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INDUSTRIAL DIVERSIFICATION AND ECONOMIC STABILITY:
A CASE STUDY OF MICHIGAN

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INDUSTRIAL DIVERSIFICATION AND ECONOMIC STABILITY:

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By

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ABSTRACT

INDUSTRIAL DIVERSIFICATION AND ECONOMIC STABILITY: A CASE STUDY OF MICHIGAN

By

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This research examines the change in Michigan's industrial structure from 1979 to 1985, and its effect on the industrial diversification of 14 regions in the State. The relationships between diversification, employment stability, and income are also examined at the regional level for 1985.

State-level annual employment estimates for 1960-85 were gathered for 21 sectors of the Michigan economy. These data, in conjunction with, regional employment proportions by sector, are used in a portfolio analytic model of industrial diversification. This model generates diversification indices, where diversification is a factor of both regional employment proportions and State-level sectoral stability.

The State, as well as, the 14 employment regions, experienced a decline in relative diversification from 1979 to 1985. This decline is due primarily to the effects of the 1982-83 recession on sectoral stability. However, the severity of this decline is not regionally uniform. It is also shown that significant relationships exist between industrial diversification, and regional employment and income stability.

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Chapter I

Introduction

The economy of the the State of Michigan has long been used as <u>the</u> example of an unstable economy. Regional economists have noted the "swings" of Michigan's economy between prosperity and stagnation and believe this economic instability is due primarily to the State's heavy dependence on durable manufacturing. It has been assumed and hypothesized in the literature that a distinct relationship between industrial diversification and regional economic stability exists. This relationship has been quantified, with some recent success (Conroy,1972; Kort,1981; Brewer,1985), but much needs to be done to determine its exact nature and strength. The past instability of Michigan's economy and the State's extreme concentration of durable manufacturing (especially automobile production) provides a unique study area to further examine the relationship between industrial diversification and regional economic stability.

Objectives of Study

This study examines the industrial structure of Michigan, through the use of a *portfolio analytic model* of industrial diversification. With this model, it is possible to identify the effect industrial diversification has on the stability of the Michigan economy. The study also examines many of the State's regional economies to determine the relationship between the State's overall economy and the economic stability of these individual regions.

This study has three primary goals.

1. Examine the industrial structure of Michigan.

The industrial structure of Michigan will be examined to determine if it has significantly changed between 1979 and 1985; 1979 being the year of the State's last employment peak prior to the most recent recession. In analyzing this change, it will also be possible to determine whether the State has become more or less diversified during this time period. Part of this examination of Michigan's industrial structure will also focus on determining which industries have become more (or less) stable over time. Of primary importance in this total analysis is to compare and contrast the regional economies that have developed around the State's industrial structure.

To further the study of the relationship between industrial diversification and economic stability, the portfolio diversification index will be compared to various measures of *regional economic instability*. Similar comparisons have been used by others (Conroy,1972; Kort, 1981; Jackson, 1984; Brewer, 1985) to measure the strength of the relationship between these two measures of a regional economy.

2. Examine possible uses of the portfolio analytic model for planning.

Industrial diversification indices are most often used for regional comparisons. Though useful in this regard, most diversification indices are of somewhat limited practical use. The results of the portfolio analytic model of industrial diversification lend themselves well to many uses in planning and economic development. Possible uses consist of weighing additions to regional income (through increased regional sectoral employment) against their impact on the regional industrial diversification level and also identifying those industries that have had an overall stabilizing impact on the State's economy.

3. Carry out a critical evaluation of the use of the portfolio analytic model of diversification to measure "small region" industrial diversification.

The use of a portfolio analytic model of industrial diversification, along with the resulting diversification indices, has been shown to be the best available measure of industrial diversification (Conroy, 1972; Brewer, 1985). As part of this study, I will evaluate the application, of this fairly recent development in measuring industrial diversification, to State and regional level data. Though the portfolio analytic technique has been applied to other "small region" data, very little work has been undertaken which identifies specific problems related to the use of "small region" data with the portfolio analytic model of industrial diversification.

Industrial Diversification, Economic Stability, and the Michigan Economy

George Borts, in one of the most detailed studies of regional manufacturing employment cycles (1960, pp. 157-158), stated,

> In terms of industrial composition the most variable states are characterized by a high proportion of durable-goods manufacture, specifically transportation equipment (e.g. automobiles), primary and fabricated metal products, machinery and lumber. The least variable states are characterized by nondurable manufactures: textiles, shoes, apparel, tobacco and food products.

In his ranking of the states by average variability, Michigan was ranked number one. Kozlowski (1979, p. 7) describes the variability of the State: "Michigan, with its heavy dependence on the automobile industry, is the most cyclically sensitive state in the region and . . . has a long standing reputation as such because of its past boom and bust performance." Haber et al. (1959, p. 62) state,

> "When slumps develop in the nation, Michigan tends to be affected more severely than the country as a whole, with a consequent higher unemployment rate. In periods of general prosperity, on the other hand, economic activity in Michigan tends to rise more rapidly than that in the national economy."

This variability or economic instability, due to the high proportion of durable manufacturing in the State, must be re-examined due to recent structural changes in the Michigan economy.

The Michigan economy, as well as the economies of some of its neighbors, is going through the process of *deindustrialization* or a decline in industrial production. This represents a significant change in the industrial structure of these States. Schnorbus and Giese (1987) examined the manufacturing output for the states of the Seventh Federal Reserve District, of which Michigan is part. They conclude, "that since 1970 the Seventh District's manufacturing sector has been producing fewer and fewer goods. This decline represents deindustrialization in the sense of an absolute decline in output" (p. 8). Corresponding to this decline in output is a reduction in the employment necessary to produce it. Though the industrial output still fluctuates up and down as demand fluctuates, the overall trend as shown by Schnorbus and Giese is toward reduced output. As the Michigan economy continues through this process of deindustrialization, and the resulting reductions in manufacturing employment needs, how will these employment reductions effect the total employment variability and the level of industrial diversification in the State and regional economies?

McLaughlin (1930, p.148), in his pioneering work on the effects of diversification on stability, suggests, "there may be some relation between degree of concentration and the severity of cyclical, as well as seasonal, fluctuations." Much recent regional economic literature suggests that the relationship between stability and industrial diversification exists, but opinions differ as to the strength and nature of this relationship. If this relationship exists, Michigan being the most variable state (according to Borts) could benefit greatly from a policy of diversification. Indeed, the Michigan Beyond 2000 Report (Hudson Institute, 1985) recognizes the need for Michigan to diversify its economy; but will the present nature of the State's economy and workforce allow it to? This need was also recognized in 1959, by Haber et al. as a way to, "mitigate the swings in production and employment in the auto industry and in certain other durable industries." They comment further, "Now, diversification becomes a 'must' for the State in order that we may compensate for the loss of . . . auto jobs." (Haber et al., 1959, p. 242). As is shown by these historical statements, the possible benefits of industrial diversification have been known for over 30 years yet the State continues to be dominated by durable manufacturing.

Koval (1970) in his analysis of the industrial diversification of Michigan gives many insights into the possibilities of diversifying the Michigan economy. He points out the necessity of diversification, but also cautions against random diversification efforts (p. 138):

> Although it is recognized that industrial diversification of the Michigan economy at a more rapid pace will bring mixed blessings to the state, it is the recommendation of this report that a selective policy designed to encourage increased industrial diversification be adopted as the official policy of the State of Michigan.
>
> The emphasis on a carefully controlled policy of selective industrial diversification cannot be overstated. If anything comes through loud and clear in this report, it is that Michigan's approach to industrial diversification should be a highly selective one -- that is, the approach should employ the "rifle" technique as opposed to the "shotgun" approach. The diffusion of energies through the random pursuit of all types of industry is not only inefficient, but will also likely prove to be largely unproductive.

A major factor underlying State-level industrial diversification is the recognition that the State is not a unique economic entity per se. The State's economy is in fact the summation of its many regional economies, with each regional economy reflecting, to some degree, an overall State economic structure. Clark, Gertler, and Whiteman (1986) discuss these relationships between national and state economic structures and local economic structure. The larger regional economic structures of Michigan, especially Detroit, Grand Rapids, Lansing, Flint, and Saginaw, are direct reflections (or causes) of the heavy dominance of durable goods production, especially automobile production, in the State. Clark, Gertler, and Whiteman, however, do not feel all specialization is necessarily detrimental: "It is important to note that a process of sectoral specialization between places produces geographical differentia which are not necessarily problems in themselves, and indeed may be signs of vitality" (p. 25). This seems to concur with the ideas of Conroy (1972) and Hoover and Giarratani (1984) that a region's economic stability is not negatively affected by specialization in general, but by specialization in *cyclically sensitive* industries. This study uses the portfolio analytic model to examine the relationship between industrial diversification (specialization) and the cyclical sensitivity of Michigan's industries.

Concepts of Cyclical Stability, Diversification, and Industrial Structure

The use of cyclical stability in the literature focuses primarily on the relationships between industries, regions and the business cycle. Briefly, the business cycle, is the response of the economy to the changes in the supply and demand for money, and the effect these changes have on the cost of money (interest rates). When interest rates are low, people and firms spend money on goods and services. They keep spending, and begin relying on credit. As more people depend on and demand credit, interest rates begin to increase. As interest rates increase, people and firms cut back on expenditures and save more. This reduction in expenditures, reduces the need for credit, so interest rates decline again. This illustrates, in a simple way, the ups and downs associated with the business cycle. Cyclical stability refers to the ability to remain "steady" as the business cycle goes through these "ups and downs". Industrial cyclical stability (or industrial stability) is directly related to the demand elasticity for the goods and services produced by a firm or industry. As prices increase (higher interest rates) the demand for new housing (construction sector) will decline greatly, but the demand for food (food and kindred products sector) will not decline very much. Since there is a direct relationship between demand and production, as demand decreases so will production (and hence employment). Regional cyclical stability (or regional economic stability) refers to the composite group of industries in the region and the joint effect their stability has on the fluctuations in total regional employment. Much recent economic research has been trying to quantify this cause and effect relationship between industrial stability and regional stability.

A diversified industrial structure is generally considered a positive regional economic goal, but how it should be obtained is the subject of much debate. Part of this problem lies in the definition of a diversified industrial structure. This concept has taken on many different meanings in the regional economic literature. An evaluation of this concept may help to exemplify why a diversified industrial structure is difficult to define and will set forth the use of this terminology in this research.

The term diversification (or diversify) has been defined in many ways in the literature. In general, it deals with, "the presence in an area of a great number of different types of industries" (Rodgers, 1957, p. 16). This definition has been qualified many times in the literature, which in turn adds to the confusion. Qualifiers such as, "balanced", "absolute", "normal", and "average" lead one to believe that diversification can be easily measured and that a specific level is desired. There has also been an assumed relationships between diversification and population size, in that larger regions are by necessity more diversified (Thompson, 1965; Clemente and Sturgis, 1971). The problem with such simple descriptions of diversification lies in that there is no standard for measuring the *differences* between industries. This study measures these differences in industries not only in sectoral size differentials, but also by the State-level cyclical stability of each sector.

What defines an industry, is subject to much historical bias. Past measures of industrial diversification used the terms "industrial" and "manufacturing" synonymously. Most of these past measures used variables such as percent of employment in manufacturing or value added in manufacturing as the indicator of industrial structure. Only recently has the scope of industry been broadened to include service activities and governmental employment, since these industries can have a profound impact on national, state, and local economies. This study uses the term industry to represent any non-agricultural employment sector in the State.

The concept of structure is probably the most vague of the three terms. Structure is often used to refer to the set of industries in an area. This definition is rather limiting, when the vast nature of industries is examined. The structure of a specific industry is in part due to its mode of operation; is an industry capital intensive or labor intensive, what is the skill level required in the industry (and its resulting impact on wages), and is the industry growing or in a state of decline. The structure of the set of industries in a region relates to the linkages and the basic/non-basic relationships between these industries. Regional industrial linkages, in terms of production and consumption, can be analyzed through the use of Input-Output analysis. This measure of structure, however, does not easily take into account (or measure) diversification and economic stability. The term structure in this study, will represent the set of industries in a region and the relationships that exist between industries in terms of cyclical stability.

The specifics of industrial structure and how to determine if that structure is diversified or not are still not totally agreed upon. It has been shown that a firm's inter-relationships can most definitely vary from industry to industry, but can also vary greatly from region to region. This regional variation, and its influence on a particular measure of industrial diversification, can often bias results. The measurement of industrial diversification is also hampered by data availability. Though it inherently has its faults, employment levels are most often used to measure and depict industrial structure due to the availability of these data. It can be ascertained from these discussions that the measurement of industrial diversification is not an exact science, but one that needs to be examined to the greatest extent possible.

Survey of Industrial Diversification Measures

The methods developed to measure industrial structure, and specifically industrial diversification, vary greatly in scope and complexity. The two most detailed surveys of industrial diversification measures are Bahl, Firestine, and Phares (1971) and Conroy

(1972). In both these studies the advantages and disadvantages of each index are analyzed, as well as, compared to indices derived by the authors.

The following survey discusses various measures developed and used in the past to measure industrial diversification. They are discussed roughly in order of complexity and historical development.

A. Coefficient of Specialization

This method, as discussed by Isard (1960, p. 271), "measures the extent to which the distribution of employment by industry classes in the given region deviate from such distribution for the United States." Simply, it compares two percentage distributions, by examining the deviations between the two. The coefficient of specialization has the limits of 0 (industrial diversification) and approaching 1 (single industry concentration). The coefficient of specialization can also be used at sub-national scales, by using a state as the all inclusive region and counties or MSA as the individual regions. This measure is useful for comparing regions for similarity in industrial mix, but by using the nation or state as a standard of reference the measure is biased by the existing industrial mix of the larger region. If the larger region itself is poorly diversified, measuring a region against this industrial profile is of limited use.

B. Durable Goods Measures

Past attempts at explaining regional cyclical variations used industrial diversification measures based on the proportion of durable manufacturing in a region. Examples include the works of Siegel (1966) and Cutler and Hansz (1971). Using the size of the durable goods manufacturing sector as the sole indicator of industrial diversification leaves much to be desired. Though these industries are historically the most sensitive to movements in the business cycle, limiting diversification analysis to only these industries will tend to bias the results against larger urban areas. Larger urban areas tend to have a larger proportion of their labor force engaged in durable manufacturing due to the benefits gained by these industries locating in the urban environment and possible agglomeration economies.

C. "Normal" Proportion Measures

A number of attempts at measuring industrial diversification fall into this category. These methods measure regional industrial diversification as some form of deviation from a given "normal" sectoral employment distribution; "normal" in terms of an ideal or expected level. Many types of "normal" proportion distributions are examined in the literature. Bahl, Firestine, and Phares (1971), summarize these measures by categorizing them into three groups: (1) equal percentage (or ogive); (2) national average; and (3) minimum requirements. These measures have been used mostly with employment data, but have also been used with income data.

Probably the oldest and most often used of the three types of "normal" proportion measures are the equal percentage measures. The equal percentage or ogive measures of industrial diversification use as a premise that each industrial sector should have equal percentages of employment to be totally (and optimally) diversified. An example of the equal percentage concept would be that if 8 industrial sectors exist, each sector should have 12.5 percent of the region's total employment to be completely diversified. The first uses of this type index are found in McLaughlin (1930) and Tress (1938). One of the most cited example of the use of this type of measure is Rodgers (1957). Rodgers' use is slightly different than most in that he constructed cumulative percentage (ogive) or Lorenz curves and compared these to the optimum diagonal (equal percentage in each sector) hence the term "ogive" is often used to refer to this type of industrial diversification measure.

The equal percentage measures have gained a wide acceptance and are still used due to their ease of use and calculation. Keinath (1985) used a modified equal percentage measure as his industrial diversification index. Keinath's index is a summation of absolute deviations from the equal percentage value, instead of using squared deviations. He felt this modification allowed for better interpretation of an individual sector's contribution to the overall index.

The major criticism of the equal percentage measure is the arbitrarily implied equal percentages for optimal (maximum) diversification. The goal of an equal percentage of employment in each sector is probably impossible to achieve in a planning context and has no empirical justification. To arbitrarily establish that all sectors in a given region should possess the same percentages of some economic variable (employment, income, etc.) allows for no differences in market structure between different sectors. Economic realities such as scale economies, regional differences in demand, and the differences in input quantities used by the different sectors are totally ignored.

The second group of "normal" percentage measures are referred to as the national average measures. These measures use as the "normal" percentage distribution the national average percentage in each sector. The use of national average measures, is represented by the works of Florence (1948), and Borts (1960). Though this type of measure represents the size of each sector better than the equal percentage measures, it is still a very rough approximation. Regional differentiation in production capabilities, demand, resources, and other components of a regional economy causes these measures to over-estimate or under-estimate the size of sectors in the regional economies. The national average measures can also extremely bias the results if a region does not include a specific sector.

The third type of "normal" proportions measure is the minimum requirements technique developed by Ullman and Dacey (1960). The authors characterize urban sectoral employment structures into "minimum requirement" employment and excess employment. The "minimum requirement" employment is that percentage needed to maintain the internal viability of a region. They conclude this employment level is the "minimum requirement" necessary since the percentages are empirically derived (through regression analysis). The employment percentage that remains in excess of the minimum required, according to Ullman and Dacey approximates the export or basic employment of the region. Ullman and Dacey do however categorize cities by sizes, acknowledging that different sized cities may need different percentages to maintain viability. Therefore they have derived a "normal" or "necessary" percentage employment in each sector for a given city size classification. Although Ullman and Dacey primarily developed this technique as a quick method for estimating the economic base of a city or region, they also developed an index of diversification from their method. The uncorrected diversification index is a summation of the squared deviations from each sector's "minimum requirements" percentage divided by its "minimum requirements" percentage. The index is then corrected for city size by dividing the unadjusted index by the ratio of squared basic employment percentage and the total minimum requirements employment percentage.

Bahl, Firestine, and Phares (1971) contend that this index is already corrected for city size differentials in the regression process used to estimate the minimum requirements percentages. They therefore use as their Adjusted Minimum Requirements Index only the numerator of the Ullman and Dacey equation.

Though both minimum requirements approaches use unique ways of determining the "normal" proportions, they both fall short in several respects. The minimum requirements percentages may differ not only by city size differentials but also by regional differentials. The calculation of the "minimum requirements" percentage from a cross section of U.S. cities implies a "national" scale to these indices, causes this measure to be biased in a way similar to the "national average" measure discussed previously.

D. Entropy Measures of Diversification

Recent attempts at measuring industrial diversification have considered the concept of entropy in defining what is concentrated and what is diversified. Entropy, as a physics or thermodynamics construct, measures the amount of disorder within a given system. This measurement of disorder has been used to analyze the spatial distribution of various socio-economic variables, including the geographic concentration of industry (Garrison and Paulson, 1973). These uses assume a relationship between entropy and equity, in that the more dispersed a variable is (higher entropy), the more equitable the distribution. The proponents of the regional economics application of entropy assume that a highly specialized regional economy is highly ordered, and therefore has a low entropy value. This assumption equates high entropy levels with well diversified economies. Hackbart and Anderson (1975), were the first to apply the concept of entropy specifically to the measurement of industrial diversification. In this study they calculated industrial diversification indices for several regions in Wyoming for the purpose of regional comparison. Wasylenko and Erickson (1978), in the first test of the statistical relevance of the regional economic application of the entropy measure, found a high degree of correlation between the entropy measure and the equal percentage or ogive measure (Spearman's r = .98, statistically significant at .001). They cited problems with both measures similar to those mentioned previously for the equal percentage measures. Wasylenko and Erickson feel that if the measures are so similar, the use of the more widely used and accepted equal proportion measure is warranted based on ease of calculation alone.

Kort (1981) applied an entropy measure of industrial diversification to 106 SMSAs in the United States. In this study he uses his diversification index as an independent variable to predict a measure of regional economic instability. This regression relationship is similar to the one tested by Conroy (1972) and suggested by Siegel (1966). Kort noted that the residuals of this initial regression exhibited marked heteroscedasticity (unequal variance) in that the residual values from smaller regions tended to be larger. These unequal variances violate one of the major assumptions of the regression model. Kort, based on a discussion by Thompson (1965), assumed this heteroscedasticity to be related to city size differentials. Thompson (1965, p. 118) states that,

> ... large urban economies tend to have diversified industrial structures and, therefore, tend to replicate the national degree of cyclical instability; the smaller urban economies exhibit a much greater range of cyclical instability, as some tend to specialize in the more unstable and some in the more stable industries.

Kort corrected the heteroscedasticity by using a weighted least squares (WLS) regression with the variables weighted by the square root of population. He found the resulting equation significant with an increase in adjusted R^2 from .080 to .642. This result was criticized by Brewer and Moomaw (1986) as being incorrect. They stated that Kort had fallen into a common pitfall of miscalculating the adjusted R^2 of a WLS regression. When Brewer and Moomaw, using the same data used by Kort, recalculated the regression and the adjusted R^2 correctly, explanatory power was significantly decreased from Kort's value of 64. 2% to 7. 5%. However, the further explanation of the relationships between industrial diversification, regional economic instability, and city size is seen as a significant accomplishment (Brewer, 1985).

Portfolio Analytic Measure of Industrial Diversification

The use of the portfolio analytic measure of diversification originated with the analysis of securities in a financial portfolio. Markowitz (1959) developed portfolio analysis as a method of measuring the risks associated with the returns to various portfolios of financial securities (stocks), and the effect diversification has on the level of this risk. Financial risk is measured as the historical variability, of the returns to a dollar, invested in a specific stock (the greater the historical variability, the greater the risk). A covariance matrix, whose elements represent the similarities between different stocks in historical risk fluctuation, is calculated from the "time series" of the individual stocks past returns. The portfolio index consists of the summation of values from the calculated covariance matrix, each weighted by the proportion of the total portfolio in each stock.

Conroy (1972) applied the Markowitz portfolio analysis model to the analysis of regional industrial structures. Conroy measured *returns* in terms of employment level and measured *diversification* as an aggregate, *expected* measure of risk, where the variability in employment level is considered the risk. This variability (or risk) is measured in terms of the covariance of residuals from detrended sectoral employment "time series". To derive the regional diversification values this calculated covariance matrix, "provides the basis for estimating the theoretical variability of the industrial structures in each region on the

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assumption that the covariability of individual industries is identical across the nation" (Conroy,1972, p. 128). **A lower measure of risk, and therefore a lower index value, indicates a more cyclically stable, more diversified industrial structure.** This inverse relationship between actual diversification level and the Markowitz-Conroy portfolio analytic diversification index value is due to the fact that a stable industry (low variance and covariances) has a positive effect on actual diversification level, but reduces the index value.

Conroy uses regression analysis to examine the relationship between diversification and regional economic instability for 52 SMSA in the United States. He calculates four different indices of diversification: an ogive or equal percentage measure, a national average measure, a percent durable measure and the portfolio analytic measure. Using these various measures of diversification as the independent variable in a number of simple linear regression models, he tries to explain the dependent variable, regional economic instability (which is a standardized amplitude measure based on the standard error of the estimate of a time series each region's manufacturing employment). The results of Conroy's tests indicate that of these four industrial diversification indices, the portfolio analytic technique significantly outperforms the other three by more accurately predicting regional economic instability. Conroy reports that the portfolio index explains 42.16% of regional economic instability and is significant at the .01 level, whereas the other indices could explain no better than 8.45% with less statistical significance. Conroy argues that this approach re-establishes the validity of the link between diversification and economic stability. Conroy (1972, p. 143-44) states:

> It would appear doubtful that any other single factor can be expected to account for as much as 42% of the variation in a cross section as small as 52 cities. In the opinion of the author [Conroy] , such significance for the data series which were previously established as a priori the most important, lends more-than-adequate credibility to a policy of careful diversification in order to stabilize regional economies.

A number of problems and concerns have been identified with Conroy's approach. One major problem is that he used a national level covariance matrix to determine the industrial structure to be applied to the SMSA. This procedure precludes any regional differentiation in the relationships between industries. As Conroy (1972, p. 162) noted, "the assumption that the variance-covariance matrix of employment in alternative industries was identical for all regions . . . is likely to have introduced further spurious variation." Brown and Pheasant (1985), identify two other difficulties with Conroy's approach: 1) that Conroy excludes non-manufacturing industries, and 2) Conroy examines only metropolitan areas. These are seen to be major problems due to the role non-manufacturing industries play in regional employment, and the vast differences in regional economic structure between industrial/urban regions versus more agricultural/rural regions.

The major concern with the use of the portfolio index of industrial diversification is the large amount of data needed to calculate the full Markowitz covariance matrix. To calculate this matrix, temporal data is needed for each industry to be examined. This problem is compounded by the desire to have as much sectoral or industry disaggregation as possible, since as the number of industries increases the size of the covariance matrix becomes very large.

Brown and Pheasant (1985) attempt to eliminate some of the problems with Conroy's method by employing an alternative method of portfolio analysis developed by Sharpe (1963). Sharpe's technique measures the risk of financial return in terms of the correlation with an economic index such as the Dow Jones Industrial Average. The percentage not correlated with this index is considered to be the "risk" level for that security, since the correlation value measures the sensitivity to the national market. Those securities that have low correlations with the economic index, though their returns may be higher, are more risky in that it is more difficult to predict the "ups and downs" of the particular stock. The regional economic application of the Sharpe technique is based on the assumption that an area's individual economic sector's rate of growth can be separated into that part which is not responsive to an economic indicator index (such as unemployment rate) and that which is; and apart from their correlation with the index the rates of growth are uncorrelated. The Sharpe type index, as noted by Brown and Pheasant, omits any linkage or inter-industry effects (similarities between two different industrial sectors' variability). They feel this is not a problem at the county level, but that it could be at the SMSA level. This distinction seems very vague since many SMSAs are single county in size. This technique also has problems identifying those industries that are doing well in times of economic slowdown or recession. If employment in the economy as a whole is declining, a low correlation value may indicate either an industry experiencing an even more difficult period or an industry that is maintaining its growth in the recessionary period (some services, "high tech" oriented industries). The primary reason Brown and Pheasant chose the Sharpe method was to eliminate the need to calculate the large number of covariances. Calculating these covariances with a microcomputer has reduced the time and difficulty of calculation, that the possible inaccuracies of the Sharpe technique far outweigh its time saving merits.

A number of studies using modifications or elaborations of the Conroy-Markowitz portfolio index exist in the literature. Barth, Kraft, and Wiest (1975) developed an index in a similar context as the Conroy-Markowitz index with the exception that instead of detrending each time series by removing a quadratic trend, they eliminate the "predictable component in industry employment" using a first-order autoregressive model (using the previous year's employment to predict the present year's employment). This is seen by the authors to be a simplistic technique but fine for "illustrative" purposes. St. Louis (1980) further develops the theoretical aspects of the Markowitz and Sharpe methods and modifies the Conroy technique by "using the notion of an efficiency frontier." St. Louis' covariance matrix is calculated from time series consisting of deviations from the mean growth rate. Using a quadratic programming technique (critical line method), he finds, "a finite number of adjacent portfolios on the efficient frontier that differ from one another with respect to the status of at least one . . . industry." These adjacent portfolios are termed "corner portfolios". St. Louis uses as his measure of diversification, the minimum "distance" between the region's portfolio index (which will be within the efficiency frontier) and a "corner portfolio". None of these adaptations of the portfolio analytic model of industrial diversification examine the relationship between diversification and regional economic instability as did Conroy (1972) or Kort (1981) so that comments as to the relative statistical merits of these various methodologies is impossible.

Brewer (1985), replicating Conroy's study, found heteroscedasticity in the residuals, when the portfolio diversification index is used in a regression equation to explain regional economic instability. This pattern of heteroscedasticity is similar to the one found by Kort (1981) in his comparable regression model. As mentioned previously this pattern has been suggested by Kort (1981) to be related to city size. When Brewer corrects for this heteroscedasticity using a Weighted Least Squares (WLS) regression (weighted by the square root of population size), the adjusted R^2 value increased to .521 in comparison to Conroy's value of .422. This lead Brewer (1985) to state, "The results further indicate that a portfolio measure of diversification deserves increased recognition in future research compared to the more traditional measures of regional diversification."

Jackson (1984) performed a study similar to Conroy's in that he calculates various types of diversification indices and compares them to a measure of regional economic instability. He attempts to address some of the applicability questions of the portfolio analytic technique of measuring industrial diversification and the policy implications of industrial diversification in general. Jackson's results lead him to state that, "... policy decisions should not be based on the relationship between currently available measures of industrial diversity and regional employment stability." This pessimism, however, probably stems from the results of his analysis. Interpreting Jackson's results, however, is a bit difficult due to some problems with his data aggregation and collection methodologies. He comments further on the complexity of regional economies and the large number of variables a policy maker must consider in making development decisions. Jackson (1984, p. 109) states,

> ... rapid growth, cyclically sensitive industries are often preferable to more stable, slow growth industries. This tradeoff is but one of many, and leads one to question whether employment stability and growth are in fact the appropriate measures of risk and return.

He fails to realize, however, that the portfolio model of diversification, provides a very useful method for determining the local stability of industries for planning and development purposes (this method is further developed in the Chapter 4 of this study). Jackson also comments that the relationship between economic stability and historical diversification levels is, "... crucial in a policy context" (1984, p.106). This relationship needs to be established in order to use the actual diversification index in a planning application.

In one of the most unique uses of the portfolio analytic model of diversification, Bolton (1986) examines State-level diversification using income data for 48 "sectors" of the economies of the New England states. Bolton's study is very unique in two respects. First, Bolton's analysis differs from that of Conroy in that he removes both trend and cyclical fluctuations. He removes these two types of fluctuations by eliminating a "constant growth-rate trend plus first- and second-order autocorrelated deviations from the trend, measured relative to the trend." Bolton states, "This trend-cycle is variability in income that is expected by the decision maker." This analysis assumes that cyclical variability is expected and that people adjust the use of their income accordingly by saving or spending differently. Second, Bolton's study is unique in that he includes the non-employment income categories of property income and transfer income as two of his "sectors". He argues that in measuring diversification in a region's total income, the effects on stability of these two income generating sectors must be included. They are included since they may account for a relatively large proportion of total personal income and the stabilization effects of these two types of income are very important.

In this context, my study will use the portfolio analytic model of diversification to examine the industrial structure of Michigan, and the change in this industrial structure from 1979-85. The study will also explore the possible uses of the portfolio analytic model's results for planning and policy purposes.

Regional Economic Instability

As has been noted, much of the discussion of industrial diversification relates to the effect the level of diversification has on the economic stability of a region. Conroy (1972, 1975b) outlines the historical development of regional economic thought concerning cyclical stability and its regional effects. The concept of regional economic instability was first measured as such by Siegel (1966). *Regional economic instability* as a measure (tool) is most often used as a region specific measure of employment variability. The calculation of regional economic instability therefore yields an index which measures the instability of a regional economic variable over time. Similar to the portfolio index, **a lower value for *regional economic instability* indicates a more stable regional economy, and consequently a larger value indicates a less stable economy.**

The concept of regional economic instability may have been applied earlier than Siegel (1966) since it is based simply on the standard error of the estimate of a trend line fit through a time series of a regional economic variable (in this case employment). Siegel and Conroy (1972) use the residuals, from a detrended total manufacturing employment time series, to calculate regional economic instability. Kort (1981), however, uses total non-agricultural employment as his variable to measure instability due to the inclusion of many non-manufacturing sectors in his analysis. Both Conroy and Kort use employment variables in their diversification indices and try to explain, through regression analysis, their instability measures which are based on regional employment. However, regional economic instability can be calculated using a number of variables.

The measurement of regional economic instability has not been limited to techniques based on the standard error. Brewer (1984), used as his measure of regional economic instability a ratio of returns to risk. The ratio consists of the percent change in manufacturing employment (returns) divided by the change in unemployment (risk) experienced in each of the SMSAs in his study. Brewer feels that, "together they [the two variables in the ratio] provide a picture of the stability of each region by capturing the in and out migration of the labor force as well as the changing experience of the more permanent labor force." Though the theoretical basis for the returns : risk ratio is logical, a measurement of economic instability based solely on a one year change will be biased by large fluctuations that may occur in either variable during the particular year period. The measure will also be biased by the sign (positive or negative) of the ratio. It is assumed in Brewer's study that a positive ratio is more stable and desirable, yet a positive percent increase in manufacturing employment divided by a negative percent change (decrease) in unemployment would yield a negative ratio. Also a negative percent change in number unemployed, for no other reason than those who were unemployed migrated out of the region, would be seen as having an important stabilizing impact. These problems with this ratio measure of stability makes the use of the measure questionable.

The present study will examine (as did Conroy, (1972); Kort, (1981); Jackson (1984); and Brewer (1985)) the relationship between industrial diversification and regional economic stability. This relationship is seen to be crucial in establishing the validity of diversification measurement techniques, as well as to regional economic development efforts. Unlike past attempts however, this study will examine the relationship between industrial diversification and regional economic instability measured not only with regional employment, but also with regional income. A temporal comparison between historical diversification (1979) and present (1985) regional economic stability will also be examined due to the possible policy implications of this historical relationship.

Chapter II

Hypotheses, Study Area, and Data

Introduction

The economy of the State of Michigan is, and has been, extremely reliant on the durable goods industries, especially the automobile industry. This State reliance is transformed into regional economic dependence, within the State, on these same industries. However, regional differentiation exists in the reliance on these durable goods industries, with some regions becoming more diversified into the nondurable industries and into the service sectors. This study aims to explore this regional differentiation by examining the State's industrial structure in 1979 and 1985 and the various regional responses to this structure.

This study will give further insight into the industrial structure of Michigan, in hopes of gaining a perspective on the possibility of Michigan diversifying its economy. The study will identify those sectors which are the most (and least) stable in the State, in order to provide alternatives for future industrial development. It will also identify those regions in the State that have had the greatest ability to maintain stability in an economy that can at best be described as volatile.

The use of the portfolio analytic model of diversification to provide measures of variability (or risk) of possible industrial structures that may be evaluated in a policy and planning context. These measures help identify possible alternatives for developing the industrial structure of a regional economy, giving policy makers many options in deciding which industrial structure to pursue.

The use and evaluation of the portfolio analytic model will further expand the literature on this recent development in measuring industrial diversification.

Research Hypotheses

As part of this study seven research hypotheses are tested to examine the industrial structure of Michigan and the regional differentiation in response to this structure. The applicability of the portfolio model of diversification for planning or development purposes is also examined in a number of hypotheses.

1. **A significant change in the regional diversification indices has occurred between 1979 and 1985.**

This hypothesis examines the change in regional diversification levels from the pre-recession employment peak (1979) to the present (1985). It is felt this time span of six years, by encompassing the recessionary employment trough, will yield a significant change in the regional diversification pattern.

2. **A significant change in the industrial structure of Michigan (as measured by the inter-industry covariance matrix) has occurred between 1979 and 1985.**

This hypothesis, actually a sub-hypothesis of the first, is used to test if the economic recovery from the most recent recession might be attributed in part to a change in the industrial structure between 1979 and 1985. Though Thompson feels (1965, p. 21), "... as much as two decades may elapse between shifts from one economic base to a substantially new one" I believe the inclusion of 1982-83 recession warrants examination of the six year span. Due to a national trend toward a service economy, the deindustrialization of the Midwest region, and the State's recovery from the recent recession it is hypothesized that a significant change in the industrial structure in Michigan has occurred. The results of this hypothesis will also detail the hypothesized change in regional diversification indices.

3. A significant positive relationship exists between the regional diversification indices (1985) and regional employment instability (1985).

This relationship is similar to those tested by Conroy and others, and is used to determine the strength of the relationship between diversification levels and regional economic stability. The relationship is important in a policy context, since a policy maker's arsenal to effect regional economic stability is limited. The ability to effect industrial diversification through tax incentives, public financial assistance, and other methods at a more local level is possible , and therefore may be used to improve regional economic stability.

4. A significant negative relationship exists between the regional industrial diversification indices and population.

It is a common assumption that larger, more populated areas are by function and necessity going to be more diversified (theory of urban hierarchies). A positive relationship between industrial diversification and population size has been hypothesized (Thompson, 1965) and examined (Clemente and Sturgis, 1971) but was tested using other, cruder measures of industrial diversification. The hypothesis is cast as a negative relationship due to a <u>lower</u> index value indicating a <u>more</u> diversified economy.

5. A significant relationship exists between regional employment instability and regional income instability.

This hypothesis is designed to test the relationship between employment stability and income stability. The relationship between these two measures is difficult to foresee. The difficulty lies in the numerical sensitivity of the two indices. Since regional employment instability is measured using a time series of annual total non-agricultural employment every employee in a region is treated as every other; a strict count. However, in the measurement of regional income instability qualitative differences exist in terms of an employee's income. The two employees which count the same in the employment measure may have different incomes (doctor vs. student) and thus are qualitatively and quantitatively different. The effect of the employment or unemployment of these two workers is very different on each measure. The ambiguous nature of this relationship is heightened by the knowledge that those industries in Michigan that historically have had the higher wages are also those most sensitive to cyclical fluctuations (transportation equipment, fabricated metals).

6. **A significant positive relationship exists between the regional industrial diversification indices and regional income instability.**

This hypothesis examines the relationship between industrial diversification and regional income stability. The hypothesis stems from the assumption that a well diversified regional economy, may be better able to maintain regional income stability.

7. **A significant positive relationship exists between the historical regional industrial diversification index (1979) and present regional economic instability (1985).**

This hypothesis examines the role historical diversification plays in determining present day regional economic instability. This relationship is seen by Jackson (1984) to be very important from a policy context. If a positive relationship does not exist, the practical use of using present diversification levels to guide policy and development decisions is very limited. The strength of this relationship will also indicate to what degree future stability can be "expected" to follow present diversification.

Study Area

The primary focus of this research is to examine regional differentiation within the State of Michigan. Though it would be desirable to examine this differentiation at the county level, data requirements of the portfolio model and the desire for as much sectoral disaggregation as possible precludes analysis at this level. The regional breakdown chosen, as shown in Figure 1, includes the eleven Metropolitan Statistical Areas (MSA), defined by the 1980 census and used by the Bureau of Labor Statistics (BLS) and three Labor Market Areas (LMA) as identified by BLS and the Michigan Employment Security Commission (MESC). A Labor Market Area is defined as, "An economically integrated geographical unit within which workers may readily change jobs without changing their place of residence." (MESC, 1986).

Due to the "metropolitan" aspect, the MSAs are by nature in the more populated areas of central and southern Michigan. The three LMAs used, are those for which suitable sectoral detail was available, due to their population size. The Upper Peninsula LMA is also divided into a number of smaller LMAs but the use of these individual units is hampered by non-disclosure regulations. The use of the entire Upper Peninsula of Michigan as an LMA seems to violate the "commuting" definition of an LMA but for the purposes of this study its use is better than having no representation of the Upper Peninsula whatsoever.

The use of these 14 regions in the study, will only give a partial picture of the regional differentiation in the State of Michigan. The 14 regions include 40 of the State's 83 counties. (See Appendix A. for county composition of each employment region). Though this is less than half of the State's counties, these 14 regions account for 89.8% of the State's 1985 total non-agricultural employment. The large percentage accounted for by the 14 regions, gives credibility to their use in examining the regional differentiation in diversification and economic stability in Michigan.

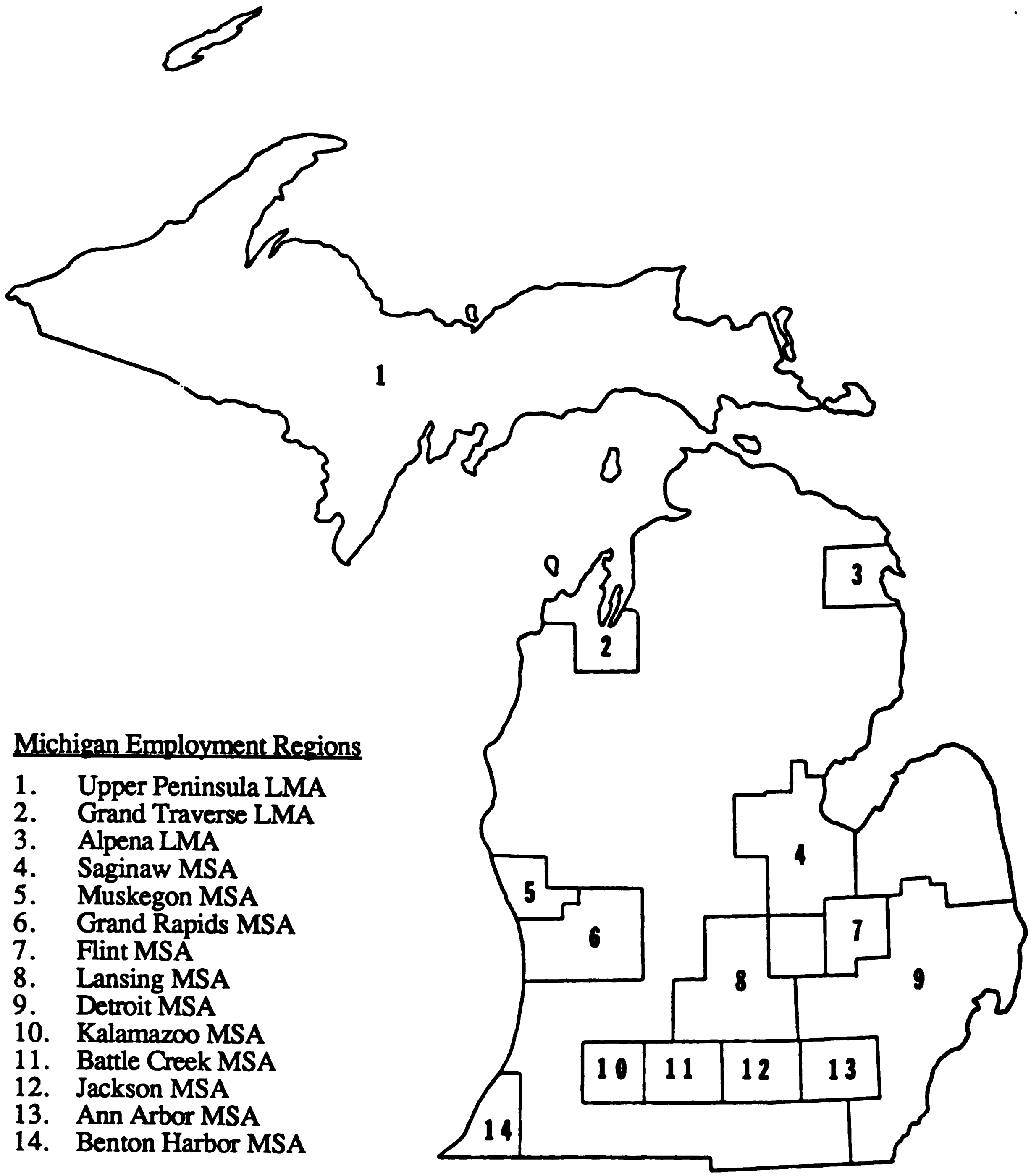

Figure 1. Michigan Employment Regions Used In This Study

Data and Data Sources

State and most regional employment data for this study were obtained with the assistance of the Michigan Employment Security Commission's Bureau of Research and Statistics. Most of the data are available from the Michigan Employment Statistics Volume I (Michigan), Volume II (Ann Arbor and Detroit MSA) and Volume III (Battle Creek, Benton Harbor, Flint, Grand Rapids, Jackson, Kalamazoo, Lansing, Muskegon, Saginaw MSA and the Upper Peninsula LMA). Regional employment proportions for the LMA of Grand Traverse/Leelanau counties and Alpena county were gathered from separate, non-published MESC materials to better represent the northern Lower Peninsula. These data, used in this study, consist of annual employment averages by sector for the State from 1960-1985, and regional employment levels by sector for 1979 and 1985. State-level data from 1956-1959 is available, but due to disclosure and aggregation problems, and the post Korean War recession these data do not fit the study well.

These MESC data are survey based and therefore are estimates of the true employment values. MESC, which collects data for the Bureau of Labor Statistics (BLS), uses the Current Employment Statistics (CES) Survey methodology as established by BLS. The CES Survey is different from the Census "household" surveys.

> The "household" survey includes unpaid family workers, domestic workers, proprietors and other self-employed persons while all are excluded by the CES survey. ... The "household" survey provides more detailed data on the characteristics of the employed while the CES provides more detailed information on the industrial and geographical distribution of the employed. (MESC, 1986, p. 164).

Due to the survey nature of these data, the values are often rounded to the nearest hundreds. This "rounding" causes some problems when the value is near the cut-off in one year and just over the cut-off in another year. This problem would give the indication of a 100 person shift from one year to the next, biasing the results. Though using employment estimates is less than ideal for these reasons, it is the best available data which meet the rigorous requirements of the Conroy-Markowitz technique while still providing suitable regional detail to examine the regional economies of Michigan. It also the most readily available data used by State and local economic development in Michigan.

Due to differences in SMSA and MSA boundaries, changes in Standard Industrial Classification (SIC) codes, and disclosure problems, a small amount of additional data was needed for clarifying and replacing some missing portions in the above data set. These data were gathered from the MESC's Wage and Earnings Employment Reports and the County Business Patterns published by the Bureau of the Census of the U.S. Commerce Department. The direct use of County Business Patterns (CBP) data is not appropriate, since the two survey techniques are different. To reduce this possible bias, only proportions were calculated from the CBP data and then applied to the corresponding MESC data. This procedure was particularly useful when disaggregating the unfortunate grouping of the mining and service sectors in some of the MESC reports. The ratio of mining to the sum of mining and services from the CBP data was calculated and then applied to the MESC data to disaggregate the grouping.

The data requirements of the portfolio analytic model of industrial diversification include detrended State-level employment time series and regional sectoral employment for a given year. However, these regional sectoral employment values must be converted into proportions for use in the model. The regional sectoral employment levels are divided by the region's total non-agricultural employment to obtain these employment proportions for each of the 14 regions in the study. A similar procedure was also used to obtain State-level sectoral employment proportions by dividing the total State employment in each sector by the total State non-agricultural employment. In hopes of still further minimizing the bias introduced by the rounding of employment values by the MESC, the regional, sectoral employment proportions were calculated to only three decimal places. By examination, additional decimal places began adding unwarranted detail to the employment proportions. These employment proportions are given in Appendix B (1985) and Appendix C (1979).

In order for the diversification index to be of use, as much sectoral disaggregation as possible is necessary. From the above data sources an all inclusive 21 "sector" breakdown (disaggregation) of Michigan's total non-agricultural employment is possible. These "sectors" were determined based on two criteria. The first and foremost criteria is based on State-level "time series" data availability. This was supplemented by a second, more subjective, criteria based on State-level employment in the sector, along with regional data availability. Some sectors such as Furniture Manufacturing (Grand Rapids) and Electrical Machinery (Benton Harbor) though a large regional employment proportion exists in each, are so regionally unique that regional employment levels for these two sectors could not be obtained for all the regions. In these instances both Furniture Manufacturing and Electrical Machinery are aggregated into Other Durable Manufacturing. The sectors and their corresponding SIC codes are given in Table 1.

As stated in Chapter 1, the calculation of regional economic instability for this study will use two different variables. First, to calculate a measure of employment instability, a total non-agricultural employment time series was gathered for each region from available MESC data. This presented a minor problem in that the regional subdivision into Labor Market Areas (LMA) had not been defined prior to 1970, and therefore data for years prior to 1970 could not be collected for the LMAs. Thus the employment time series for the MSAs are from 1960-85 and for the LMAs the employment time series are from 1970-85. This is not seen as a significant problem due to the relationship between the formulation of regional economic instability and the standard error of the estimate of a regression. Since the standard error is the square root of the sum of the squared deviations divided by N-2, the differences in the "length" of the series alone, should not cause the regional economic instability results for the LMAs to differ by any order of magnitude from the MSAs results. Though some loss of information will result from the use of these shorter time series for the LMAs, I feel the information gained from inclusion of these northern Michigan regions far outweighs any possible bias that may be introduced.

Table 1

21 Sectors of Michigan Economy and Corresponding SIC Codes.

Sector	SIC Code(s)
Mining	10, 13, 14
Construction	15, 16, 17
Durable Manufacturing	
Lumber and Wood Products	24
Primary Metal Industries	33
Fabricated Metal Industries	34
Non-electrical Machinery	35
Transportation Equipment	37
Other Durable Good Manufacturing	25, 32, 36, 38, 39
Non-durable Manufacturing	
Food and Kindred Products	20
Paper and Allied Products	26
Printing and Publishing	27
Chemical and Petroleum Products	28, 29
Other Nondurable Good Manufacturing	21-23, 30, 31
Service Producing Industries	
Transportation and Public Utilities	40-42, 44-49
Wholesale Trade	50, 51
Retail Trade	52-59
F.I.R.E.	60-67
Services	074, 075, 078, 70-89
Federal Government	--
State Government	--
Local Government	--

Second, I will use regional wage and employment income available from the Bureau of Economic Analysis (BEA) to calculate a measure of regional economic stability to examine the relationships between regional employment and income stability (RII, Regional Income Instability). This index is a region specific summary value of instability of all income earned in all sectors of employment. These BEA data were gathered by county and aggregated to the 14 regions, for the years 1962, 1965-84, the only series available. It is hypothesized that the regional differentiation possible with regional income instability, will differ from regional employment stability, and will give a better insight into the total effect industrial diversification has on a regional economy.

The specifics of the calculation of both the portfolio model of industrial diversification and regional economic instability are given in the next chapter.

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Chapter III

Methods of Data Analysis

This chapter details the procedures used to calculate the portfolio analytic model of industrial diversification, including specifics on model specification. The chapter also describes the calculation of the two measures of regional economic instability. The chapter ends with formal hypotheses statements and a description of the statistical methods used to test each.

Calculating the Portfolio Analytic Index of Industrial Diversification

Since the portfolio analytic index of industrial diversification measures diversification as a function of both the stability of the industry and the proportion of a region's employment in the industry, there are two major steps involved in the calculation of the model. The first step used in calculating the Michigan regional portfolio indices is to obtain detrended, employment time series for each sector at the State level. The original data used to obtain these time series consists of annual employment averages, by sector, for the years 1960-1985 (See Figure 2). The process of detrending the raw annual data removes the effect of growth from the time series. Without the removal of the growth trend, those sectors that experienced growth would be treated as highly variable and in a Markowitz sense, would be "risky". Through regression analysis it is possible to remove the growth trend component from each sector's time series. The residuals from this detrending regression model, are the measure of each year's "risk" or variability. If the annual employment averages conform to the trend, the "predictive" power of the trend is strong, and the risk is seen to be small. The more the actual values deviate from the trend the more "risky" the sector is assumed to be Each time series is subjected to detrending using a trend of t

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of the basic form:

$$Y = a + b_1T + b_2T^2 + e$$

where: Y = the annual employment average
T = time, 1960=1, 1961=2, ..., 1985=26
e = residual

This type trend, which removes both a linear time component (T) and a squared time component (T^2), is termed a *quadratic* trend. Figure 3 depicts a quadratic trend line through the time series of Michigan's annual employment in the construction sector. Conroy (1972) found the quadratic trend to be statistically better fitting than either a simple linear trend or a log-linear trend. He also explains that a simple linear trend is a subset of the quadratic form, when the b_2 coefficient is 0.00, making the use of the quadratic even more applicable. Upon examination of trends from higher order polynomial regressions (including T^3, T^4, T^5, T^6, ... terms) the residuals obtained either did not differ greatly from those obtained using the quadratic, or the trend equation began "fitting" and eliminating the cyclical fluctuations I wish to examine.

Conroy, however, does not detail his procedure for handling residuals from an equation with a 0.00 (statistically insignificant) coefficient on either the **T** or T^2 term. Johnston (1984, p. 262) discusses the problem of insignificant variables in a regression equation.

> ... it is more serious to omit relevant variables than to include irrelevant variables since in the former case the coefficients will be biased, the disturbance variance overestimated, and conventional inference procedures rendered invalid, while in the latter case the coefficients will be unbiased, the disturbance variance properly estimated, and and the inference procedures will be valid. This constitutes a fairly strong case for including rather than excluding variables from a regression equation. There is, however, a qualification to this view. Adding extra variables, be they relevant or irrelevant, will lower the precision of estimation of the relevant coefficients.

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From examination of residuals from sample regression equations, with and without insignificant coefficients, the residuals do not indicate any major differences. Therefore, since the sole purpose of the regression analysis is to remove the growth trend effects and not for specific coefficient estimation, and for the sake of simplicity, the quadratic trend is removed from all sectoral annual time series.

The residuals (*e*) from a regression, may also be expressed in a different notational form:

residual (*e*) for sector (i) and time (t): $e_{it} = Y_{it} - \hat{Y}_{it}$

where: Y_{it} = the actual employment level
$\hat{Y}_{it}$ = the estimated employment level

As stated above, it is the size of these residuals that indicates the variability in the sectors employment (**small residuals = low variability; large residuals = high variability**). Figure 4 graphically depicts the "size" of the residuals for Michigan's construction employment sector (the construction sector was chosen due to its apparent high variability). As can be seen, the large residuals of the construction employment, indicate that the construction sector is extremely variable and "risky".

Annual Construction Employment

Annual Construction Employment

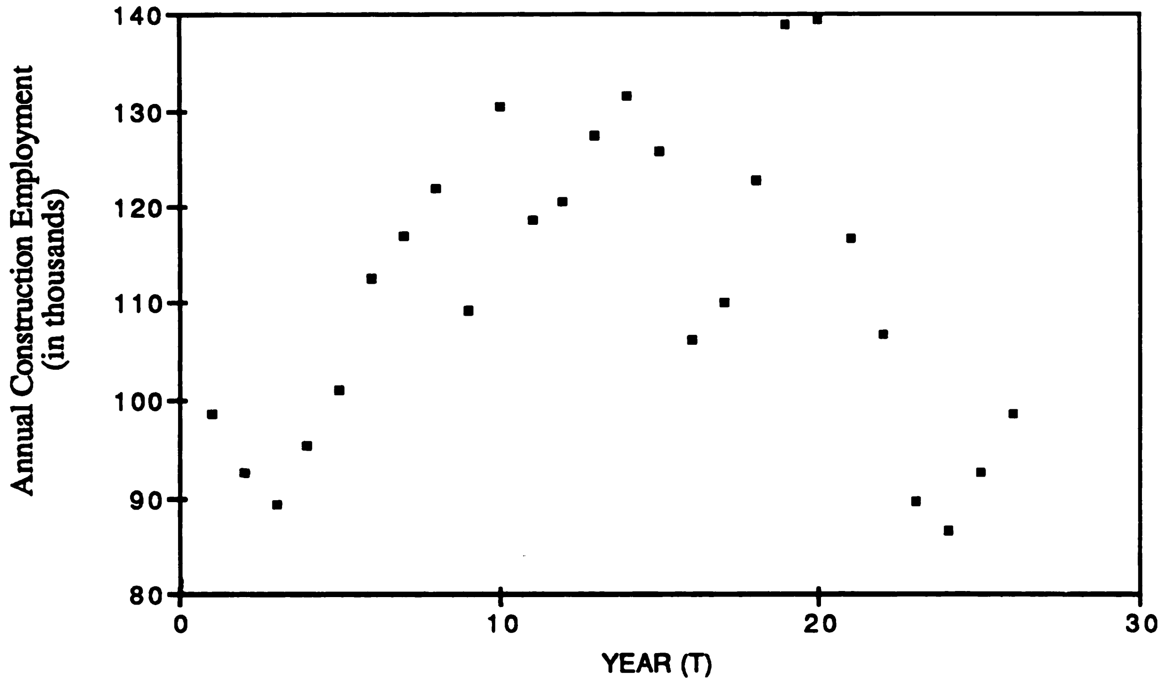

Figure 2. The time series of Michigan's Construction employment for 1960 - 1985.

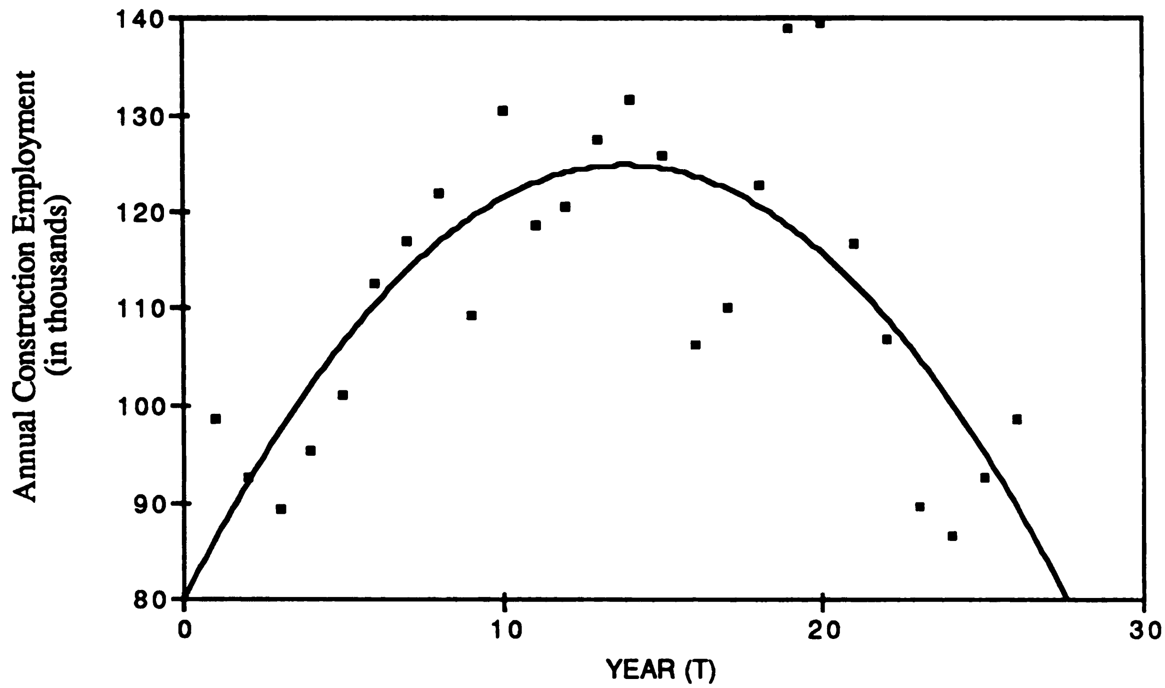

Figure 3. The State-level quadratic trend of the Construction time series.

Annual Construction Employment
(in thousands)

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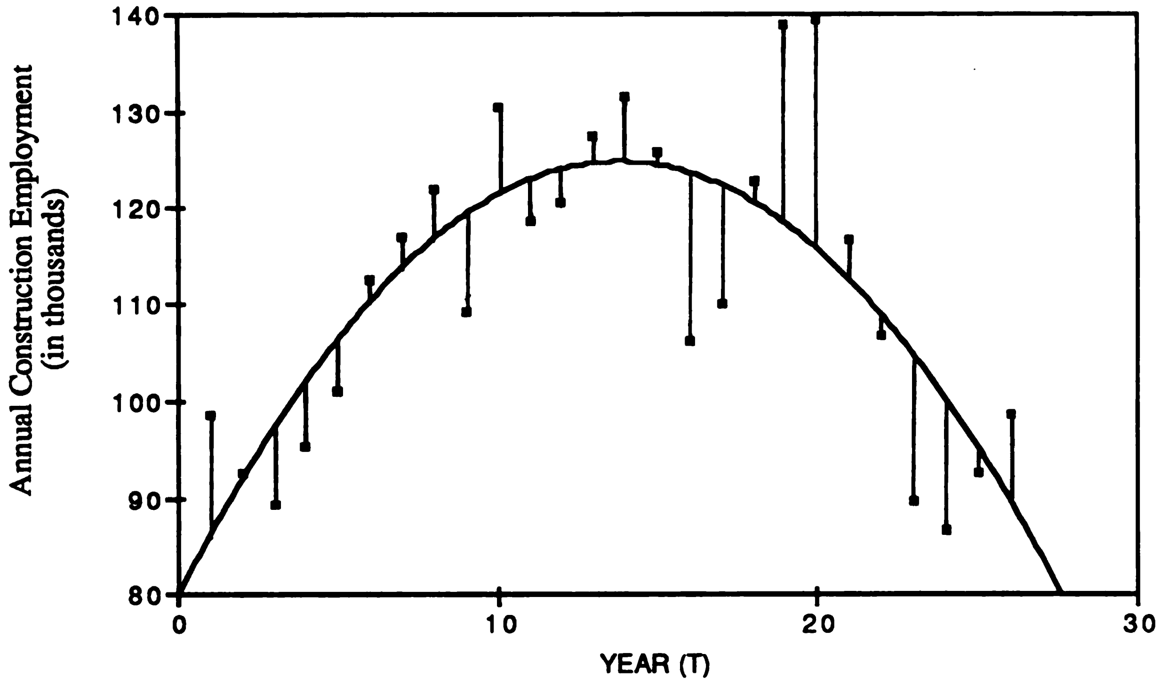

Figure 4. Vertical lines indicating the size of each residual, $Y_{it} - \hat{Y}_{it}$.

In order to compare industries of different orders of magnitude in employment (e.g. Services compared to Mining) Conroy divides the residuals by the mean of the original time series, thus creating a series of mean-relative residuals:

$$Y_{it} - \hat{Y}_{it} / \overline{Y_i}$$

There are a number of methods available for making the residuals "relative" or scaled among the different sectors. In order to better understand the process and to determine the best method five alternative methods were examined for a sector and subjected to a correlation analysis to determine what similarities exist. Table 2 lists the five methods and the correlation matrix of these five methods.

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Table 2.

Methods of Obtaining Relative Residuals (Results from Mining Sector)

1. Divide the residuals by the mean of the sectors time series as per Conroy (MEAN).
2. Standardize the residuals from the regression analysis (STDRES).
3. Standardize the original employment time series and use residuals from the regression analysis of these data (STDDATA).
4. Residuals measured as a percent of the trend estimate values (PCTEST).
5. Residuals measured as a percent of the actual employment levels (PCTACT).

Pearson's Correlation Matrix

	MEAN	STDRES	STDDATA	PCTEST	PCTACT
MEAN	1.000				
STDRES	1.000	1.000			
STDDATA	1.000	1.000	1.000		
PCTEST	0.998	0.998	0.998	1.000	
PCTACT	0.992	0.992	0.992	0.995	1.000

All values statistically significant at .05 two-tailed confidence limit.

This table shows the extreme correlation between all five methods of scaling a sector's residuals, indicating that there is a statistically significant relationship between any of the five alternatives. The values derived from each of the scaling methods will differ in actual magnitude, but will not differ in relative magnitude. Using any of the scaling methods for all 21 sectors will not yield a sector variability ranking different from that obtained using any of the other methods. Since the *mean-relative* method, as used by Conroy (1972) is the least operationally complex, and can be represented very easily mathematically I have used this method also.

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The set of 21 sectoral, ***mean-relative residual*** series are used to calculate the inter-industry covariance matrix (σ_{ij}). This covariance matrix is calculated as:

$$\sigma_{ij} = \frac{\sum_{t=1}^{N} [(Y_{it} - \hat{Y}_{it} / \bar{Y}_i)(Y_{jt} - \hat{Y}_{jt} / \bar{Y}_j)]}{N-2}$$

where **i** and **j** are two distinct sectors. In those cases where **i = j** (the diagonal of the covariance matrix), σ_{ij} yields the variance for that industry. When **i ≠ j**, the covariance (measuring the similarity in variability between the two sectors over time) is calculated.

Given this inter-industry covariance matrix, a measure of the instability (variability) of each industry can be obtained by summing over **j**, a column sum (or by summing over **i**, a row sum, since the covariance matrix is symmetrical). This summation will give a measure of the stability of the industry considering both the variability of the industry (the industry's employment fluctuations) and the effects due to the linkage or coincidental covariance relationships with the remaining industries. This value can be compared to the industry variance (from the covariance matrix diagonal) to determine the proportion of the industry's instability that is due to its own variance.

A regional portfolio index (σ_{pk}) is derived by weighting the State based inter-industry covariance matrix by a particular region's sector employment proportions (X_{ik} and X_{jk}, proportion of region ***k*** 's employment in sectors **i** and **j** respectively).

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The equation for the portfolio index of diversification:

$$\sigma_{pk} = \sqrt{\sum_{j=1}^{N} \sum_{i=1}^{N} X_{ik} X_{jk} \sigma_{ij}}$$

$$\text{where} \sum_{i=1}^{N} X_{ik} = \sum_{j=1}^{N} X_{jk} = 1.000$$

This weighting of the covariance matrix and subsequent summation of the elements produces an index that measures diversification as a function of the State-level inter-industry relationships and the regional sectoral size differentials. This relationship between diversification and the size of the covariance matrix values causes the inverse relationship between the portfolio model's diversification index value and the actual diversification level **(higher index value = lower actual diversification level)**. A region with a large proportion of its employment in those unstable industries with large variances and covariances, will have a large index value, indicating that the region is poorly diversified. Thus, diversification can be achieved by reducing employment in an unstable sector or by increasing the employment proportion in a stable sector. The ability to increase the diversification level (reduction in the index) through additional employment is gained by the condition that the sum of the employment proportions must equal 1.000. If the employment in a stable sector increases (larger proportion), all other proportions must necessarily decrease slightly (in effect decreasing the proportion in any unstable industries in the region).

This ability to diversify through either reducing employment or increasing employment, is unique to the portfolio model of diversification. This procedure for measuring diversification, allows a region to specialize, while remaining fairly diversified if the mix of its other sectors is stable. The ability to do this however, depends on the size of the industry variances when compared to the size of inter-industry covariances, and in which sectors the employment changes occur (This relationship will become more apparent in the Case Study Applications in Chapter 4). A region with a large proportion of its employment in those unstable industries with large variances and covariances, will have a large index value, indicating that the region is poorly diversified.

As part of this study, regional industrial diversification indices are calculated for 1979 and for 1985 for all 14 regions in the study. Having diversification indices for two time periods will allow a temporal comparison to be made. However, the examination of this relationship poses a problem not confronted in any of the existing literature using the portfolio index of industrial diversification.

The covariance matrix is calculated from the mean-relative residuals from the detrending regression analysis. The detrending process removes the effect of the quadratic trend estimates from the actual employment values. The State-level sectoral employment time series, used in this study, extend from 1960 to 1985. Since this study examines the change in industrial structure from 1979 to 1985, two time periods are to be examined; 1960-79 and 1960-85. This will allow a diversification index to be calculated for 1979 and for 1985. Due to the overlap in the employment series, a question arises as to which time period's trend to remove? The removal of trend, from each sector's employment series, and its impact on the size of the residuals is very important for this model, in that the removal of an incorrect trend could bias the results.

Two options for temporal trend removal exist:

1. Removal of each period's specific trend,
2. Removal of a base period's trend.

These options, in turn pose additional questions. The removal of each period's specific trend is operationally the most simple, however, it inherently has some theoretical questions, since the actual employment fluctuations used to calculate the trend from T=1 to T=20 are a "subset" of the employment fluctuations used to calculate the trend from T=1 to T=26. This "subset" notion leads one to consider the possibility of removing a base period's trend from each period under examination. However, the decision as to what base period to use is difficult.

In order to better understand these relationships, both options are explored by examining the residuals from the Construction sector detrended as follows:

Series 1) 1960-1979; trend calculated from this series and removed;
Series 2) 1960-1985; trend calculated from this series and removed;
Series 3) 1960-1979; trend calculated from 1960-1985 series and removed.

Ideally, it would be desirable to also remove from the 1960-85 Construction employment series, the quadratic trend obtained from the 1960-79 employment series, however, it would be operationally complex and theoretically questionable. The use of the 1960-79 series to base the trend on, is suspect (since 1979 was chosen specifically due to the occurrence of the last State total non-agricultural employment peak). Also of major concern is that the predictive power of regression analysis should be limited to data within the range of data for which the model is fit. It is for these reasons that this fourth method is not explored.

Examination of the residuals from the three different methods, yielded interesting results. The Series 3 results are, by nature of the methodology, identical to the first 20 residuals in Series 2. These results would seem to indicate that the removal of a "base" periods trend would be the desired method. This would cause any changes in the calculated covariance matrix to be a direct result of the additional six years (1980-1985). However, it became apparent that this method would not allow for simple temporal comparisons, especially in a planning context. With each additional year added to the employment series, a new trend can be calculated and removed. Using the base year methodology would require that every year, all previous years would need to be recalculated to maintain this base year comparison. The comparison between Series 1 residuals and Series 2 residuals yielded a Pearson's Correlation coefficient of .968 when comparing the first 20 residuals of each series. This indicates that even though the actual trends used to get these residuals were different, the residuals for the years 1960-79 are very similar. A Pairwise T-test also indicated that both series could have come from the same population; T-statistic = -0.296, Two-tailed probability = .771. Calculating each specific period's trend (Series 1 and Series 2) has the operational advantage that once calculated, the detrending for that period is complete. This would allow the portfolio model to calculate a diversification index for 1979, using Series 1 methodology, that would be a set value for future comparisons. It is for these reasons that for the remainder of this study, only employment residuals obtained with Series 1 and Series 2 methodology are used to calculate the diversification indices for 1979 and for 1985.

Measurement of Regional Economic Instability

As noted in Chapter 1, regional economic instability is a region specific measurement of the instability (or variability) in the region's economy, as measured by a specific variable. The measurement of regional economic instability is based on the standard error of the estimate from a regression analysis. However, to enable inter-regional comparisons, quadratic detrended, ***mean-relative residuals*** (similar to those used in the calculation of the portfolio model) are used to calculate the instability value, due to regional size differences. This formulation for the use of mean-relative residuals is the same formulation used by Conroy (1972). The formulation of economic instability for region k :

$$\textbf{Economic Instability}_k = \sqrt{\frac{\sum_{t=1}^{N}((Y_{tk} - \hat{Y}_{tk})/\bar{Y}_k)^2}{N-2}}$$

where: Y_{tk} = the actual regional employment level

$\hat{Y}_{tk}$ = the quadratic estimated regional employment level

$(Y_{tk} - \hat{Y}_{tk})$ = the residuals from quadratic regression analysis

$\bar{Y}_k$ = the mean regional employment level

N = the number of years in the employment series

Though I use the same formulation as Conroy, I have calculated regional economic instability using two different variables. I have calculated regional instability, for each region, using a total non-agricultural employment time series, as did Kort (1981), since I have included many non-manufacturing industries in my analysis. To use the abbreviation REI can be very confusing since I have calculated regional economic instability using not only employment but also income. The use of the abbreviation, **REI**, will be limited to the instability of regional employment (**REI**: *regional employment instability*). I have also calculated regional economic instability measured with income data (hereto referred to as **RII**, *regional income instability*) using BEA Wage and Employment Income data.

Computing Procedures

As indicated, the calculation of the portfolio analytic model of industrial diversification has two distinct computational steps: 1) the regression analysis needed to obtain the mean-relative residuals used in the model; and 2) the actual calculation of the portfolio diversification indices.

The regression analysis used in this study, was performed using the SYSTAT Version 3.0© statistical package for IBM© compatible microcomputers.

The actual calculation of the portfolio model was achieved through the use of PORTFOLIO, a program written in Microsoft FORTRAN© by the author. This program uses as inputs the mean-relative residuals from the detrended, State-level, employment time series for the 21 sectors and the sectoral employment proportions for each of the 14 regions. The output from the PORTFOLIO program includes an echo printing of the regional employment proportions matrix, various tabulation files, summary values, and the portfolio index of diversification for each of the 14 regions (as well as the State value and and equal proportions portfolio index).

Normality Tests

The analysis of the hypothesized relationships and the small number of observations used in this study, warrant the use of correlation analysis to determine the strength of these relationships. Regression analysis would allow the causality of the relationships to be tested, but the problems with degrees of freedom associated with a small number of observations (14 regional observations) preclude its use (some regressions will be utilized, however, for comparison to the results of Brewer (1985), Conroy (1972), and Kort (1981)). In correlation analysis, the decision has to be made as to which type of test to use (Pearson's parametric correlation or Spearman's non-parametric, rank-order correlation). The condition of bivariate normality, that is an assumption of the Pearson's correlation test, is often not even addressed in the literature. For this study the normality of each variable was tested using the Kolmogorov-Smirnov (KS) one-sample test of normality available within SYSTAT. Due to the small sample size, the Lilliefors option was used, which yields probabilities corrected for a small sample size. All variables used in the KS - Lilliefors tests were first standardized (condition of Lilliefors option) and then subjected to the KS test to determine normality. The hypotheses for a KS test are structured:

H_0: There is no statistical difference between the variable's distribution and a normal distribution.

H_1: There is a statistical difference between the variable's distribution and a normal distribution; the distribution is not normal.

with Alpha = .05, two tailed rejection level.

The KS hypotheses structure is unique in that to obtain the most desirable result, the H_0 hypothesis will be accepted. The results of the KS tests are shown in Table 3. Due to an initial probability plot, the variable POP84 was predetermined to be non-normal. In an attempt to achieve normality the natural log of POP84 was computed and is represented by LOGPOP84.

It can be seen in Table 3 that the H_0 hypotheses can be rejected for only POP84, and the two structure variables, STRUCT85 and STRUCT79. The natural log transformation of POP84 is shown to be successful, since the H_0 hypothesis for LOGPOP84 was accepted, indicating that the variable is normal. These results indicate that most relationships examined in this study, can be tested using the more efficient Pearson's correlation test. The correlation tests were performed using the SYSTAT computer package also.

Table 3.

Kolmogorov-Smirnov One Sample Test Using Standard Normal Distribution

Variable	MaxDif	Lilliefors Probability (2-tail)
PDIV85	.117	1.000
PDIV79	.169	.356
POP84	.401	.000
LOGPOP84	.173	.318
REI (1985)	.209	.099
RII (1984)	.157	.493
STRUCT85	.214	.000
STRUCT79	.201	.000

where: PDIV85 = portfolio diversification, 1985
PDIV79 = portfolio diversification, 1979
POP84 = regional population, 1984
LOGPOP84 = the log of POP84
REI = regional employment instability, 1985
RII = regional income instability, 1984
STRUCT85 = Michigan industrial structure, 1985
STRUCT79 = Michigan industrial structure, 1979

Formal Hypotheses

The research hypotheses as stated in the previous chapter are now restated in a formal statistical structure. The choice of statistical test used to test each hypothesis depends foremost on the normality of the variables in question. A Dependent Student's T-test is used for Hypothesis 1, since the indices are region dependent. The formal hypotheses and the statistical test(s) used for each are as follows:

Hypothesis 1.

A significant change in the regional diversification indices (PDIV79 and PDIV85) has occurred between 1979 to 1985.

H_0: PDIV79 = PDIV85

H_1: PDIV79 ≠ PDIV85

Test used: Dependent (Pairwise) Student's T-Test, alpha=.05, two-tailed.

A non-directional hypothesis is appropriate, since no *a priori* assumptions can be made as to whether the regions will become more diversified or less diversified. A Dependent Student's T-test is used for Hypothesis 1, since the indices are region dependent.

Hypothesis 2.

A significant change in the industrial structure of Michigan (as measured by the inter-industry covariance matrices; STRUCT79 and STRUCT85) has occurred between 1979 and 1985.

H_0: STRUCT79 = STRUCT85

H_1: STRUCT79 ≠ STRUCT85

Test(s) used: Non-parametric Wilcoxon Signed Ranks Test, alpha = .05, two-tailed.

Spearman's Rank Order Correlation, (T-Test for significance), alpha = .05, two-tailed.

Once again two-tailed, non-directional hypotheses are appropriate since a direction cannot be attributed to the change in structure, prior to the calculation of the model. To test whether the State's industrial structure, as measured by the inter-industry covariance matrix, has significantly changed between 1979 and 1985, and to examine the degree of change, two tests will be used. A Wilcoxon test was chosen to examine the statistical difference between the two year's industrial structure. The Wilcoxon test is a non-parametric, dependent comparison test, equivalent to a parametric Dependent T-test. A non-parametric test is warranted since both STRUCT79 and STRUCT85 are non-normal (see Table 3). Hammond and McCullagh (1978, p. 207) describe the Wilcoxon method.

> The Wilcoxon test for paired samples (let us call them A and B), although used to compare data on an interval scale, is a non-parametric test in that the differences between pairs of data from the two samples are ranked - i.e. are put on an ordinal scale - and significance levels depend upon the allocation of these ranks between those cases where A is greater than B, and those where B is greater than A.

A Spearman's Correlation analysis will be used to examine the degree of relationship between the State's industrial structure in 1979 and 1985.

Testing the similarities between the two covariance matrices (and matrices in general) is difficult, so by using both types of measures I hope to use one as a partial check for the other. In order to use these two tests the form of the inter-industry covariance matrix must be changed, since both are tests on vectors of numbers. Since the inter-industry covariance matrix is *symmetrical* those numbers above the diagonal will be deleted (a triangular matrix) since including them would add unwarranted significance to the statistical tests. The remaining values from the inter-industry covariance matrix will be "vectorized" in the sense that each column of the triangular matrix will be placed below the previous (see Figure 5). The matrix values, once calculated, are independent of their position within the matrix, but are dependent on the two industries used to obtain the value. Therefore, as long as the "vectorizing" allows comparison of a industry specific 1979 value with the same industry specific value for 1985, this procedure will not unduly change any possible result. This "vectorizing" procedure is used only to allow the application of readily available comparison tests.

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Figure 5. The "Vectorization" Procedure

I. A triangular matrix after the elements above the diagonal have been removed.
II. The matrix when "vectorized".

The remaining five hypotheses are all tested using Pearson's Product Moment Correlation. This test is chosen for these five hypotheses due to the normality of the variables (see Table 3) and the desire to test a relationship. A Student's T-test is used in each case to test the statistical significance of the Pearson's Correlation coefficient.

Hypothesis 3.

A significant positive relationship exists between the regional diversification index (PDIV85) and regional employment instability (REI).

H_0: $r = 0.000$
H_1: $r > 0.000$

Test used: Pearson's Correlation Coefficient (T-Test for significance), alpha = .05, one-tailed.

A positive directional hypothesis is used in this case, since a positive relationship was shown to exist between these two variables by Conroy (1972), Kort (1981), and Brewer (1985). It is also chosen due to the fact that both indices are based on employment. A diversified regional employment structure should be better situated to withstand cyclical shocks to particular industries and thereby maintain stability.

Hypothesis 4.

A significant negative relationship exists between the regional diversification index (PDIV85) and the log of population (LOGPOP84).

H_0: $r = 0.000$
H_1: $r < 0.000$

Test used: Pearson's Correlation Coefficient (T-Test for significance), alpha = .05, one-tailed.

A directional hypothesis is used for Hypothesis 4, due to the assumed positive relationship between city size and diversification as discussed in Thompson (1965) and Clemente and Sturgis (1971). A negative relationship, however, is hypothesized in this study. This negative hypothesis structure is an artifact of the inverse nature of the portfolio diversification indices, in that more diversified economies will have lower index values.

Hypothesis 5.

A significant relationship exists between regional employment instability REI) and regional income stability (RII).

H_0: $r = 0.000$

H_1: $r \neq 0.000$

Test used: Pearson's Correlation Coefficient (T-Test for significance), alpha = .05, two-tailed.

The structure of this hypothesis is very difficult to establish. As noted in the discussion of the research hypotheses in Chapter 2, the numerical sensitivity of the two indices precludes any directional assumptions to be applied to the hypothesis structure. It is even possible that due to this sensitivity, no relationship exists. It is for these reasons that a non-directional, two-tailed hypothesis structure is warranted.

Hypothesis 6.

A significant positive relationship exists between the regional diversification indices (PDIV85) and regional income instability (RII).

H_0: $r = 0.000$

H_1: $r > 0.000$

Test used: Pearson's Correlation Coefficient (T-Test for significance), alpha = .05, one-tailed.

This hypothesis is structured as a positive directional due to the perceived positive relationship between employment diversification and regional income stability. Those regions with a diverse employment profile will also have a diverse income profile between industries and within industries. This diverse income profile will allow a region to maintain income stability.

Hypothesis 7.

A significant positive relationship exists between the historical (1979) regional diversification indices (PDIV79) and present (1985) regional employment instability (REI).

H_0: r = 0.000

H_1: r > 0.000

Test used: Pearson's Correlation Coefficient (T-Test for significance), alpha = .05, one-tailed.

The structure of this hypothesis is designed to test the nature of the relationship between present economic stability and historical diversification as discussed by Jackson (1984). In actuality, it is testing the possibility of using a present diversification level, in an economic development context, to "forecast" a possible future stability of a region. The positive direction follows from the same arguments used to justify the positive direction in Hypothesis 3.

Chapter IV

Results and Applications

The following chapter presents the results of the statistical tests of the hypotheses, and discusses and examines the use of the results of the portfolio analytic model of diversification for State or regional economic development purposes.

Hypotheses Results

The examination of the results from the statistical tests of the research hypotheses will be in the order stated.

Hypothesis 1.

> **A significant change in the regional diversification indices (PDIV79 and PDIV85) has occurred between 1979 to 1985.**

This hypothesis compares the regional diversification indices of 1979 with those of 1985 to determine if a significant change has occurred.

Results: Paired Sample T-Test on PDIV79 vs. PDIV85 with 14 Cases

Mean Difference = -0.006

SD Difference = 0.003

T = -8.136 Df = 13 Two-tailed probability = .000

The null hypothesis is rejected and the alternative accepted, indicating a significant change in the regional diversification levels has occurred between 1979 and 1985. Directionality (One-tail T-Test) is not warranted since the direction could not be determined *a priori*, since some regions may have become more diversified and others less diversified.

Hypothesis 2.

> **A significant change in the industrial structure of Michigan (as measured by the inter-industry covariance matrices; STRUCT79 and STRUCT85) has occurred between 1979 and 1985.**

This second hypothesis (actually a sub-hypothesis of the first), examining the change in industrial structure from 1979 to 1985, will give further insight into the changing regional diversification levels. It will also allow conclusions to be drawn as to what effects deindustrialization, and the recent recession and recovery have had on the industrial structure of Michigan.

Results: Wilcoxon Signed Ranks Test Results

Counts of Differences (Row Variable Greater Than Column)

	STRUCT79	STRUCT85	
STRUCT79	0	62	
STRUCT85	169	0	
			231

Two-tailed Probability: .000

Spearman Rank Order Correlation (r_S)

	STRUCT79
STRUCT85	0.785

T-statistic: 19.176 Number of Observations: 231

The null hypothesis is rejected for this relationship, indicating that the industrial structure in 1979 (STRUCT79) <u>is significantly different</u> from the industrial structure in 1985 (STRUCT85). Due to a large sample size for this test (N = 231), a corresponding parametric Dependent (Pairwise) Student's T-Test was also calculated. As expected, the results correspond with the Wilcoxon test's results, with a T-statistic equal to 9.036, indicating extreme significance. Even though STRUCT79 and STRUCT85 are statistically different, the Spearman Correlation analysis indicates an extremely significant historical relationship between the structure values of 1979 and those of 1985. This is to be expected since a six year time span would be a very short amount of time for any major shifts in the industrial profile of a State to occur. This may possibly indicate that the recession and not deindustrialization has caused the major change in the industrial structure of Michigan. If the results of these statistical tests are examined together, it would seem to indicate that the absolute magnitudes of the covariance matrix values have significantly changed from 1979 to 1985 (structure has become less diversified), but the relative magnitude of the inter-industry relationships continue to be very similar ($r_s = .785$). This similarity in the inter-industry relationships indicates that the State's recovery from the recent recession, is more likely a function of a national economic recovery, rather than a change in the industrial structure. However, within the 231 values of the triangular covariance matrix it is possible that some individual values (certain industries' relationships) have changed dramatically. This possibility will be examined in greater detail in the next section.

Hypothesis 3.

> **A significant positive relationship between the regional diversification indices (PDIV85) and regional employment instability (REI).**

This hypothesis is used to determine the strength and significance of the relationship between industrial diversification and regional economic instability for the regional economies of Michigan.

Results: Pearson's Correlation (r)

	PDIV85
REI	.665

N: 14 T-statistic: 3.085 One-tailed Probability: .005

These results indicate a significant positive correlation, thus the null hypothesis of no relationship is rejected. These results parallel those of Conroy (1972, 1975a, 1975b), and

Brewer (1985) indicating that there is a significant relationship between industrial diversification (as measured by the portfolio analytic model) and regional employment instability.

For direct comparison to the results of these two authors a regression analysis must be used. As mentioned previous, the problems with very low degrees of freedom for this small data set limits the usefulness of regression results. For comparisons sake only, an ordinary least-squares regression was run (REI: dependent variable; PDIV85: independent variable).

The regression equation, with T-statistic in parentheses:

$$\underset{}{REI} = \underset{(-0.376)}{-0.005} + \underset{(3.085)}{1.183}\ PDIV85$$

$$\text{adjusted } R^2 = .396$$

These results show diversification can explain almost 40% of the variation in regional economic instability in Michigan. This adjusted R^2 value is very close to that obtained by Conroy of .423 (1972). An attempt was made to examine the residuals from this regression for heteroscedasticity as per Kort (1981) and Brewer (1985). Determining the presence of heteroscedasticity with such a small sample is extremely difficult. Both the Goldfeld-Quandt test and graphic portrayal proved unsatisfactory. The residuals when plotted against population exhibit a pattern somewhat similar to, but not as pronounced as, that found by Kort (1981), but due to the small sample size and the overwhelming size of the Detroit MSA not much information could be gathered from the plot. However, since this heteroscedasticity was found by both Kort (1981) and Brewer (1985) I, for the sake of curiosity, continued with the assumption that the residuals were indeed heteroscedastistic and corrected for this problem using the same Square Root of Population correction as did these authors. The resulting Weighted Least Squares (WLS) regression equation (T-statistic in parentheses):

$$(REI * SQRPOP84) = \underset{(-0.765)}{-0.013} (SQRPOP84) + \underset{(3.167)}{1.415} (PDIV85 * SQRPOP84)$$

$$\text{adjusted } R^2 = .410$$

Although these regression results do not duplicate the degree of causality exhibited in Brewer (1985), the slight increase in the adjusted R^2 value and in the significance indicates that by accounting for the effects of population size, the power of the portfolio index of industrial diversification to explain regional economic instability (REI) does increase in even a small study such as this one.

At least two possible explanations for the smaller than anticipated increase in adjusted R^2 exist. First, the overwhelming size of the Detroit MSA may be biasing the results. When an WLS regression analysis is run on the sample with the Detroit MSA removed, the adjusted R^2 increased to .491. This value is closer to the value that Brewer obtained. A second reason for the less than anticipated adjusted R^2 when accounting for the effects of population, may be due to the unique relationship between industrial diversification and regional population size in Michigan. This relationship is further examined in Hypothesis 4.

Hypothesis 4.

A significant negative relationship exists between the regional diversification indices (PDIV85) and population (LOGPOP84).

This hypothesis examines the structural relationship between industrial diversification and regional population size. As stated previous, a negative relationship is hypothesized due to the inverse nature of the portfolio diversification index.

Results: Pearson's Correlation (r)

	PDIV85
LOGPOP84	.254

N: 14 T-statistic: 0.911 One-tailed Probability: .190

The null hypothesis for this relationship cannot be rejected. Not only is the relationship between the two variables insignificant, the implied negative directionality is not shown. The results indicate that no significant correlation exists between industrial diversification (as measured by the portfolio analytic model) and population size; the statement that more populated regions are by necessity structurally more diversified cannot by accepted for this sample. This result is directly opposite of the results obtained by Clemente and Sturgis (1971). These results indicate that regional size alone will not impact the portfolio model of diversification. This factor may make the portfolio model of diversification a very helpful tool for Michigan economic development planners, who have to deal with the extreme size of the Detroit MSA.

Hypothesis 5.

A significant relationship exists between regional employment instability (REI) and regional income instability (RII).

One would assume that as regional employment stability increases so would regional income stability. However, the numerical sensitivity of these indices does not allow directionality of the regression to be hypothesized. The effect of the loss of 100 jobs on employment stability would probably be minimal. If, however, they were all $25,000 per year jobs then the effect on regional income stability may be significant.

Results: Pearson's Correlation (r)

	RII
REI	.475

N: 14 T-statistic: 1.870 Two-tailed Probability: .086

The null hypothesis for this relationship cannot be rejected. However, a two-tailed probability of .086 indicates that though the hypothesis is rejected at a two-tailed alpha of .05, it could not be rejected if a positive directional hypothesis is used (One-tailed Probability: .043). This one tailed probability may indicate that a tenuous positive relationship between REI and RII exists, and that for the most part employment fluctuations occur throughout the salary range.

Hypothesis 6.

> **A significant positive relationship exists between the regional portfolio indices (PDIV85) and regional income instability (RII).**

This hypothesis is used to further examine the relationships between employment characteristics and regional income stability. Due to the wide variations in income potential among employment sectors, a positive relationship between industrial diversification and regional income instability is hypothesized.

Results: Pearson's Correlation (r)

	PDIV85
RII	.457

N: 14 T-statistic: 1.781 One-tailed Probability: .050

The null hypothesis for this relationship must be rejected, though the T-statistic is right at the 95% rejection level. There is a statistically significant relationship between industrial diversification and regional income stability. This result indicates that by diversifying a region's employment profile, the income profile of the region is also diversified (a wide range of incomes will exist) making that region's total income less susceptible to economic shocks. A policy of industrial diversification may have a positive impact not only on employment stability (exhibited by Hypothesis 3) but also on income stability as well.

Hypothesis 7.

> **A significant positive relationship between the historical (1979) regional portfolio indices (PDIV79) and present (1985) regional employment instability (REI).**

This hypothesis is very important in terms of using the portfolio model of diversification for planning or economic development purposes. As explained in Chapter 3 this hypothesis will test whether or not it is justified to assume present diversification will have any relationship to future employment stability. If the hypothesis is accepted, a present plan of diversification may be able to modify the future stability value to a more desirable one. However, if the positive relationship is not accepted, the portfolio diversification index will be of limited use.

Results: Pearson's Correlation (r)

	REI
PDIV79	.633

N: 14 T-statistic: 2.836 One-tailed Probability: .008

The null hypothesis for this relationship must be rejected, indicating a significant relationship between historical diversification (1979) and present regional employment stability exists. These results give credibility to Jackson's (1984) statement linking historical diversification with present regional economic instability, and to the credibility of using the portfolio index of diversification as a regional economic development tool.

State-level Applications

A great amount of information about the industrial structure of Michigan can be gained by examining individual values from the inter-industry covariance matrix calculated as part of the portfolio model.

The values on the diagonal of the covariance matrix are measures of the variance of the employment levels within each industry. From Table 4 it can be seen that typically, the most variable industries in the State are the durable manufacturing sectors. The very high employment variance of the Construction sector might be explained by the extremely cyclical nature of this sector.

Two comments on these variance values are in order. First, the Other Non-Durable manufacturing sector's extreme variance is most likely an artifact of the industry groupings used for this study, where this category is the non-durable employment remaining after other individual industries (Food, Chemical Products, Printing, Paper) are removed. Second, the possible effect of unionization may be seen in the relatively higher employment stability value for the Transportation Equipment industry.

Table 4 also shows the small employment variance of the industries that can be termed "service producing industries ", such as F.I.R.E., Services, Federal Government, and Transportation and Public Utilities. The extremely small variance of the Food & Kindred Products industry has many connotations. This industry group has been targeted by the State of Michigan as a industrial sector to be promoted and developed due to its great potential. The variance value would lead one to believe that the State made a wise decision in selecting the Food & Kindred Products sector as a target industry. This optimism, for this sector and for the portfolio model in general, must be calmed in light that this sector's State employment has declined from 60,400 employees in 1960 to 43,200 employees in 1985, a decline of greater than 25%. Before this sector is to be promoted, research into why its total employment is

Table 4.

1985 Industry Variance (Diagonal) and Instability (Column Sum) Values
Ranked Most Stable (1) to Least Stable (21)

Sector	Variance (Rank)		Instability (Rank)	
Food and Kindred Products	.00051	(1)	.01420	(6)
F.I.R.E.	.00075	(2)	.01251	(3)
Services	.00085	(3)	.01663	(9)
Federal Government	.00113	(4)	.00497	(1)
Transportation and Public Utilities	.00135	(5)	.02173	(10)
Retail Trade	.00137	(6)	.02657	(12)
Wholesale Trade	.00165	(7)	.02847	(13)
State Government	.00173	(8)	.01252	(4)
Chemical and Petroleum Products	.00175	(9)	.01509	(7)
Local Government	.00194	(10)	.01520	(8)
Printing and Publishing	.00344	(11)	.01280	(5)
Other Durable Good Manufacturing	.00375	(12)	.04520	(14)
Paper and Allied Products	.00455	(13)	.01161	(2)
Primary Metal Industries	.00609	(14)	.06042	(18)
Transportation Equipment	.00653	(15)	.05702	(17)
Lumber and Wood Products	.00708	(16)	.04683	(15)
Mining	.00737	(17)	.02560	(11)
Non-electrical Machinery	.00837	(18)	.05100	(16)
Construction	.00864	(19)	.06937	(21)
Fabricated Metal Industries	.00897	(20)	.06493	(19)
Other Nondurable Good Manufacturing	.01238	(21)	.06925	(20)

declining at such a rate must be completed. This employment decline in the Food and Kindred Products industry is primarily due to the increasing use of automation in this sector. This low variance value is also an example of why caution must be used in interpreting the portfolio model's results, in that it measures stability around a given trend (growth or decline). This problem will be discussed further in the evaluation section.

By summing the columns of the covariance matrix a measure of total sector instability (versus sector variability or variance) can be calculated. These instability values are also shown in Table 4. These values are an overall measure which incorporates the specific industry variance with the covariance measures of the inter-industry cyclical relationships (the lower the instability value, the more stable the sector). These instability values give a better view as to the total effect a sector has on the regional economy.

From these values, the overall instability of the durable goods industries can again be seen by their uniformly high instability values. The non-durable goods industries show much more stability than the durable goods industries.

Of special note is the very low instability value for the Federal Government employment sector. This low value shows that Federal Government employment is very stable and counter-cyclical to almost all other sectors, making it a very desirable sector to incorporate into a regional economy. However, it is usually beyond the control of the local region to effect Federal Government employment numbers.

The examination of the "vectorized" matrices and the difference in the matrix values from 1979 to 1985, reveals that of the improvements occurring, most of the increases in sector stability (and likewise decrease in sector variability) can be attributed primarily to three sectors: Non-electrical Machinery, Chemical and Petroleum Products, and Federal Government Employment. These three sectors account for 35 of the 62 decreases (STRUCT79 value > STRUCT85 value) in the State inter-industry covariance matrix. This examination shows that even though the industrial structure of the overall Michigan economy has become less diversified, as measured by the portfolio model of diversification, some sectors have improved measurably.

By incorporating the total State's employment proportions into the portfolio model it is possible to derive a State diversification index for 1979 and 1985. These values can be considered a State diversification average.

1979 State of Michigan Diversification: .0307
1985 State of Michigan Diversification: .0366
Percent Change in Diversification Index: 19.22%

These increasing values show that the level of diversification in the State has declined 19.22% during this six year time span (since the index increased). These values, when compared to the regional diversification values given in Table 5, reveal that in 1979, seven regions were more diversified than the State, while in 1985, eight regions were more diversified. The Saginaw MSA became more diversified than the State during this time period. This diversification, however, was due primarily to reductions in the Saginaw MSA's proportions in most of the Durable Manufacturing sectors and Construction. These proportion reductions were caused mostly by unemployment in these sectors versus increased employment in others. The Saginaw MSA's total non-agricultural employment declined from 156,300 in 1979 to 145,100 in 1985.

Regional Applications

The major purpose of the portfolio analytic model of industrial diversification is to measure the level of diversification for the specified regions. Though historically, diversification values were used to compare regions, the portfolio model of diversification allows for some additional uses of the regional values in conjunction with the State-level covariance matrix. The regional diversification values are calculated from the State-level covariance matrix weighted by the proportion of each region's employment in each sector.

In the temporal examination of the change in the diversification indices from 1979 to 1985 one can make comments on the regional changes based on sector stability changes and on regional proportion changes. These comments may give rise to areas, questions, and policy issues for further study. The diversification levels for the two time periods and their rankings are given in Table 5 (the lower the diversification index, the more diversified).

As indicated in Table 5, all regions have experienced an increase in their respective diversification index values from 1979 to 1985. This overall effect can be attributed primarily to the effects of the 1982-1983 recession, its effect on employment levels, and the resulting impact on the calculation of the portfolio analytic model of diversification. The extreme employment decline from the sectoral employment peaks (primarily occurring in 1979) resulted in 18 of the 21 sectors becoming more variable or unstable. Since a majority of the values of the State-level covariance matrix increased, the regional diversification indices for 1985 demonstrate this increase also. Most important, however, in terms of this study, is the regional differentiation between the two time periods. Although the pattern of regional diversification rankings are very similar, a number of interesting changes did occur. It can be noted from Table 5 that the increases in the diversification indices were not regionally uniform. The largest percent increases occurred in those regions that were relatively well diversified in 1979 (Table 6 gives the percentage increase in the diversification indices from 1979 to 1985).

Table 5.

Regional Diversification Indices: 1979 and 1985
Ranked Most Diversified (1) to Least Diversified (14)

REGION	PDIV79 (Ranking)	PDIV85 (Ranking)
Alpena LMA	.0286 (6)	.0359 (7)
Ann Arbor MSA	.0306 (7)	.0348 (6)
Battle Creek MSA	.0282 (4)	.0297 (1)
Benton Harbor MSA	.0309 (8)	.0378 (11)
Detroit MSA	.0320 (11)	.0371 (10)
Flint MSA	.0399 (14)	.0438 (14)
Grand Rapids MSA	.0321 (12)	.0382 (12)
Grand Traverse LMA	.0231 (2)	.0339 (4)
Jackson MSA	.0320 (10)	.0368 (9)
Kalamazoo MSA	.0258 (3)	.0325 (2)
Lansing MSA	.0271 (5)	.0346 (5)
Muskegon MSA	.0346 (13)	.0391 (13)
Saginaw MSA	.0312 (9)	.0365 (8)
Upper Peninsula LMA	.0205 (1)	.0333 (3)

Table 6.

Percentage Increase in Portfolio Diversification Indices from 1979 to 1985.

Region	% Increase
Battle Creek MSA	5.17
Flint MSA	9.70
Muskegon MSA	13.20
Ann Arbor MSA	13.55
Jackson MSA	15.14
Detroit MSA	16.10
Saginaw MSA	17.09
Grand Rapids MSA	18.83
Benton Harbor MSA	22.06
Kalamazoo MSA	25.73
Alpena LMA	25.76
Lansing MSA	27.76
Grand Traverse LMA	46.83
Upper Peninsula LMA	62.62

Though the regional rankings have changed somewhat, the increase in the diversification values (decreasing diversification) was dramatic. The most dramatic increases in the diversification values from 1979 to 1985 occurred primarily in the three LMAs. These three regions in the northern parts of the State are, at present, extremely tourism oriented, and their employment characteristics (high proportions in services and retail, with very low proportions in the manufacturing sectors) reflect this fact. The recessionary period of employment instability is reflected in the State 1985 inter-industry covariance matrix, where the industry variance for both of these industries more than doubled in the six years, causing the regional diversification indices of the Alpena LMA, Grand Traverse LMA, and the Upper Peninsula LMA to increase 25.76%, 46.83%, and 62.62% respectively. The Lansing MSA also had a substantial increase in its diversification index value. From examining the region's employment proportions it is seen that during the six year span from 1979-85 the Lansing MSA's proportions in the more stable sectors of Federal and State Government declined, while the proportions in the retail and especially the service sectors increased. As mentioned above these two sectors' instability (combined with large regional proportions) along with a decline in the regional proportions of the "stabilizing" government employment caused the Lansing MSA's diversification value to increase by 27.76%.

The interesting anomaly to these scenarios, is the diversification change of only 5.17% for the Battle Creek MSA. One can conclude from this value that the economic development in this region between 1979 and 1985 not only made the Battle Creek MSA the most stable region in the State, but also cushioned the region against the severe employment shocks stemming from the 1982-1983 recession. Another interesting result obtained from the analysis of Table 6 is that except for the Battle Creek MSA, the Flint MSA had the lowest percentage increase from 1979 to 1985 (9.8%). This may indicate that the Flint region is slowly becoming more diversified. However, this change in the diversification index may be caused by automotive unemployment (thus reducing the regional proportion in the Transportation Equipment sector, increasing the proportions in the other 20 sectors and changing the portfolio index) than to a realignment of its regional industrial structure. Both the Battle Creek and the Flint MSAs will be examined in greater detail in the next section.

More can be learned of the regional economies by examining the regional economic instability indices calculated for each region. These instability values, calculated with both total non-agricultural employment and wage income, are given in Table 7.

Table 7.

Regional Instability Indices: Employment (1985) and Income (1984)
Ranked Most Stable (1) to Least Stable (14)

Region	Employment (Rank)	Income (Rank)
Alpena LMA	.0386 (7)	.0040 (13)
Ann Arbor MSA	.0414 (11)	.0031 (10)
Battle Creek MSA	.0298 (3)	.0029 (8)
Benton Harbor MSA	.0424 (13)	.0021 (2)
Detroit MSA	.0418 (12)	.0029 (9)
Flint MSA	.0472 (14)	.0043 (14)
Grand Rapids MSA	.0353 (6)	.0026 (5)
Grand Traverse LMA	.0412 (10)	.0025 (4)
Jackson MSA	.0407 (8)	.0032 (11)
Kalamazoo MSA	.0324 (4)	.0021 (1)
Lansing MSA	.0291 (2)	.0022 (3)
Muskegon MSA	.0351 (5)	.0028 (6)
Saginaw MSA	.0412 (9)	.0035 (12)
Upper Peninsula LMA	.0269 (1)	.0028 (7)

It can be seen from these values that in every case employment instability is much greater than income instability. One can conclude that regional income is much "stickier" than regional employment. A possible cause of this difference could be that in prosperous times new employees are hired (at starting salaries) and during a recession these same employees are laid off. This could give large fluctuations to the employment numbers, but the loss to regional income of losing these starting salaries is not a large percentage of the total regional income. (Example: the hiring of 20 students at minimum wage and laying them off would not have the same effect on each instability index as hiring 20 machinests at $20.00 per hour and then laying them off).

An examination of particular regional values shows that except for the Kalamazoo and Lansing MSA none of the regions have relatively low values for all three indices (diversification, employment instability, income instability). These two areas are similar in that along with a fairly well diversified manufacturing economy both are influenced by the stability of post-secondary education employment. The Battle Creek MSA matches its industrial diversification with employment stability (low instability value) but has a relatively high income instability value. This condition may indicate that even though the regional economy is well diversified, the employment stability may be more an artifact of people remaining employed in lower paid jobs (under-employment) than becoming unemployed. If my automation premise of the Food and Kindred Products industry in Battle Creek is correct, these laid-off employees may be finding work in lower income retail or perhaps food service occupations.

It is interesting to note that the Upper Peninsula LMA has the most stable employment of all the regions in the sample. It has been shown that the Upper Peninsula is fairly well diversified (though a little too dependent on the "service producing industries") and has a very stable regional employment. Yet this region remains, for the most part, ignored by the State government's employment expansion efforts, except for those related to the Upper

Peninsula's natural resource endowments (e.g. forestry, mining). Some of this optimism for the Upper Peninsula must be tempered, however, due to the unfortunate size of this region and possible effects region size has on the diversification and instability values. This problem will be better addressed in the evaluation section.

Case Study Applications: Battle Creek and Flint MSAs

The literature on the use of the portfolio model to answer questions of "What to do next?" focuses primarily on determining efficient or best portfolios. This search for efficient portfolios is prevalent in the financial literature (Markowitz, 1959; Sharpe, 1963) as well as in the regional economics literature (Conroy, 1972, 1975b; St. Louis, 1980; Brewer, 1985). The search for an efficient financial portfolio can be justified, since the owner of the portfolio has almost complete flexibility in the choice of which stocks and other assets to purchase or sell. This flexibility in asset selection, however, is not feasible in a regional economic sense; there are too many variables to consider. A region's industrial profile is influenced by a composite of variables including local supply and demand, resource availability, population size, and historical location decisions. A region's economic development agency does not have the option of "selling off" the "unprofitable" industries (such as those with low incomes or unstable employment demands) when the need arises. It is for these reasons that I feel the search for an efficient regional industrial portfolio, though a interesting theoretical abstract, is not a "real world" practical application of the portfolio model.

The search for a better portfolio, however, does not necessarily have to center on pure efficiency. By manipulating the regional proportions, one can calculate new diversification indices, which can give an idea as to the effect a change in regional, sectoral employment will have on the level of diversification. These values can then be used to aid in the decision as to which industries a region may want to promote, pursue, or avoid. It is this methodology, an extension of one developed by Conroy (1974) that I employ in examining the Battle Creek and Flint MSA.

For this exercise, I have chosen to increment an individual sector's proportion by .001, with a corresponding decrease of .00005 in each of the remaining 20 proportions; amounting to 21 vectors of sectoral proportions for each region. These corresponding decreases are to meet the portfolio analytic model's requirement that a region's sectoral proportions must sum to 1.000. The .001 increase is equal to approximately 54 persons in the Battle Creek MSA and 171 persons in the Flint MSA. The .001 value was chosen for operational simplicity and also because both values could easily represent the additional employment from a single new firm. From these values, the portfolio model was used to calculate a diversification index for each different regional proportion vector (i.e. 21 vectors for both MSA).

To use these values for economic development purposes, beyond identifying stable sectors, they need to be evaluated in the context of other regional economic measures. I have chosen to evaluate diversification against its possible effect on Total Sectoral Wage Income for 1985, made available from MESC files. Since the two sectors, Other Durable Manufacturing and Other Non-durable Manufacturing, are collections of a number of distinct industries, wage income data for these two "sectors" are not available. Therefore, these two "sectors" are not used. Those sectors included in the case studies, as well as, a numerical code for use in the MSA graphs are given in Table 8.

Table 8.

19 Sectors Used in Case Study Applications

Code	Sector	Code	Sector
1	Mining	11	Chemical and Petroleum Products
2	Construction	12	Transportation and Public Utilities
3	Lumber and Wood Products	13	Wholesale Trade
4	Primary Metal Industries	14	Retail Trade
5	Fabricated Metal Industries	15	F.I.R.E.
6	Non-electrical Machinery	16	Services
7	Transportation Equipment	17	Federal Government
8	Food and Kindred Products	18	State Government
9	Paper and Allied Products	19	Local Government
10	Printing and Publishing		

To evaluate the change in diversification and the corresponding change in regional income only total employment increases were examined. This methodology could also be used, however, to analyze the effects of decreasing sectoral employment.

A ratio formulation was used to determine the increase in regional income that would occur with increased employment in a sector.

(Income '85 / Employment '85) * .001(Employment '85) = Regional Income Increase

Though the proportional increase in regional employment will not necessarily equal the proportional increase in regional income, this equality is suitable for the illustrative use of the technique. With more detailed information, this proportional equality is not necessary. Figure 6 and Figure 7 show these positive changes in regional income plotted against the diversification level achieved by increasing the various sectoral employment proportions by the .001. The vertical line indicates the present diversification value for 1985. Table 9 and Table 10 detail the data used to plot the MSA graphs.

As shown in Figure 6, by increasing the proportion in 12 of the 19 sectors, of the Battle Creek regional economy it would become possible for the region to become even more diversified than it was in 1985 (left side of vertical line). As a regional economic development tool, this examination technique could give a policy maker many alternatives to examine in terms of attracting industries. In a strict financial gain sense, the development professional would have to advise the region to further increase its dominance in the Food and Kindred Products (8) industry. This industry while reducing the diversification value also will increase the regional income the most. If however, stability is of prime importance the attraction of Federal Government (17) employment or the Paper Products (9) industry will decrease the diversification value by the greatest amount. Figure 6 also shows the possibility of increasing regional income by attracting Non-electrical Machinery (6) firms, but also shows the negative impact on the diversification level. This examination technique allows the policy makers to weigh the benefits of this increased regional income against the negative effect on the diversification of the region.

Figure 7 presents a similar graph for the Flint MSA. Due to the larger size of the Flint economy the dollar value of the positive change in regional income is larger. The Flint regional economy can become more diversified by increasing the regional employment proportion in 13 of the 19 sectors. Only the Durable Manufacturing (3, 4, 5, 6, 7) sectors, Mining (1) or Construction (2) would cause Flint to become less diversified. An interesting finding is shown in the Flint MSA graph. Increasing the employment in the Chemical and Petroleum Products (11) sector not only will improve the region's diversification, but will also yield the largest increase in regional income ($7,473,472). Once again the "stabilizing" effect of Federal Government (17) employment is prevalent in the graph, as increasing the regional proportion in Federal Government employment would decrease the diversification index to .043712.

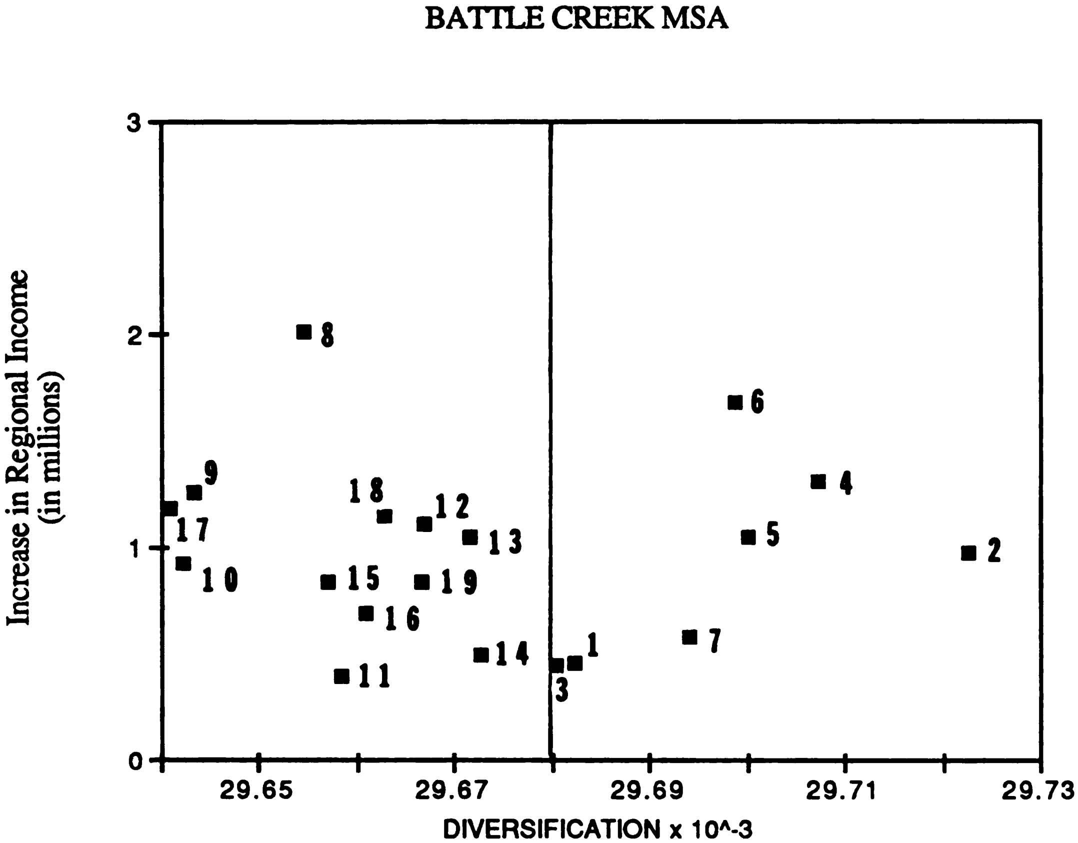

Figure 6. Regional Income Change and Diversification - Battle Creek MSA.
Vertical line indicates present (1985) diversification value.

Table 9.

Increase in Regional Income and 'New" Diversification Indices - Battle Creek MSA

Code	Sector	Incr. Reg. Income	Diversification
1.	Mining	$ 453,287	.029682
2.	Construction	$ 973,245	.029723
3.	Lumber and Wood Products	$ 447,370	.029680
4.	Primary Metal Industries	$ 1,309,061	.029707
5.	Fabricated Metal Industries	$ 1,048,328	.029670
6.	Non-electrical Machinery	$ 1,672,882	.029699
7.	Transportation Equipment	$ 575,015	.029694
8.	Food and Kindred Products	$ 2,015,577	.029655
9.	Paper and Allied Products	$ 1,256,162	.029643
10.	Printing and Publishing	$ 920,875	.029642
11.	Chemical/Petroleum Products	$ 395,872	.029658
12.	Transport. and Public Utilities	$ 1,111,623	.029667
13.	Wholesale Trade	$ 1,044,420	.029672
14.	Retail Trade	$ 493,205	.029673
15.	F.I.R.E.	$ 844,456	.029657
16.	Services	$ 692,915	.029661
17.	Federal Government	$ 1,184,814	.029641
18.	State Government	$ 1,153,189	.029663
19.	Local Government	$ 841,044	.029667
		Present (1985) Level	.029679

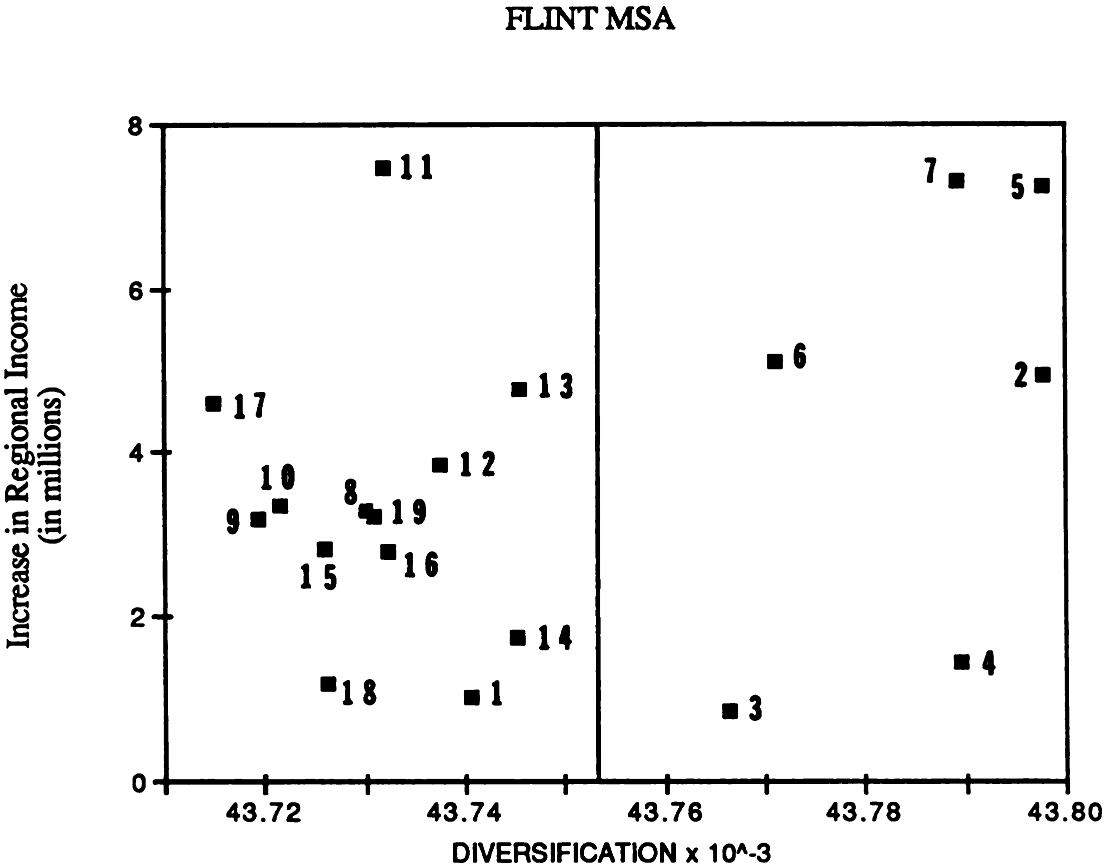

Figure 7. Regional Income Change and Diversification - Flint MSA.
Vertical line indicates present (1985) diversification value.

Table 10.

Increase in Regional Income and 'New" Diversification Indices - Flint MSA

Code	Sector	Incr. Reg. Income	Diversification
1.	Mining	$ 1,024,169	.043740
2.	Construction	$ 4,945,088	.043798
3.	Lumber and Wood Products	$ 845,316	.043766
4.	Primary Metal Industries	$ 1,457,487	.043790
5.	Fabricated Metal Industries	$ 7,254,843	.043798
6.	Non-electrical Machinery	$ 5,097,933	.043771
7.	Transportation Equipment	$ 7,301,264	.043789
8.	Food and Kindred Products	$ 3,285,279	.043730
9.	Paper and Allied Products	$ 3,185,096	.043719
10.	Printing and Publishing	$ 3,358,797	.043722
11.	Chemical/Petroleum Products	$ 7,473,472	.043732
12.	Transport. and Public Utilities	$ 3,858,465	.043738
13.	Wholesale Trade	$ 4,771,836	.043746
14.	Retail Trade	$ 1,732,794	.043745
15.	F.I.R.E.	$ 2,821,916	.043726
16.	Services	$ 2,791,102	.043732
17.	Federal Government	$ 4,606,945	.043715
18.	State Government	$ 1,170,673	.043726
19.	Local Government	$ 3,221,785	.043731
		Present (1985) Level	.043753

by .001 will decrease the diversification value by the greatest amount. It is interesting to note that the graph also shows the economic rational behind Flint maintaining its automotive employment base. The Transportation Equipment (7) sector, while a major cause of the poor diversification and stability of the Flint economy, is one of the highest paying sectors of its economy. While decreasing the employment in this sector (as well as in the Fabricated Metals (5) sector) may be better in the long run for the stability of the Flint economy, the financial burden (through loss of regional income) this would place on the region would be very unpopular with the residents.

This very simple graphical technique allows many alternatives to be examined in a relatively short amount of time, once the original data is obtained. It could also be used to examine the relationship between diversification and other quantifiable variables such as tax base increase, infrastructure costs, etc. To accommodate the addition of more than one industry or a larger employment proportion change than .001, would require simple modifications of the region's sectoral proportions vector. Though a very simple technique, this graphical method can be a very useful tool for regional economic development and planning.

Chapter V

Evaluation and Conclusions

This final chapter begins with an evaluation of the use of the portfolio analytic model of industrial diversification for "small region" economic analysis and the effect "small region" data has on the model. A discussion of the research objectives, how the model helped meet research objectives, and a summary of the hypotheses results is put forth in the second section. The chapter will close with a discussion of future research possibilities.

Evaluation of the Small Region Use of the Portfolio Model

The use of small scale or small region (sub-State, MSA, county, city) data with the portfolio analytic model of diversification must be used with caution. These data are often lacking in detail, that if not recognized, may lead to some spurious conclusions. This section will discuss five concerns with this model involving small region data: 1) data requirements; 2) sectoral aggregation; 3) regional aggregation; 4) regional sectoral responses; and 5) growth instability.

The data requirements for the portfolio analytic model of diversification, while large, are not beyond the scope of smaller region analysis. However, caution must be taken in the collection of these data from different sources. Different sources with differing collection techniques may produce slightly different results. In larger region analysis these differences may be slight enough to ignore, but in smaller regions these differences are often proportionally very large. This problem became very evident in this study when comparing MESC data with County Business Patterns data. At the State scale employment values from each source were fairly consistent. However, when analyzing certain single county MSA's, the MESC data employment values would disagree with the County

Business Patterns data by as much as 20%. These discrepancies can be attributed to differences in survey methodology and in the universe that is sampled.

Of prime concern in using the portfolio model with smaller regions is the sectoral aggregation or disaggregation that is available. Many common sources of smaller region data can be disaggregated to only 9 or 10 sectors for inter-regional comparisons. Though it is possible to use the portfolio model with only 10 sectors, the analysis and interpretation of the results would be crude, due to the differences among industries within these sectors. The wide variety of cyclical variations found in the durable manufacturing sectors is a prime example. Aggregating all durable manufacturing into a single sector, as is often done, often misrepresents the industrial profile of the region. In the use of the portfolio model, as in most regional economic investigations, as much sectoral disaggregation as possible is desired.

A problem inherent in smaller region data use is the problem of regional aggregation. To meet non-disclosure criteria, counties are often grouped together for data publication (sectoral aggregation is also used to avoid disclosure problems). In multi-county regions, such as some MSA, the use of employment proportions in the portfolio model, further obscures the differences between counties in their industrial profiles. A region may contain two counties, each concentrated in a specific sector. Stability differences between these two sectors may cause the stability and diversification levels of these two counties to be quite different. However, these county differences would be dampened in the regional aggregation since the regional proportions would be lower. Examples from this study include the Upper Peninsula LMA, and the Saginaw MSA. The Upper Peninsula LMA is an extreme example of regional aggregation for the sake of meeting non-disclosure criteria. The need to aggregate 15 counties into a single region for disclosure purposes gives an indication of the sparseness of industrial activity in the Upper Peninsula. The Saginaw MSA, however, is an example of the effect regional aggregation for other reasons (population census regionalization) can have on employment values. Saginaw County employment is concentrated in the durable goods manufacturing sectors, whereas Midland County manufacturing is almost completely dominated by the chemical industry. The regional aggregation available, the MSA, aggregates these two counties with Bay County to form the Saginaw MSA. This reduces the proportions since the employment is now a proportion of the three county total non-agricultural employment. This regional aggregation problem is very common, when using published data sources. It is often the case that to obtain better regional disaggregation you must settle with poorer sectoral disaggregation or vice versa.

The use of employment proportions in the portfolio model also causes problems identifying regional sectoral responses. Regional sectoral response refers to a region's employment proportions effected primarily by very localized events. The portfolio index can be seen to be a weighting of the regional employment proportions of each sector by the State structure (measured by the inter-industry covariance matrix) for the given sectors. Using these sectoral employment proportions to represent the region's industrial profile, can cause an large proportion in an industry (good or bad), to cause the region to have a larger index value, due to the formulation of the model. The Grand Rapids MSA and the Construction sector provide a good example. The Grand Rapids region is growing very rapidly. This regional growth leads to a great demand for new construction and therefore, Construction employment. However, at the State level the Construction sector is very unstable. A large Construction employment proportion, combined with the high sectoral instability, causes an undesirable increase in the Grand Rapids diversification value. Yet for this region, the large employment proportion in the Construction sector is a sign of its growth.

One problem inherent in the portfolio analytic model of diversification, due to its formulation, is the problem of growth instability or fluctuations in the growth trend of an industry. In calculating the inter-industry covariance matrix, the removal of the quadratic trend transforms the time series for each industry into a series of deviations from this trend. It is, however, possible that two industries with different trends (e.g. one growing, one declining) may have nearly the same deviation pattern, and therefore, yield inter-industry variance measures that are approximately the same. By not accounting for the differences in trend, in the calculation of the portfolio model, a stable and growing industry is treated exactly the same as a stable and declining industry.

Intuitively, this problem seems to be a major drawback of the portfolio model. However, the portfolio model captures the diversification of the region at a finite point in time; at a given instant the industry is not growing or declining. The use of the year designation still implies a finite point, since employment levels are changing all the time and the data values are measured for a specific instant. Given this realization, the growth instability question is not difficult to handle given sufficient information. As long as the planners and policy makers understand the nature of the employment trend, a negative growth trend is not necessarily a problem. The Food and Kindred Products sector in Michigan is a prime example of a negative growth trend. The stability of the sector has been shown, and through the case study of Battle Creek, the desirability of this sector for its impact on regional income is also shown. A negative growth trend indicates that employment in that sector has been declining. The trend does not show that the industry will continue to decline. If development efforts are successful in bringing in new (or expanding the existing) Food and Kindred Products firms, employment will increase and the trend may be reversed.

Summary of Results

This study uses a portfolio model to examine the industrial structure of Michigan. From the results of the model, the Michigan economy has been shown to have become significantly less diversified from 1979 to 1985. This result is due primarily to the effects of the 1982-83 recession and its effects on sectoral employment stability. The recent economic recovery the State is experiencing, is seen to be more a phenomenon of an overall national recovery, than from a significant change in Michigan's industrial structure from 1979 to 1985. Examination of the individual values from the inter-industry covariance matrix calculated as part of the portfolio model yielded many interesting results. The relative instability of the Durable Manufacturing sectors as well as the Construction sector is easily demonstrated. The relative stability of the Non-durable Manufacturing industries, as well as some of the service producing industries, is also shown. Though most of the sectors of the State's economy have become less stable, three sectors Federal Government, Chemical and Petroleum Products, and Non-electrical Machinery have become more stable.

The portfolio model also shows the effect the changes in the State-level inter-industry covariance matrix has had on the regional diversification pattern in Michigan. The regions of Michigan are shown to have become significantly less diversified during this six year time span. However, the percent change in diversification levels varied quite dramatically across the State.

Many of the hypotheses examined the relationships between industrial diversification (as measured by the portfolio index) and other measures of the regional economies. A significant positive relationship is demonstrated between industrial diversification and regional economic (employment) instability. This result corresponds with the recent works of Conroy (1972), Kort (1981), and Brewer (1985) and gives credence to a policy of promoting industrial diversification to maintain regional cyclical stability. The relationship between diversification and regional income stability is also examined. Though the relationship is weak (r = .457) it is shown to be statistically significant. The examination of the relationship between regional employment stability and regional income stability indicates that these two measures have a slight positive relationship. These results would seem to give additional rational for an emphasis on State and regional level industrial diversification. The relationship between diversification and regional population size is also tested. It is found that no significant relationship exists; size alone does not influence the diversity of a region's industrial structure. This result, which is contrary to Thompson (1965) and Clemente and Sturgis (1971), may be an artifact of the portfolio model. However, this is seen as a benefit in the planning use of the model, since the size does not influence the diversification values.

The examination of possible planning oriented uses of the portfolio analytic model of diversification was centered mainly on the interpretation of the many results of the model. As mentioned above, the model discerns those industries that are stable at present, the temporal comparison allowed comments on those industries that became increasingly stable from 1979 to 1985, and allows policy makers the option of "choosing" which industries to attract and maintain. The graphical technique of examining the effect a change in a region's sectoral employment will have on diversification and how that change relates to changing regional income is a useful and interesting tool. The ability to examine different regional sectoral employment proportions allows the planner to see the effect a specific firm may have on industrial diversification. This ability to foresee a positive or negative effect on regional diversification levels may influence the decision as to whether or not to give necessary zoning variances, tax incentives, or public financing assistance. The comparison to other economic indicators, such as the positive change in regional income used in the case study applications, give the planners and policy makers an even better idea as to the regional economic benefits and costs of a given location decision.

Finally, the evaluation of the use of the portfolio model of diversification for small region data discussed many pitfalls these data have and their impact on the model's results.

The common problems of data requirements, sectoral aggregation, and regional aggregation all effect the portfolio model in unique ways. The use of sectoral employment proportions in the model causes it own unique problems, especially when the proportion is responding to a very localized condition. The last concern of growth instability, although a problem, can be sufficiently dealt with, as long as the model's results are thoroughly examined and interpreted with the benefit of some additional information.

Future Research

The portfolio analytic model of industrial diversification lends itself well to many applications. The ability to examine the variance and stability of a regional economic variable is very interesting. Many research possibilities exist with the use of this model for Michigan or other small region applications. It would be very interesting to calculate the portfolio model using other regional economic variables. Two interesting examples, data permitting, would be income diversity (as per Bolton (1986)) as well as diversity in terms of capital investment or value added.

A Michigan analysis at the county level would be very desirable. Often economic development policy issues are decided based on MSA or planning region designations. A county level diversification analysis would help determine where in the region the development efforts should be concentrated, and what counties would be affected.

A possible extension of the portfolio model would be to combine it with Input-Output analysis. From this combination it would be possible to examine industry stability and how it relates to the industry technical coefficients of the State. Are those industries, with very localized markets, stable? Is the stability of an industry more closely related to those industries it sells (forward linkages) to or to those industries it purchases from (backward linkages)?

APPENDIX A.

MICHIGAN EMPLOYMENT REGION AREA DEFINITIONS

Alpena LMA	Alpena County
Ann Arbor MSA	Washtenaw County
Battle Creek MSA	Calhoun County
Benton Harbor MSA	Berrien County
Detroit MSA	Lapeer, Livingston, Macomb, Monroe, Oakland, St. Clair, and Wayne Counties
Flint MSA	Genesee County
Grand Rapids MSA	Kent and Ottawa Counties
Grand Traverse LMA	Grand Traverse and Leelanau Counties
Jackson MSA	Jackson County
Kalamazoo MSA	Kalamazoo County
Lansing MSA	Clinton, Eaton, and Ingham Counties
Muskegon MSA	Muskegon County
Saginaw MSA	Bay, Midland, and Saginaw Counties
Upper Peninsula MSA	Alger, Baraga, Chippewa, Delta, Dickenson, Gogebic, Houghton, Keweenaw, Iron, Luce, Mackinac, Marquette, Menominee, Ontonagon, and Schoolcraft Counties

APPENDIX B.

REGIONAL SECTORAL EMPLOYMENT PROPORTIONS: 1985

SECTOR	REGION														
	ALPENA	ANNARB	BATCRK	BTNHBR	DETRT	FLINT	GRDRPD	GRDTRV	JACKSN	KZOO	LANS	MUSK	SAGIN	UPPER	MICH
Mining	.009	.001	.002	.002	.001	.001	.001	.017	.004	.000	.002	.001	.001	.028	.003
Construction	.028	.025	.028	.022	.027	.023	.037	.047	.021	.029	.025	.036	.037	.046	.028
Lumber	.012	.001	.002	.005	.001	.000	.006	.003	.002	.001	.001	.002	.003	.033	.004
Primary Metals	.009	.002	.022	.044	.015	.001	.011	.003	.015	.005	.005	.040	.055	.007	.015
Fabricated Metals	.008	.014	.028	.031	.034	.061	.053	.013	.062	.056	.012	.020	.008	.005	.034
Non-elec. Mach.	.065	.021	.048	.064	.041	.008	.047	.039	.060	.023	.014	.123	.021	.013	.038
Transport. Eq.	.000	.120	.007	.029	.121	.289	.016	.017	.054	.020	.148	.025	.108	.013	.101
Other Durable	.047	.055	.011	.095	.016	.004	.106	.022	.031	.024	.007	.087	.012	.022	.028
Food Products	.000	.003	.118	.011	.009	.004	.025	.043	.012	.007	.006	.002	.016	.008	.013
Paper Products	.024	.001	.018	.012	.002	.002	.006	.005	.000	.050	.002	.019	.001	.033	.006
Print. and Pub.	.010	.018	.011	.023	.010	.005	.015	.011	.008	.014	.007	.009	.009	.008	.011
Chem./Petro. Prod.	.000	.000	.004	.003	.007	.002	.017	.000	.004	.078	.003	.013	.083	.001	.012
Other Non-Durable	.062	.013	.004	.030	.018	.004	.035	.011	.017	.022	.004	.010	.006	.002	.019
Trans. & Public Util.	.063	.029	.031	.042	.044	.027	.036	.044	.089	.032	.028	.049	.048	.051	.041
Wholesale Trade	.046	.027	.024	.044	.056	.063	.066	.040	.044	.038	.038	.036	.037	.027	.050
Retail Trade	.190	.131	.159	.153	.176	.172	.179	.235	.168	.179	.150	.174	.187	.189	.174
F.I.R.E.	.043	.028	.072	.037	.054	.034	.040	.041	.033	.040	.055	.024	.041	.035	.046
Services	.145	.194	.199	.217	.239	.168	.203	.256	.191	.223	.171	.192	.194	.173	.213
Federal Gov't.	.010	.017	.083	.008	.018	.008	.007	.012	.010	.009	.015	.007	.012	.033	.016
State Gov't.	.019	.225	.007	.008	.016	.012	.009	.025	.052	.068	.198	.020	.012	.090	.041
Local Gov't	.210	.075	.122	.120	.095	.112	.085	.116	.123	.082	.109	.111	.109	.183	.107

APPENDIX C.

REGIONAL SECTORAL EMPLOYMENT PROPORTIONS: 1979

SECTOR	REGION														
	ALPENA	ANNARB	BATCRK	BTNHBR	DETRT	FLINT	GRDRPD	GRDTRV	JACKSN	KZOO	LANS	MUSK	SAGIN	UPPER	MICH
Mining	.007	.001	.001	.003	.001	.000	.002	.012	.004	.000	.001	.002	.001	.065	.004
Construction	.051	.023	.030	.030	.035	.031	.050	.063	.036	.042	.035	.050	.054	.043	.038
Lumber	.020	.001	.001	.006	.001	.001	.006	.002	.002	.001	.001	.002	.002	.034	.004
Primary Metals	.009	.002	.029	.068	.025	.001	.019	.000	.016	.006	.005	.062	.078	.011	.024
Fabricated Metals	.009	.018	.040	.030	.044	.069	.064	.022	.060	.051	.020	.024	.010	.004	.041
Non-elec. Mach.	.074	.018	.117	.065	.052	.008	.054	.028	.051	.030	.018	.136	.034	.026	.046
Transport. Eq.	.000	.175	.019	.030	.133	.331	.018	.000	.086	.039	.147	.019	.125	.007	.112
Other Durable	.058	.085	.001	.102	.017	.002	.102	.026	.031	.023	.009	.083	.022	.022	.030
Food Products	.000	.002	.118	.019	.011	.005	.024	.046	.008	.010	.006	.006	.013	.008	.014
Paper Products	.018	.003	.021	.014	.003	.002	.006	.000	.002	.059	.002	.020	.002	.027	.007
Print. and Pub.	.009	.015	.010	.025	.009	.005	.014	.011	.009	.012	.007	.008	.007	.009	.009
Chem./Petro. Prod.	.000	.000	.003	.004	.010	.003	.017	.000	.002	.070	.000	.012	.083	.000	.013
Other Non-Durable	.070	.012	.001	.027	.018	.004	.030	.018	.037	.019	.009	.009	.001	.004	.019
Trans. & Public Util.	.073	.025	.037	.033	.049	.032	.042	.056	.095	.036	.029	.055	.045	.052	.044
Wholesale Trade	.037	.018	.023	.036	.049	.050	.054	.043	.029	.031	.037	.030	.028	.032	.047
Retail Trade	.181	.119	.139	.157	.160	.147	.167	.201	.171	.164	.145	.150	.162	.173	.162
F.I.R.E.	.039	.027	.059	.033	.059	.033	.039	.052	.031	.033	.049	.029	.038	.032	.042
Services	.122	.151	.175	.182	.190	.144	.177	.225	.171	.197	.141	.156	.160	.147	.172
Federal Gov't.	.009	.016	.064	.006	.018	.007	.007	.014	.007	.010	.014	.007	.010	.032	.016
State Gov't.	.021	.212	.007	.009	.019	.011	.011	.043	.037	.073	.208	.019	.012	.091	.041
Local Gov't	.193	.077	.105	.121	.107	.114	.097	.138	.115	.094	.117	.129	.108	.181	.115

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