INTERSTATE MIGRATION IN MEXICO, 1979-80: A SPATIAL ANALYSIS

Hiroshi Fukurai James B. Pick Edgar W. Butler
University of California, Riverside
SSR, Volume 71, No. 4, July, 1987

This paper examines 1979-80 interstate migration patterns in Mexico. Our analysis takes advantage of statistical graphic techniques to illustrate the following substantive issues of interstate migration: (1) to identify states with similar migration patterns and (2) to examine socioeconomic characteristics of states at both origin and destination of migrants. Analytic techniques include regression analysis, migration flows, and statistical residual mapping. The residual dispersion patterns, for example, suggest the extent to which socioeconomic variables explain migration differences by showing unique clusters of unexplained residuals.

The statistical graphics method has utility in describing the relationship between interstate migration patterns and socioeconomic characteristics of different states.

Interstate migration streams. Since Mexico has 32 federal entities, sometimes called states, there are 992 interstate migration streams, i.e., excluding flows from a state to itself. Figure 2 shows the 20 major interstate streams superimposed in a plotted map. This map emphasizes the dominance for population movement of the central part of Mexico consisting of Federal District and the state of Mexico.

Figure 3 presents a group of inmigration regions defined by a maximum likelihood cluster technique.[2] cluster analyses identified six unique groupings of Mexican states: (1) South/Misc., (2) South Pacific, (3) North East, (4) Veracruz, (5) North West, and (6) Central, consisting of the Federal District and state of Mexico (Fukurai et al., 1987a). Partida (1984) included the Federal District/Mexico as a separate region; otherwise there is little correspondence of our empirically delineated regions with regions delineated by others (Rodriguez, 1960; Bossals Batalla, 1961; Scott, 1982).

Table 1 shows interregional migration flows for the six regions, with the main diagonal cell showing intraregional migration for each region. Intraregional migration suggests migrants' movement among states within the same region. Since Veracruz is a single-state region, intraregional migration is zero. The largest intraregional migration exists in the Central region, i.e., the Federal District and Mexico. The large reciprocal migration streams exist from D.F./Mexico to the South Pacific Region (75,676) and from the South Pacific region to D.F./Mexico (46,396).

Detailed migration patterns of regional clusters for four migration periods, i.e., lifetime, prior to 1975, 1975-1979, and 1979-1980 show that the Central region (D.F./Mexico) had the largest average inmigration flows among the six regions, with the single-state region of Veracruz having the second highest average of inmigrants throughout the four migration periods (Fukurai et al., 1987b). The South/Misc. region had a average number of inmigrants for the same time frames.

Table 2 shows homogeneous demographic characteristics for sample of states within different regions. The South Pacific, South/Misc, and Veracruz regions show high ratios of population native to states, suggesting low interregional migration streams (13.2, 10.3, and 12.7% for agricultural population and 91.8, 80.3, 88.9% for native to state, respectively). By the same token, population speaking indigenous language (e.g., Indian dialects) are greater than other regions with high interstate migration patterns (12.9, 12.4, and 11.8%, respectively).

North West, North East, and Central regions have high levels of in/outmigration patterns and unique socioeconomic traits. For example, the Central and North West regions have larger proportions of service and support occupations (13.2 and 9.4% respectively) (Fukurai et al., 1987b). Also the Central, North West, and North East regions are characterized by high educational achievement ratios (5.8, 2.8, and 3.0%, respectively). Central (D.F./Mexico), North West (Baja California, Norte), and North East regions (Cohuila, Nuevo Leon, Tamaulipas) have the highest percentage of population completing higher education. South Pacific (Guerrero, Oxaca), South/Misc. regions (Chiapas), and Veracruz, on the other hand, show the lowest percentage of higher education completed. Agricultural occupation and higher education are nega-

tively correlated. Interregional migration patterns, thus, are closely related to regional socioeconomic characteristics.

In addition to socioeconomic variables, transportation is related to interregional migration patterns. The analysis suggests: (1) all major railroad and highways are closely connected in one way or another to the Federal District transportation network, (2) there is a greater frequency of airplane flights in more economically developed regions, i.e., the central and North West regions, and (3) the North East and North West are separated into two regions due to geographical barriers between them. Figure 4 suggests that major highways are connected to the North West from Jalisco rather than from states in the North East regional areas, such as populous Nuevo Leon. While past research suggests that the six Mexican states adjacent to the U.S. border form a distinct region, the cluster analysis results in regions characterized by distinctive transportation subsystems due to geographical obstacles lying between the North West and North East regions and the rest of Mexico.

Statistical analyses show that various socioeconomic and demographic variables are closely related to the regionalization. For example, the inverse relationship between agricultural occupation and educational achievement suggest the labor market characteristics are closely linked to the educational accomplishment of workers. Also, the higher the percent of labor force in service and support occupations, the smaller the proportion of people native to state. By the same token, the greater the proportion of native residents, the lower the education achievement.

Socioeconomic effects on interregional migration: residual analysis. While the regionalization determined by cluster analysis shows more homogeneous interregional inmigration patterns for the period of 1979-80, it also has a number of shortcomings: (1) separate and noncontiguous "regions" exist, e.g., Baja California Sur is also grouped with Tabasco, Yucatan, and other Southern and Central states, (2) the South Pacific region also includes states adjacent to Veracruz and the central part of the country, i.e., Puebla, Hidalgo, and Guranajuato, and (3) the North West "region" has been separated by Nayarit located on the Pacific Ocean. Noncontiguous states forming regions suggest that variables other than interstate migration flows need to be examined in order to explain interregional migration patterns in Mexico.

Past migration research suggests the importance of extraneous variables in explaining interregional migration patterns, i.e., socioeconomic characteristics of both sending (origin) and receiving (destination) states (Connell et al., 1976; Unikel,1977; Greenwood et al., 1987a, 1987b). For example, one socioeconomic model applied to Mexico suggests four important factors affecting interstate migration; (1) the maturity of organizational development, (2) labor market characteristics (esp., the proportion of service/support sectors), (3) income inequality for given states, and (4) a set of demographic variables (esp. distance and adjacency) (Fukurai et al., 1987a).

Table 3 shows a regression analysis to estimate the size of 1979-80 interstate inmigration streams. Demographic variables, organizational and labor market characteristics, and income inequality for both origin and destination of interstate migration are predictors of 1979-80 migration. Approximately half of the total variation of the 1979-80 interstate migration was explained by a set of economic and demographic variables.

Figure 5 presents the residual map of the socioeconomic model. A positive residual suggests that the model underestimated the magnitude of interstate migration for a particular state and vice versa. Underestimation exists for Baja California Norte, Jalisco, Mexico, and Oxaca. Overrepresentation exists for Baja California Sur, Nayarit, Aguascalientes, Colima, Queretaro, Tlaxcala, and Morelos. Organizational growth, labor market characteristics, and income inequality of both in/outmigration states overestimated the magnitude of inmigration flows for those states. Seven states overestimated inmigration from outlying states. For example, Baja California Sur had an overestimation of inmigration to Tlaxcala which also overestimated inmigrants to Nayarit. Morelos overestimated interstate migration to Queretaro which also overestimated inmigrants to Tlaxcala. With the exception of Colima, the other six states overestimated inmigration to the states from the same group. Secondly, all seven states are adjacent to economically and politically important states. For example, Aguascalientes, Colima, Morelos, Nayarit, Qeretaro, and Tlaxcala surround the central region, i.e., the Federal District and Mexico. By the same token, Baja California Sur is adjacent to an economically active Baja California Norte.

Our analysis suggests that organizational and labor market characteristics and income inequality in particular affect the inmigration flows to these noncontiguous seven states. A comparison, for the seven states, of residual dispersions and regions identified by cluster analysis, shows similar spatial patterns suggesting that interstate

regional patterns are closely related to the socioeconomic dimensions of those states. The analysis emphasizes that recent interstate migration is affected by state differentials in socioeconomic factors, i.e., organizational development, labor market characteristics, and income inequality.

Conclusions. This paper examined 1979-80 interstate migration patterns in Mexico; it identified a set of states with similar migration patterns and examined socioeconomic characteristics of both origin and destination states of inmigrants. The residual dispersion pattern demonstrated the extent to which socioeconomic variables explained regional differences by showing unique clusters of unexplained residuals. A comparison of regions identified by cluster analysis and by residual dispersions showed similar spatial pattern for certain states suggesting that interstate regional patterns were closely related to socioeconomic factors.

NOTES

1. This project was made possible by UCMEXUS grants, two Academic Senate intramural grants to Edgar W. Butler, and funds from the UCR-MEXUS program and UCR-Mexico Collaborative Research and Training Groups. Appreciation is hereby extended to these funding agencies and to Professor Adalberto Aguirre and Robert Singer. Also special thanks to several anonymous reviewers for their valuable comments on the first draft of this paper.

2. The maximum likelihood method was derived by W.S. Sarle of SAS Institute Inc. The maximum likelihood formula was obtained from Symons (1981, 37 eq.[80]) for disjoint clustering. There are currently no other published references on the maximum likelihood method.

3. Methodology for Graphic Statistics. Version 3.0 of the geographic information system ARC/INFO was used to digitize and define both boundary and reference files for the states of Mexico on a PRIME 750 minicomputer. Output from the statistical program SAS was input into the relevant INFO data file with data for each of the 32 Mexican states shown in Figure 1. Appropriate patterns were specified for each range of values defined by sextiles. The ARCPLOT utility of the PRIME 750. Final plots were prepared on a CALCOMP 4-pen plotter.

REFERENCES

Bassols Batalla, Angel. 1961. "La Division Economica Regional de Mexico." pp. 387-413. in Investigacion Economica Vol:24.

---. 1979. Mexico: Formacion de Regiones Economicas. Mexico City: El Colegio de Mexico.

Brown, Lawrence A. and John Paul Jones III. 1985 "Spatial Variation in Migration Processes and Development: A Costa Rican Example of Conventional Modeling Augumented by the Expansion Method." Demography 22:327-352.

Connell, John, Biplab Dasgupta, Roy Laishley, and Michael Lipton. 1976. Migration from Rural Areas: The Evidence from Village Studies. Delhi, India: Oxford University Press.

Fukurai, Hiroshi, James B. Pick, Edgar W. Butler, and Swapan Nag. 1987a." An Analysis of Interregional Migration in Mexico. "Mexican Studies/Estudios Mexicanos, forthcoming.

Fukurai, Hiroshi, James B. Pick, Edgar W. Butler, and Glenda Tellis. 1987b. "An Examination of Regional Migration Patterns in Mexico." Manuscript submitted for publication.

Greenwood, Michael J., Jerry R. Ladman, and Barry S. Siegel. 1981. "Long-term Trends in Migration Behavior in a Developing Country: The Case of Mexico." Demography 18:369-388.

Partida Bush, Virgillo. 1984. Migracion Entre Ocho Regiones De Mexico, 1955-1970. Demografia y Economia 18(3):378-409.

Portes, Alejandro and Robert L. Bach. 1985. Latin Journey: Cuba and Mexican Immigrants in the United States. Berkeley: University of California Press.

Rodriguez Sala, Maria Luisa. 1960. La Regionalizacion de Mexico. Revista Mexicana de Sociologia 22:231 248.

Sarle, W. S. 1983. "The Cubic Clustering Criterion." SAS Technical Report A-108, Cary, NC: SAS Institute Inc.

Scott, Ian. 1982. Urban and Spatial Development in Mexico. Baltimore: The Johns Hopkins University Press.

Symons, M. J. 1981. "Clustering Criterion and Multivariate Normal Mixtures," Biometrics 37:35-43.

Unikel, Luis. 1977. Urbanization in Mexico: Process, Implications, Policies, and Prospects. In Goldstein, Sidney and David Sly (eds.), Patterns of Urbanization: Comparative Country Studies, Dolhain, Belgium, Ordina Editions, 465-568.

Manuscript was received April 8, 1987 and reviewed April 13, 1987.

Tables start on the following pages; Figure 1 appears on p. 318; Figure 2 on p. 319; Figure 3 on p. 320; Figure 4 on p. 321; and Figure 5 on p. 322.

Table 1. Interregional 1979-80 migration flows: Clusters determined by inmigration patterns

FROM: REGIONS	TO: REGIONS (1)	(2)	(3)	(4)	(5)	(6)
1. South/Misc.	20,784[1]	23,941	7,809	8,005	14,496	24,274
2. S. Pacific	12,375	14,831	6,716	10,554	12,865	46,396
3. N. East	6,524	9,026	45,996	6,804	20,295	15,335
4. Veracruz	6,159	11,004	4,670	0	1,608	11,038
5. N. West	13,651	16,296	18,778	1,962	36,714	17,413
6. D.F./Mex.	23,620	75,676	13,923	16,409	13,701	79,121
----- Total regional Migration -----						
Inmigrants	62,329	136,539	51,896	43,734	62,965	114,456
Outmigrants	78,525	88,906	57,984	34,479	68,098	143,329
International Inmigrants	6,522	23,766	26,627	918	30,933	15,925

1. The main diagonal cells show intraregional migrants (_____).

Table 2. Socioeconomic and Demographic characteristics of six clustered regions

	Clustered Regions					
Variables	(1) South/Mis.	(2) S. Pacific	(3) N. East	(4) Veracruz	(5) N. West	(6) Central
Total Pop.	742,352 (516,932)[1]	2,541,450* (659,898)	1,801,832 (464,918)	5,387,680 (--)	2,019,162 (1,344,247)	8,197,707*** (895,723)
No. Flights	12,638 (12,316)	9,986 (11,937)	12,765 (9,947)	7,573 (--)	35,574 (25,425)	68,144 (96,370)
Railroad[2]	301.5 (183.4)	781.5* (376.4)	1406.3 (765.4)	1765.0 (--)	1095.8 (600.7)	760.0 (598.7)
Highways[2]	827.6 (452.8)	1827.1* (678.4)	1660.5 (361.3)	2597.0 (--)	1638.2 (517.9)	617.5 (658.3)
Support Occup.[3]	8.47%* (3.69)	6.37%** (1.20)	8.20%** (2.16)	7.53% (--)	9.38%** (2.08)	13.15% (4.07)
Agri. Occup.	10.30%* (3.68)	13.22%* (4.02)	7.26% (3.84)	12.71 (--)	6.81 (2.37)	2.47% (3.01)
Higher Educ.[4]	2.09%* (0.55)	1.46%** (0.42)	2.99%* (1.43)	2.02% (--)	2.77%** (0.61)	5.80% (3.70)
Native Lang.[5]	12.43% (15.36)	12.94% (13.13)	3.23% (4.19)	11.77% (--)	2.21%* (1.04)	3.56%* (1.69)
Native[6]	80.29%*** (13.65)	91.84%*** (1.22)	83.51%*** (8.01)	88.90% (--)	79.33%** (14.52)	65.04%*** (6.75)
No. of State	12	6	6	1	5	2

1. Standard deviations.
2. In kilometers.
3. Service and support occupations.
4. Higher education for population 17^{+} years.
5. Population speaking indigenous languages.
6. Population native to state.

*: significant at < .05.
**: significant at < .01.
***: significant at < .001.

Table 3. Regression coefficients in 1979-80 Inmigration

Independent Variables	Coefficients b	beta	T value	Summary Statistics
EC_i	0.035	0.019	0.730	
EC_j	0.005	0.003	0.105	
LM_i	-0.199	-0.039	-1.150	n = 992
LM_j	-0.621	-0.112	-3.594	r = 0.709
IE_i	0.593	0.348	9.796**	$r^2 = 0.502$
IE_j	0.604	0.354	9.971**	
D_{ij}	-1.134	-0.499	-17.579**	
A_{ij}	1.706	0.238	8.685**	

** indicates that the variable is significant at the 0.05 level or better.

$M_{i,j}$ = number of migrants from i to j (a dependent variable);

EC_i, EC_j = value of S.A.V.C. (corporations) in pesos per capita at i and j, respectively;

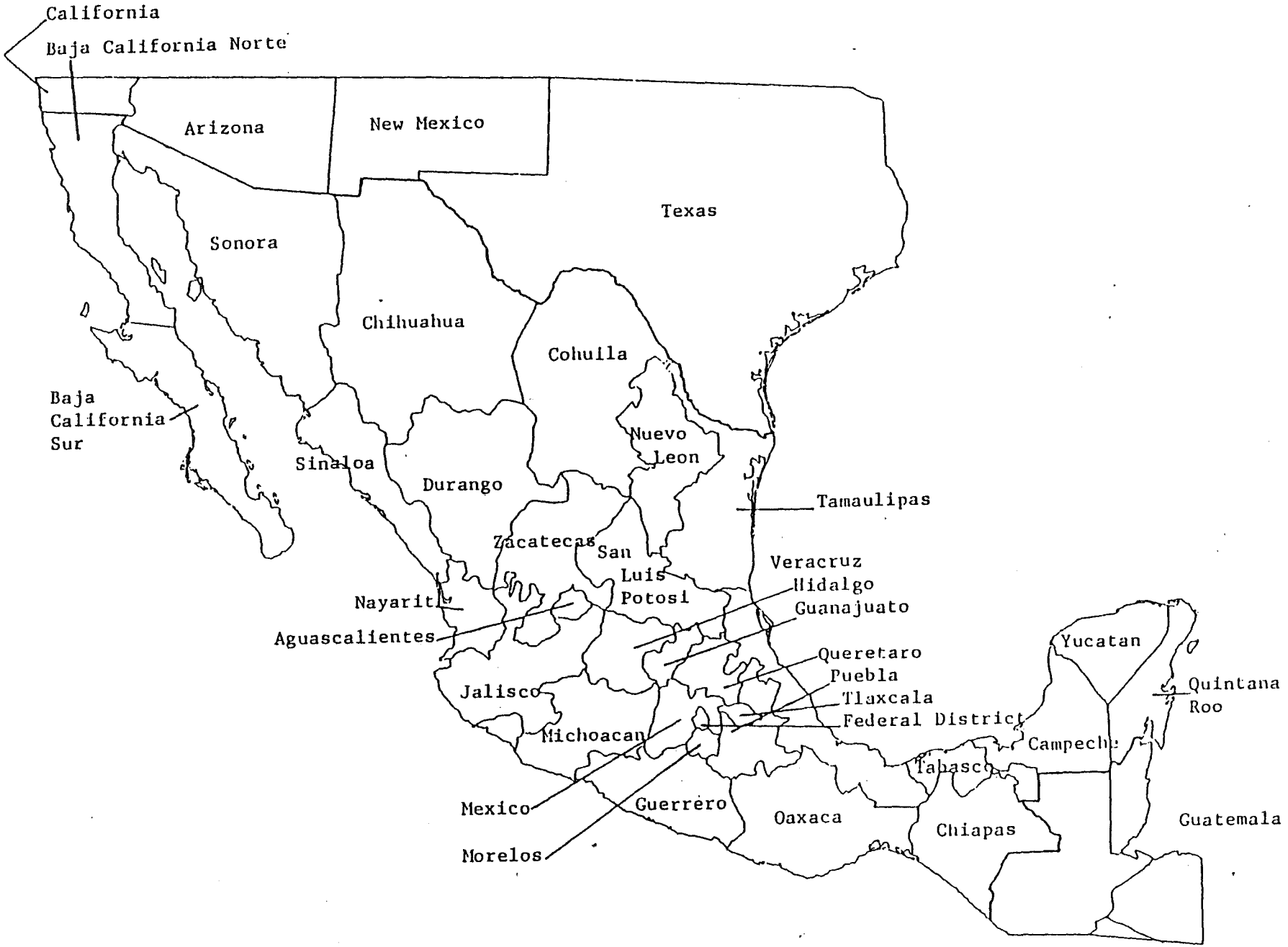
LM_i, LM_j = proportion of service and support occupations at i and j, respectively;

IE_i, IE_j = ratio of rich versus poor at i and j, respectively;

D_{ij} = distance between states i and j, respectively; and

A_{ij} = adjacency index between states i and j, respectively.

Figure 1. Republic of Mexico: State Boundaries, 1980.



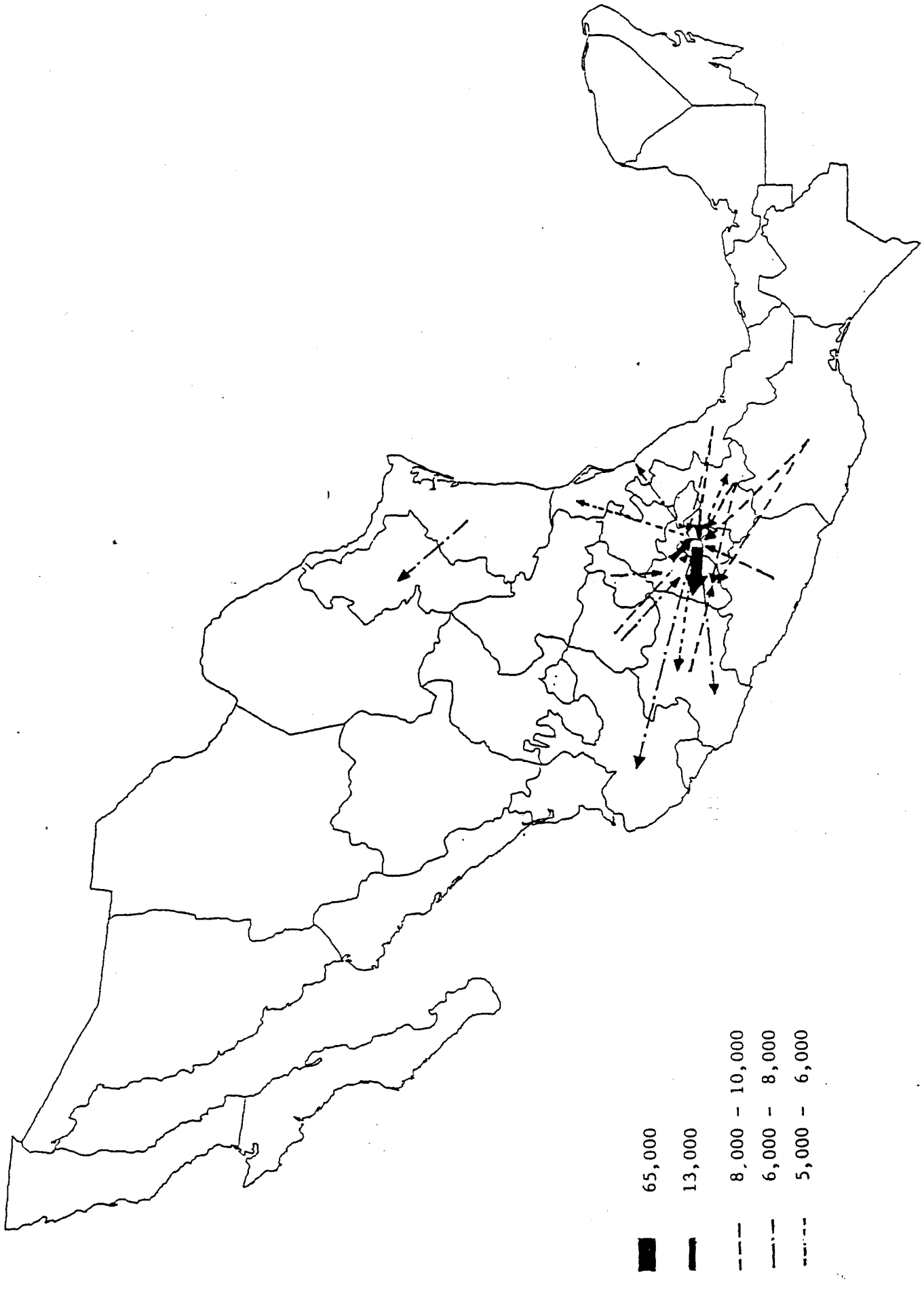
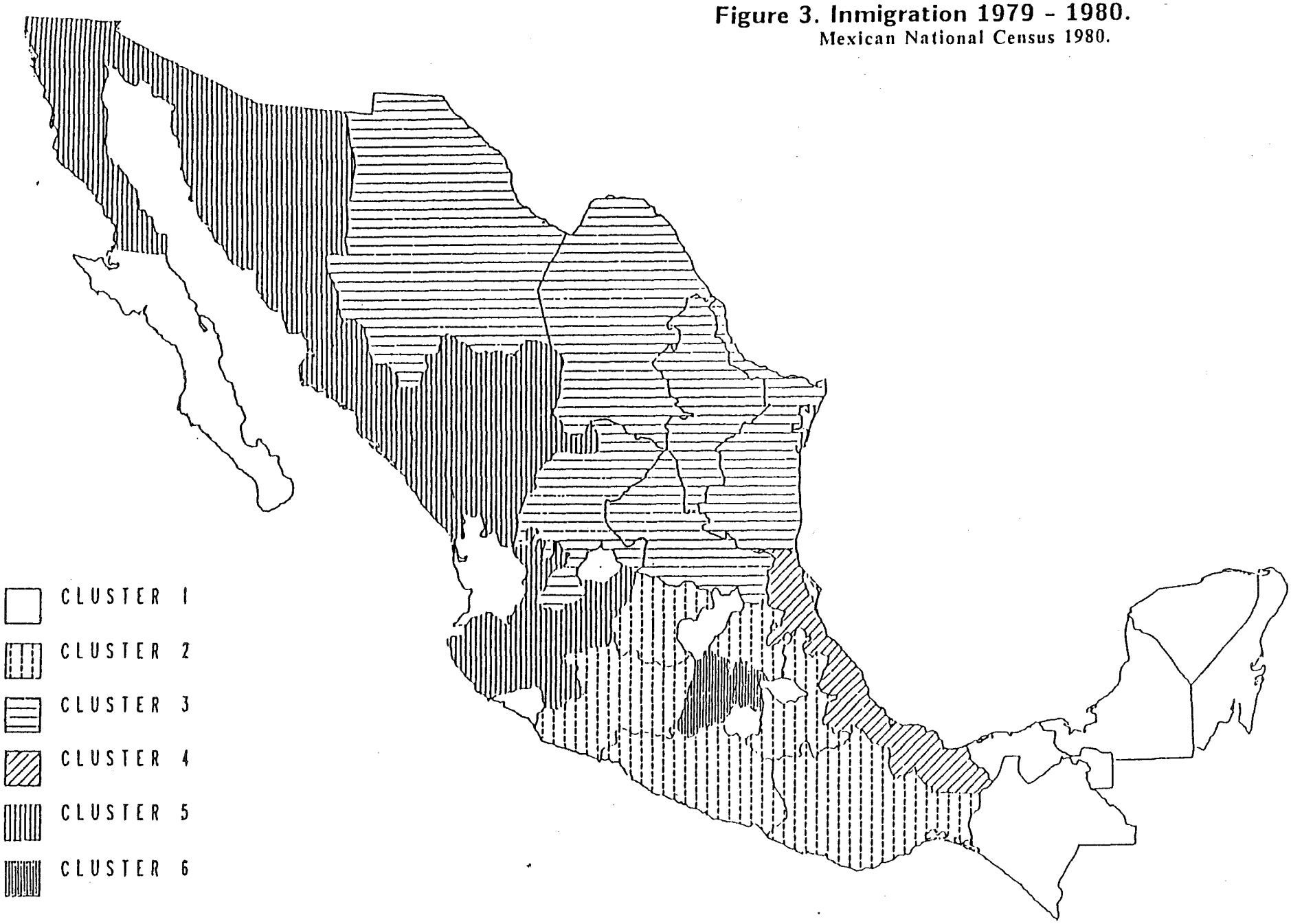


Figure 2. 1979-80 Interstate Migration.

Figure 3. Inmigration 1979 - 1980.
Mexican National Census 1980.



Butler/Pick, 1986

Figure 4. Major Highways, 1979.
Source = 1979 Mexican Turista Sec.

Figure 5. Sum of Residuals.