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Koong-lian Kao
Louisiana State University and Agricultural & Mechanical College

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Koong-Lian Kao
B.S., National Chengchi University, 1965
M.B.A., National Chengchi University, 1969
M.A., University of Connecticut, 1971
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TABLE OF CONTENTS

Acknowledgement ii

List of Tables v

Abstract viii

CHAPTER I

INTRODUCTION 1

CHAPTER II

SCOPE OF THE STUDY AND REVIEW OF LITERATURE 6

Scope of the Study 6

Review of the Literature 9

1. Gravity Approach 10

2. Economic Opportunities Approach 12

3. Modified Push-Pull Approach 15

4. Cost and Returns Approach 19

CHAPTER III

ALTERNATIVE FORMULATIONS AND EMPIRICAL ANALYSES OF INTERREGIONAL MIGRATION MODELS 22

Models Used in This Study 22

Definition of Variables 25

Regression Results 29

1. Economic Differential Model 29

2. Push-Pull Model 38

Migration Analysis by the Class of Origin and Destination 44

CHAPTER IV

ESTIMATION OF THE INTERIM MIGRATION RATES 59

Introduction 59

Regression Approach 61

Causative Matrix Approach 66

Estimation of 1960-1965 Transition Probabilities . . 71

CHAPTER V

THE PROBLEM OF POPULATION DISTRIBUTION 76

Introduction 76

Population Distribution 78

Policy Implications 82

CHAPTER VI

SUMMARY AND CONCLUSIONS 91

Conclusions 91

Limitations 96

Suggestions for Future Research 98

Appendix 99

Appendix A List of Parishes in Each State Economic Area for Louisiana 100

Appendix B Migration Flows for 1955-1960 101

Appendix C Migration Flows for 1965-1970 101

Bibliography 102

Vita 107

LIST OF TABLES

Table 3-1

The Notations and Expected Signs of the Variables Used in the Analysis 29

Table 3-2

All Interregional Migration--Differential Model 30

Table 3-3

Communication and Transportation Facilities Available Per Housing Unit In Louisiana 31

Table 3-4

Reason for Migrating, by Labor Force Status in March 1962, For Men 18 to 64 Years, to March 1963 35

Table 3-5

All Interregional Migration--Differential Model with Dummy Variable 34

Table 3-6

Inter-SEA Migration--Differential Model 37

Table 3-7

Interstate Migration--Differential Model 37

Table 3-8

All Interregional Migration--Push-Pull Model 39

Table 3-9

All Interregional Migration--Push-Pull Model with Dummy Variable 41

Table 3-10

Inter-SEA Migration--Push-Pull Model 42

Table 3-11

Interstate Migration--Push-Pull Model 43

Table 3-12

SEA to SEA Migration--Push-Pull Model 46

Table 3-13

SEA to SMSA Migration--Push-Pull Model 47

Table 3-14

SMSA to SEA Migration--Push-Pull Model 48

Table 3-15

SMSA to SMSA Migration--Push-Pull Model 49

Table 3-16

SEA to SEA Migration--Stepwise Regression 56

Table 3-17

SEA to SMSA Migration--Stepwise Regression 56

Table 3-18

SMSA to SEA Migration--Stepwise Regression 57

Table 3-19

SMSA to SMSA Migration--Stepwise Regression 57

Table 4-1

Transition Matrix for 1955-1960 62

Table 4-2

Transition Matrix for 1965-1970 62

Table 4-3

C^2 Matrix 72

Table 4-4

Estimated C Matrix 72

Table 4-5

Estimated Transition Matrix for 1960-1965 72

Table 4-6

All Interregional Migration--Push-Pull Model for 1960-1965 Migration Estimates as Compared with 1955-1960 and 1965-1970 74

Table 5-1

Transition Matrix for 1970-1975, Assuming a Constant Chain Process 81

Table 5-2

Equilibrium Relative Population Distributions Based on Stationary Markov Chain Assumption (Proportion of U.S. Total) 83

Table 5-3

Equilibrium Relative Population Distributions Among SEAs Within Louisiana (Proportion of State Total) 85

ABSTRACT

Directional place-to-place migration data is used in this analysis since net migration results in a partial offset of the factors affecting in- and out-migration. In the process of building economic models of interregional migration, several hypotheses have been tested. An economic differential model was developed and the results were as expected. The relative differentials were defined by taking the values of the variables at the origin divided by the values at the destination. It was found that migration varies directly with the unemployment differential and that it varies inversely with the income differential and distance. Inter-SEA and inter-state migrations were distinguished and the results showed that inter-state migration is better explained by economic variables. In other words, the greater the distance between the origin and the destination, the more concerned the migrants are with the economic benefits of the migration.

The importance of these variables was examined by using two sets of cross-sectional data. It was found that the distance elasticity had declined and income elasticity had also decreased. On the other hand, migrants have apparently become more aware of job opportunities at points of potential destination.

A major shortcoming of the economic differential model is that it implies the same elasticities for income and unemployment rate changes at both the origin and the destination. Thus, a

push-pull model was proposed which confirmed the expectation that the pull forces are more important than the push forces. The trend of elasticities over time also confirmed the expectations pointed out earlier in the differential model.

In a more detailed analysis, the origins and destinations were classified into classes according to their degrees of urbanization. Different patterns were found for each of the four sets of migratory flows.

Since the decennial censuses only report migration for the five-year interval immediately prior to the census date, migration for SEAs between 1960 and 1965 are not available. A causative matrix approach was employed to estimate the migration rates for this missing period. Regression results of these estimated rates on the independent variables for the same period show that these are probably reliable. The trend of the importance of independent variables was also observed in the analysis.

A balanced population distribution is both economically and socially desirable. If the projected distribution deviates from the desired one, then migration may be a means of achieving the goal. A growth center strategy was proposed by the "Commission on Population Growth and the American Future." The aim was to create medium sized urban areas in the depressed regions in order to achieve spatial equilibrium. Regression results of this study

provide some policy implications and suggest some possible strategies. The strategies could aim either at the origin or at the destination. Government also has the option as to whether direct or indirect action might be taken.

CHAPTER I

INTRODUCTION

American people are mobile. According to the 1970 Census of Population, over one third of the total population five years old or older in 1970 lived in a different house in 1965. Of those who moved to different houses during this period, about 57 percent changed their residence within the same county while the other 43 percent moved between counties. About one third moved between different state economic areas. A similar pattern was also observed in Louisiana. Of the 3.3 million total population, about 1.2 million lived in a different house in 1965. The migrants who were from different counties and different state economic areas accounted for 41 percent and 32 percent, respectively, of the total migrants in Louisiana.[1] Why do people move from a given place to another? What are the causes or incentives for people to make the movement? What are the trends of those incentives over the past two decades? What is the effect of this process on the geographic distribution? These are some of the problems needing answers.

Over the past 20 years, models of internal migration have received considerable attention in the social sciences. Scholars from at least four different disciplines have participated in the research of this problem. They include economists, sociologists,

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[1]U.S. Bureau of the Census, U.S. Census of Population 1970, Migration Between State Economic Areas (PC(2)-2E).

geographers and regional planners. A very distinctive feature of all migration studies, however, is their diversity: not only in terms of scale, coverage, and data collection, but also in the use of data, aims, and methods of research. Thus, different and sometimes even contradictory conclusions have been found.[2] Furthermore, it should also be noted that the results of different studies are not strictly comparable unless they use the same definitions for the terms used in their studies.

As Kenneth G. Willis has pointed out the genesis of migration lies in dissatisfaction with the contemporary environment. Disparity of opportunity provides the main motive force behind migration.[3] From an economic point of view, it seems likely that migration depends on the relative economic opportunities of both the points of origin and destination. For an individual, migration can be viewed as a human investment process. Migrants are trying to maximize their return by the movement. Therefore, information about potential gains and costs plays an important role in the personal decision process. On the other hand, the migration process has both economic and social effects on the society as a whole. Economically, this is an approach to adjusting the resource allocation. Socially, migration also affects the

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[2] See footnotes 34 and 35.

[3] Kenneth G. Willis, Problems in Migration Analysis, England: Saxon House, 1974, p. 1.

spatial equalization and differential growth rates among the regions. Moreover, demographic structure, such as age distribution, in a given region will also be affected.

In view of the trend and importance of migration, the research conducted in this study is designed to meet two objectives. The first objective is to identify the significant economic factors which influence interregional migration in Louisiana. It is hypothesized that higher incomes and lower unemployment rates are the main forces attracting in-migrants. Most migration research has concentrated on finding the influencing factors of migration by applying multiple regression techniques to cross-sectional data. This study, not only tries to identify the influencing factors, but also compares the importance of the factors over time by using two sets of cross-sectional data, specifically, 1955-1960 and 1965-1970. Since the 1960-1965 data are not available, the estimation of migration rates for this period will also be included in this study.

The second objective is to study the effect of migration on the population distribution. A general and well known migration phenomenon is that the population moves from low income rural or economically depressed areas toward higher income metropolitan areas. This, however, creates both economic and social problems for the society. For example, the large cities become overcrowded and have high crime rates while the rural areas become economically

more depressed. Therefore, there may be a need for the government to develop a set of population distribution guidelines to serve as a framework for regional, state and local plans and development. The factors found to influence migration may be useful in policy formulation to stimulate migration in the desirable directions.

Given the above objectives, the plan of this study will be as follows:

In Chapter II, a selected review of the relevant literature will be given. Since there has been much research in this field, it is impossible to list all of them. The review section only contains examples of the different conceptual approaches to the analysis of migration.

Alternative formulations and empirical tests of the migration models used in this study will be included in Chapter III. Using the model, inter-SEA migration and migration between Louisiana and the rest of the U.S. will be analyzed in detail.[4] Two sets of cross-sectional data, specifically, 1955-1960 and 1965-1970, will be used in the analysis. Also included in the chapter will be an analysis of the changing importance of the influencing factors over these two periods. The origins and destinations will also be

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[4] SEA stands for State Economic Area, these will be defined in Chapter II.

classified into metropolitan and nonmetropolitan subclasses in order to evaluate possible differences of the migratory behavior among these different classes.

In Chapter IV, since only 1955-1960 and 1965-1970 are reported in the decennial Census of Population, an attempt is made to estimate the migration rates for the 1960-1965 period. Assuming a constant rate of change, the estimation technique used is a causative matrix approach for a special nonstationary Markov process. These estimated migration rates are then regressed on the values of economic variables for the same time period. The relative importance of the factors which influence migration will be analyzed through the time trend of the regression coefficients.

The problem of population distribution is discussed in Chapter V. A balanced population distribution is both economically and socially desirable. The regression results in Chapter III provide some policy implications with respect to possible strategies which could be used to induce necessary migration in order to achieve the desired population distribution.

The final chapter includes the conclusions and discusses the limitations of the study.

CHAPTER II

SCOPE OF THE STUDY AND REVIEW OF LITERATURE

Scope of the Study

In its most general sense, migration refers to any change in residence of an individual, ranging from a move across the street to one across the state or across national boundaries. The scope of this study is limited to what is generally understood as internal migration, i.e., a change of residence from one geographic location to another within the same nation. The distinction between migrants and nonmigrants, thus, depends upon the definition of the geographical area. In this study, migrants are defined to be all people five years old and over at the end of the relevant period who changed their residence from one state economic area (SEA) to another during the specific five-year period. More specifically, what is of interest is the directional flow of migrants; i.e., total migration from say, SEA_i, to SEA_j. From SEA_i's point of view, it is out-migration. On the other hand, it is in-migration to SEA_j. Interest here is not in net migration, which is the algebraic difference between in-migration and out-migration, although the net migration of a specific area can be calculated by subtracting the out-migration to all possible areas from total in-migration. The use of net migration as a dependent variable is not considered to be adequate since this tends to mask the competitive features of economic opportunities which exist among the various regions. For instance, migrants from area i to area j may be

attracted to job opportunities while migrants from j to k may be attracted for some other reason, say, higher income. If net migration is used, the different causes of migration cannot be distinguished.

State economic areas are employed in this study. They are defined in such a way that the people in the clusters of land are homogeneous in their general means of livelihood and socio-economic characteristics. In addition, it is also desirable to organize the SEAs such that it is possible to obtain statistics for each unit of area. SEAs were derived by forming groups of similar counties.[5] They may consist of a single county or groups of counties with similar characteristics. The state of Louisiana was divided into eight nonmetropolitan SEAs and five metropolitan SMSAs.[6] The advantage of using this area definition is that migrant data are easily available from the United States Census reports. Both the 1960 and 1970 Censuses of Population have subject reports showing mobility between state economic areas. For instance, the 1970 Census reports the 1965 SEA residence of all persons five years of age and older in 1970. Although finer boundary definitions such as parish lines could be used; these were considered to

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[5]Donald J. Bogue and Calvin L. Beale, Economic Areas of the United States (New York: The Free Press of Glencoe, Inc., 1961).

[6]SMSA means standard metropolitan statistical area, it is equivalent to a metropolitan SEA.

be too small because they would obscure the regional features. In most cases the county or parish would be too small a unit to show migrants according to their characteristics because there would be too few migrants for counties to warrant such detailed tabulations.[7] As is the case with geographical areas, the length of time interval used is an important factor in distinguishing migrants from non-migrants. In this study, a five year interval is used to define migration. The only persons considered as migrants were those whose residence at the end of the five year interval was different from that at the beginning. This definition, of course, has several shortcomings. For instance, a person who lives in one SEA at the beginning of the time period, then subsequently moves to another, and then comes back before the end of the period is not considered as a migrant. Also, multiple movements within the specified time period are not counted. However, this definition is adequate for the purpose of this study since the main concern is with how migrants respond to changing economic conditions at both the origin and ultimate destination. In general, these relative conditions are likely to remain comparatively unchanged over a short time period, say one year.

Internal migration may be approached from two different points of view: migration streams and migration differentials. Migration stream analysis focuses on the volume and direction of

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[7] Donald J. Bogue, H. Shryock, and S. Hoermann, Subregional Migration in the United States, 1935-1940, Volume I: Streams of Migration (Miami University, Ohio, 1957), p. 4.

place-to-place movements. It is primarily concerned with the effect that different economic opportunities at origins and destinations have on the volumes and directions of flow. This is the approach used in this research. On the other hand, migration differential analysis emphasizes the differences between migrant subgroups (e.g., various age-sex-race classifications). Furthermore, differences in occupation and employment status also have different impacts on migration. However, it is not possible to examine these hypotheses here because detailed data for these classifications are not published for place-to-place directional flows. The data for this kind of disaggregated flows are available only as gross-in and out-flows and are only available for SMSA or state level. A disadvantage for using gross-in or out-flows data is that the conclusion cannot be stated unequivocally that migration flows are from areas with certain characteristics to areas with other characteristics.[8]

Review of the Literature

Internal migration is one of the most striking phenomena of national economic development. It is also one of the most pervasive: every country or region has undergone this experience as the advance of industrial and agricultural development has dictated a redistribution of population. There has been much

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[8]Celia A. Morgan, The Geographic Mobility of Labor: An Investigation of the Role of Wages and Unemployment Rates in the Migration Process, Unpublished Ph.D. dissertation, University of Houston, 1971.

research done in this field. For a comprehensive list and brief review of the related bibliography, refer to the book Problems in Migration Analysis by K.G. Willis.[9] The purpose of this section is to examine different conceptual approaches to migration analysis rather than to give a detailed review of each individual study.

As early as 1885, Ravenstein postualted a number of "laws" of migration. One of his "laws" was an inverse relation between migration and distance. His analysis was the first theoretical analysis of migration and was the beginning of the history of the subject.[10]

The research conducted in this field could be classified conceptually into the following approaches:

1. Gravity approach.

This approach focuses on the importance of population size and distance as causal factors in migration. The concept is based on the analogies of spatial interaction models to the physical laws of Newtonian physics.[11] The theory states that the flows between any two points are determined by an origin factor, a destination factor, and a linkage factor. For instance, Zipf argued that total (in- plus out-) migration between any two areas

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[9] Kenneth G. Willis, op. cit.

[10] E.G. Ravenstein, "The Laws of Migration," Journal of the Royal Statistical Society, (June, 1885), pp. 167-227.

[11] J.H. Neidercorn and B.V. Bechdolt, Jr., "An Economic Derivation of the Gravity Law of Spatial Interaction," Journal of Regional Science, (Aug. 1969), pp. 273-283.

and is inversely related to the distance between the areas. Symbolically, his model took the following form:

$$M = M_{ij} + M_{ji} = \left(\frac{P_i \cdot P_j}{D_{ij}} \right) \qquad (2\text{-}1)$$

where M is the total migration, M_{ij} is the number of migrants who moved from area i to area j, P_i is the population at i and D_{ij} is the distance between i and j.[12] Perhaps a major shortcoming of this model is that it does not distinguish between the directions of migration flow. Furthermore, it does not provide causal explanations of the migration.

Stouffer developed an "intervening opportunities" theory arguing that there is no necessary relationship between mobility and distance. Rather, the volume of a stream of migrants between an origin i and a destination j is directly proportional to the number of opportunities at the destination and inversely proportional to the number of "intervening opportunities" within the distance from the point of origin. The distribution of opportunities over space is the result of a multitude of historical, geographic, economic, political, and social factors and will vary from situation to situation. Operationally, he defined opportunities as the total number of migrants who have moved into the area. Stouffer therefore, in fact, tried to measure the relationship between

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[12]George K. Zipf, "The P_1P_2/D Hypothesis: On the Intercity Movement of Persons," American Sociological Review (December, 1946) pp. 677-686.

migration and opportunities by assuming this relation in defining opportunities. This model, like Zipf's, provided no explanation of the causes of migration.[13]

2. Economic Opportunities approach.

Carter Goodrich, et. al.,pointed out the relation between migration and relative economic opportunities by observation of data for the 1920s and early 1930s. A comparison was made of the directions of migration and relative living levels both in prosperity and depression. However, they did not specifically formulate a model to test their hypotheses.[14]

In 1947, J. Isaac published a book entitled The Economics of Migration in which he analyzed the migration phenomenon from a purely economic point of view. He suggested the use of the marginal productivity concept as a criterion for determining the optimum size of a population. Migration is a means of reaching the optimum population goal if the actual population size differs from the optimum one. In his analysis of the migration process, Isaac found the factors determining the migratory movements include cost of living, real income, and unemployment.[15]

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[13] Samuel A. Stouffer, "Intervening Opportunities: A theory Relating Mobility and Distance," American Sociological Review (December 1940), pp. 845-867.

[14] Carter Goodrich, Bushrod W. Allen, et. al., Migration and Economic Opportunity (University of Pennsylvania Press, Philadelphia, Pennsylvania, 1936).

[15] J.E. Isaac, Economics of Migration (Oxford University Press, 1947).

Some economists emphasized geographical wage differentials while others concentrated on unemployment differentials. For example, J.R. Hicks in The Theory of Wages states that "... differences in net economic advantages, chiefly differences in wages, are the main cause of migration".[16] This theory argues that labor is attracted to the area with higher wages. It is based on the following assumptions: (1) labor is homogeneous, (2) the labor market is in perfect competition, i.e., workers have perfect mobility and full knowledge of labor market conditions, (3) wage rate structures are flexible, and (4) there are no barriers (such as labor unions) to entry into the market. The adjustment mechanism of this model is simple. Consider a two market model, a relatively higher wage rate in market i will cause an inflow of workers from market j. The increase of labor supply in market i tends to lower the wage rate in i. On the other hand, a decrease of labor supply in market j, due to out-migration, will eventually raise the wage level. Static equilibrium will be reached when wage rates in two markets are equal.

Based on this theory, Robert L. Raimon used Spearman rank correlations to analyze the relationship between the net civilian migration and income levels. In general, he found that the states with above-average income levels usually have net in-migration, while the states with below-average income levels usually have net out-migration. It was also found that the correlation result was improved by

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[16]J.R. Hicks, The Theory of Wages (Gloucester, Mass: Peter Smith, 1957), p. 76.

excluding the state of Florida. Because of its mild climate, Florida is particularly attractive to retired persons.[17] Raimon found that between 1950 and 1957, the population aged 65 years old and over for all of the states increased by 21.0% while Florida's aged population increased by 77.8%. This figure for Arizona was 63.3%. For New Mexico it was 44.2%, while it was below 30% for all other states.[18] This study pointed out that climate and other conditions should be taken into account in the interstate migration analysis, as well as age differentials.

While the wage differential is important, some studies emphasize the impact of job opportunities on migration. For example, F.R. Oliver used regression techniques to analyze the relationship between net migration rates and unemployment rates in England for the period 1951-1961. It was found that relatively high regional unemployment was associated with high net out-migration; but the relationship was not particularly close. Given a low R^2, it is

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[17] It might be noted in this regard that the hypotheses of economic factors affecting migration are relevant only to age groups which move from one place to another to take advantage of better employment opportunities. People who move to Florida to retire, obviously are not attracted there by better job opportunities.

[18] Robert L. Raimon, "Interstate Migration and Wage Theory," Review of Economics and Statistics (November 1962), pp. 428-438.

clear that a substantial part of the variation was accounted for by other factors.[19]

In general, the economic opportunity approach can also be termed as "push-pull" theory. It states that comparative economic opportunities at different locations are the driving motivational forces in internal migration. In other words, people are being "pushed" out of a given area with less opportunities. On the other hand, areas with abundant opportunities usually "pull" an inflow of migration.

3. Modified push-pull approach.

This approach combines the gravity model and the economic opportunities approach to analyze the migration process. In 1957, Bogue, et. al., published a two volume study on internal migration in the United States during the five years 1935-1940. A very clear definition of the migration terminology was given in the beginning of the first volume. This is very important because different uses of the terms may result in conclusions which are not comparable. The first volume emphasized the study of migration streams. Both the number of migrcnts and migration rates were used in this study. Furthermore, they also distinguished between in-, out-,and net migration in their analyses. The explanatory variables include

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[19]F.R. Oliver, "Inter-Regional Migration and Unemployment, 1951-1961," Journal of the Royal Statistical Society, Series A (Spring, 1964), pp. 42-75.

population size, unemployment rate and other factors. However, one major shortcoming in their analysis was that out-migration was considered sensitive only to conditions at the origin, and the in-migration flow was assumed to be influenced only by conditions at the destination. Rather, it seems more reasonable that conditions, both at the origin and the destination, should be taken into account in the migration analysis. Poor conditions at the point of origin are not likely to generate out-migration if there is no place with sufficiently good conditions to attract in-migrants. The second volume deals with migration differentials. The basic characteristics considered were personal characteristics, employment status, income and occupation groups. Their conclusion was that younger people, married, better educated, and females tend to be more migratory.[20]

Cicely Blanco applied multiple correlation and regression analysis to find the determinants of interstate population movements in the United States for the period of 1950-1957. The dependent variable used was net in-migration for each state. The independent variables include unemployment levels and rates of change in unemployment, wage rates, geographical distance, level of education, racial prejudice, and changes in the location of military personnel. She concluded that only unemployment rates and the locations of

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[20] Donald J. Bogue, H. Shryock, and S. Hoermann, op. cit.

military personnel have significant influences on interstate migration.[21]

It should be noted that each of the above mentioned studies used net migration as the dependent variable. In 1966, Ira S. Lowry analyzed the directional flows between metropolitan areas. His model is of the following form.[22]

$$M_{ij} = k \left(\frac{U_i}{U_j} \cdot \frac{W_i}{W_j} \cdot \frac{L_i L_j}{D_{ij}} \right) \cdot \varepsilon_{ij} \qquad (2\text{-}2)$$

where: M_{ij} = number of migrants from i to j,

L_i, L_j = number of persons in the nonagricultural labor force at i and j,

U_i, U_j = unemployment as a percentage of civilian, nonagricultural labor force at i and j.

W_i, W_j = hourly manufacturing wage at i and j,

D_{ij} = airline distance (in miles) separating i and j,

ε_{ij} = error term,

k is a constant

Later, Andrei Rogers modified the model to the following form to analyze interregional migration in California.

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[21] Cicely Blanco, "The Determinants of Interstate Population Movements," Journal of Regional Science, (Summer 1963), pp. 77-84, and "Prospective Unemployment and Interstate Population Movement," Review of Economics and Statistics (May 1964), pp. 221-222.

[22] Ira S. Lowry, Migration and Metropolitan Growth: Two Analytical Models (University of California Press, Los Angeles, California, 1966).

$$M_{ij} = k \left(\frac{WS_i}{WS_j} \cdot \frac{LF_i LF_j}{D_{ij}} \right) \qquad (2\text{-}3)$$

where: WS_i, WS_j = per capita wages and salaries at i and j,

LF_i, LF_j = labor force eligibles (age 15 to 64) at i and j,

D_{ij} = shortest highway mileage between the major county seats at i and j.

His reason for excluding the unemployment as a variable was that it was statistically significant with the wrong signs.[23]

In 1967, L.E. Gallaway, et. al., published an article on the economics of labor mobility. They tried to measure empirically the relative importance of various quantifiable economic variables in their impact upon both gross and net interstate migration. Their model was as follows:

$$M_{ij} = f\,(Y_i - Y_j,\ D_{ij},\ U_i - U_j,\ W_i - W_j) \qquad (2\text{-}4)$$

where M_{ij} = number of migrants from state i to state j,

$Y_i - Y_j$ = differences in wage rates,

$U_i - U_j$ = differences in unemployment rates,

$W_i - W_j$ = differences in welfare benefits.

Two regression equations were estimated for each state by using as the dependent variable gross migration from each state to all other states for one equation and the net migration for each state in the other. In addition, a regression was estimated for each

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[23] Andrei Rogers, Matrix Analysis of Interregional Population Growth and Distribution (University of California Press, Berkeley, California, 1968).

dependent variable aggregating the data across all states. The correlation coefficient for regressions on each state ranged from 0 in Iowa to 0.534 in Montana, and was 0.188 for Louisiana. The average correlation coefficient for all states was around 0.30. In conclusion, they indicated that while per capita income differences are significant determinants in interstate population movements, many of the reasons underlying labor migration between states must be explained by other, possibly noneconomic, factors.[24]

4. Cost and returns approach.

This approach treats migration as an investment process and was proposed by Larry A. Sjaastad in 1962.[25] The decision to move is made by comparison of the cost of movement with the present value of the expected income difference resulting from the move. Both the cost and return should include monetary and nonmonetary considerations. An individual will migrate if the present value of his income is greater than the moving cost. That is, a person will move only if:

$$\sum_{t=1}^{n} \frac{Y_{dt} - Y_{ot}}{(1+r)^t} - C > 0 \qquad (2\text{-}5)$$

where Y_{dt} is the expected income at destination in year t,

Y_{ot} is the expected income at origin in year t,

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[24] L.E.Gallaway, R.F. Gilbert, and P.E. Smith, "The Economics of Labor Mobility: An Empirical Analysis," Western Economic Journal (June 1967),pp. 211-223.

[25] Larry A. Sjaastad, "Costs and Returns to Human Migration," Journal of Political Economy, (October 1962), pp. 80-93.

r is the interest rate

t=1, ..., n, is the expected working years, and

C is the cost of movement.

This approach provides a decision model at the individual level which is theoretically consistent with decision-making processes used in economic analysis. However, one disadvantage of this model is that it ignores information on job opportunities. Moreover, this approach can only be applied at the micro level--either if data on each individual is available or that aggregated data can be disaggregated by age, sex, race, and occupational groups such that each group has similar costs and returns. In 1970, Samuel Bowles made an empirical test of this approach by using disaggregated net migration data.[26] He showed that the present value of the expected income gain from moving out of the U.S. South is positively related to the probability of moving. However, since net figures were used, he admitted that he was unable to test hypotheses concerning geographical variations in migration rates as well as the effect of unemployment in the origin and the destination, distance, and some other variables.

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[26]Samuel Bowles, "Migration as Investment: Empirical Tests of the Human Investment Approach to Geographic Mobility," Review of Economics and Statistics, (November 1970), pp. 356-362.

In summary, for the purpose of testing the effect of different economic opportunities on interregional migration, directional place-to-place migration flow data are used in the present study. In addition to the economic differential model, a push-pull model is also used to test for possible different effects of the conditions at the origin and the destination. It was also decided to distinguish between inter-SEA and interstate migration to show the different impacts of economic opportunities on migration. Furthermore, the changing pattern of importance of these variables over time is examined by using two sets of cross-sectional data. The following chapter will provide a detailed development and empirical tests of these alternative models.

CHAPTER III

ALTERNATIVE FORMULATIONS AND EMPIRICAL ANALYSES OF INTERREGIONAL MIGRATION MODELS

Models Used in this Study

Based on economic opportunity theory, two models will be used in the present study. First, it is hypothesized that migrants respond to income and unemployment rate differentials between regions. Income and unemployment rate differentials are expressed as ratios, i.e., $Y_{ij} = \frac{Y_i}{Y_j}$ and $U_{ij} = \frac{U_i}{U_j}$ where Y is the income level and U is the unemployment rate.[27] Distance (D_{ij}) is considered as a proxy variable for the cost of migration. The cost of migration can take two forms, either money costs or psychic costs. Money costs not only include the money outlays involved in the process of moving but also include the opportunity costs implicit in the moving process. Psychic costs result from one's social and cultural ties to his original community. Both money and psychic costs associated with migration tend to vary positively with distance. The greater the distance between areas the greater the out-of-pocket cost incurred in the moving process, the greater amount of time involved and thus the greater income

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[27] Relative economic opportunities could be defined in terms of either absolute difference such as Y_i-Y_j or relative differentials such as $\frac{Y_i}{Y_j}$. It was found that relative differential models yielded better results than the absolute difference model.

foregone in the moving process. Furthermore, the greater the distance, the greater the cultural and social differences between areas thus the psychic cost for a new migrant to adjust to his new environment will be greater than the short-distance movement. It should also be noted that a part of the psychic cost results from a greater degree of uncertainty because of a lack of knowledge about the new location.

The dependent variable used in the study is the migration rate, calculated by $\frac{M_{ij}}{P_i}$, where M_{ij} is the number of migrants who moved from SEA_i to SEA_j, and P_i is the population at the origin. For the purpose of the present study, there are three advantages to using the migration rate (as opposed to the number of migrants) as a dependent variable: First, in the latter part of the study, these rates will be used as transition probabilities in a Markov Chain analysis. Second, these rates can be considered as representing propensities to migrate. Finally, by expressing migrants in terms of rates, account is taken of different population sizes in various regions. Thus, the model is specified as follows:[28]

$$\frac{M_{ij}}{P_i} = k \cdot (Y_{ij}^{b_1} \cdot D_{ij}^{b_2} \cdot U_{ij}^{b_3}) \cdot \varepsilon_{ij} \qquad (2\text{-}6)$$

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[28]Additive formulation of the model was tried; however, the result is less satisfactory than the multiplicative model. A problem associated with the multiplicative formulation is that the dependent variable will be zero if any of the independent variables has zero value. However, this is not a serious problem because none of the independent variables is likely to assume a value of zero.

or in its log form:

$$\ln \frac{M_{ij}}{P_i} = b_0 + b_1 \ln Y_{ij} + b_2 \ln U_{ij} + b_3 \ln D_{ij} + e_{ij} \quad (2\text{-}7)$$

In this model (Equation 2-7), it is expected that D_{ij} will be negatively related to the migration rate. b_1 is also expected to be negative, since an income level which is relatively larger at the origin or relatively smaller at the destination will reduce the motivation for people to move. Finally, it is expected that b_2 will be positive, because unemployed people are likely to be both "pulled" to a region where the probability of finding a job is higher than at origin and "pushed" from an origin with a relatively high unemployment rate. It should be noted that in this model the log transformations are taken after the ratio is calcualted. Thus, one potentially major shortcoming of this model is that it gives the same weight to the economic conditions at both the origin and the destination. For instance, a given proportionate increase of Y_j is considered to have the same influence on migration as an equal proportionate decrease of Y_i. However, this is not likely to be the case. People usually have certain social, cultural, and emotional ties with their present locations of residence.

Thus, it is hypothesized that the "pull" factors must be stronger than the "push" factors to result in migration. That is, separate consideration should be given to income levels and unemployment rates at the origin and the destination. Basically, the concepts of the model are not changed by this modification.

Thus, for purposes of the present study, the log of each individual Y_i and Y_j (or U_i and U_j) will be used rather than their ratio. Therefore, the second model proposed has the following form:

$$\ln(\frac{M_{ij}}{P_i}) = b_0 + b_1 \ln Y_i + b_2 \ln Y_j + b_3 \ln U_i + b_4 \ln U_j + b_5 \ln D_{ij} + e_{ij} \qquad (2\text{-}8)$$

It is expected that b_1 and b_4 in Equation 2-8 will be negative and that b_2 and b_3 will be positive. The reasons for these hypotheses are obvious. The sign of the coefficient of D_{ij} is still expected to be negative. In order to distinguish between these two models, the first (Equation 2-7) will be called an economic differential model and the second (Equation 2-8) will be termed a push-pull model.

In addition, it will also be shown that the distance elasticity has decreased over the past two decades while the elasticity for information about job opportunities has increased. This is shown by using two sets of cross-sectional data. Finally, based on the migration rates, the problem of population distribution will be discussed.

Definition of Variables

The following sections are devoted to an empirical test of the two alternative models developed in the previous section. First, detailed definitions and data sources for all dependent and independent variables are given. This is followed by regression

results and analyses of both the economic opportunity and the push-pull models. The variable definitions are as follows:

1. Number of migrants (M_{ij}). The 1960 Census of Population has a subject report entitled "Mobility for States and State Economic Areas",(PC(2) - 2B) and the 1970 Census of Population has a report on "Migration Between State Economic Areas". Both reports show the five year interval place-to-place directional migrant flows for the relevant period. For instance, Table 4 of the 1970 report gives information concerning the residence in 1970 of populations, classified by their residence in 1965, for the population 5 years old and over of each SEA (i.e., M_{ij} in this study). The migration rates were derived by dividing the number of migrants by the total population in the SEA of origin. The migration rates have been used as the dependent variable in this analysis.

2. Distance (D_{ij}) is the highway mileage distance between the major cities (usually the most populous city) in the respective SEAs. The people who moved out of state or moved into an SEA from other states are grouped under "rest of U.S.". For this group, Chicago was picked as the central point because it is the most populous city near the national center of population reported in the <u>Statistical Abstract of the United States.</u> This choice is admittedly arbitrary but is believed reasonable.

3. Y_i and Y_j are the median income levels in SEA_i and SEA_j in 1960 and 1970.[29] The 1970 Census subject report State Economic Areas (PC(2)-10B) reports median ioncome for SEAs. The 1960 Census report series (PC(3)-1A) also reports the same information. Comparable data for 1950 represent a problem since the boundaries of the SEAs were changed between 1950 and 1960. Therefore, it was necessary to obtain the median income level for each parish within the SEAs and then compute a weighted median for the SEA. This was done by weighting each parish median by the proportion of that parish's population to the total SEA population. In the models used in this study, it is assumed that migrnats make their decisions based on the levels of the independent variables at the beginning of the five-year period. However, the data for 1955 and 1965 are not available. Thus, the averages of 1970 and 1960 (or 1960 and 1950) were used as the approximate values in the analysis. Since income levels have generally increased over time in all areas, this procedure seems to be reasonable.

4. U_i and U_j are the unemployment rates stated as percentages of civilian labor force in SEA_i and SEA_j, respectively. The data used for these variables were obtained by the same

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[29]Theoretically, the mean income level would be more appropriate but the mean is reported only in the 1970 Census by parish. Only median income is available from all three (1950, 1960, and 1970) Censuses.

procedure described above for income. It should be pointed out that, unlike the income level, unemployment rates fluctuated over the ten year periods in question. However, annual statistics for unemployment rates are not available for years prior to 1960. Even in 1960, they were available only at the state level, not by parish or by SEA. The simple average of unemployment rates for the beginning and ending years of the decade does not adequately represent the true comparative unemployment situation in the SEAs. However, these are the best available data.

5. Dummy variable (DUM). All interstate migrants were grouped for analyses under the category "rest of U.S.". However, the population and geographic area of this group is not comparable to the SEAs in the analysis. The problem of population size is taken into account by using migration rates as the dependent variable. The effect of geographical area is taken into account indirectly through the distance variable. In order to distinguish the possible spatial differences between the two types of migration (i.e., inter-SEA and interstate migration) a dummy variable was included whenever analysis was made of the full 14 x 14 (thirteen SEAs in Louisiana plus rest of U.S.) matrix of migrants. The purpose of the dummy variable is to shift the level of migration to show the spatial difference. Moreover, the two sets of data are also separated in the analysis in order to compare the differences between inter-SEA migration and interstate migration.

The following table summarizes the variables described above and a priori expectation of the signs of coefficients associated with the variables:

TABLE 3-1

THE NOTATIONS AND EXPECTED SIGNS OF THE VARIABLES USED IN THE ANALYSIS

Variable	Description	Expected Sign
M_{ij}	Number of migrants from SEA_i to SEA_j	
P_i	Total population of SEA_i	
D_{ij}	Highway distance between SEA_i and SEA_j	-
U_i	Unemployment rate at SEA_i	+
U_j	Unemployment rate at SEA_j	-
Y_i	Income level at SEA_i	-
Y_j	Income level at SEA_j	+
$U_{ij}=U_i/U_j$	Relative unemployment rate differential between SEA_i and SEA_j	+
$Y_{ij}=Y_i/Y_j$	Relative income differential between SEA_i and SEA_j	-
DUM	Interstate migration (dummy)	

Regression Results

1. Economic differential model: The results for 1955-1960 and 1965-1970 without using the dummy variable are shown in Table 3-2.

TABLE 3-2

ALL INTERREGIONAL MIGRATION - DIFFERENTIAL MODEL

	1955	1965
Intercept	-2.52417*	-2.91950*
	(-4.30493)	(-4.89634)
D_{ij}	-0.63057*	-0.54570*
	(-5.59277)	(-4.75947)
U_{ij}	1.45045*	2.87553*
	(2.86454)	(4.42099)
Y_{ij}	-2.47505*	-1.48418*
	(-10.31908)	(-4.23376)
Number of observations	182	182
$\bar{R}^2$	0.42644	0.36187

The t-statistics are in parentheses.
*Significant at the 0.01 level for a one-tail test.
$\bar{R}^2$ is R^2 adjusted for degrees of freedom.

As was expected, M_{ij} varies directly with U_{ij} and inversely with D_{ij} and Y_{ij}. Moreover, the coefficients for all variables are significantly different from zero at the 0.01 level or better. Since all the variables are expressed in their natural logarithm form, these coefficients can also be interpreted as elasticities for the respective variables. It can be seen that in 1955 migrants

were more sensitive to the income differential than to the unemployment rate differential. However, this situation was reversed in the 1965 analysis. The reason is probably that communication systems were not so well developed in 1955 and that unemployment rate statistics were not easily available. In other words, the "quality" and "quantity" of information concerning job opportunities were not as good in 1955 as they were in 1965. Through time both the quality and quantity of the information has improved, people have become more aware of job opportunity differentials, and appear to have greater concern about individual job opportunities than the general income level. This is to be expected.

The following statistics might provide partial support to this claim. According to the Census of Housing, the quantities of the communication and transportation facilities available per housing unit in Louisiana for 1950, 1960, and 1970 are listed in Table 3-3.

TABLE 3-3

COMMUNICATION AND TRANSPORTATION FACILITIES AVAILABLE PER HOUSING UNIT IN LOUISIANA

	1950	1960	1970
All occupied units	710,865	892,339	1,052,038
Telephone available	N.A.	619,655	860,070
Percent		69.44	81.75
One or more Auto. Available	N.A.	627,026	831,904
Percent		70.27	79.08
One or more TV available	19,045	726,056	999,994
Percent	2.68	81.36	95.05

N.A., not available.

Source: U.S. Bureau of Census, Census of Housing, 1950, 1960, and 1970.

The rapid growth of these types of equipment, both in terms of absolute numbers and percentages, certainly has the effect of increasing the availability of information and ability to respond to this information. In addition, various government agencies have also increased the publication of economic conditions and statistics which provide valuable guides to potential job seekers.

It should be noted that the coefficient of Y_{ij} decreased over the ten year period (from 1955 to 1965). This may be an indication that relative income differentials have narrowed to some degree, perhaps partially due to the migration process itself. According to classical economic theory of labor mobility, labor moves from low wage areas to relatively higher wage areas. This shift not only changes the supply of labor at both origin and destination, but also affects the capital-labor ratios. The result of both effects tend to reduce the wage differentials between regions. The reasoning of this process is simple. Given a two market model situation, a shift of labor from low wage area, say i, to a higher wage market j will increase the labor supply in market j while it decreases the labor supply in market i. Given that a fixed amount of capital existed before the migration occured, the capital-labor ratio would be increased in market i while it would decrease in market j after the migration took place. A decrease in labor supply in market i will cause the wage rate

to rise. On the other hand, labor is relatively scarce compared to the capital in market i; thus, the wage rate will also be expected to rise. The adjustment of the price of capital could also be analyzed in a similar way. By the same token, the reverse situation will occur in the market j.

However, as was pointed out earlier in Chapter II, this theory is based on assumptions which may not, in fact, hold true in the present society. Thus, it is expected that income differentials will continue, although the migration process could reduce them gradually. Indeed, there has been a general tendency for the various areas of the United States to become more homogeneous overtime.

It is interesting to note that the distance elasticity has also declined over this period. This is indeed what was expected, since the rapid growth of automobile ownership and substantial highway improvements have had the effect of greatly reducing the distance of travel, especially for a short-distance moving within the state. While improved communications have the effect of reducing the "psychological distances" between areas, improved transportation reduces the effective physical distance.

Overall, the coefficient of determination, R^2 (or the proportion of explained variance) of this model may not be impressive. However, according to a survey conducted in 1962 by Samuel Saben, about 49.5% of the labor force listed work

related factors as their reason for migration.[30] The detailed results are shown in Table 3-4. In view of this survey, it appears that the model used here does explain most of the economic reasons why people move from one region to another. In essence, the model is constructed to explain voluntary mobility only. Some other economic factors associated with the job, such as job transfers from one location to another, losing an existing job, and the possibility of physical injury or disability requiring some change of job, are not accounted for in the present model.

Since neither the geographic area nor the population size of the "rest of U.S." are comparable to those of the SEAs, it seems clear that a dummy variable is needed to distinguish these two types of migration. The result of adding a dummy variable is shown in Table 3-5.

TABLE 3-5

ALL INTERREGIONAL MIGRATION - DIFFERENTIAL MODEL WITH DUMMY VARIABLE

	1955	1965
Intercept	-0.19653	-0.99923
	(-0.25292)	(-1.24160)
D_{ij}	-1.12941*	-0.95720*
	(-7.15282)	(-5.85310)
Y_{ij}	-2.47837*	-1.46656*
	(-10.83220)	(-4.67018)
U_{ij}	1.47240*	2.95124*
	(3.04825)	(4.30896)
DUM	1.62940*	1.34279*
	(4.31503)	(3.43506)
Number of observations	182	182
$\bar{R}^2$	0.47811	0.39837

*Significant at the 0.01 level for a one-tail test.

[30] Samuel Saben, "Geographic Mobility and Employment Status, March 1962-March 1963," Monthly Labor Review, Aug. 1964, Vol. 87, No. 8, Table 4, p. 877.

TABLE 3-4

REASON FOR MIGRATING, BY LABOR FORCE STATUS IN MARCH 1962, FOR MEN 18 TO 64 YEARS, TO MARCH 1963

Labor Force Status	Total	Reasons						
		Work-Related Factors				Marriage and Family	Other*	Not Available
		Total	To Take A Job	To Look For Work	Job Transfer			
Total	100	49.5	29.5	11.9	8.1	14.6	35.3	0.6
Employed	100	52.7	31.4	10.1	11.2	12.4	34.4	0.5
Unemployed	100	69.0	30.9	37.3	0.8	10.6	19.5	0.9
Not in Civilian Labor Force	100	33.6	24.0	8.4	1.2	22.4	43.4	0.6
In School	100	46.1	40.0	6.1	--	31.0	21.2	1.7
Other	100	27.3	16.0	9.5	1.8	18.1	54.6	--

*Other includes such reasons as better housing, health, residing far from place of work, leaving the armed forces, and miscellaneous factors.

Source: Saben, Samuel, "Geographic Mobility and Employment Status, March 1962 -- March 1963," _Monthly Labor Review_, August 1964, Vol. 87, No. 8, Table 4, p. 877.

By adding a dummy variable, the R^2s of both periods increased by about 5 percentage points. Moreover, the coefficient of the dummy variable is significantly different from zero at better than the 0.01 level. The coefficients for all other variables are still significant and have the expected signs. A general trend of decreasing distance and income elasticities and an increasing importance of unemployment rate differentials is also presented in this model. However, this formulation of the model has a basic shortcoming in that it implies that the elasticities of income, distance, and the unemployment rate differentials are the same for both interSEA and interstate migration. This is, of course, questionable. For instance, relative employment opportunities at distant destinations would have to be greater to stimulate migration than would be the case for the short distance migrant since the cost of movement for the former is much greater than for the latter. That is, it is to be expected that the unemployment rate elasticity of inter-SEA migration would be less than that of interstate migration. There is also reason to believe that an interstate migrant requires a greater income differential in order to induce him to move to another state. In other words, relatively speaking, the ratio of the coefficient of the income differential to that of distance would be greater for interstate migration than for inter-SEA migration. Therefore, the regressions were fitted on two sets of data separately. The results are shown in Tables 3-6 and 3-7.

TABLE 3-6

INTER-SEA MIGRATION - DIFFERENTIAL MODEL

	1955	1965
Intercept	-0.19561 (-0.36511)	-1.10699** (-2.31204)
D_{ij}	-1.12960* (-10.37545)	-0.93513* (-9.61106)
U_{ij}	0.12355 (0.34585)	0.91848** (2.26119)
Y_{ij}	-0.90854* (-4.58982)	-0.65647* (-3.06637)
Number of Observations	156	156
$\bar{R}^2$	0.45057	0.42186

*Significant at the 0.01 level for a one-tail test.
**Significant at the 0.05 level for a one-tail test.

TABLE 3-7

INTERSTATE MIGRATION - DIFFERENTIAL MODEL

	1955	1965
Intercept	-4.69372 (-0.38979)	-6.80649 (-0.44725)
D_{ij}	-0.20583 (-0.11341)	-0.12067 (-0.05261)
U_{ij}	3.81507** (2.13979)	7.51945* (2.80459)
Y_{ij}	-5.06992* (-12.11759)	-3.65539** (-2.36326)
Number of Observations	26	26
$\bar{R}^2$	0.86831	0.79703

*Significant at the 0.01 level for a one-tail test.
**Significant at the 0.05 level for a one-tail test.

The regression results verify the hypotheses stated above. The unemployment elasticity for interstate migration is indeed higher than that for inter-SEA migration. Comparing this with the income elasticities for the two time periods, it is again clear that information concerning job opportunities has become more important than the income differential, as was pointed out earlier in the analysis of Table 3-1. On the other hand, a comparison of the income and distance trade-off for these two types of migration would indicate that distance indeed has a larger effect on interstate migration than on inter-SEA migration. By comparing the R^2 of these two models, it is clear that the economic factors play a more important role in the interstate migration than the inter-SEA migration. This is to be expected because of the high cost (both economic and psychic costs) involved in a long distance move.

2. Push-pull model: As was pointed out earlier, a major shortcoming of the economic differential model is that it implies the same elasticities for income and unemployment rate changes at both the points of origin and the points of destination. In order to test the hypothesis that the "pull" forces are more important than the "push" forces, economic opportunity variables both at the origin and the destination are added to the model. Table 3-8 shows the result of this model.

TABLE 3-8

ALL INTERREGIONAL MIGRATION - PUSH-PULL MODEL

	1955	1965
Intercept	-15.34585*	-12.51067
	(- 3.80504)	(- 1.56249)
D_{ij}	- 0.82435*	- 0.66862*
	(- 6.68591)	(- 5.47350)
U_i	0.87282	2.32731*
	(1.18508)	(2.44538)
U_j	- 2.04656*	- 3.46882*
	(- 2.77091)	(- 3.61642)
Y_i	- 1.47523*	- 0.76285
	(- 4.04835)	(- 1.49023)
Y_j	3.47741*	2.19523*
	(9.52792)	(4.29849)
Number of observations	182	182
$\bar{R}^2$	0.45905	0.38174

*Significant at the 0.01 level for a one-tail test.

All of the coefficients, except that of U_i in 1955 and Y_i in 1965, are significant at the 1 percent level of significance. Moreover, this model explains migratory behavior better than the differential model in terms of R^2, even after adjusted for degrees of freedom.

By comparing the elasticities of U_i to U_j and Y_i to Y_j, it is obvious that the pull forces must indeed be stronger in order

to induce migration. Not only are the coefficients generally higher for the variables at the destination, but the t statistics are also more highly significant. It should be noted that the coefficients associated with income have declined overtime while the coefficients associated with unemployment rates have increased. This indicates an apparently greater concern among recent migrants about job opportunities than income levels.

The regression results, with a dummy variable added, are shown in Table 3-9. The basic relationship between the unemployment rate and income remains unchanged except that the R^2 increased by 3 percentage points.

For the same reasons discussed in the previous section, regressions for inter-SEA and interstate migration were performed separately. The results are shown in Tables 3-10 and 3-11.

In Table 3-10, U_i (unemployment rate at the origin) has the wrong sign in 1955 although the t-value indicates that it is not significant. This is probably due to the general lack of unemployment statistics and related information at that time. The fact that unemployment has the correct sign in 1965 should provide at least partial support for this point since, beginning in 1960, improved unemployment data are available from the Bureau of Labor Statistics and various state agencies. By comparing the coefficients of these variables for the two types of migration, it is clear that the elasticities of the interstate migration are higher than those of the inter-SEA migration.

TABLE 3-9

ALL INTERREGIONAL MIGRATION - PUSH-PULL MODEL
WITH DUMMY VARIABLE

	1955	1965
Intercept	-8.73902** (-1.95970)	-9.92773 (-1.25305)
D_{ij}	-1.14578* (-7.26185)	-0.96838* (-5.94033)
U_i	1.11380 (1.54136)	2.75752* (2.90804)
U_j	-1.83387* (-2.53391)	-3.14893* (-3.31611)
Y_i	-1.85167* (-4.93660)	-0.89828** (-1.77760)
Y_j	3.10528* (8.27683)	2.03414* (4.02658)
DUM	1.28728* (3.14808)	1.11950* (2.71668)
Number of Observations	182	182
$\bar{R}^2$	0.48511	0.42315

*Significant at the 0.01 level for a one-tail test.
**Significant at the 0.05 level for a one-tail test.

TABLE 3-10

INTER-SEA MIGRATION - PUSH-PULL MODEL

	1955	1965
Intercept	-7.61838* (-2.40273)	-8.14624** (-1.68518)
D_{ij}	-1.14477* (-10.59698)	-0.94354* (-9.87266)
U_i	-0.25684 (-0.49289)	0.62008 (1.05464)
U_j	-0.50548 (-0.96803)	-1.22070** (-2.07195)
Y_i	-0.34921 (-1.21311)	-0.17792 (-0.57342)
Y_j	1.46804* (5.09802)	1.13451* (3.65652)
Number of Observations	156	156
$\bar{R}^2$	0.46796	0.44331

*Significant at the 0.01 level for a one-tail test.
**Significant at the 0.05 level for a one-tail test.

TABLE 3-11

INTERSTATE MIGRATION - PUSH-PULL MODEL

	1955	1965
Intercept	-20.50697 (-1.11769)	-29.91529 (-0.81339)
D_{ij}	-1.04983 (-0.42985)	-0.89007 (-0.32677)
U_i	3.63931 (1.19674)	8.49372** (1.92430)
U_j	-3.99380 (-1.31331)	-6.54422 (-1.48263)
Y_i	-3.71445* (-3.02347)	-2.13222 (-0.83367)
Y_j	6.42518* (5.22993)	5.18062** (2.02556)
Number of Observations	26	26
$\bar{R}^2$	0.86453	0.78318

*Significant at the 0.01 level for a one-tail test.
**Significant at the 0.05 level for a one-tail test.

The trade-off between the income and distance again shows the larger effect of distance on the interstate migration than on the inter-SEA migration. According to Table 3-10, in 1955, a 10 per cent increase in the income at the destination is offset by a 12.8 percent increase in distance, while this figure for interstate migration is 61.2 percent. In other words, the interstate migrants need a larger income at the destination in order to offset the negative effect of distance. In 1965, the comparable figures decreased to 12.0 per cent and 58.2 per cent, respectively. This decreasing trend may be attributed to the combined effect of narrowed income differential and easier transportation.

A comparison of the R^2 of these two types of migration shows that economic factors are the main resons for people making long distance movements, and are much more important for long distance than for short distance movements.

Migration Analysis by the Class of Origin and Destination

Donald J. Bogue, et. al., have pointed out that the relative importance of factors of influence may be different between the metropolitan and the non-metropolitan areas.[31] In order to understand migratory behavior more clearly for different types of origins and destinations, it seems desirable to classify the migration flows according to whether their origins and destinations are rural or urban in character.

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[31] Donald J. Bogue, H. Shryock, and S. Hoermann, op. cit., p. 64.

Tables 3-12 and 3-13 present the regression results on the push-pull model for the migration flows which originate from non-metropolitan SEAs and terminate in non-metropolitan SEAs and in metropolitan SMSAs, respectively. It appears that the economic model explains SEA to SMSA flows better than the SEA to SEA flows. It is not only that the R^2s for the former are higher than the latter, but also that all the coefficients for the former are consistent with a priori expectation while the coefficient for U_j for the latter in 1965 had the wrong sign. The income elasticities for the SEA to SMSA flows are higher than those of the SEA to SEA flows. This suggests that rural-urban migration is stimulated mainly by the higher income level in the metropolitan areas. The elasticities with respect to the unemployment rate at the destination for SEA to SMSA flows are not only higher but also have a greater degree of significance than those of the SEA to SEA flows. This may be due to the fact that unemployment statistics are easier to obtain and are more generally available in SMSAs than in SEAs.[32]

The regression results for migration flows which originate from metropolitan areas and terminate in nonmetropolitan SEAs and in metropolitan SMSAs are shown in Tables 3-14 and 3-15, respectively. It seems that the model with purely economic

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[32]The annual unemployment statistics are published by the Department of Employment Security by labor market areas (which are close to SMSAs in this study); however, they are not available for non-metropolitan parishes.

TABLE 3-12

SEA TO SEA MIGRATION
PUSH-PULL MODEL

	1955	1965
Intercept	-16.41494**	-24.83719*
	(- 2.14892)	(- 3.23276)
D_{ij}	- 1.36008*	- 1.02488*
	(- 7.49571)	(- 7.39173)
U_i	0.87098	0.74654
	(0.90179)	(0.85527)
U_j	- 0.38625	0.21579
	(- 0.39991)	(0.24721)
Y_i	- 0.47845	- 0.05319
	(- 0.66742)	(- 0.09674)
Y_j	2.61615*	2.71550*
	(3.64941)	(4.93898)
Number of Observations	56	56
$\bar{R}^2$	0.55095	0.56981

*Significant at the 0.01 level for a one-tail test.
**Significant at the 0.05 level for a one-tail test.

TABLE 3-13

SEA TO SMSA MIGRATION
PUSH-PULL MODEL

	1955	1965
Intercept	-40.55689*	-27.81712**
	(- 3.25522)	(- 2.37493)
D_{ij}	- 1.45247*	- 1.31483*
	(- 9.34009)	(- 8.51255)
U_i	0.13621	0.40696
	(0.14351)	(0.36259)
U_j	- 3.08172*	- 4.29326*
	(- 3.30489)	(- 4.58731)
Y_i	- 1.71694**	- 0.42777
	(-2.43812)	(- 0.60180)
Y_j	7.45950*	4.45302*
	(4.79606)	(3.99675)
Number of Observations	40	40
$\bar{R}^2$	0.74253	0.70402

*Significant at the 0.01 level for a one-tail test.
**Significant at the 0.05 level for a one-tail test.

TABLE 3-14

SMSA TO SEA MIGRATION
PUSH-PULL MODEL

	1955	1965
Intercept	-13.85156 (- 0.99915)	-13.39765 (- 1.29014)
D_{ij}	- 1.36357* (- 7.88023)	- 1.25115* (- 9.13633)
U_i	- 0.23769 (- 0.22908)	0.59131 (0.71261)
U_j	- 0.69708 (- 0.66004)	0.41041 (0.41243)
Y_i	0.03081 (0.01780)	- 1.33804 (- 1.35454)
Y_j	2.07807* (2.65204)	2.81613* (4.46856)
Number of Observations	40	40
$\bar{R}^2$	0.62404	0.72209

*Significant at the 0.01 level for a one-tail test.

TABLE 3-15

SMSA TO SMSA MIGRATION
PUSH-PULL MODEL

	1955	1965
Intercept	-73.38620** (- 2.20488)	-30.24574 (- 1.20449)
D_{ij}	0.02709 (0.09740)	- 0.02161 (- 0.08654)
U_i	- 1.81578 (- 1.05807)	0.65220 (0.43372)
U_j	- 4.07229** (- 2.26309)	- 4.61877* (- 2.91022)
Y_i	0.75960 (0.26612)	- 1.00555 (- 0.54591)
Y_j	8.80726* (3.03374)	4.60381* (2.55123)
Number of Observations	20	20
$\bar{R}^2$	0.26344	0.37942

*Significant at the 0.01 level for a one-tail test.
**Significant at the 0.05 level for a one-tail test.

factors does not explain the migratory behavior from SMSAs very well. The signs are wrong in all cases except for SMSA to SMSA migrations in 1965. Moreover, the coefficients of determination for metropolitan migrants are generally lower than those for the non-metropolitan migrants. Metropolitan migrants are apparently more concerned with non-economic values in their migration decisions than are rural migrants. The reason is probably that the urban people, in general, have higher incomes. Therefore, some other social or non-economic factors may play more important roles in their migration decisions.[33] In view of this conclusion, certain social characteristics were added to the model. The variables added are as follows:

1. Education level at the destination (E_j) is believed to be positively related to migration, since people tend to be attracted by the opportunity for a better education for themselves or their next generation, and better education will certainly increase their earning power. The education level is measured by the median years of education completed by the adult residents in SEA_j.

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[33]It is possible here that the migrations from SMSAs to SEAs are movements back to rural areas to retire, or movements to take advantage of rural life and good highways to commute to work.

There are some controversies over the role of the educational level in migration analysis. Some studies argue that the better educated are better equipped to recognize and take advantage of economic opportunities attainable through migration. Thus, better educated people tend to be more migratory.[34] On the contrary, others argue that education may be one of the most important non-wage benefits of any location and therefore, seems to represent an addition of real income. Thus, higher educational level in a certain area tends to attract more in-migrants.[35] The latter view is used in this study.

2. Degree of urbanization (UB_j) is expected to have a positive relationship with in-migration because of the general

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[34]See, for example, C. Horace Hamilton and Elizabeth M. Suval, "Some New Evidence on Educational Selectivity in Migration to and from the South," Social Forces (May, 1965), pp. 536-547. Michael J. Greenwood, "An Analysis of the Determinants of Geographical Labor Mobility in the United States," Review of Economics and Statistics (May, 1969), pp. 189-194. Samuel Bowles, "Migration as Investment: Empirical Tests of the Human Investment Approach to Geographical Mobility," Review of Economics and Statistics (November, 1970), pp. 356-362.

[35]See, for example, Paul T. Schultz, Population Growth and International Migration in Columbia, Santa Monica, California: The Rand Corporation, 1969. G. Iden and C. Richter, "Factors Associated with Population Mobility in the Atlantic Coastal Plains Regions," Land Economics (May, 1971), pp. 189-193. Michael S. Salkin, Migration and Migration Predictions in the Western Region of the United States. Unpublished Ph.D. Dissertation, University of California, Davis, 1973.

rural-urban migration trend in the past three or four decades. Degree of urbanization, in this study, is measured by dividing urban population by total population. The reason for the importance of this factor is that irrespective of relative income levels, urban areas generally offer certain amenities that are not available in rural areas. People move to take advantage of these.

3. Proportion of young people (AG_i). Young people especially those between 20 and 40 years of age are generally more mobile than older ones. The reason is probably that young people might have more to gain by migrating in terms of possible future income streams since they have longer working years than older people. In addition, older people tend to become entrenched, to become more committed to their present locations, either because of their work or because it is more difficult for them to adjust to new situations or to find employment in new locations.

4. Proportion of farm population (FP_i). Because of agricultural mechanization and for other reasons, the demand for labor in farm areas has declined significantly. Thus, it is expected that a high out-migration rate is associated with a larger proportion of farm population.[36]

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[36]It should be noted that SEAs and SMSAs are defined by either a single parish or grouping of parishes with similar economic environment. Thus, it is possible to have farmers in a SMSA although the proportion of farm population in the SMSA is considerably smaller than that of the rural SEA.

5. Finally, information obtained by prospective migrants from previous migrants is an important factor in making migration decisions. A friend or relative already living in the point of prospective destination not only provides general information, but also provides temporary shelter for the prospective migrants should they decide to make the move. M.J. Greenwood proposed using migrant stock as a proxy variable for this information feedback.[37] He defined the migrant stock as the number of people who were born in state i and presently live in state j.[38]

Thus, a better model would be as follows:

$$\frac{M_{ij}}{P_i} = f\left(D_{ij}, \frac{U_i}{U_j}, \frac{Y_i}{Y_j}, FP_i, AG_i, UB_j, E_j, MS_{ij}\right) \qquad (3\text{-}1)$$

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[37]M.J. Greenwood, "An Analysis of the Determinants of Geographic Labor Mobility in the United States," Review of Economics and Statistics (May 1969), pp. 189-194.

[38]Thus, migrant stock includes all people who have ever (at anytime in the past) moved from state i to state j, and are still there. Migrant stock is then the total number of migrants who have ever moved from state i to state j and stayed in state j. In fact, some migration studies have used this as the dependent variable. See M.J. Greenwood, "The determinants of Labor Migration in Egypt," Journal of Regional Science (August 1969), pp. 283-290; M.J. Greenwood, "An Analysis of the determinants of Internal Labor Mobility in India," Annals of Regional Science (June 1971), pp. 137-151; and G.S. Sahota, "An Economic Analysis of Internal Migration in Brazil," Journal of Political Economy (March-April, 1968), pp. 218-246. The length of migration interval is a lifetime as opposed to the five-year period in this study.

where

FP_i is the proportion of farm population at the origin,

AG_i is the proportion of population between 20 to 40 years old at the origin, by the end of the specified five-year period,

UB_j is the proportion of urban population at the destination,

E_j is the education level at the destination,

MS_{ij} is the migrant stock from i to j.

Unfortunately, the data on the migrant stock are not available for SEAs. Geographically speaking, the area of Louisiana is not very large, in view of the present communication and transportation system, it does not seem likely that the migrant stock variable is very important to the migration decision between SEAs within the state. For long distance migration, on the other hand, it would be important.

A forward stepwise regression procedure was used in selecting the variables to include. The criterion used was the 10 per cent significance level. It should be noted that unless the independent variables are orthogonal of each other, the stepwise procedure has two potential dangers. That is, the estimates of the coefficients tends to be biased and sometimes omit some important variables when they are highly intercorrelated.[39] However, a common problem associated with the regression analysis is that the estimates of the coefficient are usually inconsistent

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[39] R.J. Wonnacott and T.H. Wonnacott, Econometrics, (New York: John Wiley and Sons), 1970, p. 310.

with a priori expectations when the number of independent variables is increased. This is what happened by using Equation (3-1) in this study.

Entering educational level, proportion of farm population, percentage of urbanized population and the age variables not only caused unexpected and uninterpretable results but also decreased the significance level of some other variables. In order to keep the number of regressors small and to provide a more succinct model, the forward stepwise procedure is used in the following analysis. The results are shown in Tables 3-16, 3-17, 3-18, and 3-19.

In the SEA to SMSA migration stream analysis, economic variables seem to have had dominant roles in 1955. Income levels at both the origin and the destination and the unemployment rate at the destination are highly significant. It is difficult to explain the importance of the education level at the destination because it has the wrong sign in 1955. In 1965, UB_j substituted for Y_j and became a significant factor. This is probably because income levels in urban areas are generally higher than in the SEAs.

In the SEA to SEA flows, only two variables, distance and income level at the destination, are significant. Both factors are primarily economic. Thus, it seems that, in general, migrants originating from non-metropolitan areas are motivated mainly by economic factors.

TABLE 3-16

SEA TO SEA MIGRATION
STEPWISE REGRESSION

	1955	1965
Intercept	-18.56196	-23.54774
D_{ij}	- 1.36535	- 1.01072
Y_j	2.52530	2.71105
Number of Observations	56	56
$\bar{R}^2$	0.56619	0.58770

TABLE 3-17

SEA TO SMSA MIGRATION
STEPWISE REGRESSION

	1955	1965
Intercept	-79.42026	-34.51381
D_{ij}	- 1.57206	- 1.32494
Y_j	15.89473	
UB_j		6.13180
U_j	- 8.14241	
E_j	- 9.09495	3.48095
Y_i	- 1.65808	
Number of Observations	40	40
$\bar{R}^2$	0.82101	0.71309

TABLE 3-18

SMSA TO SEA MIGRATION
STEPWISE REGRESSION

	1955	1965
Intercept	-13.77598	-23.03489
D_{ij}	- 1.31838	- 1.23171
Y_j	1.85413	2.77625
FP_i	0.16092	0.08813
Number of Observations	40	40
$\bar{R}^2$	0.68852	0.74178

TABLE 3-19

SMSA TO SMSA MIGRATION
STEPWISE REGRESSION

	1955	1965
Intercept	-32.51053	-44.73790
UB_j	3.82188	6.03397
FP_i	0.22143	0.18935
E_j	4.37617	5.19018
Number of Observations	20	20
$\bar{R}^2$	0.51854	0.64755

Migration flows from SMSA to SEA can be largely explained by three variables, i.e., distance, income level at the destination, and the proportion of farm population at the origin. This is to be expected since farmers are moving out of metropolitan areas because of the expansion of urban and suburban areas. However, this point does not seem to apply to the SMSA to SMSA flows. It is possible that farmers who leave one SMSA are looking for non-agricultural opportunities in another SMSA. The distance variable is not significant in this case. This is probably partially because of higher income levels in urban areas such that moving costs are less important in the migration consideration. Generally, when people move from one urban center to another, they do so for their own professional advancement. This may not be related to the relative unemployment or income levels of the two cities. The increased coefficient associated with UB seems to indicate that urban people are attracted to bigger cities. It is also interesting to find that the education level is significant and has the correct sign. All these seem to suggest that social and other non-economic factors play more important roles in the SMSA to SMSA flows. At least the economic factors tend to be private individual economic factors and are largely unaffected by general economic measures.

CHAPTER IV

ESTIMATION OF THE INTERIM MIGRATION RATES

Introduction

Since decennial census only report migration flows for five-year intervals (i.e., the 1960 Census reports migration from 1955 to 1960, and the 1970 Census reports migration from 1965 to 1970), migration data between 1960 and 1965 are not available. In this chapter, a method is discussed for estimation of the migration rates for this missing period.

Internal population movements can be arranged in the following matrix form:[40]

From \ To	SEA_1	SEA_2	. . . .	REST OF U.S.
SEA_1	M_{11}	M_{12}	. . . .	M_{1n}
SEA_2	M_{21}	M_{22}	. . . .	M_{2n}
.	.	.		
.	.	.		
.	.	.		
REST OF U.S.	M_{n1}	M_{n2}	. . . .	M_{nn}

[40]The Census of Population also reports the number of persons who stayed in the same house, same county, or same SEA. This is the source from which to derive M_{ii}. For instance, see Table 1 of the 1970 report on "Migration between State Economic Areas."

Dividing each element by its row sum, the result can be interpreted as a transition probability matrix:

$$P = \begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1n} \\ p_{21} & p_{22} & \cdots & p_{2n} \\ \vdots & \vdots & & \\ p_{n1} & p_{n2} & \cdots & p_{nn} \end{bmatrix} \qquad (4\text{-}1)$$

Each p_{ij} denotes the proportion of population that lived in area i at time period t_0 who has migrated to area j by period t_1. p_{ij} can be interpreted as the probability that a person living in location i will move to location j. If the process is a stationary one, the P matrix will be constant for successive periods. However, as has been mentioned before, the factors affecting the migration process do not remain constant from period to period. Thus, it is necessary to discuss problems of nonstationary processes. First a statistical procedure is needed to test whether or not the transition probabilities are constant. Anderson and Goodman have shown that the following statistic can be used to test the null hypothesis of stationarity:[41]

$$\chi^2 = \sum^{n} \chi_i^2 = \sum_{i} \sum_{ij} m_i\ (t-1)\ (p_{ij}\ (t) - \hat{p}_{ij})^2/\hat{p}_{ij} \qquad (4\text{-}2)$$

This statistic is distributed as χ^2 with n(n-1)(T-1) degrees of

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[41] T.W. Anderson, and L.A. Goodman, "Statistical Inference about Markov Chains," Annals of Mathematical Statistics (1957), Volume 28, pp. 89-110.

freedom, where

n is the number of areas,

T is the number of time periods,

$m_i(t-1)$ is the size of the population in SEA_i at time t-1,

$p_{ij}(t) = m_{ij}(t)/\sum_{j=1}^{n} m_{ij}(t)$ is the probability of moving from SEA_i to SEA_j in time t, and

$\hat{p}_{ij} = \sum^{T} p_{ij}(t)/T$ is the average of p_{ij} over the entire time period T.

If the calcualted χ^2 value is greater than the critical value, the null hypothesis is rejected and it is concluded that the process is not stationary. In the present case the transition matrices for 1955 to 1960, and 1965 to 1970 are shown in Tables 4-1 and 4-2.

The χ^2 value is 37229 with 182 degrees of freedom. This is a much larger χ^2 value than could be expected to result from chance alone for any reasonable level of significance. Thus, it is concluded that the migration process represents a non-stationary process. The problem, then is how to estimate nonstationary transition probabilities for such a process. The existing literature on this topic is very limited. The following sections discuss two estimation approaches: regression and matrix approaches.

Regression Approach

In the preceding two chapters, it has been shown that population movements from area i to area j are functions of

TABLE 4-1 TRANSITION MATRIX FOR 1955-1960

	SEA 1 1	SEA 2 2	SEA 3 3	SEA 4 4	SEA 5 5	SEA 6 6	SEA 7 7	SEA 8 8	SEA A 9	SEA B 10	SEA C 11	SEA D 12	SEA E 13	REST OF U.S. 14
1	0.83069	0.00290	0.00803	0.01431	0.00321	0.00356	0.00281	0.00562	0.01954	0.00598	0.00829	0.00436	0.00273	0.08796
2	0.00521	0.83994	0.00076	0.01343	0.00384	0.00261	0.00075	0.00079	0.00532	0.00550	0.00590	0.00234	0.03048	0.08311
3	0.00738	0.00025	0.88228	0.00149	0.00320	0.01466	0.01014	0.00047	0.00215	0.01110	0.01356	0.01252	0.00122	0.03958
4	0.01386	0.00719	0.00147	0.84662	0.00208	0.00386	0.00092	0.00170	0.02504	0.00246	0.00541	0.00260	0.01218	0.07459
5	0.00172	0.00076	0.00273	0.00183	0.88226	0.00843	0.00134	0.00024	0.00080	0.02841	0.02281	0.00142	0.00042	0.04682
6	0.00140	0.00041	0.01012	0.00085	0.00638	0.91637	0.00416	0.00058	0.00095	0.01470	0.00924	0.00235	0.00051	0.03196
7	0.00525	0.00090	0.02560	0.00238	0.00270	0.01361	0.85695	0.00358	0.00126	0.00497	0.00438	0.02591	0.00073	0.05177
8	0.01456	0.00229	0.00191	0.00748	0.00203	0.00247	0.00400	0.81544	0.02571	0.00137	0.00527	0.01547	0.00130	0.10068
9	0.00868	0.00155	0.00201	0.01217	0.00152	0.00234	0.00069	0.00560	0.80448	0.00478	0.00531	0.00311	0.00434	0.14344
10	0.00130	0.00046	0.00324	0.00063	0.01215	0.00587	0.00073	0.00032	0.00137	0.89219	0.00550	0.00114	0.00063	0.07445
11	0.00255	0.00129	0.00671	0.00213	0.02012	0.01466	0.00096	0.00082	0.00348	0.01337	0.86208	0.00253	0.00163	0.06767
12	0.00489	0.00126	0.01052	0.00376	0.00208	0.00705	0.01393	0.00701	0.00515	0.00513	0.00667	0.80893	0.00036	0.12329
13	0.00454	0.01567	0.00240	0.01859	0.00278	0.00269	0.00136	0.00065	0.00889	0.00637	0.00644	0.00263	0.84398	0.08299
14	0.00008	0.00005	0.00006	0.00006	0.00008	0.00009	0.00003	0.00003	0.00021	0.00035	0.00012	0.00010	0.00004	0.99870

TABLE 4-2 TRANSITION MATRIX FOR 1965-1970

	SEA 1 1	SEA 2 2	SEA 3 3	SEA 4 4	SEA 5 5	SEA 6 6	SEA 7 7	SEA 8 8	SEA A 9	SEA B 10	SEA C 11	SEA D 12	SEA E 13	REST OF U.S. 14
1	0.81661	0.00231	0.00534	0.01372	0.00407	0.00343	0.00205	0.00570	0.01434	0.00790	0.01067	0.00327	0.00366	0.10694
2	0.00365	0.86341	0.00216	0.00841	0.00309	0.00390	0.00128	0.00211	0.00522	0.00486	0.00456	0.00025	0.01953	0.07757
3	0.00524	0.00084	0.87814	0.00145	0.00323	0.01593	0.00861	0.00156	0.00192	0.01243	0.01128	0.00677	0.00108	0.05153
4	0.01218	0.00454	0.00141	0.86238	0.00330	0.00350	0.00133	0.00240	0.01704	0.00486	0.00428	0.00156	0.01179	0.06943
5	0.00136	0.00104	0.00581	0.00285	0.85478	0.00853	0.00102	0.00059	0.00147	0.02506	0.01773	0.00127	0.00086	0.07763
6	0.00134	0.00116	0.01070	0.00127	0.00586	0.91117	0.00415	0.00140	0.00084	0.01341	0.00864	0.00184	0.00064	0.03759
7	0.00392	0.00058	0.02115	0.00155	0.00458	0.01204	0.87784	0.00406	0.00207	0.00593	0.00458	0.01896	0.00090	0.04154
8	0.01072	0.00143	0.00262	0.00569	0.00316	0.00338	0.00298	0.76564	0.01629	0.00421	0.00357	0.00875	0.00148	0.17009
9	0.00838	0.00121	0.00167	0.01064	0.00340	0.00238	0.00054	0.00365	0.81845	0.00474	0.00517	0.00099	0.00403	0.13477
10	0.00100	0.00063	0.00386	0.00081	0.01689	0.00599	0.00088	0.00091	0.00152	0.86812	0.00586	0.00091	0.00061	0.09200
11	0.00291	0.00105	0.00617	0.00194	0.01838	0.01138	0.00140	0.00119	0.00339	0.01613	0.83921	0.00286	0.00180	0.09219
12	0.00470	0.00071	0.00883	0.00234	0.00278	0.00540	0.01169	0.00648	0.00215	0.00714	0.00640	0.86165	0.00315	0.07656
13	0.00542	0.01389	0.00298	0.02107	0.00366	0.00353	0.00085	0.00174	0.01011	0.00711	0.00811	0.00212	0.81719	0.10222
14	0.00007	0.00004	0.00005	0.00005	0.00010	0.00007	0.00002	0.00016	0.00018	0.00034	0.00012	0.00005	0.00005	0.99870

economic opportunity variables both at the origin and the destination. If these independent variables can explain most of the variation and if the importance of these independent variables remain the same, then it should be possible to estimate the interim transition matrix by substituting the values of the independent variables for 1960 into the model. However, neither of these two conditions are met in this case. In fact, migration is a very complicated socio-economic phenomenon. No model yet devised can explain perfectly variations in migration. Moverover, the coefficients associated with each independent variable also change through time. This estimation method does not seem to be reliable in this case.

In 1969, M.C. Hallberg proposed a regression model to estimate each transition probability.[42] By using the time series of transition probabilities, he suggested fitting a regression equation to a set of exogenous factors for each element of a transition matrix.

$$p_{ijt} = a_{ij} + \sum_{k=1}^{K} b_{ijk} x_k \qquad (4\text{-}3)$$

where p_{ijt} is the transition probability p_{ij} at time t,

x_k is the exogenous variable,

a_{ij} is the intercept,

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[42] M.C. Hallberg, "Projecting the Size Distribution of Agricultural Firms--An Application of a Markov Process With Nonstationary Transition Probabilities," Journal of Farm Economics, (May 1969) Volume 51, No. 2, pp. 289-301.

b_{ijk} is the slope coefficient of the k^{th} independent variable.

The exogenous variables of a given model depend on the purposes of the study. In M.C. Hallberg's study, his interest was in prediction of the size distribution of frozen milk product firms. Therefore, he classified the states according to the output of firms in terms of number of gallons of output. The exogenous variables used to explain the size included population, per capita income, milk price, wage rates, etc. For the purpose of predicting migration rates by this model, all the variables used in Chapter III could be included as exogenous variables.

Since the transition matrix must meet two conditions:

$$\begin{aligned} &(1) \quad 0 \leq p_{ijt} \leq 1 \\ &(2) \quad \sum_{j=1}^{n} p_{ijt} = 1, \end{aligned} \tag{4-4}$$

it is desirable to estimate the probabilities of all rows simultaneously taking account of these restrictions. Expressed in matrix form, the problem becomes

$$P = Q\ B + U \quad \text{for each row.} \tag{4-5}$$

where

$$P = \begin{bmatrix} P_1 \\ \cdot \\ \cdot \\ \cdot \\ P_j \\ \cdot \\ \cdot \\ \cdot \\ P_n \end{bmatrix}$$ is a nTx1 vector of observations, and $$P_j = \begin{bmatrix} p_{ij1} \\ p_{ij2} \\ \cdot \\ \cdot \\ \cdot \\ p_{ijt} \\ \cdot \\ \cdot \\ \cdot \\ p_{ijT} \end{bmatrix}$$ is a Tx1 vector of observations on the j^{th} element,

$$B = \begin{bmatrix} B_1 \\ B_2 \\ \cdot \\ \cdot \\ \cdot \\ B_j \\ \cdot \\ \cdot \\ \cdot \\ B_n \end{bmatrix}$$ is a n(K+1)x1 vector of parameters to be estimated, and $$B_j = \begin{bmatrix} a_{ij} \\ b_{ij1} \\ \cdot \\ \cdot \\ \cdot \\ b_{ijk} \\ \cdot \\ \cdot \\ \cdot \\ b_{ijK} \end{bmatrix}$$ is a (K+1)x1 vector of coefficients,

$$Q = \begin{bmatrix} Q_o & & & & \phi \\ & \cdot & & & \\ & & Q_o & & \\ & & & \cdot & \\ \phi & & & & Q_o \end{bmatrix}$$ is a nT x n(K+1) matrix of observations of the independent variables, and

$Q_o = [x_o\ x_1 \ldots x_k \ldots x_K]$ is a T x (1+K) matrix,

x_o is a T x 1 vector with all elements equal to 1,

x_k is a T x 1 vector of observations on the k^{th} independent variable.

The least squares estimate of this model is

$$B = (Q'Q)^{-1} Q'P \qquad (4\text{-}6)$$

or $B_j = (Q_o' Q_o)^{-1} Q_o' P_j$ for the j^{th} element in the i^{th} row.

The projection of p_{ijt} is derived by substituting future Q_t values into the equation.

$$\hat{p}_{ijt} = Q_t \hat{B}_j \qquad (4\text{-}7)$$

Hallberg has shown that in order to meet the row sum requirements the following conditions must be met:

$$(1) \quad \sum_{j=1}^{n} a_{ij} = 1$$

$$(2) \quad \sum_{j=1}^{K} b_{ijk} = 0 \quad \text{for all } i \text{ and all } k. \qquad (4\text{-}8)$$

However, this procedure does not guarantee that all p_{ij} are positive and less than one. An arbitrary rule was suggested: First, if p_{ijt} becomes negative (or greater than unity), set it equal to zero (or unity). Secondly, divide all of the remaining elements in that row by their sum.

Hallberg applied this approach to the projection of the size distribution of frozen milk product firms and found that this projection was much better than the projection which resulted from assuming a stationary process. In the present model, since data for only two periods are available, this estimation approach is impossible.

Causative Matrix Approach

In 1970, Frank Harary, et. al., proposed a causative matrix approach to nonstationary Markov chains.[43] Given two transition matrices P_1 and P_2, they defined a causative matrix C such that $P_2 = P_1 C$. Then, C can be calculated as $C = P_1^{-1}P_2$ assuming that P^{-1} exists. This assumption is not a strong restriction, since in real situations with large transition matrices, it is rare to find any linear relationship between two

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[43]Frank Harary, et. al., "A Matrix Approach to Nonstationary Chains," Operations Research (November-December, 1970), Volume 18, No. 6, pp. 1168-1181.

rows (or two columns). An exception would, of course, be where the matrix P is the steady state matrix of a regular Markov chain. Even if the matrix is singular, a small change in any element would result in nonsingularity.[44]

The C matrix is analogous to the derivative in classical analysis as an indication of the rate of change. It has been shown that the C matrix has row sums of unity but may have negative elements. If C is constant for successive periods, the process is called a constant Markov chain. Of course, if C = I, the process is stationary.

In the present study, the period from 1955 to 1970 consists of three five-year periods. It seems reasonable to assume that the rate of change in P might be constant in these periods although in the long run the rate might not remain constant. Symbolically, the following relation is assumed:

$$P_{1960} = P_{1955} \; C \tag{4-9}$$

$$P_{1965} = P_{1960} \; C = P_{1955} \; C^2 \tag{4-10}$$

Since the 1965 and 1955 transition matrices are given,

$$C^2 = P^{-1}_{1955} \; P_{1965} \tag{4-11}$$

Then, the problem is to decompose the C^2 matrix. In general, define the resulting matrix from equation (4-11) as G. Then the problem is to find a matrix G such that

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[44] Frank Harary, et. al., <u>op</u>. <u>cit</u>., p. 1170.

$$G = N\ D\ N^{-1} \tag{4-12}$$

where D is a diagonal matrix, and N is a nonsingular matrix of the same order as G. Take matrix G multiplied by itself, then

$$G^2 = (N\ D\ N^{-1})\ (N\ D\ N^{-1})$$

$$= N\ D^2\ N^{-1} \tag{4-13}$$

In general, $G^n = N\ D^n\ N^{-1}$ (4-14)

Therefore, the problem is to find

$$G^{\frac{1}{n}} = N\ D^{\frac{1}{n}}\ N^{-1} \tag{4-15}$$

It has been proved that for a G with distinct eigenvalues, a solution for D is a diagonal matrix with nonzero elements equal to the eigenvalues of G. Moreover, it has also been established that the columns of N are the left eigenvectors which correspond to the eigenvalues of G.[45]

In practical applications of this decomposition procedure, the problem arises that there is no computer subroutine to find both eigenvalues and eigenvectors for large size nonsymmetric matrices.[46] Two steps are needed by IBM Scientific Subroutine

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[45]Andrei Rogers, "A Note on the Temporal Decomposition of Interpoint Transition Matrices," Journal of Regional Science (1966), Volume 6, pp. 53-56.

[46]For a symmetric matrix, there is a computer subroutine to find both eigenvalues and eigenvectors. See: W.W. Cooley and P.R. Lohnes, Multivariate Data Analysis (John Wiley and Sons, Inc., 1971), pp. 118-122.

Program (SSP) to find eigenvalues of a nonsymmetric matrix. First, use is made of the HSBG subroutine to transform the matrix into an almost triangular matrix and then the ATEIG subroutine is used to compute eigenvalues of this transformed matrix.[47] However, no eignevectors are given by this procedure. A simple method has been developed by the writer to find eigenvectors by multiple regression techniques. By definition, an eigenvalue is a scalar λ for which there exists an eigenvector $x \neq 0$ satisfying

$$\lambda x = A \cdot x \tag{4-16}$$

where A is a given n^{th} order matrix.

Equation (4-16) can be rewritten as

$$(A - \lambda I) \cdot x = 0 \tag{4-17}$$

There will be a solution $x \neq 0$ to (4-16) if and only if

$$|A - \lambda I| = 0. \tag{4-18}$$

Define
$$B = A - \lambda I \tag{4-19}$$

Equation (4-17) implies that B is a singular matrix. In other words, the columns (or rows) of this matrix are linearly dependent. Suppose this matrix is partitioned into column vectors v_1, v_2, ..., v_n;

i.e.,

$$\begin{aligned} v_1 &= B \cdot e_1 \\ v_2 &= B \cdot e_2 \\ &\vdots \\ v_n &= B \cdot e_n \end{aligned} \tag{4-20}$$

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[47]E.M. Murphy also developed a computer routine to calculate the eigenvalues of a nonsymmetric matrix. See: E.M. Murphy, "The Latent Roots of the Population Projection Matrix," Demography (1966), Volume 3, No. 1, pp. 259-275.

where e_i is a unit column vector with i^{th} element = 1, and all others = 0. Now, by definition of linear dependence, any vector can be expressed as a linear combination of the other vectors. For example,

$$v_1 = a_2v_2 + a_3v_3 + a_4v_4 + \ldots + a_nv_n, \qquad (4\text{-}21)$$

where not all a_i are equal to zero.

or $$v_1 - a_2v_2 - a_3v_3 - a_4v_4 - \ldots - a_nv_n = 0 \qquad (4\text{-}22)$$

substituting (4-20) into (4-22),

$$Be_1 - a_2Be_2 - a_3Be_3 - \ldots - a_nBe_n = 0$$

or $$Be_1 - Ba_2e_2 - Ba_3e_3 - \ldots - Ba_ne_n = 0 \qquad (4\text{-}23)$$

Factoring the B matrix out of Equation (4-23), yields

$$B \cdot (e_1 - a_2e_2 - a_3e_3 - \ldots - a_ne_n) = 0,$$

or

$$B \cdot \begin{bmatrix} 1 \\ -a_2 \\ -a_3 \\ \cdot \\ \cdot \\ \cdot \\ -a_n \end{bmatrix} = 0 \qquad (4\text{-}24)$$

The column vector in (4-24) is, by definition, the eigenvector sought. This method can be summarized as follows: Subtract eigenvalue from the appropriate diagonal element of the matrix. Then, pick any column of this matrix as the dependent variable and other columns as independent variables. Finally, use multiple regression techniques to estimate Equation (4-21). Collecting

these regression coefficients, the eigenvector defined in Equation (4-24) can be derived.[48] There is an eigenvector associated with each eigenvalue. Therefore, n eigenvectors can be found for a given n^{th} order matrix.

Estimation of 1960-1965 Transition Probabilities

The C^2 matrix is derived by taking the inverse of the 1955 transition matrix postmultiply by 1965 transition matrix (Table 4-3).

Applying the procedure described in the preceding section, the estimated C matrix is shown in Table 4-4.[49]

Postmultiplying the C matrix by the 1955 transition matrix, the estimated 1960 transition matrix is shown in Table 4-5.

Table 4-6 shows the push-pull model regression result of this estimated transition matrix, along with the results in Table 3-8 for purposes of comparision. It appears that this procedure results in a very close estimation. The R^2 is comparable to that of the 1965 regression. A detailed examination of the trend of the coefficients over time also seems reasonable.

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[48]It should be noted that the R^2 of this multiple regression should be close to one. If it deviates from one by three or more percentage points, then it is necessary to try another column as the dependent variable.

[49]By comparing the elements of C and C^2 matrices, an approximation rule has been found. That is, the diagonal elements of C are the square roots of the corresponding elements of C^2 matrix, and the off diagonal elements of C are one half of the corresponding elements in C^2.

TABLE 4-3 C^2 MATRIX

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	0.[illegible]313	-0.00074	-0.00318	-0.00095	0.00103	-0.00010	-0.00098	0.00049	-0.00642	0.00237	0.00319	-0.00138	0.00125	0.0222[illegible]
2	-0.00177	1.02808	0.00165	-0.00636	-0.00087	0.00155	0.00065	0.00156	-0.00007	-0.00069	-0.00147	-0.00258	-0.01191	-0.00778
3	-0.00227	0.00069	0.99539	-0.00004	0.00004	0.00164	-0.00196	0.00122	-0.00019	0.00174	-0.00219	-0.00731	-0.00017	0.01342
4	-0.00170	-0.00330	-0.00004	1.01871	0.00141	-0.00040	0.00049	0.00095	-0.00985	0.00285	-0.00122	-0.00124	0.00007	-0.00673
5	-0.00036	0.00030	0.00351	0.00112	0.96869	0.00026	-0.00040	0.00035	0.00079	-0.00304	-0.00507	-0.00021	0.00049	0.03358
6	0.00000	0.00080	0.00068	0.00044	-0.00044	0.99435	-0.00010	0.00091	-0.00010	-0.00105	-0.00034	-0.00057	0.00014	0.00529
7	-0.00136	-0.00038	-0.00502	-0.00095	0.00224	-0.00173	1.02452	0.00075	0.00116	0.00111	0.00078	-0.00981	0.00011	-0.01145
8	-0.00439	-0.00106	0.00100	-0.00222	0.00134	0.00119	-0.00130	0.93893	-0.01185	0.00339	-0.00194	-0.00930	0.00021	0.08598
9	-0.00014	-0.00040	-0.00038	-0.00216	0.00233	0.00008	-0.00018	-0.00206	1.01767	-0.00003	0.00000	-0.00275	-0.00022	-0.01178
10	-0.00030	0.00018	0.00068	0.00018	0.00573	0.00020	0.00016	0.00065	0.00016	0.97302	0.00064	-0.00029	-0.00002	0.01900
11	0.00051	-0.00034	-0.00068	-0.00028	-0.00139	-0.00373	0.00052	0.00043	-0.00012	0.00367	0.97358	0.00032	0.00026	0.02725
12	-0.00002	-0.00070	-0.00196	-0.00177	0.00085	-0.00197	-0.00315	-0.00018	-0.00365	0.00256	-0.00008	1.06555	0.00347	-0.05897
13	0.00120	-0.00254	0.00069	0.00269	0.00105	0.00103	-0.00064	0.00127	0.00154	0.00097	0.00223	-0.00065	0.96846	0.02269
14	-0.00000	-0.00002	-0.00001	-0.00001	0.00002	-0.00001	-0.00001	0.00014	-0.00004	-0.00001	0.00001	-0.00006	0.00001	0.99998

TABLE 4-4 ESTIMATED C MATRIX

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	0.99153	-0.00037	-0.00160	-0.00048	0.00052	-0.00005	-0.00049	0.00025	-0.00321	0.00120	0.00161	-0.00069	0.00063	0.01114
2	-0.00088	1.01394	0.00082	-0.00314	-0.00043	0.00077	0.00032	0.00079	-0.00004	-0.00034	-0.00073	-0.00126	-0.00596	-0.00386
3	-0.00114	0.00034	0.99769	-0.00002	0.00002	0.00082	-0.00098	0.00062	-0.00010	0.00088	-0.00110	-0.00360	-0.00008	0.00666
4	-0.00085	-0.00163	-0.00002	1.00931	0.00071	-0.00020	0.00024	0.00048	-0.00488	0.00143	-0.00061	-0.00061	0.00003	-0.00339
5	-0.00018	0.00015	0.00177	0.00056	0.98422	0.00013	-0.00020	0.00018	0.00040	-0.00154	-0.00257	-0.00010	0.00025	0.01694
6	0.00000	0.00040	0.00034	0.00022	-0.00022	0.99717	-0.00005	0.00046	-0.00005	-0.00053	-0.00017	-0.00028	0.00007	0.00264
7	-0.00068	-0.00019	-0.00250	-0.00047	0.00112	-0.00086	1.01218	0.00038	0.00057	0.00056	0.00039	-0.00480	0.00006	-0.00577
8	-0.00224	-0.00054	0.00050	-0.00113	0.00069	0.00060	-0.00066	0.96898	-0.00600	0.00174	-0.00099	-0.00465	0.00011	0.04358
9	-0.00007	-0.00020	-0.00019	-0.00107	0.00117	0.00004	-0.00009	-0.00104	1.00879	-0.00001	0.00000	-0.00135	-0.00011	-0.00587
10	-0.00015	0.00009	0.00034	0.00009	0.00291	0.00010	0.00008	0.00033	0.00008	0.98642	0.00033	-0.00014	-0.00001	0.00953
11	0.00026	-0.00017	-0.00034	-0.00014	-0.00071	-0.00188	0.00026	0.00022	-0.00006	0.00186	0.98670	0.00016	0.00013	0.01371
12	-0.00001	-0.00034	-0.00097	-0.00087	0.00042	-0.00097	-0.00154	-0.00009	-0.00179	0.00127	-0.00004	1.03225	0.00172	-0.02904
13	0.00061	-0.00127	0.00035	0.00135	0.00053	0.00052	-0.00032	0.00065	0.00078	0.00049	0.00113	-0.00032	0.98410	0.01140
14	-0.00000	-0.00001	-0.00000	-0.00000	0.00001	-0.00000	-0.00000	0.00007	-0.00002	-0.00000	0.00000	-0.00003	0.00000	0.99999

TABLE 4-5 ESTIMATED TRANSITION MATRIX FOR 1960-1965

	SEA 1 1	SEA 2 2	SEA 3 3	SEA 4 4	SEA 5 5	SEA 6 6	SEA 7 7	SEA 8 8	SEA A 9	SEA B 10	SEA C 11	SEA D 12	SEA E 13	REST OF U.S. 14
1	0.82361	0.00260	0.00668	0.01401	0.00364	0.00350	0.00243	0.00566	0.01694	0.00695	0.00949	0.00382	0.00320	0.09746
2	0.00443	0.85158	0.00146	0.01095	0.00347	0.00325	0.00101	0.00146	0.00527	0.00519	0.00524	0.00132	0.02500	0.08037
3	0.00630	0.00054	0.88021	0.00147	0.00321	0.01530	0.00938	0.00102	0.00203	0.01177	0.01242	0.00969	0.00116	0.04552
4	0.01302	0.00589	0.00143	0.85446	0.00269	0.00368	0.00112	0.00205	0.02108	0.00367	0.00485	0.00209	0.01198	0.07198
5	0.00154	0.00090	0.00428	0.00234	0.86841	0.00848	0.00118	0.00042	0.00115	0.02671	0.02025	0.00136	0.00064	0.06236
6	0.00137	0.00078	0.01041	0.00106	0.00612	0.91377	0.00415	0.00100	0.00090	0.01404	0.00894	0.00211	0.00058	0.03477
7	0.00458	0.00074	0.02338	0.00197	0.00364	0.01283	0.86732	0.00382	0.00166	0.00545	0.00462	0.02251	0.00082	0.04663
8	0.01260	0.00185	0.00227	0.00657	0.00262	0.00293	0.00348	0.79014	0.02093	0.00282	0.00441	0.01210	0.00139	0.13587
9	0.00952	0.00138	0.00184	0.01141	0.00246	0.00236	0.00061	0.00461	0.81142	0.00475	0.00524	0.00207	0.00419	0.13913
10	0.00115	0.00055	0.00355	0.00072	0.01455	0.00593	0.00081	0.00062	0.00144	0.88007	0.00569	0.00103	0.00061	0.08325
11	0.00274	0.00116	0.00644	0.00204	0.01923	0.01300	0.00118	0.00101	0.00344	0.01477	0.85056	0.00270	0.00172	0.08001
12	0.00480	0.00090	0.00968	0.00306	0.00243	0.00623	0.01284	0.00674	0.00367	0.00613	0.00653	0.83486	0.00174	0.10029
13	0.00499	0.01479	0.00269	0.01984	0.00322	0.00312	0.00111	0.00121	0.00951	0.00674	0.00729	0.00238	0.83047	[illegible]
14	0.00007	0.00004	0.00005	0.00006	0.00009	0.00008	0.00003	0.00009	0.00019	0.00034	0.00012	0.00008	0.00005	0.998[illegible]

TABLE 4-6

ALL INTERREGIONAL MIGRATION - PUSH-PULL MODEL FOR 1960-65 MIGRATION ESTIMATES AS COMPARED WITH 1955-60 AND 1965-70

	1955	1960	1965
Intercept	-15.34585*	-11.49603**	-12.51067
	(- 3.80504)	(- 2.31886)	(- 1.56249)
D_{ij}	- 0.82435*	- 0.63856*	- 0.66862*
	(- 6.68591)	(- 5.60339)	(- 5.47350)
U_i	0.87282	1.61597*	2.32731*
	(1.18508)	(2.42065)	(2.44538)
U_j	- 2.04656*	- 2.11475*	- 3.46882*
	(- 2.77091)	(- 3.14200)	(- 3.61642)
Y_i	- 1.47523*	- 0.93695*	- 0.76285
	(- 4.04835)	(- 2.60791)	(- 1.49023)
Y_j	3.47741*	2.20263*	2.19523*
	(9.52792)	(6.14032)	(4.29849)
Number of Observations	182	182	182
$\bar{R}^2$	0.45905	0.36953	0.38174

*Significant at the 0.01 level for a one-tail test.
**Significant at the 0.05 level for a one-tail test.

The distance elasticities have steadily declined over this fifteen-year period. The unemployment rate elasticities not only have increased over time but also have become the most significant of all the elasticities. On the other hand, the importance of income has declined. The results further support the hypotheses which were expressed earlier in Chapter III.

CHAPTER V

THE PROBLEM OF POPULATION DISTRIBUTION

Introduction

Internal migration will affect the population distribution among areas, not only through the migration process itself, but also due to the cumulative effects of migration. Areas with substantial number of inmigrants generally represent expanding markets which will lead to the further movement or expansion of business into these areas. The result of this movement is that it creates more job opportunities and possibly higher incomes because of the increased demand for labor. Thus, more migration can be expected to occur in the future. On the other hand, the economic activities of the areas which are experiencing outmigration can be expected to shrink due to the decreased effective demand.[50] It is essential from the policymaker's standpoint to have some idea of the future population distribution. Population projections depend on three major factors, i.e., the birth rate, the death rate, and net migration. The birth and death rates are relatively stable over time. Thus, migration is the most important and most difficult element in the projection.

Furthermore, a general trend of migration is that population moves from low income areas toward higher income, and

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[50]Roger L. Burford and S.G. Murzyn, Net Migration for Louisiana and Its Parishes (Occasional Paper No. 8, Division of Research, Louisiana State University, May 1972), p. 3.

especially metropolitan, areas. The consequences of this trend is that metropolitan areas tend to become overcrowded while other areas become more and more economically depressed. This imbalance of population distribution may be undesirable from the government's point of view. Thus, if the projected population distribution deviates from a desired distribution, it seems that the government might want to take actions to induce the necessary migrations or inhibit undesirable migration. The regression results reported in Chapter III provide some possible strategies which could be used to solve this problem.

Although an optimum population distribution may be difficult to define, the following factors suggested by Edgar M. Hoover may provide some guidelines to the determination of policy. In order to achieve maximum output, he suggested the population be located where it can contribute most effectively to output. What is desirable, from a standpoint of the whole economy, is that unemployment be minimized and that the marginal product of labor be equal or as nearly as possible at all regions. It should be noted that maximum output depends also on the spatial distribution of other factors of production (notably capital), and ideally the marginal productivity of capital also should be equal everywhere. Consequently, a situation in which market i has higher returns to labor but lower returns to capital than market j might be improved by movement of labor from j to i, or

by movement of capital from i to j, or by some combination of both. Some other objectives which might be desired include spatial equalization, equalized growth rates, desegregation, shorter commuting distances and time, reduced pollution pressure on the environment, stable age structure, and economy of public services, etc.[51]

Population Distribution

1. If population movement is a stationary process, then the population distribution could easily be determined by the theory of regular Markov Chains. Suppose w_0 is the initial population distribution among areas, then the distribution after 1 period would become $w_1 = w_0 \cdot P$. Since the transition matrices remain constant for a stationary process, the distribution after n periods would be $w_n = w_{n-1} \cdot P = w_0 \cdot P^n$. The steady state equilibrium distribution (or limiting population distribution) is a vector w such that $w \cdot P = w$.[52]

James D. Tarver has applied this concept to project the population distribution of the United States.[53] However, as

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[51] Edgar M. Hoover, "Policy Objectives for Population Distribution," Population Distribution and Policy, Research reports of the Commission on Population Growth and the American Future, Volume 5, 1972.

[52] J.C. Kemeny, et.al., Finite Mathematics with Business Applications (Englewood Cliffs: Prentice-Hall, Inc., 1962), p. 277.

[53] J.D. Tarver and W.R. Gurley, "A Stochastic Analysis of Geographical Mobility in Population Projections of the Census Divisions in the U.S.", Demography (1965), Volume 2, pp. 134-139.

has been shown in the previous chapters, the population movement cannot be viewed as a stationary process. Thus, projection by this method is questionable.

2. In Chapter IV, it was assumed that the C matrix was constant in the process of estimating the transition matrix between 1960 and 1965. Thus, a special nonstationary process, i.e., constant chain, was assumed. The limiting properties of this causative matrix approach depend on the convergence or divergence of C^n as $n \to \infty$:

(1) If C is constant with eigenvalues less than 1, the system tends toward a steady-state equilibrium.

(2) If C is constant with eigenvalues greater than 1, then one or more areas will absorb the entire population.

(3) If C changes but the eigenvalues of C are less than 1, the system can continue indefinitely, flucturating around an equilibrium.

It should be noted that since C is a rate of change, a constant C matrix would mean the continuation of this trend indefinitely. If C is a stochastic matrix itself, then this constant chain could continue while the P_i, $i = 2, \ldots, n$, are still under the restriction of a stochastic matrix. The first property discussed above is this case. However, if C has some negative elements, then the successive P_i may no longer be

probability matrices.[54] The second property will occur if the limiting matrix is no longer stochastic. In this study, the eigenvalues of the C matrix are listed below:

1.03282, 1.01518, 1.01176, 1.01105, 1.00642
1.00000, 0.99691, 0.99804, 0.99122, 0.98671,
0.98489, 0.98470, 0.98335, 0.96871

Since there are five eigenvalues greater than 1, this constant chain process can not continue indefinitely. In fact, the next transition matrix (1970-1975) assuming a constant chain would be as in Table 5-1.

This matrix has two negative elements although the magnitudes are very small. Therefore, it is no longer a stochastic matrix. It is not likely in the real world that some areas will absorb all the population; thus, this population movement trend cannot continue. In other words, C will vary through time. Since data are available for only two periods, it is not possible to derive another C matrix to evaluate the patterns of change in C.

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[54]It should be noted that it is still possible for the limiting transition matrix to be stochastic without existence of all nonnegative elements in the Matrix C. See Frank Harary, et. al., _op_. _cit_., p. 1174.

TABLE 5-1

TRANSITION MATRIX FOR 1970-1975, ASSUMING A CONSTANT CHAIN PROCESS

	SEA 1 1	SEA 2 2	SEA 3 3	SEA 4 4	SEA 5 5	SEA 6 6	SEA 7 7	SEA 8 8	SEA A 9	SEA B 10	SEA C 11	SEA D 12	SEA E 13	REST OF U.S. 14
1	0.90965	0.00200	0.00403	0.01342	0.00448	0.00337	0.00165	0.00575	0.01174	0.00882	0.01181	0.00272	0.00411	0.11644
2	0.00285	0.87540	0.00286	0.00579	0.00271	0.00455	0.00157	0.00276	0.00518	0.00455	0.00388	-0.00089	0.01408	[illegible]
3	0.00418	0.00114	0.87609	0.00143	0.00324	0.01658	0.00785	0.00208	0.00181	0.01306	0.01018	0.00376	0.00101	[illegible]
4	0.01133	0.00319	0.00137	0.87038	0.00391	0.00332	0.00153	0.00275	0.01294	0.00606	0.00372	0.00102	0.01162	0.06687
5	0.00119	0.00118	0.00731	0.00334	0.94135	0.00859	0.00086	0.00075	0.00181	0.02344	0.01532	0.00120	0.00105	0.09264
6	0.00131	0.00153	0.01098	0.00147	0.00562	0.90858	0.00414	0.00180	0.00079	0.01276	0.00836	0.00158	0.00069	0.04039
7	0.00325	0.00043	0.01889	0.00114	0.00552	0.01124	0.88846	0.00429	0.00252	0.00639	0.00511	0.01525	0.00096	0.03652
8	0.00849	0.00101	0.00297	0.00485	0.00370	0.00381	0.00248	0.74189	0.01176	0.00552	0.00278	0.00540	0.00155	0.20337
9	0.00823	0.00103	0.00151	0.00986	0.00434	0.00240	0.00046	0.00272	0.82553	0.00469	0.00510	-0.00013	0.00388	0.13039
10	0.00085	0.00073	0.00418	0.00090	0.01914	0.00696	0.00095	0.00118	0.00159	0.85632	0.00603	0.00079	0.00059	0.10070
11	0.00309	0.00091	0.00591	0.00185	0.01755	0.00977	0.00162	0.00137	0.00335	0.01746	0.82799	0.00304	0.00189	0.10421
12	0.00463	0.00042	0.00793	0.00160	0.00314	0.00454	0.01049	0.00623	0.00057	0.00819	0.00628	0.88929	0.00458	0.05211
13	0.00583	0.01302	0.00326	0.02233	0.00406	0.00395	0.00061	0.00224	0.01071	0.00745	0.00889	0.00185	0.80412	0.11169
14	0.00007	0.00002	0.00004	0.00005	0.00011	0.00007	0.00002	0.00023	0.00016	0.00032	0.00013	0.00002	0.00006	0.99869

Policy Implications

Due to a lack of migration data, a precise projection of the future population distribution is not possible. However, projections based on the stationary process should provide some general idea about the future distirbution.

The equilibrium distributions based on the 1955-1960 and 1965-1970 transition matrices are listed in Table 5-2, respectively.

A comparison would indicate that Louisiana has become less attractive over this ten year period as the proportion of the U.S. population in the state has declined from 0.017810 to 0.014874. This indicates that the economic opportunities in the State are limited as compared to the rest of U.S. In view of the recent energy crisis, this situation will probably be improved because the high prices of oil and natural gas may induce more investment in the State. However, the employment opportunities associated with these industries themselves are very limited. According to a recent study by the Department of Agricultural Economics of Louisiana State University, the petroleum industry provides only 5 jobs for every 1 million dollars worth of output, the chemical industry only 15. The comparable figure for textile products industry is 64 and for

TABLE 5-2

EQUILIBRIUM RELATIVE POPULATION DISTRIBUTIONS BASED ON STATIONARY MARKOV CHAIN ASSUMPTION (PROPORTION OF U.S. TOTAL)

SEAs	(Main City)	1955	1965
SEA 1	(Alexandria)	.000833	.000673
SEA 2	(Bastrop)	.000504	.000423
SEA 3	(Lafayette)	.001279	.001042
SEA 4	(Ruston)	.000829	.000777
SEA 5	(Hammond)	.001738	.001464
SEA 6	(Houma)	.002413	.001846
SEA 7	(Crowley)	.000557	.000476
SEA 8	(DeRidder)	.000290	.000799
SEA A	(Shreveport)	.001462	.001301
SEA B	(New Orleans)	.004613	.003500
SEA C	(Baton Rouge)	.001850	.001428
SEA D	(Lake Charles)	.000885	.000690
SEA E	(Monroe)	.000557	.000455
REST OF U.S.		.982185	.985119

the furniture industry it is 68.[55] Thus, the State should not only develop petroleum related processing industries, but needs to diversify its industry. Unemployment rates for the State in 1960 and 1970 were 6.5%, 6.2%, respectively. These were considerably higher than the national averages of 5.5% and 4.9%. For this reason, as well as to achieve a more balanced industrial structure,the state should attempt to attract more labor-intensive industries, such as textiles, furniture, food processing, etc., in order to increase its job opportunities.

Table 5-3 shows the population distribution among the SEAs within the State. The distribution has remained relatively stable except for the large increase in the 8th SEA. The increase in that SEA resulted largely from the large increase of military personnel because of the expansion of Fort Polk in the height of the Viet Nam war.[56] Since 1970 this expansion has been reversed. It is also interesting to note that the number of in-migrants for this SEA from out-of-state in 1955-1960 was only 3830 (or 0.00003 in terms of migration rate) while it increased to 27656 (or 0.00016 in terms of migration rate) in 1965-1970. This is an indication of the inflow of military

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[55]T.H. Klindt and K.W. Paxton, The Impact on Employment of Increasing Output of Industries in Louisiana (D.A.E. Report No. 468, Department of Agricultural Economics, Louisiana State University, June 1974), p. 10.

[56]Roger L. Burford and S.G. Murzyn, Population Projections by Age, Race and Sex for Louisiana and Its Parishes 1970-1985 (Occasional Paper No. 10, Division of Research, Louisiana State University, June 1972), pp. 13-14.

TABLE 5-3

EQUILIBRIUM RELATIVE POPULATION DISTRIBUTIONS
AMONG SEAS WITHIN LOUISIANA
(PROPORTION OF STATE TOTAL)

SEAs	(Main City)	1955	1965
SEA 1	(Alexandria)	.048487	.045247
SEA 2	(Bastrop)	.029336	.028439
SEA 3	(Lafayette)	.074447	.070055
SEA 4	(Ruston)	.048254	.052239
SEA 5	(Hammond)	.101164	.098225
SEA 6	(Houma)	.140454	.124109
SEA 7	(Crowley)	.032421	.032002
SEA 8	(DeRidder)	.016880	.053718
SEA A	(Shreveport)	.085099	.087468
SEA B	(New Orleans)	.268510	.235310
SEA C	(Baton Rouge)	.107683	.096006
SEA D	(Lake Charles)	.051513	.046390
SEA E	(Monroe)	.032421	.030590

related personnel from other states. Now that the Viet Nam war has ended as indicated above, this trend has been reversed. This evidence also explains, at least in part, why the C matrix cannot stay constant.

It was mentioned earlier that one general trend of migration is that the population moves from low income areas toward higher income (usually) metropolitan areas. One consequence of this trend is that metropolitan areas tend to become over-crowded while other areas become more and more economically depressed. The problems associated with the large metropolitan centers are overcrowding, high levels of noise, traffic congestion, high housing cost, etc. Moreover, the social costs of further expansion of the large cities are extremely high. On the other hand, the cumulative result for depressed areas is that the young and better educated people move away, businesses shrink and fewer job opportunities are available. Tax revenues also decline, which causes essential public services to become more limited. The imbalance of population distribution is economically and socially undesirable. Although the criterion of "balance" is difficult to define, it is implied in this study that the growth of the larger cities should be slowed and that more dispersed pattern of growth, i.e., more small and medium-sized urban areas should be developed.

Suppose that the projected population distribution deviates from the "desired" distribution. Then the government might want

to take actions to induce migration toward a more desirable distribution. Based on the regression results presented in Chapter III, the following strategies could be taken to induce the migration: For a given destination, the government could directly provide jobs through public works programs. The immediate effect of this action would be to reduce the unemployment rate. This will attract new migrants. A side effect would be that this would increase the demand for labor, which would eventually bid up the general income level if the number of inmigrants does not offset the increased demand for labor. Indirectly, the government could implement manpower resource development programs to improve the quality of the labor supply. Furthermore, by providing better public facilities, such as highway and communication systems, and tax allowances, new capital flow could be attracted into the area such that more jobs are available. It is hoped that these actions would increase the relative attractiveness of the destination.

On the other hand, the government could directly subsidize the moving cost to the new migrants to encourage movement from certain origins. This would probably reduce the effect of distance on migration. Indirectly, the government could provide informational services to potential migrants. Some western European countries, for example, have an interregional clearinghouse

system for job opportunities.[57] Lists of job openings are reported to the local employment services and then to the district or regional level, and finally, to the national clearing system. This information is then distributed to all local employment services. This kind of service could greatly reduce the risk and uncertainty of migration and would be especially useful to those who are unemployed.

In order to achieve a balanced population distribution, the "Commission on Population Growth and the American Future" recently recommended a growth center strategy.[58] They suggested that migrants from economically depressed areas should be discouraged - or at least not encouraged - from moving into congested metropolitan regions. More specifically, they suggested the creation of new jobs nearer to or within the declining rural areas which have potential for future growth. The type of growth centers they suggested are expanding cities in the 25,000 to 350,000 population range whose anticipated growth may bring them to 50,000 to 500,000. In a study by Edward Murray and Ned Hege, the following criteria were suggested to select national growth centers:

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[57]Niles B. Hansen, "The Case of Government-Assisted Migration," Population, Distribution and Policy, Research Reports of the Commission on Population Growth and the American Future, (1972), Volume V, p. 1683.

[58]Population and The American Future, Research reports of the Commission on Population Growth and The American Future, (1972), Volume 1, pp. 125-126.

1. The place grew faster than the national rate of 13.3 percent during the past decade.
2. The place is more than 75 miles from an existing or projected metropolitan area of two million or more.
3. The place did not exceed an upper size limit of 350,000 in 1970.[59]

The first criterion could be used to select growth centers at the state level. However, the distance and population sizes could be reduced somewhat to encourage more medium sized urban centers.

In Louisiana, Lafayette and Alexandria would be two prospective growth centers. Lafayette is a fast-growing city, its population has grown from 40,400 in 1960 to 68,908 in 1970 or a 70.6 per cent increase over this ten year period. This growth rate is the highest among the urban areas in the state. Petroleum related industries are the major cause for such a rapid growth in Lafayette.

Alexandria is located near the geographical center of the state. Development of the textile industry there would probably be worthwhile because of an abundant cotton supply in its surrounding areas and because of a large number of low skilled workers in the area. The furniture industry could probably also be established in view of a large lumber supply. Job opportunities

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[59]Edward Murray and Ned Hege, "Growth Center Population Redistribution 1980-2000." Population Distribution and Policy, Research reports of the Commission on Population Growth and The American Future (1972), Volume 5, p. 187.

are expected to increase in both industries. Ruston, Hammond, and Houma are also good potential growth centers in the future. Houma, being a center for offshore oil exploitation, has had a rather high population growth rate, a 37.1 per cent increase over 1960. This trend is expected to continue in the near future. The growth rates for Ruston and Hammond were 24.1 per cent and 18.2 per cent, respectively. Forest industries could be developed in Ruston while food processing industries may be established in Hammond because of the nature of the agriculture in the area.

In conclusion, in order to achieve a balanced population distribution, some direct and indirect strategies could be adopted both at the origin and the destination. The government might also actively develop growth centers by providing better public facilities and a better investment environment. These recommendations are relevant for all three levels of government: Federal, State, and Local.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Conclusions

In the process of building economic models of interregional migration in this study, several hypotheses have been tested. It is believed that migratory behavior is explained better by directional place-to-place migration data rather than by the net migration. Since net migration analysis results in a partial offset of the effect of in- and out- migration, it is difficult to explain the push and pull forces behind the migratory flows.

Migration is a very complex phenomenon. A survey conducted in the early 1960s showed that, although work related factors (or economic factors) are the main reasons for people's moving, a large portion of the variation in place to place migration rates is accounted for by other social or personal reasons.

In Chapter III, several economic hypotheses were tested by using migration data between SEAs published in the Census of Population. It was verified that the unemployment rate, the income level, and distance (used as a proxy variable for migration cost as well as availability of information) are the main economic reasons for migration. An economic differential model was developed and the results were as expected. The differentials were defined by taking the values of the variables at the origin divided by the values at the destination. It was found that migration varies

directly with the unemployment differential. And that it varies inversely with the income differential and distance. Furthermore, the importance of these independent variables over time was examined by using two sets of cross-sectional migration data, i.e., 1955-1960 and 1965-1970. In view of the rapid growth of communication systems and easier transportation between the two periods, it was expected that the distance elasticity would have declined over this period. This was indeed confirmed. It was also found that the income elasticity had decreased, perhaps due to the narrowed relative income differential among the regions; a likely partial result of the migration process itself. More importantly, migrants have apparently become more aware of job opportunities. This was reflected by increased coefficients associated with unemployment rate over this period.

A major shortcoming of the economic differential model is that it implies the same elasticities for income and unemployment rate changes, at both the origin and the destination. On the contrary, it is to be expected that pull forces are more important than push forces because of the social and cultural ties of a potential migrant to his community in the origin. A push-pull model was developed to test this hypothesis by including in the model economic opportunity variables at both the origin and the distination. This hypothesis is verified by the fact that, not only are the coefficients at the destination greater than those of the origin, but they are also statistically more significant as

indicated by their t-statistics. The trend of coefficients over time also confirms the expectations pointed out earlier in the economic differential model. That is, the distance and income elasticities have declined while the importance of the unemployment rate has increased. Since both the geographic area and the population size of the "rest of U.S." are not comparable to those of the SEAs, and since the elasticities of the economic variables may not be the same for short and long distance movements, two regressions were applied to inter-SEA migration and interstate migration separately. It was confirmed in these analyses that the unemployment elasticity of interstate migration is indeed higher than that of inter-SEA migration and that interstate migrants need larger income differentials to offset the negative effect of distance.

In a more detailed analysis, the origins and destination were classified into subclasses according to their degrees of urbanization. A stepwise regression procedure was employed and the criterion used for variable selection was the 10 percent significant level. In addition to the economic variables mentioned above, several social and non-economic variables were also included. It was found that rural-urban migration is attracted mainly by higher income levels in the metropolitan areas. Other significant variables include the unemployment rate at the destination, distance, and the income level at the origin, etc. In the SEA to

SEA flows, only two variables were statistically significant, i.e., distance and the income level at the destination. Generally speaking, migrants who originated at non-metropolitan areas tend to be motivated mainly by economic factors. On the other hand, SMSA to SMSA flows seem to be more affected by social and non-economic factors than by aggregative economic variables. The distance variable was not present in the SMSA to SMSA results. The reason is probably that people move from one SMSA to another because of employment opportunities offered them individually. That is the fact that the average income level is higher may not be importent, but if an individual is offered a better job in another location he will consider it. As for the SMSA to SEA flows, they were dominated mainly by economic factors.

Since the decennial censuses only report migration flows for the five-year interval immediately prior to the census date, migration data for SEAs between 1960 and 1965 are not available. In Chapter IV, a causative matrix approach, assuming a constant rate of change, was used to estimate the migration rates for this missing period. Regression results of these estimated rates on the independent variables for the same period show that these are very close estimates. However, if a time series of transition probabilities were available for a sufficiently long period, the regression approach would seem to be more reasonable. In the present study, since data for only two periods are available, this estimation approach is impossible.

In Chapter V, the problem of the optimum or desirable population distribution was discussed. A balanced population is both economically and socially desirable. If the projected distribution deviates from the desired one, then migration may be a means of achieving the desired distribution. Based on the regression results reported in Chapter III, the following strategies might be helpful to induce the desired migration. At a given prospective destination the government can spend money directly in public works programs, such as highways, hospitals, schools, and sewage systems. The objective of this action, in addition to the resulting public facilities, is to provide job opportunities, and hopefully will bid up the general wage level. Indirectly, the government may improve the investment environment at the prospective destination by providing better public services and improved tax allowances. It is hoped that this will attract a capital flow into the area to create new job opportunities. On the other hand, direct subsidization of moving cost would reduce the effect of distance to potential migrants. It is also desirable to provide employment information services to the people in the points of prospective origin. A growth center strategy was proposed by the "Commission on Population Growth and the American Future". The aim was to create medium sized urban areas in the depressed regions in order to achieve spatial equilibrium.

Limitations

In addition to the limitations imposed by the data as was pointed out at the beginning of Chapter II, there are several other limitations of this study:

1. In this study the migration data used were migration flows between state economic areas. SEAs have been formed by grouping parishes which have similar socio-economic characteristics. The use of parishes for present purposes is considered too small and would obscure major regional features. On the other hand, the boundaries of SEAs do not necessarily remain fixed although they did not change between 1955 and 1970. Some of the existing SMSAs have expanded their boundaries. For instance, the Baton Rouge SMSA was composed of East Baton Rouge parish only for the past two decades, but has been expanded to include surrounding West Baton Rouge, Livingston, and Ascension parishes. Additionally, new SMSAs have been created. Thus, the migration data published in the next Census report will not be comparable to the data used in this study. Furthermore, the population distribution projections based on the Markov chain model will be affected by changes in boundaries. This makes it more difficult to compare the equilibrium population distribution at different time periods.

2. A five-year migration interval was used in this study. In other words, only the people who were five years old and over at the end of the migration period are included in the analysis.

The data do not include those who were born since the specified beginning date (i.e., 0-4 age group). This age group of people most likely includes the dependents of people aged between 20 and 40. It is expected that people between 20 and 40 years old represent the most mobile segment in the population and that they are most likely to be motivated by economic opportunities. Since the main concern of this study has been to assess the effect of economic conditions on human migration, the proportion of explained variation would probably be improved if the migrants of 0-4 age group were included. Moreover, exclusion of those aged over 65 would also improve the results since their movements are not likely to be affected much by economic conditions in the sending and receiving areas.

3. It was expected that migration is also affected by the factors of race, sex, age, and occupation as well as other factors not studied. However, data in the detail needed for detailed analysis are not available and hence their migration differentials can not be analyzed. From a practical point of view, the analysis of the migration stream is probably the only alternative in this study. If the migration area were expanded to include the whole state, detailed migration differential analyses could have been made and probably would have been worthwhile. However, the analysis as conducted has yielded some interesting and useful insights into the process of population movements. No major surprises, however, have resulted from the analysis.

Suggestion for Future Research

In the analysis of the migration models presented in this study, it has been verified that the migration flows depend on economic opportunities both at the origin and at the destination. It has also been pointed out that the results of migration have contributed to a narrowing of economic differentials. Thus, it is clear that migration and economic variables, as well as other social and demographic variables, have a dynamic interrelationship. That is, migration may be a lagged response to economic opportunities. On the other hand, through its effect on the labor supply both at the origin and the destination, economic differentials are influenced by the migration process, perhaps after some time lag. In view of this, a large scale econometric model could be developed to examine the interrelationships between migration and other economic variables. This would be an interesting area for future research.

APPENDIX

APPENDIX A

LIST OF PARISHES IN EACH STATE ECONOMIC AREA

LOUISIANA

AREA 1

- Natchitoches
- Rapides
- Red River

AREA 2

- Catahoula
- Concordia
- East Carroll
- Franklin
- Madison
- Morehouse
- Richland
- Tensas
- West Carroll

AREA 3

- Avoyelles
- Evangeline
- Lafayette
- Pointe Coupee
- St. Landry

AREA 4

- Bienville
- Caldwell
- Claiborne
- Grant
- Jackson
- LaSalle
- Lincoln
- Union
- Webster
- Winn

AREA 5

- East Feliciana
- Livingston
- Plaquemines
- St. Charles
- St.Helena
- St. Tammany
- Tangipahoa
- Washington
- West Feliciana

AREA 6

- Ascension
- Assumption
- Iberia
- Iberville
- Lafourche
- St. James
- St. John the Baptist
- St. Martin
- St. Mary
- Terrebonne
- West Baton Rouge

AREA 7

- Acadia
- Allen
- Cameron
- Jefferson Davis
- Vermilion

AREA 8

- Beauregard
- DeSoto
- Sabine
- Vernon

AREA A

- Bossier
- Caddo

AREA B

- Jefferson
- Orleans
- St. Bernard

AREA C

- East Baton Rouge

AREA D

- Calcasieu

AREA E

- Ouachita

APPENDIX B MIGRATION FLOWS (M_{ij}) FOR 1955–1960

	SEA 1 1	SEA 2 2	SEA 3 3	SEA 4 4	SEA 5 5	SEA 6 6	SEA 7 7	SEA 8 8	SEA A 9	SEA B 10	SEA C 11	SEA D 12	SEA E 13	REST OF U.S. 14
1	111571.	399.	1079.	1922.	431.	478.	378.	755.	2625.	803.	1113.	586.	367.	11814.
2	845.	136176.	124.	2178.	623.	423.	121.	128.	863.	892.	957.	380.	4942.	13474.
3	1656.	55.	197971.	334.	718.	3289.	2276.	105.	483.	2490.	3043.	2810.	273.	8882.
4	2414.	1253.	256.	147456.	362.	673.	161.	296.	4362.	428.	943.	453.	2122.	12991.
5	355.	157.	564.	378.	182143.	1740.	276.	50.	166.	5865.	4709.	294.	87.	9666.
6	435.	127.	3146.	265.	1983.	284742.	1293.	180.	294.	4569.	2871.	731.	160.	9931.
7	695.	119.	3390.	315.	357.	1802.	113459.	474.	167.	658.	580.	3431.	97.	6854.
8	1118.	176.	147.	574.	156.	190.	307.	62608.	1974.	105.	405.	1188.	100.	7730.
9	2073.	370.	480.	2907.	362.	559.	165.	1337.	192169.	1141.	1268.	743.	1037.	34264.
10	973.	347.	2419.	471.	9065.	4378.	547.	242.	1022.	665835.	4108.	854.	469.	55560.
11	464.	234.	1221.	388.	3658.	2665.	175.	150.	633.	2431.	156753.	460.	296.	12304.
12	562.	145.	1210.	432.	239.	811.	1602.	806.	592.	590.	767.	93046.	41.	14181.
13	383.	1321.	202.	1567.	234.	227.	115.	55.	749.	537.	543.	222.	71126.	6994.
14	11393.	8021.	8854.	9181.	12047.	13514.	4703.	3830.	32340.	53392.	17750.	15925.	6531.	151531104.

APPENDIX C MIGRATION FLOWS (M_{ij}) FOR 1965–1970

	SEA 1 1	SEA 2 2	SEA 3 3	SEA 4 4	SEA 5 5	SEA 6 6	SEA 7 7	SEA 8 8	SEA A 9	SEA B 10	SEA C 11	SEA D 12	SEA E 13	REST OF U.S. 14
1	115390.	326.	754.	1939.	575.	485.	289.	805.	2027.	1116.	1508.	462.	517.	15111.
2	542.	128260.	321.	1249.	459.	579.	190.	314.	775.	722.	678.	37.	2901.	11523.
3	1281.	205.	214550.	354.	788.	3892.	2104.	380.	468.	3036.	2756.	1654.	264.	12590.
4	2103.	784.	243.	148905.	570.	604.	230.	414.	2943.	839.	739.	270.	2036.	11988.
5	337.	258.	1440.	706.	211739.	2112.	252.	146.	365.	6208.	4393.	314.	212.	19229.
6	503.	434.	4004.	474.	2194.	341111.	1552.	525.	316.	5019.	3234.	690.	240.	14068.
7	540.	80.	2916.	214.	631.	1660.	121058.	560.	286.	818.	673.	2615.	124.	5729.
8	904.	121.	221.	480.	267.	285.	251.	64591.	1374.	355.	301.	738.	125.	14349.
9	2097.	302.	419.	2663.	851.	596.	134.	915.	204911.	1186.	1295.	247.	1008.	33742.
10	832.	524.	3223.	678.	14085.	4999.	735.	757.	1267.	723947.	4889.	760.	507.	76719.
11	675.	243.	1429.	450.	4259.	2636.	325.	275.	786.	3738.	194443.	663.	416.	21360.
12	582.	88.	1092.	290.	344.	668.	1447.	802.	266.	884.	792.	106619.	390.	9474.
13	540.	1385.	297.	2101.	365.	352.	85.	173.	1008.	709.	809.	211.	81477.	10192.
14	11814.	6022.	8507.	8736.	16306.	12862.	3553.	27656.	30492.	57882.	21403.	9400.	8009.	171344064.

BIBLIOGRAPHY

1. Anderson, T.W. and L.A. Goodman, "Statistical Inference About Markov Chains," Annals of Mathematical Statistics, (March 1957), pp. 89-109.

2. Blanco, Cicely, "The Determinants of Interstate Population Movements," Journal of Regional Science, (Summer 1963), pp. 77-84.

3. Bogue, D.J. and C.L. Beale, Economic Areas of the United States. New York: The Free Press of Glencoe, Inc., 1961.

4. ________, H. Shryock, and S. Hoermann, Subregional Migration in the United States, 1935-1940, Volume I, Streams of Migration. Ohio: Miami University, 1957.

5. Bowles, S., "Migration as Investment: Empirical Tests of the Human Investment Approach to Geographic Mobility," Review of Economics and Statistics, (November 1970), pp. 356-362.

6. Bramball, D.F. and H. J. Bryce, "Interstate Migration of Labor-Force Age Population," Industrial and Labor Relations Review, (July 1969), pp. 576-583.

7. Burford, R.L. and S.G. Murzyn, Net Migration for Louisiana and Its Parishes 1960-1970, (Occasional Paper No. 8, Division of Research, Louisiana State University, May 1972).

8. ________, Population Projections by Age, Race and Sex for Louisiana and Its Parishes 1970-1985, (Occasional Paper No. 10, Division of Research, Louisiana State University, June 1972).

9. Cebula, R.J., R.M. Kohn and R.K. Vedder, "Some Determinants of Interstate Migration of Blacks, 1965-1970," Western Economic Journal, (December 1973), pp. 500-505.

10. The Commission on Population Growth and the American Future, Population and the American Future, Washington, D.C.: U.S. Government Printing Office, 1972.

11. ___________, Population Distribution and Policy. Washington, D.C.: U.S. Government Printing Office.

12. Cooley, W. W. and P.R. Lohnes, Multivariate Data Analysis. New York: John Wiley & Sons, Inc., 1971.

13. Gallaway, L.E., R.F. Gilbert, and P.E. Smith, "The Economics of Labor Mobility: An Empirical Analysis," Western Economic Journal, (June 1967), pp. 211-223.

14. ________, and R.J. Cebula, "Differentials and Indeterminacy in Wage Rate Analysis: An Empirical Note," Industrial & Labor Relation Review, (April 1973), pp. 991-995.

15. Goodrich, Carter, B.W. Allen, et. al., Migration and Economic Opportunity, Philadelphia, Pa.: University of Pennsylvania Press, 1936.

16. Greenwood, Michael J., "An Analysis of the Determinants of Geographic Labor Mobility in the United States," Review of Economics and Statistics, (May 1969), pp. 189-194.

17. ________, "The Determinants of Labor Migration in Egypt," Journal of Regional Science, (August 1969), pp. 283-290.

18. ________, "An Analysis of the Determinants of Internal Labor Mobility in India," Annals of Regional Science, (June 1971), pp. 137-151.

19. Hallberg, M.C., "Projecting the Size Distribution of Agricultural Firms--An Application of a Markov Process with Nonstationary Transition Probabilities," Journal of Farm Economics, (May 1969), pp. 289-301.

20. Hamilton, C.H. and E.M. Suval, "Some New Evidence on Educational Selectivity in Migration to and from the South," Social Forces (May 1965), pp. 536-547.

21. Harary, Frank, B. Lipstein, and G.P.H. Styan, "A Matrix Approach to Nonstationary Chains," Operations Research, (Nov.-Dec. 1970), pp. 1168-1181.

22. Hicks, J.R., The Theory of Wages (Gloucester, Mass: Peter Smith, 1957), p. 76.

23. Iden, G. and C. Richter, "Factors Associated with Population Mobility in the Atlantic Coastal Plans Region," Land Economics, (May 1971), pp. 189-193.

24. Issac, J.E., Economics of Migration, Oxford University Press, 1947.

25. Kemeny, J.G., et. al., Finite Mathematics with Business Applications, Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1962.

26. Klindt, T.H. and K.W. Paxton, The Impact on Employment of Increasing Output of Industries in Louisiana, (D.A.E. Report No. 468, Department of Agricultural Economics, Louisiana State University, June 1974).

27. Lee, E.S., "A Theory of Migration," Demography, (1966), pp. 45-57.

28. Levy, M.B. and W.J. Wadycki, "What is the Opportunity Cost of Moving? Reconsideration of the Effects of Distance on Migration," Economic Development and Cultural Change, (January 1974), pp. 198-214.

29. Lipstein, Benjamin, "A Mathematical Model of Consumer Behavior," Journal of Marketing Research, (August 1965), pp. 259-265.

30. Lowry, Ira S., Migration and Metropolitan Growth: Two Analytical Models, Los Angeles, California: University of California Press, 1966.

31. Morgan, Celia A., The Geographic Mobility of Labor: An Investigation of the Role of Wages and Unemployment Rates in the Migration Process, Unpublished Ph.D. dissertation, University of Houston, 1971.

32. Munro, John M., "Migration in Turkey," Economic Development and Cultural Change, (July 1974), pp. 634-653.

33. Murphy, E.M., "The Latent Roots of the Population Projection Matrix," Demography, (1966), pp. 259-275.

34. Nelson, P., "Migration, Real Income and Information," Journal of Regional Science, (Spring 1959), pp. 43-74.

35. Neidercorn, J.H. and B.V. Bechdolt, Jr., "An Economic Derivation of the Gravity Law of Spatial Interaction," Journal of Regional Science, (August 1969), pp. 273-283.

36. Oliver, F.R., "Inter-Regional Migration and Unemployment, 1951-1961," Journal of the Royal Statistical Society, Series A, (Spring 1964), pp. 42-75.

37. Price, Daniel O., "Some Socio-Economic Factors in Internal Migration," Social Forces, (May 1951), pp. 409-415.

38. Raimon, Robert L., "Interstate Migration and Wage Theory," Review of Economics and Statistics, (November, 1962), pp. 428-438.

39. Ravenstein, E.G., "The Laws of Migration," Journal of the Royal Statistical Society, (June 1885), pp. 167-227.

40. Rogers, Andrei, "A Note on the Temporal Decomposition of Interpoint Transition Matrices," Journal of Regional Science, (Winter 1966), pp. 53-56.

41. ________, Matrix Analysis of Interregional Population Growth and Distribution, Berkeley, California: University of California Press, 1968.

42. ________, Matrix Methods in Urban and Regional Analysis, San Francisco: Holden-Day, 1971.

43. Saben, Samuel, "Geographic Mobility and Employment Status, March 1962-March 1963," Monthly Labor Review, (August 1964), pp. 873-881.

44. Sahota, G.S., "An Economic Analysis of Internal Migration in Brazil," Journal of Political Economy, (March-April 1968), pp. 218-246.

45. Sjaastad, Larry A., "Costs and Returns to Human Migration," Journal of Political Economy, (October 1962), pp. 80-93.

46. Schultz, Paul T., Population Growth and International Migration in Columbia, Santa Monica, California: The Rand Corporation, 1969.

47. Shryock, Henry S., Population Mobility Within the United States, Chicago: Community and Family Study Center, University of Chicago, 1964.

48. Stouffer, Samuel A., "Intervening Opportunities: A Theory Relating Mobility and Distance," American Sociological Review, (December 1940), pp. 845-867.

49. Tarver, James D. and W.R. Gurley, "A Stochastic Analysis of Geographical Mobility in Population Projections of the Census Divisions in the U.S.," Demography, (1965), pp. 134-139.

50. U.S. Bureau of the Census, U.S. Census of Population 1960, Mobility for States and State Economic Areas, (PC(2)-2B).

51. ________, U.S. Census of Population 1970, Migration Between State Economic Areas, (PC(2)-2E).

52. ________, U.S. Census of Population 1960, State Economic Areas, (PC(3)-1A).

53. ________, U.S. Census of Population 1970, State Economic Areas, (PC(2)-10B).

54. ________, U.S. Census of Population 1950, Volume II, Part 18, Louisiana.

55. ________, U.S. Census of Housing, 1950, Volume I, Part 3.

56. ________, U.S. Census of Housing, 1960, Volume I, Part 4.

57. ________, U.S. Census of Housing, 1970, Volume I, Part 20.

58. Weiss, L., and J.G. Williamson, "Black Education, Earnings, and Interregional Migration: Some New Evidence," American Economic Review, (June 1972), pp. 372-383.

59. Willis, Kenneth G., Problems in Migration Analysis, England: Saxon House, 1974.

60. Wonnacott, R.J. and T.H. Wonnacott, Econometrics, (New York: John Wiley and Sons), 1970.

61. Zipf, George K., "The P_1P_2/D hypothesis: On the Intercity Movement of Persons," American Sociological Review, (December 1946), pp. 677-686.

VITA

Koong-Lian (George) Kao was born on November 9, 1944 in Fu-kien, China. He graduated from Taipei Commercial High School in 1961 and attended National Chengchi University where he received a Bachelor of Commerce (B.S.) degree in 1965. After one year of military service, he entered the Graduate School of Business Administration of his alma mater. During the course of his master's program, he also taught basic business courses at a local high school and later worked at the Central Bank of China. In 1969, he was awarded a Master of Commerce (M.B.A.) degree. He then entered the Graduate School of the University of Connecticut and completed requirements for the Master of Arts in Economics one year later. In September 1970, he enrolled in the Graduate School at Louisiana State University. He is now a candidate for the degree of Doctor of Philosophy in Quantitative Methods.

EXAMINATION AND THESIS REPORT

Candidate: Koong-Lian Kao

Major Field: Quantitative Methods

Title of Thesis: An Economic Analysis of Interregional Migration in Louisiana and Its Policy Implications for Population Distribution.

Approved:

Roger L. Burford

Major Professor and Chairman

James G. Traynham

Dean of the Graduate School

EXAMINING COMMITTEE:

James E. Willis

Vincent E. Cangelosi

G. Randolph Rice

W. R. Swyers

Date of Examination:

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