = ratio between major and minor axis.

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[25] P.Q. Stewart and W. Warntz, Op.cit.

The Potential Surface

Assuming that all the finite areas in which the country was divided have their potentials estimated, it is possible now to represent the potential surface, using the method of contour lines linking points of equal value, resulting in the model of the potential "field quantity." The selection of the contour interval is important because the smaller it is, the more local details will appear, as the emergence of the outermost closed contour of local peaks depends partly on its being some integer multiple of the interval. The use of a constant vertical contour interval means that the gradient varies inversely with the horizontal spacing of contours. The gradients or slopes cross the contour lines, and have values expressing the change of the potential per unit of distance (in the direction selected), that is $\frac{dV}{dr}$; their units being the same as density, $\frac{\$}{\text{mile}} \cdot \frac{1}{\text{mile}} = \frac{\$}{\text{Sq.mile}}$. In summary, while the isopotential contours stress a static consistency, the slopes represent dynamic flows.

The potential surface has some singular points; the first of which are the "peaks" and "pits," that is, the highest and lowest points in the surrounding area. Other points are "passes," located between peaks, and "pales," located between pits, more commonly called "saddle" points, representing thus a local maximum and a local minimum at the same time-- depending on the direction of approach. Passes (pales) are determined by the intersection or point of tangency of isopotential lines forming a loop each one around two adjacent peaks (pits). The singular lines are also important to understand the characteristics of the surface; a "ridge" line connects peak to peak and is the only slope line that does not pass by a pit; while "course" lines connect pit to pit.

Finally, there are two sets of "districts" divisions, each one independent of the other; "hills" are districts whose lines of slope run to the same peak; and "dales" are districts whose lines of slope run to the same pit. Again, it must be remembered, that hills and dales constitute separate and overlapping systems, and that every point in the potential surface belongs to both a hill district and a dale district.[26]

5. The Climate

This model must be built so as to quantify the effects of the variable climate on agricultural production and land use. Research has been carried out by C.W. Thornthwaite,[27] and by Leslie Curry,[28] giving the bases for a quantifiable model of the influence of climate that has been adopted as the climate model in the proposed theory.[29]

There are two separate mechanisms in the process of the production of a crop--or any plant based on the photosynthesis phenomenon--that although parallel, can be distinguished. One is the process of "growth,"

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[26]For a deeper discussion, see W. Warntz, "The Topology of a Socio-Economic Terrain and Spatial Flows," Op.cit., on which the above section is based.

[27]See his "An Approach Toward a Rational Classification of Climate," Geographic Review, January 1948.

[28]See his "Climate and Economic Life," Geographic Review, July 1952.

[29]I am obliged to Prof. W. Warntz, who introduced me to those key studies.

consisting in the accumulation of dry matter (increase in size), and affecting the variable of "yields per acre per harvest." The other one is the process of "development," consisting in the progress from germination to reproduction (maturity), and affecting the seed-to-harvest period, and thus the "number of harvests per year"--besides the timing of harvest.[30]

Actually there is no clear division between these processes, which often are subject to trade-off between them, as is discussed below. The important fact is that climate has been found to control these processes with extreme accuracy

Possible Evapotranspiration Model

The first key concept is what Thornthwaite called "Potential Evapotranspiration"--which in the present study, to avoid any confusion with the word "potential" as used in the demand model, will be referred to as "Possible Evapotranspiration." This is by definition the amount of water lost by evaporation and transpiration into the atmosphere from a surface completely covered with vegetation, provided the soil always contains an adequate supply of water for the use of vegetation. This process is the reverse of precipitation and is measured in the same units. A climate is said to be dry or moist, depending on whether the level of precipitation is lower or higher than needed for the "possible" levels of evaporation and transpiration. To estimate the "Possible Evapotranspiration" values, the data needed are the mean temperature and the length of day in the site.

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[30]The two processes of growth and development were first clarified by R.O. Whyte, in his Crop Production and Environment, (London), 1946.

The essential relation is that "Possible Evapotranspiration" is the direct measure of the rate of plant development, using "development units" defined such that: in the period of time in which 1 mm. of "Possible Evapotranspiration" occurs at a given place, plants there will progress toward maturity by 10 D.U. (abbreviation for "development units"). Each type of plant will require a constant number of D.U. to reach maturity, regardless of place or season, called its "Development Index," but clearly, as D.U. values change over the national space, then the days required by a plant to reach maturity will be a variable, depending on place and season. Logically, the greater the number of accumulated D.U. in a year, the greater the range of possibilities for total production per acre per year. As an example, Florida has more than twice the "Possible" plant development level than Maine, due of course, to the higher mean temperatures and longer lengths of day. On the other hand, crops with high requirements of D.U. may be easily limited in the "climatic locus of location," as they cannot be grown in areas where the time period between the last and the first killing frost is shorter than the required period between seed and harvest. As an example, cotton has a cultivation limit in the U.S.A. on the line of 33" "Possible Evapotranspiration" level, because there the 200 days frost-free period is almost exactly the same as the seed-to-harvest period required by cotton at this site. It must be noticed that the "Possible" level of Evapotranspiration may not be the "Actual" simply because there may not be enough water to satisfy it, creating a dry condition. By extension, the higher the "Possible" values of a site, the more water it will need to avoid a dry condition.

The level of "Actual" evapotranspiration depends primarily on two factors: climate and soil-moisture supply, but other minor ones such as the plant coverage of the soil are also important (notice how those factors are included in the definition of the "Possible" level). The physical process consists in that plants need sunlight to grow, while transpiration prevents the plants exposed to sunlight from being overheated, by means of a radiation phenomenon where the plant disposes of the excess heat (i.e., energy) through the leaves. The levels of "Possible Evapotranspiration" vary in space and also in time according to season, being at a maximum in summer and at a minimum in winter.

Determination of a deficiency (or excess) of moisture is important because this indicates if a "Possible" level is also the "Actual" one. This is estimated by the moisture ratio, that is the relative humidity or aridity, per month or per year, and represents if positive, an excess of precipitation in relation to the needs of the evapotranspiration levels, and if negative, a deficit. The maximum deficit possible is 100%, but there is no limit for the excess ratio. It is also a possibility that different seasons may show alternative indices of deficit and surplus of moisture for a given region, and then it is necessary to estimate how the surplus stored in the subsoil is used in the drier season, allowing a relative loss caused by filtration out of the area.

For the purposes of the use of the climatic model in agricultural location theory, some assumptions must be clarified. The two processes of growth and development, not well separated even in the studies of Curry and Thornthwaite, are joined in a single index: yields per year (in bushels/

acre/year). In this way the model accounts for all possible effects of climate on both yields per harvest, and harvest per year. This approach is even adapted to the real world situation, due to the already mentioned trade-off often possible between factors, as there is for some crops a certain area of decision for the farmer whether to have a lesser number of crops with highest yields, or viceversa; by simply scheduling the seed and harvest dates. His decision, changing every year, will be strongly conditioned by the particular situation of market prices.

One final question is whether the use of "Actual Evapotranspiration" levels would not be more suitable than "Possible" ones. The answer is negative. In the first place, "Possible" levels indicate an absolute and pervasive variable, while "Actual" ones are subject to change, according to the progress in the irrigation programs of the country. Really, in the case study, the U.S.A., there are no radical differences between the two Evapotranspiration levels; and as will be discussed later, the main part of agricultural production and land use is in general not affected by dry conditions. The eastern half of the country actually shows a moisture surplus, the dividing zone of zero surplus and zero deficit extending in a band north to south, from the state of North Dakota down to Texas. To the west of this zone, the lowest deficit line is only 20%, except in the mountain area where there are larger deficits, but where for several other causes, agricultural production is of minimum importance.[31] This is not intended to reduce the importance of the gap between the two levels; it only

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[31] See the Empirical section in this same Chapter I.5b.

indicates that the use of the "Possible" levels in the case study is perfectly suitable, and that it will not introduce important distortions; but that does not mean that in countries with extreme dry conditions in areas that otherwise would be cultivated the same model should be used, because there "Actual" levels might be more suitable (an excellent example of this case would be Egypt). In the second place, an important by-product results from using the "Possible" levels in the model and keeping the "Actual" levels as the real conditions, in that they may be used as an element in formulating criteria for public investment projects in irrigation.[32]

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[32] This will be commented on in more detail in Chapter V.5.

CHAPTER I.b

EMPIRICAL STUDIES

4b. The Aggregate Demand: Income Population Potential Model

The model to be used is the one computed by William Warntz in the American Geographical Society for the year 1956. There is a newer potential mapping done for 1959, but a difficulty in obtaining the potential values tabulated for this last model makes choice of the 1956 model necessary. Since the last Census of Agriculture in the country dates from 1959, there is a three-year gap between the two sets of data. A close analysis reveals that this is irrelevant, because a comparison of the mappings of 1956 and 1959 [see Maps M.2 and M.3 (I.b)], though reflecting a general increase in later potential values, shows a constant relative position of the potential surface. Thus, where it is the relativity of the indices which is important, the 1956 potential model is perfectly suitable.

The basic units selected are the States; where areal dimensions are given in Square miles x 10^3; population is expressed as persons x 10^3; income per capita in $/person; and so income density is expressed in $/Square mile. The distance variable is estimated from centroid of state to centroid of state, in miles (approximated to the nearest 50 miles). The resulting income population potential values would then be in $/mile x 10^6.

It is obvious that an analysis at county level might have provided finer detail but the computational difficulties would have been impossibly greater. At the state level, with 48 control points, there are 2,304 individual distances (of which only half need to be computed) but if the 3,103 counties and independent areas of county size were to be used, there would be not less than 9,928,909 distances.[33]

In the mappings, the potential values of the different states are assigned on data points exactly on the state centroid. Following is a tabulation of the values for the 1956 potential model and the corresponding mapping, where the states are keyed according to a numerical system uniform for the whole study. It is to be noticed that this code--first proposed by W. Warntz--follows a spatial pattern movement for the assignment of consecutive numbers, thus allowing a common frontier for states with consecutive numbers, in practically all cases.

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[33] W. Warntz, Toward a Geography of Price, Op.cit., p. 58.

TABLE T.2 (I.b)

POTENTIAL VALUES, BY STATES, U.S.A., 1956

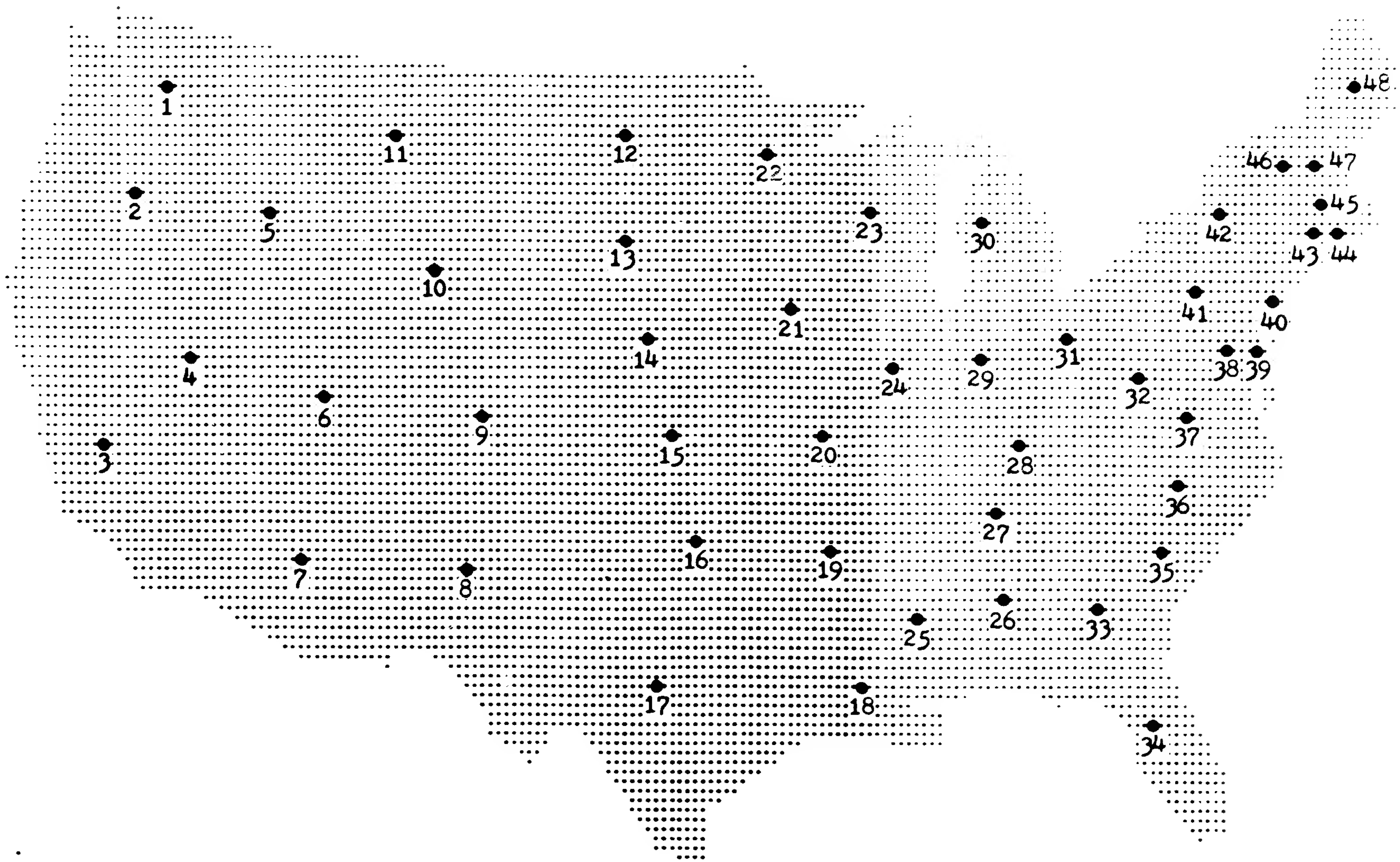
State	Income Population Potential ($/mile) x 10^6	State	Income Population Potential ($/mile) x 10^6
1) Washington	258	25) Mississippi	455
2) Oregon	254	26) Alabama	478
3) California	399	27) Tennessee	579
4) Nevada	311	28) Kentucky	673
5) Idaho	252	29) Indiana	798
6) Utah	278	30) Michigan	730
7) Arizona	257	31) Ohio	882
8) New Mexico	284	32) West Virginia	749
9) Colorado	311	33) Georgia	494
10) Wyoming	274	34) Florida	377
11) Montana	248	35) South Carolina	529
12) North Dakota	300	36) North Carolina	570
13) South Dakota	350	37) Virginia	705
14) Nebraska	406	38) Maryland & D.C.	984
15) Kansas	421	39) Delaware	929
16) Oklahoma	407	40) New Jersey	1496
17) Texas	367	41) Pennsylvania	1002
18) Louisiana	404	42) New York	966
19) Arkansas	461	43) Connecticut	1138
20) Missouri	574	44) Rhode Island	994
21) Iowa	559	45) Massachusetts	960
22) Minnesota	458	46) Vermont	550
23) Wisconsin	597	47) New Hampshire	688
24) Illinois	807	48) Maine	446

Source: W. Warntz, Macrogeography and Income Fronts, pp. 10-11.

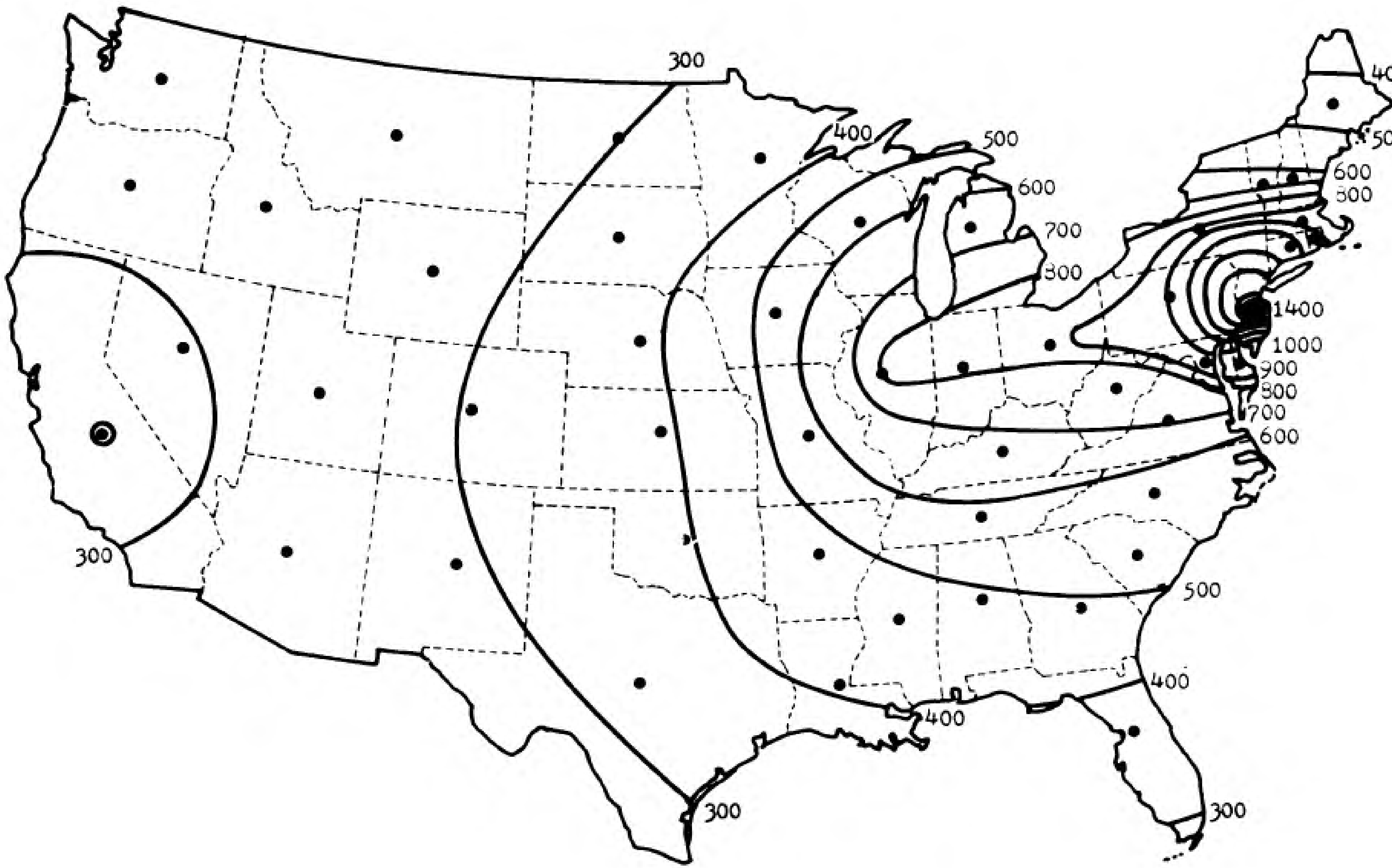
KEY TO MAP M.1 (I.b)

NUMERICAL DESIGNATION FOR EACH STATE, U.S.A.

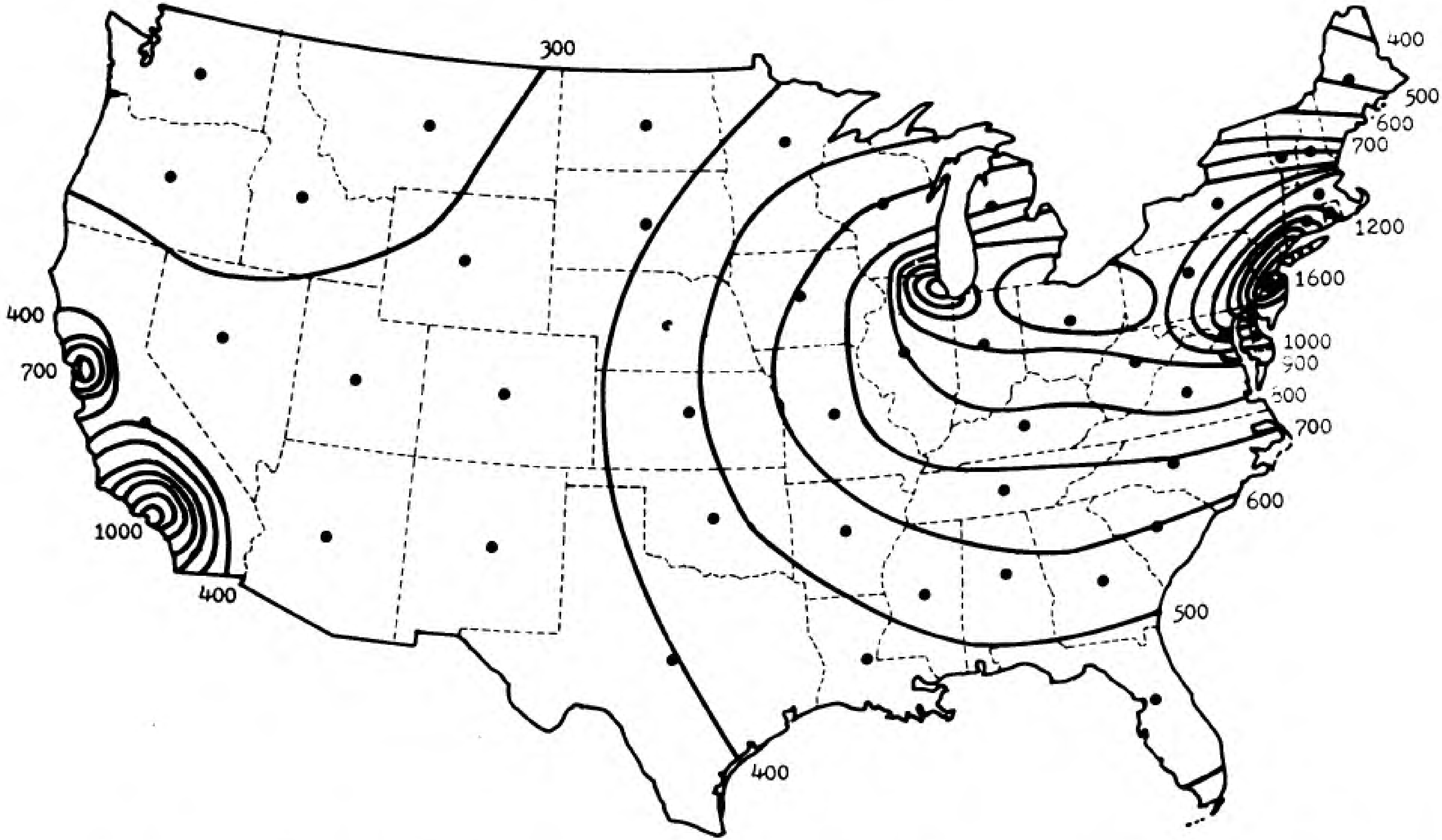
1)	Washington	25)	Mississippi
2)	Oregon	26)	Alabama
3)	California	27)	Tennessee
4)	Nevada	28)	Kentucky
5)	Idaho	29)	Indiana
6)	Utah	30)	Michigan
7)	Arizona	31)	Ohio
8)	New Mexico	32)	West Virginia
9)	Colorado	33)	Georgia
10)	Wyoming	34)	Florida
11)	Montana	35)	South Carolina
12)	North Dakota	36)	North Carolina
13)	South Dakota	37)	Virginia
14)	Nebraska	38)	Maryland & Dist.of Col.
15)	Kansas	39)	Delaware
16)	Oklahoma	40)	New Jersey
17)	Texas	41)	Pennsylvania
18)	Louisiana	42)	New York
19)	Arkansas	43)	Connecticut
20)	Missouri	44)	Rhode Island
21)	Iowa	45)	Massachusetts
22)	Minnesota	46)	Vermont
23)	Wisconsin	47)	New Hampshire
24)	Illinois	48)	Maine



Map M.1 (I.b): CENTROIDS AND REFERENCE NUMBER FOR EACH STATE, U.S.A.



Map M.2 (I.b): INCOME POPULATION POTENTIAL, BY STATES, U.S.A., 195
(in $/mile x 10⁰)



map M.3 (I.b): INCOME POPULATION POTENTIAL, BY STATES, U.S.A., 1959
(in $/mile x 10^6)

0 500 miles

5b. The Climate:

Average Annual Possible Evapotranspiration Model

The computation of Possible Evapotranspiration values is of little interest for the present study, as it is mainly a method of collecting the temperature and day length data and applying a set of empirical relationships.[34]

Following are mappings showing the Average Annual Possible Evapotranspiration values in the U.S.A. and also the Moisture Regions--so as to allow an analysis of the areas of divergence from the Actual Evapotranspiration values, that is the areas deficit in moisture. It is easy to see now that minor deficits occurred in the band from North Dakota to Texas, toward the Mountains, with the so-called Dry Subhumid climatic type where there is a deficit of -20%. More important is the deficit shown in the semiarid climatic zone of Nevada-South eastern California-Southwestern Arizona-Southern New Mexico, where there is a moisture deficiency index of -40%.

The remaining problem was the estimation of average values for the 48 states, because the geographic studies never recognized political boundaries, lacking data at state level.[35] The methodology selected was the interpolation of values in each state, from the contour lines shown in the mappings. Each state was divided into a large number of small squares, by using a generic grid; then each square unit was assigned an interpolated

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[34]This method is described in C.W. Thornthwaite, Op.cit.

[35]Statement in a letter to the author, from C.W. Thornthwaite Assoc., June 1967.

value; and finally, all squares as well as the evapotranspiration values in each one were summed. The ratio of the sum of evapotranspiration values to the sum of square units resulted in the "weighted" average evapotranspiration value in this state. Though this process is long and requires careful computation, it offers no conceptual difficulty.

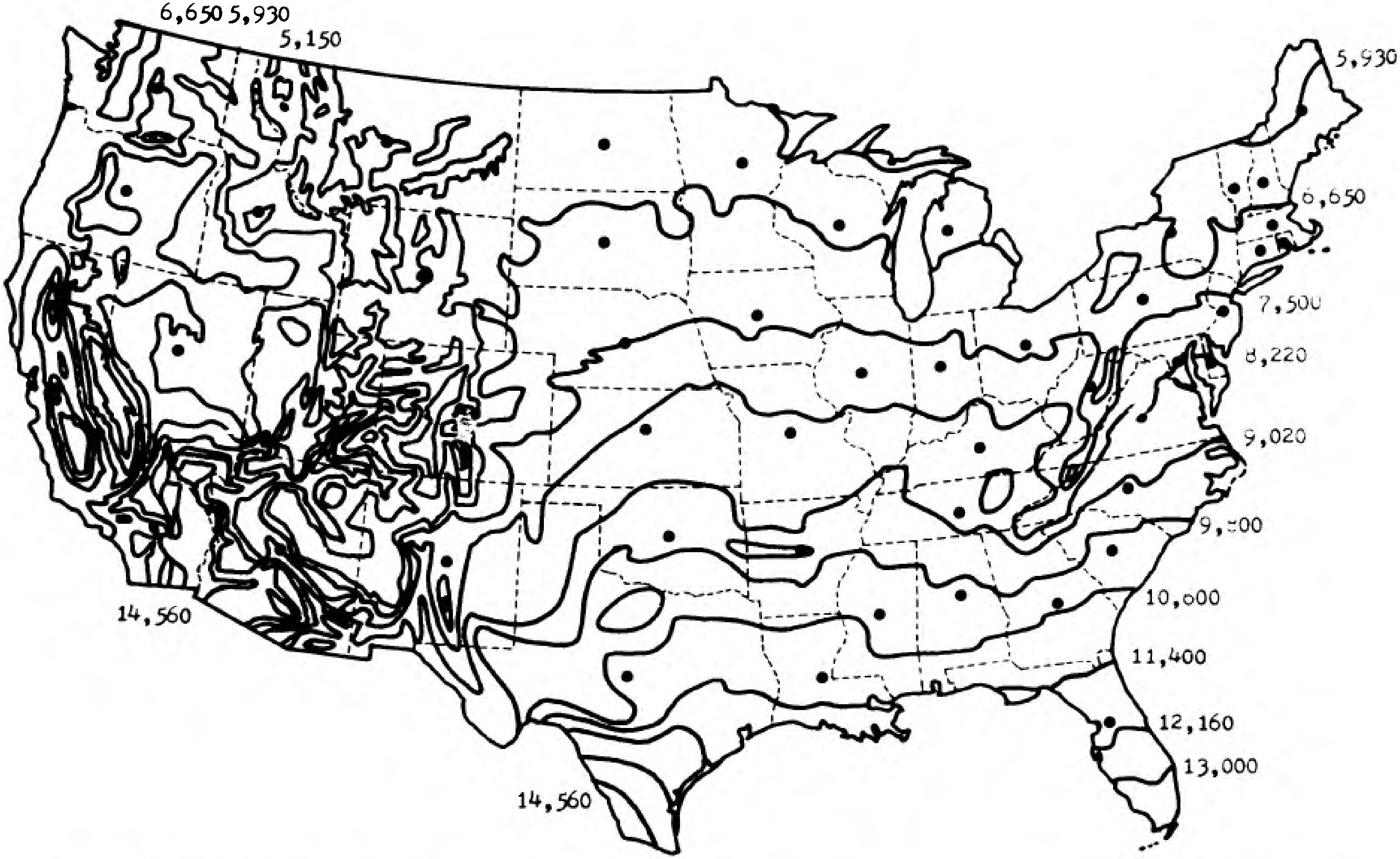
Following is a tabulation of the results.

TABLE T.3 (I.b)

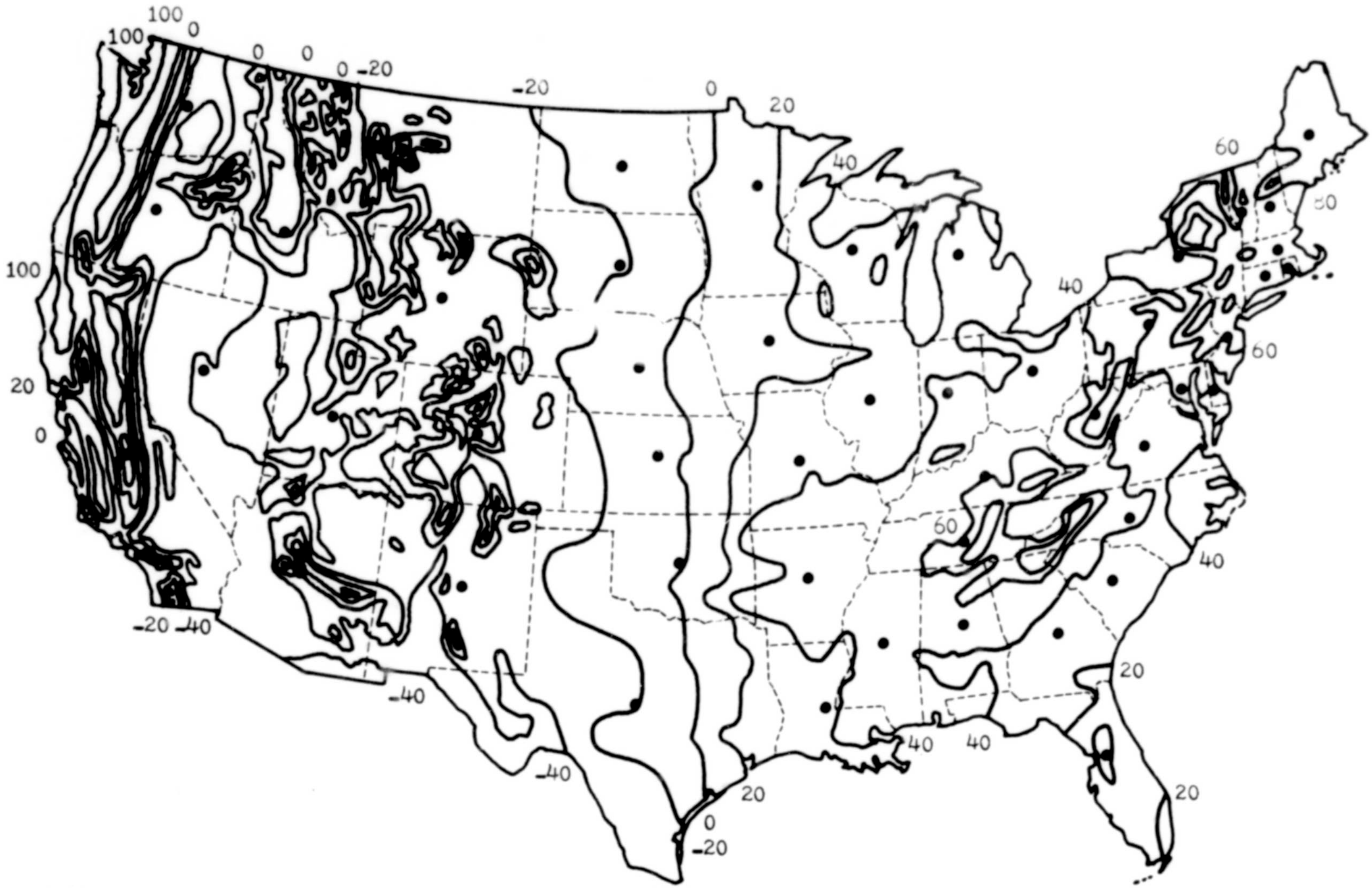
ESTIMATED AVERAGE ANNUAL POSSIBLE EVAPOTRANSPIRATION
BY STATES, U.S.A.

State	Average Annual Possible Evapotranspiration	State	Average Annual Possible Evapotranspiration
1) Washington	6,998 D.U.	25) Mississippi	10,337 D.U.
2) Oregon	6,523	26) Alabama	10,060
3) California	9,126	27) Tennessee	8,673
4) Nevada	7,133	28) Kentucky	8,419
5) Idaho	6,244	29) Indiana	7,838
6) Utah	6,810	30) Michigan	6,499
7) Arizona	9,789	31) Ohio	7,541
8) New Mexico	7,737	32) West Virginia	7,633
9) Colorado	6,262	33) Georgia	10,278
10) Wyoming	5,864	34) Florida	12,331
11) Montana	5,939	35) South Carolina	9,932
12) North Dakota	6,290	36) North Carolina	8,991
13) South Dakota	6,766	37) Virginia	8,255
14) Nebraska	7,360	38) Maryland	8,201
15) Kansas	8,338	39) Delaware	8,227
16) Oklahoma	9,484	40) New Jersey	7,710
17) Texas	10,819	41) Pennsylvania	7,171
18) Louisiana	11,142	42) New York	6,578
19) Arkansas	9,616	43) Connecticut	7,075
20) Missouri	8,446	44) Rhode Island	7,075
21) Iowa	7,437	45) Massachusetts	6,792
22) Minnesota	6,468	46) Vermont	6,290
23) Wisconsin	6,597	47) New Hampshire	6,290
24) Illinois	7,995	48) Maine	6,056

Source: Estimated by the author, with data from C.W. Thornthwaite, Op. cit.



Map M.4 (I.b): AVERAGE ANNUAL POSSIBLE EVAPOTRANSPIRATION, U.S.A.
(in Development Units)



Map M.5 (I.b): MOISTURE REGIONS, U.S.A.
(in percentage of moisture surplus and deficiency)

0 500 miles

CHAPTER II

THE AGRICULTURAL LAND USE

Prior to the study of the proposed theory of agricultural location which will be the subject of the next chapter, it is useful to estimate a series of quantitative indices of relevance for the theory in order to eliminate interruptions in continuity of the development of the theoretical proposals and its empirical analysis

1. Locational Distribution

Selection of the index to quantify the actual pattern of distribution of agricultural production is one of the first steps of the present study. Since the aim of the theory is to provide an explanation for the land use pattern observed in the location of the selected crops, a simple index of acreage under cultivation would not be enough. The index found most suitable is an adaptation of the locational coefficient method, affected by a specific "weight." This implies the selection of a "production" index, of which there are two possibilities, a "quantity" index--such as bushels or tons--and a "value" index--dollars. (The index commonly used in industrial location analysis, employment, was disregarded as clearly unsuitable for agricultural analysis.) The "quantity" index appears to be more suited to the aims of the study, because it is not affected by price differentials as the "value" index would be, and thus provides a good estimation of the actual production levels.

Furthermore, only the farm production that is oriented to the national market is relevant to the study. For this reason, only the "quantity sold" will be considered. The estimation of a locational coefficient is essentially the relationship of a production index to a "normalizing" parameter, such as area, population or employment always estimated for the given geographical area. The most appropriate one for the present study turned out to be population, because it is possible to assume that, each person consuming a constant amount of agricultural produce, a uniform distribution of agricultural production would be the location of all crops in perfect correlation with the location of population. All deviations from this "normal" distribution will be reflected in the locational coefficient, and can be interpreted as a result of the regional locational variables--aggregate demand and climate. There are then two basic indices to be established: first the share of agricultural production corresponding to each geographical area, as percentage of the national production; and second, the share of population in the same area, as percentage of the national population.

By definition, the ratio of the area's share of the national production of a given crop to the area's share of the national population results in the Locational Coefficient of the given crop in the area.

Locational coefficients are useful to study the productive structure within the area in relation to the "normal" production in the country, but it does not allow for interarea comparative studies in absolute values. The reason is simply that an area with small population and high locational coefficient may actually be producing a negligible output, in comparison with the national volumes, and viceversa. The logical method to overcome this problem is to affect the locational coefficient by the area's population "weight." The result, in a kind of circular process is to obtain again the area's share of national production--the first index to be established.

By definition, the Total Locational Distribution index of a selected crop in a given area is the result of multiplying the Locational Coefficient by the area's population weight, and it is the same as the area's share of national production.

A formal statement is summarized below:

where: X^a = production of crop a in the country

X_1^a = production of crop a in area 1

P = population in the country

P_1 = population in area 1

the area's share of production is $S_1^a = \frac{X_1^a}{X^a}$

the locational coefficient is $LC_1^a = \frac{\frac{X_1^a}{X^a}}{\frac{P_1}{P}} = \frac{P.\ X_1^a}{P_1.\ X^a}$

the total locational distribution is $TLD_1^a = \frac{P.\ X_1^a}{P_1.\ X^a} \cdot \frac{P_1}{P} = \frac{X_1^a}{X^a} = S_1^a$

all of them expressed as indices.

2. Areal Revenues

A key difference between the theory proposed and the classical theory is the introduction of the concept of revenue per area, as will be discussed in the next chapter. It is only for the purpose of grouping the analysis of the quantitative indices that the Areal Revenue variable is estimated together with the locational indices, prior to the theoretical discussion. Nevertheless, there is no particular difficulty in following the computational process.

There are two approaches to the estimation of Areal Revenues, that result in a gross or a net value. The first one is to determine the relevant prices at the market for the selected crops and their different yields according to the geographical area. The product of price time yield results in the gross Areal Revenue, for the selected crop in a given area. The second approach is to obtain the ratio of total sales to the acreage under cultivation, for a selected crop in a given area, resulting in the net Areal Revenues. It is clear that this second index is exclusive of transfer costs, because it is computing the sales at the farm level. Besides the difference of including or excluding the transfer costs, the two indices present variable levels of complexity for the computation process. The first approach, resulting in the gross index has an important problem of data collection; however, the second one, resulting in the net index, is more simple to estimate because of the availability of the necessary data in the U.S. Census of Agriculture.

The second approach was selected because it accounts also for the variable of total transfer costs which, as will be studied in the next chapter, is a secondary factor in explaining locational decisions. Areal Revenues are defined then, as the ratio between sales and acreage devoted to the sold portion of a given crop, in a geographical area. The variable of Areal Revenues will be understood to be net of transfer costs in the rest of the study. Strictly speaking, the definition of Areal Revenues mentioned above applies to an individual crop. For the purposes of the proposed theory, other index will also be useful, that is the Areal Revenue of the crop mix in a given geographical area. Often a group of crops shares the same land within the selected area,[1] and for those cases, the Areal Revenue of the crop mix is the weighted average of the Areal Revenue of the component individual crops in the area.

As a definition then, the Areal Revenues of the Crop Mix in a given geographical area is given by the ratio between total sales to total acreage devoted to the sold portions of all crops in the area.

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[1]See Chapter III.3 and 3b.

CHAPTER II.b

EMPIRICAL STUDIES

1b. Locational Distribution

The basic information necessary to obtain an index of agricultural distribution is given by the U.S. Census of Agriculture, the latest one being taken in 1959, corresponding to the series of decennial census regularly carried on in the U.S.

It is necessary to explain that this agricultural location theory only considers crops, although other agricultural enterprises such as cattle should ideally have been included in the analysis. The problem is that the U.S. Census of Livestock does not provide data on acreage in relation to the number and sales of livestock; and so, for a theory based on a relationship between area and revenues, the necessary information is essentially missing.

The preliminary step is to choose the significant crops to be used in the empirical study, out of the several dozens indicated in the Census. The criteria that guided the selection were first, that only important crops should be included, as the reduction of their number would facilitate the analysis, and the elimination of small crops should not radically affect the thesis. Secondly, the crop should be oriented to human consumption. This means that if foodstuffs are produced for animal consumption, their location would be determined by the distribution of the livestock and not by the human market, becoming a subsidiary "industry" supplying the livestock growers that in turn would be oriented to the demand market.

Obviously, the determination of the minimum inclusive level for crops can be very flexible. For the purpose of the study, it was decided that only crops with a total value of over \$100,000,000 per year were relevant--from now on, to simplify notation is going to be \$100 x 10^6. This threshold selected 17 crops, out of which 2 are not oriented to the market consumption: Dry Field and Seed Beans, and Alfalfa. Also as the study focuses on the coterminous U.S., there is one crop, Sugar cane, that though over the \$100 x 10^6 minimum value, is not included because it is mostly grown in Hawaii.

Furthermore, as was discussed in the theoretical part of this chapter, the concern of the analysis is only with the production sold, that is oriented to the market, and it should not be desirable then to include produce grown for private farm consumption which in some cases, as corn for example, represents a sizable percentage; so that the relevant data for crop selection is the Value of Sales, and not the value of production.

The following table lists the 15 selected crops, and their relevant values.

TABLE T.4 (II.b)

SELECTED CROPS WITH SALES OVER $\$100 \times 10^6$ PER ANNUM, U.S.A., 1959

Crop	Sales ($\$ \times 10^6$)	Crop	Sales ($\$ \times 10^6$)
Corn	1,779.9	Cotton	2,342.6[d]
Sorghum	332.5	Tobacco	947.6[d]
Wheat	1,736.3	Sugarbeets	187.3[d]
Oats	178.7	Irish Potatoes	414.9[e]
Barley	240.5	Vegetables (other than Potatoes)	739.6
Rice	247.0[a]	Berries	112.1
Soybeans	981.2[b]	Fruits & Nuts	1,294.8[d]
Peanuts	131.0[c]		

Source: U.S. Bureau of Census, U.S. Census of Agriculture: 1959, Vol. II, General Report, Statistics by Subjects--Chapters VII and VIII (this source to be called in the future simply U.S. Census of Agriculture, 1959).

[a]Approximate estimation based on $\$249.3 \times 10^6$ value of production and 119.0×10^6 bushels sold out of 120.8×10^6 bushels produced.

[b]Approximate estimation based on $\$1,017.9 \times 10^6$ value of production and 96.4% sold.

[c]Approximate estimation based on $\$135.1 \times 10^6$ value of production and 97% sold.

[d]Assuming that total production was sold.

[e]Approximate estimation based on $\$479.5 \times 10^6$ value of production and 86.5% sold.

States' Share of Production

In the theoretical part of the chapter, the share was defined as the percentage of the country's production that is grown in the State, expressed as the index: $S_1^a = \frac{X_1^a}{X^a}$, where X^a stands for the agricultural production of crop a, in the country and in the state 1.

Following the Census, the States are adopted as the geographical areas of the study. The Census provides information of production and sales in both quantity and value, but as was discussed in Section II.1, it is important to establish the locational distribution of production in quantities, first.

The following table indicates the quantities of agricultural production sold, in bushels or other suitable units, for the selected 15 crops, for 48 states in the U.S., as well as an estimation of the percentage that each state has in the total national production, i.e., the S (Share) values. For simplicity, the states are arranged in the same numerical order mentioned in Chapter I.

TABLE T.5 (II.b)

AGRICULTURAL PRODUCTION SOLD AND SHARE OF NATIONAL PRODUCTION FOR 15 SELECTED CROPS, FOR 48 STATES, U.S.A., 1959

State	Crop					
	Corn		Sorghum		Wheat	
	Sales (Bushels x 10^6)	Share %	Sales (Bushels x 10^6)	Share %	Sales (Bushels x 10^6)	Share %
U. S. A.	1,697.3	100%	381.9	100%	979.8	100%
1) Washington	4.1	0.2	.4	.1	70.3	7.2
2) Oregon	1.1	0.1	-	-	26.9	2.7
3) California	10.2	0.6	12.3	3.2	7.9	0.8
4) Nevada	-	-	-	-	.5	0.1
5) Idaho	.8	0.1	-	-	36.7	3.7
6) Utah	.1	-	-	-	4.8	0.5
7) Arizona	-	-	5.0	1.3	3.0	0.3
8) New Mexico	.2	-	5.8	1.5	3.4	0.4
9) Colorado	9.1	0.5	5.6	1.5	46.2	4.7
10) Wyoming	.5	-	-	-	4.9	0.5
11) Montana	-	-	-	-	66.2	6.8
12) North Dakota	3.5	0.2	-	-	84.8	8.6
13) South Dakota	24.9	1.5	1.2	0.3	14.7	1.5
14) Nebraska	184.5	10.9	40.9	10.7	61.2	6.3
15) Kansas	36.8	2.2	78.1	20.5	188.1	19.1
16) Oklahoma	2.0	0.1	9.8	2.6	78.7	8.0
17) Texas	16.4	1.0	206.2	54.0	47.6	4.9
18) Louisiana	3.0	0.2	-	-	.7	0.1
19) Arkansas	2.9	0.2	.3	.1	2.8	0.3
20) Missouri	80.9	4.8	11.4	3.0	33.6	3.4
21) Iowa	324.3	19.1	1.5	0.4	3.0	0.3
22) Minnesota	141.1	8.3	-	-	20.2	2.1
23) Wisconsin	35.4	2.1	-	-	1.5	0.2
24) Illinois	368.8	21.7	.4	0.1	40.4	4.1

TABLE T.5 (II.b)--Continued

State	Crop (Continued)					
	Corn		Sorghum		Wheat	
	Sales (Bushels x 10^6)	Share %	Sales (Bushels x 10^6)	Share %	Sales (Bushels x 10^6)	Share %
25) Mississippi	7.2	0.4	.3	.1	.7	0.1
26) Alabama	14.3	0.8	.1	-	1.0	0.1
27) Tennessee	13.4	0.8	.2	.1	2.7	0.3
28) Kentucky	19.6	1.2	.2	.1	3.4	0.4
29) Indiana	139.6	8.2	.5	0.1	28.9	3.0
30) Michigan	42.7	2.5	-	-	32.1	3.3
31) Ohio	93.5	5.5	-	-	26.1	2.7
32) West Virginia	.8	0.1	-	-	.3	-
33) Georgia	21.0	1.2	.1	-	1.6	0.2
34) Florida	2.7	0.2	-	-	.1	-
35) South Carolina	5.3	0.3	-	-	2.4	0.2
36) North Carolina	31.2	1.8	1.0	0.3	6.1	0.6
37) Virginia	9.2	0.5	-	-	4.4	0.5
38) Maryland	11.9	0.7	-	-	3.3	0.3
39) Delaware	5.0	0.3	-	-	.6	0.1
40) New Jersey	3.4	0.2	-	-	1.2	0.1
41) Pennsylvania	18.8	1.1	-	-	10.5	1.1
42) New York	5.0	0.3	-	-	6.5	0.7
43) Connecticut	-	-	-	-	-	-
44) Rhode Island	-	-	-	-	-	-
45) Massachusetts	-	-	-	-	-	-
46) Vermont	-	-	-	-	-	-
47) New Hampshire	-	-	-	-	-	-
48) Maine	-	-	-	-	-	-

TABLE T.5 (II.b)--Continued

State	Crop					
	Oats		Barley		Rice	
	Sales (Bushels x 10^6)	Share %	Sales (Bushels x 10^6)	Share %	Sales (Bushels x 10^6)	Share %
U. S. A.	279.5	100%	276.1	100%	119.0[a]	100%
1) Washington	3.3	1.2	22.8	8.1	-	-
2) Oregon	4.1	1.5	14.7	5.3	-	-
3) California	3.6	1.3	60.9	22.0	29.0	24.3
4) Nevada	-	-	.2	0.1	-	-
5) Idaho	3.1	1.1	10.6	3.8	-	-
6) Utah	.2	0.1	2.2	0.8	-	-
7) Arizona	.1	-	6.8	2.4	-	-
8) New Mexico	.1	-	.6	0.2	-	-
9) Colorado	1.3	0.5	8.3	3.0	-	-
10) Wyoming	1.0	0.4	1.3	0.5	-	-
11) Montana	1.8	0.6	33.4	12.1	-	-
12) North Dakota	14.8	5.3	54.0	19.5	-	-
13) South Dakota	10.0	3.6	2.7	1.0	-	-
14) Nebraska	6.7	2.4	2.6	0.9	-	-
15) Kansas	3.7	1.3	11.2	4.0	-	-
16) Oklahoma	3.7	1.3	7.5	2.7	-	-
17) Texas	7.7	2.8	3.7	1.3	29.6	24.9
18) Louisiana	.5	0.2	-	-	29.8	25.0
19) Arkansas	3.8	1.4	.1	-	27.7	23.3
20) Missouri	2.2	0.8	1.3	0.5	.3	0.3
21) Iowa	46.0	16.4	.3	0.1	-	-
22) Minnesota	51.4	18.4	22.2	7.9	-	-
23) Wisconsin	14.8	5.3	.8	0.3	-	-
24) Illinois	30.4	10.9	.6	0.2	-	-

[a] Only for the specified States.

TABLE T.5 (II.b)--<u>Continued</u>

State	Crop (Continued)					
	Oats		Barley		Rice	
	Sales (Bushels x 10^6)	Share %	Sales (Bushels x 10^6)	Share %	Sales (Bushels x 10^6)	Share %
25) Mississippi	4.6	1.6	-	-	2.6	2.2
26) Alabama	1.1	0.4	-	-	-	-
27) Tennessee	.9	0.3	.2	0.1	-	-
28) Kentucky	.3	0.1	.4	0.1	-	-
29) Indiana	8.7	3.1	.3	0.1	-	-
30) Michigan	10.0	3.6	1.0	0.4	-	-
31) Ohio	14.9	5.3	.4	0.1	-	-
32) West Virginia	.1	-	-	-	-	-
33) Georgia	3.7	1.3	.1	-	-	-
34) Florida	.1	-	-	-	-	-
35) South Carolina	4.6	1.6	.3	0.1	-	-
36) North Carolina	2.9	1.0	.6	0.2	-	-
37) Virginia	.7	0.3	.9	0.3	-	-
38) Maryland	.2	0.1	.9	0.3	-	-
39) Delaware	• -	-	.3	0.1	-	-
40) New Jersey	.1	-	.4	0.1	-	-
41) Pennsylvania	4.6	1.6	.9	0.3	-	-
42) New York	5.8	2.1	.3	0.1	-	-
43) Connecticut	-	-	-	-	-	-
44) Rhode Island	-	-	-	-	-	-
45) Massachusetts	-	-	-	-	-	-
46) Vermont	.1	-	-	-	-	-
47) New Hampshire	-	-	-	-	-	-
48) Maine	1.5	0.5	-	-	-	-

TABLE T.5 (II.b)--Continued

State	Crop					
	Soybeans		Peanuts		Cotton	
	Prod.[b] (Bushels x 10^6)	Share %	Prod.[c] (Pounds x 10^6)	Share %	Prod.[d] (Bales x 10^3)	Share %
U. S. A.	515.6	100%	1,413.4	100%	13,913.5	100%
1) Washington	-	-	-	-	-	-
2) Oregon	-	-	-	-	-	-
3) California	-	-	-	-	1,791.3	12.9
4) Nevada	-	-	-	-	6.0	-
5) Idaho	-	-	-	-	-	-
6) Utah	-	-	-	-	-	-
7) Arizona	-	-	-	-	696.9	5.0
8) New Mexico	-	-	9.9	0.7	299.7	2.2
9) Colorado	-	-	-	-	-	-
10) Wyoming	-	-	-	-	-	-
11) Montana	-	-	-	-	-	-
12) North Dakota	2.4	0.5	-	-	-	-
13) South Dakota	1.5	0.3	-	-	-	-
14) Nebraska	3.4	0.7	-	-	-	-
15) Kansas	8.7	1.7	-	-	-	-
16) Oklahoma	1.5	0.3	110.3	7.8	364.8	2.6
17) Texas	1.3	0.3	167.5	11.9	4,156.0	29.9
18) Louisiana	4.3	0.8	.3	-	479.3	3.4
19) Arkansas	52.3	10.1	.9	0.1	1,484.0	10.7
20) Missouri	47.4	9.2	-	-	482.1	3.5
21) Iowa	62.1	12.0	-	-	-	-
22) Minnesota	41.4	8.0	-	-	-	-
23) Wisconsin	1.9	0.4	-	-	-	-
24) Illinois	120.9	23.4	-	-	1.1	-

[b] No figures for Sales available; estimated level of sales 96.4% of production.

[c] No figures for Sales available; estimated level of sales 97.0% of production.

[d] No figures for Sales available; estimated level of sales equal to production.

TABLE T.5 (II.b)--Continued

State	Crop (Continued)					
	Soybeans		Peanuts		Cotton	
	Prod. (Bushels x 10^6)	Share %	Prod. (Pounds x 10^6)	Share %	Prod. (Bales x 10^3)	Share %
25) Mississippi	21.0	4.0	1.5	0.1	1,560.6	11.2
26) Alabama	2.7	0.5	149.0	10.6	683.5	4.9
27) Tennessee	8.2	1.6	.6	-	620.4	4.5
28) Kentucky	4.0	0.8	-	-	10.7	0.1
29) Indiana	58.4	11.3	-	-	-	-
30) Michigan	5.4	1.0	-	-	-	-
31) Ohio	35.4	6.8	-	-	-	-
32) West Virginia	-	-	-	-	-	-
33) Georgia	1.0	0.2	495.4	35.1	521.4	3.8
34) Florida	.7	0.1	44.9	3.2	13.7	0.1
35) South Carolina	6.6	1.3	8.5	0.6	411.1	3.0
36) North Carolina	8.5	1.6	245.5	17.4	318.6	2.3
37) Virginia	5.7	1.1	177.6	12.6	12.5	0.1
38) Maryland	4.4	0.8	-	-	-	-
39) Delaware	3.2	0.6	-	-	-	-
40) New Jersey	.7	0.1	-	-	-	-
41) Pennsylvania	.2	-	-	-	-	-
42) New York	-	-	-	-	-	-
43) Connecticut	-	-	-	-	-	-
44) Rhode Island	-	-	-	-	-	-
45) Massachusetts	-	-	-	-	-	-
46) Vermont	-	-	-	-	-	-
47) New Hampshire	-	-	-	-	-	-
48) Maine	-	-	-	-	-	-

TABLE T.5 (II.b)--Continued

State	Tobacco		Sugarbeets		Irish Potatoes	
	Prod.[e] (Pounds x 10^6)	Share %	Prod.[e] (Tons x 10^3)	Share %	Prod.[f] (Bushels x 10^6)	Share %
U. S. A.	1,646.5	100%	16,821.7	100%	373.6	100%
1) Washington	-	-	743.0	4.4	13.6	3.7
2) Oregon	-	-	510.7	3.0	14.0	3.8
3) California	-	-	4,781.5	28.4	38.5	10.3
4) Nevada	-	-	8.3	0.1	.4	0.1
5) Idaho	-	-	1,953.0	11.6	66.9	18.0
6) Utah	-	-	551.7	3.3	2.3	0.6
7) Arizona	-	-	-	-	2.2	0.6
8) New Mexico	-	-	8.7	0.1	.5	0.1
9) Colorado	-	-	2,438.5	14.5	17.5	4.7
10) Wyoming	-	-	585.3	3.5	1.0	0.3
11) Montana	-	-	866.7	5.1	1.9	0.5
12) North Dakota	-	-	449.1	2.7	20.3	5.4
13) South Dakota	-	-	88.6	0.5	.7	0.2
14) Nebraska	-	-	1,070.7	6.4	4.0	1.1
15) Kansas	.1	-	127.0	0.8	.3	0.1
16) Oklahoma	-	-	-	-	.2	0.1
17) Texas	-	-	36.0	0.2	3.9	1.1
18) Louisiana	.1	-	-	-	.3	0.1
19) Arkansas	-	-	-	-	.6	0.2
20) Missouri	4.3	0.3	-	-	.8	0.2
21) Iowa	-	-	15.5	0.1	.8	0.2
22) Minnesota	.1	-	884.4	5.3	18.8	5.0
23) Wisconsin	22.1	1.3	98.2	0.6	13.2	3.6
24) Illinois	-	-	28.7	0.2	.4	0.1

[e] No figures for Sales available; estimated level of sales equal to production.

[f] No figures for Sales available; estimated level of sales 86.5% of production.

TABLE T.5 (II.b)--Continued

State	Crop (Continued)					
	Tobacco		Sugarbeets		Irish Potatoes	
	Prod. (Pounds x 10^6)	Share %	Prod. (Tons x 10^3)	Share %	Prod. (Bushels x 10^6)	Share %
25) Mississippi	-	-	-	-	.3	0.1
26) Alabama	.5	-	-	-	2.7	0.7
27) Tennessee	120.7	7.4	-	-	1.3	0.4
28) Kentucky	335.1	20.4	-	-	1.3	0.4
29) Indiana	10.7	0.7	-	-	2.6	0.7
30) Michigan	-	-	1,201.7	7.1	11.5	3.1
31) Ohio	19.2	1.2	374.2	2.2	4.4	1.2
32) West Virginia	3.0	0.2	-	-	.8	0.2
33) Georgia	98.3	6.0	-	-	.2	0.1
34) Florida	23.4	1.4	-	-	5.5	1.5
35) South Carolina	129.0	7.9	-	-	.7	0.2
36) North Carolina	654.4	39.8	-	-	4.6	1.3
37) Virginia	127.8	7.8	-	-	4.9	1.3
38) Maryland	32.6	2.0	-	-	.8	0.2
39) Delaware	-	-	-	-	2.7	0.7
40) New Jersey	-	-	-	-	6.9	1.9
41) Pennsylvania	46.5	2.8	-	-	11.9	3.2
42) New York	-	-	-	-	26.7	7.2
43) Connecticut	12.6	0.8	-	-	2.1	0.6
44) Rhode Island	-	-	-	-	1.8	0.5
45) Massachusetts	6.0	0.4	-	-	2.0	0.5
46) Vermont	-	-	-	-	.6	0.2
47) New Hampshire	-	-	-	-	.5	0.1
48) Maine	-	-	-	-	53.3	14.3

Table 2.5 (II.b)--Continued

State	Crop					
	Vegetables		Berries, tot.		Fruits & Nuts,tot	
	Sales[g] ($ x 10⁶)	Share %	Sales[h] ($ x 10⁶)	Share %	Sales[h] ($ x 10⁶)	Share %
U. S. A.	739.6	100%	112.1	100%	1,294.9	100%
1) Washington	19.6	2.7	10.3	9.2	76.1	5.9
2) Oregon	22.2	3.0	15.7	14.0	27.3	2.1
3) California	268.7	36.3	29.6	26.4	555.5	42.9
4) Nevada	.7	0.1	-	-	-	-
5) Idaho	3.8	0.5	.2	0.2	6.0	0.5
6) Utah	2.6	0.4	.4	0.4	3.0	0.2
7) Arizona	37.3	5.0	.1	0.1	9.6	0.7
8) New Mexico	3.1	0.4	-	-	2.8	0.2
9) Colorado	10.6	1.4	-	-	7.0	0.5
10) Wyoming	-	-	-	-	-	-
11) Montana	-	-	.1	0.1	0.7	0.1
12) North Dakota	-	-	-	-	-	-
13) South Dakota	-	-	-	-	-	-
14) Nebraska	.4	0.1	-	-	0.3	-
15) Kansas	1.0	0.1	.2	0.2	0.7	0.1
16) Oklahoma	2.2	0.3	.6	0.5	1.2	0.1
17) Texas	31.8	4.3	.8	0.7	14.8	1.1
18) Louisiana	2.0	0.3	2.0	1.8	3.0	0.2
19) Arkansas	3.1	0.4	3.1	2.8	4.6	0.4
20) Missouri	2.9	0.4	.8	0.7	3.6	0.3
21) Iowa	2.4	0.3	.2	0.2	0.8	0.1
22) Minnesota	10.0	1.4	.5	0.4	0.8	0.1
23) Wisconsin	19.5	2.6	5.2	4.6	5.0	0.4
24) Illinois	14.9	2.0	1.2	1.1	6.2	0.5

[g] Only value in $ is available, due to heterogeneity of produce (45 types of vegetables.

[h] Only value in $ is available, due to heterogeneity of produce.

TABLE T.5 (II.b)--Continued

State	Crop (Continued)					
	Vegetables		Berries, tot.		Fruits & Nuts, tot	
	Sales ($ x 10^6)	Share %	Sales ($ x 10^6)	Share %	Sales ($ x 10^6)	Share %
25) Mississippi	2.1	0.3	.1	0.1	4.6	0.4
26) Alabama	3.7	0.5	.4	0.4	3.8	0.3
27) Tennessee	5.1	0.7	2.4	2.1	0.9	0.1
28) Kentucky	1.1	0.1	.8	0.7	1.3	0.1
29) Indiana	10.0	1.4	.7	0.6	5.1	0.4
30) Michigan	20.0	2.7	10.9	9.7	45.6	3.5
31) Ohio	15.8	2.1	1.3	1.2	10.0	0.8
32) West Virginia	.5	0.1	.2	0.2	10.6	0.8
33) Georgia	6.8	0.9	.1	0.1	16.2	1.3
34) Florida	81.9	11.1	.8	0.7	323.9	25.0
35) South Carolina	8.1	1.1	.1	0.1	15.7	1.2
36) North Carolina	8.5	1.1	2.1	1.9	5.3	0.4
37) Virginia	8.6	1.2	1.2	1.1	17.[illegible]	1.4
38) Maryland	9.3	1.3	.5	0.4	3.9	0.3
39) Delaware	4.6	0.6	.1	0.1	0.6	-
40) New Jersey	30.0	4.1	6.7	6.0	12.3	0.9
41) Pennsylvania	12.6	1.7	-	-	24.3	1.9
42) New York	35.9	4.9	3.4	3.0	41.8	3.2
43) Connecticut	3.0	0.4	.3	0.3	3.1	0.2
44) Rhode Island	.4	0.1	-	-	0.4	-
45) Massachusetts	5.4	0.7	5.0	4.5	5.6	0.4
46) Vermont	.4	0.1	.1	0.1	1.8	0.1
47) New Hampshire	.9	0.1	.2	0.2	2.7	0.2
48) Maine	2.5	0.3	2.3	2.1	3.5	0.3

Source: Sales and production data from U.S. Census of Agriculture, 1959. Share values estimated by the author.

Locational Coefficient

In the theoretical section of this chapter, the locational coefficient was defined as the ratio between the state's share of a given crop and the state's share in other universe. For the purposes of our study it can be assumed that a constant relationship between population and agricultural production results in a good comparative index, on a macro scale, leading to the adoption of population as the suitable universe.

The population share is given by $\frac{P_1}{P}$, the ratio of state to national population, so that the locational coefficient is finally defined as the ratio between the crop share and the population share for a given state.

Following are two tables, one providing the population share (P) and the second one with the locational coefficient (LC) values, for the 15 crops selected.

TABLE T.6 (II.b)

POPULATION WEIGHTS, FOR 48 STATES, U.S.A., 1960

State	% of U.S.	State	% of U.S.
1) Washington	1.6	25) Mississippi	1.2
2) Oregon	1.0	26) Alabama	1.8
3) California	8.8	27) Tennessee	2.0
4) Nevada	0.2	28) Kentucky	1.7
5) Idaho	0.4	29) Indiana	2.6
6) Utah	0.5	30) Michigan	4.4
7) Arizona	0.7	31) Ohio	5.4
8) New Mexico	0.5	32) West Virginia	1.0
9) Colorado	1.0	33) Georgia	2.2
10) Wyoming	0.2	34) Florida	2.8
11) Montana	0.4	35) South Carolina	1.3
12) North Dakota	0.4	36) North Carolina	2.5
13) South Dakota	0.4	37) Virginia	2.2
14) Nebraska	0.8	38) Maryland	1.7
15) Kansas	1.5	39) Delaware	0.3
16) Oklahoma	1.3	40) New Jersey	3.4
17) Texas	5.3	41) Pennsylvania	6.3
18) Louisiana	1.8	42) New York	9.4
19) Arkansas	1.0	43) Connecticut	1.4
20) Missouri	2.4	44) Rhode Island	0.5
21) Iowa	1.5	45) Massachusetts	2.9
22) Minnesota	1.9	46) Vermont	0.2
23) Wisconsin	2.2	47) New Hampshire	0.3
24) Illinois	5.6	48) Maine	0.5

Source: U.S. Census: Population, 1960.

TABLE T.7 (II.b)

LOCATIONAL COEFFICIENTS (LC) OF AGRICULTURAL PRODUCTION FOR 15 SELECTED CROPS, FOR 48 STATES, U.S.A., 1959

(Ratio of State's Share of Production to State's Share of Population)

State	Crop				
	Corn	Sorghum	Wheat	Oats	Barley
U. S. A.	1.00	1.00	1.00	1.00	1.00
1) Washington	0.13	0.06	4.50	0.75	5.06
2) Oregon	0.10	-	2.70	1.50	5.30
3) California	0.07	0.37	0.09	0.15	2.50
4) Nevada	-	-	0.50	-	0.50
5) Idaho	0.25	-	9.25	2.75	9.50
6) Utah	-	-	[illegible]	0.20	1.60
7) Arizona	-	1.86	0.43	-	3.43
8) New Mexico	-	3.00	0.80	-	0.40
9) Colorado	0.50	1.50	4.70	0.50	3.00
10) Wyoming	-	-	2.50	2.00	2.50
11) Montana	-	-	17.00	1.50	30.25
12) North Dakota	0.50	-	21.50	13.25	48.75
13) South Dakota	3.75	0.75	3.75	9.00	2.50
14) Nebraska	13.63	13.38	7.88	3.00	1.13
15) Kansas	1.47	13.67	12.73	0.87	2.67
16) Oklahoma	0.08	2.00	6.15	1.00	2.08
17) Texas	0.19	10.19	0.92	0.53	0.25
18) Louisiana	0.11	-	0.06	0.11	-
19) Arkansas	0.20	0.10	0.30	1.40	-
20) Missouri	2.00	1.25	1.42	0.33	0.21
21) Iowa	12.73	0.27	0.20	10.93	0.07
22) Minnesota	4.37	-	1.11	9.68	4.16
23) Wisconsin	0.95	-	0.09	2.41	0.14
24) Illinois	3.88	0.02	0.73	1.95	0.04

TABLE T.7 (II.b)--Continued

State	Crop (Continued)				
	Corn	Sorghum	Wheat	Oats	Barley
25) Mississippi	0.33	0.08	0.08	1.33	-
26) Alabama	0.44	-	0.06	0.22	-
27) Tennessee	0.40	0.05	0.15	0.15	0.05
28) Kentucky	0.71	0.06	0.24	0.06	0.06
29) Indiana	3.15	0.04	1.15	1.19	0.04
30) Michigan	0.57	-	0.75	0.82	0.09
31) Ohio	1.02	-	0.50	0.98	0.02
32) West Virginia	0.10	-	-	-	-
33) Georgia	0.54	-	0.09	0.59	-
34) Florida	0.07	-	-	-	-
35) South Carolina	0.23	-	0.15	1.23	0.08
36) North Carolina	0.72	0.12	0.24	0.40	0.08
37) Virginia	0.23	-	0.23	0.14	0.14
38) Maryland	0.41	-	0.18	0.06	0.18
39) Delaware	1.00	-	0.33	-	0.33
40) New Jersey	0.06	-	0.03	-	0.03
41) Pennsylvania	0.17	-	0.17	0.25	0.05
42) New York	0.03	-	0.07	0.22	0.01
43) Connecticut	-	-	-	-	-
44) Rhode Island	-	-	-	-	-
45) Massachusetts	-	-	-	-	-
46) Vermont	-	-	-	-	-
47) New Hampshire	-	-	-	-	-
48) Maine	-	-	-	1.00	-

TABLE I.7 (II.B)--Continued

State	Crop				
	Rice	Soybeans	Peanuts	Cotton	Tobacco
U. S. A.	1.00	1.00	1.00	1.00	1.00
1) Washington	-	-	-	-	-
2) Oregon	-	-	-	-	-
3) California	2.76	-	-	1.47	-
4) Nevada	-	-	-	-	-
5) Idaho	-	-	-	-	-
6) Utah	-	-	-	-	-
7) Arizona	-	-	-	7.14	-
8) New Mexico	-	-	1.40	4.40	-
9) Colorado	-	-	-	-	-
10) Wyoming	-	-	-	-	-
11) Montana	-	-	-	-	-
12) North Dakota	-	1.25	-	-	-
13) South Dakota	-	0.75	-	-	-
14) Nebraska	-	0.88	-	-	-
15) Kansas	-	1.13	-	-	-
16) Oklahoma	-	0.23	6.00	2.00	-
17) Texas	4.70	0.06	2.24	5.64	-
18) Louisiana	13.89	0.44	-	1.89	-
19) Arkansas	23.30	10.10	0.10	10.70	-
20) Missouri	0.13	3.83	-	1.46	0.13
21) Iowa	-	8.00	-	-	-
22) Minnesota	-	4.21	-	-	-
23) Wisconsin	-	0.18	-	-	0.59
24) Illinois	-	4.18	-	-	-

TABLE T.7 (II.b)--Continued

State	Crop (Continued)				
	Rice	Soybeans	Peanuts	Cotton	Tobacco
25) Mississippi	1.83	3.33	0.08	9.33	-
26) Alabama	-	0.28	5.89	2.72	-
27) Tennessee	-	0.80	-	2.25	3.70
28) Kentucky	-	0.47	-	0.06	12.00
29) Indiana	-	4.35	-	-	0.27
30) Michigan	-	0.23	-	-	-
31) Ohio	-	1.26	-	-	0.22
32) West Virginia	-	-	-	-	0.20
33) Georgia	-	0.09	15.95	1.73	2.73
34) Florida	-	0.04	1.14	0.04	0.50
35) South Carolina	-	1.00	0.46	2.31	6.08
36) North Carolina	-	0.64	6.96	0.92	15.92
37) Virginia	-	0.50	5.73	0.05	3.55
38) Maryland	-	0.47	-	-	1.18
39) Delaware	-	2.00	-	-	-
40) New Jersey	-	0.03	-	-	-
41) Pennsylvania	-	-	-	-	0.44
42) New York	-	-	-	-	-
43) Connecticut	-	-	-	-	0.57
44) Rhode Island	-	-	-	-	-
45) Massachusetts	-	-	-	-	0.14
46) Vermont	-	-	-	-	-
47) New Hampshire	-	-	-	-	-
48) Maine	-	-	-	-	-

TABLE T.7 (II.b)--Continued

State	Crop				
	Sugar beets	Irish Potatoes	Vegetables	Berries	Nuts & Fruits
U. S. A.	1.00	1.00	1.00	1.00	1.00
1) Washington	2.75	2.31	1.69	5.75	3.69
2) Oregon	3.00	3.80	3.00	14.00	2.10
3) California	3.23	1.17	4.13	3.00	4.88
4) Nevada	0.50	0.50	0.50	-	-
5) Idaho	29.00	45.00	1.25	0.50	1.25
6) Utah	6.60	1.20	0.80	0.80	0.40
7) Arizona	-	0.86	7.14	0.14	1.00
8) New Mexico	0.20	0.20	0.80	-	0.40
9) Colorado	14.50	4.70	1.40	-	0.50
10) Wyoming	17.50	1.50	-	-	-
11) Montana	12.75	1.25	-	0.25	0.25
12) North Dakota	6.75	13.50	-	-	-
13) South Dakota	1.25	0.50	-	-	-
14) Nebraska	8.00	1.38	0.13	-	-
15) Kansas	0.53	0.07	0.07	0.13	0.07
16) Oklahoma	-	0.08	0.23	0.38	0.08
17) Texas	0.04	0.21	0.81	0.13	0.21
18) Louisiana	-	0.06	0.17	1.00	0.11
19) Arkansas	-	0.20	0.40	2.80	0.40
20) Missouri	-	0.08	0.17	0.29	0.13
21) Iowa	0.07	0.13	0.20	0.13	0.07
22) Minnesota	2.79	2.63	0.74	0.21	0.05
23) Wisconsin	0.27	1.64	1.18	2.09	0.18
24) Illinois	0.04	0.02	0.36	0.20	0.09

TABLE T.7 (II.b)--Continued

State	Crop (Continued)				
	Sugar beets	Irisn Potatoes	Vegetables	Berries	Nuts & Fruits
25) Mississippi	-	0.08	0.25	0.08	0.33
26) Alabama	-	0.39	0.28	0.22	0.17
27) Tennessee	-	0.20	0.35	1.05	0.05
28) Kentucky	-	0.24	0.06	0.41	0.06
29) Indiana	-	0.27	0.54	0.23	0.15
30) Michigan	1.61	0.70	0.61	2.20	0.80
31) Ohio	0.41	0.22	0.39	0.22	0.15
32) West Virginia	-	0.20	0.10	0.20	0.80
33) Georgia	-	0.05	0.41	0.05	0.59
34) Florida	-	0.54	3.96	0.25	8.93
35) South Carolina	-	0.15	0.85	0.08	0.92
36) North Carolina	-	0.52	0.44	0.76	0.16
37) Virginia	-	0.59	0.55	0.50	0.64
38) Maryland	-	0.12	0.76	0.24	0.18
39) Delaware	-	2.33	2.00	0.33	-
40) New Jersey	-	0.56	1.21	1.76	0.26
41) Pennsylvania	-	0.51	0.27	-	0.30
42) New York	-	0.77	0.52	0.32	0.34
43) Connecticut	-	0.43	0.29	0.21	0.14
44) Rhode Island	-	1.00	0.20	-	-
45) Massachusetts	-	0.17	0.24	1.55	0.14
46) Vermont	-	1.00	0.50	0.50	0.50
47) New Hampshire	-	0.33	0.33	0.67	0.66
48) Maine	-	28.60	0.60	4.20	0.60

Source: Estimated by the author, with data from Tables T.5 (II.b) and T.6 (II.b).

Total Locational Distribution

According to the discussion in the theoretical section of this chapter (II.1), the use of the locational coefficient is mainly for intra-state studies, as it does not permit absolute inter-state comparisons, due to the differences in states' size. For the purpose of the present study, it is necessary to establish the total effects of the production of each state, and thus, when the locational coefficient is affected by the state's weight--population in this case-- we obtain again the value of the state's share of production [see Table T.5 (II.b)] [2]

This set of index values will be the actual data used to analyze the total locational distribution of agricultural production in the U.S.A.; and for the purpose of summarizing only this index, the following table is included.

It must be noticed that it is possible now to make inter-state comparative studies for a given crop, and for this reason the mappings--based on Table T.8 (II.b)--are offered by individual crops.

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[2] Though for the purposes of studying the total locational distribution it is not necessary to estimate the locational coefficients; they are included because of their future use in the analysis of regional specialization (see Chapters IV and V).

TABLE T.8 (II.b)

TOTAL LOCATIONAL DISTRIBUTION (TLD) OF AGRICULTURAL PRODUCTION, FOR 15 SELECTED CROPS, FOR 48 STATES, U.S.A., 1959

(Locational Coefficient times population "weight." Equal to State's Share)

State	Crop				
	Corn	Sorghum	Wheat	Oats	Barley
1) Washington	0.21	0.10	7.20	1.20	8.10
2) Oregon	0.10	-	2.70	1.50	5.30
3) California	0.62	3.26	0.79	1.32	22.00
4) Nevada	-	-	0.10	-	0.10
5) Idaho	0.10	-	3.70	1.10	3.80
6) Utah	-	-	0.50	0.10	0.80
7) Arizona	-	1.30	0.30	-	2.40
8) New Mexico	-	1.50	0.40	-	0.20
9) Colorado	0.50	1.50	4.70	0.50	3.00
10) Wyoming	-	-	0.50	0.40	0.50
11) Montana	-	-	6.80	0.60	12.10
12) North Dakota	0.20	-	8.60	5.30	19.50
13) South Dakota	1.50	0.30	1.50	3.60	1.00
14) Nebraska	10.90	10.70	6.30	2.40	0.90
15) Kansas	2.21	20.51	19.10	1.31	4.01
16) Oklahoma	0.10	2.60	8.00	1.30	2.70
17) Texas	1.01	54.01	4.88	2.81	1.33
18) Louisiana	0.20	-	0.11	0.20	-
19) Arkansas	0.20	0.10	0.30	1.40	-
20) Missouri	4.80	3.00	3.41	0.79	0.50
21) Iowa	19.10	0.41	0.30	16.40	0.11
22) Minnesota	8.30	-	2.11	18.39	7.90
23) Wisconsin	2.09	-	0.19	5.30	0.31
24) Illinois	21.73	0.11	4.09	10.92	0.22

TABLE T.3 (II.b)--Continued

State	Crop (Continued)				
	Corn	Sorghum	Wheat	Oats	Barley
25) Mississippi	0.40	0.10	0.10	1.60	-
26) Alabama	0.79	-	0.11	0.40	-
27) Tennessee	0.80	0.10	0.30	0.30	0.10
28) Kentucky	1.21	0.10	0.41	0.10	0.10
29) Indiana	8.19	0.10	2.99	3.09	0.10
30) Michigan	2.51	-	3.30	3.61	0.40
31) Ohio	5.51	-	2.70	5.29	0.11
32) West Virginia	0.10	-	-	-	-
33) Georgia	1.19	-	0.20	1.30	-
34) Florida	0.20	-	-	-	-
35) South Carolina	0.30	-	0.20	1.60	0.10
36) North Carolina	1.80	0.30	0.60	1.00	0.20
37) Virginia	0.51	-	0.51	0.31	0.31
38) Maryland	0.70	-	0.31	0.10	0.31
39) Delaware	0.30	-	0.10	-	0.10
40) New Jersey	0.20	-	0.10	-	0.10
41) Pennsylvania	1.07	-	1.07	1.58	0.32
42) New York	0.28	-	0.66	2.07	0.09
43) Connecticut	-	-	-	-	-
44) Rhode Island	-	-	-	-	-
45) Massachusetts	-	-	-	-	-
46) Vermont	-	-	-	-	-
47) New Hampshire	-	-	-	-	-
48) Maine	-	-	-	0.50	-

TABLE T.8 (II.b)--Continued

State	Crop				
	Rice	Soybeans	Peanuts	Cotton	Tobacco
1) Washington	-	-	-	-	-
2) Oregon	-	-	-	-	-
3) California	24.29	-	-	12.94	-
4) Nevada	-	-	-	-	-
5) Idaho	-	-	-	-	-
6) Utah	-	-	-	-	-
7) Arizona	-	-	-	5.00	-
8) New Mexico	-	-	0.70	2.20	-
9) Colorado	-	-	-	-	-
10) Wyoming	-	-	-	-	-
11) Montana	-	-	-	-	-
12) North Dakota	-	0.50	-	-	-
13) South Dakota	-	0.30	-	-	-
14) Nebraska	-	0.70	-	-	-
15) Kansas	-	1.70	-	-	-
16) Oklahoma	-	0.30	7.80	2.60	-
17) Texas	24.91	0.32	11.87	29.89	-
18) Louisiana	25.00	0.79	-	3.40	-
19) Arkansas	23.20	10.10	0.10	10.70	-
20) Missouri	0.31	9.19	-	3.50	0.31
21) Iowa	-	12.00	-	-	-
22) Minnesota	-	8.00	-	-	-
23) Wisconsin	-	0.40	-	-	1.30
24) Illinois	-	23.41	-	-	-

TABLE T.3 (II.b)--Continued

State	Crop (Continued)				
	Rice	Soybeans	Peanuts	Cotton	Tobacco
25) Mississippi	2.20	4.00	0.10	11.20	-
26) Alabama	-	0.50	10.60	4.90	-
27) Tennessee	-	1.60	-	4.50	7.40
28) Kentucky	-	0.80	-	0.10	20.40
29) Indiana	-	11.31	-	-	0.70
30) Michigan	-	1.01	-	-	-
31) Ohio	-	6.80	-	-	1.19
32) West Virginia	-	-	-	-	0.20
33) Georgia	-	0.20	35.09	3.81	6.01
34) Florida	-	0.11	3.19	0.11	1.40
35) South Carolina	-	1.30	0.60	3.00	7.90
36) North Carolina	-	1.60	17.40	2.30	39.80
37) Virginia	-	1.10	12.61	0.11	7.81
38) Maryland	-	0.80	-	-	2.01
39) Delaware	-	0.60	-	-	-
40) New Jersey	-	0.10	-	-	-
41) Pennsylvania	-	-	-	-	2.77
42) New York	-	-	-	-	-
43) Connecticut	-	-	-	-	0.80
44) Rhode Island	-	-	-	-	-
45) Massachusetts	-	-	-	-	0.41
46) Vermont	-	-	-	-	-
47) New Hampshire	-	-	-	-	-
48) Maine	-	-	-	-	-

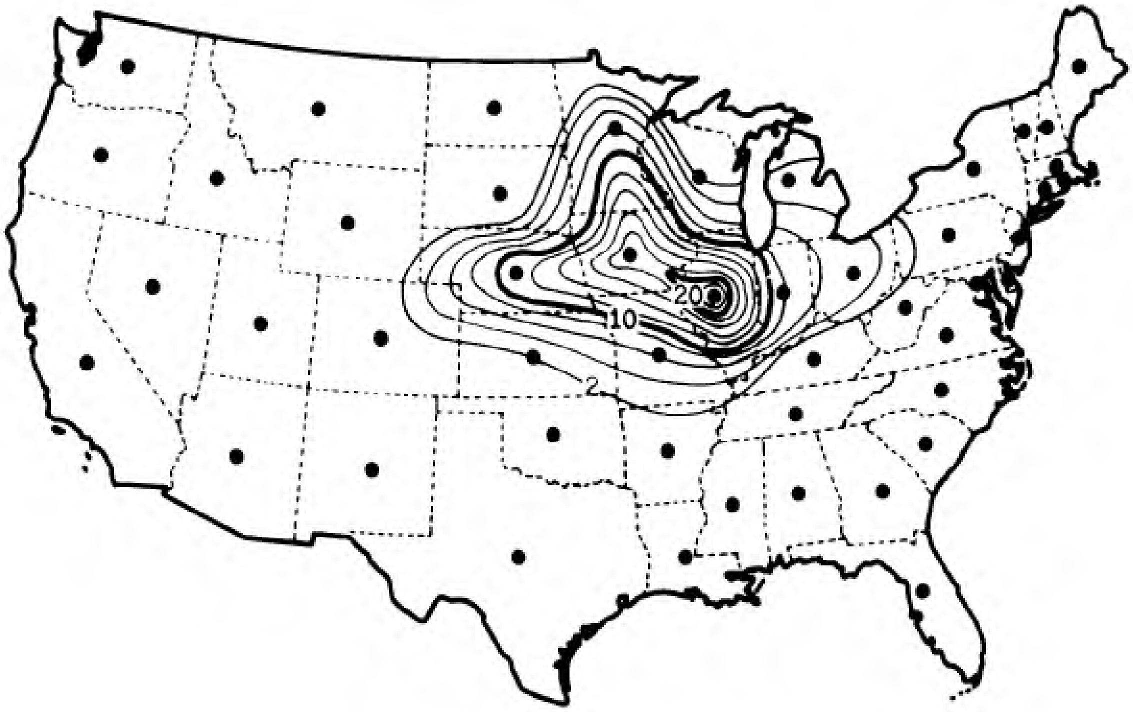
TABLE T.8 (II.b)--Continued

State	Crop				
	Sugar beets	Irish Potatoes	Vegetables	Berries	Fruits & Nuts
1) Washington	4.40	3.70	2.70	9.20	5.90
2) Oregon	3.00	3.80	3.00	14.00	2.10
3) California	28.42	10.30	36.34	26.40	42.94
4) Nevada	0.10	0.10	0.10	-	-
5) Idaho	11.60	18.00	0.50	0.20	0.50
6) Utah	3.30	0.60	0.40	0.40	0.20
7) Arizona	-	0.60	5.00	0.10	0.70
8) New Mexico	0.10	0.10	0.40	-	0.20
9) Colorado	14.50	4.70	1.40	-	0.50
10) Wyoming	3.50	0.30	-	-	-
11) Montana	5.10	0.50	-	0.10	0.10
12) North Dakota	2.70	5.40	-	-	-
13) South Dakota	0.50	0.20	-	-	-
14) Nebraska	6.40	1.10	0.10	-	-
15) Kansas	0.80	0.11	0.11	0.20	0.11
16) Oklahoma	-	0.10	0.30	0.49	0.10
17) Texas	0.21	1.11	4.29	0.69	1.11
18) Louisiana	-	0.11	0.31	1.80	0.20
19) Arkansas	-	0.20	0.40	2.80	0.40
20) Missouri	-	0.19	0.41	0.70	0.31
21) Iowa	0.11	0.20	0.30	0.20	0.11
22) Minnesota	5.30	5.00	1.41	0.40	0.10
23) Wisconsin	0.59	3.61	2.60	4.60	0.40
24) Illinois	0.22	0.11	2.02	1.12	0.50

TABLE T. (II.b)--Continued

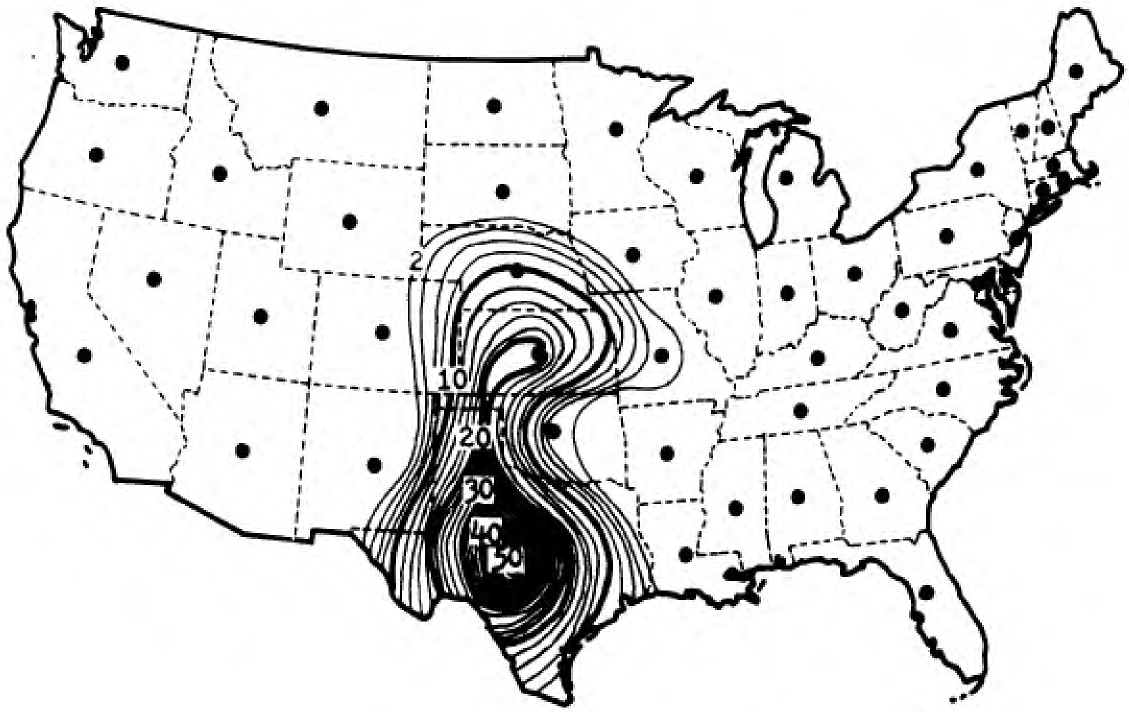
State	Crop (Continued)				
	Sugar beets	Irish Potatoes	Vegetables	Berries	Fruits & Nuts
25) Mississippi		0.10	0.30	0.10	0.40
26) Alabama		0.70	0.50	0.40	0.31
27) Tennessee		0.40	0.70	2.10	0.10
28) Kentucky		0.41	0.10	0.70	0.10
29) Indiana		0.70	1.40	0.60	0.39
30) Michigan	7.08	3.08	2.68	9.68	3.52
31) Ohio	2.21	1.19	2.11	1.19	0.81
32) West Virginia		0.20	0.10	0.20	0.80
33) Georgia		0.11	0.90	0.11	1.30
34) Florida		1.51	11.09	0.70	25.00
35) South Carolina		0.20	1.11	0.10	1.20
36) North Carolina		1.30	1.10	1.90	0.40
37) Virginia		1.30	1.21	1.10	1.41
38) Maryland		0.20	1.29	0.41	0.31
39) Delaware		0.70	0.60	0.10	-
40) New Jersey		1.90	4.11	5.98	0.88
41) Pennsylvania		3.21	1.70	-	1.89
42) New York		7.24	4.89	3.01	3.20
43) Connecticut		0.60	0.41	0.29	0.20
44) Rhode Island		0.50	0.10	-	-
45) Massachusetts		0.49	0.70	4.50	0.41
46) Vermont		0.20	0.10	0.10	0.10
47) New Hampshire		0.10	0.10	0.20	0.20
48) Maine		14.30	0.30	2.10	0.30

Source: Estimated by the author, with data from Tables T.5 (II.b) and T.6 (II.b).



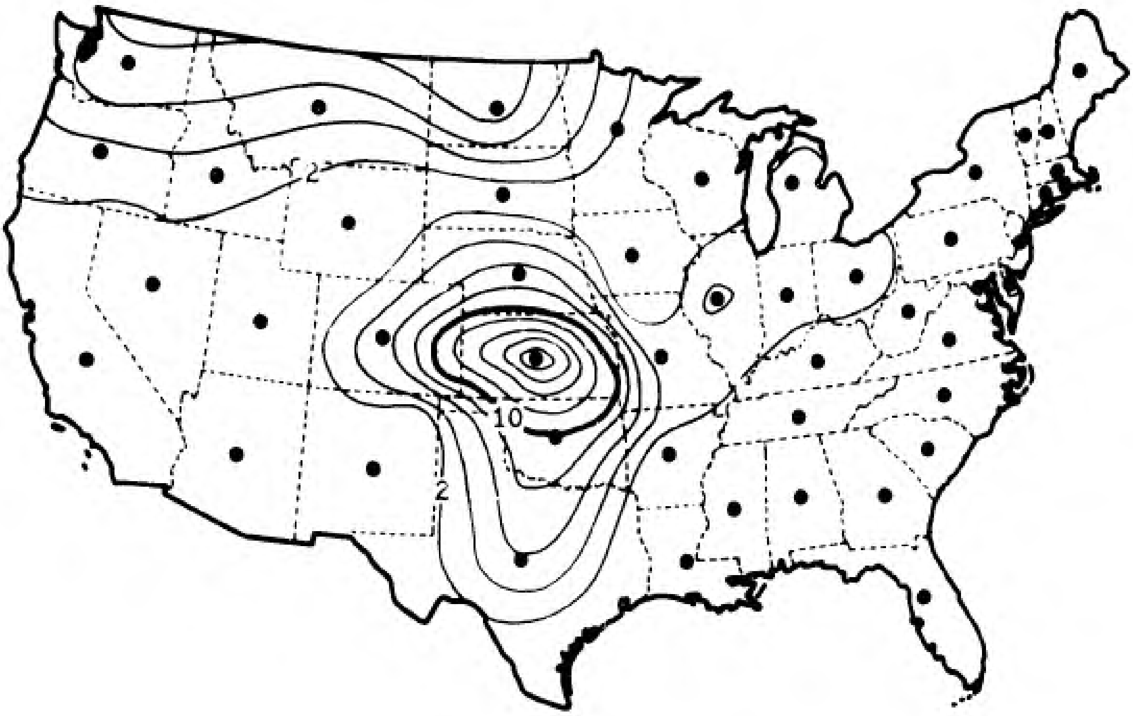
Map M.6 (II.b):
Total Locational Distribution of CORN

0 500 miles



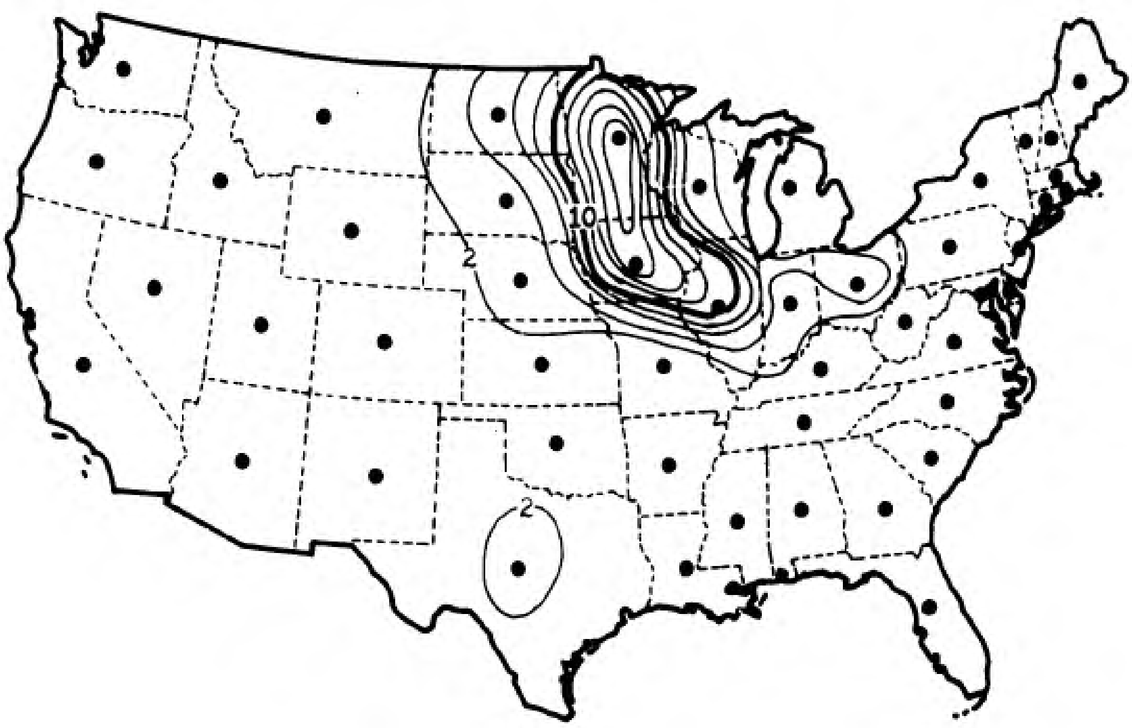
Map M.7 (II.b):
Total Locational Distribution of SORGHUM

by States, U.S.A., 1959
Contour levels each 2.00
TLD coefficient value



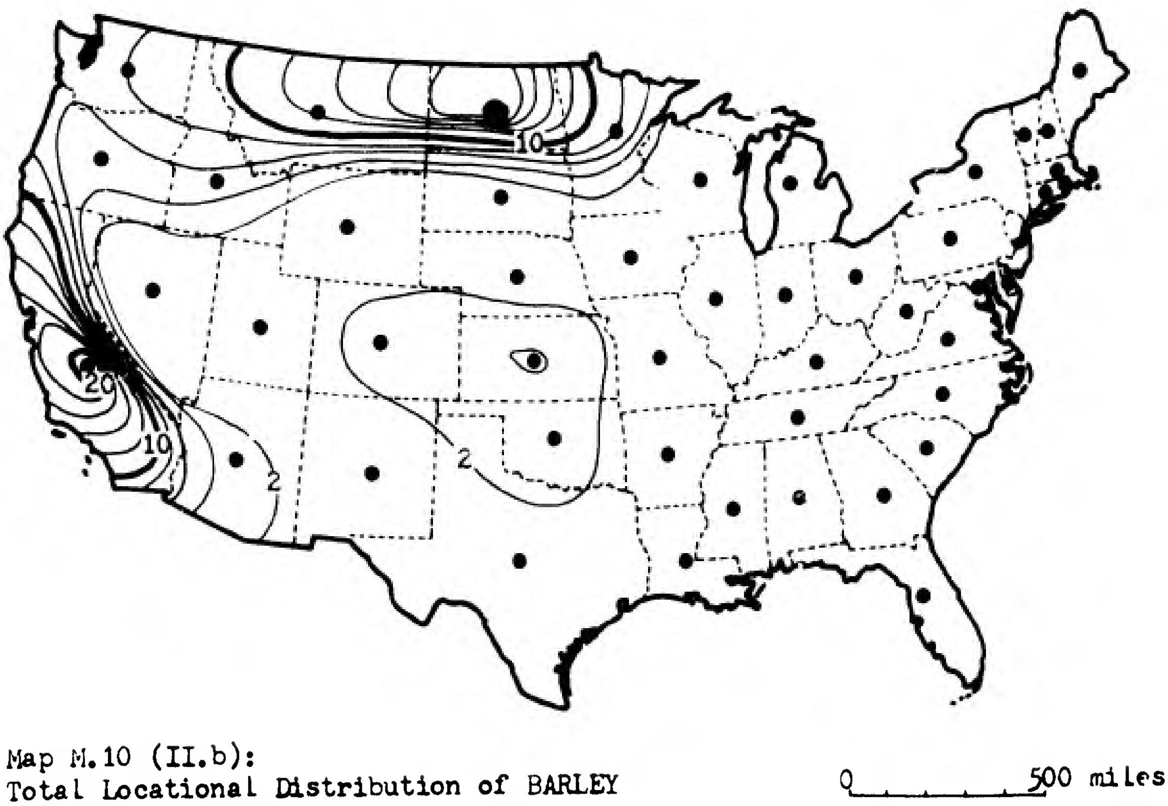
Map [illegible] (II.b):
Total Locational Distribution of WHEAT

0 500 miles

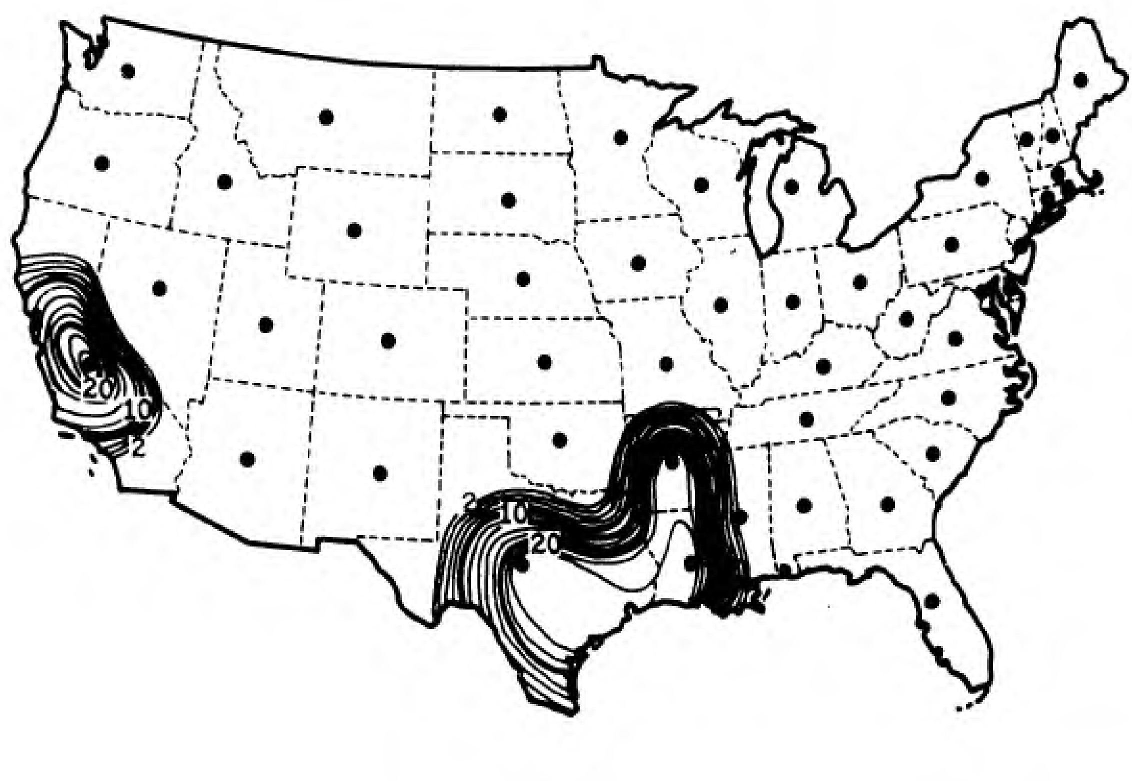


Map A.9 (II.b):
Total Locational Distribution of OATS

by States, U.S.A., 1959
Contour Levels each 2.00
TLD coefficient value

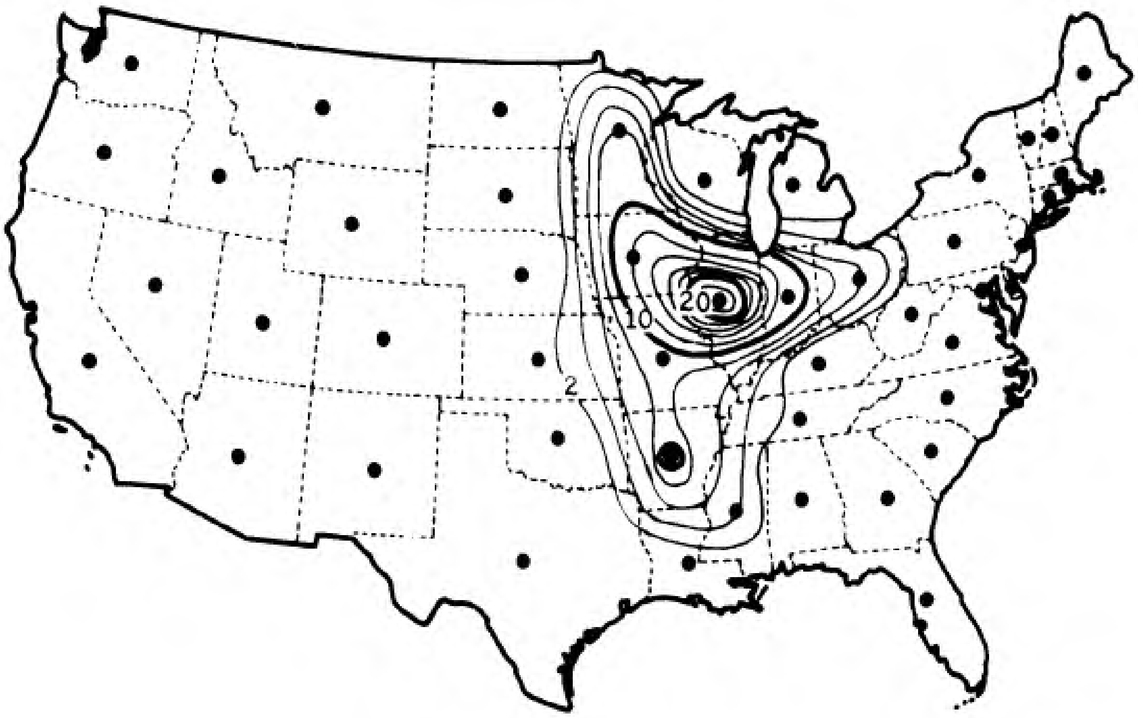


Map M.10 (II.b):
Total Locational Distribution of BARLEY



Map M.11 (II.b):
Total Locational Distribution of RICE

By States, U.S.A., 1959
Contour levels each 2.00
TLD coefficient value

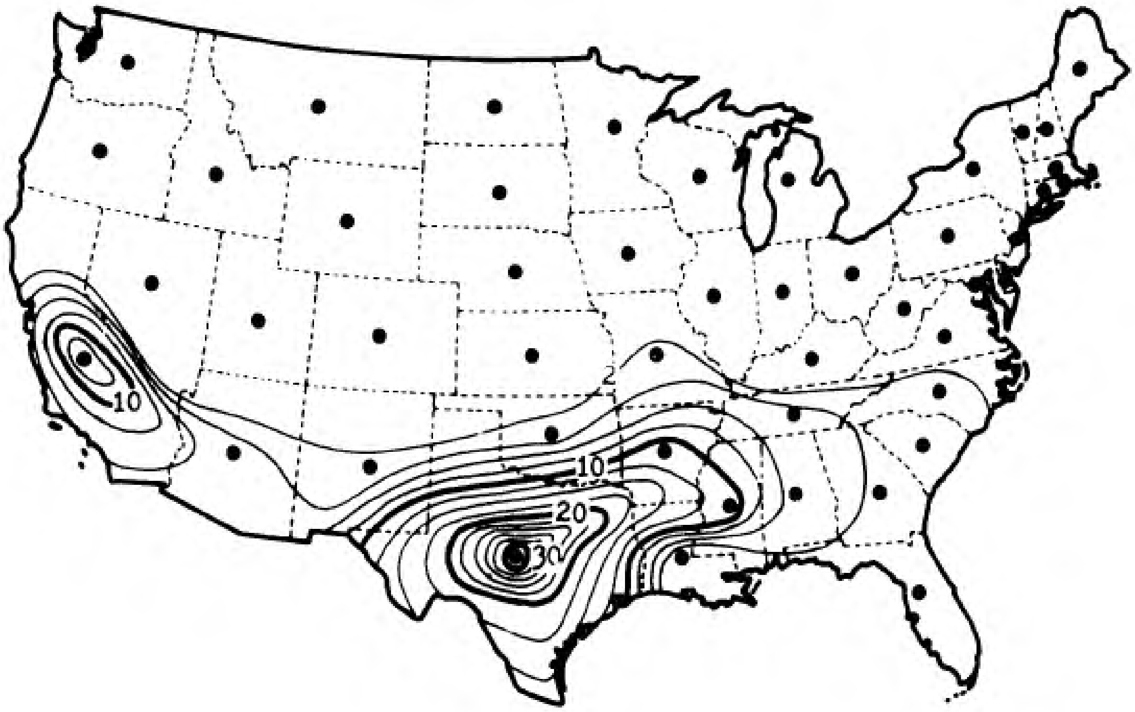


Map M.12 (II.b):
Total Locational Distribution of SOYBEANS

0 500 miles

Map M.13 (II.b):
Total Locational Distribution of PEANUTS

by States, U.S.A., 1959
Contour levels each 2.00
TLD coefficient value

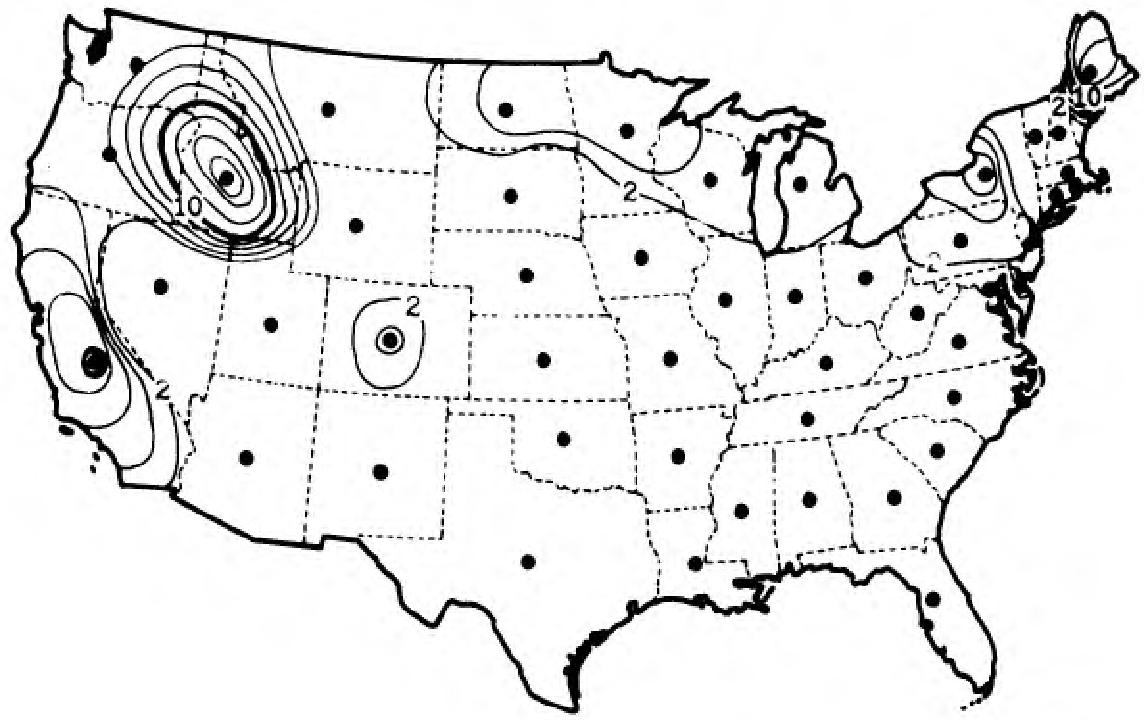


Map M.14 (II.b):
Total Locational Distribution of COTTON

0 500 miles

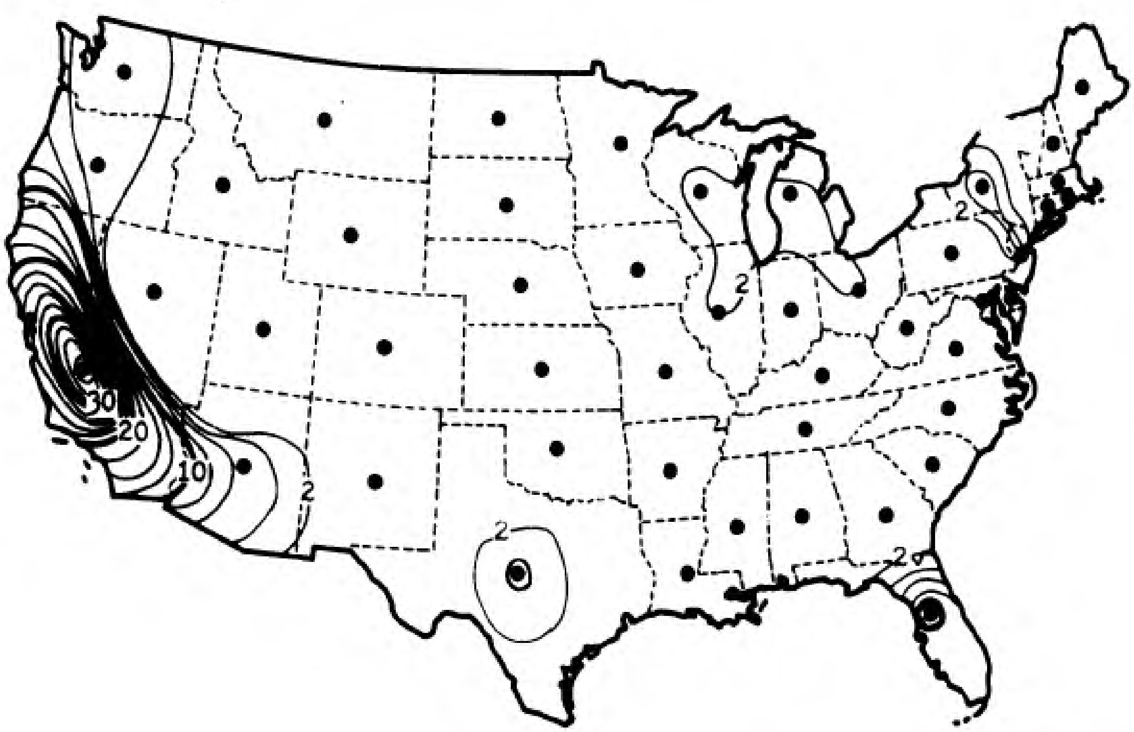
Map M.15 (II.b):
Total Locational Distribution of TOBACCO

by States, U.S.A., 1959
Contour levels each 2.00
TLD coefficient value



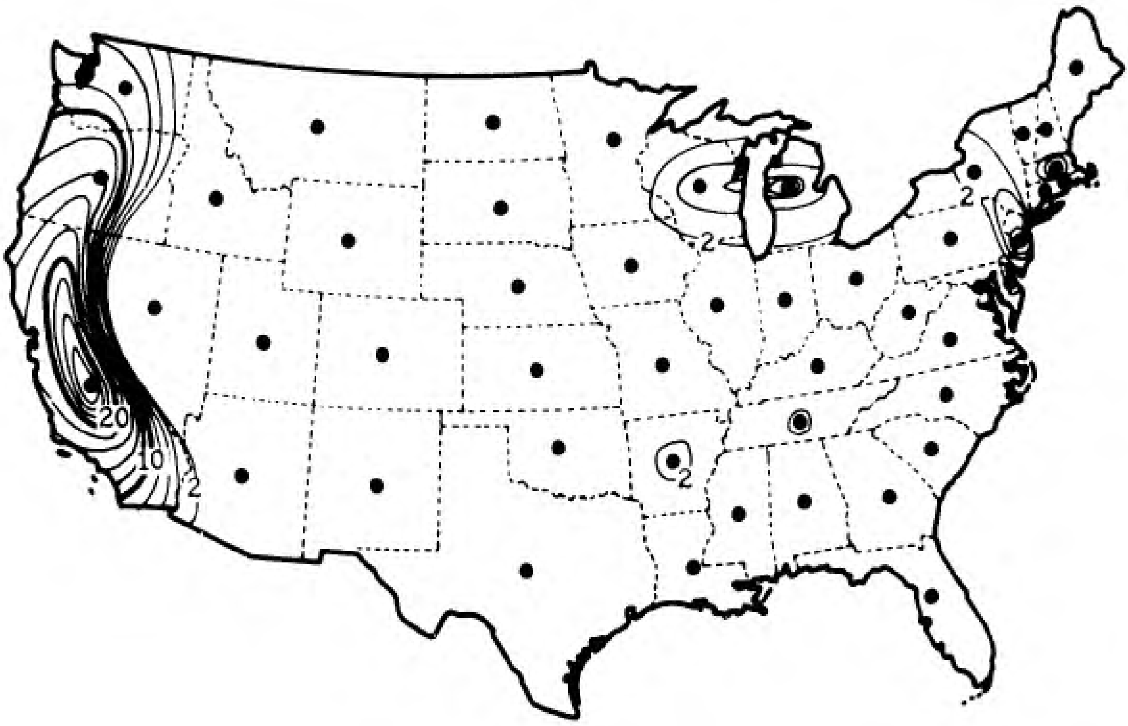
Map No. 16 (II.b):
Total Locational Distribution of POTATOES

0 500 miles



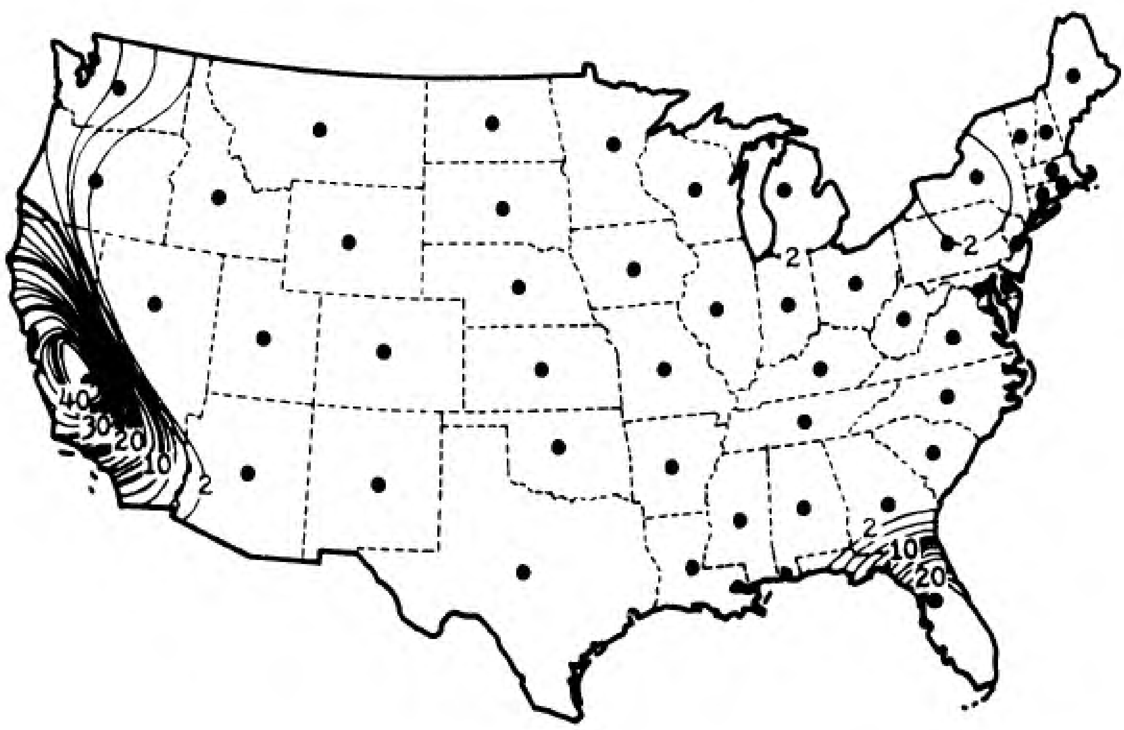
Map No. 17 (II.b):
Total Locational Distribution of VEGETABLES

by States, U.S.A., 1959
Contour levels each 2.00
LQ coefficient value



Map M.18 (II.b):
Total Locational Distribution of BERRIES

0 500 miles



Map M.19 (II.b):
Total Locational Distribution of FRUITS

by States, U.S.A., 1959
Contour levels each 2.00
TLD coefficient value

2b. Areal Revenues

Individual Crops

The estimation of the values of Areal Revenues in the U.S.A., for the 15 selected crops and in the 48 states, is based on information provided by the U.S. Census of Agriculture, 1959.

The Census have tabulated data of total sales, total acreage and percentage of crop sold in the market. It is possible then, to estimate the acreage devoted to the sold portion of the crop, by assuming a constant yield in both, the sector oriented for sale and in the one oriented to farm consumption.

The ratio of sales to acreage devoted to sold crop results in the Areal Revenue for the selected crop in the given area, expressed in $/acre.

This computational process is tabulated below.

TABLE T.9 (II.b)

ACREAGE, SALES AND AREAL REVENUES OF AGRICULTURAL PRODUCTION, FOR 15 SELECTED CROPS, FOR 48 STATES, U.S.A., 1959

State	Corn				
	Total Acreage (10^6)	% of Crop Sold	Acreage Devoted to Sold Crop (10^6)	Total Sales ($\$.10^6$)	Areal Revenues ($/acre)
1) Washington	.088	82.6	.073	5.677	77.77
2) Oregon	.052	63.2	.033	1.674	50.73
3) California	.256	92.5	.237	14.284	60.27
5) Idaho	.078	49.8	.039	1.189	30.49
9) Colorado	.474	61.0	.289	10.573	36.58
12) North Dakota	1.310	51.8	.679	3.500	5.16
13) South Dakota	4.101	40.5	1.661	24.980	15.04
14) Nebraska	6.694	59.5	3.983	193.756	48.64
15) Kansas	1.870	52.7	.985	38.701	39.29
16) Oklahoma	212	33.0	.070	2.263	32.33
17) Texas	1.415	45.2	.640	18.382	28.72
18) Louisiana	.397	27.1	.108	3.512	32.52
19) Arkansas	.379	26.0	.099	3.251	32.84
20) Missouri	4.139	40.3	1.668	84.988	50.95
21) Iowa	12.398	41.6	5.158	317.875	61.63
22) Minnesota	6.896	47.6	3.282	134.110	40.86
23) Wisconsin	2.823	26.2	.740	36.180	48.89
24) Illinois	10.034	56.7	5.689	398.345	70.02
25) Mississippi	1.151	22.3	.257	8.317	32.36
26) Alabama	1.867	34.3	.640	16.056	25.09
27) Tennessee	1.417	26.4	.374	14.760	39.47
28) Kentucky	1.650	28.0	.462	21.618	46.79
29) Indiana	5.103	45.3	2.312	146.669	63.44
30) Michigan	1.956	48.3	.945	44.901	47.51
31) Ohio	3.589	44.0	1.579	96.501	61.12
32) West Virginia	.119	20.0	.024	1.176	49.00
33) Georgia	2.428	42.2	1.025	24.155	23.56
34) Florida	.493	36.9	.172	3.132	18.21
35) South Carolina	.777	30.6	.238	6.533	27.45
36) North Carolina	1.812	44.3	.803	35.910	44.72
37) Virginia	.728	32.5	.237	11.240	47.43
38) Maryland	.462	55.5	.256	14.135	55.20
39) Delaware	.148	71.9	.106	6.324	59.66
40) New Jersey	.141	54.7	.077	4.374	56.81
41) Pennsylvania	1.134	35.2	.399	23.204	58.15
42) New York	.623	41.6	.259	6.213	24.00

TABLE T.9 (II.b)--Continued

State	Sorghum				
	Total Acreage (10^6)	% of Crop Sold	Acreage Devoted to Sold Crop (10^6)	Total Sales ($\$.10^6$)	Areal Revenues ($/acre)
1) Washington	.007	92.8	.006	.433	72.17
3) California	.215	90.3	.194	14.133	72.85
7) Arizona	.101	86.1	.087	5.709	65.62
8) New Mexico	.214	81.5	.174	5.159	29.65
9) Colorado	.384	65.0	.250	4.698	18.79
13) South Dakota	.140	39.1	.055	.992	18.04
14) Nebraska	1.393	68.3	.951	32.707	34.39
15) Kansas	3.835	63.4	2.431	61.258	25.20
16) Oklahoma	.721	56.9	.410	8.284	20.20
17) Texas	6.725	87.6	5.891	184.798	31.37
19) Arkansas	.030	42.6	.013	.348	26.77
20) Missouri	.478	55.1	.263	9.606	36.52
21) Iowa	.061	45.9	.028	1.249	44.61
24) Illinois	.018	47.1	.008	.368	46.00
25) Mississippi	.020	45.2	.009	.295	32.78
27) Tennessee	.035	20.1	.007	.251	35.86
28) Kentucky	.023	23.1	.005	.226	45.20
29) Indiana	.015	53.8	.008	.393	49.13
36) North Carolina	.073	45.7	.033	1.136	34.42

TABLE T.9 (II.b)--Continued

State	Wheat				
	Total Acreage (10^6)	% of Crop Sold	Acreage Devoted to Sold Crop (10^6)	Total Sales ($.10^6$)	Areal Revenues ($/acre)
1) Washington	1.911	95.7	1.829	122.092	66.74
2) Oregon	.781	96.3	.752	48.371	64.32
3) California	.338	96.1	.325	13.902	42.78
4) Nevada	.020	85.6	.017	.820	48.24
5) Idaho	1.087	95.6	1.039	60.071	57.82
6) Utah	.226	90.4	.204	7.958	39.01
7) Arizona	.073	98.9	.072	5.002	69.47
8) New Mexico	.213	94.0	.200	5.940	29.70
9) Colorado	2.241	93.4	2.093	78.486	37.50
10) Wyoming	.243	93.4	.227	8.185	36.06
11) Montana	3.729	93.4	3.483	109.505	31.44
12) North Dakota	6.434	89.5	5.758	163.981	28.48
13) South Dakota	1.875	85.2	1.598	27.375	17.13
14) Nebraska	2.994	94.2	2.820	108.282	38.40
15) Kansas	9.856	94.2	9.284	338.490	36.46
16) Oklahoma	4.321	94.0	4.062	139.358	34.31
17) Texas	3.031	95.1	2.882	84.803	29.43
18) Louisiana	.032	94.0	.030	1.166	38.87
19) Arkansas	.116	93.7	.109	4.831	44.32
20) Missouri	1.472	94.0	1.384	58.423	42.21
21) Iowa	.164	91.0	.149	5.187	34.81
22) Minnesota	.947	93.8	.888	39.482	44.01
23) Wisconsin	.059	81.6	.048	2.564	53.42
24) Illinois	1.642	95.2	1.563	71.975	46.05
25) Mississippi	.031	92.3	.029	1.288	44.41
26) Alabama	.047	89.5	.042	1.686	40.14
27) Tennessee	.157	77.3	.121	4.743	39.20
28) Kentucky	.158	87.3	.138	5.926	42.94
29) Indiana	1.197	93.5	1.119	49.758	44.47
30) Michigan	1.076	92.9	1.000	57.209	57.21
31) Ohio	1.226	88.5	1.085	45.702	42.12
33) Georgia	.095	78.1	.074	2.817	38.07
35) South Carolina	.158	75.6	.119	4.240	35.63
36) North Carolina	.368	70.3	.259	10.714	41.37
37) Virginia	.254	73.0	.185	7.658	41.39
38) Maryland	.150	87.9	.132	5.441	41.22
39) Delaware	.024	92.4	.022	.983	44.68
40) New Jersey	.043	92.0	.040	2.143	53.58
41) Pennsylvania	.501	79.2	.397	17.477	44.02
42) New York	.242	90.0	.218	11.440	52.48

TABLE T.9 (II.b)--Continued

State	Oats				
	Total Acreage (10^6)	% of Crop Sold	Acreage Devoted to Sold Crop (10^6)	Total Sales ($.10^6$)	Areal Revenues ($/acre)
1) Washington	.137	56.2	.077	2.232	28.99
3) California	.130	33.6	.109	2.803	25.72
5) Idaho	.128	52.9	.068	2.047	30.10
6) Utah	.019	20.2	.004	.147	36.75
9) Colorado	.106	34.2	.036	.918	25.50
10) Wyoming	.093	33.0	.031	.648	20.90
11) Montana	.232	25.7	.060	1.057	17.62
12) North Dakota	1.600	37.9	.606	7.855	12.96
13) South Dakota	2.019	25.1	.507	5.792	11.42
14) Nebraska	1.259	21.5	.271	4.208	15.53
15) Kansas	.667	22.8	.152	2.387	15.70
16) Oklahoma	.498	30.5	.152	2.346	15.43
17) Texas	.861	41.4	.356	5.250	14.75
18) Louisiana	.057	27.2	.016	.386	24.13
19) Arkansas	.145	69.1	.100	2.643	26.43
20) Missouri	.595	14.1	.084	1.476	17.57
21) Iowa	4.208	25.0	1.052	28.489	27.08
22) Minnesota	3.568	32.7	1.167	30.854	26.44
23) Wisconsin	2.383	12.2	.291	9.335	32.08
24) Illinois	2.093	35.4	.741	20.064	27.08
25) Mississippi	.187	62.5	.117	3.433	29.34
26) Alabama	.090	36.5	.033	.911	27.61
27) Tennessee	.126	22.6	.028	.753	26.89
28) Kentucky	.050	18.2	.009	.221	24.56
29) Indiana	.867	25.9	.225	5.624	25.00
30) Michigan	.852	27.6	.235	6.510	27.70
31) Ohio	1.064	31.2	.332	9.709	29.24
33) Georgia	.233	46.6	.109	2.710	24.86
35) South Carolina	.336	44.6	.150	3.285	21.90
36) North Carolina	.276	29.1	.080	1.962	24.52
37) Virginia	.102	18.9	.019	.526	27.68
38) Maryland	.053	9.1	.005	.144	28.80
41) Pennsylvania	.631	16.0	.101	3.237	32.05
42) New York	.613	17.9	.110	4.229	38.45
43) Maine	.052	64.9	.034	.991	29.15

TABLE T.9 (II.b)--Continued

State	Barley				
	Total Acreage (10^6)	% of Crop Sold	Acreage Devoted to Sold Crop (10^6)	Total Sales ($.10^6)	Areal Revenues ($/acre)
1) Washington	.674	84.9	.572	19.326	34.66
2) Oregon	.502	80.1	.402	14.960	37.21
3) California	1.508	90.2	1.360	62.565	46.00
4) Nevada	.012	37.9	.005	.223	44.60
5) Idaho	.500	68.9	.345	9.465	27.43
6) Utah	.144	32.6	.047	2.253	47.93
7) Arizona	.133	80.9	.108	7.642	70.76
8) New Mexico	.029	62.7	.018	.619	34.39
9) Colorado	.509	56.6	.288	6.386	22.17
10) Wyoming	.108	40.6	.044	1.161	26.38
11) Montana	1.743	70.9	1.236	22.702	18.36
12) North Dakota	3.762	75.7	2.848	43.189	15.16
13) South Dakota	.429	48.3	.207	2.233	10.79
14) Nebraska	.308	38.9	.120	1.932	16.10
15) Kansas	.874	49.4	.432	8.287	19.18
16) Oklahoma	.611	55.5	.339	5.597	16.51
17) Texas	.267	67.6	.180	3.020	16.78
20) Missouri	.201	22.1	.044	1.049	23.84
21) Iowa	.028	29.5	.008	.237	29.63
22) Minnesota	.952	81.6	.777	19.072	24.54
23) Wisconsin	.039	47.6	.019	.711	37.42
24) Illinois	.069	34.4	.024	.496	20.66
27) Tennessee	.044	18.8	.008	.190	23.75
28) Kentucky	.067	20.2	.014	.372	26.57
29) Indiana	.052	19.2	.010	.225	22.50
30) Michigan	.082	38.0	.031	.835	26.94
31) Ohio	.056	21.9	.012	.312	26.00
35) South Carolina	.034	35.2	.012	.328	27.33
36) North Carolina	.060	29.2	.018	.631	35.06
37) Virginia	.105	21.5	.023	.876	38.09
38) Maryland	.073	33.4	.024	.849	35.38
39) Delaware	.013	57.6	.007	.264	37.71
40) New Jersey	.021	52.2	.011	.438	39.82
41) Pennsylvania	.133	22.9	.030	.893	29.77
42) New York	.025	39.2	.010	.286	28.60

TABLE 7.9 (II.b)--Continued

State	Rice				
	Total Acreage (10^6)	% of Crop Sold	Acreage Devoted to Sold Crop (10^6)	Total Sales ($\$.10^6$)	Areal Revenues ($/acre)
9) California	.302		.302	55.441	183.58
17) Texas	.429		.429	67.201	156.64
18) Louisiana	.467		.467	62.807	134.4[illegible]
19) Arkansas	.370		.370	57.693	155.92
20) Missouri	.004		.004	.565	141.25
25) Mississippi	.045		.045	5.027	125.04

TABLE T.9 (II.b)--Continued

State	Soybeans				
	Total Acreage (10^6)	% of Crop Sold	Acreage Devoted to Sold Crop (10^6)	Total Sales ($.10^6$)	Areal Revenues ($/acre)
12) North Dakota	.203	92.9	.189	4.132	21.86
13) South Dakota	.128	93.0	.119	2.629	22.09
14) Nebraska	.145	96.8	.140	6.211	44.36
15) Kansas	.418	96.2	.402	15.252	37.94
16) Oklahoma	.085	97.8	.083	2.660	32.05
17) Texas	.055	96.8	.053	2.268	42.79
18) Louisiana	.189	96.8	.183	7.961	43.50
19) Arkansas	2.285	97.0	2.216	100.510	45.36
20) Missouri	2.207	96.9	2.139	89.664	41.91
21) Iowa	2.332	96.9	2.260	117.382	51.94
22) Minnesota	2.187	94.8	2.073	75.311	36.33
23) Wisconsin	.095	86.5	.082	3.073	37.48
24) Illinois	4.722	97.0	4.580	236.984	51.74
25) Mississippi	.951	97.0	.922	40.182	43.58
26) Alabama	.123	98.8	.122	4.366	35.79
27) Tennessee	.361	95.8	.346	15.014	43.39
28) Kentucky	.181	94.8	.172	7.348	42.72
29) Indiana	2.247	96.0	2.157	111.036	51.47
30) Michigan	.225	96.0	.216	10.293	47.65
31) Ohio	1.419	96.0	1.362	68.027	49.94
33) Georgia	.063	92.8	.058	1.861	32.09
34) Florida	.030	97.9	.029	1.294	44.62
35) South Carolina	.384	94.0	.361	12.405	34.36
36) North Carolina	.401	95.2	.382	16.776	43.92
37) Virginia	.281	95.2	.268	11.352	42.36
38) Maryland	.183	97.1	.178	8.834	49.63
39) Delaware	.141	97.1	.137	6.622	48.20
40) New Jersey	.028	94.1	.026	1.324	50.92

TABLE T.9 (II.b)--Continued

State	Peanuts				
	Total Acreage (10^6)	% of Crop Sold	Acreage Devoted to Sold Crop (10^6)	Total Sales ($.10^6$)	Areal Revenues ($/acre)
8) New Mexico	.006	98.2	.006	1.066	177.67
16) Oklahoma	.100	99.0	.099	10.917	110.27
17) Texas	.242	98.9	.240	14.909	62.12
19) Arkansas	.003	62.0	.002	.115	57.50
25) Mississippi	.005	50.0	.003	.311	103.67
26) Alabama	.188	96.7	.182	12.965	71.24
33) Georgia	.465	97.8	.456	43.595	95.60
34) Florida	.048	97.5	.047	3.502	74.51
35) South Carolina	.012	94.0	.011	.910	82.73
36) North Carolina	.164	95.5	.157	25.777	164.18
37) Virginia	.100	96.0	.096	17.053	177.63

TABLE T.9 (II.b)--Continued

State	Cotton				
	Total Acreage (10^6)	% of Crop Sold	Acreage Devoted to Sold Crop (10^6)	Total Sales ($\$.10^6$)	Areal Revenues ($/acre)
3) California	.821		.821	304.514	370.91
7) Arizona	.363		.363	122.648	337.87
8) New Mexico	.189		.189	55.439	293.33
16) Oklahoma	.602		.602	55.455	92.12
17) Texas	6.126		6.126	660.802	107.87
18) Louisiana	.481		.481	83.877	174.38
19) Arkansas	1.297		1.297	256.733	197.94
20) Missouri	.404		.404	80.996	200.48
25) Mississippi	1.450		1.450	276.223	190.50
26) Alabama	.794		.794	119.611	150.64
27) Tennessee	.510		.510	112.910	221.39
28) Kentucky	.008		.008	1.790	223.75
33) Georgia	.639		.639	88.634	138.71
34) Florida	.024		.024	2.323	96.79
35) South Carolina	.544		.544	67.835	124.70
36) North Carolina	.376		.376	49.708	132.20
37) Virginia	.015		.015	1.946	129.73

TABLE T.9 (II.b)--Continued

State	Tobacco				
	Total Acreage (10^6)	% of Crop Sold	Acreage Devoted to Sold Crop (10^6)	Total Sales ($.$10^6$)	Areal Revenues ($/acre)
20) Missouri	.003		.003	2.534	844.67
23) Wisconsin	.014		.014	7.289	520.64
27) Tennessee	.074		.074	64.992	878.27
28) Kentucky	.212		.212	196.165	925.31
29) Indiana	.007		.007	6.520	931.43
31) Ohio	.012		.012	10.001	833.42
32) West Virginia	.002		.002	1.785	892.50
33) Georgia	.069		.069	58.985	854.85
34) Florida	.018		.018	21.305	1,183.61
35) South Carolina	.078		.078	81.255	1,041.73
36) North Carolina	.450		.450	372.846	828.55
37) Virginia	.086		.086	67.792	788.28
38) Maryland	.040		.040	17.912	447.80
41) Pennsylvania	.030		.030	14.879	495.97
43) Connecticut	.008		.008	15.667	1,958.38
45) Massachusetts	.004		.004	7.269	1,817.25

TABLE T.9 (II.b)--Continued

State	Sugarbeets				
	Total Acreage (10^6)	% of Crop Sold	Acreage Devoted to Sold Crop (10^6)	Total Sales ($.10^6$)	Areal Revenues ($/acre)
1) Washington	.033		.033	8.322	252.18
2) Oregon	.021		.021	5.515	262.62
3) California	.206		.206	53.552	259.96
4) Nevada	-		-	.083	-
5) Idaho	.091		.091	21.874	240.37
6) Utah	.030		.030	6.399	213.30
8) New Mexico	.001		.001	.093	93.00
9) Colorado	.143		.143	29.018	202.92
10) Wyoming	.038		.038	6.848	130.21
11) Montana	.056		.056	10.227	182.63
12) North Dakota	.038		.038	5.165	135.92
13) South Dakota	.006		.006	1.089	181.50
14) Nebraska	.063		.063	12.849	203.95
15) Kansas	.008		.008	1.371	171.38
17) Texas	.002		.002	.382	191.00
21) Iowa	.001		.001	.185	185.00
22) Minnesota	.073		.073	9.905	135.68
23) Wisconsin	.007		.007	.687	98.14
24) Illinois	.001		.001	.250	250.00
30) Michigan	.072		.072	10.455	145.21
31) Ohio	.021		.021	3.069	146.14

TABLE T.9 (II.b)--Continued

State	Irish Potatoes				
	Total Acreage (10^6)	% of Crop Sold	Acreage Devoted to Sold Crop (10^6)	Total Sales ($.10^6$)	Areal Revenues ($/acre)
1) Washington	.030	89.0	.027	11.248	416.59
2) Oregon	.034	85.0	.029	14.316	493.65
3) California	.086	96.0	.083	60.987	734.78
5) Idaho	.200	91.0	.182	76.650	421.15
6) Utah	.008	80.0	.006	2.752	458.66
9) Colorado	.051	85.3	.044	13.431	305.25
10) Wyoming	.004	78.3	.003	.579	193.00
11) Montana	.007	76.0	.005	2.985	597.00
12) North Dakota	.100	85.4	.085	16.681	196.24
14) Nebraska	.013	84.4	.011	3.217	292.45
17) Texas	.016	90.8	.015	5.463	364.20
22) Minnesota	.088	81.7	.072	14.273	198.24
23) Wisconsin	.047	76.7	.036	13.104	364.00
30) Michigan	.046	77.8	.036	11.312	314.22
31) Ohio	.015	85.2	.013	6.017	462.84
34) Florida	.027	92.9	.025	8.623	344.92
36) North Carolina	.023	70.2	.016	6.353	397.06
37) Virginia	.024	80.1	.019	7.268	382.53
39) Delaware	.008	92.8	.007	3.439	491.29
40) New Jersey	.019	96.9	.018	7.817	434.28
41) Pennsylvania	.038	82.7	.031	15.990	515.81
42) New York	.082	88.8	.073	29.181	399.74
48) Maine	.133	89.2	.119	50.957	428.22

TABLE T.9 (II.b)--Continued

State	Vegetables				
	Total Acreage (10^6)	% of Crop Sold	Acreage Devoted to Sold Crop (10^6)	Total Sales ($\$.10^6$)	Areal Revenues ($/acre)
1) Washington	0.113	100%[a]	0.113	19.571	173.19
2) Oregon	0.107		0.107	22.198	207.46
3) California	0.657		0.657	268.649	408.90
5) Idaho	0.028		0.028	3.780	135.00
6) Utah	0.016		0.016	2.643	165.19
7) Arizona	0.078		0.078	37.297	478.17
8) New Mexico	0.012		0.012	3.105	258.75
9) Colorado	0.039		0.039	10.622	272.36
15) Kansas	0.007		0.007	1.044	149.14
16) Oklahoma	0.029		0.029	2.217	76.45
17) Texas	0.326		0.326	31.740	97.36
18) Louisiana	0.020		0.020	1.952	97.60
19) Arkansas	0.027		0.027	3.092	114.52
20) Missouri	0.015		0.015	2.882	192.13
21) Iowa	0.019		0.019	2.400	126.32
22) Minnesota	0.151		0.151	9.989	66.15
23) Wisconsin	0.243		0.243	19.465	80.10
24) Illinois	0.126		0.126	14.849	117.85
25) Mississippi	0.025		0.025	2.085	83.40
26) Alabama	0.048		0.048	3.668	76.42
27) Tennessee	0.044		0.044	5.076	115.36
28) Kentucky	0.007		0.007	1.106	158.00
29) Indiana	0.069		0.069	9.970	144.49
30) Michigan	0.109		0.109	19.943	182.96
31) Ohio	0.069		0.069	15.790	228.84
33) Georgia	0.091		0.091	6.784	74.55
34) Florida	0.274		0.274	81.910	298.94
35) South Carolina	0.063		0.063	8.148	129.33
36) North Carolina	0.064		0.064	8.476	132.44
37) Virginia	0.052		0.052	8.584	165.08
38) Maryland	0.082		0.082	9.333	113.82
39) Delaware	0.042		0.042	4.572	108.86
40) New Jersey	0.127		0.127	29.965	235.94
41) Pennsylvania	0.073		0.073	12.547	171.88
42) New York	0.175		0.175	35.891	205.09
43) Connecticut	0.010		0.010	2.951	295.10
45) Massachusetts	0.018		0.018	5.443	302.39
47) New Hampshire	0.004		0.004	.933	233.25
48) Maine	0.015		0.015	2.501	166.73

[a] This Census division accounts only Vegetables For Sale.

TABLE T.9 (II.b)--Continued

State	Berries				
	Total Acreage (10^6)	% of Crop Sold	Acreage Devoted to Sold Crop (10^6)	Total Sales ($.10^6$)	Areal Revenues ($/acre)
1) Washington	0.012	100%[b]	0.012	10.254	854.50
2) Oregon	0.029		0.029	15.736	542.62
3) California	0.014		0.014	29.593	2,113.79
19) Arkansas	0.006		0.006	3.126	521.00
23) Wisconsin	0.006		0.006	5.216	869.33
27) Tennessee	0.007		0.007	2.365	337.86
30) Michigan	0.023		0.023	10.930	475.22
40) New Jersey	0.012		0.012	6.721	560.08
42) New York	0.006		0.006	3.364	560.67
45) Massachusetts	0.013		0.013	5.014	385.69
48) Maine	0.026		0.026	2.265	87.12

[b] This Census division accounts only Berries For Sale.

TABLE T.9 (II.b)--Continued

State	Fruits and Nuts				
	Total Acreage (10^6)	% of Crop Sold	Acreage Devoted to Sold Crop (10^6)	Total Sales ($.10^6$)	Areal Revenues ($/acre)
1) Washington	0.132		0.132	76.053	576.17
2) Oregon	0.099		0.099	27.348	276.24
3) California	1.435		1.435	555.480	387.09
5) Idaho	0.015		0.015	6.025	401.67
6) Utah	0.013		0.013	2.967	228.23
7) Arizona	0.029		0.029	9.649	332.72
8) New Mexico	0.013		0.013	2.823	217.15
9) Colorado	0.019		0.019	7.045	370.79
15) Kansas	0.009		0.009	.744	82.67
16) Oklahoma	0.036		0.036	1.194	33.16
17) Texas	0.173		0.173	14.842	85.78
18) Louisiana	0.049		0.049	2.980	60.82
19) Arkansas	0.034		0.034	4.594	135.12
20) Missouri	0.026		0.026	3.573	137.42
21) Iowa	0.009		0.009	.846	94.00
23) Wisconsin	0.026		0.026	5.012	192.77
24) Illinois	0.027		0.027	6.227	230.63
25) Mississippi	0.101		0.101	4.555	45.10
26) Alabama	0.075		0.075	3.778	50.37
27) Tennessee	0.015		0.015	.905	60.33
28) Kentucky	0.017		0.017	1.349	79.35
29) Indiana	0.019		0.019	5.051	265.84
30) Michigan	0.201		0.201	45.639	227.06
31) Ohio	0.050		0.050	9.994	199.88
32) West Virginia	0.039		0.039	10.559	270.74
33) Georgia	0.195		0.195	16.206	83.11
34) Florida	0.724		0.724	323.942	447.43
35) South Carolina	0.070		0.070	15.736	224.80
36) North Carolina	0.036		0.036	5.262	146.17
37) Virginia	0.067		0.067	17.534	261.70
38) Maryland	0.013		0.013	3.873	297.92
40) New Jersey	0.026		0.026	12.324	474.00
41) Pennsylvania	0.094		0.094	24.328	258.81
42) New York	0.155		0.155	41.824	269.83
43) Connecticut	0.009		0.009	3.093	343.67
45) Massachusetts	0.014		0.014	5.556	396.86
46) Vermont	0.005		0.005	1.753	350.60
47) New Hampshire	0.007		0.007	2.739	391.29
48) Maine	0.011		0.011	3.462	314.73

General Note: For "Potatoes" and "Vegetables", States with less than 10,000 acres under cultivation have been eliminated, for reasons of statistical accuracy.

Source : Columns 1, 2 and 4 = U.S. Census of Agriculture, 1959.
Columns 3 and 5 = Author's own estimation.

TABLE T.10 (II.b)

SUMMARY: AREAL REVENUES OF AGRICULTURAL PRODUCTION, FOR 15 SELECTED CROPS, FOR 48 STATES, U.S.A., 1959

State	Areal Revenues ($/acre)				
	Corn	Sorghum	Wheat	Oats	Barley
1) Washington	77.77	72.17	66.74	28.99	34.66
2) Oregon	50.73	-	64.32	-	37.21
3) California	60.27	72.85	42.78	25.72	46.00
4) Nevada	-	-	48.24	-	44.60
5) Idaho	30.49	-	57.82	30.10	27.43
6) Utah	-	-	39.01	36.75	47.93
7) Arizona	-	65.62	69.47	-	70.76
8) New Mexico	-	29.65	29.70	-	34.39
9) Colorado	36.58	18.79	37.50	25.50	22.17
10) Wyoming	-	-	36.06	20.90	26.38
11) Montana	-	-	31.44	17.62	18.36
12) North Dakota	5.16	-	28.48	12.96	15.16
13) South Dakota	15.04	18.04	17.13	11.42	10.79
14) Nebraska	48.64	34.39	38.40	15.53	16.10
15) Kansas	39.29	25.20	36.46	15.70	19.18
16) Oklahoma	32.33	20.20	34.31	15.43	16.51
17) Texas	28.72	31.37	29.43	14.75	16.78
18) Louisiana	32.52	-	38.87	24.13	-
19) Arkansas	32.84	26.77	44.32	26.43	-
20) Missouri	50.95	36.52	42.21	17.57	23.84
21) Iowa	61.63	44.61	34.81	27.08	29.63
22) Minnesota	40.86	-	44.01	26.44	24.54
23) Wisconsin	48.89	-	53.42	32.08	37.42
24) Illinois	70.02	46.00	46.05	27.08	20.66

TABLE T.10 (II.b)--Continued

State	Areal Revenues ($/acre)				
	Corn	Sorghum	Wheat	Oats	Barley
25) Mississippi	32.36	32.78	44.41	29.34	-
26) Alabama	25.09	-	40.14	27.61	-
27) Tennessee	39.47	35.86	39.20	26.89	23.75
28) Kentucky	46.79	45.20	42.94	24.56	26.57
29) Indiana	63.44	49.13	44.47	25.00	22.50
30) Michigan	47.51	-	57.21	27.70	26.94
31) Ohio	61.12	-	42.12	29.24	26.00
32) West Virginia	49.00	-	-	-	-
33) Georgia	23.56	-	38.07	24.86	-
34) Florida	18.21	-	-	-	-
35) South Carolina	27.45	-	35.63	21.90	27.33
36) North Carolina	44.72	34.42	41.37	24.52	35.06
37) Virginia	47.43	-	41.39	27.68	38.09
38) Maryland	55.20	-	41.22	28.80	35.38
39) Delaware	59.66	-	44.68	-	37.71
40) New Jersey	56.81	-	53.58	-	39.82
41) Pennsylvania	58.15	-	44.02	32.05	29.77
42) New York	24.00	-	52.48	38.45	28.60
43) Connecticut	-	-	-	-	-
44) Rhode Island	-	-	-	-	-
45) Massachusetts	-	-	-	-	-
46) Vermont	-	-	-	-	-
47) New Hampshire	-	-	-	-	-
48) Maine	-	-	-	29.15	-

TABLE T.10 (II.b)--Continued

State	Areal Revenues ($/acre)				
	Rice	Soybeans	Peanuts	Cotton	Tobacco
1) Washington	-	-	-	-	-
2) Oregon	-	-	-	-	-
3) California	183.58	-	-	370.91	-
4) Nevada	-	-	-	-	-
5) Idaho	-	-	-	-	-
6) Utah	-	-	-	-	-
7) Arizona	-	-	-	337.87	-
8) New Mexico	-	-	177.67	293.33	-
9) Colorado	-	-	-	-	-
10) Wyoming	-	-	-	-	-
11) Montana	-	-	-	-	-
12) North Dakota	-	21.86	-	-	-
13) South Dakota	-	22.09	-	-	-
14) Nebraska	-	44.36	-	-	-
15) Kansas	-	37.94	-	-	-
16) Oklahoma	-	32.05	110.27	92.12	-
17) Texas	156.64	42.79	62.12	107.87	-
18) Louisiana	134.48	43.50	-	174.38	-
19) Arkansas	155.92	45.36	57.50	197.94	-
20) Missouri	141.25	41.91	-	200.48	844.67
21) Iowa	-	51.94	-	-	-
22) Minnesota	-	36.33	-	-	-
23) Wisconsin	-	37.48	-	-	520.64
24) Illinois	-	51.74	-	-	-

TABLE T.10 (II.b)--Continued

State	Areal Revenues ($/acre)				
	Rice	Soybeans	Peanuts	Cotton	Tobacco
25) Mississippi	125.04	43.58	103.67	190.50	-
26) Alabama	-	35.79	71.24	150.64	-
27) Tennessee	-	43.39	-	221.39	878.27
28) Kentucky	-	42.72	-	223.75	925.31
29) Indiana	-	51.47	-	-	931.43
30) Michigan	-	47.65	-	-	-
31) Ohio	-	49.94	-	-	833.42
32) West Virginia	-	-	-	-	392.50
33) Georgia	-	32.09	95.60	138.71	854.85
34) Florida	-	44.62	74.51	96.79	1,183.61
35) South Carolina	-	34.36	82.73	124.70	1,041.73
36) North Carolina	-	43.92	164.18	132.20	828.55
37) Virginia	-	42.36	177.63	129.73	788.28
38) Maryland	-	49.63	-	-	447.80
39) Delaware	-	48.20	-	-	-
40) New Jersey	-	50.92	-	-	-
41) Pennsylvania	-	-	-	-	495.97
42) New York	-	-	-	-	-
43) Connecticut	-	-	-	-	1,958.36
44) Rhode Island	-	-	-	-	-
45) Massachusetts	-	-	-	-	1,817.25
46) Vermont	-	-	-	-	-
47) New Hampshire	-	-	-	-	-
48) Maine	-	-	-	-	-

TABLE T.10 (II.b)--Continued

State	Areal Revenues ($/acre)				
	Sugar beets	Irish Potatoes	Vegetables	Berries	Fruits & Nuts
1) Washington	252.18	416.59	173.19	854.50	576.17
2) Oregon	262.62	493.65	207.46	542.62	276.24
3) California	253.96	734.78	408.90	2,113.79	387.09
4) Nevada	-	-	-	-	-
5) Idaho	240.37	421.15	135.00	-	401.67
6) Utah	213.30	458.66	165.19	-	228.23
7) Arizona	-	-	478.17	-	332.72
8) New Mexico	-	-	258.75	-	217.15
9) Colorado	202.92	305.25	272.36	-	370.79
10) Wyoming	180.21	193.00	-	-	-
11) Montana	182.63	597.00	-	-	-
12) North Dakota	135.92	196.24	-	-	-
13) South Dakota	181.50	-	-	-	-
14) Nebraska	203.95	292.45	-	-	-
15) Kansas	171.38	-	149.14	-	82.67
16) Oklahoma	-	-	76.45	-	33.16
17) Texas	-	364.20	97.36	-	85.78
18) Louisiana	-	-	97.60	-	60.82
19) Arkansas	-	-	114.52	521.00	135.12
20) Missouri	-	-	192.13	-	137.42
21) Iowa	-	-	126.32	-	94.00
22) Minnesota	135.68	198.24	66.15	-	-
23) Wisconsin	98.14	364.00	80.10	869.33	192.77
24) Illinois	-	-	117.85	-	230.63

TABLE T.10 (II.b)--Continued

State	Areal Revenues ($/acre)				
	Sugar-beets	Irish Potatoes	Vegetables	Berries	Fruits & Nuts
25) Mississippi	-	-	83.40	-	45.10
26) Alabama	-	-	76.42	-	50.37
27) Tennessee	-	-	115.36	337.86	60.33
28) Kentucky	-	-	158.00	-	79.35
29) Indiana	-	-	144.49	-	265.84
30) Michigan	145.21	314.22	182.22	475.22	227.06
31) Ohio	146.14	462.84	228.84	-	199.88
32) West Virgiria	-	-	-	-	270.74
33) Georgia	-	-	74.55	-	83.11
34) Florida	-	344.92	298.94	-	447.43
35) South Carolina	-	-	129.33	-	224.80
36) North Carolina	-	397.06	132.44	-	146.17
37) Virginia	-	382.53	165.08	-	261.70
38) Maryland	-	-	113.82	-	297.92
39) Delaware	-	491.29	108.86	-	-
40) New Jersey	-	438.28	235.94	560.08	474.00
41) Pennsylvania	-	515.81	171.88	-	258.81
42) New York	-	399.74	205.09	560.67	269.83
43) Connecticut	-	-	295.10	-	343.67
44) Rhode Island	-	-	-	-	-
45) Massachusetts	-	-	302.39	385.69	396.86
46) Vermont	-	-	-	-	350.60
47) New Hampshire	-	-	233.25	-	391.29
48) Maine	-	428.22	166.73	87.12	314.73

Source: Estimated by the author [see Table T.9 (II.b)]

Crop Mix

After the estimation of the Areal Revenues for each individual crop, summarized in the preceding tabulation, it is necessary to estimate the level of Areal Revenues for the crop mix, in each of the states. The basic data of Table T.9 (II.b), shown above, provides the relevant information. Since the Areal Revenue of the crop mix was defined in the theoretical section as the ratio between the total sales to the total acreage under cultivation devoted to the sold crop, for a given state, it is possible now to add the sales and acreage information for each of the 48 states, finally to compute the ratio. The complete series of computations for each state is not shown in its entirety because it is an extremely long process but, for the purposes of clarifying the idea, the estimation for one state is provided.

Example: Indiana.

Crop	Sales ($ x 10^3)	Area (acres x 10^3)
Corn	146,669	2,312
Sorghum	393	8
Wheat	49,758	1,119
Oats	5,624	225
Barley	225	10
Soybeans	111,036	2,157
Tobacco	6,520	7
Vegetables	9,970	69
Fruits	5,051	19
Total	335,246	5,926

Ratio of $\frac{\text{sales}}{\text{area}}$ = 56.57 $/acrea.

In this example it is clear how high revenue-earner crops such as tobacco--with 931.43 $/acre--have little influence on the weighted average of the state due to the small area under cultivation--7,000 acres out of 5,926,000 considered--; and it is also clear that the weighted average of the areal revenue--56.57 \$/acre--is close to those of the predominant crops such as corn, soybeans and wheat--with respectively 63.44; 51.47; 44.47 \$/acre. Since it is impossible to isolate areas of territory small enough to cover only one crop, this method of estimating the weighted average of the crop mix is very useful and permits an empirical analysis of the proposed locational theory.

The following table is a summary of the estimated values of the weighted average areal revenues of the crop mix and the corresponding mapping.

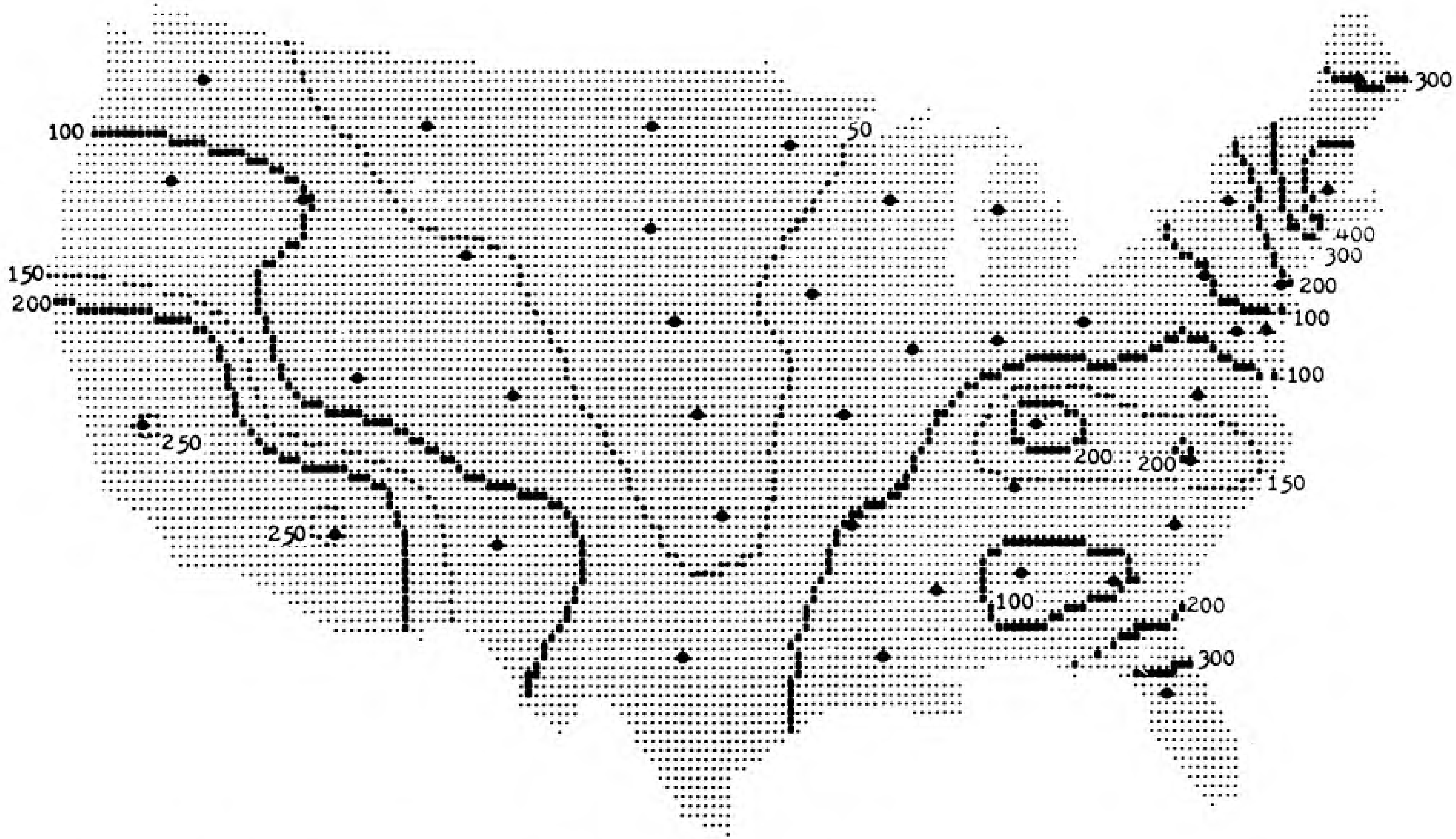
TABLE T.11 (II.b)

AREAL REVENUES OF TOTAL AGRICULTURAL PRODUCTION
AS WEIGHTED AVERAGE OF THE CROP MIX,
FOR 48 STATES, U.S.A., 1959

State	Areal Revenue ($/acre)	State	Areal Revenue ($/acre)
1) Washington	95.93	25) Mississippi	115.73
2) Oregon	101.98	26) Alabama	84.21
3) California	250.03	27) Tennessee	146.60
4) Nevada	75.10[a]	28) Kentucky	226.17
5) Idaho	100.22	29) Indiana	56.67
6) Utah	78.50	30) Michigan	76.02
7) Arizona	255.02	31) Ohio	58.46
8) New Mexico	121.16	32) West Virginia	208.00[a]
9) Colorado	50.35	33) Georgia	90.48
10) Wyoming	50.79	34) Florida	339.70
11) Montana	30.26	35) South Carolina	121.91
12) North Dakota	23.96	36) North Carolina	200.28
13) South Dakota	15.67	37) Virginia	142.30
14) Nebraska	43.44	38) Maryland	82.91
15) Kansas	34.10	39) Delaware	69.17
16) Oklahoma	39.15	40) New Jersey	193.19
17) Texas	63.16	41) Pennsylvania	97.45
18) Louisiana	121.60	42) New York	131.64
19) Arkansas	102.25	43) Connecticut	804.11[a]
20) Missouri	55.64	44) Rhode Island	n.a.
21) Iowa	54.55	45) Massachusetts	475.14
22) Minnesota	39.25	46) Vermont	305.71[a]
23) Wisconsin	67.88	47) New Hampshire	333.82[a]
24) Illinois	58.73	48) Maine	293.54

Source: Author's own estimation, with data from Table T.9 (II.b)

[a]Those five states have their estimates based on extremely small areas under cultivation--from 7 to 65 acres x 10^3--so that there may be high statistical errors.



Map M.20 (II.b): AREAL REVENUES OF TOTAL AGRICULTURAL PRODUCTION, U.S.A., 1959 (in $/acre)

The contour values show basically a dual slope surface, rising from low values in the central part of the country to the two ocean coasts. The lowest pit is in South Dakota--16 \$/acre, rounding to the nearest dollar--but otherwise there is an almost flat plateau extending over the central plains with values near the 50 \$/acre. To the west there is a clear increase after the 100 \$/acre line, on an area including the Mountain and Pacific states. The highest value is at a peak in Arizona--255 \$/acre--although more realistically it should be considered as a ridge from Arizona to California, with values in the 250 \$/acre range. To the east, the situation is not so simple, as the slope not only rises to the Atlantic, but also varies from north to south, creating a set of peaks and pits along the coast. The highest one is in Connecticut--over 800 \$/acre--corresponding really to the area of influence of the New York Metropolitan Area. To the north of it there is a downward slope, though the values in New England are still high--near 300 \$/acre in Maine--; to the south of the Connecticut peak there is a narrow valley corresponding to values slightly below the 100 \$/acre level located in Maryland and Delaware, but immediately there is a sharp increase to the next peak to the south, extending over Kentucky and North Carolina--above the 200 \$/acre. Further to the south there is a gentle slope down to the pit of Alabama and Georgia, below the value of 90 \$/acre, that is surrounded by a relative flat surface with lower values on the neighboring states of the Deep South. Finally, Florida shows a peak near the 350 \$/acre. Thus, the South displays two areas, one with higher values towards the north, and the other with lower values corresponding roughly to the Deep South. Though the high values of the Pacific and the New York City surroundings might have been suspected, the peak over Kentucky was not so easy to forecast without an analysis. In the same way, the low values of the Deep South are foreseeable perhaps, but not so the low values of the central plains, which actually are the lowest in the country.

CHAPTER III

A THEORY OF SPATIAL LOCATION

1. Land Allocation Process in the Rent Theory

According to the classical Rent theory,[1] the value of land was established as a function of the nearness of each site to the isolated punctual market; this "value" being expressed in a rent structure that has its peak around the market place. If, following the proposed hypothesis of an integrated economic space, the distribution of aggregate demand is expressed according to the Income Population Potential model, it is clear that lands located nearer to the highest equipotential contour values command higher rents. The Potential model indicates that higher contour values mean shorter distances to wider markets, leading then to a reduction of transfer costs. <u>As one conclusion, nearness to higher values of the Income Population Potential model is (partially) similar to the concept of nearness to the punctual market place in the classical rent theory</u>.

The allocation of land to different crops, starting with the most desirable location near the market, is the result of the "ability" of each crop to bid a rent value higher than the competitive crops at this particular site. As it is a process among crops and not among individual producers, the result is the formation of "rings" specializing in each

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[1]See specially, Johann H. von Thunen, <u>Der Isolierte Staat</u>, or its English version: Peter Hall (ed.), <u>Op.cit.</u>; also: William Alonso, <u>Op.cit.</u>

successful bidder crop. (Obviously, in the real world the rings are affected by particular conditions such as the network of transportation system.) The classical theory formalized this allocation process in the dictum that steeper bid rent curves capture the land nearer to the market. Individual producers were assumed to be indifferent along each rent curve, although this may not be always the case, as will be studied later in Chapter V.4.

It is useful now to analyze in depth the land allocation mechanism in the classical rent theory, in order to focus on the crop variable(s) relevant to this process. For reasons of simplicity, the analysis will use the cartesian diagrams of the classical theory, later on, translating the results from the isolated market to an aggregate demand environment. A further step will be the introduction of the second new variable, the effects of the climate, which, though not considered in classical theory, is of increasing importance in an integrated economy of continental size. Thus the two relevant regional variables for agriculture studied in Chapter I, aggregate demand and climatic conditions, will be introduced in the analysis of the land allocation process.

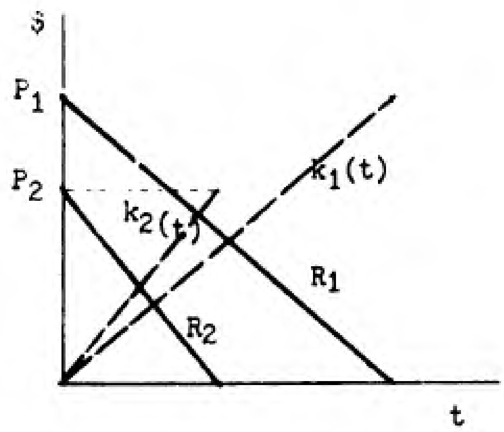
Let us imagine now two different crops bidding for the same location, around the market place of classical theory. Considering the two key variables of price at the market place and transportation rates, for each crop, it is possible to determine three basic alternatives: the crop commanding the higher price at the market place has higher, or equal, or lower transfer rates than the competing crop. In the following analysis, we will call:

P_1 = price at the market of crop 1 (in dollars per ton)

$k_1(t)$ = total transportation costs of crop 1 (in dollars per ton-mile)

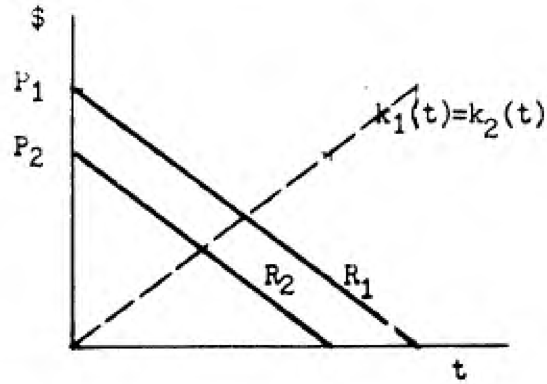
Production costs are kept constant and each case represents a static moment in time. (This problem can be extended to a three or more crops case.)

First case: $P_1 > P_2$; $k_1(t) < k_2(t)$



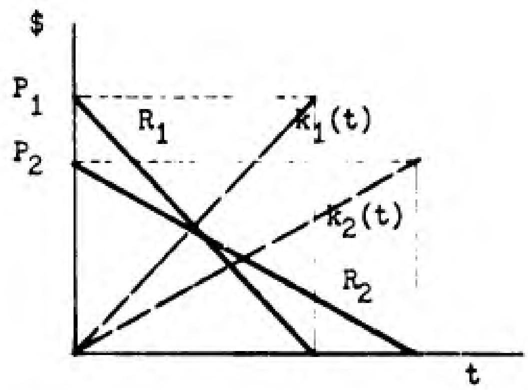
Crop 1 captures <u>all</u> land. It must be noticed that this case contradicts the dictum that steeper bid rent curves capture the land. Perhaps in the real world this case is very rare, because it implies that though crop 2 is expensive to transport there is very little demand for it, shown in the lower price at the market. Usually, crops difficult or expensive to move--such as dairy products, fresh vegetables, etc.--are also held in high esteem by the market, but it is always possible to imagine a case in which cultural values of the market assign low preferences to such a crop.

<u>Second case</u>: $P_1 > P_2$; $k_1(t) = k_2(t)$



Crop 1 captures <u>all</u> land.

<u>Third case</u>: $P_1 > P_2$; $k_1(t) > k_2(t)$



Crop 1 captures the "prime" land--nearer to the market--and crop 2 <u>may</u> obtain the rest, depending on the relationship between the slope of the total transfer cost curves and the level of prices. Clearly crop 1 may capture all the land. This is the case that is usually used to illustrate the classical rent theory, and it is from this Third case that the dictum of steeper bid rent curves capturing the prime land originated. This is also the closer representation of the real world. Nevertheless, the three cases consistently show the price at the market as the key allocating variable, while transfer rates are only secondary. It appears that, strictly speaking, steepness of the bid rent curves is not the determinant in the land allocating process, but that the price level is. The fact that often there is a correlation between higher transfer rates and higher level of prices should not obscure the role of each of the crop variables.

Up to this point constant climatic conditions have been assumed, a situation that, for agricultural production is very unrealistic if the study is focused on integrated economic spaces of continental size. The new variable of climate introduces differentials in annual yield, as it was explained in Chapter I.5. Let us now study the formal statement of the Rent theory.

The classical rent equation stated:

$$R_{c(t)} = N (P_c - C - k_{c(t)} ,$$

where $R_{c(t)}$ = rent of crop c at distance t, in \$/Sq.mile

N = annual yield (harvests time yields), in ton/Sq.mile

P_c = price of crop c at the market, in \$/ton

C = production costs, in \$/ton

$k_{c(t)}$ = total transportation costs of crop c, at distance t, in \$/ton

Total transportation cost $k_{c(t)}$ is a function of distance t to the market for each crop c, and annual yield N is a function of the climatic conditions (assuming soil fertility and level of mechanization constant). It must be noticed that though fertility and mechanization are important, they can be interpreted as the result of an increased capital investment, while the influence of climate is an absolute and pervasive variable. It must be recognized that von Thunen included some variation in yields, but only as a function of the distance to the market, using the concept of the marginal productivity of units of labor applied to land.

A change in annual yield N causes changes in other variables of the equation and its consideration as a key variable introduced within the parenthesis of the equation, means a change in units. Variable annual yields N will affect the price variable P ($/ton) and change into a new variable, Areal Revenues AR ($/Sq.mile or $/acre), because N_t (ton/Sq.mile) times P_c ($/ton) equals $AR_{c(t)}$ ($/Sq.mile) that is the revenue per area to the producer of crop c at location t. Areal Revenues are more comparable with Rents ($/Sq.mile) than simple Price per ton, this being a main difference with the classical theory. Also, variable yield N will cause a change in production costs C, expressed now in costs per area ($/Sq.mile); and will also cause a change in total transportation costs, expressed again in areal units ($/Sq.mile) as total transfer costs per area producing crop c in location t --in this case location is important in both senses, as distance to the market and as climatic conditions. If the marginal increase of Revenues per area is higher than the marginal combined increase of production and transfer costs per area, the farmer will be in a better position when moving to the new location that allows higher annual yields. At the same time it can be assumed that he will be charged higher rents, as rent is a function of the difference between revenues and combined costs.

Classically, it is considered that the farmer will keep only "normal" profits, but as they can be interpreted as a return for labor input, his "normal" profits will increase with movement to the new location, because higher yields will imply increased labor.

Having stated the influence of the yield variable N on the Rent equation, it is possible now to introduce N in the solution of the problem of land allocation between two crops (presented in this section, above), by assuming that the climatic conditions of the site allows for relatively larger yields of one of the crops. It is assumed that there are different prices at the market, P_c (\$/ton of produce), different total transfer costs $k_{c(t)}$ (\$/ton of produce for a given distance t), different annual yields N_c (ton/Sq.mile per year), for each of the two crops 1 and 2. Gross Areal Revenues AR, expressed in annual \$/Sq.mile of crop production, are the result of yields (N) times Price at the market (P). The total transfer costs per area $K_{1(t)}$, expressed in \$/Sq.mile of crop production, are the result of yields (N) times total transfer costs per ton ($k_{c(t)}$).

__First case__ : $P_1 > P_2$; $k_{1(t)} < k_{2(t)}$

(If N were considered constant, crop 1 would have captured all the land)

__alternative a__: $N_1 > N_2$

then $AR_1 > AR_2$, and either $K_{1(t)} \gtrless K_{2(t)}$, both in \$/Sq.mile as a result, either crop 1 captures the site, when $K_{1(t)} < K_{2(t)}$; or crop 1 captures only the "prime portion, when $K_{1(t)} > K_{2(t)}$

<u>alternative b:</u> $N_1 < N_2$,

then either $AR_1 \gtrless AR_2$; and $K_{1(t)} < K_{2(t)}$, both in $/Sq.mile

as a result, either crop 1 captures the site, when $AR_1 > AR_2$;

or crop 2 captures the "prime" portion, when $AR_1 < AR_2$

<u>Second case</u> : $P_1 > P_2$; $k_{1(t)} = k_{2(t)}$

(If N were considered constant, crop 1 would have captured all the land)

<u>alternative a:</u> $N_1 > N_2$

then $AR_1 > AR_2$; and $K_{1(t)} > K_{2(t)}$

as a result, crop 1 captures the "prime" portion.

<u>alternative b:</u> $N_1 < N_2$

then either $AR_1 \lessgtr AR_2$; and $K_{1(t)} < K_{2(t)}$

as a result, crop 1 captures the site, when $AR_1 > AR_2$; or crop 2 captures the "prime" part, when $AR_1 < AR_2$

<u>Third case</u> : $P_1 > P_2$; $k_{1(t)} > k_{2(t)}$

(If N were considered constant, crop 1 would have captured the "prime" land)

<u>alternative a:</u> $N_1 > N_2$

then $AR_1 > AR_2$; and $K_{1(t)} > K_{2(t)}$

as a result, crop 1 captures the "prime" portion

<u>alternative b:</u> $N_1 < N_2$

then either $AR_1 \lessgtr AR_2$; and either $K_{1(t)} \lessgtr K_{2(t)}$

as a result crop 1 captures all or the "prime" portion, when $AR_1 > AR_2$; or crop 2 captures all or the "prime" portion, when $AR_1 < AR_2$.

The conclusions are as follows: in the first solution of the problem where annual yields N hold constant for both crops, the crop commanding highest price at the market (P) captures the land. If the crop with lower price P has also lower total transfer costs (k) than the successful bidding crop, then it could obtain less valued land. In the second solution to the problem, where annual yield N is introduced as a variable of the crops, higher yields N could be combined with a lower price level P and result in a higher Revenue per area than the competing crop; allowing thus the lower priced-crop to bid successfully for the land--see alternative b in the three cases. As a secondary change, where the variation in yields causes the total transfer costs to change so that the crop earning less Revenue per area would have also a lower total transfer cost per unit of area under cultivation, in this situation this crop may obtain less valued land. Thus, the level of Gross Revenues per area is one variable in the process of land allocation among crops, being a combined index of the market Price and of annual Yields at this particular location: expressed in the following units: P ($/ton) times N (ton/Sq.mile) equal Ar($/Sq.mile). Total transfer costs is another variable in this process, affecting the Gross Areal Revenue, expressed as $K_{c(t)}$ in $/acre of land of crop c.

Proposed Theory

Clarification of the role of the combined variable of Areal Revenues is of primary importance for the study of the locational distribution of agricultural production and land use. In the first place, it was postulated that Rent is intimately connected with Areal Revenues, and that this last variable is actually an expression of "capacity" to pay rent.

Classically, rent is defined as a function of the difference between total revenues and total costs--assuming a level of "normal" profits for the producer. In the solution of the problem of land allocation between two crops, it was mentioned that the producer could increase areal revenues if he moved to a location that would allow higher yields per area, and that this movement would be possible <u>if</u> the increases in areal revenues were higher than the increases in combined costs--that is production and total transfer costs. The positive aspect of the change in location is that the increasing net revenues would, by definition, cause an increase in rent. If production costs were kept constant, only transfer costs would affect the equation; thus the estimation of the Areal Revenues net of transfer costs (i.e., ratio of sales over acreage) would result in the levels of Net Areal Revenues. Assuming then a logical behavior of the producers, it is impossible to state that <u>the level of net Areal Revenues in an expression of "capacity" to pay Rent, and can be interpreted as a surrogate for Rent</u>. To simplify notation, net Areal Revenues will be referred to as Areal Revenues, in the future, understanding that they will account for the total transfer costs also.

From now on then, the variable of Rent will be replaced by its surrogate, the variable of Areal Revenues. In the solution of the problem of land allocation between two crops, it was clear that the crop with higher combination of Price and Yields net of transfer costs bid successfully for the site. Furthermore, a crop with higher Price level would tend to locate nearer to the market, while a crop with higher Yield would be grown nearer to the favorable climatic conditions.

As a result, it can be stated that crops earning higher Areal Revenues tend to be located on sites with higher values of the Income Population Potential model--as an expression of accessibility to the national market--and with higher values of the Average Annual Possible Evapotranspiration model--as an expression of favorable climate.

It is clear that the Areal Revenue--and rent--structure must be positively correlated with both the model of aggregate demand and the model of climate conditions. An important element is that the same value of Areal Revenue could be the result of different combinations of price and yield net of transfer costs, thus this is a case of trade-off between the two locational variables. An individual producer can move in space to a location with higher (lower) values in the potential demand model but with lower (higher) values in the climatic model, and still keep the same level of Areal Revenues. This is an indication that the points in space achieving the same level of Areal Revenues are located according to the distribution of the values of the two models of potential demand and climate.

In summary, higher values of the Areal Revenues are caused by higher values of yields--indicated by higher values in the climatic model--and in turn tend to locate on land more accessible to the national market --indicated by higher values of the potential demand model--; resulting, as was already mentioned, in a positive correlation with the distribution of those two variables.

In this correlation, the dependent variable is a density--Areal Revenues, in $/Sq.mile--; and the independent variables are one potential

--Income Population Potential, in $/mile--and one integer--Average Annual Possible Evapotranspiration, in Development Units. Those two independent variables are, as has been discussed, surrogates for the theoretical variables; the demand potential stands for the degree of accessibility to the market, that is, the inverse of the friction cost of distance; while the climatic condition stands for the yield differentials. One advantage of the selection of the surrogate models is the facility to quantify them. It must be noticed that in the next stages in the development of the proposed theory, those models, and specially the potential demand, will prove to be very useful in determining secondary effects, showing richer possibilities for the analysis than the simple expression of a distance to the national market.

The proposed theory assumes constant production costs, such as labor and fertilizers. Although at a future stage it might be suitable to introduce them as variable, for the purposes of a first approximation to a theory explaining agricultural location on a macroscale, the constancy of production costs permits us to focus on the key variables of demand distribution and climate. Other complications may be added after the theory has been studied and its implications in the regional structure of the country have been evaluated. The logic of the proposed locational theory is clear if the actual formulation is reduced in a "simplification" process. It was postulated that the Areal Revenues are positively correlated with the potential demand model--that is negatively correlated with distance to the market--and positively correlated with the climatic model--that is with yields. Since, by definition, Areal Revenues is an index combining Price and Yields net of transfer costs, it is possible to state that the Yield component in the Areal Revenues is positively correlated with the climatic model. As a result, then, the Price component of the Areal Revenues must be positively correlated with the potential demand model or negatively correlated with the distance to the market. This result is clearly true, as was shown in the solution of the problem of land allocation between two crops.

The concept of Areal Revenues can be applied to an individual crop or to a crop mix grown in a given area. In this second case, Areal Revenues of the crop mix are defined as the weighted average of the Areal Revenues of the component crops.

2. Effects of the Price Structure

In the case of market equilibrium, the price level is defined by the levels of supply and demand, although traditionally this well-known concept has only been applied in a sectorial sense, that is with no implication of the effects of location, and the logical impact that the transfer costs necessary to overcome physical distance have in reducing or expanding the demand and the supply structure. Up to now, the present study of agricultural location has kept the hypothesis of a single price for every crop, as an heritage from the classical theory where a single marketplace could not possibly generate more than one price level at a given time. Nevertheless, in an integrated economy of continental size, it is not possible to postulate a single collection center for the agricultural produce that would define a single price level, but on the contrary, there exists the possibility of several important collection centers that might supply specific areas of the consumption market.

Thus, it is postulated that the distribution of demand and of supply structure influence the price level of different crops. The location of demand has been represented in the Income Population Potential model but it is still necessary to establish a model for the supply structure that can show the effects of the location of each crop. The suitable one is based on the similar concept of the Supply Potential model, that is to express the distribution of supply in relation to all the other points of the country, in units of ton per mile. It must be remembered that with these considerations the potential models represent two different types of effects: the already known one of indicating higher (lower) transfer costs for lower (higher) values of the potential demand model---see the previous analysis in this chapter, section 1--and the new one of indicating higher (lower) prices for higher (lower) values of the potential demand model and for lower (higher) values of the potential supply model.

The first effect depends on a single variable: the location of the producer in relation to the location of the total demand market (i.e., the Income Population Potential model), irrespective of the location of the rest of the producers, and results in the surrogate of the accessibility of the producer to the market, that logically could be translated into the inverse of transfer costs for the output of the given producer.

The second effect is one of equilibrium, depending on two variables: the location of all the producers (i.e., the Supply Potential model) in relation with the location of all the consumers (i.e., the Income Population Potential model); and results in the equilibrium price for the particular commodity for each given area. As a real world constraint, this is usually valid for points where an exchange center of national importance exists, providing for variation of price level over the national economic space, in contrast with the single value of price at the market assumed in classical theory.

Thus, the level of Areal Revenues is positively correlated with the values of the Income Population Potential model for two reasons: first, because it represents an inverse correlation with the transfer cost(that is the condition of accessibility) and second, because it represents a positive correlation with the price at the market (that is the condition of equilibrium).

The Supply Potential values affect the equilibrium of the price level only, but are not relevant to the determination of transfer costs (except in situations such as the reduction of rates due to the shipping of large amounts of commodities, that could eventually be included in the so-called economies of scale or of agglomeration, so important for the non-agricultural production). It is possible to draw conclusions from a previous study of this problem, William Warntz's "Toward a Geography of Price," where the equilibrium between the Demand and the Supply Potential is analyzed in terms of four commodities: wheat, potatoes, onions and strawberries. As was postulated before, the price level in each state of the U.S.A. for each of the four crops was found to be positively correlated with the Demand Potential and negatively correlated with the Supply Potential.

There are two important elements in the study mentioned above that require special comment. First, Warntz used the price at the state level, and so he is actually very near to using the farm price, that is the price paid to the producer, net of transfer costs from the farm to the exchange center. This introduction of the condition of accessibility would emphasize the reduction (increase) of prices brought by a reduction (increase) of potential demand, although the mechanism of the two phenomena must be kept clear: price level alone depends on the equilibrium between the potential demand and supply, while accessibility is the inverse of the cost of reaching the national market for each individual producer.

Secondly, there are actually two concepts of potential supply: the Supply Space Potential, that is the one we have been referring to, and the Supply Time Potential, which represents the seasonal availability of a produce at a given time of the year. The Supply Time Potential is clearly important for seasonal production such as agriculture, and the conclusion of the study is that price level varies inversely with the values of the Supply Time Potential. It is obvious that during the season of a particular crop, the abundance of produce would force prices down, while off-season there would be an increase of prices due to a reduction of supply.

The seasonal impact of prices will not be included in the first stages of the present study but will be introduced later in the analysis of the typology of agricultural zones.[2]

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[2]See Chapter V.4.

It is necessary then, to understand the price level as an "annual average price level."

Competitive and Monopolistic Location

Within the process of crop location at macroscale, there are certainly several alternatives for the individual producer. Basically, the farmer can choose between two feasible situations: a location within easy reach of the major markets--that is if he follows a rational behavior according to the theory--or a location with nominal competition. The first alternative is to locate on a site that is as economically "prime" and as climatically "favorable" as possible, that is where the selected crop could grow with higher yields and the transfer costs to the national market could be minimized, subject to the constraint that no other crop could obtain higher revenues per area and thus bid higher rents. If this is a rational behavior, it is then logical to expect that many other producers of this same crop, if not all, would follow the same path and locate in the neighborhood of the given farmer. The result is that the number of producers would continue to increase until the balance between the increasing supply and (in a short run model) the static demand would bring prices down to a level where surplus profits would be eliminated, allowing only "normal" ones.[3] This follow-the-theory behavior would allow the farmer to grow his crop and to sell it to the national market but it would also limit his benefits to the expected normal levels.

[3]For further analysis of this process, see August Losch, Economics of Location, Part II, Chapters 9 and 10 (New Haven: Yale University Press), 1954

The second alternative open to the individual producer is to locate in an area not so desirable as the first one, that is with climatic disadvantages and with reduced accessibility to smaller markets, but that for those same reasons would have attracted a reduced number of producers of the same crop. This is clearly a behavior that is not coherent with the basic theory, but it instead relies on the relative advantages of a "captive" market where only limited competition exists, such that the reduced supply structure would keep the prices at a higher level. Although, as Professor Chamberlin wrote, the problem of location involves always a case of monopolistic behavior, because of the uniqueness of each location,[4] it may be possible to attach the label of monopolistic to the second alternative, in contrast to the competitive situation in the first case, concerning the determination of the prices at the market.

The "abnormal" alternative could be found in a rather autonomous geographical area, with reduced accessibility to the rest of the country, that is close to the model for classical agricultural land rent theory. As integration of the national economic space becomes dominant, those enclaves would tend to disappear.

Regional Submarkets

It has been stated that one result of the integration of the economic space is the "normalization" of local or regional price (and rent) structures, due to the breakdown of local autonomy and increasing accessibility of the national market.

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[4]E.H.C. Chamberlin, The Theory of Monopolistic Competition, (Cambridge: Harvard University Press), 1933.

But apart from this process of integration of the system of local economies, there are cases that could result in a dual or plural price (and rent) structure. A country may have a distribution of the aggregate demand such that the Income Population Potential model results in two or more national peaks or ridges, that generates in turn national course lines, that is "valleys" of minimum value of the aggregate demand. Even accounting for cross-haulings and for specialized production on a sub-market on one side, of the national course line, there would be a tendency for the economic system to focus on one market hill.[5] A location on a site on the course line commands the smaller market possible, or in other words, it has the lowest accessibility to the national market; while the location within any of the hills would be accessible to an aggregate demand composed predominantly of the hill's market itself.

In this case, the level of prices would be strongly influenced by the equilibrium of each hill's aggregate demand and supply, as the rest of the country would contibute to it only marginally. The result is a "dual" or a "multiple" price (and rent) structure, and its existence depends not so much on the integration process as such, but rather on the future patterns of population-income distribution.

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[5]See Chapter I.4 for a definition of a "hill" in a potential surface.

3. The Areal Revenue Surface

The location of agricultural production is explained, as has been studied, as a function of the distribution of the aggregate demand and of the climatic conditions, represented in the Income Population Potential model and in the Average Annual Possible Evapotranspiration model. The surrogate for rent is the Areal Revenue, defined as the weighted average of the areal revenues of the crop mix for a given area. It is important to study the land allocation mechanism among crops, with the analysis of the effects of the two allocating variables, and to define the characteristics of the Areal Revenue surface.

It is possible to identify two processes in the variation of Areal Revenue values over the national space, that could be independent or overlapping. One is the variation produced by changes <u>within</u> a crop, due to different yields or accessibility; and the other is the variation produced by changes <u>among</u> crops, that is the replacement (sudden or not) of one crop by another.

<u>Economic Limit</u>

The potential demand is the variable that is used as surrogate for accessibility to the national market. It is clear that higher (lower) values of the potential demand model imply lower (higher) values of total transfer costs, its effects on the allocation of agricultural land use being as follows:

a) the areal revenue values of a given crop change directly with the potential demand model values; and

b) at certain sites, new crops appear where they can bid successfully for this land.

The important point is that the two types of change involve <u>continuous processes</u>, assuming the slope of the potential demand model to be smooth. Even at the lines of changes of crop, the new emergent areal revenue surface intersects the previous surface in a common line; and so though with marginal changes in the slope, there is no discontinuity.

At the lowest line of the surface, the potential demand establishes the "economic limit" for each crop, as well as a total for the agricultural system, usually called "margin of transference."

<u>Climatic Limit</u>

Climate is in a way a more absolute variable. The effects on yields are also dual, as follows:

a) the yields of a given crop vary directly with the values of the climatic model; and

b) at certain lines, new crops are allowed to appear when they are beyond the climatic limit on which the number of days in a year between killing frosts is the same as the crop requires for its cycle between seed and harvest, according to the values of Development Units existing at this site.

This indicates that the climatic limit, different for each crop, is a constraint at a minimum level only, because for practical reasons, no maximum value is found in the case study. The first effect within a crop, is of proportional increase in yields; but the second effect among crops may cause a <u>non-continuous break</u> in the areal revenue surface, after the climatic threshold has been passed. This is possible if a marginal increase in the values of the Development Units allows a new crop with a different price and yields, so that the new areal revenue values result in a non-marginal change.

This phenomenon constitutes a regional boundary, and it is comparatively permanent, as climate is not subject to trade-offs, except in extreme conditions of creation of artificial man-made climate. The break in the areal revenue surface must be coupled with the formation of a peak or a ridge on the higher values side. Climate then, defines the "climatic limit" to each crop.

It must be noticed that the climatic limit for each crop is static and absolute, but to be used effectively it must be within the economic limit. On the other hand, the economic limit is defined only in relation to the other crops, and is then dynamic, as it depends on changes of price levels and transfer costs. Further, it is possible that crops more restricted by climate could present a more restricted supply structure, and so command higher prices than crops with fewer climatic constraints. They could be imagined as the cash subtropical or tropical crops, that indeed have usually higher prices.

Transformation of the Economic and Climatic Curves. "Isorevenues."

The study of the two limits in the national space, starting either with the economic or the climatic, results in a single family of contour curves. Let us start by introducing the climatic limit, which as was mentioned can form a "regional boundary." It is clear that there are two types of limit: one is the "pure climatic limit," that is the contour line of the Development Unit threshold value, permiting the minimum level for a given crop. The other limit is the one appearing in the real world, the "transformed climatic limit," that is the transformation of the pure limit as it is affected by the locational-economic variable of aggregate demand. The higher revenue-earning crops would tend to use the land with favorable climate, pushing its use up to the climatic limit only where they could also find higher values of the potential demand, and as long as its level of areal revenue allowed them to be successful bidders, of course. As an individual producer moves along the pure climatic limit, assuming variable levels of the value of potential demand, there will be a change in its areal revenues as it is postulated in the proposed theory. As a result, the producer finds that a shift to an area of Development Units values higher than the limit would be necessary to compensate for lower values of the aggregate demand and viceversa. Logically, then, the climatic limit in areas with lower potential demand values would be preempted and could be used by crops earning lower areal revenues, resulting in the limit being shifted now to the "transformed" location.

To complete the argument, the "pure economic limit" is given by the equipotential contour lines of the demand model. The given price per ton and transfer rates of a crop would theoretically set the economic limit of cultivation--that is the area of positive rent--, but if changes in yields are introduced, they would affect the location of points of zero rent. For two points with equal values of potential demand, the one with higher values of Development Units would produce higher areal revenues, with an increase in the capacity to pay rent; resulting then in a shift of the area of positive rent. Again, as increases in the values of the climatic model extend the economic limit, we are back to the case of the transformation between the two allocating variables.

The process of trade-off between price net of transfer costs and yield, originating in the two sets of variables of the economic and climatic models, is actually the base for the "isorevenue" family of curves, of which the regional boundaries and the transformed limits are only particular curves.

Isorevenue curves link points of equal value of areal revenues, by definition. In the classical rent theory, where the small territorial dimensions of the model called for no significant change in climate, the isorevenue lines would simply overlap with the location of demand. If there is only one market as in von Thunen's, the result is a case of concentric curves around the punctual market, specifically circles if the transportation facilities are equally distributed. If there is a distribution of demand over the area, the isorevenue curves would overlap with the curves of the potential model. On the other hand, if we imagine that the market is evenly distributed over an extended territory with variable climate, a case possible in pre-industrial or pre-urban societies for example, then the isorevenue curves would overlap with the curves of the Development Unit values. This last hypothesis suggests the importance of climatically favorable regions for agricultural oriented societies in preclassical times, and indeed the first human settlements took place in warm bright spots with a good supply of humidity, as the Nile and the Indus valleys and the Mesopotamia, following closely the first stage of polystathmic regional development.[6] In contrast, in our hypothesis of an integrated continental area, both factors are interwoven. It is clear that the same areal revenues could be earned by trading yields for price paid at the farm (net of transfer costs) and viceversa.

Crop Mix

Though it is usual to speak of a crop or a succession of individual crops in a given area, it is more correct to refer to a "set of crops." Crops can and do appear together in recognizable mixes, due to several factors: first of all, crops with average prices at the market falling approximately within the same range and with similar requirements of Development Units would behave as a single crop, from the locational point of view. Second, some crops are alternatively grown in a seasonal cycle on the same site.

It should not be forgotten that other factors of the real world correspond to a more irrational behavior: historical stickiness is very important, specially in the case of a country experiencing national shifts of population and income distribution, such as the U.S.A. Those national movements imply a corresponding shift in the location of crops, although it is common to observe a lag of time in the adjustment of the production pattern to the demand market distribution.

The situation of crop mix is very common in the real world, and is theoretically acceptable if it corresponds to the two first cases mentioned

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[6]See Chapter I.2.

above. Considering the crop mix problem, the theory understands that the areal revenue of a given area is really the weighted average of the areal revenue of the component crops.

CHAPTER III.b

EMPIRICAL STUDIES

1b. Proposed Theory: First Round of Correlation Analysis

The first theoretical proposition is that Areal Revenue (surrogate of rent) values are correlated with Income Population Potential values and Average Annual Possible Evapotranspiration values. The empirical method used was a correlation analysis by the least squares regression method,[7] with three variables and, in the first round, 42 observations. There is one dependent variable:

X_1 = Areal Revenues, defined as the weighted average of the crop-mix [see Table T.11 (II.b)] composed by the 15 crops previously selected, by States (1959) and expressed in $/acre.

The two independent variables are:

X_2 = Income Population Potential values [see Table T.2 (I.b)], by States (1956), expressed in $/mile x 10^6; and

X_3 = Average Annual Possible Evapotranspiration values [see Table T.3 (I.b)], by States, expressed in Development Units.

From the original 48 states, only 42 have been used, disregarding those six states that have little or no acreage under cultivation for the market, as they could introduce sizable statistical errors in the analysis. The excluded states are Nevada, West Virginia, Connecticut, Rhode Island, Vermont and New Hampshire.

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[7] The program used was the Biomedical Least Square Regression Method, of the University of California, Los Angeles. It was computed at the Computing Center, Harvard University.

The correlation has been computed in two ways, first in the additive form: $X_1 = a + b_2 \cdot X_2 + b_3 \cdot X_3$ and second in the transgenerated form: $\log X_1 = \log a + b_2 \cdot \log X_2 + b_3 \cdot \log X_3$, corresponding to an exponential form.

For computational purposes, the variables in the transgeneration are called:

$X_4 = \log X_1$

$X_5 = \log X_2$

$X_6 = \log X_3$

The resulting correlation matrix of the first round of correlation is as follows, the relevant coefficients being underlined:

Variable number	1	2	3	4	5	6
1	1.000	0.194	0.233	0.906	0.180	0.218
2		1.000	-0.051	0.244	0.967	-0.008
3			1.000	0.334	0.036	0.995
4				1.000	0.232	0.329
5					1.000	0.083
6						1.000

The log form gives higher correlation coefficients than the additive form, so it will be analyzed below.

The form of the equation is:

$\log X_1 = - 3.52425 + 0.32313 \log X_2 + 1.18096 \log X_3$

the coefficient of multiple correlation R = 0.3879

the coefficient of multiple determination R sq= 0.1505

and the standard Error of Estimate SEE = 0.3008

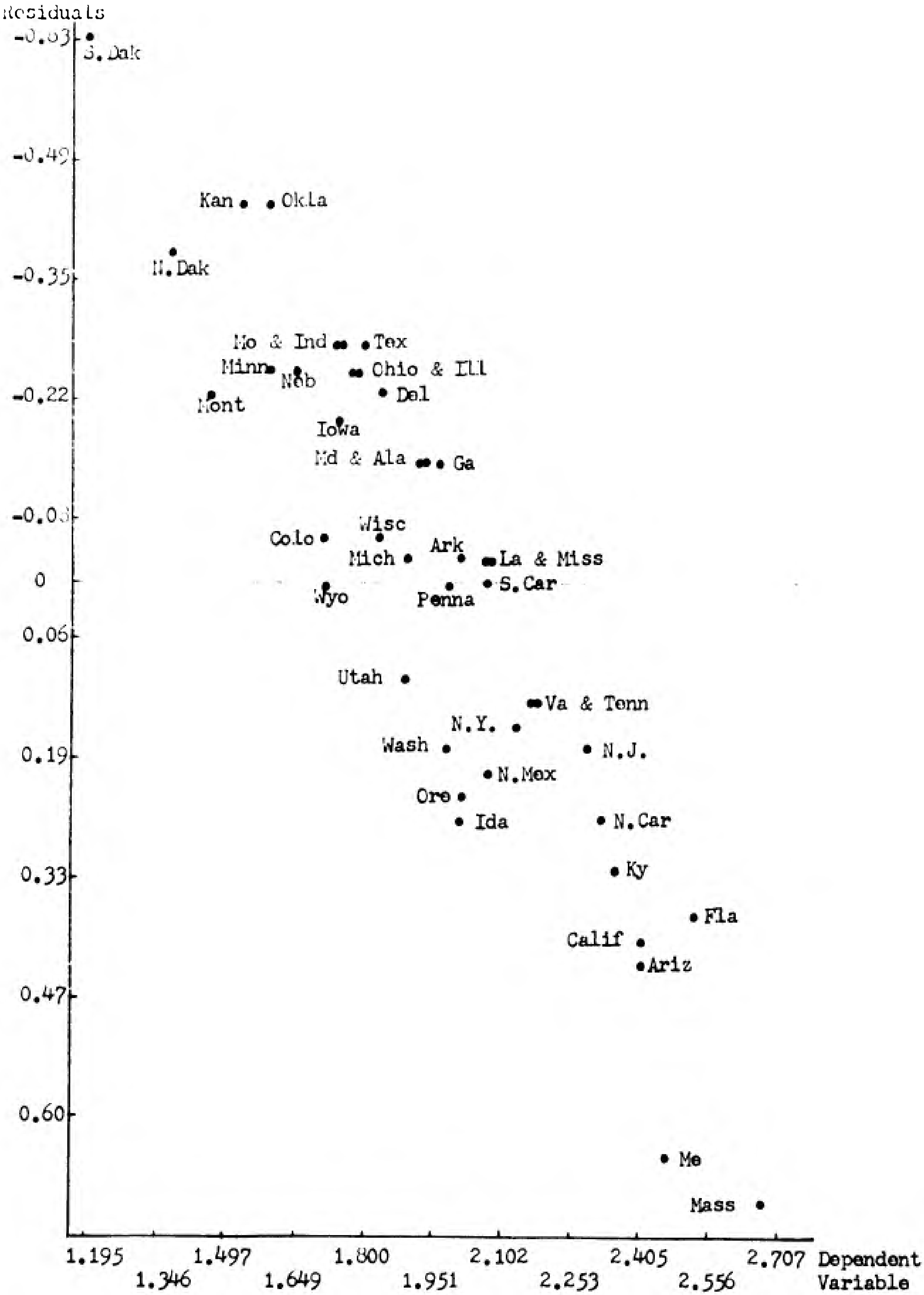
The resulting values could not be considered high enough to corroborate the theory in the first round; but the study of the residuals led to an extremely interesting situation. Due to the inclusion of three variables the analysis of the residuals was carried out in the following ways: in a three-dimensional model of the 42 observations with the three sets of variables' values; in a two-dimensional graph plotting residuals against the dependent variable; and finally in a table showing the residual values for each observation. The three methods are summarized below.

TABLE T.12 (III.b)

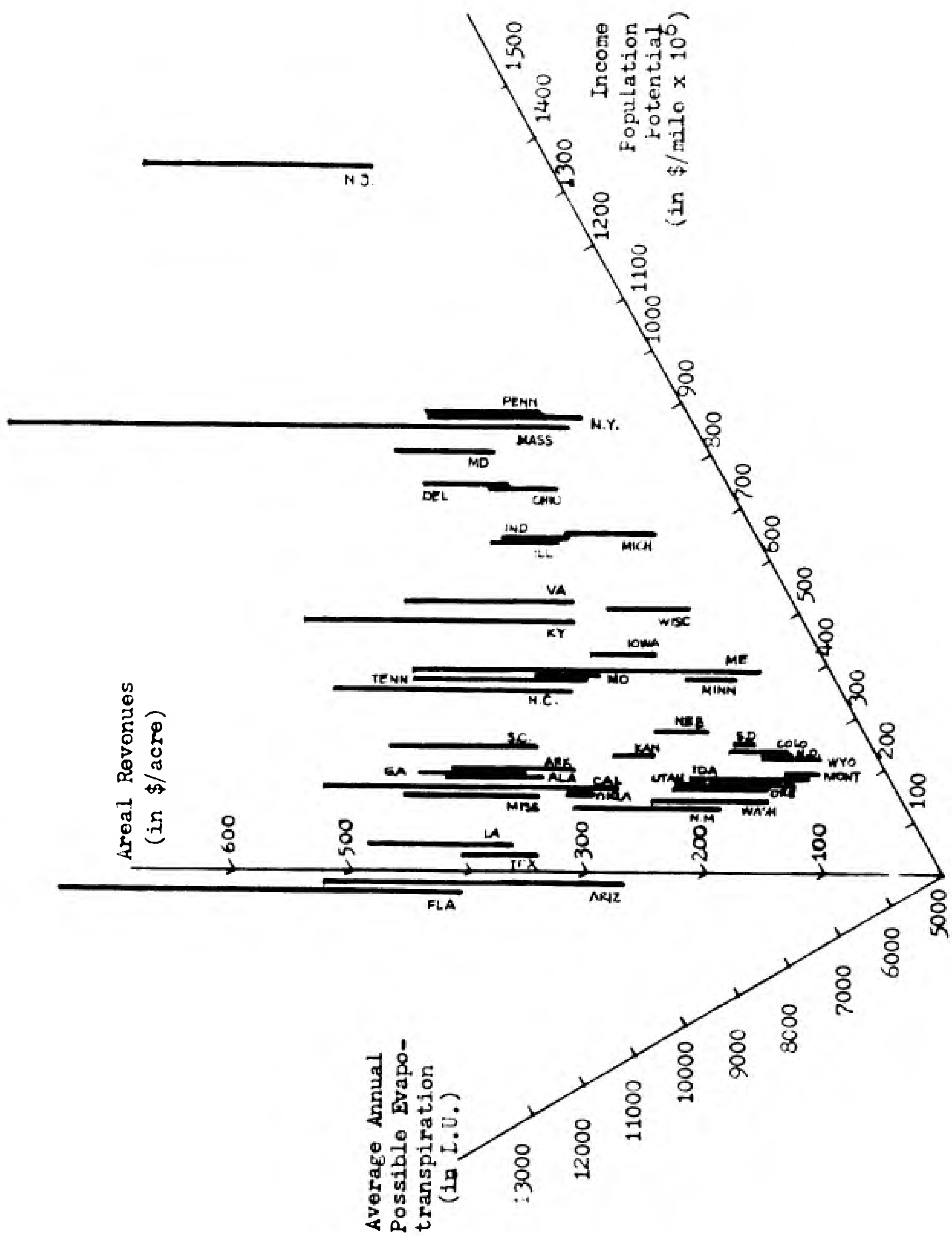
LIST OF RESIDUALS: FIRST ROUND OF CORRELATION

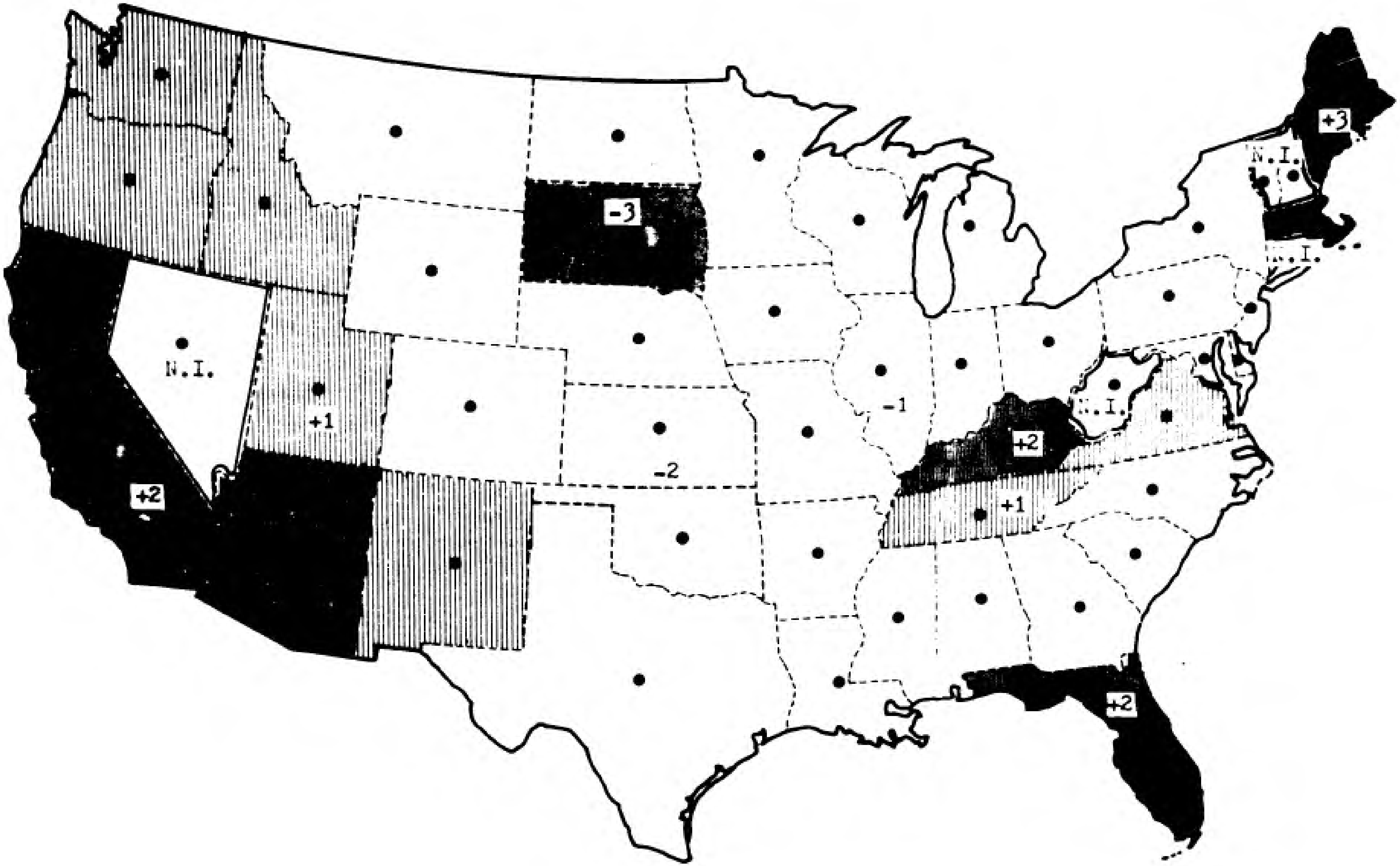
State	Residual	Standard Error of Estimate "Band" (SEE = 0.3008)	
1) Washington	0.18619		+ 1
2) Oregon	0.25100		+ 1
3) California	0.40487		+ 2
5) Idaho	0.26697		+ 1
6) Utah	0.10260		+ 1
7) Arizona	0.43922		+ 2
8) New Mexico	0.22264		+ 1
9) Colorado	-0.06299	- 1	
10) Wyoming	-0.00775	- 1	
11) Montana	-0.22519	- 1	
12) North Dakota	-0.38273	- 2	
13) South Dakota	-0.62620	- 3	
14) Nebraska	-0.24736	- 1	
15) Kansas	-0.42158	- 2	
16) Oklahoma	-0.42291	- 2	
17) Texas	-0.26823	- 1	
18) Louisiana	-0.01230	- 1	
19) Arkansas	-0.03055	- 1	
20) Missouri	-0.25905	- 1	
21) Iowa	-0.19868	- 1	
22) Minnesota	-0.24207	- 1	
23) Wisconsin	-0.05149	- 1	
24) Illinois	-0.25524	- 1	
25) Mississippi	-0.01201	- 1	
26) Alabama	-0.14308	- 1	
27) Tennessee	0.14688		+ 1
28) Kentucky	0.32931		+ 2
29) Indiana	-0.25977	- 1	
30) Michigan	-0.02285	- 1	
31) Ohio	-0.23973	- 1	
33) Georgia	-0.12751	- 1	
34) Florida	0.39156		+ 2
35) South Carolina	0.00994		+ 1
36) North Carolina	0.26611		+ 1
37) Virginia	0.13165		+ 1
38) Maryland	-0.14637	- 1	
39) Delaware	-0.21861	- 1	
40) New Jersey	0.19388		+ 1
41) Pennsylvania	-0.00991	- 1	
42) New York	0.17010		+ 1
45) Massachusetts	0.71199		+ 3
48) Maine	0.66924		+ 3

GRAPH G.1 (III.b): PLOTTING OF RESIDUALS AGAINST THE DEPENDENT VARIABLE IN LOG FORM: FIRST ROUND OF CORRELATION, U.S.A.



GRAPH G.2 (III.b): THREE-DIMENSIONAL MODEL: FIRST ROUND OF CORRELATION





Map M.21 (III.b): STATES' DEVIATIONS FROM NATIONAL CORRELATION PLANE · FIRST ROUND OF CORRELATION in S.E.E.

The study of the residuals of the first round of correlation is rewarding. It is the intention to find patterns of dispersion from the mean values such that they would correspond to the theoretical formulations. The process is then, to show first the emerging patterns.

The first element is the extremely high values of the New England area: the only represented states, Massachusetts and Maine are both between 2 and 3 Standard Errors of Estimate above the main regression plane. In the graph plotting residuals against the log of the dependent variable, both states are clearly isolated from the rest, this being also visible in the three dimensional model of the first round of correlation.

The second element is the remarkable consistency in the sign of the first 7 states: Washington, Oregon, California (Nevada was not included in the correlation), Idaho, Utah, Arizona and New Mexico, all have positive residuals, ranging from the first to the second "band" of Standard Errors of Estimate. In the graph plotting residuals against the log of the dependent variable, these 7 states are neatly arranged in a strip below and to the left of the other states. This phenomenon of being consistently higher is also shown in the three dimensional model of the correlation analysis. Furthermore the bordering states--Montana, Wyoming, Colorado and Texas--are all within the band of the first negative error of estimate, providing a smooth transition to the large negative deviations of the Dakotas, Kansas and Oklahoma, being this clear in the mapping of the residuals [see Map M.21 (III.b)]. It is possible then to state that the 7 states of the Pacific are consistently over the national correlation lane, and that there is a smooth transition to the large negative residual values of the central plains states.

The rest of the country presents a narrower range of residual values, from a widespread negative 1 to the positive 2 Standard Errors of Estimate of the southern states of Kentucky and Florida. It is interesting that out of 8 states with positive residuals--not including the already discussed New England and Pacific states 6 are part of the so-called "South" fact that will be relevant in a later development of the analysis. For the moment, let us say that this group of 33 states--plus West Virginia which was not included in the correlation analysis--do not show as clear a pattern of dispersion, as in the case of New England or the Pacific.

It should be noticed that the recognition of "correlated regions" must be studied in more than one step due to the overlapping of different locational phenomena. The best method is to select each time those observations where statistical classes and locational groups are clearly coherent.

Another interesting result is that the graph plotting residuals against the dependent variable has a suggestive distribution of points. All values are found in a diagonal strip going from the upper left corner to the lower right one. Even the identifiable strip of the Pacific states and the two New England states are in a way parallel to the main strip. According to this, the states with higher values of the dependent variable --Areal Revenues--have higher positive residuals, while the states with lower values of the dependent variable have lower negative residuals, and obviously the states with intermediate values of the dependent variable are on the main regression plane. This may mean that the explanatory equation underestimates the high revenue-earner and overestimates the low revenue-earner states. This is also clear if the mapping of the States' deviations is compared with the mapping of the Areal Revenues [see Maps M. 20 (II.b) and M.21 (III.b)]: both have lower values in the Central Plains, a slope upward to the Pacific coast and a slope upward to the Atlantic, with highest values in Florida, Kentucky and the Northeast. Interesting enough is that the two clear patterns of dispersion found--the Pacific and New England--are in the residuals mapping much more outstanding than in the Areal Revenue mapping, indicating that there are other factors besides the understatement of high revenue-earner states and viceversa, already discussed. The discovery of such factors will be the next step.

2b. Effects of the Price Structure

The two patterns of dispersion found in the previous section will now be analyzed in the light of the postulated elements of the proposed theory.

Monopolistic Location; New England

In this area of the country existed the main concentration of population in colonial times, and later it was the cradle of the Industrial Revolution in the U.S.A. with the textile and leather industry. To make a long story short, and highlight only the facts of relevance for our study, this area started to lose industry and population to other regions of the country roughly by the end of the 19th century, and by the beginning of the 20th became a stagnant region.

The interest now is to understand the extremely high deviations from the national regression plane shown in the first round of correlation. The accessibility of New England to the national market is small,[8] its highest potential demand values--measured by the Income Population Potential Model--being found in the southern area, due clearly to the influence of the New York Metropolitan area and Megalopolis in general, plus the Northern Manufacturing Belt.[9] This lack of markets is reflected in the rapidly falling values of the potential demand model, from 1,138 \$/mile (x 10^6) in Connecticut, to 446 \$/mile (10^6) in Maine. The reduction of market is more dramatic if an equal decrease is plotted in the rest of the country, indicating that similar low values of the potential demand model are reached only in Minnesota, South Dakota, Nebraska, Kansas, Oklahoma, Texas and Louisiana. Those states are about 1,200 miles from the Connecticut-New York City peak, while northern New England is only 350 miles implying a rate of decrease in the potential market 350% sharper in New England. Also important to notice is the consistency of the distribution of the potential demand model over the national space as opposed to the New England case, as the distance of the group of states around the 400 \$/mile (x 10^6) contour line, measured to the national peak of Connecticut-New York City has a small variation: from about 1,100 miles in Minnesota, to about 1,300 miles in Texas.

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[8] This fact is very much stressed in Walter Isard's study of the location of steel industry in New England.

[9] This is the group of states found to have the highest indexes of Manufacturing Specialized Locational Distribution; and includes: New Jersey Pennsylvania, Ohio, Indiana, Illinois, Michigan and Wisconsin. (The Southern Belt is composed by North and South Carolina and Tennessee but with specialized indexes much lower than the Northern Belt) (Source: unpublished research by the author.)

These results lend support to the hypothesis that New England is a case of exception to the locational theory, caused by a monopolistic location being offered to the few producers of the area. They are facing a limited market, that for this same reason have attracted few competitors, and are then able to charge higher prices. This situation would be eroded by the increasing introduction of competitive produce from the rest of the country, although it is to be noticed that this out-of-the-region produce has to bear higher transportation costs to reach the smaller and dispersed New England market in comparison with the nearer and concentrated of New York Metropolitan Area. New England is in a way an enclave with some degree of control on its own price structure.

The necessarily limited number of producers located in New England is rewarded with high Areal Revenues of the crop mix, ranging from 804.11 $/acre in Connecticut to 293.54 $/acre in Maine--the highest five values in the country with the exception of Florida. The importance of the degree of "captivity" of the market is emphasized by the unfavorable physical conditions, as the area lies between averages of 6,056 and 7,075 Development Units/year, among the lowest values of the country. If the areal revenues are high, it is also true that the need of a low competition level would allow the location of only a limited number of producers, willing to accept a limited consumption structure because of the possibility of "abnormal" revenues. This is shown in the fact that, out of the New England states, only Maine and perhaps Massachusetts have non-negligible production levels, while the other four have extremely low values--see Table T.8 (II.b) for an insight into the production structure of the area. Furthermore, a sizable part of the New England production is potatoes from Maine (Total Locational Distribution = 14.30) which is directed to the national market, its price being "normal" in relation with the national levels. The "abnormal" high values of the areal revenues in New England are mainly the result of minimal quantities of production. Consequently, New England is a case of a monopolistic location area, as explained in Chapter III.2.

Regional Submarket: The Pacific Region

The states bordering the Pacific ocean and extending up to the Mountains were developed much later than the rest of the nation, as a result of the drive toward the West. Between the Central Plains and the rich Pacific area there is a zone of high mountains and deserts which are not the most suitable environment for human settlements, with the exception of highly specialized activities such as mineral extraction. As a result there has always been some "gap" between the western part and the rest of the country. In times of more difficult communication, these western states went their own way and there is still now a kind of dichotomy in the country, although obviously not so marked as in earlier times.[10]

This is simply a case of a dual-region country, in terms of the location of population and economic activities. The Income Population Potential model shows clearly the existence of a course line (i.e., a "valley") in the U.S.A. following remarkably closely the borders of the

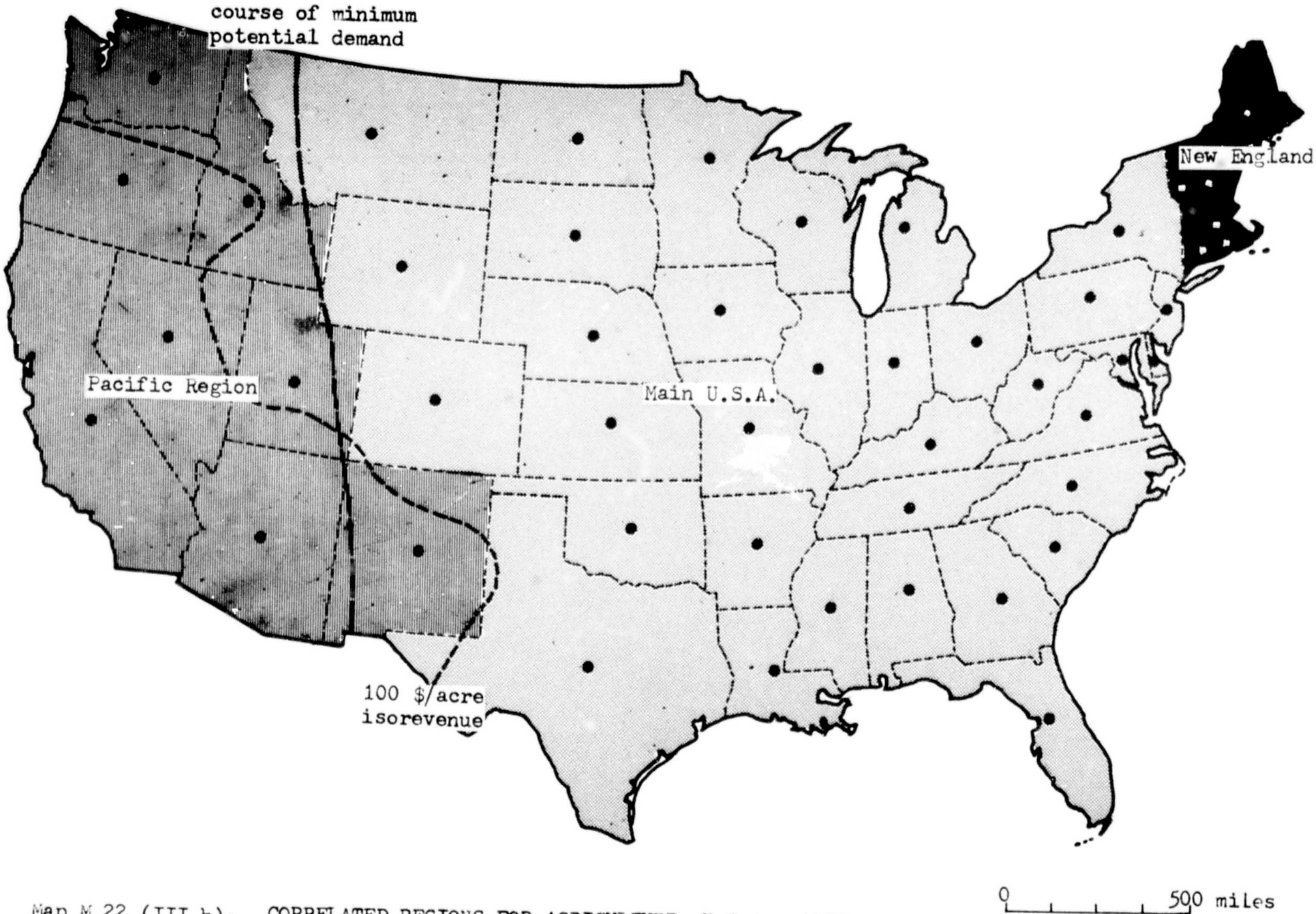
[10]It must be stressed that this dichotomy is not related with problems such as the "rich region vs. poor region" case.

Pacific region, composed of the states of Washington, Oregon, California, Nevada, Idaho, Utah, Arizona and New Mexico; defining then a kind of sub-market within the national space. These Pacific states show also a common tendency to high areal revenue values from 78.50 $/acre in Utah, to 255.02 $/acre in Arizona, reflected in the first round of the correlation analysis by a grade of consistently 1 or 2 Standard Error of Estimate above the national correlation plane.

As was mentioned in the theoretical discussion, the result of a dual or quasi-dual market structure could be the appearance of different price and rent structures, each one affected by the characteristics of the predominant market. This is not to say that the country is compartmented, but that the pervasive effects of the cost of overcoming the economic distance have an important weight. The continuation of this situation is dependent on the future national distribution of population and activities, on the reduction of friction costs and on the future importance of the first nucleus of the country. It is postulated that the development of the country would tend to minimize the effects of the submarket hills, but it is not possible to forecast its absolute disappearance. In conclusion the Pacific submarket is the result of the locational distribution of demand in the country, affected in turn by the physical conditions. Its higher-than-normal areal revenue values should not be compared with the rest of the country without making clear the implication of a regional sub-market in the revenue surface.

The previous analysis recognizes regional units in the U.S.A., based on a criterion of consistency in prices and rents regarding the agricultural production and land use. The Main U.S.A. is composed by 34 states, the Pacific region by 8 states and the exception, New England, by 5 states. This last was defined as the result of an imperfection in the national economic space, and it is postulated that this will eventually disappear. The Pacific region instead is clearly differentiated from the Main U.S.A. by locational-economic factors.

The second round of Correlation Analysis will be based on this Regional structure.



Map M.22 (III.b): CORRELATED REGIONS FOR AGRICULTURE, U.S.A., 1959

Second Round of Correlation Analysis

The theory that Areal Revenues (surrogate for Rent) are correlated with Income Population Potential and Average Annual Possible Evapotranspiration values will be tested for the three regional entities found to exist in the country. The same variables and notation used in the first round are kept in the second round, but there are three separate correlations, with 8 observations for the Pacific region, 5 observations for New England (Rhode Island has a negligible level of production) and 33 observations for the Main U.S.A. (West Virginia has a negligible level of production). Additive form and transgeneration were used again.

Pacific Region:

The resulting correlation matrix is as follows, the relevant coefficients being underlined:

Variable number	1	2	3	4	5	6
1	1.000	<u>0.459</u>	<u>0.933</u>	0.992	0.426	0.917
2		1.000	0.455	0.421	0.998	0.477
3			1.000	0.908	0.442	0.998
4				1.000	<u>0.385</u>	<u>0.892</u>
5					1.000	0.467
6						1.000

The additive form is found to be better fitted to the real world observations, though in both equations the coefficients of correlation are remarkably high. The additive form equation is:

$$X_1 = -285.43459 + 0.06641 \cdot X_2 + 0.05317 \cdot X_3$$

$$R = 0.9334$$

$$R\ Sq = 0.8713$$

The log form equation is :

$$\log X_1 = -8.19112 - 0.12270 \log X_2 + 2.73027 \log X_3$$

$$R = 0.8930$$

$$R\ Sq = 0.7975$$

The above results can be considered as a significant correlation for the theory, more than 87% of the distribution of the dependent variable being explained in the additive form by the distribution of the two independent variables. The Standard Error of Estimate in the additive form is 31.4500.

As is clear in the partial correlation matrix, the climatic variable X_3 has a much higher degree of correlation with X_1 than the demand variable X_2 --0.933 against 0.459 in the additive form. The analysis also provides further insights into the effects of each of two explanatory variables on the areal revenue values. The computation was performed in two steps, introducing first the climatic variable X_3 and later the demand variable X_2; the resulting increase in the coefficients of multiple correlation (R) and of multiple determination (R Sq.)--in the additive form--as follows:

Step Number	Variable Entered	Multiple R	Multiple R Sq.	Increase in R Sq.
1	X_3	0.9326	0.8698	0.8698
2	X_2	0.9334	0.8713	0.0016

It is consistent with the previous finding, then, that the climatic variable has a much more important effect than the aggregate demand variable. An initial explanation for this behavior of the allocating factors is that the Pacific region has an extremely even distribution of Income Population Potential values, varying slightly from 252 \$/mile (x 10^6) in Idaho, to 399 \$/mile (x 10^6) in California. Actually this area of the country has the least variation in demand potential values showing a low sloped-plateau surface, and thus it is logical to expect that the demand market would have a rather neutral effect in deciding agricultural location. (This case is close to one of the examples discussed in the theoretical section III.3, where it was postulated that if the market is assumed to be evenly distributed over the space, then the areal revenue (and rent) contour lines would follow the climatic zone lines.)

Reinforcing this explanation is the fact that the Pacific region shows an extreme variation of climatic conditions, from 6,244 D.U. in Idaho to 9,789 D.U. in Arizona. From this analysis it is only possible to say that the overwhelming impact of the climate in this submarket is the result of the particular conditions of the Pacific region, but there is no sound base for assuming that all regional submarkets in other countries must show similar characteristics.

New England:

The resulting correlation matrix is as follows, the relevant coefficients being underlined:

Variable number	1	2	3	4	5	6
1	1.000	0.917	0.932	0.993	0.869	0.925
2		1.000	0.985	0.957	0.993	0.986
3			1.000	0.965	0.968	1.000
4				1.000	0.918	0.960
5					1.000	0.971
6						1.000

Though both the additive and the log form result in high correlation values, the log form in this case provides a better fit. The log form equation is:

$$\log X_1 = -27.25265 - 0.28567 \log X_2 + 8.04761 \log X_3$$

$$R = 0.9623$$

$$R\ Sq. = 0.9259$$

It is possible that one of the causes collaborating in these high coefficients is the small number of observations, as only 5 states are included, but still the results are meaningful to corroborate the theory. Due to the fact that New England is here treated as an exception rather than as a rule, it is not necessary to study deeper the output of the correlation analysis, as was done with the Pacific region or as will be done for the Main U.S.A.

<u>Main U.S.A.</u>

This is really the essential analysis, based on a relatively large number of observations--33 states--, with wide variations in demand potential and in climate. The correlation matrix obtained is as follows, the relevant coefficients being underlined:

Variable number	1	2	3	4	5	6
1	1.000	<u>0.251</u>	<u>0.528</u>	0.915	0.261	0.512
2		1.000	-0.135	0.396	0.967	-0.082
3			1.000	0.540	-0.056	0.995
4				1.000	<u>0.438</u>	<u>0.542</u>
5					1.000	0.007
6						1.000

The log form provides higher coefficients than the additive form, indicating then that it is better fitted to the real world observations. The additive form equation is:

$$X_1 = -150.35542 + 0.08232\, X_2 + 0.02366\, X_3$$

$$R = 0.6202$$

$$R\ Sq = 0.3847$$

The log form equation is:

$$\log X_1 = -7.24333 + 0.68760 \log X_2 + 1.85243 \log X_3$$

$$R = 0.6950$$

$$R\ Sq. = 0.4830$$

In the log form, the coefficient of multiple correlation is practically 0.70, indicating that there is a meaningful level of correlation among the variables as postulated in the theory. It should be remembered that the analysis was simplified by using the surrogate models; and furthermore, that the theory explains agricultural location with only two variables, relegating all other factors to an unexplained category. Nevertheless, this simple and compact theory can achieve a meaningful coefficient of correlation level, its use being then feasible in other countries with less complete systems of data collection and statistics.

The relative weight of the two allocating variables, according to the analysis can be evaluated now. Using only the log form because of its being better fit, the partial correlation coefficients show almost equal weight for the aggregate demand and the climatic variable; 0.438 and 0.542 respectively, so that it is clear that the location of agricultural production, determined by their areal revenues (and capacity for rent consequently) is almost equally influenced by the two independent variables. It must be noticed that there is no danger of correlation between the two allocating variables as their partial correlation coefficient is -0.135 in the additive form and 0.007 in the log form. This is also shown in the computation steps; where the increases in the coefficients of multiple correlation and multiple determination brought by the introduction of the two independent variables are as follows:

Step Number	Variable Entered	Multiple R	Multiple R Sq.	Increase in R Sq.
1	log X_3	0.5423	0.2941	0.2941
2	log X_2	0.6950	0.4830	0.1889

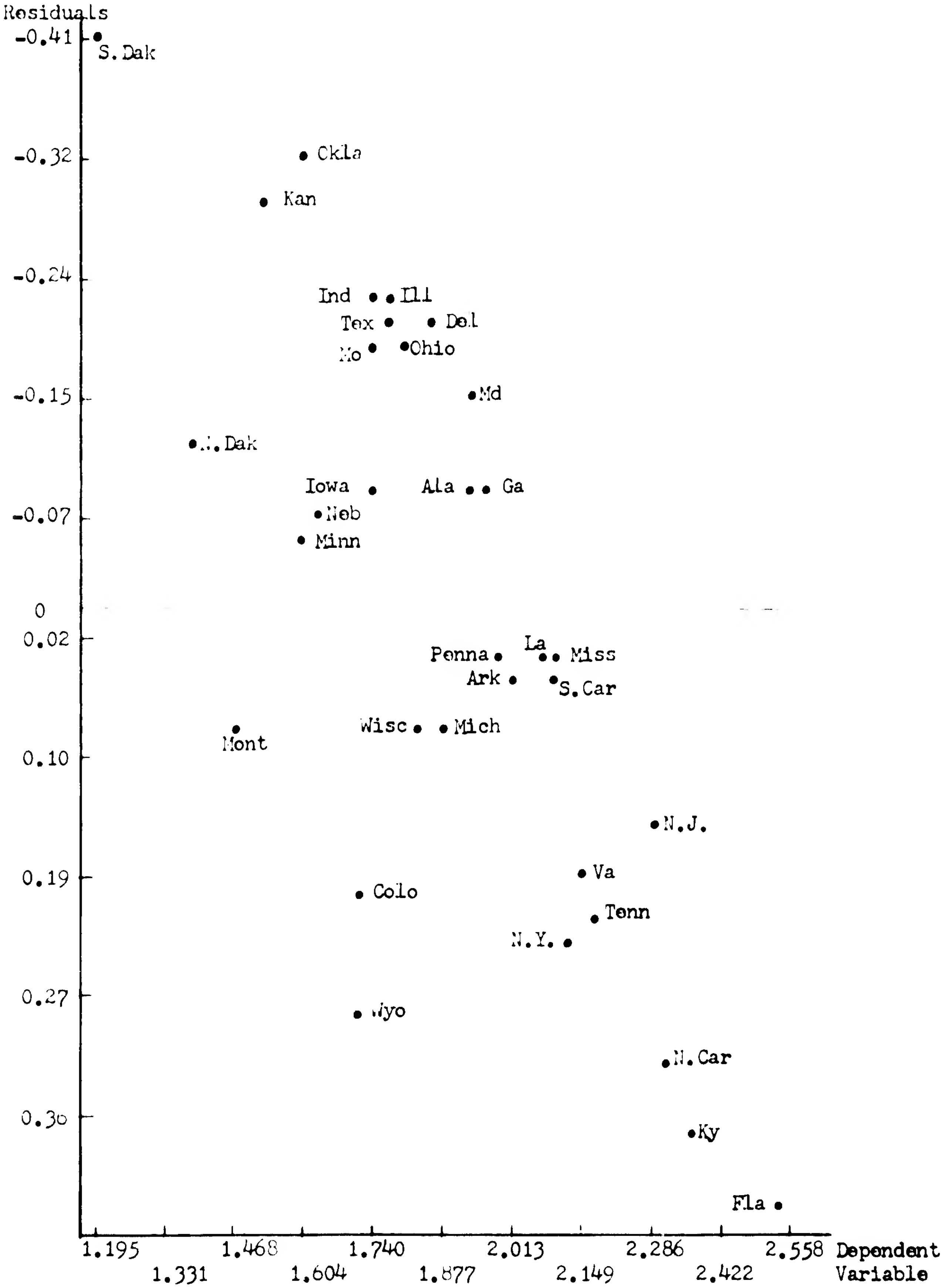
As regards the residual pattern, the Standard Error of Estimate is 0.2171, always in the log form; and the position of each state in relation to the main regression plane is shown below, in a residuals table and in a graph plotting residuals against the dependent variable.

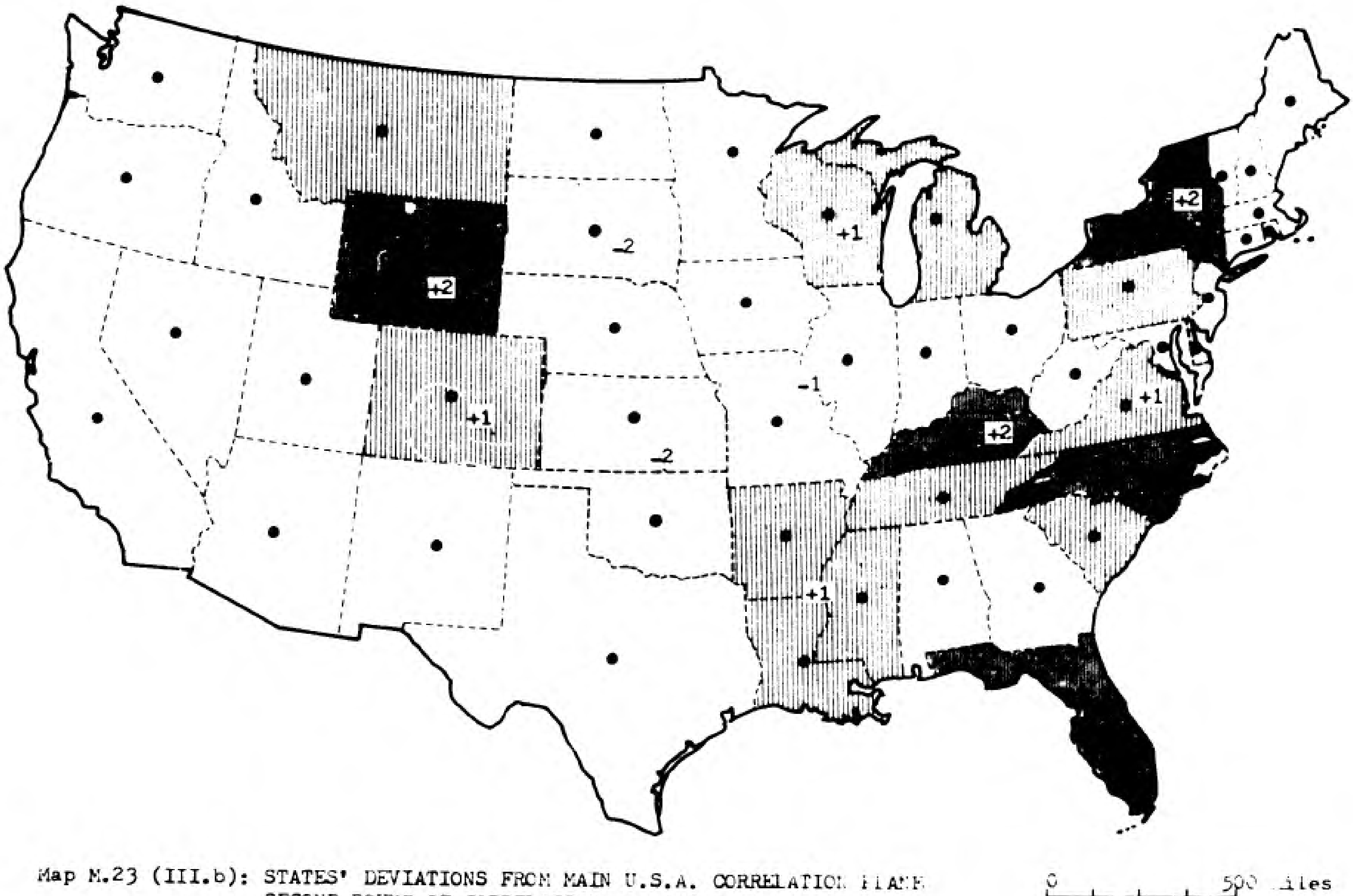
TABLE T.13 (III.b)

LIST OF RESIDUALS, MALE U.S.A.: SECOND ROUND OF CORRELATION

State	Residual	Standard Error of Estimate "band" (SEE = 0.2171)	
9) Colorado	0.19817		+1
10) Wyoming	0.29260		+2
11) Montana	0.08724		+1
12) North Dakota	-0.11718	-1	
13) South Dakota	-0.40631	-2	
14) Nebraska	-0.07551	-1	
15) Kansas	-0.29185	-2	
16) Oklahoma	-0.32538	-2	
17) Texas	-0.19273	-1	
18) Louisiana	0.03941		+1
19) Arkansas	0.04322		+1
20) Missouri	-0.18215	-1	
21) Iowa	-0.08048	-1	
22) Minnesota	-0.05162	-1	
23) Wisconsin	0.09125		+1
24) Illinois	-0.21626	-1	
25) Mississippi	0.04275		+1
26) Alabama	-0.08820	-1	
27) Tennessee	0.21467		+1
28) Kentucky	0.38196		+2
29) Indiana	-0.21323	-1	
30) Michigan	0.09242		+1
31) Ohio	-0.19777	-1	
33) Georgia	-0.08409	-1	
34) Florida	0.42466		+2
35) South Carolina	0.05250		+1
36) North Carolina	0.32589		+2
37) Virginia	0.18269		+1
38) Maryland	-0.14620	-1	
39) Delaware	-0.21026	-1	
40) New Jersey	0.14575		+1
41) Pennsylvania	0.02653		+1
42) New York	0.23751		+2

GRAPH G.3 (III.b): PLOTTING OF RESIDUALS AGAINST THE DEPENDENT VARIABLE IN LOG FORM: SECOND ROUND OF CORRELATION, MAIN U.S.A.





Map M.23 (III.b): STATES' DEVIATIONS FROM MAIN U.S.A. CORRELATION PLANE
SECOND ROUND OF CORRELATION in S.E.E.

The study of the deviations from the Main U.S.A. correlation plane indicates several interesting elements, some of them expected, but some of them new. To begin with, the higher correlation coefficients found within the Main U.S.A. as opposed to the first round of correlation, produce a more compact distribution of the observation points around the correlation plane, so that no point lies in the third band of the Standard Errors of Estimate--all are between the second positive and negative bands. Furthermore, the Standard Error of Estimate decreased from 0.3008 in the first round to 0.2171 in this second round.

At first glance, the distribution of points seems to be rather random, and if, for example, we use the theory of outliners by isolating the highest and lowest residuals, the result is that the states in the negative 1 to 2 Standard Errors of Estimate are South Dakota, Kansas and Oklahoma; and in the positive side, Wyoming, Kentucky, North Carolina, Florida and New York. Using the criterion that states within half the value of the Standard Error can be considered nominally on the correlation plane, the result is that Montana, Nebraska, Louisiana, Arkansas, Iowa, Minnesota, Wisconsin, Mississippi, Alabama, Michigan, Georgia, South Carolina and Pennsylvania are roughly near the zero value. This apparently random distribution of residuals is a confirmation of the assumption that the Main U.S.A. is indeed a coherent economic space. The aim of the analysis is not to discover areas with some degree of autonomy in an economic sense (that do not exist), but rather to understand the regional structure that is characteristic of the Main U.S.A. (always referred to the agricultural location, of course).

From a more general point of view, all the Central Plains states plus Illinois, Indiana and Ohio, and two southern states--Alabama and Georgia--have negative residuals. What is the pattern of distribution of states with positive deviations? To the west there are Montana, Wyoming and Colorado, which, as was commented regarding the Pacific region, form a kind of transition between the higher plateau of the Pacific states and the lower plateau of the Central Plains states. In the first round of correlation this was represented by moderate negative residuals in the three mentioned transitional states, but in the more compact Main U.S.A. correlation, it is logical to expect that they would appear with positive residuals. In summary, the three states of Montana, Wyoming and Colorado can be considered as "transitional" states, on the border of the higher-valued Pacific region surface.

There is a group of three other states with positive residuals that can have also a logical explanation within the first formulations of the theory. These are New York and New Jersey (Pennsylvania is almost on the correlation plane), being the nearest of the Main U.S.A. to the biggest potential demand peak of the nation, the New York Metropolitan area. As was briefly discussed in the first round of correlation, the explanatory equations tend to underestimate the higher revenue-earner states.

Finally, and this is the most interesting group, there are 9 states, all in the so-called South, that have positive residuals, 3 of which have the highest positive residuals in the whole Main U.S.A. In descending order they are: Florida, Kentucky, North Carolina, Tennessee, Virginia, South Carolina, Arkansas, Mississippi and Louisiana--the last four very close to the correlation plane. Only the two states in the middle of the South, that is Alabama and Georgia, have a negative small residual. Very significant is that four states out of the five having high positive residuals are located on the northern boundary of the area (the fifth being Florida). In this northern boundary the most striking contrast of residuals values is found, as the four southern states of Kentucky, Tennessee, Virginia and North Carolina--all with high positive residuals--face Missouri, Illinois, Indiana, Ohio, Maryland and Delaware--all with important negative residuals. Obviously, there is a very important locational phenomenon occurring along this boundary line, and its clarification is necessary to understand the structure of the economic space in Main U.S.A.

3b. The Areal Revenue Surface

Transformation of the Economic and Climatic Curves. Isorevenues.

The isorevenue curves are by one definition the result of the transformation of the curves determined only by the economic and by the climatic allocating variables, after a process of trade-off. Accordingly, particular curves such as the "Transformed economic limit" and the "Transformed climatic limit" are a result of the same transformation.

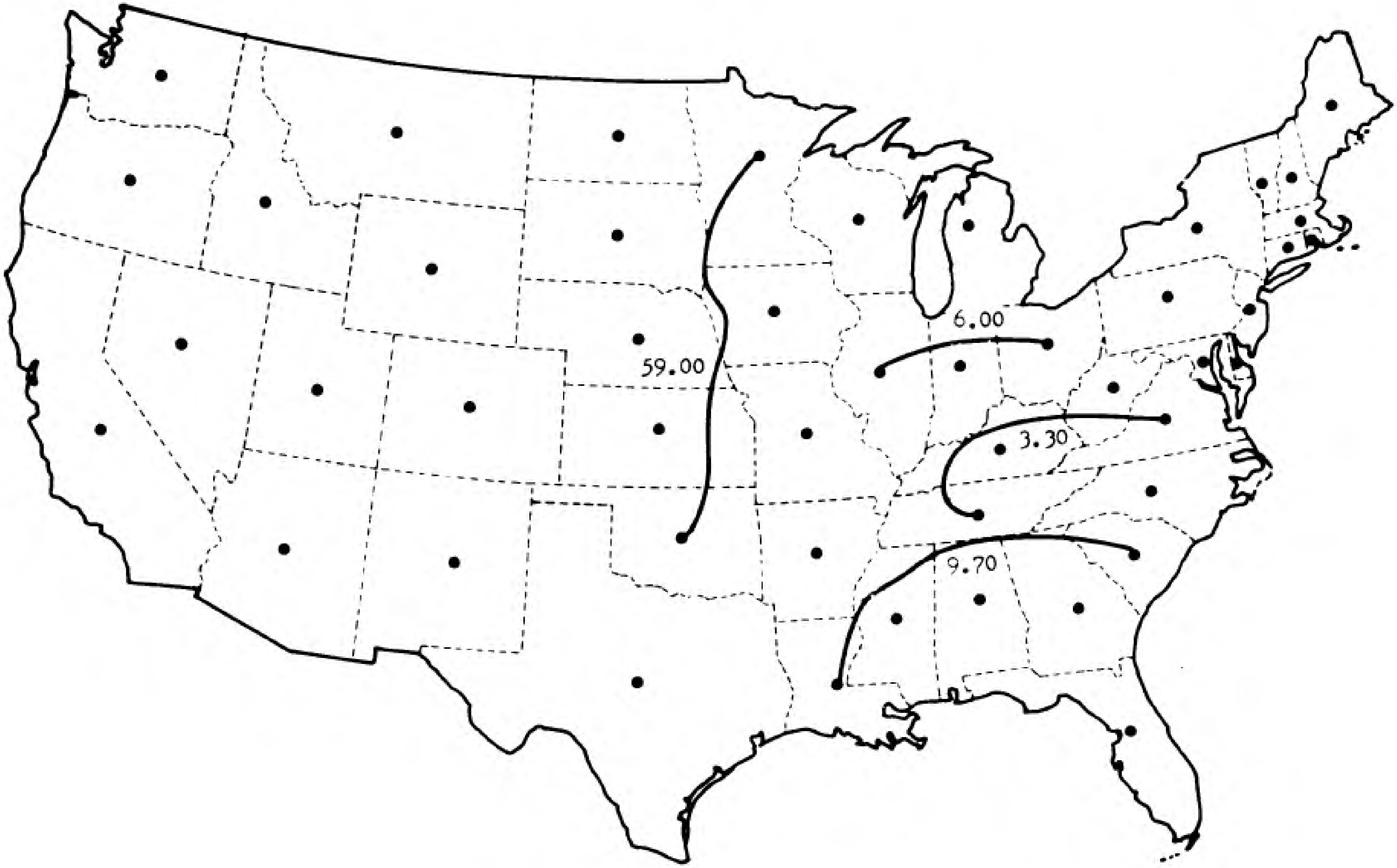
The trade-off ratios vary depending on the "price" that each factor has, measured in units of the other factor. To give an idea of the range of variation in the "prices" of the two allocating variables in agriculture, trade-off analyses among selected comparable states have been included. The following four studies simply choose two states with close areal revenue values and estimates the "price" paid in D.U. per 1 x 10^6 \$/mile of potential demand; assuming a hypothetical move from one state to the other that would leave the individual producer earning the same areal revenues, in other words, a movement along an isorevenue line.

The mapping of the trade-off ratios shows that the more parallel to the meridians the isorevenue curve is, the higher the price in D.U. will be, for the given 1×10^6 \$/mile of demand potential. This is of course quite logical due to the configuration of the climatic bands, because such a curve would cover a wider difference in D.U.

TABLE T.14 (III.b)

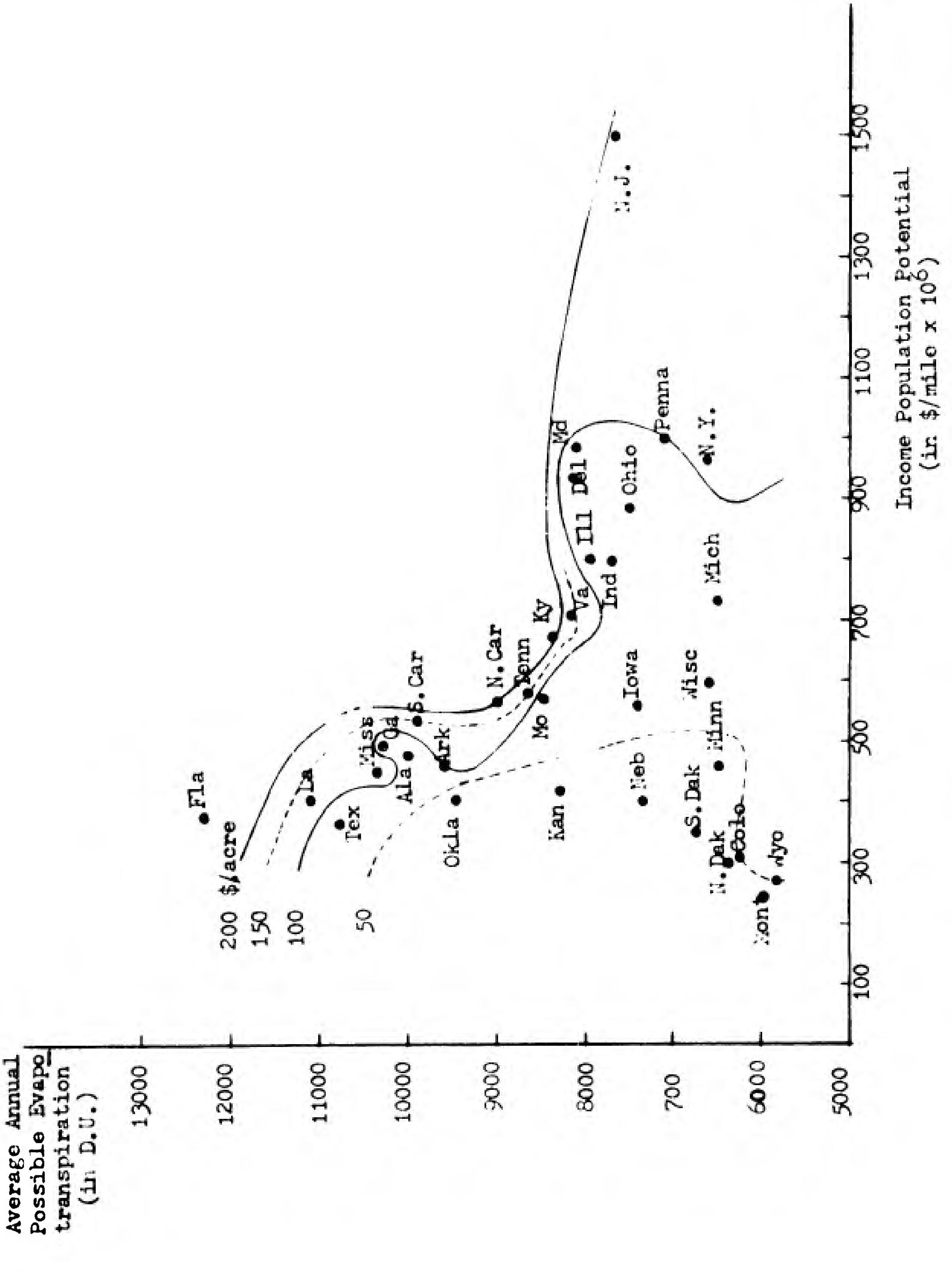
TRADE-OFF RATIOS BETWEEN THE ECONOMIC AND THE CLIMATIC COMPONENTS OF THE AREAL REVENUES, FOR SELECTED PAIRS OF STATES

State	Areal Revenues (\$/acre)	Income Pop. Potential Values (\$/mile x 10^6)	Average Annual Evapotransp. (D.U.)	Price (ratio)
16) Oklahoma	39.15	407	9,484	
22) Minnesota	39.25	458	6,468	
		- 51	+3,016	59.10 D.U. = 1×10^6 \$/mile
24) Illinois	58.73	807	7,995	
31) Ohio	58.46	882	7,541	
		- 75	+ 454	6.10 D.U. = 1×10^6 \$/mile
18) Louisiana	121.60	404	11,142	
35) South Carolina	121.91	529	9,932	
		- 125	+1,210	9.70 D.U. = 1×10^6 \$/mile
27) Tennessee	146.60	579	8,673	
37) Virginia	142.30	705	8,255	
		- 126	+ 418	3.30 D.U. = 1×10^6 \$/mile



Map M.24 (III.b): SELECTED TRADE-OFFS BETWEEN THE ECONOMIC AND CLIMATIC COMPONENTS OF "AREAL REVENUES" (in D.U. per 10^6 \$/mile)

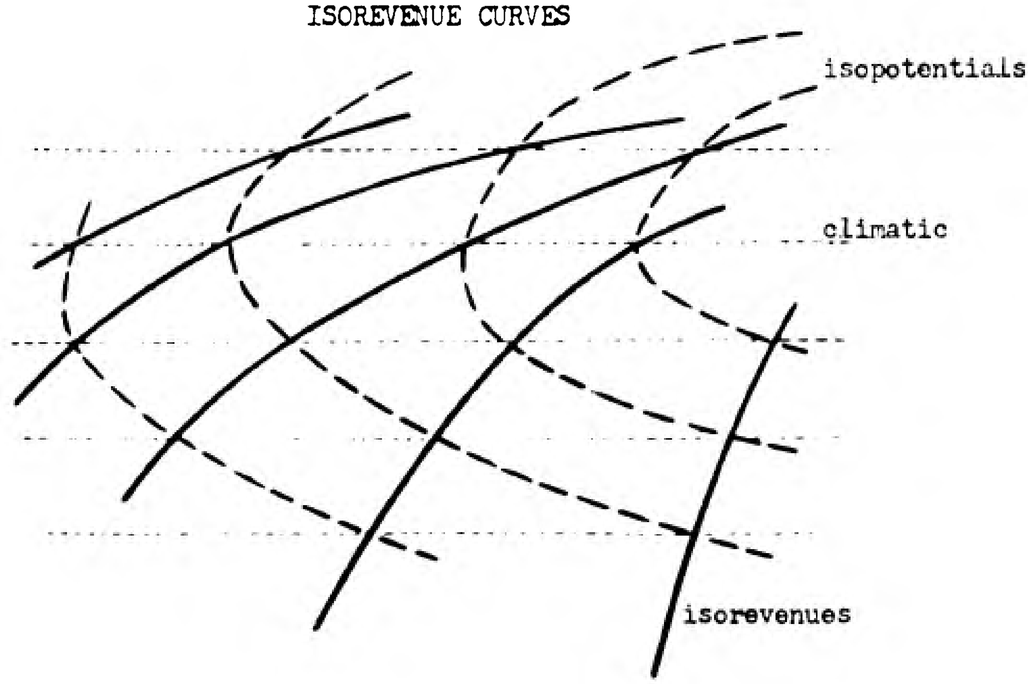
GRAPH G.4 (III.b): IMPLICIT TRADE-OFF BETWEEN THE ECONOMIC AND CLIMATIC COMPONENTS OF THE AREAL REVENUES, MAIN U.S.A.



The isorevenue contour lines are then defined as the result of the transformation between two sets of contour lines. In the following graph, a simplified sector of the U.S.A. economic space has been plotted; the isopotential curves increase toward the peak on the right side, while the climatic curves increase toward the bottom.

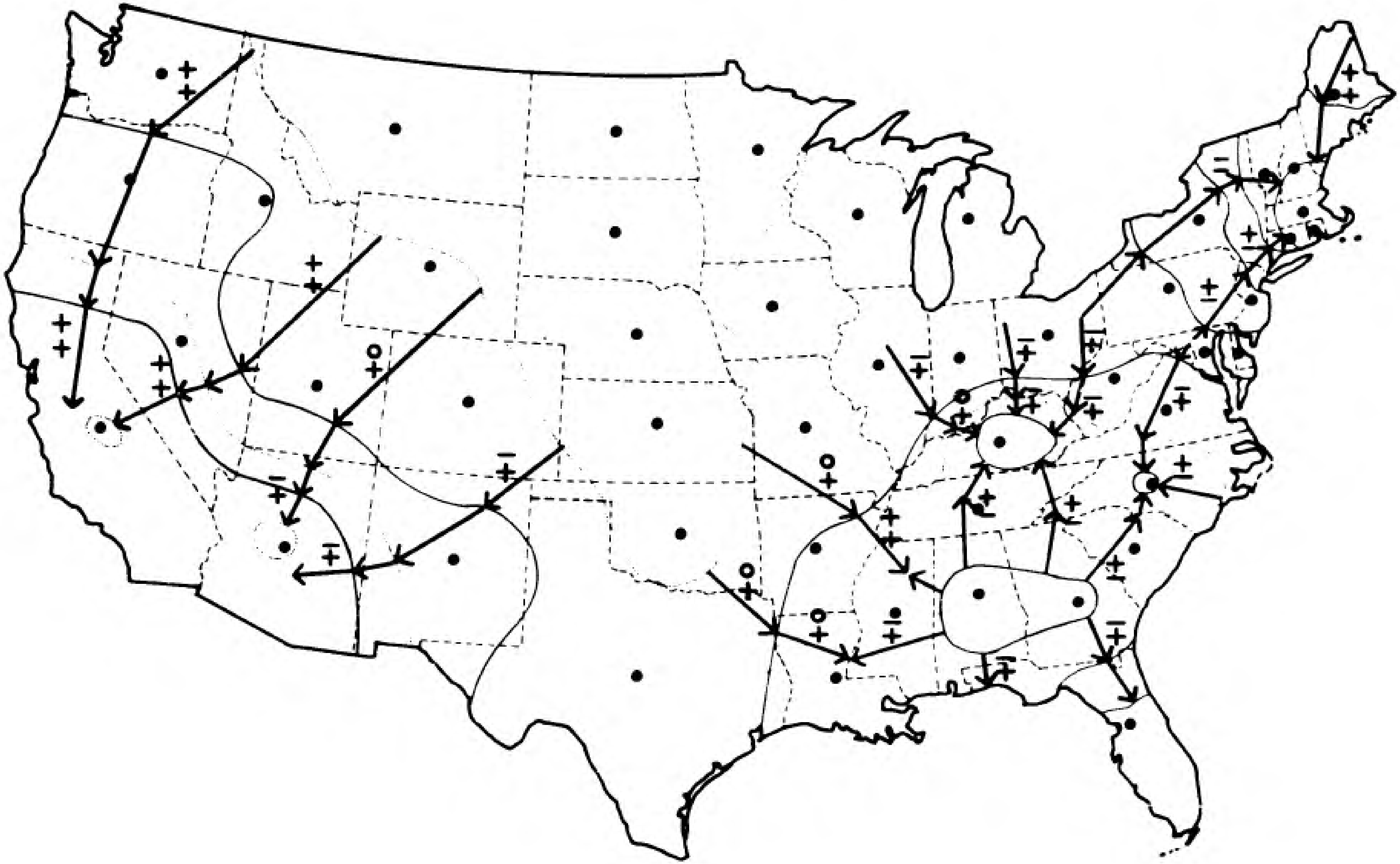
GRAPH G.5 (III.b)

ISOREVENUE CURVES



In this graphic example, a constant result is obtained when the producer moves from one point of the isorevenue curve to another point of the same curve. The direction of increased values of the isorevenue curves is determined with two hypothetical shifts. In one the producer is supposed to move to a point on another isorevenue curve, located below and to the right of the original one; and assuming for example that the shift occurred along one isopotential curve (i.e., constant potential values) there is an increase in the climatic model values, resulting in a total increase of the areal revenues. The other case is the reverse, where a producer moves to a point on another isorevenue curve above and to the left of the original one, and assuming, for example, a shift along a climatic curve (i.e., constant D.U. value) there is a decrease in the values of the demand potential model, resulting in a total decrease of the isorevenue curve. Thus, in the given example, isorevenue curves increase toward the lower right corner.

The following mapping shows the composition of the potential demand and the climatic variables on the Areal Revenues.



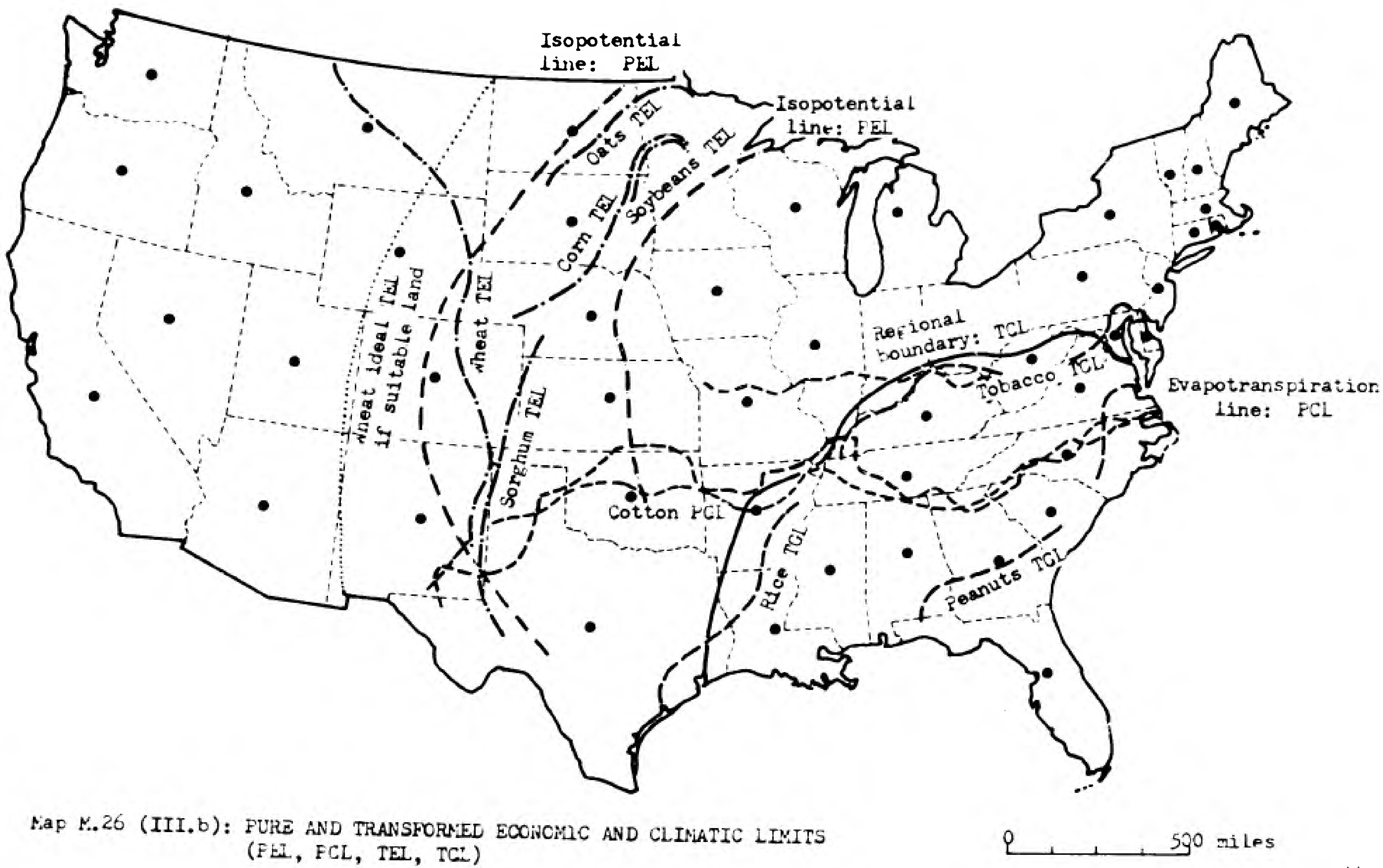
Map M.25 (IIIb): COMPOSITION EFFECTS OF THE ECONOMIC AND THE CLIMATIC COMPONENTS OF "AREAL REVENUES"
(+ - :incr.(decr.) of Potential Demand
+ - :incr.(decr.) of Climate D.U.)

0 500 miles

It has already been explained that the economic and the climatic limits are each one transformed by the other variable, becoming "transformed limits." The pure economic limits would overlap with the contour lines of the Income Population Potential model, while the pure geographic limits would lie with a contour line of the Average Annual Possible Evapotranspiration model. Thus the transformed limits are one particular isorevenue curve.

For some crops there would never be an indication of their geographic limits, because they can be cultivated in all the national space without climatic problems, and so they would only have a transformed economic limit. This is the case, in the U.S.A., with corn, sorghum, wheat, oats and soybeans, for example. Other crops, on the contrary, due to their own growth requirements, are very sensitive to climatic conditions and can be produced only in the most favorable areas of the country, so that they would present a transformed geographic limit. In the U.S.A., this is the case with rice, peanuts, cotton and tobacco, for example. An interesting exception to the postulate of limits transformation is cotton, which follows only the pure climatic limit, without being affected by the distribution of aggregate demand. Cotton production is kept exactly below the line of 9,020 D.U. per year throughout the whole country, without the slightest visible effect of the locational economic variable. The production of cotton in the Pacific region is small enough to be disregarded, but the importance of the production in Texas and Oklahoma must be accounted for--it is almost 1/3 of the national production. One explanation, apart from the possibility of factors such as differential in quality, is that there is such inefficiency in cotton production in the Deep South that it is possible for Texas to grow cotton regardless of the higher transfer costs involved.

Other anomaly must be mentioned, the existing transformed economic limit of wheat does not exactly follow the theoretical one, due to the arid conditions of Wyoming, Colorado and Arizona, where there is a difference between the Average Annual Possible Evapotranspiration and the Actual level. Government policies are not among the variables introduced in the model. Nevertheless, in the case of the distribution of cotton production they are an important factor that allows Texas to grow such a large share of national production.



Map M.26 (III.b): PURE AND TRANSFORMED ECONOMIC AND CLIMATIC LIMITS
(PEL, PCL, TEL, TCL)

Regional Boundaries

In the theoretical section on limits (III.3) was mentioned the possibility that the climatic limit could cause a "break" or a situation of non-continuity in the areal revenue surface, where the marginal change in the values of Development Units per year might allow a new crop to appear with its own price level and yields, resulting then in a non-marginal change in the revenue surface. This is the only situation that could provoke a break; otherwise the effects of increases in yields or the effects of the economic limits would not alter the continuity of the revenues surface.

One such regional "boundary" is found in the Main U.S.A., caused by the common requirements of at least a couple of crops, tobacco and peanuts. The study of the deviations from the Main U.S.A. correlation plane --second round of analysis--indicated, strikingly, that the group of four states in the so-called South with very high positive residuals--Tennessee, Kentucky, Virginia and North Carolina--has a common frontier with some states on the northern side that have important negative residuals--Missouri, Illinois, Indiana, Ohio, Maryland and Delaware. It is clear that this would generate a zone where areal revenue values change radically.

Furthermore, this division--following political borders only because the data is expressed by states--agrees remarkably closely with the isorevenue line of approximately 100 $/acre, indicating that the division line is actually a transformed curve between the economic and the climatic components. This boundary line lies between the 7,500 and the 8,220 D.U. climatic lines at the location of higher demand potential--900 to 800 $/

mile x 10^6--being this location considered closed to the pure climatic limit for the relevant crops; then the boundary is found between the values of 8,220 and 9,020 D.U., down to the 500 \$/mile x 10^6 equipotential line; finally to pass through the bands of 9,800, 10,600 and 11,400 D.U., in an arc from Virginia to Louisiana. As is logical, the most rewarding crop below the boundary, tobacco, is grown up to the pure climatic limit in the northern area of the south region capturing the land with more accessibility to the national markets, and explaining the high values of areal revenues in the four southern bordering states.

As a result, it is possible to postulate the existence of a regional boundary enclosing the South, along a line of discontinuity in the areal revenues surface. Contrary to the Pacific regional market discussed before, this regional boundary is an integral part of Main U.S.A., and it is rather stable. The only change that it could experience is by reflecting the changes of the demand potential values, as it transformed the pure climatic limit. To verify this, a boundary study has been developed, establishing the differentials in areal revenues between all pairs of states with a common border. Throughout the Center-North region of Main U.S.A., the border differentials have, with few exceptions, very low values; ranging from 0 (Wyoming-Colorado) up to 28 \$/acre (South Dakota-Nebraska). The few exceptions are short border segments around South Dakota (which have an extremely low areal revenue value) and some borders between Pennsylvania, New York, New Jersey and Delaware. As a whole this region presents then a smooth slope in the revenue surface, with an increased slope around the New York Metropolitan Area.

Instead, the differentials on the South regional boundary show a very sharp increase. The arc extending from Virginia to Louisiana has the following values: 59, 84, 129, 168, 170, 167, 171, 91, 47, 63, 39 and 58. This should be compared with the boundary differentials of the states lying on the northern side of the regional boundary. Again from the Atlantic to the Gulf of Mexico coast: 14, 15, 39, 2, 18, 2, 19, 9, 3, 1, 22, 5, and 24 --the boundary differentials being not more than one state away from the regional boundary. It is obvious that there is a break in the continuity of the areal revenue surface.

Furthermore, the boundary differentials within the South region keep their high values consistently, with the exception of two border segments around Alabama--which is a pit in the areal revenue surface--indicating that the slope of the whole region is steeper than in the Center-North. The results are also apparent in the contour mapping of the Areal Revenue surface, in Map M.20 (II.b).

In regard to the other regional entities found in the national economic space, these also show a change in the boundary differentials. The Pacific region has higher differentials at its regional boundary than do the states to the east of it, although the gap is less important than in the South region. The differentials range from 28 to 82 $/acre, in comparison with the boundaries to the east which have differential values from zero to 35 $/acre. This indicates that there is a change in the slope rather than a break in the continuity of the surface--and this is corroborated by the contour mapping which shows a gradual increase in the steepness of the surface, up to the coast.

The following table and mapping summarizes the boundary differential data for the U.S.A. It must be noticed that as West Virginia was not included as a data point, the differential boundary values around it are estimated as if the state were excluded, that is by comparing the revenue values of the states on both sides of West Virginia.

TABLE I.15 (III.b)

BOUNDARY STUDY: DIFFERENTIAL AREAL REVENUES FOR TOTAL AGRICULTURAL PRODUCTION AT STATES' BORDERS, U.S.A., 1959

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1		6			4																			
2			148		2																			
3				175			5																	
4					25	3	180																	
5						22				49	70													
6							177		28	28														
7								134																
8									71							82	58							
9										0				7	16	11								
10											21		35	7										
11												6	15											
12													8									15		
13														28							39	24		
14															9					12	11			
15																5				22				
16																	24		63	16				
17																		58	39					
18																			19					
19																				47				
20																					1			3
21																						15	13	4
22																							29	
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Within Pacific Region

Pacific/Main USA Boundary

TABLE T.15 (III.b)--Continued

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
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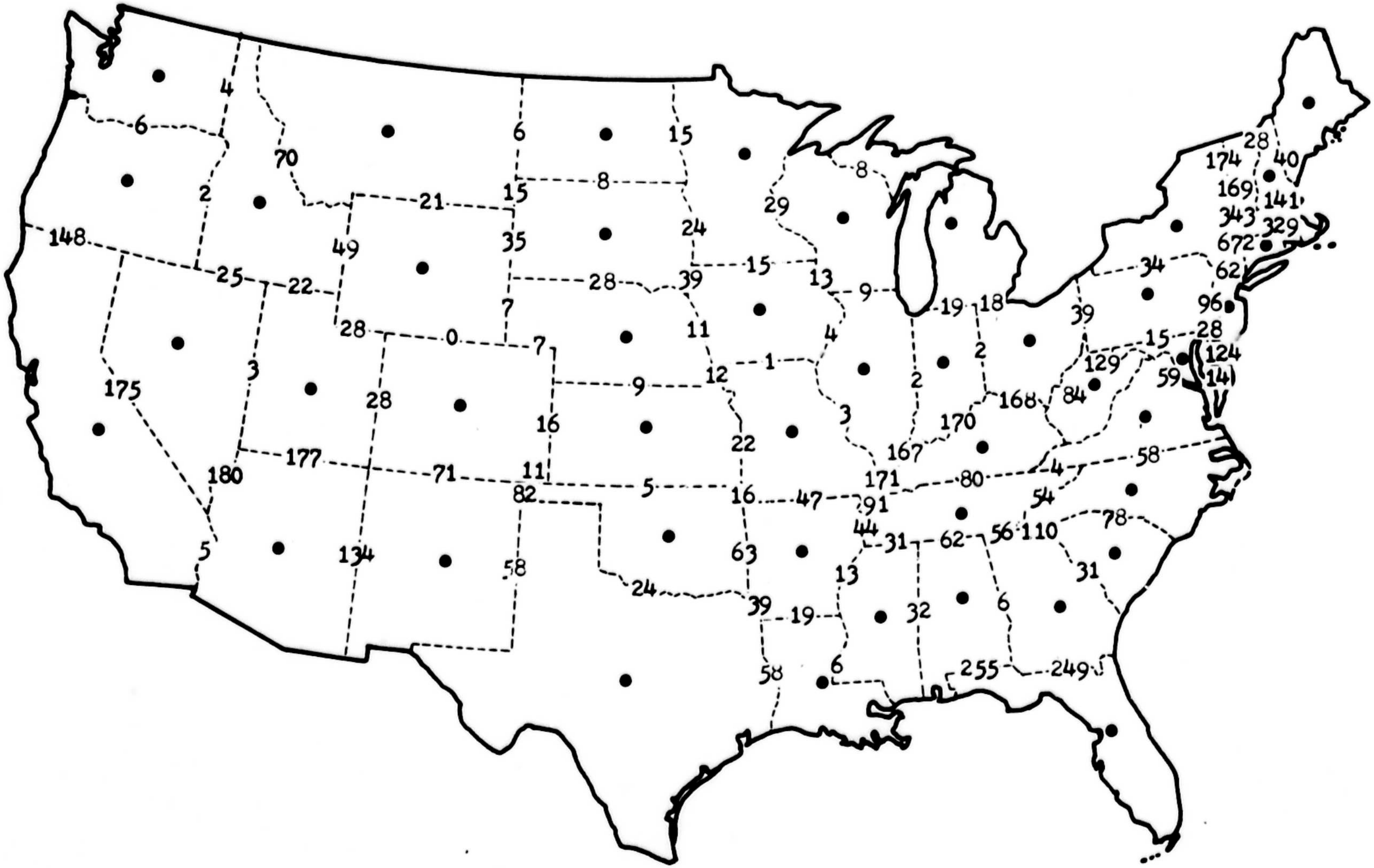
18	6																							
19	13		44																					
20			91	171																				
21																								
22																								
23						8																		
24				167	2																			
25		32	31																					
26			62						6	255														
27				80					56			54	4											
28					170		168						84				129							
29						19	2																	
30							18																	
31													84				39							
32																								
33										249	31	110												
34																								
35												78												
36													58											
37														59										
38															14		15							
39																124	28							
40																	96	62						
41																		34						
42																			672		343	174		
43																					329			
44																								
45																						169	141	
46																							28	
47																								40
48																								

Within Main USA

New England/Main USA Boundary

Within New England



Map M.27 (III.b): DIFFERENTIAL AREAL REVENUES AT STATES' BORDERS, FOR TOTAL AGRICULTURAL PRODUCTION, U.S.A., 1959 (in $/acre)

Third Round of Correlation Analysis

In this last round, the theory that Areal Revenues are correlated with Income Population Potential and Average Annual Possible Evapotranspiration--as an explanation of the locational distribution of agriculture--will be tested in the two regions found within the Main U.S.A.: the Center-North and the South, which are divided by a regional boundary caused by a transformed climatic limit. The same variables and notation of the first and second round are used in this third one; and there are two separate correlations, one with 22 observations for the Center-North and another with 11 observations for the South. The additive form and the log form have been used in each case.

Center-North Region:

The resulting correlation matrix is as follows, with the relevant coefficients being underlined:

Variable number	1	2	3	4	5	6
1	1.000	0.861	0.070	0.921	0.768	0.093
2		1.000	0.142	0.825	0.971	0.199
3			1.000	0.155	0.199	0.995
4				1.000	0.795	0.176
5					1.000	0.263
6						1.000

The additive form is better adapted to the real world observations, although both equations have a high explanatory power.

The additive form equation is:

$$X_1 = 10.20630 + 0.10426 \cdot X_2 - 0.00170 \cdot X_3$$

$$R = 0.8624$$

$$R\ Sq. = 0.7437$$

The log form equation is:

$$\log X_1 = -0.15535 + 0.86704 \log X_2 - 0.12608 \log X_3$$

$$R = 0.7958$$

$$R\ Sq. = 0.6333$$

The above results can be considered a significant degree of correlation, and a comparison with the total Main U.S.A. analysis shows that the explanatory power of the theory has been increased. In the correlation studying the Center-North and the South together, the best coefficient of correlation was R = 0.6950--now the separation of the two component regions increased the coefficient for the Center-North to R = 0.8624. For the Main U.S.A. the best coefficient of determination was R Sq. = 0.4830--now has increased in the Center-North to R Sq. = 0.7437. Obviously this was achieved by the elimination of the important differences brought by the climatic conditions in the South, which caused, as was discussed earlier, a non-marginal change in the areal revenues at the regional boundary. (This case is close to the hypothetical example of section III.3 where it was assumed that if the economic space had no variation in climate, the aggregate demand would be the definitive allocating variable. It was postulated that the Areal Revenue curves would overlap with the isopotential curves.) As a result, the analysis of the Center-North region must show a diminished weight of the climatic variable. The correlation matrix, in both the additive and log form indicates much higher coefficients between the dependent variable with X_2 and X_5 (i.e., log X_2) than with X_3 and X_6 (i.e., log X_3). Thus, the potential demand is the most important explanatory variable, for the Center-North region, while climate is only of marginal importance.

This is also shown in the analysis of the computation steps, for the additive form, indicating the increase in R Sq. brought by the inclusion of the two independent variables:

Step Number	Variable Entered	Multiple R	Multiple R Sq.	Increase in R Sq.
1	X_2	0.8608	0.7410	0.7410
2	X_3	0.8624	0.7437	0.0028

Clearly, the weight of the aggregate demand variable is overwhelming. This must be compared with the balanced importance which both allocating variables have for the correlation of the 33 states of Main U.S.A., in the Second Round.

Regarding the residual pattern, the Standard Error of Estimate is 20.5064--always in the additive equation--with none of the states falling between the 2 and 3 Standard Errors of Estimate. A study of the states' deviations shows that the highest correspond to the states near the market concentration of New York Metropolitan area, New Jersey and New York plus Texas. The negative residuals are found mainly in the states of Ohio, Indiana, Illinois and Delaware. It is interesting to notice how the negative deviations shift from the Central Plains to the states north of the South region boundary line, when Main U.S.A. was split between the two component regions, the Center-North and the South.

As before, the plotting of residuals against the dependent variable still shows a diagonal arrangement from the upper left corner to the lower right one, although the pattern is now hardly discernible.

TABLE T.16 (III.b)

LIST OF RESIDUALS, CENTER-NORTH REGION: THIRD ROUND OF CORRELATION

State	Residual	Standard Error of Estimate "band" (SEE = 20.5064)	
9) Colorado	18.33936		+ 1
10) Wyoming	21.96194		+ 2
11) Montana	4.26986		+ 1
12) North Dakota	- 6.85631	- 1	
13) South Dakota	-19.55196	- 1	
14) Nebraska	3.38695		+ 1
15) Kansas	- 5.85828	- 1	
16) Oklahoma	2.59491		+ 1
17) Texas	33.03936		+ 2
20) Missouri	- 0.08669	- 1	
21) Iowa	- 1.32403	- 1	
22) Minnesota	- 7.73729	- 1	
23) Wisconsin	6.61953		+ 1
24) Illinois	-22.05383	- 2	
29) Indiana	-23.54177	- 2	
30) Michigan	0.72693		+ 1
31) Ohio	-30.91320	- 2	
38) Maryland	-15.97825	- 1	
39) Delaware	-23.93993	- 2	
40) New Jersey	40.08861		+ 2
41) Pennsylvania	- 5.06174	- 1	
42) New York	31.87587		+ 2

South Region:

The resulting correlation matrix is as follows, with the relevant coefficients being underlined:

Variable number	1	2	3	4	5	6
1	1.000	-0.028	0.272	0.978	-0.089	0.217
2		1.000	-0.917	0.112	0.995	-0.934
3			1.000	0.120	-0.940	0.998
4				1.000	0.053	0.065
5					1.000	-0.951
6						1.000

The additive form is better adapted to the real world observations, in comparison with the log form which has a poor explanatory power.

The additive form equation is:

$$X_1 = -1308.86296 + 1.01234 \cdot X_2 + 0.09528 \cdot X_3$$

$$R = 0.6174$$

$$R\ Sq = 0.3812$$

The log form equation is:

$$\log X_1 = -21.46454 + 2.58577 \log X_2 + 4.16349 \log X_3$$

$$R = 0.3786$$

$$R\ Sq. = 0.1434$$

Although the additive form provides a fair correlation, their coefficients of multiple correlation and determination are lower than in the correlation analysis for the Center-North region and for the whole Main U.S.A. Thus the regional analysis has not increased the explanatory power of the theory for the South region--contrary to the experience in the rest of the country. One possible interpretation is that important factors are not included in the explanatory equation which have more influence in the South than in the rest of the country, and immediately it is possible to mention soil erosion, low level of mechanization due to the terrain and the abundance of cheap labor, crop pests, etc. On second thought, these factors, especially erosion and pests, cannot be called actual variables but rather imperfections of the agricultural system, and in a way the abundance of pauper labor which favors a trade-off of machines for man is the result of a surviving "feudal" structure in this region. For these reasons it can be argued that the lower level of correlation found in the South, as compared with the higher levels of the rest of the country, is the result of the imperfections of the regional system.

The Standard Error of Estimate is 66.4882, again much higher than in the Central-North region and in the total Main U.S.A., being the residual distribution as shown in the following table.

TABLE T.17 (III.b)

LIST OF RESIDUALS, SOUTH REGION:
THIRD ROUND OF CORRELATION

State	Residual	Standard Error of Estimate "band" (SEE = 66.4882)	
18) Louisiana	-40.08969	- 1	
19) Arkansas	28.24768		+ 1
25) Mississippi	-20.89206	- 1	
26) Alabama	-49.30453	- 1	
27) Tennessee	42.98650		+ 1
28) Kentucky	51.59621		+ 1
33) Georgia	-80.00223	- 2	
34) Florida	92.06044		+ 2
35) South Carolina	-51.03879	- 1	
36) North rolina	75.47983		+ 2
37) Virgi	-49.04356	- 1	

As a final comment, it must be mentioned that the border separating Georgia and Florida shows the widest differential between positive and negative residuals. In the Areal Revenue surface, Georgia is part of the pit with values of 90 $/acre or less, while Florida has its own peak of 340 $/acre--the third highest value in the country. Is it possible that there is a suggestion of a regional border separating Florida from the rest of the South? If this is so, it is clear that the size of Florida is not enough to generate a region of its own, but there is an argument for the notion that Florida is not really included in the "South."

Regional System in the U.S.A.

As a result of the studies discussed throughout, it is possible to identify the regional system of the country, in reference of course to the localization of the agricultural production. Regions must be defined in terms of specific variables, at least until it is possible to prove that a given regional system is meaningful for a considerable number of parameters. On the other hand, it can be expected that there are logical connections between regional systems, as for example, the strong similarities between our regional system and William Warntz's system, based on income differentials.[11]

One of the outputs of the study is that there is no simple subdivision in chunks of space, but that each regional entity is based on a specific characteristic belonging to different regional classes, with their own different origin and continuity in time. Obviously, the result is that the identification of regional problems in the continuous process of planning and development called for different policies and implementation, according to the specific regional structure in each case.

In the U.S.A. it has been found that there is a two-step regional subdivision; first the Pacific region and the Main U.S.A. constitute two coherent units; then the Main U.S.A. has in turn a regional subdivision between the Center-North and the South. New England appeared as a last survival of older regional structures based on more autonomous units, being

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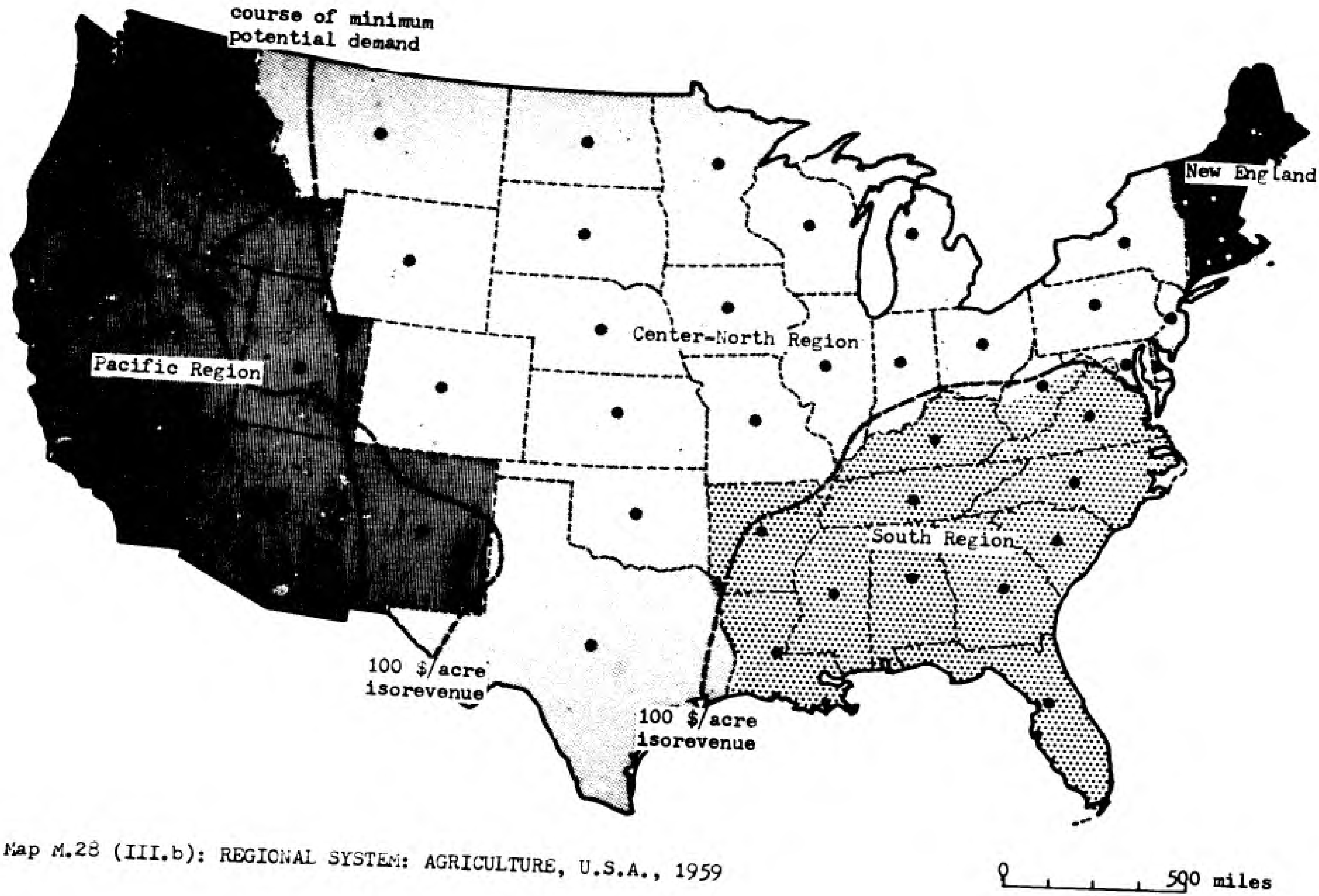
[11] See William Warntz, Macrogeography and Income Fronts (Philadelphia: Regional Science Research Institute), 1965.

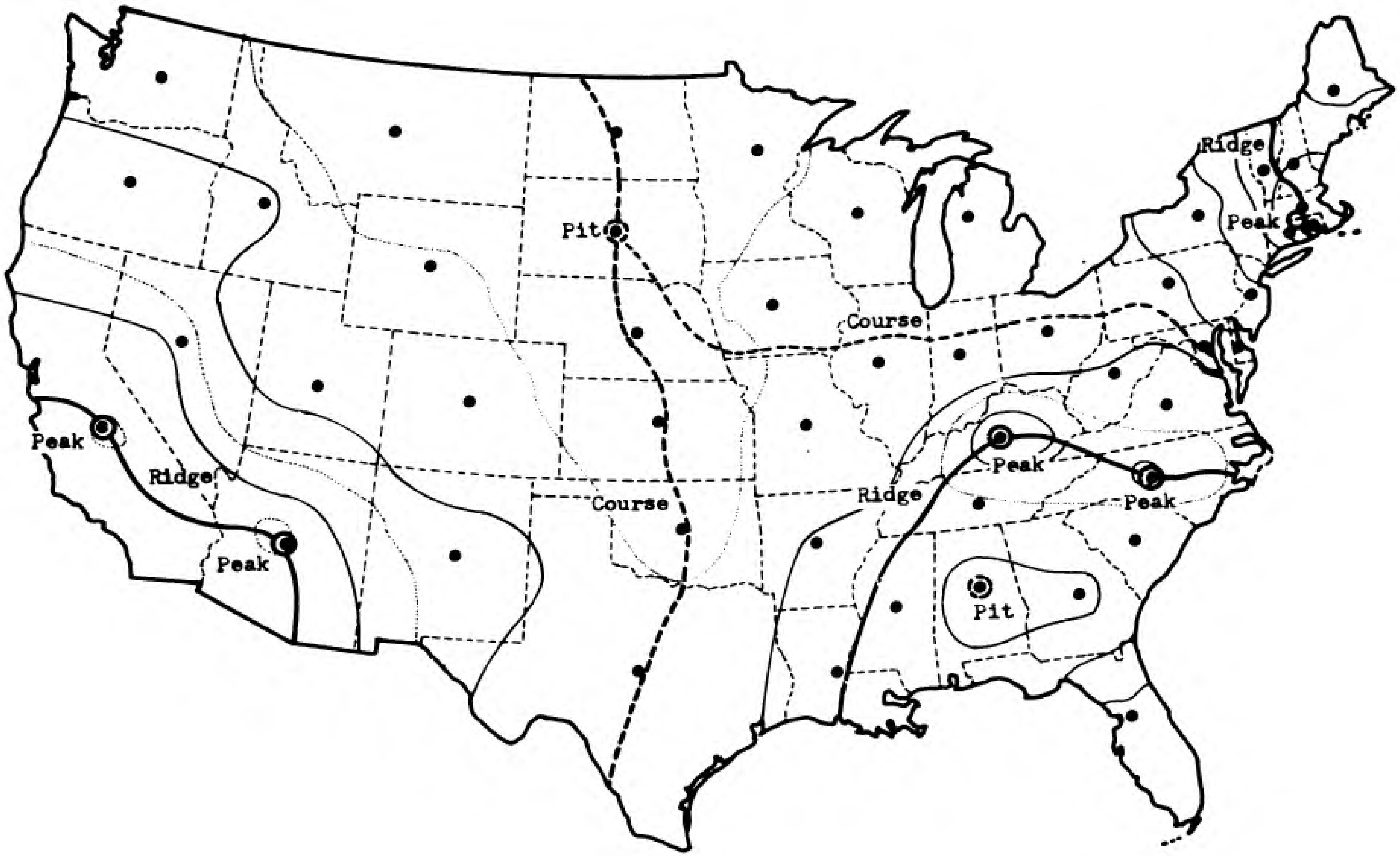
a real exception to the national system. The Pacific region is based on a locational-economic factor, the formation of two market hills in the country, with the smallest including the 8 states of Washington, Oregon, California, Nevada, Idaho, Utah, Arizona and New Mexico. It has been found that the Pacific region has higher values in the areal revenue surface, that the climate is by far the most important allocating variable and that there is no break between the two national submarkets but just a change in the direction of the slope.

The Main U.S.A. constitutes the largest integrated submarket, and in this sense it can be defined as a regional entity. Nevertheless, it is possible to recognize, within the Main U.S.A., two subdivisions: the Center-North and the South. The formation of those two regions has a different origin from the Pacific, as it is based on a locational climatic factor, that originates a boundary where a break in the continuity of the areal revenue surface occurs. It must be stressed that the potential demand of Main U.S.A. is nevertheless continuous over the two regions. The boundary line describes an arc from Virginia to Louisiana, enclosing the zone where the main difference is the non-marginal increase in areal revenues caused by the emergence of new crops. Furthermore, it must be remembered that the climatic limit is always transformed by the potential demand.

It is interesting to notice how the two allocating variables, the potential demand and the climatic conditions, each define different classes of regions. The Pacific is a submarket, in relation to the Main U.S.A.; the South is an area with profitable crops that could not be grown in the Center-North.



Map M.28 (III.b): REGIONAL SYSTEM: AGRICULTURE, U.S.A., 1959



Map M.29 (III.b): AREAL REVENUE SURFACE,
TOTAL AGRICULTURAL PRODUCTION, U.S.A., 1959

Crop Mix

In the U.S.A. it is rare to find a single crop defining a unique productive zone. The word "region" will not be used to indicate agricultural zones in order to avoid confusion with the basic regional entities studied in this chapter. In the Center-North region it is possible to distinguish the following zones located on one side of the regional boundary, that is the $100/acre isorevenue line:

- A corn-oats-soybean zone, to the southwest of the Great Lakes, extending almost from the Canadian frontier down to the regional border with the South region--and intruding slightly in it along the Mississippi River. The southeast limit is not common for the three crops, as those earning higher revenues reached farther southeast, to higher levels of the areal revenue surface; corn and soybean and then oats are having their own limits progressively set to the northwest. The three crops show increasing values as they came closer to the higher areal revenues contour lines: corn 15 to 70 $/acre, soybeans 21 to 51 $/acre, oats 11 to 27 $/acre.
- A wheat-sorghum and wheat-barley zone, along the Great Plains, with wheat from the Canadian frontier down to northern Texas; while Sorghum is grown from Texas to southern Nebraska, and barley from Oklahoma to the Canadian frontier. Following the theoretical postulate, the areal revenues of wheat increase toward the south--from 28 to 34 $/acre--; sorghum, which earns higher areal revenues than barley is located on the southern end of the zone--from 25 to 31 $/acre--, leaving barley on the northern part--from 15 to 19 $/acre. Strictly, wheat and barley invade

the Pacific region also.

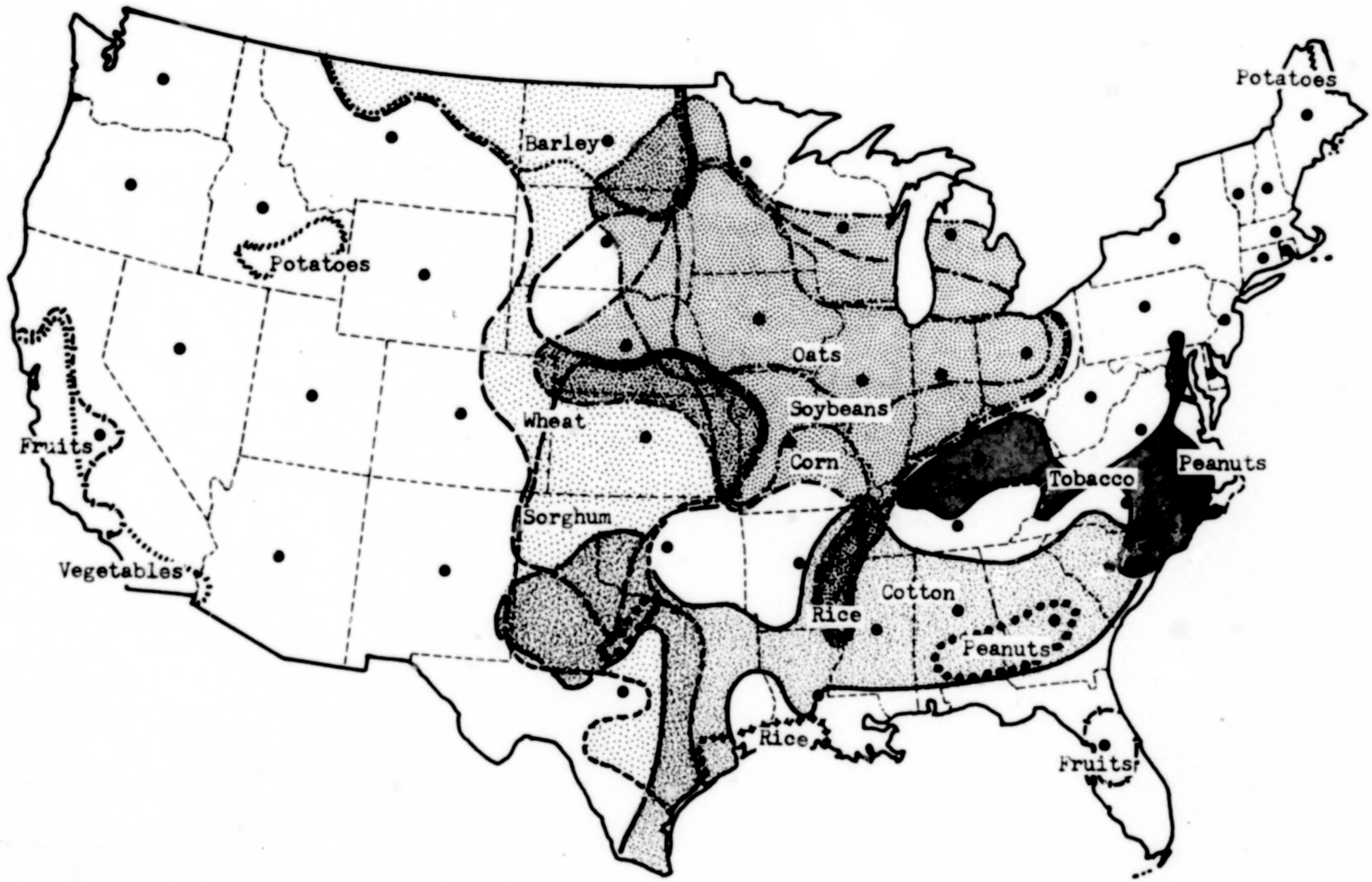
In the South region, the following zones are recognizable:

- A tobacco zone, occupying the northeast of the region--nearer to the highest values of the areal revenue surface, pushing the regional boundary (transformed climatic limit) to probably the pure limit position.
- A cotton zone, occupying the southern part of the region, and penetrating neighboring Texas to the west. It is clear that cotton, earning lower areal revenues than tobacco, has to be grown in the next best location, as it cannot successfully bid for the best land.

Overlapping those two main zones, there are some peanuts enclaves --near the Atlantic and the Gulf coast--and some rice enclaves--near the Mississippi and the Gulf coast.

Among other minor zones, there are a fruit enclave on Florida and fruit-vegetable zone on the Pacific coast.

Very relevant for the assumptions supporting this recognition of identifiable productive zones are the studies presented in Chapter IV, "A Theory of Regional Specialization."



Map No. 30 (III.b): CROP ZONES, U.S.A., 1959

Individual Crop Analysis

To complement the research using the weighted average of the crop mix, an example of the behavior of a single crop is presented. This is not intended to cover all the problems of the study at the level of the individual crop, but just to complete the picture with a representative example. The individual crop selected is wheat, because it is cultivated in most states, data being available for 40 out of 48 in coterminous U.S.A. It is not bound by particular conditions of environment such as may require the introduction of third or fourth variables to the theory; and last but not least, it has been studied for other purposes, so that there is the possibility of comparative analysis.[12]

The study will use the correlation analysis by least square regression method in additive and log form, as was described previously. The independent variables X_2 and X_3--Income Population Potential values and Average Annual Possible Evapotranspiration values--are the same as used in the previous three rounds of correlation. The dependent variable is of course different, X_1 is now the areal revenues of wheat, also in $/acre, for 1959. There are 32 observations in the Main U.S.A. The data for the wheat areal revenues was obtained from Table T.10 (II.b). The additive equation has a slightly higher explanatory power than the log form, reaching a fair level of correlation.

The additive form equation is:

$$X_1 = 30.60834 + 0.01871 X_2 - 0.00017 X_3$$

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[12] The distribution of wheat was one of the four studies undertaken in Toward a Geography of Price, by William Warntz. The other crops were onions, strawberry and potatoes, of which only the last one is included in the present study.

$R = 0.6484$

$R\ Sq = 0.4204$

The log form equation is:

$$\log X_1 = 0.83333 + 0.33774 \log X_2 - 0.04113 \log X_3$$

$R = 0.6465$

$R\ Sq. = 0.4179$

Selecting the additive form as the best explanatory equation, it will be compared now with the already mentioned analysis of William Warntz, in which wheat was one of the crop case studies.

In "Toward a Geography of Price," Warntz correlated the price paid at the farm for a particular crop with three independent variables: aggregate demand--his Annual Gross Economic Population Potential is equal to our Income Population Potential--; the Supply Space Potential and the Supply Time Potential--already mentioned before as the model of the supply structure in space and for the yearly seasons, expressed in potential terms similar to that of the demand structure. The data used are from the decade 1940-49, a good method to avoid occasional imperfections of a single year.

Clearly, the purpose of the present research is somewhat different, as it is not the intention to explain the level of prices paid at the farm, but to explain the location of production and thus the land use pattern, with an analysis of the correlation between areal revenue with the two allocating variables of aggregate demand and climate. It is stated that the combined effect of the two variables distributed over the national space determines the land allocation through the crop's areal revenue levels (and thus the capacity to pay rent). The demand potential is primarily responsible for measuring the degree of accessibility to the market--besides the secondary effect of increasing the level of price at the market--while the climatic model measures the yield differentials.

In spite of the apparent impossibility of comparison between the two studies, there is nevertheless a way of doing so. In the proposed theory, it is postulated that changes in the climatic model are reflected in similar changes in the level of yields. If the theoretical postulate is assumed to be effective, then there is a very close correlation between the climate and the yields, so that for all practical purposes both can be eliminated and the proposition still must hold. If yields are eliminated from the areal revenue side, then only one variable remains: price net of transfer costs. If the climatic model is eliminated from the side of the independent variables, only one remains, that is the demand potential. It is clear by now, that, by postulating that there must be a correlation between the areal revenues and the demand potential and climate, we are in effect saying also that there must be a similar degree of correlation between price net of transfer costs and demand potential, as well as that there is perfect correlation between yields and climate. The above statement is now comparable to a part of Warntz's analysis, where he analyses the correlation of price paid at the farm with the demand potential. Thus his coefficient of separate determination between those two variables must equal or be very close to our coefficient of determination.

The coefficient of separate determination for wheat, in "Toward a Geography of Price," between price paid at the farm and the demand potential in the country is:

$$d^2_{12.34} = 0.4379$$

The coefficient of determination for wheat in the present theory, interpreted as between the price net of transfer costs and the demand potential, is:

$$R^2 = 0.4204$$

The near equality of the two coefficients shows several things: first, the postulate of constancy between the climatic model and yields can be assumed to exist in the real world; second, there is a pervasive interdependence of the national indices at the macro level, as the results of the analyses, one with data from the decade 1940-49; and the other with data from 1956 and 1959, show a constancy of relationship at the national level--even though clearly there have been changes in all the indices.

CHAPTER IV

SPECIALIZED AGRICULTURAL LAND USE

This chapter is structured following the criteria of estimating the quantitative indices before the development of the theory, in order to keep continuity with the analysis of Chapter V.

1. Locational Distribution of Specialized Agricultural Production

The first step in the elaboration of a theory of regional specialization is to demonstrate that indeed there is such a phenomena.

As a point of departure, all the previous considerations mentioned in the study of the distribution of total production (Chapter II.1 and 1b) are valid for the present study of the distribution of the specialized production. This means that the aim is to obtain a "quantity" index, for production sold in the market, and of course that it must be based on Census data.

As before, we will denominate:

X^a = production of crop a in the country

X^a_1 = production of crop a in area 1

P = population in the country

P_1 = population in area 1

$$S^a_1 = \frac{X^a_1}{X^a} = \text{area's share of production of crop } \underline{a}$$

$$LC^a_1 = \frac{\frac{X^a_1}{X^a}}{\frac{P_1}{P}} = \frac{P \cdot X^a_1}{P_1 \cdot X^a} = \text{area's locational coefficient of crop } \underline{a}$$

$$TLD_1^a = \frac{P \cdot X_1^a}{P_1 \cdot X^a} \cdot \frac{P_1}{P} = \frac{X_1^a}{X^a} = (S_1^a)$$ area's total locational distribution of crop a

By definition, an area is said to be specialized in a given crop, when it produces more than it consumes, being able to "export" the surplus to the rest of the country.

It is necessary then to evaluate the production of surplus crop, that is the one oriented to the national market, in contrast to the part oriented to the "domestic" market.

One way of evaluating "domestic" consumption is to keep the assumption of a lineal relationship between population and agricultural consumption, previously used in Chapter II to assign a "weight" to the locational coefficient. Clearly, this approach avoids the question of product substitution, when people can consume more of one product instead of another one, if the price ratio is favorable to the first. On the other hand, the introduction of this problem would require a comparative study of prices of 15 crops in 48 states (720 cases).

It can be assumed that, in general, the domestic consumption per capita is slightly higher for the most important producing areas, than in the rest of the country, for the simple reason that the price level would be slightly lower due to the higher values of the supply potential. If this is so, the result would be a marginal reduction of the values of the specialization index. Another possible problem is that there might be quality differentials within the broad categories of a "crop"--within wheat, it is possible to distinguish some types like "spring," "winter" and "durum;" and these differentials would cause some crosshaulings.

Finally, income per capita would affect consumption levels and actually this variable was included in the potential demand model. In the case of a specialization index, it is better to start without income differentials (i.e., population only) to later on, bring the income level as an explanatory variable included in the potential demand model.

Regardless of these criticisms, the simplicity and logic of the proposed method are strong arguments favoring its use. The assumption can be expressed as follows:

the "normal" ratio of production is: $\frac{X^a}{P}$, that is the country's average;

the real ratio in area 1 is: $\frac{X_1^a}{P_1}$, variable for each area;

the ratio between the two ratios $= \frac{\text{real ratio in area 1}}{\text{"normal" ratio in country}} =$

$$= \frac{\frac{X_1^a}{P_1}}{\frac{X^a}{P}} = \frac{P \cdot X_1^a}{P_1 \cdot X^a} =$$

$=$ locational coefficient LC_1^a ,

that indicates the relation between the proportional production of crop a in area 1, and the national average.

If the locational coefficient $\frac{P \cdot X_1^a}{P_1 \cdot X^a}$ 1.00; then it is said that the area 1 is producing more than its normal proportion of crop 1, and viceversa. If furthermore, it is assumed that the consumption of crop a is directly proportional to the population P, then it is clear that any surplus over the ratio value 1.00 is not consumed domestically in the area and is "exported" to the rest of the country. Similarly, areas with a ratio value below the unity are considered to be importing crop a from the surplus areas. The locational coefficient ratio is expressed as a pure number.

As a definition, the Specialized Locational Coefficient of a given state for a given crop, is the locational coefficient index minus unity.

By the reasons offered in the discussion of the total locational distribution index (Chapter II.1 and 1b) the specialized locational coefficient is also useful for intra-area analysis, but has no possibilities for absolute inter-area comparisons; and following the same line of argument, it must be affected by the area's weight, that is its population share.

As a definition, the Specialized Locational Coefficient multiplied by the area's population share, results in the Specialized Locational Distribution index, showing the national proportion that each area have in exportable surplus of a given crop.

In summary:

The specialized locational coefficient, $SLC_1^a = LC_1^a - 1.00$

The specialized locational distribution, $SLD_1^a = \frac{P_1}{P} \cdot SLC_1^a$

In this way, the indices representing the exportable surplus of a given crop can be used in a comparative analysis among states.

2. Specialized Areal Revenues

The same concepts discussed in relation to total production distribution (see Chapter II) can be extended to the study of specialized production. For the purposes of estimating the specialized areal revenues of individual crops, the only difference from the previous analysis is that only value of sales and acreage of crops found specialized in the given area are included in the tabulations. Thus, this will reflect only the sub-system of the agricultural production that is oriented and "exported" to the national market.

Extension to the specialized areal revenues of the crop mix is also possible, by estimating this index as the ratio of the total sales and total acreage devoted to sold crop, for all crops found to be specializing in the given area.

CHAPTER IV.b

EMPIRICAL STUDIES

1b. Locational Distribution of Specialized Agricultural Production

This analysis is really a continuation of the total distribution analysis, and consequently will use the same standards, sources of data and units. For the purposes of clarifying the computation process as well as to provide easy comparisons between the total and the specialized indices, a special table has been composed where, for each state, the following data is provided: Population share, Total Locational Coefficient, Total Locational Distribution--all already known--plus the Specialized Locational Coefficient, obtained by deducting 1.00 from the Total Locational Coefficient; and the Specialized Locational Distribution, obtained by multiplying the Population share times the Specialized Locational Coefficient. All indices are pure numbers, and it must be carefully noticed that a positive Specialization index indicates a state specializing in this particular crop.

To simplify the tabulations, abbreviations are used in all headings following the already known standards. A summary is included below, as a key to Table T.18 (IV.b):

P = Population share

TLC = Total Locational Coefficient

TLD = Total Locational Distribution index

SLC = Specialized Locational Coefficient

SLD = Specialized Locational Distribution index.

TABLE T.18 (IV.b)

POPULATION SHARE (P), TOTAL LOCATIONAL COEFFICIENT (TLC), TOTAL LOCATIONAL DISTRIBUTION (TLD), SPECIALIZED LOCATIONAL COEFFICIENT (SLC) AND SPECIALIZED LOCATIONAL DISTRIBUTION (SLD) OF AGRICULTURAL PRODUCTION, FOR 15 SELECTED CROPS, FOR 48 STATES, U.S.A., 1959

State		Crops							
		Corn				Sorghum			
	P	TLC	TLD	SLC	SLD	TLC	TLD	SLC	SLD
1) Wash.	1.6	0.13	0.21	-0.87	-1.39	0.06	0.10	-0.94	-1.50
2) Ore.	1.0	0.10	0.10	-0.90	-0.90	-	-	-1.00	-1.00
3) Calif.	8.8	0.07	0.62	-0.93	-8.18	0.37	3.26	-0.63	-5.54
4) Nev.	0.2	-	-	-1.00	-0.20	-	-	-1.00	-0.20
5) Ida.	0.4	0.25	0.10	-0.75	-0.30	-	-	-1.00	-0.40
6) Utah	0.5	-	-	-1.00	-0.50	-	-	-1.00	-0.50
7) Ariz.	0.7	-	-	-1.00	-0.70	1.86	1.30	0.86	0.60
8) N.Mex.	0.5	-	-	-1.00	-0.50	3.00	1.50	2.00	1.00
9) Colo.	1.0	0.50	0.50	-0.50	-0.50	1.50	1.50	0.50	0.50
10) Wyo.	0.2	-	-	-1.00	-0.20	-	-	-1.00	-0.20
11) Mont.	0.4	-	-	-1.00	-0.40	-	-	-1.00	-0.40
12) N.Dak.	0.4	0.50	0.20	-0.50	-0.20	-	-	-1.00	-0.40
13) S.Dak.	0.4	3.75	1.50	2.75	1.10	0.75	0.30	-0.25	-0.10
14) Neb.	0.8	13.63	10.90	12.63	10.10	13.38	10.70	12.28	9.82
15) Kan.	1.5	1.47	2.21	0.47	0.71	13.67	20.51	12.67	19.01
16) Okla.	1.3	0.08	0.10	-0.92	-1.20	2.00	2.60	1.00	1.30
17) Tex.	5.3	0.19	1.01	-0.81	-4.29	10.19	54.01	9.19	48.71
18) La.	1.8	0.11	0.20	-0.89	-1.60	-	-	-1.00	-1.80
19) Ark.	1.0	0.20	0.20	-0.80	-0.80	0.10	0.10	-0.90	-0.90
20) Mo.	2.4	2.00	4.80	1.00	2.40	1.25	3.00	0.25	0.60
21) Iowa	1.5	12.73	19.10	11.73	17.60	0.27	0.41	-0.73	-1.10
22) Minn.	1.9	4.37	8.30	3.37	6.40	-	-	-1.00	-1.90
23) Wisc.	2.2	0.95	2.09	-0.05	-0.11	-	-	-1.00	-2.20
24) Ill.	5.6	3.88	21.73	2.88	16.19	0.02	0.11	-0.98	-5.49

TABLE T.18 (IV.b)--Continued

State		Crops (Continued)							
		Corn				Sorghum			
	P	TLC	TLD	SLC	SLD	TLC	TLD	SLC	SLD
25) Miss.	1.2	0.33	0.40	-0.67	-0.80	0.08	0.10	-0.92	-1.10
26) Ala.	1.8	0.44	0.79	-0.56	-1.01	-	-	-1.00	-1.80
27) Tenn.	2.0	0.40	0.80	-0.60	-1.20	0.05	0.10	-0.95	-1.90
28) Ky.	1.7	0.71	1.21	-0.29	-0.49	0.06	0.10	-0.94	-1.60
29) Ind.	2.6	3.15	8.19	2.15	5.59	0.04	0.10	-0.96	-2.50
30) Mich.	4.4	0.57	2.51	-0.43	-1.89	-	-	-1.00	-4.40
31) Ohio	5.4	1.02	5.51	0.02	0.11	-	-	-1.00	-5.40
32) W.Va.	1.0	0.10	0.10	-0.90	-0.90	-	-	-1.00	-1.00
33) Ga.	2.2	0.54	1.19	-0.46	-1.01	-	-	-1.00	-2.20
34) Fla.	2.8	0.07	0.20	-0.93	-2.60	-	-	-1.00	-2.80
35) S.Car.	1.3	0.23	0.30	-0.77	-1.00	-	-	-1.00	-1.30
36) N.Car.	2.5	0.72	1.80	-0.28	-0.70	0.12	0.30	-0.88	-2.20
37) Va.	2.2	0.23	0.51	-0.77	-1.69	-	-	-1.00	-2.20
38) Md.	1.7	0.41	0.70	-0.59	-1.00	-	-	-1.00	-1.70
39) Del.	0.3	1.00	0.30	0.00	0.00	-	-	-1.00	-0.30
40) N.J.	3.4	0.06	0.20	-0.94	-3.20	-	-	-1.00	-3.40
41) Penna.	6.3	0.17	1.07	-0.83	-5.23	-	-	-1.00	-6.30
42) N.Y.	9.4	0.03	0.28	-0.97	-9.12	-	-	-1.00	-9.40
43) Conn.	1.4	-	-	-1.00	-1.40	-	-	-1.00	-1.40
44) R.I.	0.5	-	-	-1.00	-0.50	-	-	-1.00	-0.50
45) Mass.	2.9	-	-	-1.00	-2.90	-	-	-1.00	-2.90
46) Vt.	0.2	-	-	-1.00	-0.20	-	-	-1.00	-0.20
47) N.H.	0.3	-	-	-1.00	-0.30	-	-	-1.00	-0.30
48) Me.	0.5	-	-	-1.00	-0.50	-	-	-1.00	-0.50

TABLE F.18 (IV.b)--Continued

State		Crops							
		Wheat				Oats			
	P	TLC	TLD	SLC	SLD	TLC	TLD	SLC	SLD
1) Wash.	1.6	4.50	7.20	3.50	5.60	0.75	1.20	-0.25	-0.40
2) Ore.	1.0	2.70	2.70	1.70	1.70	1.50	1.50	0.50	0.50
3) Calif.	3.8	0.09	0.79	-0.91	-8.01	0.15	1.32	-0.85	-7.48
4) Nev.	0.2	0.50	0.10	-0.50	-0.10	-	0.00	-1.00	-0.20
5) Ida.	0.4	9.25	3.70	8.25	3.30	2.75	1.10	1.75	0.70
6) Utah	0.5	1.00	0.50	0.00	0.00	0.20	0.10	-0.80	-0.40
7) Ariz.	0.7	0.43	0.30	-0.57	-0.40	-	0.00	-1.00	-0.70
8) N.Mex.	0.5	0.80	0.40	-0.20	-0.10	-	0.00	-1.00	-0.50
9) Colo.	1.0	4.70	4.70	3.70	3.70	0.50	0.50	-0.50	-0.50
10) Wyo.	0.2	2.50	0.50	1.50	0.30	2.00	0.40	1.00	0.20
11) Mont.	0.4	17.00	6.80	16.00	6.40	1.50	0.60	0.50	0.20
12) N.Dak.	0.4	21.50	8.60	20.50	8.20	13.25	5.30	12.25	4.90
13) S.Dak.	0.4	3.75	1.50	2.75	1.10	9.00	3.60	8.00	3.20
14) Neb.	0.8	7.88	6.30	6.88	5.50	3.00	2.40	2.00	1.60
15) Kan.	1.5	12.73	19.10	11.73	17.60	0.87	1.31	-0.13	-0.20
16) Okla.	1.3	6.15	8.00	5.15	6.70	1.00	1.30	0.00	0.00
17) Tex.	5.3	0.92	4.88	-0.08	-0.42	0.53	2.81	-0.47	-2.49
18) La.	1.8	0.06	0.11	-0.94	-1.69	0.11	0.20	-0.89	-1.60
19) Ark.	1.0	0.30	0.30	-0.70	-0.70	1.40	1.40	0.40	0.40
20) Mo.	2.4	1.42	3.41	0.42	1.01	0.33	0.79	-0.67	-1.61
21) Iowa	1.5	0.20	0.30	-0.80	-1.20	10.93	16.40	9.93	14.90
22) Minn.	1.9	1.11	2.11	0.11	0.21	9.68	18.39	8.68	16.49
23) Wisc.	2.2	0.09	0.19	-0.91	-2.00	2.41	5.30	1.41	3.10
24) Ill.	5.6	0.73	4.09	-0.27	-1.51	1.95	10.92	0.95	5.32

TABLE T.18 (IV.b)--Continued

State		Crops (Continued)							
		Wheat				Oats			
	P	TLC	TLD	SLC	SLD	TLC	TLD	SLC	SLD
25) Miss.	1.2	0.08	0.10	-0.92	-1.10	1.33	1.60	0.33	0.40
26) Ala.	1.8	0.06	0.11	-0.94	-1.69	0.22	0.40	-0.78	-1.40
27) Tenn.	2.0	0.15	0.30	-0.85	-1.70	0.15	0.30	-0.85	-1.70
28) Ky.	1.7	0.24	0.41	-0.76	-1.29	0.06	0.10	-0.94	-1.60
29) Ind.	2.6	1.15	2.99	0.15	0.39	1.19	3.09	0.19	0.49
30) Mich.	4.4	0.75	3.30	-0.25	-1.10	0.82	3.61	-0.18	-0.79
31) Ohio	5.4	0.50	2.70	-0.50	-2.70	0.98	5.29	-0.02	-0.11
32) W.Va.	1.0	-	-	-1.00	-1.00	-	-	-1.00	-1.00
33) Ga.	2.2	0.09	0.20	-0.91	-2.00	0.59	1.30	-0.41	-0.90
34) Fla.	2.8	-	-	-1.00	-2.80	-	-	-1.00	-2.80
35) S.Car.	1.3	0.15	0.20	-0.85	-1.11	1.23	1.60	0.23	0.30
36) N.Car.	2.5	0.24	0.60	-0.76	-1.90	0.40	1.00	-0.60	-1.50
37) Va.	2.2	0.23	0.51	-0.77	-1.69	0.14	0.31	-0.86	-1.89
38) Md.	1.7	0.18	0.31	-0.82	-1.39	0.06	0.10	-0.94	-1.60
39) Del.	0.3	0.33	0.10	-0.67	-0.20	-	-	-1.00	-0.30
40) N.J.	3.4	0.03	0.10	-0.97	-3.30	-	-	-1.00	-3.40
41) Penna.	6.3	0.17	1.07	-0.83	-5.23	0.25	1.58	-0.75	-4.73
42) N.Y.	9.4	0.07	0.66	-0.93	-8.74	0.22	2.07	-0.78	-7.33
43) Conn.	1.4	-	-	-1.00	-1.40	-	-	-1.00	-1.40
44) R.I.	0.5	-	-	-1.00	-0.50	-	-	-1.00	-0.50
45) Mass.	2.9	-	-	-1.00	-2.90	-	-	-1.00	-2.90
46) Vt.	0.2	-	-	-1.00	-0.20	-	-	-1.00	-0.20
47) N.H.	0.3	-	-	-1.00	-0.30	-	-	-1.00	-0.30
48) Me.	0.5	-	-	-1.00	-0.50	1.00	0.50	0.00	0.00

TABLE T.13 (IV.b)--Continued

State		Crops							
		Barley				Rice			
	P	TLC	TLD	SLC	SLD	TLC	TLD	SLC	SLD
1) Wash.	1.6	5.06	8.10	4.06	6.50	-	0.00	-1.00	-1.60
2) Ore.	1.0	5.30	5.30	4.30	4.30	-	0.00	-1.00	-1.00
3) Calif.	8.8	2.50	22.00	1.50	13.20	2.76	24.29	1.76	15.49
4) Nev.	0.2	0.50	0.10	-0.50	-0.10	-	0.00	-1.00	-0.20
5) Ida.	0.4	9.50	3.80	8.50	3.40	-	0.00	-1.00	-0.40
6) Utah	0.5	1.60	0.80	0.60	0.30	-	0.00	-1.00	-0.50
7) Ariz.	0.7	3.43	2.40	2.43	1.70	-	0.00	-1.00	-0.70
8) N.Mex.	0.5	0.40	0.20	-0.60	-0.30	-	0.00	-1.00	-0.50
9) Colo.	1.0	3.00	3.00	2.00	2.00	-	0.00	-1.00	-1.00
10) Wyo.	0.2	2.50	0.50	1.50	0.30	-	0.00	-1.00	-0.20
11) Mont.	0.4	30.25	12.10	29.25	11.70	-	0.00	-1.00	-0.40
12) N.Dak.	0.4	48.75	19.50	47.75	19.10	-	0.00	-1.00	-0.40
13) S.Dak.	0.4	2.50	1.00	1.50	0.60	-	0.00	-1.00	-0.40
14) Neb.	0.8	1.13	0.90	0.13	0.10	-	0.00	-1.00	-0.80
15) Kan.	1.5	2.67	4.01	1.67	2.51	-	0.00	-1.00	-1.50
16) Okla.	1.3	2.08	2.70	1.08	1.40	-	0.00	-1.00	-1.30
17) Tex.	5.3	0.25	1.33	-0.75	-3.98	4.70	24.91	3.70	19.61
18) La.	1.8	-	0.00	-1.00	-1.80	13.89	25.00	12.89	23.20
19) Ark.	1.0	-	0.00	-1.00	-1.00	23.30	23.30	22.30	22.30
20) Mo.	2.4	0.21	0.50	-0.79	-1.90	0.13	0.31	-0.87	-2.09
21) Iowa	1.5	0.07	0.11	-0.93	-1.40	-	0.00	-1.00	-1.50
22) Minn.	1.9	4.16	7.90	3.16	6.00	-	0.00	-1.00	-1.90
23) Wisc.	2.2	0.14	0.31	-0.86	-1.89	-	0.00	-1.00	-2.20
24) Ill.	5.6	0.04	0.22	-0.96	-5.38	-	0.00	-1.00	-5.60

TABLE T.18 (IV.b)--Continued

State	P	Barley TLC	Barley TLD	Barley SLC	Barley SLD	Rice TLC	Rice TLD	Rice SLC	Rice SLD
25) Miss.	1.2	-	0.00	-1.00	-1.20	1.83	2.20	0.83	1.00
26) Ala.	1.8	-	0.00	-1.00	-1.80	-	0.00	-1.00	-1.80
27) Tenn.	2.0	0.05	0.10	-0.95	-1.90	-	0.00	-1.00	-2.00
28) Ky.	1.7	0.06	0.10	-0.94	-1.60	-	0.00	-1.00	-1.70
29) Ind.	2.6	0.04	0.10	-0.96	-2.50	-	0.00	-1.00	-2.60
30) Mich.	4.4	0.09	0.40	-0.91	-4.00	-	0.00	-1.00	-4.40
31) Ohio	5.4	0.02	0.11	-0.98	-5.29	-	0.00	-1.00	-5.40
32) W.Va.	1.0	-	0.00	-1.00	-1.00	-	0.00	-1.00	-1.00
33) Ga.	2.2	-	0.00	-1.00	-2.20	-	0.00	-1.00	-2.20
34) Fla.	2.8	-	0.00	-1.00	-2.80	-	0.00	-1.00	-2.80
35) S.Car.	1.3	0.08	0.10	-0.92	-1.20	-	0.00	-1.00	-1.30
36) N.Car.	2.5	0.08	0.20	-0.92	-2.30	-	0.00	-1.00	-2.50
37) Va.	2.2	0.14	0.31	-0.86	-1.89	-	0.00	-1.00	-2.20
38) Md.	1.7	0.18	0.31	-0.82	-1.39	-	0.00	-1.00	-1.70
39) Del.	0.3	0.33	0.10	-0.67	-0.20	-	0.00	-1.00	-0.30
40) N.J.	3.4	0.03	0.10	-0.97	-3.30	-	0.00	-1.00	-3.40
41) Penna.	6.3	0.05	0.32	-0.95	-5.99	-	0.00	-1.00	-6.30
42) N.Y.	9.4	0.01	0.09	-0.99	-9.31	-	0.00	-1.00	-9.40
43) Conn.	1.4	-	0.00	-1.00	-1.40	-	0.00	-1.00	-1.40
44) R.I.	0.5	-	0.00	-1.00	-0.50	-	0.00	-1.00	-0.50
45) Mass.	2.9	-	0.00	-1.00	-2.90	-	0.00	-1.00	-2.90
46) Vt.	0.2	-	0.00	-1.00	-0.20	-	0.00	-1.00	-0.20
47) N.H.	0.3	-	0.00	-1.00	-0.30	-	0.00	-1.00	-0.30
48) Me.	0.5	-	0.00	-1.00	-0.50	-	0.00	-1.00	-0.50

TABLE T.18 (IV.8)--<u>Continued</u>

State		Crops							
		Soybeans				Peanuts			
	P	TLC	TLD	SLC	SLD	TLC	TLD	SLC	SLD
1) Wash.	1.6	-	0.00	-1.00	-1.60	-	0.00	-1.00	-1.60
2) Ore.	1.0	-	0.00	-1.00	-1.00	-	0.00	-1.00	-1.00
3) Calif.	8.8	-	0.00	-1.00	-8.80	-	0.00	-1.00	-8.80
4) Nev.	0.2	-	0.00	-1.00	-0.20	-	0.00	-1.00	-0.20
5) Ida.	0.4	-	0.00	-1.00	-0.40	-	0.00	-1.00	-0.40
6) Utah	0.5	-	0.00	-1.00	-0.50	-	0.00	-1.00	-0.50
7) Ariz.	0.7	-	0.00	-1.00	-0.70	-	0.00	-1.00	-0.70
8) N.Mex.	0.5	-	0.00	-1.00	-0.50	1.40	0.70	0.40	0.20
9) Colo.	1.0	-	0.00	-1.00	-1.00	-	0.00	-1.00	-1.00
10) Wyo.	0.2	-	0.00	-1.00	-0.20	-	0.00	-1.00	-0.20
11) Mont.	0.4	-	0.00	-1.00	-0.40	-	0.00	-1.00	-0.40
12) N.Dak.	0.4	1.25	0.50	0.25	0.10	-	0.00	-1.00	-0.40
13) S.Dak.	0.4	0.75	0.30	-0.25	-0.10	-	0.00	-1.00	-0.40
14) Neb.	0.8	0.88	0.70	-0.12	-0.10	-	0.00	-1.00	-0.80
15) Kan.	1.5	1.13	1.70	0.13	0.20	-	0.00	-1.00	-1.50
16) Okla.	1.3	0.23	0.30	-0.77	-1.00	6.00	7.80	5.00	6.50
17) Tex.	5.3	0.06	0.32	-0.94	-4.98	2.24	11.87	1.24	6.57
18) La.	1.8	0.44	0.79	-0.56	-1.01	-	0.00	-1.00	-1.80
19) Ark.	1.0	10.10	10.10	9.10	9.10	0.10	0.10	-0.90	-0.90
20) Mo.	2.4	3.83	9.19	2.83	6.79	-	0.00	-1.00	-2.40
21) Iowa	1.5	8.00	12.00	7.00	10.50	-	0.00	-1.00	-1.50
22) Minn.	1.9	4.21	8.00	3.21	6.10	-	0.00	-1.00	-1.90
23) Wisc.	2.2	0.18	0.40	-0.82	-1.80	-	0.00	-1.00	-2.20
24) Ill.	5.6	4.18	23.41	3.18	17.81	-	0.00	-1.00	-5.60

TABLE T.18 (IV.b)--Continued

State		Crops (Continued)							
		Soybeans				Peanuts			
	P	TLC	TLD	SLC	SLD	TLC	TLD	SLC	SLD
25) Miss.	1.2	3.33	4.00	2.33	2.80	0.08	0.10	-0.92	-1.10
26) Ala.	1.8	0.28	0.50	-0.72	-1.30	5.89	10.60	4.89	8.80
27) Tenn.	2.0	0.80	1.60	-0.20	-0.40	-	0.00	-1.00	-2.00
28) Ky.	1.7	0.47	0.80	-0.53	-0.90	-	0.00	-1.00	-1.70
29) Ind.	2.6	4.35	11.31	3.35	8.71	-	0.00	-1.00	-2.60
30) Mich.	4.4	0.23	1.01	-0.77	-3.39	-	0.00	-1.00	-4.40
31) Ohio	5.4	1.26	6.80	0.26	1.40	-	0.00	-1.00	-5.40
32) W.Va.	1.0	-	0.00	-1.00	-1.00	-	0.00	-1.00	-1.00
33) Ga.	2.2	0.09	0.20	-0.91	-2.00	15.95	35.09	14.95	32.89
34) Fla.	2.8	0.04	0.11	-0.96	-2.69	1.14	3.19	0.14	0.39
35) S.Car.	1.3	1.00	1.30	0.00	0.00	0.46	0.60	-0.54	-0.70
36) N.Car.	2.5	0.64	1.60	-0.36	-0.90	6.96	17.40	5.96	14.90
37) Va.	2.2	0.50	1.10	-0.50	-1.10	5.73	12.61	4.73	10.41
38) Md.	1.7	0.47	0.80	-0.53	-0.90	-	0.00	-1.00	-1.70
39) Del.	0.3	2.00	0.60	1.00	0.30	-	0.00	-1.00	-0.30
40) N.J.	3.4	0.03	0.10	-0.97	-3.30	-	0.00	-1.00	-3.40
41) Penna.	6.3	-	0.00	-1.00	-6.30	-	0.00	-1.00	-6.30
42) N.Y.	9.4	-	0.00	-1.00	-9.40	-	0.00	-1.00	-9.40
43) Conn.	1.4	-	0.00	-1.00	-1.40	-	0.00	-1.00	-1.40
44) R.I.	0.5	-	0.00	-1.00	-0.50	-	0.00	-1.00	-0.50
45) Mass.	2.9	-	0.00	-1.00	-2.90	-	0.00	-1.00	-2.90
46) Vt.	0.2	-	0.00	-1.00	-0.20	-	0.00	-1.00	-0.20
47) N.H.	0.3	-	0.00	-1.00	-0.30	-	0.00	-1.00	-0.30
48) Me.	0.5	-	0.00	-1.00	-0.50	-	0.00	-1.00	-0.50

TABLE T.13 (IV.b)--Continued

State	P	Cotton TLC	Cotton TLD	Cotton SLC	Cotton SLD	Tobacco TLC	Tobacco TLD	Tobacco SLC	Tobacco SLD
1) Wash.	1.6	-	0.00	-1.00	-1.60	-	0.00	-1.00	-1.60
2) Ore.	1.0	-	0.00	-1.00	-1.00	-	0.00	-1.00	-1.00
3) Calif.	8.8	1.47	12.94	0.47	4.14	-	0.00	-1.00	-8.80
4) Nev.	0.2	-	0.00	-1.00	-0.20	-	0.00	-1.00	-0.20
5) Ida.	0.4	-	0.00	-1.00	-0.40	-	0.00	-1.00	-0.40
6) Utah	0.5	-	0.00	-1.00	-0.50	-	0.00	-1.00	-0.50
7) Ariz.	0.7	7.14	5.00	6.14	4.30	-	0.00	-1.00	-0.70
8) N.Mex.	0.5	4.40	2.20	3.40	1.70	-	0.00	-1.00	-0.50
9) Colo.	1.0	-	0.00	-1.00	-1.00	-	0.00	-1.00	-1.00
10) Wyo.	0.2	-	0.00	-1.00	-0.20	-	0.00	-1.00	-0.20
11) Mont.	0.4	-	0.00	-1.00	-0.40	-	0.00	-1.00	-0.40
12) N.Dak.	0.4	-	0.00	-1.00	-0.40	-	0.00	-1.00	-0.40
13) S.Dak.	0.4	-	0.00	-1.00	-0.40	-	0.00	-1.00	-0.40
14) Neb.	0.8	-	0.00	-1.00	-0.80	-	0.00	-1.00	-0.80
15) Kan.	1.5	-	0.00	-1.00	-1.50	-	0.00	-1.00	-1.50
16) Okla.	1.3	2.00	2.60	1.00	1.30	-	0.00	-1.00	-1.30
17) Tex.	5.3	5.64	29.89	4.64	24.59	-	0.00	-1.00	-5.30
18) La.	1.8	1.89	3.40	0.89	1.60	-	0.00	-1.00	-1.80
19) Ark.	1.0	10.70	10.70	9.70	9.70	-	0.00	-1.00	-1.00
20) Mo.	2.4	1.46	3.50	0.46	1.10	0.13	0.31	-0.87	-2.09
21) Iowa	1.5	-	0.00	-1.00	-1.50	-	0.00	-1.00	-1.50
22) Minn.	1.9	-	0.00	-1.00	-1.90	-	0.00	-1.00	-1.90
23) Wisc.	2.2	-	0.00	-1.00	-2.20	0.59	1.30	-0.41	-0.90
24) Ill.	5.6	-	0.00	-1.00	-5.60	-	0.00	-1.00	-5.60

TABLE T.18 (IV.b)--Continued

State	P	Crops (Continued)							
		Cotton				Tobacco			
		TLC	TLD	SLC	SLD	TLC	TLD	SLC	SLD
25) Miss.	1.2	9.33	11.20	8.33	10.00	-	0.00	-1.00	-1.20
26) Ala.	1.8	2.72	4.90	1.72	3.10	-	0.00	-1.00	-1.80
27) Tenn.	2.0	2.25	4.50	1.25	2.50	3.70	7.40	2.70	5.40
28) Ky.	1.7	0.06	0.10	-0.94	-1.60	12.00	20.40	11.00	18.70
29) Ind.	2.6	-	0.00	-1.00	-2.60	0.27	0.70	-0.73	-1.90
30) Mich.	4.4	-	0.00	-1.00	-4.40	-	0.00	-1.00	-4.40
31) Ohio	5.4	-	0.00	-1.00	-5.40	0.22	1.19	-0.78	-4.21
32) W.Va.	1.0	-	0.00	-1.00	-1.00	0.20	0.20	-0.80	-0.80
33) Ga.	2.2	1.73	3.81	0.73	1.61	2.73	6.01	1.73	3.81
34) Fla.	2.8	0.04	0.11	-0.96	-2.69	0.50	1.40	-0.50	-1.40
35) S.Car.	1.3	2.31	3.00	1.31	1.70	6.08	7.90	5.08	6.60
36) N.Car.	2.5	0.92	2.30	-0.08	-0.20	15.92	39.80	14.92	37.30
37) Va.	2.2	0.05	0.11	-0.95	-2.09	3.55	7.81	2.55	5.61
38) Md.	1.7	-	0.00	-1.00	-1.70	1.18	2.01	0.18	0.31
39) Del.	0.3	-	0.00	-1.00	-0.30	-	0.00	-1.00	-0.30
40) N.J.	3.4	-	0.00	-1.00	-3.40	-	0.00	-1.00	-3.40
41) Penna.	6.3	-	0.00	-1.00	-6.30	0.44	2.77	-0.56	-3.53
42) N.Y.	9.4	-	0.00	-1.00	-9.40	-	0.00	-1.00	-9.40
43) Conn.	1.4	-	0.00	-1.00	-1.40	0.57	0.80	-0.43	-0.60
44) R.I.	0.5	-	0.00	-1.00	-0.50	-	0.00	-1.00	-0.50
45) Mass.	2.9	-	0.00	-1.00	-2.90	0.14	0.41	-0.86	-2.49
46) Vt.	0.2	-	0.00	-1.00	-0.20	-	0.00	-1.00	-0.20
47) N.H.	0.3	-	0.00	-1.00	-0.30	-	0.00	-1.00	-0.30
48) Me.	0.5	-	0.00	-1.00	-0.50	-	0.00	-1.00	-0.50

TABLE T.18 (IV.b)--Continued

State	P	Sugarbeets TLC	Sugarbeets TLD	Sugarbeets SLC	Sugarbeets SLD	Irish Potatoes TLC	Irish Potatoes TLD	Irish Potatoes SLC	Irish Potatoes SLD
1) Wash.	1.6	2.75	4.40	1.75	2.80	2.31	3.70	1.31	2.10
2) Ore.	1.0	3.00	3.00	2.00	2.00	3.80	3.80	2.80	2.80
3) Calif.	8.8	3.23	28.42	2.23	19.62	1.17	10.30	0.17	1.50
4) Nev.	0.2	0.50	0.10	-0.50	-0.10	0.50	0.10	-0.50	-0.10
5) Ida.	0.4	29.00	11.60	28.00	11.20	45.00	18.00	44.00	17.60
6) Utah	0.5	6.60	3.30	5.60	2.80	1.20	0.60	0.20	0.10
7) Ariz.	0.7	-	0.00	-1.00	-0.70	0.86	0.60	-0.14	-0.10
8) N.Mex.	0.5	0.20	0.10	-0.80	-0.40	0.20	0.10	-0.80	-0.40
9) Colo.	1.0	14.50	14.50	13.50	13.50	4.70	4.70	3.70	3.70
10) Wyo.	0.2	17.50	3.50	16.50	3.30	1.50	0.30	0.50	0.10
11) Mont.	0.4	12.75	5.10	11.75	4.70	1.25	0.50	0.25	0.10
12) N.Dak.	0.4	6.75	2.70	5.75	2.30	13.50	5.40	12.50	5.00
13) S.Dak.	0.4	1.25	0.50	0.25	0.10	0.50	0.20	-0.50	-0.20
14) Neb.	0.8	8.00	6.40	7.00	5.60	1.38	1.10	0.38	0.30
15) Kan.	1.5	0.53	0.80	-0.47	-0.71	0.07	0.11	-0.93	-1.40
16) Okla.	1.3	-	0.00	-1.00	-1.30	0.08	0.10	-0.92	-1.20
17) Tex.	5.3	0.04	0.21	-0.96	-5.09	0.21	1.11	-0.79	-4.19
18) La.	1.8	-	0.00	-1.00	-1.80	0.06	0.11	-0.94	-1.69
19) Ark.	1.0	-	0.00	-1.00	-1.00	0.20	0.20	-0.80	-0.80
20) Mo.	2.4	-	0.00	-1.00	-2.40	0.08	0.19	-0.92	-2.21
21) Iowa	1.5	0.07	0.11	-0.93	-1.40	0.13	0.20	-0.87	-1.31
22) Minn.	1.9	2.79	5.30	1.79	3.40	2.63	5.00	1.63	3.10
23) Wisc.	2.2	0.27	0.59	-0.73	-1.61	1.64	3.61	0.64	1.41
24) Ill.	5.6	0.04	0.22	-0.96	-5.38	0.02	0.11	-0.98	-5.49

TABLE T.18 (IV.b)--Continued

State		Crops (Continued)							
		Sugarbeets				Irish Potatoes			
	P	TLC	TLD	SLC	SLD	TLC	TLD	SLC	SLD
25) Miss.	1.2	-	0.00	-1.00	-1.20	0.08	0.10	-0.92	-1.10
26) Ala.	1.8	-	0.00	-1.00	-1.80	0.39	0.70	-0.61	-1.10
27) Tenn.	2.0	-	0.00	-1.00	-2.00	0.20	0.40	-0.80	-1.60
28) Ky.	1.7	-	0.00	-1.00	-1.70	0.24	0.41	-0.76	-1.29
29) Ind.	2.6	-	0.00	-1.00	-2.60	0.27	0.70	-0.73	-1.90
30) Mich.	4.4	1.61	7.08	0.61	2.68	0.70	3.08	-0.30	-1.32
31) Ohio	5.4	0.41	2.21	-0.59	-3.19	0.22	1.19	-0.78	-4.21
32) W.Va.	1.0	-	0.00	-1.00	-1.00	0.20	0.20	-0.80	-0.80
33) Ga.	2.2	-	0.00	-1.00	-2.20	0.05	0.11	-0.95	-2.09
34) Fla.	2.8	-	0.00	-1.00	-2.80	0.54	1.51	-0.46	-1.29
35) S.Car.	1.3	-	0.00	-1.00	-1.30	0.15	0.20	-0.85	-1.11
36) N.Car.	2.5	-	0.00	-1.00	-2.50	0.52	1.30	-0.48	-1.20
37) Va.	2.2	-	0.00	-1.00	-2.20	0.59	1.30	-0.41	-0.90
38) Md.	1.7	-	0.00	-1.00	-1.70	0.12	0.20	-0.88	-1.50
39) Del.	0.3	-	0.00	-1.00	-0.30	2.33	0.70	1.33	0.40
40) N.J.	3.4	-	0.00	-1.00	-3.40	0.56	1.90	-0.44	-1.50
41) Penna.	6.3	-	0.00	-1.00	-6.30	0.51	3.21	-0.49	-3.09
42) N.Y.	9.4	-	0.00	-1.00	-9.40	0.77	7.24	-0.23	-2.16
43) Conn.	1.4	-	0.00	-1.00	-1.40	0.43	0.60	-0.57	-0.80
44) R.I.	0.5	-	0.00	-1.00	-0.50	1.00	0.50	0.00	0.00
45) Mass.	2.9	-	0.00	-1.00	-2.90	0.17	0.49	-0.83	-2.41
46) Vt.	0.2	-	0.00	-1.00	-0.20	1.00	0.20	0.00	0.00
47) N.H.	0.3	-	0.00	-1.00	-0.30	0.33	0.10	-0.67	-0.20
48) Me.	0.5	-	0.00	-1.00	-0.50	28.60	14.30	27.60	13.80

TABLE T.18 (IV.b)--Continued

State	P	Vegetables TLC	Vegetables TLD	Vegetables SLC	Vegetables SLD	Berries TLC	Berries TLD	Berries SLC	Berries SLD
1) Wash.	1.6	1.69	2.70	0.69	1.10	5.75	9.20	4.75	7.60
2) Ore.	1.0	3.00	3.00	2.00	2.00	14.00	14.00	13.00	13.00
3) Calif.	8.8	4.13	36.34	3.13	27.54	3.00	26.40	2.00	17.60
4) Nev.	0.2	0.50	0.10	-0.50	-0.10	-	0.00	-1.00	-0.20
5) Ida.	0.4	1.25	0.50	0.25	0.10	0.50	0.20	-0.50	-0.20
6) Utah	0.5	0.80	0.40	-0.20	-0.10	0.80	0.40	-0.20	-0.10
7) Ariz.	0.7	7.14	5.00	6.14	4.30	0.14	0.10	-0.86	-0.60
8) N.Mex.	0.5	0.80	0.40	-0.20	-0.10	-	0.00	-1.00	-0.50
9) Colo.	1.0	1.40	1.40	0.40	0.40	-	0.00	-1.00	-1.00
10) Wyo.	0.2	-	0.00	-1.00	-0.20	-	0.00	-1.00	-0.20
11) Mont.	0.4	-	0.00	-1.00	-0.40	0.25	0.10	-0.75	-0.30
12) N.Dak.	0.4	-	0.00	-1.00	-0.40	-	0.00	-1.00	-0.40
13) S.Dak.	0.4	-	0.00	-1.00	-0.40	-	0.00	-1.00	-0.40
14) Neb.	0.8	0.13	0.10	-0.87	-0.70	-	0.00	-1.00	-0.80
15) Kan.	1.5	0.07	0.11	-0.93	-1.40	0.13	0.20	-0.87	-1.31
16) Okla.	1.3	0.23	0.30	-0.77	-1.00	0.38	0.49	-0.62	-0.81
17) Tex.	5.3	0.81	4.29	-0.19	-1.01	0.13	0.69	-0.87	-4.61
18) La.	1.8	0.17	0.31	-0.83	-1.49	1.00	1.80	0.00	0.00
19) Ark.	1.0	0.40	0.40	-0.60	-0.60	2.80	2.80	1.80	1.80
20) Mo.	2.4	0.17	0.41	-0.83	-1.99	0.29	0.70	-0.71	-1.70
21) Iowa	1.5	0.20	0.30	-0.80	-1.20	0.13	0.20	-0.87	-1.31
22) Minn.	1.9	0.74	1.41	-0.26	-0.49	0.21	0.40	-0.79	-1.50
23) Wisc.	2.2	1.18	2.60	0.18	0.40	2.09	4.60	1.09	2.40
24) Ill.	5.6	0.36	2.02	-0.64	-3.58	0.20	1.12	-0.80	-4.48

TABLE T.18 (IV.b)--Continued

State	P	Crops (Continued): Vegetables TLC	TLD	SLC	SLD	Berries TLC	TLD	SLC	SLD
25) Miss.	1.2	0.25	0.30	-0.75	-0.90	0.08	0.10	-0.92	-1.10
26) Ala.	1.8	0.28	0.50	-0.72	-1.30	0.22	0.40	-0.78	-1.40
27) Tenn.	2.0	0.35	0.70	-0.65	-1.30	1.05	2.10	0.05	0.10
28) Ky.	1.7	0.06	0.10	-0.94	-1.60	0.41	0.70	-0.59	-1.00
29) Ind.	2.6	0.54	1.40	-0.46	-1.20	0.23	0.60	-0.77	-2.00
30) Mich.	4.4	0.61	2.68	-0.39	-1.72	2.20	9.68	1.20	5.28
31) Ohio	5.4	0.39	2.11	-0.61	-3.29	0.22	1.19	-0.78	-4.21
32) W.Va.	1.0	0.10	0.10	-0.90	-0.90	0.20	0.20	-0.80	-0.80
33) Ga.	2.2	0.41	0.90	-0.59	-1.30	0.05	0.11	-0.95	-2.09
34) Fla.	2.8	3.96	11.09	2.96	8.28	0.25	0.70	-0.75	-2.10
35) S.Car.	1.3	0.85	1.11	-0.15	-0.20	0.08	0.10	-0.92	-1.20
36) N.Car.	2.5	0.44	1.10	-0.56	-1.40	0.76	1.90	-0.24	-0.60
37) Va.	2.2	0.55	1.21	-0.45	-0.99	0.50	1.10	-0.50	-1.10
38) Md.	1.7	0.76	1.29	-0.24	-0.41	0.24	0.41	-0.76	-1.29
39) Del.	0.3	2.00	0.60	1.00	0.30	0.33	0.10	-0.67	-0.20
40) N.J.	3.4	1.21	4.11	0.21	0.71	1.76	5.98	0.76	2.58
41) Penna.	6.3	0.27	1.70	-0.73	-4.60	-	0.00	-1.00	-6.30
42) N.Y.	9.4	0.52	4.89	-0.48	-4.51	0.32	3.01	-0.68	-6.39
43) Conn.	1.4	0.29	0.41	-0.71	-0.99	0.21	0.29	-0.79	-1.11
44) R.I.	0.5	0.20	0.10	-0.80	-0.40	-	0.00	-1.00	-0.50
45) Mass.	2.9	0.24	0.70	-0.76	-2.20	1.55	4.50	0.55	1.60
46) Vt.	0.2	0.50	0.10	-0.50	-0.10	0.50	0.10	-0.50	-0.10
47) N.H.	0.3	0.33	0.10	-0.67	-0.20	0.67	0.20	-0.33	-0.10
48) Me.	0.5	0.60	0.30	-0.40	-0.20	4.20	2.10	3.20	1.60

TABLE T.18 (IV.b)--Continued

State	Crops				
	Fruits & Nuts				
	P	TLC	TLD	SLC	SLD
1) Washington	1.6	3.69	5.90	2.69	4.30
2) Oregon	1.0	2.10	2.10	1.10	1.10
3) California	8.8	4.88	42.94	3.88	34.14
4) Nevada	0.2	-	0.00	-1.00	-0.20
5) Idaho	0.4	1.25	0.50	0.25	0.10
6) Utah	0.5	0.40	0.20	-0.60	-0.30
7) Arizona	0.7	1.00	0.70	0.00	0.00
8) New Mexico	0.5	0.40	0.20	-0.60	-0.30
9) Colorado	1.0	0.50	0.50	-0.50	-0.50
10) Wyoming	0.2	-	0.00	-1.00	-0.20
11) Montana	0.4	0.25	0.10	-0.75	-0.30
12) North Dakota	0.4	-	0.00	-1.00	-0.40
13) South Dakota	0.4	-	0.00	-1.00	-0.40
14) Nebraska	0.8	-	0.00	-1.00	-0.80
15) Kansas	1.5	0.07	0.11	-0.93	-1.40
16) Oklahoma	1.3	0.08	0.10	-0.92	-1.20
17) Texas	5.3	0.21	1.11	-0.79	-4.19
18) Louisiana	1.8	0.11	0.20	-0.89	-1.60
19) Arkansas	1.0	0.40	0.40	-0.60	-0.60
20) Missouri	2.4	0.13	0.31	-0.87	-2.09
21) Iowa	1.5	0.07	0.11	-0.93	-1.40
22) Minnesota	1.9	0.05	0.10	-0.95	-1.81
23) Wisconsin	2.2	0.18	0.40	-0.82	-1.80
24) Illinois	5.6	0.09	0.50	-0.91	-5.10

TABLE T.18 (IV.b)--Continued

State	Crops (Continued)				
	Fruits & Nuts				
	P	TLC	TLD	SLC	SLD
25) Mississippi	1.2	0.33	0.40	-0.67	-0.80
26) Alabama	1.8	0.17	0.31	-0.83	-1.49
27) Tennessee	2.0	0.05	0.10	-0.95	-1.90
28) Kentucky	1.7	0.06	0.10	-0.94	-1.60
29) Indiana	2.6	0.15	0.39	-0.85	-2.21
30) Michigan	4.4	0.80	3.52	-0.20	-0.88
31) Ohio	5.4	0.15	0.81	-0.85	-4.59
32) West Virginia	1.0	0.80	0.80	-0.20	-0.20
33) Georgia	2.2	0.59	1.30	-0.41	-0.90
34) Florida	2.8	8.93	25.00	7.93	22.20
35) South Carolina	1.3	0.92	1.20	-0.08	-0.10
36) North Carolina	2.5	0.16	0.40	-0.84	-2.10
37) Virginia	2.2	0.64	1.41	-0.36	-0.79
38) Maryland	1.7	0.18	0.31	-0.82	-1.40
39) Delaware	0.3	-	0.00	-1.00	-0.30
40) New Jersey	3.4	0.26	0.88	-0.74	-2.52
41) Pennsylvania	6.3	0.30	1.89	-0.70	-4.41
42) New York	9.4	0.34	3.20	-0.66	-6.20
43) Connecticut	1.4	0.14	0.20	-0.86	-1.20
44) Rhode Island	0.5	-	0.00	-1.00	-0.50
45) Massachusetts	2.9	0.14	0.41	-0.86	-2.49
46) Vermont	0.2	0.50	0.10	-0.50	-0.10
47) New Hampshire	0.3	0.66	0.20	-0.34	-0.10
48) Maine	0.5	0.60	0.30	-0.40	-0.20

Source: Column 1: U.S. Census: Population, 1960.
Columns 2,3 : From Tables 7 (II.b) and 8 (II.b).
Columns 4,5 : Author's own estimation, with data from Tables 5 (II.b) and 7 (II.b).

TABLE T.19 (IV.b)

SUMMARY: SPECIALIZED LOCATIONAL DISTRIBUTION (SLD) OF AGRICULTURAL PRODUCTION, FOR 15 SELECTED CROPS, FOR 48 STATES, U.S.A., 1959

State	Crops				
	Corn	Sorghum	Wheat	Oats	Barley
1) Washington	-	-	5.60	-	6.50
2) Oregon	-	-	1.70	-	4.30
3) California	-	-	-	-	13.20
4) Nevada	-	-	-	-	-
5) Idaho	-	-	3.30	0.70	3.40
6) Utah	-	-	-	-	0.30
7) Arizona	-	0.60	-	-	1.70
8) New Mexico	-	1.00	-	-	-
9) Colorado	-	0.50	3.70	-	2.00
10) Wyoming	-	-	0.30	0.20	0.30
11) Montana	-	-	6.40	0.20	11.70
12) North Dakota	-	-	8.20	4.90	19.10
13) South Dakota	1.10	-	1.10	3.20	0.60
14) Nebraska	10.10	9.82	5.50	1.60	0.10
15) Kansas	0.71	19.01	17.60	-	2.51
16) Oklahoma	-	1.30	6.70	-	1.40
17) Texas	-	48.71	-	-	-
18) Louisiana	-	-	-	-	-
19) Arkansas	-	-	-	0.40	-
20) Missouri	2.40	0.60	1.01	-	-
21) Iowa	17.60	-	-	14.90	-
22) Minnesota	6.40	-	0.21	16.49	6.00
23) Wisconsin	-	-	-	3.10	-
24) Illinois	16.19	-	-	5.32	-

TABLE T.19 (IV.b)--<u>Continued</u>

State	Crops (Continued)				
	Corn	Sorghum	Wheat	Oats	Barley
25) Mississippi	-	-	-	0.40	-
26) Alabama	-	-	-	-	-
27) Tennessee	-	-	-	-	-
28) Kentucky	-	-	-	-	-
29) Indiana	5.59	-	0.39	0.49	-
30) Michigan	-	-	-	-	-
31) Ohio	0.11	-	-	-	-
32) West Virginia	-	-	-	-	-
33) Georgia	-	-	-	-	-
34) Florida	-	-	-	-	-
35) South Carolina	-	-	-	0.30	-
36) North Carolina	-	-	-	-	-
37) Virginia	-	-	-	-	-
38) Maryland	-	-	-	-	-
39) Delaware	-	-	-	-	-
40) New Jersey	-	-	-	-	-
41) Pennsylvania	-	-	-	-	-
42) New York	-	-	-	-	-
43) Connecticut	-	-	-	-	-
44) Rhode Island	-	-	-	-	-
45) Massachusetts	-	-	-	-	-
46) Vermont	-	-	-	-	-
47) New Hampshire	-	-	-	-	-
48) Maine	-	-	-	-	-

TABLE T.19 (IV.b)--Continued

State	Crops				
	Rice	Soybeans	Peanuts	Cotton	Tobacco
1) Washington	-	-	-	-	-
2) Oregon	-	-	-	-	-
3) California	15.49	-	-	4.14	-
4) Nevada	-	-	-	-	-
5) Idaho	-	-	-	-	-
6) Utah	-	-	-	-	-
7) Arizona	-	-	-	4.30	-
8) New Mexico	-	-	0.20	1.70	-
9) Colorado	-	-	-	-	-
10) Wyoming	-	-	-	-	-
11) Montana	-	-	-	-	-
12) North Dakota	-	0.10	-	-	-
13) South Dakota	-	-	-	-	-
14) Nebraska	-	-	-	-	-
15) Kansas	-	0.20	-	-	-
16) Oklahoma	-	-	6.50	1.30	-
17) Texas	19.61	-	6.57	24.59	-
18) Louisiana	23.20	-	-	1.60	-
19) Arkansas	22.30	9.10	-	9.70	-
20) Missouri	-	6.79	-	1.10	-
21) Iowa	-	10.50	-	-	-
22) Minnesota	-	6.10	-	-	-
23) Wisconsin	-	-	-	-	-
24) Illinois	-	17.81	-	-	-

TABLE T.19 (IV.b)--Continued

State	Crops (Continued)				
	Rice	Soybeans	Peanuts	Cotton	Tobacco
25) Mississippi	1.00	2.80	-	10.00	-
26) Alabama	-	-	8.80	3.10	-
27) Tennessee	-	-	-	2.50	5.40
28) Kentucky	-	-	-	-	18.70
29) Indiana	-	8.71	-	-	-
30) Michigan	-	-	-	-	-
31) Ohio	-	1.40	-	-	-
32) West Virginia	-	-	-	-	-
33) Georgia	-	-	32.89	1.61	3.81
34) Florida	-	-	0.39	-	-
35) South Carolina	-	-	-	1.70	6.60
36) North Carolina	-	-	14.90	-	37.30
37) Virginia	-	-	10.41	-	5.61
38) Maryland	-	-	-	-	0.31
39) Delaware	-	0.30	-	-	-
40) New Jersey	-	-	-	-	-
41) Pennsylvania	-	-	-	-	-
42) New York	-	-	-	-	-
43) Connecticut	-	-	-	-	-
44) Rhode Island	-	-	-	-	-
45) Massachusetts	-	-	-	-	-
46) Vermont	-	-	-	-	-
47) New Hampshire	-	-	-	-	-
48) Maine	-	-	-	-	-

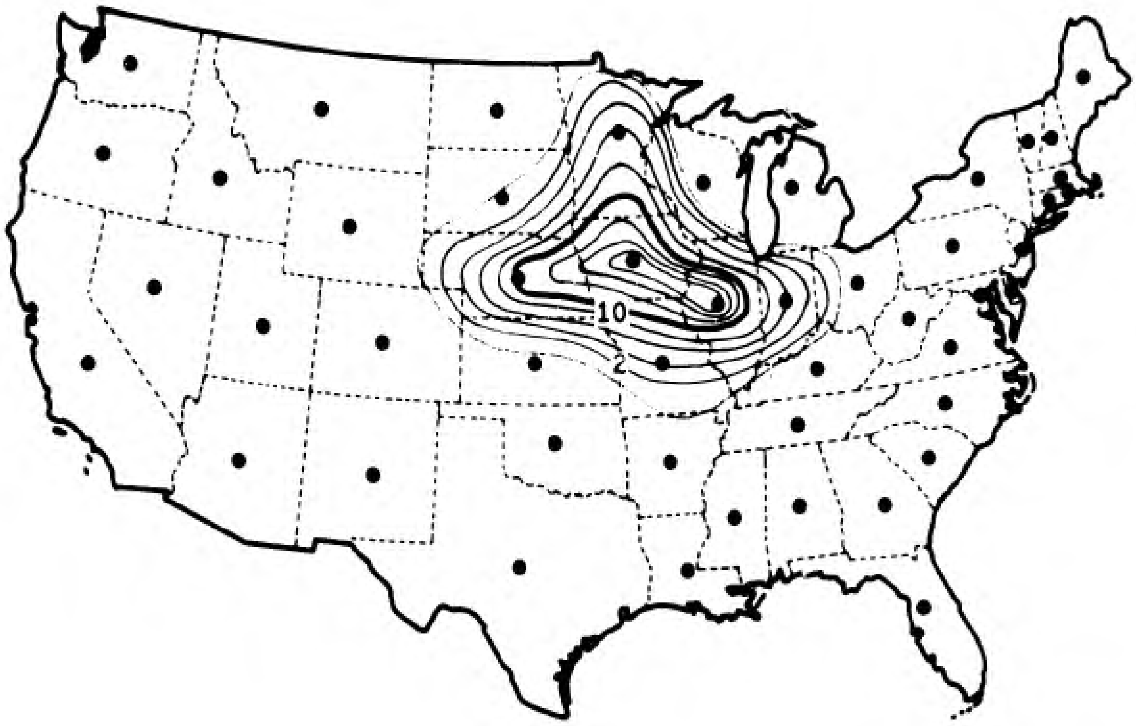
TABLE T.19 (IV.b)--Continued

State	Crops				
	Sugar beets	Irish Potatoes	Vegetables	Berries	Fruits & Nuts
1) Washington	2.80	2.10	1.10	7.60	4.30
2) Oregon	2.00	2.80	2.00	13.00	1.10
3) California	19.62	1.50	27.54	17.60	34.14
4) Nevada	-	-	-	-	-
5) Idaho	11.20	17.60	0.10	-	0.10
6) Utah	2.80	0.10	-	-	-
7) Arizona	-	-	4.30	-	-
8) New Mexico	-	-	-	-	-
9) Colorado	13.50	3.70	0.40	-	-
10) Wyoming	3.30	0.10	-	-	-
11) Montana	4.70	0.10	-	-	-
12) North Dakota	2.30	5.00	-	-	-
13) South Dakota	0.10	-	-	-	-
14) Nebraska	5.60	0.30	-	-	-
15) Kansas	-	-	-	-	-
16) Oklahoma	-	-	-	-	-
17) Texas	-	-	-	-	-
18) Louisiana	-	-	-	-	-
19) Arkansas	-	-	-	1.80	-
20) Missouri	-	-	-	-	-
21) Iowa	-	-	-	-	-
22) Minnesota	3.40	3.10	-	-	-
23) Wisconsin	-	1.41	0.40	2.40	-
24) Illinois	-	-	-	-	-

TABLE T.19 (IV.b)--Continued

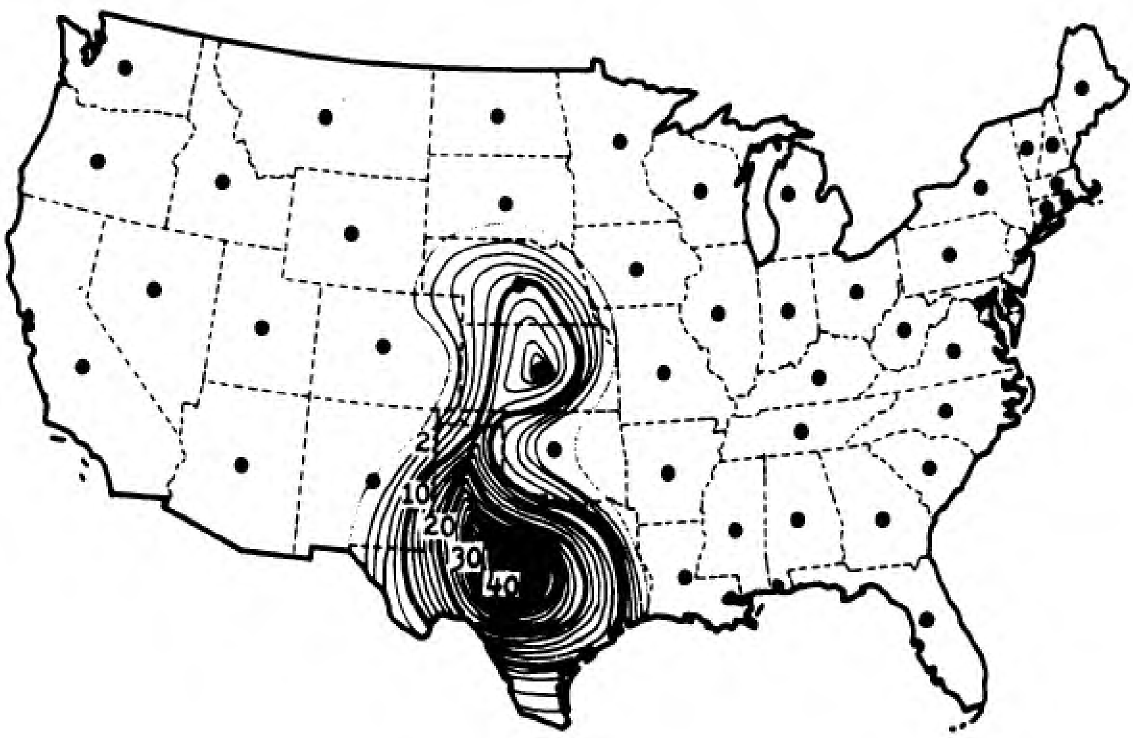
State	Crops (Continued)				
	Sugar beets	Irish Potatoes	Vegetables	Berries	Fruits & Nuts
25) Mississippi	-	-	-	-	-
26) Alabama	-	-	-	-	-
27) Tennessee	-	-	-	0.10	-
28) Kentucky	-	-	-	-	-
29) Indiana	-	-	-	-	-
30) Michigan	2.68	-	-	5.28	-
31) Ohio	-	-	-	-	-
32) West Virginia	-	-	-	-	-
33) Georgia	-	-	-	-	-
34) Florida	-	-	8.28	-	22.20
35) South Carolina	-	-	-	-	-
36) North Carolina	-	-	-	-	-
37) Virginia	-	-	-	-	-
38) Maryland	-	-	-	-	-
39) Delaware	-	0.40	0.30	-	-
40) New Jersey	-	-	0.71	2.58	-
41) Pennsylvania	-	-	-	-	-
42) New York	-	-	-	-	-
43) Connecticut	-	-	-	-	-
44) Rhode Island	-	-	-	-	-
45) Massachusetts	-	-	-	1.60	-
46) Vermont	-	-	-	-	-
47) New Hampshire	-	-	-	-	-
48) Maine	-	13.80	-	1.60	-

Source: From Table T.20 (IV.b).



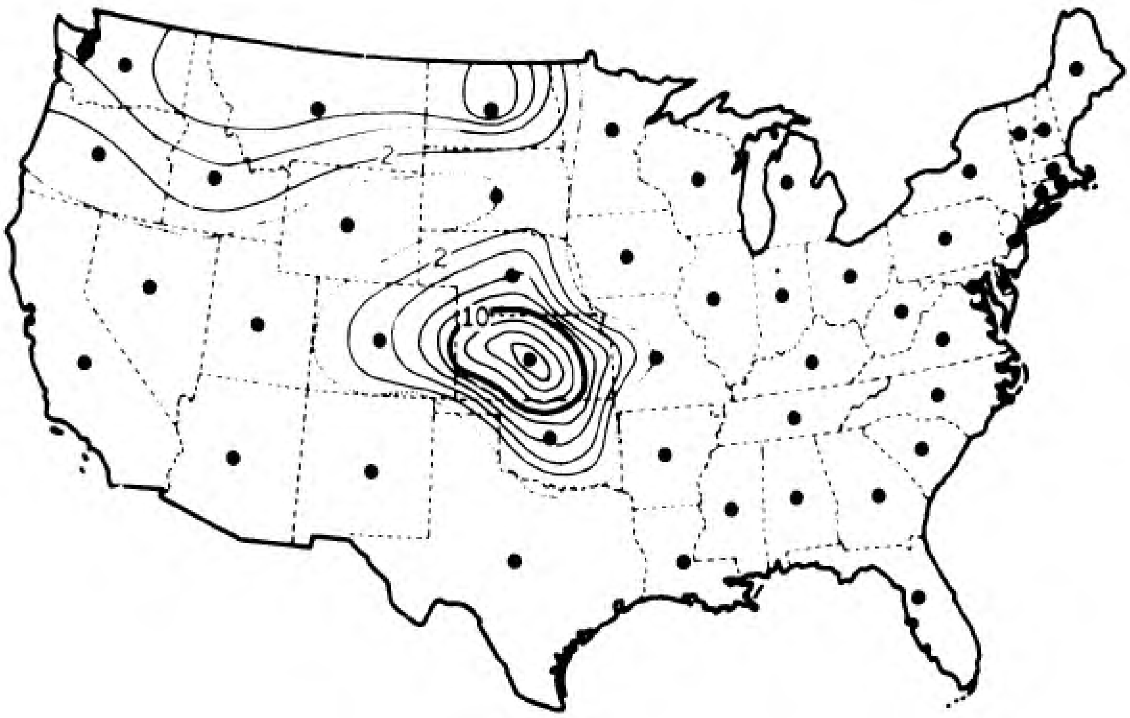
Map M.31 (IV.b):
Specialized Locational Distribution of CORN

0 500 miles



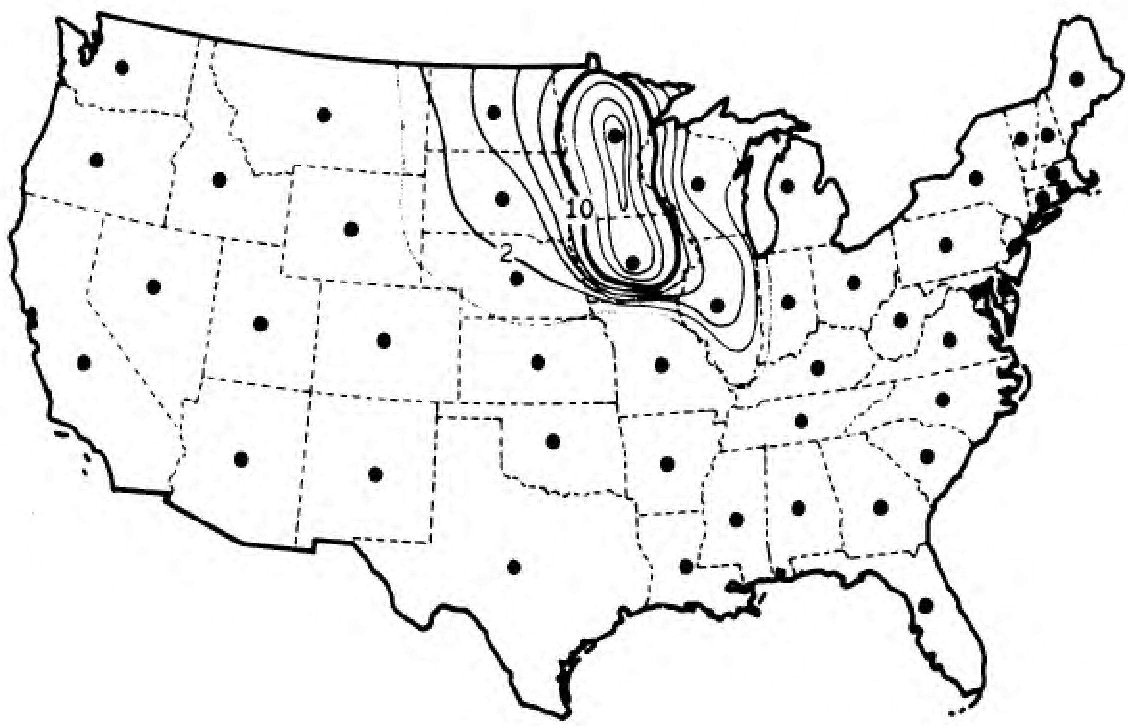
Map M.32 (IV.b):
Specialized Locational Distribution of SORGHUM

by States, U.S.A., 1959
Contour levels each 2.00
SLD coefficient value



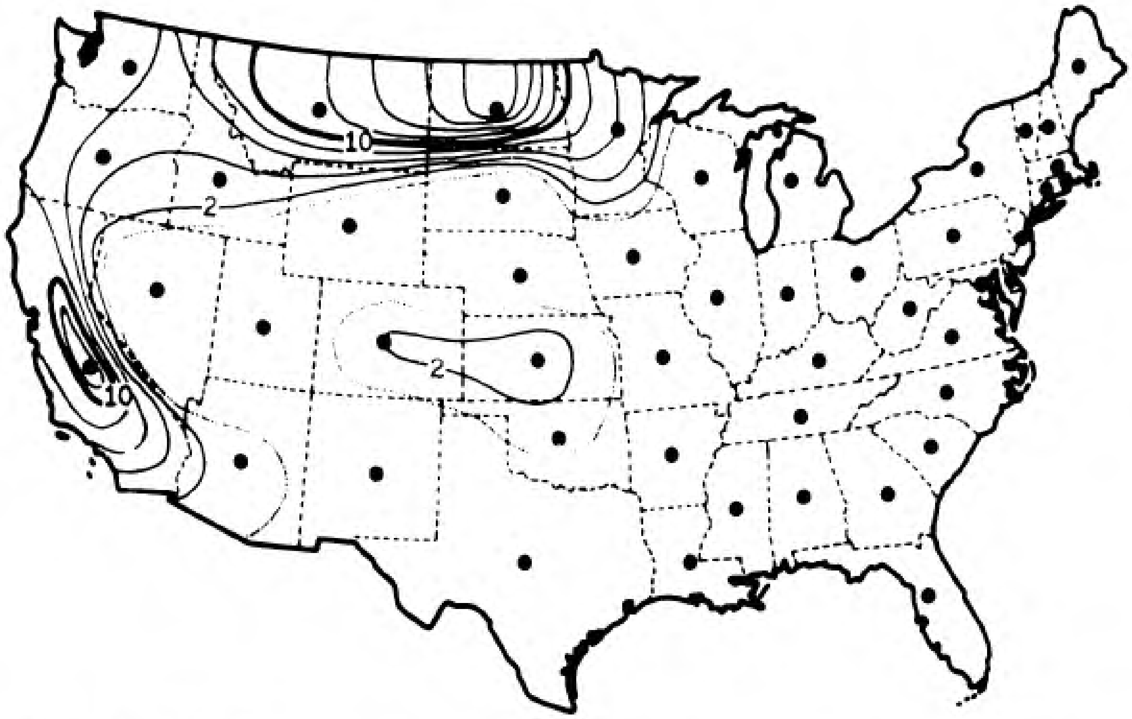
Map M.33 (IV.b):
Specialized Locational Distribution of WHEAT

0 500 miles



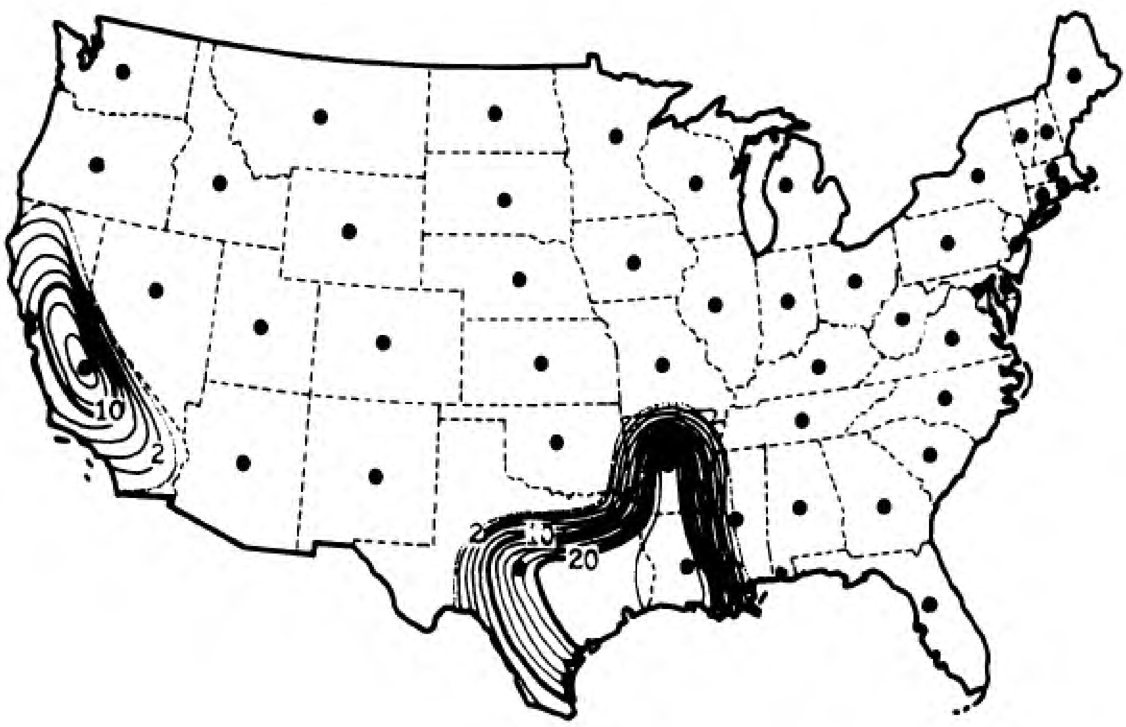
Map M.34 (IV.b):
Specialized Locational Distribution of OATS

by States, U.S.A., 1959
Contour Levels each 2.00
SLD coefficient value



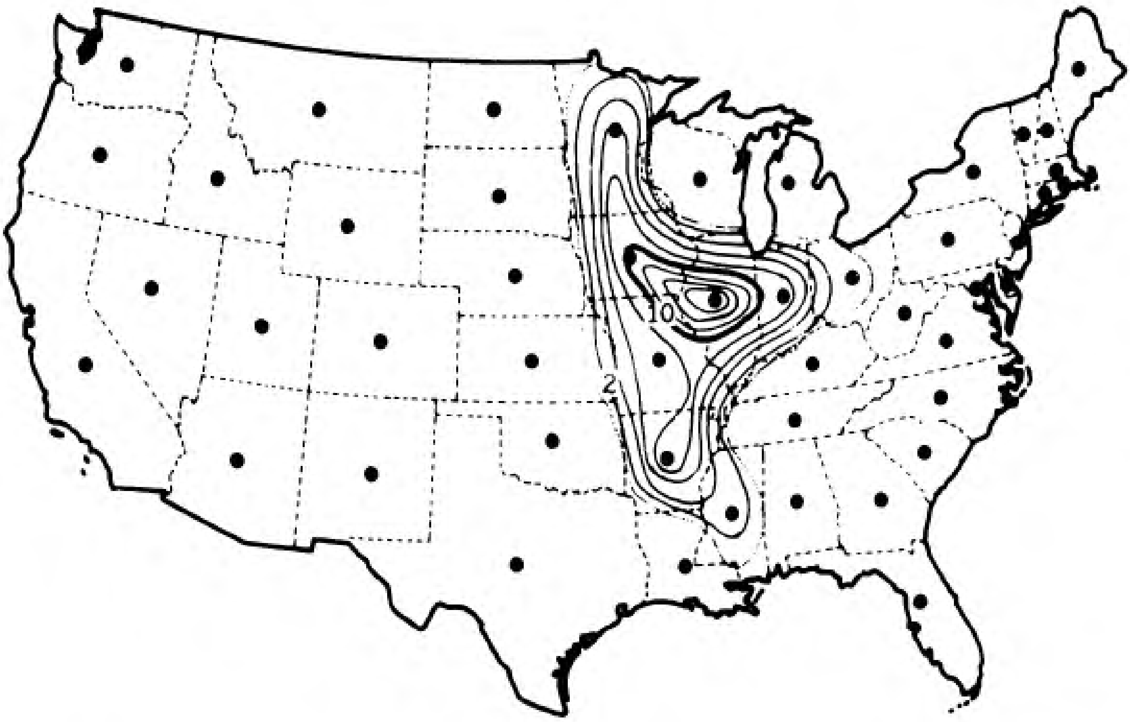
Map M.35 (IV.b):
Specialized Locational Distribution of BARLEY

0 500 miles



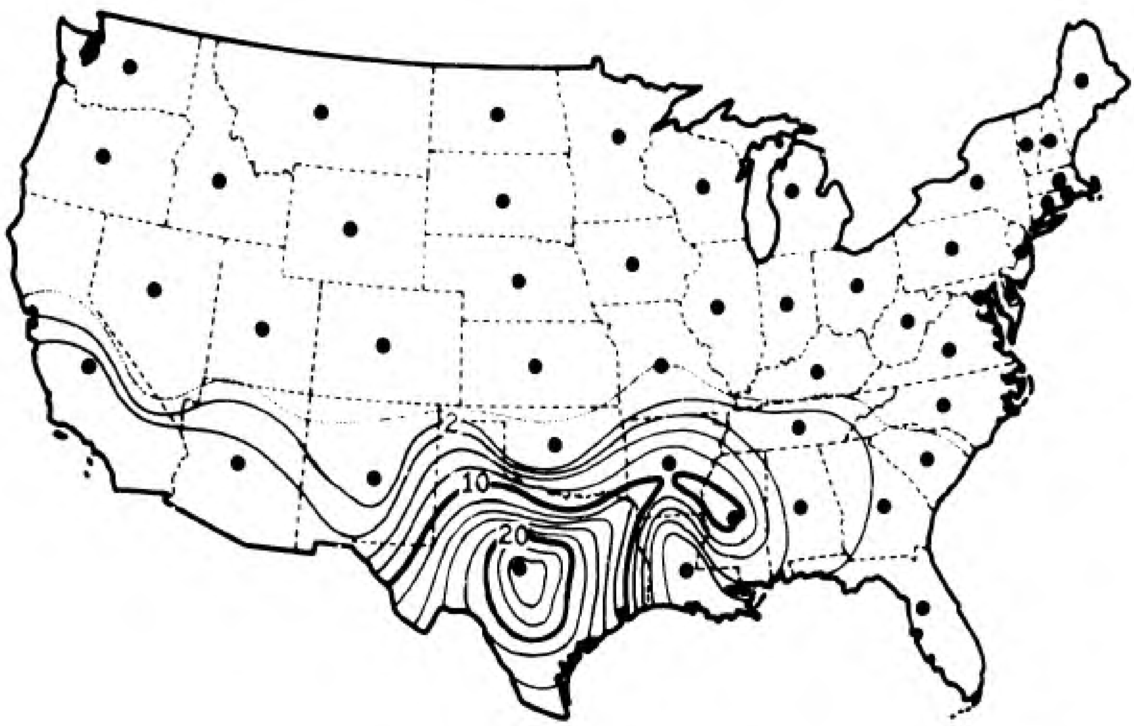
Map M.36 (IV.b):
Specialized Locational Distribution of RICE

by States, U.S.A., 1959
Contour levels each 2.00
SLD coefficient value



Map M.37 (IV.b):
Specialized Locational Distribution of SOYBEANS 0 500 miles

Map M.38 (IV.b):
Specialized Locational Distribution of PEANUTS by States, U.S.A., 1959
Contour levels each 2.00
SLD coefficient value

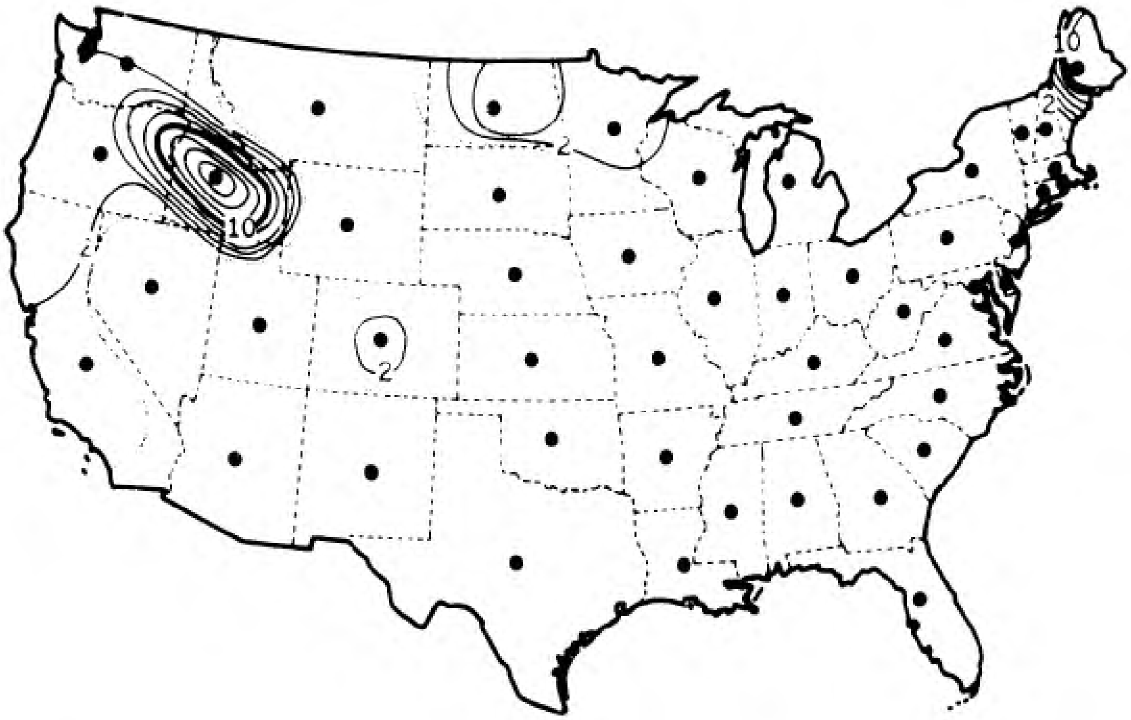


Map M.39 (IV.b):
Specialized Locational Distribution of COTTON

0 500

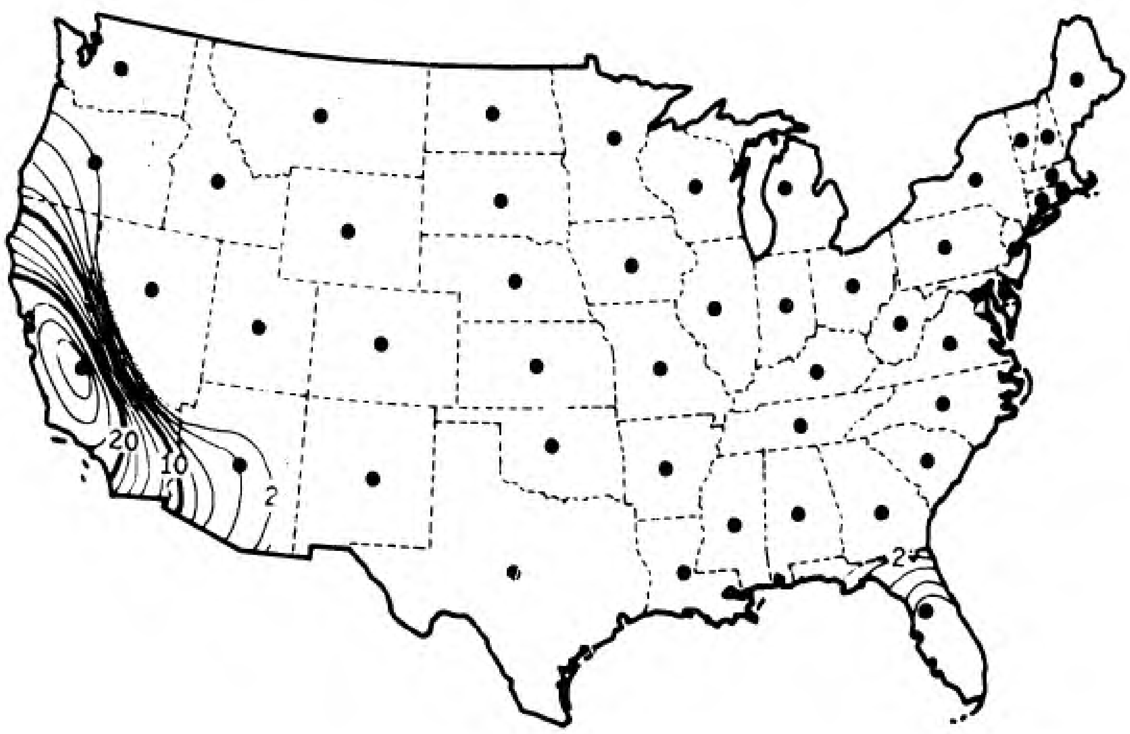
Map M.40 (IV.b):
Specialized Locational Distribution of TOBACCO

by States, U.S.A., 1959
Contour levels each 2.00
SLD coefficient value



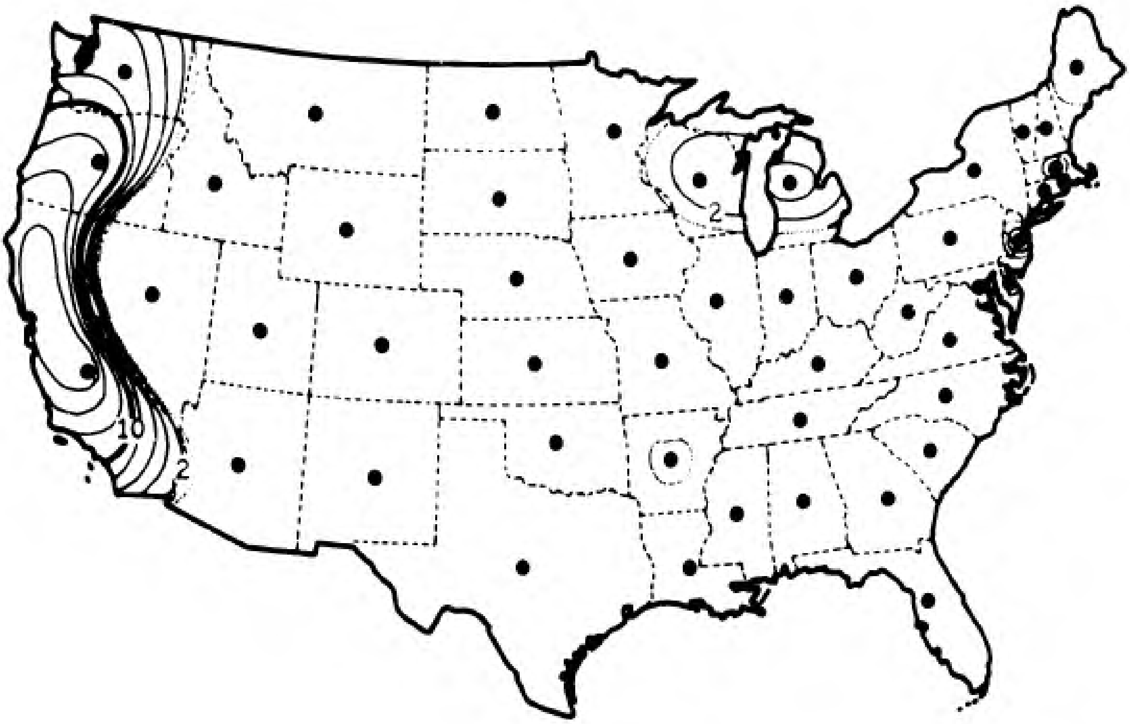
Map M.41 (IV.b):
Specialized Locational Distribution of POTATOES

0 500 miles



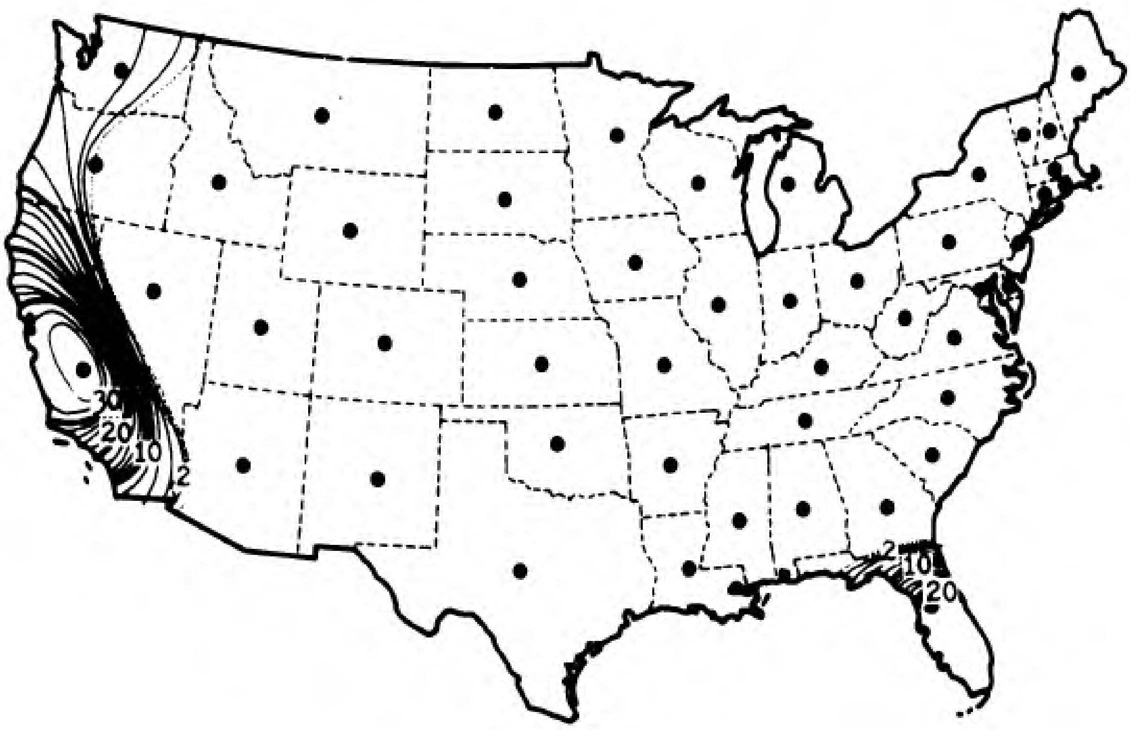
Map M.42 (IV.b):
Specialized Locational Distribution of VEGETABLES

by States, U.S.A., 1959
Contour levels each 2.00
SLD coefficient value



Map M.43 (IV.b):
Specialized Locational Distribution of BERRIES

0 500 miles



Map M.44 (IV.b)
Specialized Locational Distribution of FRUITS

by States, U.S.A., 1959
Contour levels each 2.00
SLD coefficient value

2b. Specialized Areal Revenues

Individual Crops

Estimation of the Areal Revenues of Specialized Crops has already been computed as part of the Areal Revenues study of all crops, as shown in Table T.10 (II.b). The remaining step consists in identifying the specialized crops in each state, and this data is obtained from Table T.18 (IV.b). According to the definitions given, all crops with a positive Specialized Locational Distribution (SLD) are considered specialized. It is simple then, to choose the Areal Revenues only for those crops found to be specialized in a given state. Following is a summary tabulation.

TABLE T.20 (IV.b)

SUMMARY: AREAL REVENUES OF SPECIALIZED AGRICULTURAL PRODUCTION, FOR 15 SELECTED CROPS, FOR 48 STATES, U.S.A., 1959

State	Areal Revenues ($/acre)				
	Corn	Sorghum	Wheat	Oats	Barley
1) Washington	-	-	66.74	-	34.66
2) Oregon	-	-	64.32	-	37.21
3) California	-	-	-	-	46.00
4) Nevada	-	-	-	-	-
5) Idaho	-	-	57.82	30.10	27.43
6) Utah	-	-	-	-	47.93
7) Arizona	-	65.62	-	-	70.76
8) New Mexico	-	29.65	-	-	-
9) Colorado	-	18.79	37.50	-	22.17
10) Wyoming	-	-	36.06	20.90	26.38
11) Montana	-	-	31.44	17.62	18.36
12) North Dakota	-	-	28.48	12.96	15.16
13) South Dakota	15.04	-	17.13	11.42	10.79
14) Nebraska	48.64	34.39	38.40	15.53	16.10
15) Kansas	39.29	25.20	36.46	-	19.18
16) Oklahoma	-	20.20	34.31	-	16.51
17) Texas	-	31.37	-	-	-
18) Louisiana	-	-	-	-	-
19) Arkansas	-	-	-	26.43	-
20) Missouri	50.95	36.52	42.21	-	-
21) Iowa	61.63	-	-	27.08	-
22) Minnesota	40.86	-	44.01	26.44	24.54
23) Wisconsin	-	-	-	32.08	-
24) Illinois	70.02	-	-	27.08	-

TABLE T.20 (IV.b)--Continued

State	Areal Revenues ($/acre)				
	Corn	Sorghum	Wheat	Oats	Barley
25) Mississippi	-	-	-	29.34	-
26) Alabama	-	-	-	-	-
27) Tennessee	-	-	-	-	-
28) Kentucky	-	-	-	-	-
29) Indiana	63.44	-	44.47	25.00	-
30) Michigan	-	-	-	-	-
31) Ohio	61.12	-	-	-	-
32) West Virginia	-	-	-	-	-
33) Georgia	-	-	-	-	-
34) Florida	-	-	-	-	-
35) South Carolina	-	-	-	21.90	-
36) North Carolina	-	-	-	-	-
37) Virginia	-	-	-	-	-
38) Maryland	-	-	-	-	-
39) Delaware	-	-	-	-	-
40) New Jersey	-	-	-	-	-
41) Pennsylvania	-	-	-	-	-
42) New York	-	-	-	-	-
43) Connecticut	-	-	-	-	-
44) Rhode Island	-	-	-	-	-
45) Massachusetts	-	-	-	-	-
46) Vermont	-	-	-	-	-
47) New Hampshire	-	-	-	-	-
48) Maine	-	-	-	-	-

TABLE T.20 (IV.b)--Continued

State	Areal Revenues ($/acre)				
	Rice	Soybeans	Peanuts	Cotton	Tobacco
1) Washington	-	-	-	-	-
2) Oregon	-	-	-	-	-
3) California	183.58	-	-	370.91	-
4) Nevada	-	-	-	-	-
5) Idaho	-	-	-	-	-
6) Utah	-	-	-	-	-
7) Arizona	-	-	-	337.87	-
8) New Mexico	-	-	177.67	293.33	-
9) Colorado	-	-	-	-	-
10) Wyoming	-	-	-	-	-
11) Montana	-	-	-	-	-
12) North Dakota	-	21.86	-	-	-
13) South Dakota	-	-	-	-	-
14) Nebraska	-	-	-	-	-
15) Kansas	-	37.94	-	-	-
16) Oklahoma	-	-	110.27	92.12	-
17) Texas	156.64	-	62.12	107.87	-
18) Louisiana	134.48	-	-	174.38	-
19) Arkansas	155.92	45.36	-	197.94	-
20) Missouri	-	41.91	-	200.48	-
21) Iowa	-	51.94	-	-	-
22) Minnesota	-	36.33	-	-	-
23) Wisconsin	-	-	-	-	-
24) Illinois	-	51.74	-	-	-

TABLE T.20 (IV.b)--Continued

State	Areal Revenues ($/acre)				
	Rice	Soybeans	Peanuts	Cotton	Tobacco
25) Mississippi	125.04	43.58	-	190.50	-
26) Alabama	-	-	71.24	150.64	-
27) Tennessee	-	-	-	221.39	878.27
28) Kentucky	-	-	-	-	925.31
29) Indiana	-	51.47	-	-	-
30) Michigan	-	-	-	-	-
31) Ohio	-	49.94	-	-	-
32) West Virginia	-	-	-	-	-
33) Georgia	-	-	95.60	138.71	854.85
34) Florida	-	-	74.51	-	-
35) South Carolina	-	-	-	124.70	1,041.73
36) North Carolina	-	-	164.18	-	828.55
37) Virginia	-	-	177.63	-	788.28
38) Maryland	-	-	-	-	447.80
39) Delaware	-	48.20	-	-	-
40) New Jersey	-	-	-	-	-
41) Pennsylvania	-	-	-	-	-
42) New York	-	-	-	-	-
43) Connecticut	-	-	-	-	-
44) Rhode Island	-	-	-	-	-
45) Massachusetts	-	-	-	-	-
46) Vermont	-	-	-	-	-
47) New Hampshire	-	-	-	-	-
48) Maine	-	-	-	-	-

TABLE T.20 (IV.b)--Continued

State	Areal Revenues ($/acre)				
	Sugar beets	Irish Potatoes	Vegetables	Berries	Fruits & Nuts
1) Washington	252.18	416.59	173.19	854.50	576.17
2) Oregon	262.62	493.65	207.46	542.62	276.24
3) California	259.96	734.78	408.90	2,113.79	387.09
4) Nevada	-	-	-	-	-
5) Idaho	240.37	421.15	135.00		401.57
6) Utah	213.30	458.66	-	-	-
7) Arizona	-	-	478.17	-	-
8) New Mexico	-	-	-	-	-
9) Colorado	202.92	305.25	272.36	-	-
10) Wyoming	180.21	193.00	-	-	-
11) Montana	182.63	597.00	-	-	-
12) North Dakota	135.92	196.24	-	-	-
13) South Dakota	181.50	-	-	-	-
14) Nebraska	203.95	292.45	-	-	-
15) Kansas	-	-	-	-	-
16) Oklahoma	-	-	-	-	-
17) Texas	-	-	-	-	-
18) Louisiana	-	-	-	-	-
19) Arkansas	-	-	-	521.00	-
20) Missouri	-	-	-	-	-
21) Iowa	-	-	-	-	-
22) Minnesota	135.68	198.24	-	-	-
23) Wisconsin	-	364.00	80.10	869.33	-
24) Illinois	-	-	-	-	-

TABLE T.20 (IV.b)--Continued

State	Areal Revenues ($/acre)				
	Sugar beets	Irish Potatoes	Vegetables	Berries	Fruits & Nuts
25) Mississippi	-	-	-	-	-
26) Alabama	-	-	-	-	-
27) Tennessee	-	-	-	337.86	-
28) Kentucky	-	-	-	-	-
29) Indiana	-	-	-	-	-
30) Michigan	145.21	-	-	475.22	-
31) Ohio	-	-	-	-	-
32) West Virginia	-	-	-	-	-
33) Georgia	-	-	-	-	-
34) Florida	-	-	298.94	-	447.43
35) South Carolina	-	-	-	-	-
36) North Carolina	-	-	-	-	-
37) Virginia	-	-	-	-	-
38) Maryland	-	-	-	-	-
39) Delaware	-	491.29	108.86	-	-
40) New Jersey	-	-	235.94	560.08	-
41) Pennsylvania	-	-	-	-	-
42) New York	-	-	-	-	-
43) Connecticut	-	-	-	-	-
44) Rhode Island	-	-	-	-	-
45) Massachusetts	-	-	-	385.69	-
46) Vermont	-	-	-	-	-
47) New Hampshire	-	-	-	-	
48) Maine	-	428.22	-	87.12	-

Source: Table T.10 (II.b)

Crop Mix

Estimation of Areal Revenues of the specialized crop mix is based in the same concept used in the study of the total distribution patterns and revenues (Chapter II.2), with the obvious difference that only crops considered specialized in this particular state are to be included. To clarify the idea, the same example state as was used previously is analyzed below, but the rest of the extensive computation has been omitted.

The example state, Indiana, has been found to be specialized in: corn, wheat, oats and soybean, because in each of these crops there is an "exportable" surplus represented in a positive Specialized Locational Distribution index, with the values of: 5.59 ; 0.39 ; 0.49 ; and 8.71 for the corresponding crop.

Indiana:

Crop	Sales ($ x 10^3)	Area (acres x 10^3)
Corn	146,669	2,312
Wheat	49,758	1,119
Oats	5,624	225
Soybean	111,036	2,157
Total	313,087	5,813

Ratio of $\frac{\text{sales}}{\text{acres}}$ = 53.86 $/acre

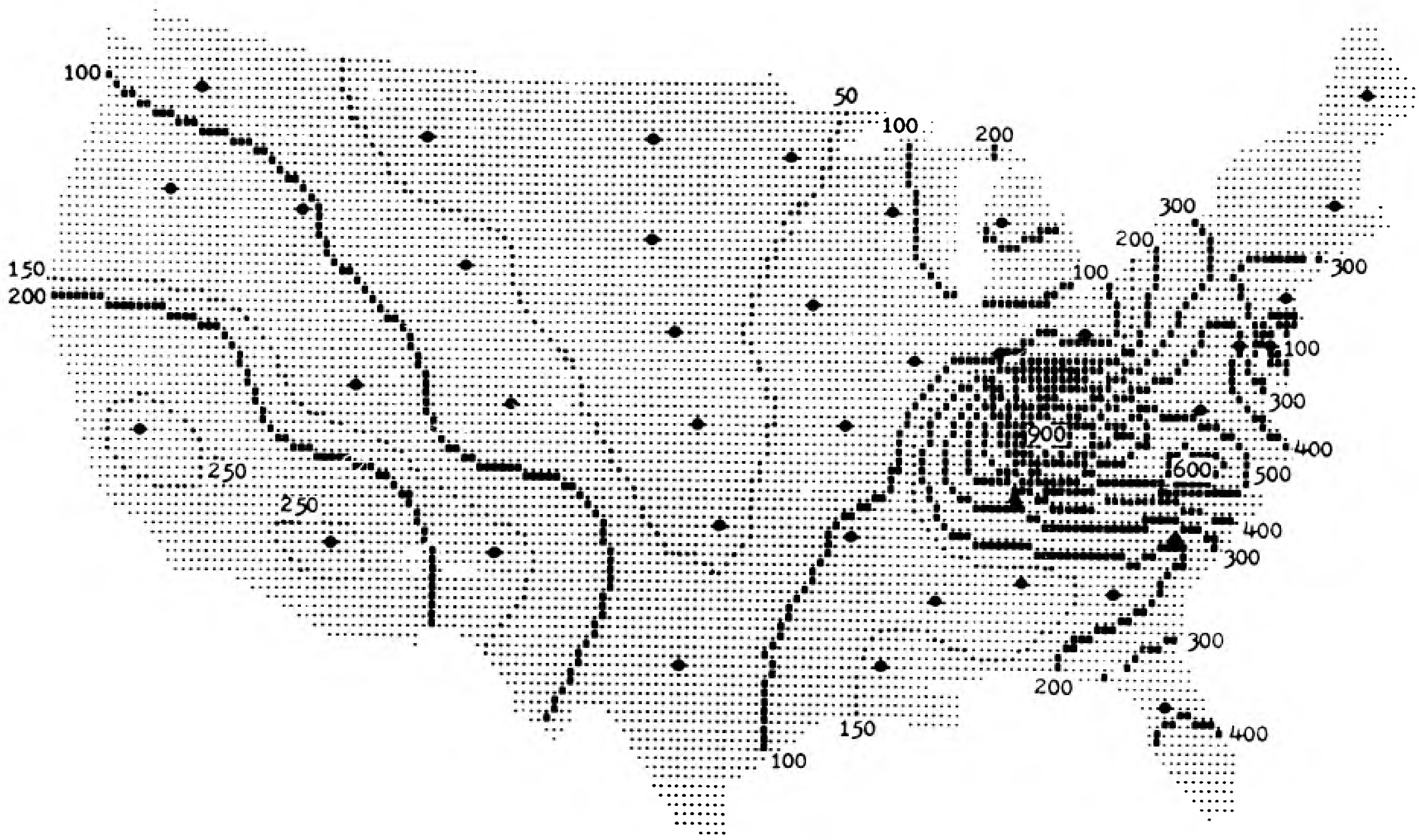
This areal revenue is different from the total one, that is 56.57 $/acre.

The following table provides the Specialized Areal Revenues for the coterminous U.S.A., covering all states where at least one crop was found to be specialized. This means that some states, by not fulfilling this criterion are not included, them being: Nevada, West Virginia, Pennsylvania, New York, Connecticut, Rhode Island, Vermont and New Hampshire. The corresponding mapping is based on Table T.21 (IV.b).

TABLE T.21 (IV.b)

AREAL REVENUES OF SPECIALIZED AGRICULTURAL PRODUCTION AS WEIGHTED AVERAGE OF THE SPECIALIZED CROP MIX FOR 40 STATES WITH AT LEAST ONE SPECIALIZED CROP, U.S.A., 1959

State	Specialized Areal Revenue ($/acre)	State	Specialized Areal Revenue ($/acre)
1) Washington	98.36	22) Minnesota	38.76
2) Oregon	103.15	23) Wisconsin	81.81
3) California	285.11	24) Illinois	59.53
5) Idaho	101.75	25) Mississippi	128.44
6) Utah	137.40	26) Alabama	135.83
7) Arizona	272.48	27) Tennessee	305.04
8) New Mexico	167.11	28) Kentucky	925.31
9) Colorado	49.93	29) Indiana	53.86
10) Wyoming	50.79	30) Michigan	225.11
11) Montana	30.26	31) Ohio	55.94
12) North Dakota	25.30	33) Georgia	164.27
13) South Dakota	15.45	34) Florida	391.73
14) Nebraska	43.44	35) South Carolina	197.38
15) Kansas	34.13	36) North Carolina	656.71
16) Oklahoma	39.84	37) Virginia	466.17
17) Texas	73.13	38) Maryland	447.80
18) Louisiana	154.73	39) Delaware	78.67
19) Arkansas	105.46	40) New Jersey	263.92
20) Missouri	55.25	45) Massachusetts	385.69
21) Iowa	54.75	48) Maine	367.04



Map M.45 (IV.b): AREAL REVENUES OF SPECIALIZED AGRICULTURAL PRODUCTION, U.S.A., 1959 (in $/acre)

The mapping of the Areal Revenue surface of the specialized production shows a striking similarity to the surface corresponding to the total production. Nevertheless, it is apparent that there is a general increase in values throughout most of the surface. The Central Plains are still a low plateau, with the surface sloping upwards in both east and west directions, up to the highest values in the Pacific--a peak of 285 $/acre in California--and up to the highest values in the Atlantic--a peak of 925 $/acre in Kentucky. As in the total analysis case, the eastern side of the surface is more complex, showing a succession of peaks and pits from north to south, including the low values in the Deep South and the higher one in Florida.

A deeper comparative analysis between the two surfaces will be developed in Chapter V.2b.

CHAPTER V

A THEORY OF REGIONAL SPECIALIZATION

1. Proposed Theory

Throughout the previous analysis, the emergence of specialized areas that have an exportable surplus in a given crop(s) has been discussed several times.[1] In the first place, the theoretical arguments for the existence of this phenomenon are many: in the comments on alternative paths of regional development (Chapter I.2) it is shown that in the later stages of the "polystathmic" model and in the "monostathmic" model, the locational division of labor is a complementary phenomenon to increasing trade. From another point of view, in the classical rent theory of agriculture the resulting land use pattern is a set of concentric circles around the market, each cultivated with a different crop, forming then ring-shape zones specializing each in a particular crop.

Assuming a rational behavior it is possible to deduce, from the proposed locational theory (Chapter III), that if the process of allocation of land follows the distribution of the two variables of potential demand and climate, then the producers of a given crop will have reason to locate in the same zone, resulting in a concentration of production in the most "suitable" area. Nevertheless, this could not be true for all the agricultural production in a country, as it is only valid for those producers oriented to the national market. It is clear that farmers growing produce

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[1]See especially Chapter IV and IV.b.

for local consumption are scattered over the country. Thus, it is postulated that the agricultural production oriented to the national market is concentrated in areas specialized according to crops.

The empirical proof of the emergence of specialized zones is developed in Chapter IV, where the locational distribution of production shows clearly defined zones of concentration.

The next problem is the evaluation of the effects of this territorial division of labor. As is well known, the sectorial division of labor is an important factor in the increased productivity of industry. Is the agricultural regional specialization efficient? With the hypothesis that the specialization process follows the postulates of the proposed locational theory (Chapter III), it is expected--and will be proved--that locational specialization tends to a greater efficiency of the agricultural system in the country; the analysis of this postulate is developed in sections 2 and 2b of this Chapter.

One result of the process of regional specialization is the emergence of areas defined in terms of their production of an exportable surplus of a given crop. (These areas will be referred to as "zones" to distinguish them from the set of regional entities studied in Chapter III.) The criterion for zonal definition is the production of a specialized crop.

Furthermore, it has already been shown in Chapter III that a regional system may be formed by regions with different characteristics. If this concept is translated to the agricultural "zones," it is safe to expect that a regional analysis will discover the existence of several types of zones. Thus, it is postulated that different spatial interrelationships of the two allocating variables will generate different types of agricultural zones; being this postulate developed in sections 4 and 4b of this Chapter.

2. Efficiency and Specialization

One of the important problems posed by the locational specialization trend are the effects of this process on the national economic space. To assess these effects, the analysis will begin by studying the locational decision--and results--of the individual producer. For every farmer, the level of the Areal Revenues of his crop, on a site, is essential in determining the success of his bid to rent and occupy the given land. Within the area of positive rent (i.e., "margin of transference" for the crop), the farmer is assumed to be indifferent along the rent structure (although exceptions to this will be presented in section V.4).

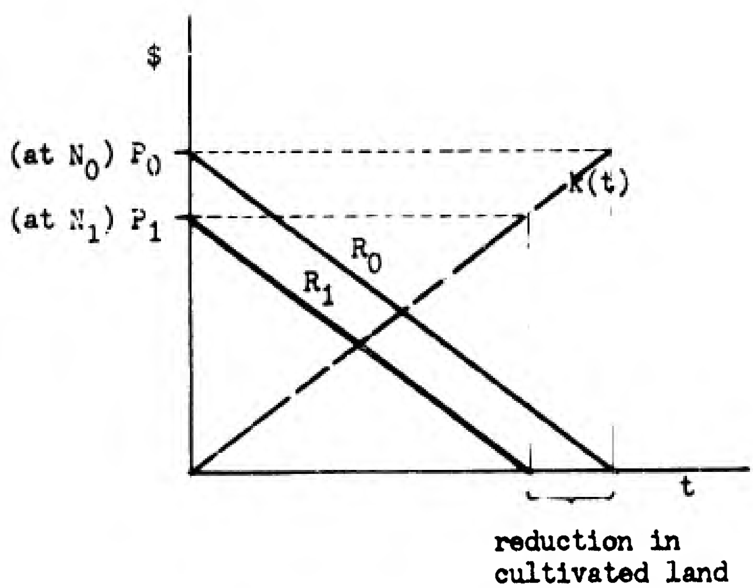
Starting from the postulates of the classical rent theory and the modifications introduced in Chapter III, it is possible to state now that, given a price at the market--and thus a price at the farm net of total transfer costs for its particular location--the farmer will increase his areal revenues by moving to an area of higher yields, if the new site is inside of the margin of transference for the crop. This would imply an increase in rents and also an increase in the level of "normal" profits rewarding a larger labor input caused by larger yields. Furthermore, it is assumed at this point that production costs per acre and total transfer costs per acre increase at a slower rate than the increase in revenues per acre, all caused by igher yields per acre per year.

The farmer's problem is then to:

Maximize yields N, subject to the constraint that rent $R_{(t)} > 0$

It must be noted that a complementary problem, the maximization of price P at the farm net of transfer costs is not relevant, because it is solved by locating nearer to the market, within the zone allocated to the crop, although now the price differential is absorbed by the corresponding rent differential, while "normal" profits remain constant. Clearly, if the assumption of slower rate of increase for production and total transfer costs are relaxed, the problem has a new constraint: the farmer will move in space to increase his yields, up to a point where a marginal increase in Gross Areal Revenues caused by higher yields is equal to a marginal increase in production and total transfer costs caused by the same increase in yields.

The total effects of solving the farmer problem of maximization of Areal Revenues through maximization of yields can be studied first in the cartesian diagrams, by simply introducing the variable N into the classical theory.



An increase in yields from N_0 to N_1 , results in a lower level of Price P_1 because the larger supply structure forces down the level of the price at the market, from P_0 to P_1 ; causing then a reduction of the area under cultivation. It must be remembered that the new equilibrium in the cartesian diagram is actually an iterative process, in which price level and amount of cultivated land experience successive increases and decreases, until they reach a balance point. The effects of maximization of yields can be summarized as intensification of use and reduction in area.

The result in the aggregate, is that if the different crops could locate so that they maximize yield, within the margin of positive rents--an alternative way of stating the proposed locational theory of Chapter III --then the agricultural system would use less land to produce a greater quantity of crops per acre, leaving less desirable land for other crops or even other purposes. On the other hand, rents would be increased (really they would be maximized, as will be demonstrated below).

It is postulated that the process of locational specialization, result of the mechanism formalized in the proposed locational theory, leads to the best use of the agricultural land, keeping each cultivated acre under the highest areal revenue (and rent) condition.

The postulate that rents are actually maximized in the process studied above will now be analyzed, including the conditions for maximization according to different assumptions.

The analysis of the conditions of Rent (Areal Revenues) maximization presents the problem of finding the maximum points of the Rent equation, for different hypothetical assumptions. First, it will be assumed that a movement in space of the producer affects only yields, while price, production costs and total transfer costs remain constant. Second, transfer costs will be assumed variable; third, production costs, and fourth, price, will be included as variables resulting in that all elements of the rent equation are variable in the last step.

It is clear that movement in space causes changes in yields because of different climatic conditions. Total transfer costs vary with the distance variable; and price changes are a result of the new equilibrium between the supply and demand structure, when there is a change in yields, as was studied above.

The rent equation is as follows:

$R_{(t)} = N_{(t)}(P - C - K_{(t)})$; for a given crop c ; where

$R_{(t)}$ = rent at location t

$N_{(t)}$ = yields at location t

P = price at the market

C = production costs

$K_{(t)}$ = total transfer costs at location t

Since the mathematical conditions for the maximization of a function are that the first derivative be zero and that the second derivative be negative, it is necessary to differentiate the rent equation with respect to the variable t (location) to estimate the effects on rent, of movement in space.

Differentiating with respect to t , assuming P, C and K are constant, we obtain:

$$\frac{dR}{dt} = N \frac{d}{dt} (P - C - K) + (P - C - K) \frac{dN}{dt}$$

as P, C and K are constant, its derivative with respect to t is zero, then:

$$\frac{dR}{dt} = (P - C - K)\frac{dN}{dt}$$

the first condition for a maximum of a function is that its first derivative must be zero, then:

$$\frac{dR}{dt} = (P - C - K)\frac{dN}{dt} = 0$$

as it is clear that the constant within the brackets (P - C - K) is not zero (except on the margin of transference, that is the line of zero rent), then it must be that:

$$\frac{dN}{dt} = 0$$

this means that the condition for maximization of rents is the maximization of yields, as was postulated.

Assuming now that P and C are constant, but that K (total transfer costs) is variable, differentiating with respect to t, we obtain:

$$\frac{dR}{dt} = N\frac{d}{dt}(P - C - K) + (P - C - K)\frac{dN}{dt}$$

as P and C are constant, the derivative with respect to t is zero, then:

$$\frac{dR}{dt} = -N\frac{dK}{dt} + (P - C - K)\frac{dN}{dt}$$

applying again the first condition for a maximum, we obtain:

$$\frac{dR}{dt} = -N\frac{dK}{dt} + (P - C - K)\frac{dN}{dt} = 0$$

or manipulating:

$$(P - C - K)\frac{dN}{dt} = N\frac{dK}{dt}$$

this condition for maximum of rents can be interpreted in the following way: the expression to the left is composed of the marginal increments of N corresponding to marginal changes of location t, times the net revenue of a unit of yield--price minus production costs minus total transfer costs--resulting in the marginal revenue caused by the movement in space. The expression to the right is composed of the marginal increments of K corresponding to marginal changes of t, times the yield N; resulting in the marginal total transfer cost caused by the change of distance and by the increase in yields. This indicates that the increase in yields N will increase the rent R, up to a point where the marginal increase in total transfer costs equals the marginal revenue. It is also clear that if it is assumed that transfer costs increase at a slower rate than yields, there would be no transfer costs constraint and the maximization of rents would correspond again to the site of maximum yields.

The third and fourth steps follow the same pattern; if it is now assumed that production costs are variable, the condition for maximum of the rent equation results in:

$$(P - C - K)\frac{dN}{dt} = N\left(\frac{dK}{dt} + \frac{dC}{dt}\right)$$

this indicates simply that the site of maximum rent will be where the marginal increase in revenues equals the marginal increase in combined costs.

The last assumption introduces the price at the market as a variable and it must be noticed that, while K and C normally increase with increases in N, the variable P decreases, because higher levels of production will reduce prices, other things being equal. Under this assumption, the condition of maximization results in:

$$(P - C - K)\frac{dN}{dt} = N\left(\frac{dK}{dt} + \frac{dC}{dt} - \frac{dP}{dt}\right)$$

this indicates that the site of maximum rent will be where the marginal increase in revenues equals the marginal increase in combined costs plus the marginal decrease in price at the market.

In summary, the analysis of the first condition for maximum indicates that, in general, rents (and areal revenues) will be maximized where the yields are also maximized. If the production costs or the total transfer costs or both increase at a higher rate than the increase in revenues caused by the increase in yields, then rents will be maximized at the site where the marginal increase in costs equals the marginal increase in revenues; and if the price at the market decreases at a higher rate than the revenues increase, both due to increase in yields, then the site of maximum rents will be where the marginal decrease in price equals the marginal increase in revenues.

The analysis of the second condition is not important, because it is obvious in this case that the point of maximum rent cannot be confused with a minimum. Nevertheless, the second order conditions are included, for the four successive assumptions. As was mentioned, this condition states that the second derivative of the function must be negative. For simplicity, the first derivative is called now N', that it is equal to $\frac{dN}{dt}$, or to $\frac{d}{dt}$ (N); being the second derivative N''.

Under the assumption of P, C and K constant, the second condition is:

$$(P - C - K)\, N'' < 0$$

obtained by differentiating the first derivative of the rent function with respect to t.

The other three assumptions, where K, then C and finally P are introduced as variables, result in the following second order conditions (eliminating the intermediate steps):

$$(P - C - K)\ N'' - 2N'\ K' - N\ K'' < 0$$

$$(P - C - K)\ N'' - 2N'\ C' - 2\ N'\ K' - N\ C'' - N\ K'' < 0$$

$$(P - C - K)\ N'' + 2N'\ P' - 2\ N'\ C' - 2\ N'\ K' + N\ P'' - N\ C'' - N\ K'' < 0$$

In summary, the proposed locational theory developed in Chapter III implies a locational specialization of agriculture, resulting in an increase efficiency, defined as: reduction of land under cultivation, intensification of production and maximization of areal revenues and rents.

3. Crop Typology

(Specialized-Ubiquitous; Concentrated-Dispersed)

In a study of locational specialization of the agricultural production, it is necessary to assert if all the production is susceptible of such a process, or only part. To begin with, it is possible to oppose the notion of ubiquity to specialization and in a slightly different sense, dispersion as opposed to concentration.

The above criteria used to define "types" of crops are very similar, and may occasionally overlap, but nevertheless, a distinction between the two can be made. The criterion of specialization or ubiquity corresponds to whether a crop tends to show higher or lower percentage of its production grown in areas oriented to the national market. In other words, it is based on the proportion of the "exportable" surplus that this crop has in relation to the total national production. Thus, a specialized crop is one with a high proportion grown in specialized areas and a ubiquitous crop is one with a correspondingly low proportion. The criterion of concentration or dispersion corresponds to whether a crop tends to cluster the productive zones over a relatively reduced or a relatively extended area of the country; and this criterion is applicable either to the total production or to the specialized production. Thus, a concentrated crop is one with a high proportion grown in a relatively small geographical area, and a dispersed crop is one grown in a correspondingly large area.

Both criteria are related to the spatial distribution of crops, but there is a slight difference between them. The first one--Specialized and Ubiquitous--is more "sectorial," while the second one--Concentrated and Dispersed--is more "locational." An example will probably illustrate the concept more clearly: it is possible to have at the same time a crop specializing over 15 states (barley) or over 5 states (rice), the first case being one of dispersed and the second one of concentrated location, though referring always to the production already grown in specialized states. Clearly, it is possible to find the following combinations: Specialization + Concentration; Specialization + Dispersion; and Ubiquity + Dispersion (the fourth possibility of an ubiquitous concentrated production is not feasible). Nevertheless it must be noticed that usually, the characteristics of relatively high specialization will tend to overlap with high concentration, and viceversa.

Ubiquitous crops are, by definition, those oriented to the local market, and often are the so-called "fresh produce." The quality of freshness compensates--from the consumer's point of view--for the possible reduction in quality of the produce when compared to that grown in areas more suitable for the given crop, essentially in terms of climate. Obviously, the fresh produce must be able to compete in terms of price level with the processed produce grown in the specialized areas. A typical case is where there is a possibility of product substitution presented to the market and where the trade-off is based not only on price but also in terms of the alternative of freshness versus processed quality produce.

Within the crops showing a strong specialization index, a distinguishable group is made up of those crops having stringent climatic requirements, i.e., which cannot be cultivated below an existing Development Unit value. In these cases, the reduction of alternatives implies a necessary specialization, as well as often a concentration. As a result it is expected that crops with propensity to ubiquity would be much slower in the specialization process, and even that part of those crops would be permanently unavailable to a possible "specialization," as long as competitive position in the local markets were not upset.

4. Agricultural Specialized Zones

The concept of an agricultural "zone" is directly derived from the hypothesis that a crop or a crop mix would tend to concentrate, locationally speaking, and thus configurate an area specialized in this production. Clearly, this would be true for all the production, with the exception of the ubiquitous group, and as long as it maintains a favorable competitive position against the national-oriented production. Actually, as was commented before, the concept of region depends on the criteria used, and so it is legitimate to speak of agricultural "zones," such as the cotton belt, based on the criterion of an homogeneous agricultural production. As is clear, these would be "homogeneous" regions.

There is an important difference between the zones as defined by the total production, and zones as defined by specialized production. The latter is the result of deducing the population density distribution from the total production. By definition, the specialized index was obtained by assuming a domestic consumption directly proportional to the area's population and assigning the rest of the produce to "export surplus."

5. Zonal Typology

The classical Agricultural Land Rent theory results logically in no differentiation among zones, that is, all regions would be the same type of concentric rings around an urban center economically autonomous.

The two locational variables found relevant in the proposed theory can instead determine different types of zones in an integrated economic space. The analysis will be based on the interrelationship of the two variables--Potential Demand and Climatic Conditions--, and on agricultural zones defined as the area producing one or more common output for the national market, regardless of physical continuity. Within a zone it is possible to find constancy or variability of the two locational variables, defined as follows: constancy (variability) of the Potential Demand means that different sites in the zone have the same (different) range of values of the Income Population Potential model; and similarly, constancy (variability) of the Climatic Conditions means that different sites in the zone have the same (different) range of values of the Average Annual Possible

Evapotranspiration model. The combination of two variables with two extreme possibilities results in four basic cases:

a) All sites of the zone have relatively constant climate and constant Potential Demand.

b) At least two sites have different climate; but all have constant Potential Demand.

c) All sites have constant climate; but at least two sites have different Potential Demand.

d) At least two sites have different climate; and at least two sites have different Potential Demand.

Analysis of the four cases:

Case a) : All sites of the zone have both relatively constant climate and constant Potential Demand: Static zone.

This case is not very interesting, as obviously the zone fitting this description must be a compact area with no meaningful variation in Potential Demand or climate, and thus constitute what might be called a "Static" region. Clearly the narrower the ranges defined as "constant" in both models of demand and of climate the less probable is it that a "Static" region will exist.

Case b) : At least two sites have different climate, but Potential Demand is relatively constant: Dynamic Elastic zone.

The region can be interpreted as occupying land over approximately constant values of the demand model, but spanning ranges of different development unit values, with perhaps even physical discontinuity over the geographic space.

Let us call C (Cold) the subzone located in the lower climate range and W (Warm) the subzone on the higher climate range.

Subzone C is not able to produce output in off-season--or at least cannot produce as much total annual yield as subzone W--due to constraints of climate. On the contrary, subzone W can produce during off-season, due to the higher development unit values of its location.

The market price level is sensitive to the Time Potential Supply,[2] caused by changes in seasonal production levels, and thus will naturally respond with a lower price level during season time and a higher price level during off-season. Subzone C is faced only with the lower level of Ps (price during season), but for subzone W both levels Ps and Poff (price during off-season) are relevant, which compose an average Pa (price average for the year). Logically, Pa > Ps, as Ps < Pa < Poff, since Pa is the average between the two.

In this type of region, subzone C is faced with a lower price level than subzone W, implying then that W rent structure is <u>higher</u> than C rent structure extending consequently the area of positive rent for subzone W. Furthermore, in the extreme case, subzone C will <u>not</u> be able to produce during off-season, while subzone W will have the virtual monopoly of off-season production.

The interpretation in the cartesian diagrams of the classical rent theory is:

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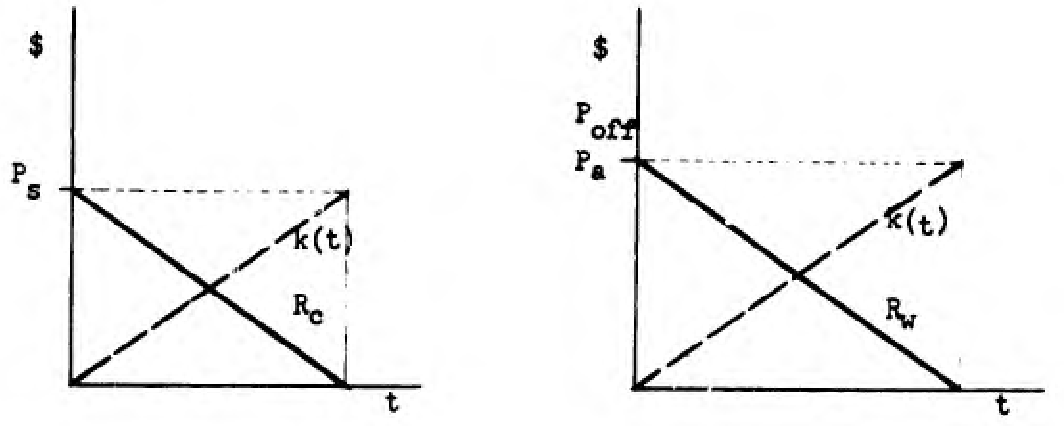
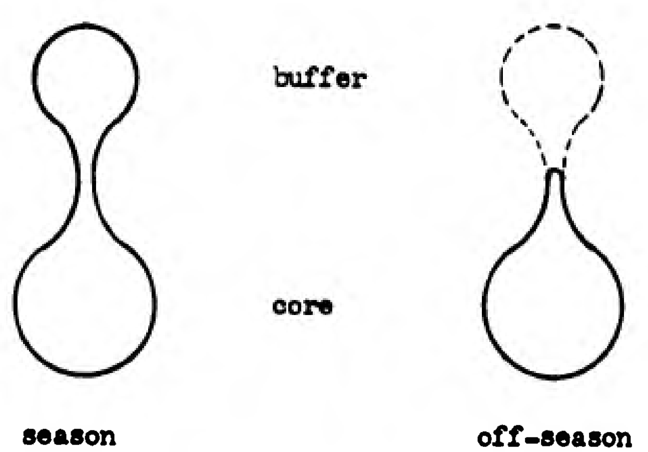
[2]See a brief summary in Chapter III, section 2, and for a deeper discussion: William Warntz, <u>Towards a Geography of Price</u>, Op.cit.



This indicates that for a location on a given equipotential contour line of the demand model, land rent would be higher in subzone W. This raises a question of indifference along the bid rent surface, especially if the larger annual production of subzone W is rewarded with higher levels of "normal" profits.

This type of region would appear seasonally as follows; indicating a yearly shift in and out of the "buffer" area, and suggesting the denomination of Dynamic Elastic.



The implications are clear: the "buffer" area will be characterized by rural unemployment of seasonal type, and it will not be possible to encourage the same production throughout the year, due to climate constraints requiring other types of compensatory policies.

Case c) : The zone has relatively constant climate, but at least two sites have different values in the Potential Demand model: Dynamic Continuous.

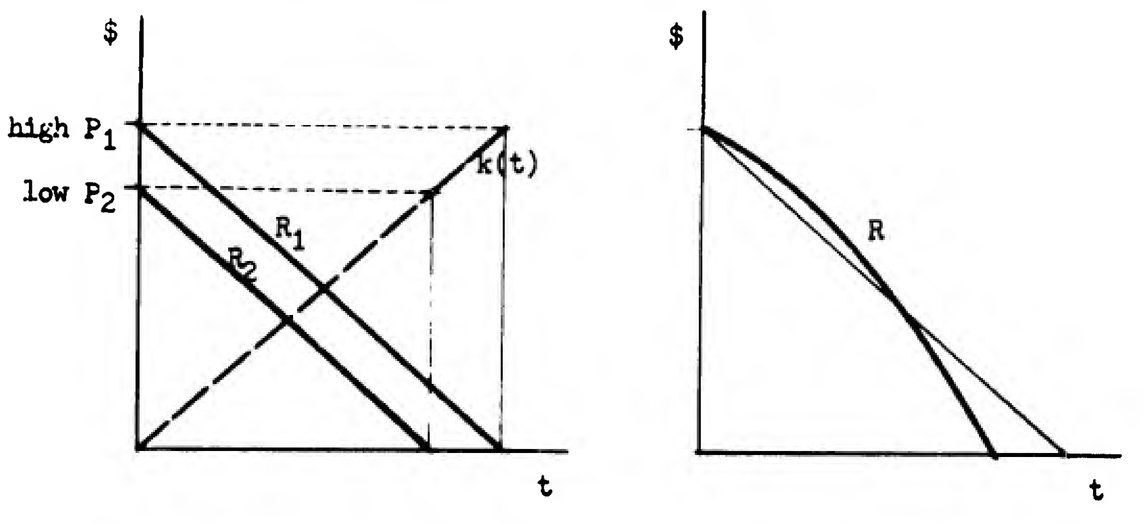
This can be interpreted as a region that occupies the same range in the Development Units model but due to its geographical extension some sites operate on different values of the Potential Demand model than others. The whole region is able to produce the same quantity of crop, so the yearly range of price during season and off-season, expressed as an average price, defines the margin of economic cultivation. The yearly fluctuations of seasonal prices are not important here, but the cyclical changes of the price level over the years, caused by recessions, depressions or prosperities, will be very relevant, as they will force the "margin" to change.

As a result, individual producers located near the margin may be economically eliminated with reductions of the price level, leading to a condition of uncertainty in those sites, regarding the continuity of the production in the long run. It is clear that continuity is an essential factor for the farmer. The conclusion is that for this type of zone, the sites with lower Potential Demand values are "marginal" lands, subject to much uncertainty as to the feasibility of production in the long run.

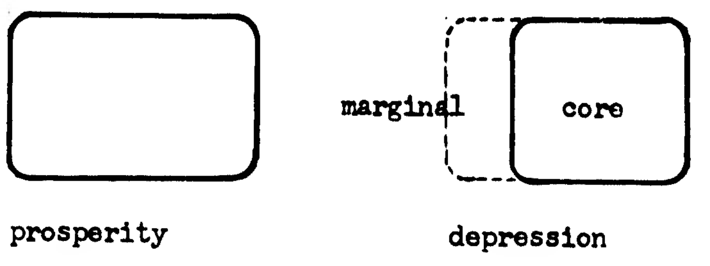
It is also evident that farmers cannot be indifferent along the complete bid rent curve, as they will try to avoid the marginal lands--even though with favorable low rent in any particular year--because in a few years they may be carrying negative rent. It is probable then, that lands near the margin may have actual rents at a level lower than the theoretical bid rent curve indicates, and that the actual margin of zero rent would be smaller than the theoretical margin.

One hypothesis is that other sites of the zone might have higher actual rents, in comparison with the theoretical bid rent curve values, as a kind of "premium" paid for sites free of uncertainty. If the cyclical variations of the price level are included their effects could affect the bid rent curve, indicating a situation of partial non-indifference from the farmers.

In the cartesian diagrams of the classical rent theory, this is shown below.



The region would appear cyclically as follows, indicating a cyclical extension and contraction from the "marginal" lands, and suggesting the denomination of Dynamic Continuous.



Spatial variations is in this type of zone, not due to climatic conditions but purely to economic factors.

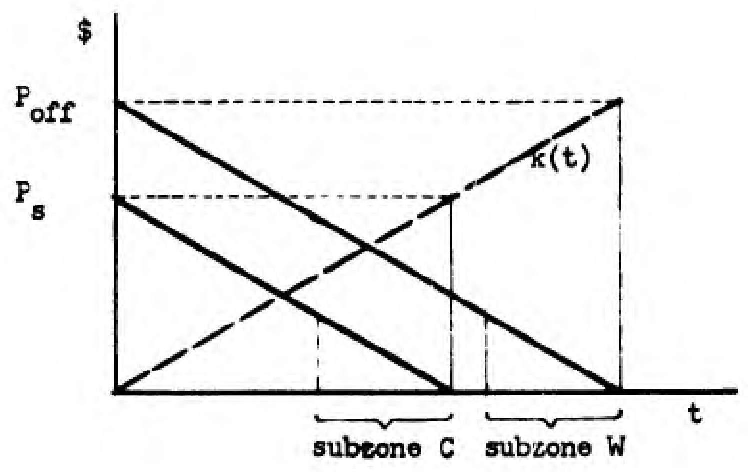
Case d) : Zones with at least two sites showing both different climate and different Potential Demand: Dynamic Bipolar.

This can be interpreted as a zone with at least two subzones, each of them located on different equipotential contour lines of the demand model, and on different development unit values of the climate model. Let us assume that the subzone located on higher values of the potential demand is on lower values of the development units model.

Again, we will call subzone C the one located on the lower climatic range--and that is also on the higher contour line of the demand model--; and subzone W the one in the higher climatic range--and the lower demand values as well.

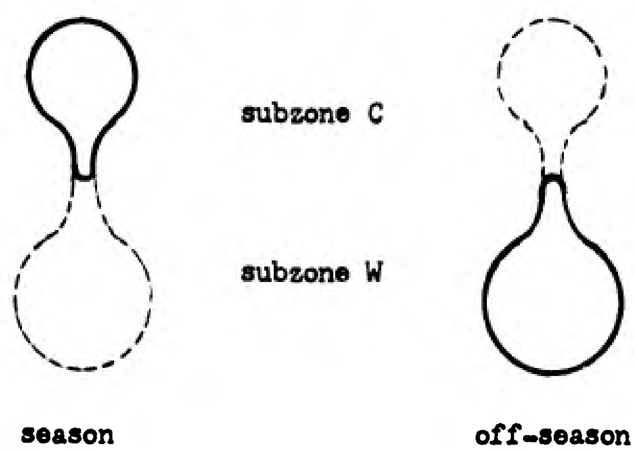
As in Case b), it is assumed that the crop price Poff (during off-season) is higher than Ps (during season) and that due to climate constraints, subzone C is not able to produce during off-season. Subzone W has then virtual monopoly during off-season and can produce at the higher price Poff, while subzone C is idle (or devoted to other endeavors). The interesting case is that during the season, when the price is at a lower level Ps, the higher total transfer costs for subzone W--due to longer distances to the aggregate market--may force its rent to negative levels for part or the whole subzone W, while still allowing positive rent for subzone C.

The cartesian diagrams of the classical theory will make this more clear:



This indicates that while the higher price Poff allows for economical production of subzone W, the lower price Ps eliminates subzone W, allowing only subzone C, which contrariwise, can produce only during season, due to climatic conditions. The influence of higher total transportation costs for subzone W is the economic differential that allows production in C but not in W. The production then shifts location: on season is in the colder subzone, nearer the aggregate market; on off-season is in the warmer subzone, farther away .

Seasonally, the situation would appear as follows, indicating a seasonal jump of production from one subzone to the other, and suggesting the denomination of Dynamic Bipolar.



Some of the implications are clear: both subzones will have seasonal rural unemployment, in subzone C it will not be possible to encourage the production of the same specialized crop during off-season, due to climatic constraints. In subzone W instead, production is climatically possible throughout the year, but not economically feasible.

Another important problem is the condition of indifference of farmers along the bid rent curve assumed in the classical agricultural land rent theory. This is based on the concept that "normal" profits being constant, the producer is indifferent as long as his farm is located within the margin of transference of the system.

Following the typological study of the agricultural zones it is necessary to revise these concepts. The simplest case of divergence from the "indifference" assumption emerged from the study of the Dynamic Continuous zones. In this type the "marginal" lands are estimated by the farmer at a lower rent level than the classical complementarity with transfer costs would indicate. The important concept is that in the Dynamic Continuous zones farmers are <u>not</u> indifferent, at least along the marginal part of the bid rent curve, unless through the use of certain policies, "normalcy" to the rent curve and indifference along it could be restored.

Following is a summary of the four types of zones specializing in agricultural production:

TABLE T.22 (V)

ZONAL TYPOLOGY: AGRICULTURAL SPECIALIZED ZONES

Type	Spatial Changes	Time Changes
Static : Constant climate constant demand	None	None
Dynamic Elastic : variable climate constant demand	Extension and contraction from "core" to "buffer" subzone.	Regular seasonal
Dynamic Continuous : constant climate variable demand	Extension and contraction from "core" to "marginal" subzone.	Irregular, cyclical
Dynamic Bipolar : Variable climate variable demand	Shifts from one "core" to other "core".	Regular seasonal

The four zonal types are ideal models, that means that in the real world they are found mixed; and furthermore, that the chances of finding specific zonal typologies depend on the range selected to define the climate and the potential demand values as constant or as variable. It is clear that for a very small range, practically all zones will present at least two subzones with variations in the two factors, while for wide ranges they will appear under assumed constancy.

On studying the specialized agricultural zones in Chapter IV, a clear concept was their homogeneity, understood as the common characteristic of occupying extensive areas of the national space with a common type of production. After the spatial-temporal analysis discussed above, it can be stated that those "homogeneous" zones have an internal dynamic with changes in space and in time.

As was mentioned before, a direct implication of the agricultural regional typology appears in the solution of the unemployment problem in rural areas. In each case, unemployment is caused by a different combination of factors, requiring then a different policy approach, as will be summarized in section 5 of this chapter.

Shifts in a Time Period

The agricultural zones--that is "regions" defined by the production of a common crop--have a location as a function of the two allocating variables of climate and potential demand, as has been presented in the proposed theory in Chapter III. This implies that any change in the locational distribution of the demand market--climate is assumed constant for the periods under consideration--must bring a change in the locational distribution of crops. In other words, the national processes of settlement of new frontiers, redistribution of population densities and incomes and of internal migration affect the location of production.

If such national processes are studied during a considerable time period, that is in a historical perspective, it is obvious that there is also a shift in the productive zones of the country corresponding to the locational changes of the national demand. It is to be expected, nevertheless, that some degree of "stickiness" may retard the locational adjustment of the regional productive structure. In general, the set of zones growing a common crop is not static, but essentially dynamic, as much as the other internal dynamic processes in the country. Thus, a growing or highly mobile country might generate more locational changes in its productive regional structure, than a stable or poorly mobile country.

CHAPTER V.b

EMPIRICAL STUDIES

1b. Proposed Theory

<u>Correlation Analysis</u>

The purpose of this analysis is to establish if the specialized "subsystem" is also spatially distributed according to the theory explained in Chapter III. If the correlation coefficients of the specialized subsystem are higher than those of the total production, this corroborates the proposed theory and postulates, because the specialized production would be more "rationally" located. Nevertheless, cases where the specialized subsystem shows a lower degree of correlation do not invalidate the theory if the specialization process of the particular region is in a formative stage or if it is experiencing shifts in space.

The method, variables and use of the additive and log form are the same as in the previous correlation analysis of the total system, with the natural exceptions that only data from specialized production are considered. The dependent variable is

X_1 = Specialized Areal Revenues

while the independent variables X_2 and X_3 are the same, because the potential demand and the climatic models have no reason to change. Finally, only 40 observations are used, excluding the states for which there is no possibility of estimating areal revenues due to their lack of specialized production.

Fourth Round of Correlation Analysis: U.S.A., 40 observations.

The correlation matrix is as follows, with the relevant coefficients underlined:

Variable Number	1	2	3	4	5	6
1	1.000	0.289	0.221	0.883	0.323	0.235
2		1.000	0.008	0.314	0.963	0.055
3			1.000	0.343	0.099	0.995
4				1.000	0.327	0.351
5					1.000	0.148
6						1.000

A first comparison with the correlation coefficients of the analysis of total production indicates that in general the specialized cases have higher levels of correlation: the coefficients of X_1 with variables X_2 and X_5 (log X_2) are both higher now--0.289 against 0.194 and 0.327 against 0.232--, the coefficient of X_1 with variable X_3 is slightly lower now--0.221 against 0.233--, and the coefficient with variable X_6 (log X_3) is again higher--0.351 against 0.329. As a result, the specialized locational pattern appears to be better correlated with the potential demand model than the total locational pattern, the conformity to the climatic model being roughly the same in both cases.

The log form corresponds better to the real world observations, as happened in the analysis of the total case.

The log form of the equation is as follows:

$$\log X_1 = -5.59770 + 0.60925 \log X_2 + 1.54656 \log X_3$$

R = 0.4482

R Sq. = 0.2008

Although the level of correlation is still low, there is nevertheless a higher multiple correlation coefficient and multiple determination coefficients than in the total case-- R = 0.4482 against 0.3879 ; and R Sq. = 0.2008 against 0.1505.

The conclusion is that the specialized locational distribution is more approximate to the proposed theory of agricultural location than the total one.

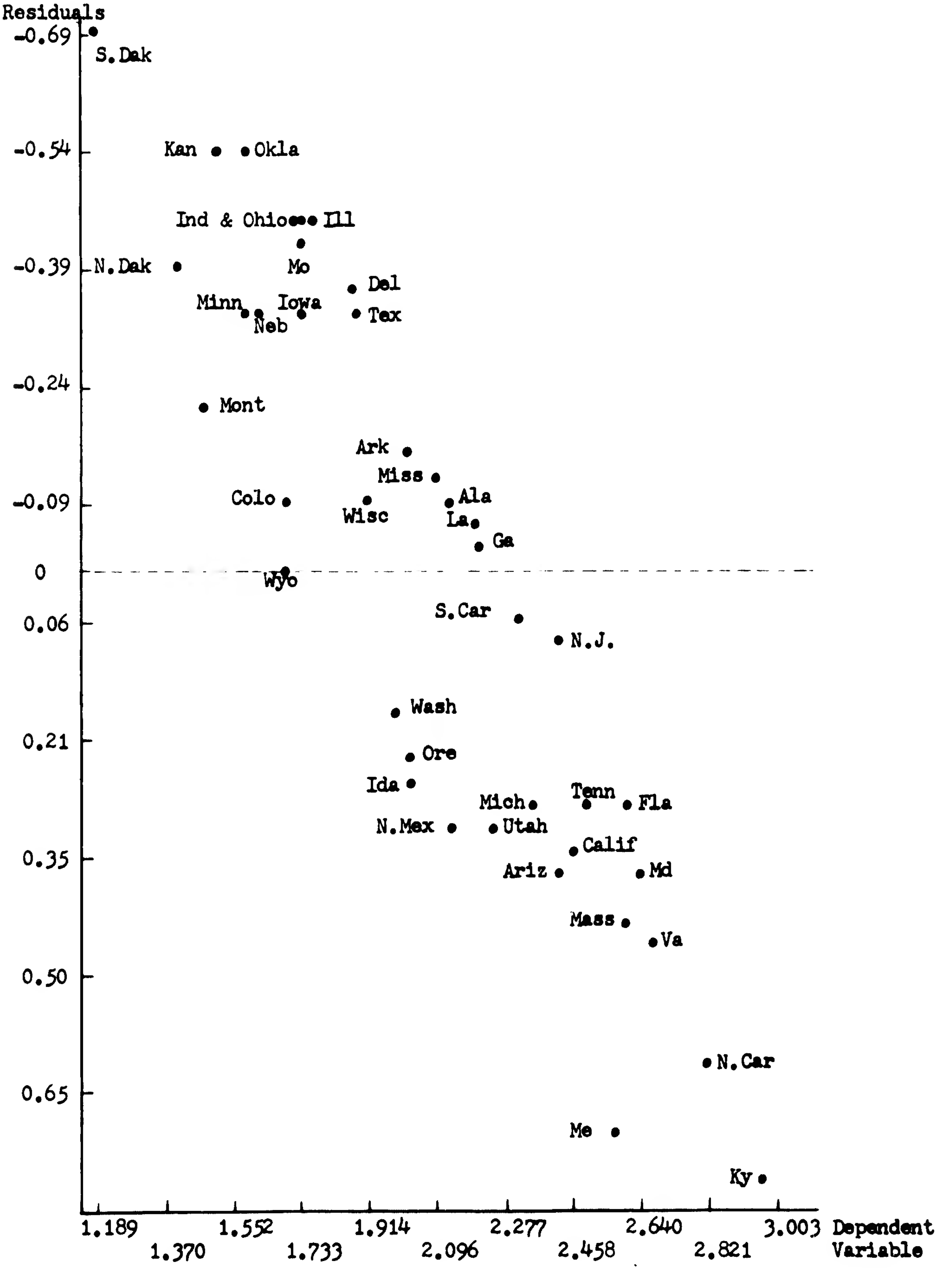
In the first round of correlation the study of the residual pattern was extremely important, so it is necessary to verify the new dispersion of the observation points. The Standard Error of Estimate is now 0.3894, and the detailed deviation of each state is analyzed below.

TABLE T.23 (V.b)

LIST OF RESIDUALS: U.S.A., FOURTH ROUND OF CORRELATION

State	Residual	Standard Error of Estimate "band" (SEE = 0.3894)	
1) Washington	0.17475		+ 1
2) Oregon	0.24675		+ 1
3) California	0.34326		+ 1
5) Idaho	0.27227		+ 1
6) Utah	0.31846		+ 1
7) Arizona	0.39287		+ 2
8) New Mexico	0.31211		+ 1
9) Colorado	-0.09450	- 1	
10) Wyoming	-0.00946	- 1	
11) Montana	-0.21653	- 1	
12) North Dakota	-0.38321	- 1	
13) South Dakota	-0.68718	- 2	
14) Nebraska	-0.33401	- 1	
15) Kansas	-0.53217	- 2	
16) Oklahoma	-0.54253	- 2	
17) Texas	-0.33984	- 1	
18) Louisiana	-0.05954	- 1	
19) Arkansas	-0.16201	- 1	
20) Missouri	-0.41364	- 2	
21) Iowa	-0.32513	- 1	
22) Minnesota	-0.32863	- 1	
23) Wisconsin	-0.08761	- 1	
24) Illinois	-0.43452	- 2	
25) Mississippi	-0.12150	- 1	
26) Alabama	-0.09200	- 1	
27) Tennessee	0.30828		+ 1
28) Kentucky	0.77037		+ 2
29) Indiana	-0.46170	- 2	
30) Michigan	0.30882		+ 1
31) Ohio	-0.44578	- 2	
33) Georgia	-0.03255	- 1	
34) Florida	0.29408		+ 1
35) South Carolina	0.05208		+ 1
36) North Carolina	0.62125		+ 2
37) Virginia	0.47355		+ 2
38) Maryland	0.37227		+ 1
39) Delaware	-0.36991	- 1	
40) New Jersey	0.07328		+ 1
45) Massachusetts	0.44057		+ 2
48) Maine	0.69893		+ 2

GRAPH G.6 (V.b): PLOTTING OF RESIDUALS AGAINST THE DEPENDENT VARIABLE IN LOG FORM: FOURTH ROUND OF CORRELATION, U.S.A.



A comparative analysis of the residual pattern of the specialized and the total cases indicates that both have the same distribution, with very minor exceptions. The Pacific region is consistently positively higher in both studies and the two states of Massachusetts and Maine show high positive residuals, although in the specialized case they are not distinguishable from the other states of Main U.S.A. with high positive deviations.

A first conclusion is that the specialized subsystem also shows the dual-market structure that made the Pacific region and the Main U.S.A. as recognizable entities. But, in a very interesting difference, New England is no longer clearly separated from the rest of the Main U.S.A., and this is fully coherent with the hypothesis: if it is postulated that the specialized subsystem is oriented to the national market, then there is no possibility of an enclave with a "monopolistic" location. New England shows only the production oriented to the rest of the country and as such the advantages of a monopolistic location have disappeared. The only minor difference of this study from the previous one of total production is in the shift of Michigan and Maryland to a positive residual. And as in the total study, the majority of the positive residuals are southern states, although this will be more fully discussed below.

Among the largest negative residuals can be found the already known area of Great Plain states--South Dakota, Kansas and Oklahoma--, but in the specialized study two other states appear in the second band of negative standard errors, Missouri and Illinois, which interestingly enough are on the regional boundary between the Center-North and South.

As a result the structure established for two regions based on different submarkets, the Pacific and the Main U.S.A., is still valid, and thus the fifth round of correlation can be similar to the second one.

It must be noticed that the plotting of state's residuals against the dependent variable is also distributed diagonally, in a pattern from the upper left corner to the lower right one; indicating again that states with higher areal revenue values have higher positive residuals and vice-versa.

Fifth Round of Correlation Analysis

The location theory will be tested in the regional entities found to be caused by the distribution of the potential demand, that is the Pacific and the Main U.S.A. As was mentioned, New England was also included in the second round (similar to the present round in the total study) but is not considered now, as the specialized subsystem does not allow for enclaves but only for the effects of national-oriented production. The same variables and data of the fourth round are used here, with 7 observations for the Pacific and 31 for the Main U.S.A.

Pacific Region:

The correlation matrix results as follows, with the relevant coefficients underlined:

Variable Number	1	2	3	4	5	6
1	1.000	0.657	0.961	0.992	0.654	0.958
2		1.000	0.495	0.644	0.999	0.512
3			1.000	0.951	0.492	0.999
4				1.000	0.647	0.951
5					1.000	0.512
6						1.000

Even though the correlation coefficients of the analysis of total production were high, those of the specialized subsystem are even higher. It is noticeable that the variable increasing most in its correlation with the dependent variable is the demand potential: the correlation coefficient of X_1 with X_2 rise from 0.459 in the total to 0.657 in the specialized case; and the one of X_1 with X_5 (log X_2) rise from 0.385 in the total to 0.647 in the specialized case. The climatic variable experiences moderate increases. This indicates that the specialization process in the Pacific results in a better approximation to the demand distribution, while the adaptation to the climatic model was already very good in both analyses.

By a slight difference, the additive form of the equation offers a better approximation to the real world observations, as happened also in the total study.

The additive form equation is:

$X_1 = - 316.95081 + 0.36750\ X_2 + 0.04989\ X_3$

$R = 0.9836$

$R\ Sq. = 0.9674$

The log form equation is:

$\log X_1 = -7.96744 + 0.60750 \log X_2 + 2.23511 \log X_3$

$R = 0.9696$

R Sq. $= 0.9400$

The resultant coefficients of multiple correlation and of multiple determination are in the specialized analysis higher than in the total case, reaching extremely high explanatory powers: R = 0.9836 against 0.9334 in the total study; and R Sq. = 0.9674 against 0.8713 in the total study--both in the additive equation. This follows the same pattern observed in the analysis of the whole country, where the specialized subsystem conforms better to the proposed spatial location theory. From this point of view it is possible to say that the Pacific region reaches a more rational spatial allocation of the agricultural production through its process of locational specialization.

As happened in the total case, a step-by-step analysis of the computation shows that the climatic model is still the most important in the location process, although now the market variable is of more weight than it was in the total case.

Step Number	Variable Entered	Multiple R	Multiple R Sq.	Increase in R Sq.
1	X_3	0.9612	0.9240	0.9240
2	X_2	0.9836	0.9674	0.0434

The Standard Error of Estimate is now of 17.8348, almost half of the value in the total analysis.

Main U.S.A.

The resulting correlation matrix is as follows, with the relevant coefficients underlined:

Variable Number	1	2	3	4	5	6
1	1.000	<u>0.283</u>	<u>0.259</u>	0.887	0.338	0.279
2		1.000	-0.062	0.404	0.963	-0.003
3			1.000	0.455	0.022	0.994
4				1.000	<u>0.468</u>	<u>0.472</u>
5					1.000	0.092
6						1.000

In comparison with the analysis of the total production, the correlation coefficients of X_1 with the variables X_2 and X_5 (log X_2) are higher in the specialized case--0.283 against 0.251 in the total; 0.468 against 0.438 in the total. Instead the correlation coefficients of X_1 with the variables X_3 and X_6 (log X_3) are lower in the specialized case--0.259 against 0.528 in the total; 0.472 against 0.542 in the total. The conclusion is that in the Main U.S.A., the specialized subsystem is better suited to the potential demand, while the total system is better suited to the climate.

As is the case in the total analysis, the log form equation conforms better to the real world observations than the additive one. (Notice that in the correlation analysis of the whole country, of the Pacific and of the Main U.S.A., the same form of equation showed a closer approximation in both the total and the specialized case.)

The additive form equation is:

$X_1 = -253.63103 + 0.24131\ X_2 + 0.03494\ X_3$

$R = 0.3961$

$R\ Sq. = 0.1569$

The log form equation is:

$\log X_1 = -9.80734 + 1.08048 \log X_2 + 2.26885 \log X_3$

$R = 0.6362$

$R\ Sq. = 0.4047$

In a comparison with the previous results obtained in the analysis of the total production, the coefficients of multiple correlation and of multiple determination shows higher values for the total case (contrary to the previous comparative studies for the whole country and the Pacific region) R = 0.6362 against 0.6950 in the total study; R Sq. = 0.4047 against 0.4830 in the total study. In the Main U.S.A. then, the specialized subsystem conforms less closely to the proposed theory of spatial location than the total production. If, based on the analysis of Chapters III, III.b and V, the proposed theory is accepted as valid, the conclusion then may be that the process of locational specialization is in an intermediate stage in the Main U.S.A., showing imperfections in its actual distribution.

The study of the steps of the computation process shows as in the case of total production that both independent variables--potential demand and climate--are of roughly equal importance in the allocating process in the Main U.S.A.

Step Number	Variable Entered	Multiple R	Multiple R Sq.	Increase in R Sq.
1	log X_3	0.4724	0.2231	0.2231
2	log X_2	0.6362	0.4047	0.1816

While the increase in explanatory power caused by the introduction of log X_2 is practically the same in both the total and the specialized cases--0.1816 against 0.1889--a difference does occur with the introduction of log X_3, where the specialized case shows a lower increase in explanatory power--0.2231 against 0.2941--the climatic variable then is less adjusted in the specialized case than in the total one, as was apparent also in the study of the correlation matrix.

The Standard Error of Estimate is 0.3589, this value being considerably higher than the standard error for the total case (0.2171). This indicates that there is more "dispersion" in the specialized subsystem than in the total one, and this is also visible in the residual pattern of data points. With the hypothesis that the locational specialization is still in process in the Main U.S.A., it is possible to assume that some states might be well ahead in this process while others might be still lagging behind, causing a more dispersed pattern and a lower correlation.

The tabulation of the states' residuals follows almost the same pattern as in the total case, although as was commented, it is now more dispersed. The three important producer states north of the regional boundary of the South, that is Illinois, Indiana and Ohio are now fully in the second negative band of the Standard Error of Estimation; and at the same time the states on the South side, Tennessee, Kentucky, Virginia and North Carolina are in the second and the third positive band of the Standard Error.

Thus the regional boundary is even stronger than it appeared in the case of total production. This characteristic is a good key to explain the lower correlation values and higher dispersion found in the specialized case. It is possible that, as the specialized production tends to use more effectively the existing conditions of demand and climate at the regional boundary, a marginal change in Development Units now causes more important effects than in the total case, producing then a wider gap, a factor that must affect the correlation between the areal revenues and the climate.

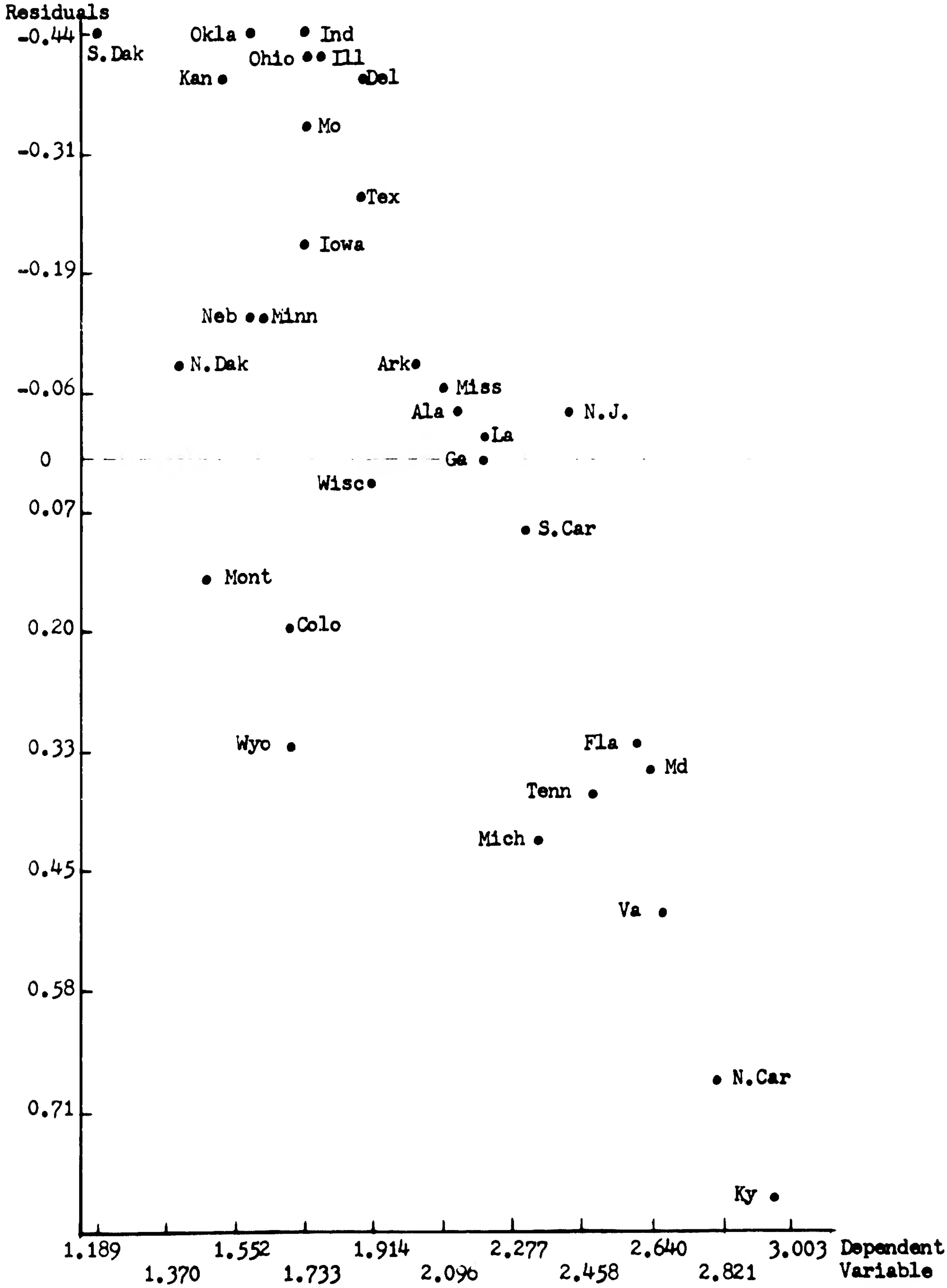
This study of the residuals offers a logical explanation to the lower correlation of areal revenues with climate found in the specialized subsystem in comparison with the total one. It also corroborates the presence of a regional boundary creating two regions, the Center-North and the South, based on the break of the areal revenues surface at a line of non-marginal increases. As a minor difference Maryland appears to be now integrated in the South region, as it has changed its residual pattern from a negative to a positive Standard Error of Estimate.

TABLE T.24 (V.6)

LIST OF RESIDUALS: MAIN U.S.A., FIFTH ROUND OF CORRELATION

	State	Residual	Standard Error of Estimate "band" (SEE = 0.3589)	
9)	Colorado	0.19812		+ 1
10)	Wyoming	0.32968		+ 1
11)	Montana	0.13903		+ 1
12)	North Dakota	-0.08462	- 1	
13)	South Dakota	-0.44303	- 2	
14)	Nebraska	-0.14663	- 1	
15)	Kansas	-0.39134	- 2	
16)	Oklahoma	-0.43519	- 2	
17)	Texas	-0.25263	- 1	
18)	Louisiana	-0.00121	- 1	
19)	Arkansas	-0.08450	- 1	
20)	Missouri	-0.34029	- 1	
21)	Iowa	-0.20645	- 1	
22)	Minnesota	-0.12539	- 1	
23)	Wisconsin	0.05520		+ 1
24)	Illinois	-0.41369	- 2	
25)	Mississippi	-0.06398	- 1	
26)	Alabama	-0.03606	- 1	
27)	Tennessee	0.37153		+ 2
28)	Kentucky	0.81215		+ 3
29)	Indiana	-0.43235	- 2	
30)	Michigan	0.41516		+ 2
31)	Ohio	-0.42480	- 2	
33)	Georgia	0.00993		+ 1
34)	Florida	0.33475		+ 1
35)	South Carolina	0.09129		+ 1
36)	North Carolina	0.67642		+ 2
37)	Virginia	0.51200		+ 2
38)	Maryland	0.34454		+ 1
39)	Delaware	-0.38686	- 2	
40)	New Jersey	-0.02082	- 1	

GRAPH G.7 (V.b): PLOTTING OF RESIDUALS AGAINST THE DEPENDENT VARIABLE IN LOG FORM: FIFTH ROUND OF CORRELATION, MAIN U.S.A.



Sixth Round of Correlation Analysis.

This analysis is similar to the third round, but including only the specialized production. As the residual study of the previous round indicated that the regional boundary is still valid in the specialized subsystem--and even stronger than in the total case--the study will follow the lines of a regional correlation of the Center-North and of the South, with Maryland now shifted to the South. The methods, variables and data are the same as used in the previous two rounds, with 19 observations for the Center-North and 12 for the South.

Center-North Region:

The correlation matrix is as follows, with the relevant coefficients underlined:

Variable Number	1	2	3	4	5	6
1	1.000	0.734	0.018	0.922	0.652	0.031
2		1.000	0.183	0.733	0.963	0.241
3			1.000	0.146	0.251	0.995
4				1.000	0.706	0.158
5					1.000	0.317
6						1.000

In comparison with the correlation matrix of the total case, the specialized subsystem has only slightly lower correlation coefficients. Both independent variables, the potential demand and the climate, keep the same proportional weight in the matrix, that is an overwhelming predominance of correlation with the potential demand; the coefficient of correlation of X_1, with variables of X_2 and X_5 (log X_2) is lower in the specialized case--0.734 against 0.861, and 0.706 against 0.795 in the total case--and the same occurs with the coefficients of X_1 with variables X_3 and X_6 (log X_3)--0.018 against 0.070 and 0.158 against 0.176 in the total case. This shows that the specialized subsystem is consistently and slightly less suited to the distribution of the two independent variables.

The additive form of the equation shows higher correlation than the log form, and this again repeats the results of the analysis in the total case.

The additive form equation is:

$X_1 = 25.68538 + 0.15665\ X_2 - 0.00612\ X_3$

$R = 0.7436$

R Sq. = 0.5530

The log form equation is:

$\log X_1 = 0.20019 + 0.99613 \log X_2 - 0.29998 \log X_3$

$R = 0.7090$

R Sq. = 0.5027

Even if the correlation is slightly lower than in the case of total production, still the equation has good explanatory power. The predominant role of the potential demand variable can be seen in the study of the computational steps, for the additive form.

Step Number	Variable Entered	Multiple R	Multiple R Sq.	Increase in R Sq.
1	X_2	0.7340	0.5388	0.5388
2	X_3	0.7436	0.5530	0.0142

The resulting Standard Error of Estimate is in the specialized case of 45.5026, more than double the Standard Error in the total case--20.5064--showing the tendency toward a greater dispersion of the data points, as was observed in the analysis of the Main U.S.A. The dispersion pattern of the states' deviation is practically the same as in the total case, with the exception that Michigan has increased from the "band" of one positive Standard Error to the "band" of three, showing that specialization has increased the areal revenues more than in the rest of the country.

South Region:

The correlation matrix results as follows, with the relevant coefficients underlined:

Variable Number	1	2	3	4	5	6
1	1.000	0.498	-0.496	0.958	0.533	-0.530
2		1.000	-0.805	0.562	0.988	-0.827
3			1.000	-0.477	-0.878	0.998
4				1.000	0.583	-0.520
5					1.000	-0.895
6						1.000

The South appears to be the region with lowest degree of correlation in both forms of equation. This is true in the analysis of the specialized subsystem, where the correlation coefficients between the dependent variable of areal revenues X_1 and the climatic variable X_3 and X_6 (log X_3) are negative in the additive and the log form. It is also the only region that has a different "best-fit" form of equation for the total and the specialized analysis; in the last the log form is better, contrary to the total case where the additive form was found to have higher explanatory powers. According to the correlation matrix, the only important variable is the demand potential for the specialized subsystem.

The additive form equation is:

$X_1 = 627.48741 + 0.42527 X_2 - 0.05424 X_3$

$R = 0.5234$

$R\ Sq. = 0.2739$

The log form equation is:

$\log X_1 = -1.83739 + 1.56134 \log X_2$

$R = 0.5833$

$R\ Sq. = 0.3402$

(the F-level is insufficient for computation of the log X_3 variable)

In comparison with the additive equation of the total case, the log equation of the specialized subsystem has slightly lower coefficients; R = 0.5833 against 0.6174 in the total; R Sq. = 0.3402 against 0.3812 in the total.

The Standard Error of Estimate is now 0.2634.

As a result the South appears to be the most imperfect region, both in the total case and in the specialized case. It is tempting to recall the well-known characterizations of this region as a backward, low-income area.[3]

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[3] In William Warntz's Macrogeography and Income Fronts, the same South region was found to have consistently lower income per capita than the rest of the nation, in a correlation with the Income Population Potential

Regional Boundaries

A boundary study is necessary in order to corroborate the existence of regional boundaries in the specialized subsystem. The previous rounds of correlation analysis have been based on a regional structure that is similar in the total and in the specialized subsystem. The verification involves the repetition of the process used previously for the regional structure in the total production case (Chapter III.3b); that is, the estimation of the areal revenue differentials on each border between states. Thus, it will be clear where the areal revenue surface changes slope or suffers a "break" in its continuity.

Following is a table with the border differential values, as well as a mapping of the differentials in the national space. The similarities with the boundary study in the total case are striking: there is an increase in the values--as well as a reversion of the slope direction--along the Pacific regional boundary. There is a noticeable break along the South regional boundary--sharper than in the total case--and a continuation of the high border values inside the South, with a levelling around Alabama and Georgia. The only exception, already noticed in the residual analysis, is that Maryland has become part of the South region. This is

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values. Warntz's "Income Front" exactly follows the "Regional Boundary" found in the present study defining the South region. As a matter of fact, the Pacific region was also significant for Warntz, as it was found to be an area of higher level of income per capita, again in a correlation with the potential demand. This is in conformity with our findings of a separate market with higher values in the areal revenues (rent) surface, and with an advanced process of localizational specialization in agriculture.

not surprising, as this state has been participating in both regions' characteristics, and is practically over the boundary.

As a result, the boundary study confirms the regional structure adopted in the correlation analysis similar to that of the total case.

TABLE T.25 (V.b)

BOUNDARY STUDY: DIFFERENTIAL AREAL REVENUES FOR SPECIALIZED AGRICULTURAL PRODUCTION AT STATES' BORDERS, U.S.A., 1959

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1					3																			
2			182		1																			
3							13																	
4																								
5						36				71	76													
6							135		87	87														
7								105																
8									117							127	94							
9										1				6	16	10								
10											21		35	7										
11												5												
12													10									13		
13														28								23		
14															9						9			
15																6				21				
16																	33		66					
17																		82	32					
18																								
19																				50				
20																					1			4
21																						16		5
22																							43	
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Pacific region — Pacific/Main USA boundary — Main USA

TABLE T.25 (V.b) -- Continued

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
1																								
2																								
3																								
4																								
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18	26																							
19	23		200																					
20			250	870																				
21																								
22																								
23						143																		
24				866	6																			
25		7	177																					
26			169						28	256														
27				620					141			352	161											
28					871		869						459											
29						171	2																	
30							169																	
31																								
32																								
33										227	33													
34																								
35												459												
36					Main USA								191											
37														18										
38															369	184								
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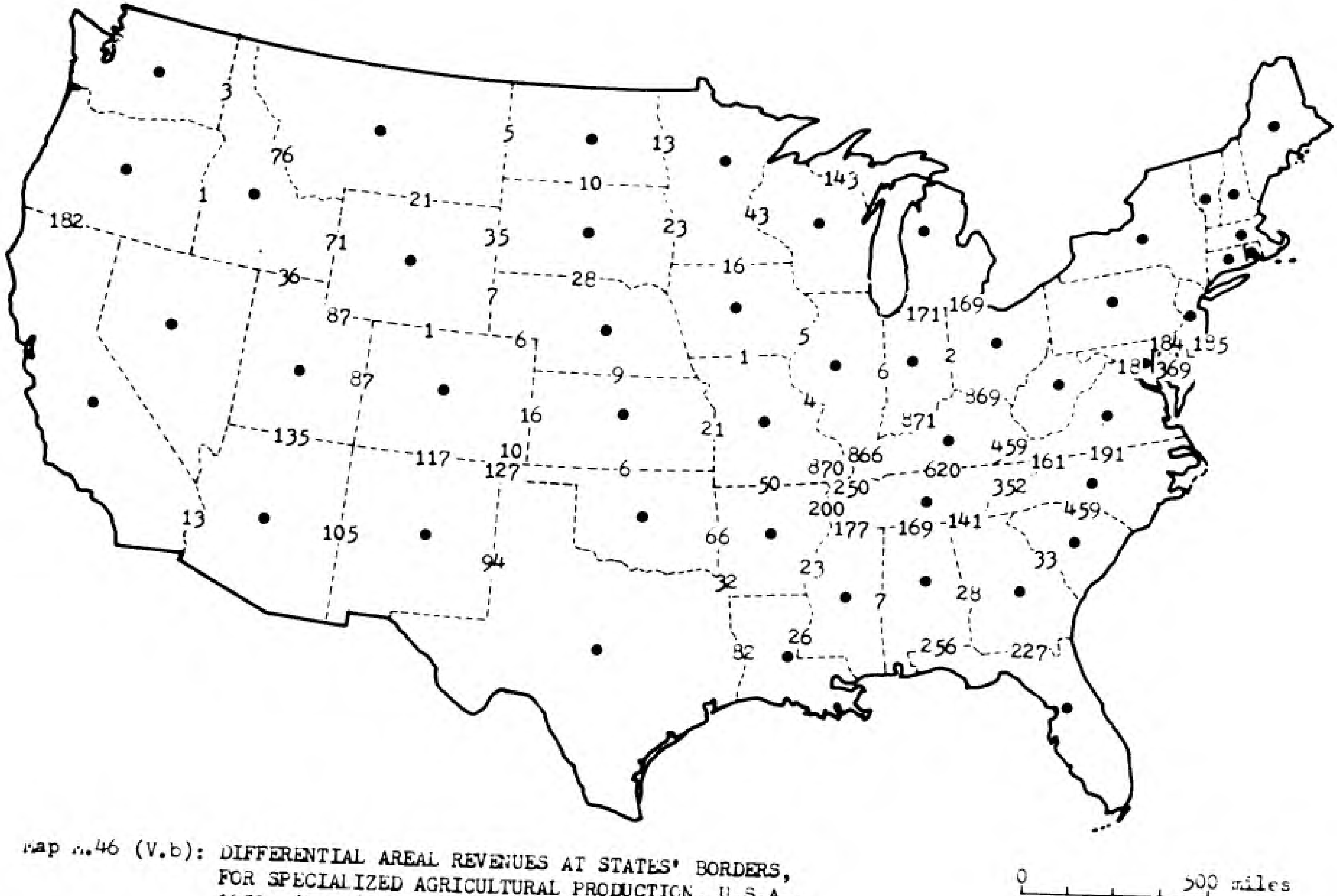


Map ..46 (V.b): DIFFERENTIAL AREAL REVENUES AT STATES' BORDERS, FOR SPECIALIZED AGRICULTURAL PRODUCTION, U.S.A., 1959 (in $/acre)

2b. Efficiency and Specialization

The hypothesis that locational specialization causes an increase of efficiency in the agricultural land use system, must also be proved empirically. The basic analysis should determine if the levels of areal revenues (rent) are higher in conditions of locational specialization than otherwise. The adopted method is a comparative study between the Areal Revenues of the specialized production and the Areal Revenues of the total production, for the corresponding crop mix, by states. This would determine if the specialized subsystem is causing higher values than the total system--confirming the hypothesis.

The study will use the mapping of the two areal revenue levels, M.20 (II.b) and M.45 (II.b), as well as a state-by-state analysis to obtain the corresponding difference for each state. The following tabulation includes the absolute and relative differentials, obtained by deducing the Total Areal Revenue value from the Specialized one, for each state. Thus, a positive result will mean that the Areal Revenue in the Specialized subsystem is higher than in the total system.

The relative increases in Areal Revenues caused by the Specialization process are mapped after the tabulation.

TABLE T.26 (V.b)

ABSOLUTE AND RELATIVE INCREASE OF THE SPECIALIZED AREAL REVENUES OVER THE TOTAL AREAL REVENUES, U.S.A., 1959

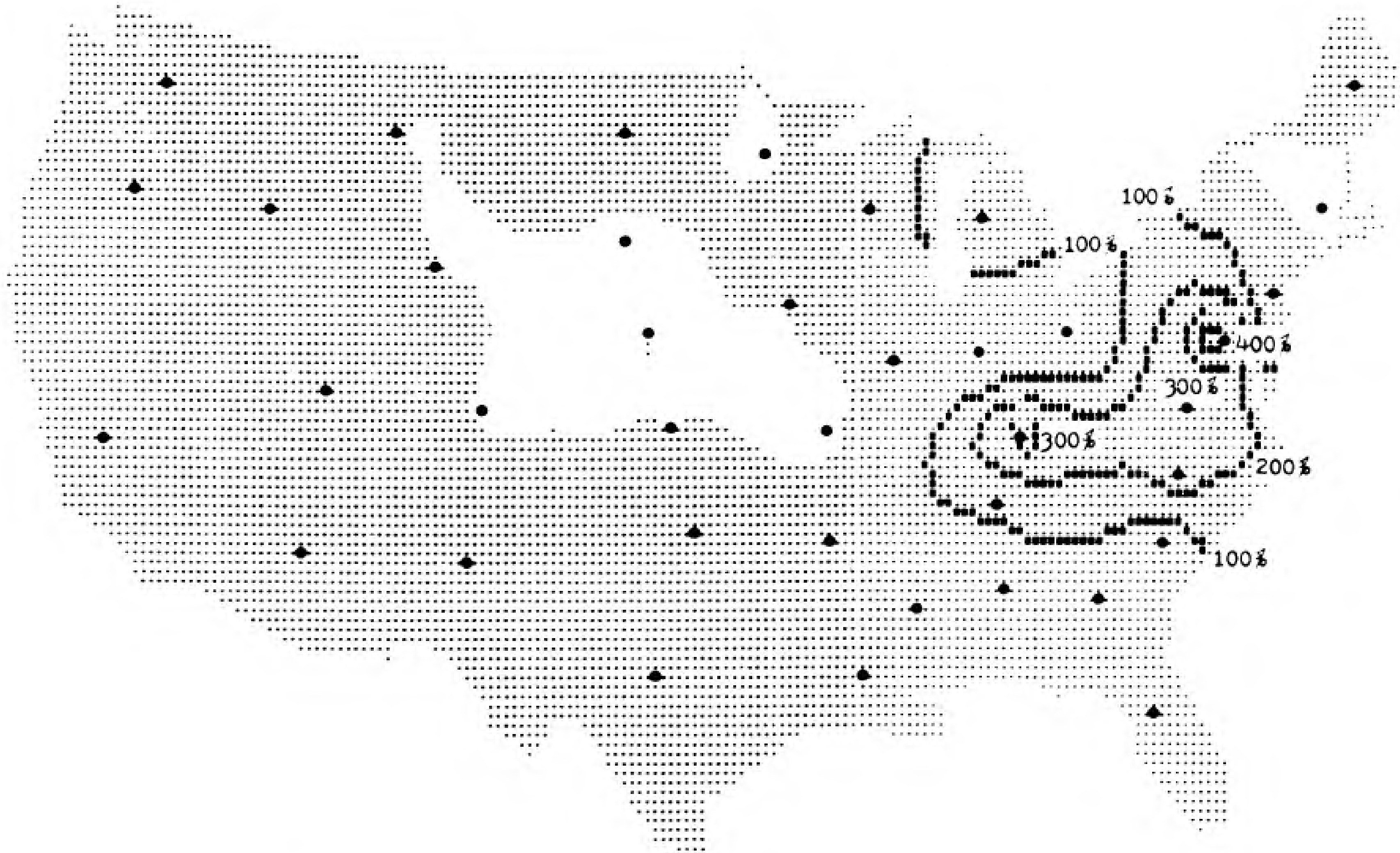
(positive differences indicate specialized Areal Revenues higher than total)

State	Revenues per Area ($/acre)		Difference	
	Total Crops	Specialized Crops	Net $/acre	%
1) Washington	95.93	98.36	2.43	3
2) Oregon	101.98	103.15	1.17	1
3) California	250.03	285.11	35.08	14
4) Nevada	75.10	-	-	-
5) Idaho	100.22	101.75	1.53	2
6) Utah	78.50	137.40	58.90	75
7) Arizona	255.02	272.48	17.46	7
8) New Mexico	121.16	167.11	45.95	38
9) Colorado	50.35	49.93	- 0.42	- 1
10) Wyoming	50.79	50.79	0.00	0
11) Montana	30.26	30.26	0.00	0
12) North Dakota	23.96	25.30	1.34	6
13) South Dakota	15.67	15.45	- 0.22	- 1
14) Nebraska	43.44	43.44	0.00	0
15) Kansas	34.10	34.13	0.03	0
16) Oklahoma	39.15	39.84	0.69	2
17) Texas	63.16	73.13	9.97	16
18) Louisiana	121.60	154.73	33.13	27
19) Arkansas	102.25	105.46	3.21	3
20) Missouri	55.64	55.25	- 0.39	- 1
21) Iowa	54.55	54.75	0.20	0
22) Minnesota	39.25	38.76	- 0.49	- 1
23) Wisconsin	67.88	81.81	13.93	21
24) Illinois	58.73	59.53	0.80	1

TABLE T.26 (V.b)--Continued

State	Revenues per Area ($/acre)		Difference	
	Total Crops	Specialized Crops	Net $/acre	%
25) Mississippi	115.73	128.44	12.71	11
26) Alabama	84.21	135.83	51.62	61
27) Tennessee	146.60	305.04	158.44	108
28) Kentucky	226.17	925.31	699.14	309
29) Indiana	56.57	53.86	- 2.71	- 5
30) Michigan	76.02	225.11	149.09	196
31) Ohio	58.46	55.94	- 2.52	- 4
32) West Virginia	208.00	-	-	-
33) Georgia	90.48	164.27	73.79	82
34) Florida	339.70	391.73	52.03	15
35) South Carolina	121.91	197.38	75.47	62
36) North Carolina	200.28	656.71	456.43	228
37) Virginia	142.30	466.17	323.87	228
38) Maryland	82.91	447.80	364.89	440
39) Delaware	69.17	78.67	9.50	14
40) New Jersey	193.19	263.92	70.73	37
41) Pennsylvania	97.45	-	-	-
42) New York	131.64	-	-	-
43) Connecticut	804.11	-	-	-
44) Rhode Island	-	-	-	-
45) Massachusetts	475.14	385.69	-89.45	-19
46) Vermont	305.71	-	-	-
47) New Hampshire	333.82	-	-	-
48) Maine	293.54	367.04	73.50	25

Source: Author's own estimation.



Map M.47 (V.b): RELATIVE INCREASE OF SPECIALIZED OVER TOTAL AREAL REVENUES, 1959

A comparison of the national revenues per area, of total production and of specialized production, shows that indeed, the areal revenues (rent) are higher in the specialized case. The 100 $/acre revenue line that overlaps with the "boundary" separating the South region from the Main U.S.A. in the total case, has shifted slightly towards the north and northwest; the 100 $/acre line on the Pacific "boundary" has noticeably shifted toward the east; as a result there is a reduction of the area below the 100 $/acre level. Even more marked is the increase in the values of the peaks: the South peak has increased from 226 to 925 $/acre, and the Pacific has increased from a ridge of 250-255 to a ridge of 272-285 $/acre. The peak around New York Metropolitan Area, that is the high value of Connecticut in the total case, does not appear because the surrounding states do not show any specialization index, but the individual comparison of neighboring values shows that they also increase correspondingly--New Jersey rises from 193 to 264 $/acre.

The analysis of the mapping showing the percentage increase in the areal revenues indicates that the country has experimented a consistent increase, with the exception of a group of central states--Colorado, South Dakota, Missouri, Minnesota, Indiana and Ohio--although their negative difference is seldom more than one percent. The rest of the country experiences remarkable increases: there is a wide plateau ranging from zero up to 50%, that covers from the Pacific to the South, from there positive percentages increase up to a high peak over the regional boundary with the South--on Maryland with more than 400% differential increase.

As is expected, Massachusetts, that was so benefited in a case of "monopolistic" location,[4] is the only state experiencing a decrease of near 20% in the specialized case.

<u>The conclusion is that locational specialization increases the values of the areal revenues in practically the whole country</u>.

The analysis of the tabulated states' areal revenues shows that for practically all of them there is a positive differencial in the specialized case. Only 7 out of 40 do not show this difference, but it is important to notice that only Massachusetts has an important negative reduction, of 89.45 $/acre--from 475.14 down to 285.69 $/acre.

In the other negative cases, 4 states have very small differentials (Colorado, South Dakota, Missouri and Minnesota) ranging from 0.22 to 0.49 $/acre; while the other two show small but not negligible differentials (Indiana and Ohio) ranging from 2.71 to 2.52 $/acre.

Of the 33 states having positive differentials, 3 are actually balanced on zero (Wyoming, Montana and Nebraska) while the other 30 have positive differentials ranging from 0.03 in Kansas to 699.14 $/acre in Kentucky.

In relative terms, the four negligibly negative states have a 1% decrease, Indiana and Ohio show between a 4 and 5% decrease, and Massachusetts has a 19% decrease. The increases range between the states with no change to 440% increase in Maryland and 309% in Kentucky. The mapping of the percentage differentials between total and specialized areal revenues shows that the central plains, with zero or a small negative change, have

[4] See Chapter III.2 and 2b.

also lower areal revenue values. In the South region, the relative increase up to a peak of 400% follows the higher values of areal revenues. With a few exceptions then, there is an increase in the revenues per area in the country when only the specialized production is accounted for; and furthermore, the relative increases tend to be directly proportional to the areal revenue values. Clearly, the higher areal revenues of the specialized subsystem originate in a better adaptation to the economic and climatic conditions of the national space. The study of the relative differentials of each state is not so simple, because it is not known, at this moment, in which stage of the specialization process each is. An example will clarify this: a state completely specialized will show no difference between areal revenues of total and specialized production, but neither will a state with little specialization; nevertheless, the "zero differential" condition has opposite meanings, the first case indicates that the state is near the optimum of economic efficiency, while the other indicates that the state is in a pre-specialization stage.

A better understanding of the structure of each state is given by the individual tables of production and revenues, where "inefficiency" will be--tentatively--shown by low areal revenue-earner crops located higher in the production index (except for the case of ubiquitous production, as will be defined and studied in Chapter V.3).

The following table shows the ranking data by states, selecting the twenty highest increases in areal revenues due to specialization. From this, it is clear that out of twenty, there is a high proportion of Southern and Pacific states. If the criterion of absolute increases is used, 11 South states and 4 of the Pacific appear in the list. If the criterion of relative increases is used, again the 11 South states and 3 of the Pacific appear. Of the Center-North region, Michigan, New York, Wisconsin and Delaware appear in both tables. Although no formal correlation analysis has been made, it is striking that the states experiencing highest increases with locational specialization are those that show highest areal revenues.

TABLE T.27 (V.b)

RANKING OF THE STATES WITH HIGHEST GAINS IN THE SPECIALIZED OVER THE TOTAL AREAL REVENUES, U.S.A., 1959

State	Absolute Increase ($/acre)	State	Relative Increase %
28) Kentucky	699	38) Maryland	440
36) North Carolina	456	28) Kentucky	309
38) Maryland	365	36) North Carolina	228
37) Virginia	323	37) Virginia	228
27) Tennessee	158	30) Michigan	196
30) Michigan	149	27) Tennessee	108
35) South Carolina	75	33) Georgia	82
33) Georgia	74	6) Utah	75
48) Maine	74	35) South Carolina	62
40) New Jersey	71	26) Alabama	61
6) Utah	59	8) New Mexico	38
34) Florida	52	40) New Jersey	37
26) Alabama	52	18) Louisiana	27
8) New Mexico	46	48) Maine	25
3) California	35	23) Wisconsin	21
18) Louisiana	33	17) Texas	16
7) Arizona	17	34) Florida	15
23) Wisconsin	14	3) California	14
25) Mississippi	13	39) Delaware	14
39) Delaware	10	25) Mississippi	11

Source: Table T.26 (V.b).

3b. Crop Typology

The process of locational specialization is conditioned by the tendency of each crop to follow it, that can be summarized, as was mentioned, in the Crop Typology.

In order to study the 15 selected crops in the U.S. in terms of the criteria of Specialized vs. Ubiquitous, and Concentrated vs. Dispersed, it is necessary to tabulate some basic information.

The following table includes, for each crop, the number of states where the total production is grown; the number of states where the specialized production is grown; and the percentage of specialized production out of total production.

The graph actually shows the path of each crop, from the total distribution to the specialized distribution pattern. The X-axis quantify the number of states where both total and specialized production are grown, while the y-axis quantify the percentage of each one out of total production (clearly the points corresponding to total production will be on the 100% ordenade). The two positions for each crop indicate the total production--100% on the y-axis--for the states where grown, and secondly, the specialized production--always less than 100%--for the states where grown. Clearly, the more states involved in the production, the more dispersed the crop is; and the higher the percentage a specialized crop has out of total production, the more specialized the crop is. As a result, in a comparative study, higher values on the y-axis indicate higher specialization, lower ones indicate higher ubiquity; higher values on the x-axis indicate higher dispersion, lower ones indicate higher concentration.

These criteria of the typological analysis are relative, being meaningful when used in a comparative analysis.

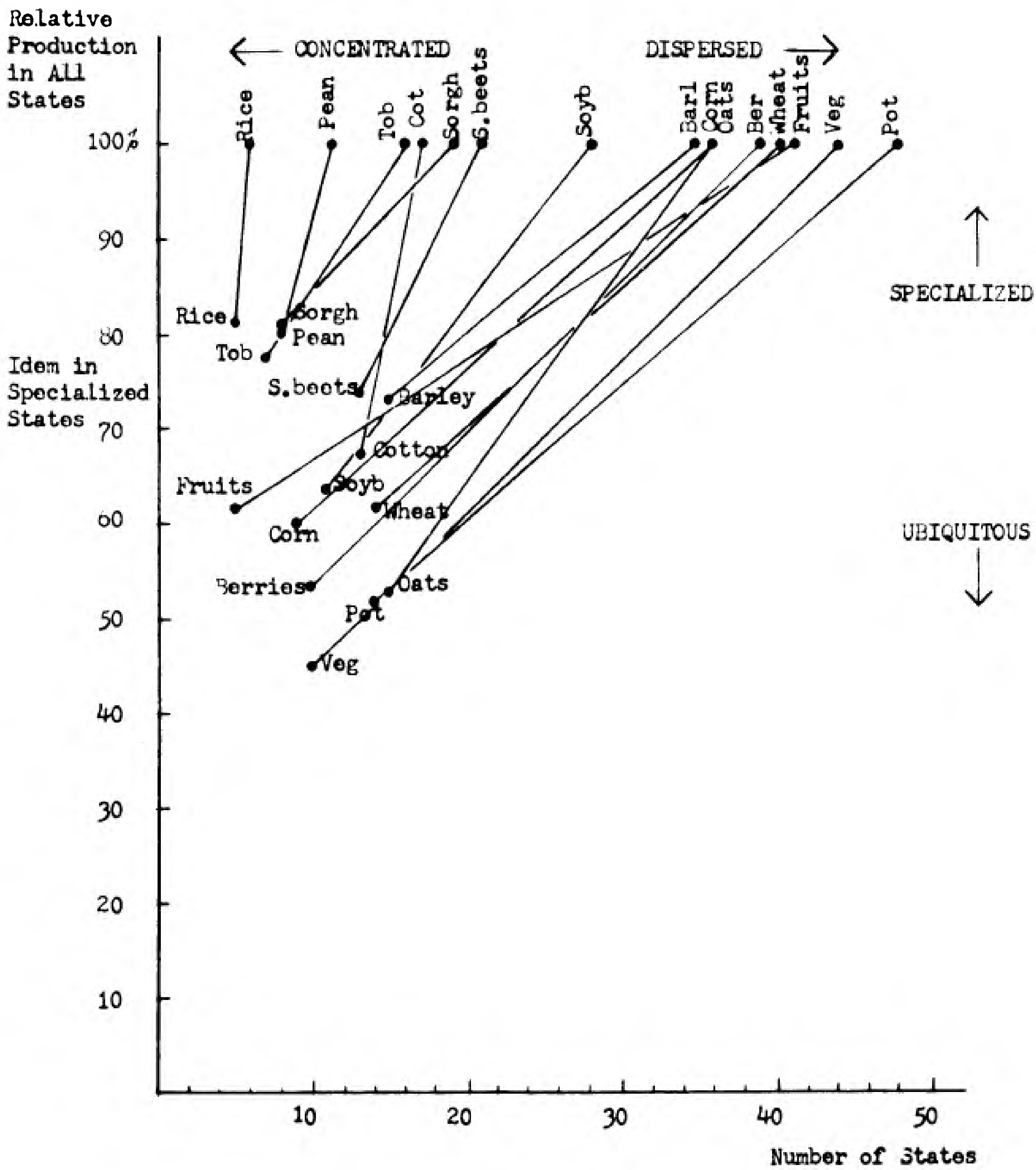
TABLE T.28 (V.b)

SPECIALIZATION AND CONCENTRATION OF 15 SELECTED CROPS, BY NUMBER OF STATES WHERE PRODUCED, BY PERCENTAGE OF TOTAL PRODUCTION, U.S.A., 1959

Crop	States where produced (total)	Specialized States	Percentage of Specialized Production, out of total
Corn	36	9	60.20 %
Sorghum	19	8	81.54
Wheat	40	14	61.71
Oats	36	15	52.70
Barley	35	15	73.11
Rice	6	5	81.60
Soybeans	28	11	63.81
Peanuts	11	8	80.66
Cotton	17	13	67.34
Tobacco	16	7	77.73
Sugarbeets	21	13	74.00
Irish Potatoes	48	14	52.01
Vegetables	44	10	45.33
Berries	39	10	53.56
Fruits	41	5	61.84

Source: Author's own estimation.

GRAPH G.8 (V.b): CROP TYPOLOGY



It is possible to apply now these criteria to define the typology of the different crops. From the point of view of Specialization, rice, sorghum, peanuts and tobacco are the highest, with over 3/4 of the total production specialized; then sugarbeets, barley, cotton, soybeans, wheat, fruits and corn, with over 60% (but less than 75%) of the total production oriented to the national market; and finally berries, oats, potatoes and vegetables, with over 45% (but less than 60%) of the total production specialized. This result is logical according to the theoretical considerations mentioned in this chapter (V.3); in the final group, three out of the four "specialized" crops have within the national space minimum climatic threshold (rice, peanuts and tobacco). On the other end, three out of the four "ubiquitous" crops are of the "fresh produce" class (berries, potatoes, vegetables).

There are two cases that need further comment: cotton is among the intermediate group, while it might have been expected to be found in the first group due to its climatic constraint; fruits is also in the intermediate group, while the expectations might have been to find it in the last group, with the other "fresh" produce. In the case of cotton, it has shown a rather imperfect behavior throughout the study--following only the pure geographic limit--so it is logical that its behavior is reflected in a reduction of its specialization index. In the case of fruit, the possibility of a successful competitive position reached by the California, Florida and other specialized states growers, suggests that important inroads occurred in the "fresh" local markets, due to lower costs of the higher quality processed produce.

In terms of Concentration of the total production: rice, peanuts, tobacco, cotton, sorghum and sugarbeets are the highest, with production in less than 1/2 of the states of the country; then soybeans, barley, oats and corn, with cultivation in less than 3/4 (but more than 1/2) of the states of the country; and finally berries, wheat, vegetables and potatoes with cultivation in more than 3/4 of the states. In terms of concentration of the specialized production, rice, tobacco, peanuts, sorghum and also fruits (but not cotton and sugarbeets) are the highest, with cultivation in less than 8 states; then corn, berries, vegetables and soybeans, with cultivation in less than 12 (but more than 8) states; and finally, cotton, sugarbeets, potatoes, wheat, barley and oats, with cultivation in more than 12 states (though less than 15).

Considering now the slope of the path of each state, from the total to the specialized production, it is noticeable that they are quite similar, with the qualification that highly specialized and concentrated crops (rice, peanuts) have a steeper slope. Again, an exception is cotton that has either too little specialization for the number of states under cultivation, or too many states under specialized production for the index of specialization shown.

4b. Agricultural Specialized Zones

Using the table T.19 (IV.b) that provides the specialized locational distribution coefficient for 48 states and the 15 selected crops, it is possible to map those productions [see Maps M.31 to M.44 (IV.b)] to obtain the areal distribution pattern of the specialized subsystem, by crops. It must be noticed that only positive coefficients will be mapped, showing the "export surplus"; but it would be equally possible to map the negative ones showing the "import deficits" of the country, for each crop.

The definition of the specialized coefficient will tend to reduce the importance of the populous states as well as to increase it for the sparsely populated ones. An example would help to clarify this fact: the states of Texas and Colorado produce about the same quantities of wheat, the coefficient of the first being 4.88 and 4.70 for the second one; but their population weight is different, Texas having a high 5.3 weight against a 1.00 for Colorado. As a result, while Texas has a negative -0.42 coefficient of Specialized Locational Distribution, Colorado has a positive 3.70. The implication is that in the total production mapping both states are approximately at the same level, but in the specialized one, Texas does not appear.

The mappings of the locational distribution of the specialized subsystem can be compared with the previous charts of the total system (Chapter II.1b). Although in general, there is a similarity in the agricultural "zones" defined by the two criteria, there are cases where populous states disappear and sparsely populated ones appear in the specialized mapping. It is noticeable that the climatically constrained crops (rice, peanuts, cotton, and tobacco) tend to show minimum changes; and, very generally, the more specialized a crop is the less change between the two mappings there tends to occur, which is a reasonable proposition, as the specialized subsystem in this case increasingly becomes the dominant part of the total system.

TABLE T.29 (V.b)

DIFFERENTIAL STATES BETWEEN THE SPECIALIZED AND THE TOTAL LOCATIONAL DISTRIBUTION OF AGRICULTURAL PRODUCTION U.S.A., 1959 [a]

Crop	States Eliminated in the Specialized Mapping	States Added in the Specialized Mapping
Corn	Wisconsin, Michigan	South Dakota
Sorghum	California	Arizona, New Mexico, Colorado
Wheat	Texas, Illinois, Indiana, Michigan, Ohio	Wyoming, South Dakota
Oats	Texas, Michigan, Ohio, New York	Washington, Oregon, Idaho, Wyoming, Montana
Barley	- - -	Nevada, Wyoming, South Dakota, Nebraska
Rice	Missouri	- - -
Soybeans	- - -	North Dakota, Kansas
Peanuts	- - -	New Mexico
Cotton	North Carolina	- - -
Tobacco	Pennsylvania	- - -
Sugarbeets	Ohio	South Dakota
Potatoes	Michigan, Pennsylvania, New York	Nevada, Wyoming, Montana, Nebraska
Vegetables	Texas, Illinois, Michigan, Ohio, New York	Idaho, Colorado, Delaware
Berries	New York	- - -
Fruits	Michigan, New York	Idaho

[a]The total distribution mappings show only states with a Locational distribution coefficient of 2.00 or more, to simplify the picture and avoid areas with negligible surplus production.

Zonal Typology

One of the most rewarding analyses was found to be the recognition of the different "types" of productive zones that could exist in the national space, and their effects on the policy-making process. For this reason, the agricultural zones are now studied from the point of view of of their typology. The first step is to determine the maximum difference between 2 given points, in the Potential Demand and in the Climatic model, within each agricultural zone. As the determination of the "range" within which the two variables are assumed constant is arbitrary, it is essential to select them in relationship with the rest of the values; implying, for example, that the smallest set of differentials will be the "range of constancy."

Once the differentials for the 15 basic productive zones are estimated and compared, it will be possible to establish the typology of each, according to the definition of table T.22 (V). This will be done in a graph, plotting potential demand differentials on the x-axis and climate differentials on the y-axis.

The study could be done for the total or the specialized subsystem. In this case, the last one is chosen , to represent the production purely oriented to the national market.

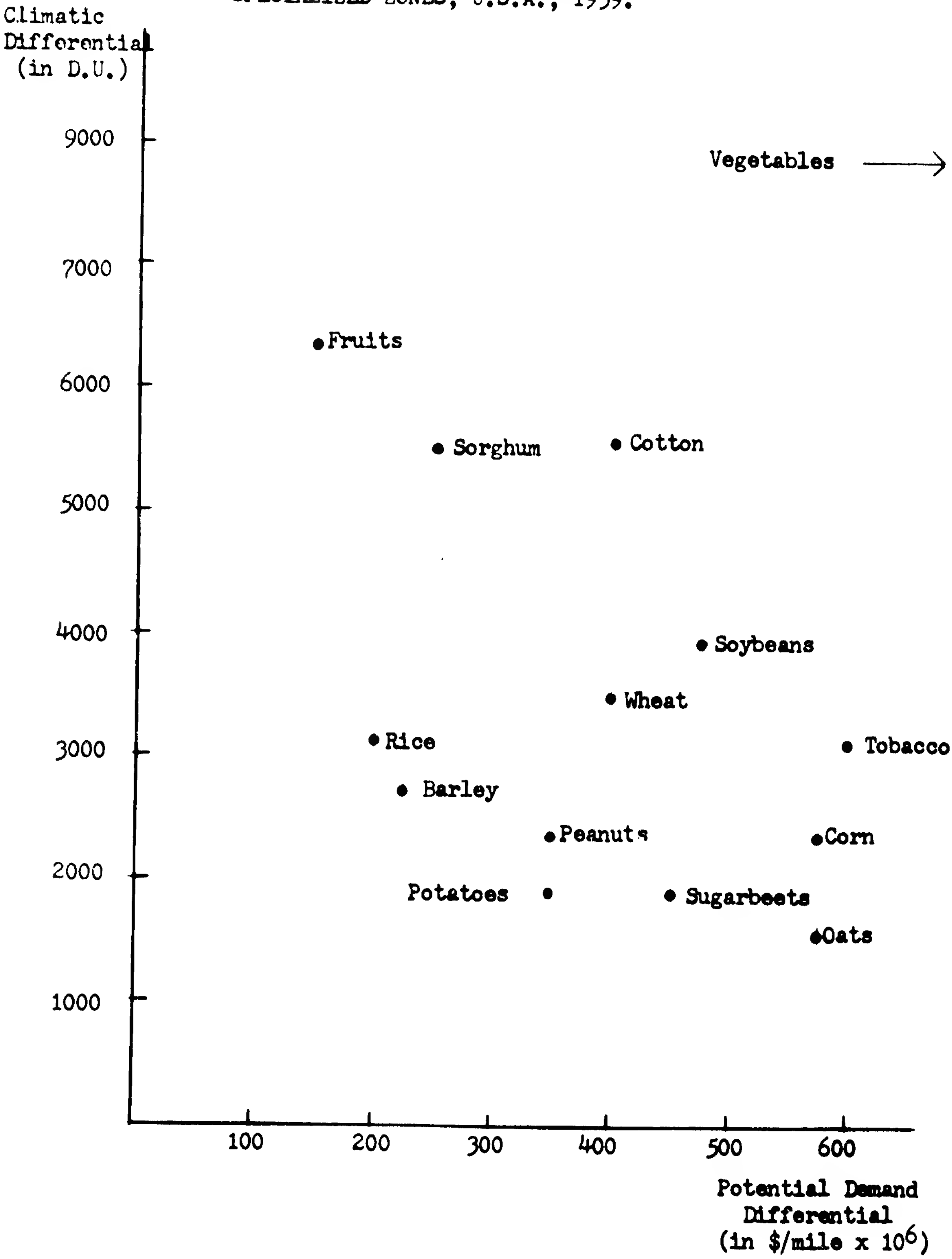
TABLE T.30 (V.b)

MAXIMUM DIFFERENTIALS IN THE POTENTIAL DEMAND AND IN THE CLIMATIC MODELS, FOR EACH OF THE 15 BASIC AGRICULTURAL SPECIALIZED ZONES, U.S.A., 1959

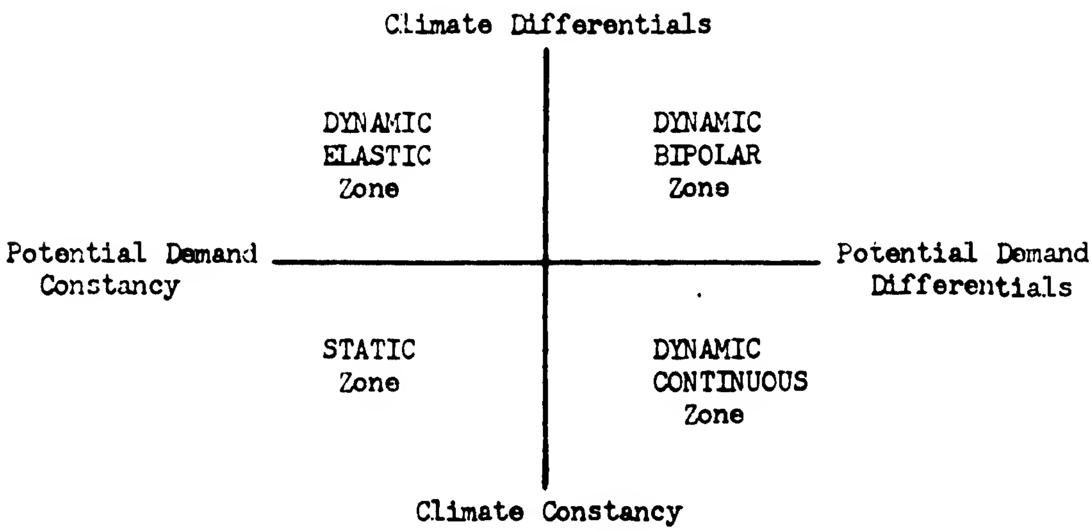
Crop	Maximum Differentials in Climate (D.U.)	Maximum Differentials in Potential Demand ($/mile x 10^6)
Corn	2,370	575
Sorghum	5,500	250
Wheat	3,510	400
Oats	1,570	575
Barley	2,730	225
Rice	3,140	200
Soybeans	3,950	475
Peanuts	2,380	350
Cotton	5,540	400
Tobacco	3,180	600
Sugarbeets	1,930	450
Potatoes	1,930	350
Vegetables	7,910	1,200
Berries	-	-
Fruits	6,350	150

Source: estimated by the author.

GRAPH G.9 (V.b): MAXIMUM DIFFERENTIALS IN THE POTENTIAL DEMAND AND IN THE CLIMATIC MODELS FOR EACH OF THE AGRICULTURAL SPECIALIZED ZONES, U.S.A., 1959.



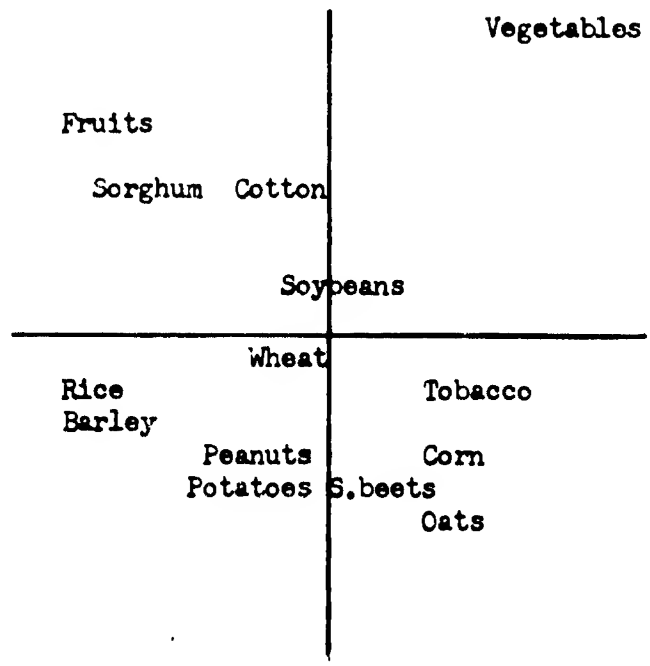
It is necessary now to assign relative ranges of constancy or variability, so as to qualify the lower differentials in the two models as constant and the higher ones as variable. In summary, the criteria used are explained in the following diagram, where the name of each of the four types of zone is also indicated.



It is possible now, based on relative criteria, to assign the 14 specialized agricultural areas a typology--with the understanding that no pure type exists in the real world.

GRAPH G.10 (Vb):

ZONAL TYPOLOGY FOR 14 SELECTED AGRICULTURAL SPECIALIZED ZONES, U.S.A., 1959



The analysis of the graph is based on the assumption that, given the distribution of points in the Graph G.9 (V.b), half of the points have a larger than normal differential and half a smaller than normal one, in both models. As a result, some crops are clearly in one single "type" while others fall rather in mixed categories.

Shifts in a Time Period

The study of the shifts of the agricultural zones in historical times in the U.S.A. is beyond the aims of the present study. A good understanding of the internal dynamics of this country, since the age of the thirteen colonies, through the Louisiana Purchase and the expansion to the West, to the era of industrialization and urbanization, may be obtained from the excellent "Regions, Resources and Economic Growth."[5] It is clear that the location of agricultural zones has changed according to the dis-

[5] op.cit.

tribution of demand market in the country, and also according to the cost of economic distance.

It is nevertheless possible, within the realm of the present study, to show the existence of regional shifts even in short time periods. The method followed was to obtain from the U.S. Census of Agriculture the ratios of the acreages in 1959 to the acreages in 1954 for the selected crops and the 48 states. In a lapse of 5 years there have been noticeable shifts, represented by the difference between states showing the highest percentage of gains in acreage and those showing the highest Total and/or Specialized Distribution coefficients. This obviously assumes that if the zones were static in time, the states with higher production in a given crop would show higher gains in acreage under cultivation, as well. Furthermore, it is assumed that the higher gain indicates the shift trend of the zone, for the given time period.

As an example of an analytical method, there are tabulations with the exact percentages for one crop, corn.

TABLE T.31 (V.b)

RELATIVE CHANGES IN THE ACREAGE UNDER CULTIVATION FOR CORN, U.S.A., 1959-1954

State	Acreage % 59/54	State	Acreage % 59/54
U. S. A.	101.9		
1) Washington	235.5	25) Mississippi	70.7
2) Oregon	187.8	26) Alabama	80.7
3) California	179.1	27) Tennessee	77.0
4) Nevada	137.0	28) Kentucky	84.1
5) Idaho	176.8	29) Indiana	106.5
6) Utah	119.4	30) Michigan	104.6
7) Arizona	107.3	31) Ohio	100.9
8) New Mexico	84.6	32) West Virginia	63.0
9) Colorado	119.9	33) Georgia	88.0
10) Wyoming	110.1	34) Florida	92.7
11) Montana	70.6	35) South Carolina	73.9
12) North Dakota	106.9	36) North Carolina	89.3
13) South Dakota	102.2	37) Virginia	83.0
14) Nebraska	99.4	38) Maryland	92.7
15) Kansas	91.9	39) Delaware	87.2
16) Oklahoma	76.7	40) New Jersey	74.1
17) Texas	77.0	41) Pennsylvania	88.9
18) Louisiana	65.4	42) New York	87.4
19) Arkansas	53.4	43) Connecticut	89.4
20) Missouri	102.7	44) Rhode Island	76.9
21) Iowa	120.8	45) Massachusetts	88.3
22) Minnesota	127.6	46) Vermont	80.7
23) Wisconsin	108.4	47) New Hampshire	89.6
24) Illinois	111.2	48) Maine	83.3

Source: U.S. Census of Agriculture, 1959.

Commenting briefly on this crop, and understanding that ratios over 100 indicate that the state incorporated land to the cultivation of corn, if the zone were stable, the states with larger gains should be the states with highest production. Otherwise, there is an indication of a locational shift in the period 1954-59. The first impression is that all but one of the specialized states have also ratios of 100 or over, the exception being Kansas (91.9). Furthermore, the two states with high total distribution coefficients, but without positive specialization index, Michigan and Wisconsin, also show ratios higher than 100. On the other hand, the group of states in the Pacific region have all of them ratios higher than 100, but in the distribution indexes show either small or almost zero values. The conclusion is that the corn zone has been basically stable in the five-year period under study, but that there is a slight trend to move north--indicated in the reduction in Kansas and in the increases in Michigan and Wisconsin. This shift is coherent with the shift of the potential demand model, where the isopotential lines in the area have moved to the north due to the general increase of values. The Pacific region increments in acreage actually affect relatively small amounts of production, so that the net increase in the region's demand can cause a noticeable increase in the percentages, because they are estimated over small acreages. It must be remembered that not all shifts shown in a five-year period would necessarily correspond to a long-term pervasive trend.

SUMMARY AND CONCLUSIONS

This research intends to widen the theoretical field of Location and Rent Theories and to enrich it with the results of empirical studies. Throughout the study, a feedback between theory and empirical analysis has been the source of new hypotheses. Agricultural production and the corresponding land use was the sector under study.

A first consideration is the importance of the environment, as different stages in the development of a country would lead to different spatial distributions of production. Strictly, the proposed set of theories included in the present work are the result of introducing the new regional parameters into the theoretical model of classical Rent Theory.

The process of regional development follows well defined paths: the "polystathmic" model corresponds to the Theory of Regional Growth while the "monostathmic" model corresponds to the Theory of the Economic Base. In this latter one, a process of national colonialism can shape frontier regions producing export commodities without experiencing previous stages of small autonomous regions, i.e., literally jumping stages. The well known work of von Thunen corresponds clearly to stages of development earlier than the actual stage of integrated economies, such as the case study, the USA.

The problem is then, the introduction of the new characteristics of an integrated economy into classical Rent Theory. The two main characteristics are: first, the change of the demand market from a punctiform one to an aggregate spatially continuous distribution over the country; and second, the considerable increase in size of what is considered an integrated economic space.

It is no longer possible to refer to distance to the punctiform market, but instead, to nearness to the aggregate market --represented by a field quantity or a potential model. Furthermore, the continental size of the new economic space causes the climatic variable to influence the agricultural yields --represented in a physical evapotranspiration model.

As a result, the price paid at the farm is a variable, owing to varying transfer costs; and also the yield is a variable, owing to varying climatic conditions. Thus, the classical formulation of price and costs per quantity of produce is replaced by the concept of areal revenue, as a product of price times yield --or of total sales over acreage.

It is postulated that areal revenue is a surrogate for rent. And furthermore that areal revenue is positively correlated with the potential demand and the evapotranspiration values. Higher values of potential demand indicate nearness to the aggregate market --increasing the price, net of transfer costs --but also indicate a larger demand structure facing the given supply structure --increasing the price at the market. Higher evapotranspiration values mean higher yields per unit of area. The distribution of supply structure would have the corresponding effect of reducing the price at the market for increasing potential supply of a given crop. As the proposed model is explaining space allocation and not price variation, this supply effect was not formally introduced in it.

The distribution of the two regional allocating variables, potential demand and evapotranspiration, may produce important effects in the model. In first place, if a region is partially isolated from the national market, their producers could find this to be a monopolistic location, regarding the possibility of a higher price structure, owing to limited competition.

Such is the case of New England.

In second place, a potential demand surface with two or more national peaks could lead to the creation of regional submarkets, each one with its own price and rent structure. Such is the case of the Pacific region and Main USA.

Finally, within a region, the interplay of the two sets of values of potential demand and especially evapotranspiration could lead to the formation of a regional boundary, where the values of areal revenue change non-marginally because of climatic thresholds offered to new higher revenue-earner crops. Such is the case of the boundary defining the South region from the Center-North.

The situation of trade-off between the potential demand and the evapotranspiration values is essential to the theory, as an expression of the possibility of trade-off between the two components of areal revenue: price and yield. Thus, the isorevenue family of curves is the transformation of the sets of the isopotential and the isoclimatic family curves. Specific isopotential curves define the pure economic limit for each crop and specific isoclimatic curves define their pure climatic limit, being the usual case to find transformed limits to each crop, owing to the interplay of the two allocating variables.

Assuming a rational behavior, the producers of the same crop would tend to concentrate in the same area. This has also been implied in classical Rent Theory and is observed in other productive activities. The phenomenon of regional specialization is interpreted as the result of the locational process explained by the proposed theory, occuring in an integrated economy.

Theoretically and empirically, regional specialization proved to be efficient, tending to maximize rent and areal revenue, to reduce area under cultivation and transfer costs, to intensify use of land and to leave marginal land open for other uses. In the rent equation, specialization is reduced to a case of maximization of yields within the area of positive rent.

Clearly, the process of specialization is not possible for ubiquituos crops.

The emergence of specialized regions producing a common surplus for export to the rest of the country lead to a typological classification of regions, according to the degree of variancy or constancy of the two allocating variables --potential demand and climate --within the region. The resulting economic or climatic constraints may cause periodical shifts of production, a phenomenon associated with rural unemployment.

Finally, if extended periods of time are considered, agricultural producing regions also shift in space according to the change of the potential demand market.

As a conclusion, assuming a trend to sizable integrated economic spaces, it is to be expected that the distribution of the national market and the climatic conditions largely would determine the location of agricultural production. High areal revenue-earner crops would tend to locate on the areas showing high combined values of the two allocating variables. By extension, factors reducing the economic distance, such as better transportation systems, would extend the economic margin of cultivation.

An increasing trend towards regional specialization of production is also to be expected. This should be regarded as an indication of a more efficient supply structure.

Though this work has not dealt with policies issues, it must be mentioned that sharpening of the elements of the theory of rent in agriculture can reduce uncertainty in the implementation of agricultural development policies. As an indication, transportation policies are linked with the effects of the economic limit of the system, while irrigation policies are linked with the effects of the climatic limit. Furthermore, the resultant regional typology defines different kinds of rural unemployment, and the crop typology offers an insight into the competition between local and national-oriented producers.

In a moment when scarcity of foodstuffs and increasing pressure for agrarian reform and development are spreading in many countries, it is essential to increase the understanding of the locational process of agricultural production.

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13. ABSTRACT

This paper reports on research intended to lead to the widening of the theoretical field of Location and Rent Theories and to enrich it with the results of empirical studies. Throughout the study, a feedback between theory and empirical analysis has been the source of new hypotheses. Agricultural production and the corresponding land use was the sector under study.

A first consideration is the importance of the environment, as different stages in the development of a country would lead to different spatial distributions of production. Strictly, the proposed set of theories included in the present work are the result of introducing the new regional parameters into the theoretical model of classical Rent Theory.