METROPOLITAN INDUSTRIAL MIX AND CYCLICAL EMPLOYMENT STABILITY*

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Diversity, it has been asserted, is one property that is likely to lead an enterprise toward stability. With this in mind investors try to diversify their portfolios, manufacturers try to diversify their product lines, and regions try to diversify their industrial bases. But what, exactly, does diversity mean? Intuitively, it can be thought of as not putting all of one's assets into a single project, but instead distributing them so as to minimize risk. Measuring diversity is difficult, however, especially in the context of regional industrial bases. Some of the methods used in the past to measure industrial diversity will be examined in this paper. As shall be demonstrated, some of these measures are, at times, counterintuitive.

In an attempt to determine the characteristics of industrial mix which are, in fact, related to cylical employment stability, an econometric model will be introduced. This model, which relates proportions of regional workforces employed in specific categories to employment stability over time, shows that concentrations of employment in different categories have differing effects upon cyclical employment stability.

The goal of this analysis is to identify the relationship between regional industrial mix and regional cyclical employment stability. What is meant by "cyclical employment stability" in this analysis is the degree of temporal variation in employment experienced by a firm or a region over the course of a business cycle.

Review of Previous Attempts to Measure Diversity

Past attempts to measure regional industrial diversity can be classified under two headings: indexes of diversity, and the industrial portfolio approach.

Four different indexes of diversity are discussed to show that, in general, there is little theoretical justification for the way in which these indexes have been constructed. It will be shown, in fact, that each index is a measure which conforms solely to the opinions of its author. Each author attempts to define regional industrial diversity and then to operationalize his definition. In each case a different definition or method of operationalization is suggested. Implicit in each of the studies cited is the assumption that, ceteris paribus, a diversified economy is desirable because, presumably, it will be more stable than an undiversified economy. This assumption is never tested or even discussed.

The most serious problem of these indexes, however, is that a single definition of diversity seems unobtainable. Each author appears to have a similar intuitive feel for the term, but who is to determine the proper explicit definition. An examination of the indexes clearly reveals the problem.

Rectangular Distribution Method. The rectangular distribution method of measuring regional industrial diversity is presented most clearly by Bahl, Fires-

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tine, and Phares [2]. According to this model, a perfectly diversified regional economy is one in which each industry class in a region employs an equal proportion of the region's workforce. Any deviation from this "rectangular distribution" of employment across industry classes implies a lack of diversity in a region.

Bahl, Firestine, and Phares measured employment across 39 Standard Industrial Classification (SIC) classes. This set as a norm for employment in each SIC class, 2.56 percent of a region's workforce (100/39=2.56). They calculated, with the following equation, an index of diversity for each region:

$$(1)\quad \text{Index of Diversity} = \sum_{i=1}^{n} \frac{(P_i - E_i)^2}{E_i} \qquad i=1,2,3,\ldots,39$$

where P_i = percent of the region's workforce employed in the $_i$th industry class, and E_i = norm for each SIC class, which in this case is 2.56 percent. A perfectly diversified region would have an index of zero.

One property of this index is that it weighs very heavily the absence of employment in any of the measured industrial classes. More specifically, the greater the deviation of employment in an industry class from the norm, the greater the effect of that industry class on the index for that particular city. This weighting is a result of squaring the numerator of the index.

Bahl, Firestine, and Phares conclude that, "... while the list of those urban areas identified as most diverse does not conform to a priori notions, the ... index does appear to pick up the extreme cases of industrial specialization." [1, p. 418].

This passage raises an interesting question. Where did they acquire the "a priori notions" to which they refer? Are they using anything other than intuition as a basis for comparison?

Aggregate Average Approach. Advocates of the aggregate average method of measuring regional industrial diversity believe that a perfectly diversified regional economy is one in which the proportion of a region's workforce employed in each industry class is identical to the proportion of a region's workforce employed in each industry class is identical to the proportion of the nation's workforce employed in the same industry classes. To operationalize this definition, Rodgers [17] and Bahl, Firestine, and Phares found it appropriate to include average measures from the SMSA's in their studies, rather than proportions of the nation's workforce, because national averages take into account a much larger sample than was accounted for in the individual SMSA's.

Rodgers first calculated the proportion of each SMSA's workforce employed in each of 22 industrial categories, based on figures from the 1950 U.S. Census of Population. He then ranked each SMSA's industrial categories in descending order according to the number of people employed in each category. A series of progressive totals was made (percent in the largest group, percent in the largest group plus percent in the second largest group, etc.) and summed. Rodgers called the resulting number a "Crude Index" of diversity. Since he used 22 industrial categories, the Crude Index for least diversity would have been 2200, and that for most diversity about 1500. After arriving at a Crude Index for each SMSA, Rodgers went on to calculate Refined Indexes of diversity which were meant to take average employment figures into account. This is shown in equation 2.

$$(2)\quad \text{Refined Index} = \frac{\text{Crude Index for region — Crude Index for all SMSA's}}{\text{Crude Index for least diversity — Crude Index for all SMSA's}}$$

Using this method, a perfectly diversified economy would have a Refined Index of zero, and a completely undiversified economy would have a Refined Index of one.

This approach seems to obscure Rodgers' original assertion that employment percentages in each industry in a region must be equal to national (or aggregated SMSA) averages to achieve perfect diversity. Rodgers' index never examines specific industries. This point can be illustrated with the case of two hypothetical regions A and B, each of which has three industries, X, Y and Z. The workforces of the two regions are distributed as in Table 1.

Table 1: Distribution of Workforces in Regions A and B

	% of Region A's Workforce	**% of Region B's Workforce**
Industry X	50	30
Industry Y	30	20
Industry Z	20	50

By Rodgers' method, these two regions would come out with identical indexes of diversity, regardless of the fact that industries X, Y and Z may differ significantly in terms of relative stability and importance to their regions.

In Rodgers' model, as in the previous one, characteristics of specific industries are never taken into consideration. What matters in these indexes is the quantity of employment in each industry rather than the qualities of the industries themselves.

Bahl, Firestine, and Phares also calculated indexes of diversity for SMSA's using the aggregate average method. They used the following equation:

$$(3)\quad \text{Index of Diversity} = \sum_{i=1}^{n} \frac{(P_i - N_i)^2}{N_i} \qquad i=1,2,\ldots,39$$

where P_i = percent of the region's workforce employed in the $_i$th industry class for all SMSA's sampled and N_i = aggregate average employment in each SIC class. This index, like the rectangular distribution index, weighs heavily against a region in which one or more industry classes deviate greatly from the norm.

They note that, "The national [aggregate] average and ogive [rectangular distribution] indexes should give similar results," (Bahl, et al., 418) and they claim that the simple correlation between the two indexes (r = 0.85), "indicates that there is little distinction between the two." [1: p. 418] However, a closer examination reveals that none of the six most diversified SMSA's calculated with the rectangular distribution method appears on the list of the six most diversified economies calculated with the aggregate average method. Only two of the six least diversified SMSA's — Flint and Steubenville — are common to the two indexes. It would seem that the given definition of diversity has a greater influence on the degree of diversity in any specific region than do the properties of the region itself.

Minimum Requirements Method. The minimum requirements technique of computing an index of diversity was presented by Ullman and Dacey [22] and was later modified by Bahl, Firestine, and Phares. This technique was originated for the purpose of distinguishing between local and export sectors of regional economies, but has also been used to measure industrial diversity.

Ullman and Dacey define as "normal," the percent of employment needed in an SIC category to exactly satisfy local needs. Any SIC category in which employment exceeds the minimum local requirement is thought of as being a category in which the region "specializes." With this in mind, a perfectly diversified economy would be one in which the percent of the workforce employed in each SIC category is equal to the amount necessary to exactly satisfy local needs.

To operationalize this model Ullman and Dacey first grouped SMSA's into six population categories. To estimate minimum requirements by industry they regressed the minimum percent employed in each industry for each size class on population, as in this equation:

$$(4) \quad M_i = \alpha_i + \beta_i \log \text{(population)}$$

where M_i = minimum required percent of a region's workforce employed in the $_i$th industry class, and α and β are parameters. For each industry, i, a regression equation was fitted to the six population-employment points (one point for each size class).

To determine the minimum required employment for an industry in a specific region, the population of the region can be substituted into the regression equation for the particular industry. For example, the regression equation for industry Q might be

$$M_Q = 2.5 + .64 \log \text{(population)}$$

By substituting the population of any region into the equation the minimum employment in industry Q needed to satisfy local needs can be estimated.

The following equation, which is a modified version of Ullman and Dacey's original equation, was used by Bahl, Firestine, and Phares to measure the diversity of specific SMSA's.

$$(5) \quad \text{Index of Diversity} = \sum_{i=1}^{n} \frac{(P_i + M_i)^2}{M_i} \qquad i = 1,2, \ldots, 39$$

where P_i = percent of a region's workforce employed in the $_i$th industry class, and M_i = minimum required percent employed in the $_i$th industry class.

The major difficulty of this model is that it uses the lowest percent actually employed in an industry class to estimate the minimum percent required to satisfy local needs. That is, if the percent of Indianapolis' workforce employed in industry Q is smaller than the corresponding value for any other SMSA in its size class-perhaps three percent — then three percent is the minimum required proportion of a workforce that must be employed in industry Q to satisfy the local needs of any SMSA in Indianspolis' size class. This ordered pair (Indianapolis population, 3%) will be one of the six used (one ordered pair per size class) to estimate the parameters of the regression equation for industry Q. It follows that every other SMSA in Indianapolis' size class will have more than three percent of its workforce in industry Q, and will thus specialize, to some degree, in industry Q.

As Pratt [16] suggests, "The technique presents a paradox in that it leads to a group of cities in which each city exports and none imports." To pursue the previous example a bit further, every SMSA in Indianapolis' size class has more than three percent of its workforce in industry Q, with the exception of Indianapolis which has exactly three percent. Since three percent is assumed to be the minimum percent required to satisfy local needs, it is implied that any SMSA in Indianapolis' size class that has more than three percent of its workforce in industry Q is using the number beyond three percent to produce goods for export. In this case, Indianapolis produces just enough of industry Q's product to satisfy local needs, and every other SMSA in its size class produces more than enough of industry Q's product for its own use and presumably exports what it doesn't need. This means that every SMSA produces at least enough of every product to satisfy its local needs. Those with surplus products export them, but to whom? Each SMSA already has enough for itself.

Evaluation of Indexes of Diversity. Putting aside for a moment specific problems associated with each of the indexes of diversity, a few general shortcomings of all the indexes should be brought out.

First, none of these authors ever tests, challenges or supports the assumption that diversity is good, or whether it actually leads to stability. This is an assumption that should be challenged and, as shall be shown, can be tested.

Another assumption that each of the authors makes implicitly is that a regional economy, and more specifically a region's industrial base, can be treated and measured as a single entity. A regional economy is not just one unit but is composed of many different elements — various manufacturers, services, government, etc. — each of which affects a region and its economic stability uniquely.

A final assumption implied by each of the authors is that all employment in each sector of a region's economy is equally important and should be weighted equally. Theoretically, however, an automobile factory and a bread factory should have very different effects upon a region's economy, especially in terms of cyclical employment stability.

This is not to suggest that there is a less subjective method for calculating an index of diversity. Rather, this is to suggest that there is perhaps a more objective way to look at a region's distribution of employment across industry classes. Indexes of diversity are affected too greatly by the whims of their creators.

To illustrate this point, imagine the case of four hypothetical SMSA's, A, B, C and D, each of which has four industries, W, X, Y and Z. Employment in these industries is distributed as in Table 2.

Indexes of diversity are calculated for each SMSA by each of the four methods presented in this chapter (it is assumed that the four SMSA's have approximately equal populations) and the SMSA's are then ranked from most diverse, 1, to least diverse, 4, for each of the methods. The results as shown in Table 3, are, at best, inconclusive as to how the SMSA's should actually be ranked.

This exercise shows the subjectivity inherent in indexes of diversity. It also strengthens the case against trying to characterize the economy of any region with a single number, such as an index of diversity.

Table 2: Distribution of Workforces in SMSA's A, B, C, and D

Industries	SMSA's			
	A	B	C	D
W	40	35	30	25
X	30	30	25	25
Y	20	25	25	25
Z	10	10	20	25

Table 3: Ordinal Rankings of SMSA's A, B, C, and D, According to Each Index of Diversity

Indexes	SMSA's			
	A	B	C	D
Rodgers' Aggregate Average	1	2	3	4
Bahl, et al., Aggregate Average	2	3	4	1
Rectangular Distribution	4	3	2	1
Minimum Requirements	2	1	3	4

Industrial Portfolio Approach. The most complicated method of estimating regional industrial diversity is the industrial portfolio approach introduced by Conroy [7].

> The real resources which a region implicitly 'invests' in any given industry may thus be expected to generate a stream of returns which also may be considered essentially stochastic .... The precise form in which these characteristics enter the region's objective or criterion function with respect to returns may vary greatly, but so long as there is any aversion to differences in the spread of those returns or to skewness in them, aversion generally associated with the 'risk' involved in stochastic returns, it is rational to assess more than the mean value. [7, p. 495].

If the variance of these stochastic returns is accepted as a measure of risk, and the set of industries in an economy at a specific point in time is considered that economy's portfolio, then, the "portfolio variance" provides an aggregate measure of that risk. The portfolio variance may be defined as follows:

$$(6) \qquad \sigma p = \sum_i \sum_j w_i \, w_j \, \sigma ij$$

Where:

w_i and w_j denote the proportion of regional resources (or other relative weights) allocated to industries i and j; and σ_{ij} denotes the covariance of the predetermined returns criterion over time for industries i and j." [7, p. 495].

Conroy applied average figures from the national economy to the 52 SMSA's contained in his model. In so doing, he implicitly sets national averages as the norms for employment in each of the 118 manufacturing industries included in his model. Further, Conroy's method fails to address the fact that the given assets of any region play a large role in determining the returns of each industry in the region. While the "industrial structures" that were used varied across SMSA's, the variances and covariances did not vary by SMSA for each of the 118 manufacturing industries in the model. Thus, the expected rate of returns in any industry is assumed to remain unaffected by location, and subsequently, by available resources.

Description of Econometric Models

In an effort to analyze indexes of diversity and improve on them, two sets of econometric models are developed. The first set, which employs indexes of diversity as independent variables, are used to determine the extent to which these indexes consistently estimate industrial mix characteristics which influence the cyclical employment instability of SMSA's. The second set, which uses for independent variables the proportions of SMSA workforces employed in each of several types of industries, is meant to determine the relative effect of employment in each of these types of industries upon cyclical employment stability of SMSA's. In each of the models the dependent variable is an "index of instability" which was derived from each SMSA's monthly unemployment rate over a given period. This index measures relative variation in unemployment rates across SMSA's.

The models used in the analysis serves two distinct purposes. The first set of models is meant to test the explanatory capabilities of indexes of diversity. That is, to determine whether indexes of diversity actually represent the industrial mix characteristics which affect cyclical employment instability in regions. As discussed earlier, the creators of the indexes assume that diversity, as each of them defines it, is good, presumably in that it has a stabilizing effect on the rate of unemployment in an SMSA over the course of a business cycle. This first set of models is constructed, therefore, to reveal how much of the variation in unemployment rates across SMSA's is explained by indexes of diversity, and whether the relationships between the indexes of diversity and the index of instability are consistent.

The second set of models is constructed to determine the relative effects of specific types of industries upon the cyclical employment instability of SMSA's.

A random sample of 48 SMSA's was used in the analysis. Data sources included various issues of the *Census of Manufacturers* [3] and *Employment and Earnings.* [6].

Indexes of Diversity as Independent Variables. For the first set of three models, the three indexes of diversity used by Bahl, Firestine, and Phares were applied to each of the 48 SMSA's as per equations 1, 3 and 5. The index of instability derived from the unemployment rates for each SMSA was then regressed separately on each of the indexes of diversity.

The index of instability for each SMSA was determined by dividing the standard deviation for the SMSA's unemployment rate over a given period by its mean unemployment rate over the same period, as in equation 7.

$$(7)\quad INST_i = \text{Index of Instability}_i = \frac{\text{standard deviation of rate of unemployment in } SMSA_i \text{ for time period r}}{\text{mean of rate of unemployment in } SMSA_i \text{ for time period r}} \times 100$$

$$i = 1, 2, \ldots, 48$$

The standard deviation of each SMSA's rate of unemployment for a given period is thus expressed as a percentage of its mean rate of unemployment for that period. The value of the index is expected to be higher for relatively unstable SMSA's than it is for relatively stable SMSA's.

In the first model the independent variable is the index of diversity calculated by the minimum requirements method. The regression equation is as follows:

$$(8)\quad INST_i = \alpha + \beta\,(DIV\text{-}MIN)_i + u_i \qquad i=1,2,\ldots,48$$

where $INST_i$ = the index of instability for the $_i$th SMSA; DIV-MIN = the index of diversity calculated with the minimum requirements equation for the $_i$th SMSA; α and β are parameters estimated by ordinary least squares, and u_i is the error term for the $_i$th SMSA. It is assumed that the mean of the error term is zero, that the variance of the error term is constant and independent of the independent variable, and that the various values of the error term are drawn independently of one another. The aggregate average (DIV-AVE) and rectangular distribution (DIV-REC) equations were used to calculate indexes of diversity for the second and third models, respectively. Each of these models was estimated for the period from January, 1967 through November, 1976. This was done by calculating the indexes of instability for the entire 119-month period, and by averaging the 1967, 1972 and 1975 industrial mix data for each SMSA as a proxy for the average industrial mixes over the ten years.

This set of models tests the following hypotheses:

1. Indexes of diversity do not explain variations in employment instability across SMSA's significantly.
2. Indexes of diversity are not highly correlated with one another.

Employment Categories as Independent Variables

Four models were constructed with the proportions of SMSA workforces employed in each of 12 categories as the 12 independent variables. Again, the index of instability was the dependent variable for each model. One model was estimated for the entire 119-month period from January, 1967 through November, 1976, and one was estimated for each of three shorter periods; January, 1967 through December 1970; January, 1970 through December, 1973; and January, 1973 through November, 1976. To avoid having to construct arbitrary boundaries between the time periods in the shorter models, they were allowed to overlap by 12 months. The purposes of the shorter, 48-month models and the long 119-month model differ somewhat. In each of the shorter models parameters were estimated for periods with different kinds of macroeconomic conditions. The first period, 1967-1970, was relatively stable, though inflation increased in the second half of the period and unemployment increased during the last year. This period can be thought of as the end of the Vietnam boom. The second period, 1970-1973, is a period of stagflation, as the unemployment rate rises above five percent and the inflation rate increases dramatically. The third period, 1973-1976, shows an economy whose rate of unemployment leaps to about eight percent and whose rate of inflation continued to grow. This is a recessionary period. The long model, on the other hand, encompasses all these phases of the business cycle and, accordingly, estimates parameters for the long-run.

The regression equations for the four models vary only in that they refer to different periods of time. They are all cross-section models, where each observation of each variable is meant to represent an average or typical measure of employment in a particular category in an SMSA, for the period represented in the model.

The general equation is as follows:

$$(9)\quad INST_i = \alpha + [\beta_{ji}]\,[X_{ji}] + u_i \qquad i=1,2,3,\ldots,48 \quad j=1,2,3,\ldots,12$$

where $INST_i$ = the index of instability for the $_i$th SMSA; α is a parameter; β_{ji} = row vector of coefficients; X_{ji} column vector of the proportion of a workforce in the $_i$th SMSA employed in the $_j$th employment category; and u_i is the error term for the $_i$th SMSA. The same assumptions apply to the error terms for this set of models as for the first set of models. The 12 employment categories are presented in Table 4.

Table 4: Employment Categories Used in Regressions

Category	S.I.C.
1. Food and kindred products	20
2. Consumer durables	23,25,27
3. Intermediate goods	22,24,26
4. Raw material processing	28,29,30,31,32,33
5. High-technology	34,35,36,38,39
6. Transportation equipment	37
7. Mining	B
8. Construction	C
9. Transportation and public utilities	E
10. Wholesale and retail trade	F and G
11. Finance, insurance, and real estate	H
12. Government	J

SIC Division I, which is services, was held out of the regression as a reference category. It includes personal, business, health, legal, educational and social services as well as motion pictures, recreation and museums. Thus, each of the regression coefficients, the β_{ji}, is interpretable as follows: if one percent of the $_i$th SMSA's total workforce was employed in services, and this entire group moved to the $_j$th employment category, then the index of instability would change by the amount β_{ji}.

The models were designed to that the equations would estimate the effect of each employment category upon cyclical employment instability, and their effects relative to each other.

The hypotheses tested in this second set of models are as follows:

1. Concentrations of employment in certain categories influence the in stability of SMSA's over time more than concentrations in other in dustries, and, the degree of relative instability in an SMSA is related directly to the proportion of its workforce employed in these industries.

This hypothesis can be tested by comparison of the regression coefficients for the various categories.

2. This second set of models explains more of the variation in the index of instability than the indexes of diversity over the entire 119-month period.

Assumptions. Several assumptions were needed in the construction of these models to make them useful, interpretable tools.

1. It was assumed that each SMSA provides a good proxy for a regional labor market.
2. It was assumed that the industrial mix of an SMSA, defined here as the proportion of an SMSA's workforce in each employment category, changes slowly enough over time that data from 1967 could be used to estimate industrial mixes from January, 1967 through December, 1970; data from 1972 could be used to estimate industrial mixes from January, 1970 through December, 1973; data from 1975 could be used to estimate industrial mixes from January, 1973 through November, 1976; and means for the years 1967, 1972 and 1975 could be used to estimate industrial mixes for the entire 119-month period from January through November, 1976.

This assumption was made necessary by the unavailability of monthly, or even annual industrial mix data. Its validity was tested by applying the index of instability to each employment category in each SMSA for the data from 1967, 1972 and 1975, as in equation 10.

$$(10)\quad \text{Index of Instability}_{ji} = \frac{\text{Standard deviation of \% employed in the }_j\text{th category in the }_i\text{th SMSA}}{\text{Mean of \% employed in }_j\text{th category in }_i\text{th SMSA}}$$

$$i=1,2,\ldots,48$$
$$j=1,2,\ldots,13$$

The results of this test indicate that there is indeed a high degree of stability in the proportion of SMSA workforces employed in specific categories. Of the 624 tested (13 employment categories x 48 SMSA's) 538 had indexes that were interpretable. The other 76 were uninterpretable because the categories employed zero percent of the SMSA workforces in either two or all of the three years. Of the 538 groups whose indexes could be interpreted, 428, or 79 percent, had indexes smaller than 10, while 38, or 7 percent, had indexes greater than 50. While the reliability of the models would certainly be increased by the availability of more frequent industrial mix data, the results of this test indicate that industrial mixes do change slowly over time, and that this assumption is not a drastic one.

Monthly unemployment rates for each SMSA were estimated by calculating the percentage of the workforce receiving benefits under State, Federal and Ex-Servicemen's unemployment insurance programs. The workforce was defined as the total number of employees on non-agricultural payrolls plus the number on the various unemployment insurance programs. Because of the fact that the number of people receiving unemployment insurance is lower than the number actually unemployed (this is because some unemployed people are either ineligible for unemployment insurance or simply elect not to receive any), the unemployment rates estimated in this analysis are somewhat low. This is illustrated in Table 5 where the unemployment rates estimated in this analysis for April, 1970 are

Table 5: Comparison of SMSA Unemployment Rates — April, 1970

SMSA	% Unemployed as Estimated by U.S. Census	% Unemployed as Estimated in this Analysis
Birmingham, Ala.	4.2	1.5
Phoenix, Ariz.	3.9	1.3
San Bernardino, Cal.	5.9	3.6
San Diego, Cal.	6.3	3.6
San Francisco, Ca.	5.8	2.9
Denver, Colo.	3.7	0.9
Hartford, Conn.	2.2	1.8
Wilmington, Del.	3.8	1.6
Tampa, Fla.	3.7	1.0
Atlanta, Ga.	3.0	1.2
Peoria, Ill.	3.2	1.3
Fort Wayne, Ind.	3.0	1.2
Indianapolis, Ind.	3.9	0.5
Wichita, Kansas	7.1	5.6
Louisville, Ky.	4.0	1.4
Baltimore, Md.	3.5	2.0
Springfield, Mass.	4.2	3.8
Detroit, Mi.	5.7	3.4
Grand Rapids, Mi.	5.7	4.5
Minneapolis, Minn.	3.3	1.3
Kansas City, Mo.	3.4	1.8
St. Louis, Mo.	4.9	3.7
Newark, N. J.	3.5	2.5
Albany, N.Y.	3.4	1.8
Buffalo, N.Y.	4.8	2.6
Rochester, N.Y.	3.6	2.1
Charlotte, N.C	2.6	0.8
Akron, Oh.	4.4	1.8

(continued next page)

SMSA	% Unemployed as Estimated by U.S. Census	& Unemployed as Estimated in this Analysis
Canton, Oh.	4.3	3.2
Cleveland, Oh.	3.5	1.8
Columbus, Oh.	3.5	1.2
Dayton, Oh.	3.8	1.0
Youngstown, Oh.	5.6	3.1
Oklahoma City. Okla.	3.3	1.2
Portland, Ore.	6.1	3.5
Allentown, Pa.	2.4	1.5
Harrisburg, Pa.	2.2	1.1
Lancaster, Pa.	2.1	1.0
Philadelphia, Pa.	3.7	1.9
Pittsburgh, Pa.	4.3	2.1
York, Pa.	2.3	2.0
Greenville, S.C.	2.9	1.4
Chattanooga, Tenn.	3.2	1.5
Memphis, Tenn.	4.9	2.6
Nashville, Tenn.	3.2	1.5
Richmond, Va.	2.2	0.3
Seattle, Wash.	8.2	6.2
Milwaukee, Wis.	3.5	2.3

listed with the rates estimated by the Bureau of the Census for the same month. [4]. For each of the 48 SMSA's the estimate made by the Bureau of the Census was greater.

3. Thus, while individual unemployment rates were underestimated, it was assumed that the trends apparent in these month-by-month estimates are consistent with actual unemployment rate trends in the SMSA's. That is, it was assumed that variations in monthly unemployment rates estimated in this analysis are unbiased.

It should be noted that, because of the fact that eligibility for unemployment insurance lasts for only a limited time, this method would estimate trends in unemployment rates unreliably during a protracted recession.

4. It was assumed that the standard deviation of an SMSA's unemployment rate as a percentage of its mean unemployment rate over a given period of time is a good proxy for the SMSA's employment instability over the time period.

This index was designed so that an SMSA with maximum instability would be clearly distinguishable from one with maximum stability, and SMSA's with intermediate degrees of instability would be ranked between them. A hypothetical example is useful here. The unemployment rates for three hypothetical SMSA's, A, B, and C, are listed in Table 6 for six months.

Table 6: Unemployment Rates for SMSA's A, B and C

	SMSA's		
Month	A	B	C
1	5%	4%	3%
2	1	2	3
3	5	4	3
4	1	2	3
5	5	4	3
6	1	2	3

SMSA A which, intuitively, is the most unstable, has an index of 73. SMSA B which, intuitively, is the next most stable, has an index of 36, and SMSA C, the most stable SMSA, has an index of 0. These estimates are consistent with expectations. One shortcoming of the index is that there are certain cases that it fails to distinguish between. This is illustrated in Table 7 where six monthly unemployment rates for SMSA's B and D are listed.

In this case, where SMSA B is intuitively more unstable than SMSA D, the two have identical indexes of instability.

The index of instability can be interpreted as follows: if, for example, an SMSA has an index of 20, then any randomly chosen unemployment rate observation during the given period can be expected to vary from the mean unemployment rate by 20 percent.

These assumptions are part of each of the models, and the fact that they are assumed properties of the models should be kept in mind when interpreting them.

Results of Models

Results from the models described above are reported in this section. The results from the first set of models indicate that indexes of diversity are not good proxies for the characteristics of industrial mix that are correlated with cyclical employment stability. Results from the second set of models indicate which

Table 7: Unemployment Rates for SMSA's B and D

Month	SMSA B	SMSA D
1	4%	4%
2	2	4
3	4	4
4	2	2
5	4	2
6	2	2

employment categories are correlated with cyclical employment stability, and the effects of the categories relative to each other. Also, for purposes of comparison, the results obtained by Conroy in an analysis similar to that in the first set of models will be presented.

Indexes of Diversity as Independent Variables. To test whether indexes of diversity explain variations in the index of instability for the period January, 1967-November, 1976, F-tests were used for each of the regressions. The parameters estimated by the regression equations along with F and t-statistics and R^2 values are given in Table 8.

Table 8: Regression Results: Indexes of Diversity as Independent Variables

	Independent Variable	α	β (t)	F	R^2
1.	DIV-MIN	53.21	0.4567 (2.56)[b]	6.58[b]	.1252
2.	DIV-AVE	53.20	17.38 (3.02)[a]	9.13[a]	.1657
3.	DIV-REC	69.97	-13.40 (-1.56)	2.44	.0505

[a]Significant at .01

[b]Significant at .05

The critical values of F for each of these models are 4.05 at the five percent and 7.21 at the one percent level of significance, respectively. Thus, the R^2 values in equations 1 and 2 are significantly different from zero at the five percent level of significance, and only equation 2 has an R^2 greater than zero at the one percent level of significance. The critical values of t for regression coefficients in these models are 2.01 at the five percent and 2.68 at the one percent level of significance, respectively. Thus, the regression coefficients estimated in equations 1 and 2 are significantly different from zero at the five percent level of significance, and only the regression coefficient estimated in equation 2 is significantly different from zero at the one percent level of significance.

These tests indicate that the aggregate average index of diversity captures more of the variation in the index of instability than the other indexes of diversity, and that the rectangular distribution index of diversity is not significantly related to variations in the index of instability.

The fact that the highest R^2 value in this set of regressions is .16 suggests that most of the variation in unemployment rates expressed by the index of instability is not captured by any of these indexes of diversity.

Both the simple correlations of the indexes of diversity and the estimated elasticities of the regression equations were used to test the consistency of the indexes with one another. The correlation matrix in Table 9 illustrates that, while there is a reasonably strong positive relationship between the aggregate average and minimum requirements indexes (r = .76), neither of the other relationships are at all strong, and they are both negative.

Table 9: Correlation Matrix

Index			
Rectangular Distribution	1.000		
Aggregate Average	-0.065	1.000	
Minimum Requirements	-0.396	0.762	1.000

The elasticities estimated by the three regression equations are shown in Table 10.

Table 10: Elasticities Estimated by Regression Equations

Independent Variable	Estimated Elasticity
DIV-MIN	0.1194
DIV-AVE	0.1195
DIV-REC	-0.1578

Again, this test indicates that the aggregate average and minimum requirements indexes of diversity are similar proxies for the characteristics of industrial mix that are correlated with cyclical employment stability, while the rectangular distribution index of diversity is not consistent with them.

Employment Categories as Independent Variables. The regression coefficients estimated in each of the four sample periods using employment categories as independent variables are listed in Table 11, along with t-statistics for each of the regression coefficients and F-statistics, R^2 and adjusted R^2 ($\bar{R}^2$) values for each of the regressions. ($\bar{R}^2 = R^2 - [(K-1) / (T-K)] (1-R^2)$, where K = number of independent variables, and T = number of observations. [13]. The critical values for t are 1.68, 2.03 and 2.72 at the ten, five and one percent levels of significance, respectively. The critical values for F are 2.11 at the five percent and 2.89 at the one percent level of significance. Thus, the values of R^2 in the first two short-term

Table 11: Regression Results: Employment Categories as Independent Variables

Independent Variables	Jan. 67- Dec. '70 β (t)	Jan. '70- Dec. '73 β (t)	Jan. '73- Nov. '76 β (t)	Jan. '67- Nov. '76 β (t)
Food	-83.29 (0.35)	203.23 (1.26)	256.34 (1.18)	312.78 (1.16)
Consumer Durables	-107.37 (-0.53)	49.23 (0.41)	419.19 (3.62)[a]	359.79 (1.99)[c]
Intermediate Goods	-3.69 (-0.03)	167.05 (1.92)[c]	523.64 (5.47)[a]	528.49 (3.99)[a]
Raw Materials	-6.04 (-0.04)	188.44[c] (1.82)	410.19 (3.64)[a]	400.51 (2.65)[b]
High Technology	56.65 (0.42)	122.17 (1.31)	528.45 (5.03)[a]	517.51 (3.53)[a]
Transportation Equipment	67.13 (0.48)	243.95 (2.25)[b]	421.75 (3.59)[a]	502.31 (2.89)[a]
Mining	99.45 (0.26)	-152.39 (-0.49)	-288.85 (-0.87)	-111.92 (-0.26)
Construction	2.31 (0.00)	82.56 (0.53)	963.31 (4.79)[a]	1007.12 (3.29)[a]
Transportation and Public Utilities	-115.10 (-0.51)	-149.52 (-1.02)	372.89 (2.11)[b]	509.84 (2.11)[b]
Wholesale and Retail Sales	233.64 (1.17)	283.15 (1.79)[c]	631.35 (3.58)[a]	634.60 (2.70)[b]
Finance, Insurance and Real Estate	-71.80 (-0.51)	182.56 (1.49)	333.13 (2.42)[b]	302.94 (1.62)
Government	-42.32 (-0.28)	85.22 (0.76)	406.16 (4.31)[a]	391.54 (2.62)[b]
R^2	.3382	.3562	.6512	.5431
$\bar{R}^2$	.1359	.1594	.5446	.4034
F-statistic	1.49	1.61	5.44[a]	3.46[a]

[a]Significant at .01

[b]Significant at .05

[c]Significant at .10

models (January, 1967-December, 1970 and January, 1970-December, 1973) are not significantly different from zero at the five percent level of significance. The R^2 values in the last short-term model (January, 1973-November, 1976) and the long-term model (January, 1967-November, 1976) are both significantly greater than zero at the one percent level of significance.

The correlation matrices for the independent variables showed that the only possible problem is in the relationship between employment in transportation and public utilities, and wholesale and retail sales in the long-term model. These two categories have a simple correlation of .58 which means that multicollinearity is a possibility in this model.

None of the estimated regression coefficients in the model covering the period January, 1967-December, 1970 are significantly different from zero at the ten percent level of significance. This does not mean that the employment categories used were not related to instability during this period, but that employment in these categories had an insignificant effect upon instability relative to employment in services.

The regression coefficients significantly different from zero at the ten percent level of significance in the other three models were ranked ordinally in Table 12, according to their magnitudes. In the model covering the period from January, 1970 through December, 1973 the employment category which most influenced the variations in the index of instability was wholesale and retail sales. Employment in this category is theoretically very responsive to changes in income. Wholesale and retail sales was the only nonmanufacturing employment category which explained significantly the variations in the index of instability for this period, which was characterized by stagflation. The manufacturing categories with significant regression coefficients, manufacturers of transportation equipment, users of high technology and processors of raw materials, all produce goods with relatively high income elasticities, whereas employment in the production of food and consumer durables, goods with relatively low income elasticities, was insignificant in explaining variations in the index of instability during this period of rising prices. Given the macroeconomic conditions of the period from January, 1970 through December, 1973, the estimates from this model are consistent with theory.

The estimates from the model covering the recessionary period from January, 1973 through November, 1976 and the long-term model covering January, 1967 through November, 1976 are very similar. In each case, the concentration of employment in construction, which can be thought of as the producer of extreme durables, was estimated to have the greatest effect upon the index of instability, and wholesale and retail sales was ranked second. In each model, employment in these two categories was followed in magnitude by employment in the heavy manufacturing categories, high technology industries, producers of intermediate goods and transportation equipment, then processors of raw materials and producers of consumer durables. Employment in the remaining non-manufacturing categories was estimated to have the least effect upon variations in the index of instability. Employment in transportation and public utilities, which was ranked fifth in the long-term model, was the only departure from the above pattern. Again, these estimates are consistent with the theory. Employment in construction, which is generally quite labor-intensive, was estimated to be strongly correlated to instability, while employment in the production of goods with relatively high income elasticities was estimated to have a greater effect upon instability than employment in the production of goods with relatively low income elasticities.

To test the hypothesis that this second set of models explains more of the variation in the index of instability than the indexes of diversity over the entire 119-month period, the R^2 values in the first set of models were compared with the ajusted R^2 value of the long-term model in the second set. Only the long-term model is applicable for comparison as it is the only model in the second set that covers the same period as the models in the first set. A comparison of these numbrs indicates that the long-term model from the second set, in which R^2 = .4034, is indeed a better tool for explaining variations in the index of instability.

Table 12: Ordinal Rankings of Regression Coefficients (at 10% Level of Significance)

Independent Variables	Jan. '70-Dec. '73	Jan. '73-Nov. '76	Jan. '67-Nov. '76
Food	-	-	-
Consumer Durables	-	6	9
Intermediate Goods	4	4	3
Raw Materials	3	7	7
High Technology	-	3	4
Transportation Equipment	2	5	6
Mining	-	-	-
Construction	-	1	1
Transportation and Public Utilities	-	9	5
Wholesale and Retail Sales	1	2	2
Finance, Insurance and Real Estate	-	10	-
Government	-	8	8

Results of Conroy's Analysis. In his empirical analysis Conroy [7] used an index of historical instability, denoted z_k, as his dependent variable. It is defined in equation 11.

$$(11) \qquad Z_k = \frac{\sum_{t=1}^{120} \left(\frac{y_t^k - \hat{y}_t^k}{\bar{y}_t^k} \right)^{1/2}}{118}$$

where

y_t^k denotes observed employment in region k for month t,

$\hat{y}_t^k$ denotes employment in that region and period predicted by the trend equation, and

$\bar{y}_t^k$ denotes the arithmetic average of the respective time series.

In a series of simple regressions, Conroy estimated how well the rectangular distribution and aggregate average indexes of diversity explained variations in the index of historical instability across SMSA's, and also estimated the explanatory capacity of the portfolio variance measure of diversity. The results of these regressions, as presented in Table 13, seem to reinforce the results presented in Table 8. That is, indexes of diversity are again shown not to be good proxies for the characteristics of industrial mix that cause fluctuations in employment over the course of a business cycle. The portfolio variance, with its strong significance and high R^2, provides what must be considered a better proxy for the characteristics. Little else about the portfolio variance can be drawn from this limited analysis, however.

Table 13: Conroy's Regression Results

Dependent Variable	Independent Variable	Adjusted R-Squared	t Statistic	F Statistic
Z_k	Portfolio Variance	.4216	6.179[a]	38.1793[a]
Z_k	Rectangular Distribution	.0499	1.92[c]	3.68[b]
Z_k	Aggregate Average	.0071	1.17	1.37

[a]Significant at .01

[b]Significant at .05

[c]Significant at .10

Summary

The aggregate average and minimum requirements indexes of diversity were shown to be similar proxies for the characteristics of industrial mix that are correlated with cyclical employment stability, while the rectangular distribution index of diversity was shown to be inconsistent with the other two. Construction and wholesale and retail sales were estimated to be the non-manufacturing employment categories most responsible for variations in the index of instability for the periods January, 1973-November, 1976 and January, 1967-November, 1976. The most influential manufacturing categories were estimated to be high technology manufacturing, producers of intermediate goods and transportation equipment, and processors of raw material. Models which use employment categories as independent variables were found to explain more of the variation in the index of instability for the period from January, 1967 through November, 1976 than models using indexes of diversity as independent variables.

Conclusions

A number of conclusions can be drawn from the analysis presented here. The first one deals with indexes of diversity. It was shown that a different definition of diversity is used for each index of diversity and that none of the definitions is necessarily more appropriate than the others. After demonstrating that the indexes are not always consistent with one another, and that none of them accounts for more than 17 percent of the variation in the index of instability — even though diversity and instability should theoretically be strongly related to each other — it can be concluded that none of the indexes of diversity examined here is a good proxy for the industrial mix characteristics which influence cyclical employment stability. The most likely reason for this is that the indexes fail to distinguish between the characteristics of specific employment categories. The indexes operate under the assumption that a concentration of employment in any category has the same impact upon a region as a concentration of employment in any other category. This assumption is not a proper theoretical one and, as illustrated by the estimates of the second set of models, can be disproved empirically.

Most of the conclusions that can be drawn from this analysis have to do with this second set of models. The models estimated that, especially during periods of relative instability (specifically, January, 1973 through November, 1976 and January, 1967 through November, 1976), concentrations of employment in construction and wholesale and retail sales had the most effect upon cyclical employment stability. Employment in the heavy manufacturing categories, the production of intermediate goods and transportation equipment, high technology production, and the processing of raw materials, had the next greatest effect, while employment in transportation and public utilities, government, the production of consumer durables, and in finance, insurance and real estate were the smallest significant determinants of cyclical employment stability. Concentrations of employment in mining and in the production of food were estimated to be insignificant factors, relative to employment in services, in the determination of cyclical employment stability.

It can be concluded first from these estimates that concentrations of employment in different categories do have different relative effects upon cyclical employment stability. This finding undermines the principle upon which indexes of diversity are constructed, the principle that employment in all categories can be weighted equally. It is also strengthened by the fact that the $\overline{R}^2$ value of the long-term model in the second set ($\overline{R}^2$=.40) was considerably larger than the only significant R^2 value in the second set (when DIV-AVE was the independent variable R^2=.16).

A second conclusion that can be drawn from these estimates is that the theory is consistent with the patterns observed in the models. During the periods of greatest instability, concentrations of employment in the manufacuturing categories whose products have the highest relative income elasticities, and in the labor-intensive category of construction were estimated to have the most profound impacts upon employment instability. Concentrations of employment in the manufacturing categories whose products have relatively low income elasticities were estimated to have smaller effects upon employment instability. This correlates closely with the theory.

These estimates also suggest that there is at least one other problem with the way industrial mix, or "diversity," has been measured in the past. Historicaly, studies measuring diversity have looked only at concentrations of employment in manufacturing categories. The estimates here, however, indicate that concentrations of employment in at least two non-manufacturing categories, construction and wholesale and retail sales, have significant effects upon regional cyclical employment stability. This finding is not inconsistent with any existing theory and makes more sense intuitively than the exclusion of employment in non-manufacturing categories from empirical studies.

Obviously, though, with R^2 values not greater than .65, the model used here to estimate the relationship between industrial mix and cyclical employment stability could be improved upon. One improvement might be to estimate loglinear rather than linear parameters. There is nothing in the existing theory to suggest that the relationships between concentrations of employment in certain categories and employment stability should be linear.

There are other regional properties which could be incorporated into models also. Inclusion of some, such as climate or geographical location, might be used to help distinguish between cyclical and seasonal instability. One could theorize that a region located in a temperate climate would be more unstable due to seasonality than one located in a sub-tropical climate. Inclusion of other properties such as population might also lend insight as to the determinants of cyclical employment stability.

One more area that should be considered for improvement is the method used to estimate employment instability. The index of instability used in this analysis might be considered a somewhat blunt instrument in that, as illustrated above it sometimes fails to distinguish between dissimilar patterns of unemployment. The development of other measures of instability which can distinguish between patterns of unemployment that are only slightly dissimilar is desirable.

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