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A STUDY OF MUNICH COMMUTING

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Abstract:

In 1962 D. Fliedner published an investigation of traffic in three German cities: Göttingen, München, and Osnabrück. In the case of Munich he reported on commuting between thirty-three districts. He then applied an iterative proportional fitting procedure to the 33 by 33 table, seemingly having independently invented this technique. Since the IPF Procedure shifts movement to the outlying places he interprets this as a cyclonic effect. I re-examine his results.

During my sabbatical from the University of Michigan in 1974/75 I spent time at The International Institute for Applied Systems Analysis outside of Vienna. Browsing in the IIASA library I found a paper from 1962 by D. Fliedner. Always on the hunt for interesting data, which needs not be contemporary since this is not a requirement for scholarly work, I was happy to find his table of commuting in the year 1939 between 33 districts in Munich (Figure 1) accompanied by a map of the districts (Figure 2). As is typical in these situations the central districts are quite small and the peripheral ones large. The map allowed me to locate the districts and assign centroid coordinates. As I tell students, publish your data and you increase the chance that your work (right or wrong) will be cited!

At the time I was studying geographical movement patterns, especially their asymmetries, and developing computer programs to display these patterns. My thought was that Fliedner's data for Munich provides a good test case. The first map produced from the commuting table was the plus and minus depiction in Figure 3a, using a plus sign for arriving commuters and a minus sign for departures, both located at the centroids of the districts. The magnitude of the symbol represents the in or out commuting volume. Then using a technique that I developed I was able to draw small arrows at each of the locations indicating whether the movement was inward or outward (Figure 3b). Then an interpolation of the arrow directions produced the vector field shown in Figure 3c. Integration, in the mathematical sense, taking the vector field to represent gradients, allowed construction of a potential surface depicting the pressure to commute. All this was then published and also presented at a subsequent conference. I have now, using the Flow Mapper program from CSISS.org, made more conventional maps of the total and net commuting pattern (Figure 4).

In this work I paid scant attention to the substance of Fliedner's paper, simply using it as a data source. When I got around to actually reading his study I found that he had in fact examined residential relocations in another city (Göttingen) and truck traffic in a further urban area (Osnabrück). For each of these he gave further movement tables, maps, and analysis. The analyses that he performed I found rather curious. In each case he transformed the tables so that the marginals (row and column sums) were about the same. He did this in order to adjust for the size differences of the districts, arguing that *it was the arbitrariness of the district borders that caused the extreme differences in the tables. He could not readjust these boundaries* – he did not have data on individuals – *but he could readjust the tables*. For this he used a two-step transformation adjustment. He does not give a source for this idea so I assume that possibly he invented it for himself. In the current literature this is known as biproportional adjustment, or the Iterative Proportional Fitting Procedure. On a computer - Fliedner seems to have done it by hand – more than two iterations are used, with a stopping criterion based on the closeness of the adjustment.

In Fliedner's case he produced tables and maps for the three cities, but the maps shown are only after the adjustment. Figures 5 and especially Figure 6 are his results for Munich. I have now used a computer to run the IPFP to compare with Fliedner's adjustment, as given in his table (Figure 7). His two step procedure seems to have gotten the results that he wanted since his result is not substantially different from that obtained when using a modern digital computer.

Once he obtained the adjustment, and put it into map form, he comments that the pattern was as expected from central place theory. Before the adjustment most of the commuting is inward and radial in direction. He then discusses the map produced from the adjusted movement. Here he claims to have detected a vortex-like counterclockwise rotation about the city center, superimposed on the more prominent radial pattern. This is followed by rather unclear speculation as to the cause of this rotation and whether it is a general tendency in towns.

I have now taken his data for Munich and recreated maps of the commuting before and after adjustment. (Figures 8, 9 &10). Movement has definitely shifted to the outer area, but rotation? Do you see a vortex or whirlpool effect when comparing the before and after picture?

Since I have long been curious about what effect the often used biproportional procedure has on data tables, and the interpretation of the resulting adjustment of the table entries and marginals, I computed, and used maps to display, the results for two cases several years ago (Figures 11 & 12). In the case of France the effect is to displace the worker migration away from Paris. In the US migration case the pattern is spread more widely. In both cases the effect is one of disbursement but not really rotation. But these examples are country wide. Now, perhaps, urban commuting should be studied for such effects.

References:

Bishop, Y., Fienberg, S., Holland, P. 1975, *Discrete Multivariate Analysis: Theory and Practice*, MIT Press.

Fliedner, D., 1962, "Zyklonale Tendenzen bei Bevõlkerungs- und Verkehrsbewegungen in städtischen Bereichen, untersucht am Beispiel der Städte Göttingen, München und Osnabrück", *Neues Archiv für Niedersachsen*, 10(15),4:277-294. (Translation available upon request)

Slater, P,. 1976, "Hierarchical Internal Migration Regions of France" *IEEE Transactions on Systems, Man, and Cybernetics*, 321-324.

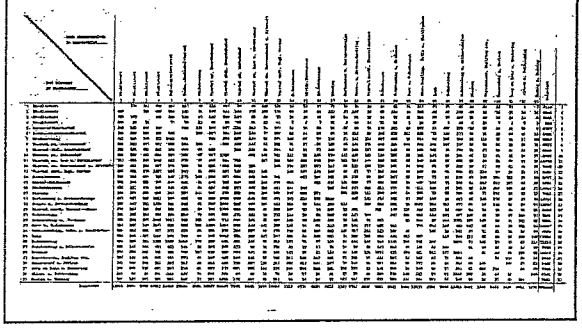
Tobler, W., 1976, "Spatial Interaction Patterns", *J. of Environmental Systems*, VI: 4: 271-301.

Tobler, W. 2005, "Using Asymmetry to Estimate Potentials", *International Social Network Conference, SUNBELT XXV*, Redondo Beach, CA, 2005-02-17.

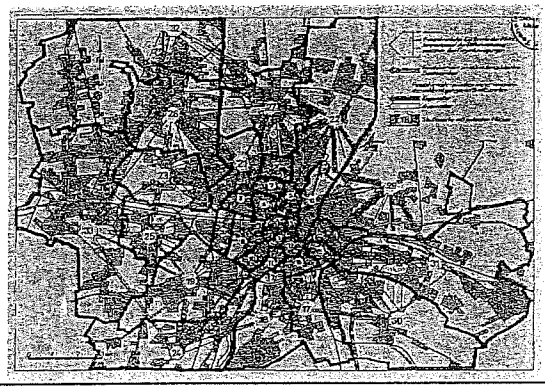
Figures:

1) Original pattern; Fliedner Tabelle 2.
2) Districts and centroids.
3) Size, Displacement, Interpolation.
4) Gross and net commuting; original.
5) After adjustment; Fliedner Abb. 3.
6) After adjustment; Fliedner Abb. 4.
7) Adjusted pattern; Fliedner Tabelle 10.
8) Before and after comparison; total.
9) Comparison; two-way commuting.
10) Comparison; net commuting.
11) France worker movement, before and after.
12) US migration before and after.

Munich Commuting 1939
Between 33 districts



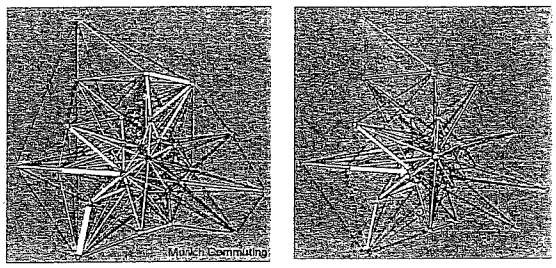
33 Munich 1939 commuting districts



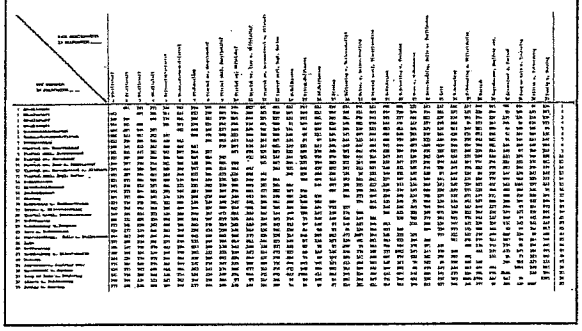
Munich commuting 1939
(Tobler 1975)

Magnitude Displacement Interpolated

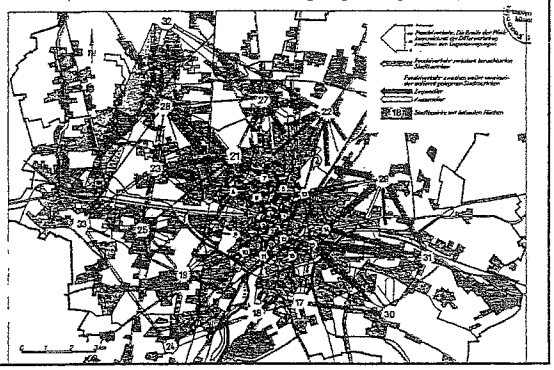
Munich Commuting 1939
Total (left) and net (right) commuting



Munich Commuting, adjusted

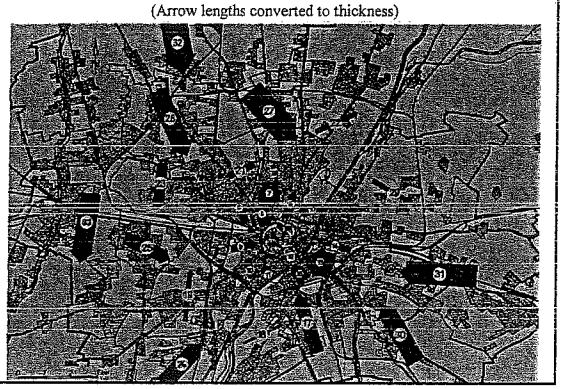


Munich Commuting after adjustment
(Difference between in and out commuting. Original image in color)



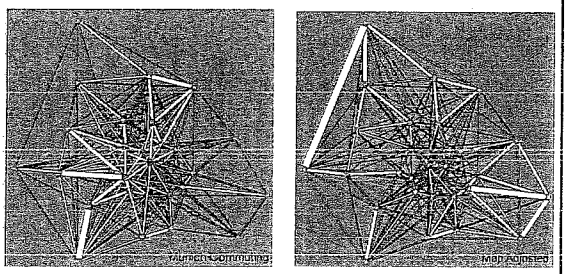
Munich Commuting after adjustment

(Arrow lengths converted to thickness)



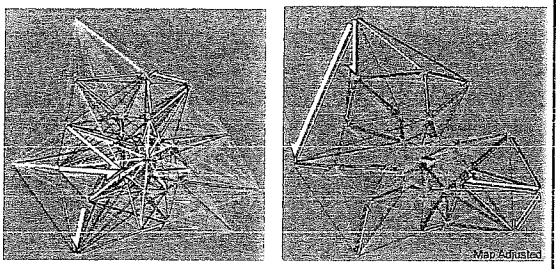
Comparison of commuting patterns

Total (gross) commuting
Original (left) and Adjusted (right)



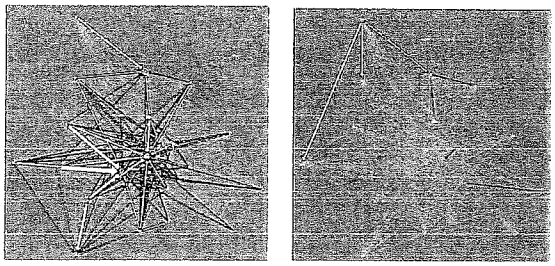
Comparison of commuting patterns

Two way commuting
Original (left) and Adjusted (right)



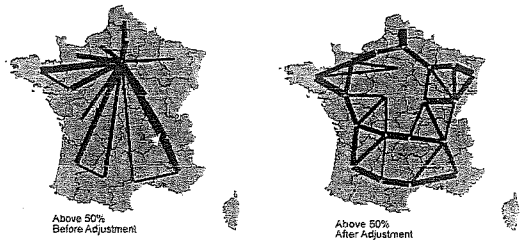
Comparison of commuting patterns

Net commuting
Original (left) and Adjusted (right)



Biproportional adjustment applied to worker migration

Left: original Right: adjusted



Another example: US migration