Looking At Some Data from Isard's "Methods of Regional Analysis"

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In his path-breaking book “Methods of Regional Analysis” (MIT Press, 1960) Walter Isard presented several sets of data. Some of these are fictitious, designed to illustrate concepts. Others contain real empirical values. Among the latter are several tables. I have used two of these, not in a research mode, but rather as exploratory visualizations. Of the two matrices one is 36 by 36 in size, the other is 47 by 47. I have used these tables in their original form without attempting any transformations such as biproportional adjustment to equalize marginals, or eigenvector analysis, or partitioning into symmetric and skew symmetric parts to estimate potentials[1]. Nor have I attempted to reduce the resolution of the data by combining, or by omitting, rows or columns from the matrices.

Relating to the first of my examples, Isard has four maps of the movement of funds between Federal Reserve cities. These are illustrated on pages 149, 154-156. of the book. He also presented a table[2] of similar monetary transfers between the thirty-six Federal Reserve cities in the United States. Curiously none of the four maps shown is made using the information from this table. But he argued, rightly in my opinion, that such tables and maps should be used more widely. To date I have not seen much evidence that this suggestion has been followed. An examination of recent issues of the *Annals of Regional Science* convinces one of this fact. Isard thus recognized that insufficient use is often made of the human power of inference from visualizations in research. As an exercise to demonstrate the usefulness of this idea I have used a simple and freely available computer program[3] to create several maps from the 36 by 36 table. In order to do this it was only necessary to look up the latitudes and longitudes of the cities on the internet and to find a computer compatible outline map of the United States. The preparation of such maps is then very simple and alternate versions of the maps can be created quickly. The computer program allows one to interactively hover (with a mouse) over a location to read its name, and to hover over the flow symbol to be presented with the numerical value. Thus exploratory research use can be made of the maps. This interaction of course is not possible with the printed versions of the maps[5].

The thirty six by thirty six matrix yields a possible 1,260 movements so that some parsing is desirable. Such tables are not random, but contain considerable structure. The majority of the volume is contained in a minority of the flows so that deleting flows below the mean tends to leave 75% of the movement volume but requires only 20% of the movement activity. This is a far better strategy than, for example, reducing the resolution by lumping all of the

thirty six cities into the twelve Federal Reserve Districts and thereby reducing the 1260 values to 132 with the attendant loss of geographic detail.

Examples of maps from one set of data hardly constitutes a research project – but inclusion of such fiscal-movement maps can enhance most studies, and a sequence from several time periods is certain to be enlightening, especially if rendered within an animation.

Table and five maps go here
Map 1: Original map from Isard, p.149.
Table I (part)
Map 2: All fiscal transfers during a week (of 1,260 possible)
Map 3: Net transfers greater than $2*10^7$ dollars
Map 4: Above average transfers **to** New York City
Map 5: Above average transfers **from** New York City

Another important data array is available in an input-output table. As pointed out by Isard[4] "…the *interregional input-output* approach is most prominent, both in terms of accomplishment and recognition. It represents a fruitful approach for depicting and investigating the underlying processes which bond together the regions of a system and all the separate facets of their economies." A graphical exercise, similar to that given above, has been undertaken with respect to the New England input/output table from the "Methods" book[6]. In this case there are forty-seven industry groupings and the flows are represented by a 47 by 47 table. The industries are quickly given coordinate locations by a metric multidimensional scaling program[7]. This works somewhat as follows. Consider two industries to be "close" if the quantity of exchanges between them is large. Then construct a diagram in which "close" industries are placed near each other. Do this by positioning a first industry at random. Take the industry "closest" to this and place it on a circle of chosen radius near the first one, thereby establishing a scale for the diagram. The next industry, the third industry, then lies at the intersection of two circles drawn about the first two, with appropriately scaled radii. There is a slight ambiguity and arbitrariness here because two circles can intersect in two places. Choose one of the options and insert the third industry. and then proceed to locate the next (fourth) industry using more circles. The degrees of freedom rapidly decrease and the choices become more difficult. Mathematically the fitting via

circles can be replaced by an iterative procedure that places industries into the diagram so that "close" industries are also close in the diagram[8]. The contacts between industries are then drawn as flows between these locations using the same mapping computer program. Curiously the scaling algorithm has placed most of the industries on the perimeter of a circle with only a few industries in the interior. My suspicion is that the starting configuration - the Gower algorithm was used - began with all items on a circle. The non-metric version - the Torsca algorithm - gave very similar results.

The few interior-lying industries seem to dominate the table. The "Household" category is especially prominent. The important industries exchanging goods and services are easily identified when using the interactive computer program, as are the magnitudes involved. Close visual examination of the original input-output matrix would permit recognition of these major flows, especially when studied by the original compiler of the table. But without such close scrutiny a casual user could find the graphical version(s) more useful and especially rapid. This technique has, to the best of my knowledge, not been used very often, if at all, with input/output tables.

The 47 by 47 matrix could contain as many as 2,162 entries, if the diagonal is ignored, so that a parsing by size is again appropriate, as is seen clearly in the diagrams. Only a little over a dozen entries are significant. As is the case with the movement maps, one example does not constitute a research project but a series of such diagrams, even an animation, can enhance the study of changing regional structure. An opportunity to study regional dynamics thus becomes available. An interesting experiment might be provided by applying the technique to the Leontiev inverse, or to the input/output coefficient matrix.

Input / Output table & maps go here
Table 3 (part).
Map 6: The complete I/O table in graphic form
Map 7: All exchanges above the average
Map 8: Above $5 * 10^8$ dollars, with labels
Map 9: Net exchanges above $2 * 10^7$ dollars

Citations

[1] W. Tobler, 2005, "Estimation of Potentials from Asymmetries", in Solstice, A refereed electronic journal, XVI, 2 (Winter) at: http:/www.imagenet.org

[2] "Table 1. Net Commercial And Financial Flows Between Federal Reserve Zones, Week Ended October 13, 1954", pages 152-153 of W. Isard, 1960, Methods of Regional Analysis, Cambridge, MIT Press. Careful examination of Isard's table and the maps reveals that they came from different sources and relate to different time periods. Thus the flows mapped here differ from those illustrated in the book.

[3] The program, tutorial, and sample data can be downloaded without charge from: www.csiss.org\spatial tools\flow mapper

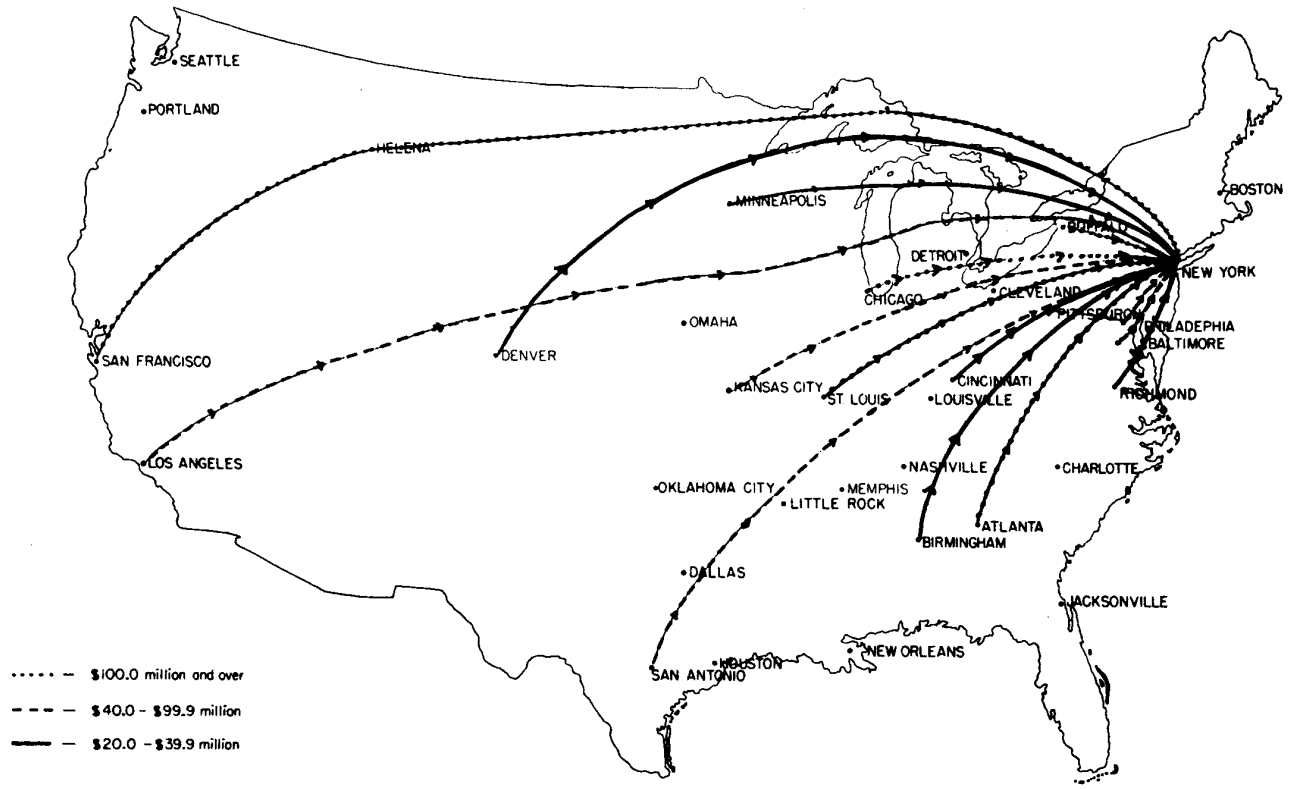
[4] An alternate graphical method of representing dollar movement is presented in W. Tobler, 1981, "A Model of Geographic Movement", Geographical Analysis, 13, 1 (Jan):1-20; Table I, Figures 1-6..

[5] Isard, op. cit., 310; emphasis as in the original.

[6] "Table 3. New England: Input Requirements And Commodity Balances, 1947, Estimated from National Coefficients", pages 604-607 of Isard, 1960, op. cit. Also see the discussion of the data in the table on pages 603-617.

[7] Borgatti, 1996, ANTHROPAC 4.0, Natick, MA, Analytic Technologies. The two-dimensional stress after eight iterations was 0.40. A three dimensional solution was not attempted.

[8] A simple introduction to one of the iterative methods is given in: W. Tobler, 1996, "A Graphical Introduction to Survey Adjustment", Cartographica, 33-42.



Map 17. Net inflows through Interdistrict Settlement Fund to the New York Federal Reserve Office, June–July 1954. Source: N. N. Bowsher, J. D. Daane, R. Einzig [8], p. 142.

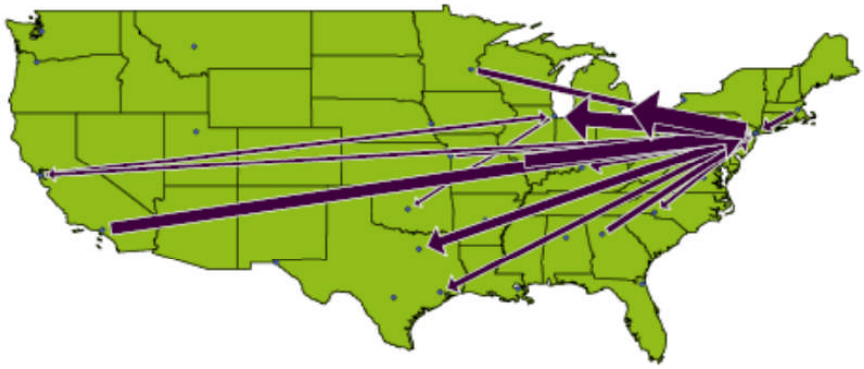
TABLE 1. NET COMMERCIAL AND FINANCIAL FLOWS BETWEEN FEDERAL RESERVE ZONES, WEEK ENDED OCTOBER 13, 1954
(Millions of dollars; plus sign indicates net inflow to area at top of column)

	Boston	New York	Buffalo	Philadelphia	Cleveland	Cincinnati	Pittsburgh	Richmond	Baltimore	Charlotte	Atlanta	Birmingham	Jacksonville	Nashville	New Orleans	Chicago	Detroit	St. Louis
Boston	–	+26	+1	+3	+1	+1	+4	+1	+1	+3	0	0	+1	+1	0	+8	+6	−1
New York	−26	–	+3	−25	+33	−3	+27	−4	−6	+24	−36	−19	+10	−9	+19	+70	+77	−66
Buffalo	−1	−3	–	0	+2	0	+1	0	0	0	0	–	0	−1	0	+6	−3	0
Philadelphia	−3	+25	0	–	−3	−3	−6	−4	−3	−4	−5	−1	−2	−1	−1	+7	−5	−1
Cleveland	−1	−33	−2	+3	–	+3	+5	+2	+1	−1	−1	0	+1	+1	0	+10	−5	+3
Cincinnati	−1	+3	0	+3	−3	–	−1	−1	0	0	0	0	0	−1	0	+8	−3	0
Pittsburgh	−4	−27	−1	+6	−5	+1	–	−5	+5	0	−5	+1	0	+1	+1	+7	+1	−1
Richmond	−1	+4	0	+4	−2	+1	+5	–	+8	−15	+6	0	−2	0	0	+7	+3	+2
Baltimore	−1	+6	0	+3	−1	0	−5	−8	–	−1	0	0	−1	0	0	+3	−1	0
Charlotte	−3	−24	0	+4	+1	0	0	+15	+1	–	+9	+1	0	0	0	−4	0	+1
Atlanta	0	+36	0	+5	+1	0	+5	−6	0	−9	–	−6	−11	−4	−12	+5	+3	+2
Birmingham	–	+19	–	+1	0	0	−1	0	0	−1	+6	–	0	−2	−2	+1	0	+2
Jacksonville	−1	−10	0	+2	−1	0	0	+2	+1	0	+11	0	–	+1	+1	−3	0	+1
Nashville	−1	+9	+1	+1	−1	+1	−1	0	0	0	+4	+2	−1	–	+1	+1	0	+2
New Orleans	0	−19	0	+1	0	0	−1	0	0	0	+12	+2	−1	−1	–	+5	+1	+3
Chicago	−8	−70	−6	−7	−10	−8	−7	−7	−3	+4	−5	−1	+3	−1	−5	–	–	−9
Detroit	−6	−77	+3	+5	+5	+3	−1	−3	+1	0	−3	0	0	0	−1	–	–	0
St. Louis	+1	+66	0	+1	−3	0	+1	−2	0	−1	−2	−2	−1	−2	−3	+9	0	–
Little Rock	0	−1	–	0	0	0	0	0	–	0	0	–	0	0	−1	−1	0	+4
Louisville	−1	−30	0	0	−2	+3	0	0	0	−1	−1	0	−1	0	0	+3	0	+9
Memphis	+2	−11	–	0	0	0	0	0	0	−7	0	−2	−1	−1	+1	−1	+2	+15
Minneapolis	0	+34	−4	0	−4	+1	0	+1	0	0	0	–	0	0	−1	−15	+3	+4
Helena	0	−1	–	0	0	–	–	–	–	–	–	–	–	–	–	−1	0	0
Kansas City	0	+21	+2	+2	+3	+1	−2	−1	0	0	0	−1	0	0	−1	+10	+1	+5
Denver	−1	+5	–	0	+1	0	0	0	0	0	0	–	–	–	+1	−2	+1	+2
Oklahoma City	0	+12	–	+1	0	+1	+1	0	0	0	+3	0	–	–	−4	−21	0	+5
Omaha	0	+3	0	0	0	+1	0	0	0	0	0	–	−1	–	0	−1	0	+1
Dallas	−3	−46	0	0	+1	+2	0	0	0	0	+2	0	−2	−1	−3	+7	+2	+10
El Paso	−1	−1	–	0	0	–	–	0	–	0	–	–	–	–	0	+1	0	+1
Houston	−1	−31	0	−3	0	0	−4	0	0	0	−1	0	−1	+2	+4	+3	0	+1
San Antonio	0	+6	–	+1	0	0	0	0	0	0	0	0	0	0	+1	+6	0	+1
San Francisco	+14	−23	+2	+1	−1	+1	−4	−5	+1	0	−1	0	0	0	+5	+22	0	+2
Los Angeles	+3	+56	+1	+2	+2	+1	+1	+1	0	+1	−1	0	0	0	+1	+15	+11	+3
Portland	−1	+5	0	−3	0	0	0	−1	0	–	0	0	0	–	0	+1	+1	−1
Salt Lake City	0	−2	–	–	0	0	0	0	–	–	–	–	–	–	–	−2	0	+1
Seattle	0	+7	0	+1	0	0	0	0	0	0	0	–	0	–	–	−2	+2	+1

Total Transfers



Federal Reserve Dollar Flows, above 20 Million
Week ended October 13,1954



To New York

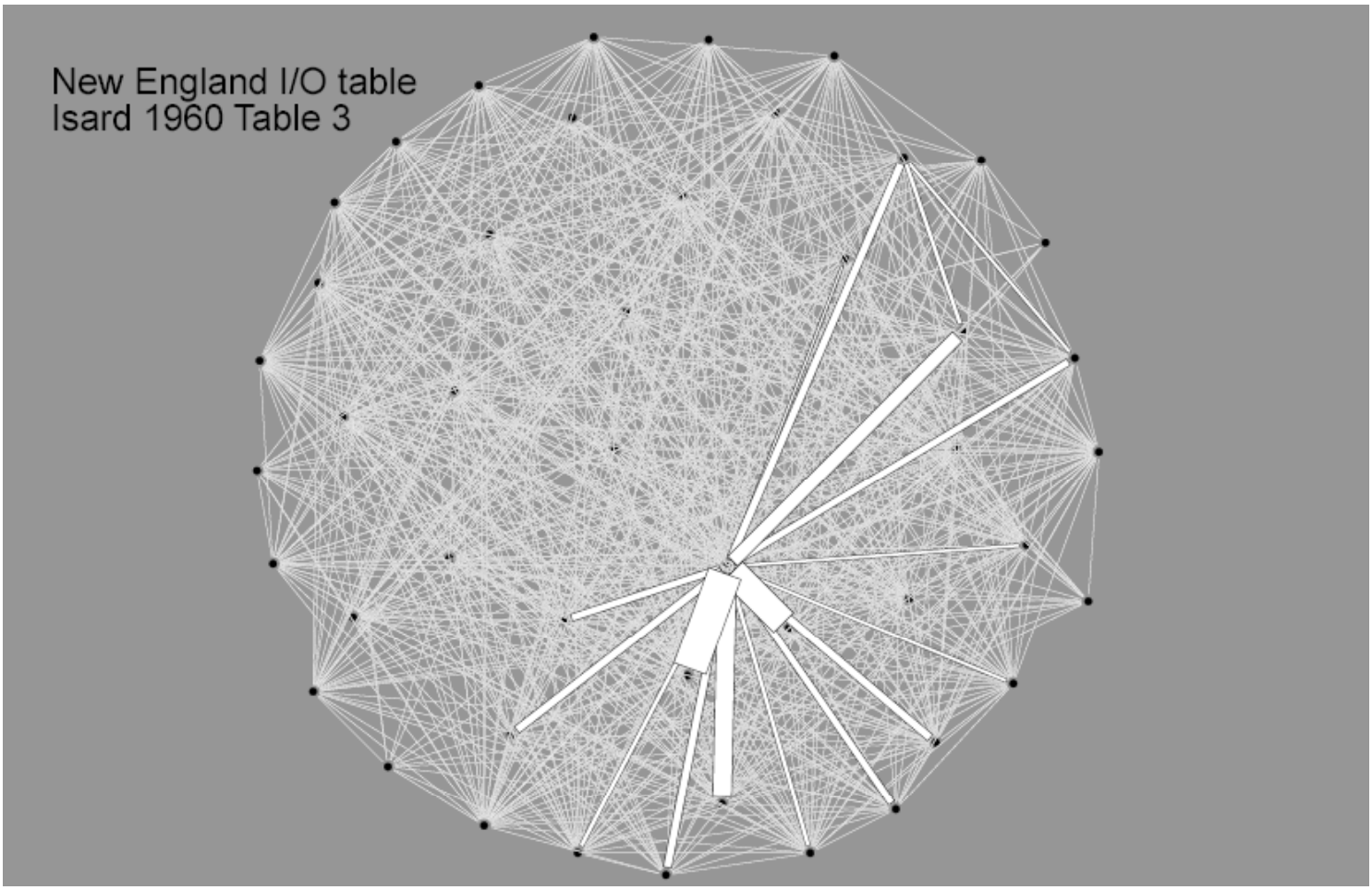


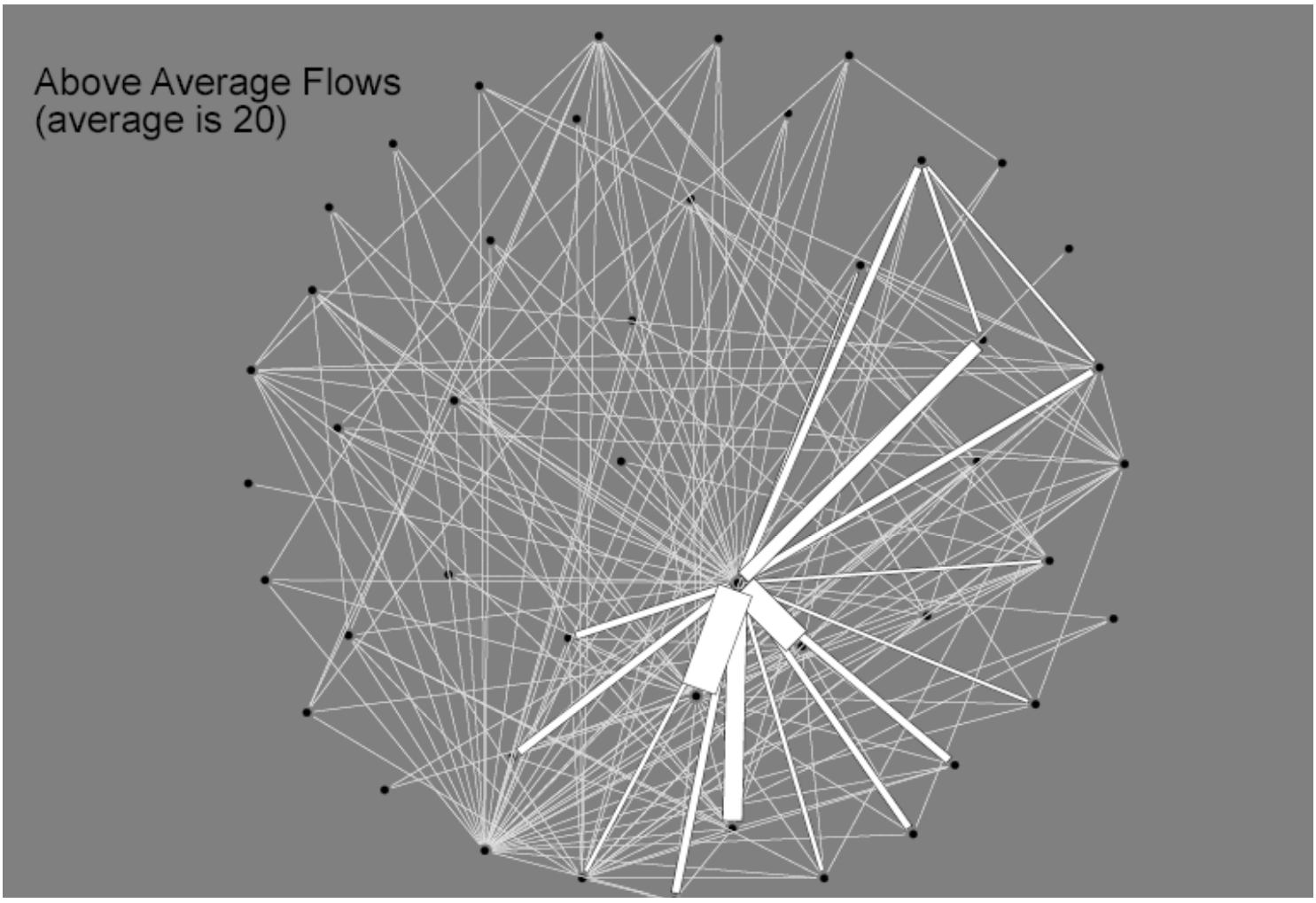
From New York

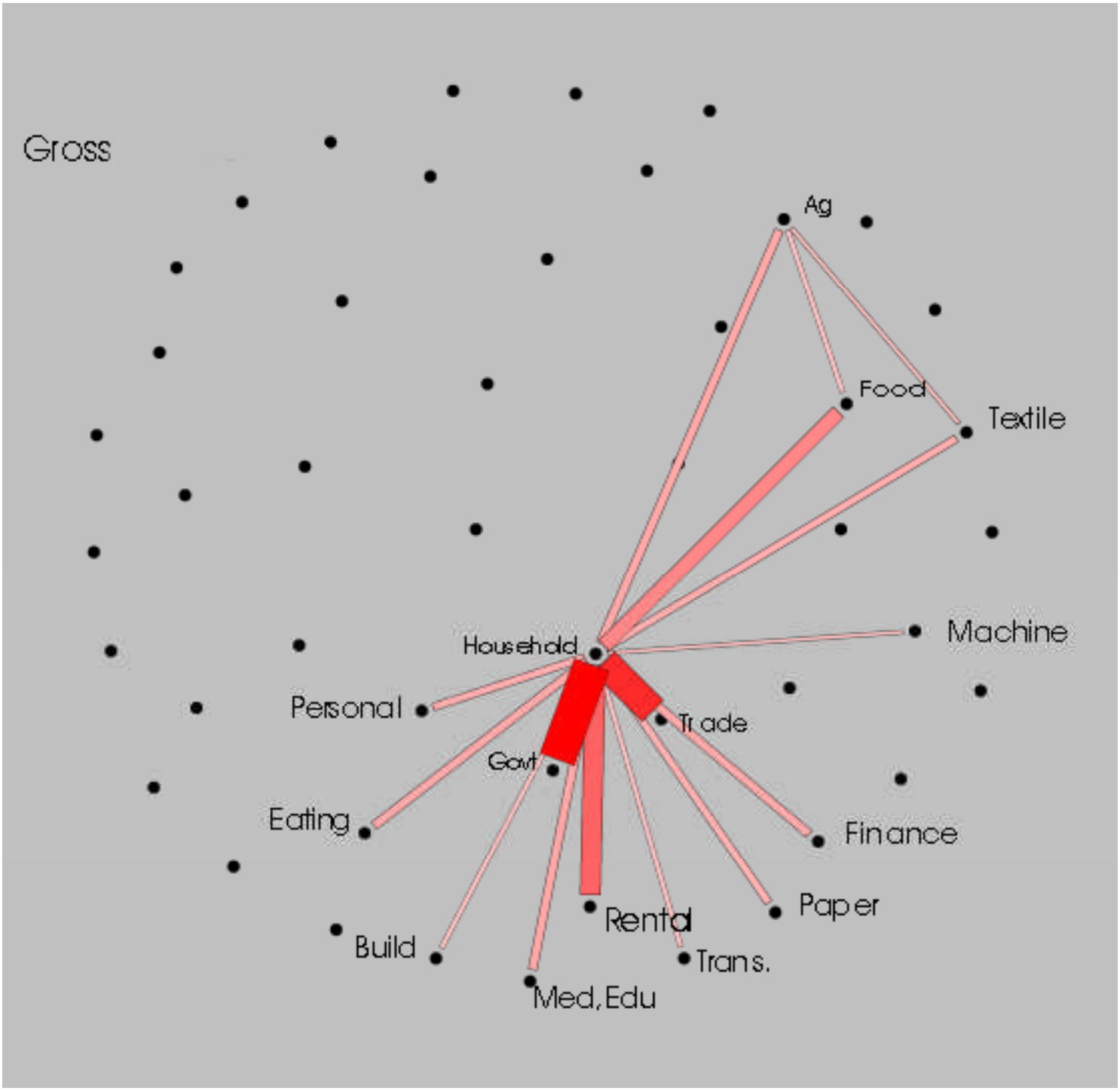


TABLE 3. NEW ENGLAND: INPUT REQUIREMENTS AND COMMODITY

Industry (Sector) Producing \ Industry (Sector) Purchasing	1. Agriculture and Fisheries	2. Food and Kindred Products	3. Tobacco Manufactures	4. Textile Mill Products	5. Apparel	6. Lumber and Wood Products	7. Furniture and Fixtures	8. Paper and Allied Products	9. Printing and Publishing	10. Chemicals
1. Agriculture and Fisheries	244.5	534.2	7.6	571.2	1.2	8.3	–	1.2	–	57.9
2. Food and Kindred Products	53.6	174.3	0.1	16.5	0.6	*	*	4.1	*	32.8
3. Tobacco Manufactures	–	–	8.1	–	–	–	–	–	–	†
4. Textile Mill Products	1.4	0.1	–	358.0	246.0	0.1	15.4	5.9	1.6	0.6
5. Apparel	1.0	7.2	–	–	124.2	–	0.3	2.8	–	1.4
6. Lumber and Wood Products	3.3	2.9	0.2	4.9	0.1	47.2	20.8	36.8	0.1	2.2
7. Furniture and Fixtures	–	–	–	3.3	–	–	0.4	0.7	–	–
8. Paper and Allied Products	†	16.1	0.6	21.4	1.6	0.2	0.8	358.0	70.3	15.8
9. Printing and Publishing	–	1.4	–	0.6	–	–	–	–	49.8	0.8
10. Chemicals	18.7	51.5	0.2	219.8	9.0	1.1	3.4	25.2	6.3	127.0
11. Products of Petroleum and Coal	10.3	2.1	*	8.2	0.3	3.2	0.1	8.7	0.2	15.5
12. Rubber Products	2.7	0.3	–	3.6	1.1	0.4	0.3	1.2	0.2	†
13. Leather and Leather Products	–	–	–	0.6	3.4	0.2	0.4	–	0.3	–
14. Stone, Clay and Glass Products	1.5	9.0	†	0.3	–	0.6	1.8	3.9	–	12.3
15. Iron and Steel	0.1	0.1	–	–	0.1	0.4	5.2	–	–	0.2
16. Nonferrous Metals	–	–	–	–	–	0.1	0.9	–	0.9	9.0
17. Plumbing and Heating Supplies	–	–	–	–	–	–	–	–	–	–
18. Fabricated Structural Metal Products	–	–	–	–	–	–	0.3	–	–	–
19. Other Fabricated Metal Products	1.9	19.3	0.1	*	0.4	1.5	7.1	2.3	0.1	6.2
20. Agricultural, Mining and Construction Machinery	1.3	–	–	–	–	–	–	–	–	–
21. Metalworking Machinery	–	–	–	–	–	–	–	–	–	–
22. Other Machinery (except electric)	–	0.5	–	9.6	1.3	0.6	0.6	1.9	2.3	†
23. Motors and Generators	–	–	–	–	–	–	–	–	–	–
24. Radios	–	–	–	–	–	–	–	–	–	–
25. Other Electrical Machinery	–	–	–	–	–	–	–	–	–	†
26. Motor Vehicles	2.5	0.1	–	–	–	†	–	–	–	–
27. Other Transportation Equipment	0.2	–	–	–	–	–	–	*	–	†
28. Professional and Scientific Equipment	–	–	–	–	–	–	0.1	0.8	2.1	0.6
29. Miscellaneous Manufacturing	0.1	0.4	–	1.1	16.2	†	0.9	2.1	–	1.4
30. Coal, Gas, and Electric Power	1.4	6.9	†	28.8	2.3	1.0	1.0	17.0	1.9	9.0
31. Railroad Transportation	9.9	19.5	0.2	25.8	3.8	6.2	2.9	30.9	4.4	13.7
32. Ocean Transportation	1.6	4.5	†	3.6	0.7	0.4	*	2.2	*	2.1
33. Other Transportation	12.5	13.0	0.2	21.7	1.6	6.0	2.2	16.1	1.6	4.5
34. Trade	30.6	14.8	0.4	62.6	23.4	2.6	3.2	24.3	2.0	8.3
35. Communications	†	1.5	†	2.5	1.2	0.4	0.3	1.1	2.5	1.1
36. Finance and Insurance	5.4	5.1	†	5.5	1.5	3.3	1.0	2.5	1.5	0.9
37. Rental	53.9	3.2	–	6.9	6.1	0.8	0.9	3.6	4.0	1.6
38. Business Services	0.2	18.9	1.0	19.5	6.1	0.8	3.1	3.0	3.8	20.3
39. Personal and Repair Services	8.3	4.2	*	0.8	0.2	1.8	0.2	0.6	1.3	0.5
40. Medical, Educational and Nonprofit Organizations	–	–	–	–	–	–	–	–	–	–
41. Amusements	–	–	–	–	–	–	–	–	–	–
42. Scrap and Miscellaneous Industries	–	–	–	6.6	–	–	–	34.5	–	5.3
43. Undistributed	–	73.1	1.3	120.3	83.0	38.0	17.7	27.7	39.6	83.2
44. Eating and Drinking Places	–	–	–	–	–	–	–	–	0.1	–
45. New Construction and Maintenance	4.5	4.2	†	10.7	1.0	0.5	0.4	5.8	1.0	1.7
48. Government	18.3	40.3	1.0	175.6	23.8	14.6	6.0	68.5	21.8	36.5
50. Households[d]	431.7	222.3	3.8	902.8	254.3	110.6	57.3	297.9	197.2	164.1
Total Gross Outlays	921.5	1250.7	25.0	2612.9	814.6	251.1	154.9	991.4	416.8	636.9


New England I/O table
Isard 1960 Table 3


Above Average Flows
(average is 20)


Gross
Ag
Food
Textile
Machine
Household
Personal
Trade
Govt
Eating
Finance
Paper
Rental
Build
Trans.
Med, Edu

Net Flow Above 20

