THE IDENTIFICATION OF TURKISH REGIONS USING 1965 LIFETIME INTERPROVINCIAL MIGRATION DATA

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INTRODUCTION

Many nations publish information on the number of people resident in each province (prefecture, department, state, etc.) who previously resided in each of the other provinces. Data of this nature can, with the use of appropriate analytical techniques, reveal the underlying regional migration structures of these countries (Hollingsworth, 1969; Ng, 1969a, b; Slater, 1974a, b; 1975a, b). 1965 lifetime migration data for the 67 provinces of Turkey are studied here with such an objective.

METHODOLOGY

A 67 x 67 matrix was constructed from Table 16 ("Population by Permanent Residence, Places of Birth and Sex") of the October 24, 1965 Census of Population: Social and Economic Characteristics of the Population, issued in 1969 by the State Institute of Statistics in Ankara. The ij entry of this matrix gave the number of males born in the ith province who lived in the jth province in 1965. In order to control for the fact that provinces differ in their total numbers of immigrants as well as outmigrants, the matrix was adjusted by a biproportional (Bacharach, 1970) or, equivalently, an iterative proportional fitting (Fienberg, 1970) procedure, so that all row and column sums were the same. (The actual number used is essentially irrelevant. It was chosen to be 1000 here.) The entries of the adjusted table are estimates of the number of people who would have migrated from one province to another, if all provinces had the same number (1000) of males leaving, as well as entering. The adjustment is accomplished by first scaling the rows of the original table so that they all sum to 1000, and then scaling the columns so that they too sum to 1000. The process is then repeated a sufficient number of times so that adequate convergence to a final table in which all row and column sums are simultaneously 1000 is obtained. Convergence is guaranteed if all entries of the original table are positive. If some cells have zero values, it may be necessary to decompose the table into subtables. Each subtable could then be individually adjusted.

Each entry of the adjusted (or doubly standardized) table can be considered as an interprovincial directional linkage value. A hierarchical clustering (regionalizing) procedure--which takes into account possible asymmetries of linkage that may exist between pairs of provinces--can then be applied to the table. The method is based upon directed graph (digraph) concepts (Harary, <u>et al.</u>, 1965; Warfield, 1973); in particular, the notion of a <u>strong</u> <u>component</u>. A strong component of a directed graph is a collection of vertices (provinces are represented as vertices) each one of which has a path of directed links emanating from it to any other vertex in the strong component. The strong components--which are computable through matrix multiplication--provide a partitioning of the vertices into mutually exclusive sets (clusters).

The hierarchical clustering is determined through the use of threshold values. For a given threshold, all entries of the adjusted table greater than the threshold are set to one, and all others to zero. The Boolean matrix obtained has a canonical representation as a digraph. The strong components for a given threshold are the clusters or regions at that level. As the threshold is raised, strong components obtained at lower levels fragment, until finally only isolated vertices remain. Unlike many other clustering procedures, these divisions need not be binary ones; that is, a group may separate into more than two subgroups.

The 67 x 67 lifetime migration matrix for Turkey was adjusted to possess row and column sums of 1000. The hierarchical clustering algorithm was then applied to the resultant table. Two separate analyses were conducted. In one, all diagonal entries of the original table were set to zero; in the other, the number of people who were living in their province of birth was taken into account. The former analysis provided richer insight into regional structures.

ZERO-DIAGONAL ANALYSIS

If the diagonal entries of an interprovincial migration table are ignored, only the distribution of those people who have actually left their province of birth can influence the regionalization procedure.

Such a zero diagonal table for Turkey was biproportionally adjusted to possess row and column sums of 1000. The use of any threshold less than 56.06 resulted in a digraph in which every province was in the same strong component. At 56.06, however, the province of Istanbul (Figure 1 and 2) was isolated. Istanbul, thus, has the strongest national identity of any of the provinces. It does not possess particularly strong ties to any of the other provinces. (In a parallel fashion, the Paris region was the first isolated in an analogous study of migration between 21 French conscriptions d'action regionale [Slater, 1974a], as was the Moscow city and oblast in an analysis of 72 administrative units of the Russian S.F.S.R. [Slater, 1975b].)

Erzincan--an important center of eastern Anatolia--was isolated at the considerable higher threshold of 78.17. The capital of this province has been destroyed frequently by earthquakes. It occupies an important position on the rail line and highway from the Caucasus to central Anatolia and from Ankara to Erzurum. It also has air connections with these two cities. Ankara, the capital of Turkey, was itself isolated at 81.22, indicative of the national role that it plays.

Well-defined regions can be ascertained from the dendrogram (Figure 2) by finding groups of provinces that cluster together over a wide range of thresholds. Sixteen such groups-though there are other possible configurations-have been selected here for discussion.

(1) A group of four central Anatolian provinces--Amasya, Tokat, Corum, and Sivas--that are situated about the Cekerek River, formed a strong component between the thresholds of 93.12 and 102.44. Amasya and Tokat, which are drained by the Yesil Irmak or Iris River, form the most tightly bound pair in this group.

(2) Four other central Anatolian provinces--Kayseri, Kirsehir, Nevsehir, and Yozgat--form a more strongly defined region, with a range of existence from 93.12 to 130.02. The Kizil Irmak and the Delice Irmak are important rivers of this region.

(3) The Black Sea coast provinces of Bolu, Kocaeli, and Sakarya clustered together over a wide range of existence, 88.42 to 141.55. Kocaeli is bordered on the west by the Sea of Marmara, as well as by the Black Sea on the north.

(4) The silk-producing provinces of Bilecik and Bursa were grouped with the grain-raising province of Eskisehir between 98.21 and 103.05. The city of Eskisehir is one of the leading industrial centers of Turkey, producing sugar, textiles, bricks, cement, chemicals, and railway and agricultural equipment. It lies on the Istanbul-Ankara and Istanbul-Baghdad rail lines. Bilecik is also situated on the Istanbul-Ankara line.

(5) The three southwestern areas of Aydin, Mugla, and Denizli cohered by themselves between 98.21 and 112.18. Aydin is an important trading center on the Afyonkarahisar-Izmir railway line. It also has good road connections with these two cities. Denizli lies on a branch line of the Dinar-Izmir railway, and Mugla is linked by road with Izmir and Denizli.

(6) The western Anatolian provinces of Kutahya and Usak had a range of existence, as a strong component, from 98.21 to 112.75. Sugar refining and carpet making are among the industries of these two areas. Usak lies on the main road and railway line from Izmir to Ankara.

(7) The Mediterranean province of Antalya was grouped with the inland provinces of Afyon, Burdur, and Isparta from 98.21 to 100.80, a relatively short range. Burdur lies on the Anatalya-Afyonkarahishar highway and is linked by rail with Afyonkarahisar and Eskisehir. Afyonkarahisar is an important railway junction on the Izmir-Ankara line. Isparta is connected by a branch line with the main Anatolian railway.

(8) The only three Turkish provinces--Edirne, Kirklareli, and Tekirdag--which lie completely within Europe formed a particularly well-defined region. It existed between the thresholds of 88.87 and 185.13. (The relatively low threshold of formation, 88.87, indicates that these three provinces form a relatively isolated region. The Sea of Marmara separates this European area from Asiatic Turkey.) The city of Edirne lies on the London-to-Istanbul railway. The city of Tekirdag is linked by road at Murath with this line, while the city of Kirklareli is connected to it by a branch railway. Tekirdag lies on the main highway from Ipsala, on the Greek border, to Istanbul.

(9) The isolated southeastern provinces of Hakkari and Van, which have large Kurdish populations, formed the strongest couplet in the entire analysis, not dissolving until 322.01. Their threshold of formation was 91.73. Animal raising is a major activity in this region. (In the comparable study of migration between Japanese prefectures Slater, 1974b, two underdeveloped areas, Shimane and Tottori, also formed the strongest pair.)

(10) The eastern Anatolian provinces of Agri, Bitlis, Kars, and Mus, which are historically associated with Armenia, were clustered together between the thresholds of 91.73 and 108.57. Agri is a transit station on the main highway from Turkey to Iran. Mus lies on the Elazig-Tatvan railway. Tatvan, on Lake Van, is the chief port of Bitlis. Iars is an important military station.

(11) Three southeastern provinces--Diyarbakir, Mardin, and Siirt--which have large Kurdish populations, formed a well-defined region, since it had a wide range of existence, 96.25 to 136.93. The Tigris River drains this area. Siirt is the center of the Turkish oil-producing region. Diyarbakir and Mardin are linked by road with Aleppo in Syria, and Mosul in Iraq.

(12) Bingol and Tunceli, primarily stockraising districts, were grouped with the agricultural province of Elazig, which produces cereals and fruits, in addition to livestock, from 96.25 to 120.43. Bingol is linked by main roads with Elazig to the east and Mus to the west. Tunceli lies on the Erzurum-Elazig road.

(13) The Black Sea provinces of Artvin and Rize, which lie near the Soviet Union, formed a strong component from 91.73 to 111.18. Due to their mild climate and high humidity, tea is a major crop. The Lazes, a Caucasian people, form a substantial part of the population. The city of Artvin has road connections with the port of Hopa to the northwest and Erzurum to the south.

(14) The Mediterranean Sea, the Syrian border and the Taurus Mountains help to bound a well-defined region composed of eight provinces--Adana, Adiyaman, Gaziantep, Hatay, Icel, Malatya, Maras, and Urfa. The significance of the cluster is attributable not only to its range of existence, 89.78 to 113.18, but to its large number (8) of constituents, as well. The Euphrates River is an important geographic feature of the eastern part of this region.

Adana is situated on the Istanbul-Baghdad railway and is connected by a branch line to the Mediterranean port of Mersin in the province of Icel, through which its products of textiles, agricultural machinery, and vegetable oils are shipped.

Malatya is a rail and road junction at which the line from Aleppo (in Syria) via Fevzipasa meets the lines east from Elazig and Diyarbakir and north from Sivas and Erzincan. Maras is linked by a branch line with the Adana-Malatya railway and is also connected by road with Adana, Gaziantep, Antioch, and Malatya.

Urfa is tied by main roads with Gaziantep to the west, Mardin to the northeast, Adiyaman to the northwest, and northern Syria to the south. It is separated from Diyarbakir on the east by

Karaca Dag (1,919 m.).

(15) Six provinces that lie on the Black Sea--Giresun, Kastamonu, Ordu, Samsun, Sinop, and Zonguldak--and one inland province, Cankiri, formed a large cluster from 81.22 to 87.37. The city of Cankiri lies on the Ankara-Zonguldak rail line. The port of Samsun is the largest city in this region. (It exports tobacco and wool from the interior and cigarettes, fertilizer, and textiles produced in its factories. It is the terminus of the railway line from inner Anatolia, on which iron ore is brought from Divrigi. The ports of Giresun and Ordu are centers for hazelnut processing and exporting. Ordu lies on the Samsun-Trabzon coastal road. Zonguldak is the center of heavy industry in Turkey. It contains large iron and steel complexes at Karabuk and Eregli. Coalfields are located near the city of Zonguldak.

(16) Trabzon, site of the Black Sea Technical University, and Gumushane, a mountainous area, were clustered from 81.22 to 156.13. The city of Gumushane serves as a transit station en route from the port of Trabzon to western Iran.

ANALYSIS WITH ORIGINAL DIAGONAL RETAINED

If the diagonal of the interprovincial migration table is set to zero, then the entries of the table after its biproportional adjustment to possess equal row and column sums are estimates of the number of people who would have migrated between provinces, if all provinces had had the same number of inmigrants and outmigrants. If the original diagonal entries are retained, the adjusted table provides estimates of the number of people who would have migrated between provinces, if all provinces had the same number of people born in them, as well as residing in them.

"Since the areas of the provinces do vary substantially (from 3,920 to 47,420 km², \bar{x} = 11,572, s = 712)" (Munro, 1974, p. 641), it would be expected that provinces with large areas would tend to retain more of their native-born population. The diagonal entries associated with these larger provinces in the adjusted table should, therefore, be relatively large. Their linkages with other provinces would, correspondingly, tend to be small. It is not, therefore, surprising that the most tightly bound pair of provinces--Kocaeli and Sakarya--in this second analysis (Figure 3) should be realtively small. (The area of Kocaeli is 3,986 km², while that of Sakarya is 4,457 km².) These two provinces formed a strong component between the thresholds of 14.92 and 16.47. (The thresholds are much smaller than in the first analysis, although all row and column sums are still 1000, because the diagonal entries, rather than being zero, now assume large values.) Kocaeli and Sakarya, together with two other Thrace provinces--Istanbul and Tekirdag--as well as Ankara form a well-defined region, with a range of existence from 11.66 to 14.73. (The diagonal entries associated with these five provinces were: Ankara, 808.6; Istanbul, 684.8; Kocaeli, 913.4; Sakarya, 915.6; and Tekirdag, 941.0. Istanbul and Ankara had the smallest associated diagonal entries of all 67 provinces, indicative of the large extent to which people

migrate to and from them. 1.2 million of Turkey's 4.0 million lifetime migrants were located in Istanbul.) The Western provinces of Izmir and Manisa form a strong pair, which together with Bursa, unite with these five provinces.

"The development of Ankara into the in-migration province of Eastern Anatolia, as well as of the Central Anatolian Region, has had and is having great influence, as we gather, on the distributional pattern of the population who leave their province of birth. Ankara as an in-migration centre, which attracts the outmigrants from Interior and Eastern Anatolian Regions, is in a very suitable position for this post. Had it not been for Ankara, to think of the condition Istanbul would be in, would not at all end in positive results in the matters or urbanization and city planning. There is no doubt that Ankara, as it did in years past, is now attracting an important part of the migrations directed to Istanbul and Izmir. Consequently, it can be said that Ankara has the role of a dam in its relation with Istanbul and Izmir; and this role is similar to the role of the settlements which are generally planned close to, or in the surroundings of important inmigration centres, in order to avoid to a certain extent the raids directed to these centres" (Tumertekin, 1968).

Hakkari $(9,521 \text{ km}^2)$ and Van $(19,069 \text{ km}^2)$, the most strongly bound pair of provinces in the zero-diagonal analysis, are relatively more weakly bound in the second analysis. This indicates that they tend to retain a greater portion of their native-born population than Kocaeli and Sakarya, for instance. The diagonal entry associated with Hakkari, 990.5, was the largest in the adjusted table. Hakkari has the smallest population of any of the 67 provinces.

In general, there are fewer well-defined regions in Figure 3 than in Figure 2, since a large number of provinces are peripherally attached to the Thrace-oriented cluster described above. Diyarbakir, Mardin, Siirt, Bingol, Elazig, and Tunceli form a strong component in each analysis. Pairs of provinces that form well-defined strong components in each analysis are: Amasya and Tokat, Adiyaman and Malatya, Elazig and Tunceli, Burdur and Isparta, and Bitlis and Mus.

CONCLUSIONS

Dewdney (1971, p. 149) points out that in the case of Turkey there are "at least two sets of officially accepted regions: the standard statistical regions, used particularly in recent censuses, and the regions used by the Ministry of Agriculture in the publication of agricultural data." He finds neither of these regionalizations satisfactory and proceeds to develop another one. Regionalization schemes alternative to these three, that are based upon lifetime migration flows, can be derived from Figure 2 or 3. The clusters, or strong components, at a given t threshold level, can be identified as regions. (Fifteen of the 16 regions described above, for example, exist at the threshold of 100.) Any number of regions between 1 and 67 can be selected in this manner. The persuasiveness of any particular regional scheme would depend upon its stability in the analysis. Stability is a function of the range of existence of the strong components.

Directed graph representations of the strong components can be employed to show the particular relationships between the individual members of the regions. This has been done in parallel studies of migration tables from other nations (Slater, 1974a, b; 1975a, b). In all five of these studies, the regions found have always been composed of contiguous units. Usually geographers need to impose explicit constraints to achieve contiguity. That this has not been necessary in this series of studies attests to the meaningfulness of the methodology utilized.

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Figure 1. Turkish Provinces



Figure 2. Hierarchical Clustering with Zero Diagonal



