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Urban Industrial Structure and Diversification : Converging Trend among Urban Economies

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This study examines the competitiveness of urban industrial structure and its changing characteristics. Cluster analysis of Arizona towns based on economic functions revealed the changing characteristics of urban functions over time. The relationship between the changes of urban functions and industrial competitiveness was confirmed through shift-share analysis. The level of industrial specialization has become more closely related to urban size in terms of both population and employment, but the relationship between metropolitan location and specialization level is not clear. Also, it is validated that the economies of Arizona towns have become more diversified and, consequently, have tended to converge toward the state average in industrial structure over time.

Key Words: urban industrial structure, economic convergence, shift-share analysis, industrial diversification, urban function.

1. Introduction

Economic growth of urban areas is affected not only by endogenous factors like local resources but also by exogenous factors like regional or national economies. Changes in regional economic structure usually influence and transform the functional activities of the individual places in the region. However, the sensitivity of an urban areas to such economic changes depends on the industrial composition of the area; if a town is specialized in industrial sectors that have not been competitive and have been on the decline in the region, the town will be more affected by the regional decline in those sectors. Therefore, examining how the changes in regional employment structure have been distributed across the regional urban system and which sectors have led towns to growth and decline helps to elucidate the economic factors in urban growth.

The questions on changing characteristics of the urban industrial structure have been pursued in various perspectives of economic and geographic research. So far, most research in such topics has focused on the specialized urban functions and has found evidence of structural divergence among towns. However, the evolution of urban characteristics in North America during the last few decades has already exhibited the new tendency of structural convergence.

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Economic restructuring patterns since the 1960s in North America seem to have contributed to reduce the specialization level in urban economic bases. Marshall found such a tendency in his study of Canadian cities from 1951 to 1971:

…this longitudinal study makes it clear that the employment profiles of Canadian cities have tended to converge toward the system-wide average profile over time. If this convergence is true for North American cities in general, we may infer a gradual weakening of the structural distinctions that separate the various functional classes of cities (Marshall, 1989, p.134).

In relation to such topics as urban industrial structure and its changing characteristics, this study will examine two themes. The first theme pertains to the competitiveness of industrial composition in urban places, and the second theme pertains to whether the characteristics of the various urban economies have been converging or diverging.

2. Hypotheses

Based on previous studies on urban industrial structure, the following hypotheses were developed to be probed in this study.

① Towns specializing in the primary sector tend to decline.

This hypothesis was derived from classical stage theories of economic development. According to such theories, the core of the developmental process is the transition from a primary economy to a secondary economy and further to a tertiary economy (Berzeg, 1978, p.463; Hoover and Giarratani, 1984, p.337). Since most underdeveloped economies are dominated by the primary sector such as agriculture and mining, it is expected that agricultural and mining towns tend to decline.

② Urban size is closely related to industrial diversification. In other words, larger towns tend to be more diversified in industrial composition.

The relevancy of industrial diversification to urban size has been an interesting topic for a long time. Thompson (1965, p. 147) has mentioned that "clearly, increased city size brings greater industrial diversification," which had been a widely accepted proposition, but Clemente and Sturgis (1971) and Marshall (1975, 1989) demonstrated somewhat limited statistical support for that proposition.

③ Distance to the metropolis has no association with industrial diversification.

Concerning the relationship between industrial diversification and the locational factor, Marshall (1988, p.120) argued that "location does not significantly influence the level of diversification attained by any particular city." From this proposition, the above hypothesis was derived to test the relevancy of metropolitan location to diversification level of industries.

④ Towns become more diversified and more alike over time.

Marshall (1989) found that the employment profiles of Canadian cities showed increasingly diversifying trends from 1951 to 1971, a result which implies the convergence tendency of urban economies over time. This trend is assumed to be universal in North American cities, and the above hypothesis will be tested with a different data set in this study.

3. Data and Methodology

In order to fulfill the research objectives, this study adopted the towns in Arizona as the object of the case study. Arizona was selected because it is a fast-growing sunbelt state where many changes in demography and economy have been experienced during the last 30 years, and where a number of town-level studies on economic bases and functional variations have been conducted. The time span of this study covers the industrial characteristics of Arizona towns in 1970, 1980 and 1990. Data were collected for 42 towns with population greater than 2,500 in 1970, which were defined as urban areas in the 1970 U.S. census. In order to see the systematic changes during the period of 1970–1990, this analysis adopted all continuously existing (without incorporation or annexation) Arizona urban areas since 1970. For those towns, employment data in nine industrial sectors were compiled from the 1970, 1980, and 1990 U.S. censuses.

In order to examine the effects of the state economic changes and the town industrial structure on the employment growth of the town, shift-share analyses on each town will be performed for the two time spans, 1970–1980 and 1980–1990. This study will employ an extended version of the shift-share technique, which was suggested by Arcelus (1984) to take the effects of local industrial structure into account. The shift-share components resulting from the analysis will be presented by types of magnitude and compared with the functional groups of towns resulting from the cluster analysis, in order to show which typer of towns are growing fast or stagnating. Further, in order to look at the converging tendency among urban economies, this study will investigate the relationship between the level of industrial specialization and urban size as well as distance to the metropolis (Phoenix or Tucson) for 1970, 1980, and 1990. These investigations will reveal the overall tendency and specific variations of diversification in the industrial structure of Arizona towns since 1970.

4. Shift-Share Models

In order to analyze the relationship between industrial structure and regional growth, many scholars have contributed to the development of the shift-share technique as a sophisticated analytical tool over several decades (Dunn, 1960, 1980; Esteban-Marquillas, 1972; Herzog and Olsen, 1977; Berzeg, 1978; Fothergill and Gudgin, 1979; Stevens and Moore, 1980; Arcelus, 1984; Haynes and Machunda, 1987; Barff and Knight, 1988; Knudsen and Barff, 1991). Although there has been long-standing criticism of the shift-share analysis (Richardson, 1978a, 1978b), the technique has been popualr with economic planners as well as regional economic theorists. To provide a reason for this contradiction, Fothergill and Gudgin (1979, p.309) explained that "when a technique is simple and apparently useful, it will be both widely used and heavily criticized."

1) Classical Shift-Share Model

The shift-share analysis provides a quantitative explanation of comparative regional growth rates in sectoral employment using the growth rates of the nation or other reference regions such as a state. Given regional employment data by industrial sectors at two points in time, the traditional shift-share model breaks down the regional employment change, d, into three components: national growth component, g, industry-mix (proportional) component, m, and competitive (differential) component, c, Letting E_{ij} be employment in industrial sector i of region j in the base year of the analysis, E^*_{ij} be employment in sector i of region j in the terminal year, r_{ij} be the change rate in employment in sector i of region j between the base year and the terminal year, r_{io} be the change rate in national employment in sector i, r_{oj} be the change rate in total employment of region j, and r_{oo} be the change rate in total national employment, the traditional shift-share equation may be written as follows:

$$d_{ij}=g_{ij}+m_{ij}+c_{ij} \qquad (1)$$

where $d_{ij}=E^*_{ij}-E_{ij}$

$g_{ij}=E_{ij}\,r_{oo}$

$m_{ij}=E_{ij}\,(r_{io}-r_{oo})$

$$c_{ij}=E_{ij}\,(r_{jj}-r_{io})$$

Thus the shift-share equation for sector i in region j can be rewritten as

$$d_{ij}=E_{ij}\,r_{oo}+E_{ij}(r_{io}-r_{oo})+E_{ij}(r_{ij}-r_{io}) \quad (2)$$

The national growth effect, g_{ij} reflects the change in regional employment which would occur when the regional sector grows at the same rate as the overall m_{ij} national employment. The industry-mix effect, measures the amount of employment change attributable to the relative importance of the sector in the overall national economy. The competitive effect, C_{ij}, is the difference between the actual change in sectoral employment and the expected change that the region will experience when each regional industrial sector grows at the national rate of the same sector. The sum of the industry-mix component and the competitive competitive component, $m_{ij}+c_{ij}$, is called the net shift.

When each of the shift-share components in summed over all sectors, the resulted sign of each combined component indicates the direction of regional change compared to the national change. A positive industry-mix effect indicates that the region has a favorable growth mix of industries because the region specializes more, on balance, in sectors whose national growth rates exceed the overall national growth rate (Plane, 1988, p.267). A positive competitive effect indicates that the region competes well on the whole because the regional employment grew faster than the national industry-mix (or employment structure) would suggest (Herzog and Olson, 1977, p.443).

The problems with this classical shift-share model come mainly from two sources: the weights on the base year and the interwoven effects between industry-mix and competitive components (Herzog and Olsen, 1977, pp.443-44). Since growth rates of all components are weighted by base year employment levels, this model cannot reflect changes in regional industrial structure over the analysis period. Also, the competitive effect of a sector in this model is affected not only by the pure competitive nature of the sector but also by the level of concentration of total regional employment on that sector. In addition, the industry-mix and competitive effects are, by nature, interdependent because of technical linkages among supplying sectors and induced multiplier effects on service sectors (MacKay, 1968). Two other frequently mentioned problems of this model are the inaccuracy of the model in the projection application, which is related to the problem of weights, and the sensitivity of the model to the degree of industrial disaggregation, which is the problem of most regional analysis models.

2) Esteban-Marquillas Model

The classical form of the shift-share model was modified by Esteban-Marquillas (1972) in an effort to solve the problem of interwoven effects making the decomposed competitive effect an impure measure of regional competitiveness. His model overcame the problem by introducing the concept of homothetic employment, $\hat{E}_{ij}$, while separating the competitive effect, c_{ij}, into a pure competitive effect, c'_{ij}, and an allocation effect, a_{ij}. His model can be specified as

$$d_{ij}=g_{ij}+m_{ij}+c'_{ij}+a_{ij} \quad (3)$$

Where $\hat{E}_{ij}=E_{oj}\,(E_{io}/E_{oo})$
$c'_{ij}=(\hat{E}_{ij})(r_{ij}-r_{io})$
$a_{ij}=(E_{ij}-\hat{E}_{ij})(r_{ij}-r_{jo})$.

Homothetic employment, $\hat{E}_{ij}$, is defined as "the employment that sector i of region j would have if the structure of the employment in such a region were equal to the national structure" (Esteban-Marquillas, 1972, p.251). However, Herzog and Olson (1977) found that this refinement creates another weighting problem. Since homethetic employment also refers to the base year, the allocation effect comprising the specialization component, $(E_{ij}-\hat{E}_{ij})$, and the competitive advantage component, $(r_{ij}-r_{io})$, does not give a reliable sign of change when the regional employment sturcture changes between the base year and the terminal year. If a sector is defined as not specialized in the base year and then becomes specialized in the terminal year, the reversed sign of the allocation effect may lead to an incorrect interpretation of the employment change of that sector.

3) Arcelus Model

In an effort to resolve problems stemming from the entanglement of the regional growth effect and the regional employment structure effect in the competitive component, Arcelus (1984) further extended the shift-share model by subdividing the traditional competitive effect, c_{ij}, into the regional growth effect, Rg_{ij}, and the regional industry-mix effect, Rm_{ij}. Employing the homethetic employment concept of the Esteban-Marquillas model, he formulated the following model :

$$d_{ij}=g_{ij}+m_{ij}+Rg_{ij}+Rm_{ij} \quad (4)$$

where $Rg_{ij}=\hat{E}_{ij}(r_{oj}-r_{oo})+(E_{ij}-\hat{E}_{ij})(r_{oj}-r_{oo})$

$$Rm_{ij}=\hat{E}_{ij}[(r_{ij}-r_{oj})-(r_{io}-r_{oo})] +(E_{ij}-\hat{E}_{ij})[(r_{ij}-r_{oj})-(r_{io}-r_{oo})]$$

According to his model (Arcelus, 1984, p. 6), the regional growth effect, Rg_{ij}, which is the difference in total growth rates between region j and the nation, attempts to capture the component of the regional employment change in sector i which is attributable to the total growth of region j. The regional industry-mix effect, Rm_{ij}, which is the difference in sector i's competitiveness between region j and the nation, attempts to measure that component of the regional employment change which is attributable to the regional industry mix. In other words, the regional industry-mix effect explains whether sector i enjoys a competitive advantage in region j (Arcelus, 1984, p.6). It was found that, like the classical shift-share model, the extensions of Esteban - Marquillas and Arcelus maintain the region-to-region additive properties under regional disaggregation of the data (Haynes and Machunda, 1987).

4) ANOVA-Based Model

Since the traditional shift-share formulation is a standardization technique, statistical tests on the informative results from the analysis are imopossible. Berzeg (1978), however, formulated a stochastic linear model based on analysis of variance (ANOVA) so as to statistically test predictive hypotheses on the shift-share identity. His model can be specified as follows :

$$r_{ij}=\alpha+\beta_i+\varepsilon_{ij} \quad (5)$$

Where α is an estimate of the national growth rate, r_{oo}, and β_j is an estimate of the industry-mix rate, $(r_{io}-r_{oo})$. In this model, the competitive rate which equals $(r_{ij}-r_{io})$ is not a systematic component of r_{ij} but a random error term, ε_{ij}. As seen in the specification of the equation, this model is estimated in terms of growth rate instead of employment number. This linear model can be transformed so as to estimate Arcelus' extension model which includes the regional effect. The modified equation is as follows (Berzeg, 1978; Knudsen and Barff, 1991, p. 427):

$$r_{ij}=\alpha+\beta_i+\gamma_i+\varepsilon_{ij} \quad (6)$$

Where γ_i is an estimate of the regional growth effect, $(r_{oj}-r_{oo})$, and ε_{ij} is assumed to be an error term for the regional industry-mix effect, $(r_{ij}-r_{oj})-(r_{io}-r_{oo})$.

The stochastic properties of these ANOVA-vased models make it possible to test hypotheses for prediction and policy formulation. It was also found that these ANOVA - based estimates using weighted

Table 1. Sectoral Employment Changes in Arizona, 1970-1990

Sector	Employment			Percent Distribution			Change Rate	
	1970	1980	1990	1970	1980	1990	1970-80	1980-90
AGR	24,605	32,791	40,210	4.0	2.9	2.5	0.333	0.226
MIN	18,986	26,605	13,927	3.1	2.4	0.9	0.401	−0.477
CON	46,673	90,381	107,558	7.6	8.1	6.7	0.936*	0.190
MAN	95,958	161,302	206,379	15.6	14.5	12.9	0.681	0.279
TCU	37,450	73,779	116,598	6.1	6.6	7.3	0.970*	0.580*
TRD	133,925	246,094	358,390	21.8	22.1	22.3	0.838*	0.456*
FIR	35,65	77,266	120,14	5.7	6.9	7.5	1.197*	0.555*
SRV	182,46	332,072	554,190	29.7	29.8	34.6	0.823*	0.669*
PAD	39,47	72,980	86,503	6.4	6.6	5.4	0.864*	0.185
Total	614,055	1,113,270	1,603,896	100.0	100.0	100.0	0.813	0.441

* The employment of these sectors has grown faster than the state total employment.
Source : U.S. Bureau of the Census, 1970, 1980, 1990, *Census of population.*

least squares are numerically identical to the results generated from the classical shift-share model (Knudsen and Barff, 1991). Notwithstanding these advantages, the limitations of the ANOVA-based models stem mainly from the operational difficulties (Knudsen and Barff, 1991, p.430). The stochastic shift-share models require system closure for the data set ; if a study is concerned with a region in Arizona, then all regions of Arizona must be included in the data set. Another difficulty lies in the calibration of the models; ANOVA-based models, by their theoretical nature, require additional calculation of the parameters for aliased variables.

5) Dynamic shift-share Approach

In an effort to solve the problem of weights of the classical shift-share model, a dynamic shift-share approach was developed by Barff and Knight (1988). Since the classical static approach uses employment structure of the base year to calculate changes over to the terminal year, it cannot explain continuous changes in regional total employment and industrial mix over the time period.

Barff and Knight (1988) eliminated this problem by using the annual employment data which enable the shift-share to adjust the components annually for changes in industrial structure. Though some approaches of the earlier literature attempted to reduce the problem by fracturing the study period into two or more subperiods, their contributions were limited bescause of the relatively long time spans adopted for the subperiods (Barff and Knight, 1988, pp.3-4). Since annual employment data, in the formats of both publication and computer disk, is now available in the U.S. up to the county level, the task of calculating annual shift-share components has become much easier.

5. Industrial Structure of Arizona Towns

1) Sectoral Employment Structure in Arizona

The growth of the Arizona's economy was remarkably rapid from 1970 to 1990. According to the U.S. decennial census data, Arizona's total employment increased by 81.3 percent during 1970-1980 and by 44.1 percent during 1980-1990. For the same periods, the U.S. total employment increased by 24.9 percent and by 18.5 percent, respectively. Table 1 shows the total and sectoral employment changes in Arizona

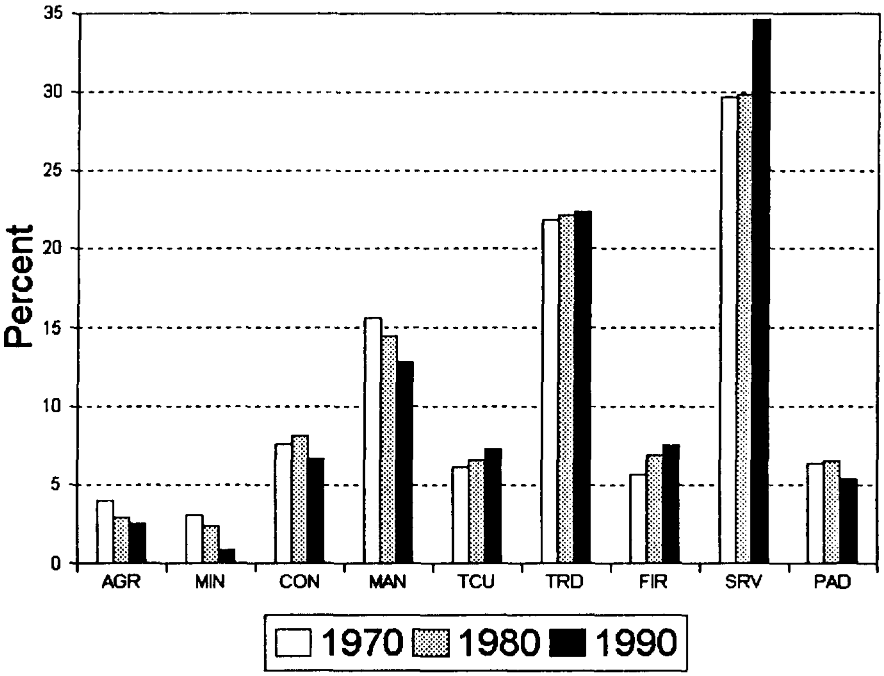

Figure 1 Percent changes of sectoral employment in Arizona, 1970–90.

from 1970 to 1990. The total employment was disaggregated by nine major industrial sectors: Agriculture (AGR), Mining (MIN), Construction (CON), Manufacturing (MAN), Transportation, Communications, and Public. Utilities (TCU), Wholesale Trade and Retail Trade (TRD), Finance, Insurance, and Real Estate (FIR), Services (SRV), and Public Administration (PAD). The percent distributions of sectoral employment are also graphically displayed in Figure 1.

Among the nine sectors, continuously growing sectors, in terms of percentage, from 1970 to 1990 are TCU, TRD, FIR, and SRV. Most notably, the services sector (SRV) holds the largest portion of the total employment and its percentage increased greatly during the 1980s. On the other hand, continuously decreasing sectors in terms of percentage are AGR, MIN, and MAN. For CON and PAD, the percentages increased during the 1970s but decreased during the 1980s. These growth patterns represent the general picture of the industrial structure of Arizona. Reflecting the recent post-industrial trend of urban society, the manufacturing sector (MAN) decreased and FIR and SRV increased in percentage. Additionally, the increasing immigration of the elderly contributed to the rapid rowth of the FIR and SRV sectors. The ariculture sector (AGR) must have been affected by the urbanization trend due to the rapid population increase in Arizona. The decrease in the percentage of the mining sector (MIN) is mainly due to the declining copper mining industry in Arizona. The construction sector (CON) was booming during the 1970s because of the demand of the rapidly increasing population for new housing, but construction slowed down during the 1980s.

The change rates of sectoral employment offer somewhat different perspectives on Arizona's industrial structure. During 1970–1980 period, all the sectors except AGR, MIN, and MAN grew faster than the state total employment. Of all sectors, the growth rate of FIR, 1.197, was highest. During the period from 1980-1990, only four sectors, TCU, TRD, FIR, and SRV, grew faster than the total employment. Among them, SRV showed the highest gowth rate. Though all other sectors increased in absolute number of employment during the 1970-1990 period, only the mining sector decreased in absolute number. Such changing patterns of

Table 2. Clustering of Arizona Towns based on Industrial Structure, 1970-1990.

Cluster	1970	1980	1990
Diversified Manufacturing Towns	Chandler Cottonwood Douglas Glendale Mesa Phoenix Scottsdale	Chandler Douglas Glendale Mesa hoenix Scottsdale Tempe	Casa Grande Chandler Glendale Mesa Peoria Phoenix Scottsdale Tempe
Diversified Towns	Benson Tucson Case Grande Coolidge Flagstaff Prescott South Tucson	Casa Grande Cottonwood Flagstaff Nogales Prescott Tucson	Cottonwood Tucson Flagstaff ' Willcox Kingman Nogales Prescot South Tucson
Trade & Service Towns	Holbrook Kingman Nogales Safford Wickenburg Willcox Yuma	Benson Bisbee Coolidge Holbrook Kingman Safford	Ajo Coolidge Douglas Holbrook Safford Wickkenburg Yuma
Diversifying Agricultural Towns		Peoria Tolleson	Avondale Eloy Buckeye Tolleson
Agricultural Towns	Avondale Eloy Buckeye Peoria El Mirage Tolleson	Avondale Eloy Buckeye El Mirage	El Mirage
Mining Towns	Ajo Kearny Bisbee Miami Clifton San Manuel Globe Superior	Ajo Miami Clifton San Manuel Globe Superior Kearny	Clifton San Manuel Globe Superior Kearny Miami
Transportation Towns	Winslow	Winslow	Benson
Suburban Residential Towns	Paradise Valley Sun City Tempe	Paradise Valley Sun City	Paradise Valley Sun City
Government Towns	San Carlos Sierra Vista	San Carlos Sierra Vista	Bisbee San Carlos Sierra Vista
Military Base	Luke AFB	Luke AFB	Luke AFB

the industry-mix reflect mainly the national economic restructuring where tertiary sectors have become more important since the 1960s.

2) Cluster Analysis of Arizona Towns

To understand better the functional variations of Arizona towns, this study also analyzed the industrial employment composition of these towns for 1970, 1980, and 1990 usin the cluster analysis method. The cluster analysis enabled this study to compare employment data from all industrial sectors simultaneously and establish relatively similar subgroups of towns in terms of the industrial structure. The clustering rule adopted in this study is the average linkage between the groups method with squared Euclidean distance measure, with which the distance between two towns is obtained first by calculating each sector's percentage of total employment for each town and then by summing the squared differences of percentage between two towns for all the sectors. Table 2 shows the interpreted results of cluster analysis with the same 42 Arizona towns for 1970, 1980, and 1990. Since raw results from the analysis show only the clustering tendency with the merging steps, the interpretation of the results requires considerable judgement, especially when we label the clustering groups. Therefore, the labels for town groups shown in Table 2 do not imply the definition of the groups but the central tendency of clustering.

The most apparent changes in town groupings between 1970 and 1980 were that agricultural towns like Peoria and Tolleson became diversifying agricultural towns and that Bisbee, a mining town, became a trade and service town. While rapid suburbanization is the main reason for the functional changes in Peoria and Tolleson, towns which are located in the suburbs of Phoenix, the closure of copper mines was the reason for the functional change of Bisbee. Tempe's shift from a suburban residential town to a diversified manufacturing town is also remarkable. Nogales, which had been a traditional border trade town for Mexican visitors, became a diversified town because of the increasing manufacturing function. Many manufacturing firms in Nogales are operated under the twin plant system which involves the maquiladora operation in Mexican border areas (Pavlakovich and Kim, 1990). In the case of Cottonwood, which was oriented toward manufacturing in 1970, the high increase of trade and service employment along with the rapidly growing population contributed to make this town a diversified service center for the outlying areas. Note also that most diversified manufacturing towns are located in the Phoenix metropolitan area.

During the 1980-1990 period, the functional changes in the Arizona urban system continued in the almost same direction as that of the 1970s. Continuing population influx accelerated the functional shift of the agricultural towns around the Phoenix area ; most agricultural towns became diversifying agricultural towns. Peoria, in fact, eliminated virtually all agricultural traces and became a diversified manufacturing town. Ajo, an old copper mining town, finally became a trade and service town, and Bisbee, which is a county seat, became more governmental service-oriented. Douglas, which had been a manufacturing town accommodating many twin plants, gradually became a trade and service town because of the closures of some manufacturing plants. Benson has declined in population and employment since 1980 and its railroad service function has become relatively more important to the town's economy.

3) Shift-Share Analyses of Arizona Towns

In order to examine the effects of the sate economic structure on changes in the employment structure of towns in Arizona and the sectoral competitiveness of those towns, this study adopted Arcelus' exten-

Table 3. Shift-Share Analysis of Arizona Towns, 1970-80 and 1980-90

No	Town	Components of Change 1970-1980*				Components of Change 1980-1990				1990 Employment
		d	*g*	*m*	*c*	*d*	*g*	*m*	*c*	
1	Ajo	-3.9	1586	-427	-1199	-1238	843	-438	-1642	674
2	Avondale	1264	1363	-152	52	2870	1296	-123	1697	5,811
3	Benson	556	721	-1	-164	-263	636	-23	-866	1,190
4	Bisbee	-314	2254	-222	-2346	-48	1083	1	-1132	2,410
5	Buckeye	466	761	-76	-219	463	618	-44	-110	1,865
6	Casa Grande	2200	3091	-67	-824	2165	2645	-266	-214	8,167
7	Chandler	7843	3775	-72	4139	34795	5503	-180	29472	47,282
8	Clifton	-241	1390	-277	-1354	-488	647	-658	-477	981
9	Coolidge	823	1288	-72	-393	-79	1061	-5	-1134	2,328
10	Cottonwood	494	734	-17	-223	588	616	21	-49	1,985
11	Douglas	591	2915	-43	-2281	-533	1840	-192	-2181	3,643
12	El Mirage	500	689	-146	-42	571	594	-69	47	1,918
13	Eloy	482	1296	-190	-624	198	915	-132	-585	2,274
14	Flagstaff	6408	7983	315	-1890	6684	7151	899	-1366	22,911
15	Glendale	30432	10557	-74	19949	30193	19134	475	10584	73,610
16	Globe	1	2089	-151	-1937	-75	1133	-610	-597	2,495
17	Holbrook	870	1332	69	-531	-472	1106	17	-1594	2,037
18	Kearny	5	872	-228	-64	-229	475	-335	-369	849
19	Kingman	988	2234	54	-1300	1573	1646	-27	-46	5,309
20	Luke AFB	98	265	0	-167	301	187	33	81	725
21	Mesa	42963	18680	131	24152	69591	29060	548	39982	135,531
22	Miami	-180	881	-127	-934	-245	398	-282	-361	659
23	Nogales	3380	2115	99	1166	1018	2636	36	-1654	7,000
24	Paradise Valley	2275	1986	76	213	680	2079	340	-1740	5,398
25	Peoria	2776	1251	-88	1613	17494	1902	22	15571	21,809
26	Phoenix	136893	187148	5404	-5565	113852	161780	6538	-54467	480,945
27	Prescott	3156	3570	99	-513	2573	3326	354	-1107	10,120
28	Safford	798	1490	-50	-642	-139	1160	-202	-1097	2,492
29	San Carlos	325	363	-33	-5	-156	340	-103	-393	615
30	San Manuel	624	1103	-260	-220	-452	873	-1213	-112	1,529
31	Scottsdale	18252	22150	565	-4463	24783	20051	2099	2633	70,281
32	Sierra Vista	3595	2347	122	1126	5604	-180	-180	2927	12,086
33	South Tucson	20	1394	2	-1376	-287	-22	-22	-1030	1,448
34	Sun City	2299	1181	63	1054	24	381	381	-2010	3,776
35	Superior	157	1198	-344	-696	-675	-777	-777	-617	995
36	Tempe	30520	20777	379	9363	23925	2154	2154	-2943	80,002
37	Tolleson	319	969	-94	-556	299	-21	-21	-346	1,810
38	Tucson	52200	73652	1714	-23166	36909	1846	1846	-27870	179,702
39	Wickenburg	58	794	22	-759	719	40	40	222	1,754
40	Willcox	90	913	1	-824	56	2	2	-481	1,269
41	Winslow	217	2229	158	-2170	242	166	166	-1228	3,201
42	Yuma	2807	10242	318	-7753	6279	17	17	-527	21,684

* *d*=employment change, *g*=growth component, *m*=industry mix component, *c*=competitive component.

sion of shift-share technique. Although his original model was specified using the homothetic employment, this study eliminated the homothetic employment terms from the model because they create additional problem of weights (Herzog and Olson, 1977). Thus, this study employed the following version of Arcelus' model:

$$d_{ij}=g_{ij}+m_{ij}+Rg_{ij}+Rm_{ij} \quad (7)$$

where $c_{ij}=Rg_{ij}+Rm_{ij}$
$Rg_{ij}=E_{ij}\,(r_{oj}-r_{oo})$
$Rm_{ij}=E_{ij}\,[(r_{ij}-r_{oj})-(r_{io}-r_{oo})]$.

The data set consists of employment data of 9 industrial sectors for 42 urban places in Arizona, compiled from the 1970, 1980 and 1990 U.S. census, which is identical with the data set used for the cluster analysis. Since it is almost impossible to obtain the annual sectoral employment data at the town level, this study cannot utilize the dynamic form of shift-share analysis suggested by Barff and Knight (1988). Nor can it adopt the stochastic models because the town-level data does not cover the most rural areas of the state. Rather, this study employs the static approach utilizing the decennial census publications which furnish a fairly detailed town-level employment data.

The base economy that this study refers to for the shift-share model is the economy of the state of Arizona, and not the nation. The reason for this arrangement is that the towns in Arizona are assumed to be affected by the state's economic structure far more than the nation's. Since, as mentioned earlier, Arizona's economy has grown much faster than the U.S. economy, it is reasonable to choose the state for the base economy in this study of Arizona towns, so as to examine the competitiveness of the economies of those towns compared to the fast-growing state economy.

The summarized results obtained from the shift-share analyses are displayed in Table 3. This table shows the magnitudes of three component effects on the total employment changes of 42 individual towns in Arizona, which were computed for two periods, 1970-1980 and 1980-1990, and aggregated from sectoral component effects. During the period between 1970-1980 only four mining towns declined in overall employment, while during the period between 1980-1990 some 15 towns declined in total employment. Though many towns gained employment during those periods, it is revealed that for a number of cases the increases of employment are due mainly to the state growth effect, and not the structural compertitiveness of the towns, considering the many cases of negative industry-mix and competitive effects.

In order to understand better the relation of industrial structure and competitiveness of towns, a grouping procedure was required. As suggested by Dunn (1960, p.107), grouping towns into six categorical types according to the possible combinations of industry-mix and competitive effects offers insights into the sources of regional employment changes. Table 4 illustrates such possible categorical types. Applying this typology, the results of the shift-share analyses shown in Table 3 were further analyzed by sorting the towns in accordance with the categorical types. Table 5 shows the rearranged distribution of towns and the coefficients for the net shift, industry-mix, and competitive effects. The coefficients were displayed instead of the absolute employment numbers in order to compare the pure change effects not affected by the urban employment size.

Accidentally, there was no type III town characterized by positive net shift, positive mix and negative competitive effects. It is noted from Tabel 5 that for a number of towns, component sources of employment changes during 1980-1990 became different from those during 1970-1980. In fact, for type I and II towns, only Mesa and Chan-

Table 4. Possible Combinations of Industry-Mix and Competitive Effects

Type	Net Shift ($m+c$)	Industry Mix (m)	Competitive (c)
I	+	+	+
II	+	−	+
III	+	+	−
IV	−	−	+
V	−	+	−
VI	−	−	−

Table 5. Categorical Types and Shift-Share Coefficients, 1970-80 and 1980-90

Type	Town	1970-1980		
		Net Shift	*m*	*c*
I	Mesa	1.057	0.006	1.051
I	Nogales	0.486	0.038	0.448
I	Paradise Valley	0.118	0.031	0.087
I	Sierra Vista	0.432	0.042	0.390
I	Sun City	0.769	0.044	0.726
I	Tempe	0.381	0.015	0.366
II	Chandler	0.876	−0.015	0.891
II	Glendale	1.531	−0.006	1.536
II	Peoria	0.991	−0.057	.048
IV	Avondale	−0.059	−0.090	0.031
V	Flagstaff	−0.160	0.032	−0.117
V	Holbrook	−0.282	0.042	−0.164
V	kingman	−0.453	0.019	−0.192
V	Phoenix	−0.218	0.023	−0.242
V	Prescott	−0.094	0.023	−0.256
V	Scottsdale	−0.143	0.021	−0.324
V	South Tucson.	−0.801	0.001	−0.473
V	Tucson	−0.237	0.019	−0.615
V	Wickenburg	−0.754	0.023	−0.734
V	Willcox	−0.733	0.001	−0.792
V	Winslow	−0.34	0.058	−0.776
V	Yuma	−0.590	0.025	−0.803
VI	Ajo	−0.833	−0.219	−0.614
VI	Benson	−0.186	−0.001	−0.185
VI	Bisbee	−0.926	−0.080	−0.846
VI	Buckeye	−0.315	−0.082	−0.234
VI	Casa Grande	−0.234	−0.018	−0.217
VI	Clifton	−0.954	−0.162	−0.792
VI	Coolidge	−0.293	−0.045	−0.248
VI	Cottonwood	−0.266	−0.019	−0.247
VI	Douglas	−0.648	−0.012	−0.636
VI	El Mirage	−0.223	−0.173	−0.050
VI	Eloy	−0.511	−0.119	−0.391
VI	Globe	−0.813	−0.059	−0.754
VI	Kearny	−0.808	−0.212	−0.596
VI	Luke AFB	−0.512	−0.000	−0.512
VI	Miami	−0.979	−0.117	−0.862
VI	Safford	−0.378	−0.027	−0.350
VI	San Carlos	−0.084	−0.073	−0.011
VI	San Manuel	−0.353	−0.191	−0.162
VI	Superior	−0.706	−0.234	−0.473
VI	Tolleson	−0.545	−0.079	−0.466
	Average	−0.219	−0.039	−0.180
	Std. Dev.	0.590	0.079	0.565

Type	Town	1980-1990		
		Net Shift	*m*	*c*
I	Glendale	0.255	0.011	0.244
I	Luke AFB	0.269	0.079	0.190
I	Mesa	0.615	0.008	0.606
I	Peoria	3.614	0.005	3.609
I	Scottsdale	0.104	0.046	0.058
I	Wickenburg	0.254	0.039	0.215
II	Avondale	0535.	−0.042	0.577
II	Chandler	2.346	−0.014	2.360
II	Sierra Vista	0.424	−0.028	0.452
IV	El Mirage	−0.017	−0.052	0.035
V	Bisbee	−0.460	0.000	−0.461
V	Cottonwood	−0.020	0.015	−0.035
V	Flagstaff	−0.029	0.055	−0.084
V	Holbrook	−0.629	0.007	−0.635
V	Nogales	−0.271	0.006	−0.277
V	Paradise Valley	−0.297	0.072	−0.369
V	Phoenix	−0.131	0.018	−0.148
V	Prescott	−0.100	0.047	−0.147
V	Sun City	−0.434	0.101	−0.536
V	Tempe	−0.014	0.038	−0.052
V	Tucson	−0.182	0.013	−0.195
V	Willcox	−0.395	0.002	−0.396
V	Winslow	−0.359	0.056	−0.415
V	Yuma	−0.033	0.001	−0.034
VI	Ajo	−0.088	−0.229	−0.859
VI	Benson	−0.616	−0.016	−0.600
VI	Buckeye	−0.110	−0.032	−0.079
VI	Casa Grande	−0.080	−0.044	−0.036
VI	Clifton	−0.773	−0.448	−0.325
VI	Coolidge	−0.474	−0.002	−0.471
VI	Douglas	−0.568	−0.046	−0.522
VI	Eloy	−0.345	−0.064	−0.282
VI	Globe	−0.470	−0.237	−0.232
VI	Kearny	−0.653	−0.311	−0.342
VI	Kingman	−0.020	−0.007	−0.012
VI	Miami	−0.712	−0.312	−0.400
VI	Safford	−0.494	−0.077	−0.417
VI	San Carlos	−0.643	−0.133	−0.510
VI	San Manuel	−0.669	−0.612	−0.056
VI	South Tucson	−0.606	−0.013	−0.593
VI	Superior	−0.855	−0.477	−0.378
VI	Tolleson	−0.243	−0.014	−0.229
	Average	−0.104	−0.062	−0.042
	Std. Dev.	0.798	0.156	0.759

Table 6. Competitive Components of Sectoral Employment for Arizona Towns, 1970–1980.

Type	Town	AGR	MIN	CON	MAN	TCU	TRD	FIR	SRV	PAD
		c Rg Rm	*c Rg Rm*	*c Rg Rm*	*c Rg Rm*	*c Rg Rm*	*c Rg Rm*	*c Rg Rm*	*c Rg Rm*	*c Rg Rm*
I	Mesa	+ + −	+ + −	+ + +	+ + −	+ + +	+ + +	+ + +	+ + −	+ + −
I	Nogales	+ + +	− + −	− + −	+ + +	+ + +	− + −	+ + −	+ + +	+ + +
I	Paradise Valley	− + −	− + −	+ + +	− + −	+ + +	+ + +	+ + +	+ + −	− + −
I	Sierra Vista	+ + +	+ + +	+ + +	+ + +	− + −	+ + +	+ + +	+ + +	− + −
I	Sun City	− + −	− + −	− + −	− + −	+ + +	+ + +	+ + −	+ + +	− + −
I	Tempe	+ + +	− + −	+ + −	+ + +	+ + +	+ + +	+ + +	+ + −	+ + +
II	Chandler	+ + +	+ + −	+ + +	+ + +	+ + +	+ + −	+ + +	+ + −	− + −
II	Glendale	− + −	+ + −	+ + +	+ + −	+ + +	+ + +	+ + +	+ + −	+ + +
II	Peoria	− + −	+ + −	+ + −	+ + −	+ + +	+ + +	+ + +	+ + +	+ + +
IV	Avondale	− − −	− − −	+ − +	− − −	+ − +	− − −	+ − +	+ − +	− − −
V	Flagstaff	+ − +	+ − +	− − −	+ − +	− − −	+ − +	− − −	− − −	− − −
V	Holbrook	− − −	+ − +	+ − +	− − −	− − −	− − −	− − +	− − −	− − +
V	Kingman	− − +	+ − +	− − −	− − +	− − −	− − −	− − +	− − −	+ − +
V	Phoenix	+ − +	+ − +	− − +	− − −	− − +	− − −	− − −	− − −	− − +
V	Prescott	+ − +	+ − +	− − −	− − −	− − −	− − −	+ − +	− − +	− − +
V	Scottsdale	+ − +	+ − +	− − −	− − −	− − +	− − −	+ − +	+ − +	− − −
V	South Tucson	− − +	− − +	− − +	− − +	− − −	− − −	− − −	− − +	− − +
V	Tucson	+ − +	− − +	− − −	+ − +	− − −	− − +	− − −	− − −	− − −
V	Wickenburg	− − +	− − +	− − +	− − +	− − −	− − −	− − +	− − +	− − +
V	Willcox	− − +	− − +	− − +	− − +	− − −	− − −	− − +	− − +	− − −
V	Winslow	+ − +	− − −	− − +	− − −	− − −	− − −	− − +	− − +	− − +
V	Yuma	+ − +	− − +	− − −	− − +	− − −	− − −	− − −	− − −	− − −
VI	Ajo	− − +	− − −	− − +	+ − +	− − −	− − +	− − −	− − +	+ − +
VI	Benson	+ − +	+ − +	− − −	− − −	− − −	+ − +	− − −	+ − +	− − −
VI	Bisbee	− − +	− − −	+ − +	− − −	− − −	− − +	− − +	− − +	− − +
VI	Buckeye	− − −	− − −	+ − +	− − +	+ − +	− − −	− − −	− − −	− − −
VI	Casa Grande	− − +	+ − +	− − −	− − +	− − −	− − −	− − +	− − −	− − +
VI	Clifton	− − +	− − +	− − −	+ − +	− − +	− − −	− − +	− − +	+ − +
VI	Coolidge	− − −	+ − +	− − −	− − −	+ − +	− − −	− − −	− − +	+ − +
VI	Cottonwood	− − −	− − −	− − −	− − −	+ − +	+ − +	− − −	+ − +	+ − +
VI	Douglas	− − +	+ − +	− − +	− − +	− − −	− − −	− − −	− − −	− − +
VI	El Mirage	− − −	− − −	− − −	+ − +	− − −	+ − +	+ − +	− − +	− − −
VI	Eloy	− − +	+ − +	− − −	− − +	− − +	− − −	− − +	− − −	+ − +
VI	Globe	− − +	+ − +	− − −	− − −	− − +	− − −	− − +	− − +	− − +
VI	Kearny	− − −	− − +	− − −	+ − +	− − −	− − +	+ − +	− − −	− − −
VI	Luke AFB	− − −	0 0 0	− − −	− − −	− − −	− − −	+ − +	− − +	+ − +
VI	Miami	+ − +	− − +	− − −	− − −	− − +	− − −	− − +	− − +	− − +
VI	Safford	− − +	+ − +	− − −	− − −	− − −	− − −	− − +	− − +	+ − +
VI	San Carlos	− − −	− − −	+ − +	+ − +	− − −	− − −	− − −	+ − +	+ − +
VI	San Manuel	+ − +	+ − +	− − −	− − −	− − −	− − −	+ − +	− − +	− − −
VI	Superior	− − +	− − +	− − +	+ − +	− − +	− − −	+ − +	− − −	− − +
VI	Tolleson	− − −	− − −	− − +	− − +	− − −	− − +	− − +	− − +	− − +

Table 7. Competitive Components of Sectoral Employment for Arizona Towns, 1980−1990

Type	Town	AGR	MIN	CON	MAN	TCU	TRD	FIR	SRV	PAD
		c Rg Rm	*c Rg Rm*	*c Rg Rm*	*c Rg Rm*	*c Rg Rm*	*c Rg Rm*	*c Rg Rm*	*c Rg Rm*	*c Rg Rm*
I	Glendale	− + −	− + −	+ + −	+ + −	+ + −	+ + −	+ + +	+ + +	+ + +
I	Luke AFB	+ 0 +	0 0 0	+ + +	− + −	+ + +	+ + −	+ + +	− + −	+ + +
I	Mesa	+ + +	+ + −	+ + −	+ + +	+ + +	+ + −	+ + −	+ + +	+ + −
I	Peoria	− + −	+ + −	+ + −	+ + −	+ + +	+ + +	+ + +	+ + +	+ + +
I	Scottsdale	+ + −	+ + +	+ + +	− + −	+ + +	− + −	+ + +	+ + +	+ + −
I	Wickenburg	+ + +	+ + −	+ + +	+ + +	+ + −	− + −	+ + +	− + −	+ + +
II	Avondale	− + −	+ + −	− + −	+ + +	+ + +	+ + +	+ + +	+ + +	+ + −
II	Chandler	+ + −	− + −	+ + −	+ + −	+ + −	+ + −	+ + −	+ + +	+ + −
II	Sierra Vista	+ + +	+ + +	+ + +	+ + +	+ + −	+ + +	− + −	+ + +	+ + −
IV	El Mirage	− − −	− − −	+ − +	− − −	+ − +	− − −	+ − +	+ − +	− − −
V	Bisbee	+ − +	+ − +	− − +	− − −	− − −	− − −	− − +	− − −	− − +
V	Cottonwood	+ − +	− − −	+ − +	− − −	+ − +	− − +	+ − +	− − −	− − −
V	Flagstaff	− − −	+ − +	+ − +	− − −	− − −	− − −	+ − +	− − −	+ − +
V	Holbrook	+ 0 +	+ − +	− − −	+ − +	− − −	− − −	− − −	− − +	− − +
V	Nogales	− − −	+ − +	− − +	− − +	− − −	+ − +	− − −	− − −	− − −
V	Paradise Valley	+ − +	− − −	− − −	− − −	− − −	− − −	− − −	− − −	+ − +
V	Phoenix	+ − +	+ − +	− − −	− − −	− − −	− − −	− − +	− − +	− − +
V	Prescott	− − −	− − −	+ − +	+ − +	− − −	+ − +	− − −	− − −	− − −
V	Sun City	+ − +	+ − +	+ − +	− − +	− − −	− − −	− − −	− − −	− − +
V	Tempe	+ − +	+ − +	+ − +	− − −	+ − +	− − −	− − −	− − −	+ − +
V	Tucson	+ − +	− − −	− − −	− − +	− − −	− − +	− − −	− − −	− − +
V	Willcox	− − +	− − −	− − +	+ − +	− − −	− − +	− − −	− − −	− − −
V	Winslow	+ − +	+ 0 +	− − −	− − +	− − −	− − +	− − −	− − −	+ − +
V	Yuma	− − −	+ − +	− − −	+ − +	− − −	− − −	− − −	+ − +	+ − +
VI	Ajo	+ − +	− − +	− − +	− − −	− − +	− − +	+ − +	− − +	− − +
VI	Benson	− − +	− − +	+ − +	− − −	− − +	− − −	+ − +	− − +	− − −
VI	Buckeye	+ − +	− − −	− − −	+ − +	− − −	− − −	+ − +	+ − +	+ − +
VI	Casa Grande	− − −	− − −	− − +	+ − +	+ − +	+ − +	− − −	− − −	+ − +
VI	Clifton	+ − +	+ − +	+ − +	− − −	− − +	− − +	− − +	− − +	− − −
VI	Coolidge	+ − +	+ − +	+ − +	+ − +	− − −	− − +	− − +	− − −	− − +
VI	Douglas	− − +	− − +	− − +	− − −	+ − +	− − +	− − +	− − −	− − +
VI	Eloy	− − −	− − −	+ − +	+ − +	− − −	− − +	− − −	− − −	− − −
VI	Globe	− − −	+ − +	− − −	− − −	− − −	− − +	− − −	− − +	− − +
VI	Kearny	+ 0 +	+ − +	− − +	− − −	+ 0 +	− − −	− − −	− − +	+ − +
VI	Kingman	+ − +	− − −	+ − +	+ − +	+ − +	− − −	+ − +	− − −	− − −
VI	Miami	− − +	− − +	− − +	− − −	+ − +	− − +	− − +	− − −	− − +
VI	Safford	− − −	+ − +	− − −	+ − +	− − +	− − −	− − −	− − +	− − +
VI	San Carlos	− − +	− − +	+ − +	− − −	+ − +	+ − +	+ − +	− − +	− − −
VI	San Manuel	− − −	− − +	+ − +	+ − +	+ − +	− − +	− − −	− − +	+ − +
VI	South Tucson	− − +	− − +	− − +	− − +	− − −	− − +	+ − +	− − −	− − −
VI	Superior	+ − +	− − +	− − +	+ − +	− − +	− − −	− − −	− − +	+ − +
VI	Tolleson	− − −	0 0 0	+ − +	+ − +	+ − +	− − −	+ − +	− − −	− − +

dler remained in the same type, respectively. These categorical changes indicate that there were substantial changes in industrial structures of both the state and its urban system between the 1970s and the 1980s.

As a whole, the industrial competitiveness of Arizona towns improved during the last 20 years. As seen in Table 5, the average coefficient of competitive effects became higher from −0.18 of 1970–1980 to −0.042 of 1980–1990, though still remained negative. Subsequently, the average net-shift coefficient also improved in spite of the weakened average mix coefficient. Although the high competitive cofficients of Peoria and Chandler affected the average values and the standard deviations severely, the direction of average coefficient change is the same even if we remove the two cities from the table. Without Peoria and Chandler, the average coefficient of competitive effects changes from −0.237 of 1970–1980 to −0.194 of 1980–1990, and the standard deviation changes from 0.515 of 1970–1980 to 0.324 of 1980–1990.

When we compate the town types in Table 5 with the town clusters in Table 2, the relationship between the functional structure of the towns and the growth of the towns is revealed to some extent. In general, most type I and II towns showing positive competitive effects and positive net shift effects are either diversified, diversified-manufacturing, or suburban residential towns, while most specialized towns such as agricultural and mining towns and some trade and service towns are grouped into type VI, showing negative competitive and industry-mix effects. In other words, diversified and diversified-manufacturing towns included in type I maintained favorabel industrial structure based on fast-growing industries of the state and also grew faster than expected because they had more competitive industries. On the other hand, agricultural and mining towns and trade and service towns in type VI did not have favorable industrial structure, a result attributable to their lack of many competitive industries. Also, it is noted that except for Nogales and Sierra Vista, all towns included in type I, II and IV, where competitive effects are all positive, are located in the Metropolitan Phoenix area.

In order to supplement these statements and to obtain a detailed picture of variations in shift-share components, two tables illustrating the results of shift-share analyses for sectoral employment growth of each town are presented. Table 6 and Table 7 represent the competitive effects, c_{ij}, with two subcomponents, regional growth effect, Rg_{ij}, and regional industry-mix effect, Rm_{ij}, for each sector during 1970–1980 and 1980–1990, respectively. To make the interpretation simple and easy these tables display the results with signs instead of numbers. The industry-mix component was omitted from these tables because the results can be inferred from Table 1 which shows change rates of sectoral employment in Arizona, where the marked sectors would have positive signs in the industry-mix effects for all towns. In other words, for the period 1970–1980 all sectors would show positive mix effects, and for the periode 1980–1990 only TCU, TRD, FIR and SRV except AGR, MIN and MAN would show positive mix effects.

While in this study the regional growth effect, Rg_{ij}, refers to the difference between a town's growth rate and the state's growth rate, the regional industry-mix effect, Rm_{ij}, mesaures the competitive advantage of a sector in a town compared to that of the same sector in the state. The signs of competitive effects in individual sectors reflect the pattern of regional (in this study, a town's) competitiveness, which is the main pursuit of shift-share analysis.

As seen in Tables 6 and 7, however, the sign combinations of the regional industry-mix effect, denoted as Rm and the competitive effect, c, can vary for each sector, even in the same type of town. For example, Mesa ahd positive regional industry-mix effects in CON, TCU, TRD, and FIR during the 1970-1980 period and in AGR, MAN, TCU, and SRV during the 1980-1990 period, though the city had positive competitive effects and positive regional growth effects for all sectors for both periods. In the case of Tucson, the pattern is more complex. Tucson's competitiveness was better than the state's in the sectors of AGR, MIN, MAN, and TRD during 1970-1980 and AGR, MAN, TRD, and PAD during 1980-1990, but Tucson's competitive effects were positive only in AGR and MAN during 1970-1980 and AGR during 1980-1990 because Tucson's total growth was slower than the state's for both periods.

Oon interesting feature of Tables 6 and 7 is that all type I and II towns have grown faster than the state in terms of the change rate of total employment as we see the positive signs of the regional growth effects, ***Rg***, for all sectors of those towns (except for a few zero signs), and this fact contributed to the type I and II towns being competitive (positive) in many sectors and positive in aggregated competitive effects. For the towns of type IV, V, and VI, the signs of the regional growth effects are all negative for all sectors (except for a few zero signs).

In order to compare the sectoral competitiveness of Arizona towns for the 1970-1980 period with that for the 1980-1990 period, the numbers of positive coefficients

Table 8. Comparison of Competitiveness by Sector and Town Type, 1970-80 and 1980-90

Sector	Period	Nos. of "+" coeff.			Town Type	Period	Average "+" sectors			
		c	*Rg*	*Rm*			N	*c*	*Rg*	*Rm*
AGR	1970-80	15	9	27	I	1970-80	6	6.5	9	4.8
	1980-90	22	8	26		1980-90	6	7.3	8.7	4.5
MIN	1970-80	20	9	24	II	1970-80	3	8	9	5
	1980-90	20	8	24		1980-90	3	7.7	9	4
CON	1970-80	12	9	19	IV	1970-80	1	4	0	4
	1980-90	22	9	28		1980-90	1	4	0	4
MAN	1970-80	15	9	22	V	1970-90	12	1.8	0	4.9
	1980-90	20	9	22		1980-90	14	2.8	0	4.3
TCU	1970-80	12	9	19	VI	1970-80	20	2.1	0	5
	1980-90	20	9	21		1980-90	18	2.9	0	5.9
TRD	1970-80	12	9	16						
	1980-90	11	9	20						
FIR	1970-80	17	9	28						
	1980-90	18	9	21						
SRV	1970-80	14	9	25						
	1980-90	10	9	21						
PAD	1970-80	14	9	26						
	1980-90	19	9	26						
Average	1970-80	14.6	9.0	22.9	Average	1970-80	42	3.1	1.9	4.9
	1980-90	18.0	8.8	23.2		1980-90	42	3.9	1.9	5.0

in sectoral competitive components shown in Table 6 and 7 were counted and summarized in Table 8. While there is no substantial difference between the two periods in the sectoral regional growth effect, ***Rg***, there are noticeabel differences between the two periods in the sectoral regional industry-mix effect, ***Rm***, and the sectoral competitive effect, ***c***, In general, Arizona towns were more competitive in the 1980-1990 period than in the 1970-1980 period in the sectors of AGR, CON, MAN, TCU, FIR, and PAD, while the competitiveness of Arizona towns was more advantageous than the state's in the sectors of CON, TCU, and TRD. The difference in competitive sectors between ***Rm*** and ***c*** is due the various magnitudes of ***Rg*** for each sector of each town, as mentioned earlier. On average, the numbers of towns in positive competitive effect per one sector ard 14.6 for the 1970-1980 period and 18.0 for the 1980-1990 period, although the average numbers of towns in the positive signs of ***Rg*** and ***Rm*** show no substantial differences between the two periods. These results indicate that Arizona towns during the 1980s became competitive in more sectors than during the 1970s.

The comparison of competitiveness by town type also draws conclusions similar to the sectoral comparison. The average number of sectors with positive signs per each town varies in accordance with two groups: one is for town type I and II, and the other is for town type V and VI. On average, towns in type I and II have about 6 to 8 competitive sectors, and towns in tye V and VI have only about 2 to 3 competitive sectors for both periods. While, as mentioned earlier, the regional growth effects, ***Rg***, are positive in all sectors for type I and II towns and all negative for type IV, V and VI towns, the regional industry-mix effects, ***Rm***, are all alike in the level of 4 to 6 sectors for both periods. When we consider the number of competitive sectors and town types, it is again obvious that the town's competitiveness is associated with the functional type of the town. Diversified towns which belong mainly to type I and II tend to have more sectors in a competitive position, and specialized towns which mainly belong to type VI tend to have fewer competitive sectors.

However, the changes of competitiveness between the 1970-1980 period and the 1980-1990 period are quite obvious for the competitive effects. Except for the town type II and IV where a small number of towns were included, the number of competitive sectors increased between the two periods. On average, 3.1 sectors among 9 sectors were competitive during the 1970-1980 period, but during the 1980-1990 period, 3.9 sectors were competitive, which adds almost one more sector to the 1970's competitiveness. These results again confirm that Arizona towns have become more competitive and also indicate that Arizona towns have become more diversified because they are competitive in more sectors than before. More specific discussion of diversification is presented in the next section.

4) Industrial Diversification

As seen from the results of shift-share analyses, the level of industrial diversification seems to be associated with the size of towns. In relation to industrial specialization and diversification, there have been two research themes: one is the measurement of industrial specialization or diversification (Parr, 1965; Bahl, Firestine, and Phares, 1971; Marshall, 1975), and the other is the association of industrial diversification with other regional aspects (Clemente and Sturgis, 1971; Gilmour and Murricane, 1973; Marshall, 1989; Gilchrist and St. Louis, 1991; Bagchi-Sen and Pigozzi, 1993). Current measurement methods of industrial specialization are largely originated from two devices: one is the classical method developed by Lorenz and Gini in the early 20th century, which is usually called the Gini index of concentration, and other is the coefficient of specialization initiated by P.S. Florence (1943, pp.120-21, cited by Parr, 1965, p.21).

The Gini index of town j, G_j, is given by

$$G_j = 10^{-4} \sum_{i=1}^{n-1} | X_i Y_{i+1} - X_{i+1} Y_i | \quad (8)$$

where X_i denotes the coumulative percentages of industry i ranked by their location quotients for the town j, y_i denotes the cumulative percentages of industry i ranked by their location quotients for a reference region, and n denotes the number of industry categories (Marshall, 1975 ; 1989, p.119).

The coefficient of specialization for town j, S_j, can be formulated as

$$S_j = 10^{-2} \sum_{i=1}^{n} | X_{ij} - Y_i |)/2 \quad (9)$$

where X_{ij} is the percentage which industrial sector i makes up in the total employment of town j, Y_i is the percentage which sector i makes up in the total employment of a reference region (Arizona in this study), and n is the number of industry categories ($n=9$ in this study) (Marshall, 1975 ; Hoover and Giarratani, 1984, pp.262-263). Here, a coefficient of zero indicates perfect diversification and a coefficient of 1 (or 100 percent) indicates perfect specialization. The Gini index also has the same range of coefficients.

In fact, the Gini index of concentration is identical with the proportion of the area on a Lorenz diagram which falls between the Lorenz curve and the diagonal (Bowman, 1945), and the coefficient of specialization is identical with the maximum vertical distance between the corresponding Lorenz curve and the diagonal that is expressed as a percentage of the total height of the diagram (Marshall, 1975). Thus, it is expected that the Gini index and the coefficient of specialization are highly correlated. Empirically, the correlation coefficient between the two measures has been as high as 0.986 for 108 Canadian cities in 1961 (Marshall, 1975), and 0.98 for 268 U.S. and Canadian cities in 1970 and 1971 (Marshall, 1988). Therefore, there was no need to use both methods to measure the level of industrial specialization, and this study chose one measure, the coefficient of specialization method, which is the simpler to calculate. The results obtained from this method are utilized to test the relevancy of industrial diversification to time, town type, urban size, and urban location.

The coefficients of specialization of 42 Arizona towns for 1970, 1980, and 1990 are presented in Tabel 9 in percentage form. The average coefficients of specialization dropped from 22.0 in 1970, to 20.9 in 1980 to 17.1 in 1990, and the standard deviations declined from 13.0 in 1970 to 12.8 in 1980 to 9.5 in 1990. From these results, it is clear that the economies of Arizona towns became increasingly diversified and also became increasingly similar over time. The diversification trend seemed even to accelerate considering that the average change rates were −1.1 for the 1970-1980 period and −3.7 for the 1980-1990 period.

In order to see the variations of the specialiation coefficients among the town types proposed in Table 5, average coefficients for each town type of two periods, 1970-1980 and 1980-1990, were also calculated and illustrated in Table 10. During the 1970-1980 period, type II towns (positive competitive and net shift effects, and negative mix effect) were most diversified in both 1970 and 1980. However, this result cannot be generalized, considering that there are only 3 cases in town type II. If type I and type II towns, where both competitive and net shift effects are positive, are combined (N=9), the average coefficients become 18.0 in 1970 and 14.4 in 1980. In the case of type V towns (negative competitive and net shift effects and positive mix effect), the average coefficients show a higher level of diversification and a little change toward more diversification from 1970 to 1980. On the other hand, type VI towns (negative in both competitive and

Table 9. Coefficients of Specialization in Industry for Arizona Towns, 1970–1990

Town	Sepecialization Coeff.			Change		Town Type	
	1970	1980	1990	1970–80	1980–90	1970–80	1980–90
Glendale	7.6	7.4	5.1	−0.2	−2.3	II	I
Luke AFB	20.3	25.0	15.9	4.7	−9.1	VI	I
Mesa	9.0	8.4	6.2	−0.7	−2.1	I	I
Peoria	17.5	8.0	6.6	−9.5	−1.4	II	I
Scottsdale	13.6	11.4	8.3	−2.2	−3.1	V	I
Wickenburg	22.0	19.7	12.1	−2.3	−7.6	V	I
Avondale	24.4	21.4	16.2	−3.0	−5.3	IV	II
Chandler	12.6	11.1	11.0	−1.6	−0.1	II	II
Sierra Vista	40.5	26.2	20.0	−14.3	−6.2	I	II
El Mirage	34.1	22.8	17.4	−11.3	−5.4	VI	IV
Bisbee	24.7	18.0	21.3	−6.7	3.3	VI	V
Cottonwood	13.1	10.1	14.2	−3.0	4.1	VI	V
Flagstaff	17.7	16.7	13.2	−1.0	−3.4	V	V
Holbrook	21.7	23.0	15.3	1.3	−7.6	V	V
Nogales	27.7	17.5	20.6	−10.2	3.2	I	V
Paradise Valley	18.1	16.7	18.4	−1.4	1.7	I	V
Phoenix	7.7	6.3	3.8	−1.4	−2.6	V	V
Prescott	10.2	12.9	11.8	2.7	−1.1	V	V
Sun City	17.3	24.2	21.3	6.9	−2.9	I	V
Tempe	11.9	10.1	6.9	−1.7	−3.2	I	V
Tucson	10.4	9.8	9.3	−0.6	−0.5	V	V
Willcox	15.9	12.2	15.7	−3.7	3.5	V	V
Winslow	24.4	18.3	16.1	−6.1	−2.2	V	V
Yuma	16.0	15.1	11.4	−0.9	−3.7	V	V
Ajo	52.0	37.6	11.8	−14.4	−25.8	VI	VI
Benson	15.7	12.8	17.6	−2.9	4.8	VI	VI
Buckeye	18.1	24.3	20.2	6.2	−4.1	VI	VI
Casa Grande	7.2	8.5	10.3	1.2	1.9	VI	VI
Clifton	44.4	47.0	45.3	2.5	−1.7	VI	VI
Coolidge	17.6	24.5	20.2	6.9	−4.3	VI	VI
Douglas	9.8	12.3	6.2	2.5	−6.1	VI	VI
Eloy	23.2	26.4	22.4	3.2	−4.0	VI	VI
Globe	18.1	27.0	23.5	8.8	−3.5	VI	VI
Kearny	50.8	37.2	29.9	−13.6	−7.3	VI	VI
Kingman	12.9	10.4	8.8	−25	−1.6	V	VI
Miami	31.1	32.7	27.6	1.6	−5.1	VI	VI
Safford	11.8	18.5	17.9	6.7	−0.6	VI	VI
San Carlos	35.9	36.4	33.2	0.5	−3.1	VI	VI
San Manuel	50.9	67.6	46.9	16.7	−20.7	VI	VI
South Tucson	13.9	16.2	9.8	2.3	−6.4	V	VI
Superior	55.7	51.1	30.9	−4.6	−20.2	VI	VI
Tolleson	16.5	13.7	18.0	−2.9	4.4	VI	VI
Average	22.0	20.9	17.1	−1.1	−3.7		
Std. Dev.	13.0	12.8	9.5	6.3	6.2		

Table 10. Average Specialization Coefficients by Town Types, 1970-80 and 1980-90

1970-80 Town Type	N	1970 Mean	1970 s.d.*	1980 Mean	1980 s.d.
I	6	20.7	10.6	17.2	6.6
II	3	12.5	4.0	8.8	1.6
IV	1	24.4	—	21.4	—
V	12	15.5	4.9	14.3	4.5
VI	20	27.6	15.3	27.7	14.8

1980-90 Town Type	N	1980 Mean	1980 s.d.*	1990 Mean	1990 s.d.
I	6	13.3	6.7	9.0	3.8
II	3	19.6	6.3	15.7	3.7
IV	1	22.8	—	17.4	—
V	14	15.1	4.9	14.2	5.1
VI	18	28.0	15.6	22.2	11.4

• s.d=standard deviation.

mix effects) were most specialized, and the level of specialization did not change substantially from 1970 to 1980.

During the 1980-1990 period, type I towns (positive in both competitive and mix effects) were most diversified in both 1980 and 1990. If type I and type II towns are combined, the average coefficients become 15.4 in 1980 and 11.3 in 1990, which are lower than those in the earlier period. While type V towns show almost the same coefficients as in the 1970-1980 period, type VI towns show a substantial difference from that period in terms of the change level. Though type VI towns were still most spcialized, the level of specialization dropped substantially from 28.0 in 1980 to 22.2 in 1990.

From these results regarding Table 10, we can determine some general relationship between specialization coefficients and the town types. If we ignore the town type IV that includes only one town in both periods, it is clear for both periods that type I, II and V towns showed average coefficients of less than about 20 and that type VI towns showed average coefficients of higer than abotu 20. From this, it is concluded that towns with positive competitive effects or positive industry-mix effects tend to be diversified in terms of industrial structure, and towns with both negative competitive effects and negative mix effects tend to be more specialized. As for the changes of specialization coefficients, it is generally true that towns in all types have become less specialized over time as mentioned earlier from Table 9, although towns in type VI have not become less specialized between 1970 and 1980.

The relevancy of industrial diversification to urban size and location has been another interesting topic with regard to urban industrial structure. Thompson (1965, p.147) has mentioned that "increased city size brings greater in dustrial diversification", a proposition which had been widely accepted for a long time, and Clemente and Sturgis (1971) and Marshall (1975; 1988) have tested the validity of the proposition. Their studies showed that the correlations (γ) between population size and industrial diversification were 0.41 for 535 U. S. communities, 0.55 for 92 U.S. West communities in 1960 (Clemente and Sturgis, 1971), 0.452 for 108 Canadian cities in 1961 (Marshall, 1975) and 0.61 for 268 U.s. and Canadian cities in 1970 and 1971 (Marashall, 1988), although these coefficients depend on the measurement methods of diversification and correlation. For the relationship between diversification and locational factor, Marshall (1988, p.120) argued that "location does not significantly influence the level of diversification attained by any particular city." In relation to these propositions on industrial diversification, this study utilized data on 42 Arizona towns for 1970, 1980, and 1990 to test the correlations between the industrial specialization level and three other variables : population size, employment size, and distance to the nearest metropolitan center (Phoenix or Tucson). Although there is a very strong correlation between town population and

Table 11. Correlations between Industrial Specialization and Town Population, Employment, and Location

	LCS70	LCS80	LCS90
LPOP70	−0.541		
LPOP80		−0.627	
LPOP90			−0.736
LEMP70	−0.551		
LEMP80		−0.641	
LEMP90			−0.740
LDMT	0.273	0.309	0.334

Acronyms indicated as follws:
- LCS70 = Natural log of coefficient of specialization for 1970
- LCS80 = Natural log of coefficient of specialization for 1980
- LCS90 = Natural log of coefficient of specialization for 1990
- LPOP70 = Natural log of town population for 1970
- LPOP80 = Natural log of town population for 1980
- LPOP90 = Natural log of town population for 1990
- LEMP70 = Natural log of town employment for 1970
- LEMP80 = Natural log of town employment for 1980
- LEMP90 = Natural log of town employment for 1990
- LDMT = Natural log of distance to nearest metropolitan center (Phoenix or Tucson)

town employment, urban size was measured by both population and employment here. The results of correlation tests are displyed in Table 11.

In order to obtain the maximum values of correlation coefficients (γ) from the Pearson product-moment correlation method, the data was transformed into natrual log forms. The results indicate that the relationships between the coefficients of specialization and the three variables are not necessarily linear. Both population size and employment size appeared to have moderate to strong negative associations with the specialization coefficients depending on the years. In other words, larger towns in terms of population and employment tend to be less specialized and more diversified in industrial structure. The negative correlation between population (employment) and specialization level becomes stronger from -0.541 (-0.551) in 1970 to -0.627 (-0.641) in 1980 to -0.736 (-0.74) in 1990. This indicates that the proposition depicting the close relationship between urban size and diversification level becomes more true over time. On the other hand, the relationship between diversification and distance to nearest metropolis is not clear as Marshall asserted, becauses the correlations were less than 0.34. However, it is expected, to some extent, that towns located in the metropolitan areas tend to be gradually diversified over time, since the correlation between two variables has been increasing from 0.273 in 1970 to 0.309 in 1980 to 0.334 in 1990.

6. Summary and Conclusions

Cluster analysis of Arizona towns based on sectoral employment composition revealed the changing characteristics of urban functions over time. In particular, agricultural towns and mining towns have undergone a lot of change, because agricultural towns, mostly located in the suburbs of Metropolitan Phoenix, were transformed into residential communities, and mining towns, based on the declining industrial sector, have lost their populations gradually. Although Arizona towns, in general, became more competitive than before, it was also confirmed that most agricultural and mining towns and some trade and service towns in Arizona did not have favorable industrial structure to grow faster, because of their lack of competitive industries. On the other hand, diversified towns tended to grow faster because of their many competitive industries. Thus, the hypothesis that towns specializing in the primary sector tend to decline is generally confirmed in this study.

The level of industrial specialization has become more closely related to urban size in terms of both population and employment, but the relationship between metropolitan location and specialization level is not clear. Thus the proposition that larger towns tend to be more diversified in industrial structure is becoming more valid than before. Also, it is validated in this study that urban economies have become more diversified and, consequently, have become increasingly alike over time.

It is generally accepted that diversified communities can cope with market fluctration more effectively than specialized communities. Although diversification policies are usually formulated to reduce dependence on unstable industries and to enhance economic stability, we need to be cautious in implementation of diversification policies because policies exploiting a comparative advantage by specialization can be more profitable in some cases.

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도시산업구조와 다변화 : 도시경제간의 수렴성향

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본 논문은 도시산업구조의 경쟁력과 특화도, 그리고 그것의 변화특성에 관한 연구이다. 사례지역은 미국 Arizona의 42개 도시로서, 1970년부터 1990년가지의 9개 산업부문을 대상으로 분석하였다. 본 연구에서 설정된 가설은 다음과 같다.

(1) 1차 산업부문에 특화된 도시들은 쇠퇴하기 쉬운 경향이 있다.
(2) 도시의 규모는 산업의 다변화와 밀접한 관련이 있다. 즉 도시규모가 클수록 산업구성에 있어서 다변화되는 경향이 있다.
(3) 대도시까지의 거리는 도시산업의 다변화와 무관하다.
(4) 도시들은 시간이 경과되면서 대체로 더욱 다변화되며, 그래서 도시특성이 상호간에 더욱 유사해진다.

이러한 가설들을 검증하기 위해서 도시산업구성에 대한 클러스터분석(cluster analysis)을 통해서 1970년부터 1980년, 그리고 1990년까지의 도시기능의 변화특성을 살펴보았고 도시기능과 산업구성상의 경쟁력이 관계가 있음이 Arcelus가 변형한 변화·할당모형의 분석을 통해서 확인되었다. 즉 1차산업(농업, 광업)에 특화된 도시들은 경쟁력이 약해서 성장이 지체되는 경향이 나타났다.

특화계수(coefficient of specialization)의 상관분석을 통해서는 산업특화수준이 인구와 고용을 지표로 한 도시규모와 밀접하게 연관이 되어 있어서 큰 도시일수록 산업구성이 다변화되는 것이 확인되었다. 그러나 대도시까지의 거리와 도시의 특화정도의 상관성은 약하게 나타났다. 1970년부터 1990년까지의 특화계수의 변화를 살펴보면, 시간이 경과되면서 도시들은 더욱 다변화하는 경향이 확인되었고, 이것은 결국 도시상호간의 산업구조상의 차별성을 약화시켜서 서로 수렴되는 특성으로 나타난다.

主要語 : 도시산업구조, 경제적 수렴, 변화할당모형, 산업다변화, 도시기능

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