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THE DEVELOPMENT OF NATIONS: TEMPORAL RELATIONSHIPS FROM AN ECOLOGICAL PERSPECTIVE

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ABSTRACT

This study involves an examination of the temporal relationships between a number of different dimensions related to the process of the development of nations. Duncan's ecological complex serves as the basic framework for this largely inductive work. The ecological complex is comprised of four general realms: population, organization, environment, and technology. Together these four realms are viewed as comprising an interdependent system, where development occurs as a consequence of the continual process of adjustment between the four realms. Although the concept of development clearly involves a process of change over time, most cross-national studies have relied upon static data. The most unique aspect of this study involves the use of data from several points in time. This permits inferences of time order between several development dimensions, and as such represents important information notably lacking in the existing literature. This study has operationalized 63 variables representative of different aspects of the four parts of the ecological complex for 57 nations at three points in time: circa 1950, 1960, and 1970. From this data ten composite indices (dimensions) were derived through the use of factor analysis. The ten indices were examined in terms of the strength of their mutual associations. Seven of the ten were found to be highly associated with each other. Each pair among the seven indices were then cross-plotted. In some instances the plots revealed curvilinear trends of development, such that it was possible to infer time order between certain indices, where major changes in some indices were found to occur prior to major changes in others. Declines in the index of mortality were found to generally precede changes in the other six indices. Declines in the index of population growth, and gains in the indices of the division of labor, urbanization, and agricultural production, were found to generally precede major gains in the indices of material technology and trade. The relationships between the seven indices were then examined for spuriousness, using all possible combinations of first-order partial correlations. Several of the relationships were found to be essentially spurious when other indices among the seven were controlled. From the analysis involving association, time order, and spuriousness, two models were built describing the interrelationships between the seven indices as a whole. As such the models represent at least some of the interrelationships involved in the process of development. The structure of the models appear to support demographic transition theory. They also suggest that changes in the division of labor play an important role in the process of development. There are also certain implications for the concept of over-urbanization. Overall, the results of this study illustrate at least part of the system of temporal interrelationships involved in the process of development. It is a multidimensional view of development that clearly shows that the process involves a sequence of changes in a number of distinct areas. The results also suggest that the process of development tends to be comparable over time. That is, the developmental experiences of contemporary less-developed nations appear to be quite similar to the earlier experiences of the more-developed nations.

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CHAPTER I

INTRODUCTION

By definition the development of nations implies a process of change over time in a specified direction along one or more dimensions. Cross-national studies, however, have generally relied upon static data when analyzing relationships between various developmental dimensions. With static data it is impossible to infer the nature of the temporal relationships involved in the process of development since all that is evident are cross-sectional arrays; the actual changes that nations are experiencing cannot be considered. In this study cross-national data at three points in time are analyzed such that the actual changes experienced by nations over time are taken into account, permitting legitimate inferences of a temporal nature with respect to the interrelationships between various developmental dimensions.

Providing an adequate definition of development can be a difficult task. Some authors avoid the issue completely by using such terms as modernization or social change. Admittedly such terms are not always to be taken for synonyms of development and are in any case relatively free from the organismic or evolutionary implications the term development can carry (Chodak, 1975:252). In general the term development refers to the passage from a lower to a higher state over time, and hence improvement (Villard, 1963:27). Improvement can be considered a value-laden term, however, this is relative to time, place and culture. In this study the degree of development of a nation is viewed in terms of its relative position on various dimensions with respect to other nations and different points in time. The question is whether a nation is relatively high, low, or somewhere in between on different operational measures of development. Whether being "high" or "low" is to be viewed as being desirable or not, in the context of some value system, is not at issue here.

The most common use of the term development appears to be in the context of "economic development" or "socio-economic development." Economic development suggests a change in the economic conditions of a population (Trewartha, 1972:1). It can be viewed as an improvement in the basic productive elements of a society (Gill, 1963:4). Economic development would seem to be concerned with one particular aspect of development in a broader sense. However, a number of authors who use the term recognize that societies are comprised of a number of interacting parts of which the economy is but one. Rostow (1971:2), for example, takes the view that major economic changes are primarily a consequence of changes in political and social factors. Heilbroner (1963:16) goes so far as to suggest that economic development is primarily a political and social process, rather than an economic one. He maintains that various social and political changes are necessary preconditions before a society can be in a position to accumulate wealth and progressively enlarge incomes. The term socio-economic development implies such a broader perspective, incorporating both economic and non-economic factors.

The general view of development taken in this study is multi-dimensional in nature, in that development is assured to occur over time in nations on a number of conceptually distinct factors, only some of which can be conventionally viewed as being part of the economic realm. To the extent that such factors can be operationally measured, development can be observed by the movement of individual nations over time on these factors in specified directions, if you will, from relatively low to relatively high values. High and low simply refers to the position of a nation at a given point in time relative to other nations and other points in time. It is not assumed here that such development is of necessity always continuous over time or inevitable for all nations. Some nations remain more or less stationary, and some may retrogress. Nevertheless it is assumed that most nations will generally move over time toward higher developmental levels; of course the amount of time required for a given unit of change may vary between nations.

The view of development taken in this study is also holistic in the sense that various dimensions of development are assumed to comprise an interdependent system, where changes in certain dimensions are assumed to be related to changes in other dimensions, and where significant changes on some dimensions may tend to precede significant changes on others. Thus, overall the view is one of change over time along a number of distinct dimensions in specified directions, with the changes on certain dimensions being related to the changes on others.

The view of development as a process of change within a system of interdependent parts seems particularly compatible with an ecological perspective, especially the framework set forth by Duncan (1959) known as the "ecological complex." Through this framework Duncan attempted to define the scope of human ecology, suggesting that the ecological complex is comprised of four major parts, population, organization, environment, and technology, which together comprise a functionally interdependent system presumed to be equilibrium-seeking. Duncan maintained that an ecological account of social change could be obtained by referring to changes in each of the four parts, with the expectation that a change in any one will result in changes in the others. In this study the ecological complex serves as a general framework from which the process of development is considered, and from which variables are operationalized. While heuristically useful, Duncan's framework is very general. Although it defines rather clearly a number of significant aspects of social change, it leaves unspecified the nature of the interrelationships between the various parts. One purpose of this study is to empirically consider the nature of such interrelationships using a cross-national perspective with data over time.

Many disciplines claim some form of the concept of ecology as their own. In sociology it is found in the specialty of human ecology. And within human ecology, Duncan's ecological complex is representative of one school of thought. This school has been variously labeled as neo-orthodox (Theodorson, 1961:129), neo-classical materialism (Wilhelm, 1964:241), or simply materialism (LeClair, 1969:143). It is generally recognized as a direct descendant of the classical school of human ecology, whose major exponents have included Robert Park (1936) and Roderick McKenzie (1924,1926,1934).

The neo-orthodox school is but one of at least three different perspectives in human ecology that emerged from a period of intense perspectives in human ecology that emerged from a period of intense criticism of the classical school (see Alihan, 1938; Gettys, 1940; Hollingshead, 1947). The other perspectives include: social area analysis (see Shevky and Bell, 1955; Bell, 1958), which is primarily a method of analysis used to differentiate areas of a city, rather than a theoretical perspective (Sjoberg, 1965:169); and the socio-cultural approach (see Firey, 1945, 1947; Sjoberg, 1965; Wilhelm, 1964; and Wilhelm and Sjoberg, 1960), which stresses the importance of non-material factors on urban structure.

In the neo-orthodox school emphasis is placed on material factors in accounting for the structure of communities and societies, with the four parts of the ecological complex being representative of the major types of variables of importance to the school. While the realm of the non-material (e.g. values, attitudes, beliefs) has been relatively ignored by this school, its significance has not necessarily been denied (hawley, 1950:73). Of particular importance to the school is the structure of sustenance activities (organization). This is part differentiates it from other schools of thought within human ecology, as well as from the ecological concerns of other disciplines. In addition to Duncan (1959, 1964), major exponents of the neo-orthodox school include: Hawley (1950, 1967), Schnore (1958, 1961a), and Gibbs and Martin (1959).

The major work of Hawley (1950) is probably the most comprehensive treatise of the neo-orthodox school, from which Duncan's formulation of the ecological complex has drawn heavily. The major contribution of Duncan's framework, beyond Hawley's efforts, appears to lie in the clear specification of the major concerns of human ecology, and the suggestion that they constitute a system of interdependent parts. From Duncan's conceptualization it appears that essentially equal importance is placed on each of the four major factors, although given their varying natures it should be expected that they play different roles in the process of social change. Hawley (1950:73; 1967:329), on the other hand, appears to view organization as the primary concern of human ecology. Gibbs and Martin (1959) take a position similar to Hawley, in that they argue that sustenance organization is central to human ecology. Schnore (1958), in a position somewhat closer to Duncan, suggests that sustenance organization, as well as any major ecological factor, may be treated as either a dependent or independent factor, depending on the problem at issue. In any case, these different views are really matters of emphasis, rather than irreconcilable differences.

As a general starting point from which to consider development this study draws heavily from the works of the neo-orthodox school. Duncan's ecological complex serves as the basic framework of this study, and the ideas of other authors in the field serve to elaborate the nature of the various parts of the complex. The ecological complex appears to be of value in the study of development because it specifies four general realms that are significant to social change, and it suggests that the various realms constitute an interdependent system. As such it is very compatible with the general view of development stated earlier, as well as the views of a number of authors that are not generally associated with an ecological perspective (see for example Rostow, 1971; Heilbroner, 1963; Chodak, 1973; Oechsli and Kirk, 1975). The basic purpose of this study is an examination of the temporal relationships between a number of different dimensions derived from the perspective of the eological complex, in the context of the development of nations. The concern is not only with association, as has been the case with numerous studies, but also with time order and spuriousness between factors. All three elements are necessary for legitimate causal inferences with non-experimental data (Allardt, 1969:42). In one sense this study is concerned with providing an empirical specification of the nature of the interdependent system comprising the ecological complex as it relates to development. The most unique aspect of this study lies in the use of data from several points in time. With such data it may be possible to uncover information not generally found in cross-national studies. Numerous studies (see the next chapter) have demonstrated static association between various factors related to development, but consideration of the possible time order between such factors has been notably lacking in the literature. This study represents an attempt to partially fill this gap.

The basic approach taken in this study is largely inductive since the ecological complex represents a general conceptual framework rather than a precise theoretical formulation which can be readily subjected to rigorous empirical testing. The essentially inductive approach also seems warranted in light of the dearth of cross-national studies concerned with time order between developmental factors. In essence the question this study addresses is: what are the nature of the temporal relationships empirically evident between a number of ecological factors presumed to be involved in the process of the development of nations? Such information should contribute to an increased understanding of the processes involved in development.

In this study 63 variables are operationalized in terms of the four parts of the ecological complex. They are taken from 57 nations of the world at three points in time: circa 1950, 1960, and 1970. From this data ten composite indices of development are derived using factor analysis. Of the ten, seven that are highly associated with each other are used in further analysis. This analysis involves association, time order, and spuriousness between the seven indices. From the results of this analysis two models are built describing the structure of relationships between the seven ecological indices of development. Standardized path coefficients are derived for the latter model.

CHAPTER II

HUMAN ECOLOGY AND THE DEVELOPMENT OF NATIONS

While Duncan (1959:683-84) has not explicitly put the ecological complex in the context of the development of nations, he has maintained that the complex is a framework useful in accounting for social change.[1] Given this, as well as its conceptualization as a functionally interdependent system seeking equilibrium, the ecological complex appears to offer one potentially useful perspective from which the process of development may be considered. The quilibrium-seeking characteristics of the system do not necessarily imply a static perspective, but rather one in which constant adjustments are being made in some of the parts in response to changes in others. From a more or less continuous process of interaction between different parts of the system, higher levels of development or complexity presumably emerge in nations over time.

It is obvious that this perspective excludes certain significant factors related to the process of development, such as changes in political systems and value systems. The complex does include aspects of development commonly considered as economic, but rather than grouping technological and organizational factors together under the rubric of industrialization, the two are kep conceptually distinct.

A major assumption of this study is that each of the parts of the ecological complex constitute conceptually distinct, although related, areas of development. In other words, nations can develop along a number of different lines, and development along one line is related to development along others. If various aspects of the ecological complex provide a meaningful basis of differentiation between nations, then it should be possible to view them as different continua of development along which nations are arrayed. On such continua nations would be ordered in terms of levels of development on different aspects of population, environment, technology, and organization, at any one point in time. A number of studies have demonstrated that nations are arrayed along developmental continua (not necessarily ecological), and a number of studies have identified various dimensions of development from which such arrays could presumably be derived (such studies are discussed below). Unfortunately such efforts have limited import because of their reliance on static cross-sectional data. It seems that the major utility, or significance, of developmental continua lies not in a static array at one point in time, but rather in the movement (or process of change) that presumably occurs along the continua over time. Because this study uses data over three points in time for each nation such movement along continua can be observed and assessed.

With developmental continua several conditions appear to be significant: (1) the absolute position of each nation on each continuum; (2) the relative position of each nation with respect to the positions of other nations; and (3) the degree of movement over time of each nation on each continuum. The latter two concerns are of greater relevance to this study since development is essentially a relative concept, and since absolute positions have little meaning without knowledge of the beginning and end points of each scale.

The second condition permits the categorization of nations with respect to levels of development at a given point in time. The third condition permits the assessment of the relative amount of development each nation experiences over time. It is the third condition which has generally not been examined in other studies.

Of greatest interest to this study are the interrelationships between different dimensions of development, rather than unidimensional arrays. The interrelationship of two dimensions may form continua of a higher order. That is, continua based on (or formed by) the relationship between two different ecological factors over time. The assessment of how nations develop along such continua should be of great value in understanding developmental processes in terms of a system of interdependent parts. This study devotes much of its attention to such continua.

The view of development taken in this study does suggest an evolutionary perspective of societal change. However, such a perspective does not necessarily imply unilinear evolution, involving a fixed and limited number of stages through which all societies must inevitably pass. Rather, the view of development taken here is multidimensional in nature, where various dimensions comprise an interdependent system, from which higher levels of development emerge from the process of interaction between different parts of the system. Varying conditions in different nations should be expected to result, at least in some instances, in somewhat different sequences of change. Obviously, however, it must be assumed that certain general patterns of development will be evident across nations over time.

Efforts dealing with developmental continua are not new. Several studies have demonstrated that nations are apparently arrayed along various continua. Again, the unfortunate aspect of such efforts is the reliance upon static data.[2] For example, Oechsli and Kirk (1975: 395) have found clear continua among 116 nations, circa 1970, for birth rates, death rates, and GNP per capita. They argue that the world has been moving from a dichotomy of developed and underdeveloped nations towards a continuum. Their data, however, being rather contemporary, only supports the contention that a continuum exists.

Another effort with developmental continua is the work of Brian Berry (1960, 1961). Two dimensions derived from a factor analysis of 43 variables for 95 nations, circa 1950, were interpreted as continua. The first dimension, accounting for nearly 85 percent of the variance, was interpreted as a general developmental continuum, being comprised largely of technological and organizational variables. It was labeled as a "technological scale." The second dimension was labeled as a "demographic scale," being comprised of a number of variables related to population growth. Berry cross-plotted the two scales, the result of which he interpreted as a third scale, one of "economic-demographic" development.

The work of Takamori and Yamashita (1973) is of considerable relevance to this study. Six composite indices of development, which in essence represent continua, were derived from 45 variables for 79 nations, crica 1970, using principle component analysis and factor analysis. Scores for each nation on each pair among the six indices were cross-plotted, thus providing a view of developmental trends in terms of the interrelationships of different continua. Since this represents one of the interests of the present study, the work of Takamori and Yamashita is discussed in greater detail in Chapter VI, following a discussion of similar findings from the analyses of this study.

Several other cross-national factor analytic studies have identified various developmental dimensions, including Schnore (1961b), adelman and Morris (1967), Russett (1968), and Rummel (1972). These works have been primarily concerned with identifying dimensions among nations, rather than using such dimensions to derive continua of development. Presumably continua can be readily derived from such dimensions by calculating scores for individual nations. Once again these studies have analyzed only static data.

Schnore (1961b) factor analyzed twelve different variables related to modernization, for 75 nations circa 1950-1955. Two dimensions were identified. The first was so powerful, however, that Schnore felt that it constituted an approximation of unidimensionality. This dimension was comprised of measures related to technology, organization, and population. The second dimension was comprised of measures related to population growth and trade. From the composition of the first dimension, Schnore concluded that very high degrees of empirical association exist between conceptually distinct aspects of development.

Adelman and Morris (1967) utilized a series of factor analyses in a study concerned with the relationships between economic growth and other social and political changes that nations experience. Forty-one social, political, and economic variables were analyzed for

74 less-developed nations of the world, circa 1960. Although the entire 41 variables were never analyzed together as a set, analyses of various combinations of the 41 generally revealed a major developmental dimension comprised largely of organizational, technological, and population variables. Other dimensions that were identified were usually of a political, or more strictly economic nature. The major developmental dimensions found in several factor analyses were invariably the dimensions most highly associated with per capita GNP (used as a representative measure of economic development). One conclusion drawn from this research was that an intimate interrelationship exists between the economic development of nations and the changed experienced in non-economic factors.

Russett's (1968) analysis involved 54 variables from 82 nations for the period of the late 1950s. The variables included technological, organizational, population, trade, and political measures. As in the other cross-national factor analytic studies discussed in this chapter, a major developmental dimension was identified. It was comprised largely of variables related to technology, organization, and population growth. Other factors, accounting for more than five percent of the variance, were found to be related to population size, religion, population density, and political variables.

Rummel (1972) factor analyzed some 236 variables from 82 nations, circa 1955. Many of his variables can be conceptualized in terms of one or the other of the four parts of the ecological complex, however, they also include political variables, strictly economic ones, and variables related to social and cultural measures, such as religion and language. Rummel's analysis identified eight major dimensions, the strongest of which, accounting for about 20 percent of the variance, was again a general developmental dimension. The variables comprising this dimension are primarily of a technological and organizational nature. Rummel (1972:220) interpreted this dimension as a continuum along which nations lie with respect to a large number of traits associated with modernization. He cautioned against making any causal interpretations from it; however, he did note that it was suggestive of attributes appropriate for time-series analysis. Other major dimensions that were identified by Rummel include those related to political oritnation, population size, religion, foreign conflict behavior, density, domestic conflict behavior, and censorship.

Clearly the cross-national factor analytic studies discussed above have much in common. All have been concerned with identifying major dimensions among nations and, despite somewhat different sets of variables and nations, a number of similar dimensions have been found across these studies. The most significant uniformity among these efforts is that each has identified a major developmental dimension which is comprised of similar variables, primarily measures related to technology and organization. Such variables are highly associated with each other, yet they are conceptually distinct, at least from the point of view of the ecological complex. A number of lesser dimensions found in these studies also tend to be similar. One common shortcoming of these studies is the reliance on static data. The use of static data makes it difficult to assess with any certainty the nature of the interrelationships involved in the process of development over time.

As a theoretical formulation, one of the problems of Duncan's ecological complex is its extreme generality in defining the nature of the interrelationships between the parts of the complex. All that is posited is a system of mutual interdependence between the major parts. Clearly it would be of value to have precise empirical specifications of the interrelationships within the complex. This is one basic question which this study addresses. There are a number of studies (Gibbs and Martin, 1958; Gibbs and Schnore, 1960; Gibbs and Martin, 1962; Martin, 1962; Gibbs and Browning, 1966) that have demonstrated that relatively high degrees of association exist between a number of different aspects of the ecological complex on a cross-national basis. Unfortunately, that is all that has been demonstrated, simple association at one point in time. While such information is useful, the findings of these studies are of little value in untangling the web of interrelationships between ecological factors in the process of development. In addition to simple association, information on the temporal relationships between variables in required as well as information on the spuriousness of relationships, before a relatively complete picture emerges.

Gibbs and Martin (1958) and Martin (1962) have found that several measures of urbanization, and one measure of external trade between nations, have high degrees of association with each other. Gibbs and Schnore (1960) found that several measures of metropolitan growth and per capita energy consumption (a measure of technology) are moderately associated with each other. Gibbs and Martin (1962) demonstrated that high levels of association exist between variables representative of all four parts of the ecological complex, including per capita energy consumption (technology), urbanization (population), a measure of dispersion among occupational categories (organization), and a measure of trade (social environment). Finally, Gibbs and Browning (1966) have demonstrated that substantial associations exist between several measures of organization (the average size of productive association, the degree of intra-industry dispersion among occupational categories, and the degree of dispersion among industrial categories) and one measure of technology (per capita energy consumption).

To summarize, the cross-national studies considered in this chapter suggest several things of relevance to this study: (1) it is evident that the concept of developmental continua is a legitimate view, and one that is potentially useful in understanding the process of development; (2) from the factor analytic studies it is evident that a major developmental dimension exists among nations of the world. This dimension is comprised of a number of conceptually distinct, but highly associated variables; and (3) it is evident that a number of variables representative of different aspects of the ecological complex are highly associated with each other on a cross-national basis at one point in time. Needless to say such empirical information is only rudimentary in understanding the relationships between ecological factors in the process of development.

CHAPTER III

DEFINING THE PARTS OF THE ECOLOGICAL COMPLEX

Each of the four parts of the ecological complex represents a rather broad area of interest in human ecology. Within each of the parts it is possible to identify a number of conceptually distinct areas that are of relevance to the development of nations. In this chapter the nature of each of the four parts of the ecological complex is considered, as well as the various areas subsumed under each part.

Population

Human populations provide a point of reference in ecological analysis (Hawley, 1967:330). They are comprised of spatially delimited aggregates of individuals. Population characteristics represent one of the principle permissive, or limiting, factors of social organization, containing the possibilities, and setting the limits of organized group life (Hawley, 1950:78-9). Characteristics of relevance to this study include those related to population size and growth, the distribution and concentration of population, and population composition.

Hawley (1950:104) has pointed out that changes in population growth are sensitive indices of social change, particularly with respect to the degree of specialization possible in a society. Furthermore, there can be little doubt that changes in population growth are intimately bound up with the general process of development in nations. Certainly demographic transition theory is based on such a premise. Hauser (1959) has gone so far as to suggest that demographic measures may be used as general indicators of development, in the absence of other kinds of developmental measures, because various demographic changes are closely associated with the process of development in general. In any case, measures related to population growth are important in a study of development. Such measures might include those related to fertility, mortality, life expectancy, rates of population increase, as well as simple population size.

The distribution and concentration of individuals within a territory are also important population characteristics. For one things, how individuals are distributed is related to the efficiency of group organization. Concentrations of individuals in space permit more efficient group organization, increasing the potential for contact between individuals and groups (Hawley, 1950:101-102). Durkheim (1893) has, of course, utilized such population variables in his explanation of the division of labor (see Schnore, 1958). One aspect of population concentration involves the process of urbanization within nations. Urbanization has been clearly shown to be related to a number of different aspects of development (for examples see Gibbs and Martin, 1958; Martin, 1962; Gibbs and Schnore, 1960; Schnore, 1961b). It has been suggested that increases in urbanization are a necessary concomitant for the enlargement of the scope of interdependencies within a population (Hawley, 1950:371). The integration and coordination of an ever more complex system of interdependencies appears to be impossible without it. Thus, measures related to urbanization, as well as population density, appear to be relevant to a study of development.

The compositional characteristics of a population also appear to be relevant to the study of development, since they may limit the kinds of collective activities that are possible in a population. One important compositional characteristic is that of age structure, particularly with respect to its relationship with the size and quality of a nation's labor force (Hawley, 1950:143-44). It is obvious that the potential size of a labor force is smaller when a nation has a heavy concentration of people in the very old and very your age groups. Also, the quality of a labor force if effected to the extent that such groups actually participate in it. It can be assumed that the very old and very young are less likely to participate in the labor force of a nation, and when they do their capacity to perform certain tasks will be limited by their strength and/or training and experience. Questions of dependency are also related to age structure. That is, the extent of the burden of support laid upon those in the labor force by those that are not. Measures of age structure may thus be of relevance to a study of development. Presumably, however, such measures will be closely related to measures of fertility and mortality.

Environment

The environment represents the medium of existence for a population. It includes all factors external to a population (Hawley, 1967:330). To be significant, however, environmental factors must interact in some way with a population (Wagner, 1960:6). Salient characteristics include the fact that environments are subject to change over time, and vary considerably in nature over different populations. The environment of a population includes various natural features such as terrain, climate, mineral resources, flora and fauna, etc. Also included is the social environment which is comprised of the other populations with which a given population interacts (Mott, 1965:39).

A basic premise of human ecology is that every population must contend with, and adapt to, the conditions of its environment. These are conditions which are constantly changing. Through the process of adaptation, a population alters its environment. Thus environments act upon populations, and populations in turn act upon the environment. This represents a continual dynamic process, rather than the maintenance of a static equilibrium. The technology and social organization of a population facilitates this process of adaptation and adjustment (Duncan, 1959:681-82). From this process higher levels of development and complexity presumably emerge in nations over time.

Within the realm of the natural environment, the suitability of the environment for agriculture is certainly important to the process of development, since agriculture is ultimately the basis of human subsistence. Meggers (1954) has argued that the agricultural potential of different environments places a limit on the kinds of societies that can be supported. It must be noted, however, that her point was made in the context of "pre-modern" groups, rather than contemporary nations. Measuring the agricultural potential of different nations is difficult, however, the agricultural productivity of nations can be readily measured. Presumably measures of agricultural productivity reflect in part the general suitability of a nation's environment for agriculture, however it must be recognized that such measures also reflect, in part, the application of technology, and the nature of social organization within a nation.

Another relevant aspect of the natural environment is the presence of various natural resources, including such things as stands of timber and mineral deposits, such as iron ore, copper, petroleum, coal, etc. Clearly the dependency of a population on various natural resources is likely to increase with higher levels of technology and social organization. However, it seems that the most significant aspect of this area of the environment is not the mere presence of such resources, but rather the extent to which a population utilizes them. Like agricultural productivity measures, measures of resource utilization are, of necessity, functions of techology and organization, as well as the environment.

The social environment of a nation appears to be particularly significant to the process of development. Since the social environment is comprised of the other populations with which a given population interacts, measures of trade and communications between nations should be indicative of at least some aspects of it. Trade and communications bring a population new ideas, techniques and materials, as well as supplementing the natural resources available in the immediate environment of a population (Mott, 1965:67-8).

Hawley (1967:332) has in fact argued that as the reliance on exchange with other populations increases, the social environment may actually displace the natural environment at the most critical set of environmental factors. Implicit is a decreasing reliance on the immediate natural environment, and an increasing dependence on the environments of other populations. Thus, as nations develop they become more sensitive to the events and conditions of other nations. A reasonable expectation is that as the technology and social organization of a population increases, the importance of the social environment will also increase (Hawley, 1950:162). Measures of trade between nations have been shown empirically to be closely associated with other aspects of development, such as urbanization, technology, and the division of labor (Gibbs and Martin, 1958; Gibbs and Martin, 1962).

Technology

The technology possessed by a population facilitates its adaptation to the environment. Increases in technology enhance the efficiency of adaptation (Mott, 1965:46). From the point of view of Duncan (1959:682), technology does not simple refer to "...a complex of art and artifact...but to a set of techniques employed by a population to gain sustenance from the environment and to facilitate the organization of sustenance-producing activities." Technology, as well as social organization, can be viewed as specific aspects of culture. Hence one can say that culture helps facilitate adaptation to the environment. However, rather than viewing culture in very global terms, the ecological perspective tends to focus on specific aspects of it, namely technology and social organization (Duncan, 1959:682).

The set of techniques on which technology centers may reduce the amount of labor involved in a given task, or accomplish tasks that cannot be achieved by manpower alone (Gibbs and Martin, 1962:672). An important aspect of technology is the increase in efficiency it affords a population. Efficiency refers to the difference between the amount of time and labor required to perform a task with tools and techniques, and the amount of time and labor required without them, plus the number of tasks that can be accomplished only by such tools and techniques (Labovitz and Gibbs, 1964:3). As technology becomes more efficient it also becomes more complex. Such complexity can be guaged by the number and variety of artifacts, tools, and techniques present in a population (Labovitz and Gibbs, 1964:3). Increases in technological efficiency extend the scope of interdependencies between different aspects of the ecological complex, permitting larger and more concentrated populations to be supported, greater utilization of environmental resources, greater agricultural productivity, increased levels of exchange with other populations, and a more differentiated social organization. Measures of technology significant for a study of development should include those related to technological efficiency, transportation and communications (Hawley, 1950:154), and agricultural production.

There is considerable empirical evidence that differences in the efficiency and complexity of technology are associated with many other developmental characteristics of nations. Consider again the studies of Gibbs and Schnore (1960), Gibbs and Martin (1962), and Gibbs and Browning (1966), where measures of techology were found to have substantial degrees of association with measures of metropolitan growth, urbanization, trade, and the division of labor. Also consider the results of the factor analyses discussed in the preceding chapter. In each of these studies the major developmental dimension which was identified invariably was comprised of several high loading technological variables, as well as a number of high loading non-technological measures.

The view of technology taken here implies that technology is more than just material artifacts and tools. It also implies a non-material aspect, involving the application of knowledge and beliefs directly to carrying out different tasks. Such ideational tools may be applied to the creation of new material artifacts, or they may be applied directly to the environment. As an example, consider how the application of ideas such as crop rotation, or contour plowing, may increase the efficiency of agricultural production yet involve no new material artifacts, or improvements in material artifacts. Measuring non-material technology is obviously more difficult than measuring material technology. It does not seem unreasonable, however, to assume that the level of education in a nation is closely related to its level of non-material technology.

Organization

Although social organization can be conceptualized in a variety of ways, ecological conceptualizations tend to focus on the structure of sustenance-producing activities in a population (Duncan, 1959:682).

From this viewpoint organization represents the collective adaptation of a population to its environment (Duncan and Schnore, 1959:135). Organization emerges from the process of adaptation and adjustment to the environment, and in turn changes in organization facilitate further adaptation.

Sustenance activities are the most basic or organizational structures. They specifically exclude all activities not directly related to obtaining a livelihood. Such activities tend to be regular, repetitive, and enduring. While it is possible that they may be undifferentiated, they usually possess some division of labor (Gibbs and Martin, 1959:30). The structure of sustenance activities within a population constitutes a kind of system within itself, in that different activities serve different functions and are bound together in a complex pattern of interaction and mutual dependence. Organizational structure is based upon the patterns of interaction between sustenance activities (Mott, 1965:18).

From an ecological point of view there are two important characteristics of the structure of sustenance activities in a population (Gibbs and Martin, 1962:669; Gibbs and Poston, 1975:470; Clemente, 1972:34). The first involves the degree of differentiation, including both the number of different sustenance activities, and the distribution of individuals among them. This characteristics appears to be virtually indistinguishable from the concept of the division of labor. The second characteristic involves the degree of functional interdependence between activities. In effect, this refers to the degree of exchange of goods and services. Measuring the degree of interdependence between activities is difficult. Land (1970:265), however, has argued that the differentiation of activities, which can be measured readily, implies the existence of interdependence since the specialization of activities is not likely to occur without some degree of exchange.

It appears to be clear that changes in the structure of sustenance activities occur as nations develop. With development increases in the number of different activities tend to occur, that is, there is increasing specialization. Changes also occur in the distribution of individuals among activities, and in the degree of interdependence between activities. One of the best documented changes is the shift from agricultural to non-agricultural activities (Moore, 1969:113). It has been suggested that shifts out of agriculture tend to be accompanied by large proportional increases in secondary activities, followed later by substantial shifts into tertiary activities (Clark, 1951). Moore (1969:116), however, has pointed out that there may be substantial shift directly from agriculture into service industries in these developing nations with high rates of urbanization. The reason for this lies in urbanization occurring more rapidly than the expansion of secondary industries. Other organizational changes that appear to be related to increasing development include increasing bureaucratization, increases in the size of productive associations, and increased participation in the labor force by certain segments of a population, such as females (Moore, 1969).

Organizational differences between nations have been shown empirically to be substantially associated with a number of other developmental factors (Gibbs and Martin, 1962; Gibbs and Browning, 1966), including urbanization, technology, and trade. Organizational variables were also found to have high loadings on the major developmental dimensions identified in the factor analytic studies discussed in the preceding chapter.

Measures of the structure of sustenance activities important to the study of development would include those related to the proportion of the labor force in various activities, the overall distribution of individuals in different activities, the degree of bureaucratization, the size of productive associations, and the participation of males and females in the labor force.

CHAPTER IV

NATIONS, TIME PERIODS, AND VARIABLES

The primary direction of this study involves an empirical consideration of the nature of the temporal interrelationships between different aspects of the ecological complex in the context of the development of nations. Towards this end 63 variables, representative of different areas of the ecological complex, have been taken from secondary sources for 57 nations of the world, at three points in time: circa 1950, 1960, and 1970. This chapter discussed the nations that were studied, the variables which were analyzed, and the time periods covered.

Nations

Table 1 lists the 57 nations of the world used in this study along with the specific years for which most of the data for each nation is based (all tables and figures are located in the Appendix). With the exception of certain "mini-states" such as Andorra, Monaco, or the Vatican, this set of nations has been derived in terms of the availability of data for a reasonable proportion of the major variables used in this study over the three time periods. Clearly this set of nations is not truly representative of the world as a whole. Strictly speaking, any generalizations from the analyses of this study must be limited to this set of nations. This is not as restrictive, however, as it may seem, since the set of nations constitutes a substantial proportion of the world as a whole. This set includes about 51 percent of the world's population around 1970, and about 44 percent of the world's land area, excluding Antartica.

The set of nations used in this study is somewhat biased in terms of the over-representation of more highly developed nations. As a group, African nations are by far the most under-represented, followed next by Asian nations. The nations of Europe and the Western Hemisphere are well represented in the set. Of the total set, European nations constitute about 37 percent, nations of the Western Hemisphere constitute about 32 percent, Asian nations about 18 percent, African nations about 9 percent, and nations of Oceania about 5 percent.

Time Periods

Data for each nation are taken from three time periods, spanning a total of approximately twenty years, at circa 1950, 1960, and 1970. The specific dates for each nation are listed in Table 1. Most of these dates are within two or three years of the base data. It is evident that a substantial number of nations in the set have attained relatively high levels of development prior to the beginning of the time period covered in this study. It also seems likely that a twenty year time span will often be insufficient to observe the relatively full transition of a nation from low to high levels of development. Such limitations are regretable, yet necessitated by the availability of data. Despite such limitations, the twenty year span represents a substantial improvement over cross-national studies which have analyzed data from only one point in time. At the very least, the data used here may permit some limited references of a temporal nature.

It would be difficult, and most likely impossible, to obtain data from much farther back in time and still maintain a relatively large and diverse set of nations and variables. It should also be recognized that the boundaries of many nations were radically different prior to World War II, and this would complicate temporal comparisons. Also, the older the data, everything else being equal, the greater is the probability that it is less reliable.

Variables

In Table 2 a list of the 63 variables used in this study may be found, as well as a listing of sources, and the percent of missing cases for each variable. In most instances the percent of missing cases is relatively low, with the major exceptions being the measures of life expectancy, agricultural production, and iron ore production. The data come from a variety of secondary sources, the major ones being three United Nations yearbooks, and the Yearbook of Labour Statistics (International Labour Office, 1949-1974).

It should be recognized that in some instances such data are of questionable reliability. Data quality is a major problem facing most cross-national studies. The reliability of data most certainly varies between specific nations, variables, and time periods (Clubb, 1970:15-16). In general, the more developed a nation, the greater the likelihood of obtaining reliable data. However, the reliability of data from "less-developed" nations may be highly variable. Former colonies of Western nations often appear to have more reliable data.

Reliability also appears to vary with specific variables. In some instances only estimates can be made (for example the number of radios in a nation). In other instances it seems reasonable to presume that reasonably accurate official records are kept (for example the virtually universal phenomena of motor vehicle registration). Obviously data reliability varies over time, with the likelihood that older data tends to be less reliable. These problems can be considered rather formidable, however there is little that can be done other than to avoid the use of variables which obviously appear to have serious difficulties of reliability. The only other alternatives are to avoid serious cross-national studies completely, or gather the data directly. The latter alternative is obviously impossible from a practical point of view. In this study published variables with obvious problems of reliability have not been used (for example, radios per capita). It seems reasonable to assume that while the specific published figures for particular nations may be open to question, the relative position of each nation (rank) with respect to other nations on a given variable is less open to doubt. Some studies (for example Berry, 1960, 1961) have used rank order rather than interval scale measurement in their analyses because of these problems. Rank order measurement has not been used in this study because it would tend to conceal certain attributes of the data that are essential to the analysis. In most instances several different variables representative of one sub-area of the ecological complex are used in this study in the hope of reducing problems of data reliability. Most of the variables used here are expressed in terms of rates, percentages, or averages, thus permitting comparisons between nations of differing size.[1]

Variables operationalized under the element of population include measures related to population size, population growth, age composition, density, and urbanization. The population growth variables include several standard measures of fertility, mortality, and life expectancy, as well as the average annual rate of population increase. Also included is the child-women ratio, which is used as an index of fertility, but is derived from census data rather than vital registration (Bogue, 1969:662). Measures of age composition include three standard dependency ratios, where the non-dependent population is taken as those aged 20 to 64 years (Bogue, 1969:155). Variables related to population density include a measure of simple density per square kilometer of land, a measure based on the amount of arable land rather than total land area, and also one based on the number of agricultural workers per unit of arable land. The urbanization measures are based on three different criteria of definition for what is considered urban. One uses a population of 100,000 or more, another uses a population of 20,000 or more, and a third (percent rural) uses the varying definitions of each nation (David, 1969:112). Also included is a measure of urban primacy, based on the percentage of the total population in localities of 100,000 or more that are found in the single largest locality of 100,000 or more.

The variables operationalized under the element of the environment include several measures related to trade, agricultural land, agricultural production, and natural resource production. The trade variables are viewed as indicators of the social environment of a nation, and include measures of imports, exports, and total trade in United States dollars per capita, as well as two measures of sea-borne shipping expressed in metric tons. The amount of land available in a nation for agriculture is measured by the variables of arable land per capita, and the percent of total land area that is arable. Agricultural production is reflected by measures of the yields per hectare of three basic crops: what, rice, and maize (corn). The substantial percentage of missing cases for these three variables certainly reflects environmental differences between nations with respect to their suitability for the cultivation of certain crops. In this area of environment a measure of the average calorie intake per capita is also included. As previously mentioned, measures of agricultural production are also clearly functions of the application of technology, and the state of social organization in a nation.

The production of natural resources is one important area of the environment which has received considerable attention in recent years, particularly with respect to petroleum. Unfortunately, it is one of the most difficult areas to operationalize successfully. While there are published figures for the production of a great variety of natural resources, it is difficult to obtain such data for most of the nations under study here. In other words, there is a very unequal distribution of many natural resources throughout the world, and this would result in a very large percentage of missing cases if production measures for these resources were used. In addition, there is a very clear lack of comparability across nations for petroleum related measures. Apparently such figures are not published for a number of the major petroleum-producing nations of the world. One measure of natural resource production is included in this study, namely iron ore production. It has been selected because it is a commonly used mineral in industry, and data for it are available for a substantial number of nations. However, even at that, the percentage of missing cases for this variable is about 30 percent.

The technological variables used in this study include both measures of material and non-material technology. Material technology is represented by several measures of transportation within a nation, such as vehicles per capita and railroad freight volume; several measures of communications within a nation, such as newspaper circulation, newsprint consumption, domestic mail volume, and telephones per 1000; and several measures related to agricultural production, such as tractors per 1000, and tractors per unit of arable land. Also included are several measures of the overall efficiency of a nation's technology. Gibbs and Martin (1962) have suggested that per capita energy consumption is a useful measure of total technological efficiency. Several other energy measures are also included, such as electrical energy production per capita, and the installed capacity of electrical energy per 1000. In addition, steel consumption is used as an indicator of material technology since it is basic to so many aspects of industrial production.

In the area of non-material technology it is important to consider the accumulation, transference, and development of knowledge within and between populations. Unfortunately the available measures do not fully reflect these attributes. In this study the measurement of non-material technology has been restricted to several variables related to the extent of education in a nation at three levels: primary, secondary, and higher education.

The variables operationalized under organization include a variety of measures related to the structure of sustenance activities in a nation. Included are a number of variables measuring the percent of the labor force in various activities such as agriculture, manufacturing, service, and primary, secondary, and tertiary industries. These measures are based on ten standard industrial categories, rather than occupational groups, because of the greater availability of industrial data in the Yearbook of Labour Statistics (International Labour Office, 1949-1974). There is also a measure of the total degree of differentiation among sustenance activities, based on the degree of dispersion among the ten industrial categories.[2] In addition there are measures related to the degree of bureaucatization, such as the percent of the labor force that are employers and workers on their own account, and the percent that are wage and salary earners (Moore, 1969:122-23). There is a crude measure of the average size of productive associations (Gibbs and Brownin, 1966). And finally, there are three measures related to the labor force participation of males, females, and the total population.

A comment on the general difficulties of operationalization is in order. Clearly in this study, as in most others, there is a gap between the theoretical concepts and the empirical measures used to represent them. Two particularly noteworthy problem areas are in the realms of the environment and organization. Clearly many of the natural features of the environment of a nation have not been operationalized (for example, terrain, climate, and the presence of many natural resources). Among those that have (for example agricultural productivity measures, and iron ore production) many are clearly functions of technology and social organization, as well as the environment. Under organization certain essential characteristics of the structure of sustenance activities have not been measured, namely the actual degree of specialization (number of different activities), and the degree of interdependence between activities. The actual organizational measures that are used are at best approximations of the distribution among activities since they are based on rather large general categories. Numerous other specific operational problems could be mentioned. In a slightly different vein, there are also problems of operationalization in terms of changing definitions of specific variables over time. In some instances the differences are rather slight, and thus of little consequence. Where it was obvious that definitions varied greatly over time, such variables were avoided. In any case, the reader should be aware of these difficulties. They represent problems common to most of the empirical research in the social sciences.

CHAPTER V

ECOLOGICAL DIMENSIONS OF DEVELOPMENT

This study uses composite indices to represent different dimensions of development among nations. There are several reasons for this. One concerns the validity of the measures used to represent various aspects of the ecological complex. It appears that the four parts of the ecological complex, as well as the various sub-areas of each part, each stand as a conceptually distinct complex of closely related traits which as a general rule would be rather poorly represented if operationalized in terms of only a single indicator. As an example consider the concept of material techology. It clearly seems to be a conceptually distinct trait, yet it is obviously comprised of a large number of individual components. Any one of these might be used to represent technology (as Gibbs and Schnore, 1960; and Gibbs and Martin, 1962; have done with per capita energy consumption), but the use of any single indicator may not fully reflect the general state of material technology within a nation. Furthermore, certain components of material technology may be more significant in some nations than in others. Therefore the use of composite indices derived from several different individual components may be of value. Similar reasoning would also apply to other aspects of technology, as well as the various areas of population, environment, and organization.

Another reason for the use of composite indices concerns the reliability of the data used in this study. As previously noted many of the cross-national variables used here are commonly subject to problems of measurement accuracy. It is hoped that by combining individual variables into composite measures some of the problems of measurement accuracy will be reduced. A third reason for the use of composite indices is that some of the problems presented by missing data are also reduced. With such a large set of data over time, it is virtually impossible to avoid having some missing data. While nations and variables which would have had excessive amounts of missing data have been excluded, most of the nations in the set are missing several pieces of data. By using composite indices there is a reduction in the probability that a given nation cannot be represented on a particular ecological factor because of missing data. Finally, with a very large set of variables, the use of composite indices serves the cause of parsimony.

In this study factor analysis is used as a means of identifying different dimensions of development, and as a technique which provides information that is useful in the construction of composite indices.[1] Rather than using a purely inductive approach to the problem of identifying dimensions, as was the case with the factor analytic studies discussed in Chapter II, the variables subsumed under each of the four parts of the ecological complex have been subjected to separate factor analyses instead of analyzing all 63 variables together as one set. Thus there are four separate analyses, one each for the population, environmental, technological, and organizational variables. This procedure combines elements of both an inductive and deductive approach. The deductive aspect involves an assumption that the four parts of the ecological complex represent meaningful conceptual distinctions, and hence can be factor analyzed separately. The inductive aspect allows the factor analyses to identify the empirically meaningful dimensions within each of the four parts of the ecological complex. Hopefully, the dimensions which emerge from this procedure are both empirically meaningful and conceptually sensible.

The four factor analyses undertaken in this study are each based on a principle components solution with orthogonal rotation.[2] Rotation has been confined to those factors having eigenvalues equal to or greater than one (Rummel, 1970:362-63). This is a common convention in a realm with no hard and fast rules. Each of the four factor solutions have been derived from the input of a correlation matrix based on a pair-wise deletion of missing-data. Such pair-wise deletion results in a number of the correlations being based on slightly different sized sets of nations. The alternative of list-wise deletion was not feasible since most of the nations in the set are missing at least one piece of information. Estimating procedures for the missing information represents legitimate zero values, and in some instances it is impossible to determine whether missing information is a legitimate zero, or whether it is indeed missing. Throughout the analyses data at all three points in time have been factored together, thus permitting the location of each nation on each dimension over time.

Population Dimensions

In Table 3 the factor solution for the 19 population variables is presented. Four rather distinct dimensions were identified. The first, accounting for 47.2 percent of the variance, has as its highest loading variable the crude rate of natural increase. Other high loading variables on this dimension include two fertility measures, the average annual rate of population increase, and the three dependency ratios. It appears that this dimension is closely associated with the patterns of population growth within a nation. The fact that the dependency ratios load highly on this factor is not surprising. Nations with high fertility levels tend to have an age structure heavily represented in the young age groups, while nations with low fertility levels tend to be represented heavily in the older age categories (Barclay, 1958:266-67). Note the negative loading for the old age dependency ratio, while the others have positive loadings.

The second population dimension, accounting for 13 percent of the variance, appears to be related to patterns of mortality. The crude death rate has the highest loading, while other high loading variables include the two life expectancy measures (with negative signs), and the infant mortality rate. It is interesting that the mortality and fertility measures separated into distinct factors, rather than loading on the same factor with opposite signs.

On the third population dimension three measures of density load highly. They are, in order of loading, the density per hectare of arable land, the density of agricultural workers per hectare of arable land, and the simple population density.

Like the first three, the fourth dimension is rather clear-cut. It appears to be associated with the level of urbanization in a nation. The percent in localities of 100,000 or more has the highest loading, followed by percent rural (negative sign), and the percent in localities of 20,000 or more. The population size and urban primacy measures are not strongly associated with any of the four factors.

Environmental Dimensions

In Table 4 the factor solution for the 12 environmental variables may be found. Three dimensions were identified. The first, accounting for 44.6 percent of the variance, has as its highest loading variable the amount of total trade per capita. The next three highest loading variables on this dimension are also trade related measures, including imports per capita, exports per capita, and good unloaded in sea-borne shipping. Two measures of agricultural production (wheat and maize yields) also load highly on the first dimension, although at somewhat lower levels than the trade measures. Despite the loadings of the latter two variables, it seems reasonable to view the first factor as one essentially representative of the levels of external trade of a nation. It is a dimension representing the social environment.

The second environmental dimension, accounting for 13.5 percent of the variance, appears to be related to levels of agricultural production. Three such measures load highly, including rice yields, maize yields, and average calorie intake. A fourth agricultural production measure, wheat yields, has a rath low loading on the second dimension.

The third environmental dimension is rather unclear conceptually. Only two variables load highly on it, being goods loaded in sea-borne shipping (a trade measure) and iron ore production (a measure of natural resource production).

The dimensions identified in the factor analysis of environmental variables are somewhat less clear and distinct than the population dimensions. It will also be evident shortly that the environmental dimensions are less distinct than those for technology and organization. This condition, in part, may reflect the greater difficulty experienced in operationalizing the environmental realm of the ecological complex.

Technological Dimensions

The factor solution for the 19 technological variables may be found in Table 5. Only two dimensions were identified, with the first accounting for 59.7 percent of teh variance, and the second accounting for only 6.9 percent. The first factor is strongly associated with a number of variables measuring the communications and transportation technology, levels of energy use, and the agricultural production technology of nations. The highest loading variable on the first factor is the number of telephones per 1000. A reasonable interpretation of this dimension would be that it is representative of the level of material technology within a nation.

On the second technological dimension only two variables were found to load highly. They are educational measures. The first is the number of those enrolled in primary schools as a percentage of those aged 5-14 years, and the second is the number of those enrolled in secondary schools as a percentage of those aged 15-19 years. While this dimension can be viewed as an aspect of non-material technology, some caution must be exercised in its interpretation since three other educational measures do not load highly on it. Two of these (university and college enrollment per 1000, and secondary school enrollment per 1000) have rather substantial loadings on the first technological factor.

Organizational Dimensions

In Table 6 the factor solution for the 13 organizational variables is presented. As with technology, only two dimensions were identified, with the first accounting for 19.7 percent. The first factor is primarily associated with variables measuring the differentiation of sustenance activities. The highest loading variable on the first factor is the percent of the labor force in agricultural and related industries. Other high loading variables include the percent of the labor force in manufacturing, service, primary, secondary, and tertiary industries, the percent of the labor force that are wage and salary earners, the percent that are employers and workers on their own account, the measure of the overall dispersion among sustenance activities (D), and the average size of production associations. The percent in agriculture, primary industries, and employers and workers on their own account are positively loaded, while the rest have negative signs. A reasonable interpretation of this dimension would be that it is representative of the division of labor within a nation.

The second organizational dimension is related to labor force participation. The three variables with high loadings on this dimension include the percent of the total population that are economically active, the percent of females that are economically active, and the percent of males that are economically active.

Summary of Factor Analyses

Four separate factor analyses of variables operationalized under each of the four parts of the ecological complex have identified eleven different dimensions among nations of the world. Each of the dimensions can be viewed as representing a different aspect of the ecological complex. With one exception, the eleven dimensions are rather clear conceptually. Excluding this exception (the third environmental factor), the identified dimensions are representative of the following aspects of the ecological complex: population growth, mortality, density, urbanization, trade, agricultural production, material technology, education, the division of labor, and labor force participation.

Composite Scores

For ten of the eleven dimensions described above, composite scores have been constructed for each of the 57 nations at each of the three points in time. The third environmental dimension, where goods loaded in sea-borne shipping and iron production load highly, has not been used because it seems to lack a clear conceptual interpretation. The bracketed loadings in Tables 3 to 6 indicate the variables used in the construction of composite scores for each dimension. With one exception, only those variables loading at greater than .65 on a dimension have been included. This figure is arbitrary, serving the purpose of identifying the highest loading variables, and hence those most closely associated with a dimension. The exception to this cutting point is found in the second environmental dimension (agricultural production), where the criterion was lowered slightly so that two additional variables (calorie consumption and maize yields) would be included in the index. The composite indices for the population dimensions are based on seven, four, three, and three variables respectively. The environmental indices are based on six and three variables respectively. The technological indices are based on fourteen and two variables, and the organizational indices are based on nine and three variables respectively.

A procedure outlined by Rummel (1970:441-42) has been followed in the construction of the composite scores. It is a procedure for the derivation of composite factor score estimates when there are missing data. In this procedure the selected variables for each dimension are standardized for every case, and weighted by the square of the appropriate factor loading. This is a good weighting coefficient because with orthogonal factors the squared loadings measure the amount of variance of a variable directly associated with a factor (Rummel, 1970:441). After weighting, all the variables included in a dimension are summed for each case and divided by the number of available variables. The process of summation and division creates a kind of average, and thus deals with the problem of missing data in most instances.

It should be noted that despite the use of squared loadings in the weighting procedure it was necessary to retain the signs of the original unsquared loadings. This is due to the fact that several of the dimensions have both positively and negatively loaded variables. In such situations the differences in signs are significant, yet they would be lost when the loadings are squared. For example, consider the mortality dimension where the crude death rate and infant mortality rate have positive loadings and the life expectancy measures have negative ones. On this dimension nations with high mortality rates should lie at one end of the continuum while those with high levels of life expectancy should lie at the other end. This distinction would be lost if the original signs were not retained, and the dimension would not represent a meaningful continuum of mortality.

The composite scores derived in this study permit the observation of the relative position of each nation at three points in time on ten different dimensions of development. Given this, the nature of the process of development over time on different aspects of the ecological complex can be assessed. Table 7 lists the composite scores for each nation on each of the ten dimensions.

CHAPTER VI

RELATIONSHIPS BETWEEN ECOLOGICAL DIMENSIONS

Association

From Duncan's formulation of the ecological complex, and from the results of the studies discussed in Chapter II, it is reasonable to expect that the ten composite indices will have rather substantial degrees of association with each other. Thus the first stage of analysis in this study has involved the calculation of correlation coefficients between each of the ten indices.[1] The coefficients are presented in Table 8.[2] With some qualification, the expectation of substantial association has been met. Seven of the ten indices each have rather substantial correlations with most of the other indices, while three indices each have relatively low correlations with the others. The three indices include: the density dimension, with an average correlation of .052 (with the other nine indices); the education dimension , with an average correlation of .122; and the labor force participation dimension, with an average correlation of .262. The average correlations for the other seven indices range from .437 to .512. Because this study is concerned with the interrelationships between a set of highly associated ecological factors, the three indices with low correlations have not been included in any further analysis. The remaining seven indices have rather substantial correlations with each other, ranging from .47 to .80.

There are several possible reasons why the three indices generally have such low correlations. One obvious possibility is that the three measures are not particularly significant to the process of development, at least in the context of the other seven indices. Another possibility is that they are poor operational representations of the underlying concepts. For example, the low correlations associated with the density index need not imply that the distribution of population within a territory is unimportant to development, but rather that it is better to measure the distribution in some other manner, such as with indicators of urbanization. This may also be the case with the educational index. Clearly, the two variables comprising this index are rather crude, in that they are highly dependent on the age structure of a nation. Perhaps some measure as simple as the percent literate would be more appropriate. Literacy measures, however, have not been used due to lack of comparable data for all three time periods. In a similar manner the variables underlying the labor force participation index may also not be the most appropriate of operationalizations.

Plots and Temporal Relationships

With a set of seven highly associated composite indices, the next stage of analysis has been to consider the form of the relationships by plotting the scores for each possible pair among the seven. These plots permit the observation of the temporal change of each nation in terms of the interrelationship of each pair of indices. How each nation moves over the twenty year span (circa 1950 to 1970) can actually be observed on each of the plots. Within the context of certain criteria that are discussed in the next paragraph, it should be possible to view each of the plots as representations of continua of development. Note that these continua are not unidimensional, but rather are based on the interrelationships of two dimensions. As such they should be of considerable value in illustrating some of the processes of development.

In the evaluation of the plots several criteria appear to be significant. First, the clustering of the scatter of points should be considered in terms of whether a relatively narrow or wide band of points is evident, running from low to high levels of development on both indices. Obviously, the wider the scatter of point the less sensible it is to view a particular plot as a continuum. Second, it is important to consider the direction of the movement of nations over time along the scatter of points. It is in this area that the actual processes of development are evident. There may be a relatively tight progression of points in a particular plot, but unless the individual movements of most nations are in a direction consistent with that of the general scatter, it is difficult to view such a plot as a continuum. In other words, most nations should be moving towards higher levels of development over time in a direction similar to that of the overall scatter of points, or at least their positions over time should remain relatively stationary. If the movements of most nations zigzag sharply back and forth within the scatter of points, or if most nations move toward lower levels of development over time, a process of development is not really being illustrated. Ideally what is sought is a scatter of points that forms a narrow band, progressing from low to high developmental levels on both indices, where nations attain higher developmental levels at each succeeding point in time by following a path consistent with the shape of the scatter. Obviously, this ideal is unlikely to be met in all instances, and a subjective judgment is involved in determining how closely each plot comes to it.

Finally, if the two criteria above have been reasonly satisfied, it is important to consider the shape of the scatter of point on each plot. The significant question is whether a linear or curvilinear form is evident. With a linear pattern the correct inference is that the two indices tend to change together over time. With some curvilinear patterns, however, it may be possible to infer a temporal relationship between two indices. For example, a curve will be formed if significant changes in one index tend to precede in time significant changes in another. The ability to make inferences of time order is quite important since time order is an essential aspect of causal interpretation with non-experimental data.

Among the seven composite indices there are 21 possible plots. Each is discussed below. To ease the burden of interpretation, plots which are similar in terms of the above criteria have been grouped together into sets.

The first set is comprised of four plots, including those for the indices of the division of labor and material technology, mortality and material technology, the division of labor and trade, and mortality and trade. They are presented in Figures 1 to 4, where the points for several nations are labeled as examples. Although it is a subjective judgment, this set appears to contain the best plots in terms of the criteria discussed above. Each of the four plots exhibits a rather tight clustering of points, progressing from low to high levels of development on both indices.[3] Also, most of the nations in each of the four plots move in a direction over time which is toward higher levels of development. It thus seems reasonable to view these four plots as continua of development.

The most significant element which is evident in the first four plots is that each exhibits a rather sharp and clear curvilinear form. In each of the plots note that most of the variation (or difference) among nations at the low end of each continuum is primarily in terms of either the division of labor or mortality, while most of the variation among nations at the high end of each continuum is in terms of either material technology or trade. In a similar manner, most of the movement of nations over time at the low end of each continuum is primarily in terms of changes in the division of labor or mortality, while most of the movement of nations at the high end of each continuum is in terms of gains over time in material technology or trade. There are several nations, however, that bridge this difference of the twenty year span. For example, Japan experiences larger gains in the division of labor, and larger declines in mortality, between 1950 and 1960, and larger gains in material technology and trade between 1960 and 1970.

From these observations it is possible to make certain inferences with respect to the processes of temporal change. It seems reasonable to infer that major gains in the division of labor tend to precede in time major gains in material technology and trade, and that major declines in mortality tend to precede in time major gains in material technology and trade. In other words, most nations appear to achieve a relatively differentiated divsion of labor, and a relatively low level of mortality, before they begin to experience major advances in material technology, and major increases in external trade. Once a given level of mortality and the division of labor are reached, further changes in these two indices are minimal, while major changes in technology and trade begin in earnest.

The second set is comprised of five plots, including those for the indices of population growth and material technology, agricultural production and material technology, population growth and trade, agricultural production and trade, and mortality and agricultural production. The plots are presented in Figures 5 to 9. As in the first set, rather clear curvilinear patterns are evident, although the spread of points in the second set tend to be somewhat wider than those found in the first set. With certain exceptions, due to the peculiarities of the index of population growth, the movement of most nations in these plots are in the direction of higher developmental levels, following paths consistent with the shape of the scatter.

The exceptions presented by the population growth index are due to the movement of a substantial number of nations in directions over time which are other than toward higher developmental levels. That is, between 1950 and 1960, 43 of the 57 nations experienced gains on the population growth index. Of course, higher levels of development on this index are indicated by declines rather than gains. These gains unquestionably reflect post-war upsurges of population throughout much of the world. When the three points in time for each nation are connected with lines, a zigzag pattern is commonly found. This of course does not represent a consistent path of develpment. The problem may not be too serious, however, because the number of nations experiencing gains on the population growth index between 1960 and 1970 are substantially fewer, only 15 out of 57. If only the movement during the latter period is considered, most nations move in a direction which is consistent with the trends of the scatter of points on the affected plots, towards higher developmental levels.

The general pattern of movement of the population growth index between 1950 and 1960 appears to represent a rather unique situation, which is discussed more fully in later chapters. In the light of demographic transition theory, and the post-war "baby boom," these apparent deviations are sensible. In any case, given the movements between 1960 and 1970, it does appear that most nations reach relatively levels of population growth, and then begin to experience major gains in material technology and trade. Once a relatively low level of population growth is reached, further declines appear to be minimal while the gains on the other two indices continue over time. With this in mind it seems reasonable to infer that major declines in population growth tend to precede in time major gains in material technology and trade.

The remaining three plots of the second set exhibits more clear-cut temporal patterns of change. It is evident that major gains in agricultural production tend to precede in time major gains in material technology and trade, and that declines in mortality tend to precede in time gains in agricultural production. In other words, relatively high agricultural production levels are reached in most nations before major advances occur in material technology and trade. Also, relatively low mortality levels are achieved in most nations before agricultural production reaches relatively high levels.

The third set is comprised of two plots, including those for the indices of urbanization and material technology, and urbanization and trade. They are presented in Figures 10 and 11. As in the preceding sets, clear curvilinear forms are evident in these two plots, and the movement of most nations over time are consistently in the direction of higher developmental levels. The spread of points, however, in these two plots, tends to widen substantially between moderate and high levels of development. This spread of points suggests that the range of variation among nations at higher developmental levels is rather substantial. Despite this, it is evident that nations generally progress to at least moderate levels of urbanization before major gains occur in both material technology and trade, although relatively high levels of urbanization may be reached before the gains occur on the other two indices. More specifically, it can be inferred that substantial gains in urbanization, ranging from the attainment of moderate to high levels, tends to precede in time major gains in the levels of material technology and trade.

The spreading of points in the plots of the third set can perhaps be more readily understood if the total set of nations is broken up into two groups and considered separately. Nations which achieved only moderate levels of urbanization before major advances began in technology and trade are typically nations of Europe and North America, although there are exceptions, such as the United Kingdom, West Germany, and the Netherlands, which achieved relatively high levels of urbanization will be reached before major gains in material technology and trade occur. This difference may reflect the so-called phenomena of "over-urbanization" (see Davis and Golden, 1954; Sovani, 1964; Kmerschen, 1969; Hill, 1974). Over-urbanization is based on the idea that urbanization and other aspects of development are closely associated, and hence presumably changing together over time. This idea seems to be derived from the historical experiences of most of the more-developed, western nations. Over-urbanization is considered to be a relatively recent phenomena in some developing nations, where levels of urbanization are higher than would be expected given the levels of development in other areas, particularly the proportion in non-agricultural sustenance activities. The expectation is apparently one of a linear relationship between urbanization and changes in other developmental factors. However, it appears that nations labeled as over-urbanized are really exhibiting a curvilinear relationship over time between urbanization and other developmental factors. With respect to Figures 10 and 11, it is possible that for some nations the historically based linear relationship (actually more of a gentle curve) is changing to a relationship that is more sharply curvilinear. In other words, the relationships between urbanization and material technology, and urbanization and trade, have changed from that of more or less simultaneous change over time, to relationships where major changes in urbanization have clear temporal precedence over changes in material technology and trade. This would account for the spread of points in Figures 10 and 11.

The fourth set is comprised of three plots, including those for the indices of mortality and population growth, mortality and urbanization, and mortality and the division of labor. They are presented in Figures 12 to 14. As in the previous sets, curvilinear forms are evident, but the curves are not as pronounced. In addition, the scatter of points in the plots of the fourth set tend to be fairly wide throughout. However, the movement of most nations over time are generally toward higher developmental levels following paths consistent with the shapes of the curves. Because of the gentle shape of the curves any temporal inferences made from the fourth set of plots should be considered somewhat less powerful, or clear-cut, than those made for the plots of the preceding three sets.

From the fourth set of plots it appears that declines in mortality tend to precede declines in population growth, and gains in urbanization and the division of labor. More specifically, most nations tend to attain relatively low levels of mortality while they are located somewhere between low and moderate levels of development on the indices of population growth, urbanization, and the division of labor. Once relatively low levels of mortality are achieved, there tends to be little further change in mortality, while gains begin and continue to occur on the other three indices.

The final set is comprised of seven plots, including those for the indices of the division of labor and population growth, the division of labor and agricultural production, the division of labor and urbanization, population growtn ana agricultural production, population growth and urbanization, agricultural production and urbanization, and material technology and trade. They are presented in Figures 15 to 21. These seven plots are grouped together as a set because each exhibits a form which appears to suggest essentially linear progression over time.

Figure 15, the plot of material technology and trade, exhibits a linear trend over time for most nations, however, the scatter of points is very tightly clustered at the low ends of trade and material technology, while it tends to spread out between moderate and high levels on these indices. This suggests an increasing range of variation between these two indices as nations develop over time.

Figures 16, 17, and 18, the plots of the division of labor and population growth, population growth and agricultural production, and population growth and urbanization, each exhibit a fairly wide scatter of points which follow an essentially linear progression over time. As before, the index of population growth presents certain difficulties due to the increases experienced by many nations on this index between 1950 and 1960. Again, this problem is diminished if only the progression between 1960 and 1970 is considered.

Figures 19 and 20, the plots of the division of labor and agricultural production, and agricultural production and urbanization, also exhibit fairly wide scatters of points. In comparison to Figures 15 to 18, however, the interpretation of the progression of nations over time is more straightforward, where essentially linear trends are apparent.

Figure 21, the final plot, involving the indices of the division of labor and urbanization, exhibits a scatter of points somewhat narrower than those of the preceding six plots. In this plot most nations move toward higher levels of development over time in an essentially linear manner.

Because the final seven plots exhibit essentially linear forms it is difficult to make any inferences with respect to temporal sequences of change between the indices. The only completely legitimate conclusion is that these particular pairs of indices tend to change together over time. In some instances it may be possible to make some very tentative inferences that changes in some indices tend to slightly precede changes in others, but as it will be seen in the next chapter, such inferences have only a very weak empirical basis. At this point the inferences for the final set of plots are that the indices of the division of labor and population growth, the division of labor and agricultural production, the division of labor and urbanization, population growth and agricultural production, population growth and urbanization, agricultural production and urbanization, and material techology and trade each tend to change together over time.

Among the 21 relationships discussed thus far in this chapter, 14 have been found to be clearly curvilinear, thus permitting the inference of temporal sequences between certain indices. In general, such temporal sequences have not been found in other analyses of this sort because of the reliance on static data. It is interesting, however, to compare the plots of some of the relationships found here with those found in a study by Takamori and Yamashita (1973). Despite the fact that these two authors utilized static cross-national data, the form of some of their plots between composite indices of development bear a striking similarity to the form of some of the plots discussed above. While the plots of Takamori and Yamashita are based on static data, they are suggestive of the kinds of temporal relationships found in this study.

Takamori and Yamashita derived six composite indices of development from 45 variables for 79 nations, circa 1970, using principle component analysis and factor analysis. Many of their 45 variables could be readily conceptualized as being representative of different aspects of the ecological complex, although a number of the variables are strictly economic in nature, being based on such measures as Gross Domest Product and Gross National Product. Although several of their composite measures could be viewed as being somewhat unclear conceptually, or at least inappropriately labeled, four of them (standard of living, urbanization, economic activities, and industrialization) do a-pear to be roughly comparable with four of the composite indices derived in the present study (mortality, urbanization, material technology, and the division of labor respectively). When the six possible plots among the above four measures of Takamori and Yamashita are compared with the equivalent plots of this study, each appears to be of the same form with respect to linearity or curvilinearity, and with respect to the spread of points. For example, Takamori and Yamashita's plot of economic activities and urbanization, equivalent to the plot of material technology and urbanization in the present study, exhibits a spreading of points between moderate and high levels of development.

Also, like the equivalent plot of this study, it is possible to discern two somewhat different developmental trends, where western nations tend to exhibit a gentle curvilinear relationship (or perhaps linear) and non-western nations tend to exhibit a sharper curvilinear form.

The findings of Takamori and Yamashita are thus very similar in some ways to findings of this study. The unfortunate aspect of their work is the reliance on static data. While their plots suggest some temporal relationships, none can be legitimately inferred as was possible above.

A Limited Analysis of Data for Periods Prior to 1950

A reasonable question is whther the relationships found between the seven composite indices for the period 1950 to 1970 would also be found if similar data spanning a substantially longer period of time were analyzed. Clearly the temporal inferences made in this chapter are based on a rather limited span of time, being roughly 20 years for each nation. For nations which were relatively highly developed at the beginning of this period, it can only be assumed that they followed paths of development in earlier periods that are similar to the paths of development exhibited by the less-developed nations for the period 1950 to 1970. Such assumptions, of course, have no real empirical basis. In order to provide such a basis, a very limited amount of data have been analyzed for 24 nations, spanning periods ranging from circa 1880 to 1970, to circa 1930 to 1970, at approximately ten year intervals. Most of the 24 nations are from Europe, North America, and Oceania, and hence are among the more-developed nations of the contemporary world. However, there are several nations in the set which could be considered as less-developed today, such as Mexico and Brazil. The 24 nations are listed in Table 9, along with the specific years for which the data from each are based. The use of this particular set of nations is based on the availability of data.

Available data for such early periods of time are very limited, and most probably of questionable reliability. It was possible, however, to obtain seven different variables for these nations from two different sources, permitting a limited representation of four different aspects of the ecological complex. One measure of the division of labor was obtained from Kunznets (1957), being the percent in agricultural activities. This was the variable found to have the highest loading on the division of labor dimension in the factor analysis of 1950 to 1970 organizational data. The remaining six variables have been taken from Banks (1971). Included is a measure of urbanization, being the percent of the population in cities of 100,000 or more. This was found to be the highest loading variable on the 1950 to 1970 urbanization dimension. Also included are two measures of trade, being the value of imports and exports per capita in United States Dollars. Both of these variables had high loadings on the 1950 to 1970 trade dimension. Finally, there are three measures of material technology, including the number of telephones per 1000 (which had the highest loading on the 1950 to 1970 material technology dimension), the number of pieces of mail per 1000 (both of which also had high loadings on the material technology dimension.

Since it would make little sense to factor analyze such a small set of variables, a simpler procedure for deriving composite scores was followed. For the two aspects of the ecological complex represented by single variables (percent in agricultural activities and urbanization), the values for each nation at each point in time were simply standardized. This provides scores for each nation that can be meaningfully plotted. For the three measures of technology, and the two measures of trade, the values for each nation were standardized and then averaged. This results in two composite measures, one for material technology (based on three variables), and one for trade (based on two variables). Altogether, four measures have been derived that are roughly comparable to four of the seven composite indices analyzed for the period 1950 to 1970.

The six possible plots from the four measures are presented in Figures 22 to 27. The remarkable fact about these plots are that they exhibit forms that are very similar to the equivalent plots for the 1950 to 1970 data. This lends the desired additional empirical support to at least some of the temporal inferences which were made above. As with the 1950 to 1970 data, very pronounced curves are found in the plots of the division of labor and material technology measures, and the division of labor and trade measures. Curvilinear trends are also found in the plots of the urbanization and material technology measures, and the urbanization and trade measures, where the points tend to spread from moderate to high developmental levels, as before. Thus, again, the inferences are that gains over time in the division of labor and urbanization tend to precede major gains in material and technology and trade, with the qualification that levels of urbanization may vary from moderate to high before major gains occur in material technology and trade.

The plots of material technology and trade, and urbanization and the division of labor, both exhibit linear forms of a similar nature to those found in the 1950 to 1970 data. As before, the spread of points widens substantially towards higher developmental levels in the plot of the material technology and trade measures, while in the plot of the division of labor and urbanization measures the spread of points is more of the same width throughout. Again, the inferences from these two plots are that measures of material technology and trade, and the division of labor and urbanization, tend to change together over time.

To summarize, the analysis of limited amounts of data from periods of time prior to 1950 lends some empirical support to some of the temporal inferences made from the 1950 to 1970 data. At least with respect to the measures for which earlier data were obtained, it appears reasonable to assume that the more-developed nations of today have generally followed paths of development which are similar in nature to those now being followed by contemporary less-developed nations. Of course, there are two exceptions (the relationships between urbanization and material technology, and urbanization and trade), but these relationships exhibit essentially the same form in both the 1950 to 1970 data, and the data from earlier periods of time, where it appears that the relationships of material technology and trade with urbanization may be changing.

Spuriousness and Causal Inferences

In order to infer causality in a non-experimental situation three basic criteria must be satisfied (Allardt, 1969:42). To simplify matters consider them in terms of the relationship between two variables. First, it must be demonstrated that both variables tend to occur together. This can be satisfied through the use of measures of association. Secondly, it must be demonstrated that one of the variables precedes the other in time. This is often difficult to do, particularly with static data, but it may be possible under some circumstances with time-series data. Finally, it must be shown that the relationship between the two variables is not the result of a common relationship to other variables. That is, it must be shown that the relationship is one which is direct and non-spurious. It is very unlikely that this can ever be achieved completely, given an almost infinite number of potentially related variables. However, in a more limited sense within the context of a specific set of variables, it may be possible to demonstrate spuriousness, or the lack of it, by the use of such procedures as control tables or partial correlation.

Because this study is concerned with the empirical specification of the interrelationships between different aspects of the ecological complex as they relate to the process of development, the three criteria of causality are important. They essentially represent the only major ways relationships can be considered in non-experimental situations.[4] In this study, thus far, relationships which reflect the first two criteria have been considered. First, it has been demonstrated that the seven composite indices of development have rather substantial degrees of association with each other, with correlation coefficients ranging from .47 to .80. Secondly, the temporal relationships between the seven indices have been considered, where it was found that changes in some of the indices tend to precede changes in others, and where some of the indices apparently tend to change together over time. Specifically, it was found that declines in mortality tend to precede declines in population growth, and gains in agricultural production, urbanization, the division of labor, material technology, and trade; also it was found that declines in population growth and gains in agricultural production, urbanization, and the division of labor tend to precede gains in material technology and trade. Pairs of indices which have been found to essentially change together over time include: material technology and trade, population growth and agricultural production, population growth and urbanization, population growth and the division of labor, agricultural production and urbanization, agricultural production and the division of labor, and urbanization and the division of labor.

In order to satisfy the third criterion of causality, at least in the limited context of the seven indices, it is necessary to establish which of the 21 relationships between the seven indices are essentially direct (non-spurious), and which are essentially indirect (spurious). Obviously, this ignores the question of common relationships with additional variables outside of the set, and hence the satisfaction of the third criterion cannot be fully achieved.

To get an idea of which relationships are essentially spurious, first-order partial correlation coefficients have been calculated for each pair of indices, controlling in turn for each of the other indices.[5] By observing which of the partials reduce to near zero, it is possible to determine which of the relationships between the seven indices are essentially indirect (see Blalock, 1960:337-43). Near zero partial correlation coefficients have been arbitrarily defined as those less than or equal to .10, and hence are relationships explaining one percent or less of the variance. Table 10 presents all of the possible first-order partial correlation coefficients between the seven composite indices.

Among the 105 first-order partials found in Table 10, only eight are less than or equal to .10. These correlations are starred in the table. From these eight coefficients it is possible to infer that the relationships between certain pairs of indices are essentially spurious, and hence exist primarily because of a common relationship to other indices. Of the 21 possible direct relationships, seven appear to be essentially indirect. They are: the relationship between mortality and urbanization, when the division of labor is controlled for (partial of .02); the relationship between mortality and material technology, when the division of labor is controlled for (partial of -.08); the relationship between mortality and trade, when the division of labor is controlled for (partial of -.06); the relationship between urbanization and population growth, when the division of labor or agricultural production are controlled for (partials of .03 and .02 respectively); the relationship between population growth and trade, when material technology is controlled for (partial of -.09); the relationship between agricultural production and trade, when material technology is controlled for (partial of .05); and the relationship between urbanization and trade, when material technology is controlled for (partial of -.08). The fact that these relationships have been found to be indirect still leaves the question of whether the control variables are intervening, or have a direct effect on the other two indices. It should be noted that if a different cut off criterion had been used, the number of apparent indirect relationships would vary somewhat. With a criterion of .05 the number of indirect relationships would be reduced to three, while with a criterion of .15 the number of indirect relationships would be judged as nine.

Summary

This chapter has considered the interrelationships between seven composite ecological indices of development in basically three different ways. First, it has been shown that the associations between the seven indices are rather substantial. This in itself does not really provide any new information, but serves to reconfirm in a general sense what has been found in previous studies. The use of composite indices, however, is apparently a less common approach than the use of individual variables. Secondly, the form the relationships between each pair of the seven indices over time have been considered. From the curvilinear relationships found between some of the indices it has been possible to infer several time sequences, where changes in some of the indices have been found to infer several time sequences, where changes in some of the indices have been found to occur largely prior to changes in others. It seems apparent that in this area significant new information has been uncovered since previous cross-national studies have generally relied upon static data. Clearly more could be done in the area of sequences of temporal change. One aspect which has not been considered has been the pace of change. That is, the amount of time required for a given unit of change on the various indices. Such information would be of particular value for projections of future trends. Finally, it has been shown that the relationships between some of the pairs of indices are essentially indirect when other indices among the seven are controlled for.

CHAPTER VII

MODELS OF DEVELOPMENT

The ecological complex as Duncan has described it, in terms of a system of interdependent parts, clearly suggests the possibility of building a model to represent the structure of relationships within the complex as a whole. However, to derive a model solely from Duncan's discussion would be rather difficult, and if it were done the model surely would be of a very tenuous and general nature. Because of the generality of Duncan's framework, a model built solely on a theoretical basis could do little more than suggest that the various parts of the ecological complex are interdependent. Since this study has focused on analyzing the empirical relationships between different aspects of the ecological complex over time, it may be possible to use the various findings discussed in the preceding chapter to build a model of development based on the ecological complex that is more specific, and grounded on empirical information. Figure 28 presents such a model. Its structure has been derived from the empirically observed interrelationships between the seven composite indices of development used in this study.

The elements necessary to build this model are essentially the same as the three criteria of causality discussed in the preceding chapter. First, the set of variables comprising the model should be substantially associated with each. This is indeed the case with the seven indices in Figure 28. Each of these indices are also rather conceptually distinct, despite the fact that they are composite measures. These indices represent dimensions of mortality, population growth, urbanization, trade, agricultural production, material technology, and the division of labor among nations.

Second, it is necessary to order the variables of the model with respect to time sequences. This establishes directionality among the variables. In Figure 28 this was done by using the temporal inferences made from the plots discussed in Chapter VI. From these inferences a three-stage temporal sequence was established in the diagram, moving from left to right. Because several of the relationships were judged to be essentially linear in form, and hence changing together over time, it was not possible to order all of the indices in model. Thus, there is no directionality among the indices of second stage, and among the indices of the third stage. Since delines in mortality were found to generally precede major changes in the other six indices, the index of mortality constitutes the first stage of the model. The final stage of the model is comprised of material technology and trade because changes in the other five indices were generally found to precede gains on these two dimensions. The second stage of the model is comprised of the indices of population growth, agricultural production, urbanization, and the division of labor. These four indices occupay an intermediary position in the model because changes in them were found to generally follow declines in mortality, and precede gains in material technology and trade.

The final element in building this model is to establish which of the relationships between the indices are direct, and which are essentially indirect (spurious). This was achieved in Figure 28 by using the results of the partial correlation analysis discussed in the preceding chapter. Where there are no lines directly connecting two indices in the model, this is indicative of a relationship found to be essentially indirect, or spurious. Hence there are no lines connecting mortality with urbanization, material technology, and trade; population growth with urbanization and trade; agricultural production with trade; and urbanization with trade. Where lines directly connect two indices in the model, this is indicative of a direct, non-spurious relationship. There are two types of lines, however. Those with double-headed arrows represent non-spurious relationships where no temporal sequence (directionality) was inferred. These are the essentially linear relationships. Lines with single-headed arrows represent non-spurious relationships where a temporal sequence was inferred. These are the curvilinear relationships, and they are the ones which provide directionality in the model.

Figure 28 is thus an empirically derived model representing the structure of relationships between seven different aspects of the ecological complex, in terms of association, temporal change, and spuriousness. Because it illustrates a sequence of change across nations, it constitutes a model depicting some of the processes of development. It obviously has certain limitations. One is the assumption that the empirical interpretations upon which it is based are essentially correct. Another limitation is the fact that it does not incorporate all of the dimensions relevant to the process of development. This limitation, in part, stems from the use of the ecological complex as a theoretical framework in this study.

As a model, Figure 28 has been derived in a manner which is different from the way most models in the social sciences are derived. Figure 28 has been built from the results of an empirical analysis which has been only loosely framed by theoretical concerns. The more common approach to model building seems to involve the derivation of hypothetical model from theory, followed by an attempt to empirically determine whether the postulated relationships are consistent with a set of data. The latter approach has some significant limitations as a rule. In such models the association levels between variables can be readily determined, and through the use of path analysis the relative contribution of one variable to another can be assessed. However, it is rarely possible to completely ascertain the correctness of the postulated ordering of variables. That is, it is very difficult to establish directionality empirically. There are approaches which permit the elimination of some of all the possible ways a given set of variables can be ordered (see Simon, 1954; Blalock, 1962), essentially through the use of partial correlations, but with these approaches the elimination of all possible structure, save one (presumably the correct one), can never be achieved. This study has thus been fortunate in avoiding these problems by being able to infer at least limited directionality from the curvilinear relationships over time.

There is one glaring problem with Figure 28, if it is to be considered an empirical representation of the cological complex. The problem involves the unidirectional paths between the indices. It seems obvious from Duncan's formulation that two-way relationships are to be expected between the parts of the ecological complex. This is implicit in the conept of mutual interdependence. The most likely form of such two-way relationships would seem to be in terms of a time lag, or feedback, between indices. Determining two-way relationships can be difficult to do empirically. However, the fact that feedback was not found in this study does not necessarily preclude the possibility that it exists between the seven indices. It must be kept in mind that the time sequences of the model are based on the tendency of changes in some indices to occur before significant changes in other indices, and not on the fact that major changes occur in some indices before there is any change at all in other indices. Thus it is possible that there is some feedback between indices which has been undetected, or overlooked, because it involves relatively small changes in one of the indices.

In addition to the possibility of undetected feedback, it may be difficult to accept some of the unidirectional paths in the model from an intuitive point of view. Where, for example, do the declines in mortality come from? One obvious possibility is from factors outside of the model. However, it also seems reasonable to assume that declines in mortality are dependent on changes in some of the indices within the model, particularly material technology. It may be that the relevant technological measures have not been incorporated in the material technology index. It is also possible that the necessary technological changes have come from outside of a number of the nations in the set. That is, the technology which has brought about dramatic mortality declines over the past several decades in many less-developed nations has not been a function of internal developments in these nations, but rather has been external input from the technology of more developed nations. If this is so, then the dependency of mortality on technology would not be particularly evident in the data of this study. Similar explanations may also apply for the lack of feedback between other indices in Figure 28.

A desirable addition to Figure 28 would be measures of the relative contribution made to each index, by each of the indices that precede it and have direct relationships with it. One way of providing such measures is through the use of path coefficients (see Duncan, 1966; Land, 1969). Unfortunately, the structure of Figure 28 is such that it is not legitimate to derive path coefficients. The problem lies in the double-headed arrows connecting the indices within the second and third stages. These are the relationships lacking directionality. Path coefficients can be legitimately derived only when such non-directional relationships are among exogenous variables, and clearly this is not the case in Figure 28. Path coefficients can be derived, however, if the structure of Figure 28 is altered somewhat by finding a way of specifying directionality among the indices of the second and third stages. Figure 29 presents a modified version of Figure 28, where additional specifications of directionality have been made. Standardized path coefficients between the indices are entered on this model, as are the residual figures for each of the endogamous indices.

The additional specifications of directionality made in Figure 29 have an empirical basis, although of a rather tenuous nature. An additional step was taken by examining the plots initially judged to be linear in form. The attempt was made to ascertain if any temporal sequences were evident in these plots, however slight. Although it may seem peculiar on the surface, judgments of linearity are really quite relative. These plots were examined with the idea in mind that there may be some slight curilinear trends evident within them. That is, if there is a slight curve within the plots which way does it bend, and hence which of the two indices has a slight temporal precedence? This process of examination was facilitated by connecting the three points in time for each nation with lines. With such lines curvilinear trends are sometimes more evident than with a simple scatter of points. Through this process slight curvilinear trends were noted in the seven plots originally judged to be linear in form. Keep in mind that such judgments are very subjective, and hence are quite tenuous. They do, however, permit a complete ordering of the indices as shown in Figure 29. The purpose of making the additional judgments of directionality lies in the desire to provide a more complete model; one which provides more information, particularly in terms of path coefficients. The additional judgments of curvilinearity do not really contradict the linear interpretations that were made earlier for these plots. What the plots of this study really illustrate are varying degrees of temporal precedence between indices. The sharper the curve the greater the degree of change in one index prior to changes in another. In a general sense, Figure 29 should be viewed as a more detailed, but more tentative version of Figure 28.

The additional judgments of temporal precedence include the placement of the division of labor prior to population growth, agricultural production, and urbanization; also the placement of population growth prior to agricultural production and urbanization; the placement of agricultural production prior to urganization; and finally, the placement of material technology prior to trade. The temporal precedence of the division of labor over urbanization and agricultural production, and the precedence of population growth over agricultural production, appear to be somewhat clearer than the remaining arrangements noted above.

The value of the models presented in Figures 28 and 29 lie in the ability to represent all of the various relationships which have been found in this study, together as a whole. Although feedback is lacking in these models, they are depictions of a system of interrelated parts, and they do illustrate at least some of the empirical relationships apparently involved in the process of the development of nations over time.

CHAPTER VIII

INTERPRETATION OF FINDINGS

Figures 28 and 29 provide a convenient basis from which to interpret the major empirical findings of this study, since the total structure of relationships are set forth as a whole. Any interpretations, of course, can be made only within the context of the procedures and data used in this study, inlcuing: a limitation on generalization to the nations and time periods studied, the degree of reliability and validity of the 63 original variables and the seven composite indices, the appropriateness of the analytical techniques which were used, and the correctness of the temporal inferences made from the plots. To facilitate this discussion, the position of each index in the models is considered in turn. Of necessity, some of the interpretations which are made in this chapter are rather speculative. They are provided in an effort to make some sense out of the apparent empirical relationships which have been found.

Mortality

The attainment of relatively low levels of mortality has been found to generally precede major changes in the other six indices. This accounts for its position as an exogenous index on the left-hand side of the models. From the models it is apparent that the temporal precedence of declines in mortality is somewhat greater in relation to the indices of material technology and trade, than with the other four indices; that is, the curvilinear relationships of mortality with material technology and trade are very sharp. The index of mortality has been found to have non-spurious relationships with three of the other six indices, including the indices of population growth, agricultural production, and the division of labor. The relationships with urbanization, material technology, and trade have been found to be essentially spurious. It has already been mentioned that at least in part, declines in mortality are logically dependent on changes in other indices in the model, especially technology. Several possible reasons have been given as to why no evidence was found to substantiate this. It may be that the requisite technological changes are relatively small, and hence undetected. Or, more likely, the requisite technology has come from outside many less-developed nations in the past few decades, and thus is not reflected in the measures of technological change within these nations.

The temporal precedence of mortality declines over the attainment of relatively high developmental levels on the other six indices appear to be consistent with, and in support of, the theory of demographic transition (see Bogue, 1969:55-56; Thompson, 1929; Notestein, 1945; Oechsli and Kirk, 1975). The demographic transition is commonly outlined as a process of change over time in nations from relatively high levels of fertility and mortality, to relatively low levels of fertility and mortality. These demographic changes are assumed to occur as nations develop in other ways. Related changes would include increasing urbanization, and increasing proportions of the labor force in non-agricultural activities. Before the transition occurs, nations are characterized by both high fertility and mortality levels, producing little or no population growth. Such nations are presumed to be relatively undeveloped, being predominately rural and agricultural. As the transition begins, mortality levels are found to drop substantially, while levels of fertility remain high. This produces substantial increases in population growth. Nations so characterized are assumed to be beginning the process of development and urbanization. Finally, the transition is completed by fertility levels dropping substantially, and once again producing little or no population growth. Nations at this stage are assumed to be highly developed and urbanized. From the process of the demographic transition it is clear that substantial mortality declines are expected to occur before declines in population growth, and before the attainment of relatively high developmental levels in general. Thus the position of the index of morality in the models is very sensible in the context of the demographic transition. Declines in mortality appear to be one of the first major antecedents of the development of nations.

From the path coefficients of Figure 29 it is apparent that the contributions of mortality to declines in population growth, and to increases in agricultural production, are fairly small (coefficients of .173 and -.149 respectively). The small contribution to declines in population growth is sensible in the context of the demographic transition. It is not declines in mortality, per se, that are assumed to directly affect declines in population increase, but rather it is other developmental changes that are assumed to have such direct effects. From Figure 29 it can perhaps be inferred that the most significant developmental changes are those in the division of labor. Note the substantial path coefficients from mortality to the division of labor (-.716), and from the division of labor to population growth (-.487). Changes in the division of labor may, thus, be a key factor in the completion of the demographic transition.

The Division of Labor

The attainment of relatively high levels on the index of the division of labor has been found to precede the achievement of relatively high levels of material technology and trade, and follow the attainment of relatively low mortality levels. The temporal relationships of the division of labor with population growth, agricultural production, and urbanization can be viewed as those of more or less simultaneous change over time, or where changes in the division of labor have some slight temporal precedence. Unlike the other indices, the index of the division of labor has been found to have clear non-spurious relationships with each of the other indices in the models. From Figure 29 it can also be seen that most of the path coefficients associated with the division of labor are fairly substantial. Thus, it is apparent that changes in the division of labor play an important role in the process of development.

In either model the division of labor occupies an intervening position. This suggests, at least within the context of the development of nations, that the emphasis of some of the ecological literature (for example Hawley, 1950; Gibbs and Martin, 1959) on the division of labor (or organization) as a major factor to be explained may be misplaced. From the structure of relationships found in this study it appears that changes in the division of labor may have greater utility as an explanatory factor. Consider that only one of the other six indices has been found to have a clear temporal precedence over the division of labor.

The position of the division of labor in the models also suggests that the common practice of grouping measures of technology and the division of labor into one index of industrialization, or economic development, may serve only to confuse some of the underlying processes involved in development. Since changes in the division of labor have been found to clearly precede major changes in technology over time, it seems unwise to combine measures from the two realms. This would only cloud the very distinct differences between the two. These temporal differences also lend some empirical support to the conceptual distinctions made between organization and technology by the ecological complex.

As noted above, the path coefficients associated with the division of labor are for the most part rather substantial. The largest contribution the division of labor makes is the urbanization (a coefficient of .642). This is not surprising, since almost by definition a nation cannot be highly urbanized without having experienced substantial changes in the division of labor, primarily reductions in the proportion of the labor force in agricultural activities. The contribution made by the division of labor to population growth is also rather substantial (coefficient of -.487). As previously mentioned, changes in the division of labor may play a key role in the completion of the demographic transition. The position of the division of labor prior to material technology, and the substantial path coefficient (.445) between the two, are sensible if it is assumed that relatively high levels of transportation and communications, and enery use, are not attainable so long as the division of labor remains relatively undifferentiated. The contributions of the division of labor to agricultural production and trade are more modest (coefficients of .214 and .245 respectively), but they do suggest that an increasingly differentiated division of labor contributes to greater agricultural productivity in a nation, and higher levels of external trade.

Population Growth

The attainment of relatively low levels on the index of population growth have been found to precede the achievement of relatively high levels of material technology and trade, and follow the attainment of relatively low levels of mortality. The temporal relationships of population growth with the indices of agricultural production, urbanization, and the division of labor can be viewed as those of more or less simultaneous change over time, or where declines in population growth have some slight temporal precedence over gains in urbanization and agricultural production, and where gains in the division of labor have some slight temporal precedence over declines in population growth. The index of population growth has been found to have non-spurious relationships with four of the other six indices. The four indices include mortality, the division of labor, agricultural production, and material technology. The relationships with urbanization and trade have been found to be essentially spurious. The path coefficients associated with population growth indicate a rather modest contribution from mortality (.173), and a rather substantial one from the division of labor (-.487). Population growth in turn makes a rather substantial contribution to agricultural production (coefficient of -.542), and a very weak one to material technology (coefficient of -.099).

The position of mortality prior to population growth in the models, and its rather modest contribution to it, have already been considered. In line with demographic transition theory, substantial direct contributions by declines in mortality to declines in population growth should not be expected. The intervening position of the division of labor in Figure 29, between the two indices, is more reasonable. It appears to be consistent with an observation made by Mamdani (1972). Mamdani's detailed observations of the failure of a long-term family planning program in a rural Indian village led him to conclude that changes in the social structure must occur before declines in the rate of population growth begin in earnest. This conclusion is based on the observation that children become more costly, and hence less desirable, only within the context of non-agricultural, non-rural employment. To the Indian farmer more children mean greater rather than less prosperity. Thus, if Mandani's conclusions can be generalized, the strong effect of changes in the division of labor on declines in population growth, and its possible temporal priority, are quite reasonable.

In Chapter VI the general trends of the population growth index were outlined. Between 1950 and 1960 most of the nations considered in this study experienced increases in the index of population growth, while between 1960 and 1970 most of the nations experienced decreases. Because of the trends for the latter period, it was inferred that declines in population growth tended to precede changes in several of the other indices. It is possible that the divergent trends for the two periods reflect differences in the stage of progression along the demographic transition for various nations. While mortality levels are decreasing and fertility levels reamin high, increases in population growth are to be expected. When mortality reaches relatively low levels, and when fertility begins to decline, decreases in population growth are to be expected. Thus, the up and down trend of the population growth index by itself over time is reasonable. At least some of the nations which experiences increases in the population growth index between 1950 and 1960, and then decreases between 1960 and 1970, were probably moving into a later stage of the demographic transition. Nations which experienced increases in the index of population growth for both of these periods were probably in an earlier phase of the demographic transition. These differences, however, are complicated somewhat by the post-war increases in population that occurred in many nations, including those relatively far along the demographic transition.

The apparent lack of direct relationships between the population growth index, and the indices of urbanization and trade are difficult to explain, except to refer to the roles of the other indices that are related to both. The division of labor appears to be especially significant since it is strongly related to both population growth to material technology, and its more substantial contribution to agricultural production, are also difficult to explain. Apparently declines in population growth have little direct significance to the achievement of relatively high technological levels. They do, however, contribute significantly to increases in agricultural productivity.

Agricultural Production

The attainment of relatively high levels on the index of agricultural production have been found to precede the achievement of relatively high levels of material technology and trade, and follow the attainment of relatively low levels of mortality. The temporal relationships of agricultural production with the remaining three indices may be viewed as those of more or less simultaneous change over time, or where changes in the division of labor and population growth have some slight temporal precedence over increases in agricultural production, and increases in agricultural production have some slight temporal precedence over increases in urbanization. The index of agricultural production has been found to have direct non-spurious relationships with all of the other indices in the models except trade. From the path coefficients of Figure 29 it can be seen that both mortality and the division of labor make modest contributions to agricultural production (coefficients of -.149 and .214 respectively), while the index of population growth make a more substantial contribution (coefficient of -.542). The index of agricultural production in turn makes moderate contribution to both material technology and urbanization (coefficients of .319 and .244 respectively).

Given the structure of Figure 29, it appears that increases in agricultural production are dependent on declines in mortality, an increasingly differentiated division of labor, and declines in population growth, although the temporal precedence of the last two indices are very slight at best. The direction contribution made by agricultural production to urbanization is quite reasonable, since relatively high levels of agricultural production would be necessary to support a proportionately large urban population. Admittedly, this ignores the question of food imports which may greatly supplement the food produced within a nation. However, the agricultural production index is not only comprised of two measures of crop yields, but also the average calorie intake per capita, which presumably should reflect in part supplemental food imports.

The temporal precedence of agricultural production over material technology is quite clear empirically, and this can be understood if material technology is taken as a crude indicator of the average state of material well-being within a nation. The temporal ordering of these two indices seems consistent with Rostow (1971:8) who has argued that changes in agricultural productivity are essential to successful industrial takeoff. Gill (1963:94-95) has also outlined the position that industrialization is dependent on inputs from agriculture. On the other hand, from a logical point of view, the possibility of technological changes affecting agricultural production seems quite reasonable. However, this study has not uncovered any evidence to support this. As already noted in terms of the relationship to mortality, the most appropriate technological measures may not have been included in the index of material technology, or the necessary changes in technology for increases in agricultural production may be relatively slight, and hence undetected.

It is also possible that the requisite technological changes have largely come in recent decades as external input from more-developed nations, rather than as a function of internal advances.

The lack of direct relationship between agricultural production and trade may seem a little surprising, particularly if it is assumed that high agricultural productivity levels increase the probability of an agricultural surplus, which in turn may be disposed of through external trade. However, most of the nations with both high trade and agricultural productivity levels are relatively small (in area) European nations. It is possible, given a limited natural environment and a relatively dense population, that these nations are forced to maximize their agricultural output, without producing much of a surplus, as well as having to rely heavily on trade for economic survival. Thus, the lack of a direct link between the two indices may be reasonable. Other conditions not incorporated in the model, such as the characteristics of the natural environment, may be important to both.

Urbanization

The attainment of relatively high levels of urbanization has generally been found to precede the achievement of relatively high levels of material technology and trade, and follow the attainment of relatively low levels of mortality. The temporal relationships of urbanization and the remaining three indices can be viewed as those of more or less simultaneous change over time, or where changes in the indices of population growth, agricultural production and the division of labor have some slight temporal precedence over increases in urbanization. The index of urbanization has been found to have non-spurious relationships with the indices of the division of labor, agricultural production, and material technology. Its relationships with mortality, population growth, and trade have been found to be essentially spurious. From the path coefficients of Figure 29, it is evident that the division of labor makes a rather substantial contribution to urbanization (coefficient of .642), while agricultural production makes a more modest contribution (coefficient of .244). The contribution made by urbanization to material technology is very small (coefficient of .040).

From the models it is apparent that declines in mortality have little direct significance for increases in the degree of urbanization, although changes in the division of labor may play an important intervening role between the two. Increases in agricultural production may also play such an intervening role, although one of less importance. As already noted these relationships are reasonable given the need to supply a large urban population with agricultural products, and given the fact that a proportionately large urban population is virtually impossible while a nation's labor force is relatively undifferentiated and primarily engaged in agricultural activities.

The very small direct contribution made by urbanization to material technology, and the lack of a direct relationship between urbanization and trade, may be sensible in the context of over-urbanization, if as previously suggested, the relationships between urbanization and these two indices have been changing over time. The plots for these two relationships apparently reveal two divergent trends. One primarily involves more-developed nations, where major gains began to occur in material technology and trade after only moderate levels of urbanization were reached. The other trend, primarily involving recently developed nations and nations which are still relatively less-developed, is where relatively high levels of urbanization have been reached (or apparently will be reached) before major gains occur in material technology and trade. Nations following the latter trend which have reached relatively high urbanization levels, but have not yet made major gains in material technology and trade, could be considered over-urbanized. For example, consider the positions of Mexico and South Korea in Figures 10 and 11. The two divergent trends suggest that the relationships between urbanization and material technology, and urbanization and trade, may have been changing over time. Once, as in the first trend, the relationships may have been relatively linear (or a gentle curve), while in recent decades the relationships may have become more sharply curvilinear. Hence, the attainment of a certain level of urbanization may have once been more directly important to advances in material technology and trade than has been the case in more recent decades. One source of this change may lie in the nature of the changes in the division of labor within a nation.

Material Technology

The attainment of relatively high levels on the index of material technology has been found to follow the achievement of relatively low levels of mortality and population growth, and relatively high levels of urbanization, agricultural production, and the division of labor. The temporal relationship between material technology and trade can be viewed as one of more or less simultaneous change over time, or where changes in material technology have some slight temporal precedence over changes in trade. The index of material technology has been found to have non-spurious relationships with all of the other indices in the models, except mortality. From the path coefficients in Figure 29 it can be seen that the indices of population growth and urbanization make very small contributions to material technology (coefficients of -.099 and .040 respectively), while the indices of agricultural production and the division of labor make more substantial contributions (coefficients of .319 and .445 respectively). Material technology in turn makes a substantial constribution to trade (coefficient of .586).

Material technology lies at or near the end of the temporal sequence of development outlined in the models. As such it can, perhaps, be viewed as a kind of developmental end state. Not so much in terms of nations reaching a given level of material technology, and then no longer developing on this, or other indices, but rather in the sense that relatively high levels of material technology are reached only after a series of major changes in five other indices. The index of material technology can perhaps be viewed as being indicative of the average state of material, or economic, well-being within a nation. If so, then its position near the end of the temporal sequence of development is reasonable. First, consider the kinds of variables comprising this index. High per capita levels of motor vehicles, telephones, newspaper circulation, energy use, etc., are only likely to be found in nations with a relatively high material standard of living. Also consider that many of the variables comprising this index have been found by other studies to be closely associated with commonly used measures of economic level, such as GNP per capita (see for example Berry, 1961:113; Russett, 1968:323; Rummel, 1972:224; Adelman and Morris, 1967). Thus, the interrelationships in this study found to occur prior to the attainment of relatively high levels of material technology can be viewed as contributing to the attainment of a relatively high material standard of living within a nation.

The rather small direct contribution made be devlines in population growth to gains in material technology suggest that such declines are not of great direct significance to the achievement of relatively high technological levels. Apparently the role of other indices, such as the division of labor, are important to both. Certainly the substantial contribution of the division of labor makes more sense, since it seems unlikely that high levels of material technology can be reached until there are substantial shifts in the labor force out of agricultural activities, and into secondary and tertiary activities. The very small contribution of urbanization to material technology is reasonable, if as already mentioned, the relationship between the two has been changing over time, where the attainment of a given level of urbanization may no longer insure, by itself, the attainment of high levels of material technology.

Trade

The attainment of relatively high levels on the index of trade have been found to follow the attainment of relatively low levels of mortality and population growth, and relatively high levels of urbanization, agricultural production, and the division of labor. The temporal relationship between material technology and trade can be viewed as one of more or less simultaneous change over time, or where increases in material technology have some slight temporal precedence over increases in trade. The index of trade has been found to have direct non-spurious relationships with the indices of the division of labor and material technology. The relationships of trade with mortality, population growth, agricultural production, and urbanization have been found to be essentially spurious. From the path coefficients in Figure 29 it can be seen that material technology makes a substantially greater contribution to trade than does the division of labor (coefficients of .586 and .245 respectively).

The relationship between the division of labor and trade appears to be quite reasonable. As the labor force of a nation becomes more differentiated and specialized it seems reasonable to expect an increased need for a wider variety and larger amount of both natural materials and man-made goods. As these needs increase it seems probable that it becomes increasingly difficult for them to be met from within the confines of a nation. Hence levels of trade are likely to increase in response to increased differentiation of the labor force. A similar situation may also apply to the relationship between material technology and trade. The more advanced a nation's technology, the more likely the need for a greater variety and amount of materials; also, the greater the need for external outlets of material technology. Thus, the higher the level of material technology, the higher the probability of substantial external trade. In any case it is apparent that the level of material technology within a nation is of greater and more immediate significance to trade levels, than is the division of labor. In a general sense, it is clear that development along a number of different indices leads to increased interdependence between nations.

The lack of direct (non-spurious) relationships between trade and the indices of mortality, population growth, agricultural production, and urbanization are difficult to explain. Clearly the four indices have little direct significance to the achievement of high levels of trade. As metnioned before, high agricultural levels might be expected to contribute directly to trade, but no empirical evidence was uncovered to support this. In general, the intervening roles of the division of labor, and especially material technology must be referred to. It appears that these four indices may have major significance only within the context of the internal conditions of a nation, and not its external relations.

CHAPTER IX

SUMMARY AND CONCLUSION

The basic purpose of this study has been reasonably fulfilled. Substantial empirical information describing the nature of the interrelationships between seven different aspects of the ecological complex have been analyzed within the context of the development of nations. The interrelationships have been analyzed in terms of association, temporal sequence of change, and spuriousness. From this analysis two models were built which describe at least some of the processes apparently involved in the development of nations over time. Path coefficients were derived for the latter model as well. While some of the information described in this study simply serves to support the findings of previous research, the analysis of temporal relationships contributes new and significant information not found in the existing literature.

Several significant findings are apparent from the analysis of temporal relationships across nations. First, demographic transition theory appears to be supported by some of the relationships found in this study, despite recent suggestions by several individuals (Arriaga, 1970; Davis, 1967; Peterson, 1969) that it may not be applicalbe to contemporary developing nations. The finding that substantial declines in the index of population growth appears to support the demographic transition, at least in a general sense. Also, some evidence has been found which suggests that changes in the division of labor may intervene between the changes in these two demographic indices. Changes in the division of labor may, thus, be important to the completion of the demographic transition. There is very clear evidence that changes in these three indices precede the attainment of relatively high levels of material technology. This is of interest, if, as previously noted, the index of material technology can be viewed as an indicator of the average material standard of well-being within a nation. Thus it can be seen, as in Figure 29, that declines in mortality act as an antecedent factor, contributing substantially to an increasingly differentiated division of labor, which in turn contributes substantially to declines in population growth, and increases in material technology. This sequence of change appears to be compatible with the general outline of the demograph transition, where declines in mortality are supposed to occur first, contributing to an increase in population growth, and ultimately followed by fertility declines, which reduce the rate of population growth as a nation develops. The period of population increase that is associated with mortality declines can perhaps be observed in the large majority of nations that experienced increases on the index of population growth between 1950 and 1960. Between 1960 and 1970 a substantial majority of nations experienced declines in the index of population growth. Together the two trends on the population growth index may reflect movement along the demographic transition. In any case, the demographic transition suggests that decreases in mortality, as well as decreases in population growth, tend to occur before a nation becomes highly developed, and this sequence is quite consistent with the findings of this study. One aspect of the demographic transition which has not been considered by this study is the amount of time required to accomplish these changes.

In addition to the possibility that changes in the division of labor may play an important role in the completion of the demographic transition, it appears that changes in the division of labor play an important role more generally in the process of development. This conclusion is based on the following: the division of labor was the only index found to have clear non-spurious relationships with all of the other indices; it was found to be a major control variable in the partial correlation analysis, and most of the path coefficients associated with the division of labor in Figure 29 were found to be rather substantial. These findings seem to support the dominant emphasis of the ecological literature on sustenance-organization, although the emphasis of some of this literature on organization as a dependent variable seems misplaced. From this study the division of labor (organization) appears to have more value as an explanatory factor, since changes in only one of the indices used here were found to clearly precede changes in the division of labor.

The very clear temporal sequence of change between the indices of the division of labor and material technology has some interesting implications. If the index of material technology can be viewed as an indicator of the average standard of material well-being within a nation, then it is evident that changes in the division of labor are crucial to the attainment of high material standards. However, while there is a direct effect from the division of labor to material technology, the division of labor is also related to a number of other indices, such as population growth, agricultural production, and urbanization, which in turn effect material technology as well.

Because of the very clear temporal differences between changes in the indices of the division of labor and material technology, it appears that caution should be exercised whenever variables from either, or both, of the two realms are used to represent the level of industrialization or economic development within a nation. In some studies variables from both realms are found together in one dimension judged to be representative of economic level. For example, consider the major dimensions of Rummel (1972:224), Russett (1968: 323-24), and Schnore (1961). Variables from both realms obviously load together on these dimensions because they are highly associated, however there is a difference between the two which is significant. In studies such as Sovani (1964) which deals with over-urbanization, an organizational measure (percent in agricultural activities) is used to represent industrialization. In other studies, such as Hill (1974) which also deals with over-urbanization, a technological measure (per capita energy consumption) is used to represent industrialization. The point is that measures from these two realms are not completely interchangable, since major changes in one clearly precedes in time major changes in the other. Granted that measures from the two realms are usually highly associated, but in light of the temporal differences the most reasonable approach seems to be to keep them distinct. It may be that changes in the division of labor are more significant at an earlier stage of development, while changes in material technology are more significant at a later stage. In any case, future studies desiring to operationalize industrialization, or economic development, could benefit from the temporal distinction found between these two realms.

The temporal relationships found between the indices of urbanization and material technology, and urbanization and the division of labor, have some interesting implications for the idea of over-urbanization. Once again, over-urbanization refers to a condition where a nation has a higher level of urbanization than would be expected given its level of development on other dimensions. Thus over-urbanized nations represent deviations from an expected linear relationship between urbanization and other developmental measures. The variable most commonly used to judge over-urbanization is an organizational measure, the percent in agricultural activities (see Davis and Golden, 1954; Sovani, 1964), although technological measures have also been used (see Hill, 1974). From the preceding paragraph it should be evident that it makes a substantial difference whether organizational or technological measures are used to judge over-urbanization. Consider that the relationship between urbaniztion and material technology was found to be rather sharply curvilinear, while the relationship between urbanization and the division of labor was found to be essentially linear (or at best a gentle curve). Because of this difference, considerably more nations would be judged as over-urbanized if technological measures were used, in comparison with organizational measures where substantially fewer nations would be judged as over-urbanized. This is so because over-urbanized nations essentially represent major deviations from a linear regression line, and the more curvilinear the relationship, the more deviations from a linear fit. Perhaps, all the term over-urbanization really means is the presence over time of a curvilinear relationship between urbanization and other developmental indices.

The two divergent trends found within the plot of urbanization and material technology suggest that the relationship between these two indices may have been changing over time. The change apparently involves a shift from a more linear relationship (or gentle curve), experienced primarily by more-developed western nations, to one that is more sharply curvilinear, and which appears to be the course of development for many contemporary less-developed non-western nations. This shift can be viewed in terms of many less-developed nations becoming over-urbanized with respect to material technology, at least for a time, until these nations progress around the bend in the curve and begin to make major gains in material technology, as some have done like Japan. The increasingly curvilinear relationship may explain why Hill (1974) found decreasing correlations between urbanization and various technological measures, at five succeeding points in time, for 57 nations between 1946 and 1966. For succeeding points in time the relationship between urbanization and technology becomes increasingly curvilinear, and hence it is not surprising to find that linear-based correlations decrease.

The nature of the curvilinear relationship between urbanization and material technology can perhaps be explained by the contention of several individuals (for example Sovani, 1964; Moore, 1969) that recently there have been shifts out of low-productivity agricultural activities, in many less-developed nations, into low-productivity non-agricultural activities of primarily a tertiary nature. First consider the apparent change in the relationship over time between urbanization and material technology found in this study, assuming for the moment that relatively high levels of material technology imply relatively high levels of production. If nothing else, the effects of urbanization on material technology have probably become less immediate. And it is also possible that these effects have been decreasing in strength (consider the low path coefficient in Figure 29 between urbanization and material technology). Thus, changes in urbanization may have once had a greater and more immediate effect on advances in material technology than is the case today for many developing nations. A reasonable explanation for this apparent change may lie in the kinds of changes which have been occurring within the division of labor. Presumably, the historical experience of the more-developed western nations was one of the shifts out of agricultural activities, largely into secondary activities of a highly productive nature, and hence contributing more directly to increases in material technology. If the shifts out of agriculture in many less-developed nations today are more likely to be directly into less-productive tertiary activities, then the change in the relationship between urbanization and material technology is sensible. As long as there are shifts out of agriculture, irrespective of whether they are mainly into secondary or tertiary activities, there is likely to be an increase in the level of urbanization. This also means that the nature of the relationship between urbanization and the division of labor should not be expected to change over time. However, if the shifts out of agriculture are increasingly into tertiary activities, rather than secondary activities, then the relationship between urbanization and material technology should be expected to change; to one suggesting that urbanization has less immediate and strong effects on material technology. In other words, the increasingly curvilinear relationship between urbanization and material technology may be due to changes in the kinds of shifts occurring within the division of labor. Unfortunately, the division of labor index in this study is comprised of both secondary and tertiary measures and hence cannot reflect such differences in the kinds of changes taking place within the division of labor.

The general findings of this study seem to clearly suggest that the ecological complex provides one legitimate and useful perspective from which to view development. Certainly, the composite indices derived from the ecological complex provide meaningful distinctions between nations. Seven of these indices clearly represent continua of development among nations where it has been shown that nations move along the continua over time. It must be admitted that similar indices could have been derived without using the ecological complex. Indeed, the primary utility of the ecological complex has been to provide a reasonable framework in the initial stages of analysis. Other frameworks could have been used, and most probably similar results would have been obtained. Nevertheless, the ecological complex provides useful distinctions between different realms that are related to social change. One important distinction made by the ecological complex, that is not always found in other perspectives, is the clear differentiation between organization and material technology. This distinction has been empirically supported in this study by the very clear temporal differences found between the two.

The findings of this study may have value as a basis for an elaboration of the ecological complex. This could be done by dividing each of the parts of the ecological complex into several distinct areas. Indeed, it can be argued that the four parts need not be dealt with at all, but rather simply deal with a larger number of sub-areas. Such an elaboration would provide a more complete view of interrelationships within the complex. While the various dimensions identified in this study should not necessarily be viewed as all inclusive, they would provide a useful starting point for such an elaboration of the ecological complex.

With respect to the structure of relationships within the ecological complex, the findings of this study illustrates a system of relationships between a number of highly associated, but conceptually distinct parts, which together contribute to the development of nations over time. What has been found is a temporal sequence of change within this system, where certain changes tend to occur before others and where changes in some dimensions tend to be dependent on changes in others. Thus, the multi-dimensional view of development taken here suggests that development on certain dimensions tends to occur before development on others. Overall, the changes in this system reflect a kind of evolutionary process of development. For the most part, different nations, at different periods of time, apparently follow similar paths of development on a number of different dimensions. Thus, there is some basis for comparing the earlier developmental experiences of the more-developed nations with the experiences of contemporary less-developed nations. In other words, the process of development tends to be comparable over time. Possible exceptions to this may lie in the relationships between urbanization and material technology, and urbanization and trade. Aside from these exceptions, there certainly may be some other differences between the experiences of the less-developed and more-developed nations of today. One possible difference may lie in the pace (or rate) of change over time. This is one area which has not been explored in this study, and which could provide fruitful ground for further research.

In summary, this study illustrates the process of the development of nations in terms of a system of interrelated parts, where changes in some of the parts have clear temporal precedence over others and where certain changes are dependent on others. It is apparent that this process of development includes declines in mortality and population growth over time, an increasingly differentiated division of labor, increases in the level of agricultural production, urbanization and material technology, and increased interdependence between nations (trade). These changes apparently have varying degrees of importance at different stages of development, and it is evident that the interrelationships between them become more complex with the passage of time.

FOOTNOTES

CHAPTER II

[1] The relationship of ecological factors to the process of development is perhaps more explicit in a later work by Duncan (1964), where societal evolution is dealt with.

[2] It can be argued that cross-national studies have commonly relied upon static data because comparable measures over several points in time have not generally been available. While this is essentially true for "early" studies, such as those using circa 1950 data, it is not generally the case for more recent works using circa 1960 or 1970 data. For the latter works, data at two or three points in time is available for a substantial number of nations over a wide range of variables, if a through search of secondary sources is made.

CHAPTER IV

[1] The use of ratio measures may present certain problems because such ratios are potentially responsive to two different sources of variation, the numerator and denominator (Cartwright, 1969:160). When ratios are included in a correlation, such that there are common elements in both the dependent and independent variables, part of the resultant correlation may be attributed to these common elements. Whether or not this constitutes a serious problem depends on whether interest lies in the actual ratio scores, or in the component variables. It has been argued (Fuguitt and Lieberson, 1974:132-33) that when interest lies in the actual ratio scores, rather than the components, there is not much of a problem. Obviously, the interest of this study lies in the ratio scores since absolute values have little meaning when compared across nations with differences in population size.

[2] This variable measures the degree of dispersion among different sustenance activities. It has been used in several different studies to represent the division of labor (Gibbs and Martin, 1962; Labovitz and Gibbs, 1964; Gibbs and Browning, 1966; also see Rushing and Davies, 1970; Mueller, Schuessler and Costner, 1970; Clemente, 1972; Gibbs and Poston, 1975). It is derived from the formular: $D=1-(\Sigma x^2/(\Sigma x)^2)$, where D represents the degree of dispersion among activities, and x is the number of individuals in each activity. The measure is at a maximum when all individuals are evenly distributed among the different activities, and hence it can be assumed that the larger the D for a nation, the greater the differentiation among sustenance activities. The measure is at a minimum, always zero, when all individuals are found in one activity. Such a situation is obviously never likely to be found in actuality. Unfortunately, the maximum possible value for this measure varies with the number of

different categories of activity that are used. This can be corrected for, however, by dividing D by 1-1/n, where n is the number of categories (Labovitz and Gibbs, 1964:6). This correction has been carried out in this study because of a few nations which have industrial distributions at variance with the standard of ten categories.

CHAPTER V

[1] The use of factor analysis in this study should not be over-emphasized. Upon reflection, it appears to the author that similar findings would have resulted if factor analysis had not been used to construct composite scores, and a simpler method had been followed. Such a method might include identifying significant factors simply from theory and previous research, and creating composite scores by averaging standardized values without any weighting.

[2] The factor analyses undertaken in this study were executed by the BMD08M computer program from Biomedical Computer Programs (Dixon, 1974).

CHAPTER VI

[1] When correlations based on aggregate units are used in a study, it is almost standard procedure to refer to the issues brought forth in Robinson's (1950) classic statement on ecological correlations. Robinson made the very valid point that it is not legitimate to make inferences to individuals from correlations based on aggregate data. However, not all studies using aggregate data are concerned with explaining individual behavior. In many instances aggregate units are of interest, and meaningful, in their own right. Such is the case with this study. The concern is solely with differences between, and changes within nations.

[2] Because of the negative loadings on variables comprising the agricultural production and division of labor dimensions, the composite scoes for these dimensions have negative values for higher levels of development. The measures of association shown in Tables 8 and 10 have been corrected for this by reversing the signs, so that the relationships can be more meaningfully interpreted.

[3] Since development has been defined in this study in terms of change over time in a specified direction, higher levels of development refer to higher values on the indices of material technology, the division of labor, urbanization, agricultural production, and trade, and lower values on the indices of mortality and population growth.

[4] This is not strictly true. For example, regression coefficients could be derived for each pair of indices, and curvilinear correlations could be calculated. However, such measures really fall under the realm of association.

[5] It is obvious that a number of technical violations have occurred in this study with respect to the linearity assumptions underlying the use of partial correlation, simple correlation, and factor analysis. Since considerable attention has been given to several curvilinear relationships among the seven indices, it may seem peculiar that linear based techniques have been relied upon. The following may serve to clarify the situation. First, with respect to simple correlations, various curvilinear correlation programs could have been run. It seems probable that one or more such programs would have produced correlations which on the average would have been higher than those found in Table 8. Thus, the correlations within Table 8 can be viewed as conservative representations of the strength of association between the seven indices. Even as such, however, they are rather substantial. In addition, given a choice between conservative and over-estimated correlations, the former seems preferable. With respect to partial correlations and factor analysis it would be very questionable to base these procedures on zero-order curvilinear correlations; hence their use required linear-based correlations. While the plots reveal clear curvilinear forms in some instances, all of the curves are rather simple in form, and as such it is not difficult to imagine stragiht lines being fitted to these plots. Finally, it could have been possible to reduce the curvilinearity of some of these plots through the use of various data transformation procedures (see Rummel, 1972:171-195). However, because such transformations would have tended to hide the curvilinear relationships, the inferences of time order so central to this study could not have been made. Thus, the linearity violations made in this study do not appear to be too serious, and were in any case unavoidable. Judgments of linearity are almost always relative, and sociological literature is replete with linearity violations. The most unique, and crucial aspect of this study, the inferences of time order, remain unaffected by these violations.

APPENDIX

Table 1. Nations Used in Study and Years of Data Collection

Nations	Years	Nations	Years
1) Algeria	48-56-66	30) Italy	51-61-71
2) Argentina	47-60-70	31) Japan	50-60-70
3) Australia	54-61-71	32) South Korea	55-60-71
4) Austria	51-61-71	33) Luxembourg	47-60-66
5) Barbados	46-60-70	34) Mauritius	52-62-71
6) Belgium	47-61-71	35) Mexico	50-60-70
7) Brazil	50-60-70	36) Morocco	52-60-71
8) British Honduras	46-60-69	37) Netherlands	47-60-70
9) Bulgaria	46-65-70	38) New Zealand	51-61-71
10) Canada	51-61-71	39) Nicaragua	50-63-71
11) Ceylon	53-63-73	40) Norway	50-60-70
12) Chile	52-60-70	41) Pakistan	51-61-71
13) Colombia	51-64-70	42) Panama	50-60-70
14) Costa Rica	50-73-73	43) Philippines	48-60-70
15) Cyprus	46-60-72	44) Poland	50-60-70
16) Czechoslovakia	50-61-71	45) Portugal	50-60-70
17) Denmark	50-60-70	46) South Africa	51-60-70
18) Dominican Republic	50-60-70	47) Spain	50-60-70
19) El Salvador	50-61-71	48) Sweden	50-60-70
20) Fiji	46-56-66	49) Switzerland	50-60-70
21) Finland	40-60-70	50) Thailand	54-60-70
22) France	54-62-71	51) Trinidad & Tobago	54-60-71
23) West Germany	50-61-71	52) Turkey	50-60-70
24) Greece	51-61-71	53) Egypt (U.A.R.)	47-60-66
25) Guatemala	50-64-73	54) United Kingdom	51-61-66
26) Guyana	46-60-65	55) United States	50-60-70
27) India	51-61-71	56) Venezuela	50-61-71
28) Ireland	51-61-66	57) Yugoslavia	53-61-71
29) Israel	55-61-71		

Table 2. Variables, Variable Codes, Sources of Data, and Percent of Missing Cases for Each Variable.

Variables	Code	Data Source	% Miss. Cases
Population:			
1) Population Size	POP	A	0
2) Crude Birth Rate	CBR	A,E,H,J	6
3) Crude Death Rate	CDR	A,E,K	9
4) Crude Rate of Natural Increase	NATINC	A,E,J,K	9
5) Child-Woman Ratio[a]	CHWO	A	5
6) Infant Mortality Rate	INFMORT	A,E,H,J,K,M	10
7) Average Annual Rate of Population Increase	POPINC	A,E,I	0
8) Life Expectancy, Males	LEM	A,K	23
9) Life Expectancy, Females	LEF	A,K	23
10) Dependency Ratio	DR	A,C	2
11) Youth Dependency Ratio	YDR	A,C	2
12) Old Age Dependency Ratio	OADR	A,C	2
13) Population Density	DEN	B	0
14) Population Density per ha. of Arable Land	DENARAB	A,D	0
15) Agricultural Workers per 1000 ha. of Arable Land	AGARAB	C,D	1
16) Percent of Population in Localities of 100,000 or more	%100+	G	12
17) Percent of Population in Localities of 20,000 or more	%20+	A.E.F.I	15
18) Percent Rural	RURAL	G	0
19) Urban Primacy[b]	PRIM	A,F,G	12
Environment:			
20) Imports per Capita, U.S.$	IMPORTS	B	0
21) Exports per Capita, U.S.$	EXPORTS	B	0
22) Total Trade (Imports+Exports) per Capita U.S.$	TOTRADE	B	0
23) Goods Loaded in International Sea-Borne Shipping, Metric Tons per 1000	GBSLD	B	9
24) Goods Unloaded in International Sea-Borne Shipping, Metric Tons per 1000	GDSUNLD	B	9
25) Arable Land, ha. per Capita	ARABLE	A,D	0
26) Percent of Total Land Area that is Arable	%ARAB	D	0
27) Wheat Yields, 100 kgs per ha.	WHEAT	D	24
28) Rice Yields, 100 kgs per ha.	RICE	D,L	36

Table 2. continued (2)

Variables	Code	Data Source	% Miss. Cases
29) Wheat Yields, 100 kgs. per ha.	WHEAT	D	24
30) Average Calories per capita	CALOR	B,D,L	11
31) Iron Ore Production, metric tons per 1000	IRON	B	30
Technology:			
32) Energy Consumption, per capita	ENERGY	B	0
33) Electrical Energy, Installed Capacity, kws. per 1000	EEIC	B	0
34) Electrical Energy Production, kws. per capita	EEPROD	B	1
35) Steel Consumption, kgs. per capita	STEEL	B,I	10
36) Passenger Vehicles per 1000	PASSVEH	B,F	2
37) Commercial Vehicles per 1000	COMVEH	B,F	2
38) Total Vehicles per 1000	TOTVEH	B,F	2
39) Railroad Freight Volume, net-ton-kilometers per capita	RRFGT	B	13
40) Tractors per 1000	TRACT	B,D	2
41) Tractors per 1000 ha. of Arable Land	TRACTARAB	B,D	1
42) Telephones per 1000	PHONES	B	1
43) Newsprint Consumption per capita	NEWSPRT	B,E	1
44) Daily Newspaper Circulation per 1000	NEWSCIR	B	2
45) Domestic Mail per capita	MAIL	B,F,M	0
46) Primary School Enrollment per 1000	PS1000	B,E,F,	)
47) Secondary School Enrollment per 1000	SS1000	B,F	0
48) University and College Enrollment per 1000	UNIV	B,E,F,M	4
49) Number Enrolled in Primary School as a Percentage of Those Aged 5-14	%PS	A,B,E	5
50) Number Enrolled in Secondary School as a Percentage of Those Aged 15-19	%SS	A,B,E	3
Organization:			
51) Dispersion Among Industries	D-I	C	0
52) Percent in Agriculture and Related Industries	%AGRI	C	1
53) Percent in Manufacturing Industries	MANUFACT	C	2

Table 2. continued (3)

Variables	Code	Data Source	& Miss. Cases
54) Percent in Service Industries	SERVICE	C	2
55) Percent in Primary Industries[c]	PRIMARY	C	2
56) Percent in Secondary Industries[d]	SECOND	C	0
57) Percent in Tertiary Industries[e]	TERT	C	1
58) Percent Employers or Workers on Their Own Account	EMPLOY	C,E	9
59) Percent Wage & Salary Earners	W+S	C,E	9
60) Relative Size of Productive Associations[f]	PRODSIZE	C,E	9
61) Percent of Total Population that is Economically Active	TOTEA	C	2
62) Percent of Males that are Economically Active	MALEEA	C	2
63) Percent of Females that are Economically Active	FEMEA	C	2

[a] population 0-4 years / females 15-49 years (Bogue, 1969:662).

[b] population of largest locality of 100,000 or more / total population in all localities of 100,000 or more.

[c] includes agriculture, forestry, hunting, fishing, mining and quarrying industries.

[d] includes manufacturing and construction industries.

[e] includes electricity, gas, water, and sanitary service, commerce, transportation, communications, and service industries.

[f] percent wage and salary earners / percent employers and workers on their own account.

Data Sources:

A: Demographic Yearbook (United Nations, 1951-1973).
B: Statistical Yearbook (United Nations, 1948-1974).
C: Yearbook of Labour Statistics (International Labour Office, 1949-1974).
D: Production Yearbook (Food and Agriculture Organization of the United Nations, 1952-1972).
E: Compendium of Social Statistics, 1967 (United Nations, 1968).
F: Cross-Polity Time Series Data (Banks, 1971).
G: World Urbanization, 1950-1970, Volume I (Davis, 1969).
H: Principles of Demography (Bogue, 1969:586, 664-667).

Table 2. continued (4)

Data Sources: (continued)

I: Atlas of Economic Development (Ginsburg, 1961).
J: Population Program Assistance (Agency for International Development, 1970:172-178).
K: World Population and Analysis of Vital Data (Keyfitz and Flieger, 1968).
L: World Crop Statistics: Area, Production and Yield (Food and Agriculture Organization of the United Nations, 1966).
M: World Handbook of Political and Social Indicators (Taylor and Hudson, 1972)

Table 3. Loading Order of Nineteen Population Variables on Orthogonal Factors

Variables	Orthogonally Rotated Factors F1	F2	F3	F4
NATINC	(.956)	.153	-.007	-.178
YDR	(.935)	.140	-.008	-.243
DR	(.918	.114	-.017	-.209
CHWO	(.915)	.144	-.055	-.224
CBR	(.871)	.386	-.009	-.249
POPINC	(.835)	-.047	-.113	.096
OADR	(-.733)	-.227	-.043	.324
CDR	.078	(.898)	-.004	-.271
LEM	-.434	(-.804	.024	.327
LEF	-.510	(-.758)	.014	.346
INFMORT	.377	(.752	-.015	-.317
DENARAB	-.053	-.054	(.875)	.164
AGARAB	.159	.167	(.763)	-.197
DEN	-.164	-.007	(.696)	.147
%100+	-.234	-.224	-.010	(.878)
RURAL	.359	.317	.092	(-.762)
%20+	-.070	-.153	.167	(.760)
POP	-.066	.466	.090	.130
PRIM	.337	-.253	-.211	-.429
variance explained:	47.2%	13.0%	10.4%	6.8%

Table 4. Loading Order of Twelve Environmental Variables on Orthogonal Factors

	Orthogonally Rotated Factors		
Variables	F1	F2	F3
TOTRADE	(.952)	-.149	.199
IMPORTS	(.948)	-.145	.50
EXPORTS	(.934)	-.151	.247
FDSUMLD	(.809)	.005	.071
WHEAT	(.790)	-.211	-.422
MAIZE	(.653)	(-.613	-.205
RICE	.090	(-.827)	-.112
CALOR	.480	(-.647)	-.101
GDSLD	.320	.167	.604
IRON	.325	-.129	.516
ARABLE	-.192	-.465	.455
%ARAB	.606	0.095	-.371
variance explained:	44.6%	13.5%	9.2%

Table 5. Loading Order of Nineteen Technological Variables on Orthogonal Factors

Variables	Orthogonally Rotated Factors F1	F2
PHONES	(.953)	.056
TOTVEH	(.941)	.206
PASSVEH	(.938)	.181
NEWSPRT	(.913)	.116
ENERGY	(.891)	.146
STEEL	(.891)	.105
MAIL	(.881)	.035
EEPROD	(.862)	-.004
TRACT	(.857)	.083
EEIC	(.853)	-.056
COMVEH	(.838)	.293
NEWSCIR	(.783)	-.065
TRACTARAB	(.689)	-.163
UNIV	(.683)	.305
SS1000	.622	.311
RRFGT	.603	.274
%PS	.019	(.687)
%SS	.114	(.654)
PS1000	.007	.374
variance explained:	59.7%	6.9%

Table 6. Loading Order of Thirteen Organization Variables on Orthogonal Factors

Variables	Orthogonally Rotated Factors F1	F2
%AGRI	(.980)	-.093
PRIMARY	(.977)	-.105
TERT	(-.901)	-.080
D-I	(-.890)	-.074
W+S	(-.879)	.120
SECOND	(-.834)	.422
SERVICE	(-.823)	-.205
MANUFACT	(-.782)	.466
EMPLOY	(.690)	.395
PRODSIZE	-.608	.293
TOTEA	-.023	(.966)
FEMEA	.026	(.847)
MALEEA	-.144	(.727)
variance explained:	57.6%	19.7%

Table 7. Composite Scores on Ten Ecological Dimensions, For 57 Nations Circa 1950, 1960, 1970

Nations	Dimensions[a] (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Circa 1950:										
1) Algeria	.45	1.91	-.30	-.74	-.47	.48	-.52	-.30	.20	1.15
2) Argentina	-.20	.11	-.54	.63	-.22	-.11	-.25	-.12	.20	-.40
3) Australia	-.37	-.48	-.57	1.02	-.06	-.64	.66	.00	.26	-.72
4) Austria	-1.02	.04	.04	.25	-.22	-.11	-.14	-.04	.95	-.24
5) Barbados	-.23	1.05	.77	.12	-.32	.17	-.46	-.07	.95	-.41
6) Belgium	-.98	.10	.58	.15	.11	-.24	.06	-.01	.26	-.61
7) Brazil	.59	1.18	-.19	-.46	-.51	.34	-.49	-.25	-.48	.54
8) Brit. Hond.	.13	.98	-.57	-.14	-.31	.24	-.52	-.09	-.33	.09
9) Bulgaria	-.83	.45	-.11	-.75	-.57	.16	-.40	-.12	1.90	.97
10) Canada	-.24	-.39	-.57	.31	.30	-.31	.95	-.01	-.05	-.57
11) Ceylon	.53	.11	.38	-.95	-.49	.57	-.52	-.10	-.20	.39
12) Chile	.12	.72	-.43	.14	-.36	.16	-.40	-.12	-.12	-.27
13) Colombia	.60	1.10	.04	-.16	-.51	.34	-.51	-.26	-.45	.43
14) Costa Rica	.64	.45	-.25	-.64	-.37	.49	-.46	-.20	-.39	.34
15) Cyprus	-.20	-.22	-.25	-.73	-.50	.16	-.50	-.10	-.11	.30
16) Czechslov.	-.79	.06	-.14	-.44	-.26	-.03	-.12	-.06	.91	-.06
17) Denmark	-.66	-.43	-.27	.42	.31	-.41	.05	-.01	.90	-.47
18) Domin. Repub.	.83	--	-.05	-.85	-.48	.47	-.53	-.22	.07	.85
19) El Salvador	.65	.66	.01	-.69	-.49	.42	-.54	-.25	-.26	.65
20) Fiji	.82	.19	-.33	-.90	-.46	.53	-.53	-.14	.02	.24
21) Finland	-.36	-.06	-.34	-.40	-.25	-.51	-.19	-.06	.99	.14
22) France	-.86	-.19	-.25	.03	-.11	-.09	.09	-.05	.60	-.33
23) W. Germany	-.77	-.20	.32	.70	-.22	-.12	-.10	.06	.77	-.48
24) Greece	-.51	-.53	-.21	-.14	-.49	.16	-.49	-.08	-.05	.40
25) Guatemala	.70	1.34	-.25	-.80	-.57	.80	-.54	-.28	-.32	.92
26) Guyana	.25	.73	-.27	-.57	-.09	.34	-.51	-.12	-.33	.22
27) India	.10	2.36	-.06	-.95	-.61	.71	-.56	-.26	.05	1.04
28) Ireland	-.65	.02	-.24	-.19	-.06	-.75	-.20	.02	.41	-.00
29) Israel	.17	-.56	-.02	.62	-.19	-.23	-.26	-.05	-.33	-.66
30) Italy	-.70	-.11	.03	-.09	-.35	-.20	-.34	-.13	.52	.04
31) Japan	-.03	.19	2.24	.24	-.44	.04	-.37	.01	.45	.31
32) S. Korea	.55	1.02	1.75	-.58	-.58	.33	-.55	-.13	-.16	1.65
33) Luxembourg	-1.00	.13	-.07	.10	-.06	-.20	.08	-.12	.76	-.45
34) Mauritius	.71	.67	.57	-.47	-.24	.31	-.50	-.19	-.52	-.09
35) Mexico	.69	.92	-.36	-.33	-.53	.38	-.46	-.23	-.52	.66
36) Morocco	.26	--	-.39	-.58	-.52	.05	-.53	-.32	.03	1.22
37) Netherlands	-.27	-.50	.69	.56	-.06	-.13	-.11	-.01	.18	-.51
38) New Zealand	-.27	-.45	-.18	.45	.56	-.56	.62	.00	-.02	-.60
39) Nicaragua	.61	--	-.39	-.65	-.51	.47	-.53	-.26	-.63	.81
40) Norway	-.72	-.51	-.14	-.21	.05	-.46	.22	-.06	.40	-.39
41) Pakistan	.10	--	.01	-1.09	-.55	.63	-.56	-.27	-.75	1.50
42) Panama	.61	.09	-.25	-.46	-.48	.51	-.41	-.15	-.33	.58
43) Philippines	.65	.81	-.08	-.79	-.53	.59	-.52	-.09	-.06	.94

Table 7. continued (2)

44) Poland	-.25	.27	-.21	-.27	-.41	-.05	-.34	-.09	1.05	.55
45) Portugal	-.44	.33	-.18	-.48	-.52	-.07	-.47	-.21	.12	.11
46) S. Africa	.20	--	-.39	-.20	-.38	.22	-.24	-.20	-.21	-.06
47) Spain	-.65	.08	-.32	.01	-.52	-.25	-.41	-.16	.12	.18
48) Sweden	-.83	-.46	-.38	-.05	.08	-.51	.34	-.03	.55	-.58
49) Switzerland	-.78	-.36	.57	-.11	.26	-.44	.19	-.09	.74	-.58
50) Thailand	.54	1.21	.10	-1.07	-.53	.51	-.54	-.19	1.06	1.67
51) Trinidad	.54	-.02	.09	-.63	.56	.70	-.32	-.07	-.26	-.33
52) Turkey	.45	--	-.29	-.83	-.54	.04	-.54	-.25	2.01	1.53
53) Egypt	.31	1.47	.60	-.40	-.40	-.04	-.53	-.26	-.22	.75
54) U. K.	-.96	-.24	.27	1.40	.13	-.39	.36	.01	.77	-1.00
55) U. S. A.	-.49	-.38	-.51	.53	-.32	-.16	1.42	.04	.14	-.75
56) Venezuela	.77	.11	-.38	-.19	-.18	.46	-.41	-.23	-.42	.17
57) Yugoslavia	-.22	.43	-.11	-.86	-.46	-.01	-.41	-.16	.74	1.01

Circa 1960:

58) Algeria	.52	--	-.35	-.60	-.45	.14	-.50	-.28	-.04	1.15
59) Argentina	-.32	-.24	-.50	.92	-.37	-.07	-.16	-.08	-.06	-.45
60) Australia	-.31	-.56	-.58	1.24	.06	-.70	1.05	.07	.16	-.76
61) Austria	-.91	-.24	-.02	.24	.25	-.39	.36	-.05	.86	-.51
62) Barbados	.14	-.19	1.22	.23	-.14	.26	-.36	-.04	.11	-.40
63) Belgium	-.88	-.35	.66	.16	.92	-.52	.42	.14	-.00	-.79
64) Brazil	.83	-.06	-.27	-.15	-.53	.22	-.41	-.18	-.56	.53
65) Brit. Hond.	.97	-.34	-.07	-.15	-.16	.59	-.44	-.01	-.76	.02
66) Bulgaria	-.81	-.53	-.21	-.35	-.01	-.17	.02	.01	1.17	.23
67) Canada	-.04	-.59	-.57	.54	.44	-.51	1.21	.06	-.29	-.76
68) Ceylon	.54	-.12	.56	-.92	-.49	.45	-.51	1.68	-.58	.36
69) Chile	.44	.52	-.37	.39	-.32	.10	-.34	-.08	-.55	-.34
70) Colombia	1.00	.30	-.15	-.08	-.50	.37	-.45	-.14	-.84	.23
71) Costa Rica	1.42	-.05	-.28	-.28	-.34	.43	-.37	-.07	-.82	.17
72) Cyprus	.05	-.77	-.34	-.42	-.22	.19	-.27	-.05	.28	-.07
73) Czechoslov.	-.71	-.49	-.15	-.34	.07	-.21	.16	-.01	.77	-.54
74) Denmark	-.80	-.55	-.28	.55	.88	-.53	.58	.02	.68	-.66
75) Domin. Rep.	1.04	.51	-.12	-.63	-.43	.29	-.51	-.13	-1.07	.78
76) El Salvador	.94	.39	.16	-.60	-.45	.42	-.50	-.18	-.56	.47
77) Fiji	1.09	-.30	-.28	-.87	-.28	.51	-.49	-.11	-1.08	.68
78) Finland	-.54	-.46	-.36	-.10	.22	-.40	.29	.03	.66	-.17
79) France	-.82	-.37	-.25	.28	.11	-.33	.50	.08	.38	-.55
80) W. Germany	-.83	-.34	.34	.87	.25	-.29	.51	.03	.89	-.75
81) Greece	-.66	-.48	-.14	.13	-.35	-.17	-.39	-.07	.46	.55
82) Guatemala	1.03	.87	-.12	-.63	-.48	.51	-.51	-.22	-.64	.76
83) Guyana	.99	-.02	-.56	-.30	-.16	.25	-.37	-.06	-.69	-.02
84) India	.37	1.51	.12	-.91	-.57	.49	-.55	-.17	.37	1.16
85) Ireland	-.61	-.29	-.29	-.05	.33	-.73	.09	.00	.08	-.14
86) Israel	.49	-.73	.05	1.18	.04	-.33	-.17	-.02	-.40	-.65
87) Italy	-.78	-.40	.01	.09	-.09	-.53	-.07	-.08	.16	-.30
88) Japan	-.56	-.46	1.79	.84	-.19	-.22	-.08	.04	.77	-.15

Table 7. continued (3)

89) S. Korea	.72	.82	1.51	-.40	-.54	.27	-.50	-.11	-.82	.90
90) Luxembourg	-.96	-.15	-.03	.16	.92	--	.74	-.09	.19	-.70
91) Mauritius	.85	-.01	.76	-.17	-.24	.19	-.46	-.06	-1.04	-.23
92) Mexico	.93	.24	-.33	-.05	-.47	.20	-.39	-.17	-.55	.39
93) Morocco	.70	1.17	-.38	-.46	-.54	.08	-.52	-.26	-.96	.78
94) Netherlands	-.40	-.71	.87	.55	1.10	-.47	.34	.07	-.18	-.83
95) New Zealand	-.11	-.53	-.26	.56	.69	-.77	1.19	.04	-.13	-.73
96) Nicaragua	1.17	.80	-.34	-.46	-.39	.44	-.47	-.20	-.69	.53
97) Norway	-.75	-.62	-.15	-.11	.55	-.23	.73	.03	.09	-.59
98) Pakistan	.78	1.27	.14	-1.04	-.57	.44	-.54	-.25	-.50	1.26
99) Panama	.80	.08	-.34	-.12	-.30	.48	-.40	-.10	-.50	.34
100) Philippines	.99	.33	.11	-.73	-.54	.63	-.52	-.14	-.68	.86
101) Poland	-.25	-.37	-.18	-.05	-.29	-.40	-.23	-.04	.77	.18
102) Portugal	-.51	.01	-.17	-.41	-.47	-.04	-.38	-.13	.11	-.01
103) S. Africa	.05	--	-.41	.04	0.36	.21	-.10	-.07	-.25	-.23
104) Spain	-.57	-.41	-.32	.19	-.44	-.56	-.34	-.08	.05	-.01
105) Sweden	-1.01	-.58	-.38	.13	.68	-.28	.95	.00	.39	-.79
106) Switzerland	-.75	-.53	.74	.04	.79	-.42	.63	-.07	.76	-.84
107) Thailand	.85	.63	.09	-1.04	-.47	.39	-.55	-.15	1.23	1.46
108) Trinidad	.66	-.20	.10	.47	.97	.24	-.22	-.03	-.47	-.46
109) Turkey	.67	1.15	-.33	-.63	-.49	-.30	-.50	-.19	.70	1.23
110) Egypt	.59	.75	.86	-.17	-.30	-.31	-.50	-.19	-.75	-.48
111) U. K.	-.89	-.36	.30	1.61	.38	-.54	.71	.70	.80	-1.00
112) U. S. A.	-.33	-.44	-.50	.77	-.10	-.40	1.76	.06	.03	-.88
113) Venezuela	1.16	-.24	-.26	.33	-.10	.42	-.23	-.08	-.68	-.12
114) Yugoslavia	-.40	-.08	-.12	-.56	-.36	-.17	-.35	-.05	.60	.66

Circa 1970:

115) Algeria	1.29	.81	-.40	-.43	-.26	.67	-.49	-.20	-1.54	.44
116) Argentina	-.42	-.24	-.51	1.15	-.28	-.34	.05	2.86	.02	-.59
117) Australia	-.41	-.59	-.58	1.46	.47	-.88	1.57	.26	.29	-.80
118) Austria	-.98	-.26	-.03	.22	1.25	-.77	1.06	.05	.22	-.64
119) Barbados	-.28	-.38	1.16	.32	.45	.17	-.13	.04	-.38	-.74
120) Belgium	-.93	-.17	.78	.27	3.00	-.70	.98	.11	.22	-.94
121) Brazil	.65	.09	-.17	.11	-.47	.20	-.38	-.12	-.63	.11
122) Brit. Hond.	.74	-.51	-.34	-.02	-.00	.30	-.37	--	-.80	-.47
123) Bulgaria	-.87	-.51	-.26	-.15	.33	-.42	.19	.01	--	-.90
124) Canada	-.50	-.67	-.56	.75	1.48	-.66	1.95	.11	--	-.90
125) Ceylon	.34	-.45	.51	0.87	-.52	.35	-.49	.92	-.38	.37
126) Chile	.18	-.04	-.40	.66	-.22	-.10	-.24	-.05	-.83	-.44
127) Colombia	1.08	.07	-.09	.43	-.47	.18	-.40	--	-.86	-.11
128) Costa Rica	.77	-.63	-.33	-.23	-.14	.27	-.26	1.00	-.68	-.14
129) Cyprus	-.25	-.76	-.31	-.16	.33	.19	-.03	-.05	1.19	0.05
130) Czechoslov.	-.95	-.35	-.15	-.26	.56	-.43	.47	-.03	.89	-.71
131) Denmark	-.90	-.59	-.26	.72	2.20	-.52	1.31	.08	.91	-.89
132) Domin. Rep.	1.19	.52	-.01	-.51	-.35	.25	-.45	-.12	-.52	.36
133) El Salvador	1.11	-.40	.43	-.41	-.34	.11	-.45	-.16	-.15	.41

Table 7. continued (4)

134)	Fiji	.97	-.62	-.25	-.75	-.18	.17	-.43	-.04	-1.13	.79
135)	Finland	-.89	-.46	-.40	.19	1.16	-.24	.93	.07	.67	-.62
136)	France	-.87	-.49	-.22	.55	.95	-.63	1.00	.04	.31	-.71
137)	W. Germany	-1.14	-.35	.39	.97	1.41	-.66	1.14	.09	.51	-.93
138)	Greece	-.81	-.56	-.19	.35	.05	-.50	-.10	.01	-.08	.19
139)	Guatemala	.89	.47	-.04	-.48	-.44	.50	0.48	.37	-.79	.55
140)	Guyana	.88	-.32	-.24	-.26	-.09	.26	-.31	.00	-1.11	-.13
141)	India	.57	.98	.19	-.88	-.52	.45	-.52	--	-.55	1.21
142)	Ireland	-.47	-.34	-.26	.09	.67	-.70	.32	.09	.02	-.25
143)	Israel	.10	-.68	.21	1.17	.74	-.54	.30	-.04	-.46	-.82
144)	Italy	-.81	-.46	.10	.00	.60	-.68	.51	.03	-.30	-.55
145)	Japan	-.68	-.71	1.92	1.34	.25	-.41	.91	.05	1.15	-.49
146)	S. Korea	.46	.01	1.66	.16	-.27	-.14	-.40	-.01	-.57	.34
147)	Luxembourg	-.96	-.12	.03	.22	1.98	-.50	1.28	.02	.07	-.82
148)	Mauritius	.48	-.32	.84	.00	-.22	-.37	-.47	-.06	--	.12
149)	Mexico	1.06	-.05	-.34	.63	-.29	.14	-.30	-.10	-1.08	.01
150)	Morocco	1.11	.94	-.32	-.26	-.46	-.13	-.50	-.23	-1.14	.52
151)	Netherlands	-.61	-.69	1.14	.86	2.81	-.52	1.12	.08	-.18	-.93
152)	New Zealand	-.29	-.61	-.28	.84	1.14	-1.00	1.65	.06	-.00	-.78
153)	Nicaragua	1.22	.94	-.31	-.20	-.30	.36	-.41	-.20	-1.12	.16
154)	Norway	-.82	-.59	-.14	-.00	2.14	-.24	1.70	.06	.15	-.83
155)	Pakistan	.89	1.36	.23	-.92	-.54	.35	-.55	-.17	-.77	.82
156)	Panima	.72	-.30	-.26	.06	.01	.42	-.25	-.04	-.42	.13
157)	Philippines	.85	.25	.04	-.65	-.49	.47	-.37	-.07	-.49	.46
158)	Poland	-.69	-.49	-.13	.16	-.12	-.26	.03	.33	1.18	-.10
159)	Portugal	-.61	-.22	-.23	-.24	-.20	-.22	-.17	2.74	.17	-.22
160)	S. Africa	.48	1.01	-.38	.18	-.25	.26	.07	2.24	-.13	-.14
161)	Spain	-.58	-.53	-.34	.35	-.12	-.62	.11	-.02	-.29	-.47
162)	Sweden	-1.02	-.63	-.36	.39	2.25	-.16	1.77	.08	.32	-.97
163)	Switzerland	-.83	-.58	1.03	.15	2.35	-.77	1.32	.04	.88	-.93
164)	Thailand	.96	-.05	.17	-1.03	-.39	.22	-.52	.39	-.81	1.43
165)	Trinidad	.20	-.67	.39	-.26	1.27	.28	-.01	-.06	-.41	-.59
166)	Turkey	.56	.78	-.31	-.47	-.46	-.16	-.43	-.13	.44	.88
167)	Egypt	.74	.91	.84	.03	-.23	-.52	-.47	--	1.12	.39
168)	U. K.	-.86	-.38	.30	1.44	.67	-.46	.91	.09	.83	-1.08
169)	U. S. A.	-.61	-.50	-.49	1.25	.22	-.74	2.53	.11	.19	-1.02
170)	Venezuela	1.14	-.27	-.40	.63	-.07	.30	-.10	-.06	-.81	-.62
171)	Yugoslavia	-.64	-.31	-.12	-.25	.01	-.49	-.11	-.06	.43	.25

[a]The Dimensions are:

(1) Population Growth
(2) Mortality
(3) Density
(4) Urbanization
(5) Trade
(6) Agricultural Production
(7) Material Technology
(8) Education
(9) Labor Force Participation
(10) Division of Labor

Table 8. Correlation Coefficients Between Composite Indices

Indices	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1) Pop. Grow.	.52	-.05	-.48	-.53	-.75	-.63	-.14	-.61	-.69
2) Mortality		.03	-.57	-.52	-.58	-.57	-.16	-.72	-.26
3) Density			.06	.12	.03	-.08	-.02	-.01	.07
4) Urban.				.47	.66	.66	.18	.80	.16
5) Trade					.56	.77	.08	.68	.22
6) Agr. Prod.						.71	.13	.65	.44
7) Mat. Tech.							.14	.74	.31
8) % Education								.21	.04
9) Div. of Lab.									.17
10) Lab. Force									

Table 9. Nations Used in Analysis of Limited Data For Earlier Time Periods, With Years of Data For Each Nation

Nations	Years From Which Data is Taken
1) Australia	1921-1933-1939-1954-1961-1971
2) Belgium	1890-1900-1910-1920-1930-1947-1961-1971
3) Brazil	1920-1940-1950-1960-1970
4) Canada	1881-1891-1901-1911-1921-1931-1941-1951-1961-1971
5) Denmark	1890-1901-1911-1921-1930-1940-1950-1960-1970
6) Finland	1920-1930-1940-1950-1960-1970
7) France	1886-1896-1906-1926-1931-1936-1950-1954-1962-1971
8) Germany	1882-1895-1907-1925-1933-1939-1950-1961-1971
9) Hungary	1920-1930-1941-1960-1970
10) Ireland	1926-1951-1961-1966
11) Italy	1881-1901-1911-1921-1931-1936-1951-1961-1971
12) Japan	1897-1912-1920-1930-1936-1950-1960-1970
13) Mexico	1900-1910-1920-1930-1940-1950-1960-1970
14) Netherlands	1909-1920-1930-1947-1960-1970
15) New Zealand	1911-1921-1936-1951-1961-1971
16) Norway	1890-1900-1910-1920-1930-1946-1950-1960-1972
17) Portugal	1890-1911-1930-1950-1960-1970
18) South Africa	1921-1946-1951-1960-1970
19) Spain	1900-o910-1920-1930-1950-1960-1970
20) Sweden	1910-1920-1930-1940-1945-1950-1960-1970
21) Switzerland	1888-1900-1910-1920-1930-1941-1950-1960-1970
22) U. K.	1891-1911-1924-1930-1934-1951-1961-1966
23) U. S. A.	1880-1890-1900-1910-1920-1930-1940-1950-1960-1970
24) Yugoslavia	1931-1953-1961-1971

Table 10. Zero Order Correlation Coefficients and First-Order Partial Correlation Coefficients Between All Possible Pairs of Seven Indices

Correlation Coefficients Between:		Zero-Order Correlations	First-Order Partials
Mortality and	Pop. Growth	.52	
controlling	Div. of Labor		.15
"	Urbanization		.34
"	Agric. Prod.		.16
"	Mat. Tech.		.25
"	Trade		.34
Mortality and	Agric. Prod.	-.58	
controlling	Div. of Labor		-.22
"	Urbanization		-.33
"	Pop. Growth		-.34
'	Mat. Tech		-.30
"	Trade		-.40
Mortality and	Urbanization	-.57	
controlling	Div. of Labor		.02*
"	Agric. Prod.		-.11
"	Pop. Growth		-.47
"	Mat. Tech.		-.31
"	Trade		-.43
Mortality and	Div. of Labor	-.72	
controlling	Urbanization		-.52
"	Agric. Prod.		-.55
"	Pop. Growth		-.60
"	Mat. Tech.		-.54
"	Trade		-.58
Mortality and	Mat. Tech.	-.57	
controlling	Div. of Labor		-.08*
"	Urbanization		-.32
"	Agric. Prod.		-.27
"	Pop. Growth		-.37
"	Trade		-.31
Mortality and	Trade	-.52	
controlling	Div. of Labor		-.06*
"	Urbanization		-.35
"	Agric. Prod.		-.28
"	Pop. Growth		-.34
"	Mat. Tech.		-.16
Div. of Labor	and Pop. Growth	-.61	
controlling	Mortality		-.40
"	Urbanization		-.43
"	Agric. Prod.		-.24
"	Mat. Tech.		-.28
"	Trade		-.39

Table 10 continued (2)

Correlation Coefficients Between:	Zero-Order Correlations	First-Order Partials
Div. of Labor and Agric. Prod.	.65	
controlling Mortality		.41
" Urbanization		.27
" Pop. Growth		.37
" Mat. Tech.		.26
" Trade		.43
Div. of Labor and Urbanization	.80	
controlling Mortality		.68
" Agric. Prod.		.65
" Pop. Growth		.73
" Mat. Tech.		.62
" Trade		.73
Div. of Labor and Mat. Tech.	.74	
controlling Mortality		.60
" Urbanization		.47
" Agric. Prod.		.63
" Pop. Growth		.59
" Trade		.47
Div. of Labor and Trade	.68	
controlling Mortality		.52
" Urbanization		.57
" Agric. Prod.		.50
" Pop. Growth		.53
" Mat. Tech.		.26
Urbanization and Pop. Growth.	-.48	
controlling Mortality		-.26
" Div. of Labor		.02*
" Agric. Prod.		.03*
" Mat. Tech.		-.12
" Trade		-.31
Urbanization and AGric. Prod.	.66	
controlling Mortality		.50
" Div. of Labor		.31
" Pop. Growth		.52
" Mat. Tech.		.37
" Trade		.54
Urbanization and Mat. Tech.	.66	
controlling Mortality		.49
" Div. of Labor		.15
" Agric. Prod.		.36
" Pop. Growth		.53
" Trade		.53

Table 10 continued (3)

Correlation Coefficents Between		Zero-Order Correlations	First-Order Partials
Urbanization and Trade		.47	
controlling	Mortality		.25
"	Div. of Labor		-.17
"	Agric. Prod.		.15
"	Pop. Growth		.29
"	Mat. Tech.		-.08*
Agric. Prod. and Pop. Growth		-.75	
controlling	Mortality		-.64
"	Div. of Labor		-.59
"	Urbanization		-.66
"	Mat. Tech.		-.55
"	Trade		-.64
Agric. Prod. and Mat. Tech.		.71	
controlling	Mortality		.56
"	Div. of Labor		.44
"	Urbanization		.49
"	Population Growth		.47
"	Trade		.52
Agric. Prod. and Trade		.57	
controlling	Mortality		.38
"	Div. of Labor		.23
"	Urbanization		.39
"	Pop. Growth		.31
"	Mat. Tech.		.05*
Pop. Growth and Mat. Tech.		-.63	
controlling	Mortality		-.47
"	Div. of Labor		-.33
"	Urbanization		-.48
"	Agric. Prod.		-.21
"	Trade		-.41
Pop. Growth and Trade		-.53	
controlling	Mortality		-.36
"	Div. of Labor		-.20
"	Urbanization		-.39
"	Agric. Prod.		-.19
"	Mat. Tech.		-.09*
Mat. Tech. and Trade		.77	
controlling	Mortality		.67
"	Div. of Labor		.53
"	Urbanization		.69
"	Agric. Prod.		.63
"	Pop. Growth		.66

*Partials less than or equal to .10

Figure 1. Plot of Division of Labor and Material Technology Dimensions

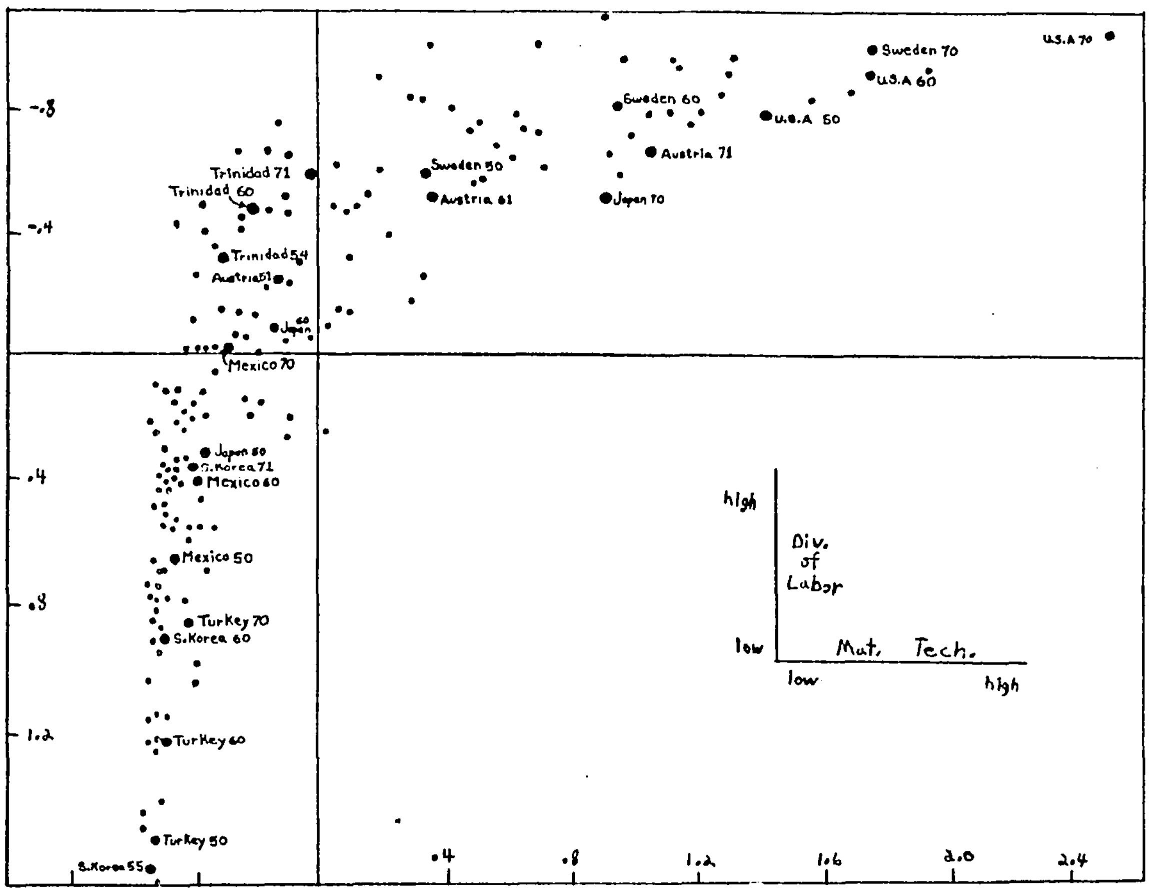


Figure 2. Plot of Mortality and Material Technology Dimensions

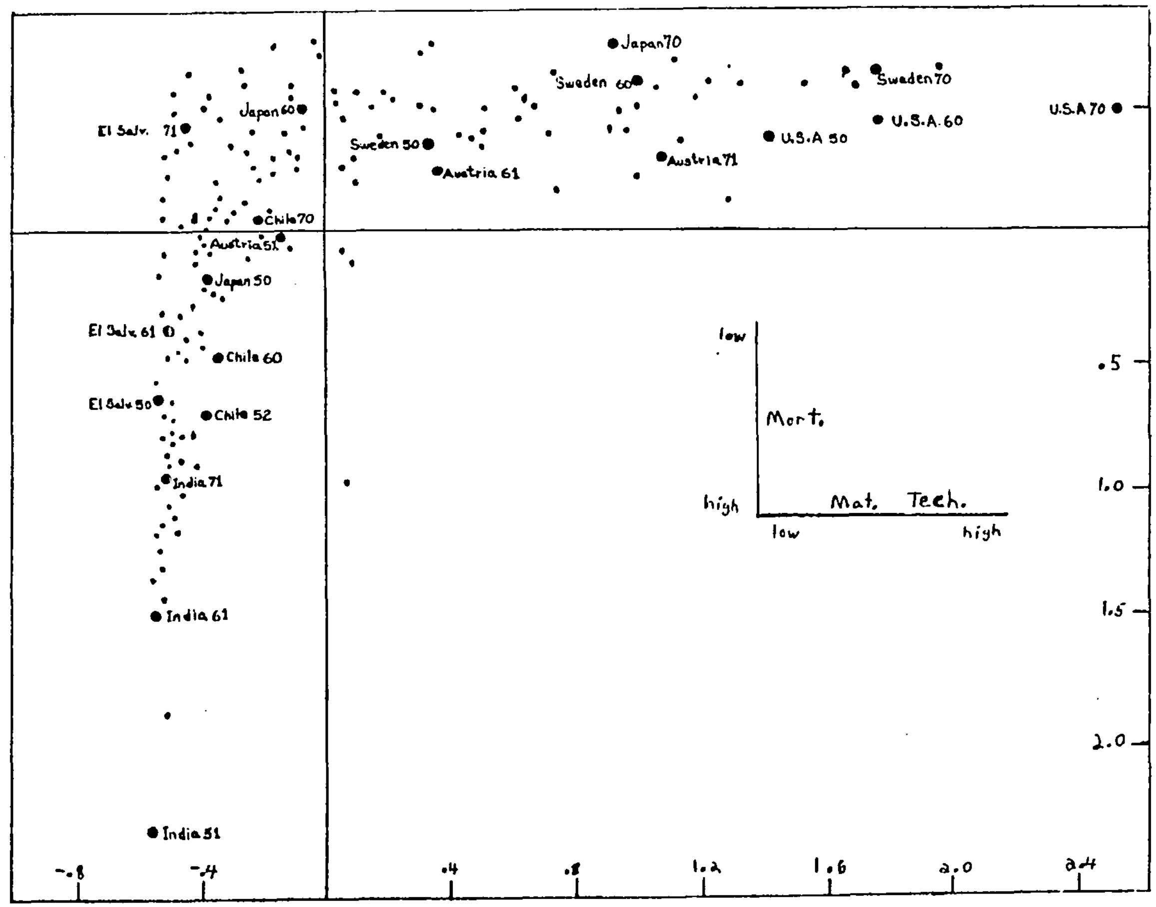


Figure 3. Plot of Division of Labor and Trade Dimensions

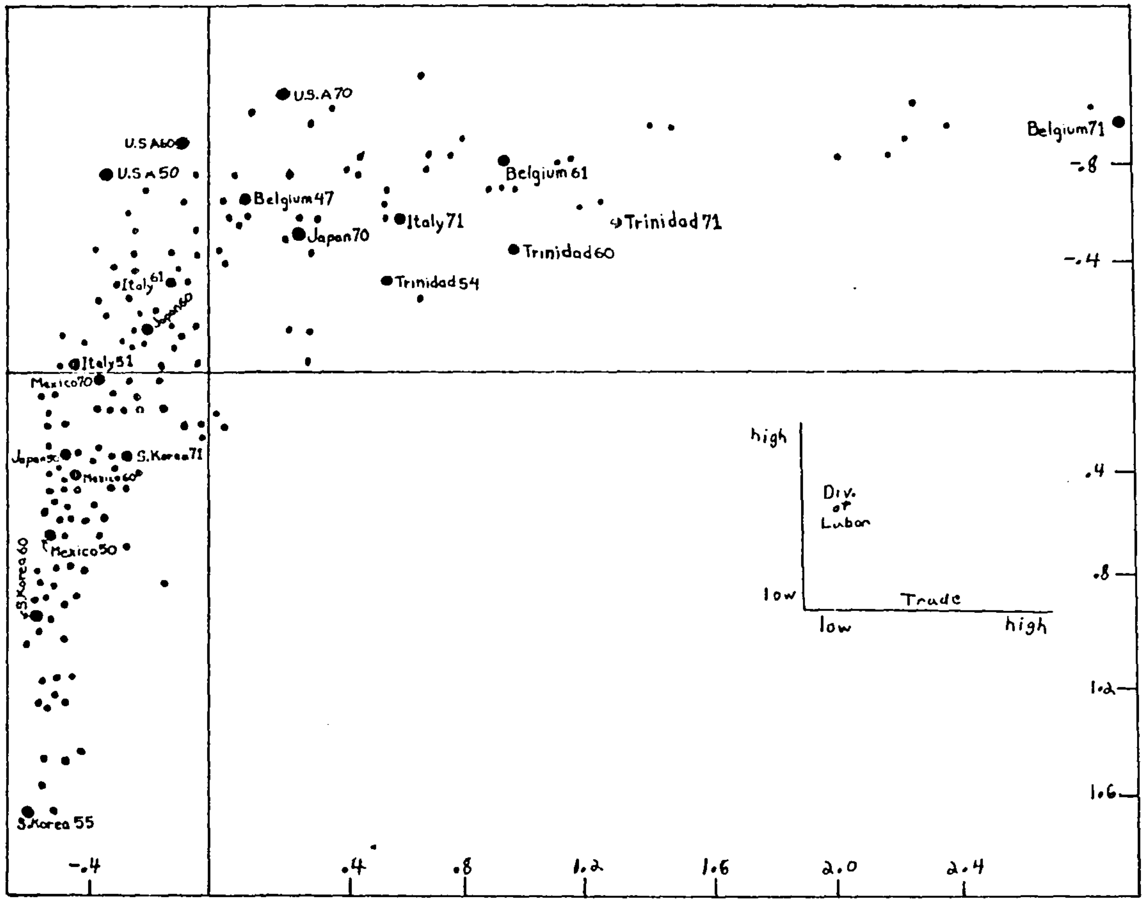


Figure 4. Plot of Mortality and Trade Dimensions

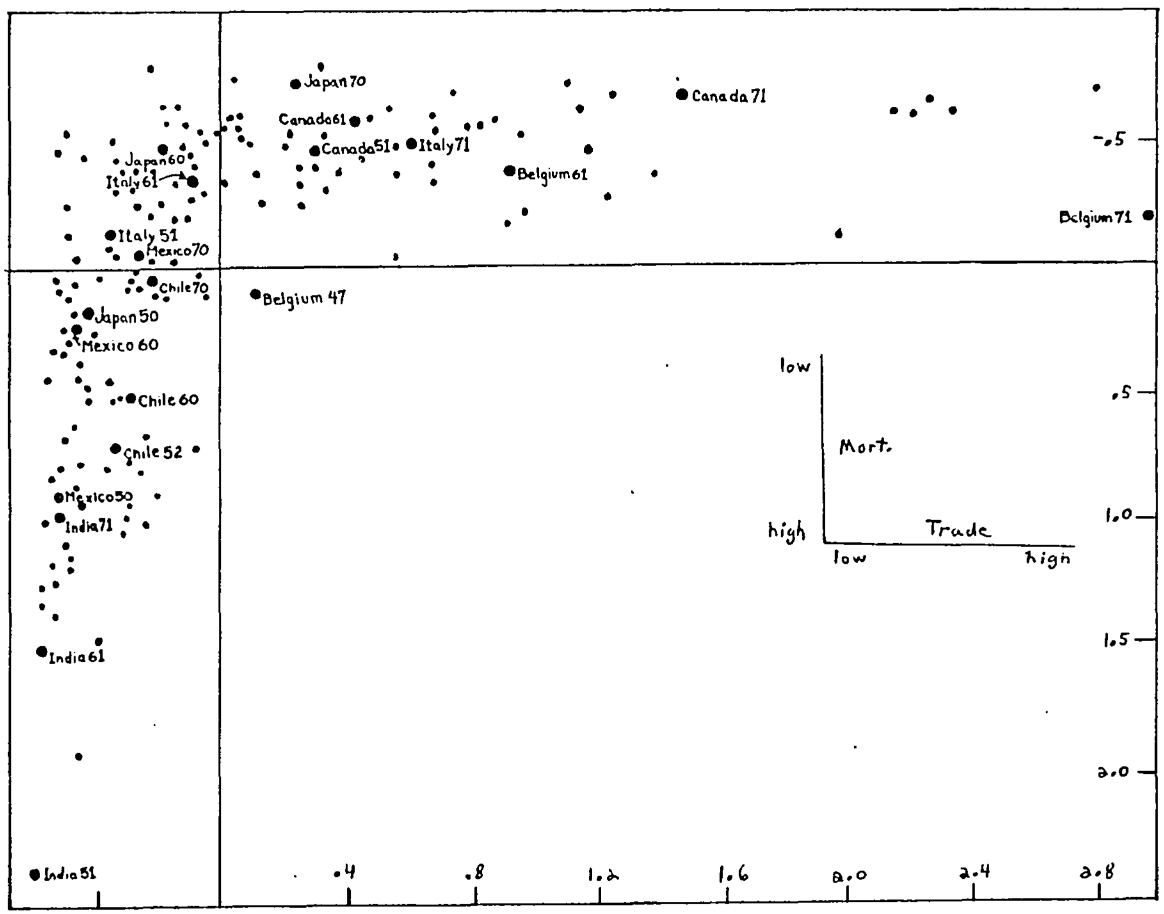


Figure 5. Plot of Population Growth and Material Technology Dimensions

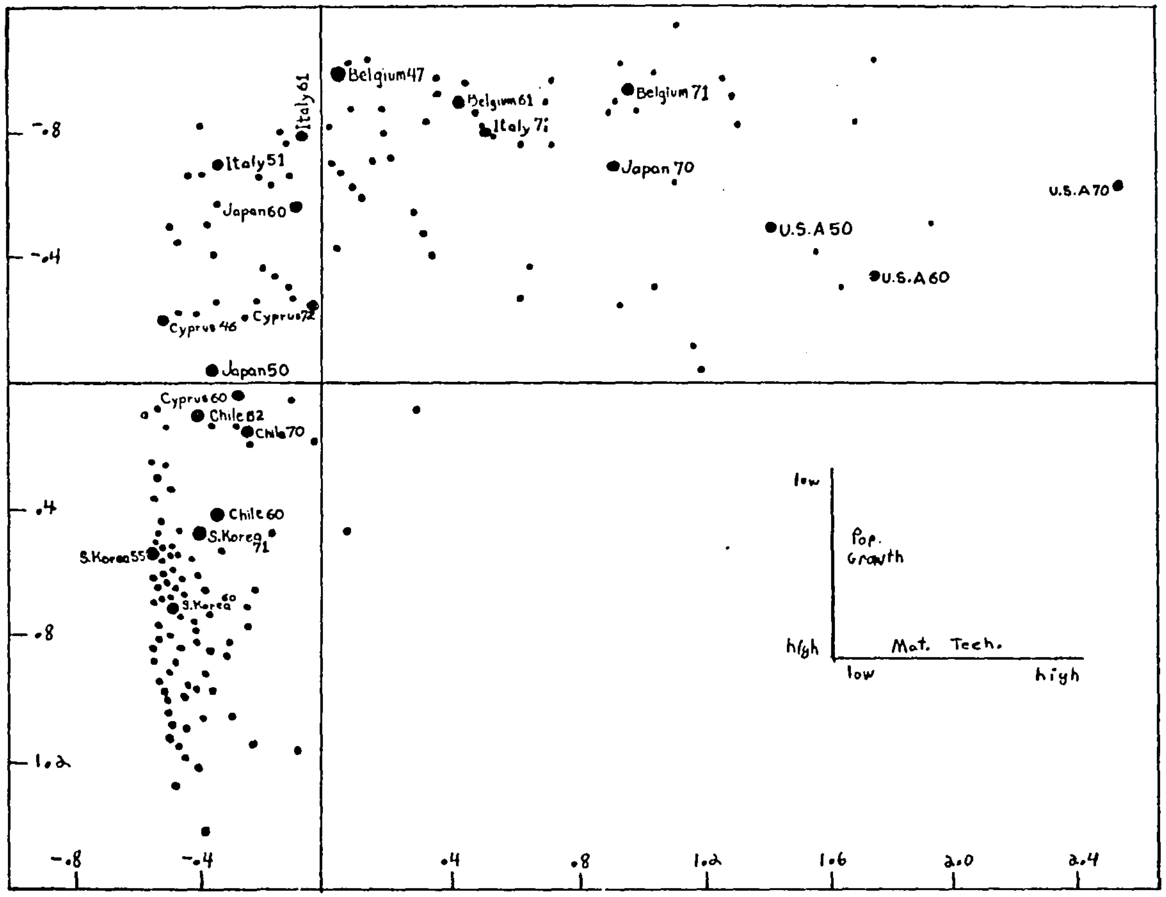


Figure 6. Plot of Agricultural Production and Material Technology Dimensions

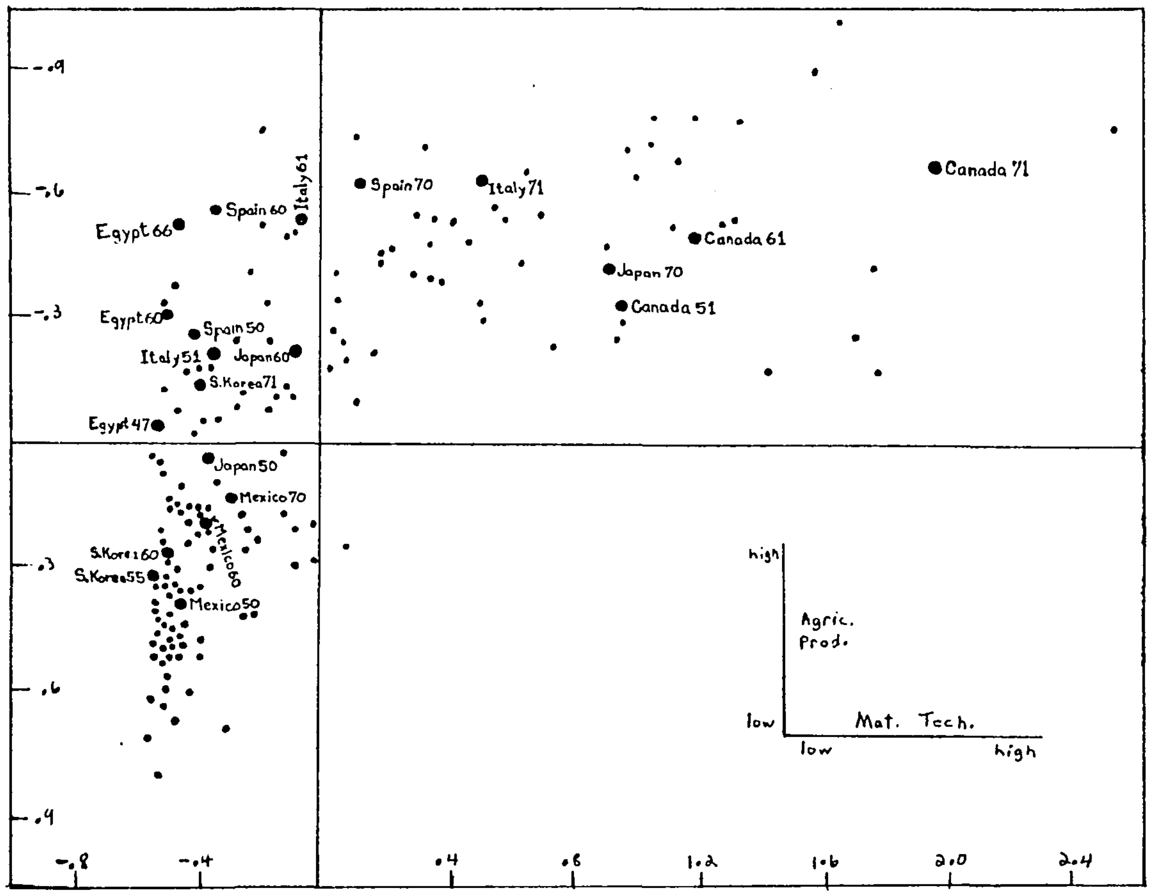


Figure 7. Plot of Population Growth and Trade Dimensions

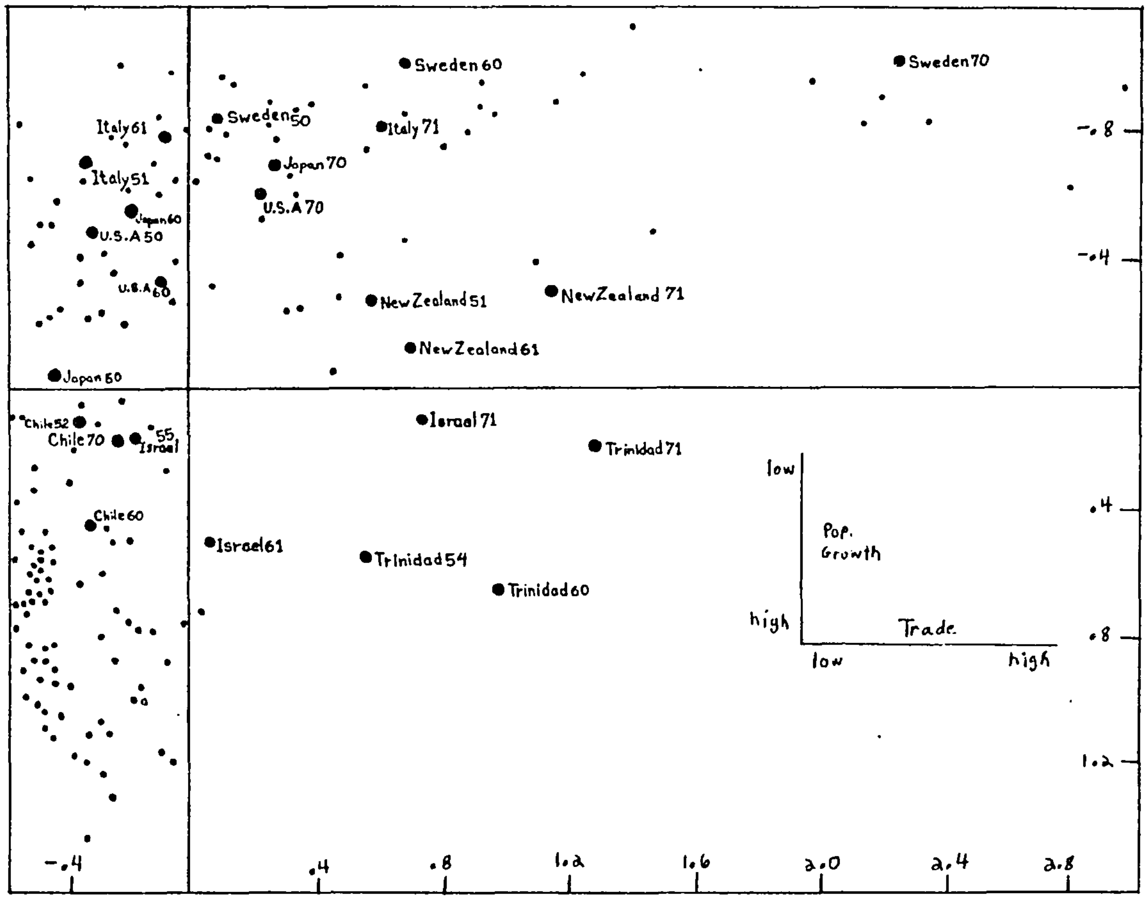


Figure 8. Plot of Agricultural Production and Trade Dimensions

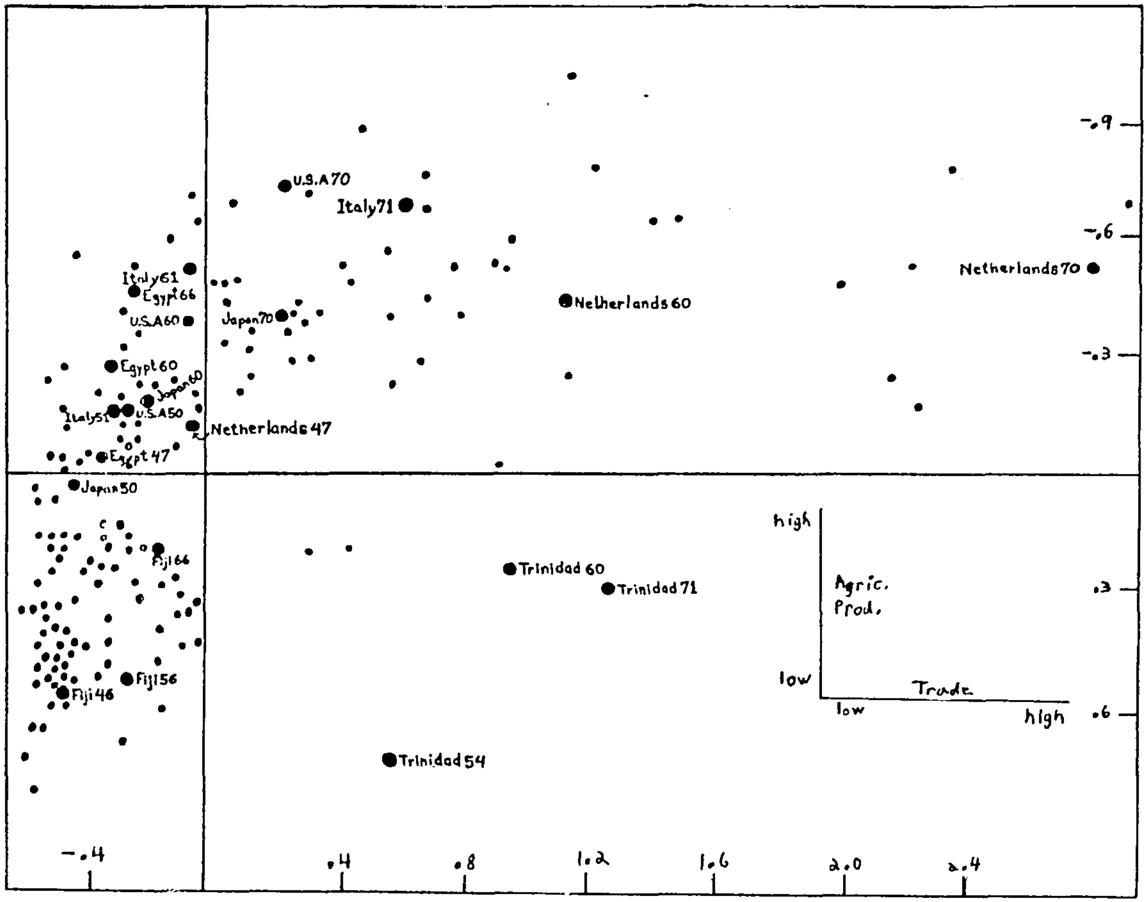


Figure 9. Plot of Mortality and Agricultural Production Dimensions

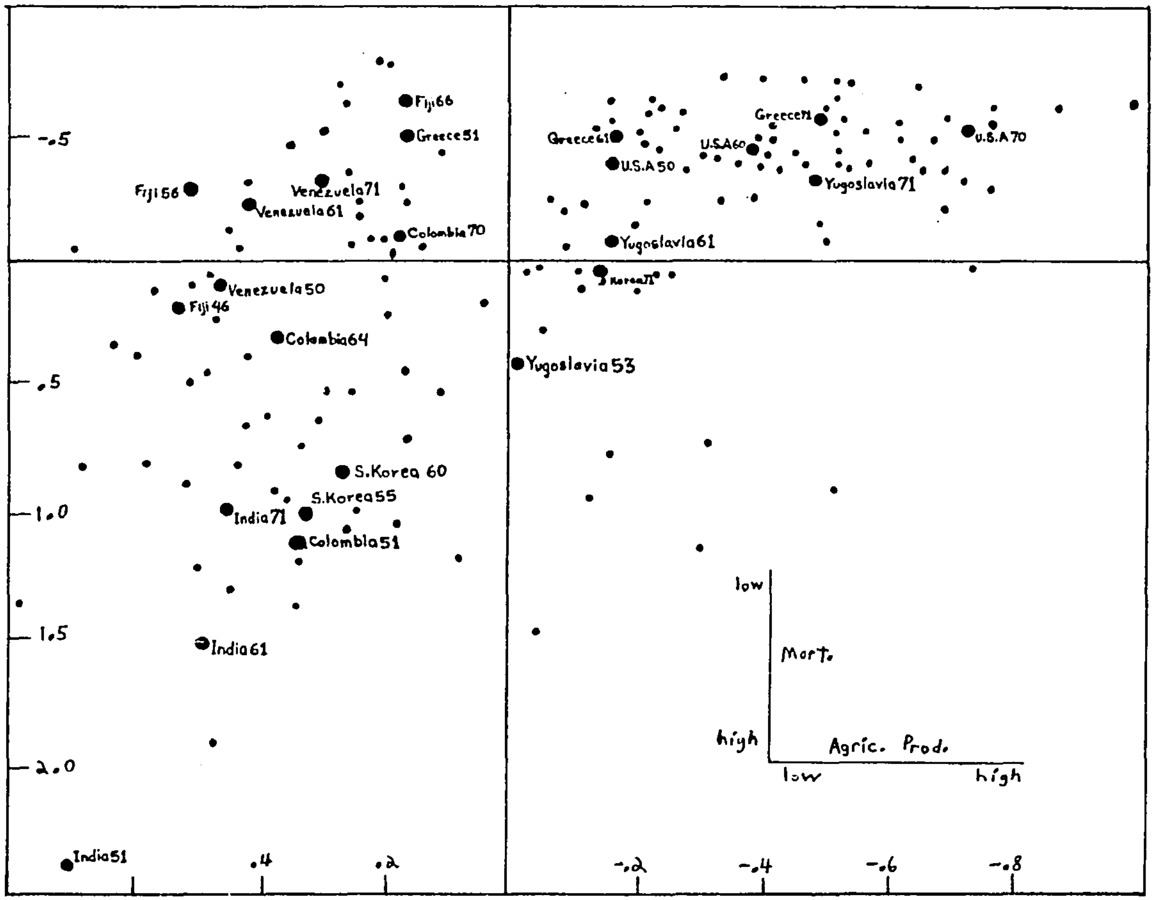


Figure 10. Plot of Urbanization and Material Technology Dimensions

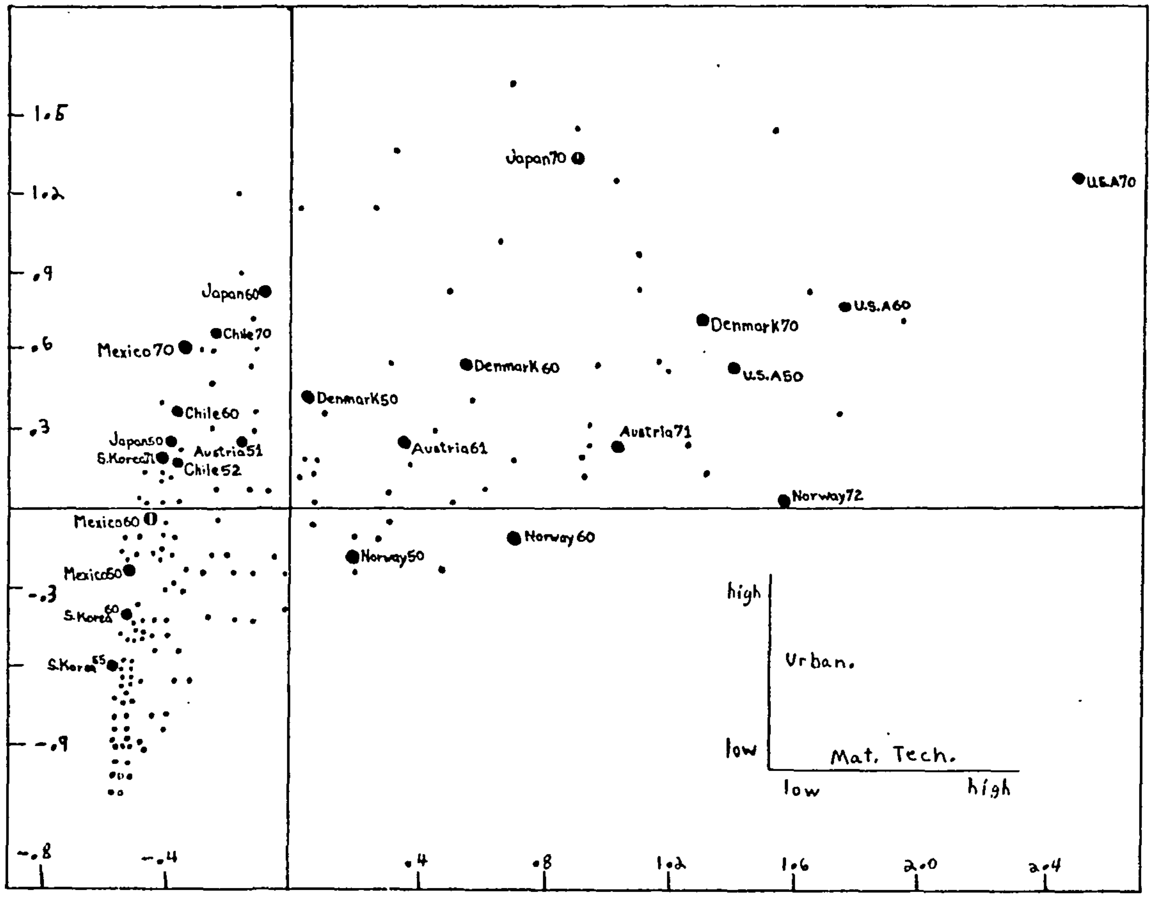


Figure 11. Plot of Urbanization and Trade Dimensions

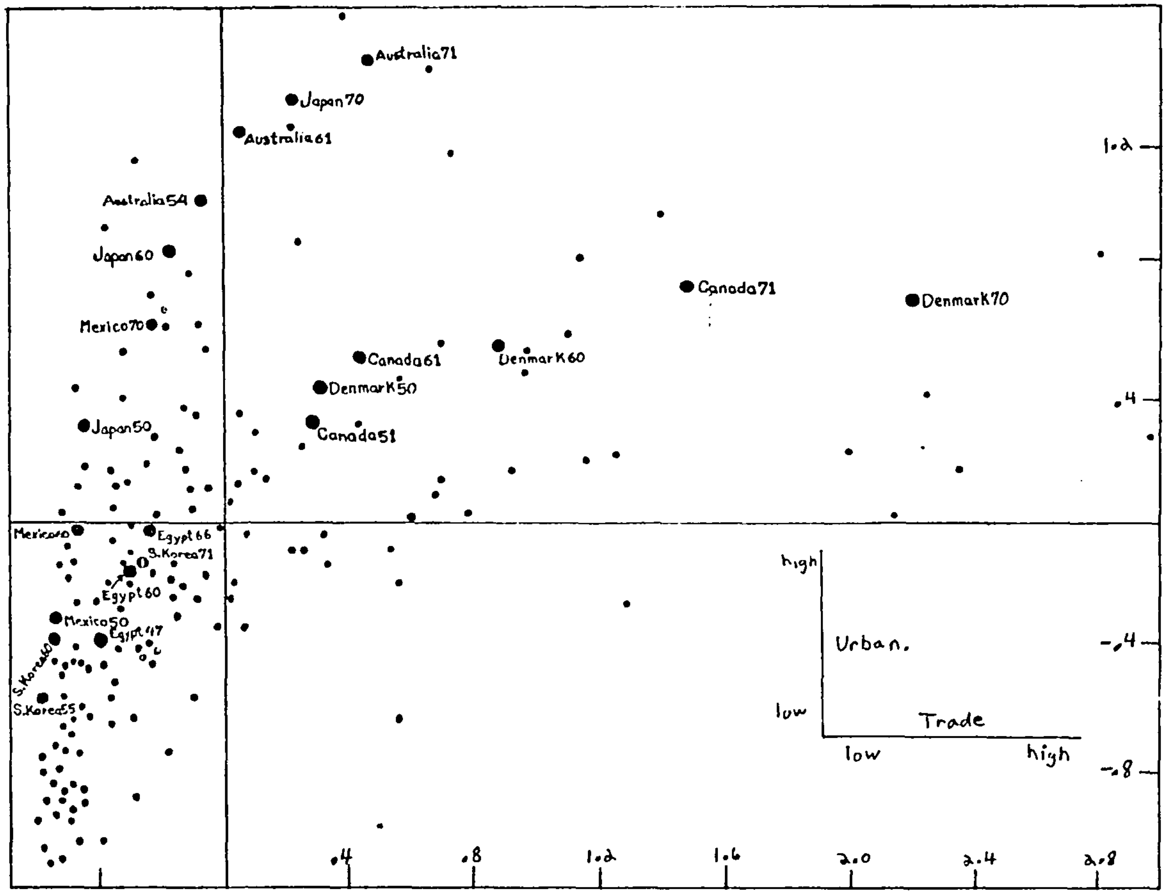


Figure 12. Plot of Mortality and Population Growth Dimensions

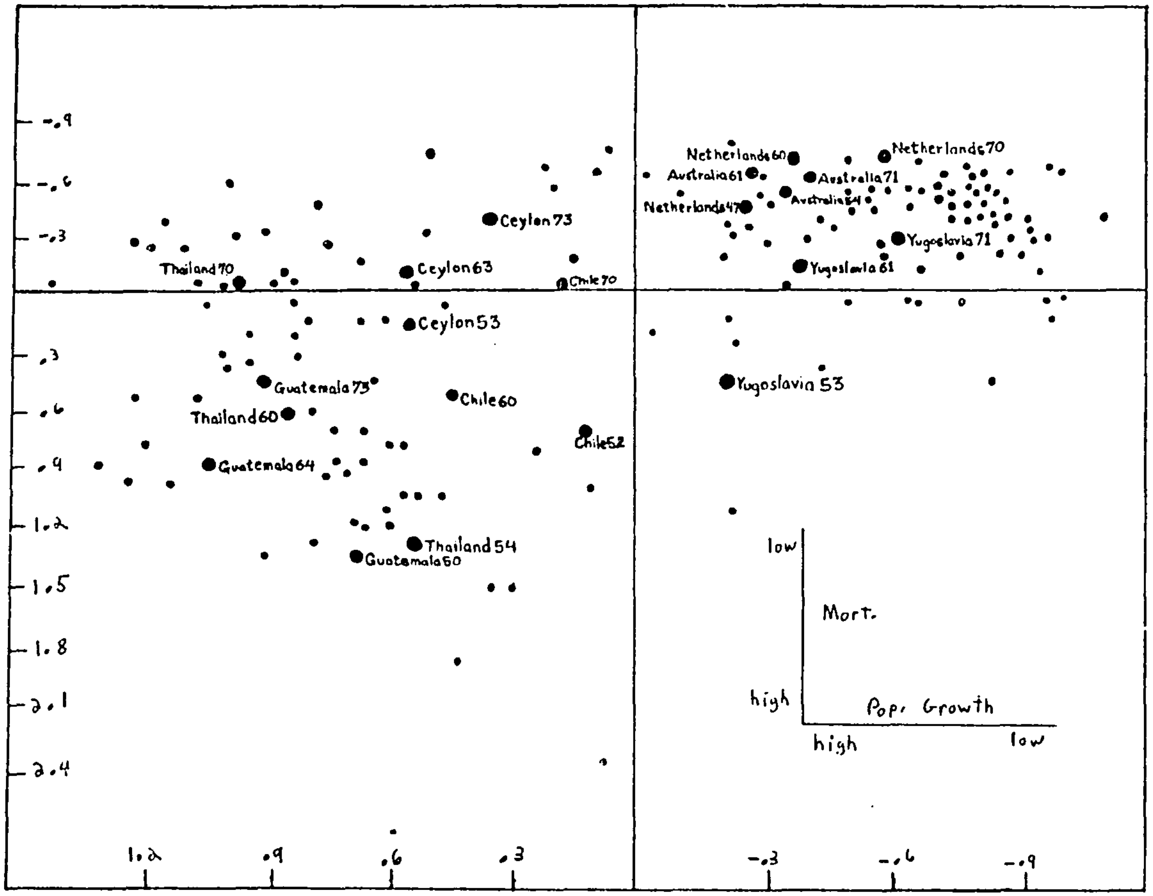


Figure 13. Plot of Mortality and Urbanization Dimensions

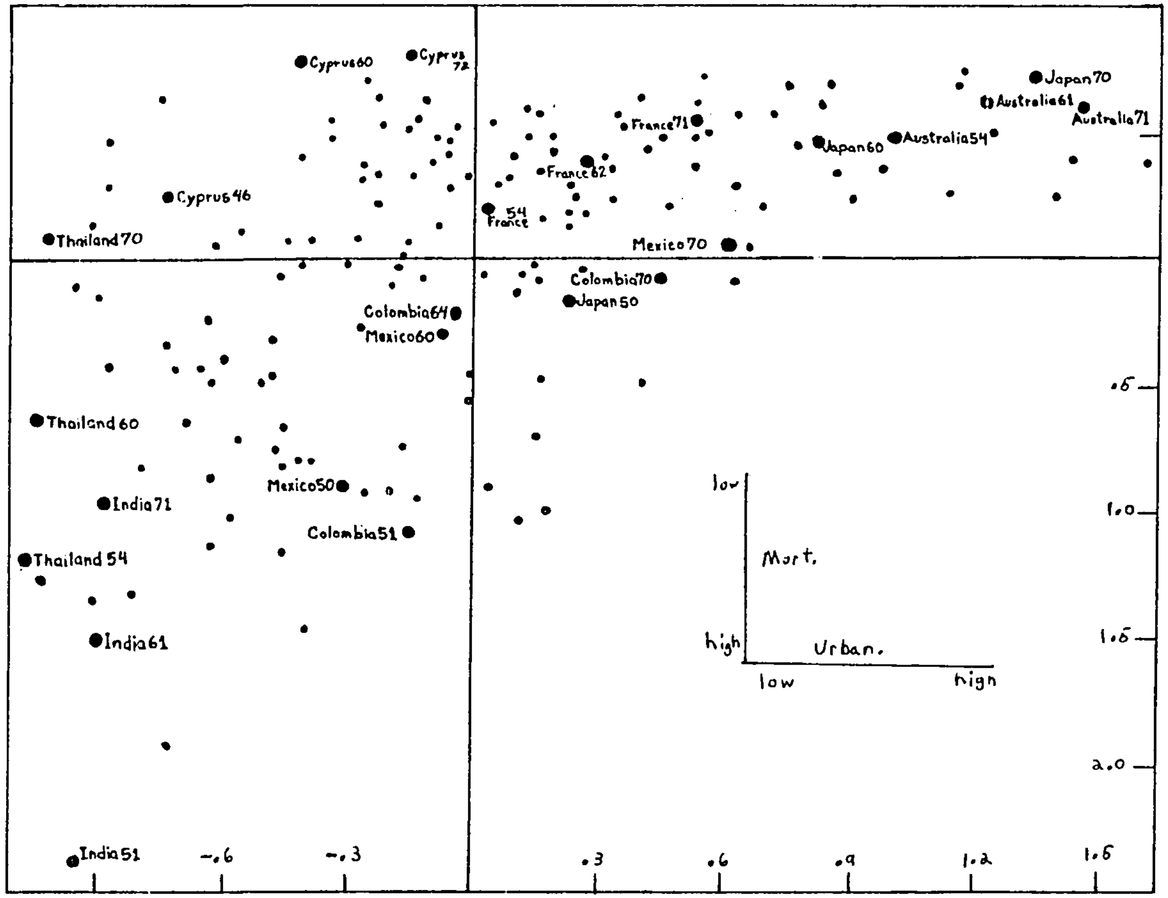


Figure 14. Plot of Mortality and Division of Labor Dimensions

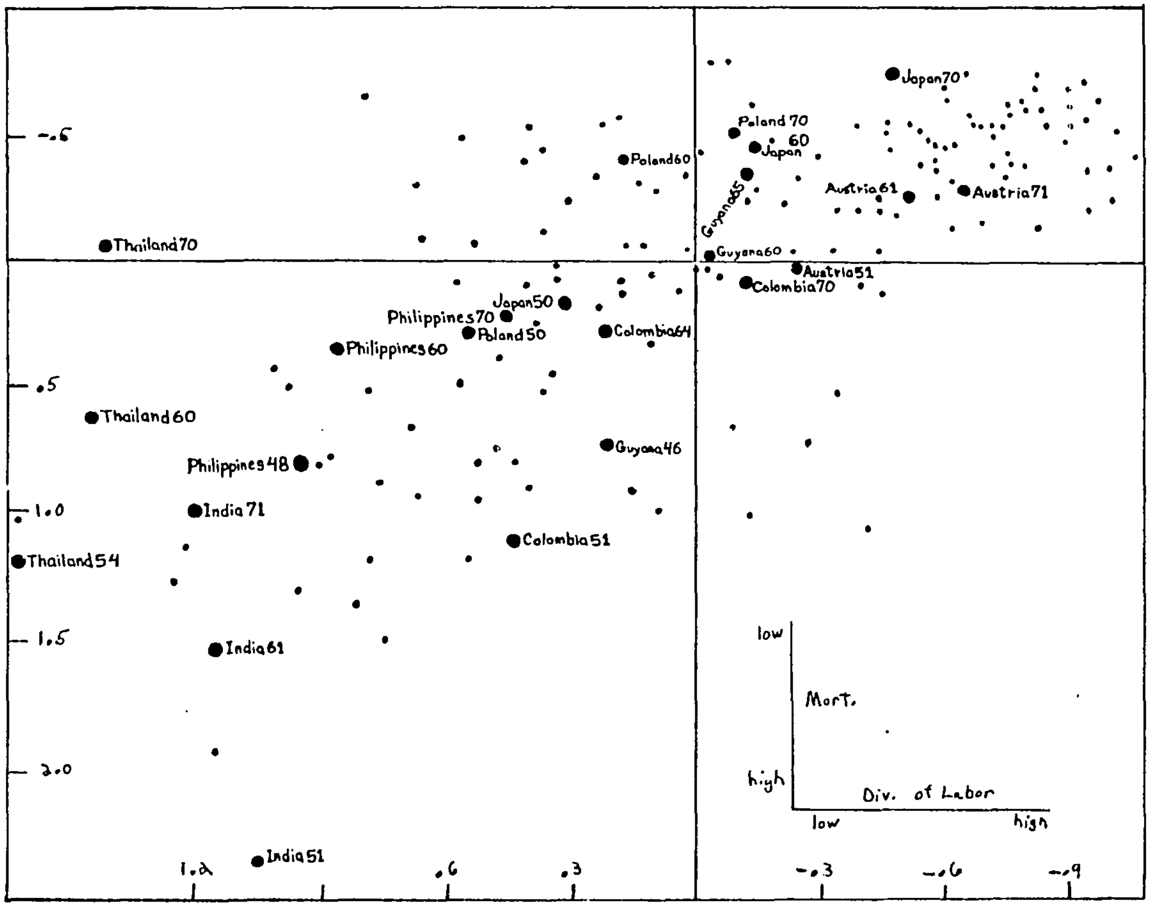


Figure 15. Plot of Trade and Material Technology Dimensions

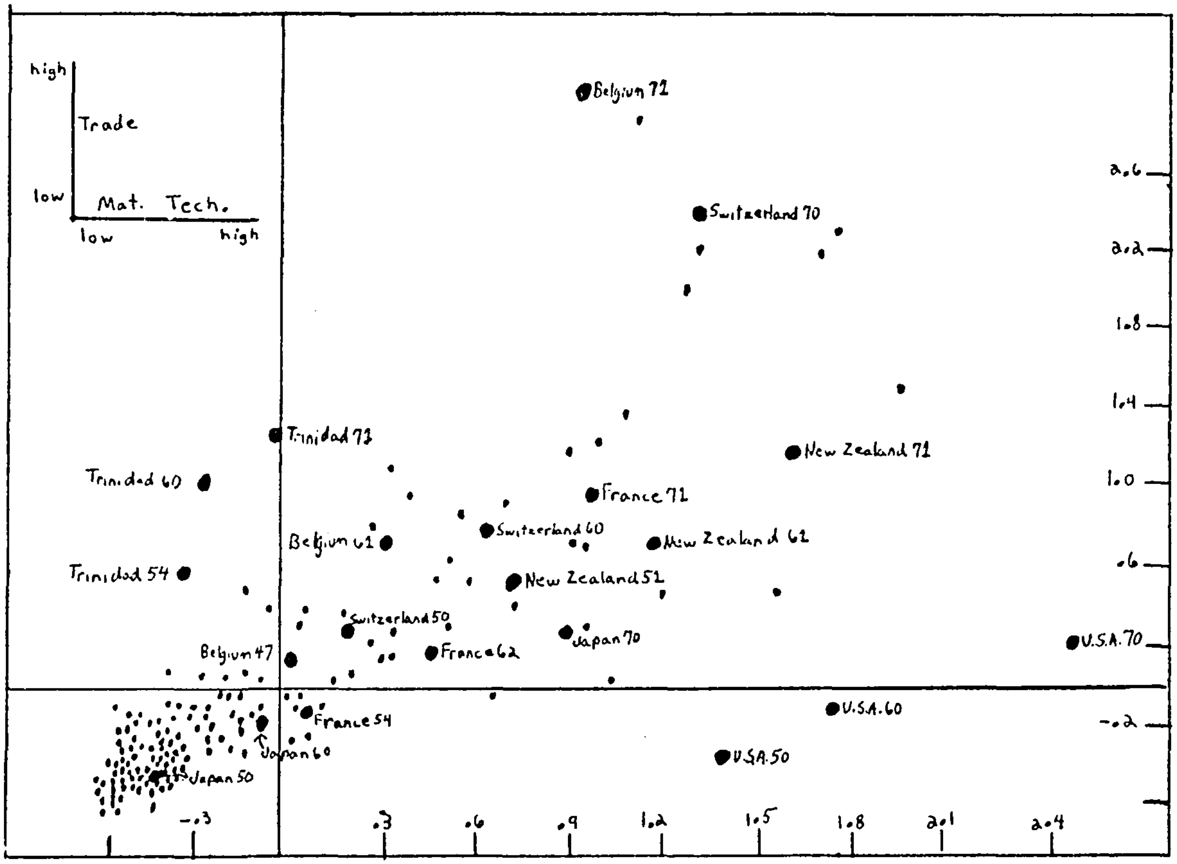


Figure 16. Plot of Division of Labor and Population Growth Dimensions

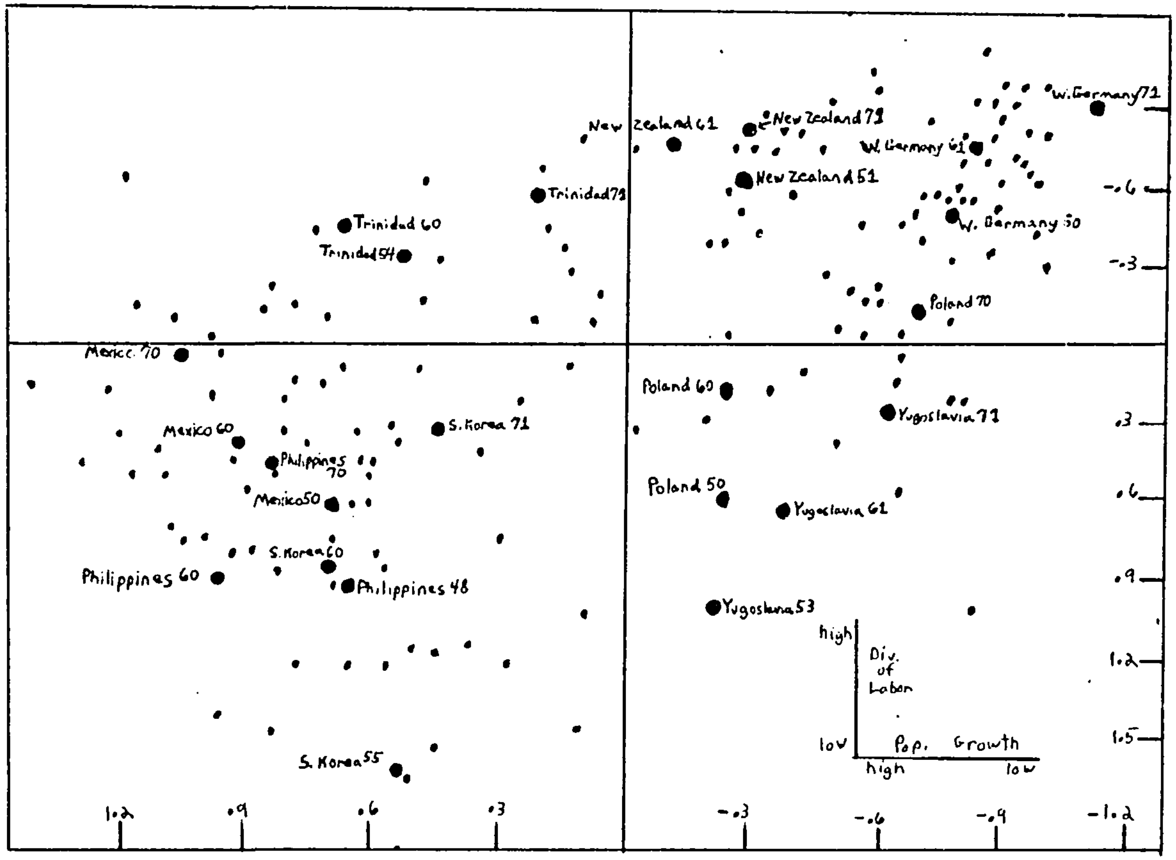


Figure 17. Plot of Agricultural Production and Population Growth Dimensions

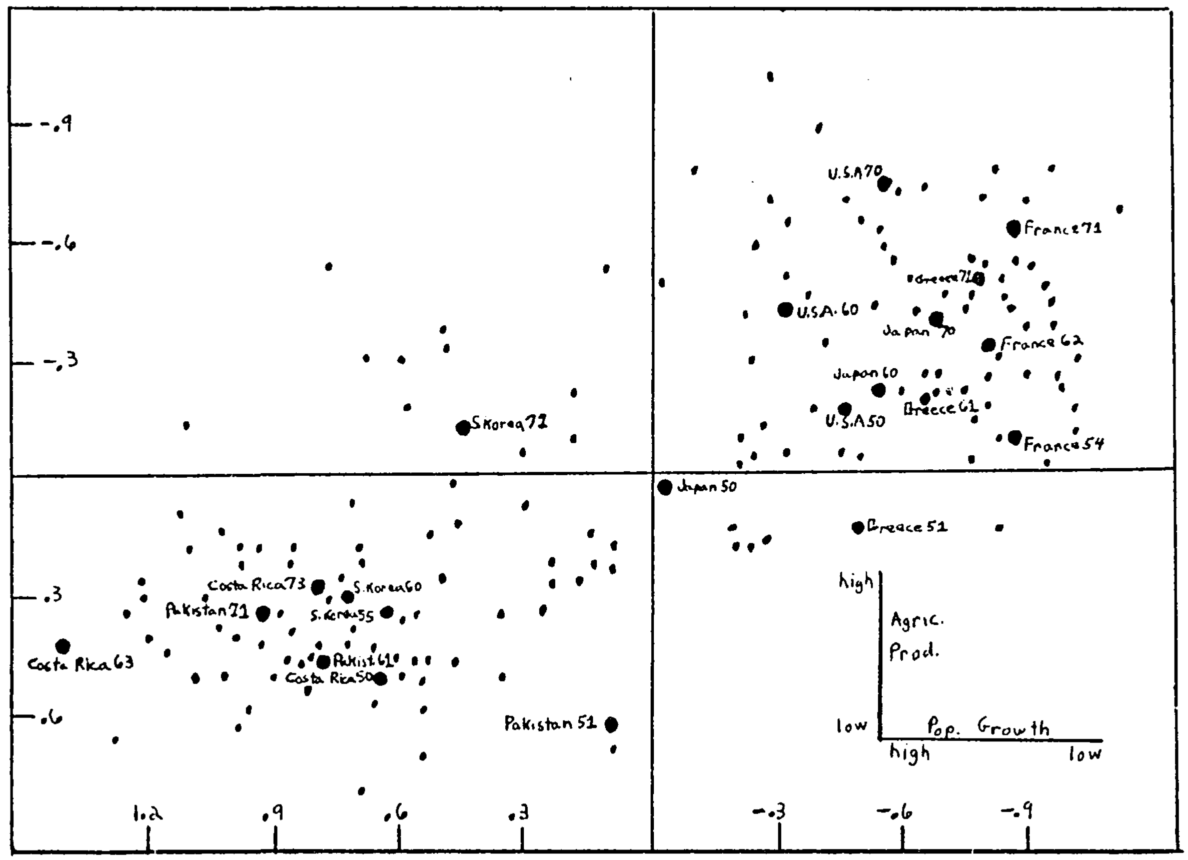


Figure 18. Plot of Urbanization and Population Growth Dimensions

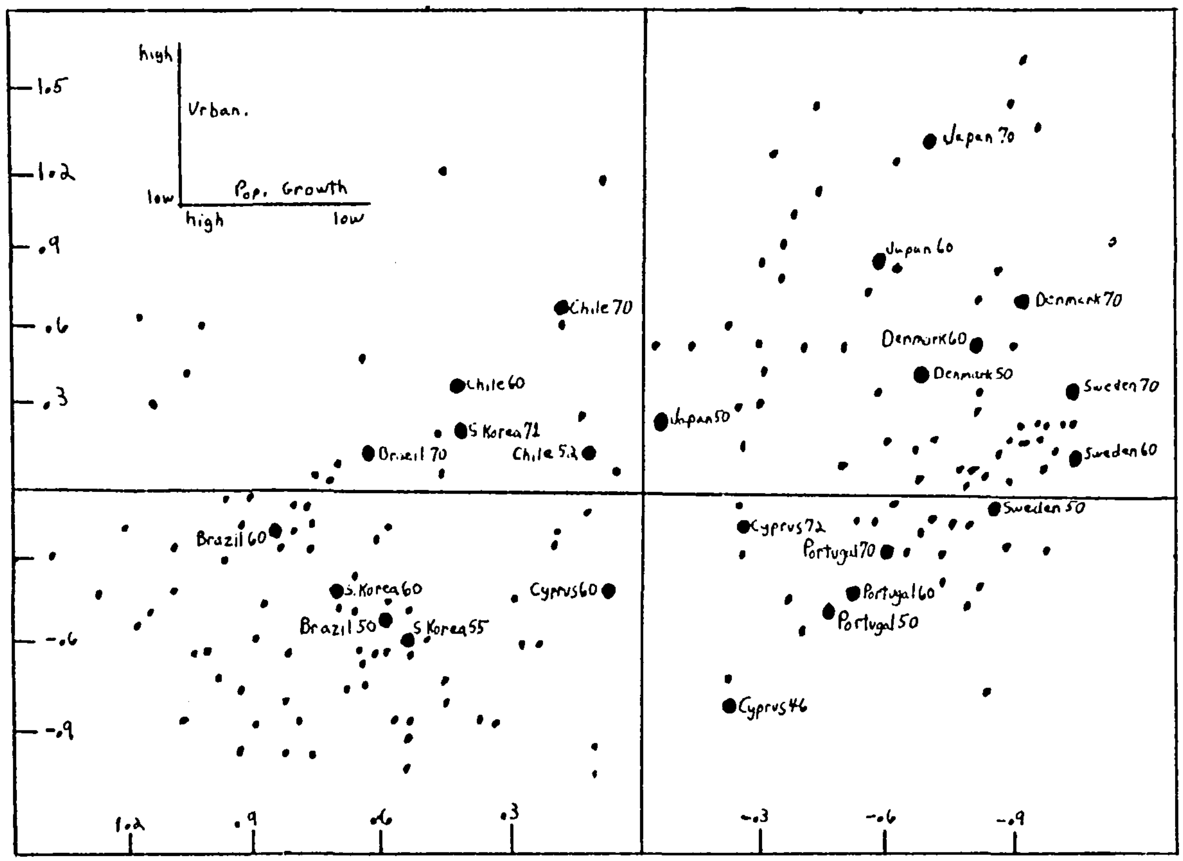


Figure 19. Plot of Division of Labor and Agricultural Production Dimensions

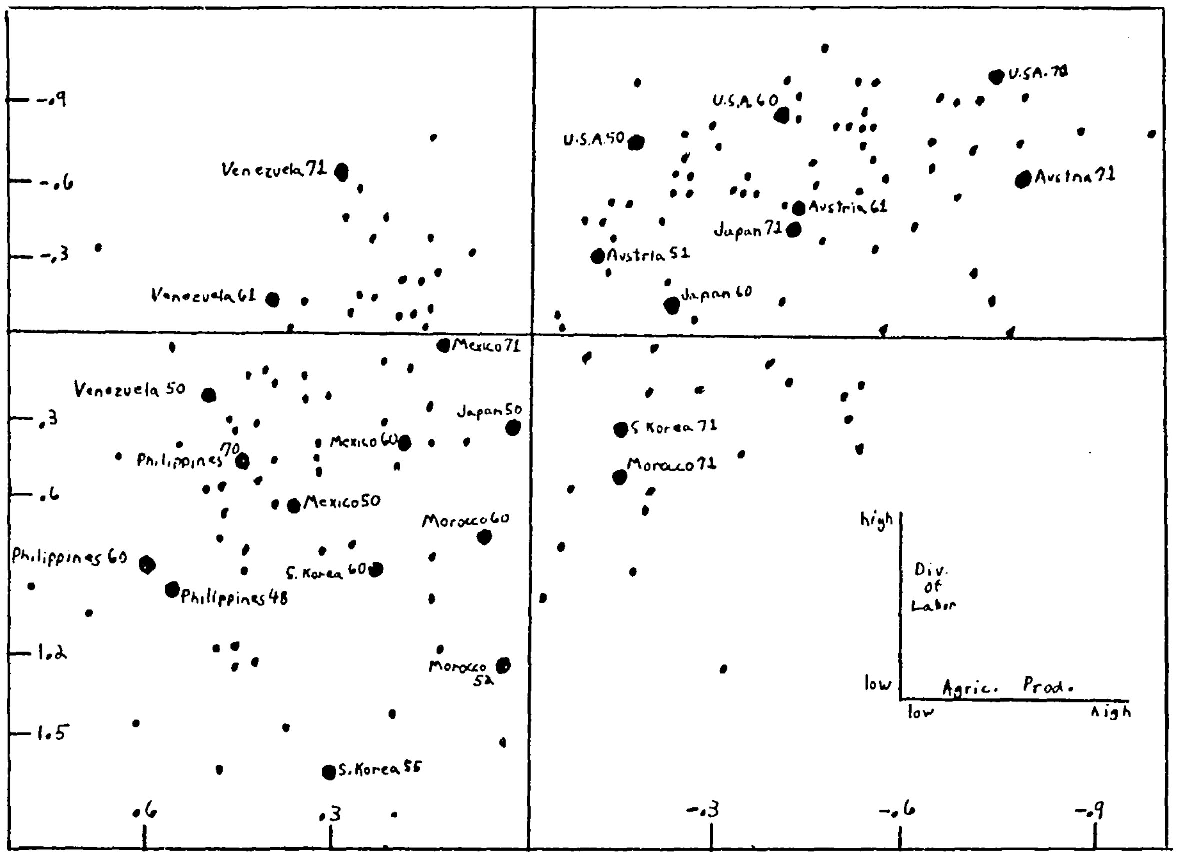


Figure 20. Plot of Agricultural Production and Urbanization Dimensions

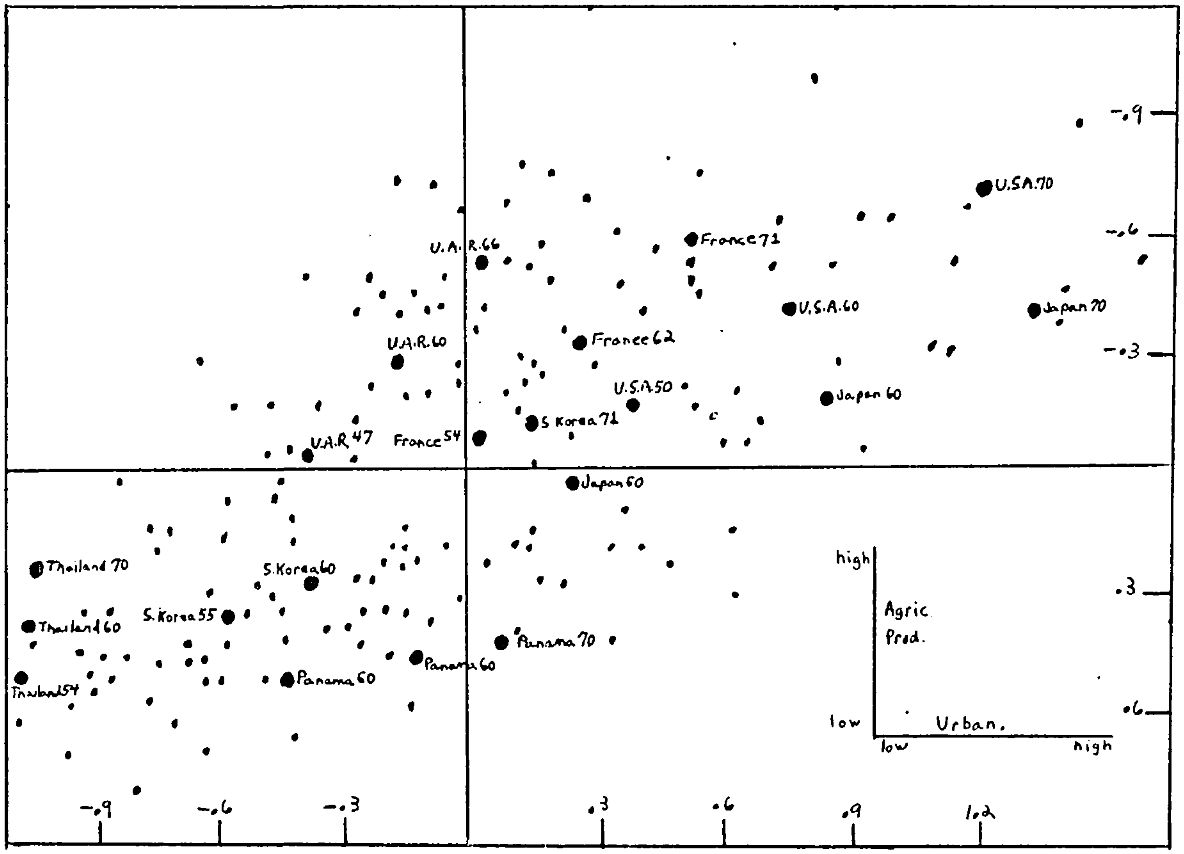


Figure 21. Plot of Division of Labor and Urbanization Dimensions

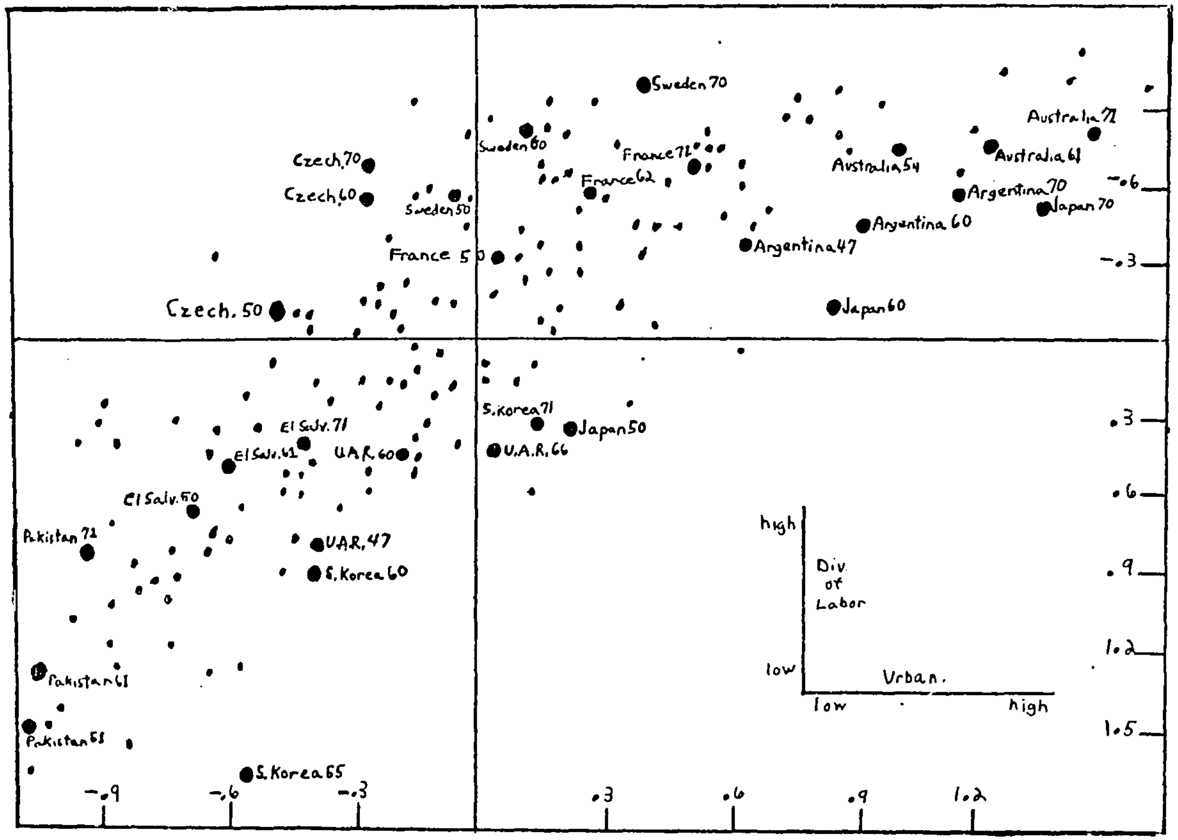


Figure 22. Plot of Percent in Agriculture and Technology Indices, for Data Prior to 1950

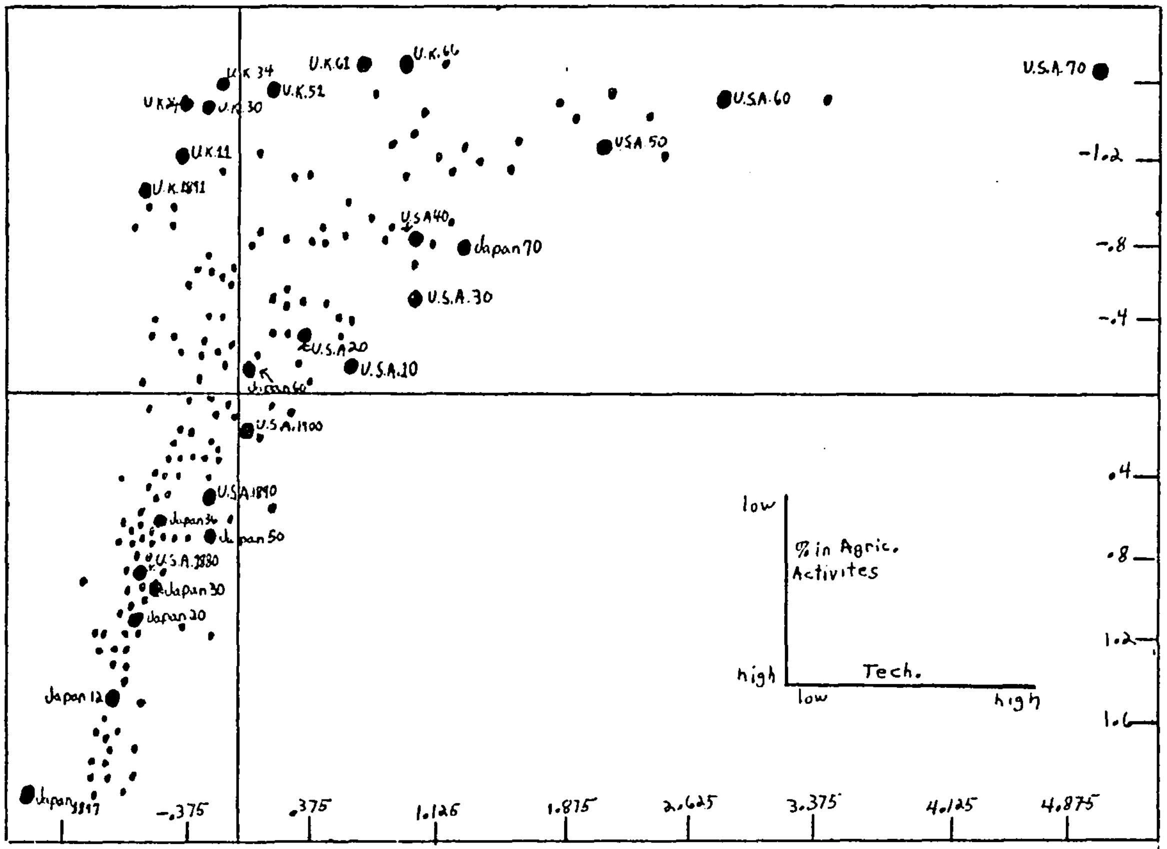


Figure 23. Plot of Percent in Agriculture and Trade Indices, for Data Prior to 1950

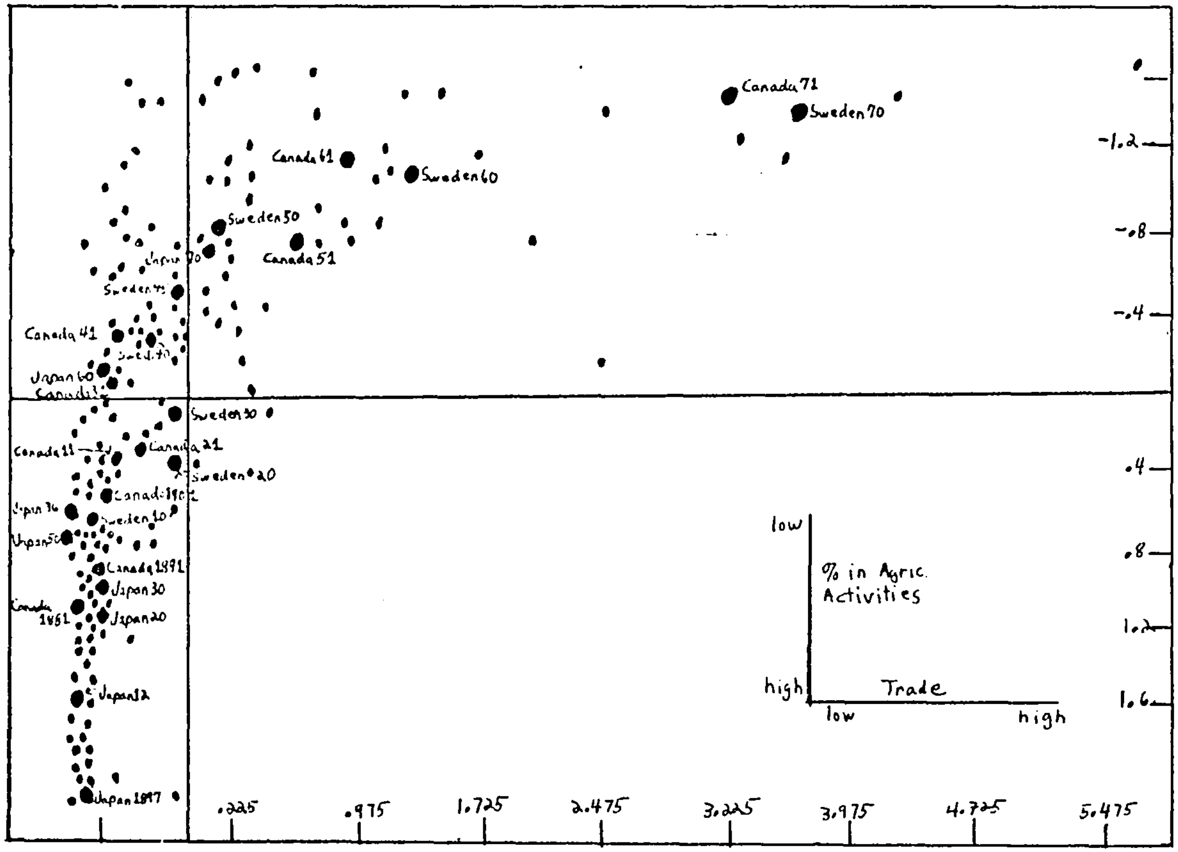


Figure 24. Plot of Urbanization and Technology Indices, for Data Prior to 1950

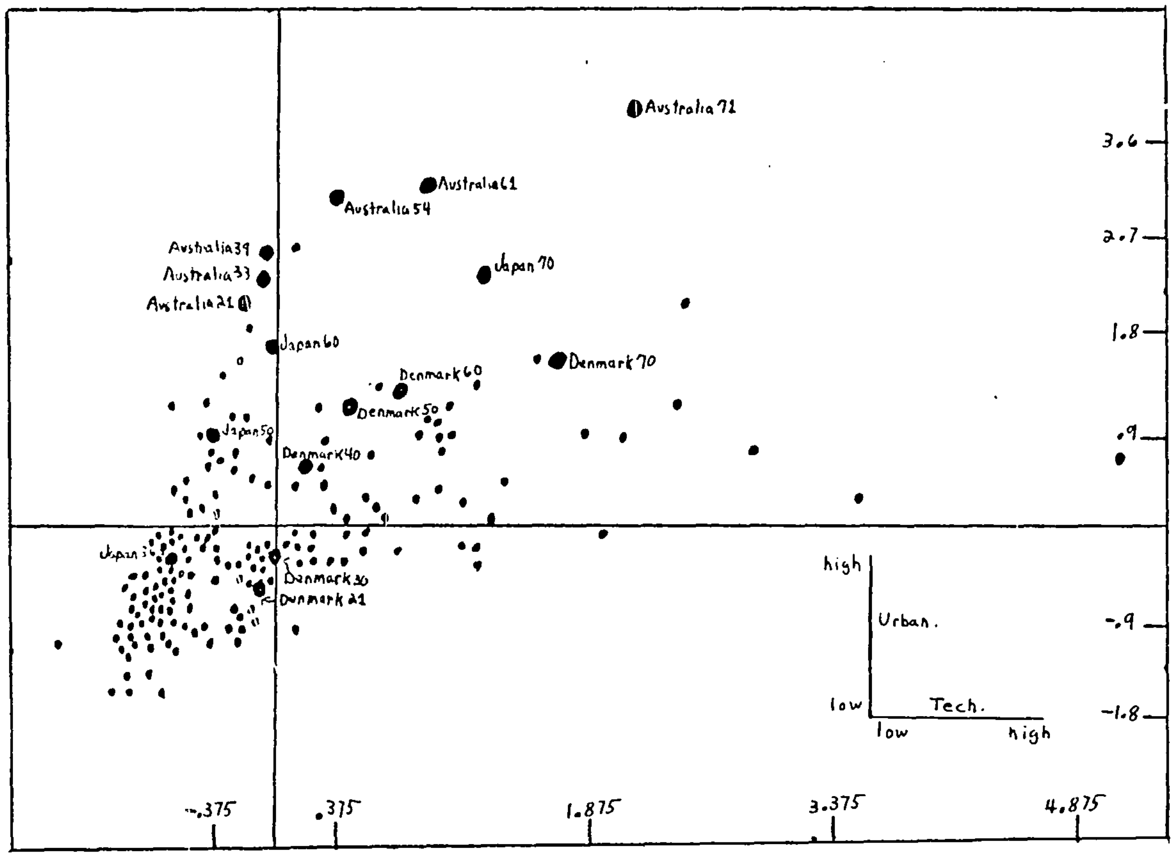


Figure 25. Plot of Urbanization and Trade Indices, For Data Prior to 1950

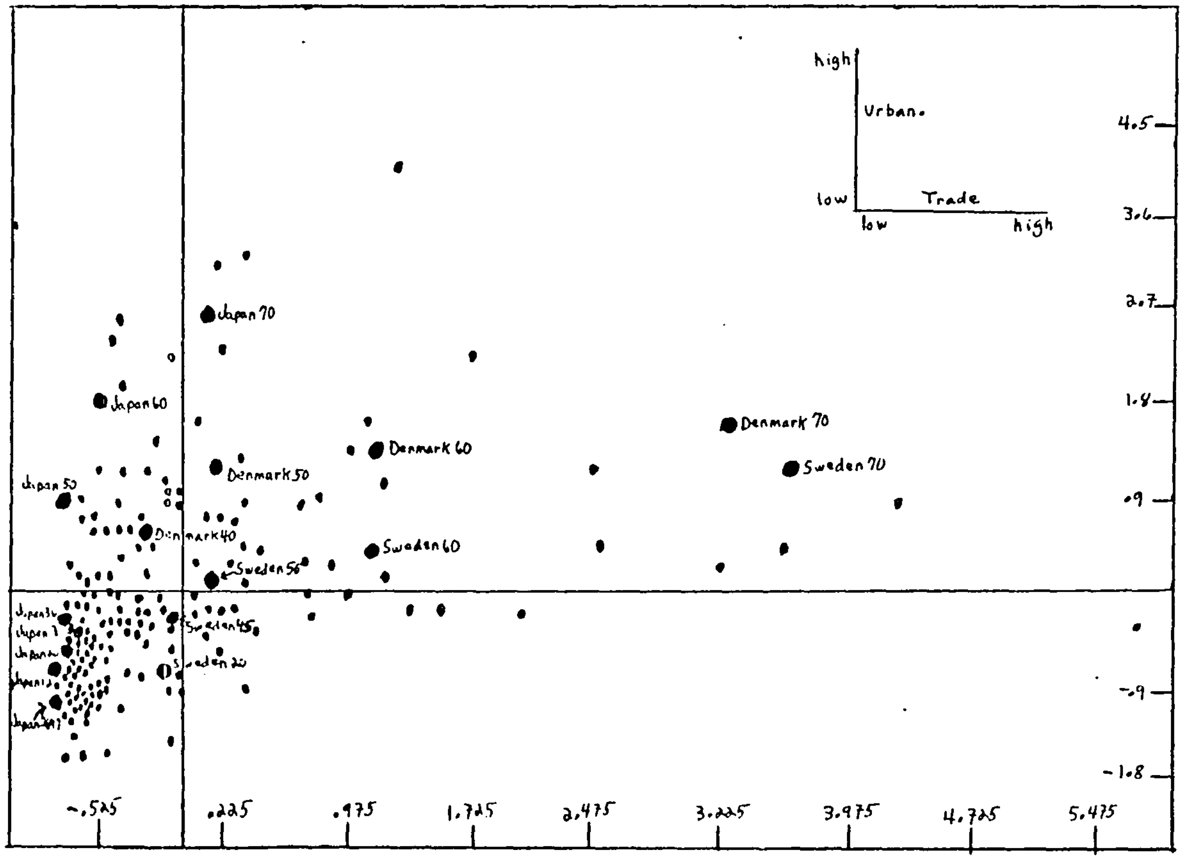


Figure 26. Plot of Trade and Technology Indices, For Data Prior to 1950

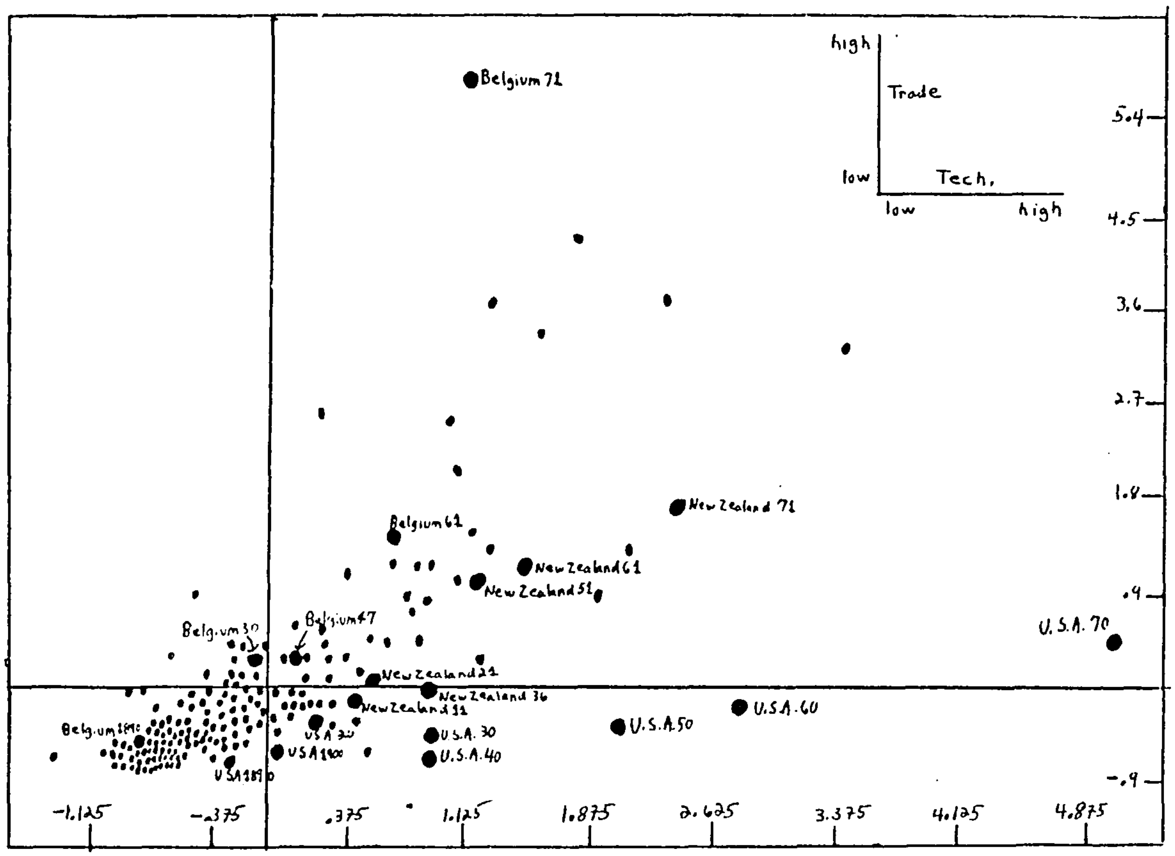


Figure 27. Plot of Percent in Agriculture and Urbanization Indices, for Data Prior to 1950

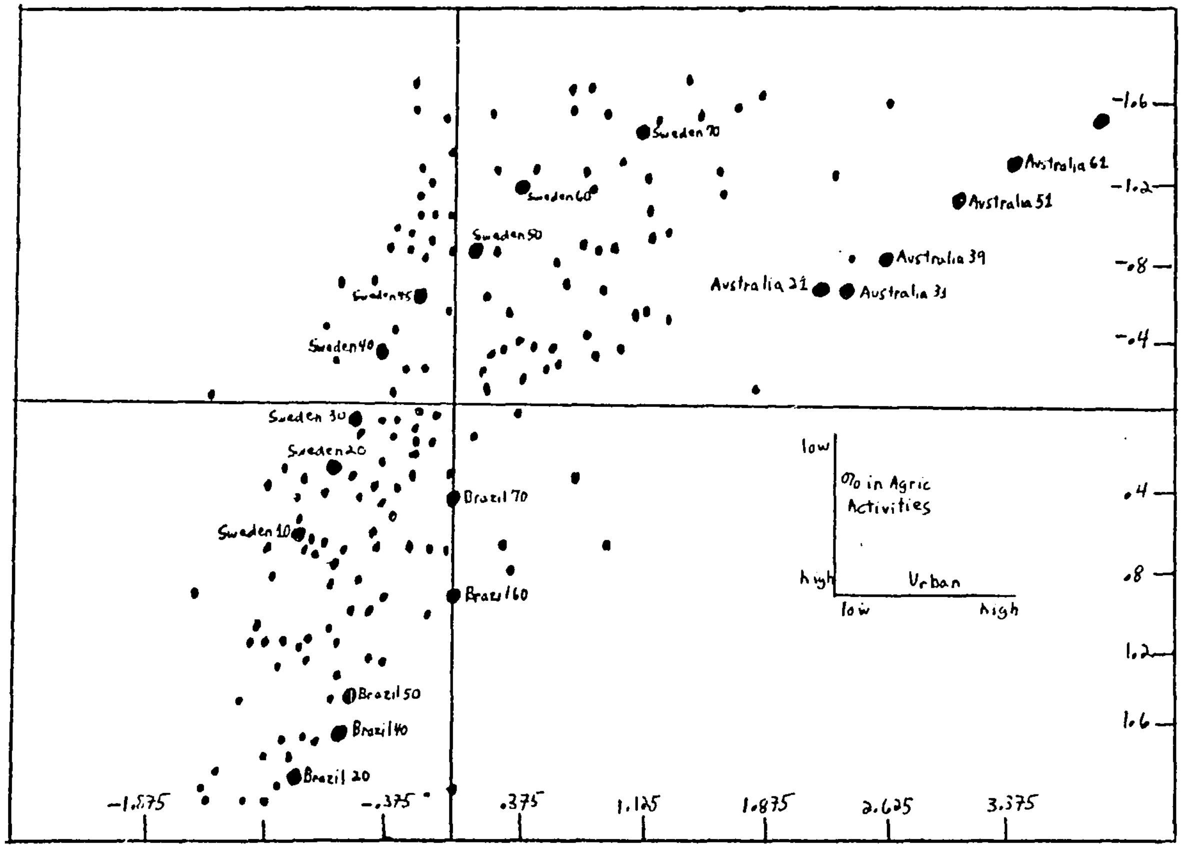


Figure 28. A Model of the Temporal Relationships Between Seven Ecological Indices of Development

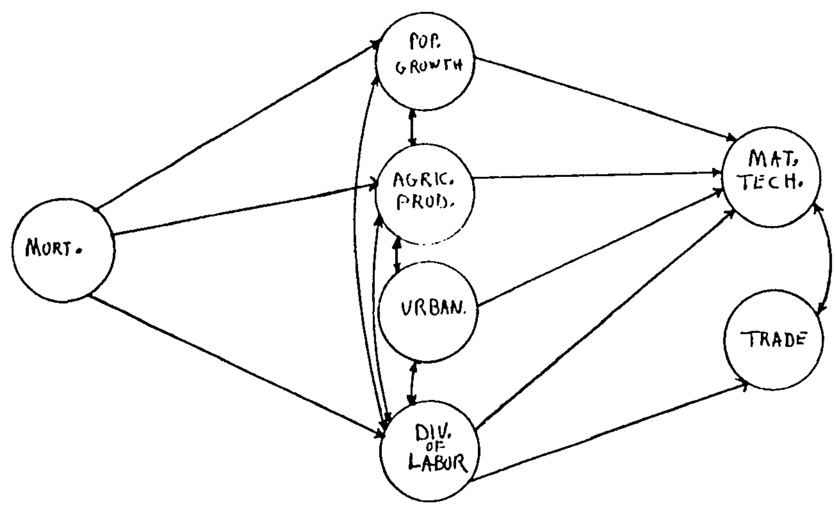
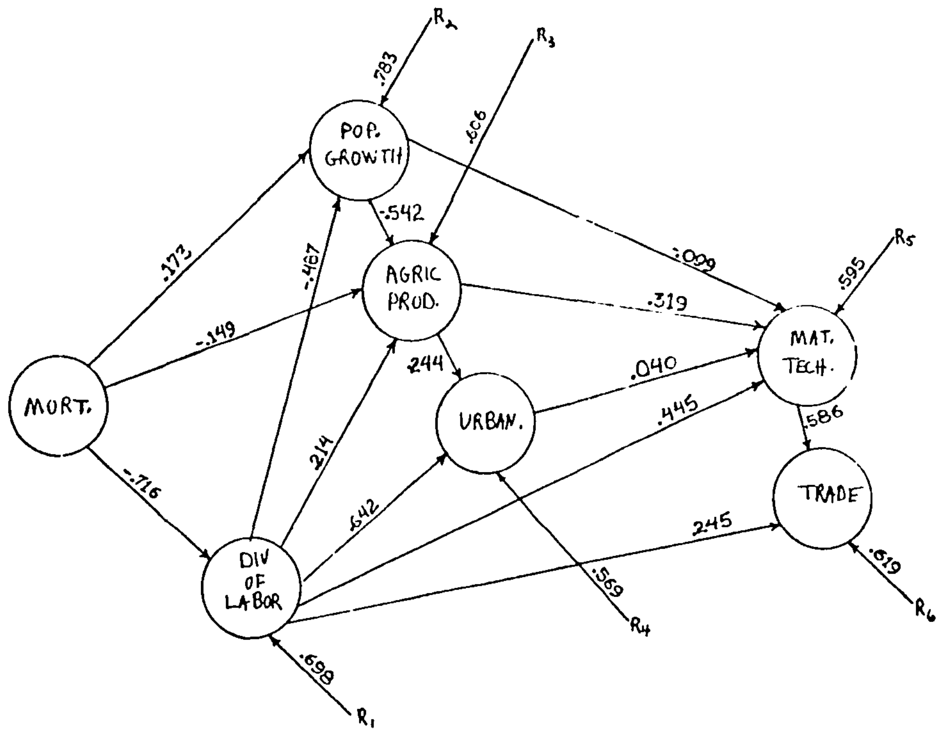


Figure 29. A Tentative Model of the Temporal Relationships Between Seven Ecological Indices of Development, With Standardized Path Coefficients



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