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STATISTICAL DETERMINANTS OF SEVERAL RETAIL ACTIVITIES FOR VARIOUS HOMOGENEOUS REGIONS IN THE STATE OF MINNESOTA[+]

By

Raymond L. Raab*

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* Associate Professor, Department of Economics, University of Minnesota, Duluth, Duluth, Minnesota 55812.

I. Introduction

The following study measures the statistical determinants of several retail business activities for various homogeneous regions in the state. Past examination of the determinants of small business activities have used either broad geographic regions in terms of comparing states for their relative abundance of small business (Wall Street Journal, January 11, 1982), or smaller urban areas in terms of measuring population threshhold size of particular retailing activities (Berry and Garrison, 1958, and Forbes, 1972). A more sophisticated approach identified the determinants of manufacturing plant location for 594 non-metropolitan communities for the West North Central Region of the U. S. (Dorf and Emerson, 1978). The factors which they found of main importance were related to community size, distance from urban areas, and labor force characteristics. Interestingly, these factors were not subject to public policy control.

The primary purpose of this study, however, is to investigate the statistical determinants of several retail activities for identifiably homogeneous regions within the State. With this goal in mind, two major stages of analysis were required. In the first stage (Section II), a principle components, cluster analysis was done in order to identify regions or groups of counties which had a similar economic base. The second stage (Section III), using OLS regression techniques, estimates the relationship between number of firms in a particular retail activity and variables which indicate the economic base of region.

II: The Cluster Analysis

Principle component analysis was utilized to organize the variables into a more manageable set and then to define homogeneous clusters of counties. The data was obtained for covered (by unemployment compensation) employees or firms from the Minnesota Department of Economic Security.

Three clusters of counties were identified on the basis of general economic barometers (i.e., county population density and county income per capita) as well as variables indicative of the economic base of these counties (i.e., employment in one of nine economic sectors as a proportion of county population).

These eleven variables were rotated using the varimax rotational procedure which resulted in a three factor structure. See Table I, page 3. Together these factors explained 71.9% of the total variation in the system while factor 1 explained most of the variation (51.0%), factor 2 added a smaller amount of additional explained variation (11.4%), while factor 3 added even less (9.6%). (See Table I, page 3). Factor I consists of seven of the nine variables which indicate a specific economic sector's share of total county employment. Factor II is made up of the two marketing variables in the study which are population density and income per capita. Factor III consists of the agriculture and mining variables. The mining category is somewhat heterogeneous because it consists of iron ore mining in St. Louis County and sand and gravel operations in the rest of the state. The agricultural employment data excludes the many small farms of less-than-three employees not covered by unemployment compensation. Because both of these variables are somewhat anomalous, Factor III was excluded from the cluster analysis. The factor loadings, which represents the individual variables' correlation with the overall factor, are indicated on Table I also.

An unweighted, composite index (scale) was calculated for each of the 87 counties in Minnesota. The values of this index or factor scores represent how a particular county rates based on the two underlying factors which have already been determined. See Table II, p. 4. These factor scores serve as a basis for selecting homogeneous clusters of counties. Using the factor scores in Table II

TABLE I

Factor (Component Breakdown)
(10 variables, total)

Factor I: Seven Variables	Loadings
1. Construction labor (share)	.93
2. Manufacturing labor (share)	.68
3. Transportation, communication & utility labor (share)	.82
4. Trade labor (share)	.96
5. Finance, insurance, real estate labor (share)	.89
6. Service labor (share)	.87
7. Government labor (share)	.91
(Factor I explained 51.0% of total variation)	
Factor II: Two Variables	
1. Population density	.81
2. Income per capita	.75
(Factor II explained 11.4% of remaining variation)	
Factor III: Two Variables	
1. Mining	.76
2. Agriculture	-.67
(Factor III explained 9.6% of remaining variation)	

Source: 1980: Minnesota Employment and Wages by County, 1980, Minnesota Department of Economic Security.

Note: 1980 figures were obtained from the month of September.

TABLE II

Factor Analysis Results

County	Factorscore	Cluster	County	Factorscore	Cluster
Aitkin	-1.25	Low	Marshall	-1.28	Low
Anoka	1.83	High	Martin	+0.43	High
Becker	-0.67	Low	McLeod	+1.10	High
Beltrami	-0.84	Low	Meeker	-0.22	Med
Benton	+0.37	High	Mille Lacs	-0.52	Low
Bigstone	-0.32	Med	Morrison	-1.21	Low
Blue Earth	+4.14	High	Mower	-0.03	Med
Brown	+0.64	High	Murray	-0.05	Med
Carlton	-0.22	Med	Nicollet	-0.09	Med
Carver	+0.67	High	Nobles	-0.14	Med
Cass	-0.93	Low	Norman	-1.36	Low
Chippewa	-0.46	Med	Olmstead	+2.06	High
Chisago	-0.01	Med	Ottertail	-0.73	Low
Clay	+0.103	Med	Pennington	+0.18	Med
Clearwater	-1.92	Low	Pine	-1.32	Low
Cook (A)	-0.18	Med	Pipestone	-0.57	Low
Cottonwood	+0.20	Med	Polk	-0.95	Low
Crow Wing	+0.18	Med	Pope	-0.80	Low
Dakota	+6.81	High	Ramsey	+6.07	High
Dodge	-0.27	Med	Red Lake	-0.99	Low
Douglas	-0.06	Med	Red Wood	+0.07	Med
Faribault	+0.32	High	Renville	-0.49	Med
Fillmore	-0.20	Med	Rice	-0.13	Med
Freeborn	+0.63	High	Rock	+0.42	High
Goodhue	+0.55	High	Roseau	-0.50	Low
Grant	-0.14	Med	St. Louis	-0.42	Med
Hennipen	+4.91	High	Scott	+0.61	High
Houstan	-0.75	Low	Sherburne	-0.19	Med
Hubbard	-1.30	Low	Sibley	-0.27	Med
Isanti	-0.49	Med	Stearns	+0.42	High
Itasca	-0.34	Med	Steele	+0.46	High
Jackson	-0.11	Med	Stevens	-0.04	Med
Kanabec	-0.72	Low	Swift	-0.50	Low
Kandiyohi	-0.10	Med	Todd	-1.28	Low
Kittson	-0.85	Low	Traverse	-1.67	Low
Koochiching	-0.81	Low	Wabasha	-0.12	Med
Lac Qui Parle	-0.26	Med	Wadena	-0.36	Med
Lake	-1.20	Low	Waseca	-0.22	Med
Lake of Woods	-1.17	Low	Washington	+0.89	High
LeSeur	+0.36	High	Watonwan	-0.19	Med
Lincoln	-0.70	Low	Wilkin	-0.15	Med
Lyon	+0.44	High	Winona	+0.30	High
Mahnonen	-1.31	Low	Wright	-0.12	Med
			Yellow Medicine	-0.83	Low

1. High factor score: (H) $\geq$ + 0.20
2. Medium factor score: 0.20 $\geq$ (M) $\geq$ - 0.50
3. Low factor score: (L) $<$ - 0.50

(See Minnesota map, p. 6, for groupings)

a mapping of Minnesota counties was completed. See Map 1, p. 6. Although the choice of interval limits is somewhat arbitrary, three groups of counties were identified in Table III below:

TABLE III*

	Range of Factor Scores	Number of Counties
Low factor scores:	(L) $\leq$ - .50	29
Medium factor scores:	- 0.50 $\leq$ (M) $\leq$ + 0.20	36
High factor scores:	(H) $\geq$ + 0.20	22

* Source: Calculations by author.

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It should be noted that the low factor scores represent primarily rural counties with little economic diversification. The medium factor scores represent metropolitan and outlying counties with relatively more economic diversification, while the high factor scores represent the metropolitan areas with the greatest amount of diversification.

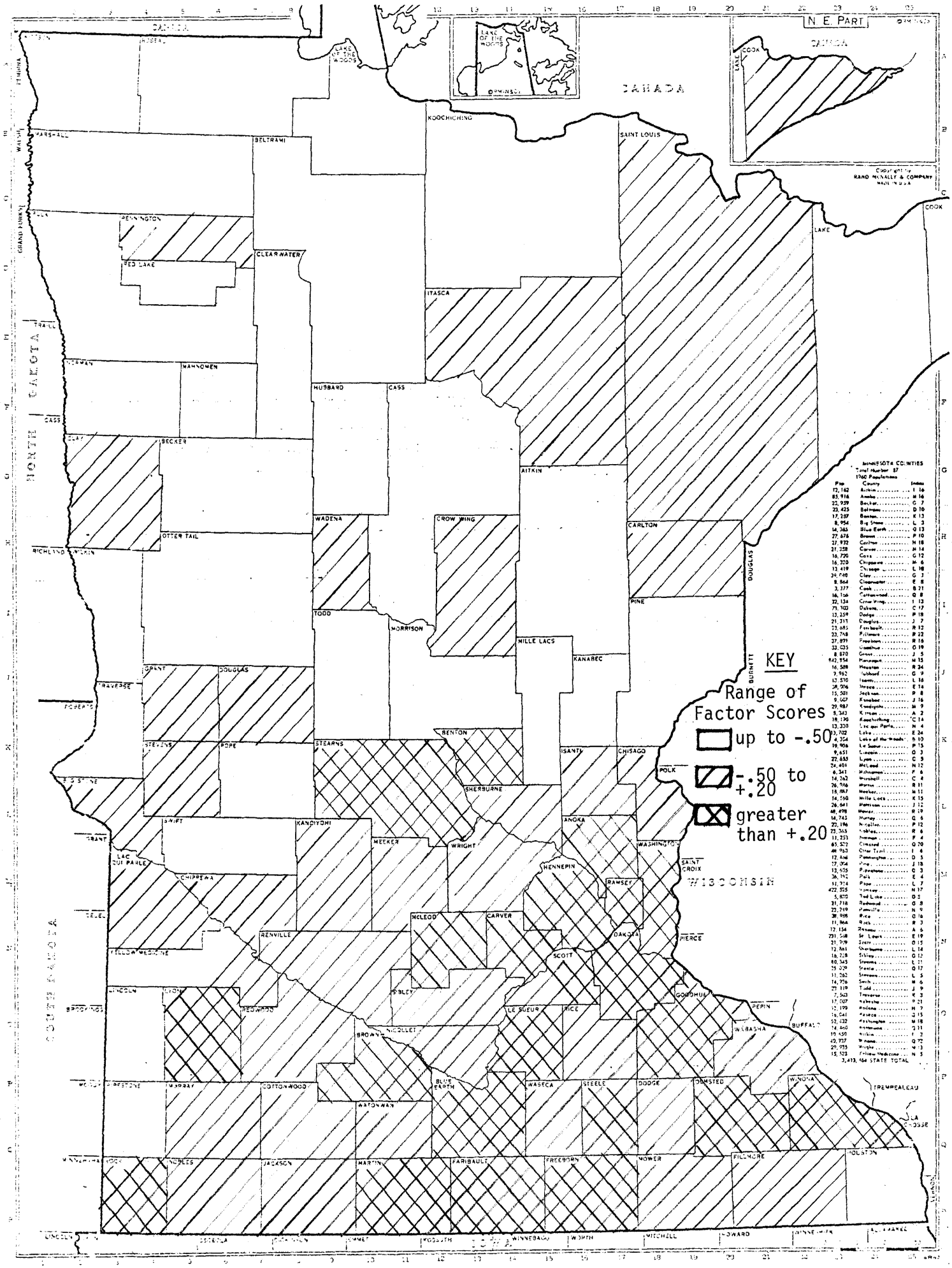
From these three clusters of counties (i.e., counties representing more similar economic diversification and settlement) separate regression estimates which accounted for most of the variation in number of firms in several retail activities were calculated. The following section examines how the economic base and two marketing variables affect these retail activities.

RAND M.NALLY

STATE COUNTY OUTLINE MAP

MINNESOTA

SIZE 8½ x 11



MINNESOTA COUNTIES
Total Number 87
1960 Populations

Pop.	County	Index
72,162	Aitkin	I 16
85,918	Anoka	M 16
22,939	Becker	G 7
23,423	Beltrami	D 10
17,287	Benton	K 13
8,954	Big Stone	L 3
14,365	Blue Earth	Q 13
27,676	Brown	P 10
27,932	Carlton	N 18
21,258	Carver	N 14
16,726	Cass	G 12
16,229	Chippewa	M 6
13,419	Chisago	L 18
34,048	Clay	G 3
8,864	Clearwater	E 8
3,277	Cook	B 21
16,166	Cottonwood	Q 8
32,134	Crow Wing	I 13
75,300	Dakota	C 17
13,259	Dodge	P 18
21,311	Douglas	J 7
23,685	Fairbault	R 12
23,768	Fillmore	R 22
27,891	Freeborn	R 16
32,025	Goodhue	O 19
8,870	Grant	J 5
842,954	Hennepin	M 15
16,588	Houston	R 24
7,962	Hubbard	G 9
63,510	Isanti	L 16
38,096	Itasca	E 14
15,301	Jackson	P 8
9,607	Kanabec	J 16
29,987	Kandiyohi	M 9
9,343	Kittson	A 2
18,190	Koochiching	C 14
13,330	Lac qui Parle	N 4
33,702	Lake	E 24
4,304	Lake of the Woods	D 12
19,906	Le Sueur	P 15
9,651	Lincoln	Q 3
22,653	Lyon	O 5
24,401	McLeod	N 12
6,341	Mahnomen	F 6
14,762	Marshall	C 4
26,796	Martin	R 11
18,857	Meeker	M 11
14,760	Mille Lacs	K 15
26,641	Morrison	J 12
48,498	Mower	R 19
24,743	Murray	Q 6
22,186	Nicollet	P 12
23,363	Nobles	R 6
13,251	Norman	F 4
65,522	Olmsted	O 20
48,963	Otter Tail	I 6
12,466	Pennington	D 5
17,054	Pine	J 18
13,625	Pipestone	Q 3
36,192	Polk	E 4
31,974	Pope	L 7
422,255	Ramsey	M 14
5,800	Red Lake	D 8
21,718	Redwood	O 8
22,749	Renville	N 9
38,598	Rice	O 16
11,864	Rock	R 3
12,154	Roseau	A 6
221,548	St. Louis	E 19
21,749	Scott	O 15
12,861	Sherburne	L 14
16,128	Sibley	O 12
80,545	Stearns	L 11
25,309	Steele	O 17
11,262	Stevens	L 5
14,926	Swift	M 6
29,119	Todd	J 9
7,343	Traverse	K 3
17,007	Wabasha	P 21
12,199	Wadena	H 7
16,541	Waseca	O 15
52,432	Washington	M 18
14,660	Watonwan	Q 11
19,459	Wilkin	I 3
40,937	Winona	Q 22
29,935	Wright	M 13
15,923	Yellow Medicine	N 5
3,413,864 STATE TOTAL		

This map is also available showing Cities. 4/30

III. A Model Used to Estimate Determinants of Retail Activity.

The second stage of this study was to choose activities which could be reasonably analyzed with the proposed model. The original study by Berry and Garrison looked at the affect of population on specific retail activities, while other variables were ignored. Part of the purpose of this study was to also determine the effects of the economic base upon these retail activites. It was felt that the necessary detail, required by the model, could be satisfied by using four two-digit SICs (i.e., food, automobile service, apparel, and eating and drinking establishments) from the data collected directly the Minnesota Bureau of Labor Statistics. For these four retail activities a model was estimated of the following form:

$$Y_{ij} = f\ (X_{1,.,5,7,.,9,ij}, X_{10ij}, X_{11ij}), \text{ where}$$

Dependent Variable:

Y_{ij} number of firms in retail activity i, county j

Independent Variables:

Eight Economic Sectors:

X_{1ij} Agriculture, fish, forestry's labor share (of county population)

X_{2ij} Mining's labor share

X_{3ij} Construction labor's share

X_{4ij} Manufacturing labor's share

X_{5ij} Transportation and Communication's labor's share

X_{7ij} Finance, Insurance, Real Estate's labor share

X_{8ij} Service labor's share

X_{9ij} Federal, State, and Local labor's share

Two Marketing Variables:

X_{10} Population density in county j

X_{11} Average family income per capita in county j

The dependent variable, county number of firms in a particular two-digit retail activity, was used because it was available for as recent as 1980. The use of firms as a dependent variable would be suitable if this dependent variable could be adjusted firm size as an additional dependent variable. However, no such firm size information is available at this time. The legitimate inclusion of number of firms in this model requires the use of a tacit assumption that this retail activity is subject to constant returns to scale (i.e., a "β" coefficient will indicate that by increasing employment share of population in one of the eight sectors will justify an increase in the number of "constant-sized" retail firms). One would expect, a priori, that the constant scale assumption is fairly reasonable for these four retail trade activities. For the "constant size" assumption an indirect statistical test was formulated based on the average employment size per firm for 13 groups of counties, which suggested that very small differences existed for these county groups in terms of that variable.[1]

Overall, this model looks very much like the row of a transactions table in an input-output table. The dependent variable is number of firms in a specific output-activity while the independent variables are very much like direct coefficients of the input (or selling) industries, except that a ratio is a particular sector's share of employment out of county population. The intrasectoral transfer, retail and wholesale trade's labor share of county population (X_6) with the number of firms in retail activity j, is omitted because Y_{ij} and $X6_{ij}$ are related measures of trade activity. The other two marketing variables,

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[1] No data for individual counties or individual firms was available for 1980 which would have allowed for a direct test of differences in firm sizes across counties. Moreover, the scale differences between the three county clusters were much more significant than firm size differences between the counties in a given cluster.

county population density and average family income per capita would not be part of an input-output table, but necessary to any market location study for a particular retail activity.

IV. The Results of the Model.

The results of the estimation of the model are shown in Table III, p. 10. Separate regressions for a given industry (i.e., four industries) and within an industry, four groupings of counties (i.e., 87 counties in the State, 22 urbanized-metropolitan counties with high factor scores, 36 metropolitan-outlying counties with medium factor scores, and 29 undiversified, rural counties with low factor scores) are measured, yielding 16 regression equations, columns 1 through 16. The coefficients of the constant and each variable in the regression equation are stated in each column while the t-values are written in parentheses below the corresponding coefficient. Also stated on the bottom of each column are the overall F statistic and the coefficient of determination, one unadjusted and the other adjusted for degrees of freedom.

The first independent variable, the agriculture's, fishery's, and forestry's employment share of county population (column 4) appears to be statistically significant at the 10 percent level only for the number of food stores (SIC 54), and only for the low, factor score cluster. Inasmuch as the low factor score counties are rural, low population areas, this result appears reasonable. The coefficient indicates that an increase of 717.1 food stores will result if this sector's employment were to rise by 100 percent. Sector one's employment share of the low factor score's county population would have to double from one half of one percent to one percent of county population. This is a substantial increase in this sector's share of activity, even though it is very small in

TABLE III: REGRESSION EQUATIONS

Dependent Variable: (Industry SIC) / Cluster / Independent Variables: (8 sectors)	SIC 54 Food Stores				SIC 55 Auto Dealers & Service Stations				SIC 56 Apparel Stores				SIC 58 Eating and Drinking			
	State (1)	High (2)	Med (3)	Low (4)	State (5)	High (6)	Med (7)	Low (8)	State (9)	High (10)	Med (11)	Low (12)	State (13)	High (14)	Med (15)	Low (16)
1. Ag, Fish, Forestry labor (share)				717.1 (1.86)												
2. Mining labor (share)	2929.0 (4.20)	965421.6 (18.19)	2980.0 (19.95)		4395.0 (3.92)	1543789.5 (16.75)	4380.6 (15.16)		1670.6 (3.17)	750703.9 (24.4)	1648.0 (17.56)		7146.4 (4.72)	2107363.0 (18.66)	7022.9 (20.08)	
3. Construction labor (share)			294.6 (2.05)				738.8 (2.33)					225.1 (1.98)				
4. Manufacturing labor (share)			-41.0 (1.37)												-118.1 (1.68)	
5. Transport & Communication labor (share)		459.3 (2.73)		212.2 (.953)		1034.9 (3.54)				486.4 (4.81)				1653.3 (4.62)		
7. Finance, Ins., Real Estate labor (share)	1039.8 (2.73)		1186.9 (7.17)		1642.5 (2.68)		1821.21 (4.80)		793.5 (2.76)		613.6 (5.02)		2475.4 (3.00)		2307.0 (5.90)	
8. Service labor (share)	159.7 (1.45)			179.6 (1.94)	383.0 (2.15)		179.0 (1.88)		162.6 (1.94)		76.5 (2.02)		457.5 (1.91)		156.8 (1.58)	272.5 (1.80)
9. Govt. labor (share)	-352.5 (2.34)				-602.4 (2.48)			233.1 (1.63)	-289.6 (2.54)		64.3 (1.63)		-799.8 (2.44)			
(Two market variables):																
10. Population (density)	.123 (10.70)	.0854 (14.16)	.218 (2.48)	.354 (1.31)	.157 (8.47)	.0937 (8.94)		.822 (2.13)	.0775 (8.88)	.0471 (13.47)	.310 (5.56)		.3200 (12.78)	.2353 (18.31)	1.031 (5.01)	.911 (2.01)
11. Income (per capita)							.00963 (2.32)				.00457 (3.29)					
Constant	17.7 (2.40)	12.33 (2.22)	-7.70 (1.85)	-1.637 (.25)	33.2 (2.80)	32.4 (3.35)	-97.21 (2.67)	2.44 (.19)	-6.26 (1.12)	3.02 (.936)	-49.5 (4.01)	1.29 (.69)	32.4 (2.03)	23.5 (1.99)	-22.8 (2.30)	7.83 (.78)
F-Overall (Sig.)	40.7 (.000)	327.0 (.000)	95.15 (.000)	2.47 (.072)	31.2 (.000)	219.3 (.000)	48.6 (.000)	2.65 (.090)	31.4 (.000)	471.9 (.000)	64.9 (.000)	3.93 (.058)	57.6 (.000)	433.2 (.000)	100.7 (.000)	3.46 (0.46)
R^2	.715	.982	.941	.292	.658	.973	.910	.169	.660	.987	.931	.127	.781	.986	.944	.210
Adj. R^2	.698	.979	.931	.173	.637	.969	.891	.105	.639	.985	.916	.095	.767	.984	.934	.150

relative terms; the coefficient represents a large number of firms because of a large (100 percent) change in sector one's share of county population.[1]

Sector two, or minings share of county population, is one of the most statistically significant variables in all of the equations for the high and medium factor score counties with a possible exception of population density. Even though the sector's activities are a mix of iron mining and sand and gravel operations, the sector's share of employment seems to have a uniform impact on the four retail activities. Minnesota's iron mining industry is virtually wholly located in the iron range county of St. Louis. As St. Louis County is an anomoly with respect to the rest of the medium factor score counties, a separate regression was run without St. Louis County. The results of these estimates were poorer than the regressions of medium factor scores including St. Louis County, thus it was felt that St. Louis was "typical" and included in the regression estimates.

Sector 3, construction employee's share of country population, is significant and positive (columns 3, 7, 12), although the coefficient is of moderate size. Sector 4, manufacturing employee's share of county population, has a negative coefficient, however, but is not significant. Significantly, the simple correlation coefficient for manufacturing share in 1980 were negative for all four retail activities in the medium cluster of counties.

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[1] The arc elasticity coefficient for this variable is 0.22, where

$$\varepsilon = \frac{\Delta Y}{\Delta X_1} \cdot \frac{\bar{X}_1}{\bar{Y}} = b_1 \cdot \frac{\bar{X}_1}{\bar{Y}} = 717.1 \frac{.005}{17.2} = 0.22.$$

This coefficient indicates that a 1% rise in sector one's employment will justify an increase of .22% in food stores.

The sector 5 coefficient transport and communication employment share of county population, was positive and significant in the urban-metropolitan, high factor score cluster (columns 2, 6, 10, and 14). This appears appropriate and suggests that this sector is important for enhancing retail sales activities in the cluster of urbanized counties. Likewise, in sector 7, finance, insurance and real estate employee's share of population is positive and significant for the metropolitan-outlying cluster of counties (columns 3, 7, 11, and 15). Sections 8 and 9 are marginally significant in the three clusters.

Of the two market variables, population density and income per capita, the population density seems to affect retail activities the most. This is an expected result consistent with the earliest population threshhold size literature, as well as supported by the simple correlation coefficients being nearly twice as large for population than for income in explaining retail activity.

It is interesting to note that in each regression for the state involving all 87 counties (equations 1, 5, 9, 13), the percent of explained variation (r^2) is lower, the equation significance (overall F) is less, and the coefficient significance (t values) is less, than for the high and medium factor score clusters. This suggests that the regressions for the individual clusters offer better estimates than the aggregation of counties for the state. One important reason for this is that more multicollinearity exists for the state regression than for the clusters. For example, the government employee's share of county population is significant, but has a negative sign for each retail activity even though the simple correlation coefficient is positive. One reason for this is that a good deal of multicollinearity exists between the service sectors (such as 7, 8, and 9) as compared to more basic sectors (such as 1, 2, and 4). The simple correlation coefficients at the state level between these sectors are:

$$r_{78} = .76,$$

$$r_{79} = .77,$$

$$r_{89} = .78.$$

These coefficients are inconsequential for the medium and low factor score counties, suggesting that the multicollinearity problem is more severe for the state, than for the low and medium factor score counties. This observation suggests that the aggregation of sectors into basic and service categories, as is done in economic base models, seems reasonable, considering the interrelationship of the sectors within the two categories. In this study some amount of aggregation of sectors, given the cluster and the particular retail industry, might be appropriate.

V. Implications of This Two-Stage Approach

In terms of regional-urban development techniques, this approach has several implications. Input-output techniques are useful for examining interindustry relationships; these are measured in terms of industry multipliers. In the previous regressions, high industry multipliers will appear as multicollinearity among the independent variables. Moreover, in those clusters of counties where new economic development is most needed (i.e., medium and low factor scores), the short-run multipliers are seldom much larger than unity, implying that this two-stage approach would be more valid.

In terms of shift-share analysis, one might learn that less-than-national employment exists in a particular industry, or that an industry is losing its share of a particular industry. However, this information does little to indicate what structural changes are accounting for the problems in the industry. The two-stage procedure used here does suggest which factors determine the level of a given activity, and whether the activities are being carried on at above or below the expected level. This information should be useful in planning economic development in those clusters of counties which need it most.

An example of how community planners may use the estimated equations is suggested in Table IV. This table measures the deficit number of firms for the four retail activities based upon the difference between actual and predicted number of firms in a given county (i.e., the large negative residuals for each regression of the medium factor scores). See Table IV below:

TABLE IV

County*	Deficit Number of Firms			
	SIC 54	SIC 55	SIC 56	SIC 58
1. Carlton			5.8	
2. Chippewa	5.9			
3. Chisago		20.2		
4. Cook		36.3	4.1	
5. Dodge			4.6	13.2
6. Isanti	6.5			
7. Itasca			4.6	
8. Nicollet	7.0		5.2	
9. Pennington		16.6		13.6
10. Rice	6.5		4.6	17.5
11. Sherburne	8.0		5.2	15.4
12. Stevens		17.6		
13. Wadena				13.9

*Medium factor score counties which had negative regression residuals greater than three-quarters of a standard deviation from the expected mean residual of zero.

Thirteen counties with high positive residuals (i.e., residuals greater than three-quarters of a standard deviation from the mean residual of zero) are listed in the column. These counties have less than the expected number of "constant sized" firms based on economic and demographic structure of the medium score counties and logically would be the candidates for expansion in the given county. Presumably a marketing study by a firm seeking to expand its locations would have similar results.

Some comments to these conclusions should be made. For instance, some of the counties represented here are counties surrounding major urban or metropolitan shopping areas such as Dodge, Isanti, Nicollet, Rice and Sherburne Counties. These counties having less than the expected number of firms are likely being serviced by counties having large positive residuals. Successful firm location in one of these counties depends upon the extent of the attraction of nearby, competitive opportunities. On the other hand some of the counties of the thirteen such as Chippewa, Cook, Pennington, and Wadena do not seem to face such competitive opportunities and perhaps other reasons may be suggested as explanations. These reasons similarly should be indicative of whether new firms may successfully locate in the counties represented.

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