COMPARATIVE DEVELOPMENT:

A QUANTITATIVE APPROACH

by

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abstract

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Submitted to the Department of City and Regional Planning on September 23, 1968 in partial fulfillment of the requirements for the degree of Master of City Planning.

This is a comparative study of ninetythree developing nations. Each country is measured on fortyfive economic, social, and political indicators and compared against one another to reveal development types. The study uses a recently developed statistical procedure called Cluster Analysis and thus becomes an inquiry into the abilities and usefulness of such techniques. A computer program named CLUSTER was programmed on the M.I.T. C.T.S.S.

Chapter One is an introduction into developmental and comparative studies. Chapter Two defines the development indicators and offers a detailed discussion on each indicator. The Third Chapter examines the results of the cluster computations. Chapter Four presents a discussion of other cluster procedures and areas of applications and a description of the computer program CLUSTER and the statistical method upon which it is based.

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ERRATUM:

PAGE 135

Third Line: 'general types' should read 'phenomenal types'

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Fifth Line: "general type" should read 'phenomenal type'

CHAPTER ONE:

1. INTRODUCTION:

It is well understood that the delemma of the underdeveloped countries is a complex and highly interrelated process of social, political and economic change. Such complexity requires multivariate analysis while clarity of the interrelations calls for simplification. This study seeks to define the ambiguous term development and to offer some means of conceptualization by identifying quantifiable measurements which define development levels. Since the national level of economic, social and political development offers too many variables and complex interrelationships to enable generlizations and hypothesis formation, a simplification and classification of development types is proposed. This study thus presents a numerical synthesis of the development indicators which organize the data into classifications for the sake of comparative analysis.

There are three stages to classification studies. The first stage is the impressionistic view of the classes to be studied. Development types at this stage are ideal classifications such as Rostow's (1.) five categories of economic growth which are holistic rather than empirical. The second stage to classification schemes is the development of typologies. This stage has two approaches, either to assign elements to predetermined pigeonholes or to permit the data to internally define the classes. The self-defining schemes are usually of the one or two factor continuum scales such as Friedman's (2.) schema of traditional, transitional, industrial, and post-industrial socieites which are determined by the industrial share of the GNP. The third stage is that of hypotheses testing and formation of generalizations which are empirically verifiable. The stage that con-

cerns us here is the second stage of typology formation but we demand more than the pigeonhole or two factor contiuum schemes. Instead we define a set of developing countries each of which has a list of development indicators upon which a statistical classification analysis will be based. The analysis will offer a typology which reveals significant contrasts between types, which implies membership with respect to patterns of variables and which describes the variables in which the patterns differ..

2. PURPOSE OF COMPARATIVE CLASSIFICATION STUDY:

The development process, requiring structural changes within the developed nations, must be brought about through careful coordination of projects and programs which complement each other and promote the development potential. The assumption basic to this change is that a certain number of well chosen projects and plans will place the country on the path to development. (3.) It is contended by many development planners that the development process is not achieving these goals due to a lack of comparative analysis upon which the planner can rationally arrive at policies and programs suitable to the context of the country. Moreover what is needed to spur the development process on is the ability to apply programs and policies which have been successful in the developed countries to developing countries. Such rational decision-making depends upon the ability to determine what level of development a given country has achieved, what path of development the country is currently charted for, and at what rate change is likely to occur so that policies and programs can be applied to those countries to which they are applicable. The purpose of this study is to determine development levels at a given point in time. It

leaves the important questions of rate, direction and paths of development for a future study which through the use of time-series data and historical studies would link the development levels or stages into connected paths.

The application of experimental projects requires that the sample population of countries be controlled with respect to development level presently obtained, inherent development potential, and geographical and political type distribution. If development types and potentials were known, projects could then be selected for countries whose development environment demonstrates a high probability that the projects would be successful. Projects could also be assigned to countries belonging to a populous development type so that if the project is successful it then could be transferred to other countries of the same type. Furthermore controlling the development environment would allow for comparative analysis of the impact of development on certain institutions and of the patterns of change which seem to occur along similar development paths.

In the search for a typology of development the concern is for a conceptual framework in which the planning process is carried out. What basic variables about a country's level of development, institutional and political environment describe the context of the planning environment? John Friedman (4.) has stated that there exists a "Style of National Planning in every society ..." and that this style effects the manner of decision making. (i.e. the social context of planning.) This study is consequently motivated by the attempt to understand the economic, social and political conditions in which development planning must occur. There are those

variables which will be pro-planning and those which will demonstrate anti-planning ability and the attempt is made in this study to determine in each country what elements create the predisposition for or against the 'context of planning'. Success in development planning is not based on economic achievement alone but is determined as well by the receptivity to a pro-planning environment.

In the attempt to discover whether developing countries tend to cluster about specific points in the development continuum, several development hypotheses can be tested. Lerner has stated that a certain percentage of urbanization (10%+ of the population living in 'urban' areas) has to be obtained before literacy rates begin to rise and that urbanization and literacy rise monotonically until 25% urbanization has been reached. Although this question is not directly verifiable by the development patterns produced by cluster analysis the study can demonstrate the apparent patterns of urbanization and literacy at various development levels. Another area to question is the relationship between modernization and urbanization and whether urbanization is a prerequisite to modernization. Other patterns to account for in each development type are the relationships of fertility and mortality rates and education levels. It would also be of interest to determine whether development types can be defined regionally.

3. GOALS OF THE STATISTICAL ANALYSIS:

The purposes of this analysis are multifold. First an attempt is made to gain insight into the variables which are the basic determinants of development levels and which indicate the stage of development a

country has reached. Secondly a definition of development level or development type is sought by allowing a set of variables to demonstrate natural groupings. Natural in the sense that they are unaided by hypothesized patterns which appear to the investigator to be typical of development. It is precisely the typicality question that the study seeks to answer; the determination of countries which are central to a given type. A development type consequently is a grouping of countries by certain internally determined patterns of development indicators. Third the interpretation of the cluster analysis of development indicators will reveal density of types through the demonstration of agglomeration or sparceness of member countries and will define type typicality through the use of nucleus or cluster centers. Fourth the internal analysis of each type should attempt to explain what pattern of variables is most significant for the formation of that type and what variables seem to have the least significance.

In the attempt to arrive at a quantitative measurement of development fortyfive qualitative and quantitative indicators of economic, social, and political development were defined for ninetythree independent countries as of 1960. The statistical technique of cluster analysis was applied to the data in a search for the significant patterns of relationships among the indicators and for the consequent definition of development types.

CHAPTER TWO:

1. DEVELOPMENT INDICATORS:

THE SAMPLE:

The universe of analysis consists of the ninety-three independent countries as of 1960, excluding the Australasian, North American, Scandinavian and West European countries. The developed nations were excluded in the effort to concentrate on the description of underdevelopment. The ninety-three countries included in the sample are listed below, names other than the official name used in the study are given in parentheses.

Argentina
Bolivia
Brazil
Chile
Colombia
Costa Rica
Cuba
Dominican Republic
Ecuador
El Salvador
Gautemala
Haita
Honduras
Jamaica
Mexico
Nicaragua
Panama
Paraguay
Peru
Uruaguay
Venezuela
Algeria
Burundi
Ferderal Republic of Cameroun (Cameroon)
Central African Republic
Republic of Chad (Chad)
Congo(Brazzaville)
Congo(Leopoldville)
Dahomey
Ethiopia
Republic of Gabon (Gabon)
Ghana
Republic of Guinea (Guinea)
Republic of Ivory Coast (Ivory Coast)
Republic of Kenya (Kenya)
Liberia
Libya
Malagasy Republic
Morocco
Republic of Niger (Niger)
Nigeria
Rwanda
Republic of Senegal (Senegal)
Sierra Leone
Somali Republic
Republic of South Africa
Sudan
Tanganyika
Togo
Tunisia
Uganda
Upper Volta
Burma
Cambodia
China(Taiwan)
Indonesia
Japan
Korea (North)
Republic of Korea (South)
Laos
Malaysia
Philippines
Thailand
Vietnam (North)
Vietnam (South)
Ceylon
India
Nepal
Pakistan
Afghanistan
Cyprus
Greece
Iran
Iraq
Israel
Jordan
Lebanon
Saudi Arabia
Syria
Turkey
United Arab Republic (U.A.R.)
Yemen
Albania
Bulgaria
Czechoslavia
Hungary
Poland
Romania
USSR
Yugoslavia

2. THE SCALING AND WEIGHTING SCHEMES:

The indicators describe interrelationships between the social, economic and political factors of development at a given point in time. Both quantitative and qualitative variables were used. The forty-five indicators were measured along a development scale from High, Medium, Low, Very low and Extremely low although the choice of this scale appears to be somewhat arbitrary. It must also be noted that the scale of High is in the context of the developing nations and not with respect to the developed countries.

No weighting schemes have been considered although this is somewhat of an oversimplification. For example in the set of indicators which express the amount of Communication Resources, the indicators of newspaper circulation and Radio distribution are more important in implying the extent of communication than the indicators of television distribution and cinema attendance. Instead of considering unequal weights in the initial indicator comparison, weighting schemes were postponed until the analysis of the results. At this point the degree of importance that each indicator should have in producing the levels of development is considered.

3. THE INDICATORS:

The set of indicators present a framework of social, economic and political conditions under which development must occur. The indicators are related to the areas of economics, human resources, education, health, communication, national unity, self-governing experience, government direction, amount of opposition, power distribution and administrative structure.

Groups of indicators therefore constitute a summarization of a nation's ability or experience in one of these categories. The indicators are listed below in the order they will be described in detail.

1./ Gross National Product (GNP)
2./ Gross National Product / capita
3./ Capital Percentage of GNP
4./ Energy consumed per capita
5./ Percentage of Labor Force employed in agriculture
6./ Percentage of the working age employed in Industry
7./ Absolute Population Size
8./ Population Change (% per year)
9./ Density: population per square mile
10./ Percentage of population that is working age
11./ Size of country in square miles
12./ Urbanization
13./ Literacy (% of population aged 11 and over)
14./ % of population enrolled in Primary-Secondary schools to the Total School age population
15./ Ratio of Teachers to Enrolled students
16./ Life expectancy at Birth (Female)
17./ Birth Rate
18./ Death Rate
19./ Ratio of Inhabitant per Physician
20./ Automobiles per capita
21./ Daily Newspaper Circulation per 100 population
22./ Radios per 100 population
23./ Television per 100 population
24./ Cinema attendance per capita
25./ Relegious Homogeneity
26./ Linguistic Homogeneity
27./ Racial Homogeneity
28./ Date of Independence
29./ Former colony
30./ History of Self-governing experience
31./ Experience of Political and Economic Development
32./ Ideological Orientation
33./ System Style
34./ Constitutional Status of present regime
35./ Government Stability
36./ Freedom of Group Opposition
37./ Political Encultration
38./ Sectionalism
39./ Political Leadership
40./ Charismatic Leader
41./ Vertical Power Distribution
42./ Horizontal Power Distribution

43/ Current Status of Legislature
44./ Current Status of Executive
45./ Character of Bureaucracy

4. DETAILED DESCRIPTION OF DEVELOPMENT INDICATORS:

(1,2,3,4,5,6)

ECONOMIC RESOURCES:

Indicator 1: GNP

Scale 1:	High	124.9 - 25 billion $
Scale 2:	Medium	24.9 - 5 billion $
Scale 3:	Low	4.9 - 1 billion $
Scale 4:	Very Low	.9 - .5 billion $
Scale 5:	Extremely low	.49 - 0 billion $

Source: Statistics and Reports Division, U.S. Agency for International Development, March 1962 (AID)

Indicator 2: GNP/capita

Scale 1:	High	$600 +
Scale 2:	Medium	$599 - $300
Scale 3:	Low	$299 - $150
Scale 4:	Very Low	$149 - $75
Scale 5:	Extremely low	$74.9 - 0

Source: AID

Indicator 3: Capital percentage of GNP

Scale 1:	High	25% +
Scale 2:	Medium	15 - 24.9%
Scale 3:	Low	14.9% - 10%
Scale 4:	Very Low	9.9% - 5%
Scale 5:	Extremely Low	Less than 4.9%

Source: Russett, B., H.R. Alker, K.W.Deutsch, H.D. Lasswell. World Handbook of Political and Social Indicators. Yale University Press, New Haven, 1964.

Indicator 4: Energy consumed per capita

Scale 1:	High	1000 + kwhr per year /c.
Scale 2:	Medium	999 - 500
Scale 3:	Low	499 - 250
Scale 4:	Very Low	249 - 100
Scale 5:	Extremely Low	Less than 99

Source: AID

*Indicator 5: Percentage of the Labor Force employed in Agric.

Scale 1:	High	Less than or equal to 25%
Scale 2:	Medium	25.1% - 50%
Scale 3:	Low	50.1% - 60%

* Error in coding, should be reordered.

Scale 4:	Very Low	80%- 60.1
Scale 5:	Extremely low	Greater than or equal to 80%

Source: Russett et al.

Indicator 6: Percentage of Working age employed in Industry

Scale 1:	High	Greater than or equal to 30%
Scale 2:	Medium	29.9% - 10%
Scale 3:	Low	9.9% - 5%
Scale 4:	Very Low	Less than 4.9%

Source: Russett et al.

GNP is a questionable indicator because it is difficult to convert the sum of local currency into $ figures which are comparable between nations. This is in part due to the variety of methods by which GNP figures are computed for different countries. Further complication is involved in the determination of the buying power of the local monetary standard which should be the basis for translation into similar measures.

The most common use of total GNP is as an indicator of the total wealth or economic resources of a country. Used as an indicator of power it implies how much capital a country is able to invest in industrial production and scientific and technological abilities which produce control or influence over other countries. Used as an indicator of well-being it refers to the amount of wealth that a country might be able to invest in leisure and consumer goods. These indicators are of course extremely relative and are further complicated by the fact that a high level of GNP has its own price to pay for support and maintenance. GNP hence has limited value as an indicator of the state of well-being or any welfare related condition. It is used here as an indicator of absolute wealth to be combined with other indicators of health, well-being, education and personal wealth..

GNP/capita is often used to define the term 'underdeveloped'. A

country with a GNP/capita greater or equal to $600 is defined as developed. This indicator however tells little about the distribution of wealth or the degree of concentration of wealth in the hands of a few. Capital % of GNP indicates to some degree the amount of investment a country might employ in economic growth.

The last three indicators refer to the degree of industrialization which can occur within a given country. Rostow discusses the transition which must occur from an agriculturally based (75%) labor force to an industrially based one before the 'take-off' stage can occur. The first two of these indicators refer to the level of industrialization that a country has obtained. A high percentage of the labor force in agricultural pursuits is correlated with a low energy consumption per capita and indicates a low level of development. The reverse situation refers to a highly developed or industrial society. The two indicators of % of labor force in agriculture and industry refer to absolute levels of development with respect to the industrialization continuum. The greater the percentage involved in agriculture the more rural oriented the country and hence the less industrialized.

(6,7)

HUMAN RESOURCES:

Indicator 7: Absolute population size:

Scale 1:	High	More than 100 million
Scale 2:	Medium	99.9 - 50 million
Scale 3:	Low	49.9 - 10 million
Scale 4:	Very low	9.9 - 5 million
Scale 5:	Extremely low	Less than 4.9 million

Source: AID

Indicator 8: Population change (% per year)

Scale 1:	Very High	Greater than or equal to 3.5

Scale 2:	High	3.5 - 2.51
Scale 3:	Medium	1.51 - 2.5
Scale 4:	Low	1.1 - 1.5
Scale 5:	Very low	Less than 1.0

Source: AID

Indicator 9: Density: Population per square mile

Scale 1:	Very High	Greater than 600
Scale 2:	High	599 - 300
Scale 3:	Medium	299 - 100
Scale 4:	Low	99 - 50
Scale 5:	Very Low	Less than 49.9

Source: AID

Indicator 10: Percentage of Population that is Working Age

Scale 1:	Very High	Greater than 65%
Scale 2:	High	65% - 60.1%
Scale 3:	Medium	60% - 55.1%
Scale 4:	Low	55% - 50.1%
Scale 5:	Very low	Less than 50%

Sources: United Nations Statistical Yearbook, 1966.
+ Supplemented by Russett et al.

Indicator 11: Size of Country in square miles:

Scale 1:	Very large	Greater than or equal to 2 million square miles
Scale 2:	Large	1.9 million - .3
Scale 3:	Medium	.299 million - .075
Scale 4:	Small	Less than .075 million

Source: Banks, Arthur,S. and Robert Textor. A Cross-Polity Survey. (Cambridge, Massachusetts), MIT Press, 1963.

Indicator 12: Urbanization

Scale 1:	High	20% of the population resides in settlements of 20,000 and 12.5% of the population resides in settlements of 100,000 +.
Scale 2:	Low	Less than 20% live in 20,000 settlements and less than 12.5% live in 100,000 + settlements

Source: Cross-Polity

Density, urbanization and the size of a country are related indicators contributing to economic development. A low density country without urbanized areas may impede development with the necessity to provide extensive investment in communication networks before effective mobilization can occur. These indicators measure to some degree the wealth invested in land and urban infrstructure.

The indicators of population size and population change and dependency ratio are another form of wealth. The absolute size and the size of the nonproductive population refer to the amount of services and investment that must be devoted to nonproductive investment such as famine control for an overpopulated agricultural population and income maintenance programs for the elderly. A rapid population growth and a high dependency ratio impede development by requiring higher investments in consumer goods, health and educational services and reduce the amount of capital available for production investment. A further repercussion of an expanding population even with an increasing GNP is the possible reduction in or constant level of GNP/capita so that economic gains are nullified and shifts in the economy required for development are prevented. Density can be further viewed as an indicator of the upper bound for urbanization. High density rates without urbanization however imply stagnant development as overhead expenses consume most capital expenditures.

These indicators are grouped together to produce a category of human resource endowment. This category measures the degree to which the population, area and degree of urbanization produce a climate which is amenable to development rather than a climate which nullifies available

resources.

EDUCATIONAL RESOURCES: (4,8,9,10)

Indicator 13: Literacy Rates (% of population aged 11 and over)

Scale 1:	High	Greater than or equal to 90%
Scale 2:	Medium	89% - 50%
Scale 3:	Low	49% - 25%
Scale 4:	Very Low	24.9% - 10%
Scale 5:	Extremely Low	Less than 10%

Source: AID

Indicator 14: % of population enrollled in Primary-Secondary Schools to the total school age population

Scale 1:	High	Greater than or Equal to 60%
Scale 2:	Medium	59% - 40.1%
Scale 3:	Low	40% - 25.1%
Scale 4:	Very Low	Less than or Equal to 25%

Source: Russett et al.

Indicator 15: Ratio of Teachers to Enrolled Students

Scale 1:	Very Good ratio	Less than or Equal to 1:20
Scale 2:	Good ratio	Between 1:20 and 1:35
Scale 3:	Poor ratio	Between 1:35 and 1:50
Scale 4:	Bad ratio	Greater than 1:50

Source: Computed from a set of figures from AID

Education very well may be the prerequisite for social and economic change; certainly it has a major role of instigating change on all levels. The educational system is often viewed as the vehicle for political socialization and national unity. It is to be noted that literacy figures and enrollment rates do nd reflect the quality of teaching, the drop-out rates, absenteeism or failures. The rate of enrollment may however reflect the value placed upon education in the country under consideration.

The teacher:student ratio points to the quality of education with respect to personal student attention and overcrowded classes.

Educational training, especially literacy, can be considered to be an indicator of a country's potential for development. Countries undergoing rapid urbanization but with low rates of enrollment and teacher : student ratios and consequently low literacy rates will find that many of the recent arrivals to the cities from the countryside will be unemployable. Many of the technical skills required for technological development will not be met. Similar difficulties produced by low standrds of education occur with respect to the education of skilled administrators required to execute and coordinate development plans.

(1,4,9)

HEALTH RESOURCES:

Indicator 16: Life Expectancy at Birth (Female)

Scale 1:	High	Greater than 65.1
Scale 2:	Medium	65 - 50.1
Scale 3:	Low	50 - 40.1
Scale 4:	Very Low	Less than or equal to 40

Source: Statistical Yearbook, 1966

Indicator 17: Birth Rate

Scale 1:	Low	Less than or equal to 20 (per 1000 pop.)
Scale 2:	Medium	34.9 - 20.1
Scale 3:	High	Greater than or Equal to 35

Source: Statistical Yearbook, 1966

Indicator 18: Death Rate

Scale 1:	Low	Less than or equal to 15 (per 1000 pop.)
Scale 2:	Medium	24.9 - 15.1
Scale 3:	High	Greater than or equal to 25

Source: Statistical Yearbook, 1966

Indicator 19: Ratio of Inhabitants per Physician

Scale 1:	Low	Less than or equal to 2,000 per physician
Scale 2:	Medium	25,000 - 2,000
Scale 3:	High	49,999 - 24,999
Scale 4:	Very High	Greater than or equal to 50,000

Together these indicators represent the health level of a nation which has a consequent effect on the population rate. A higher birth rate, a longer life expectancy, more physicians per capita and lower death rates are secondary determinants of increased population growth rates. Even one of these indicators showing considerable increase effects the growth rate. They can also be considered to represent the level of living standards or the risks upon life that one encounters in a given nation.

COMMUNICATION RESOURCES:

Indicator 20: Automobiles per capita

Scale 1:	High	Greater than or equal to .025
Scale 2:	Medium	.01 - .025
Scale 3:	Low	Less than or Equal to .01

Source: Calculated from AID figures

Indicator 21: Daily Newspaper Circulation per 100 population

Scale 1:	High	Greater than or equal to 10.0 (per 100)
Scale 2:	Medium	10 - 3
Scale 3:	Low	3.0 - .9
Scale 4:	Very Low	Less then 0.9

Source: UNESCO World Communications: Press, Radio, Television, Films. Netherlands, 1964. (.C.62/D.52?A)

Indicator 22: Radios per 100 population

Scale 1:	High	Greater than or equal to 10 (per 100)
Scale 2:	Medium	10.0 - 3.0
Scale 3:	Low	3.0 - 0.9
Scale 4:	Very Low	Less than 0.9

Source: UNESCO

Indicator 23: Television per 100 population

Scale 1:	High	Greater than or equal to 5.0
Scale 2:	Medium	5.0 - 1.5
Scale 3:	Low	Less than 1.5

Source: UNESCO

Indicator 24: Cinema attendance per capita

Scale 1:	High	Greater than or equal to 5.0
Scale 2:	Medium	4.9 - 1.0
Scale 3:	Low	Less than or equal to 1.0

Source: Russett supplemented by UNESCO

To some extent these indicators can be said to measure the degree of modernization of a country. This concept is difficult to define in terms that will be agreeable to most concerned, however it is used here in the sense of awareness of and communication with ideas and materials foreign to the native culture or locale; the channels of information which produce social and economic upward mobility and cultural change. Daniel Lerner (11.) has pointed out that "...modernization is the transition to participient society..." and it is for this reason that the communication category becomes an important vehicle for developing countries; the mode of transition from traditional to modern society.

NATIONAL UNITY: (6,12,13,14,15,16,17,18,19,20)

Indicator 25: Religious Homogeneity

Scale 1: Homogeneous
Scale 2: Heterogeneous

Source: Cross-Polity

Indicator 26: Linguistic Homogeneity

Scale 1: Homogeneous
Scale 2: Heterogeneous

Source: Cross-Polity

Indicator 27: Racial Homogeneity

Scale 1: Homogeneous(Majority of one race 85%+ and no strong minority race)
Scale 2: Weakly Heterogeneous (Majority 85%+ of one race but strong minority of 15% or less)
Scale 3: Strongly Heterogeneous (no one group of 85% or more)

These indicators seek to establish the degree of cultural fragmentation of a country. Key to the adoption of most centrally directed development plans is the accepted norm of a national polity by the residents of the country. A country split be religious, racial and linguistic diversity will have difficulty in obtaining commitment to or organization for comprehensive planning or institutional changes. A prerequisite for development planning thus becomes a degree of national unity. Perhaps much of the effort in non-unified countries must go to establishing a basis for future planning and agreement and to eradicating hatreds and divisive ideologies. Witness the effort in this direction by the campaign of Attaturk for national unity. These indicators can also be used as indirect implications to economic and social aspects which are likewise divergent if national unity is lacking.

The role of national unity in development appears to be extremely sensitive. The issue of linguistic or racial diversity can not be disregarded by directing everyone's allegiance to the unity concept. Particularists' views and actions will continue to thwart the nationalistic politicians. In India, the recognition of particularist groups has weakened the strength of the main political party although broadening the base of national unity.

SELF-GOVERNING EXPERIENCE: (6,12,13,14,15,16,17,18,19,20)

Indicator 28: Date of Independence

Scale 1:	Very Early	Before the 19th century
Scale 2:	Early	1800 - pre WWI
Scale 3:	Recent	1913 -1945 (pre WWII)
Scale 4:	Present	1945 - present

Source: Cross-Polity

Indicator 29: Former Colony

Scale 1: Never Colonized (or for short times only)

Scale 2: Governed by colonial power for some periods of time

Source: Cross-Polity

Indicator 30: History of Self-government

Scale 1: Self-governing experience gained through early self-modernization period

Scale 2: Limited experience gained through a developed society modernizing under tutelage

Scale 3: Very weak experience gained by an underdeveloped society under tutelage

Source: Cross-Po lity

Indicator 31: Experience of Political and Economic Development

Scale 1: Experience --- The transitional phase of creating a politically organized society, of asserting

political policies to develop, and of breaking with agrarian forms of institutions has been completed. In this phase, the power structure is in accord that development is desirable and effort now is concentrated on achieving such in the best manner.

Scale 2: Some experience --- This characteristic is displayed by those countries who entered the transitional phase prior to 1945.

Scale 3: Weak Experience --- This phase involves those countries who entered the transitional phase after 1945 and consequently have obtained moderate experience, political orientation and direction toward the basic aims of development.

Scale 4: No experience --- This is displayed in those traditional societies for which modernization has had no profound effect.

Source: Cross-Polity

These indicators represent the political leadership experience which a country has gained. The first indicator measures the length of time during which the country has been an independent polity. Although independence does not imply stability it can be used as a measure of governing experience. The fact that a country has recently achieved independence and prior to this has had colonials holding most authoritative positions implies a current void when independence is obtained with respect to self-governing experience. The third indicator points to possible situations under which institutional adaption to the changing conditions of development was inspired by internal or external powers. In other words, did a country receive development impetus from an external colonial source or were the self-governing institutions developed internally? The fourth indicator is concerned with the length of time during which a country has been motivated or committed to development. This attempts to measure the

degree to which the leaders have gained general support of their development programs or to which there will be battles of acceptance to fight for any non-traditional procedure. Self-governing experience is thus derived from a country's political support of some basic aims of development. This support implies that the divisive conditions of colonial versus national power, traditional versus modernizing attitudes, regionally located political systems as opposed to centrally based ones have been eradicated and have therefore produced some degree of self-governing experience and some establishment of a political and administrative structure in the interim.

The prevailing self-governing experience will contribute to the general aims and direction of planning programs; the degree to which the politicians can organize and implement plans and the boundaries by which their suggestions are constrained. The degree of self-governing experience will also help to determine the ability with which the leaders can modify their policies and can maintain leadership in the face of inflexible opposition. Negotiating and flexibility of governmental methods can be produced by relatively long periods of self-governing experience.

GOVERNMENTAL DIRECTION: GUIDANCE AND CONTROL SYSTEM (6,12,13,14,15,17,18,19,20)

Indicator 32: Ideological Orientation

Scale 1:	Doctrinal -- Communist States
Scale 2:	Developmental -- development has been accepted as the first priority national goal
Scale 3:	Situational -- These countries have no commitment to development
Scale 4:	Conventional -- Innovative procedures or changes in power relations are accomplished through conventional channels.

Scale 5: Traditional -- these countries produce no changes and are based on traditional means for accomplishing goals.

Source: Cross-Polity

Indicator 33: System Style

Scale 1: Mobilized
Scale 2: Lim ited mobilization
Scale 3: Non-mobilization

This indicator refers to the absolute level of political commitment of all resources to solve urgent problems of development.

Source: Cross-Polity

Indicator 34: Constitutional Status of Present Regime

Scale 1: Constitutional
Scale 2: Authoritarian
Scale 3: Totalitarian

This indicator represents the degree to which individual rights are honored and hence the degree to which a country can compel its citizens to accept its development programs or to which the interests of all major groups are served.

Source: Cross-Polity

Indicator 35: Government Stability

Scale 1: Stable since W.W.I
Scale 2: Stable since W.W.II
Scale 3: Moderately stable since W.W.II
Scale 4: Unstable since W.W.II

This indicator although difficult to measure represents the period of time during which a country has had a stable government with which to implement its development plans.

Source: Cross-polity

These four indicators are grouped together to represent a category referred to as Governmental Direction. Perhaps they should be put into separate subcategories of a guidance indicator of the degree of political and resource commitment and a control indicator of enforcement and implementation ability. The category of Government Direction seeks to re-

late comitment with implementation procedures in order to assess the degree to which a government can direct its development programs.

D. E. Apter (12.) discusses a similar concept when he defines development types with respect to different approaches to economic development and to different processes of change within each type of system. These development types provide a framework with which to assess the development goals and decisions and the patterns of legitimacy, loyality, and authority which occur in a given country.

A government with a strong degree of commitment to and mobilization for development plus an ability to enforce these programs will perhaps be found to sacrifice such things as immediate consumer consumption for the eventual attainment of a higher level of income per capita and more equal income distribution. On the other hand, a government equally committed to development but constitutionally required to listen to the opposition would not be able to direct its programs against the will of major concerns. Yet another cause of ineffective governmental guidance is seen in all countries with unstable governments. Internal political unrest mainly presents itself as a barrier to development programs. Stable and committed governments on the other hand seem to be required for program implementation.

The category of government direction in some respects points to the degree of action a government can impel, assuming of course the required resources. Note that one difficulty of a highly committed, mobilized and enforced program is the over-rigidity and resistance to change that may make a program incapable of adapting itself to unexpected problems. Once a typology of government direction has been established it would be insightful to determine the relationship of types to instances of planning

successes or failures.

The level of development may also imply the degree of government direction required. For example a strongly committed and mobilized system may be necessary to overcome stagnation and promote structural change to move a backward country onto the development escalator. On the other hand, a fairly developed country may require a relaxed environment of government direction that enables innovative decision making techniques or sophisticated methods of guidance to play a more dominate governing role. In the latter group of countries, central control may not be the most effective development procedure.

(6,12,13,14,15,16,17,18,19,20)

AMOUNT OF OPPOSITION:

Indicator 36: Freedom of Group Opposition

Scale 1: Autonomous groups politically allowed to oppose the government
Scale 2: Autonomous groups politically allowed but their capacity to oppose the government is limited
Scale 3: Autonomous groups only allowed informally, extra-political
Scale 4: No autonomous groups allowed

Source: Cross-Polity

Indicator 37: Political Encultration

Scale 1: High -- a highly integrated and homogeneous polity with no fractions nonassimilated, or disenfrancised.
Scale 2: Medium -- a less integrated polity with minority groups in extreme opposition
Scale 3: Low -- a nonintegrated or restrictive polity with a majority in extreme opposition

Source: Cross-Polity

Indicator 38: Sectionalism

Scale 1: Extreme --groups which identify extremely with a sizeable geographic area and consequently challenge the cohesion of the polity.

Scale 2: Moderate --One group with strong feelings or several with moderate feelings of sectionalism
Scale 3: Negligible -- there are no significant feelings to be taken into account

Source: Cross-Polity

These three indicators are combined to represent the amount of opposition which occurs in a given country. Those which drive all political opposition underground and have no fractional groups and little sectionalism will be able to enforce their programs with considerable allegiance. The resources required such as maintenance of a police force and surveillance measures to drive opposition underground may however divert funds required for development programs. On the other hand a country that has a multiplicity of political groups, allegiances and loyalties may find itself unable to reach consensus programs and hence unable to proceed with development plans.

This category seeks to measure the degree to which political, group and sectional opposition influence major planning decisions and the level of unity or diversity of allegiance which is sought. The degree of opposition can be viewed as representing the strength of interest groups which have achieved an effective voice in a relatively advanced society. For a traditional society it might represent the degree of individualism that marks the psychological position of individuals in underdeveloped countries.

Where extreme opposition exists, in one form or another, it is necessary to discover the degree of influence or control it can have over development decisions. Extreme sectionalism requires regrouping of allignments into national political institutions before development plans can be pursued and this procedure may be painful and slow.

POWER DISTRIBUTION (Governmental Organization) (6,12,13,14,15,16,17,18,19,20)

*Indicator 39: Political Leadership

Scale 1: Elitist -- recruitment is from a particular racial, social or ideological class
Scale 2: Moderate Elitist -- recruitment is not completely closed to the non-elite
Scale 3: Non-elitist -- recruitment is based on achievement

Source: Cross-Polity

Indicator 40: Charismatic Leader

Scale 1: High
Scale 2: Moderate
Scale 3: Weak

Source: Cross-Polity

Indicator 41: Vertical Power Distribution

Scale 1: Federalism -- general and regional government coordinated but independent
Scale 2: Limited Federalism -- displays limited separation or strong centralism
Scale 3: Formal acceptance of Federalism but not implemented
Scale 4: Unitarism

Source: Cross-Polity

Indicator 42: Horizontal Power Distribution

Scale 1: Effective allocation of power to structurally autonomous legislature, executive and judiciary governmental branches
Scale 2: Allocation of power to one branch or two branches with limited autonomy
Scale 3: Government dominated by one body (Governmental agency or branch)

Source: Cross-Polity

Power distribution effects the ability and climate for planning in governmental system; the command, control and coordination required for action. If horizontal and vertical power is effective then there should be a distribution of persons who will guide and implement projects through-

* Error in coding

out the structure. A government dominated by an elite group may not have effective channels through which to mobilize involvement in planning. The more effective the power distribution the more coordination among governmental units involved in the development process. Certainly the methodology for plan implementation is shaped by the existing type of governmental organization.

Governmental organization refers to the distribution of power throughout the government. In part this category indicates the quality of environment which allows for the development of administrators throughout the levels of government. Administrators in developing countries can be viewed as major channels of innovating ideas and direction.

An elitist leadership with strong centralist tendencies and suffering from limited numbers of qualified administrators will produce an environment that will find the lower ranks of the government organizations ineffectual and unable to execute any plans. Furthermore conflicting or controversial plans may have more success if they can call on allegiance throughout the governmental organization.

The charismatic leader indicator is included in this category because of the substitutions in effective power distributions that the "great man" theory can produce. Given a charismatic leader, mobilization and commitment to his program can supercede the prerequisites of effective power distribution. In this case personality types are substituted for institutional structure.

ADMINISTRATIVE STRUCTURE: (6,12,13,14,15,16,17,18,19,20)

Indicator 43: Current Status of Legislature

Scale 1: Highly effective

Scale 2: Partially effective
Scale 3: Largely ineffective
Scale 4: Wholly ineffective
Source: Cross-Polity

Indicator 44: Current Status of Executive

Scale 1: Dominant
Scale 2: Strong
Scale 3: Weak

Source: Cross-Polity

Indicator 45: Character of Bureaucracy:

Scale 1: A modern effective and responsible civil service.
Scale 2: Limited effectiveness because of personnel shortage , inadequate recruitment and performance criterion or dominated by some other governmental organization.

Scale 3: Colonial bureaucracy in the process of personnel 'nationalization'
Scale 4: Traditional non-nationalized bureaucratic structure

Source: Cross-Polity

This category is similar to that of governmental organization although here the concern is directed toward the characteristics of personnel rather than the effective structure of communication and coordination. Both these categories describe the "machinery for planning". The degree of personnel competence greatly effects the climate of program guidance and again emphasis is on the ability to translate policies and plans into action. The relationship of the legislature, executive, and bureaucracy to one another and the degree to which the effectiveness of one can be substituted for that of another is indeed open to question; however it is assumed here that their effectiveness is not independent and that a strong bureaucracy can compensate for a weak executive, etc.

M6409 5459 .TAPE. 4 FOR M6409 5459	
222212335221222123411121111221103041303320202	ARGENTINA
553442545322332311322200223221222131333342222	BOLIVIA
232340235311232213322222121221103141312311222	BRAZIL
324222425331233231121132101221143131332341202	CHILE
332432325421223313322132121221243131212342222	COLOMBIA
522333514440222213322230111221143131133341222	COSTA RICA
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532443512342332213332132121221233242331342312	EL SALVADOR
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422322532441224113312202221422303101233241122	JAMAICA
222333325421223213322121121221143122202332212	MEXICO
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322444335322040432323432113422421200220243313	ALGERIA
550000003042500431000000011423323002033042303	BURUNDI
550300555432534432234400213423323002223212223	CAMEROON
550500545332540431234300013423323203333243313	CENTRAL AFRICAN REPUBLIC
550504535322540431134403223423323002323243303	CHAD
550500535432430432334300213423323002323243313	CONGO(BRAZZAVILLE)
341453325422330433234403213423323040313C00003	CONGO(LEOPOLDVILLE)
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552500525332544000234303111423323002212342303	SOMALI REPUBLIC
222122325321332221412202223221243010211341111	REPUBLIC OF S. AFRICA
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452500435322544412334403213423322002233143313	TANGANYIKA
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443550434442233312134433112422302233220143414	CAMBODIA
342333321440123123432231010111111324021143412	CHINA(TAIWAN)
255540233222233112133432113422322232313143310	INDONESIA

12112125123111313342111121111113312113334112 2	JAPAN
55000030344000001300000000111021113240312434 12	KOREA (NORTH)
35354333144122421233223201110210024033034000 2	KOREA, REPUBLIC OF
55055054533244201213440321342233324031104340 4	LAOS
33343342344032222332220122342232321132332112 2	MALAYSIA
34454443454022322343333311342214312122234112 2	PHILIPPINES
34353332234221222333230221342230314122234220 2	THAILAND
34000034304000000000000012422311324031143412	VIETNAM(NORTH)
34450033304040402333340201242230103333234341 0	VIETNAM, REPUBLIC OF
34355432333222321333343011211125232312134340 4	CEYLON
14354313232243331332340211342210312121313111 2	INDIA
55005443334250201210440020311130324330104342 4	NEPAL
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45055035433254000013440012311325321322104241 4	AFGHANISTAN
52232253334222312341113121342214310133004112 2	CYPRUS
32232245314122323343110111213143131233341202	GREECE
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21252053234122102343221121132214314132034222 2	LEBANON
33000040532244200022433010131245321333124301 4	SAUDI ARABIA
23004042434133202333232112322133040320040002	SYRIA
13344332432133321343223211211314310113334122 2	TURKEY
24354333432133321233323211142212122303014341 2	UNITED ARAB REPUBLIC
14000050433230000010000010131230000031004000 0	YEMEN
43004052344220012300220221121311132402134341 2	ALBANIA
32104244314121213300113111221311132402134341 2	BULGARIA
21002134324111213300111121331311132401134341 2	CZECHOSLAVIA
32202134314111213300112121131311130303134341 2	HUNGARY
22102134333111213300112111131311132313134341 2	POLAND
22004034313112213300113111221311132403134341 2	ROMANIA
11202110431112113300112101311311132401100301 2	USSR
22104234323221212300223121331311132331124341 2	YUGOSLAVIA

CHAPTER THREE

ANALYSIS OF THE RESULTS:

Although the technique of cluster analysis is explained in detail elsewhere, a few words about the procedure are necessary in order to understand the results. Fourtyfive indicators of development for 93 independent countries are compared against each other to obtain an agreement coefficient for each pair of countries. A significance test S0 is placed on each of the 8,649 agreement coefficients to produce an incidence matrix whose entries are '1' when the agreement coefficient passes the test and otherwise '0'. All the consequent cluster formations are based on this incidence matrix. Four test levels are tried: S0 = 0.8, S0 = 0.5, S0 = 0.2, and S0 = 0.1 . The incidence matrix is analyzed to determine space-types which are further defined as phenomenal and nuclear clusters. Phenomenal clusters are obtained directly from the linkages contained in the incidence matrix. Each member of a phenomenal cluster is linked to every other cluster member. The number of overlaps in the phenomenal clusters yield a matrix of nucleus counts from which the nuclear clusters are determined. When orders of overlaps are introduced, the concept of 'typicality' is defined. The overlap matrix is also given a significance test S1, usually S1=2 , to determine relatedness. A matrix of related-types is produced by combining all the phenomenal clusters which have a significant number of overlaps in common. The indicator patterns of agreement and variability are next examined to produce development-stages for each related-type. These stages are then compared against each other to offer tentative development paths.

1. STAGE ONE: Cluster and Type formation at SO = 0.8:

This test appears to be too stringent a criterion for the data of comparative development for no agreement coefficient is able to pass it. The significance test SO is consequently lowered to SO = 0.5 .

2. STAGE TWO: Cluster and Type formation at SO = 0.5:

Testing the agreement coefficients against this significance level yields the incidence matrix of Table 1. This matrix produces the eight phenomenal clusters of Table 2 and Table 3. The column for cluster frequency is obtained from the percentage of clusters of a given size to the total number of clusters. Obviously clusters of size two are the most prevalent. When the matrix of nucleus counts is analyzed it becomes apparent that there are no significant overlaps (S1 = 2 or greater) among the phenomenal clusters. However when the criterion is lowered to S1 = 1, the Tables 5,6, 7, and 8 yield the related-types. The overlaps of Table 6 are best displayed by the diagrams of Figure 1 .

Regional Definitions at SO = 0.5:

The second stage of cluster formation reveals that regional boundaries are maintained. The five related-types can be defined by the following regional descriptions: (type 1): Eastern European; (type 2): Latin American; (type 3): African; (type 4): Carribean; (type 5): African.

Indicator Patterns of Agreement and Variability:

In order to facilitate analysis, the 45 indicators have been grouped into eleven categories. The following sets of indicators repre-

(continued on page 38.)

INCIDENCE MATRIX: SO = 0.5

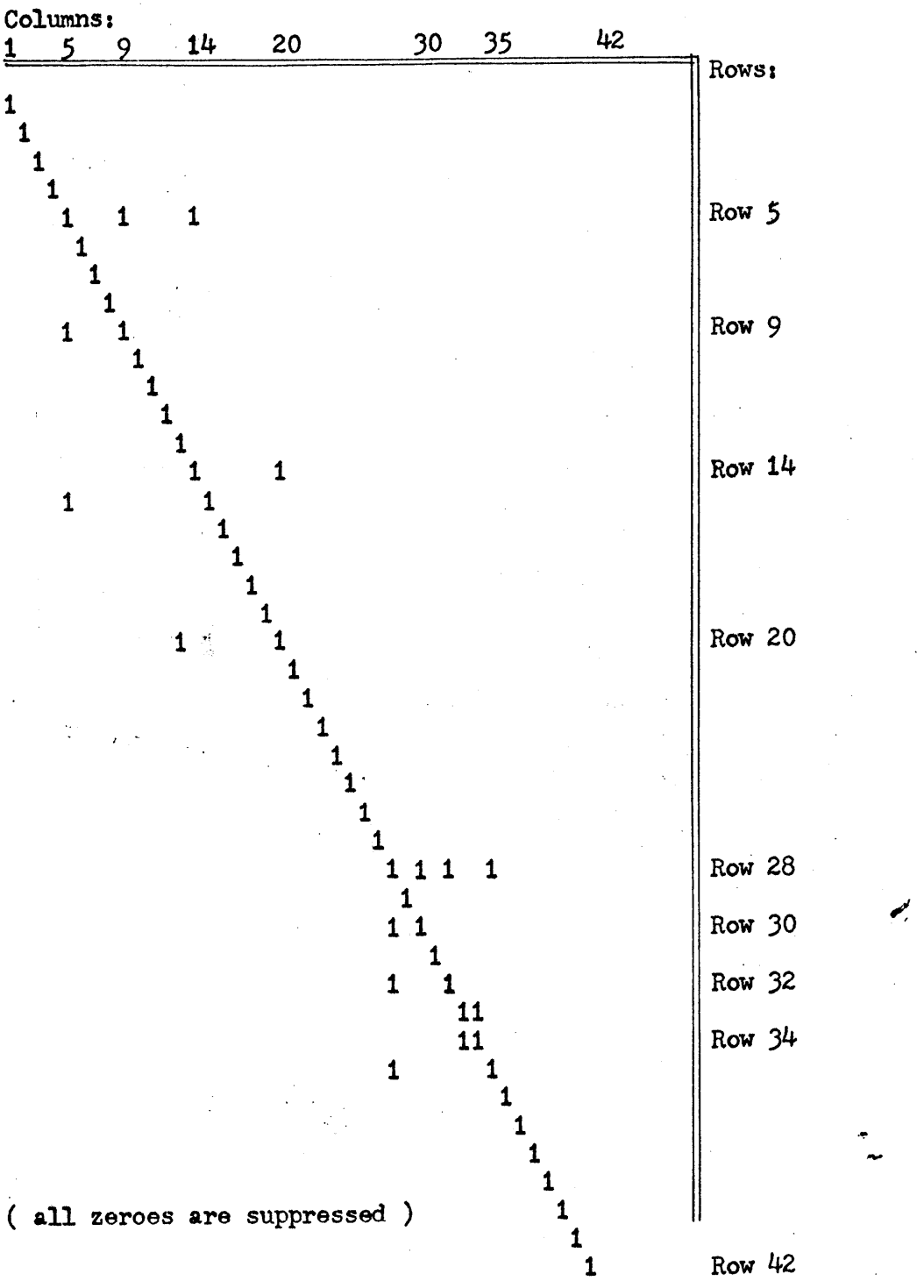
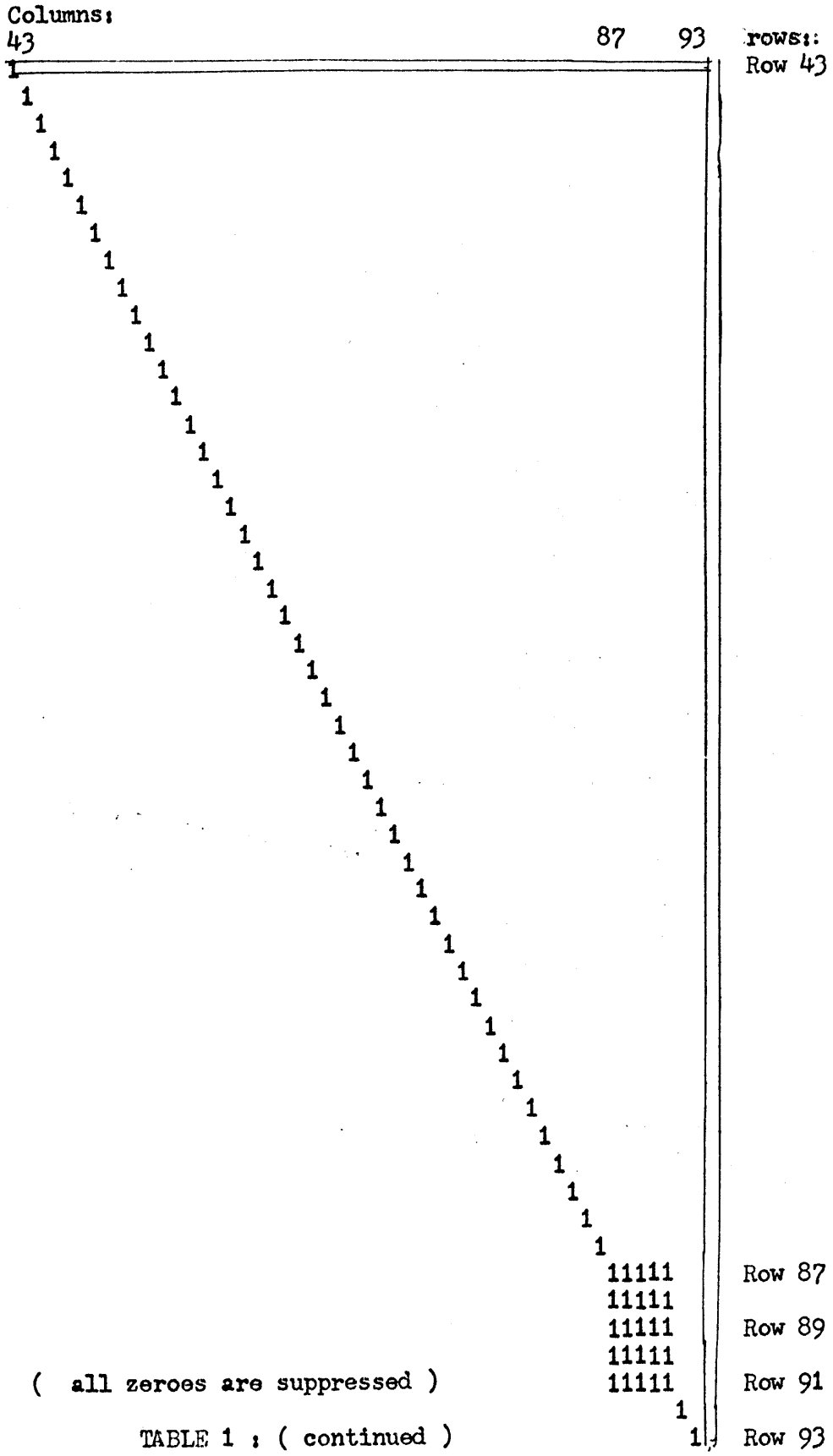


TABLE 1 (continued on next page)



(all zeroes are suppressed)

TABLE 1 : (continued)

TABLE 2: LINKAGE MATRIX WITH ZERO ROWS DELETED:

Row 5:	01010000	Colombia
Row 9:	01000000	Ecuador
Row 14:	00100000	Jamaica
Row 15:	00010000	Mexico
Row 20:	00100000	Trinidad
Row 28:	00001101	Congo (B.)
Row 30:	00001000	Dahomey
Row 32:	00000100	Gabon
Row 33:	00000010	Ghana
Row 34:	00000010	Guinea
Row 35:	00000001	Ivory Coast
Row 87:	10000000	Bulgaria
Row 88:	10000000	Czechoslavia
Row 89:	10000000	Hungary
Row 90:	10000000	Poland
Row 91:	10000000	Romania
	12345678	Cluster Identification Numbers

TABLE 3: PHENOMENAL CLUSTERS:

Cluster Id. Numbers	Size of Cluster	Member Countries of Cluster	Cluster frequency
(1.)	5	Bulgaria, Czechoslavia, Hungary, Poland, Romania	12.5%
(2.)	2	Colombia, Ecuador	87.5%
(3.)	2	Jamaica, Trinidad	
(4.)	2	Colombia, Mexico	
(5.)	2	Congo(B.), Dahomey	
(6.)	2	Congo (B.), Gabon	
(7.)	2	Ghana, Guinea	
(8.)	2	Congo(b.), Ivory Coast	

TABLE 4: Matrix of Nucleus Counts:

	12345678
1	50000000
2	02010000
3	00200000
4	01020000
5	00002101
6	00001201
7	00000020
8	00001102

TABLE 5: Nuclear Clusters

Size	Number of Peclusters involved in overlap	Member Countries
1	3	Congo(B.)
1	2	Colombia

TABLE 6: Incidence Matrix among Phenomenal Clusters:

	12345678
1	10000000
2	01010000
3	00100000
4	01010000
5	00001101
6	00001101
7	00000010
8	00001101

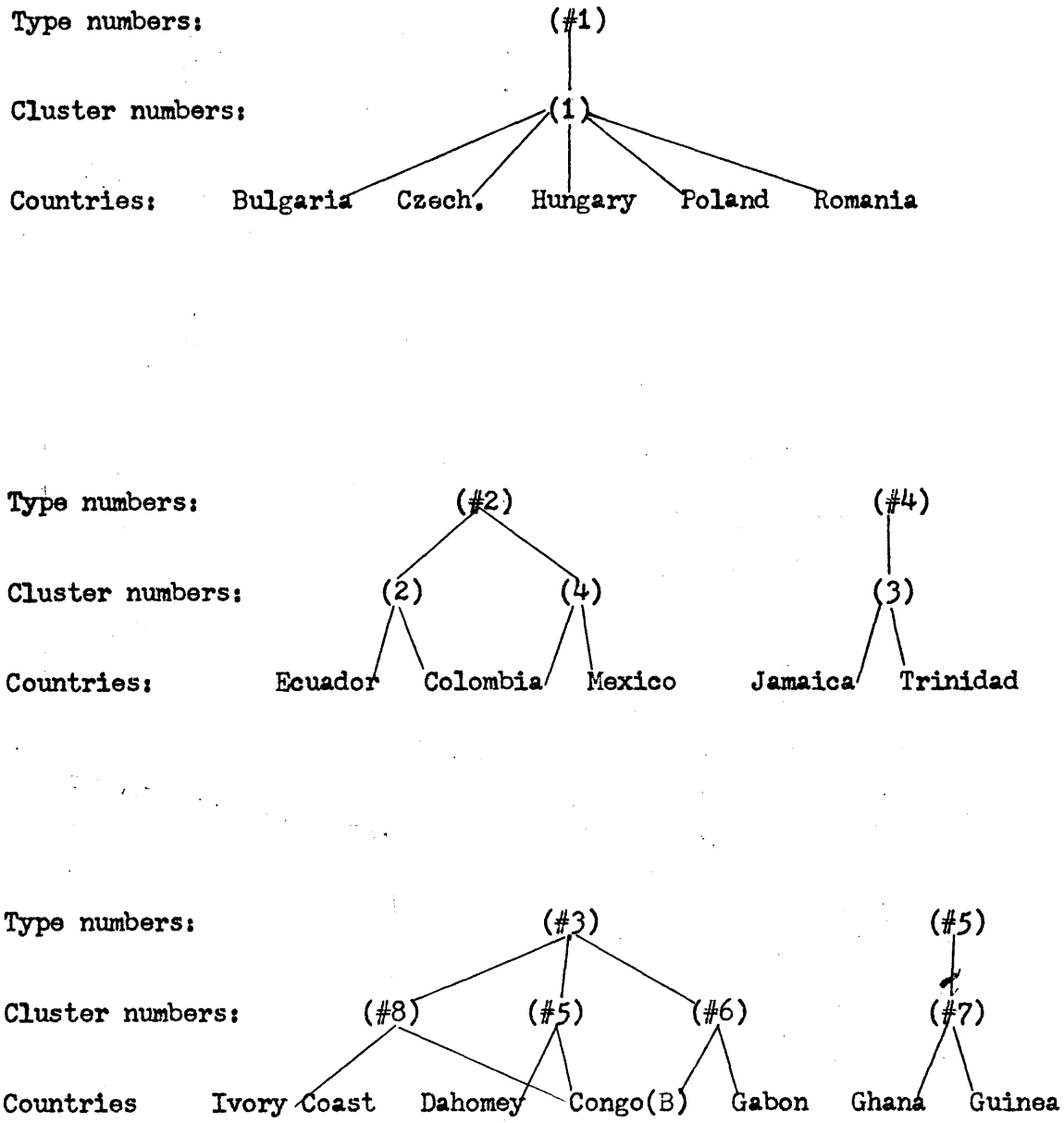
TABLE 7: Matrix of Related-Types:

Id. numbers	#1	#2	#3	#4	#5
	1	0	0	0	0
	0	1	0	0	0
	0	0	1	0	0
	0	1	0	0	0
	0	0	0	1	0
	0	0	0	1	0
	0	0	0	0	1
	0	0	0	0	1

TABLE 8: Table of Related-Types:

Id. Number	Size	Member Countries:
(#1)	5	Bulgaria, Czechoslavia, Hungary, Poland, Romania
(#2)	3	Colombia, Ecuador, Mexico
(#3)	4	Cong(B.), Dahomey, Gabon, Ivory Coast
(#4)	2	Jamaica, Trinidad
(#5)	2	Ghana, Guinea

FIGURE 1:


Type numbers:
(#1)
Cluster numbers:
(1)
Countries:
Bulgaria
Czech.
Hungary
Poland
Romania
Type numbers:
(#2)
(#4)
Cluster numbers:
(2)
(4)
(3)
Countries:
Ecuador
Colombia
Mexico
Jamaica
Trinidad
Type numbers:
(#3)
(#5)
Cluster numbers:
(#8)
(#5)
(#6)
(#7)
Countries
Ivory Coast
Dahomey
Congo(B)
Gabon
Ghana
Guinea

sent each category:

Categories:	Indicators:	
I. Economic Resources:	1/	GNP
	2/	GNP/capita
	3/	Capital formation of GNP
	4/	Energy consumption
	5/	% of labor force in agriculture
	6/	% of working age employed in industry
II. Human Resources:	7/	Absolute population size
	8/	Rate of population change
	9/	Density
	10/	% of population working age
	11/	Size of country
	12/	Urbanization
III. Educational Resources:	13/	Literacy rates
	14/	% of enrollment to school age population
	15/	Teacher:Student ratio
IV. Health Resources:	16/	Life expectancy at birth
	17/	Birth rate
	18/	Death rate
	19/	Population:Doctor ratio
V. Communication Resources:	20/	Automobiles/capita
	21/	Daily newspaper circulation
	22/	Radios per 100 population
	23/	Television per 100 population
	24/	Cinema attendance/ capita
VI. National Unity	25/	Religious homogeneity
	26/	Linguistic homogeneity
	27/	Racial homogeneity
VII. Self-governing experience:	28/	Date of independence
	29/	Former colony
	30/	History of self-government
	31/	Experience of political and economic development
	32/	Ideological orientation
	33/	System style-- degree of commitment to development

VIII. Governmental Direction:	34/	Constitutional status
	35/	Governmental stability
VIV. Amount of Opposition:	36/	Freedom of group opposition
	37/	Political encultration
	38/	Sectionalism
X. Power Distribution:	39/	Political leadership
	40/	Charismatic leader
	41/	Vertical power distribution
	42/	Horizontal power distribution
XI. Administrative Structure:	43/	Status of legislature
	44/	Status of executive
	45/	Status of bureaucracy

The indicators have been grouped into three categories; those which demonstrate agreement between all members of the related-type, those variables which demonstrate near agreement, and those indicators which are either no measured or vary widely between members. Near agreement means that indicators vary at most by one measurement.

RELATED TYPES

(#1)

MEMBER COUNTRIES

Bulgaria
Czechoslavia
Hungary
Poland
Romania

PATTERNS OF INDICATORS:

Agreement indicators:

(8) a low population growth rate
(9) medium population density
(12)a high degree of urbanization
(13)a good teacher:student ratio
(14)a high life expectancy
(17)a high birth rate
(18)a high death rate
(21)a high daily newspaper circulation
(22)a high number of radios per 100 population

(24) a high cinema attendance
(26) linguistically homogeneous
(27) never been colonized
(30) a weak history of self-governing experience
(31) a high degree of experience in economic and political development
(32) communist ideology
(33) a mobilized or high degree of political commitment to development
(34) totalitarian status
(39) elitist leadership
(40) weak charismatic leaders
(41) no vertical power distribution (top-down)
(42) no horizontal power distribution (dominated by one body)
(44) a dominant executive
(45) a limited effective bureaucracy

Near Agreement Indicators:

(1) a medium to low GNP
(2) a high to medium GNP per capita
(6) a high to medium % of the working force in industry
(7) a low or very low population size
(11) medium and small country size
(14) a near high literacy rate
(35) Governments been stable since WWI or WWII.
(36) no opposition groups allowed or only allowed informally

Highly variable indicators:

(4) energy consumption
(5) % of population that is working age
(19) population:doctors ratio
(20) automobiles/ capita
(23) Television/ capita
(25) Religious homogeneity
(27) racial homogeneity
(28) date of independence
(37) political encultration
(38) sectionalism

(#2) Colombia
Ecuador

PATTERNS OF INDICATORS:

Agreement indicators:

(2) low GNP/capita
(5) low % of the labor force employed in agriculture
(6) low % of working age em ployed in industry
(8) a high rate of population change
(9) a very low density
(10) a low % of the population is working age
(12) a high urbanization
(13) a medium literacy rate
(15) a poor ratio teachers:students
(16) a low life expectancy
(17) a low birth rate
(18) a high death rate
(19) a high population:doctor ratio (bad)
(21) a medium amount of daily newspaper circulation
(23) low television rate
(24) medium cinema attendance
(26) linguistically heterogeneous
(28) early independence
(29) former colony
(30) history of self-government
(31) entered transitional phase prior to 1945
(32) Change through conventional channels
(33) non-mobilized system
(34) constitutional
(36) opposition groups freely allowed
(40) weak charismatic leaders
(41) no vertical power distribution
(43) partially effective legislature
(44) strong executive
(45) limited effective bureaucracy

Near Agreement Indicators:

(1) low or very low GNP
(3) medium or low capital % of GNP
(4) low or very low energy consumption
(11) large or medium country size
(14) medium to low % of the school age population enrolled in schools
(20) medium to high rate of automobiles/capita
(22) high or medium rate of radios
(35) government is mainly unstable or has been unstable since WWII
(42) effective or semi-effective horizontal allocation of power to governmental branches

Highly variable indicators:

(7) Population size
(25) Mixed religions
(27) mixed races
(37) mixed political encultration
(38) mixed sectionalism
(39) mixed elitest or nonelitest leaders

(#3) Jamaica
Trinidad

PATTERNS OF INDICATORS:

Agreement indicators:

(2) medium GNP/capita
(7) extremely low population size
(9) high density
(10) low % population is working age
(11) small size countries
(13) medium literacy rates
(16) high life expectancy
(18) high death rate
(19) high population:doctors ratio (bad)
(20) high rate of automobiles per capita
(21) medium newspaper circulation
(22) medium radios
(25) religious heterogeneity
(26) linguistic heterogeneity
(29) former colony
(30) limited self-government history
(33) non-mobilized
(34) constitutional
(36) opposition groups allowed
(37) medium political encultration
(38) negligible sectionalism
(39) non-elitist leadership
(41) no vertical power distribution
(42) effective horizontal distribution
(43) effective legislative
(44) strong executive
(45) limited effective bureaucracy

Near Agreement indicators:

(1) very low or extremely low GNP
(3) high or medium capital % of GNP
(4) medium to low energy consumption
(5) high to medium % of the labor force in agriculture
(6) high to medium % of working age in industry

(8) high to medium population growth rate
(14) high to medium % enrolled in school
(17) low to medium birth rate
(24) medium to low cinema attendance
(31) high or medium development experience
(40) moderate or weak charismatic leaders

Highly Variable Indicators:

(12) Urbanization
(15) ratio of teachers to students
(23) Television distribution
(27) Mixed racially
(28) date of independence
(32) ideological orientation
(33) System style
(34) Consitutional status
(35) Government stability

(#4) Colombia
Mexico

PATTERN OF INDICATORS:

Agreement Indicators:

(3) Medium capital % GNP
(5) Low % of labor force in agriculture
(7) Low population size
(8) High population change
(9) Very low density
(10) Low % of the population is working age
(11) Large size
(12) High Urbanization
(13) Medium literacy
(14) Medium % enrollment
(15) Poor teacher:student ratio
(17) Low birth rate
(18) High death rate
(19) High population:doctor ratio (badd)
(20) Medium automobile distribution
(21) Medium newspaper circulation
(22) High radios/ population
(25) Religiously homogeneous
(26) Linguistically heterogeneous
(27) Racially homogeneous
(28) Obtained early independence
(29) Former colonies
(30) History of self-governing experience
(32) Change through conventional channels

(33) Non-mobilized
(34) Constitutional
(37) Medium amount of Political encultration
(39) Moderate elite leadership
(40) Weak charismatic leader
(41) Horizontal power allocated to one body or two limited bodies
(43) Partially effective legislature
(45) Limited bureaucracy

Near Agreement Indicators:

(1) Medium to low GNP
(2) Medium to low GNP/capita
(4) Low to very low energy consumption
(6) Medium to low % of working age in Industry
(16) Medium to low life expectancy
(23) Medium to low television distribution
(24) High to medium cinema attendance
(31) Experience or some experience in development
(35) Stable or moderately stable government since WWII
(36) Group opposition freely allowed or or allowed but capacity limited
(41) Formally accepted federalism or no vertical power distribution
(44) a dominant or strong executive

Highly Variable Indicators:

(38) the degree of sectionalism

(#5) Congo(B.)
Dahomey

PATTERN OF INDICATORS:

Near Agreement Indicators:

(1) Extremely low GNP
(2) Extremely low GNP/capita
(4) Extremely low energy consumption
(7) Extremely low population size
(9) Very low density
(12) Low urbanization
(16) Very low life expectancy
(17) High birth rate
(20) Low automobile distribution
(21) Very low newspaper circulation

(25) Religious heterogeneity
(26) Linguistic homogeneity
(27) Strongly racial heterogeneity
(28) Obtained independence since 1945
(29) Former colony
(30) Weak history of self-government
(31) Recent experience in development
(32) Developmental type
(33) Non-mobilized
(37) Non-integrated polity, extreme opposition
(38) Moderate sectionalism
(39) Non-elitist leadership
(40) Moderate charismatic leaders
(41) No vertical power distribution
(42) No horizontal power distribution
(43) Largely ineffective legislature
(44) Dominant executive
(45) "National" bureaucracy

Near Agreement Indicators:

(8) High to medium population change
(11) Medium to small country size
(13) Very low to extremely low literacy
(14) Low to very low enrollment
(18) Low to medium death rate
(19) Medium to high population: doctor ratio
(22) Low to very low radio distribution
(36) Limited or extraneous opposition

Highly Variable indicators:

(3) Capital formation of GNP
(5) % labor force in agriculture
(6) % working age employed in Industry
(10) % population that is working age
(15) Teacher:student ratio
(23) Television distribution
(24) Cinema attendance
(34) Constitutional status
(35) Government stability

(#6) Congo(B.)
Gabon

PATTERN OF INDICATORS:

Agreement Indicators:

(1) Extremely low GNP
(4) Extremely low energy consumption
(7) Extremely low population size
(9) Very low density
(11) Medium country size
(12) Low urbanization
(14) Low enrollment %
(19) High population:doctor ratio
(21) Very low newspaper distribution
(25) Religious heterogeneity
(26) Linguistically homogeneous
(27) Strong racial heterogeneity
(28) Recently obtained independence
(29) Former colony
(30) Weak history of self-government
(31) Recent experience in development
(32) Developmental type
(33) Non-mobilized
(36) Opposition allowed but power limited
(37) Non-integrated polity
(38) Moderate sectionalism
(39) Non-elitest leadership
(40) Moderate charismatic leaders
(41) No vertical power distribution
(42) No horizontal power distribution
(43) Largely ineffective legislature
(44) Dominant executive
(45) "National" Bureaucracy

Near Agreement:

(2) Very low to extremely low GNP/capita
(13) Very low to extremely low literacy
(16) Low to very low life expectancy
(17) Medium to high birth rate
(18) Low to medium death rate
(20) Medium to low automobile distribution
(22) Medium to low radio distribution

Highly Variable Indicators:

(3) Capital formation of GNP
(5) % labor force in agriculture
(6) % working age employed in Industry
(8) Population change
(10) % population working age
(15) student:teacher ratio
(23) Television distribution

(24) Cinema attendance
(34) Constitutional status
(35) Government stability

(#7) Ghana
Guinea

PATTERN OF INDICATORS:

Agreement Indicators:

(4) Extremely low energy consumption
(7) Very low population size
(8) High population change
(11) Medium country size
(12) Low urbanization
(15) Poor student:teacher ratio
(17) High birth rate
(19) High population:doctor ratio
(20) Low atutomobile distribution
(22) Low radio distribution
(25) Religious heterogeneity
(26) Linguist homogeneity
(27) Very heterogeneous racially
(28) Recently obtained independence
(29) Former colony
(30) Weak history of self-government
(31) Recent development experience
(32) Developmental
(33) Mobilized
(34) Authoritarian
(35) Stable since 1945
(36) No formal opposition
(37) Medium encultration
(38) Medium sectionalism
(39) Moderate elitist leadership
(40) High charismatic leaders
(41) No vertical power distribution
(42) No horizontal power distribution
(43) Wholly ineffective legislature
(44) Dominant executive
(45) Limited effective bureaucracy

Near Agreement Indicators:

(5) low to very low % of labor force in agriculture
(9) low to very low density
(10) low to very low % population is working age
(13) low to very low literacy rates
(14) low to very low enrollment ratio
(16) low to very low life expectancy

(18) Medium to low death rate

Highly Variable Indicators:

(1) GNP
(2) GNP/capita
(3) Captial % of GNP
(6) % working age employed in Industry
(21) Newspaper circulation
(23) Television distribution
(24) Cinema attendance

(#8) Congo(B.)
Ivory Coast

PATTERN OF INDICATORS:

Agreement Indicators:

(4) Extremely low energy consumption
(7) Extremely low population size
(8) Medium population change
(9) Very low density
(10) Low % of the population is working age
(11) Medium country size
(12) Low urbanization
(16) Very low life expectancy
(17) High birth rate
(20) Low automobile distribution
(21) Very low newspaper distribution
(22) Low radio distribution
(25) Relgious heterogeneity
(26) Linguistically homogeneous
(27) Strong racial heterogeneity
(28) Recently obtained independence
(29) Former colony
(30) Weak history of self-government
(31) Recent experience in development
(32) Developmental type
(39) Non-elitest leadership
(41) No vertical power distribution
(42) No horizontal power distribution
(43) Largely ineffective legislature
(44) Dominant executive
(45) "National" bureaucracy

Near Agreement Indicators:

(1) Very low to extremely low GNP
(13) Very low to extremely low literacy
(14) Low to very low enrollment ratio
(18) Low to medium death rate
(19) Medium to high population:doctor ratio
(33) Non-mobilized or limited mobilization

(36) Opposition is limited or informal
(37) High to medium political encultration
(38) Moderate to negligible sectionalism
(40) High to medium charismatic leaders

Highly Variable Indicators:

(2) GNP/capita
(3) Capital formation of GNP
(5) % labor force in agriculture
(6) % of working age employed in Industry
(15) Teacher/student ratio
(23) Television circulation
(24) Cinema attendance
(34) Constitutional status
(35) Government stability

SUMMARY OF PATTERNS OF INDICATORS FOR STAGE TWO:

If the categories I through VIII are combined to represent development resources and categories IX through XI are reflective of political styles, then the five related-types of stage two can be summarized as representing the following patterns of indicators.

The Eastern European countries (#1) display high development resources and totalitarian, communistic and generally stable governments which are committed to development and which limit power distribution and opposition groups as well as dominating all other governmental bodies.

The Latin American countries break into two types. One (#2) is characterized by large countries with a high degree of urbanization demonstrating moderate levels of development resources. These countries obtain ed independence at an early date, have obtained moderately directive and stable governments and have all entered the stage of economic and political transition required for development prior to 1945. The other type (#4) are smaller countries which demonstrate lower levels of development resources and a slightly higher degree of administrative ef-

fectiveness. These countries are characterized by a degree of discord both with respect to the indicators of national unity as well as the indicators of the amount of opposition allowed and present.

The African types have recently obtained independence and are currently experiencing political and economic transitions required for development. The first African type (#4) are characterized by low development resources and mobilized authoritarian developmental type governments headed by charismatic leaders . These governments which have been stable since WWII, allow no opposition and dominate all branches of the government. The other type (#5) demonstrate lower development resources and have developmental non-mobilized governments which have no power distribution, are headed by moderately charismatic leaders, limit opposition and have to cope with problems of a non-integrated polity with moderate degrees of sectionalism.

3. STAGE THREE: Cluster and Type formation at SO = 0.2:

The significance test, SO = 0.2 , yields the incidence matrix of Table 9. All the linkages inherent in the incidence matrix are represented by Table 10. Many additional countries are now introduced into the clusters. Table 11 lists the phenomenal clusters formed at this level and although larger groups are beginning to form, again the prevalence of two member clusters predominates at a frequency of 41%. Significant overlapping is occuring in these clusters as displayed in the Table 12 of nuclear counts and Table 13 of Nuclear clusters. Since it has been determined that only two overlaps is too insignficant to imply relatedness,

the significance level for related-types must be at least S1 = 3. Note that this is too stringent a test for the clusters produced at S0 = 0.5, consequently for the comparison of related-types produced at the two S0 levels the weaker requirement (S1 = 2) must be used for cluster formed at S0 = .5 .

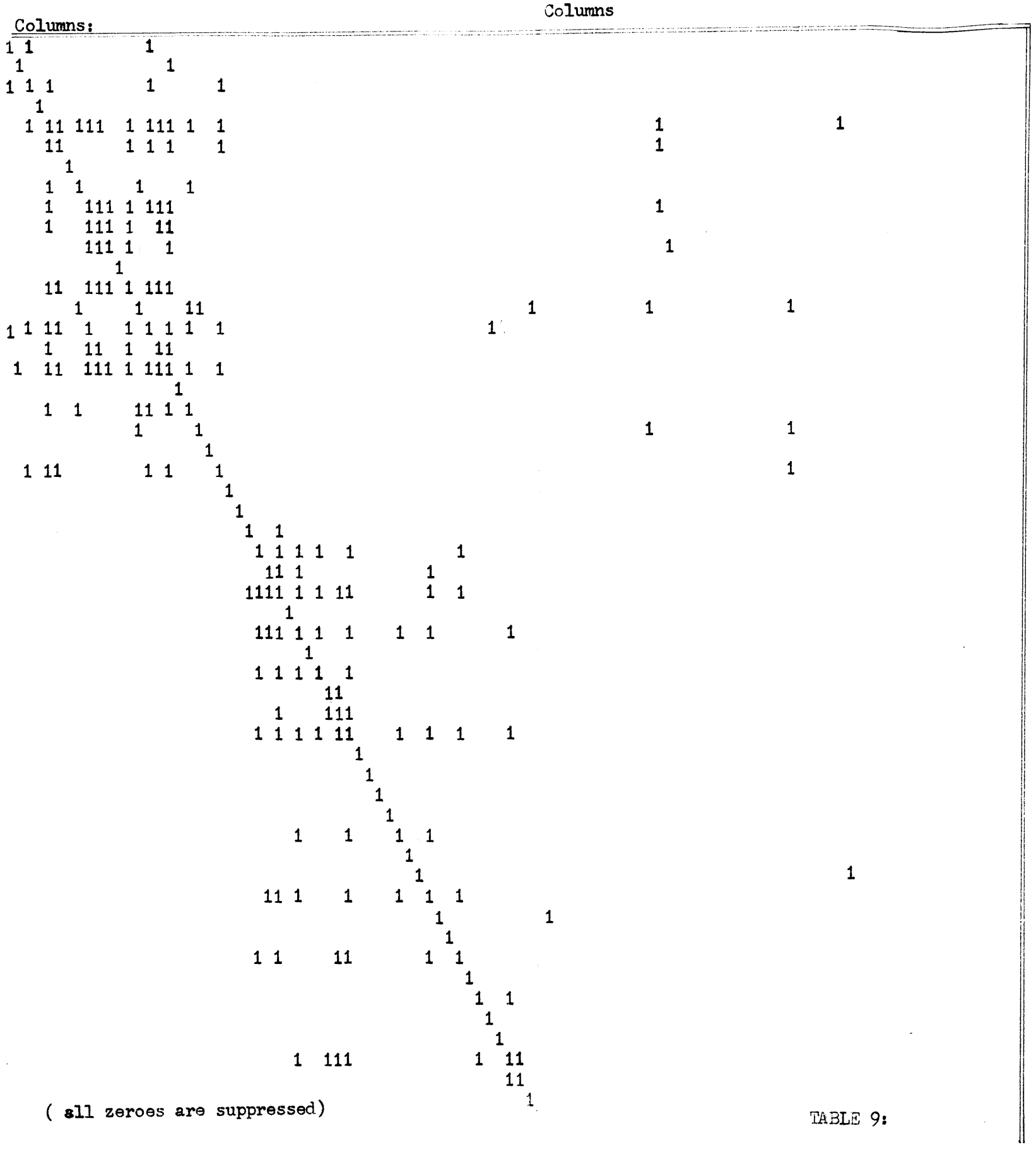
The table of nuclear clusters can be further analyzed to obtain a hierarchy of overlaps expressed in Table 14 and Figure 2. The five countries which are contained in the most number of clusters are sufficient to express most of the linkages to the remaining countries. For this reason these countries are depicted as the most typical representations of the related types. (with the exception of the Eastern European countries) Table 15, 16 and 17 represent the related-types that occur at the respective levels of S1 = 2, S1 = 3 , and S1 = 4. Figure 3 shows type formations at the various S1 levels.

The related-types for S1 = 3 are studied for compactness or the ratio of the links between all member countries of a given type to the total possible number of links. Compactness allows the investigator to be concerned with the degree of relatedness demonstrated by a type. (Table 17)

Regional Definitions at S0 = 0.2:

The third stage of cluster formation demonstrates that the pure regional types begin to break down although Types #2,#3, and #4 maintain the regional boundaries of the Eastern European, African and Latin American countries respectively. Types #1 and #5 however are a combination of Latin American, Middle Eastern and Asian countries.

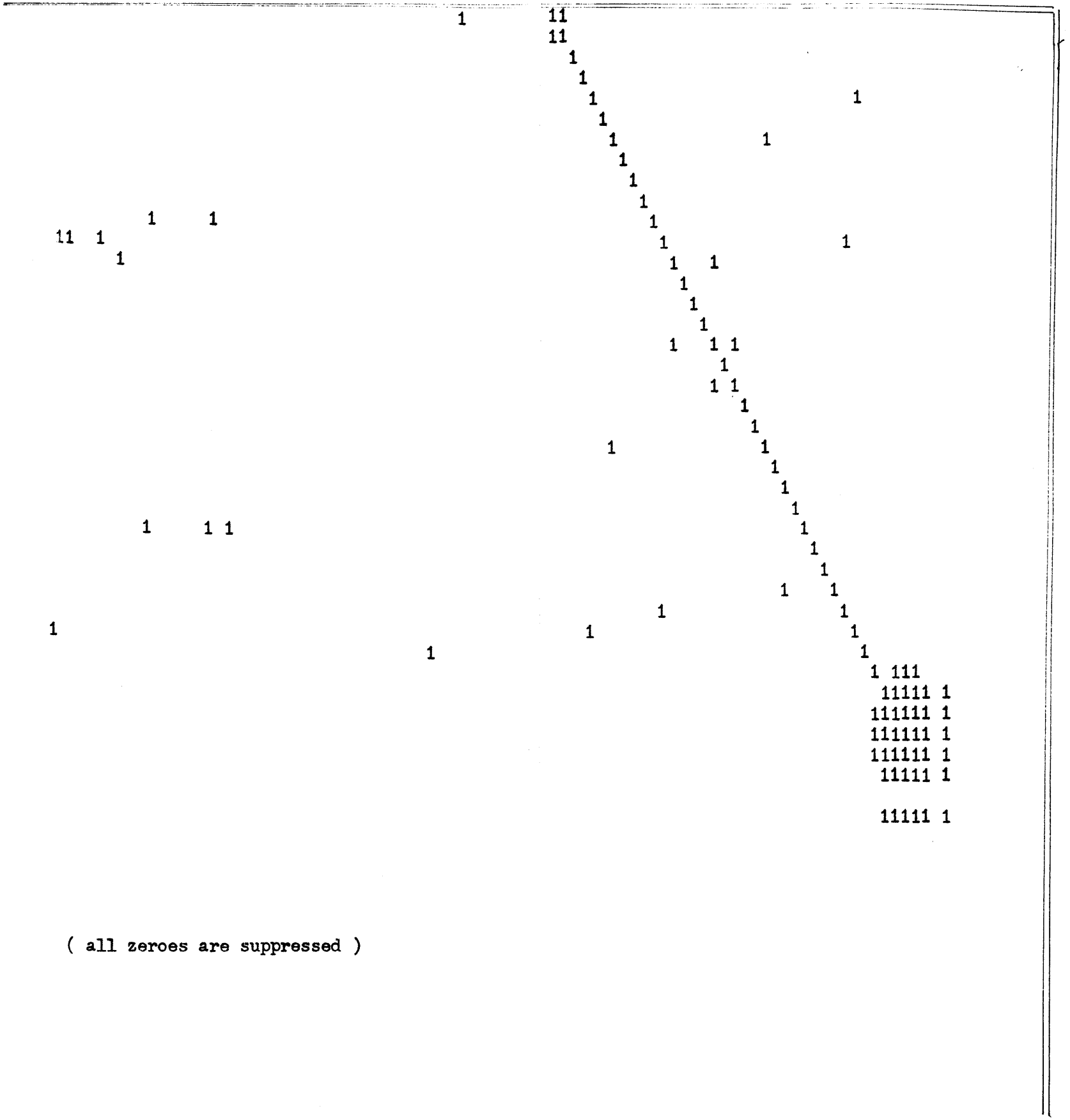
INCIDENCE MATRIX: S0= 0.2



(all zeroes are suppressed)

TABLE 9:

INCIDENCE MATRIX: SO = 0.2 cont...2



(all zeroes are suppressed)

TABLE 9 (continued)

TABLE 10: LINKAGE MATRIX WITH ZERO ROWS DELETED:

Row 1:	00000000000001000000000000000000000000	Argentina
Row 2:	00000000000000000000010000000000000000	Bolivia
Row 3:	00000010000001000000000000000000000000	Brazil
Row 5:	10101010000000100001010000000000000000	Colombia
Row 6:	00101000000000000001000000000000000000	Costa Rica
Row 8:	00000000000000110000000000000000000000	Dominican Republic
Row 9:	10010000000000000000000000000000000000	Ecuador
Row 10:	10010000000000000000000000000000000000	El Salvador
Row 11:	00010000000000000000000000000000001000	Gautemala
Row 13:	10110000000000000000000000000000000000	Honduras
Row 14:	00000000000000011000100000000010000000	Jamaica
Row 15:	00101010000001000000000000001000000000	Mexico
Row 16:	10000000000000000000000000000000000000	Nicaragua
Row 17:	10111000000000000000010000000000000000	Panama
Row 19:	00000000000000110000000000000000000000	Peru
Row 20:	00000000000000001000100000000000000000	Trinidad
Row 22:	00001010000000000000000000000000000000	Venezuela
Row 25:	00000000000000000000000100000000000000	Cameroon
Row 26:	00000100000100000000000000000000000000	Central African Rep.
Row 27:	00000001000000000000000000000000000000	Chad
Row 28:	00000101101100000000000100000000000000	Congo(B.)
Row 30:	00000101011000000010000000000000000000	Dahomey
Row 32:	00000100000000000000000000000000000000	Gabon
Row 33:	00000000000000000100000000000000000000	Ghana
Row 34:	00000000100000000100000000000000000000	Guinea
Row 35:	00000100111100000010000000000000000000	Ivory Coast
Row 40:	00000000010000000000000000000000000000	Mali
Row 42:	00000000000000000000000010000000000000	Morocco
Row 43:	00000001011000000000000000000000000000	Niger
Row 44:	00000000000000000000000010000000000000	Nigeria
Row 46:	00000000100100000000000000000000000000	Senegal
Row 48:	00000000000000000000000010000000000000	Somali Republic
Row 49:	00000000000000000000000010000000000000	Rep. of South Africa
Row 51:	00000000000000000110000000101000000000	Taganyika
Row 52:	00000000000000000000000000010000000000	Togo
Row 53:	00000000000000000000000000010000000000	Tunisia
Row 54:	00000000000000000000000010000100000000	Uganda
Row 55:	00000000000000000000000000010000000000	Upper Volta
Row 58:	00000000000000000000000000100000000000	China (T.)
Row 60:	00000000000000000000000000010000000000	Japan
Row 64:	00000000000000001000000000000000000000	Malaysia
Row 65:	00000000000000000010100000000000000000	Philippines
Row 66:	00000000000000000000000000000001100000	Thailand
Row 70:	00000000000000000000000000000000110000	India
Row 72:	00000000000000000000000000000000010000	Pakistan
Row 75:	00000000000000000000000000000010000000	Greece
Row 77:	00000000000000000000000000000000000001	Iraq
Row 78:	00000000000000000001000000000000000000	Israel

TABLE 10: continued

Row 82:	00000000000000000000000000000000000001	Syria
Row 83:	00000000000000000000100000000000000000	Turkey
Row 84:	00000000000000000000000010000001000000	UAR
Row 86:	00000000000010000000000000000000000000	Albania
Row 87:	01000000000000000000000000000000000000	Bulgaria
Row 88:	01000000000010000000000000000000000000	Czechoslavia
Row 89:	01000000000010000000000000000000000000	Hungary
Row 90:	01000000000010000000000000000000000000	Poland
Row 91:	01000000000000000000000000000000000000	Romania
Row 93:	01000000000000000000000000000000000000	Yugoslavia
	12345678910 ---------- 37	Cluster Identification Numbers

TABLE 11: PHENOMENAL CLUSTERS:

Cluster Id. Numbers	Size of Cluster	Member Countries of Cluster	Cluster Frequency
(1.)	6	Colombia, Ecuador El Salvador, Honduras, Nicaragua, Panama	6 %
(2.)	6	Bulgaria, Czechoslavia Hungary, Poland, Romania Yugoslavia	
(3.)	5	Colombia, Costa Rica Honduras, Mexico, Panama	11%
(4.)	5	Ecuador, El Salvador, Gautemala, Honduras, Panama	
(5.)	5	Colombia, Costa Rica, Mexico, Panama, Venezuela	
(6.)	5	Central African rep., Congo(B.), Dahomey, Gabon, Ivory Coast	

(7.)	4	Brazil, Colombia, Mexico, Venezuela	
(8.)	4	Chad, Congo(B.), Dahomey, Niger	
(9.)	4	Congo(B.), Guinea, Ivory Coast, Senegal	
(10.)	4	Dahomey, Ivory Coast, Mali, Niger	20%
(11.)	4	Congo(B.), Dahomey, Ivory Coast, Niger	
(12.)	4	Central African Rep., Congo(B.), Ivory Coast, Senegal	
(13.)	4	Albania, Czechoslavia, Hungary, Poland	
(14.)	3	Argentina, Brazil, Mexico	
(15.)	3	Colombia, Dominican Rep., Peru	
(16.)	3	Dominican Rep., Jamaica, Peru	
(17.)	3	Jamaica, Trinidad, Malaysia	
(18.)	3	Ghana, Guinea, Tanganyika	24%
(19.)	3	Dahomey, Ivory Coast, Tanganyika	
(20.)	3	Colombia, Costa Rica, Philippines	
(21.)	3	Jamaica, Trinidad, Israel	
(22.)	3	Colombia, Philippines, Turkey	

TABLE 11: continued

(23.)	2	Bolivia, Panama	
(24.)	2	Cameroon, Congo(B.)	
(25.)	2	Morocco, U.A.R.	
(26.)	2	Nigeria, Uganda	
(27.)	2	Somali Republis, Tanganyika	
(28.)	2	Mexico, Rep. of South Africa	
(29.)	2	Tanganyika, Togo	41%
(30.)	2	Jamaica, Tunisia	
(31.)	2	Uganda, Upper Volta	
(32.)	2	China (T.), U.A.R.	
(33.)	2	Japan, Greece	
(34.)	2	Gautemala, Trinidad	
(35.)	2	Thailand, India	
(36.)	2	India, Pakistan	
(37.)	2	Iraq, Syria	

TABLE 11: continued

TABLE 12: Matrix of Nucleus Counts:

1	60342010000000100001011000000000000000
2	06000000000030000000000000000000000000
3	30524020000001100002011000010000000000
4	40251000000000100000001000000000001000
5	20415030000002200002011000010000000000
6	00000502223300000020000100000000000000
7	10203040000002100001010000010000000000
8	00000204123100000010000100000000000000
9	00000201412300000110000100000000000000
10	00000202143100000020000000000000000000
11	00000303234200000020000100000000000000
12	00000301312400000010000100000000000000
13	00000000000040000000000000000000000000
14	00101020000003000000000000001000000000
15	10101000000000320001010000000000000000
16	00000000000000231000100000001000000000
17	00000000000000013000200000001000000000
18	00000000100000003100000001010000000000
19	00000201122100000130000000101000000000
20	10202010000000100003020000000000000000
21	00000000000000012000300000000100000000
22	10101010000000100002030000000000000000
23	10111000000000000000002000000000000000
24	00000101101100000000000200000000000000
25	00000000000000000000000020000001000000
26	00000000000000000000000002000010000000
27	00101010000001000000000000201000000000
28	00101010000001000000000000020000000000
29	00000000000000000110000000102000000000
30	00000000000000011000100000000200000000
31	00000000000000000000000001000020000000
32	00000000000000000000000010000002000000
33	00000000000000000000000000000000200000
34	00010000000000000000000000000000021000
35	00000000000000000000000000000000012100
36	00000000000000000000000000000000001200
37	00000000000000000000000000000000000020

TABLE 13: Nuclear Clusters:

	Size	Number of clusters involved in overlap		Member Countries:
1.	4	2	(1,4)	Ecuador, El Salvador, Honduras, Panama
2.	4	2	(3,5)	Colombia, Costa Rica, Mexico, Panama
3.	3	2	(1,3)	Colombia, Honduras, Panama
4.	3	2	(2,13)	Czechoslavia, Hungary, Poland
5.	3	2	(6,11)	Congo(B.), Dahomey, Ivory Coast
6.	3	2	(6,12)	Central African Rep., Congo(B.), Ivory Coast
7.	3	2	(5,7)	Colobia, Mexico, Venezuela
8.	3	2	(8,11)	Congo(B.),Dahomey, Niger
9.	3	2	(9,12)	Congo(B.), Ivory Coast, Senegal
10.	3	2	(10,11)	Dahomey, Ivory Coast, Niger
11.	2	3	(1,3,5)	Colombia, Panama
12.	2	3	(3,5,7)	Colombia, Mexico
13.	2	3	3,5,20)	Colombia, Costa Rica
14.	2	3	(1,3,4)	Honduras, Panama
15.	2	2	(20,22)	Colombia, Philippines
16.	2	4	(6,9,11,12)	Congo(B.), Ivory Coast
17.	2	4	(6,10,11,19)	Dahomey, Ivory Coast
18.	2	3	(6,8,11)	Congo(B.), Dahomey
19.	2	3	(8,10,11)	Dahomey, Niger

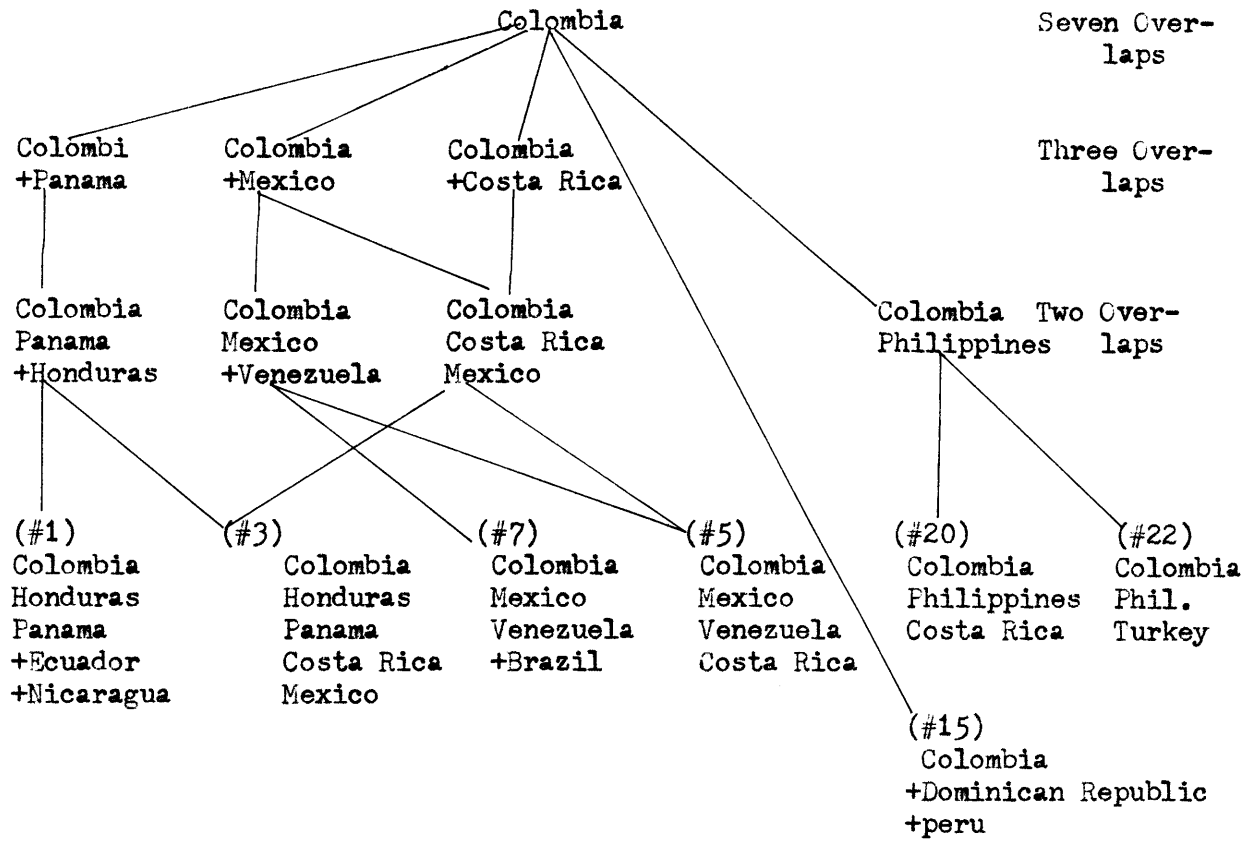
TABLE 13: continued

	Size	Number of clusters involved in overlap		Member countries
20.	2	2	(7,14)	Brazil, Mexico
21.	2	2	(15,16)	Dominican Republic, Peru
22.	2	2	(17,21)	Jamaica, Trinidad

TABLE 14: TEXTURE

Country	Number of phenomenal clusters containing the country	
Colombia	7	(1,3,5,7,20,15,22)
Ivory Coast	6	(6,9,10,11,12,19)
Congo(B.)	6	(6,8,9,11,12,24)
Dahomey	5	(6,8,10,11,19)
Panama	5	(1,3,4,5,23)
Mexico	5	(3,5,7,14,28)
Jamaica	4	(16,17,21,30)

Since Colombia is contained in three of the five clusters containing Panama and three of the five clusters containing Mexico, one assumes that Colombia is more central to or more typical of the cluster formations. Similarly, since Ivory Coast is contained in four of the six clusters containing Congo(B.) and four of the five clusters containing Dahomey that Ivory Coast is more typical. Figure 2 describes the overlap structure of Colombia and Ivory Coast at successively lower number of overlaps.


Colombia
Seven Overlaps
Colombi +Panama
Colombia +Mexico
Colombia +Costa Rica
Three Overlaps
Colombia Panama +Honduras
Colombia Mexico +Venezuela
Colombia Costa Rica Mexico
Colombia Philippines
Two Overlaps
(#1) Colombia Honduras Panama +Ecuador +Nicaragua
(#3) Colombia Honduras Panama Costa Rica Mexico
(#7) Colombia Mexico Venezuela +Brazil
(#5) Colombia Mexico Venezuela Costa Rica
(#20) Colombia Philippines Costa Rica
(#22) Colombia Phil. Turkey
(#15) Colombia +Dominican Republic +peru

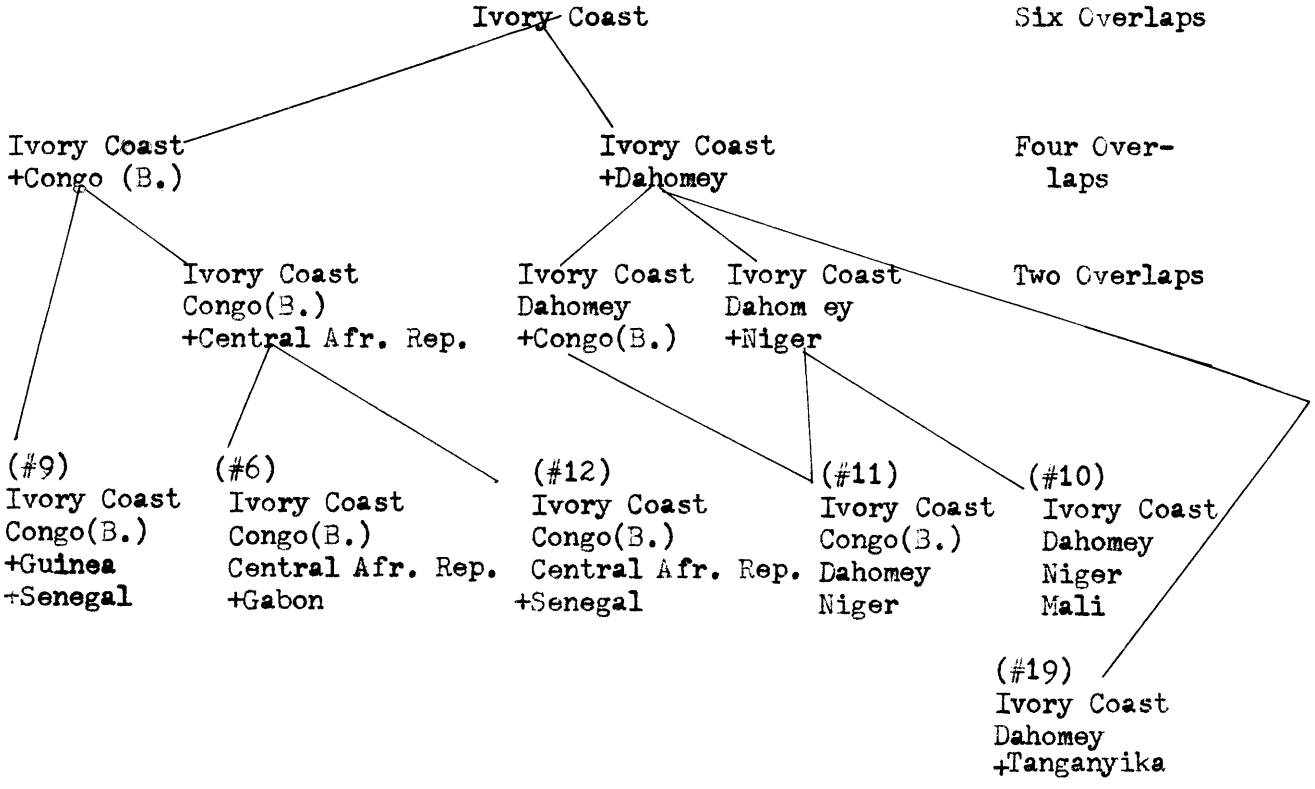

Ivory Coast
Six Overlaps
Ivory Coast +Congo (B.)
Ivory Coast +Dahomey
Four Overlaps
Ivory Coast Congo(B.) +Central Afr. Rep.
Ivory Coast Dahomey +Congo(B.)
Ivory Coast Dahom ey +Niger
Two Overlaps
(#9) Ivory Coast Congo(B.) +Guinea +Senegal
(#6) Ivory Coast Congo(B.) Central Afr. Rep. +Gabon
(#12) Ivory Coast Congo(B.) Central Afr. Rep. +Senegal
(#11) Ivory Coast Congo(B.) Dahomey Niger
(#10) Ivory Coast Dahomey Niger Mali
(#19) Ivory Coast Dahomey +Tanganyika

TABLE 15: MATRIX OF RELATED TYPES
S0 = 0.2, S1 = 2

1	10111010000001000001010000000000000000
2	01000000000010000000000000000000000000
3	10000101111100000010000000000000000000
4	10000000000000110000000000000000000000
5	10000000000000001000100000000000000000
6	00100000000000000100000000000000000000
7	10000000000000000000000000000000000000
8	00100000000000000000000000000000000000
9	00100000000000000000000000000000000000
10	00100000000000000000000000000000000000
11	00100000000000000000000000000000000000
12	00100000000000000000000000000000000000
13	01000000000000000000000000000000000000
14	10000000000000000000000000000000000000
15	00010000000000000000000000000000000000
16	00010000000000000000000000000000000000
17	00001000000000000000000000000000000000
18	00000100000000000000000000000000000000
19	00100000000000000000000000000000000000
20	10000000000000000000000000000000000000
21	00001000000000000000000000000000000000
22	10000000000000000000000000000000000000
23	00000000000000000000001000000000000000
24	00000000000000000000000100000000000000
25	00000000000000000000000010000000000000
26	00000000000000000000000001000000000000
27	00000000000000000000000000100000000000
28	00000000000000000000000000010000000000
29	00000000000000000000000000001000000000
30	00000000000000000000000000000100000000
31	00000000000000000000000000000010000000
32	00000000000000000000000000000001000000
33	00000000000000000000000000000000100000
34	00000000000000000000000000000000010000
35	00000000000000000000000000000000001000
36	00000010000000000000000000000000000100
37	00000000000000000000000000000000000010
	00000000000000000000000000000000000001

TABLE OF RELATED TYPES: S0 = 0.2, S1 = 2

Id. Number	Size	Member countries
(#1)	14	Argentina, Brazil, Costa Rica, Ecuador, El Salvador, Gautemala, Honduras, Mexico, Nicaragua, Panama, Philippines, Turkey, Venezuela

Id. Number	Size	Member Countries
(#2)	7	Albania, Bulgaria, Czechoslavia, Hungary, Poland , Romania, Yugoslavia
(#3)	11	Central African Republic, Chad, Congo(B.), Dahomey, Guinea, Gabon, Ivory Coast, Mali, Niger, Senegal, Tanganyika
(#4)	4	Colombia, Dominican Republic, Jamaica, Peru
(#5)	4	Jamaica, Trinidad, Israel, Malaysia
(#6)	3	Ghana, Guinea, Tanganyika
(#7)	2	Bolivia, Panama
(#8)	2	Cmeroon, Congo(B.)
(#9)	2	Morocco, U.A.R.
(#10)	2	Nigeria, Uganda
(#11)	2	Somali Republic, Tanganyika
(#12)	2	Mexico, Republic of South Africa
(#13)	2	Tanganyika, Togo
(#14)	2	Jamaica, Tunisia
(#15)	2	Uganda, Upper Volta
(#16)	2	China (T.), U.A.R.
(#17)	2	Japan, Greece
(#18)	2	Gautemala, Trinidad
(#19)	2	Thailand, India
(#20)	2	India, Pakistan
(#21)	2	Iraq, Syria

TABLE 16: MATRIX OF RELATED TYPES

S0 = 0.2, S1 = 3

1	10111010000000000000000
2	11000000000010000000000
3	00000101111100000000000
4	10000000000000000000000
5	10000000000000000000000
6	10100000000000000000000
7	00000000000000000000001
8	10100000000000000000000
9	00100000000000000000000
10	00100000000000000000000
11	00100000000000000000000
12	00100000000000000000000
13	01000000000000000000000
14	00000000000001000000000
15	00000000000000100000000
16	00000000000000010000000
17	00000000000000001000000
18	00000000000000000100000
19	00000000000000000010000
20	00000000000000000001000
21	00000000000000000000100
22	00000000000000000000010

TABLE OF RELATED TYPES: S0 = 0.2, S1 = 3

Id. Number	Size	Member Countries
(#1)	10	Colombia, Costa Rica, Ecuador, El Salvador, Gautemala, Honduras, Mexico, Nicaragua, Panama, Venezuela
(#2)	7	Albania, Bulgaria, Czechoslavia, Hungary, Poland, Romania, Yugoslavia
(#3)	10	Central African Repbulic, Chand, Congo(B.), Dahomey, Guinea, Gabon, Ivory Coast, Mali, Niger, Senegal,
(#4)	3	Argentian, Brazil, Mexico
(#5)	3	Colombia, Dominican Repbulic, Peru
(#6)	3	Dominican Republic, Jamaica, Peru
(#7)	3	Jamaica, Trinidad, Malaysia
(#8)	3	Ghana, Guinea, Tanganyika

(#9)	3	Dahomey, Ivory Coast, Tanganyika
(#10)	3	Colombia, Costa Rica, Philippines
(#11)	3	Jamaica, Trinidad, Israel
(#12)	3	Colombia, Philippines, Turkey
(#13)	4	Brazil, Colombia, Mexico, Venezuela

TABLE 17: MATRIX OF RELATED TYPES

S0 = 0.2, S1 = 4

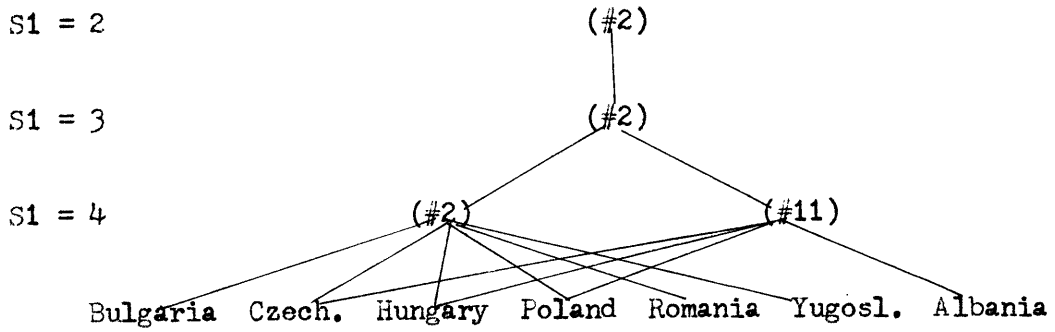
1	10010000000
2	01000000000
3	00101000000
4	10010000000
5	00101000000
6	00000100000
7	00000010000
8	00000001000
9	00000000100
10	00000000010
11	00000000001

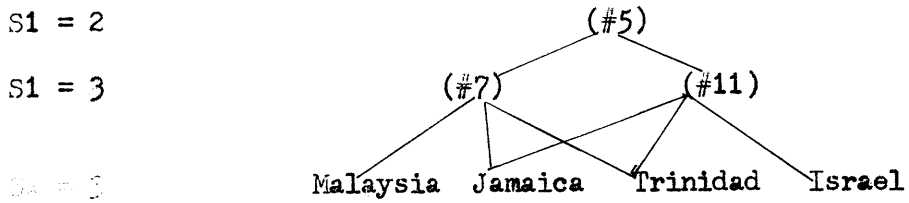
TABLE OF RELATED TYPES: S0 = 0.2, S1 = 4

Id. Number	Size	Member Countries
(#1)	7	Colombia, Ecuador, El Salvador, Gautemala, Honduras, Nicaragua, Panama
(#2)	6	Bulgaria, Czechoslavia, Hungary, Poland, Romania, Yugoslavia
(#3)	6	Colombia, Costa Rica, Honduras, Mexico, Panama, Venezuela
(#4)	5	Central African Republic, Congo(B.), Dahomey, Gabon, Ivory Coast
(#5)	4	Brazil, Colombia, Mexico, Venezuela
(#6)	4	Chad, Congo(B.), Dahomey, Niger
(#7)	4	Senegal, Guinea, Congo(B), Congo(B.), Ivory Coast,

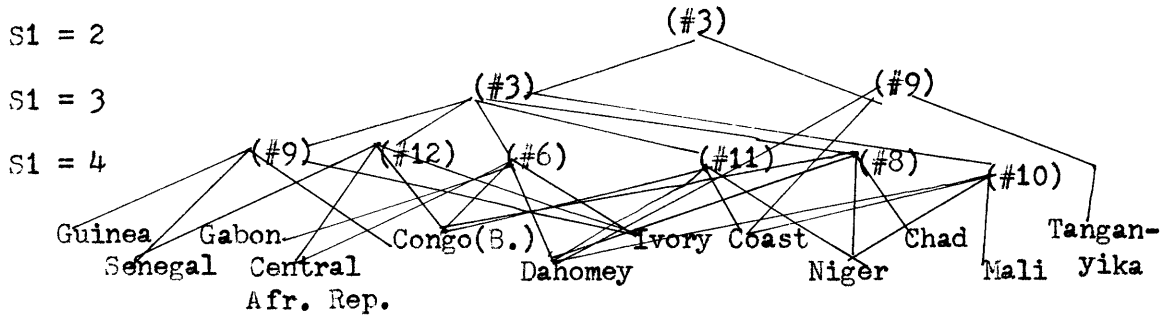
Id. Number	Size	Member Countries
(#8)	4	Dahomey, Ivory Coast, Mali, Niger
(#9)	4	Congo(B.), Dahomey, Ivory Coast, Niger
(#10)	4	Central African Republic, Congo(B.), Ivory Coast, Senegal
(#11)	4	Albania, Czechoslavia, Hungary, Poland

FIGURE 3: TYPE FORMATION AT VARIOUS LEVELS OF S1: (for types with more than three members)





S1 = 4 nothing formed at this level



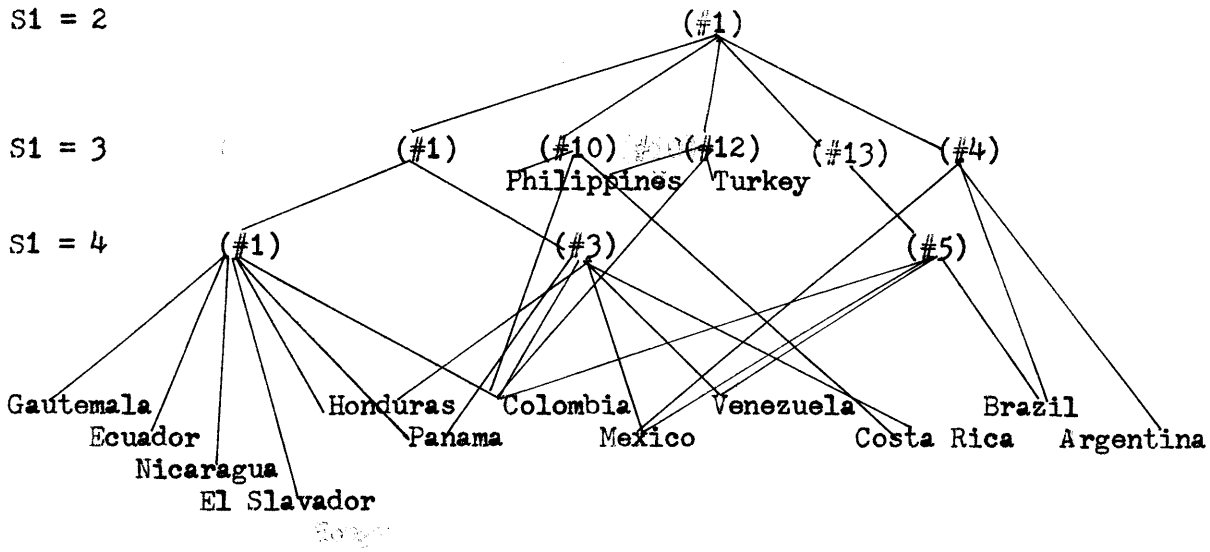

S1 = 2
(#1)
S1 = 3
(#1)
(#10)
(#12)
(#13)
(#4)
Philippines
Turkey
S1 = 4
(#1)
(#3)
(#5)
Gautemala
Ecuador
Nicaragua
El Slavador
Honduras
Panama
Colombia
Mexico
Venezuela
Costa Rica
Brazil
Argentina

TABLE 18: COMPACTNESS OF RELATED TYPES -- The ratio of the total number of links in a given type to the total number possible. Computed from Table 15 for S0 = 0.2, S1 = 2.

(#1) In a type with 14 members there are 91 possible links. 40 links actually occur in type (#1) . The compactness ratio = 40:91 which is approximately equal to 1:2.3 . Since the number of links is less than half the possible number this type formation is less than moderately compact.

(#2) In a type with 7 members there are 21 possible links. 18 links actually occur in type (#2). The compactness ratio = 18:21 or approximately 1:1.2 . Since the number of actual links is slightly less than the possible number this type formation is almost compact.

(#3) In a type with 11 members there are 51 possible links. 29 links actually occur in type (#3). The compactness ratio 29:51 is approximately equal to 1:2 and hence this type is moderately compact.

(#4) In a type with four members there are 6 possible links. 5 links actually occur in type (#4). The compactness ratio = 5:6 is approximately 1:1.2 and hence the type is considered to be almost compact.

(#5) In a type with 4 members there are 6 possible links. 5 links actually occur in type (#5). The compactness ratio 5:6 is approximately equal to 1:1.2 and hence the type is almost compact.

(#6)---(#21) In types (#6) through (#21) the total possible links equals the total actual links hence the compactness ratio = 1:1 and the types are considered to be compact.

The analysis of related-types must keep in mind that the types (#1) and (#3) represent looser, less related types than do the types (#2), (#4) and (#5). The types (#6) through (#21) represent the most related types.

INDICATOR PATTERNS OF AGREEMENT AND VARIABILITY:
S0 = 0.2, S1 = 3

RELATED TYPES (#1)

MEMBER COUNTRIES

Colombia
Costa Rica
Ecuador
El Salvador
Gautemala
Honduras
Mexico
Nicaragua
Panama
Venezuela

PATTERN OF INDICATORS:

Agreement Indicators:

(17) Low birth rate
(19) High population : doctor ratio
(26) Linguistically heterogeneous
(28) Obtained independence early
(29) Former colony
(30) Strong history of self-government
(31) Strong experience in development
(33) Non-mobilized
(40) Weak charismatic leaders
(41) No vertical power distribution
(42) No horizontal power distribution
(45) Limited effective bureaucracy

Near agreement Indicators:

(2) Low GNP/capita
(5) Low to very low percentage of the labor force in agriculture
(6) Low % of working age employed in Industry
(7) Extremely low population size
(8) High population change
(10) Low % of the population is working age
(12) High to medium urbanization
(13) Medium to low literacy rate
(15) Good to poor ration of Teachers : Students
(18) Medium to high death rate
(20) Medium to low automobile distribution
(21) Medium newspaper circulation
(23) Medium to low television distribution

(25) Religious homogeneity
(35) Mainly unstable since WWII
(37) Mainly low political encultration
(39) Mainly elitist leadership

Highly Varaible Indicators:

(1) GNP
(3) Captial % of GNP
(4) Energy consumption
(9) Density of country
(11) Size of country
(14) % enrollment
(16) Life expectancy
(22) Radio distribution
(24) Cinema attendance
(27) Racial homogeneity
(32) Ideological orientation
(34) Constitutional status
(36) Freedom of group opposition
(38) Sectionalism
(43) Status of legislature
(44) Status of executive

(#2) MEMBER COUNTRIES

Albania
Bulgaria
Czechoslavia
Hungary
Poland
Romania
Yugoslavia

PATTERN OF INDICATORS:

Agreement Indicators:

(9) Medium density
(16) High life expectancy
(18) High death rate
(26) Linguistically homogeneous
(29) Not a former colony
(30) Weak history of self-government
(31) Strong experience in development
(32) Doctrinal orientation
(33) Mobilized system
(34) Totalitarian
(39) Elitist leadership
(41) No power distribution (vertical)
(42) No horizontal power distribution

(43) Wholly ineffective legislature
(44) Dominant executive
(45) Limited effective bureaucracy

Near Agreement Indicators:

(8) Low rate of population change
(11) Small country size
(12) High urbanization
(13) High literacy rates
(14) High ratio of enrollment
(15) Good teacher:student ratio
(17) High birth rate
(21) High newspaper circulation
(22) High radio distribution
(23) Medium television distribution
(24) High cinema attendance
(25) Religious heterogeneity
(27) Racial heterogeneity
(28) Recently obtained independence
(35) Almost stable since WWII
(36) No autonomous group opposition allowed
(40) Weak charismatic leaders

Highly Varaible Indicators:

(1) GNP
(2) GNP/capita
(3) Capital % of GNP
(5) % of Labor Force in Agriculture
(6) % of working age employed in Industry
(7) Population size
(10) % of population that is working age
(37) political encultration
(38) sectionalism

(#3) MEMBER COUNTRIES:

Central African Republic
Chad
Congo (B.)
Dahomey
Guinea
Gabon
Ivory Coast
Niger
Mali
Senegal

PATTERN OF INDICATORS:

Agreement Indicators:

(4) Extremely low energy consumption
(12) Low urbanization
(20) Low automobile distribution
(21) Very low newspaper distribution
(27) Strongly heterogeneous linguistically
(28) Recently obtained independence
(29) Former colony
(30) Weak self-governing experience
(31) Weak development experience
(32) Developmental style
(41) No veritcal power distribution

Near Agreement Indicators:

(1) Extremely low GNP
(2) Extremely low GNP/capita
(7) Extremely low population size
(9) Low density
(13) Extremely low literacy rates
(14) Very low enrollment %
(16) Very low life expectancy
(17) High birth rates
(25) Relgious heterogeneity
(26) Linguistic homogeneity
(36) Opposition allowed but either limited or informal
(37) Medium to low political encultration
(38) Moderate sectionalism
(39) Non-elite leadership
(40) Medium charismatic leaders
(42) No horizontal power distribution
(43) Largely ineffective legislature
(44) Dominant executive
(45) Colonial bureaucracy

Highly Variable Indicaotrs:

(6) % working age employed in Industry
(8) Population change
(10) % population working age
(11) Country size
(15) Teacher : student ratio
(18) Death rate
(19) Population:doctor ratio
(22) Radio distribution
(24) Cinema distribution
(33) System style
(34) Constitutional status
(35) Governmental stability

DISCLAIMER

MISSING PAGE(S)

Page 75 has been ommitted due to a pagination error by the author.

(#4)

MEMBER COUNTRIES

Argentina
Brazil
Mexico

PATTERN OF INDICATORS

Agreement Indicators:

(1) Medium GNP
(3) Medium capital % of GNP
(9) Very low density
(12) High Urbanization
(13) Medium literacy rate
(18) High death rate
(23) Medium television distribution
(25) Religious homogeneity
(27) Rácial homogeneity
(28) Obtained early independence
(29) Former colony
(30) Strong self-governing experience
(31) Strong development experience
(33) Non-mobilized
(40) Weak charismatic leaders
(43) Partially effective legislature
(45) Limited effective bureaucracy

Near Agreement Indicators:

(2) Medium GNP/capita
(4) Low energy consumption
(7) Low population size
(8) Medium population change
(11) Large size
(14) Medium enrollemnt %
(15) Good teacher:student ratio
(16) Medium life expectancy
(17) Low birth rate
(19) High Population: doctor ratio
(20) Medium automobile distribution
(21) Medium newspaper circulation
(22) High radio distribution
(24) High cinema attendance
(34) Constitutional
(36) Opposition allowed
(37) Medium political encultration
(39) Moderately elite leadership

Highly Variable Indicators:

(5) % labor force in agriculture
(6) % labor force in Industry

(10) % of population working age
(26) Linguistically homogeneous
(32) Ideological orientation
(35) Government stability
(38) Sectionalism
(41) Vertical power distribution
(42) Horizontal power distribution
(44) Status of executive

(#5) MEMBER COUNTRIES

Colombia
Dominican Republic
Peru

PATTERN OF INDICATORS:

Agreement Indicators:

(2) Low GNP/capita
(10) Low % of population is working age
(12) High urbanization
(17) Low virth rate
(19) High population:doctor ratio
(23) Low television distribution
(26) Linguistically heterogeneous
(29) Former colony
(30) Strong self-governing experience
(31) Moderate development experience
(33) Non-mobilized
(34) Constitutional
(36) Opposition groups allowed
(37) Medium political encultration
(40) Weak charismatic leaders
(41) No vertical power distribution
(44) Strong executive
(45) Limited effective bureaucracy

Near Agreement Indicators:

(1) Low GNP
(3) Medium capital formation of GNP
(4) Very low energy consumption
(5) Low % of labor force in agriculture
(8) High population change
(13) Medium literacy rates
(14) Medium enrollment ratio
(15) Poor studend:teacher ratio
(18) High death rates
(20) Medium automobile distribution
(21) Medium newspaper circulation

(22) High radio distribution
(24) High Cinema attendance
(25) Religious homogeneity
(42) Horizontal power distribution is three branch system (Legislature, executive, judiciary)
(43) Highly effective legislature

Highly Variable Indicators:

(6) % of labor force in industry
(7) population size
(9) density
(11) size
(16) life expectancy
(27) racial homogeneity
(28) period of independence
(32) ideological orientation
(35) Governmental stability
(38) Sectionalism
(39) Political leadership

(#6) MEMBER COUNTRIES:

Dominican Republic
Jamaica
Peru

PATTERN OF INDICATORS:

Agreement Indicators:

(10) low % of population is working age
(12) High urbanization
(17) Low birth rates
(19) High population : doctor ratio
(26) Linguistic heterogeneity
(29) Former colony
(33) Non-mobilized system
(34) Constitutional
(36) Opposition groups allowed
(37) Moderate political encultration
(38) No sectionalism
(39) Non-elite leadership
(41) No veritcal power distribution
(42) Horizontal three branches: Legislature, executive, judiciary
(44) Strong executive
(45) Limited effective bureaucracy

Near Agreement Indicators:

(1) Very low GNP
(2) Low GNP/capita
(3) Medium capital formation of GNP
(4) Low energy consumption
(13) Medium literacy rates
(14) Medium enrollment %
(15) Bad teacher:student ratio
(16) High life expectancy
(18) High death rate
(21) Medium newspaper distribution
(22) Medium radio distribution
(24) Medium cinema attendance
(25) Religious heterogeneity
(27) Weak racial heterogeneity
(30) Self-government experience:strong
(31) Medium development experience
(40) Weak charismatic leaders
(43) Highly effective legislature

Highly Variable Indicators:

(5) % labor force in agriculture
(6) % of working age employed in Industry
(7) Population size
(8) Country size
(11) Population change
(20) Automobile distribution
(23) Television distribution
(28) Date of independence
(32) Ideological orientation

(#7) MEMBER COUNTRIES

Jamaica
Malaysia
Trinidad

PATTERN OF INDICATORS

Agreement Indicators:

(10) Low population % is working age
(11) Small size country
(18) High death rate
(19) High ratio of population : doctor
(21) Medium newspaper distribution
(22) Medium radio distribution
(25) Religious heterogeneity
(26) Linguistic heterogeneity
(29) Former colony

(30) Weal self-government experience
(33) Non-mobilized
(36) Opposition groups allowed
(39) Non-elitest leadership
(42) Three branch horizontal power distribution: legislature, executive, judiciary.
(43) Highly effective legislature
(44) Strong executive
(45) Limited effective bureaucracy

Near Agreement Indicators:

(2) Medium GNP/capita.
(7) Extremely low population size
(8) High population change
(9) High density
(12) High urbanization
(13) Medium literacy rates
(14) Medium enrollment ratio
(16) Medium life expectancy
(17) Medium birth rates
(20) High automobile distribution
(24) High cinema attendance
(28) Moderately recent independence
(31) Weak experience in development
(32) Doctrinal
(34) Constitutional
(37) Medium political encultration
(38) No sectionalism
(40) Weak charismatic leaders
(41) No vertical power distribution

Highly variable Indicators:

(1) GNP
(3) Captial formation of GNP
(4) Energy consumption
(5) % of labor force in agriculture
(6) % of working age employed in Industry
(15) Teacher:student ratio
(27) Racial homogeneity
(35) Government stability

(#8) MEMBER COUNTRIES

Ghana
Guinea
Tanganyika

PATTERN OF INDICATORS:

Agreement Indicators:

(4) Extremely low energy consumption
(7) Very low population size
(12) Low urbanization
(19) High population:doctor ratio
(20) Low automobile distribution
(25) Religious heterogeneity
(26) Linguistic homogeneity
(27) Extreme racial heterogeneity
(28) Recent independence
(29) Former colony
(30) Very weak self-governing experience
(31) Weak development experience
(32) Developmental style
(37) Medium political encultration
(40) High charismatic leaders
(41) No vertical power distribution
(42) No horizontal power distribution
(44) Dominant executive

Near Agreement Indicators:

(8) High rate of population change
(9) Low density
(11) Medium size country
(14) Very low enrollment %
(15) Poor teacher:student ratio
(16) Very low life expectancy
(18) Medium death rate
(22) Low radio distribution
(33) Mobilized
(36) Only informal opposition groups
(38) Medium political sectionalism
(39) Moderate elitest leadership
(43) Wholly ineffective legislature
(45) Limited effective bureaucracy

Highly Variable Indicators:

(1) GNP
(2) GNP/capita
(3) Capital formation of GNP
(5) % of labor force in agriculture
(10) % of population working age
(13) Literacy rates
(17) Birth rates
(21) Newspaper circulation
(24) Cinema attendance
(34) Constitutional status
(35) Government stability

(#9)

MEMBER COUNTRIES

Dahomey
Ivory Coast
Tanganyika

PATTERN OF INDICATORS:

Agreement Indicators:

(4) Extremely low energy consumption
(9) Very low density
(12) Low urbanization
(16) Very low life expectancy
(20) Low automobile distribution
(21) Very low newspaper circulation
(25) Religious heterogeneity
(26) Linguistic homogeneity
(27) Strong racial heterogeneity
(28) Recent independence
(29) Former colony
(30) Very weak self-governing experience
(31) Weak development experience
(39) Non-elite leadership
(41) No vertical power distribution
(42) No horizontal power distribution
(43) Largely ineffective legislature
(44) Dominant executive
(45) Colonial bureaucracy

Near Agreement Indicators:

(1) Very low GNP
(2) Extremely low GNP/capita
(7) Extremely low population size
(8) Medium population change
(13) Extremely low literacy rates
(14) Very low enrollment ratio
(18) Low death rate
(19) Medium population:doctor ratio
(22) Very low radio distribution
(33) Weak mobilization
(36) Informal or extrapolitical opposition groups
(37) Medium political encultration
(38) No sectionalism
(40) High charismatic leaders

Highly Variable Indicators:

(3) Capital formation of GNP

(10) % population working age
(11) Country size
(15) Teacher:student ratio
(17) Birth rate
(24) Cinema attendance

(#10) MEMBER COUNTRIES

Colombia
Costa Rica
Philippines

PATTERN OF INDICATORS:

Agreement Indicators:

(5) Low % of the labor force is in agriculture
(10) Low % of the population is working age
(13) Medium literacy rates
(17) Medium enrollment %
(20) Medium automobile distribution
(22) Low radio cistribution
(26) Linguistic homogeneity
(40) Weak charismatic leaders
(41) No vertical power distribution
(45) Limited effective bureaucracy

Near Agreement Indicators:

(6) % of working age employed in Industry
(8) High population change rate
(16) Medium life expectancy
(18) High death rates
(19) Medium population : doctor ratio
(21) Medium newspaper circulation
(27) Weakly racially homogeneous
(25) Religious homogeneity
(29) Never colonized
(30) Weak self-governing experience
(31) Weak development experience
(34) Constitutional
(35) Moderately stable since WWII
(36) Opposition groups allowed

Highly Variable Indicators:

(1) GNP
(2) GNP/capita

(3) Capital formation of GNP
(4) Energy consumption
(7) Population size
(9) Density
(11) Country size
(12) Urbanization
(15) Teacher:student ratio
(23) Television circulation
(24) Cinema attendance
(28) Independence date
(32) Ideological orientation
(33) System style
(37) Political encultration
(38) Sectionalism
(39) Political leadership
(42) Horizontal power distribution
(43) Legislature status
(44) Executive status

(#11)

MEMBER COUNTRIES:

Jamaica
Israel
Trinidad

PATTERN OF INDICATORS:

Agreement Indicators:

(7) Extremely low population size
(11) Small country size
(18) High death rate
(20) High automobile distribution
(29) Former colony
(30) Weak self-government experience
(34) Consitutional
(36) Opposition groups allowed
(37) Medium political encultration
(38) No sectionalism
(39) Non-elite leadership
(41) No vertical power distribution
(42) Three branch horizontal power distribution: legislature, executive, judiciary
(43) Highly effective legislature
(44) Strong executive
(45) Limited effective bureaucracy

Near Agreement Indicators:

(2) Medium GNP/capita

(3) High capital formation of GNP
(5) High % of labor force in agriculture
(6) Medium % working force in industry
(8) High population change rate
(9) High density
(10) Low % of population is working age
(12) High urbanization
(13) Medium literacy rates
(14) High enrollment %
(16) Medium life expectancy
(17) Medium birth rates
(19) High population : doctor ratio
(21) Medium newspaper circulation
(22) Medium radio distribution
(24) High cinema attendance
(25) Religious heterogeneity
(26) Linguistic heterogeneity
(27) Weak racial heterogeneity
(33) Non-mobilized
(35) Stable since WWII
(40) Weak charismatic leadership
(45) Effective or limited effective bureaucracy

Highly Variable Indicators:

(1) GNP
(4) Energy consumption
(15) Student : teacher ratio
(23) Television distribution
(28) Date of independence
(31) Political modernization
(32) Ideological orientation

(#12)

MEMBER COUNTRIES:

Colombia
Philippines
Turkey

PATTERN OF INDICATORS:

Agreement Indicators:

(7) Low population size
(8) High population change rate
(15) Poor teacher:student ratio
(18) High death rate
(23) Low television distribution
(25) Religious homogeneity

(32) Conventional ideology
(33) Non-mobilized
(34) Constitutional
(36) Opposition groups allowed
(40) Weak charismatic leaders
(41) No vertical power distribution
(42) Strong executive
(43) Limited effective bureaucracy

Near Agreement Indicators:

(2) Low GNP/capita
(4) Very low energy consumption
(5) Low % of labor force in agriculture
(6) Low % of working age in industry
(11) Large country size
(12) Almost high urbanization
(13) Medium literacy rates
(14) Medium enrollment %
(16) Medium life expectancy
(17) Low birth rate
(19) High ratio Population :doctors
(20) Low automobile distribution
(21) Medium newspaper circulation
(24) Medium cinema attendance
(26) Linguistic homogeneity
(29) Former colony
(31) Developmenting experience
(37) Medium political encultration
(39) Moderate elite leadership
(42) Three branch horizontal power distribution
(43) Partially effective legislature

Highly Variable Indicators:

(1) GNP
(3) Capital formation of GNP
(9) Density
(10) % of population working age
(22) radio distribution
(27) Racial homogeneity
(28) Date of independence
(30) History of self-government
(35) Governement stability
(38) Sectionalsim

SUMMARY OF PATTERNS OF INDICATORS FOR STAGE THREE:

The five related-types which are summarized at the end of Stage two, are maintained in stage three but expanded to include more members. The Communist countries of Albania and Yugoslavia demonstrate a lower level of development resources join the more developed Eastern European type. The large South American countries are joined by the more developed nations of Argentina, Brazil and Venezuela and the moderately developed nations such as the Philippines , and Turkey and the less developed nations such as Peru, Gautemala, and Honduras. The small South American countries are now joined by the moderately developed nations of Israel and the less developed nation of Malaysia. The authoritarian mobilized African states are joined by Tanganyika and the less developed African nations are linked to the extremely underdeveloped nations of Chad, Niger, Mali, Central African Republic, and Senegal. Although the labels given to the related-types of stage two are no longer relevant, they will be maintained for purpose of discussion.

Measures of typicality for stage three imply that Colombia is the most central member of the large South American countries while Ivory Coast is the most central member of the less developed African states. Compactness demonstrates that the Eastern European Nations, the small South American nations, and clusters of three or two members demonstrate the most interrelatedness. The Large South American countries are the most loosely related while the less developed African nations demonstrate more interrelatedness.

It also should be noted that the following interesting clusters occur: (Morroco, U.A.R.), (U.A.R., China(T.)), (Nigeria, Uganda),

(Mexico, Republic of South Africa), (Jamaica, Tunisia), (Nigeria, Uganda), (Uganda, Upper Volta), (Japan, Greece), (Gautemala, Thailand),(Thailand, India), (India, Pakistan), and (Iraq, Syria).

4. STAGE FOUR: Cluster and Type formation at SO = 0.1:

The significance level SO is lowered once more to SO = 0.1 . Although this level is considered too weak a criterion to determine relatedness, since SO = 0.0 is no better than chance relatedness, the linkage matrix (Table 18), the Table of Nucleus Counts (Table 19), the Table of Phenomenal Clusters (Table 20), and the Table of Related-types (Table 21) are given here in order to display further linkages to the types already described in Stages One, Two and Three, Since SO = 0.1 is considered too weak a criterion no further analysis of type formations is offered.

loadgo record
W 1437.6
EXECUTION.
S1 = 2
INPUT ON TAPE 7, OUTPUT ON TAPE 8 AND 9

TABLE 18: LINKAGE MATRIX

REORDERED MATRIX

```
00000000000000000000000010000000000000000000000000000000 ARGENTINA
00000000001000000000000000010000000000000000000000000000 BOLIVIA
00000000000010010000000100000000000000000000000000000000 BRAZIL
00000000000000000000000000000000000000000000000000000000 CHILE
11101000100010010000000010100010000000000000000000000000 COLOMBIA
10101000100000000000000000001100000000000000000000000000 COSTA RICA
00000000000000000000000000000000000000000000000000000000 CUBA
10101000100001000000000000000000000000000000000000000000 DOMINICAN REP.
11101100000110000000010000001000000000000000000000000001 ECUADOR
11000100000000000000000000000000000000000000000000000000 EL SALVADOR
00000100000100000000000000000000000000000000001000000000 GAUTEMALA
00000000000000000000000000000000000000000000000000000000 HAITA
11001100000100000000000000000000000000000000000000000000 HONDURAS
00000000000001100000001000010000000000000000000000000000 JAMAICA
11101000100010010000110110100000000000000000000000000000 MEXICO
01000100000000000000001000000000000000000000000000000000 NICARAGUA
11100100000101100000111000011100000000000000000000000000 PANAMA
00000000000000000000000000000000000001000000000000000000 PARAGUAY
00100000100011110000010000000000000000000000000000000000 PERU
00000000000001100000001000000000000000000000000000000000 TRINIDAD
00000000000000000000000000000010000000000000010000000000 URUGUAY
00000000000000010000100100100100000000000000000000000000 VENEZUELA
00000000000000000000000000000000000000000000000000000000 ALGERIA
00000000000000000000000000000000000000000000000000000000 BURUNDI
00000010000000000000000000000000000000000000000000000000 CAMEROON
00010000000000000010000000000000000000000000000000000000 CENTRAL AFRICAN REP.
00000000000000001000000000000000000000000000000000000000 CHAD
00010011000000001011000000000000000000000000000000000000 CONGO (B.)
00000000000000000000000000000000000000000000000000000000 CONGO(B.)
00010001000000001001000000000010000010000000000000000000 DAHOMEY
00000000000000000000000000000000000000000000000000000000 ETHIOPIA
00010000000000000000000000000000000000000000000000000000 GABON
00000000000000001000000000000000010000010000000000000000 GHANA
00000010000000000110000000000001000000000000000000000000 GUINEA
00010011000000001111000000000000000000000000000000000000 IVORY COAST
00000000000000000000000000000000000000000000000000000000 KENYA
00000000000000000000000000000000000001000000000000000000 LIBERIA
00000000000000000000000000000000000010000000000000000000 LIBYA
00000000000000000000000000000000000000000000000000000000 MALAGASY REPUBLIC
00000001000000000000000000000000000000000000000000000000 MALI
00000000000000000000000000000000000000000000000000000000 MAURITANIA
00000000000000000000000010000000001000000000010000000000 MOROCCO
00010001000000001000000000000000000000000000000000000000 NIGER
00000000000000000000000000000000000001000000000000000000 NIGERIA
00000000000000000000000000000000000000000000000000000000 RWANDA
00010011000000001110000000000000000000000000000000000000 SENEGAL
00000000000000000000000010000011000000000000010000000000 SIERRA LEONE
00000000000000000000000010000000000000000000000000000000 SOMALI REPUBLIC
00000000000000000000000001000000000000000000000000000000 REP. OF S. AFRICA
00000000000000000000000000000000000000000000000000000000 SUDAN
00000010000000000101000001000011000000000000000000000000 TANGANYIKA
00000000000000000000000010000000000000000000000000000000 TOGO
00000000000000000000010000001000000111010000000000000000 TUNISIA
00000000000000000000000000000000000000000011000000000000 UGANDA
00000000000000000000000000000000000000010000000000000000 UPPER VOLTA
00000000000000000000000000000000000000000000000000000000 BURMA
```

00000000000000000000000000000000000000000110000000000	CAMBODIA
00000000000000000000000000000000000000000001000000000	CHINA (TAIWAN)
00000000000000000000000000000000000000000000000000000	INDONESI
00000000000000000000000000000000010000000000100000000	JAPAN
00000000000000000000000000000000000000000000000000000	KOREA (NORTH)
00000000000000000000000000000000000000000000000000000	REP. OF KOREA
00000000000000000000000000000000000000000000010000000	LAOS
00000000000000100000111000011000000000000000000000000	MALAYSIA
00001000000000000000000000000000000000000000000000000	PHILIPPINES
00000000000000000000000000000000001000000000001001000	THAILAND
00000000000000000000000000000000000000000000000000000	VIETNAM (NORTH)
00000000000000000000000000000000000000000000000000000	VIETNAM (REP. OF)
00000000000000000000000000000000000000000000000100000	CEYLON
00000000000000000000000000000000000000000000000011100	INDIA
00000000000000000000000000000000000000000000000000000	NEPAL
00000000000000000000000000000000000000000000000000100	PAKISTAN
00000000000000000000000000000000000000000000000000000	AFGHANISTAN
00000000000000000000000000000000000000000000000000000	CYPRUS
00000000000000000000000000000000010000000000000000000	GREECE
00000000000000000000000000000000000000000000000000000	IRAN
00000000000000000000000000000000000000000000000000010	IRAQ
00000000000000000000001000000100010000000000000000000	ISRAEL
00000000000000000000000000000000000000000000000000000	JORDAN
00000000000000000000000000000000000000000000000000001	LEBANON
00000000000000000000000000000000000000000000000000000	SAUDI ARABIA
00000000000000000000000000000000000000000000000000010	SYRIA
00000000100000000000000000000000000000000000000000000	TURKEY
00000000000000000000000000000000000100000011000100000	UNITED ARAB REP.
00000000000000000000000000000000000000000000000000000	YEMEN
00000000010000000000000000000000000000000000000000000	ALBANIA
00000000011000000000000000000000000000000000000000000	BULGARIA
00000000011000000000000000000000000000000000000000000	CZECHOSLAVIA
00000000011000000000000000000000000000000000000000000	HUNGARY
00000000011000000000000000000000000000000000000000000	POLAND
00000000011000000000000000000000000000000000000000000	ROMANIA
00000000000000000000000000000000000000000000000000000	USSR
00000000001000000000000000000000000000000000000000000	YUGOSLAVIA

TABLE 18: (continued)

62440

TABLE 19:

MATRIX OF NUCLEUS COUNTS

```
866004004003321200002311202122200000000000000000000001
674045002003311200002311302121100000000000000000000001
647052005002432300002411202122200000000000000000000001
000700350000000042440000000000100000100000000000000000
645072004002310200001201202011200000000000000000000001
452026000004111000001210100121000000000000000001000001
000300630000000024440000010000012000000000000000000000
000500360000000042340000000000010000010000000000000000
425040006000321300001201202001200000000000000000000000
000000000650000000000000000000000000000000000000000000
000000000560000000000000000000000000000000000000000000
332024000005111000001210000131000000000000000001000001
334031003001511400001302202010100000000000000000000001
213011002001154100001230000211000000000000000000000000
112001001001145100002340000321000000000000000000000000
223020003000411500002203203001100000000000000000000000
000400240000000051230000000000010000010000000000000000
000200420000000015330000010000012010000001000000000000
000400430000000023530000000000001000000000000000000000
000400440000000033350000010000021000010000000000000000
222011001001112200005322102322000011101000000000000000
334022002002323200003521101231000000000000000000000001
111001000001034000002250000322000100000000000000000000
111010001000200300002104102001000000000000000000000000
232021002000200200001101402000100001000000000000010000
000000100000000001010000040000022000000000000010000000
222020002000200300002102204001100000000000000000000000
111001000001023000003230000421000011101000000000000000
222012000003112000002320000241000000000000000000000001
212011001001011100002121001114100100000000000000000000
212020002000100100000000101001300000000000000100000000
000100110000000011020000020000032000010000000010000000
000000200000000002110000020000023000000000000010000000
000000000000000000000001000000100030000000000100000000
000000000000000000100100000010000003110100100001001000
000000000000000000010001001000006131010001100011000000
000000000000000000001000000100000112010000000000000000
000100010000000001001000000000001000002000000000000000
000000000000000000001000000100000111020000000000000000
000000000000000000000000000000000000000021000000000000
000000000000000000000000000000000000000120000000000000
000000000000000001000000000000000010000021000000000000
000000000000000000000000000000000001000012100010000000
000000000000000000000000000000000001000001200010000000
000000000000000000000000000000100100000000020000000000
000000000000000000000000010000011000000000020000000000
000001000001000000000000000000001000000000201000000000
000000000000000000000000000000000010000011000200000000
000000000000000000000000010000000001000000000021100000
000000000000000000000000000000000001000000000101210000
000000000000000000000000000000000000000000000011200000
000000000000000000000000000000000000000000000000020000
111011000001100000000100000010000000000000000000000002
```

PCLUSTER MATRIX

1

TABLE 20: TABLE OF PHENOMENAL CLUSTERS

SO = 0.1

Identification Number	Size of Cluster	Member Countries of Cluster
(1)	8	Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Honduras, Mexico, Panama
(2)	7	Colombia, Ecuador, El Salvador, Honduras, Mexico, Nicaragua, Panama
(3)	7	Colombia, Costa Rica, Dominican Republic, Ecuador, Mexico, Panama, Peru
(4)	7	Central African Republic, Congo(B.), Dahomey, Gabon, Ivory Coast, Niger, Senegal
(5)	7	Colombia, Costa Rica, Dominican Republic, Ecuador, Honduras, Mexico, Philippines
(6)	6	Ecuador, El Salvador, Gautemala, Honduras, Nicaragua, Panama
(7)	6	Cameroon, Congo(B.), Guinea, Ivory Coast, Mali, Niger, Senegal.

Id. Number	Size	Member Countries
(8)	6	Congo(B.), Dahomey, Ivory Coast, Mali, Niger, Senegal
(9)	6	Colombia, Costa Rica, Dominican Republic, Mexico, Peru, Turkey
(10)	6	Albania, Bulgaria, Czechoslavia, Hungary Poland, Romania
(11)	6	Bulgaria, Czechoslavia, Hungary, Poland, Romania, Yugoslavia
(12)	5	Bolivia, Ecuador, Gautemala, Honduras, Panama
(13)	5	Brazil, Colombia, Ecuador, Mexico, Peru
(14)	5	Dominican Republic, Jamaica, Panama, Peru, Trinidad
(15)	5	Jamaica, Panama, Peru, Trinidad, Malaysia
(16)	5	Brazil, Colombia, Mexico, Peru, Venezuela
(17)	5	Chad, Congo(B.), Dahomey, Ivory Coast, Niger
(18)	5	Ghana, Guinea, Ivory Coast, Senegal, Tanganyika
(19)	5	Central African Republic, Congo(B.), Guinea, Ivory Coast, Senegal,
(20)	5	Congo(B.), Dahomey, Ivory Coast, Senegal, Tanganyika
(21)	5	Mexico, Panama, Venezuela, Tunisia, Malaysia
(22)	5	Ecuador, Mexico, Panama, Peru, Malaysia
(23)	5	Jamaica, Panama, Trinidad, Malaysia, Israel
(24)	4	Argentina, Brazil, Mexico, Venezuela

Id. Number	Size	Member Countries
(25)	4	Colombia, Mexico, Nicaragua, Morocco
(26)	4	Sierra Leone, Somali Republic, Tanganyika, Togo
(27)	4	Colombia, Mexico, Venezuela, Republic of South Africa
(28)	4	Jamaica, Panama, Tunisia, Malaysia
(29)	4	Bolivia, Ecuador, Panama, Malysia
(30)	4	Costa Rica, Panama, Venezuela, Israel
(31)	3	Colombia, Costa Rica, Uruaguay
(32)	3	Dahomey, Sierra Leone, Tanganyika
(33)	3	Guinea, Sierra Leone, Tanganyika
(34)	3	Japan, Greece, Israel
(35)	3	Ghana, Tunisia, Thailand
(36)	3	Morocco, Tunisiam United Arab Republic
(37)	2	Paraguay, Tunisia
(38)	2	Dahomey, Liberia
(39)	2	Libya, Tunisia
(40)	2	Nigeria, Uganda
(41)	2	Uganda, Upper Volta
(42)	2	Ghana, Cambodia
(43)	2	Cambodia, United Arab Republic
(44)	2	China (T.), United Arab Republic
(45)	2	Uruaguay, Japan
(46)	2	Sieera Leone, Laos
(47)	2	Gautemala, Thailand
(48)	2	Ceylon, United Arab Republic

(49)	2	Morocco, India
(50)	2	Thailand, India
(51)	2	India, Pakistan
(52)	2	Iraq, Syria
(53)	2	Ecuador, Lebanon

TABLE 21: TABLE OF RELATED-TYPES: S0 = 0.1, S1 = 2

Identification Number	Size	Member Countries
(#1)	28	Argentina, Bolivia, Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Gautemala, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay*, Peru, Trinidad, Uruaguay*, Venezuela, Morocco*, Republic of South Africa*, Tunisia*, Malaysia, Philippines, Israel, Turkey
(#2)	17	Cameroon*, Central African Repbulic, Chad, Congo(B.), Dahomey, Gabon, Ghana, Guinea, Ivory Coast, Mali, Niger, Senegal, Sierra Leone*, Somali Republic*, Tanganyika, Togo*, Tunisua*
(#3)	7	Albania, Bulgaria, Czechoslavia, Hungary, Poland, Romania, Yugoslavia
(#4)	3	Japan*, Greece, Israel
(#5)	3	Ghana, Tunisia*, Thailand
(#6)	3	Morocco*, Tunisia*, United Arab Repbulic
(#7)	2	Paraguay*, Tunisia*
(#8)	2	Dahomey,,Liberia*
(#9)	2	Libya*, Tunisia*
(#10)	2	Nigeria*, Uganda
(#11)	2	Uganda*, Upper Volta
(#12)	2	Ghana, Cambodia*
(#13)	2	Cambodia*, United Arab Republic
(#14)	2	China(T.), United Arab Republic

(#15)	2	Uruaguay*, Japan*
(#16)	2	Sierra Leone*, Laos*
(#17)	2	Gautemala, Thailand
(#18)	2	Ceylon*, United Arab Republic
(#19)	2	Morocco*, India
(#20)	2	Thailand, India*
(#21)	2	India, Pakistan
(#22)	2	Iraq, Syria
(#23)	2	Ecuador, Lebanon*

(* Those countries which enter related-types for the first time)

5. COMPARATIVE LEVELS OF DEVELOPMENT:

By combining the 45 development indicators into eleven categories a level of development for each related-type can be determined category by category. The types can then be compared against each other to yield development levels and variances between the definitions of each development type.

For the purpose of comparative development, the phenomenal clusters of S0 = 0.5 were compared against the related-types of S0 = 0.2 , S1 = 3. To avoid confusion with respect to the identification numbers of types the reated-types were renumbered so that #1 through #5 represent the five clusters of Table 3 respectively and #6 through #20 are the twelve related-types of Table 16.

The indicators which were grouped into the eleven categories were scaled along a development continuum from High High (HH), High(H), Low-High (LH), High-Medium (HM), Medium (M), Low-Medium (LM), High - Low (HL), Low (L), and Low-Low (LL). It was found that the categories of Government Direction (8), Degree of Opposition (9), Power Distribution (10), and Administrative Structure (11) contained too many highly variable indicators to be included in the comparison of types and consequently the development levels produced are reflective of the development resource categories 1 through 7. Table 23 displays the seven category scales from HH to LL for the 20 types. The score for each category was obtained by averaging the scores of the Agreement or Near Agreement indicators that belong to that category. Asterisks mark the categories which contain too many variable indicators.

It must be kept in mind that high development in this context does not mean the development levels of the industrialized countries but

instead refers to the highest developed nations that can still be considered underdeveloped in some respect. The patterns of indicators which produce these types help to define what the degree of underdevelopment might be. Table 23 is interpreted to mean the following: If Type #A and Type #B contain several countries in common and Type #B is lower on the development continuum then type #A then those countries contained in #A but not in #B are more developed than those countries contained in #B but not in #A, furthermore those countries contained in both #A and #B are between the two extreme development levels. Analyzing Table 23 in this manner produces the development paths of Table 24.

In order to understand the variables which produce each development level, the patterns of variability must also be understood. Those categories considered insignificant have one half or more of their indicators demonstrating high variability. Type #1 and Type #2 demonstrate insignificance in the categories of National Unity and Degree of Opposition allowed. Type #3 has the category of Government Direction measuring variability. Types #5, #6, #8, #20 contain the insignificant categories of Economic Resources and Government Direction. The categories of Economic and Communication Resources are the Variable ones for Type #7. Type #9 demonstrates variability in the categories of Economic Resources, Government Direction, Degree of Opposition, and Administrative Structure. Type #11 contains Economic and Human Resource categories and Self-government, Degree of Opposition, Power Distribution and Administrative Structure, which are highly variable. Type #12 is only insignificant in the category of Self-governing experience. Type #13 varies in the categories of Economic Resources and the Degree of Opposition allowed. Type #14 has insignificance with respect to the categories of Human and Health resources and

Government Direction. Type #16 varies in the category of Economic Resources and Type #17 has variable self-Government experience. Type #18 contains Variable Human Resources and Government Direction while Type #19 varies only with respect to the categaory of Human Resources.

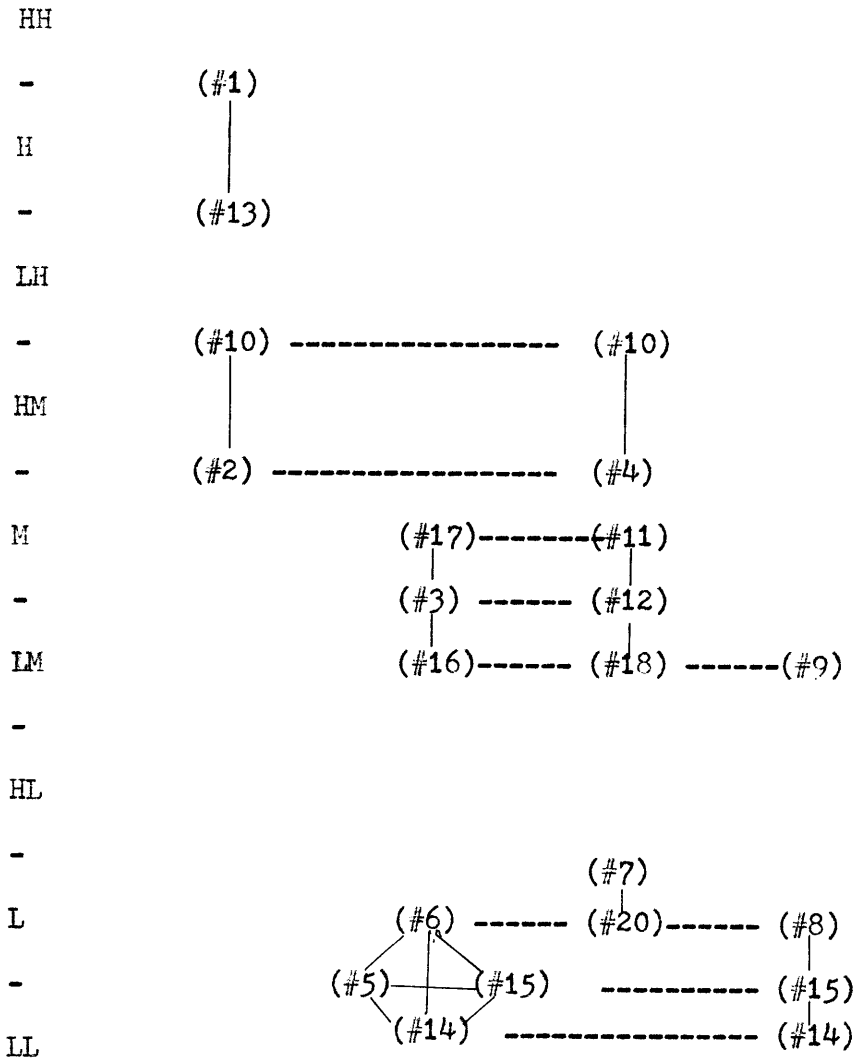
TABLE 22: RELABELED RELATED - TYPES FROM S0 = 0.5 AND S0 = 0.2:

New Label	Old Id. #	Member Countries
(#1)	(#1)	Bulgaria, Czechoslavia, Hungary, Poland, Romania
(#2)	(#2)	Colombia, Ecuador
(#3)	(#3)	Jamaica, Trinidad
(#4)	(#4)	Colombia, Mexico
(#5)	(#5)	Congo(B.), Dahomey
(#6)	(#6)	Congo(B.), Gabon
(#7)	(#7)	Ghana, Guinea
(#8)	(#8)	Congo(B.), Ivory Coast
(#9)	(#1)	Colombia, Costa Rica, Ecuador, El Salvador, Gautemala, Honduras, Mexico, Nicaragua, Panama, Venezuela
(#10)	(#4)	Argentina, Brazil, Mexico
(#11)	(#10)	Colombia, Costa Rica, Philippines
(#12)	(#12)	Colombia, Philippines, Turkey
(#13)	(#2)	Albania, Bulgaria, Czechoslavia, Hungary, Poland, Romania, Yugoslavia
(#14)	(#3)	Central African Republic, Chad, Congo(B.), Dahomey, Guinea, Gabon, Ivory Coast, Mali, Niger, Senegal
(#15)	(#9)	Dahomey, Ivory Coast, Tanganyika
(#16)	(#7)	Jamaica, Trinidad, Malaysia
(#17)	(#11)	Jamaica, Trinidad, Israel
(#18)	(#5)	Colombia, Dominican Republic, Peru
(#19)	(#6)	Dominican Republic, Jamaica, Peru
(#20)	(#8)	Ghana, Guinea, Tanganyika

TABLE 23: CATEGORIES OF DEVELOPMENT LEVELS:

	HH	H	LH	HM	M	LM	HL	L	LL
ECONOMIC RESOURCES	#1			#3	#10 #16 #17*	#4 #11	#2 #19	#6 #12 #18	#5 #7 #8 #9 #14 #15 #20* #13*
HUMAN RESOURCES	HH #1 #4 #13	H	LH #10 #12	HM	M #2 #16 #17	LM #9 #18	HL #7	L #3 #5 #6 #8 #11 #14 #19*	LL #15 #20
EDUCATIONAL RESOURCES	HH #1	H	LH #13	HM #17	M #3 #4 #10 #11 #12 #16 #18	LM #2 ##9 #19	HL #7	L #5 #6 #8 #20	LL #14 #15
HEALTH RESOURCES	HH	H #1	LH #13	HM #3 #19	M #16 #17	LM #11	HL #4 #5 #9 #10 #12	L #2 #6 #8 #15 #18	LL #7 #14 #20
COMMUNICATION RESOURCES	HH #1	H	LH #13	HM #2 #3 #4 #10 #16 #17 #18	M #11	LM #9	HL #6 #12	L #7 #8 #20	LL #5 #14 #15
NATIONAL UNITY	HH #1* #10 #12	H	LH #4 #11	HM #2*	M #9	LM #18	HL	L #3 #6 #7 #8 #13 #16	LL #5 #14 #15 #17 #19 #20

TABLE 24: DEVELOPMENT PATHS



DEVELOPMENT PATHS:

PATH 1: H+ Bulgaria, Czechoslavia, Hungary, Poland, Romania

(H-LH) Albania, Yugoslavia

PATH 2: M Israel
- Jamaica - Trinidad
LM Malaysia

PATH 3:

(LH - HM) Argentina -- Brazil

Mexico

Colombia

(M) Costa Rica, Philippines

Turkey

(LM) Dominican Rep. -- Peru

PATH 4: (M) Israel

Jamaica - Trinidad

(LM) Malaysia

PATH 5: Ghana - Guinea

(L) Gabon

Congo (B.)

Ivory Coast - Dahomey

(LL) Tanganyika

6. SUMMARY OF THE ANALYSIS:

It has been shown through the use of multivariate analysis that the concept of development stages is not unidimensional. Underdevelopment has been defined by multipatterned economic, social and political indicators that inhibit development. Although no two countries are alike in these inhibiting factors, countries do tend to cluster around certain patterns of variables.

The results of cluster analysis are too detailed to offer concise summaries; moreover it appears that the value of the results would best be obtained by using the development types as a reference manual. Each type indicates several areas for more intensive study. The 'typical' countries of Colombia and Ivory Coast should be studied in depth in order to gain insight into the other countries which are linked to these central points. Another area to study is concerned with the problem of linkages between related-types. Several countries are linked to larger types through association with a single member country. What do these single linked countries such as Jpan, Greece, Libya, U.A.R., India or Lebanon, to mention only a few, represent? Are they transitional points between the two development types or do they merely represent isolated development types? The question of development priorities or indicators which imply conditions that are not compatible with development has not been studied here. Special weights of development potential must be related to certain indicators. Furthermore the development priorities must be ascertained for each development type for the development priorities which are related to the type with members Ghana, Guinea and Tanganyika would not be the same as those related to the type with members Gongo (B.), Dahomey,

and Ivory Coast? The pattern of development priorities could then be translated into unique policy guidelines for each development type.

Clearly better data needs to be obtained through the use of secondary resources such as questionnaires, interviews and planning reports. Time-series and historical data should be included to reveal transitions between development types. The question of how to determine if development has moved upward or downward must be studied. Data which indicates the distribution or duality problem within countries should be obtained. Finally the concepts of modernization, urbanization and growth poles should be further defined to be included in the set of development indicators.

CHAPTER FOUR: DISCUSSION OF THE STATISTICAL TECHNIQUE OF CLUSTER ANALYSIS:

1. CLASSIFICATION SCHEMES:

Classification, defined as the ordering of elements into groups based upon internal measurements of association, is essential to the understanding of many complex situations. Current classification schemes often fail in two manners. Either they use inconsistent sets of indicators (i.e. the data which determines classification groups varies between sets of data), or they force the sample units into predetermined categories. To avoid these faults a method is needed which will reveal the relations and classifications inherent in the structure of the data.

Cluster analysis is the generic name for statistical techniques which organize large quantities of data from the internal structure of the data itself. These numerical classification schemes are used to identify subgroups within the data and to reveal similarities and differences among these groups. Such analysis permits new arrangements or groupings of the sample data and clarifies the distinction between groups.

Cluster analysis can aid the development of conceptual frameworks and testable hypotheses from a given set of data. Often the number of variables and the complexities of their relationships prevent the formulation of generalizations and hypotheses without simplification or type classification. Cluster analysis reveals the significant contrasts between types, presents patterns of variables which produce these types, and isolates variables which differ among types. This permits the construction of frameworks, generizations and hypotheses.

Cluster analysis is essentially an exploratory process of data pre-scanning. Consequently these methods do not offer homogeneous groupings which can be taken as absolute categories. Their function might be better analogized to topographical maps; analysis reveals the valleys and

peaks of the overall terrain in which the criteria for clustering act as the contour lines. Strick criteria will reveal only the peak tops while the relaxation of these criteria will produce larger clusters as lower levels of the map are encountered. As the criteria is reduced more and more of the hills are uncovered until valley bottoms have been reached. The output from cluster analysis can consequently be complex and subtle and perceptive interpretation of hills (clusters) and their differences gives the technique its value and power.

2. RELATIONSHIP OF THIS METHOD TO OTHER STATISTICAL PROCEDURES:

The research question thus becomes a search for significant patterns of relationships or co-occurences among the set of indicators. Those investigators who have asked this question have usually utilized the method of factor analysis. Since there exists a superficial similarity between clustering and factor analysis their distinctions should be clarified. In the attempt to organize a diversity of data, two approaches can be pursued.(1.) The method followed by Factor Analysis is to <u>simplify</u> the data to a few significant variables which reveal all the information embodied in the larger variable set. Cluster Analysis pursues the alternative by seeking to <u>classify</u> types which are considered to be ideal representations of the data.

Factor analysis attempts to define the units as functions of a set of new variables called factors which adequately express all of the relationships in the given matrix of correlation coefficients. Each factor in a weak sense can be called a type. The factor constraints require that each variable which defines a set of relationships between the sample units defines only those relationships and has negligible effect on the

others. A major difference between these methods is the fact that factor analysis simultaneously considers all the correlation coefficients while most forms of cluster analysis leave out those coefficients which fail to pass the cluster admission requirements until the admission requirements have been reduced to include these isolated units. Cluster analysis therefore has a tendency to exaggerate the degree of isolation of some units while factor analysis on the other hand over generalizes by placing all units in some factor. Factor analysis can tell only to which factor or type a unit belongs and how much it resembles an average representation of that group. Cluster analysis on the other hand yields much of the structure of group formation both within and between groups.

Cluster analysis begins with an attempt to define an index of similarity between all pairs of sample units. A profile of measurements is obtained for each sample unit and these are combined by some procedure to yield a similarity index for each pair. Clustering then seeks to determine, based on this similarity matrix, which sample units are closer to each other than to the remaining units. Most classification procedures require that the investigator have a clear picture of the characterizations of the sample population with which he is interested. There are times, however, when this can not be the case and the investigator wants the data itself to display the 'natural' subgroups inherent in the structure of profile measurements. The goal of cluster analysis therefore becomes the selection of subgroups or clusters from some internal criterion and the display of these classifications in some meaningful manner in order to lead insight for further classifications, to guide the selection of more meaningful data, as well as to aid hypotheses formation.

3. AREAS OF APPLICATION:

The fruitful areas of application are those in which a complex phenonmenon is often erroneously measured by a single variable due to the misunderstanding of the intricacy of the situation. The Council of Economic Advisors in 1964 defined the poverty level based solely on income criterion. Poverty is therefore defined as the homogeneous group of people who fall below the specified income level. Clearly poverty is not caused by a single factor but contains a multiple of interrelated factors which produce a variety of 'poverty types'. Poverty has no uniform label and consequently requires no uniform programs. It thus becomes essential for anyone concerned with directing social and/or economic change or with the provision, allocation, or evaluation of services to know and understand the various types of poverty which exist in the community. Cluster analysis provides an analytical framework to describe typologies of poverty and to analyze the structure and relationship of various factors which compose these types.

Occupational mobility can effectively be examined by cluster analysis. Often mobility is considered with no relation to other variables which might effect both the rate and degree of change. There is no economic escalator up and down, but a complicated system of income levels, educational attainments, ethnic backgrounds, age groupings, family structure, and sex. Contextual variables of metropolitan and local environment also have their effect. Cluster analysis could be employed to describe subgroups of mobility types and to demonstrate relationships among those factors which influence mobility at different occupational levels. Using Census statistics from the Current Population Survey and the major occupational categories, analysis could proceed on various levels. Basic cate-

gories could be redefined by clustering homogeneous subgroups under each occupational category. An alternative way to redefine the basic categories would be to run a cluster analysis on a population sample containing all occupational categories. Finally an analysis of inter- and intra- metropolitan Census data could determine comparative occupational mobility types.

Another problem area could be in the redefinition of the term ' community' . This ambiguous concept could be given substance by describing the relationships among factors which are community based. Some relevant measures would be housing conditions and patterns of ownership, employment measures, income levels, racial characteristics, and relevant population characteristics such as migration, age levels, family size, and educational levels. Cluster analysis would reveal fine grain homogeneous sub-community types and, with the use of time series data, would indicate areas undergoing rapid population or physical change.

4. REVIEW OF TYPES OF CLUSTER ANALYSIS:

A. CLUSTER SCHEMES

Cluster analysis is a 'new' statistical technique for analyzing the inherent structure in a given body of data. It is rather difficult to state how recent these procedures actually are although Geoffrey H. Ball (2.) in his coverage of clustering techniques states " that nearly all the techniques ... originated after 1960." This however does not appear to be the case as many investigators have applied these techniques dating back at least as early as R. C. Tryon in 1939. (3.) This misunderstanding is created by a lack of documentation and coordination of research efforts, and an absence of a single disciplinary sponsor such as occurred with the psychologists' promotion of factor analysis. There still are no relevant source books for cluster analysis and instead the investigator must resort to journal searching in such diverse fields as information theory, numerical taxonomy, and statistical psychology. (4.)

This study is concerned with the techniques defined by G. H. Ball as the clumping and clustering schemes. The essential difference is whether one defines what can be called a 'typical' or average measure of similarity demonstrated by the original data or whether one proceeds by measuring agreement between all pairs of sample units and allowing these measures to imply groupings. The clumping schemes create groupings by first defining a typicality measure or some method which selects multiple points to be considered as cluster centers. Members are admitted into the cluster if their admission improves the resulting cluster. "Typicality' and 'improve' can be defined in several ways but the basic aspect to clumping schemes is the search for cluster centers around which the clusters grow, combine, and split. The second category of techniques, the clustering schemes, begin by defining an agreement measure between all sample units

and forming clusters by applying a boundary limit to the agreement measures . These boundaries are lowered and a new iteration produces more and larger clusters until some maximum group number is achieved. The agreement matrix may or may not be recalculated each iteration. This study is concerned with the second category of cluster schemes since these procedures imply no foreknowledge of 'typicality' and instead precede to demonstrate what natural groupings occur within the data itself.

For the purpose of this discussion, clustering has been defined to mean the numerical evaluation of the similarity between two sample units and the ordering of these units based on their similarity into groups or clusters. There are a multitude of ways to define similarity and methods by which to order the units into clusters but the essential concepts remain constant. These are the definition of each sample unit by an n-dimensional indicator vector, an m by m matrix of similarity coefficients (where m is the size of the sample population), and a method by which to discover the structure of that matrix.

In all but the most trivial of cases, the calculations required by these methods will be repetitive and tedious requiring the use of a computer. Since all clustering procedures require extensive data manipulations on several n by n or m by n matrices , where m is the size of the sample population and n is the number of indicators, a data base of n and m = 2,000 entities is the maximun limit for core storage. There are alternative measures to deal with larger data bases but the implications and requirements for these will not be explored in this study.

B. DEFINITIONS OF SIMILARITY COEFFICIENTS:

All clustering techniques are based on an analysis of a similarity matrix. There are numerous procedures to define similarity and a compre-

hensive coverage of these techniques is offered in Principles of Numerical Taxonomy (5.) by R. R. Sokal and P. H. A. Sneath. A few of the methods are described below to demonstrate the diversity of choice in the operational definition of similarity. All methods assume that a profile of measurements has been obrained for each sample unit. References are made to the researchers who first used the specific coefficients in their studies.

Simple Matching: (6.)

Each measurement is binary coded, + for presence of attribute and - for its absence. A match measurement is defined as ++ or --, between sample unit i and sample unit j.

$$A_{i,j} = \frac{(\text{the number of matched measurements})}{(\text{the total number of measurements})}$$

The range of the coefficient is between zero and one.

A refinement of the matching coefficient is to let matches carry twice the weight of mis-matches. Its range is 0 to 1.

$$A_{i,j} = \frac{(\text{two times the number of matched measurements})}{(\text{two times the matches plus once the unmatched})}$$

Coefficient of Jacard or Similarity Coefficient: (7.)

Again a binary coding is assumed and the range of the coefficients is between zero and one.

$$A_{i,j} = \frac{(\text{the number of matches ++})}{(\text{the total number of matches ++ plus the mis-matches})}$$

Coefficient of Rogers and Tanimoto: (8.)

This method deal with measurements which have several states. Two measurements receive a + if they have the same state and a - if they do not. Each state is binary coded + or -.

$$A_{i,j} = \frac{(\text{ the total number of + matches })}{(\text{ the total number of character states with + in at least one sample unit})}$$

Coefficients of Correlation: Product -- Moment

This is used on data which has several states for each measurement and which may not be binary coded. Range is -1 to +1.

$$A_{i,j} = \frac{\sum_{k=1}^{n} (X_{k,i} - \bar{X}_i)(X_{k,j} - \bar{X}_j)}{\sqrt{\sum_{k=1}^{n} (X_{k,i} - \bar{X}_k)^2 \sum_{k=1}^{n} (X_{k,j} - \bar{X}_j)^2}}$$

where $\bar{X}_i$ = the mean of all measurements for unit i, and $X_{k,i}$ is the kth measurement for unit i.

(9.)

Average Mean Distance Measure:

This is used on multi-state data and its range is -1 to +1.

$$A_{i,j} = \frac{1}{n} \sum_{k=1}^{n} (X_{k,i} - X_{k,j})$$

(10.)

N-Dimensional Distance:

$$A_{i,j} = \left(\sum_{k=1}^{n} (X_{k,i} - X_{k,j})^2 \right)^{\frac{1}{2}}$$

This coefficient can be to be the average distance:

$$A'_{i,j} = (A_{i,j} / n)^{\frac{1}{2}}$$

Which coefficient is used by the researcher depends upon the data which is collected and the manner in which it is coded. Some data will be coded in discrete states while other data will have continuous quantitative measurements. Some of the coefficients displayed above are for discrete data while others are for continuous. Whatever the method used, the result is the production of an m by m Matrix $A_{i,j}$ of coefficients between each pair (i,j).

C. DEFINITIONS OF CLUSTER FORMATION:

The impetus behind ordering units according to their similarity measures comes from the reality that we can neither remember all of the indicators nor group the units according to these weakly remembered quantities. Consequently we need a method with which to demonstrate the similarity groupings. The resultant groupings carry a high quality of predictability for if one is given a member who can be assigned to a particular grouping on the basis of several known indicators, one can then predict what the other indicators might be.

Classification schemes have traditionally been of the form which classify units based first on one attribute and then another until the set of units has been exhausted. Systems of this form are commonly encountered in library cateloging. Here we are going to clasify units based on all of the n-attributes simultaneously. Thus in searching our matrix of similarity coefficients we are looking for gaps in the n-dimensional patterns of indicators which we will consider to be boundary lines for our groupings.

Since Sneath and Sokal (11.) offer a comprehensive coverage of cluster formations, only a few of the more diverse methods are described below. Reference is made to research employing these techniques.

SINGLE LINKAGE: (12.) This method clusters those units which are most similar (i.e. demonstrate the highest similarity coefficient) and admits new members to each cluster by subsequently reducing the similarity criterion. The admission into the cluster is called single linkage because similarity to one of the units in the given cluster is criterion enough to allow the unit under question to be admitted to the cluster. This

produces clusters of long chains where unit A is related to Unit B and unit B is related to unit C and they all are members of cluster X. Membership in the same cluster does not imply that members are necessarily related.

(12)
COMPLETE LINKAGE: This method, which is similar to the single linkage technique, requires that admission to a cluster be based on the relatedness to all the existing members of the cluster. Only one unit is allowed to join a cluster at one time. When groups overlap, the clusters are fused to form one group. Fusion can be defined in several ways, the simpliest being the Boolean operations of union and intersection. Complete techniques usually require recomputing the similarity matrix after each cluster admission has been made. The clusters in this method are tight clumps of interrelated units.

(13.)
CLUSTERING BY AVERAGE LINKAGE: The admission requirement in this method is based on an average similarity with all of the members of the cluster. The admission criterion is weakened by gradually lowering the level of the average similarity. Many units may join a given cluster at a given time. Once all units passing the admission requirements have been admitted into the cluster, the similarity matrix of all clusters and single units is recalculated.

(14.)
NODAL CLUSTERING: This method proceeds by first calculating for each unit i a sum T_i which is a count of all the positive similarity coefficients unit i has with all of the other units. This means all units with which i has at least one indicator or attribute in common. Next the product H_i is computed for all units i equal to the product of all similarity coefficients with unit i as one member. The higher the value of H_i,

the more typical the unit i. The next step is to rank all units according to T_i. If a tie occurs then the units are ranked according to H_i. The unit with the highest T_i and H_i is considered the prime node. All units having a high similarity coefficient with the prime node form a cluster. A second node now has to be found. The unit with the next highest T_i and H_i and is not included in the cluster around the prime node is considered to be the second node. The units are admitted to a cluster formed around the prime node one at a time, with the closest units being considered first. After each admission the resulting cluster is tested for inhomogeneity. When there is a considerable jump in the value of inhomogeneity, the 'natural' boundaries of the prime cluster have been exceeded and the cluster is closed. The units belonging to this cluster are removed from the study and new primary and secondary nodes are produced from the remaining sample. This set of steps is repeated until all units join clusters or only a few residuals remain.

5. THE METHOD:

A. THE STATISTICAL MODEL:

A clustering technique developed by Cattell and Coulter (15.) has been programmed on the Computer-Time-Sharing-System at MIT and has the generic name of CLUSTER. This method was picked over the other procedures because it seems to embody the most sophisticated similarity measures and in particular operationally defines what is meant by the various concepts of 'type'. This latter point is often the cause of much research confusion and nowhere has received such explicit description. A final point which guided the selection of this method is the fact that it simultaneously forms all clusters instead of the more common iterative methods. The price that is paid for this simultaneity is the necessity of keeping several different copies of n by m matrices in core storage. (where n is the size of the sample population and m is the number of measurements on each unit) The strains placed on core storage greatly limit the size data base under consideration. The advantage of simultaneity is the production of a unique set of clusters for each boundary level which offers a greater power of interpretation. Iterative techniques require the additional choice of the 'best' of several cluster sets.

A theoretical discussion of the Cattell and Coulter technique is presented below in order to clarify the concepts embodied in the technique as well as describe the effect and importance of each question that has to be answered by the investigator. The program and general flowcharts are also included.

The definition of 'type' is essential to this study and hence we must begin our discussion by offering a vague meaning for 'type' and proceed to clarify it with operational definitions. We tentatively define 'type'

to mean the most representative groups from a given set of sample units. These groups can be formed in two ways. Either they are a set of units which demonstrate a high mutual similarity or they are units, albeit remote from each other, that demonstrate less remoteness from each other than from units outside the group. These two types will be referred to as space-type, meaning close similarity within n-dimensional space, and related-type, meaning closely related to one another through other members but not necessarily through space similarity. Cattell and Coulter refer to these two types as 'homostat' and 'segregate' respectively because of the psychological intent of their research. In discussing other clustering techniques, it is wise to keep these two definitions of type in mind. The method of Cattell and Coulter was selected for this study because of the clarity between the two definitions and the added power of the method in enabling the researcher to see both type formations. It is felt that other methods are neither clear in their intent or results with respect to which definition of type they are most concerned with if indeed they are aware of the discrepancy.

The primary purpose of this study is to apply to an n-dimensional set of indicators the method of Cattell and Coulter to identify space- and related-types. Secondly, as far as the interpretation of results is concerned, the goal of any system of classification is to display distinct characteristics of members within a type as opposed to outside the type for the sake of applying 'tests' or forming policies which may be quite uniquely designed for within-type application and be non-applicable to between-types.

The type formation will produce three sets of variables which will have to be further analyzed. These will be within type variables,

between type variables and across the whole range of sample unit variables. These variable classes will be analyzed further by implying higher order structures within the data referred to as texture and hierarchies.

The first procedure in this clustering technique, after having obtained a profile of n-measurements or indicators for each sample unit, is to define a resemblance index between each pair of units. We use the profile similarity coefficient R_p attributed to Cattell.(16.)

$$R_p = \frac{2K_m - \sum_{i=1}^{n} D_{i,j}}{2K_m + \sum_{i=1}^{n} D_{i,j}}$$

where n = the number of measurements for each unit

$D_{i,j}$ = the difference between the standard scores of two sample units i and j on any one measured indicator.

K_m = the median χ^2 value for k degrees of freedom.

It is to be noted that when n = 20, Km = 19.337 and consequently if the number of indicators is larger than 20, the value of n may be used instead of K_m without introducing significant error. The values of R_p range between -1 and +1, registering +1 when the two sample units are entirely similar, -1 when they are absolutely unlike each other, and 0 when the relation is no better than chance. One very significant contribution of the measure R_p is the fact that it allows the use of different numbers of measurements, n, without losing comparability between studies. Furthermore the differences between measured indicators are reduced to the differences between standard scores implying that again comparability is maintained between studies. It should be noted that this similarity measure gives equal weights to all measured indicators and linear combinations of squared differences $D_{i,j}$.

The next step of the procedure is to establish a boundary to R_p defining a circle within which two sample units will be considered to be similar. Call this a significance level. Its range, of course, will be 0 to +1 since less than 0 implies less than chance similarity and therefore must be discounted. Cattell and Coulter remind us that if the R_p boundary is well chosen then for most pairs of sample units, no more than two will fall into the same circle. Since this level is critical to the boundary centers of space-types, it is important to wisely select the significance level. Some studies will dictate the level of significance by predetermining the number of units desired in each cluster formation. A suggestion in the Cattell and Coulter approach is to take the mean of the positive R_p's as the initial significance level. Another suggestion is to run tests on three standard levels of $R_p = 0.2$, 0.5, and 0.8 to provide an adequate description of all type formations. Some note should also be taken to the fact that types with a large number of members imply a dense space rather than greater typicality since all cluster boundaries are the same once R_p has been established. Since the significance level can be changed, revealing different space-type formations, the space-types have no property of uniqueness with respect to boundary lines or cluster centers. This uniqueness characteristic is assigned to related-types alone. The analysis of space-types is consequently complex when it is understood that these types can overlap and that units belonging to separate related-types can occur in the same space-type.

The complexity of space-types requires a further refinement into phenomenal and nuclear clusters. Phenomenal clusters are formed by grouping all units which mutually satisfy the significance level and hence are linked together to form homogeneous groupings. Nuclear clusters are based

on phenomenal clusters with the additional property that they are the overlaps between two or more phenomenal clusters. Orders of nuclear types are introduced when the number of general types involved in the overlap is introduced. (i.e. a nuclear cluster that is a member of three phenomenal clusters has higher order than a nuclear cluster which is a member of only two phenomenal clusters.) One must note that nuclear types as well as phenomenal types are a function of the significance level. Phenomenal clusters are so named because they are directly implied by the data while nuclear clusters are not inherently obvious but are the result of phenomenal cluster operations.

At this point the concept of texture can be explained as the number of phenomenal clusters at different sizes and the number of nuclear clusters at different overlap counts for the range of significance levels tested. Texture thus defines the number of clusters occurring in large and small groups and the degree of overlap among large and small groups.

The next procedure is to define related-types. Utilizing the space-type formations the search is made for larger masses of units which separate one clump of units from another more than the space-types do. Remember that the first and last members added to a related-type may be very different from one another, being related only through mutual units. A significance level must be assigned to the number of overlaps deemed acceptable evidence of relatedness. Usually an overlap of two or three is acceptable. Related-types are formed by combining all phenomenal clusters which satisfy the overlap criterion. (i.e. nuclear clusters greater than two members) The combination operation is Boolean addition. (intersection)

The interpretation of this statistical analysis will describe

types and the texture of the domain of study. Clusters can occur in small or large, sparce or densely populated clumps, evenly spaced along a continuum or overlapped and linked at various centers. The analysis can be compared with respect to the structures revealed at different cutting levels, the ratio of nuclear to general cluster types and the degree of compactness of related-types. Compactness being defined as the ratio of the total number of links in a type to the total number possible.

B. PRACTICAL CONSIDERATIONS:

The variables or indicators considered must be adequate measurements of the elements expected to vary among the sample units. Principles guiding the choice of the set of variables must be developed so that the data does not contain redundant measures but includes all relevant information. Pre-analysis of the data should reveal composite indicators that define highly correlated sets of measures. The elimination of redundant measurements naturally reduces data manipulations. The data must next be given numerical scores; this procedure often appears arbitrary but must be reduced to some systematic method. The next decision must consider whether the data should be standardized.

The next step in preparing the data is to decide whether all indicators will receive equal weight. Unequal weightings often have negligible effect. Weighting systems, where appropriate, must be devised, and further study is needed in this area. If weightings B_i are assigned to each indicator then the similarity coefficient R_p must be changed to R_p'.

$$R_p' = \frac{2K_m - \sum_{k=1}^{n} B_i D_{i,j}}{2K_m + \sum_{k=1}^{n} B_i D_{i,j}}$$

Measures of similarity must next be assigned to all pairs of entities in the sample. The similarity coefficients are arranged in an m by m matrix where m equals the number of sampling units considered.

A system to determine the level at which similarity coefficients are considered significant must be devised. This level should be allowed to run the range from high to low, thus enabling the analyst to view contours that yield the peaks of hills as well as floors of valleys.

Having established a significance criterion, one must then generate all clusters by linking pairs of units who mutually satisfy the significance criterion. The final steps of the technique determine what number of elements in a cluster are relevant and discard anything less than these. Usually clusters with less than three elements are thrown away. The next consideration determines all overlaps between clusters and the size of the overlap as a percentage of the sample. It also determines the group size frequency distribution, that is the number of groups of a given size as a percentage of the total number of groups. Finally, larger and more loosely structure groups can be determined from overlaps which are thought to be significantly large.

The final result of cluster analysis is the display of types within group variables and between group variables, and their distribution across the whole population. It is at this point that the significance criterion of similarity coefficients is relaxed and another clustering at a looser level is produced. Relaxation of this criterion is reduced until all entities form one cluster or until the level approaches the 'no better than chance ' zone.

C. THE PROGRAM:

CLUSTER is programmed in the MAD language on CTSS. It presently accepts a data base of 93 sample units each of which have 45 measurements. The size of the data base can be altered by changing the dimension statements of all arrays. The investigator must also change the level of of two significance tests S0 and S1.

CLUSTER consists of four separate subroutines AGREE, TEST, TYPE, AND REORD. The routine AGREE accepts the raw data and standardizes each score before computing an agreement coefficient for each pair of sample units. The routine TEST turns the agreement matrix into an incidence matrix by testing each agreement entry against a signficance level S0. If the agreement coefficient is greater than the significance level S0 then the matrix entry is marked 'true', otherwise the entries are marked 'false'. The routine TYPE forms all linkages between sample units from the incidence matrix. By forming a new incidence matrix of linkages and squaring it, TYPE then tests the results against the original incidence matrix of linkages. If no new elements can be added to the linkage matrix then TYPE is completed, if new elements can be added then a new linkage matrix is formed and TYPE goes through the matrix multiplication and testing procedures until no new elements can be produced. The REORD routine takes the finished linkage matrix and ranks the clusters (i.e. columns) according to the number of entries in each column. Each column of the reordered matrix contains a separate <u>space-type</u> formation. REORD then forms a matrix of nucleus clusters by counting all overlaps that occur in the matrix of <u>space-types</u>. After establishing the level of significance S1 for overlaps, REORD forms <u>related-type</u> clusters by adding all columns of the reordered linkage matrix that have at least one element in common. All subsets and equivalent columns are removed from the matrix of <u>related-types</u>.

```
        R COMPUTE MEAN AND STANDARD DEVIATION FOR EACH CHARACTER
        R THEN COMPUTE THE AGREEMENT MATRIX USING RESEMBLANCE COEF.
         D'N DATA(4185,G),SD(45),MC(45),T(45),A(8649,GG)
         D'N FDATA(4185,G)
         V'S GG=2,1,93
         V'S G=2,1,45
         I'R I,J,K,L,M,N
         I'R DATA
         EQUIVALENCE (FDATA,DATA)
         EXECUTE READP.
         F'E M,L
         M=93
         L=45
         LL=45.
         THROUGH J1, FOR J=1,1,J.G.L
         T(J)=0.
         THROUGH J2, FOR I=1,1,I.G.M
         W'R (DATA(I,J).G.0), T(J)=T(J)+1.
J2       C'E
J1       C'E
         THROUGH I1, FOR J=1,1,J.G.L
         S=0.
         SS=0.
         THROUGH I2, FOR I=1,1,I.G.M
         S=S+DATA(I,J)
         SS=SS+(DATA(I,J)).P.2
I2       C'E
         MC(J)=S/T(J)
         SD(J)=.ABS.(SQRT.(.ABS.((SS-(S.P.2)/T(J))/(T(J)-1.))))
I1       C'E
         THROUGH I3, FOR J=1,1,J.G.L
         THROUGH I4, FOR I=1,1,I.G.M
I4       FDATA(I,J)=( DATA(I,J)-MC(J))/SD(J)
I3       C'E
         THROUGH I5, FOR I=1,1,I.G.M
         SS=0.
         A(I,I)=1.
         THROUGH I6, FOR J=I+1, 1,J.G.M
         THROUGH I7, FOR K=1,1,K.G.L
I7       SS=SS+(FDATA(I,K)-FDATA(J,K)).P.2
         A(I,J)=(2.*LL-SS)/(2.*LL+SS)
         SS=0.
I6       A(J,I)=A(I,J)
I5       C'E
         N=5
         WRITE BCD TAPE N, FRR, A(1)...A(8649)
         V'S FRR=$12F8.6*$
         REWIND TAPE N
         N=10
         WRITE BCD TAPE N, FRM, FDATA(1)...FDATA(4185)
         V'S FRM=$ 9F10.6*$
         REWIND TAPE N
         I'N
         E'O READP.
         N=4
         READ BCD TAPE N, FMT1, DATA(1)...DATA(4185)
         REWIND TAPE N
         V'S FMT1=$45I1,S39*$
         E'N
         E'M
```

```
M6409        5459        TEST        MAD FOR   M6409        5459        082
R TEST MATRIX OF AGREEMENT COEFFICIENTS AGAINST A SIGNIFI-
R CANCE LEVEL SO TO FORM BOOLEAN MATRIX Q
          D'N A(8649,GG), Q(8649,GG)
          V'S GG=2,1,93
          B'N Q
          F'E M
          PRINT COMMENT $     SO =.2 $
          I'R I,J,N,M
          M=93
          N=5
          SC=0.2
          READ BINARY TAPE N, A(1)...A(8649)
          REWIND TAPE N
          THROUGH K1, FOR I=1,1,I.G.M
          THROUGH K2, FOR J=1,1,J.G.M
          Q(I,J)=0B
           W'R (A(I,J).G.SO), Q(I,J)=1B
K2        C'E
K1        C'E
          N=6
          WRITE BCD TAPE N,FMT1, Q(1)...Q(8649)
          V'S FMT1=$93I1*$
          REWIND TAPE N
          E'M
```

```
M6409        5459        TYPE        MAD FOR   M6409        5459        082
            R MAIN PROGRAM
            D'N Q(8649,GG),G(8649,GG),S(93),B(100,DD)
            V'S DD=2,1,2
            V'S GG=2,1,93
            R CHANGE DIMENSIONS, N=, AND  M= FOR EACH DATA SET
            B'N EEQV.,SING.,MATCH.,BOOLM., COMP.
            B'N Q,G,S,P,GT
            I'R M,N,I,J,K,L,X,LL,C,II,T,JP, KK, B,SL,SLL,TT
            M=93
            C=93
            N=6
            READ BCD TAPE N,FR1, Q(1)...Q(8649)
            V'S FR1=$93I1*$
            REWIND TAPE N
            F'E C,LL,L,SLL
            TT=0
            LL = 0
            EXECUTE LINK.(G)
            EXECUTE MULT.
T2          W'R (TT .E.0), T'O T1
            SLL=LL
            READ BCD TAPE N, FR1, Q(1)...Q(8649)
            REWIND TAPE N
            EXECUTE MULT.
            W'R (LL .E. SLL), T'O T1
            T'O T2
T1          N=7
            PRINT COMMENT $   FINISHED LINKAGE MATRIX ON .TAPE. 7 $
            WRITE BCD TAPE N, FR2, LL, G(1)...G(8649)
            V'S FR2=$I3/93(93I1/)*$
            C'E
            I'N (G)
            E'O LINK.
            I = 1
J2          EXECUTE COUNT.(II)
            W'R (1.G.II), T'O JJ1
            T=1
            THROUGH J1,FOR JP=1,1,JP .G.II
            J=1
            THROUGH I1, FOR K=1,1,K.G.M
I1          S(K)=0B
K4          W'R (Q(I,J)),T'O K6
K5          J=J+1
            W'R J .LE. M, T'O K4
            EXECUTE STORE.(S)
J1          C'E
JJ1         I=I+1
            W'R I .LE.M,T'O J2
            F'N
K6          S(J) = 1B
            W'R SING.(S), T'O J3
            W'R EEQV.(Q,S), T'O K5
            S(J)= 0B
            T'O K5
J3          W'R ((JP - T).E.0), T'O K5
            T=T+1
            S(J)=0B
            T'O K5
            END OF FUNCTION
```

```
          I'N (Q,S)
          E'O EEQV.
          THROUGH K7, FOR X=1,1,X.G.M
          W'R S(X) .THEN. Q(X,J), T'O K7
          F'N OB
K7        C'E
          F'N 1B
          END OF FUNCTION
          I'N (S)
          E'O STORE.
          W'R SING.(S), T'O K8
          W'R LL.E.0, T'O K9
          W'R MATCH.(S,LL),T'O K8
K9        LL =LL+1
          THROUGH I2, FOR K=1,1,K.G.M
I2        G(K,LL)=S(K)
          PRINT COMMENT $      NEW LINKAGE VECTOR S(K)$
          P'T MTX1, S(1)...S(K)
          V'S MTX1=$S5, 'C'I1*$
K8        C'E
          F'N
          END OF FUNCTION
          I'N (S)
          E'O SING.
          X=0
          THROUGH K11,FOR K =1,1,K.G.M
          W'R (S(K)),X=X+1
          W'R X.G.1,T'O K12
K11       C'E
          F'N 1B
K12       F'N OB
          END OF FUNCTION
          I'N (S,LL)
          E'O MATCH.
         R REMOVES SUBSETS AND EQUIVALENTS
          THROUGH K14,FOR K = 1,1,K.G.LL
          THROUGH K13,FOR KK= 1,1,KK.G.M
          W'R S(KK) .THEN. G(KK,K), T'O K13
          T'O K14
K13       C'E
          F'N 1B
K14       C'E
          F'N OB
          E'N
          I'N (II)
          E'O COUNT.
          II=0
          THROUGH J4,FOR K=1,1,K .G. M
          W'R Q(I,K).E.1B, II=II+1
J4        C'E
          II=II-1
          F'N
          E'N
          I'N
          E'O MULT.
         R SET TEMPORARY M,C
          L=1
LP1       THROUGH M3,FOR I=1,1,I.G.M
          THROUGH M4, FOR J=1,1,J.G.LL
         R CO ROW BY ROW G(I,J) * G(J,I)
          W'R BOOLM.(I,J), T'O M5
```

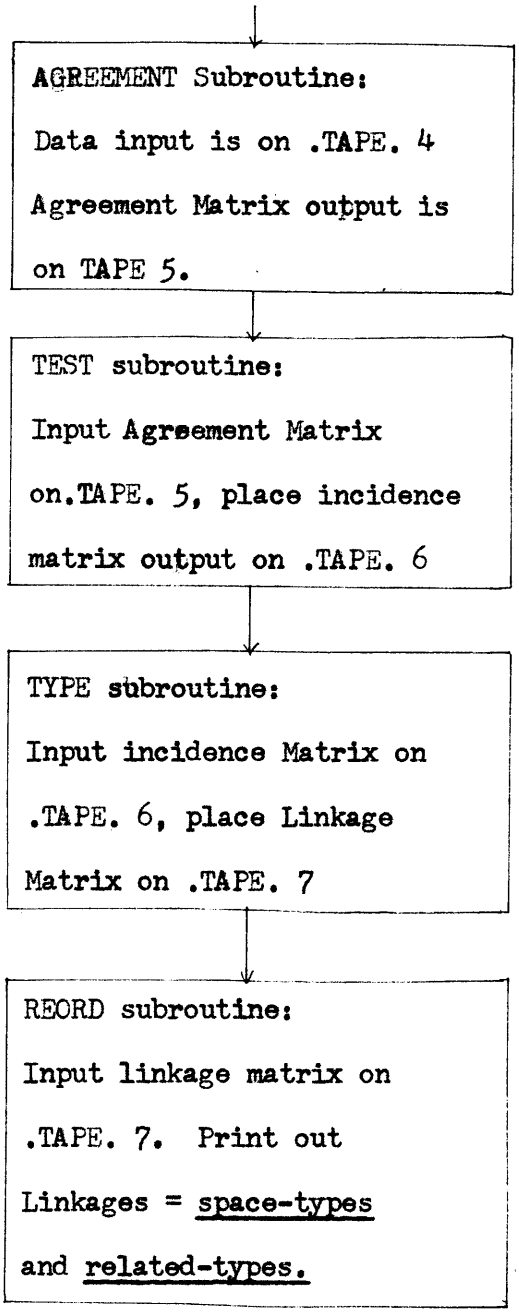
```
                S(J) = 0B
                T'O M4
M5              S(J)=1B
M4              C'E
                THROUGH M6, FOR K = 1,1,K.G.M
                W'R I .E. K, T'O M7
                W'R (Q(I,K) .THEN. S(K)), T'O M7
                B(L,1)=I
                B(L,2)=K
               R #'S CONTAIN INDICES OF DISAGREEMENT
                L=L+1
                SL=L
M7              C'E
M6              C'E
M3              C'E
                W'R L .E.1, F'N
                PRINT COMMENT $B VECTORS$
                L=L-1
                P'T MTX2, B(1,1)...B(L ,2)
                V'S MTX2 = $S5,2I3*$

                W'R .NOT.(COMP.(G,Q)), F'N
                SL=L
                L=1
                THROUGH L11, FOR I=1,1,I.G.SL
                B(I,1)=0
L11             B(I,2)=0
                SL=0
                F'N
                E'N
                I'N (I,J)
                E'O BOOLM.
                THROUGH M1, FOR K=1,1,K.G.LL
                W'R (G(I,K) .AND. G(J,K)), T'O M2
M1              C'E
                F'N 0B
M2              F'N 1B
                E'N
                I'N (G,Q)
                E'O COMP.
                W'R (1.G.L), T'O L14

                THROUGH L4, FOR I=1,1,I.G.M
                THROUGH L5,FOR K=1,1,K.G.L
                W'R B(K,1).E.I, T'O L6
L5              C'E
                THROUGH L7, FOR J=1,1,J.G.M
L7              Q(I,J)=0B
                T'O L4
L6              THROUGH L8, FOR J=1,1,J.G.M
                THROUGH L9, FOR K=1,1,K.G.L
                W'R B(K,2).E.J, T'O L8
L9              C'E
                Q(I,J)=0B
L8              C'E
L4              C'E
                THROUGH LL9, FOR I=1,1,I.G.M
LL9             Q(I,I)=1B
                TT=TT+1
                F'N 1B
L14             TT=0
                F'N 0B
                E'N
```

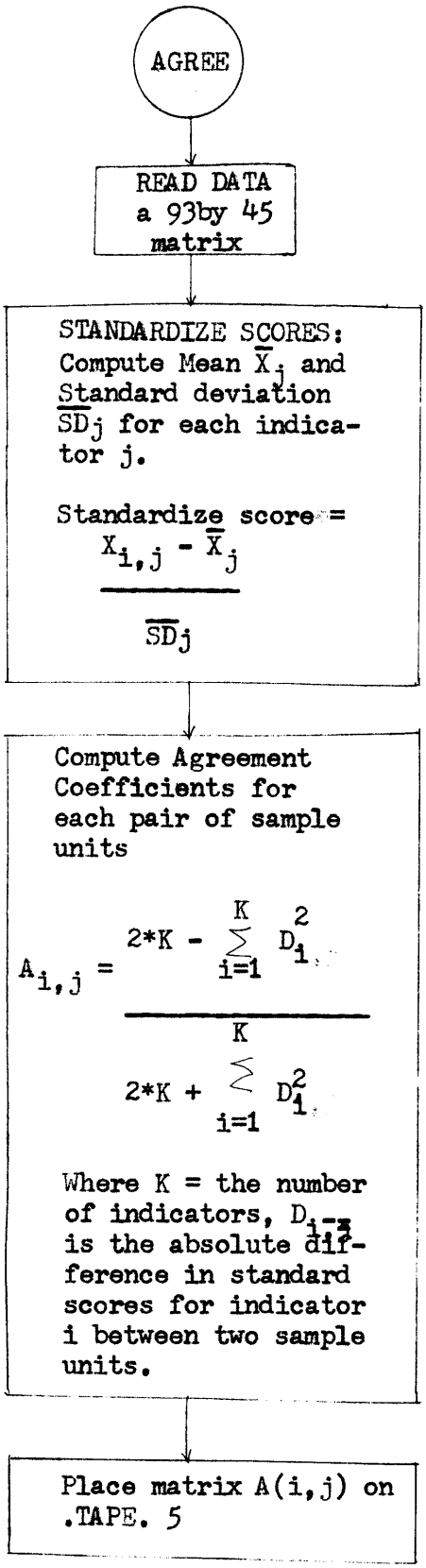
```
M6409      5459      REORD      MAD FOR  M6409      5459      082
          R SEPARATE PROGRAM REORD
           D'N G(8649,GG),Q(8649,GG),IQ(8649,GG),A(93),S(93)
           V'S GG=2,1,93
           EQUIVALENCE (G, IQ)
           B'N ZERO.
           B'N G, IQ, A
           F'E LL,SLL
           I'R I,J,K,L,M,N,NN,LL,SLL,NJ,Q,S1,D
           N=7
           READ BCD TAPE N, FR1, LL,G(1)...G(8649)
           V'S FR1=$I3/,93(93I1/)*$
           REWIND TAPE N
           M=93
           SLL=LL
           THROUGH J7, FOR J =1,1,J.G.LL
           EXECUTE COUNT.
J7         C'E
           THROUGH J3, FOR J=1,1,J.E.LL
J4         W'R S(J).GE. S(J+1), T'O J3
           D=S(J)
           S(J)=S(J+1)
           S(J+1)=D
           THROUGH J5, FOR I=1,1,I.G.M
           A(I)=G(I,J)
           G(I,J)=G(I,J+1)
J5         G(I,J+1)=A(I)
           W'R J.LE.1, T'O J3
           J=J-1
           T'O J4
J3         C'E
           PRINT COMMENT $ REORDERED MATRIX$
           N=9
           WRITE BCD TAPE N, FR1, LL, G(1)...G(8649)
           REWIND TAPE N
           THROUGH JJ6, FOR I=1,1,I.G.M
JJ6        P'T MTX3, G(I,1)...G(I,LL)
           EXECUTE PCLUS.
           N=8
           WRITE BCD TAPE N,FR1,LL, IQ(1)...IQ(8649)
           REWIND TAPE N
           I'N
           E'O COUNT.
           THROUGH J6, FOR I=1,1,I.G.M
           W'R G(I,J) .EQV. OB, T'O J6
           S(J)=S(J)+1
J6         C'E
           F'N
           E'N
           I'N
           E'O PCLUS.
          R FORM Q(I,J) WHERE ENTRIES ARE NUMBERS OF ARGU
          R MENTS BETWEEN CLUSTERS I AND J
          R MENTS BETWEEN CLUSTER I AND CLUSTER J
          R DIMENSIONS OF Q ARE LL BY LL
           LL=SLL
           THROUGH I1, FOR J=1,1, J.G.LL
           THROUGH I2, FOR K=J,1,K.G.LL
           D=0
           THROUGH I3, FOR  I=1,1,I.G.M
           W'R .NOT.(G(I,J).AND.G(I,K)), T'O I3
```

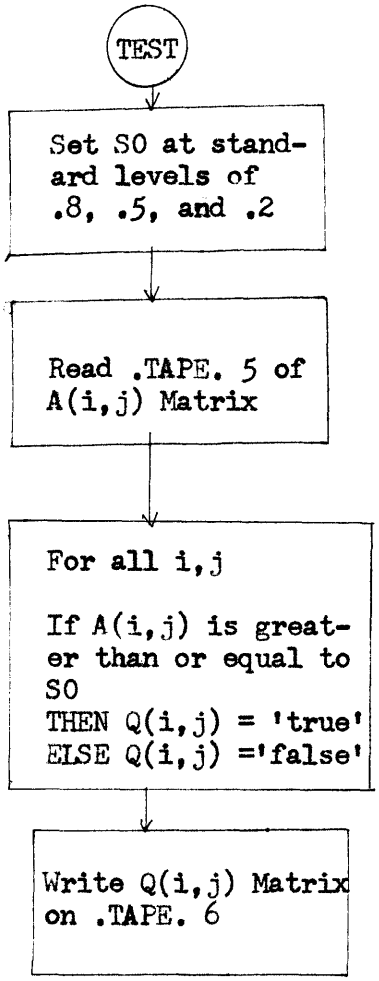
```
          C=D+1
I3        C'E
          Q(K,J)=D
          Q(J,K)=D
I2        C'E
I1        C'E
          PRINT COMMENT $  MATRIX OF NUCLEUS COUNTS$
          THROUGH II6, FOR I=1,1,I.G.LL

II6       P'T MTX3, Q(I,1)...Q(I,LL)
          V'S MTX3=$S5,'LL'I1*$
         R DIAGONALS OF Q ARE THE NUMBER OF ELEMENTS IN
         R THE CLUSTER I
         R SET CUTOFF LIMIT S1 FOR PCLUSTERS
         R S1 IMPLIES THE NUMBER OF OVERLAPS WHICH WILL FORM SEGREGATES
          S1=1
          THROUGH I4, FOR I=1,1,I.G.LL
          THROUGH I5, FOR J=I,1,J.G.LL
          W'R Q(I,J).GE.S1, T'O I6
          IQ(I,J)=0B
          IQ(J,I)=0B
          T'O I5
I6        IQ(I,J)=1B
          IQ(J,I)=1B
I5        C'E
I4        C'E
          PRINT COMMENT $ PCLUSTER MATRIX$
          THROUGH II7, FOR I=1,1,I.G.LL
II7       P'T MTX3, IQ(I,1)...IQ(I,LL)
         R FORM SEGREGATES
          THROUGH I8, FOR J=1,1,J.G.LL
          THROUGH I7, FOR K=J+1,1,K.G.LL
          W'R (.NOT.(ZERO.(J,K))),T'O I7
          EXECUTE BADD.(J,K)
I7        C'E
I8        C'E
         R REMOVE SUBSETS AND EQUIVALENTS FROM IQ(LL,LL)
         R IQ MATRIX BECOMES IQ(SLL,LL)
          SLL=LL
          THROUGH I11, FOR J=1,1,J.G.LL
          THROUGH I12, FOR K=J+1,1,K.G.LL
          THROUGH I13, FOR I=1,1,I.G.SLL
          C=0
          W'R .NOT.(IQ(I,J).THEN.IQ(I,K)), T'O I14
I13       C'E
          D=2
I14       THROUGH I15, FOR I=1,1,I.G.SLL
          W'R .NOT.(IQ(I,K).THEN.IQ(I,J)), T'O I16
I15       C'E
          D=D+1
         R IF D=0 DELETE NOTHING, IF D=1, DELTER COLUMN K, IF D=2 DELET
         R COLUMN J, IF D=3 DELETE EITHER K OR J
         R CONDENSE THIS SO THAT IF D IS GE. 2 THEN DELETE J
I16       W'R (D.E.1).OR.(D.E.3)
               D=K
          C'R (D.E.2)
               D=J
               K=J+1
          O'R (D.E.0)
               T'O I12
          E'L
```

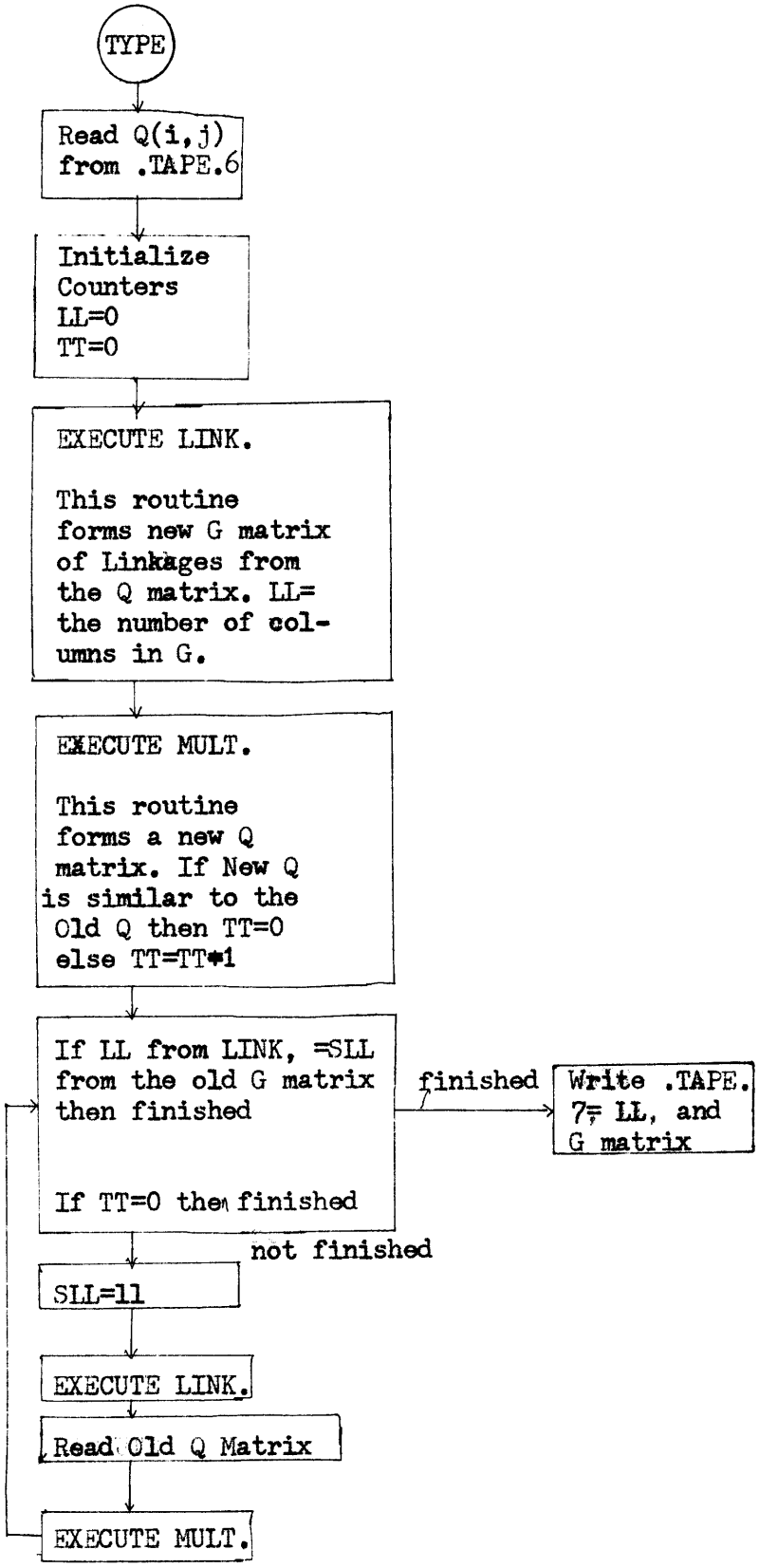
```
            THROUGH I17, FOR L=D,1,L.E.LL
            THROUGH I18, FOR I=1,1,I.G.SLL
I18         IQ(I,L)=IQ(I,L+1)
I17         C'E
            LL=LL-1
            K=K-1
I12         C'E
I11         C'E
          R COLUMNS WITH CNLY ONE ELEMENT COULD BE REMOVED
            P'T MTX4, SLL, LL
            V'S MTX4=$ S2, 5HROWS=I2, S3, 8HCOLUMNS=I2*$
            PRINT COMMENT $COMPLETE SEGREGATES$
            THROUGH III, FOR I=1,1,I.G.SLL
III         P'T MTX3, IQ(I,1)...IQ(I,LL)
            F'N
            E'N
            I'N (J,K)
            E'O ZERO.
            THROUGH I9, FOR I=1,1,I.G.LL
            W'R (IQ(I,J).AND.IQ(I,K)), F'N 1B
I9          C'E
            F'N OB
            E'N
            I'N (J,K)
            E'O BADD.
            THROUGH I10, FOR I=1,1,I.G.LL
I10         IQ(I,J)=IQ(I,J).OR.IQ(I,K)
            F'N
            E'N
            E'M
```

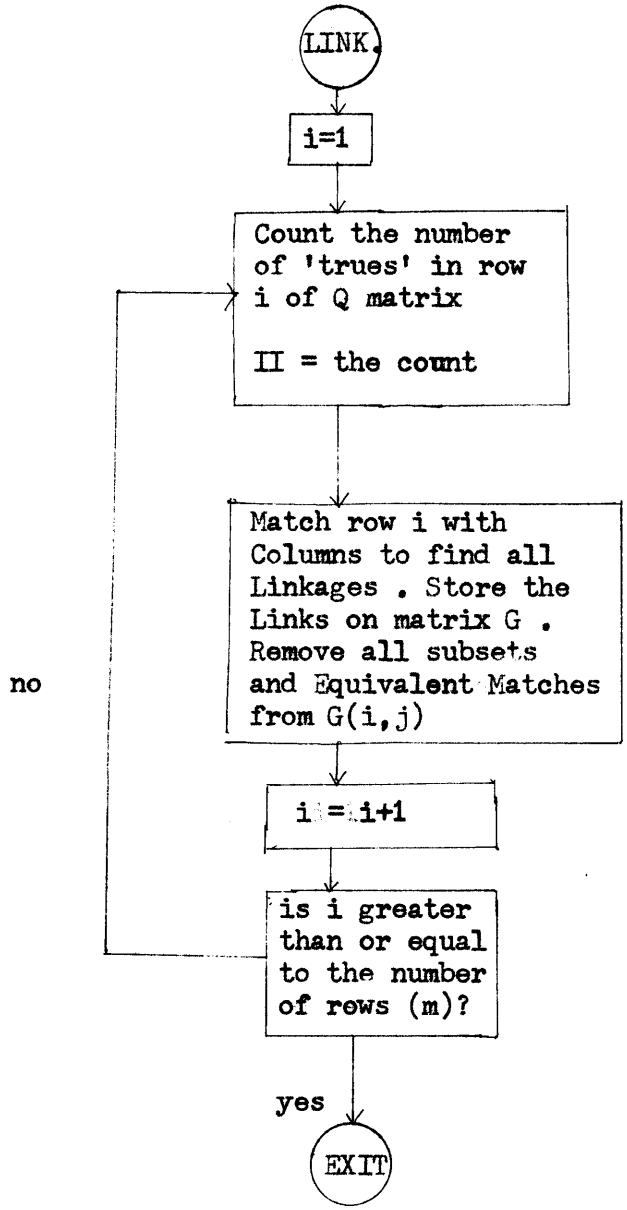
D. GENERAL FLOWCHARTS:

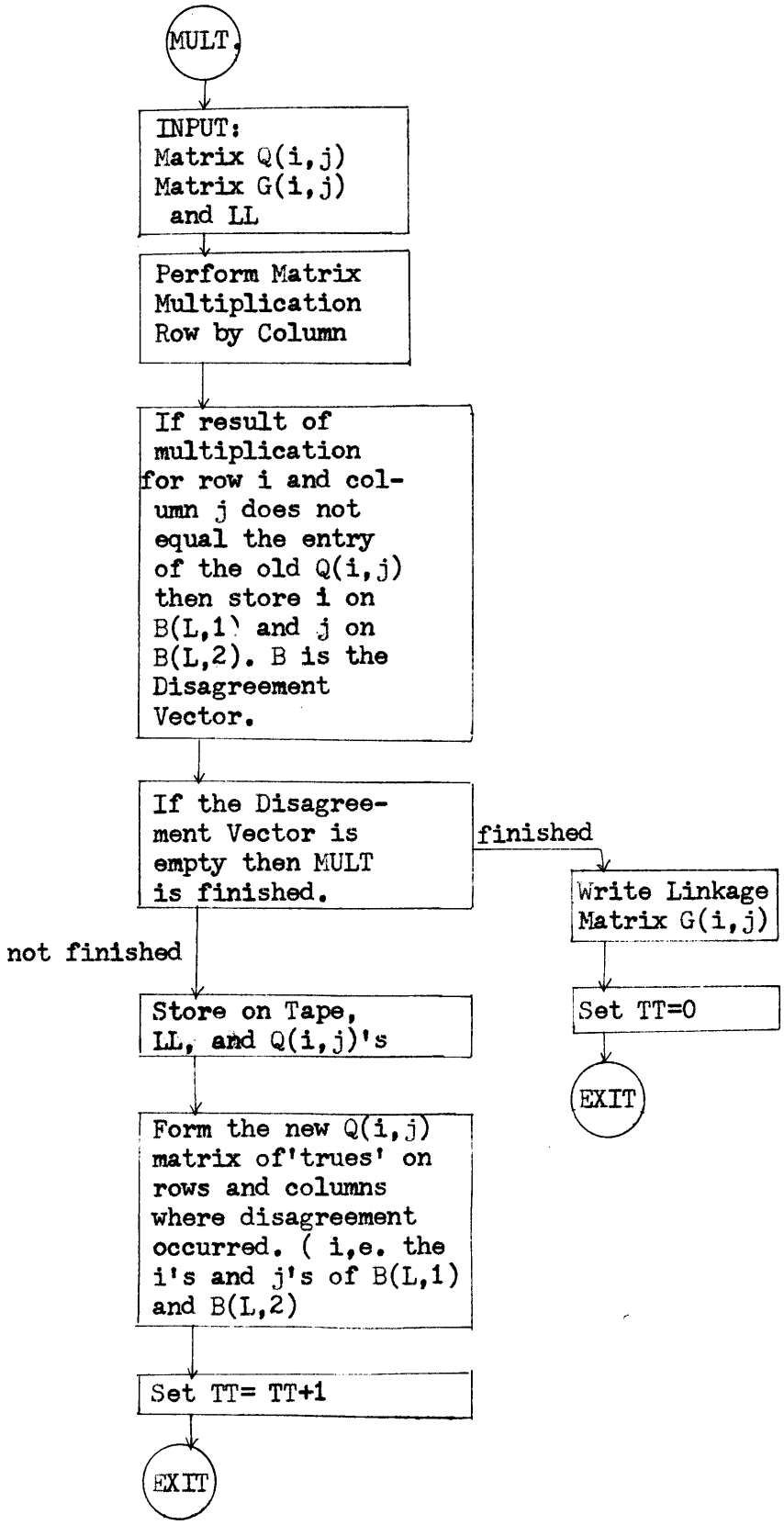


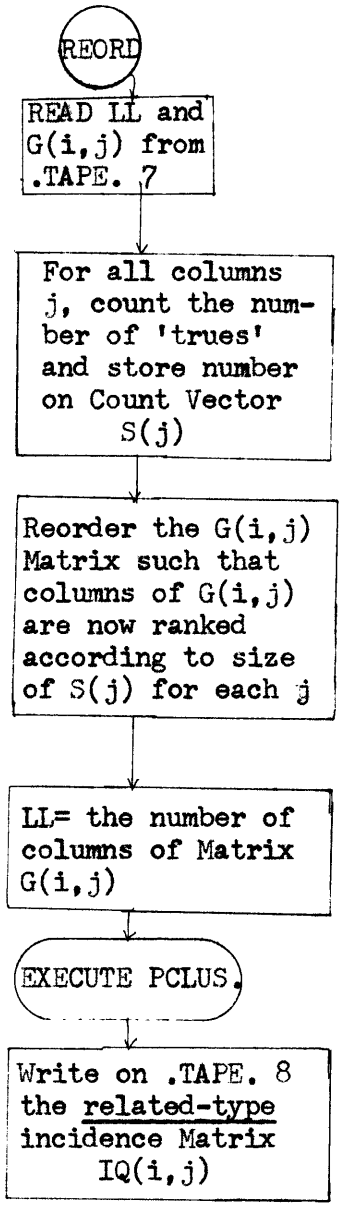

AGREE
READ DATA a 93by 45 matrix
STANDARDIZE SCORES: Compute Mean $\overline{X}_j$ and Standard deviation $\overline{SD}_j$ for each indicator j.
Standardize score = $\frac{X_{i,j} - \overline{X}_j}{\overline{SD}_j}$
Compute Agreement Coefficients for each pair of sample units
$A_{i,j} = \frac{2*K - \sum_{i=1}^{K} D_i^2}{2*K + \sum_{i=1}^{K} D_i^2}$
Where K = the number of indicators, D_{i-} is the absolute difference in standard scores for indicator i between two sample units.
Place matrix A(i,j) on .TAPE. 5

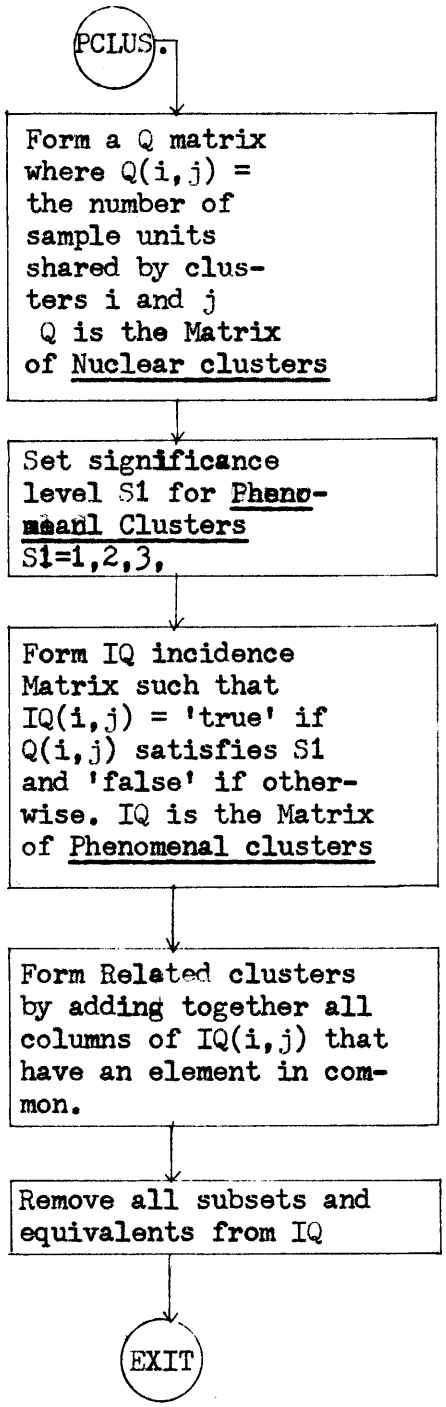

TEST
Set S0 at standard levels of .8, .5, and .2
Read .TAPE. 5 of A(i,j) Matrix
For all i,j
If A(i,j) is greater than or equal to S0
THEN Q(i,j) = 'true'
ELSE Q(i,j) ='false'
Write Q(i,j) Matrix on .TAPE. 6


TYPE
Read Q(i,j) from .TAPE.6
Initialize Counters LL=0 TT=0
EXECUTE LINK.
This routine forms new G matrix of Linkages from the Q matrix. LL= the number of columns in G.
EXECUTE MULT.
This routine forms a new Q matrix. If New Q is similar to the Old Q then TT=0 else TT=TT+1
If LL from LINK, =SLL from the old G matrix then finished
If TT=0 then finished
finished
Write .TAPE. 7= LL, and G matrix
not finished
SLL=11
EXECUTE LINK.
Read Old Q Matrix
EXECUTE MULT.


LINK
i=1
Count the number of 'trues' in row i of Q matrix
II = the count
Match row i with Columns to find all Linkages . Store the Links on matrix G . Remove all subsets and Equivalent Matches from G(i,j)
no
i = i+1
is i greater than or equal to the number of rows (m)?
yes
EXIT


MULT.
INPUT:
Matrix Q(i,j)
Matrix G(i,j)
and LL
Perform Matrix Multiplication Row by Column
If result of multiplication for row i and column j does not equal the entry of the old Q(i,j) then store i on B(L,1) and j on B(L,2). B is the Disagreement Vector.
If the Disagreement Vector is empty then MULT is finished.
finished
Write Linkage Matrix G(i,j)
Set TT=0
EXIT
not finished
Store on Tape, LL, and Q(i,j)'s
Form the new Q(i,j) matrix of'trues' on rows and columns where disagreement occurred. (i,e. the i's and j's of B(L,1) and B(L,2)
Set TT= TT+1
EXIT


REORD
READ LL and G(i,j) from .TAPE. 7
For all columns j, count the number of 'trues' and store number on Count Vector S(j)
Reorder the G(i,j) Matrix such that columns of G(i,j) are now ranked according to size of S(j) for each j
LL= the number of columns of Matrix G(i,j)
EXECUTE PCLUS.
Write on .TAPE. 8 the related-type incidence Matrix IQ(i,j)


PCLUS
Form a Q matrix where Q(i,j) = the number of sample units shared by clusters i and j Q is the Matrix of Nuclear clusters
Set significance level S1 for Phenomenal Clusters S1=1,2,3,
Form IQ incidence Matrix such that IQ(i,j) = 'true' if Q(i,j) satisfies S1 and 'false' if otherwise. IQ is the Matrix of Phenomenal clusters
Form Related clusters by adding together all columns of IQ(i,j) that have an element in common.
Remove all subsets and equivalents from IQ
EXIT

CHAPTER FIVE:

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