Office Employment Growth and the Changing Function of Cities

*Leon G. Shilton**
*James R. Webb***

Abstract. **The proportion of a city's local and regionally/nationally supported office employment changes as the city assumes more central place functions. Certain mixes of office employment should reflect the central place function of the city and promote office growth. Forty-five cities are studied using data from 1976, 1982 and 1985. The results indicate that the variance of office employment does not help predict a city's growth, but that certain cluster categories of office employment are associated with office employment growth. Finally, the results indicate that office employment profiles of cities have become more homogenized over time.**

Introduction

In searching for commercial office development opportunities, real estate developers, institutional lenders and individual investors analyze and classify cities according to their major function as a manufacturing, trade, or service economy (Carn et al. [3], Miles and Wurtzebach [15], and Shenkel [19]). In order to determine the demand for office space, the proportional inference approach is normally used. This approach assumes that the office space demand depends on the total employment (Carn et al. [3]). Estimates of office employment are based on the aggregate grouping of the FIRE (finance, insurance and real estate) employment, and some service employment, as a proportion of total employment growth. This study demonstrates that it is useful to group office employment according to its four-digit Standard Industrial Classification (SIC) designation in order to estimate office space growth.

A theoretical model is used to explain the relative changes in both local population support and regional/national business support for office services as a city assumes central place functions. Because cities serve different types of central place functions, such as financial centers and retailing centers, unique patterns of office employment are identified. The clusters and city group variances of these employment patterns are then tested for their suitability in predicting office employment growth across forty-five cities for the period 1976 to 1985. The results indicate that the rate of office employment growth varies because of the synergism of the office employment mix, and not because of total employment growth.

*Department of Finance, Fordham University, Lincoln Center, Graduate School of Business, New York, New York 10023
**James J. Nance College of Business, Cleveland State University, Cleveland, Ohio 44115.
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Function of Cities

Using shift-share techniques (Carn et al. [3]), the real estate developer usually examines the total work force and population growth and then estimates the proportion that will result in office employment. He/she then compares the local area averages with national averages. The estimate of total worker growth is adjusted by whether the city is manufacturing or service based (Del Casino [9]).

In another approach, the portfolio approach, Hartzell, Hekman and Miles [10] and Hartzell, Shulman and Wurtzebach [11] attempt to directly link the returns of office buildings in a given region to the economic and social characteristics of these same regions using the NCREIF (National Council of Real Estate Investment Fiduciaries) pension fund data. However, because of the small sample size by city, it was not possible to do a city-by-city analysis. The later study [11] found that high employment growth within a region did not generate high returns from office buildings.

This seemingly contradictory result parallels other economic base studies on employment growth and the structure of city. Luck [14] observed that cities experiencing high growth in a particular industry or service did not necessarily achieve high growth for the whole city. Classifying cities by function, growth and geography, he observed that mixed diversified cities enjoyed moderate and sustained growth. Cities that relied on a major industry either experienced high growth or low growth.

Studying 140 metropolitan areas from 1959 through 1976, Noyelle and Stanback [16] concluded that it was impossible to link the growth of metropolitan area with a major industry. They concluded that for the period those cities that were regional, diversified centers sustained moderate growth. In an analysis of 68 metropolitan areas from 1965–1970 and 1975–80, Cadwallader [2] observed that an above average percentage of employment in manufacturing was a key characteristic of a declining metropolitan area. He did not use any other employment indicators to test for the differences between growing and declining metropolitan statistical areas. For an urban area that did not exhibit growth, New York City, Shilton [20] observed the lag effect between the cyclical office employment due to the business cycle in Manhattan and the office building occupancy rate from 1969 through 1983.

The puzzle the real estate investor encounters is analogous to the problem a stock analyst has in assembling a portfolio of stocks. It is possible to have several high-growth stocks for a short period, but for longer periods of time, growth is largely the result of diversification [6]. For this study distinct office employment groups are being used, instead of stocks.

Office Employment Theory

Heilbrun [12] and Kass [13] review that in central place theory there is a hierarchy of functions regionally and nationally. Luck [14] illustrated that when America had a manufacturing-based economy prior to 1960, the function of the central city (i.e., manufacturing center, or a mixed trade/service center) was a good predictor of a region's growth. Heilbrun [12], among others, confirms the validity of the spatial pecking order of central place theory in the location of consumer retailing, consumer market-oriented manufacturing, and service industries. As a place assumed more regional and national

functions, the profile of its employment changed. Ettlinger and Clay [5] review the methodologies and data problems in quantifying the difference between the specialized function of the central place and the routine function of the typical urban area. Using the data for a few specialized occupations on a regional basis, they note concentrations of specialized employment such as engineers, and computer specialists occur in core areas along the two regional coasts of the United States.

Central places theory asserts that the location of a service and the geographic area it supports depend on the:

a. density of the demand for a service (the more dense the population, the more likely that a greater array of services will be found),

b. level of export activity for the manufacturing or service activity,

c. economies of scale of the service (certain types of services need a minimum level of support),

d. cost of transportation and the forms of communication available, and

e. need for physical face-to-face communications and decisionmaking.

Office employment stems from the demand for office services by the local population and the demand for services by the primary, secondary and tertiary exporting activities.

$$O_L = f(P_{SES}), \tag{1}$$

where

O_L = office employment due to local service functions, and
P_{SES} = local population of a given socioeconomic status.

After the local population needs are met, office employment caters to primary manufacturing, secondary trading, and the tertiary specialized functions.

$$O_{Ep} = f\left(\sum_{j=1}^{N} I_j\right) + \sum_{k=1}^{N} A_k, \tag{2}$$

where:

O_{Ep} = primary office employment in a given county,
f = a function denoting a proportion of the primary manufacturing/service employment that is office.
I_j = the j^{th} industry, and
A_k = the k^{th} ancillary office support service.

A positive correlation exists between the ratio of office employment in the j^{th} industry to total office employment and the ratio of office support services to total office employment:

$$\rho O_{rIrA} = \frac{\sigma_{rIrA}}{\sigma_{rI}\sigma_{rA}}, \tag{3}$$

where:

ρ = the correlation for the ratio of office employment in industry j, and office support service employment in service k.

At the secondary level, office space would be a function of the trading and servicing activities. Office space demand depends on the local and regional/national retailing and wholesaling activities.

$$O_{Ei} = f(\sum_{j=1}^{N} T_j) + \sum_{k=1}^{N} A_k , \tag{4}$$

where:

O_{Ei} = office employment in the wholesaling/retailing industries and the ancillary support services attributed to those industries, and
T_j = a wholesaling or retailing industry, and the other terms are as specified previously.

Additional functions, beyond that of controlling the plant or unit operations occur in the offices of central places: exchange, control, and leadership. These functions are headquarters functions. In these functions, the activity in the office is no longer related to a specific production process, but a higher level of decisionmaking. In this hierarchy, spans of local, national, and international control evolve. Adapting this hierarchy to office space usage requires modifications. In addition, the function of the office space will also depend on the territory served and the type of client served. In any given city for any given office space function, there is a territory that goes with the activity-local unit to the world.

$$O_{Ep,H} = (\sum_{h=1}^{N} H_1) + f(\sum_{j=1}^{N} I_j) + \sum_{j=1}^{N} A_{H,j} , \tag{5}$$

where:

$O_{Ep,H}$ = the office employment due to the primary manufacturing activity and the headquarters activity of primary industries,
H_n = headquarters activity,
I_j = primary industrial activity, and
$A_{H,j}$ = ancillary support activity for the headquarters and primary industrial activity.

As the economic base of an area evolves from a local economy to a central place economy, the vector of office employment shifts. A base of office employment consists of several office industry types. As the intensity of the headquarters activity increases per spatial area, the proportion of office industry employment, as a percentage of total office employment, will change. Central place theory suggests that as the intensity of functions increases the proportion of specialized office employment will increase. Therefore central place office employment and local office employment will differ.

The major tenet of central place theory is that activities at the central place achieve economies of scale. An increase in the central place activity implies an increase in population to serve those activities, but specialized services will increase faster than local services.

$$\frac{\partial O_{Ep,H}}{\partial H,I,T,A} > \frac{\partial O_L}{\partial P_{SES}}. \tag{6}$$

The service/professional office employment of physicians, local attorneys, local brokers and insurance agents predominate in a local economy. As the economy becomes more intensive, the more specialized ancillary services appear such as public relations, computer business services, and media control. As the local economy undergoes this central place intensification, the office employment would increase. Local serving office employment rises as the population increases, while specialized service office employment increases as the central place and headquarters activities increase. As a result, the ratio of local service office employment to total office employment would decline and the ratio of specialized office employment to total office employment would increase.

Furthermore, groups of office employment for the growth service industries will grow faster than older office/service employment groups.

$$\frac{\partial O_{Ep^*,H^*}}{\partial H^*,I^*,T^*,A^*} > \frac{\partial O_{Ep,H}}{\partial H,I,T,A}, \tag{7}$$

where * denotes those growth office service industries.

In order to ascertain if there is a difference in the office employment profiles among cities, the four-digit SIC Code for the major counties of each city is used. Office employment is often generalized as the FIRE (finance, insurance and real estate) and Services SIC groups at the two-digit level. This generalization, which has led to the conclusion that office employment is approximately 25% of total employment, can lead to serious erroneous conclusions. The FIRE component of total private office employment varies from 16% to 34% and, as will be shown, is changing over time.

The four-digit-level SIC data must be examined closely. The services group (SIC 70 series) contains many non-office categories and office employment is found in most of the other SIC groupings of manufacturing, trade, construction, etc. Two-digit SIC categorization often results in the combination of office and non-office types of employment. For example, service employment, the SIC group 70, contains public relations personnel as well as beauty salon personnel. This study uses the specific SIC categories that represent non-government office employment. All SIC categories have been reviewed and those functions that are office users are included. Within manufacturing, there are functions that lend themselves to office use, such as publishing. Printing, per se, is not an office use, but note that both publishing and printing are within SIC category 27.

In all manufacturing-supported office employment, the ancillary and administrative functions at the end of the major SIC categories have been used for office proxies. The administrative grouping at the end of the SIC listings was corroborated using the categorical listings of the New York State Department of Labor surveys [7], [8], [17], [18]. These surveys detail the percentages of a given industry's workers in managerial, supervisory, technical, clerical, production, and assembly functions. Managerial, super-

visory, technical and clerical are office functions. In examining the relationship between office space demand and office employment in Manhattan, Shilton [20] found that the use of the SIC classifications as presented here paralleled the results of the New York Department of Labor Surveys. Exhibit 1 lists the office employment groups used in this study.

In the urban central county of each city, all office employment, O, is summed from the relevant SIC categories. By taking the office employment for each SIC category, o, over the total office employment, a ratio r_j is obtained.

A city is a portfolio of employment groups that changes over time. Therefore in a given office market:

$$E(P_o)=\sum_{i=1}^{N} W_i E(p_i), \tag{8}$$

Exhibit 1
Office Employment Groups Used in This Study

Categories (in order as they appear in SIC listings)
Publishing
Corporate Headquarters
Transportation
Communications
Transportation Company Headquarters
Wholesalers
Retailers
Total Banking
Federal Reserve Bank
Commercial Bankers
Credit Bankers
Financial Brokers
Life Insurance Headquarters
Insurance Brokers
Real Estate
R.E.—Insurance. Brokers
Financial Holding Companies
Total Office Service
Total Specialty Serv.
Advertising
Credit Agencies
Mail Handlers
Newspaper Offices
Computer Consultants
Public Relations
Misc. Business Serv.
Motion Picture Prod.
Motion Picture Dist.
Physicians
Dentists
Other Health Pract.
Legal Offices
Membership Org.
Miscellaneous Groups
Engineers
Accountants
Misc. Service Prof.
Service Company Headquarters

where:

$E(P_o)$ = the expected change in the percentage in the total office employment,
W_i = the weight (ratio) of each office employment group, i, to the total office employment group,
$E(p_i)$ = the expected change in the percentage of change in each office employment group, i.

$$\mathrm{Var}_o = \sum_{i=1}^{N} \sum_{j=1}^{N} R_i R_j \mathrm{Cov}_{ij} \tag{9}$$

where:

Var_o = the variance of the ratios of the office employment groups to total office employment,
R_i = the ratio of specific office employment groups, i, to total office employment (note that W and R are synonymous for each office employment group), and
Cov_{ij} = the covariance between the ratio of office employment in group i and group j.

Given the vector of office employment ratios, cities would differ in the skewness of these ratios. Central place cities would exhibit positive skewness; non-central place cities would exhibit negative skewness.

The expected change in the city portfolio of office employment, o, is the weighted sum of the expected changes in each office industry. There are related changes, covariances, among industries and therefore a city has a variance of office employment ratios, $\sigma^2 R_j$ of industry groups.

In the empirical tests, the ratios, r_j, are for each office employment group to total office employment, at a given point in time in a country. The study examines how the variances of these ratios differ across cities and across time.

Research Design

The first proposition is that cities differ significantly in their central place activities. Cities should vary in the aggregate proportion of their total employment in office employment and the diversity of their office employment. Central place cities should have a higher ratio of their total employment in office employment. Because of the diversity, central place cities should have a higher variance of the office employment groups.

The second proposition is that the variance (as a proxy for diversity) is an indicator of growth. The more diversified the city, the more likely growth will be stable and consistent over time.

The third proposition is that the mix of office employment is an indicator of future office employment in a city. That is, clusters of office employment ratio groupings are better predictors of office employment growth than the diversity measure of variance alone.

The statistical tests performed were ANOVA, MANOVA, ordinary least squares regression (OLS), ranking tests, tests of sample means, cluster analysis and discriminant analysis with the SPSS statistical package.

For the three years, 1976, 1982, and 1985, forty-five cities are grouped by use of cluster analysis. The year 1976 was chosen because it was at the trough of a business cycle and

Exhibit 2
45 Cities Ranked by Size of 1985 Total Office Employment

City	Total Employment	Office Employment
Los Angeles	3345520	1070636
Chicago	2187992	777128
Dallas–Ft. Worth	1064956	390382
Houston	1215870	379955
San Francisco	520167	252770
Boston	486045	226736
Philadelphia	608980	223363
Detroit	698986	220052
Miami	677133	218430
Washington	364771	212255
Pittsburgh	572764	208928
Seattle	621133	207372
Atlanta	459524	198862
Phoenix	716445	196888
San Diego	655927	191001
San Jose	733881	188582
Cleveland	651267	186757
Columbus	394051	140188
Oakland	427056	138413
Denver	352714	132079
Indianapolis	380396	113564
San Antonio	371394	108613
Tampa	304199	97801
Portland	274622	90816
Memphis	320563	90127
Jacksonville	259031	88628
Birmingham	276892	84814
Nashville	276017	83125
Louisville	292719	82885
Tulsa	251246	79958
Oklahoma City	274285	78802
Sacramento	252745	77558
Austin	234833	75929
Omaha	203851	74054
New Orleans	215308	67188
Baltimore	251831	66893
Albuquerque	168834	54072
Toledo	177908	46025
Tucson	187297	44491
Wichita	182847	38411
Colorado Springs	115734	33601
El Paso	138445	27608
Norfolk	68725	22463
Beaumont	92771	18071
Brownsville	53000	9477

antedates the structural shift in the United States from a manufacturing to a service economy. The ending year, 1985, was the latest available data. The cluster analysis procedure allows for testing whether the percentage allocations are the same or are significantly different among cities. If there is no significant difference between city office groups, the ANOVA and the discriminant test results would not be statistically significant. Further, the cluster analysis will trace the composition of the group and the stability of the groups over the sample period. For each year, the stability of the grouping is traced as the number of clusters is allowed to increase.

Exhibit 2 lists the forty-five cities used in this study ranked by their total central county employment in 1985. Data requirements and the availability of real estate market data determined the forty-five cities. New York was specifically omitted because, a priori, it was known that its central county office employment (Manhattan, New York County) is skewed and does not cover all employment and office employment in the counties within the city. Cluster routines in SPSS were used to explore all possible ratio groupings within the office employment categories. For each city, a ratio was computed for each SIC category of office employment, as a percentage of office employment, for the years 1976, 1982 and 1985. The ratios contained both the generally recognized categories such as headquarters office employment, banking, investment, insurance, lawyers, and medical professions, besides the more quixotic categories such as motion picture producers, advertising, and news services.

Results

Proposition 1—Office Employment Variance

The percentage of office employment increased over this period from an average for all cities of 0.276 in 1976, to 0.322 in 1985 (see Exhibit 3). This increase probably reflects the increased service nature of the national economy. The difference between the two years was dramatic, statistically, and using a paired samples t-test, the t-value was -6.16 and significant at the 99% confidence level! The ratio of office employment to total employment for a city ranged from a high of 48% (San Diego 1985) to a low of 15% (Beaumont 1976), over the 1976–1985 period.

However, the average of the variances of office employment per city decreased. In 1976, the average variance of office employment per city was 0.0052 (see Exhibit 5). This average variance declined to 0.0049 in 1985. Using the paired samples t-test, the years were significantly different with a t-value of 2.78 (confidence level of 99%). Office employment increased its importance in the economic base, but the decreasing variance signals that cities have become more homogeneous in their office employment.

In reviewing the cities and their variances, note that at the high variance are cities such as San Francisco and Brownsville. The skewness was different, however. San Francisco is a central place city and therefore has higher percentages in the tertiary specialized office employment. Brownsville, on the other hand, has lower percentages in these specialized services, and as a result office worker groups serving the local population will have higher percentage ratios. The high ratio of local specialized services and the low ratio of central place specialized services contribute to a variance above the average. Low variances indicate that cities have no unique clusters of specialized services and that their local office ratios follow the norm for that mid-size population.

Exhibit 3
Percentage of Total Employment in Office Employment

City	1976	1982	1985
Los Angeles	0.276	0.310	0.320
Chicago	0.307	0.336	0.355
Houston	0.250	0.303	0.312
Dallas–Ft. Worth	0.270	0.301	0.367
Detroit	0.324	0.309	0.257
Philadelphia	0.338	0.304	0.275
Cleveland	0.271	0.241	0.315
Pittsburgh	0.289	0.302	0.323
Miami	0.275	0.348	0.291
San Francisco	0.439	0.314	0.287
Seattle	0.276	0.331	0.334
San Jose	0.242	0.290	0.367
Boston	0.445	0.275	0.365
San Diego	0.249	0.509	0.486
Atlanta	0.347	0.442	0.466
Phoenix	0.256	0.400	0.433
Indianapolis	0.258	0.291	0.324
Washington	0.519	0.296	0.356
Oakland	0.270	0.378	0.299
Columbus	0.300	0.387	0.292
Denver	0.336	0.263	0.382
Louisville	0.232	0.590	0.374
Memphis	0.243	0.335	0.281
Birmingham	0.236	0.272	0.322
San Antonio	0.237	0.269	0.283
Portland	0.266	0.278	0.306
New Orleans	0.277	0.326	0.301
Nashville	0.295	0.269	0.331
Oklahoma City	0.269	0.305	0.287
Jacksonville	0.338	0.308	0.342
Baltimore	0.223	0.272	0.307
Tampa	0.254	0.298	0.266
Tulsa	0.280	0.259	0.318
Omaha	0.333	0.341	0.421
Toledo	0.217	0.324	0.323
Sacramento	0.299	0.343	0.312
Wichita	0.184	0.202	0.363
El Paso	0.173	0.314	0.238
Albuquerque	0.281	0.256	0.210
Tucson	0.219	0.226	0.259
Austin	0.303	0.318	0.320
Beaumont	0.151	0.184	0.199
Colorado Springs	0.273	0.271	0.195
Norfolk	0.270	0.321	0.327
Brownsville	0.155	0.157	0.179
Mean	0.276	0.308	0.322

Exhibit 4
Variance and Growth of Cities

City	1976 Variance	Total Employ Growth	Office Employ Growth	Elasticity
Jacksonville	0.009	1.184	1.196	1.010
San Francisco	0.008	1.053	1.221	1.159
Boston	0.007	1.169	1.162	0.994
Brownsville	0.007	1.415	1.438	1.017
Albuquerque	0.007	1.297	1.465	1.130
San Antonio	0.006	1.401	1.555	1.110
Norfolk	0.006	1.316	1.562	1.187
Indianapolis	0.006	1.044	1.197	1.147
Omaha	0.006	1.096	1.130	1.032
Tampa	0.006	1.341	1.630	1.215
Detroit	0.006	0.807	0.771	0.956
Birmingham	0.006	1.076	1.392	1.294
Seattle	0.006	1.394	1.585	1.137
Phoenix	0.006	1.558	1.676	1.075
Miami	0.006	1.265	1.399	1.106
Atlanta	0.006	1.119	1.289	1.152
Austin	0.005	1.680	1.736	1.033
New Orleans	0.005	1.063	1.143	1.075
Dallas–Ft. Worth	0.005	1.400	1.564	1.117
Colorado Springs	0.005	1.528	1.515	0.992
El Paso	0.005	1.220	1.303	1.068
Oklahoma City	0.005	1.438	1.451	1.010
Philadelphia	0.005	0.933	0.961	1.030
Pittsburgh	0.005	1.041	1.194	1.147
San Diego	0.005	1.505	1.751	1.163
Tucson	0.005	2.428	2.980	1.227
Denver	0.005	1.294	1.454	1.124
Columbus	0.005	1.134	1.461	1.289
Chicago	0.005	1.006	1.100	1.093
Houston	0.005	1.454	1.761	1.211
Nashville	0.005	1.139	1.052	0.923
Portland	0.005	1.114	1.366	1.226
Louisville	0.005	1.034	1.230	1.189
Beaumont	0.004	1.163	1.383	1.189
Sacramento	0.004	1.406	1.523	1.083
Wichita	0.004	1.197	1.313	1.097
San Jose	0.004	1.592	1.587	0.997
Baltimore	0.004	1.226	1.425	1.162
Memphis	0.004	1.129	1.251	1.108
Washington	0.004	1.039	1.181	1.137
Oakland	0.004	1.243	1.342	1.079
Toledo	0.004	0.998	1.175	1.177
Los Angeles	0.004	1.228	1.381	1.125
Cleveland	0.003	1.015	1.130	1.114
Tulsa	0.003	0.879	0.711	0.809

Proposition 2—Variance and Growth

Exhibit 4 lists the variance and changes in total employment and office employment and an elasticity measure of change in office employment to total employment. Exhibit 5 shows that there is no significant relationship between the variance of the office employment and resulting office growth. Additional regressions confirmed that there is no significant relationship between the variance of the office employment and the resulting elasticity measure. Further work is needed to test the relationship between the skewness of the ratios and subsequent office employment growth.

Exhibit 5
1976 Variance–Office Growth Regression

Correlation: (1976)	Variance Employment	Total Employment	Office	Elasticity
Variance	1.00			
Total	0.049	1.000		
Office	0.026	0.943	1.000	
Elasticity	−0.010	0.141	0.450	1.000

Dependent Variable: Office Employment
Independent Variable: Variance

Multiple *R*	0.02637
R-Square	0.00070
Adjusted *R*-Square	−0.02254
Standard Error	0.34254

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	0.00351	0.00351
Residual	43	5.04540	0.11733
F = 0.02992	Signif *F* = 0.8635		

Variable	*B*	SE *B*	*Beta*	*T*	Sig *T*
Variance (1976)	7.81104	45.15861	0.02637	0.173	0.863
(Constant)	1.33908	0.24108		5.555	0.000

Exhibit 6
Cluster Membership, 1976, 1985

1976 Office Function	1976 Cluster	1985 Cluster	Office Growth
City			
*Manufacturing, Media**			
Oakland	1	1	1.342
Cleveland	1	2	1.130
Louisville	1	2	1.230
Tulsa	1	2	0.711
Washington	1	2	1.181
Los Angeles	1	3	1.381

Exhibit 6 (continued)

1976 Office Function	1976 Cluster	1985 Cluster	Office Growth
Nashville	1	3	1.052
Wichita	1	5	1.313
TOTAL 8			
*Manufacturing**			
San Jose	2	1	1.587
Detroit	2	2	0.771
Pittsburgh	2	2	1.194
Toledo	2	2	1.175
TOTAL 4			
*FIRE, Insurance**			
Albuquerque	3	1	1.465
Atlanta	3	1	1.289
Houston	3	1	1.761
Tampa	3	1	1.630
Baltimore	3	3	1.425
Chicago	3	3	1.100
Columbus	3	3	1.461
Dallas–Ft. Worth	3	3	1.564
Norfolk	3	3	1.562
Oklahoma City	3	3	1.451
Philadelphia	3	3	0.961
Portland	3	3	1.366
Memphis	3	5	1.251
New Orleans	3	5	1.143
TOTAL 14			
*Banking**			
Birmingham	4	3	1.392
Boston	4	3	1.162
Indianapolis	4	3	1.197
Jacksonville	4	3	1.196
Omaha	4	3	1.130
San Antonio	4	3	1.555
Seattle	4	3	1.585
San Francisco	4	4	1.221
TOTAL 8			
*Wholesale, Retail Trade**			
San Diego	5	1	1.751
Austin	5	3	1.736
Denver	5	3	1.454
El Paso	5	3	1.303
Miami	5	3	1.399
Phoenix	5	3	1.676
Sacramento	5	3	1.523
Brownsville	5	4	1.438
Beaumont	5	5	1.383
Colorado Springs	5	5	1.515
Tucson	5	5	2.980
TOTAL 11			

1985 Clusters

1. Business Services, Manufacturing, Wholesale
   TOTAL 7
2. Manufacturing, Retail
   TOTAL 7
3. Mixed
   TOTAL 23
4. FIRE, Banking
   TOTAL 2
5. Legal, Media, Public Relations
   TOTAL 6

*This office employment grouping dominated the cluster.

Note: The predominance of office employment groups changes, and different clusters emerge between 1976 and 1985. In 1985, two different clusters of specilized service emerge. Cluster one is dominated by business services and office employment for the wholesale and manufacturing. Another cluster emerges with the dominance of media, legal and public relations employment.

Proposition 3—Growth and Office Employment Groupings

To test the significance of grouping a city by its major employment function, i.e., manufacturing, cities were clustered by three main variables: the ratio of manufacturing employment to total employment, office employment to total employment, and service employment to total employment. There was no relationship between growth and the 1976 characterization of the city as predominantly manufacturing or service.

Statistical significance between clusters and growth was found when cities were clustered by office worker ratios. Exhibit 6 summarizes the groupings among cities for the years 1976

Exhibit 7
ANOVA of Significant Employment Groups, 1976

Variable	Cluster MS	DF	Error MS	*F*	Prob
Publishing	0.0009	4	0.0004	2.5254	0.055
Manufact. Office	0.0289	4	0.0009	31.1488*	0.000
Transportation Serv.	0.0000	4	0.0000	0.9404	0.450
Communications	0.0025	4	0.0006	4.2994*	0.005
Transportation HQ	0.0009	4	0.0004	2.0955	0.099
Wholesale Trade	0.0010	4	0.0005	2.0423	0.106
Retail Trade	0.0005	4	0.0005	0.9458	0.447
FIRE	0.0214	4	0.0009	23.4720*	0.000
All Banking	0.0006	4	0.0004	1.6600	0.178
Federal Reserve	0.0000	4	0.0000	3.6693	0.012
Commercial Banking	0.0007	4	0.0003	2.8870	0.034
Credit Banking	0.0006	4	0.0001	6.7644*	0.000
Investment Brokers	0.0000	4	0.0000	1.2137	0.320
Insurance	0.0151	4	0.0006	24.4405*	0.000
Insurance Agents	0.0002	4	0.0000	4.0581	0.007
Real Estate	0.0020	4	0.0003	6.2095*	0.001
R.E. & Ins. Agents.	0.0000	4	0.0000	0.4310	0.785
Holding Cos.	0.0001	4	0.0001	1.3035	0.285
Business Services	0.0069	4	0.0011	6.1220*	0.001
Advertising	0.0000	4	0.0000	1.4671	0.230
Credit Reporting	0.0000	4	0.0000	0.9084	0.468
Mail Services	0.0000	4	0.0000	0.6552	0.627
News Reporting	0.0000	4	0.0000	0.6933	0.601
Computer Services	0.0001	4	0.0001	0.7427	0.568
Public Relations	0.0001	4	0.0001	2.1968	0.086
Misc. Services	0.0001	4	0.0001	1.4851	0.224
Motion Pic. Prod.	0.0001	4	0.0001	0.9043	0.470
Motion Pic. Servs.	0.0001	4	0.0001	1.3353	0.273
Physicians	0.0010	4	0.0001	6.7847*	0.000
Dentists	0.0001	4	0.0000	2.0419	0.106
Chiropractors	0.0000	4	0.0000	2.9630	0.031
Law Offices	0.0001	4	0.0001	1.4545	0.234
Membership Groups	0.0009	4	0.0006	1.3801	0.258
Misc. Prof.	0.0002	4	0.0003	0.4902	0.743
Engineering Firms	0.0002	4	0.0002	0.9201	0.462
Accountants	0.0000	4	0.0000	1.1740	0.336
Misc. Prof.	0.0000	4	0.0000	2.1698	0.089
Service Co. HQ.	0.0001	4	0.0001	1.4618	0.231

*significant at 95% level of confidence

and 1985. For each year, the cities were sequentially clustered by their office employment ratios from a two-cluster group to a twenty-cluster grouping. Stability of core membership was achieved when cluster partitioning was at five.

For 1976, a pattern of two core groups of cities emerged. One core emphasized the office activities of manufacturing firms (clusters one and two). The other core emphasized banking and service centers (clusters three and four). By 1985, a new core group of cities emerged (cluster three in Exhibit 6). This core group dominated the clusters. Over half the cities belong to cluster three. It was a mixture of functions with no single office function

Exhibit 8
ANOVA of Significant Employment Groups, 1985

Variable	Cluster MS	DF	Error MS	*F*	Prob
Publishing	0.0004	4	0.0003	1.5080	0.218
Manufact. Office	0.0193	4	0.0009	20.8405*	0.000
Transportation Serv.	0.0000	4	0.0000	0.9732	0.433
Communications	0.0006	4	0.0003	1.7655	0.155
Transportation HQ	0.0003	4	0.0002	1.2923	0.289
Wholesale Trade	0.0002	4	0.0001	1.6808	0.173
Retail Trade	0.0008	4	0.0006	1.2887	0.291
FIRE	0.0178	4	0.0009	20.2885*	0.000
All Banking	0.0025	4	0.0002	11.4399*	0.000
Federal Reserve	0.0000	4	0.0000	1.0241	0.407
Commercial Banking	0.0022	4	0.0003	7.7953*	0.000
Credit Banking	0.0002	4	0.0001	1.2436	0.308
Investment Brokers	0.0001	4	0.0001	1.0164	0.411
Insurance	0.0054	4	0.0010	5.4417*	0.001
Insurance Carriers	0.0001	4	0.0000	4.8813*	0.003
Real Estate	0.0008	4	0.0003	3.1518	0.024
R.E. & Ins. Agents.	0.0000	4	0.0000	1.7143	0.166
Holding Cos.	0.0000	4	0.0000	1.8190	0.144
Business Services	0.0102	4	0.0011	9.2551*	0.000
Advertising	0.0000	4	0.0000	0.8176	0.522
Credit Reporting	0.0000	4	0.0000	1.6277	0.186
Mail Services	0.0000	4	0.0000	1.5354	0.210
News Reporting	0.0000	4	0.0000	0.8018	0.531
Computer Services	0.0006	4	0.0002	3.9120	0.009
Public Relations	0.0002	4	0.0002	1.1949	0.328
Misc. Services	0.0000	4	0.0000	1.8516	0.138
Motion Pic. Prod.	0.0000	4	0.0001	0.2666	0.898
Motion Pic. Servs.	0.0000	4	0.0000	0.3683	0.830
Physicians	0.0004	4	0.0002	1.6587	0.179
Dentists	0.0000	4	0.0000	0.8744	0.488
Chiropractors	0.0000	4	0.0000	2.1669	0.090
Law Offices	0.0005	4	0.0002	2.0156	0.111
Membership Groups	0.0037	4	0.0004	9.0428*	0.000
Misc. Prof.	0.0002	4	0.0004	0.4974	0.738
Engineering Firms	0.0002	4	0.0003	0.4765	0.753
Accountants	0.0000	4	0.0000	0.6959	0.599
Misc. Prof.	0.0000	4	0.0000	1.2180	0.318
Service Co. HQ	0.0001	4	0.0001	0.7859	0.541

*significant at 95% level of confidence

being conspicuous. This core group did not decompose into two groups until the number of clusters reached twelve. At the twelve-cluster level, the employment group differed slightly in their averages although no specific employment group dominated within the twelve clusters. Exhibit 7 and Exhibit 8 list the office employment groups and the asterisk besides the *F*-value denotes those groups that were statistically significant in composing the clusters. For both years, cities differed due to the amount of office employment for manufacturing, FIRE, insurance and business services. By 1985, banking and membership groups took on added significance in distinguishing between clusters.

Using the groups based on low or high manufacturing, some predictive power was obtained. Low manufacturing cities achieved higher office growth by 1985 than high manufacturing cities, on average, but as noted, by 1985, there was no significant difference in manufacturing among cities.

Both on an ex-ante and ex-post basis, the clusters of cities were associated with different growth rates. The difference in the average growth rate per cluster was significant for 1976 and 1985 at the 95% confidence level, with an *F*-statistic of 3.728 (Exhibit 9 and 10). Cities with the highest proportion of their office employment in the wholesale and trade SIC categories had a growth rate that averaged 65% from 1976 to 1985. The lowest growth clusters was for cities that had a concentration of office employment for manufacturing firms. The range of average growth per cluster was from 16.7% to 65% for the period 1976 through 1985.

Looking back from 1985, the patterns of growth are consistent. Those cities that were characterized by a high degree of office employment associated with primary manufacturing activities experienced the lowest growth rate in office employment, 5.4% from 1976 to 1985. Two groups of cities, those with a concentration of business services, wholesale and manufacturing (as opposed to only manufacturing and retail), and those

Exhibit 9
1976 Group Prediction of Growth

ANOVA by Growth Cluster, 1976

Source of Variation	Sum of Squares	DF	Mean Square	*F*	Signif of *F*
Main Effects	1.371	4	0.343	3.728	0.011
Cluster	1.371	4	0.343	3.728	0.011
Explained	1.371	4	0.343	3.728	0.011
Residual	3.678	40	0.092		
Total	5.049	44	0.115		

Cluster	Count	Growth Mean	Standard Deviation	Standard Error	95 Pct Conf Int for Mean		
Group 1	8	1.1675	0.2152	0.0761	0.9875	To	1.3474
Group 2	4	1.1819	0.3332	0.1666	0.6518	To	1.7120
Group 3	14	1.3878	0.2202	0.0589	1.2607	To	1.5150
Group 4	8	1.3047	0.1813	0.0641	1.1531	To	1.4562
Group 5	11	1.6508	0.4647	0.1401	1.3385	To	1.9630
Total	45	1.3798	0.3387	0.0505	1.2781	To	1.4816

Exhibit 10
1985, Ex-Ante, Group Prediction of Growth

ANOVA by Growth Cluster, 1985

Source of Variation	Sum of Squares	DF	Mean Square	*F*	Signif of *F*
Main Effects	1.218	4	0.304	3.178	0.023
Cluster, 1985	1.218	4	0.304	3.178	0.023
Explained	1.218	4	0.304	3.178	0.023
Residual	3.831	40	0.096		
Total	5.049	44	0.115		

Cluster	Count	Mean	Standard Deviation	Standard Error	95 Pct Conf Int for Mean		
Group 1	7	1.5463	0.1877	0.0709	1.3728	To	1.7199
Group 2	7	1.0561	0.2178	0.0823	0.8546	To	1.2575
Group 3	23	1.3753	0.2066	0.0431	1.2859	To	1.4646
Group 4	2	1.3295	0.1540	0.1089	−0.0544	To	2.7134
Group 5	6	1.5975	0.6888	0.2812	0.8746	To	2.3204
Total	45	1.3798	0.3387	0.0505	1.2781	To	1.4816

with the specialized office employment of law, media and public relations experienced a growth of over 50% in their office employment during the nine years.

Conclusions

Based upon an analysis of the office employment ratios of forty-five cities for 1976, 1982, and 1985, we can ascertain that U.S. cities have become more homogeneous in their office employment structure. The functional grouping of the cities in 1976 served to predict growth by groups over the subsequent decade. A backward look from 1985 confirmed that major differences exist between cities that had a high level of office employment associated with manufacturing and those cities that had a high level of office workers at the secondary and tertiary economic base levels of trading and specialized central place skills (such as public relations business services, and specialized finance).

This study demonstrates that cities should no longer be classified by their concentration of manufacturing employment in order to predict office employment through the use of the proportional inference method. To predict office employment growth, the analyst must be aware of the clusters of office employment groupings that characterize cities. This clustering reinforces the concept of linkage among employment groups (Carn et al. [3]). Brokers, investors and developers would be well advised to be aware of these groupings when developing their marketing, investment and development programs. Developers should be aware of these office employment groupings in assessing how a city will grow and how they should configure their new office complexes.

This study also used four-digit SIC Code office employment categories in an attempt to test whether the functional grouping of cities helped determine growth and change. The results suggest that the ties have been broken between the manufacturing base and the office employment of a city. However, further research is needed to test the relationship

between the overall economic base and the office employment groupings vis-a-vis the performance of specific industry groups and firms.

References

[1] S. J. Bernstein and W. G. Mellon. Urban Modeling: An Introduction to and Critique of Large Scale Models. In *Selected Readings in Quantitative Urban Analysis*, 3 9. New York: Pergamon Press, 1975.

[2] M. Cadwallader. Metropolitan Growth and Decline in the United States: An Empirical Analysis. *Growth and Change* 22:3 (Summer 1991), 1–17.

[3] N. Carn, J. Rabiansky, R. Racster and M. Seldin. *Real Estate Market Analysis.* Englewood Cliffs, N.J.: Prentice Hall, 1988.

[4] T. M. Clauretie. Regional Economic Diversification and Residential Mortgage Default Risk. *Journal of Real Estate Research* 3:1 (Spring 1988), 87–96.

[5] J. J. Del Casino. On Assembling Real Estate Portfolios. *Real Estate Issues* (Fall/Winter), 1985.

[6] E. Elton and M. Gruber. The Correlation Structure of Security Returns Multi-Index Models and Grouping Technique. In *Modern Portfolio and Investment Analysis.* New York: John Wiley and Sons, 1981.

[7] *Employment by Occupation, Finance, Insurance and Real Estate, New York State.* Albany: New York Department of Labor, Division of Research and Statistics, 1980.

[8] *Employment by Occupation, Manufacturing, New York State.* Albany: New York Department of Labor, Division of Research and Statistics, 1980.

[9] N. Ettlinger and B. Clay. Spatial Divisions of Corporate Services Occupations in the United States, 1983 1988. *Growth and Change* 22:1 (Winter 1991), 36 53.
(Winter 1987), 85–95.
Journal 15:1 (Spring 1987), 617–37.

[11] D. J. Hartzell, D. G. Shulman and C. H. Wurtzebach. Refining the Analysis of Regional Diversification for Income-Producing Real Estate. *Journal of Real Estate Research* 2:2 (Winter 1987), 85–96.

[12] J. Heilbrun. *Urban Economics and Public Policy.* New York: Martins Press, 1974.

[13] R. Kass. A Functional Classification of Metropolitan Communities. *Demography* 10:3 (August 1973).

[14] D. J. Luck. The Changing Economic Base and Its Significance to Marketers. Southern Illinois University, Carbondale, *Business Perspectives* 4:4 (Summer 1968).

[15] M. Miles and C. Wurtzebach. *Modern Real Estate.* New York: John Wiley, 1990.

[16] T. J. Noyelle and T. M. Stanback, Jr. *The Economic Transformation of American Cities.* Totowa, N.J.: Rowman and Allanheld, 1984.

[17] *Occupational Employment Statistics, Selected Transportation and Public Utilities, New York State.* Albany: New York Department of Labor, Division of Research and Statistics, 1979.

[18] *Occupational Employment Statistics, Wholesale and Retail Trade, New York State.* Albany: New York Department of Labor, Division of Research and Statistics, 1979.

[19] W. M. Shenkel. *Real Estate Finance and Analysis.* Plano, Tex.: Business Publications, 1988.

[20] L. Shilton. *Manhattan Office Industries.* New York: New York University, Sylvan Lawrence Research Center, 1984.

[21] W. R. Thompson. Internal and External Factors in the Development of Urban Economics. In *Issues in Urban Economics, Resources for the Future*, 43–62. Washington D.C.: Johns Hopkins Press, 1968.

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