The Effect of Industrial Diversification on Employment and Income: A Case Study

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One of the major outcomes of the depression of the thirties was a drive toward diversification of industrial activity in many areas of this country. Diversification became an important policy objective because of the belief that specialization was a dangerous liability that could lead to instability of income and periodic high unemployment.

The advantages of diversity have been argued and analyzed in the regional economics literature [6, 10]. Specifically, regional business cycle theorists have debated the thesis that as a region's industrial structure becomes more diversified, its economy becomes less responsive to fluctuation caused by changes in extraregional economic factors [11, 14]. It has been suggested that the less specialized an area is, the greater its ability will be to cushion adverse cyclical effects. Conversely, specialization brings the added risk that a region’s specialty might be undercut by the discovery of new and cheaper supply sources, by improvements in production elsewhere by improvement in transportation, or by shifts in demand.

For years now, economic planners have thus assumed that diversification in the economic activity of a region increases the aggregate level of regional income or income per capita, reduces unemployment rates, increases growth rates, and stabilizes (in the sense of reducing fluctuations over time) the levels of aggregate income, employment, or other regional economic characteristics [3].

These assumptions are the “conventional wisdom,” but in fact may not be true. While attempts have been made to relate measures of diversity to indicators of economic performance [2, 15], the issue has not been adequately explored. We do not, as yet, really know whether measures of diversity have explanatory or predictive value in relation to levels, rates of growth, and instability of per capita income, employment, and other economic variables.

The interest in economic diversification is a nationwide phenomenon, but it has been particularly felt in Oregon. Many of Oregon’s 36 counties rely heavily on the timber industry, which provides 80,000 jobs throughout the state. In 1980, the lumber and wood products industries employed one out of three workers in several Oregon counties such as Crook, Harney, Grant, and Lake. Heavy reliance in these counties on logging and mill payrolls has made them vulnerable to downturns in the national business cycle. In the recent recession, for example, the lumber and wood products industry in Oregon was severely afflicted. By mid-May 1980, nearly 17,000 of the industry’s workers in the state had been laid off.

During the past several years, state programs in Oregon have attempted to promote economic diversification by attracting new industry. For instance, during the 1975 to 1980 period, the state approved $245 million in economic development revenue bonds for the purpose of financing new industries. From 1976 to 1984, Oregon issued 72 industrial development revenue bonds for a total of $201.59 million. The above revenue saved a total of 670 jobs and created 4,830 new ones (industrial development bonds issued, 1976–1984, Economic Development Department).

This study undertakes an investigation of the various aspects of economic diversity to determine whether support can be found for some of the generally held assumptions regarding its value. These assumptions are tested with data from the counties of Oregon for the ten-year period, 1972–1981. Such an investigation should provide insight into the patterns of growth and sources of cyclical instability of the units (counties) during the period of study. This, in turn, may offer both a conceptual and an historical perspective for decision-makers responsible for formulating policies for economic recovery.

RESEARCH METHODOLOGY

Measure of Diversity

In the present study, diversity is defined as the extent to which the economic activity of a region is dispersed among a great many employment fields, and Shannon’s entropy function is used as a quantitative measure [16]. An extensive treatment of entropy-based measures in the analysis of economic data has been given by Henri Theil, who discusses in detail the technical information theory concepts and illustrates them with economic examples. Theil's books [17, 19] are primarily concerned with distributional issues and with decomposition analysis.

The entropy measure has been used in empirical studies in economics and in the business areas of management, marketing, finance, and accounting. In a marketing context, entropy can represent the distribution of consumer preference for various brands [5]. In market structure analysis, entropy has often
been employed as a measure of "competitiveness" of an industry [7]. In portfolio analysis, the use of entropy, rather than variance, as a measure of the risk of a securities portfolio whose components yield stochastic returns has been advocated by Philippatos and Wilson [12, 13]. In the analysis of accounting data, entropy has been used to measure the loss of information from aggregation of items on financial statements [18, 8, 9].

Entropy has also been used to measure employment diversity [4, 1], as follows:

\[ D(E_1, E_2, \ldots E_n) = -\sum_{i=1}^{n} E_i \log_2 E_i \]

where \( n \) = the number of economic sectors, \( E_i \) = the proportion of total employment of the region that is located in the \( i \)th sector, and \( \log_2 \) is logarithm to the base 2. The most important properties of this measure are: (1) the maximum value of \( D \) is attained when the \( E_i \) are all equal. This is the case where the region is totally diversified, that is, all sectors contribute equally to the region's employment. Also, the greater the number of sectors sharing in the region's economic activity, the greater the value of \( D \). (2) \( 0 \leq D \leq \log_2 n \). (3) \( D = 0 \) when only one of the \( E_i = 1 \) and the remaining are 0. This is the extreme case where the economic activity of a region is concentrated in only one sector; therefore, economic diversity is totally absent.

Using the entropy formula, diversity indexes based upon employment data were calculated for Oregon's 29 counties and three multi-county areas for a ten-year period from 1972 through 1981. Oregon's multi-county labor force areas are: the Portland SMSA (which includes Clackamas, Multnomah, and Washington counties, plus Clark County, Washington), the Salem SMSA (which includes Marion and Polk counties), the Eugene SMSA (which includes the Eugene and Springfield areas), and the two-county Wasco-Sherman labor market area.

Calculation of the entropy measure for Oregon counties is based on employment data from nine sectors: agriculture; durable goods; nondurable goods; construction; transportation, communication, and utilities; trade; finance, insurance, and real estate; service and miscellaneous; and government. The value \( E_n \), which measures the \( i \)th sector's relative share of employment for a given county, is calculated from Oregon Resident Labor Force data provided by the State of Oregon, Employment Division, Department of Human Resources. For nine sectors, the maximum value of the diversity index is \( \log_2 9 \) or 3.1699.

Research Hypotheses

The major aim of this study to determine whether diversity is statistically correlated with improved economic performance. Economic performance is assessed in terms of two economic variables, unemployment and per capita income, considered in four different ways: the level of the variable, its rate of change over time, the degree of instability of the variable, and the degree of instability of the rate of change. Eight hypotheses are thus tested:

Hypothesis 1. Diversity and unemployment level are negatively correlated.
Hypothesis 2. Diversity and per capita income level are positively correlated.
Hypothesis 3. Diversity and unemployment growth rate are negatively correlated.
Hypothesis 4. Diversity and per capita income growth rate are positively correlated.
Hypothesis 5. Diversity and unemployment instability are negatively correlated.
Hypothesis 6. Diversity and per capita income instability are negatively correlated.
Hypothesis 7. Diversity and instability of (yearly) changes in unemployment rate are negatively correlated.
Hypothesis 8. Diversity and instability of (yearly) changes in per capita income are negatively correlated.

RESULTS

Variation in Diversity within Oregon

The map indicates the diversity indexes for Oregon counties based on employment data averaged for the period from 1972–1981. The indexes range from 2.19 for Wheeler County to 2.89 for the Portland SMSA.

The highly diversified regions occupy the Portland SMSA, the mid-Willamette Valley consortium, which consists of the Salem SMSA and Yamhill County, their neighboring counties, Jackson County, and the North Coast area. Oregon's major population and industrial concentrations are found in the Portland and Salem SMSAs, which contain Oregon's eight largest cities. This rapidly growing area is characterized by a diversified economy; a relative lack of dependence on wood products and related industries; and considerable federal, state, and local governmental activities.

The three highly diversified coastal counties (Clatsop, Columbia, and Tillamook) lie roughly west to northwest of the Portland SMSA. The economy of communities in these counties is dependent upon tourist-related activities, dairy products, fresh and processed seafood, and forest products.

Another region of high diversification, the mid-Columbia area (Hood River, Wasco-Sherman) lies east to northeast of the Portland SMSA. Its economy primarily relies on the harvesting and processing of fruit and lumber and wood products. Manufacturing also includes aluminum reduction, knitted wear, and sporting goods.
Comparatively low diversification indexes are found in central and eastern Oregon. This region contrasts sharply with western Oregon due to its higher elevation, greater temperature extremes, and shorter growing season. Counties in central and eastern Oregon are engaged mainly in the production of grain, potatoes, fruit, and hay crops. With seven of Oregon's national forests located east of the Cascade Mountains, the eastern counties remain economically dependent on resource-oriented industries such as lumber and wood products.

Outlying areas of moderately high diversification are generally to be found elsewhere in Oregon. Most of the counties located in the midwestern and southwestern portion of the state are engaged mainly in agriculture and lumbering industries. This rapidly growing area, home of several universities and colleges, which contains two of Oregon's largest cities, is characterized by a moderately diversified economy, less dependence on wood products, considerable service and trade activities, and finally, Oregon's largest and most important agricultural producing area.

The chart displays frequency distributions of the employment diversity indexes of 32 counties of Oregon averaged for the period from 1972 through 1981. During this period, 26 percent of Oregon's counties averaged diversity indexes between 2.73 and 2.79. This interval contains the highest relative frequency, and the intervals tend to contain a smaller fraction of the counties as the diversity indexes get smaller and a larger fraction of the counties as the diversity indexes get larger.

The Difficulty of Accurately Measuring Diversity

The range of diversity indexes for Oregon counties is narrow (the lowest value being 2.19), despite the fact that many counties are known to be extremely dependent on the lumber industry (and, judging intuitively, extremely undiversified). Also, the calculated entropies may not reflect "true" diversity because the sectors for which employment data are tabulated are interdependent. The interdependence of the economic sectors used in tabulating employment data is apparent if one calculates the correlations between employment in different sectors. Extremely high positive correlations are typically observed.

The way in which the employment data is categorized might be the cause of the problem. Although a county may, in reality, be heavily dependent on the lumber and wood products industry, the employment which actually depends on this industry might be counted in other sectors (for example, paper and allied products, transportation, and so on) rather than in durable goods. It would be most desirable if diversity (entropy) were calculated from sectors that were as nearly independent as possible. Though such an assumption might be tenable at the three- or 4-digit Standard Industrial Classification (SIC) level, it cannot be held at the level used for this research, essentially the one-digit SIC level.
The question thus arises of whether such "orthogonal" sectors can be obtained, either from the official data by some mathematical transformation, or by seeking employment data that are initially less interdependent. One possible approach to this task, namely factor analysis, has been explored with negative results. Factor analysis necessitates the conversion of fractional employment data into the form of standardized variables, and this form is incompatible with specific a priori constraints on the data, for example, \( \Sigma P_i = 1 \). A simpler method, that of aggregating strongly correlated sectors, has also proven to be ineffective.

**Changes over Time in Diversity Patterns**

An important question concerning diversity is whether there is a tendency toward greater diversity as an area matures. Oregon has reduced its reliance on traditional resource-oriented industries such as food and forest products. As the traditional bases of timber and agricultural products decline in relative importance, the high technology and metal-processing sectors increase.

While there has been a significant movement away from dependence on the lumber and wood products industry, it has nonetheless continued to dominate the manufacturing sector. Lumber and wood products account for virtually the entire economic base in many of the state's counties. It was also noted that most of the changes in the Oregon economy have been geographically concentrated in the metropolitan areas of Portland and Salem. Over 60 percent of the nonforest and food products employment is located there, with the balance of the state, for the most part, still subjected to the unpleasant side effects of slow-growing, highly seasonal, and cyclical industries.

To examine the changes in diversity over time, the diversity indexes of employment data were calculated for Oregon for the ten-year study period. The results are shown in Table 1. There is some evidence in these results of a slight trend toward greater industry concentration in the overall Oregon economy.

**Factors Associated with Diversity (Hypothesis 1 and 2)**

Unemployment is a factor that is often asserted to have a negative association with diversity [15]. One of the objectives of this study, as indicated earlier, is to test the hypothesis that there is a negative relationship between diversification and unemployment. To assess this association statistically, the diversity indexes of the 32 counties of Oregon for the years 1972 to 1981 were correlated with their corresponding unemployment rates (unemployment as a percent of labor force). Table 2 shows the calculated Pearson Product Moment Correlation Coefficient (above the line) and the level of significance for the one-tailed test (below the line). It is noted that the calculated correlation coefficients for employment diversity measures and unemployment rates are statistically significant (at the .05 level) for three years, and negative associations are there observed.

The data for the ten-year period were then aggregated. This yielded a Pearson Product Moment Correlation Coefficient of \(-.09 (r^2 = .008)\), indicating an extremely weak negative correlation between diversity and unemployment. The empirically derived level of significance was calculated to be .05792. At the .05 level of significance, the null hypothesis (that is, there is no correlation between the two variables, diversity and unemployment) cannot be rejected.

Another hypothesis tested was the existence of a positive correlation between diversity and per capita income for the same ten-year period. To assess this association statistically, the diversity indexes of the 32 counties of Oregon were correlated with their corresponding per capita income (logarithm of per capita income in constant dollars, that is, 1967 value = 100). In Table 3, the calculated correlation coefficient (above the line) and the level of significance for the one-tailed test (below the line) are shown. Positive correlations are observed between employment diversities and logarithms of real per capita income for the four years where correlations are statistically significant.

The data for the ten-year period were then aggregated. This yielded a correlation coefficient of \(+.18 (r^2 = .03)\), indicating a weak positive correlation between diversity and per capita income. The calculated level of significance was .0007, which is less than the .05 established criterion; thus, the null hypothesis may be rejected. There is, then, a statistically significant, but very weak degree of positive correlation between diversity indexes and real per capita income.

**The Effect of Recession on the Strength of Relations**

As a supplementary test of the relationship between diversity indexes and unemployment, the period of study was divided into recession (1974–1975 and 1980–1981) and nonrecession years. Diversities were correlated with unemployment and real per capita income for these two periods. Results are presented in Table 4. For each period, four values are reported: correlation coefficient,
Table 2

CORRELATION COEFFICIENT OF DIVERSITY WITH UNEMPLOYMENT FOR OREGON COUNTIES, 1972–1981

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* significant correlation at .05 level

Table 3

CORRELATION COEFFICIENTS OF DIVERSITY WITH LOGARITHMS OF REAL PER CAPITA INCOME FOR THE COUNTIES OF OREGON, 1972–1981

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* significant correlation at .05 level

Table 4

SUMMARY OF HYPOTHESES 1 AND 2: LEVEL STUDIES FOR RECESSION, NONRECESSION, AND TOTAL STUDY PERIOD

<table>
<thead>
<tr>
<th></th>
<th>Unemployment</th>
<th>Per Capita Income</th>
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<td>Recession years</td>
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<tr>
<td>1974–75, 1980–81</td>
<td>Correlation Coefficient</td>
<td>-0.06 (.24833)</td>
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<td>Slope</td>
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<td>Nonrecession years</td>
<td>Correlation Coefficient</td>
<td>-0.12 (.04275)*</td>
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<td>1972–73, 1976–79</td>
<td>Slope</td>
<td>-1.35066</td>
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<td></td>
<td>Intercept</td>
<td>11.22415</td>
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<tr>
<td></td>
<td>% Change</td>
<td>-15.46</td>
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<tr>
<td>Total Study Period</td>
<td>Correlation Coefficient</td>
<td>-0.09 (.05792)</td>
</tr>
<tr>
<td>1972–1981</td>
<td>Slope</td>
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<td>Intercept</td>
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* significant at .05 level

* No information on regression lines are reported for nonsignificant correlations
slopes and intercepts of the regression line, and the percent of change in unemployment or per capita income that would be associated with a change in diversity from the calculated minimum average diversity (that is, 2.19 for Wheeler County) to the maximum possible diversity (3.17). This may be calculated by:

\[
\text{% change} = \frac{(D_{max} - D_{min})}{I + m D_{min}} = \frac{98}{1/m + 2.19},
\]

where \( m \) and \( I \) are slopes and intercept, respectively, of the regression line. For the nonrecession years, for example, the slopes and intercept of the regression equation that estimates the relationship between diversity and unemployment are \( m = -1.35 \) and \( I = 11.52 \), respectively. The percent of change in unemployment associated with a change in diversity given by this equation is -15.46, which indicates that, if the diversity index had changed from the minimum observed (actual) diversity (in which the economic activity of a region is concentrated in only one sector) to the maximum possible diversity (in which all sectors contribute equally to the region's employment), the regression line would yield an associated 15.5 percent decrease in total regional unemployment.

The information contained in Table 4 suggests a major difference in the strength of relationship between the pair of variables during the different periods. The following summarizes the results: (1) The direction of the correlations for each of the two hypotheses for three periods does agree with the hypothesized direction of correlation; that is, diversity is negatively correlated with unemployment and positively correlated with income. (2) The statistical test did not allow the two null hypotheses to be rejected at the .05 level of significance for the recession years. (3) The correlation coefficient for diversity and unemployment and/or between diversity and per capita income, when measured for the nonrecession years, was higher and more statistically significant than when measured for the other two periods. (4) A major portion of Oregon's unemployment during the study period can be attributed to structural changes in the Oregon economy. Growing competition from domestic and foreign competitors has forced several industries, for example, lumber, wood products, and paper manufacturing, to become more efficient. The application of new technologies has cut unit production costs and demand for labor input. The recession of the 1970s also increased structural unemployment in Oregon. As a result of the housing slump, many jobs in construction, lumber, wood, and food industries disappeared for good. Many of the unemployed, after several attempts to obtain work in Oregon, dropped out of the labor force. If structural unemployment accounts for a major portion of Oregon's unemployment figures during the nonrecession years, then diversification correlates more strongly with variation in this type of unemployment (as opposed to cyclical, seasonal, or frictional unemployment). (5) Diversity accounts for more of the variation in the level of per capita income than in the level of unemployment (correlation coefficients are higher). (6) But to the degree that diversity is associated with unemployment and per capita income, differences in diversity are associated with greater differences in unemployment. That is, the percent of change in unemployment is higher than the change in per capita income for a particular level of diversity.

The calculations contained in Table 4 suggest that there is a statistically significant but extremely weak relationship between the level of economic diversity and the rate of unemployment and per capita income. This finding is intriguing since it appears to contradict conventional assumptions about the relationship between diversity and economic performance. However, as discussed earlier, the range of diversity for Oregon counties is narrow. The calculated entropy values may thus not accurately reflect real economic diversity, and this may explain the very weak correlations found between the level of diversity and the rate of unemployment and per capita income.

Another explanation for these results might be the nature of the economy during the 1970s. The 1970s witnessed a turnaround in the previously sluggish performance of the Oregon economy. Housing prices were rising rapidly, and the real cost of home ownership was decreasing nationwide. The resulting activity in housing construction led to an increase in the work force in Oregon. Also, the dramatic decline in the value of the dollar made agricultural commodities favorable for export to foreign countries. These two factors benefited states such as Oregon, which are dependent on lumber and agriculture. This may account for the weak relationships which have been found.

**Levels and Rate of Growth (Hypotheses 1–4)**

As a supplementary test of the relationship between diversification and unemployment and real per capita income (Hypotheses 1 and 2), the mean of diversity indexes over the ten-year study period of each of the 32 counties were correlated with the corresponding ten-year means of unemployment and real per capita income for these counties. The resulting correlation coefficient, derived levels of significance, slopes and intercepts of the regression lines, and the calculated percent changes are shown in Table 5. Columns (1) and (2) are closely related to the results presented in Table 4 and bear on Hypotheses 1 and 2; columns (3) and (4) present the findings for Hypotheses 3 and 4.

The relationship between mean diversity and mean unemployment proved to be statistically insignificant at the .05 level. However, there was a significant but weak degree of positive correlation between mean diversity and mean per capita income for the period of study. The results support the previously stated findings regarding the strength of relationship between diversity and level of employment and per capita income. (This support is, of course, expected. In Table 4, the yearly level of unemployment was used; here the average level over time is considered.)
Regarding growth rates, two hypotheses were tested; (1) the expectation of a negative correlation between diversity and the rate of growth of unemployment and (2) the anticipation of a positive correlation between diversity and rate of growth of per capita income. Using the least-squares method, trend lines (that is, estimated unemployment or per capita income expressed as a function of time) were derived for each of the 32 counties of Oregon over the ten-year study period. The slopes of these trend lines were then correlated with the mean indexes of diversity for the counties. These results are also shown in Table 5.

The calculated correlation coefficients indicate a significant but weak degree of negative correlation between mean diversities of the counties and slopes of their unemployment trend lines and a significant, moderate degree of positive correlation between mean diversity and slopes of per capita income trend lines. The results support the hypotheses that diversity is associated with lower rates of growth of unemployment and higher rates of growth of real per capita income for the counties of Oregon during the ten-year period.

It is also noted that the calculated percent of change for the growth rate of per capita income is higher than the percent of change for the growth rate of unemployment. This means that to the degree that diversity is associated with growth in unemployment and per capita income levels, the differences in diversity are associated with greater differences in the growth rate of per capita income than of unemployment.

Cyclical Fluctuations (Hypotheses 5–8)

Fluctuations in the general level of economic activity over periods of several months to several years may be described as medium-term instability or cyclical instability. The term “cyclical” instability has also been used by Wilbur Thompson [20] to refer to “a more or less regular oscillation of business activity about a growth trend . . . .” (p. 160).

One of the objectives of this study, as indicated earlier, is to test the hypotheses (5 and 6) that there is a negative correlation between diversity and cyclical fluctuation of the unemployment level and between diversity and cyclical fluctuation of the level of per capita income. To assess this relationship empirically over the years 1972 to 1981, the mean of diversity indexes of the 32 counties of Oregon were correlated with the corresponding standard deviations of unemployment and real per capita income of these counties.

The results are shown in Table 6. The calculated levels of significance for the two correlation coefficients of columns 1 and 2 were below the .05 established criterion, thus allowing the null hypotheses to be rejected. These empirical results are thus consistent with the initial assumption that diversity stabilizes levels of employment and income through compensation of cyclical fluctuations. It is also noted that to the degree that diversity is associated with stability of unemployment levels and per capita income levels, differences in diversity are associated with greater differences in the stability of per capita income than in unemployment (that is, percent of changes are higher).
In connection with this analysis, two additional hypotheses (7 and 8) were tested statistically: the existence of negative correlations between diversity and instability of (yearly) changes in unemployment and real per capita income (columns (3) and (4)). To assess these relationships empirically, mean diversity indexes and standard deviations of annual changes of unemployment and real per capita income were calculated for the period of study. These results are also shown in Table 6. The standard deviation statistic serves as a direct index of cyclical economic instability in that it measures the degree of cyclical fluctuations in economic activity around a long-run secular growth trend. Here again, the associations are negatively correlated and statistically significant. This would again suggest that the diversified areas were more stable (in terms of yearly changes of employment and per capita income) than the specialized ones during the period of study.

CONCLUSIONS

The diversity indexes of Oregon counties were calculated for the study period and the extent to which diversity indexes vary within the state was examined. Economic diversity was then studied in relation to unemployment and per capita income, and the effect of the recession on the strength of relations was analyzed. It was concluded that the strength of the relations between variables for nonrecessionary years was stronger and more statistically significant than when measured for the recessionary periods.

As expected, diversity correlated negatively with unemployment levels and their rates of growth and positively with per capita income levels and their rates of growth. The magnitudes of correlations with the growth variables were consistently higher than with the unemployment variables, but all magnitudes were small, that is, the strength of the relation between diversity and both variables is consistently weak.

Finally, economic diversity was studied in relation to growth and cyclical instability of unemployment and per capita income. The results suggest that the diversified counties of Oregon were more stable (in terms of unemployment and per capita income) than the specialized ones. The results also are consistent with the notion that diversification brings about lower rates of growth of unemployment and higher rates of growth of real per capita income for the study areas during the period from 1972–1981.

REFERENCES