

MIGRATION FIELDS

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MIGRATION FIELDS

The accompanying maps were produced in conjunction with a larger study of spatial interaction.* They are extracted here because they have as a common theme the migration of people. The larger study treats of more general classes of geographical interaction, specifies in greater detail the theoretical justification for the particular technique used, and develops additional consequences therefrom. It is asserted that the method of representation employed provides a particularly felicitous and dramatic summary of the asymmetry of large geographical exchanges. A table of county to county migration in the United States would contain in excess of 9×10^6 numbers, for example, and this is an incomprehensible amount of data. A flow field, on the other hand, showing these data and summarizing them as a set of vectors seems more tractable. The reader knowledgeable in migration studies is invited to comment on the degree to which the maps do in fact accord with insights obtained from alternate modes of study and analysis. One may also compare these maps with previous studies of Adams, Kuznets, Thornthwaite, Warntz, and others.

The data in each case consist of square, asymmetric, tables in which are indicated the number of people (M_{ij}) migrating from region i to region j . In addition the coordinates (x,y) of a point within each region are required, and, for display purposes, the coordinates of an outline of the area. The following calculation is then performed.

$$\vec{V}_i = \frac{1}{n-1} \sum_{\substack{j=1 \\ j \neq i}}^m \frac{M_{ij} - M_{ji}}{M_{ij} + M_{ji}} \cdot \frac{1}{d_{ij}} \cdot \left[(X_j - X_i), (Y_j - Y_i) \right]$$

where

$$d_{ij}^2 = (X_j - X_i)^2 + (Y_j - Y_i)^2. \text{ The vector } \vec{V}_i \text{ is plotted}$$

*National Science Foundation Grant GS-34070X, "Geographical Patterns of Interaction", Department of Geography, University of Michigan, 1972-1974

at the map location (X_i, Y_i) , after an arbitrary scaling appropriate to the particular map. It appears to be a dimensionless number, the relative net migration. The interpretation is thus not quite as simple as would be the case for a vector field based on the net migration. The field seems to show the directional tendency toward migration, rather better than would the absolute amount of flow. "If, at any point on the map, a person were thrown into the air, he would tend to fall in the direction indicated by the migration wind field". The sources of the data are listed at the end of this report.

W. Tobler,
Laxenburg,
1 March, 1975.

Data Sources:

- England and Wales: A.J. Fielding, Internal Migration in England and Wales, Centre for Environmental Studies, University Working Paper 14, London, 1971.
- France: L. Klaassen, P. Drewe, Migration Policy in Europe, Saxon House (Lexington Books), New York, 1973; Appendix.
- Sweden: Klaassen & Drewe, Loc Cit
- Turkey: Census of Turkey; Courtesy of Prof. John Clark, Dept. of Geography, Dartmouth University.
- United States: U.S. Bureau of the Census Reports; 1940, 1950, 1960, 1970.
- Upper Midwest: R. Adams. Population Mobility in the Upper Midwest, Upper Midwest Economic Study No. 6, University of Minnesota, Minneapolis, 1964.
- Minneapolis & St. Paul: J. Adams, Op. Cit.
- Italy: Istituto Centrale di Statistica.
- Canada: Unpublished data, Statistics Canada; Courtesy of Professor R. MacKinnon

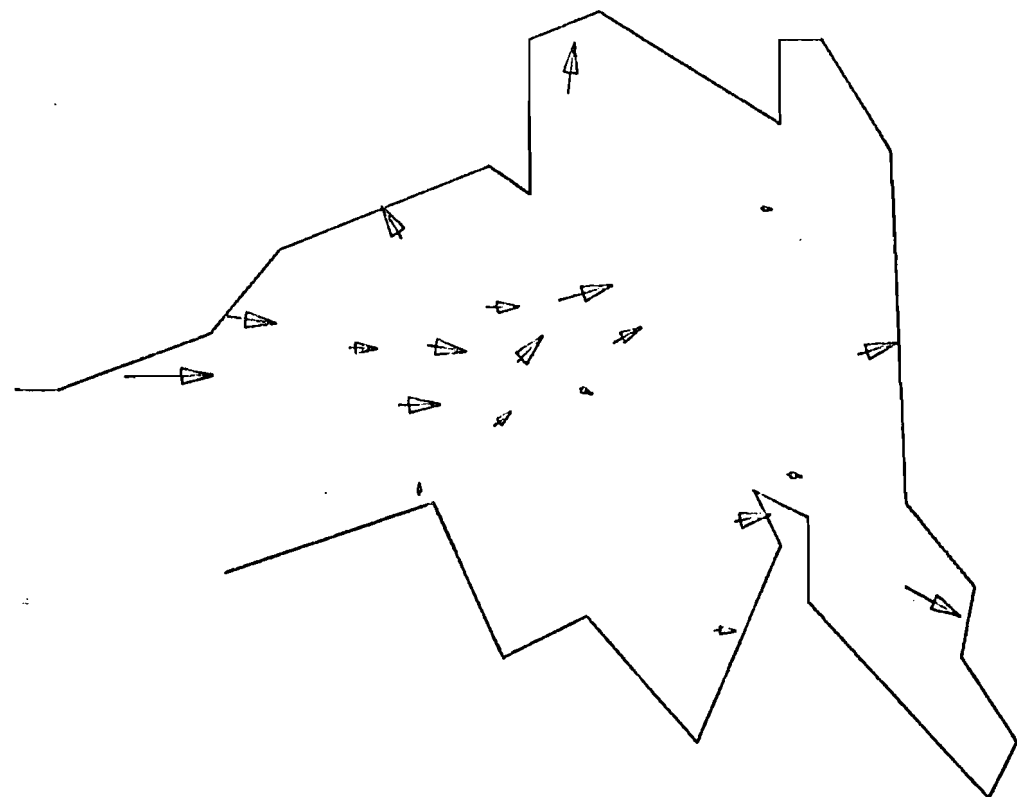
Degree of Asymmetry of Migration

		<u>Ratio of Variances</u>	<u>Ratio of Flows</u>
England and Wales (20 x 20)	Ages 0-14	2.2%	14.4%
	Ages 15-64	1.6%	11.5%
	Ages 65+	13.1%	26.9%
	Total	2.0%	12.3%
France	(21 x 21)	3.5%	14.1%
Sweden (23 x 23)	Total	4.3%	14.6%
	Assisted	52.8%	78.0%
Italy	(20 x 20)	31.1%	35.4%
Canada	(22 x 22)	12.6%	28.5%

Degree of asymmetry is defined as $(\sigma_-^2 / \sigma_+^2) * 100$,

where $\sigma_+^2 = \text{Var} \left(\frac{M_{ij} + M_{ji}}{2} \right)$, $\sigma_-^2 = \text{Var} \left(\frac{M_{ij} - M_{ji}}{2} \right)$,

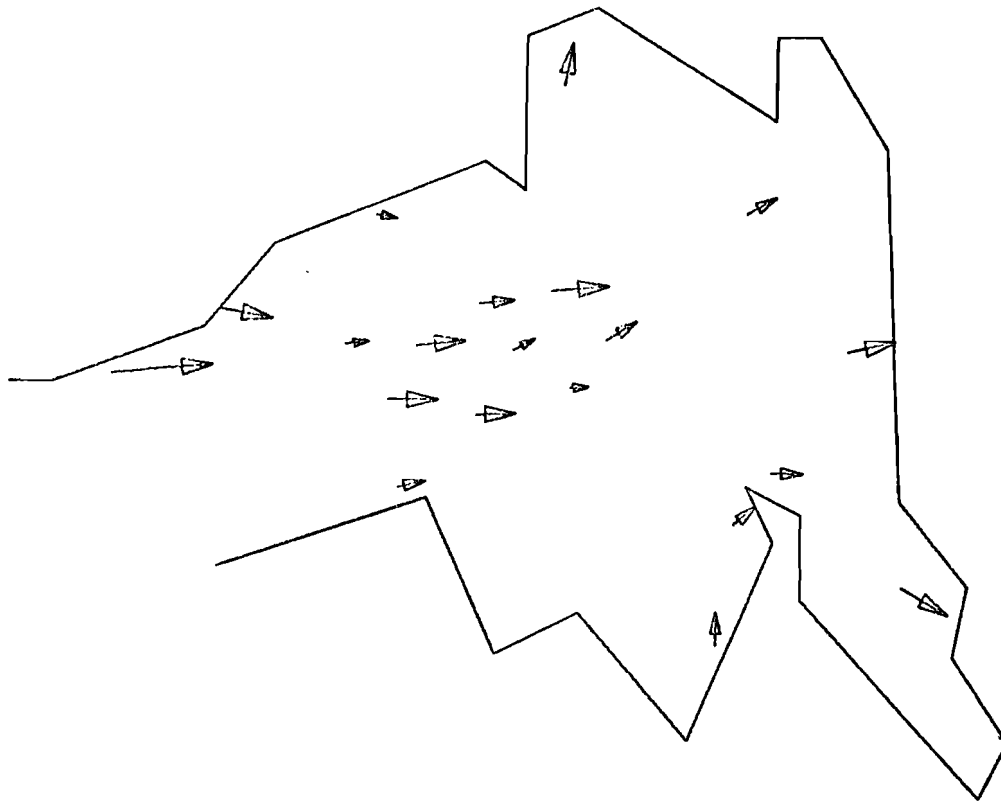
$\sigma_\tau^2 = \text{Var} (M_{ij})$ and $\sigma_\tau^2 = \sigma_+^2 + \sigma_-^2$. In the present instance $M_{ii} \equiv 0$, and values not shown (U.S.A., Turkey, etc.) were not computed. The alternate method is to use the ratios of the net flows to the total flows.



England and Wales

Asymmetry of Migration, 1960-1961

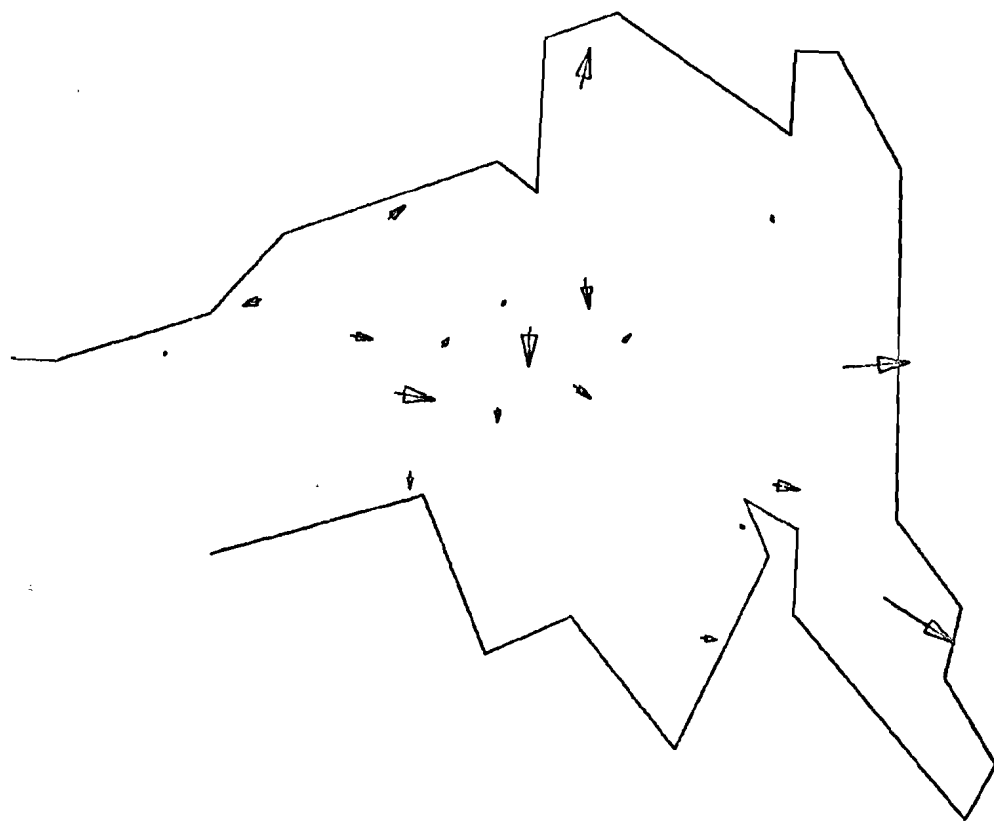
Persons aged 0 to 14 years



England and Wales

Asymmetry of Migration, 1960-1961

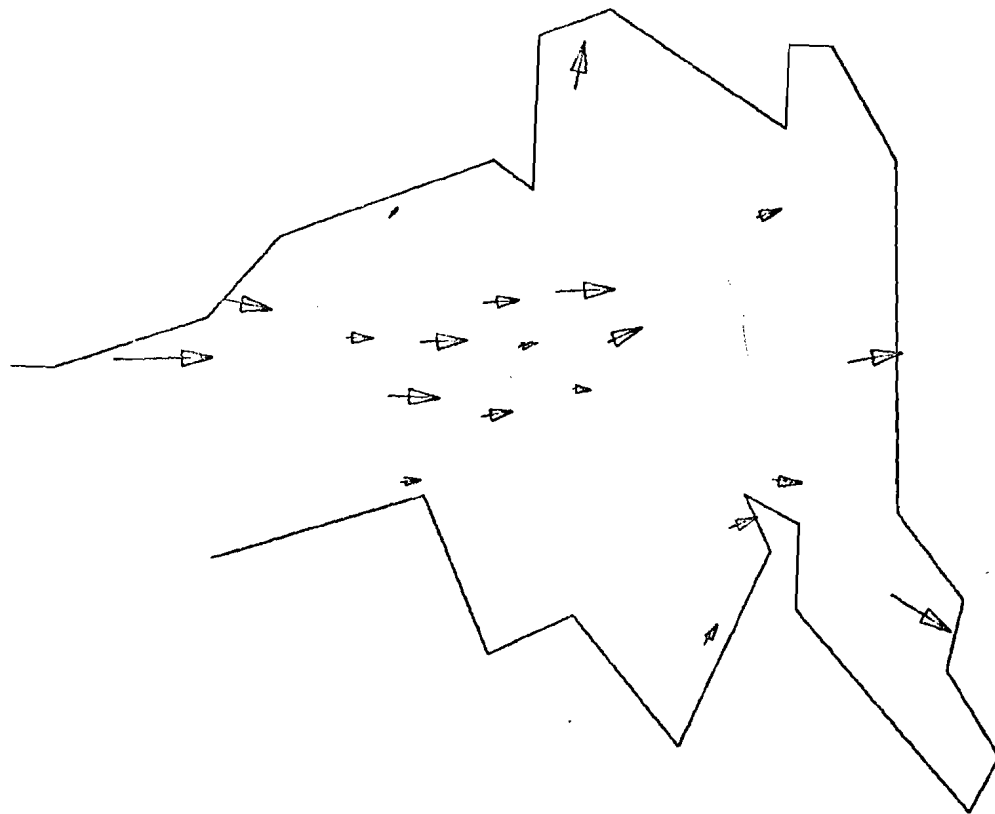
Persons aged 15 to 64 years



England and Wales

Asymmetry of Migration, 1960-1961

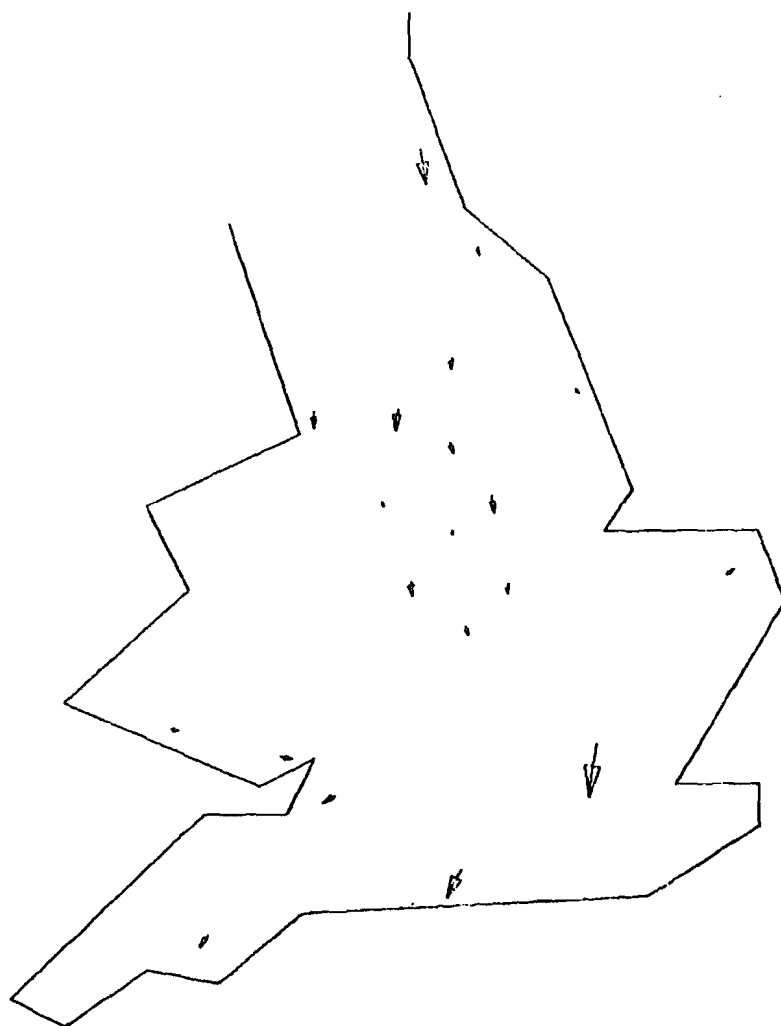
Persons aged 65 and over



England and Wales

Asymmetry of Migration, 1960-1961

All age groups

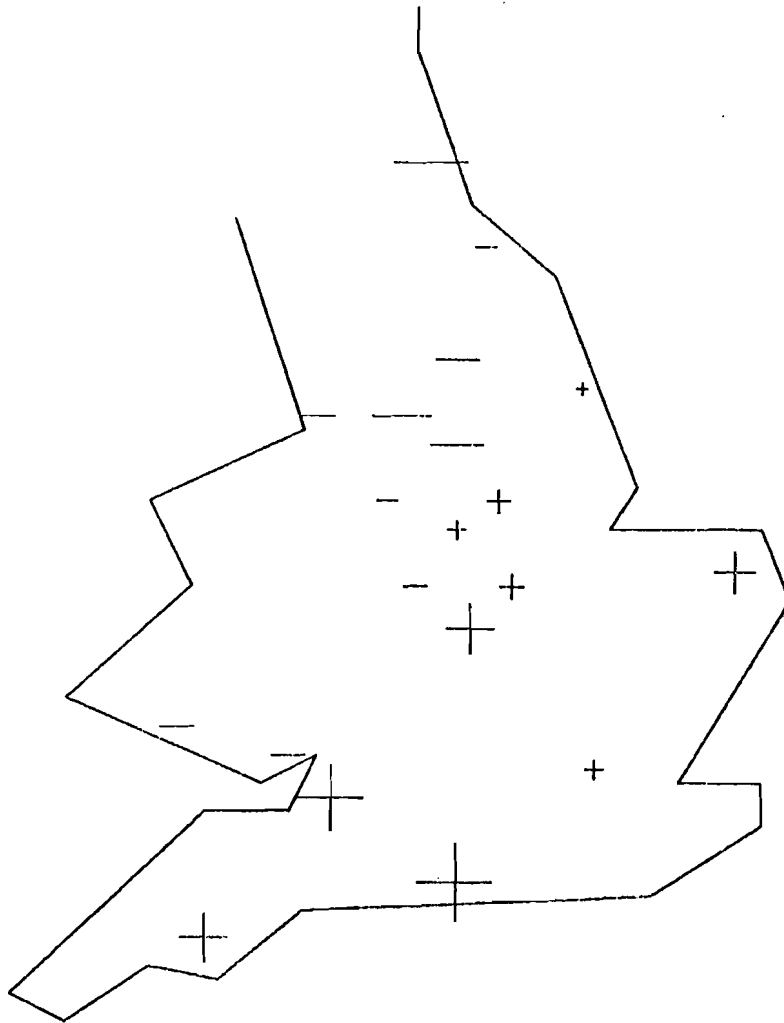


England and Wales

Net Flow Field

All age groups, 1960-1961

*The contention is that the field of
net flows is not as revealing as is
the field of relative net flows.*

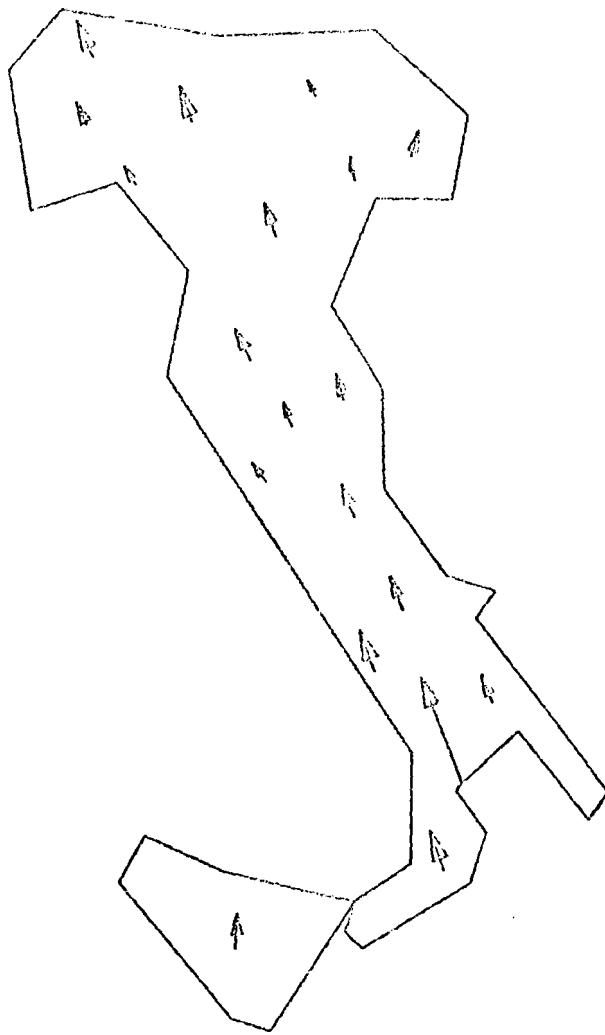


England and Wales

Accumulation due to Migration

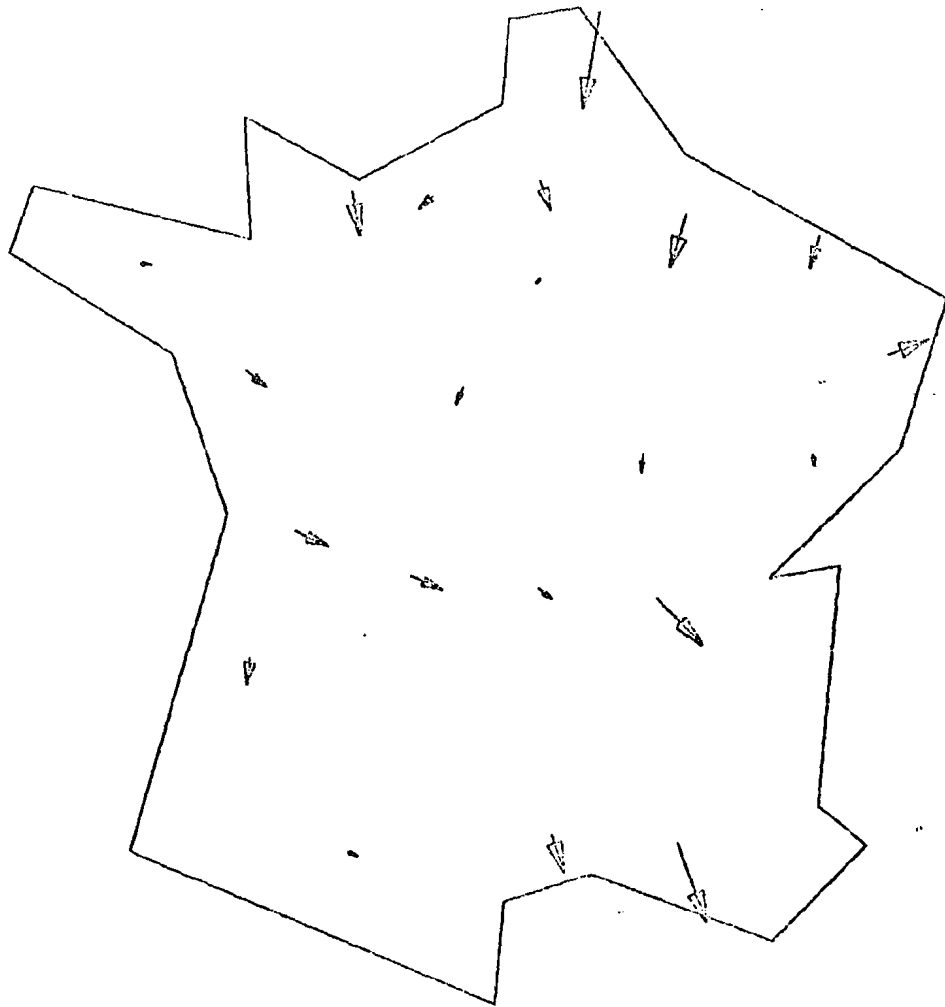
All age groups, 1960-1961

The computer program which produces the maps of the migration fields simultaneously produces this diagram of the departure (-) and accumulation (+) regions. The area of the symbol on the map is proportional to the magnitude of the resultant of all flows. This technique is not novel and additional maps of this type are therefore not included in this report. But notice the strong degree of spatial association even at the coarse geographical resolution of the present data.



Italy, 1960-1961

Asymmetry of Migration



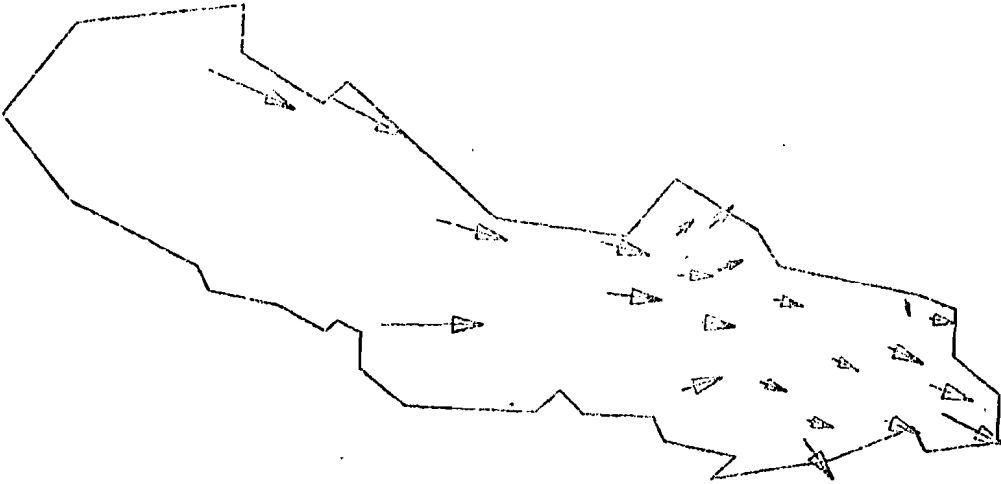
France, 1962-1968

Asymmetry of Change-of-Residence Table.



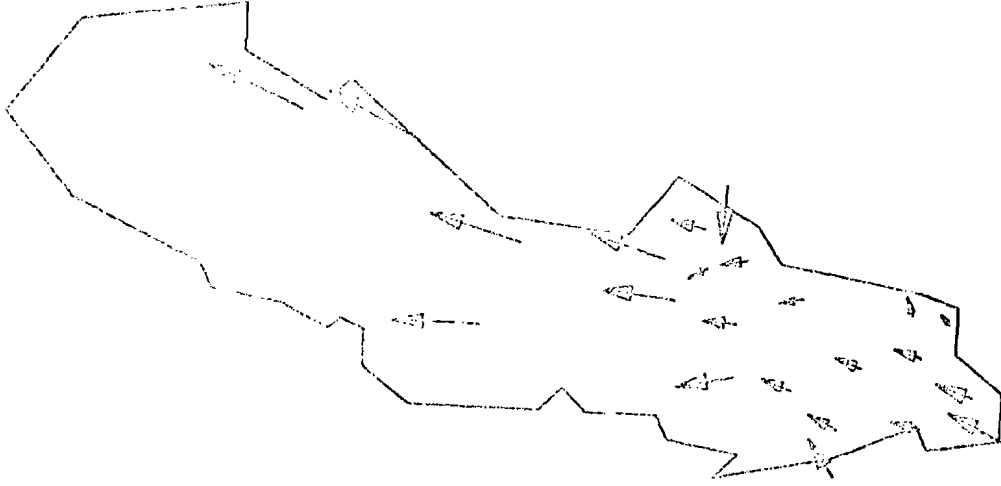
Canada, 1971

Asymmetry of Interurban Migrations.



Sweden, 1961-1966

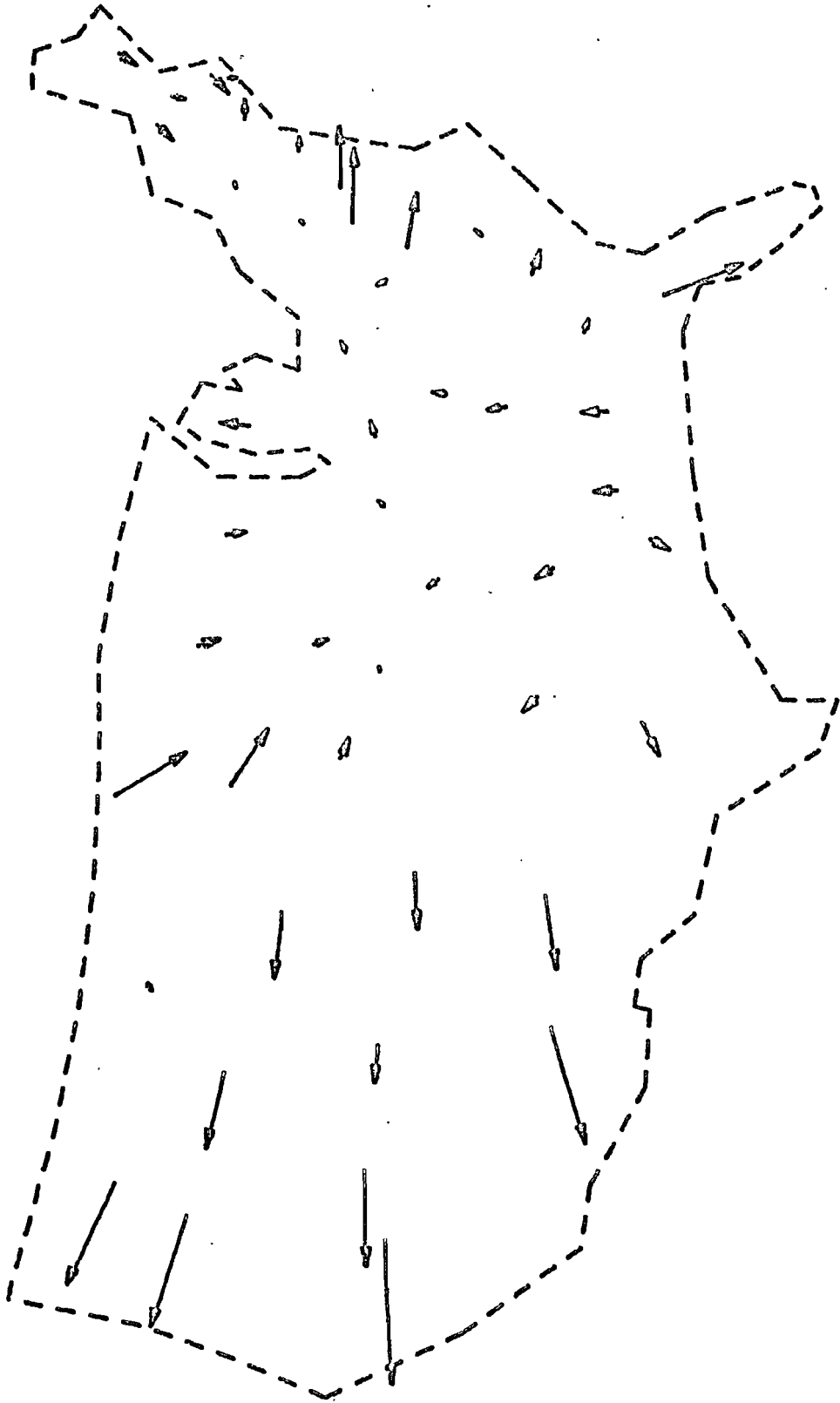
Asymmetry of Migration.



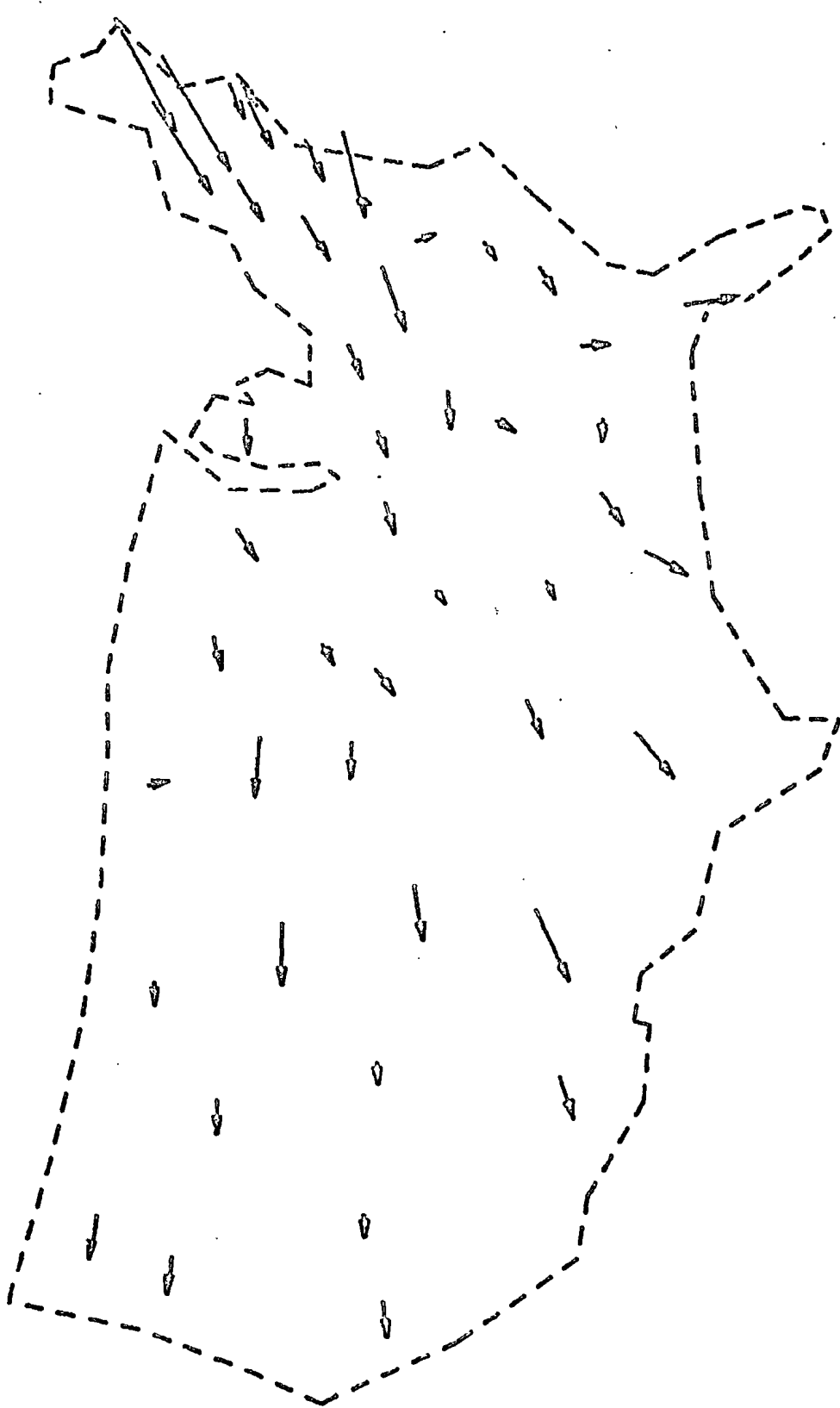
Sweden, 1963-1966

Asymmetry of Migrations

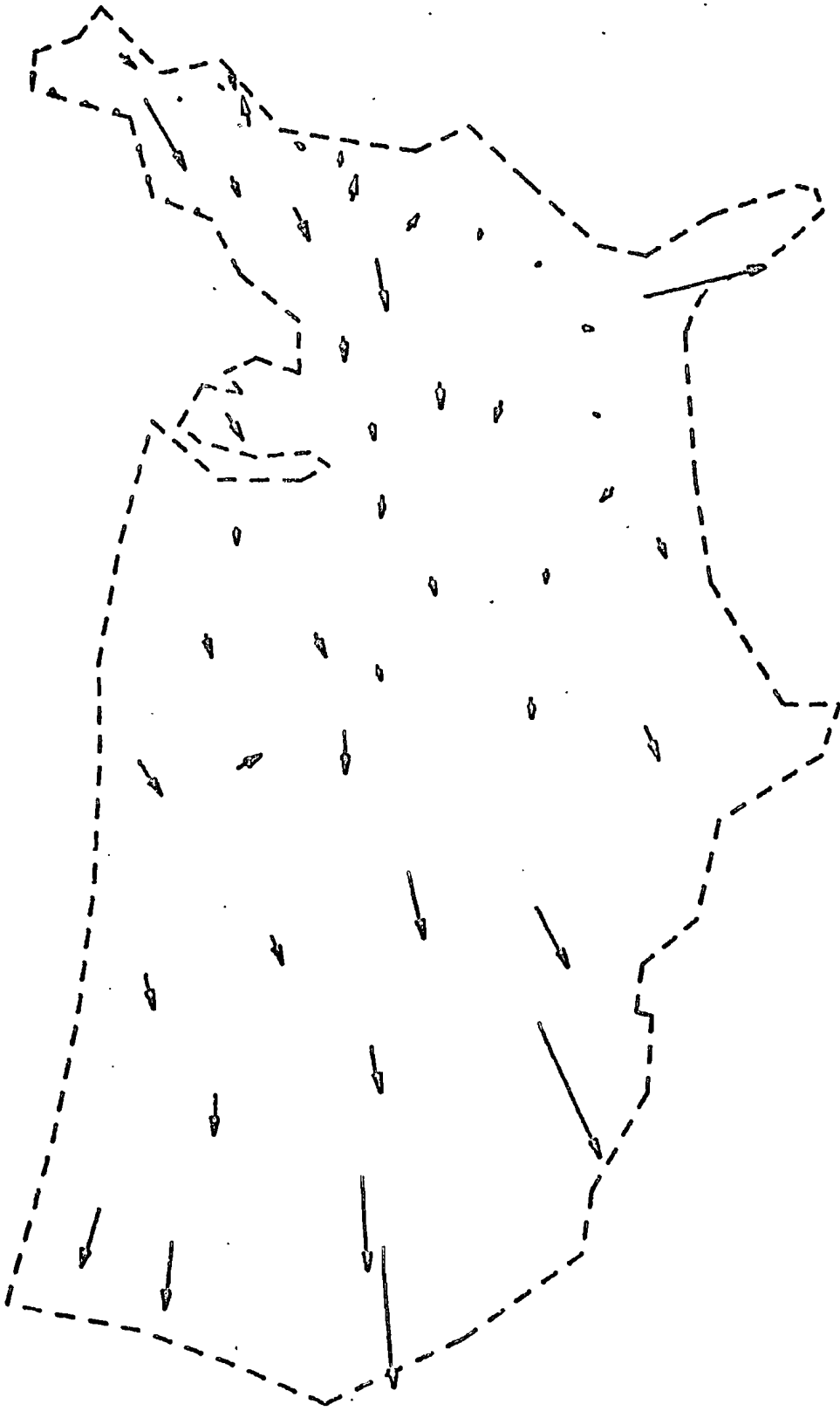
which were assisted by governmental stipends.



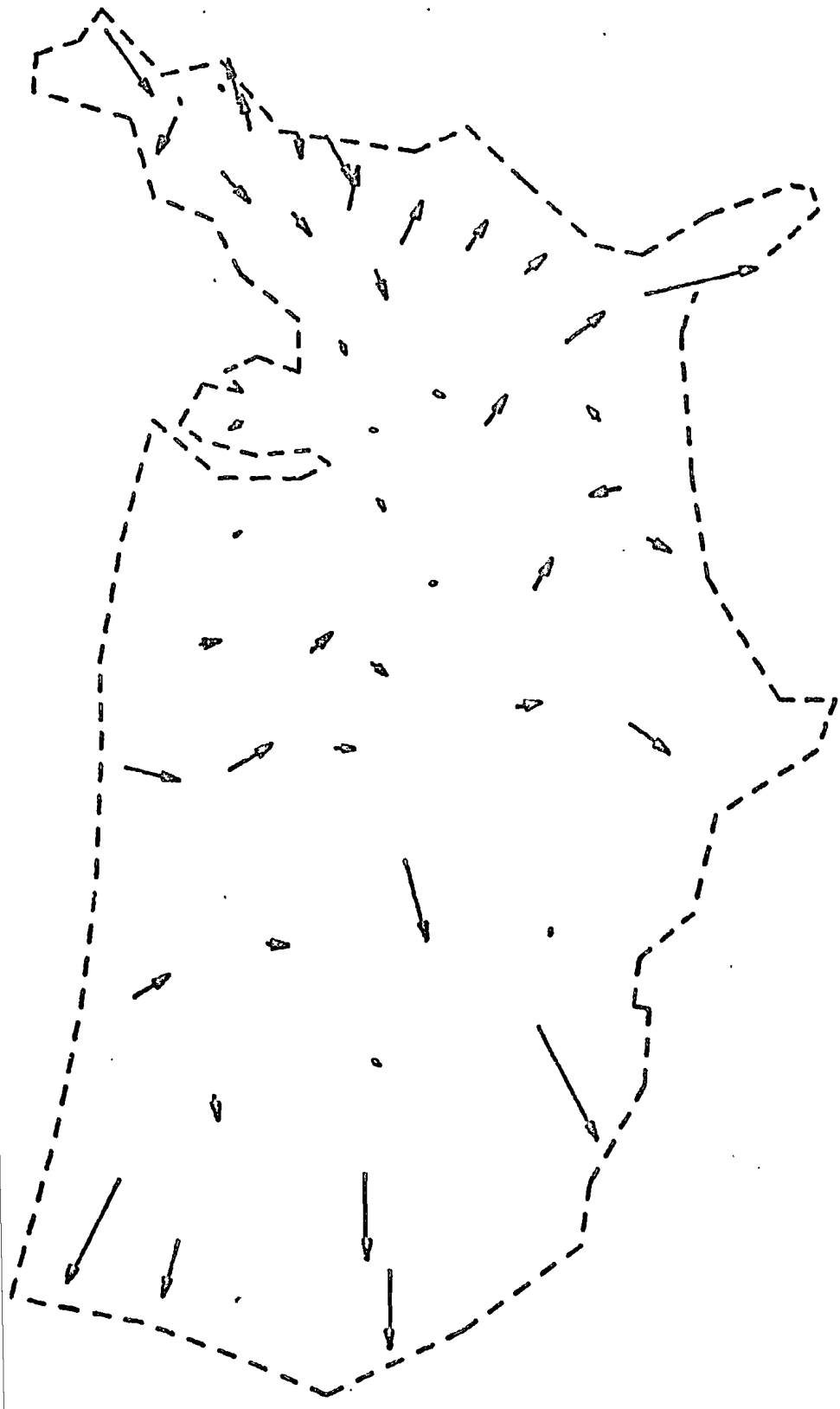
ASYMMETRY OF 1935 TO 1940 STATE TO STATE MIGRATION



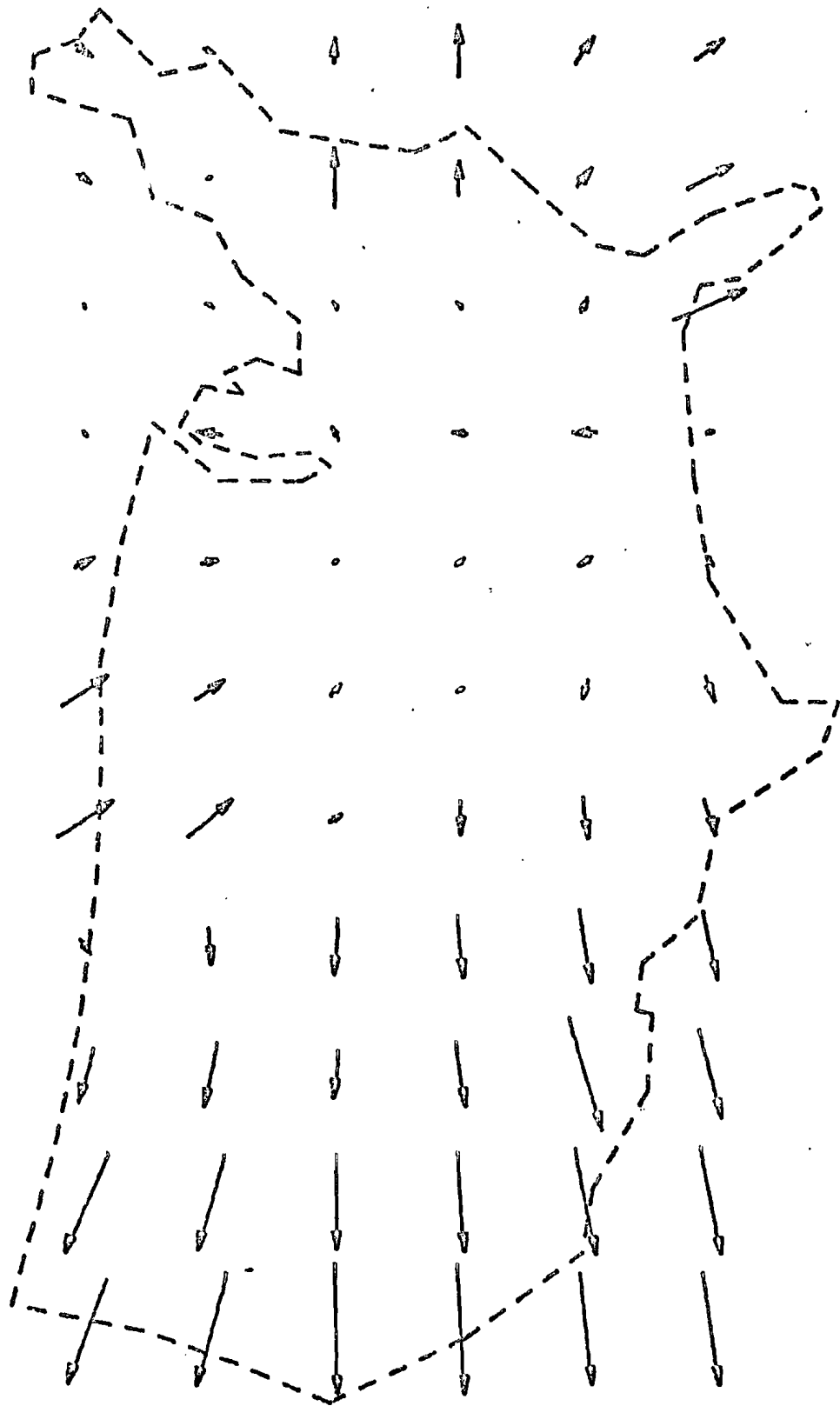
US STATE TO STATE MIGRATION (INDEX) 1949-1950



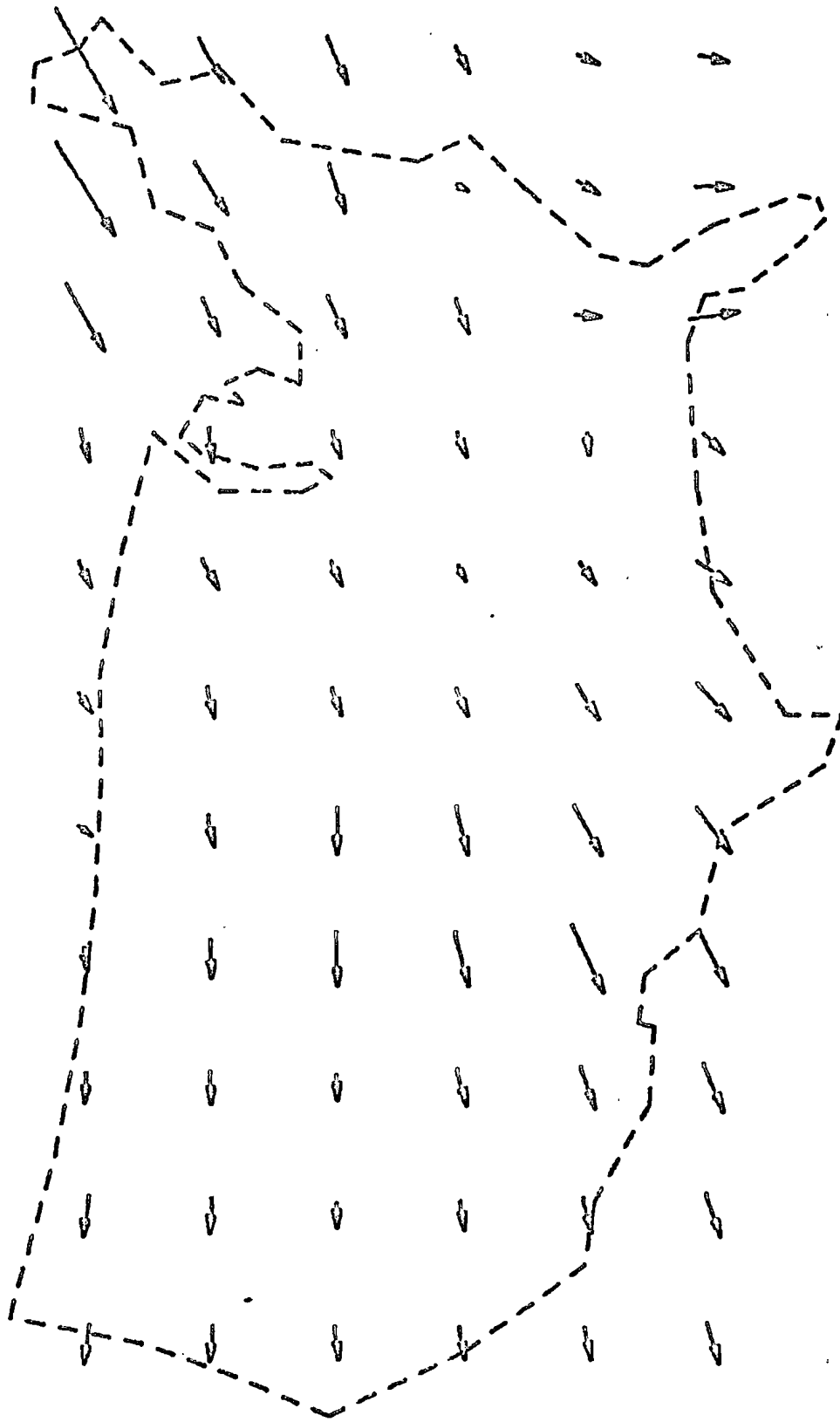
US STATE TO STATE MIGRATION (WEX48) 1955-1960



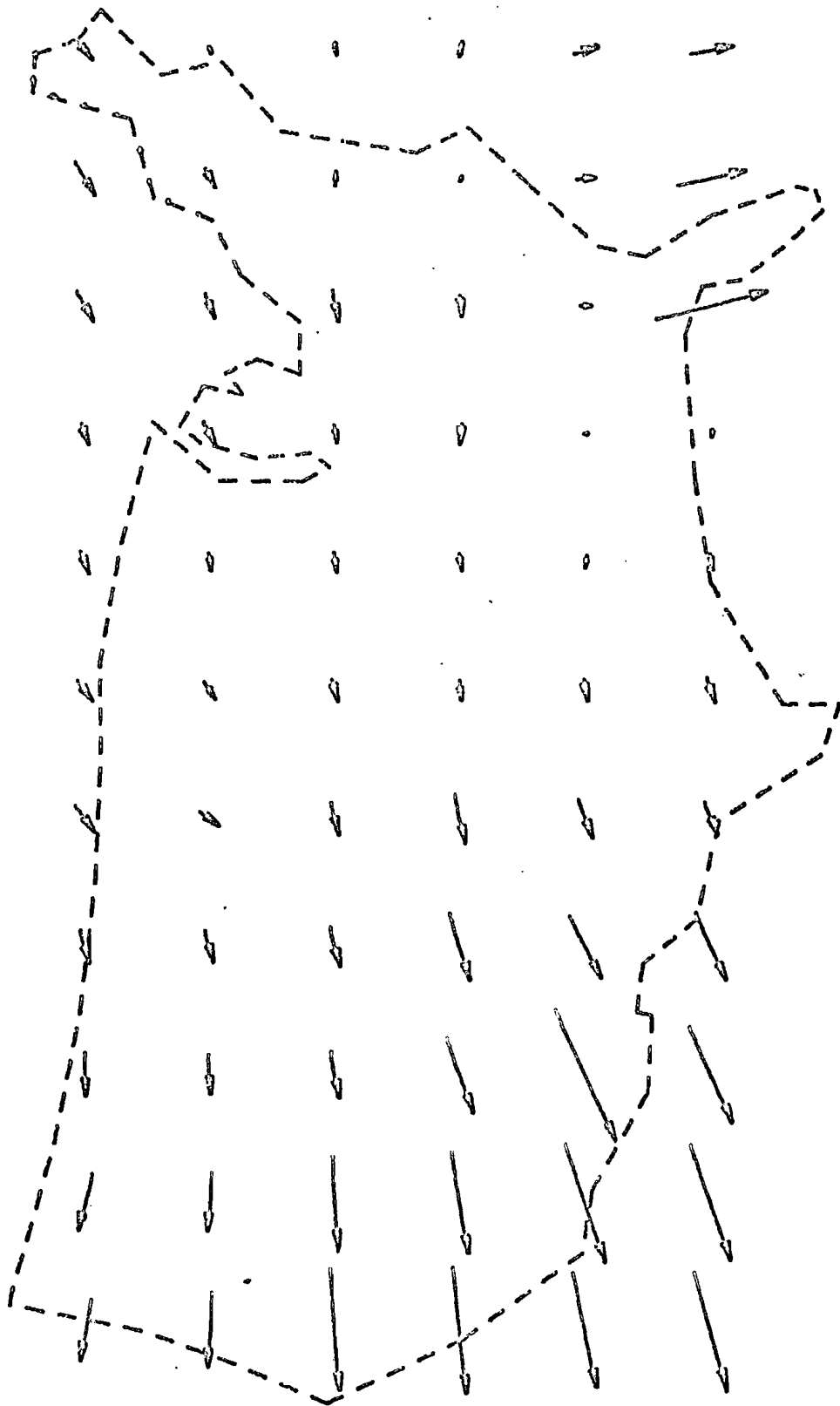
ASYMMETRY OF STATE TO STATE MIGRATION, 1965 TO 1970



INTERPOLATED VECTOR FIELD
ASYMMETRY OF 1935 TO 1940 STATE TO STATE MIGRATION

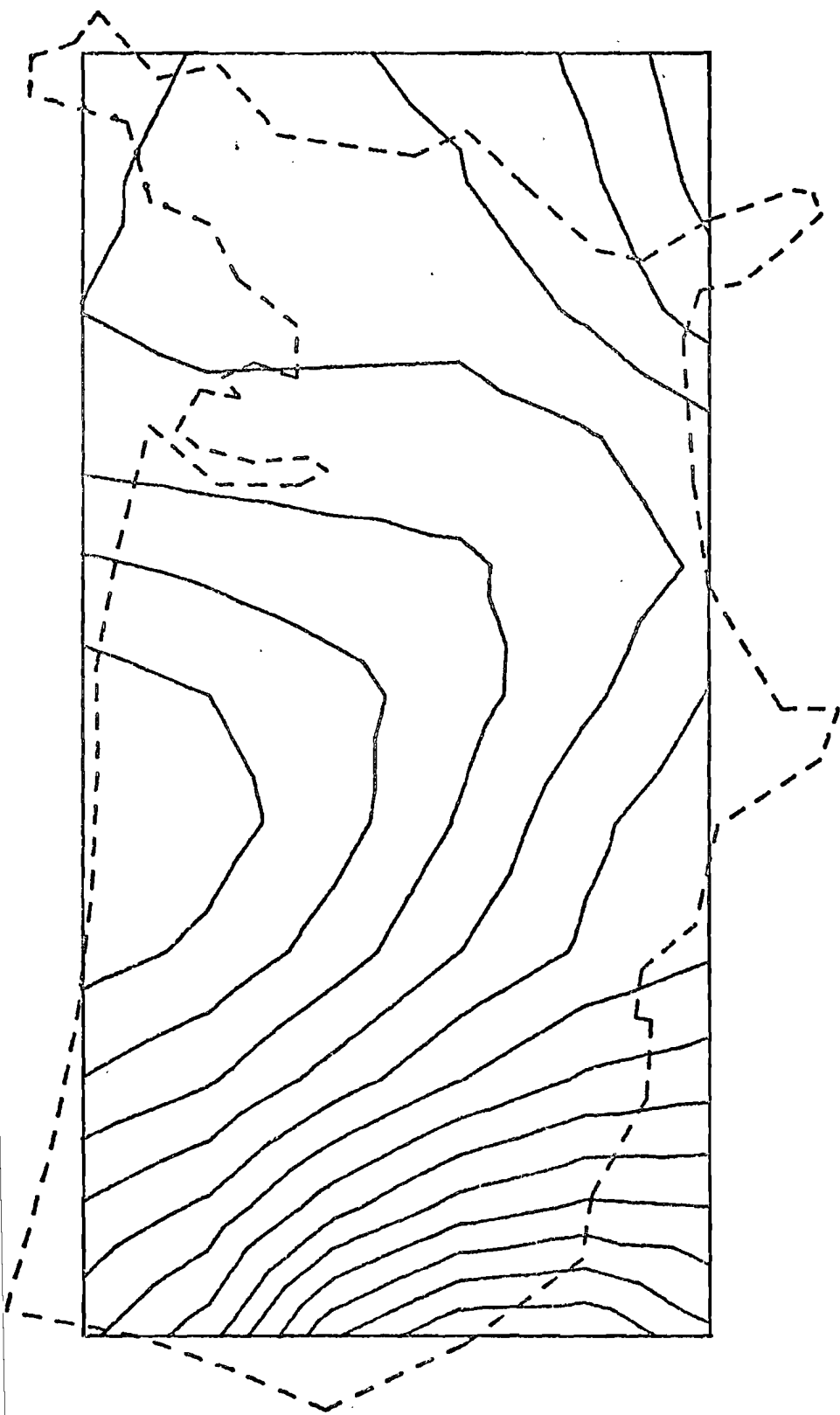


INTERPOLATED VECTOR FIELD
US STATE TO STATE MIGRATION (1981) 1549-1950



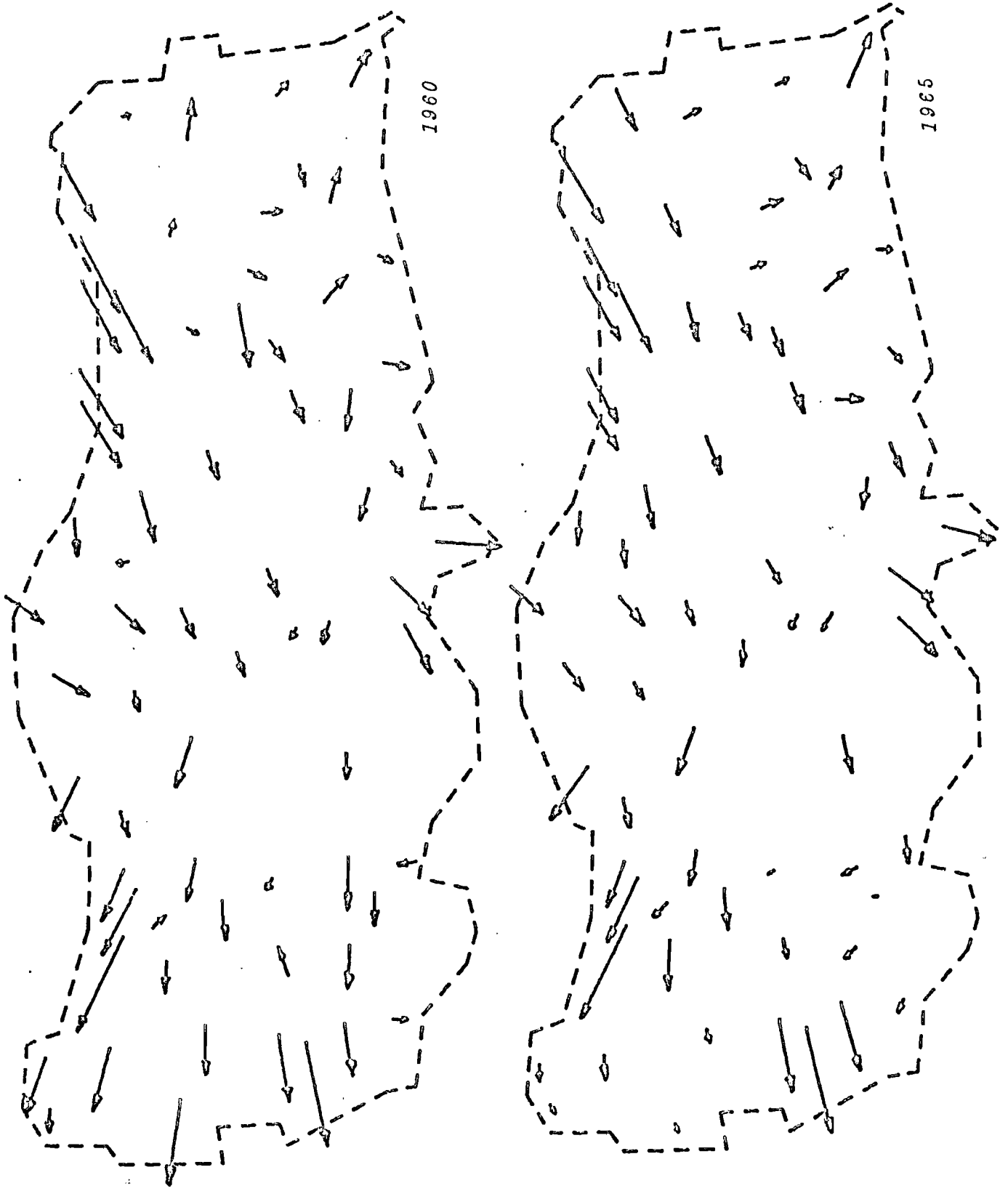
INTERPOLATED VECTOR FIELD

US STATE TO STATE MIGRATION (USXUS) 1955-1960



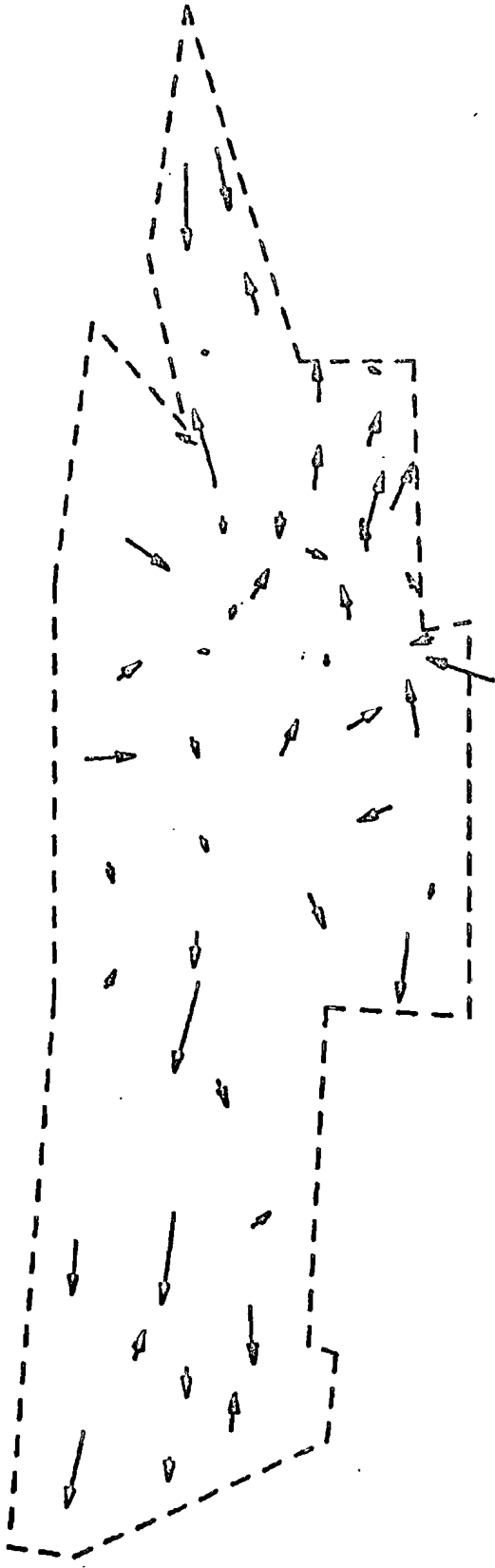
The scalar potential derived from the asymmetry of the 1965 to 1970 migration field by solving Poisson's equation.

**ASYMMETRY OF STATE TO STATE POPULATION SHIFT. 1965 TO 1970
THE FORCING FUNCTION**

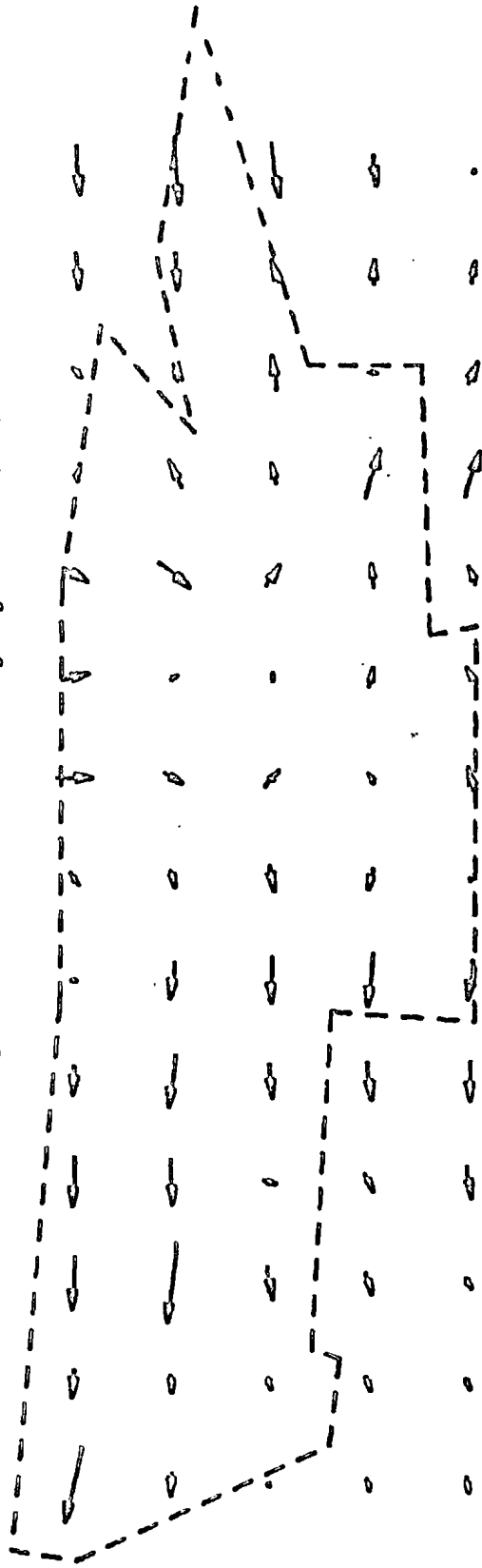


Turkey: Asymmetry of Inter-Provincial Migration.

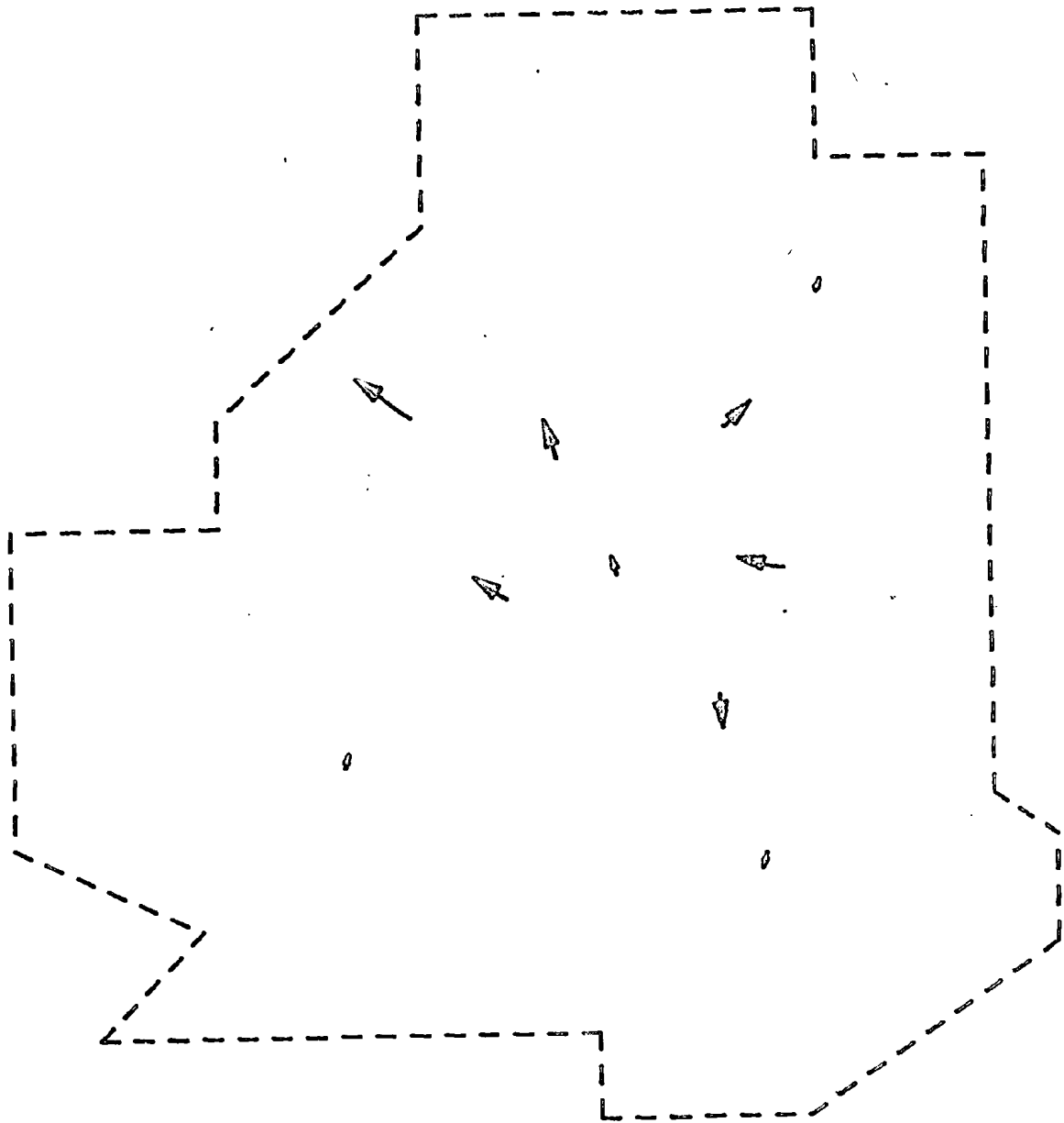
ASYMMETRY OF UPPER MICHEST MIGRATION, 1955-1959



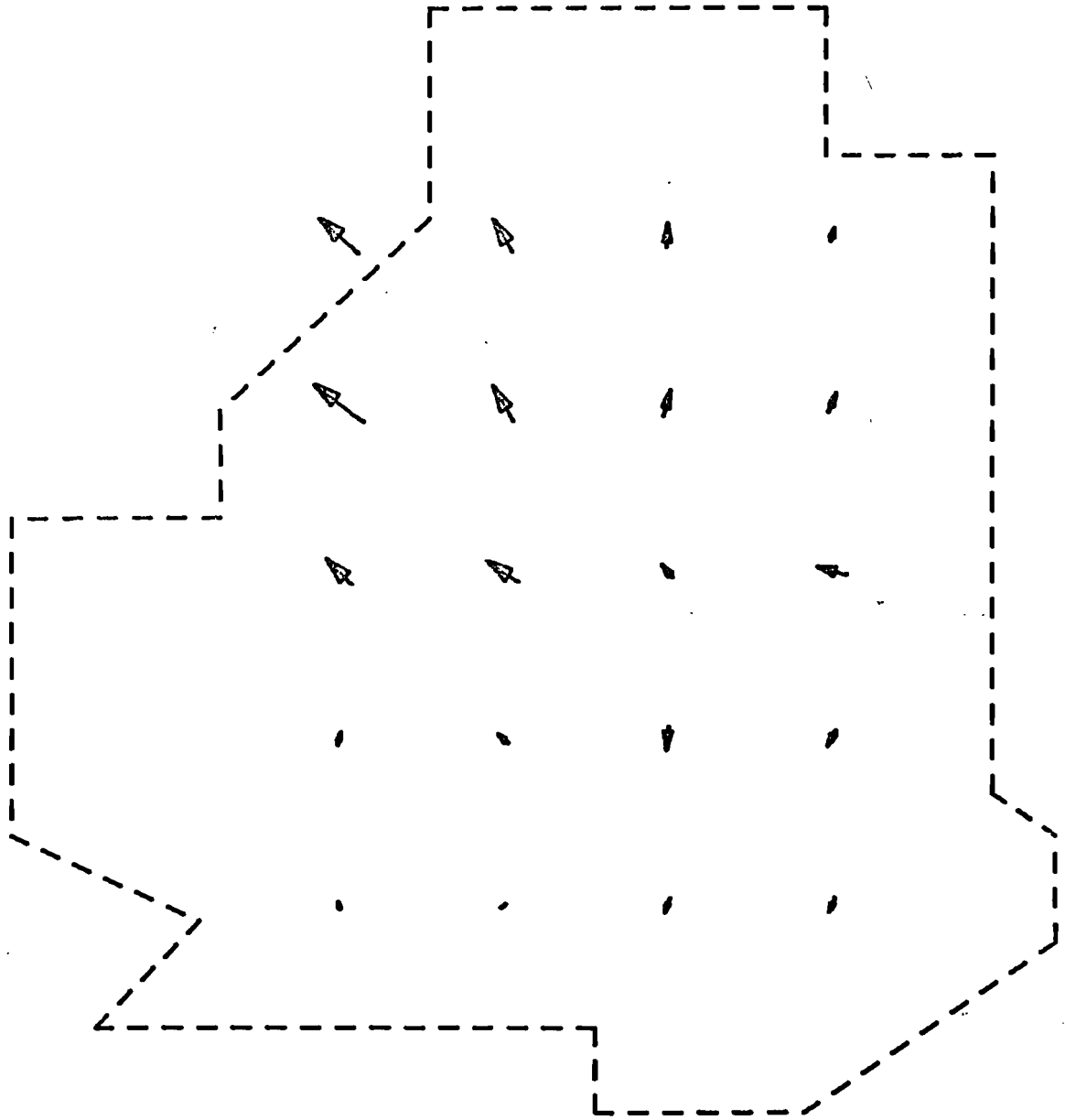
For comparison with the study by R. Adams.



INTERPOLATED VECTOR FIELD



LOCAL MIGRATION: TWIN CITIES METROPOLITAN AREA 1955-1960



INTERPOLATED VECTOR FIELD

LOCAL MIGRATION: TWIN CITIES METROPOLITAN AREA 1955-1960