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THE THEORY OF REGIONAL ECONOMIC STABILITY DIFFERENTIALS:
ANALYSIS, REFORMULATION, AND EMPIRICAL EVIDENCE

A Dissertation
Presented for the
Doctor of Philosophy
Degree
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ABSTRACT

The objectives of this study were to analyze the four theories of regional economic stability differentials--the industrial mix, growth differentials, city size, and industrial diversification hypotheses--to arrive at a more precise formulation of an hypothesis; to develop measures of regional economic instability and industrial diversification which overcome the conceptual and empirical shortcomings of previous measures; to test the reformulated hypothesis that industrial diversification, combined implicitly with city size and industry mix elements, is a factor in explaining regional economic stability differentials; and to compare these empirical results with those of previous studies.

The traditional measures of industrial diversification and regional economic instability were shown to have a number of shortcomings. It was argued that the entropy measure of industrial diversification and the coefficient of variation measure of economic instability overcome these shortcomings.

These two measures were calculated for a sample of 106 metropolitan areas in the U.S. and for three data sets--nonagricultural, manufacturing, and basic employment. Previous diversification measures were also constructed for comparative purposes. The index of economic instability used quarterly total nonagricultural employment data covering the period 1967 through 1976, and the indexes of industrial diversification used 1972 annual average two-digit nonagricultural employment data. These data were obtained from the U.S. Department of Labor, Bureau of Labor Statistics.

Several major conclusions based on a number of empirical tests conducted in this study were apparent. First, the econometric problems of multicollinearity and heteroscedasticity were found to plague regional economic stability models. Second, chi square tests of independence indicated dependence between industrial diversification and regional economic stability. Third, the entropy measure of industrial diversification was shown to perform better than previous measures as an explanatory variable of regional economic stability differentials, especially when adjusted by city size to correct for heteroscedastic error variances. Fourth, industry mix descriptions proved useful supplements to the industrial diversification explanation for cases of small cities specialized in traditionally stable economic activity such as education or public administration.

Quite obviously, this study could not attempt to answer all questions about regional stability differentials. Still to be explored is the question of to what extent does industrial diversification of regions reduce the economic instability of the nation. Second, what are the differences in the timing and duration of regional instability, and what are their causes? Third, to what extent will the availability of data disaggregated at the three- and four-digit levels improve the explanatory power of the industrial diversification variable? Finally, what are the potential uses of the decomposition property of entropy in explaining, either in an empirical or descriptive sense, the differences in regional economic stability?

The results of this study did indicate, however, that a region which desires to reduce the degree of its economic instability, may use industrial diversification as at least a partial means to accomplish this goal.

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CHAPTER I

INTRODUCTION

Within the United States economy, where factors of production are not perfectly mobile across space and transportation costs are not equal to zero, component subnational economies naturally exhibit varying degrees of economic growth and stability. Patterns of growth in economic activity, levels of production of goods and services, and the distribution of income derived from such production differ from region to region and city to city. Similarly, there is considerable regional variation in the degree and manner in which an economy experiences fluctuations in the level of its economic activity in response to changes in national monetary and fiscal policy.

Formulators of regional economic development policy in the U.S. have made significant contributions toward the goals of higher per capita income levels, improved income distributions, and stronger growth in economic activity during the last two decades. The creation of the Economic Development Administration, the establishment of the five regional development commissions,¹ and the enactment of such public laws as the Area Redevelopment Act of 1961, the Public Works Acceleration Act of 1962, and the Appalachian Regional Development Act of 1965 indicate the strong commitment of federal and state and local government officials to accomplish these goals.

¹The Public Works and Economic Development Act of 1965 created five multi-state economic development commissions encompassing the Ozarks, New England, Four Corners, Coastal Plains and Upper Great Lakes regions. There are now 11 such regional commissions.

The goal of regional stability (where the act of stabilizing a region is defined as minimizing the deviations of some regional economic aggregate from its long-run secular growth trend), while somewhat less important than the goals of increased per capita income levels, improved distributions of income, and strong economic growth, is nevertheless a desirable economic objective. Like the latter goals, stabilization of regional economies has important implications for economic policy at the national level. In particular, to the extent that the economic stability of regions in the U.S. differs, national monetary and fiscal policies may have to be regionally differentiated. In a national economy characterized by high rates of unemployment and inflation, for example, the institution of expansive fiscal policy to ameliorate the national unemployment problem may in fact exert wage-increase pressure on regions with already low unemployment rates, thus exacerbating inflationary problems in such regions.² The identification of regional differences in economic stability is also useful in the development of macroeconomic forecasting models which operate from the "bottom-up" framework, modeling regional economies and aggregating to the national level. Such modeling efforts are currently being conducted by a number of researchers.³

To the extent that stabilization of regions is an important regional as well as national economic policy goal, investigations into the causes

²This observation was first made by Dong Cho and Gerald McDougall in their article, "Regional Cyclical Patterns and Structure, 1954-1975," Economic Geography 54 (January 1978): 66-74.

³See, for instance, K. P. Ballard and R. M. Wendling, "The National-Regional Impact Evaluation System: A Spatial Model of U.S. Economic and Demographic Activity," paper presented at the Southern Economic Association Meetings, Washington, D. C., November 1978.

of regional instability are therefore warranted. Such investigations have permeated the literature over the last 20 years, but yet there is still considerable controversy over the issue. In particular, four alternative explanations of regional differences in economic stability have been offered by various researchers; they may be identified as the industrial mix hypothesis, the growth differentials hypothesis, the city size hypothesis and the industrial diversification hypothesis. It is quite often difficult to determine whether researchers intend these to be substitute or complementary theories. For instance, the terms industrial mix and industrial diversification are often used interchangeably, even though industrial mix variables do not measure the extent of regional diversification. Some proponents of the city size hypothesis disregard industrial diversification as a causal factor in regional stability, when in fact many other studies have indicated a high correlation between city size and industrial diversification.

Furthermore, whichever theory or juxtaposition of theories is used by researchers, tests of the relevant hypothesis can be questioned on numerous empirical grounds: too often generalizations are made on the basis of small samples; data are sometimes too highly aggregated to produce meaningful results; regions are occasionally defined on the basis of political boundaries rather than natural market area boundaries; indexes of regional instability and industrial diversification have been based upon questionable and sometimes erroneous assumptions; the methods of testing the hypotheses have been inappropriate, given the description of the theory.

Because of the ambiguity surrounding the causal explanations of regional stability differentials and the quality of accompanying empirical

investigations, further studies which scrutinize the economic logic of the four alternative hypotheses and which attempt to improve upon empirical methods are clearly needed. Accordingly, this study has three major objectives. First, the industrial mix, growth differentials, city size, and industrial diversification hypotheses will be critically evaluated in order to determine which theory or theories is the most efficacious. It will be argued that the industrial diversification hypothesis, combined implicitly with elements of the city size and industrial mix hypotheses, has the least theoretical objections of the four explanations of observed differences in regional economic instability. Second, indexes of industrial diversification and regional instability will be developed, and it will be shown that these measures overcome most of the theoretical and empirical shortcomings of previously used measures. Third, the hypothesis that industrial diversification is a factor in explaining differences in regional stability will be tested, and the results of this investigation will be compared with previous studies.

The plan of the study is as follows: in Chapter II, the four alternative hypotheses will be reviewed, along with some of the most prominent empirical investigations. After eliminating the redundant aspects of some hypotheses, and reducing other hypotheses to a more fundamental basis, the remaining elements in each hypothesis will be synthesized to form an alternative explanation of the causes of regional economic instability. It will be argued in Chapter II that industrial diversification, adjusted by city size and accompanied by industrial mix descriptions in the case of small, very specialized cities, offers the most promise as an explanation of regional stability differentials.

In Chapter III, traditional diversification measures will be shown to have certain inadequacies with regard to measuring diversification in the context of regional instability, and an industrial diversification index based on the thermodynamic concept of entropy will be developed. Calculation of the diversification index, along with the construction of an index of regional economic instability, will be presented in Chapter IV. This study's data, data sources and data set construction methods will also be presented in Chapter IV. The major data used are two-digit nonagricultural employment data by quarter from 1967 to 1976 for 106 Standard Metropolitan Statistical Areas (SMSA's) in the U.S., available from the U.S. Department of Labor, Bureau of Labor Statistics.

The hypothesis that industrial diversification is a factor in explaining differences in regional economic instability is tested in Chapter V using chi square tests of independence and the regression techniques of ordinary least squares and weighted least squares. Based on the discussion in Chapter II, it will be shown that weighted least squares is the more appropriate estimation method. These results will then be supplemented by industrial mix descriptions in cases of small, very specialized cities. In addition, the results of using entropy as a diversification measure to explain regional instability differentials will be compared with results using more traditional diversification measures.

Chapter VI presents a summary of major conclusions and provides direction for further refinements of the methods and results of this study.

Finally, it is hoped that, with a more careful review of the arguments of previous researchers on this topic, and with the refinement of data, indexes of instability and diversification, and estimation methods, regional and national policy-makers can come one step closer to understanding and perhaps lessening the differences in economic instability of regions in the U.S.

CHAPTER II

REGIONAL DIFFERENCES IN ECONOMIC STABILITY:

ANALYSIS OF THE THEORIES

One of the major reasons that statistical identification of the causes of regional economic stability differentials has been inconclusive is the conceptual ambiguity of the various underlying theories. Increased city size and rapid economic growth have been offered as explanations of these differentials without, it seems, consideration of the more fundamental economic factors which give rise to such regional characteristics. The assumptions of the industrial mix hypothesis can be questioned on a number of grounds. The terms "industrial mix" and "industrial diversification" have sometimes been used interchangeably, ostensibly implying that they measure the same economic phenomenon, while in other studies no such pairwise discussion of these regional characteristics is present.

Another factor contributing to the inconclusive nature of the evidence in previous studies revolves around the empirical methods used in testing the hypotheses. The quality of the data, data sources, indexes of instability, diversification and industrial mix, and the estimation methods used in these studies require that results be treated with some skepticism. In fact, various researchers have reached entirely opposite conclusions on the basis of the same underlying theory, and sometimes with similar data sources. This confusion has led a number of regional

economists like Walter Isard to call for ". . . considerably more research . . . to clear up the clouded picture."⁴

The purpose of this chapter is therefore to present and analyze the various theories that have been offered as explanations of regional economic stability differentials and to examine the empirical methods used in the most prominent studies. Analysis of these theories will be shown to lead inevitably to a more precise formulation of the theory of regional economic stability differentials, and examination of the empirical methods will give direction for necessary improvements in data, construction of indexes and estimation methods.

Industrial Mix Hypothesis

Formulators of the industrial mix hypothesis claim that differences in regional economic stability can be explained by a region's mix of sensitive industries. This hypothesis is based on the widely accepted view that certain broad classes of industries such as durable goods manufacturing industries or producers' goods industries are more unstable than other classes such as nondurable goods manufacturing or consumer goods industries. Econometric studies of income elasticities of demand have shown that, as a group, durable goods manufacturing industries have relatively higher income elasticities of demand than nondurable goods.⁵ The same holds true for producers' goods industries

⁴Walter Isard, Methods of Regional Analysis: An Introduction to Regional Science (Cambridge: MIT Press, 1960), p. 188.

⁵See, for instance, Herman Wold, Demand Analysis (New York: John Wiley and Sons, Inc., 1953) and C.E.V. Leser, "Commodity Group Expenditure Functions for the United Kingdom, 1948-1957," Econometrica 29 (1961): 24-32.

in comparison with consumer goods industries. Since these industries are not likely to be evenly distributed across space, regions with a large proportion of economic activity in durable goods manufacturing, for example, should theoretically be more unstable than regions with a high proportion of economic activity in nondurable goods manufacturing.

As intuitively appealing as this approach may at first glance appear, there are a number of important theoretical objections to its economic logic. First, since proponents of this theory claim that the business cycle is a national-industrial phenomenon, the method ascribes to each industry in a region the national average decline (or increase) in economic activity in that industry.⁶ That is, the hypothesis assumes that industries are spatially homogeneous and that there will be an equiproportionate decline (or increase) in economic activity in a given industry in all regions, equal to the percentage decline (or increase) in economic activity in that industry nationally.⁷ In fact, there are substantial regional differences in the structure, age and size of plants which preclude such spatial homogeneity of industries.

Second, the industrial mix hypothesis ignores the type of market served by an industry. Those industries within a region which serve

⁶See H. W. Richardson, "Regional Business Cycles," Regional Economics (New York: Praeger, 1969), pp. 275-286. See also Stanley Engerman, "Regional Aspects of Stabilization Policy," in Essays in Fiscal Federalism, ed. R. A. Musgrave (Washington, D.C.: The Brookings Institution, 1965), pp. 7-31.

⁷It might be noted that the assumption of equiproportionate changes need not be made in order to use the industrial mix hypothesis. If "percent durable" is the relevant industrial mix variable, for instance, it might be weighted by certain regional characteristics like size and age of plant or other regional aspects of heterogeneous industries. However, since every industrial mix study uses percent durable without such weights, this assumption is implicit in the analyses.

the local market are likely to be affected by certain characteristics of the region such as tastes, incomes, demographic composition and local habits. Similarly, those industries in a region which serve an international market will be affected by changes in economic activity of countries with which they trade. Local and international market conditions may or may not be identical to national market conditions.

Third, since the industrial mix hypothesis places full blame of regional economic instability on a disproportionate share of sensitive industries, it ignores all other characteristics of regions such as size, pattern of growth, level of diversification and age of plants. Such exclusions imply that there is nothing particularly characteristic of a region which induces differences in economic stability. Rather, these differences are assumed to be a function of the volatility of demand for a firm's product, regardless of the firm's location. If this were the case, i.e., if regional characteristics played absolutely no role in differences in economic stability, two regions containing identical distributions of industries would be expected to experience identical fluctuations in the levels of their economic activity.

These theoretical objections thus indicate that, in terms of the empirical problems of this approach, "percent durable" is an inappropriate explanatory factor of regional economic stability differentials, particularly when used without reference to any other factor. In addition, there have been two other categories of empirical difficulties with industrial mix explanations: the instability index and "other data problems" such as sample size, geographic and/or industrial levels of aggregation and type of data used. While these two categories of empirical problems have not been limited to industrial mix studies, it is

nevertheless useful to discuss them in the context of industrial mix explanations since such explanations comprise the bulk of the literature on the subject. The works of Williams, Cutler and Hansz, and Bretzfelder fall under the first category, since the instability indexes used in their works are questionable, while the works of Borts and Engerman may be criticized on the basis of other data problems.

In 1950, Williams tested the hypothesis that industry mix is a factor in explaining regional economic stability differentials for a sample of 13 cities in the U.S.⁸ The test consisted of calculating a rank correlation coefficient between the percentage of manufacturing activity accounted for by nondurable goods (as a measure of industrial mix) and an index of instability defined as the ratio of central city retail sales in 1933 to the average sales in 1929 and 1937 (where 1933 was a national business cycle trough and 1929 and 1937 were cycle peaks). Williams concluded with a rank correlation of 0.84 (significant at the 0.01 percent level) that industry mix was a factor in explaining regional economic stability differentials. However, it is doubtful that such a generalization is valid based on such a small sample. Furthermore, Williams excludes a considerable amount of regional economic activity in both his index of industrial mix and index of instability. Nonmanufacturing activity is unaccounted for in his description of a region's industrial mix, since only the percentage of total manufacturing employment attributed to nondurable goods is measured. Moreover, his index of instability measures fluctuations in retail sales, which

⁸Robert M. Williams, "The Timing and Amplitude of Regional Business Cycles," Papers and Proceedings of the Pacific Coast Economics Association 4, n.p., 1950, pp. 47-51.

is only one of approximately 73 two-digit Standard Industrial Classification (SIC) industries within total nonagricultural employment. The use of this instability index is therefore valid if and only if fluctuations in retail sales in U.S. cities are representative of fluctuations in total economic activity in these cities.

In 1971, Cutler and Hansz conducted a more comprehensive study of the industrial mix hypothesis by measuring the differences in economic stability for 35 SMSA's in the U.S.⁹ Using quarterly data on nonagricultural employment and bank debits for these cities, they calculated a rank correlation coefficient of 0.361 between percentage of total manufacturing employment accounted for by durable goods and a measure of economic stability. The latter measure was calculated as the ratio of the average percentage change in weighted nonagricultural employment and bank debits for SMSA's during eight quarters of "acceleration" or "deceleration," to the mean percentage change in these weighted series for the 35 SMSA's.¹⁰ Such an index is likely to be biased against rapidly growing SMSA's: an SMSA which experiences no declines in activity during the period under consideration (in their case, 1961-1968), but which instead grows rapidly, will register large percentage changes in the numerator of their ratio index, and would therefore be considered highly unstable. Indeed, the period (1961-1968) for which Cutler and Hansz conducted their analyses was one of general economic expansion in the U.S. There is therefore a growth bias inherent in the

⁹Addison T. Cutler and James E. Hansz, "Sensitivity of Cities to Economic Fluctuations," Growth and Change 2 (January 1971): 23-28.

¹⁰The weights used were approximately 3 to 1, nonagricultural employment to bank debits.

instability index used by Cutler and Hansz. As will be argued in the next chapter, an instability index should measure the extent of economic fluctuations around the long-run secular growth trend, whether positive or negative. Regions which, in fact, experience very few economic fluctuations, but which grow steadily over time should not be classified as unstable simply because of strong growth performance.

Note should also be made of the difference in magnitude of the rank correlation coefficient calculated by Cutler and Hansz in comparison with that of Williams. Using the same underlying theory and the same industrial mix variable, the rank correlation between regional economic instability and industry mix was found to be 0.84 in one study and 0.36 in the other. Such divergent results are those which are most frequently cited when pointing out the confusion surrounding this issue.

The instability index used by Bretzfelder in his study of regional economic stability differentials conducted in 1973 is also biased against regions which experience steady growth.¹¹ His index, similar to the Cutler and Hansz index, was calculated as the difference between the average quarterly percentage changes in nonfarm income for states during 71 postwar quarters of expansion, and the average of such changes during 17 quarters of recession, where the quarters of expansion and recession were identified on the basis of National Bureau of Economic Research-defined GNP peaks and troughs. Thus, again, if a state experiences rapid growth in nonfarm income during expansions and little or no declines during recessions, it displays substantial instability on

¹¹Robert B. Bretzfelder, "Sensitivity of State and Regional Income to National Business Cycles," Survey of Current Business 53 (April 1973): 22-27.

the basis of Bretzfelder's index. Although no empirical tests were conducted, Bretzfelder concludes on the basis of descriptive analyses that "the differential effect of the national business cycle on the individual states was mainly a product of state differences in industrial composition."¹² In particular, "states in which a large share of nonfarm income consists of . . . durable goods manufacturing . . . were the states most sensitive to the cycle."¹³

The works of Borts and Engerman are examples of industrial mix studies with other data problems.¹⁴ Both studies used annual data for states to conduct empirical tests of the relevance of the industrial mix hypothesis in explaining differences in regional cyclical instability. While substantially more data are available on a state basis, there are considerable flows of output, natural and human resources across state boundaries which warrant the use of more meaningful economic regions in such studies. Standard Metropolitan Statistical Areas, for instance, where "the general concept of a metropolitan area is one of an integrated economic and social unit with a recognized urban population nucleus of substantial size"¹⁵ more accurately fits the economist's description of a functional economic region. BEA economic areas are also useful geographic units on which to conduct economic analyses.

¹²Ibid., p. 22.

¹³Ibid.

¹⁴George H. Borts, Regional Cycles of Manufacturing Employment in the United States, 1914-1953, National Bureau of Economic Research, Occasional Paper Number 73 (New York: National Bureau of Economic Research, 1960), and Engerman, op. cit., pp. 20-24.

¹⁵U.S., Executive Office of the President, Office of Management and Budget, Standard Metropolitan Statistical Areas, 1975 (Washington, D.C.: Government Printing Office, 1975), p. iii.

Furthermore, the use of annual data is likely to obscure cyclical movements in economic aggregates and thereby attenuate the degree of severity of regional economic instability. Monthly or quarterly data more accurately reflect cyclical movements in economic variables.

With these considerations in mind, the empirical results of Engerman's study showed a rank correlation between "percent durable" and average annual amplitude in total employment in states of 0.14 for the period 1949-1954, and 0.29 for the period 1954-1958. This is in marked contrast to the rank correlation coefficient obtained in the Williams' study of 0.84, again emphasizing the inconclusive nature of industrial mix studies.

Two additional studies of regional economic instability, those of Siegel, and Wasylenko and Erickson, indicate that, given proper data sets and indexes of economic stability, a region's industry mix may in fact play a role in explaining the differences in such stability in spite of the theoretical objections discussed at the beginning of this section. In particular, Siegel used an index of economic instability defined as the coefficient of variation of residuals around a linear trend of total manufacturing employment for 31 SMSA's, using monthly employment observations over the period 1949-1962.¹⁶ The rank correlation coefficient between this and the "percent durable" measure of industrial mix was 0.71, and the coefficient of determination was 0.50, indicating that "half the variation in amplitude of total manufacturing

¹⁶Richard A. Siegel, "Do Regional Business Cycles Exist?" Western Economic Journal 5 (December 1966): 44-57.

employment between SMSA's is explained by the proportion of manufacturing employment in durable goods industries."¹⁷

Given the commendable quality of Siegel's data set and instability index, his results are more convincing than those of his precursors and may indicate that industry mix can be at least a supplemental explanation of regional economic stability differentials. The work of Wasylenko and Erickson points out what this supplemental role may be.¹⁸ In their study of economic diversification, Wasylenko and Erickson point out that where the industrial diversification explanation of regional differences in economic stability usually fails is in cases of cities which are specialized in activity such as public administration or education, the so-called state-capital or college towns. Regions specializing in these activities "are typically among the most stable of regional economies."¹⁹ Thus, as will be argued at the end of this chapter, if industrial diversification offers the most promise of the four explanatory factors of regional economic stability differentials, but empirical tests produce inconclusive results because of the exceptions of state-capital or college towns, then industrial mix variables may be useful supplements to the diversification argument in such cases.

Growth Differentials Hypothesis

The growth differentials explanation of regional economic stability differences states that rapidly growing regions will experience

¹⁷Ibid., p. 52.

¹⁸M. J. Wasylenko and R. A. Erickson, "On Measuring Economic Diversification: Comment," Land Economics 54 (February 1978): 106-109.

¹⁹Ibid., p. 108.

smaller declines and larger expansions than slowly growing regions, and conversely, slowly growing regions will experience larger declines and smaller expansions than rapidly growing regions. Reasons for these observations most frequently cited by proponents of the growth differentials hypothesis include both demand and cost factors. First, it is argued that rapidly growing regions have a relatively abundant share of more efficient, low-cost, newer industrial plants in comparison with slowly growing regions. During periods of national economic decline, high-cost plants are usually the first to be cut back in production and employment. Only if a recession lasts for a great length of time will the more efficient lower-cost plants experience capital and labor layoffs. Thus, since rapidly growing regions have a higher proportion of low-cost plants than slowly growing regions, they experience less severe economic declines.

Second, during periods of national economic expansion, it is argued that rapidly growing regions typically experience concomitant increases in levels of in-migration which further serve as a source of stimulating investment demand. Thus, rapidly growing regions experience larger expansions than slowly growing regions.

The implications of this line of reasoning in terms of a model of regional economic stability differentials are, however, unclear. Do the proponents of the growth differentials hypothesis mean to imply that rapidly growing regions will be more stable or less stable than slowly growing regions? Their arguments certainly indicate that they expect rapidly growing regions to be more stable than slowly growing regions during contractionary periods, but since they argue for larger expansions for rapidly growing regions, does this imply greater

instability during expansionary periods for such regions? What then is the total expected effect over the course of an entire cycle or several national business cycles?

Answers to this dilemma are as numerous as are the researchers who have tested this hypothesis. Borts and Engerman, for instance, argue that the growth differentials hypothesis was never intended as an alternative explanation of regional economic stability differences, but rather as a complementary explanation to the industrial mix hypothesis.²⁰ Borts concluded that rapidly growing regions experience less severe economic fluctuations than the industry mix of these regions would lead one to expect a priori, thereby postulating a negative correlation between growth and regional economic instability. Similarly, Engerman called for the juxtaposition of the industrial mix theory and the growth differentials theory. Yet, in their empirical analyses, Borts found that "the combination of high growth rates and wide fluctuations and low growth rates and mild cycles are found more frequently than their opposites,"²¹ and Engerman found a positive correlation between growth and regional instability, based on a calculated Spearman rank correlation coefficient of 0.32.²² The fact that Borts and Engerman found positive correlations between growth and instability should not be surprising since, throughout the entire business cycle history of the U.S. economy, expansionary periods have dominated contractionary periods both in number and duration. More recent studies such as that

²⁰Borts, op. cit., p. 152; Engerman, op.cit., p. 27.

²¹Borts, loc. cit., p. 152.

²²Engerman, op. cit., p. 29.

of Cho and McDougall have also found a positive rank correlation between growth and instability.²³

Other researchers such as Richardson suggest that growth differentials should not be relegated to a secondary position but should be considered as a factor by themselves: "there is a strong a priori case, supported by some empirical evidence, for believing that regional growth differentials play a major role in accounting for the diversity of cyclical patterns between regions."²⁴ Richardson did not, however, cite this empirical evidence.

It is therefore an understatement to say that there is both theoretical and empirical confusion surrounding the growth differentials explanation of regional economic stability differences. While the title of the hypothesis implies that growth is the causal factor, the arguments of the proponents of the hypothesis indicate that it is really the more fundamental economic factors of demand and cost which are at work. Furthermore, it is unclear whether the hypothesis was intended to be substitute or complementary to other hypotheses such as industry mix. Finally, the overwhelming empirical evidence points to a positive (not negative as postulated) correlation between growth and instability. Even if proponents could convincingly argue for a positive correlation, such a position would have unacceptable regional and national policy implications: if stability is the desired goal, growth must be sacrificed. Given the policy implications and the inconclusive nature of the theoretical arguments and empirical results, the merits

²³Cho and McDougall, op. cit., p. 73.

²⁴Richardson, op. cit., p. 277.

of the growth differentials hypothesis, either as a principal or supplementary explanation, are doubtful.

City Size Hypothesis

The city size hypothesis of regional economic stability differentials very simply states that the larger the city, the more stable will be the economy. The basis upon which this relationship is postulated is unclear in some works, but seems to emanate from the Keynesian-type economic base framework. Such models assume that regional income can be apportioned into two components: one, called basic income, defined as income derived from sales of regional exports, and a second, called nonbasic income, defined as income derived from the local sale of consumption and investment goods. Export or basic income is considered to be exogenously determined, while local consumption and investment income are considered to be functions of regional income. In particular, the following equations depict the Keynesian economic base model of regional income determination, as documented by Charles Tiebout in 1962:²⁵

$$Y_B = X_o \quad (1)$$

$$Y_N = C_L + I_L \quad (2)$$

$$C_L = (MPCL \cdot Y\$C_L)Y \quad (3)$$

$$I_L = (MPIL \cdot Y\$I_L)Y \quad (4)$$

$$Y = Y_N + Y_B \quad (5)$$

$$Y = (MPCL \cdot Y\$C_L)Y + (MPIL \cdot Y\$I_L)Y + X_o \quad (6)$$

²⁵Charles M. Tiebout, The Community Economic Base Study, Supplementary Paper Number 16 (New York: Committee for Economic Development, 1962).

where Y_B = basic income, X_O = exports, Y_N = nonbasic income, C_L = local consumption income, I_L = local investment income, Y = total regional income, $MPCL$ = marginal propensity to consume locally, $MPIL$ = marginal propensity to invest locally, $Y\$C_L$ = income created per dollar of local consumption and $Y\$I_L$ = income created per dollar of local investment. Equations (1) through (6) differ from the traditional Keynesian model of national income determination only inasmuch as the terms $Y\$C_L$ and $Y\$I_L$ are included. These terms, income created per dollar of local consumption/per dollar of local investment, account for the fact that, whatever the propensity to consume, not all that is spent on local consumption and investment goods remains as local income. Part of this income goes for import payments, while another part may go to nonresidents in the form of wages and salaries. Whatever portion remains as local income is called income created per dollar of local consumption and income created per dollar of local investment.

Tiebout as well as other economic base theorists argue that the terms $MPCL$, $MPIL$, $Y\$C_L$, $Y\$I_L$ increase as the size of the region increases so that larger cities are less dependent upon imports for their products and also export less outside their boundaries. That is, there is a greater propensity to consume and invest in local consumption and investment goods since more of a variety of goods and services are and can be offered in larger cities. Similarly, there is less need to depend on exports as a major source of income in larger cities since nonbasic industries constitute an increasing share of total regional economic activity, as the size of the region grows.

Thus, the deductive conclusion that proponents of the city size hypothesis reach is that since exports, the demand for which is

determined by forces outside the region, are the deus ex machina of local cycles, less reliance on exports as a source of regional income implies greater stability. However, the counterpart to lower marginal propensities to import and export is a large multiplier, where the Keynesian economic base multiplier is defined as

$$\frac{dY}{dY_B} = \frac{1}{1 - [(MPCL \cdot Y\$C_L) + (MPIL \cdot Y\$I_L)]} \quad (7)$$

The larger the terms, MPCL, MPIL, Y\$C_L and Y\$I_L, the larger will be the base multiplier. The larger the base multiplier, the greater will be the decreases in regional income with a given decline in exports.

There are thus two offsetting effects: increased city size is accompanied by a larger multiplier which implies greater instability, but increased city size is also accompanied by less reliance on exports (a lower base/nonbase ratio) which implies lesser instability.

As Wilbur Thompson explains:

Under the simplest and most reasonable set of assumptions, the larger city's higher multiplier is exactly offset by a lower export orientation, to the net effect that a given proportionate change in the export base of large and small urban economies would effect exactly the same proportionate change in the total level of total activity in the two economies. . . .there seems to be no deductive presumption, via a simple Keynesian model, in favor of any systematic functional relationship between size and stability . . . the multiplier and the base-to-service ratio tend to cancel out.²⁶

One factor often overlooked by proponents of the city size hypothesis (even though it is implicit in their analyses) is that along with increased city size comes greater diversification. The larger the city,

²⁶Wilbur R. Thompson, A Preface to Urban Economics (Baltimore: Johns Hopkins Press, 1965), pp. 141-147.

the more diverse is its basic activity likely to be; this diversification probably occurs in cyclically less-sensitive industries such as finance, trade, and services. Indeed, central place theory clearly defines the movement from a village, to a town, to a city and finally to a metropolis in terms of the number and variety of goods and services offered.²⁷ The movement from a lower to a higher order central place is defined as the movement from lesser to greater diversification. In addition, there have been a number of empirical studies which have found a very high correlation between city size and industrial diversification.²⁸

One very interesting study of this type by Wilbur Thompson showed that increased city size very definitely implied greater diversification.²⁹ The appropriate relationship to focus on, according to Thompson, is therefore diversification and regional economic instability. Thompson postulated that large urban economies tend to have diversified industrial structures and are therefore stable, but that smaller urban economies exhibit a much greater range of cyclical instability, "as some tend to specialize in the more unstable and some the more stable industries."³⁰ The expected relationship between city size,

²⁷Walter Christaller, Central Places in Southern Germany, trans. Carlisle W. Baskin (Englewood Cliffs: Prentice-Hall, 1966).

²⁸See, for instance, Frank Clemente and Richard B. Sturgis, "Population Size and Industrial Diversification," Urban Studies 8 (1971): 65-68; and John U. Marshall, "City Size, Economic Diversity, and Functional Type: The Canadian Case," Economic Geography 51 (January 1975): 37-49.

²⁹Thompson, op. cit., p. 147.

³⁰Ibid., p. 148.

diversification and instability was depicted by Thompson in graphical form and is reproduced in Figure 1.

An interesting thing to note about Thompson's statement as portrayed in Figure 1 is that it is a perfect textbook representation of heteroscedastic variances. That is, in a model of regional economic stability with diversification as an explanatory factor, the normal assumption of constant error variance appears not to hold. Moreover, as Thompson suggests, this variability seems to be a function of city size. The implication of this observation is that models which attempt to explain regional economic stability differentials using ordinary least squares regression techniques are inappropriate. Instead, the regression technique of weighted least squares, where it is assumed that the σ_i^2 are functions of city size, seems more appropriate given the findings of Thompson.

Thus, although city size may not play a direct role in explaining regional economic stability differentials because of the theoretical contradictions in the argument, it may play an indirect role, if cross-section studies of instability indicate wider variability for small, specialized cities. Furthermore, the concept of the economic base upon which the city size hypothesis is based may still hold promise as a factor in regional stability differentials, if used in the correct manner, absent of the city size arguments. In particular, if diversification is shown to affect these differentials, it might be hypothesized that it is diversification of basic activity which is the pertinent explanatory factor.

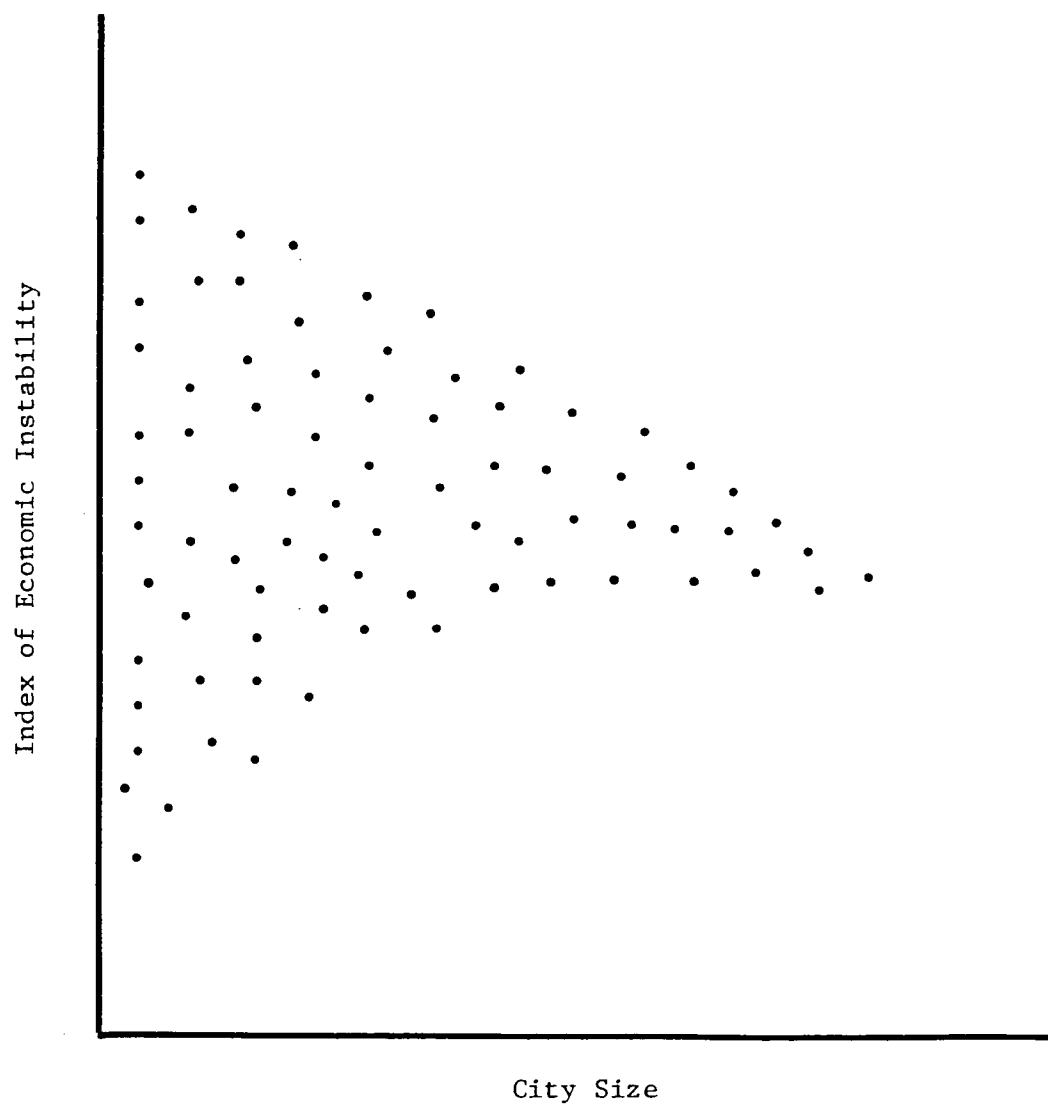


Figure 1. City Size and Economic Stability.

Source: Thompson, op. cit., p. 148.

Industrial Diversification Hypothesis

The earliest published work on regional economic stability differentials known to this writer was completed by R. C. Tress in 1938. Writing about the unemployment problem in England and Wales during the Great Depression, Tress noted that,

Since the last depression, considerable prominence has been given to the idea of preventing unemployment through some form of diversification of industry. Government policy regarding the Special Areas has often been defined on the basis of such an argument, and the notion has received considerable popular approval.³¹

The argument that greater diversification implies greater stability seemed to be common sense to Tress, and the economic basis upon which the argument is founded can be stated no better than by him:

An area in which a large fraction of those employed are engaged in a single industry [or group of industries] does run a grave risk that sooner or later it will be confronted with a heavy unemployment problem. That is merely to say that, if a certain industry [or group of industries] should at some time fall into depression, whether as a result of a temporary slump in trade or as a result of a secular decline in the demand for that industry's [or group's] products, the effect on any area is likely to be the greater, the greater the number of employed persons in that area who are dependent upon that particular industry [or group].³²

Clearly, reliance on a single industry or a group of industries for the totality of regional income is a risky business. Diversification in the context of reducing regional economic instability therefore becomes a type of hedging process: declines in certain industries because of changes in technology or industry demand, or as a result of a

³¹R. C. Tress, "Unemployment and the Diversification of Industry," The Manchester School 9 (1938): 140-152.

³²*Ibid.*, p. 141.

general recession, can be offset by increases in other industries not so affected. The greater the variety of industries located within a region, and the more equal the distribution of employment among these industries, the less the risk of severe overall economic decline within a region.

Is this not, however, in direct conflict with the theory of international/interregional trade, wherein industrial specialization has long been venerated as the key to maximum economic growth? Investigators of the advantages of regional industrial diversification have for many years grappled with this question, and the overwhelming consensus seems to be that specialization vis-a-vis trade theory, and diversification vis-a-vis regional stabilization policy are not at opposite ends of a spectrum. Indeed, the assumptions of the Heckscher-Ohlin model of trade for two countries and two goods lead to a situation where production of both goods occurs in both countries, and, only under the most perverse set of circumstances (where there is an extreme difference in the factor endowments of the two countries, or where production techniques are identical), is complete specialization implied.³³ If, in fact, diversification of a region is at odds with the specialization advantages of interregional trade, it would be expected that the most diversified regions experience the least growth. Such is not the case, as the empirical work of Rodgers indicates: "diversified areas in many cases experienced more rapid rates of growth than specialized regions and no set pattern could be observed."³⁴

³³See, for instance, Eli Heckscher, "The Effect of Foreign Trade on the Distribution of Income," Ekonomisk Tidskrift 21 (1919): 497-512.

³⁴Allan Rodgers, "Some Aspects of Industrial Diversification in the United States," Economic Geography 33 (January 1957): 29.

The conventional wisdom of regional economists on the issue of diversification versus specialization is therefore that the advantages of both can be realized by a region. McLaughlin has conveniently summarized this viewpoint:

It is not impossible to combine the advantages of variety of employment in different industries or in trade with those of the localization of industry. A city's economic structure can be well diversified and still include a sufficient number of mills working within a given industry to secure the advantages of division of labor, adequate supply of skilled workers, specialized service, and the like. There may even be effective diversification among the general types of occupation; as between trade, transportation, manufacturing, and the various service groups.³⁵

Recent studies of industrial diversification in the context of reducing regional economic instability have shown much promise. For example, the work of Cho and McDougall cited earlier resulted in a 0.32 rank correlation coefficient significant at the 0.10 percent level between measures of diversification and regional stability.³⁶ Similarly, the work of Conroy resulted in an adjusted R^2 of 0.42 for his model of diversification and regional stability.³⁷ Although not void of empirical problems, these examples indicate that industrial diversification can be an important factor in explaining regional economic stability differentials.

³⁵ Glenn McLaughlin, "Industrial Diversification in American Cities," Quarterly Journal of Economics 44 (November 1930): 132.

³⁶ Cho and McDougall, op. cit., p. 70.

³⁷ Michael E. Conroy, "The Concept and Measurement of Regional Industrial Diversification," Southern Economic Journal 41 (January 1975): 492-505.

Synthesis of the Theories: A Reformulation

In the first section of this chapter, the industrial mix hypothesis of regional economic stability differentials was shown to be based on several questionable assumptions, and the empirical techniques used in such studies were shown to have various problems which produced contradictory results. Nevertheless, it was argued that industry mix may be an important supplemental factor in cases of regional economies which are highly specialized in traditionally stable industries such as public administration and education. Such exceptions appear to be a partial cause of failures of the industrial diversification hypothesis.

The growth differentials hypothesis was demonstrated to be a rather superficial explanation of economic stability differentials--the real factors being demand and cost. Empirical tests of the growth differentials hypothesis were shown to produce results in conflict with postulated relationships, and the policy implications of these results were found to be unacceptable. Since diversification of a regional economy is likely to mean the location of newer, more efficient plants in a region, and simultaneously an in-migration of workers to operate these plants, at least some of these demand and cost factors identified as the more fundamental causes of regional stability are probably captured in any diversification measure.

In the third section of this chapter, the important work of Wilbur Thompson concerning city size, industrial diversification and regional economic instability was discussed, and it was indicated that models of instability differentials may suffer from the econometric problem of heteroscedasticity. Though perhaps recognized heretofore, the heteroscedastic problem has never been dealt with empirically in studies of

regional economic stability differentials. According to Thompson, the observed variation in economic stability is theoretically a function of city size, with diversification the main causal factor in explaining differences in regional instability.

Finally, in the fourth section of this chapter, the common sense approach of diversification of a regional economy in order to reduce cyclical fluctuations was discussed along with some empirical studies.

Ignoring, for argumentative purposes, the theoretical objections to the industrial mix, growth differentials, and city size hypotheses, one approach to explaining regional economic stability differentials might be to include all relevant variables in a model of these differentials: industry mix, growth rate, size, and diversification. However, because of considerable multicollinearity among these variables, estimates derived on the basis of such a model are likely to be inefficient. A better approach which implicitly combines some of the various aspects of regional economies but which would not suffer from multicollinearity problems would be to use industrial diversification as an explanatory factor, adjusted by city size to take into account heteroscedastic variances, and accompanied by industrial mix descriptions for small, specialized regions. Such an approach would not only avoid some of the theoretical objections of the industry mix, growth differentials, and city size hypotheses, but would at the same time correct for the problems of multicollinearity and heteroscedasticity.

This latter approach will accordingly be used in this study, provided that the problems of heteroscedasticity and multicollinearity are first empirically verified as significant. In particular, after calculating correlation coefficients between industry mix, growth rates,

city size, and industrial diversification to determine the extent of multicollinearity, and after conducting the Goldfeld-Quandt test³⁸ for heteroscedasticity, the model given by equation (8) will be used as the theoretical basis of this study:

$$\text{INSTBI}_i = \alpha + \beta \text{ DIVERS}_i + \varepsilon_i \quad (8)$$

where the INSTBI_i are the economic instability indexes for regions $i=1, \dots, n$, DIVERS_i are the industrial diversification indexes for regions $i=1, \dots, n$, ε_i are the disturbance terms, and α and β are parameters to be estimated.

Equation (8) will then be transformed as given in equation (9) based on the assumption that the disturbances are normally distributed with mean zero and variances equal to σ_i^2 , where σ_i^2 are assumed to be functions of city size as measured by population (POP).

$$(\text{INSTBI}_i \cdot \sqrt{\text{POP}_i}) = (\alpha \cdot \sqrt{\text{POP}_i}) + \beta (\text{DIVERS}_i \cdot \sqrt{\text{POP}_i}) + (\varepsilon_i \cdot \sqrt{\text{POP}_i}) \quad (9)$$

where it is assumed that

$$\sigma_i^2 = \lambda / \text{POP}_i, \quad \lambda > 0. \quad (10)$$

Note that equation (10) states that the error variances decrease with city size, as postulated by Thompson and illustrated in Figure 1, page 25.

It can then be shown that equation (9) overcomes the problem of heteroscedastic variances:

$$E(\varepsilon_i \cdot \sqrt{\text{POP}_i}) = 0, \quad (11)$$

³⁸Stephen M. Goldfeld and Richard E. Quandt, "Some Tests for Homoscedasticity," Journal of the American Statistical Association 60 (June 1965): 539-547.

and unbiasedness is preserved, and

$$\begin{aligned}
 E (\varepsilon_i \cdot \sqrt{POP_i})^2 &= POP_i \cdot E (\varepsilon_i)^2 \\
 &= POP_i \cdot (\lambda/POP_i) \\
 &= \lambda
 \end{aligned}
 \tag{12}$$

and homoscedasticity is preserved. The weighted least squares (WLS) estimates of (9) are therefore unbiased, consistent, and efficient.

The results of equation (9), buttressed by chi square tests of independence between regional industrial diversification and regional economic instability, will be supplemented by industrial mix descriptions for small specialized regions.

CHAPTER III

DIVERSIFICATION AS A FACTOR IN EXPLAINING REGIONAL

DIFFERENCES IN ECONOMIC STABILITY:

THE METHODOLOGY

Prerequisite to any empirical test of the relationship between industrial diversification and regional economic stability is the development of legitimate measures or indexes of regional industrial diversification and regional economic instability. Such measures should be based on economically reasonable assumptions, should have a number of desirable properties, should be easy to calculate with readily available regional data and should truly measure what they purport to measure. Since the time that regional economic stability differentials became an issue of considerable interest to economists, a number of industrial diversification and economic instability indexes have been developed. In the previous chapter, some of the most prominent economic instability indexes were presented and critically evaluated. It was shown that some of these indexes have a number of conceptual and empirical shortcomings. Traditional measures of industrial diversification similarly have a number of conceptual and empirical shortcomings in the context of regional economic stability models. The purpose of this chapter is therefore to describe these measures of industrial diversification and to point out their deficiencies. An alternative index of diversification, based on the thermodynamic concept of entropy, will then be developed. It will be shown that the entropy measure of industrial diversification overcomes most of the conceptual and empirical difficulties of the more

traditional measures and, in addition, has a number of desirable properties. Finally, based on the discussion of Chapter II, an index of regional economic instability will be developed which, again, overcomes some of the objections to such indexes.

Alternative Measures of Industrial Diversification

There are five general classes of measures of regional industrial diversification which have appeared in the literature over the past 40 years; they are summarized in Table 1. As indicated, the first class of measures may be entitled "national average." Developed by Florence, Steigenga and Borts,³⁹ the national average measure in general form is the sum of the deviations of regional employment proportions from corresponding national employment proportions. Let y_i denote the regional employment proportion for the i^{th} industry, where y_i is equal to employment in the i^{th} industry in a given region divided by total employment in that region, and let y_i^{US} denote the corresponding ratio for the nation. The national average regional industrial diversification measure is thus defined as the summation over N industries of the difference between y_i and y_i^{US} , weighted by the factor $1/y_i^{\text{US}}$ and raised to some power ρ .

Second, the "ogive" or equal shares measure of diversification, developed and used by McLaughlin, Tress and Rodgers,⁴⁰ is the sum of the deviations of regional employment proportions from a balanced

³⁹P. Sargent Florence, Investment, Location and Size of Plant (Cambridge: Cambridge University Press, 1948); W. Steigenga, "A Comparative Analysis and Classification of Netherlands Towns," Tijdschrift voor Economische en Sociale Geografie, no. 6/7 (June-July 1955): 105-118; Borts, op. cit.

⁴⁰McLaughlin, op. cit.; Tress, op. cit.; Rodgers, op. cit.

TABLE 1
MEASURES OF REGIONAL INDUSTRIAL DIVERSIFICATION

Measure	General Form	
NATIONAL AVERAGE	USRDV	$= \sum_{i=1}^N \frac{(y_i - y_i^{us})^2}{y_i^{us}}$
OGIVE	OGVDV	$= \sum_{i=1}^N \frac{(y_i - 1/N)^2}{1/N}$
MINIMUM REQUIREMENTS	MINRQ	$= \frac{\sum_{i=1}^N \frac{(y_i - y_i^m)^2}{y_i^m}}{\left(\frac{\sum_{i=1}^N y_i - \sum_{i=1}^N y_i^m}{\sum_{i=1}^N y_i^m} \right)^2}$
PERCENT DURABLE	PERDR	$= y_d / y_T \cdot 100$
PORTFOLIO VARIANCE	PRTVR	$= \sum_{h=1}^N \sum_{i=1}^N y_h y_i \cdot \sigma_{hi}$

industrial structure, i.e., from the proportion $1/N$, where N is the total number of industrial classes under consideration.

The third class of industrial diversification measures, the "minimum requirements" measure, was developed by Ullman and Dacey as a by-product of their study of the minimum requirements approach to the urban economic base.⁴¹ This measure is defined very generally as the sum of the squared deviations of regional employment proportions from the corresponding "minimum requirements employment proportions," weighted by the factor $1/y_i^m$, where y_i^m is the minimum requirements employment proportion for the i^{th} industry. This procedure yielded an unadjusted index which was then divided by the square of the difference between the sum over i of all employment proportions y_i and the sum of all minimum requirements employment proportions y_i^m , weighted by $1/\Sigma y_i^m$. The term Σy_i^m is simply the proportion of total regional employment accounted for by total nonbasic employment. The adjustment factor is thus the proportion of basic employment in a region, squared, divided by the proportion of nonbasic employment in a region. This adjustment supposedly reconciled each index to city size; Bahl, et al.,⁴² later showed that in fact this introduced a city size bias into the index and therefore dropped the adjustment. Indeed, as indicated in the third section of Chapter II, the base-to-nonbase ratio decreases with city size.

The fourth industrial diversification measure is simply the proportion of total regional employment engaged in durable goods production,

⁴¹E. L. Ullman and M. F. Dacey, "The Minimum Requirements Approach to the Urban Economic Base," Papers and Proceedings of the Regional Science Association 6, n.p., 1960, pp. 176-194.

⁴²Roy W. Bahl, R. Firestone, and D. Phares, "Industrial Diversification in Urban Areas: Alternative Measures and Intermetropolitan Comparisons," Economic Geography 47 (July 1971): 414-425.

denoted as y_d/y_T in Table 1, where y_d is durable goods employment and y_T is total regional employment. This measure has been used by Siegel and Cutler and Hansz,⁴³ for instance, in their analyses of the relationship between regional economic instability and industrial mix. This measure has also been used quite often as an industrial diversification variable in studies concerned with regional instability and economic structure, as indicated in Chapter II.

Of the existing diversification measures, the fifth and theoretically most sophisticated has been developed by Conroy and Barth, et al.⁴⁴ Using a portfolio-theoretic approach to industrial diversification, they view each industry in the regional economy as a community investment and therefore refer to the industrial structure of the regional economy as the community "industrial portfolio." Industrial diversification in terms of the community industrial portfolio is described as the act of reducing the variability in aggregate returns to the region, given the portfolio of returns-producing assets. As is the usual convention, the portfolio variance is used as the measure of fluctuations in aggregate returns, or, in other words, as a measure of risk. The formulation of the portfolio variance measure of industrial diversification appears in Table 1, where σ_{hi} denotes the covariance of the predetermined returns criterion (employment) over time for industries h and i for the nation and y_h and y_i denote regional employment proportions in industries h and i , respectively.

⁴³Siegel, op. cit.; Cutler and Hansz, op. cit.

⁴⁴Conroy, op. cit.; J. J. Barth, J. Kraft, and P. Wiest, "A Portfolio Theoretic Approach to Industrial Diversification and Regional Employment," Journal of Regional Science 15 (April 1975): pp. 9-15.

The construction of an appropriate measure of regional industrial diversification requires that the assumptions upon which such an index is based be economically reasonable. The national average measure defines a region as specialized, if its employment distribution deviates greatly from the national employment distribution, and diversified, if its employment distribution matches exactly that of the nation. This formulation thus equates complete diversification with a situation in which every region is endowed with exactly the same quantities of factors of production as the nation. Such a prospect is accordingly inconsistent with the theory of interregional trade, for it is in fact differences in factor endowments which are the basis for such trade. Defining the extent of diversification of a region in terms of the industrial distribution of its parent economy may be fine for fairly diversified national economies such as the U.S., but it is absurd for such an assumption to be made in cases such as the regional economies of South America or Saudi Arabia, for instance.

The minimum requirements diversification measure, produced as a by-product of the minimum requirements approach to the urban economic base, is subject to the criticisms which have recently been made by Pratt⁴⁵ concerning the assumptions of this approach to economic base models. In particular, Pratt notes that by grouping cities by size-class, finding the minimum employment proportion for each industry and size-class, and defining this minimum as that proportion of employment just capable of satisfying local needs, one is left with a group of urban areas in which every city exports and no city imports! For example,

⁴⁵Richard T. Pratt, "An Appraisal of the Minimum Requirements Technique," Economic Geography 44 (January 1968): 117-124.

consider the apparel industry and an economy comprised of three cities, A, B and C. Suppose that the minimum employment proportion of the apparel industry in these three cities was found to be 3 percent of total employment in city A. Then, cities B and C would by definition contain larger proportions of total employment in the apparel industry and would therefore, according to the theory, export that amount of output produced by the employment in excess of 3 percent, while city A would just be supplying its own needs. Extending this argument to all industries in this three-city economy, one is forced to conclude that the minimum requirements technique produces a weird economy in which no city imports and every city exports. "The theory clearly precludes the importing of any goods and services for internal consumption."⁴⁶ The assumptions of the minimum requirements approach to economic base models therefore attenuate the usefulness of the minimum requirements approach to industrial diversification.

As noted in Chapter II of this study, "percent durable," either as a measure of industrial mix or industrial diversification, suffers from the problems of assuming that industries are spatially homogeneous and that the market which an industry within a region serves is unimportant. Percent durable in the special context of measuring industrial diversification suffers from the additional shortcoming that the extent of diversification is really unknown. For example, when manufacturing employment is the data set under consideration, researchers have indicated that a 50-50 distribution of durables-nondurables would imply a fairly diversified manufacturing sector. However, this 50 percent can

⁴⁶Ibid., p. 119.

be accounted for by one industry within either the durables or nondurables groups. Indeed, if there is only one industry in durables and one in nondurables, then the economy is not really diversified at all. In short, the use of percent durable as a measure of regional industrial diversification suffers from the familiar "aggregation problem" in regional economics. There is not sufficient industry detail in such a measure to capture the extent of regional diversification.

Finally, the portfolio variance approach may be criticized on the grounds that it is the weighted sum of the covariances of national employment in individual industries, with weights being given by the regional proportions of employment in the respective industries. As such, the measure assumes the covariability of individual industries is identical across the nation. While the spatial identicalness of industrial covariability may be an empirical question, insufficient data have, until now, precluded the testing of this assumption. Until such evidence becomes available, it is best to argue that the covariance between industry x and industry y in region A is not identical with the covariance between the same industries in region B, due to specifically regional characteristics such as age and size of plants, distance to the market, and so forth.

The Entropy Measure of Industrial Diversification

In 1975, a short paper in the journal of Land Economics discussed the use of entropy as a measure of economic diversification.⁴⁷ Although not all of the properties of entropy were considered by the authors, and

⁴⁷M. M. Hackbart and D. A. Anderson, "On Measuring Economic Diversification," Land Economics 51 (November 1975): 374-378.

there was no attempt to use entropy in the context of regional economic stability differentials, the properties which they demonstrated entropy to have indicated that some of the conceptual and empirical shortcomings of the more traditional measures of diversification might be avoided with entropy. It is therefore useful to review the development of entropy, as it evolved from its application in thermodynamics to its various applications in economics. The desirable properties of entropy as a measure of industrial diversification will be discussed, and it will be shown that entropy overcomes most of the objections to diversification measures discussed in the previous section.

Originally formulated as a thermodynamic measure of the amount of energy unavailable for useful work in a system undergoing change, the concept of entropy has received its greatest impetus from the work of Shannon in communications theory.⁴⁸ In this context, entropy measures the expected information content of a definite and reliable message transmitted by a communications system and is given by equations (13) through (15).

$$H^S = \sum p_i h(p_i) \quad (13)$$

$$= \sum p_i \ln (1/p_i) \quad (14)$$

$$= \sum p_i \ln p_i, \quad (15)$$

where p_i 's, $i = 1, \dots, n$ are the respective probabilities that the events e_i , $i = 1, \dots, n$ will occur and $h(p_i) = \ln (1/p_i)$ is the information content of a message which states that the event e_i has occurred, and the H superscript in this entropy measure denotes the researcher Shannon to distinguish his measure from the researchers who

⁴⁸C. E. Shannon, "A Mathematical Theory of Communication," Bell Systems Technical Journal 27 (July and October 1948): 379-423, 623-656.

will be discussed in the next few pages. Note that the information content $[h(p_i)]$ is a decreasing function of the probabilities p_i , as shown by the particular function, $\ln (1/p_i)$. H^S then is the expected information content, or entropy of a message, which reduces simply to the negative of the expectation of the logarithms of the probabilities.

Entropy may equivalently be regarded as a measure of the degree of uncertainty in a communications system. Indeed, when the probability that an event e_i will occur is, for example, 0.99, there is little uncertainty in the system, and the information content is small. When the probability that an event will occur is low, there is considerable uncertainty in the system, and the information content is large. Thus, expected information and uncertainty can be regarded as dual concepts.

Since Shannon's work, several economic applications of the concept of entropy have appeared in the literature. The Horowitzs, for instance, has used entropy to measure the degree of competition in a particular industry.⁴⁹ They have suggested that, since entropy measures the degree of uncertainty in a communications system, it can analogously be used as a measure of the degree of uncertainty in an industrial system. The greater the uncertainty as to which firm would be patronized by a customer chosen at random, the greater the degree of competition within that industry of which the firm is a part. Since the probabilities of a customer patronizing a particular firm are usually unknown, these probabilities are estimated by the ratio S_{ij}/S_j , where S_{ij} is the i^{th} firm's sales and S_j is total industry sales. Denoting this ratio, the

⁴⁹ Ann Horowitz and Ira Horowitz, "Entropy Markov Processes and Competition in the Brewing Industry," Journal of Industrial Economics 16 (July 1968): 196-211.

i^{th} firm's share of total industry sales, as s_{ij} , the entropy equation (15) may be rewritten as

$$H^W = - \sum s_{ij} \ln s_{ij}. \quad (16)$$

Using the i^{th} firm's share of total industry sales as an estimate of the probabilities (p_i) unfortunately produces H^W values (entropy values) which do not have obvious economic interpretations. Thus, the Horowitzs have introduced the use of a counterpart measure, known as the "numbers-equivalent" measure given by

$$F = \exp H^W, \quad (17)$$

which is defined here as the number of equal-sized firms necessary to generate the observed entropy values H^W . An F value of 1 for instance might be interpreted as a monopoly; there is no uncertainty as to which firm would be patronized by a customer chosen at random, inasmuch as $F = 1$ implies $H^W = 0$ which can only occur when the i^{th} firm's sales are identical to total industry sales, i.e., when $s_{ij} = 1$. When the number of equal-sized firms is $F < 10$, they claim the industry is characterized by oligopoly, while $F > 500$ implies there is much uncertainty in the industrial system and the structure would approach the economist's model of perfect competition.

More recently, Garrison and Paulson have used entropy as a measure of geographic concentration of economic activity, thus carrying the Horowitzs' analogy a step further.⁵⁰ In this case, entropy measures the degree of uncertainty in a regional system. Thus, the greater the uncertainty in a regional system, the greater the degree of competition

⁵⁰ Charles B. Garrison and Albert S. Paulson, "An Entropy Measure of the Geographic Concentration of Economic Activity," Economic Geography 49 (October 1973): 319-324.

among counties in the region in attracting industry, and therefore the more dispersed within the region are those location factors considered important by firms. In their formulation, the probabilities p_i given in equation (15) are estimated by the i^{th} county's share of total regional employment. Denote employment in the i^{th} county as E_{ij} and total employment in the region as E_j . Then the ratio $E_{ij}/E_j = e_{ij}$ denotes the i^{th} county's share of region j 's total employment and equations (15) and (16) may be rewritten as

$$H^P = - \sum e_{ij} \ln e_{ij}. \quad (18)$$

If all employment is located in the i^{th} county, then $e_{ij} = 1$ and $H^P = 0$; there is no uncertainty in the regional system and thus there is no geographic dispersal of economic activity. When the N counties are equally strong in attracting employment, then H^P reaches its maximum value, and there is complete uncertainty in the regional system and therefore complete geographic dispersal of economic activity within the region.

Entropy in the context of industrial diversification may be defined as

$$H^D = - \sum_{i=1}^N \left(\frac{e_i}{e} \right) \ln \left(\frac{e_i}{e} \right), \quad (19)$$

where H^D , the entropy measure of industrial diversification for a particular region and time period, is equal to the negative summation of the product of the regional employment proportions in the N industries and the natural logarithm of these proportions; e_i is equal to employment in the i^{th} industry in this particular region, and e is equal to total regional employment. The ratio e_i/e is thus the regional employment proportion for the i^{th} industry in this region.

If all employment in the r^{th} region, for instance, is concentrated in one industry, say the m^{th} industry, then the ratio e_m/e is of course equal to unity, while e_i/e , $i \neq m$, $i = 1, \dots, N$ is equal to zero. The value of the entropy measure of diversification for this region, H^D , is thus equal to zero, indicating maximum specialization (or minimum diversification). If regional employment is equally dispersed among the N industries, then the ratio e_i/e is equal to $1/N$ for every i , and entropy obtains its maximum value, indicating maximum diversification (or minimum specialization).

Entropy has a number of properties which are desirable in terms of measuring industrial diversification. In particular, entropy has been shown⁵¹ to satisfy the following five properties: (1) it is single-valued in its arguments; (2) it is size and scale independent; (3) it can be modified to consider either continuous or discrete distributions; (4) there is additivity in the case of independent events; and (5) it can measure two scales simultaneously, i.e., total entropy can be decomposed into between-set and within-set components. The first four properties follow from the fact that entropy is simply a function of the regional employment proportions (e_i/e) which are estimates of the probabilities that a given event will occur [as explained in equation (15) in the context of communications theory]. First, the employment proportions are unique and therefore produce a unique solution. Multi-valued solutions would almost make diversification measurement impracticable. Second, a doubling of all employment values (e_i) doubles total employment (e) but leaves the proportions (e_i/e) unchanged. Similarly, a region containing

⁵¹Henri Theil, Economics and Information Theory (Amsterdam: North-Holland Publishing Co., 1967).

twice as much total employment as another would not necessarily be considered more diversified simply because of size; entropy is a function of proportions and not absolute magnitudes. A diversification measure should not contain a city-size bias (as does the minimum requirements measure), nor should it change when the scale of activity changes. Third, since the proportions are estimates of probabilities, both continuous and discrete distributions may be measured, and fourth, if it can be shown that e_i/e is independent of e_j/e , then $h(e_i/e, e_j/e) = h(e_i/e) + h(e_j/e)$.⁵²

One of the unique properties of entropy is that total entropy (H^D) can be decomposed into between-set entropy and within-set entropy, as shown by Theil.⁵³ Denote the ratio e_i/e by y_i and rewrite (19) as

$$H^D = - \sum_{i=1}^N y_i \ln y_i. \quad (20)$$

Combine the N industries into G sets and define the employment share of the g^{th} set, say S_g , as

$$Y_g = \sum_{i \in S_g} y_i \quad g = 1, \dots, G. \quad (21)$$

Then entropy (H^D) may be disaggregated as follows:

$$H^D = h_o + \sum_{g=1}^G Y_g \cdot h_g, \quad (22)$$

where

$$h_o = - \sum_{g=1}^G Y_g \ln Y_g \quad (23)$$

⁵²Ibid., p. 6.

⁵³Ibid., pp. 43-46.

is the between-set entropy and

$$h_g = - \sum_{i \in S_g} \left(\frac{y_i}{Y_g} \right) \ln \left(\frac{y_i}{Y_g} \right) \quad (24)$$

is the entropy within set S_g . The expression $\sum_{g=1}^G Y_g \cdot h_g$ is defined as total within-set entropy. This decomposition property of entropy has been used, for instance, by Garrison in the measurement of geographic concentration of economic activity within counties in a particular region.⁵⁴

To illustrate how this property works, consider the combination of the 20 two-digit S.I.C. manufacturing industries into two sets--durable goods and nondurable goods industries ($N = 20$, $G = 2$). The ratio y_i is thus the employment proportion of the i^{th} two-digit manufacturing industry ($i = 1, \dots, 20$) and Y_1 and Y_2 denote the employment proportions of the durable goods industries set and the nondurable goods industries set, respectively. The entropy measure of industrial diversification (H^D) given in (20) may thus be decomposed as in (22) into diversification as between the durable goods and the nondurable goods industries sets (h_0), and diversification as within these two sets (h_g , $g = 1, 2$).

Specification of entropy as a diversification measure in this manner thus distinguishes it from previously proposed diversification measures including the "national average," the "ogive," the "percent durable" and the "minimum requirements" measures, by providing additional information concerning the extent of industrial diversification within a region.

⁵⁴Charles B. Garrison, "Industrial Growth in the Tennessee Valley Region, 1959 to 1968," American Journal of Agricultural Economics 56 (February 1974): 50-60.

In particular, diversification is measured on two levels simultaneously: diversification between various industry groups as well as diversification within these groups.

In addition to these properties, which are indeed desirable in terms of a measure of industrial diversification, entropy is not based on national employment proportions, and therefore overcomes the objections to the national average diversification measure. Similarly, it does not use the minimum requirements technique to measure the extent of diversification, nor does it assume anything about industrial homogeneity, or the covariability of industries. It therefore overcomes the objections to the minimum requirements, percent durable and portfolio variance diversification measures. Further, while the ogive measure is based on an equal distribution of employment in a manner similar to entropy, it does not satisfy the five desirable properties considered above.

In sum, the use of entropy in economic applications has been widely successful, particularly because of the five desirable properties entropy exhibits. The logic applied to the arguments in previous economic applications of entropy holds as well in the case of entropy as a diversification measure. The assumptions underlying the traditional measures of diversification are not necessary for the entropy diversification measure. Finally, entropy is easy to calculate with readily available regional data. Thus, it satisfies all the criteria of an ideal diversification measure outlined in the beginning of this chapter, and will accordingly be the basis upon which diversification will be measured in this study.

The Index of Regional Economic Instability

A second criticism of studies attempting to relate regional industrial diversification to the sensitivity of regions to national fluctuations concerns the index of economic instability. The basic requirement of this index is that it measures the manner and extent to which regions respond to national business cycles. That is, an economic instability index should measure fluctuations in the level of some regional economic aggregate over a period of several major business cycles. The measure shown to have the most promise in the literature, as indicated in Chapter II, and the one which will be used in the present study is given by equation (25):

$$S^r = \left[\frac{\sum_{t=1}^T \left(\frac{e_t^r - \hat{e}_t^r}{\bar{e}^r} \right)^2}{T - 2} \right]^{\frac{1}{2}} \quad (25)$$

where e_t^r denotes total nonagricultural employment in region r over time (where time t is expressed in quarters), $\bar{e}^r$ denotes the arithmetic mean of the total nonagricultural employment observations for region r , and $\hat{e}_t^r$ denotes the predicted values of total nonagricultural employment in region r estimated by

$$\hat{e}_t^r = \hat{\alpha} + \hat{\beta} t. \quad (26)$$

Thus, S^r , the measure of economic instability for region r , is the sample coefficient of variation of residuals around a linear trend. It is defined as the square root of the summation of the relative differences between the actual and predicted total nonagricultural employment values squared, corrected by the factor $T-2$. This economic instability

measure is, of course, a relative measure of dispersion (the differences between the actual and predicted employment values are weighted by the mean of the employment observations) to adjust for differences in scale among regions. Furthermore, since it measures deviations of a regional economic aggregate (total nonagricultural employment) from its trend over time, any bias resulting from regions with a positive or negative growth trend is eliminated. (Such would not be the case if, for instance, deviations from the mean were measured; regions with employment which fluctuates very little over time but which experiences steady growth over time would be regarded as unstable since the actual values of employment move steadily away from the mean value over time.) Finally, note that since the index is basically a coefficient of variation, higher values indicate greater economic instability, while lower values indicate greater economic stability.

CHAPTER IV

INDUSTRIAL DIVERSIFICATION AND ECONOMIC STABILITY OF A SAMPLE OF U.S. METROPOLITAN AREAS

In Chapter II it was indicated that the conclusions reached in certain studies of regional economic stability differentials were of limited value because of various data problems. Examples of these problems included the levels of geographical and industrial aggregation, the use of average annual data rather than monthly or quarterly data to measure the extent of cyclical fluctuations, the size of the sample, and, in general, the type of data used to construct indexes of economic instability, industrial diversification, or industrial mix. In conjunction with the major objectives outlined in Chapter I, one subordinate or corollary objective of this study is to overcome some of the criticisms of the data sets used in previous studies of regional economic instability. Accordingly, the purpose of this chapter is to describe the data, data sources, and methods of data set construction used in this study, and to present the results of the calculation of the indexes of regional economic instability and regional industrial diversification given by equations (25) and (19), which use these data as a base.

Data and Data Sources

As argued in the previous two chapters, an index of regional economic instability should measure the extent of fluctuations in the level of some regional economic aggregate from its long-run secular growth trend. Such an index should cover a time span long enough to encompass several major national business cycles, should be based on reliable

quarterly or monthly data so that economic fluctuations are more accurately measured, and should be defined for subnational regions which are functional economic units rather than political units such as states.

An index of regional industrial diversification similarly should be based on reliable data for functional economic regions and should measure the extent of regional diversification on as highly a disaggregated level as possible. Since levels of diversification are not subject to substantial changes from quarter to quarter, average annual data are probably sufficient for the index. Both the diversification and instability indexes should be based on data for a fairly large sample of regions, since it is difficult to justify making generalizations on the basis of for instance, 13 or even 30 of the 212 SMSA's in the U.S. Both indexes should also be calculated on data sets available from primary data sources, rather than on secondary or constructed data sets.

Accordingly, the raw data for this study consist of two-digit S.I.C. quarterly nonagricultural employment data and their totals for 106 SMSA's in the U.S., covering the period from the first quarter, 1967, through the fourth quarter, 1976. These data were obtained from the U.S. Department of Labor, Bureau of Labor Statistics (BLS) and are accumulated by BLS from surveys conducted by the employment security agencies of the 50 states each month. The employment numbers represent the number of workers earning wages during the pay period which encompasses the twelfth day of every month, and only those occupations covered by unemployment insurance laws are included in the surveys.⁵⁵

⁵⁵U.S. Department of Labor, Bureau of Labor Statistics, BLS Handbook of Methods, Bulletin 1910 (Washington, D.C.: Government Printing Office, 1976), pp. 66-73.

They are not seasonally adjusted since seasonal variation in economic activity is also an important source of economic instability. Since these data are generally unpublished because of federal disclosure rules, written permission had to be obtained from each of the commissioners of the 50 states' employment security offices in order for BLS to supply the data set. Those states which denied permission were excluded from the sample, and the remaining states (26 in all), which encompassed 106 of the 212 SMSA's in the U.S., were used as the geographical basis of the sample. Since the raw data on the computer tapes supplied by BLS were for counties in the U.S., the employment data had to be aggregated to the SMSA level, as defined in the publication, Standard Metropolitan Statistical Areas, 1975. SMSA's which crossed state boundaries into states which denied permission were either excluded from the sample or were redefined to include only those counties and the central city in the SMSA located in the states granting permission to use the data.

The resultant sample set of metropolitan areas and their component counties and government-assigned SMSA numbers appear in Appendix A. A description of the two-digit industries included in these nonagricultural employment data appears in Appendix B. The time period which the data covers includes three major U.S. economic expansions and two major recessions with peaks occurring in December 1969 and November 1973, and troughs occurring in November 1970 and March 1975. The most recent economic expansion, which began in April 1975, continued into 1977 and 1978 without reaching a peak before the data series ended in the fourth quarter of 1976.

Thus, the geographical, industrial and temporal coverage of this study's data represent somewhat of an improvement over the coverage in

previous studies because of the following reasons: (1) this is the largest sample set on which an empirical test of the causes of regional economic stability differentials has been conducted; (2) SMSA's rather than states are the geographic units; (3) two-digit S.I.C. industries constitute the level of industrial disaggregation rather than one-digit; (4) the study uses quarterly data rather than annual; and (5) the time period covers several national economic expansions and recessions. While not every study of regional stability differentials suffered from all of these deficiencies, at least one of these deficiencies was apparent in every previous study.

Calculation of the Index of Regional Economic Instability

Construction of the index of regional economic instability given by equations (25) and (26) in the previous chapter preceeded as follows. First, the quarterly two-digit employment data for the 106 SMSA's were summed to total quarterly nonagricultural employment, and these totals were used as the regional economic aggregate upon which the regional instability measure was based. These actual total employment observations for the 40 quarters were denoted by e_t^r in equation (25).

Second, since the nonagricultural employment data are data covered by unemployment insurance, a major change in coverage which occurred in 1972 must be accounted for. Coverage was extended to include industries with only one employee or more, whereas previously, industries with four employees or more were covered. This change in the unemployment insurance laws produced a jump in the total nonagricultural employment series for a number of SMSA's, as depicted in Figure 2. To account for this change, SMSA's were assigned dummy variable values

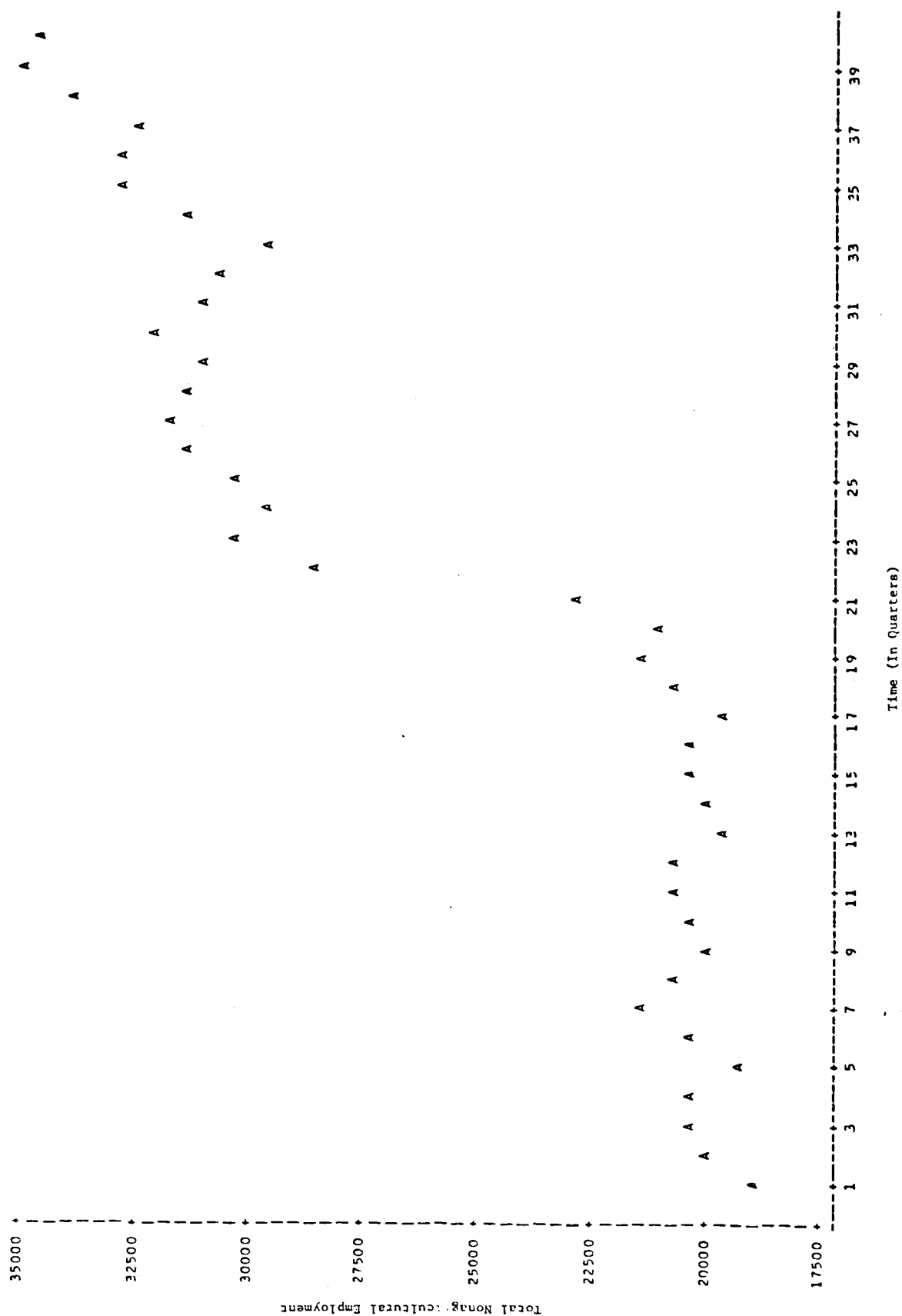


Figure 2. The Effects of Changes in Unemployment Insurance Coverage on Total Nonagricultural Employment.

of 0 or 1, depending on whether or not the change in coverage affected the state in which the SMSA was contained.⁵⁶ These dummy variables were used in the estimation of the predicted levels of total nonagricultural employment ($\hat{e}_t^r$) so that equation (26) was revised in the following manner for those SMSA's which were affected by the change:

$$\hat{e}_t^r = \hat{\alpha} + \hat{\beta} t + \hat{\gamma} \text{COVDUM} \quad (27)$$

where,

$$\begin{aligned} \text{COVDUM} &= 0 \text{ prior to 1972} \\ &1 \text{ 1972 and thereafter.} \end{aligned}$$

Third, the mean levels of total nonagricultural employment ($\bar{e}^r$) over the 40 quarters were calculated for each SMSA. The actual, predicted and mean levels of total nonagricultural employment for the SMSA's were then substituted into equation (25) to obtain an index of regional economic instability for each SMSA. Since this index is basically the coefficient of variation of residuals around a linear trend, the larger the value of the index, the greater is the extent of economic instability. A lower index value indicates greater stability.

The results of this process appear in Table 2, where SMSA numbers are used rather than SMSA names for convenience of tabular presentation. (SMSA names and corresponding numbers appear in Appendix A.) As is indicated in the table, there is a considerable range of economic instability among the 106 sample metropolitan areas, from a high of 13.8 to a

⁵⁶Some states already had the post-1972 coverage law in effect before 1972. Those states which were not affected by the change include Maryland, Massachusetts, Montana, Nevada, New Jersey, New York, Pennsylvania, Washington, D.C. and Wyoming. The following states were affected: Arizona, Delaware, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Missouri, Nebraska, New Hampshire, South Dakota, Tennessee, Vermont, Virginia and Wisconsin.

TABLE 2

INDEXES OF REGIONAL ECONOMIC INSTABILITY

SMSA #	Instability Index	SMSA #	Instability Index	SMSA #	Instability Index	SMSA #	Instability Index
120	5.481	2040	2.391	4410	5.090	6680	3.555
160	3.250	2290	2.801	4520	3.340	6720	4.521
220	3.626	2335	3.363	4680	1.977	6840	2.832
240	3.302	2360	4.586	4763	3.500	6880	3.550
280	4.808	2440	3.077	4920	3.244	7000	2.637
400	4.423	2760	5.600	5080	2.586	7040	2.738
460	4.494	2960	3.221	5200	5.053	7520	3.896
520	4.020	3040	6.350	5280	3.208	7680	4.268
560	8.999	3080	5.139	5360	3.121	7760	4.384
600	3.543	3240	6.802	5380	2.910	7800	3.309
720	4.024	3480	2.657	5403	4.099	7880	2.301
760	8.061	3640	3.079	5460	3.964	7920	3.243
880	6.090	3660	4.283	5560	3.058	8003	5.308
960	2.527	3680	4.011	5600	2.474	8160	3.449
1020	5.900	3740	2.267	5640	3.364	8320	2.361
1040	2.585	3760	2.470	5745	4.277	8440	2.564
1123	4.323	3800	5.939	5920	2.044	8480	5.105
1280	2.587	3840	2.146	5990	2.631	8520	2.974
1299	2.905	3870	5.940	6040	3.877	8680	2.698
1400	4.294	3880	5.528	6120	2.707	8760	4.976
1560	3.166	3920	2.607	6160	3.406	8840	3.368
1579	7.812	3960	5.277	6200	3.880	9040	7.286
1600	2.428	4000	4.204	6280	3.136	9140	4.818
1660	3.514	4120	2.741	6323	4.955	9160	5.001
1740	13.800	4150	11.235	6460	2.945	9240	4.071
1800	2.452	4280	3.288	6600	5.227	9280	3.365
1960	6.635	4360	5.478				

low of 1.98, with an average index of instability of 4.0. Metropolitan areas which were found to be the most stable include such cities as Macon, Georgia; Omaha, Nebraska; Knoxville, Tennessee; and Kankakee, Illinois; while those SMSA's which were the most unstable include Columbia, Missouri; Lawrence, Kansas; Atlantic City, New Jersey; and Baton Rouge, Louisiana. The observations of Wilbur Thompson concerning the variability in economic stability between large and small cities were borne out as may be seen in Figure 3, a plot of these instability indexes against 1970 urban population in the sample SMSA's. It indeed appears that smaller cities experience a greater range of economic instability than do larger cities, as suggested by Thompson. Thus, this is preliminary evidence of the presence of heteroscedasticity. /

Calculation of the Index of Regional Industrial Diversification

Since this is a cross-section study, it is necessary only to measure the levels of diversification of the sample metropolitan areas for a particular time period representative of the extent of diversification over the entire 40-quarter time span. Because of the coverage problems discussed in the last section, any quarter or year before 1972 would not accurately reflect the true extent of industrial diversification of the metropolitan areas. While there may have been substantial employment in such uncovered industries as state government and certain service industries, these numbers were not reported in the individual state surveys. Use of the employment data before 1972 would therefore result in underestimated diversification levels. Similarly, after 1972 the U.S. economy experienced a rather severe economic recession lasting from the fourth quarter of 1973 to the first quarter of 1975, and measurement

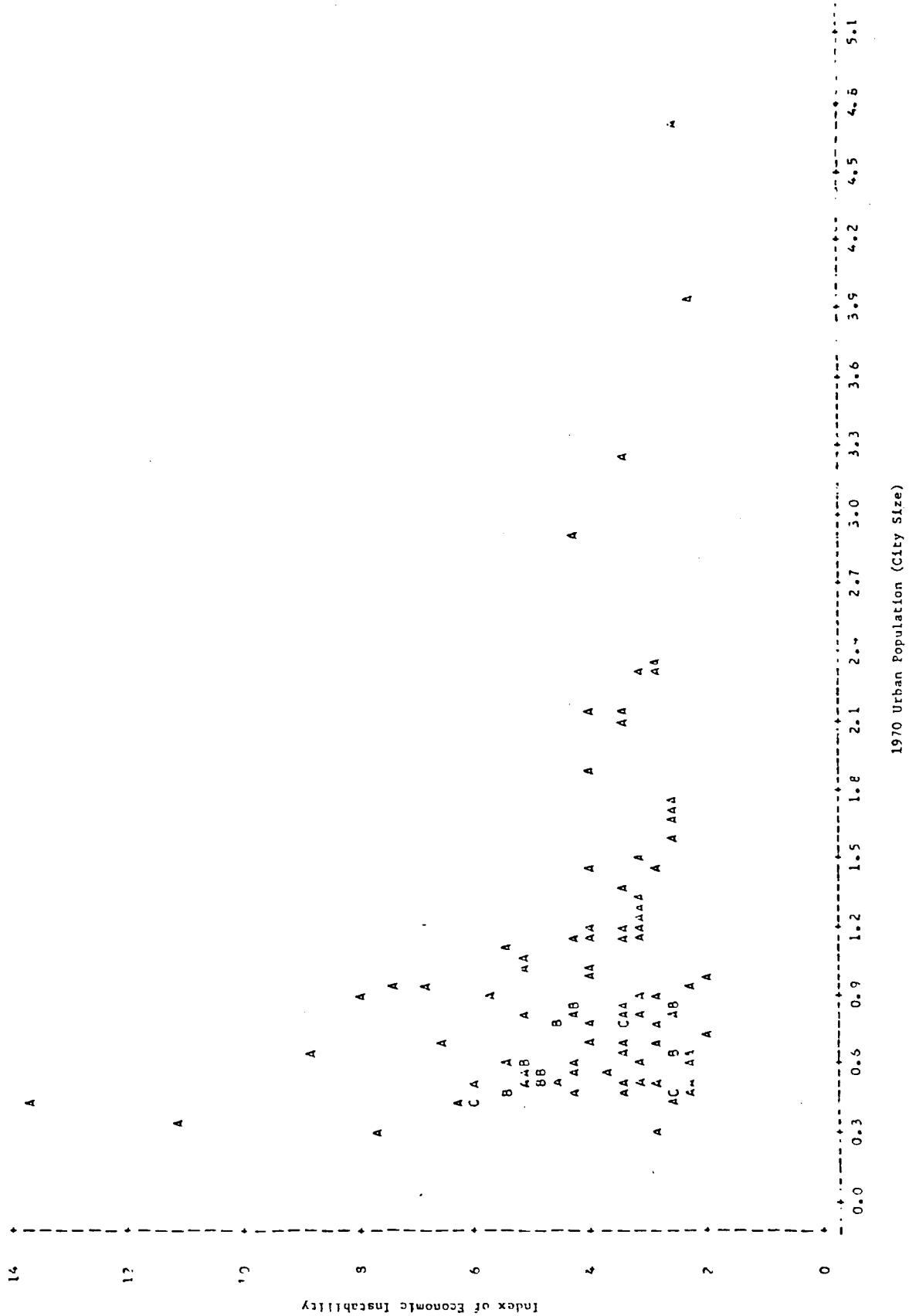


Figure 3. City Size Variation in Regional Economic Stability.

of the extent of diversification during this time period would also result in biased estimates. Accordingly, since 1972 was about the midpoint of the time series, the quarterly two-digit nonagricultural employment data were averaged for 1972 and these numbers formed the basis of the entropy measure of industrial diversification. As indicated earlier, a list of these two-digit industries appears in Appendix B.

After summing the two-digit employment data to get total nonagricultural employment for 1972 for each SMSA, the industry proportions e_i/e were calculated and substituted into the entropy diversification index formula given by equation (19) in the previous chapter. The results of these calculations appear in Table 3, where it is indicated that the entropy index ranges from 3.78, illustrating highest diversification (for this sample) to 2.58, showing a high degree of specialization. The metropolitan areas which were found to be the most diversified in the sample include New York, Philadelphia, Nashville and Boston, while the most specialized SMSA's include Anderson, Indiana; Bloomington, Indiana; Kenosha, Wisconsin; and Washington, D.C. Representative of the average level of diversification (3.47) were such metropolitan areas as Springfield, Missouri; Augusta, Georgia; and Binghamton, New York.

Construction of Other Indexes and Data Sets

Since the results of this study are to be compared with those of previous studies, it was also necessary to calculate other diversification indexes, and to use data sets other than nonagricultural employment. In particular, the national average, ogive and percent durable diversification indexes were calculated as given in Table 1, page 35, in the previous chapter. The minimum requirements and portfolio variance

TABLE 3

THE TOTAL ENTROPY MEASURE OF REGIONAL INDUSTRIAL DIVERSIFICATION,
NONAGRICULTURAL EMPLOYMENT DATA SET

SMSA #	Entropy	SMSA #	Entropy	SMSA #	Entropy	SMSA #	Entropy
120	3.47361	2040	3.37714	4410	3.55949	6680	3.63864
160	3.54616	2290	3.43230	4520	3.70579	6720	3.33503
220	3.41399	2335	3.45663	4680	3.28804	6840	3.37739
240	3.51677	2360	3.55104	4763	3.58701	6880	3.28448
280	3.61446	2440	3.61912	4920	3.63127	7000	3.40168
400	2.58677	2760	3.44303	5080	3.58962	7040	3.71692
460	3.45996	2960	2.99170	5200	3.47302	7520	3.59571
520	3.66415	3040	3.36340	5280	3.39355	7680	3.68376
560	3.43746	3080	3.32628	5360	3.74659	7760	3.31598
600	3.47045	3240	3.49890	5380	3.72492	7800	3.54301
720	3.67600	3480	3.62926	5403	3.48077	7880	3.39774
760	3.40417	3640	3.53057	5460	3.62742	7920	3.46570
880	3.49414	3660	3.41997	5560	3.66673	8003	3.72782
960	3.48891	3680	3.28676	5600	3.75935	8160	3.67935
1020	2.61322	3740	3.44897	5640	3.72843	8320	3.59953
1040	3.27750	3760	3.72380	5745	3.65871	8440	3.49382
1123	3.73121	3800	2.94155	5920	3.60028	8480	3.65721
1280	3.68562	3840	3.47987	5990	3.46712	8520	3.49901
1299	3.28138	3870	3.34190	6040	3.63347	8680	3.65578
1400	3.39222	3880	3.29312	6120	3.18153	8760	3.14234
1560	3.52247	3920	3.36947	6160	3.78597	8840	2.98892
1579	3.41207	3960	3.39634	6200	3.65850	9040	3.50014
1600	3.70461	4000	3.67224	6280	3.57672	9140	3.61296
1660	3.49553	4120	3.11178	6323	3.39567	9160	3.48785
1740	3.21130	4150	3.07048	6460	3.26738	9243	3.67366
1800	3.34325	4280	3.60274	6600	3.35056	9280	3.67143
1960	3.19816	4360	3.57244				

diversification indexes were not calculated, due to formidable data requirements. The data requirements to calculate the ogive and percent durable diversification indexes were the same as for the entropy measure, thus no additional data collection was necessary. For the national average diversification index, the two-digit employment proportions for the nation for 1972 were required. These were again obtained from the U.S. Department of Labor, Bureau of Labor Statistics, and are from the same data source as the metropolitan area data, thus preserving data consistency. The national average measure was then calculated as given in Table 1, page 35.

In addition to calculating the extent of metropolitan area diversification on the nonagricultural employment data set, diversification was also measured on the basis of manufacturing and basic employment data sets. The former data set is directly derivable from the nonagricultural set and was included since the majority of previous studies have measured diversification within the manufacturing sector only.

The basic employment data set was included to account for the arguments of economic-base theorists (presented in Chapter II) concerning basic employment as the vehicle for interregional transmission of cyclical fluctuations. Basic employment for a given SMSA was calculated from the nonagricultural employment data set using a combination of the assumption and the location-quotient techniques. In particular, it was assumed that all employment in the mining and manufacturing sectors was basic, and the location-quotient technique (with national employment proportions as benchmarks) was used for the remaining nonagricultural industries.

The results of these procedures appear in Appendix C, where Tables C1 and C2 present the entropy diversification index for the manufacturing and basic employment sets; Tables C3 through C5 present the ogive, national average and percent durable diversification indexes for non-agricultural employment; Table C6 through C8 present these three indexes for the manufacturing employment set; and Tables C9 through C11 present these same three indexes for the basic employment data set.

In addition to these data requirements, city size and growth rates (as discussed in Chapter II) were measured by 1970 urban population from the 1970 Census of Population and from growth in total nonagricultural employment over the entire 40-quarter time period, respectively.

CHAPTER V

DIVERSIFICATION AS A FACTOR IN EXPLAINING REGIONAL

DIFFERENCES IN ECONOMIC STABILITY:

THE EVIDENCE

In Chapter II of this study, a number of theoretical objections to the industrial mix, growth differentials and city size hypotheses of regional economic stability differentials were discussed. The statement was made that the industrial mix hypothesis, in its pure form, is based on the unreasonable assumption of spatial homogeneity of industries, and empirical tests of the hypothesis have produced inconclusive results. It was argued, however, that industry mix explanations are useful supplements to industrial diversification explanations for the interesting, yet explainable, exceptions of regions which specialize in highly stable economic activity such as public administration or education. The growth differentials hypothesis was shown to be more fundamentally a demand/cost factor explanation, and it was argued that the act of diversifying a regional economy would account for at least some of these demand and cost factors. In particular, diversification of a region is likely to mean the location of newer, more efficient industrial plants, accompanied by increased levels of employment, where part of the additional labor requirements may be drawn from labor markets outside the immediate area. The city size explanation of regional economic stability differentials was shown to be based on assumptions which lead to contradictory conclusions: larger cities were found to rely less on exports for their regional income at the same time they experience larger Keynesian multiplier effects.

The two effects were shown to be offsetting, the net result of which was the abandonment of the city size hypothesis in its pure form. City size was, however, found to play a role in explaining differences in regional stability differentials, in that smaller cities were shown to experience wider variation in economic instability than larger cities. This observation indicated the presence of heteroscedasticity in regional stability models--heteroscedasticity which is a function of city size. Finally, the industrial diversification explanation was shown to have a sound theoretical basis, and it was argued that a reformulation of the theory of the causes of regional stability differences might be based on industrial diversification, adjusted by city size, and accompanied by industry mix descriptions for certain exceptional cases. This study's data and indexes of regional economic stability and industrial diversification which will be used to test the relevance of this reformulated hypothesis were shown to be superior in many respects to those used in previous studies.

The empirical tests developed in this study were accordingly based on the theoretical discussion of Chapter II, and the data, data sets and indexes of diversification and instability developed in Chapters III and IV. The investigation was a six-step process. First, Spearman rank correlation coefficients were calculated between measures of industry mix, growth differentials, city size and industrial diversification to determine the degree of multicollinearity among these factors which have at various times been suggested as causes of regional stability differentials. Second, the Goldfeld-Quandt test of homoscedasticity along with a graphical analysis of the model's residuals were used to test the hypothesis that models of regional stability are plagued by

heteroscedasticity. Third, as a preliminary determination of the relationship between industrial diversification and regional economic stability, chi square tests of independence were conducted for the entropy, national average, ogive and percent durable diversification measures and the index of economic instability, and for all three data sets--nonagricultural, manufacturing and basic employment. Fourth, the regression technique of ordinary least squares (OLS) was used to determine the significance of the various diversification measures in explaining differences in regional economic stability. Regressions were performed for all four diversification indexes and three data sets. Fifth, the regression technique of weighted least squares (WLS) was used to determine the extent to which correction for heteroscedastic error variances alters the significance of the various diversification measures in explaining regional stability differentials. Sixth, the results of the WLS regressions were combined with industry mix descriptions for cases of small, specialized cities. The purpose of this chapter is to report on these results.

Multicollinearity and Heteroscedasticity in Regional Economic Stability Models

Presented in Table 4 are the results of the rank correlation test for multicollinearity among the various factors said to affect regional economic stability differentials.⁵⁷ Industrial diversification and industry mix were measured by entropy and the percentage of total non-agricultural employment accounted for by durable goods manufacturing

⁵⁷ Pearson correlation coefficients were also calculated for these variables and the results were essentially identical to the Spearman correlation results.

TABLE 4

EXAMINATION OF THE EXTENT OF MULTICOLLINEARITY AMONG FACTORS
AFFECTING REGIONAL ECONOMIC STABILITY
(Spearman Rank Correlation Coefficients with
Levels of Significance in Parentheses)^a

	Diversification ^b	Industrial Mix ^c	City ^d Size	Growth Rate ^e
Diversification ^b	--	0.01 (0.9007)	0.66 (0.0001)	-0.30 (0.0016)
Industrial Mix ^c	--	--	0.12 (0.2058)	-0.51 (0.0001)
City Size ^d	--	--	--	-0.41 (0.0001)

^aProbability $> |R|$ under $H_0: \text{RHO} = 0$.

^bAs measured by total entropy with nonagricultural employment.

^cAs measured by percent durable with nonagricultural employment.

^dAs measured by 1970 urban population.

^eAs measured by 1967-1976 total nonagricultural growth rate.

industries, respectively, and city size and growth rate were measured by 1970 urban population in the SMSA and the 1967-1976 growth rate in total nonagricultural employment, respectively. As shown in the table, there are very high correlations between various pairs of these four variables, indicating substantial multicollinearity. In particular, the Spearman rank correlation coefficient between city size and industrial diversification is 0.66, significant at less than 1 percent, indicating that the larger the city, the more diversified is the economy. The rank correlation between industry mix and growth differentials is -0.51, also significant at less than 1 percent, therefore implying that the larger the percentage of total regional economic activity in durable goods, the less growth the region will experience. Similarly, there is a rank correlation of -0.41 between city size and growth differentials, significant at less than 1 percent.

It might be noted that the sign of the correlation coefficient between growth and diversification is negative, thus producing evidence contradictory to most previous correlation studies between growth and diversification. It was argued in Chapter II that the industrial diversification hypothesis does not conflict with the advantages of specialization identified in interregional trade theory since most of the empirical evidence has indicated that the most diversified regions experience the most growth. The sign of the correlation coefficient in Table 4 appears to contradict this argument. However, this result should not be surprising since the most diversified cities in this sample are also the largest. It has often been observed that larger, more mature cities have recently experienced slower economic growth than smaller, more

rural areas⁵⁸ because, for instance, the advantages of agglomeration economies have been realized by larger cities; these cities have probably reached parity with the nation in terms of per capita income levels. Moreover, the most diversified cities are generally in the Northeast; this area has experienced declines in economic growth relative to more recently developing sections of the country such as the Southeast and West. In other words, the negative correlation between growth and diversification as shown in Table 4 is probably due to the influence of city size and all of the economic characteristics which accompany larger economies and not to the true relationship between growth and diversification.

The only pair of variables which appears not to be correlated in this sample is industry mix and industrial diversification, since the rank correlation coefficient between these factors is only 0.01. Thus, indeed there is substantial correlation among these four factors, and therefore any model of regional economic stability differentials which combines all four factors is likely to suffer from the problem of multicollinearity, thereby producing inefficient estimates of the coefficients.

The Goldfeld-Quandt test for homoscedasticity is essentially a test for equality between two variances.⁵⁹ The test procedure for this case is as follows: (1) estimate the basic model of regional economic stability and industrial diversification as given by equation (8) using OLS; (2) divide the 106 observations into three separate groups of approximately equal size and run OLS regressions on the top and bottom

⁵⁸Garrison, 1974, op. cit.

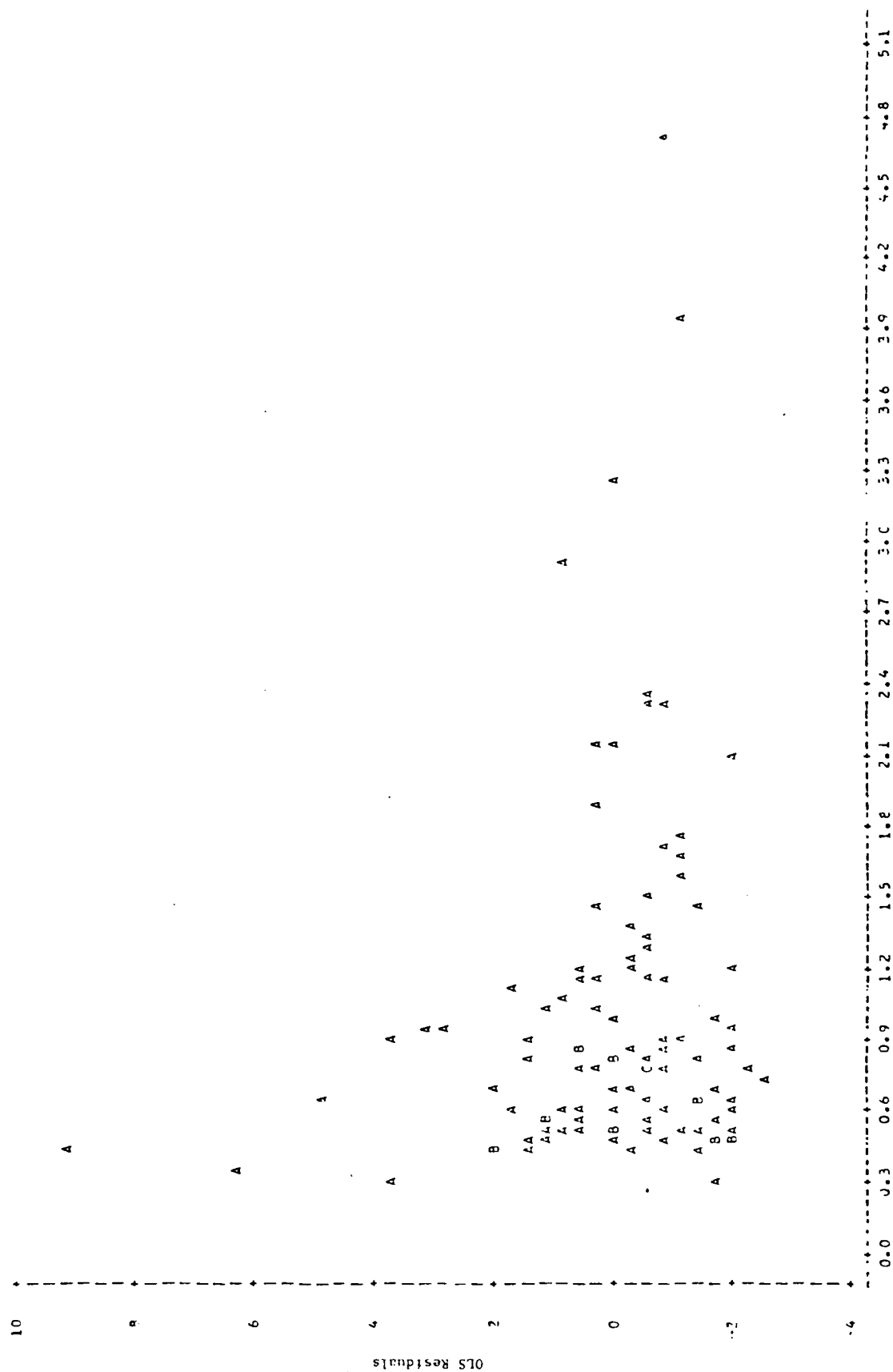
⁵⁹Goldfeld and Quandt, op. cit.

groups of observations where the top group of observations are the most diversified SMSA's and the bottom group of observations are the most specialized SMSA's; (3) find the estimated model variance for these two groups of observations and calculate the statistic,

$$s_1^2/s_2^2 \sim F_{(m_1-2), (m_2-2)},$$

where s_1^2 is the estimated error variance for the bottom group of observations and s_2^2 is the estimated error variance for the top group of observations.

Since the Thompson hypothesis concerning residual variation in regional economic stability models is that the error variance decreases with city size, it is expected that the top group of observations has a smaller variance than the bottom group. While the 106 observations were divided by diversification levels rather than city size levels, since city size and diversification were found to be highly correlated, this grouping method is probably a good approximation. This expectation was borne out since s_1^2 was found to be 5.76, while s_2^2 was 0.94. The calculated F value was therefore 5.76/0.94, or 6.089, which exceeds the appropriate F value of 1.63, with (46-2), (48-2) degrees of freedom. The hypothesis that $\sigma_1^2 = \sigma_2^2$ is therefore rejected at the 0.01 percent level of significance. There is, in fact, heteroscedasticity in the error variance of regional economic stability models. Furthermore, that this heteroscedasticity is a function of city size is also confirmed, as indicated in Figure 4. The residuals of the original model, equation (8), were graphed against 1970 urban population as a measure of city size, and, indeed, the graph appears almost identical to the theoretical



1970 Urban Population (City Size)

Figure 4. Ordinary Least Squares Residuals and City Size

graph of Thompson's given in Figure 1, page 25. Small cities do experience a wider range of economic instability than do larger cities.

Chi Square Tests of Independence

Next, chi square tests of independence were conducted between the index of regional economic instability given by equation (25) and the indexes of regional industrial diversification given in Table 1, page 35, and equation (19). If diversification of a region's industrial structure does reduce the degree of economic instability, then it is expected that there is a higher proportion of regions with low diversification levels and high economic instability levels than with high diversification levels and high economic instability levels. Calculation of these proportions for a sample of SMSA's might produce such evidence, but chi square tests of independence allow the researcher to make generalizations from the sample to the population. The test procedure is as follows: (1) divide the observations of industrial diversification and economic instability into ranges, e.g., high-medium-low; (2) find the observed frequencies f_i for each cell in the chi square contingency table, where the number of cells is determined by the number of groups into which the instability and diversification observations are divided; (3) calculate the hypothetical frequencies q_i by dividing the product of the row and column totals by the total number of observations in the sample; and (4) calculate the statistic,

$$\chi^2 = \sum_{kr} \frac{(f_i - q_i)^2}{q_i},$$

where k is the number of columns and r is the number of rows in the chi square contingency table. This statistic follows the χ^2 distribution

with $(k-1)(r-1)$ degrees of freedom. If the calculated χ^2 value exceeds the critical value with appropriate degrees of freedom, then the two regional characteristics are said to be dependent upon each other.

As an example of this process, consider Table 5. The entropy diversification measure has been divided into three ranges--high, medium

TABLE 5
CHI SQUARE CONTINGENCY TABLE FOR INSTABILITY AND TOTAL ENTROPY
(Nonagricultural Employment Set)

Instability Index	Diversification Index (Entropy Values)			Total
	3.6-above	3.41-3.59	3.409-below	
4.3 - above	5	13	17	35
3.2 - 4.29	18	11	6	35
3.19 - below	13	11	12	36
Total	36	35	35	106

and low--where the mean diversification level falls exactly in the middle of the medium range. Similarly, the regional economic instability index has been divided into high, medium and low ranges with the mean economic instability level falling in the middle of the medium range. Thus, $K = 3$ and $r = 3$ and the total number of observations is equal to 106. The observed frequencies (f_{ij}) are presented in the cells of this 3×3 contingency table as 5, 13, 17, etc. The hypothetical frequency for the first cell (q_{11}) is found by multiplying the total number of observations in the first column by the total number of observations in the first row and dividing this product by the total number of

observations in the sample, (i.e., $36 \times 35/106$). Hypothetical frequencies for the remaining cells are found in an analagous manner.

Since Table 5 was actually constructed from the nonagricultural employment data used in this study, examination of the table provides useful insights into the degree of dependence between industrial diversification and regional economic instability. As indicated in the first row of Table 5, there are, as expected, more than three times as many regions which experience high economic instability and low diversification levels than experience high economic instability and high diversification levels. Furthermore, as the second row indicates, three times as many regions experience average instability and high diversification levels than experience average instability and low diversification levels. These factors are thus preliminary evidence that the higher the degree of industrial diversification within a metropolitan area, the lower the degree of economic instability.

The last row of Table 5 does not appear to conform with a priori expectations since the observed frequencies are about the same for the high, medium and low diversification levels. However, as pointed out in Chapter II with reference to the theoretical arguments of Wilbur Thompson, and as indicated in Figures 3 (p. 59) and 4, smaller SMSA's are expected to experience a wider range of variation in economic instability than larger SMSA's. The fact that the observed frequency in the last row and column of Table 5 is not smaller is further evidence of heteroscedasticity in regional economic stability models. If the metropolitan areas in this cell are generally small in size and are specialized in stable industries such as public administration or education, the hypothesis of Thompson will be confirmed. Analysis of the SMSA's which comprise this

cell will appear later in this chapter, in conjunction with the OLS and WLS regression results.

Analysis of the columns of Table 5 also presents evidence of the dependence between diversification and regional economic stability. In particular, in the first column, there are about three times as many SMSA's which experience low instability (high stability) and high diversification, than experience high instability and high diversification. As indicated in the third column of Table 5, about one and one-half as many metropolitan areas experience high instability and low diversification than experience low instability and low diversification. Again, the cell in Table 5 which appears to need further explanation is the last row and last column cell.

The results of the chi square test for all three data sets and four diversification measures appear in Table 6. As indicated, there is indeed strong evidence that industrial diversification and regional stability are related. The calculated chi square values exceed the critical value of 9.488 for most diversification measures and for most data sets. The exception to this is the national average diversification measure, where the chi square values imply independence in two of the three cases and only weak dependence in the case of the manufacturing employment data set. The entropy diversification measure shows dependence in the nonagricultural and manufacturing employment sets, but not in the basic employment set. In general, the chi square values for the basic set for all four diversification indexes do not show as strong dependence as the nonagricultural and manufacturing sets. Perhaps this is due to the techniques used to estimate basic employment in each SMSA. It is quite often pointed out that the assumption that manufacturing

TABLE 6
CHI SQUARE VALUES FOR INSTABILITY AND DIVERSIFICATION
(3 x 3 Contingency Tables)

Diversification Measure	Employment Sets		
	Nonagricultural	Manufacturing	Basic
Entropy	12.686 ^a	14.844 ^a	4.987
Ogive	13.519 ^a	18.742 ^a	12.641 ^a
National Average	2.991	9.774 ^a	3.820
Percent Durable	12.668 ^a	4.002	11.674 ^a

^aIndicates this value exceeds the appropriate critical value of 9.488 with 4 degrees of freedom, significant at the 5 percent level.

Source: Calculated from diversification and instability indexes.

activity is totally export-oriented is erroneous for a number of industries. (Bakery and dairy products are prime examples.)

In any case, using three alternative employment sets and four diversification measures, dependence between regional industrial diversification and regional economic stability is implied in eight of the twelve instances. These results thus indicate that a metropolitan area which chooses to reduce its sensitivity to national cyclical fluctuations, may do so by diversifying its industrial structure.

Ordinary Least Squares Regression Results

The regression technique of OLS was used to determine the significance of the various diversification measures as explanatory variables of regional economic stability differentials. While the discussion in Chapter II and empirical results of the tests for homoscedasticity

indicated that OLS was an inappropriate estimation method, the exercise was nevertheless useful in comparing the entropy diversification results with those of traditional diversification measures. Equation (8), where regional economic instability is a simple function of industrial diversification, was estimated using the cross-section data for the 106 sample SMSA's.

Comparison of the levels of significance of the four diversification measures appears in Tables 7, 8, and 9, for the nonagricultural, manufacturing, and basic employment data sets, respectively. The estimates of the constant terms (the $\hat{\alpha}$'s) are not reported in these tables, since their values and levels of significance are not crucial to the formulated hypothesis. The estimates of the coefficients of the diversification measures (the $\hat{\beta}$'s) are contained in the column labeled "coefficient," with the levels of significance of these coefficients given by the column labeled "t value." The R^2 and F values for these equations appear in the last two columns of the tables.

For all three employment sets, the algebraic signs of the entropy, ogive and national average diversification measures accord with a priori expectations, but the sign of the percent durable diversification measure does not. As explained in Chapter III, a high entropy value implies greater diversification; a negative relationship between entropy and instability is therefore postulated. The ogive index of diversification defines a region as diversified if it follows a balanced industrial structure (i.e., if all industry proportions approach $1/N$) so that the greater the value of the index, the less diversified (or more specialized) is the region. A positive relationship between ogive and instability is

TABLE 7

ORDINARY LEAST SQUARES REGRESSION RESULTS FOR INDEXES OF INSTABILITY
AND ALTERNATIVE MEASURES OF DIVERSIFICATION,
NONAGRICULTURAL EMPLOYMENT

Diversification Measure	Coefficient	t value	R ²	F
Entropy	-2.3714	-2.99 ^a	0.079	8.94
Ogive	0.1743	2.01 ^b	0.037	4.06
National Average	0.1682	1.50	0.021	2.24
Percent Durable	-3.0363	-1.95 ^c	0.035	3.81

^aSignificant at the 0.01 percent level.

^bSignificant of the 0.05 percent level.

^cSignificant at the 0.10 percent level.

TABLE 8

ORDINARY LEAST SQUARES REGRESSION RESULTS FOR INDEXES OF INSTABILITY
AND ALTERNATIVE MEASURES OF DIVERSIFICATION,
MANUFACTURING EMPLOYMENT

Diversification Measure	Coefficient	t value	R ²	F
Entropy	-1.2236	-2.91 ^a	0.075	8.44
Ogive	0.1898	2.54 ^b	0.059	6.47
National Average	0.1482	2.13 ^b	0.042	4.55
Percent Durable	-1.5950	-1.79 ^c	0.030	3.21

^aSignificant at the 0.01 percent level.

^bSignificant at the 0.05 percent level.

^cSignificant at the 0.10 percent level.

TABLE 9

ORDINARY LEAST SQUARES REGRESSION RESULTS FOR INDEXES OF INSTABILITY
AND ALTERNATIVE MEASURES OF DIVERSIFICATION,
BASIC EMPLOYMENT

Diversification Measure	Coefficient	t value	R ²	F
Entropy	-0.6388	-1.52	0.022	2.30
Ogive	0.0446	1.64	0.025	2.68
National Average	0.0249	0.92	0.008	0.86
Percent Durable	-2.1388	-2.61 ^a	0.062	6.82

^aSignificant at the 0.01 percent level.

is therefore postulated. Similarly, the national average measure defines perfect diversification of a region as an industrial distribution identical to the national industrial distribution. A higher index value indicates greater specialization and therefore a positive relationship between the national average measure and instability is assumed. If durable goods manufacturing industries experience relatively high income elasticities of demand and are therefore unstable relative to other industries, then a positive relationship between percent durable and economic instability is implied. As indicated in Tables 7 through 9, the coefficient of the percent durable diversification measure is negative.

With the exception of the basic employment data set, the t values and R²'s of the diversification measures are highest for entropy, indicating that if regional economic stability differentials are to be explained by levels of industrial diversification, entropy, with all its desirable properties, may be the appropriate diversification measure.

For the basic employment data set, the statistics of the equations are so poor that they render meaningless any conclusions based on the results.

Given the overwhelming evidence of the presence of heteroscedasticity in regional economic stability models, the coefficients and their standard errors of these various OLS regressions should not be taken as accurate estimates of the true parameters. The estimates of the β 's are inefficient, thus invalidating significance tests. As indicated previously, weighted least squares is the more appropriate estimation method, since it produces efficient parameter estimates and thereby more accurate tests of significance.

Weighted Least Squares Regression Results

The weighted least squares regression technique is a form of generalized least squares to be used when the presence of heteroscedasticity, which produces inefficient estimates of the model's parameters, is detected. In his Preface to Urban Economics, Wilbur Thompson theorized that regional economic stability models are plagued by heteroscedasticity, although he did not use this terminology, and that this heteroscedasticity was a function of the size of the region. Smaller regions were said to experience wider variation in economic stability levels than larger regions. The Goldfeld-Quandt test for homoscedasticity, the results of which were reported on in the first section of this chapter, confirmed the hypothesis that heteroscedasticity was present in regional economic stability models. Moreover, Figure 4 on page 71, a graph of the OLS residuals of equation (8) against city size,

confirmed that this heteroscedasticity was a function of the size of the city, as hypothesized by Thompson. The weighted least squares regression technique, where the weights are given by a measure of the size of the city, is therefore more appropriate than ordinary least squares for models of regional economic stability differentials. Until now, this technique has been untried in such models.

As shown in Chapter II, the assumptions that the error variances (σ_i^2) are functions of the levels of urban population (as a measure of city size) mandates that the OLS regression equation (8) be weighted by the square roots of population ($\sqrt{POP_i}$). Since the levels of the variables POP_i are relatively high (they range from below 100,000 to 10,000,000), the product of $\sqrt{POP_i}$ and $INSTBI_i$ will be relatively high, producing a large mean of the new transformed dependent variable. Many standard econometric textbooks call for the normalization of the weights in a WLS regression, so that any bias in the estimates resulting from a high mean value of the transformed dependent variable is eliminated. To overcome this bias, Feldstein,⁶⁰ for instance, suggests that the weights be indexed to make their average equal to one. For the WLS regressions in this study, the average population level of the 106 sample SMSA's was therefore calculated, and each observation POP_i was divided by this average. The square roots of the resultant values were then used as weights in the WLS regressions given by equation (9).

This equation, appropriately transformed by the square roots of the population index values, was then estimated using OLS for all four diversification measures and three data sets. The resultant estimates,

⁶⁰M. S. Feldstein, Economic Analysis for Health Service Efficiency (Chicago: Markham Publishing Company, 1968), pp. 52-54.

given in Tables 10 through 12, are equivalent to the generalized least squares (GLS) estimates of the parameters and are therefore unbiased, consistent, and efficient. The format of Tables 10 through 12 is identical to the OLS tables.

As indicated in the tables, correction for inefficient estimates reduces the significance of the ogive, national average and percent durable diversification measures, while preserving or increasing the significance of the entropy measure. For the nonagricultural and basic employment sets, the t values for the nonentropy diversification indexes fall below the critical value of 1.96, while the t values for entropy are all above this level. For the manufacturing set, the national average diversification measure was found to be significant at the 5 percent level, while entropy was significant at the 1 percent level. Percent durable was highly insignificant for all three data sets.

It is standard practice for researchers to use the calculated R^2 of an equation to measure the proportion of variation in the dependent variable which is explained by the independent variable(s). If an OLS regression results in an R^2 value of 0.86, for instance, the statement is often made that these independent variables therefore explain 86 percent of the variation in the dependent variable. However, it should be emphasized that the R^2 's produced from WLS (or GLS) regressions have been shown to be inappropriate estimates of the goodness-of-fit in such models.⁶¹ There is considerable controversy over the issue as to whether or not GLS-produced R^2 's are meaningful, and no clear guidance on a

⁶¹See, for example, A. Buse, "Goodness of Fit in Generalized Least Squares Estimation," The American Statistician 27 (June 1973): 106-108.

TABLE 10

WEIGHTED LEAST SQUARES REGRESSION RESULTS FOR INDEXES OF INSTABILITY
AND ALTERNATIVE MEASURES OF DIVERSIFICATION,
NONAGRICULTURAL EMPLOYMENT

Diversification Measure	Coefficients	t value	R ²	F
Entropy	-1.6309	-2.99 ^a	0.911	529.68
Ogive	0.1232	1.76 ^b	0.906	499.60
National Average	0.1304	1.46	0.905	494.58
Percent Durable	-0.3930	-0.32	0.903	484.13

^aSignificant at the 0.01 percent level.

^bSignificant at the 0.10 percent level.

TABLE 11

WEIGHTED LEAST SQUARES REGRESSION RESULTS FOR INDEXES OF INSTABILITY
AND ALTERNATIVE MEASURES OF DIVERSIFICATION,
MANUFACTURING EMPLOYMENT

Diversification Measure	Coefficient	t value	R ²	F
Entropy	-0.9315	-2.82 ^a	0.910	524.68
Ogive	0.1796	2.72 ^a	0.910	521.80
National Average	0.1352	2.33 ^b	0.908	511.60
Percent Durable	-0.3453	-0.51	0.903	484.96

^aSignificant at the 0.01 percent level.

^bSignificant at the 0.05 percent level.

TABLE 12

WEIGHTED LEAST SQUARES REGRESSION RESULTS FOR INDEXES OF INSTABILITY
AND ALTERNATIVE MEASURES OF DIVERSIFICATION,
BASIC EMPLOYMENT

Diversification Measure	Coefficient	t value	R ²	F
Entropy	-0.5793	-2.34 ^a	0.908	511.78
Ogive	0.0343	1.83 ^b	0.906	500.93
National Average	0.0296	1.39	0.905	493.54
Percent Durable	-0.3836	-0.64	0.903	485.73

^aSignificant at the 0.05 percent level.

^bSignificant at the 0.10 percent level.

goodness-of-fit statistic for GLS regressions is given. Rao and Miller,⁶² for instance, suggest that in cases where WLS regressions have no intercept term (as in the present case), the R² produced by standard statistical packages is incorrect, and that to correct for this, an intercept should, nevertheless, be included in the transformed equation. However, the resultant estimates of the model's parameters would no longer be equivalent to the GLS estimates and transformation of the OLS equation by the appropriate weights would therefore accomplish nothing. Buse,⁶³ has developed an alternative estimate of R² when the model is estimated by GLS (or by OLS on a transformed equation), but empirical verification

⁶²P. Rao and R. L. Miller, Applied Econometrics (Belmont: Wadsworth Publishing Company, 1971), pp. 118-121.

⁶³Buse, op. cit.

of his measure is lacking and tests of its accuracy in the present instance produced absurd R^2 values.

This discussion thus indicates that the extreme differences between the R^2 's produced by the OLS estimates given in Tables 7 through 9 (pp. 78-79), and those produced by the WLS estimates given in Tables 10 through 12 (which in the former case were below 0.10 and in the latter, above 0.90), should not be taken as evidence that with the WLS technique, 90 percent of the variation in regional economic stability differentials is explained by diversification. The only conclusion which can be drawn from the two regression techniques is that correction for heteroscedastic error variances improves the significance of entropy as an explanatory variable of regional stability while lessening the significance of the other diversification measures. As stated in the introduction to this study, the primary objective was not to determine how much variation in regional economic stability differentials was explained by the entropy diversification measure, but whether or not diversification was a factor at all. While previous tests may have concluded that diversification is in fact a significant explanatory variable, they have done so using inappropriate estimation methods, since heteroscedasticity was found to plague regional stability models. Any conclusions about the significance of diversification based on OLS estimates are therefore questionable. Correction for heteroscedasticity, as was accomplished in this study, results in conclusions which are less likely to be questioned.

Industry Mix Descriptions for Small, Specialized SMSA's

While the regression technique of weighted least squares may correct for the observation that smaller cities experience substantially

more variation in economic stability than larger cities, it does not explain why this phenomenon occurs. Furthermore, if industrial diversification was the sole causal factor of regional stability differentials, then Thompson's graph given by Figure 1, page 25, and the empirical graphs in Figures 3 and 4, pages 59 and 71, would not appear wedge-shaped, but would be negatively sloped lines. The fact that there were observations in the lower left-hand portion of the figures, representing stable, yet specialized cities, combined with the empirically verified need for heteroscedasticity correction, is evidence that explanations of regional stability differentials supplementary to industrial diversification are required. As argued in Chapter II, industry mix descriptions are useful supplements to the industrial diversification hypothesis, especially if the observations of Wasylenko and Erickson concerning the failure of diversification in cases such as specialization in public administration or education are correct.

In recalling the third row of the chi square contingency table (Table 5, page 73), it may be seen that there are roughly equal frequencies for the high, medium and low diversification ranges. It was indicated in that regard that the cell in the last row and last column of Table 5 contained SMSA's which were highly specialized, yet highly stable, thus running contrary to the diversification hypothesis. For these exceptional cases, then, it is useful to analyze the metropolitan areas in this cell to see whether, in fact, as hypothesized (1) they are small in size; (2) they are highly specialized and highly stable; and (3) their industry mixes are relatively stable ones, characterized by specialization in traditionally stable industries such as public administration or education. Each of the twelve 3 x 3 contingency tables

constructed in this study illustrated abnormally large frequencies for the cell in the last row and column. Not surprisingly, for each diversification measure and data set, the SMSA's which comprised this cell were about the same. A list of the SMSA's contained in the last row and column cell of the chi square tables, common to all diversification indexes and data sets, appears in Table 13.

The first thing to note about the metropolitan areas in this table is that they rank in the upper quarter of economic stability for this sample of 106 SMSA's. The stability ranks, where a rank value of one indicates most stable, appear in the first column of Table 13. Second, these SMSA's are all relatively specialized, as their rank diversification values shown in the second column of the table indicate (a diversification rank of one is considered most diversified in the sample). Third, with one exception, these metropolitan areas are quite small in size in comparison with the average SMSA. For the 106 sample SMSA's, the average 1970 urban population level was 689,220. Almost all of the SMSA's in Table 13 have 1970 urban population levels of less than half this average. Fourth, if the proportion of total nonagricultural employment accounted for by relatively stable industries is calculated (percent nondurable plus percent services and government), the industry mixes of these areas are found to be relatively stable. Considering services and government industries alone, the average proportion of total nonagricultural employment accounted for by these industries for the 106 sample areas is 50 percent.

All SMSA's in Table 13 have services and government proportions which are substantially above this average. Two SMSA's, Columbus, Georgia, and Macon, Georgia, are highly concentrated in nondurable goods

TABLE 13

ANALYSIS OF SMSA'S SPECIALIZING IN STABLE INDUSTRIES

SMSA #	SMSA Name	Stability Rank	Diversification Rank	1970 Population	Percent Non-durable	Percent Durable	Percent Services & Government
960	Binghamton, NY ^b	12	54	302,672	12.14	32.65	50.00
1040	Bloomington, IN ^b	14	94	104,389	8.49	13.72	72.12
1299	Burlington, VT ^c	27	93	38,633	4.16	21.17	67.70
1800	Columbus, GA	9	84	193,190	26.78	5.52	59.68
2040	Decatur, IL	7	80	125,010	16.38	28.78	49.26
2290	Eau Claire, WI ^b	25	68	114,936	19.87	13.01	59.88
3920	Lafayette, IN ^b	17	81	109,378	8.26	22.20	65.37
4120	Las Vegas, NV ^c	24	100	273,288	2.07	2.07	88.13
4680	Macon, GA	1	90	226,782	13.40	7.27	71.08
5990	Owensboro, KY	18	61	79,486	10.75	26.42	53.83
6120	Peoria, IL	22	98	341,979	8.22	32.53	52.57
6460	Poughkeepsie, NY ^b	29	95	222,295	9.48	29.68	56.36
6840	Rochester, NY ^b	26	79	961,516	9.36	35.18	50.58
7000	St. Joseph, MO	19	73	98,828	23.64	8.94	61.31
7880	Springfield, IL ^a	5	74	171,020	5.22	14.60	72.72
8440	Topeka, KS ^a	13	53	180,619	16.64	2.95	74.17

^aState capital.^bCollege town.^cResort town.

Note: Average population level for the sample was 689,220. A stability rank value of 1 indicates most stable. A diversification rank value of 1 indicates most diversified.

manufacturing industries relative to durable goods manufacturing, as indicated in the fourth and fifth columns of Table 13. Furthermore, a cursory description of the metropolitan areas in this table indicates that two of the SMSA's are in fact state capitals, while seven contain one or more colleges or universities, and two are traditional resort towns. These observations may thus be viewed as evidence that the explanatory power of industrial diversification explanations of regional stability differentials is improved when diversification explanations are supplemented by industry mix descriptions in the exceptional cases of small cities which are specialized in traditionally stable economic activity such as public administration or education.

The Usefulness of the Decomposition Property of Entropy

A final exercise in utilizing all the desirable properties of the entropy diversification measure to illustrate its advantages over traditional diversification measures in explaining regional stability differentials was performed. In particular, the decomposition property of entropy was used to calculate diversification between various industry groups as well as diversification within these groups, as given by equations (20) through (24). The sets into which the nonagricultural employment data were divided include: mining, construction, durable goods, nondurable goods, service-oriented, and public administration. For the manufacturing data, employment was divided into the durables and nondurables groups. For basic employment, the sets were mining-construction, durables, nondurables, and services-public administration. The resultant between-set and within-set diversification indexes for the nonagricultural, manufacturing and basic employment samples appear in Appendix D, in Tables D1, D2 and D3, respectively.

In certain instances, a more detailed description of the extent of industrial diversification of metropolitan areas may be desired. The decomposition property of entropy is useful for this purpose. For instance, if it is found that a metropolitan area is highly specialized in certain types of industries, it might be useful to know whether this specialization occurs in only one or two, or a great number of industries. The within-set entropy values yield this type of information. A low services within-set entropy value, for instance, indicates that a region is highly specialized within the services sector--that services employment in the region is concentrated in one or two service industries. Conversely, a high services within-set entropy value indicates that services employment within the region is widely dispersed among all the service industries.

Thus, if diversification is to be used as a regional economic stabilization policy tool, additional information besides the fact that the region is or is not relatively diversified may be required. If a region is found to be specialized in services, the policymaker may wish to know whether this specialization occurs in one or a great number of service industries. If specialization occurs in a small number of service industries, the obvious policy implication is to diversify the services sector of this region. While largely lying beyond the scope of this study, this property of entropy nevertheless emphasizes the additional information which the entropy diversification measure provides the policymaker.

CHAPTER VI

OVERVIEW, SUMMARY OF MAJOR CONCLUSIONS AND

DIRECTIONS FOR FURTHER RESEARCH

Recent studies of regional economic stability, important because of their implications for regional as well as national economic stabilization policy, have made notable progress toward mitigating the confusion surrounding the issue of why one region experiences more severe economic fluctuations than another. Elements of theoretical ambiguity and empirical inconclusiveness nevertheless still remain in some of these works. For instance, the four theories which have been extended as explanations of regional differences in economic stability--the industrial mix, growth differentials, city size and industrial diversification hypotheses--have been sometimes used in a complementary manner, and, at other times, as substitutes to one another. At times, it has been quite difficult to determine whether in fact there were four distinct theories, or simply four alternative viewpoints of the same economic phenomenon. The economic reasoning upon which some of these theories have been based has not been as careful as required by the issue's importance to the economic welfare of nations and their regions. Moreover, the empirical investigations of these studies, while contributing significantly to the regional economist's body of knowledge, have been marred by insufficient or poor quality data, questionable assumptions and inappropriate hypothesis tests.

In an attempt to clear up some of these remaining confusing issues, the objectives of this study were to analyze each of the four theories of regional stability differentials in order to arrive at a more precise

formulation of an hypothesis; to develop measures of regional economic instability and industrial diversification which were less able to be questioned on both theoretical and empirical grounds; to test the (reformulated) hypothesis that industrial diversification, combined implicitly with elements of city size and industry mix, is a factor in explaining regional economic stability differentials; and to compare these empirical results with those of previous studies.

With regard to the first objective, it was argued that the industry mix hypothesis implicitly assumes that industries are spatially homogeneous and that proponents of the theory ignore the type of market served by an industry and the characteristics of regions. The growth differentials hypothesis was more fundamentally a demand/cost factor explanation, some of the principal elements of which were found to be captured by the industrial diversification of a region. The city size hypothesis, based on the Keynesian economic base model, lead to the contradictory theoretical conclusion that larger cities are more stable because they depend less on exports for their regional income, but experience greater instability because of larger multiplier effects. It was noted, however, that the work of Wilbur Thompson implied that heteroscedasticity which is a function of city size is present in regional economic stability models. The industrial diversification hypothesis offered some appeal as a factor in explaining differences in regional stability, but could not account for exceptional cases such as a small city which specializes in traditionally stable industries, e.g., public administration or education. All of these theories and resultant empirical investigations were found to suffer from the lack of consideration of the fact that heteroscedasticity plagued regional economic stability models. Accordingly, the theory of

regional economic stability differentials was reformulated to state that industrial diversification, adjusted by city size to take into account heteroscedastic variances and accompanied by industry mix descriptions for exceptional cases, was an important factor in explaining these regional differentials.

The traditional measures of industrial diversification--the national average, ogive, minimum requirements, percent durable and portfolio variance measures--were found to be based on questionable assumptions, and it was argued that entropy as a measure of industrial diversification overcomes these problems in addition to having a number of other desirable properties. The coefficient of variation measure of regional economic instability was similarly found to have a number of desirable properties and avoided problems of previous instability measures.

The entropy measure of industrial diversification and the coefficient of variation measure of economic instability were calculated for a sample of 106 metropolitan areas in the U.S. and for three data sets--nonagricultural, manufacturing and basic employment. For comparative purposes, the national average, ogive and percent durable diversification measures were also constructed. The index of economic instability used quarterly total nonagricultural employment data covering the period 1967 through 1976, and the indexes of industrial diversification used 1972 annual average two-digit nonagricultural employment data. These data were obtained from the U.S. Department of Labor, Bureau of Labor Statistics, and represent the number of employees covered by unemployment insurance laws.

A number of empirical tests were conducted based on the reformulated hypothesis, data sets and indexes of diversification and regional

economic instability. First, correlation coefficients were calculated between measures of industrial diversification, industry mix, city size, and growth rates to determine the extent of multicollinearity among these variables. Second, tests of heteroscedasticity were performed to ascertain whether, in fact, smaller cities experience wider variation in economic stability than do larger cities. Third, chi square tests of independence were conducted between industrial diversification and regional economic stability in order to establish dependence between these two factors. Fourth, the regression techniques of OLS and WLS were used to determine the relative significance of the four diversification measures in explaining regional economic stability differentials. Finally, industry mix descriptions were presented for SMSA's which did not appear to follow the diversification-stability pattern.

A number of conclusions, which were based on these empirical tests, contributed positively to the knowledge of regional economic stability differentials. First, it was determined that there is substantial multicollinearity among the four main factors of these stability differentials and that, therefore, models which attempt to incorporate all these variables as explanatory factors will suffer from inefficiently produced parameter estimates. Second, heteroscedasticity was also found to plague regional stability models, and it was shown, both theoretically and empirically, that this heteroscedasticity is a function of the size of the city. Third, dependence between the extent of industrial diversification and regional economic stability was established using chi square contingency tables. This technique thus presented a method alternative to the usual rank correlation tests between diversification and stability, which confirmed the relationship between these two variables. Fourth,

the entropy measure of industrial diversification was shown to perform better than traditional diversification measures in explaining regional stability differentials, based on standard tests of significance. Furthermore, correction for heteroscedastic error variances improved the significance of the entropy diversification measure relative to other diversification measures. In fact, with efficient parameter estimates, most of the traditional diversification measures were found to be insignificant as explanatory variables of regional stability differences. Finally, regions which did not appear to follow the diversification-stability hypothesis were explainable by their industry mixes--most were either specialized in education or in public administration. In addition, it was noted that the decomposition property of entropy provides further information about the extent of diversification of a region in that diversification within various industry groups, as well as diversification between these groups, can be measured simultaneously.

There remain a number of unanswered questions concerning regional economic stability which were not explored in this study. First, to what extent does reducing the economic instability of regions reduce the degree of national economic fluctuations? In particular, in what manner and to what degree does industrial diversification of regional economies lessen the cyclical fluctuations of the national economy? Second, since the measure of regional economic instability used in this study measured only the magnitude of regional fluctuations, what are the regional differences in the timing and duration of these fluctuations and what are their causes? Third, can a measure of industry mix be developed which overcomes the conceptual and empirical problems of the percent durable measure of industry mix; and will incorporation of this new industry

mix variable, along with the entropy diversification measure into an OLS or a WLS model of regional economic stability differentials, improve the explanatory power of such models? This can be an alternative to the technique of using diversification in an instability model and combining these results with industry mix descriptions. Fourth, it would have been interesting to test the relative performance of the entropy and portfolio variance measures of industrial diversification since the OLS results of Conroy reported on in Chapter II resulted in adjusted R^2 's of about 0.42. Quarterly three- and four-digit employment data would have been required for this comparison; these data are simply not available. Further industrial disaggregation of diversification would, in other words, produce even more meaningful results. Fifth, the usefulness of the decomposition property of entropy was only touched upon in this study. Additional use of this property, either in an empirical or descriptive sense, needs to be explored. Finally, the results of the weighted least squares regression would benefit from a clearer definition of a goodness-of-fit statistic for GLS models.

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APPENDIXES

APPENDIX A

GEOGRAPHICAL COMPOSITION OF THE SAMPLE

TABLE A1
GEOGRAPHICAL COMPOSITION OF THE SAMPLE
(Component Counties)

SMSA #	SMSA Name	State #	County #	County Name
0120	Albany, GA	13	095	Dougherty, GA
		13	177	Lee, GA
0160	Albany-Schenectady-Troy, NY	36	001	Albany, NY
		36	057	Montgomery, NY
		36	083	Rensselaer, NY
		36	091	Saratoga, NY
		36	093	Schenectady, NY
0220	Alexandria, LA	22	043	Grant, LA
		22	079	Rapides, LA
0240	Allentown-Bethlehem-Easton, PA-NJ	34	041	Warren, NJ
		42	025	Carbon, PA
		42	077	Lehigh, PA
		42	095	Northampton, PA
0280	Altoona, PA	42	013	Blair, PA
0400	Anderson, IN	18	095	Madison, IN
0460	Appleton-Oshkosh, WI	55	015	Calumet, WI
		55	087	Outagamie, WI
		55	139	Winnebago, WI
0520	Atlanta, GA	13	035	Butts, GA
		13	057	Cherokee, GA
		13	063	Clayton, GA
		13	067	Cobb, GA
		13	089	De Kalb, GA
		13	097	Douglas, GA
		13	113	Fayette, GA
		13	117	Forsyth, GA
		13	121	Fulton, GA
		13	135	Gwinnett, GA
		13	151	Henry, GA
		13	217	Newton, GA
		13	223	Paulding, GA
		13	247	Rockdale, GA
		13	297	Walton, GA
0560	Atlantic City, NJ	34	001	Atlantic, NJ
0600	Augusta, GA-SC ^a	13	073	Columbia, GA
		13	245	Richmond, GA
		45	003	Aiken, SC ^b
0720	Baltimore, MD	24	003	Anne Arundel, MD
		24	005	Baltimore, MD
		24	013	Carroll, MD
		24	025	Harford, MD
		24	027	Howard, MD

TABLE A1 (Continued)

SMSA #	SMSA Name	State #	County #	County Name
		24	510	Baltimore, MD (Ind. City)
0760	Baton Rouge, LA	22	005	Ascension, LA
		22	033	East Baton Rouge, LA
		22	063	Livingston, LA
		22	121	West Baton Rouge, LA
0880	Billings, MT	30	111	Yellowstone, MT
0960	Binghamton, NY-PA	36	007	Broome, NY
		36	107	Tioga, NY
		42	115	Susquehanna, PA
1020	Bloomington, IN	18	105	Monroe, IN
1040	Bloomington-Normal, IL	17	113	McLean, IL
1123	Boston-Lowell-Brockton- Lawrence-Haverhill, MA-NH	25	009	Essex, MA
		25	017	Middlesex, MA
		25	021	Norfolk, MA
		25	023	Plymouth, MA
		25	025	Suffolk, MA
		33	015	Rockingham, NH
1280	Buffalo, NY	36	029	Erie, NY
		36	063	Niagara, NY
1299	Burlington, VT	50	007	Chittenden, VT
1400	Champaign-Urbana- Rantoul, IL	17	019	Champaign, IL
1560	Chattanooga, TN-GA	13	047	Catoosa, GA
		13	083	Dade, GA
		13	295	Walker, GA
		47	065	Hamilton, TN
		47	115	Marion, TN
		47	153	Sequatchie, TN
1579	Cheyenne, WY	56	021	Laramie, WY
1600	Chicago, IL	17	031	Cook, IL
		17	043	Du Page, IL
		17	089	Kane, IL
		17	097	Lake, IL
		17	111	McHenry, IL
		17	197	Will, IL
1660	Clarksville-Hopkinsville, TN-KY	21	047	Christian, KY
		47	125	Montgomery, TN
1740	Columbia, MO	29	019	Boone, MO
1800	Columbus, GA-AL ^a	01	113	Russell, AL ^a
		13	053	Chattahoochee, GA
		13	510	Columbus, GA
1960	Davenport-Rock Island- Moline, IA-IL ^a	17	073	Henry, IL

TABLE A1 (Continued)

SMSA #	SMSA Name	State #	County #	County Name
		17	161	Rock Island, IL
		19	163	Scott, IA ^b
2040	Decatur, IL	17	115	Macon, IL
2290	Eau Claire, WI	55	017	Chippewa, WI
		55	035	Eau Claire, WI
2335	Elmira, NY	36	015	Chemung, NY
2360	Erie, PA	42	049	Erie, PA
2440	Evansville, IN-KY	18	051	Gibson, IN
		18	129	Posey, IN
		18	163	Vanderburgh, IN
		18	173	Warrick, IN
		21	101	Henderson, KY
2760	Fort Wayne, IN	18	001	Adams, IN
		18	003	Allen, IN
		18	033	De Kalb, IN
		18	179	Wells, IN
2960	Gary-Hammond-East Chicago, IN	18	089	Lake, IN
		18	127	Porter, IN
3040	Great Falls, MT	30	013	Cascade, MT
3080	Green Bay, WI	55	009	Brown, WI
3240	Harrisburg, PA	42	041	Cumberland, PA
		42	043	Dauphin, PA
		42	099	Perry, PA
3480	Indianapolis, IN	18	011	Boone, IN
		18	057	Hamilton, IN
		18	059	Hancock, IN
		18	063	Hendricks, IN
		18	081	Johnson, IN
		18	097	Marion, IN
		18	109	Morgan, IN
		18	145	Shelby, IN
3640	Jersey City, NJ	34	017	Hudson, NJ
3660	Johnson City-Kingsport- Bristol, TN-VA ^c	47	019	Carter, TN
		47	073	Hawkins, TN
		47	163	Sullivan, TN
		47	171	Unicoi, TN
		47	179	Washington, TN
		51	169	Scott, VA ^c
		51	191	Washington, VA ^c
		51	520	Bristol City, VA ^c
3680	Johnstown, PA	42	021	Cambria, PA
		42	111	Somerset, PA
3740	Kankakee, IL	17	091	Kankakee, IL
3760	Kansas City, MO-KS	20	091	Johnson, KS
		20	209	Wyandotte, KS

TABLE A1 (Continued)

SMSA #	SMSA Name	State #	County #	County Name
		29	037	Cass, MO
		29	047	Clay, MO
		29	095	Jackson, MO
		29	165	Platte, MO
		29	177	Ray, MO
3800	Kenosha, WI	55	059	Kenosha, WI
3840	Knoxville, TN	47	001	Anderson, TN
		47	009	Blount, TN
		47	093	Knox, TN
		47	173	Union, TN
3870	La Crosse, WI	55	063	La Crosse, WI
3880	Lafayette, LA	22	055	Lafayette, LA
3920	Lafayette-West Lafayette, IN	18	157	Tippecanoe, IN
3960	Lake Charles, LA	22	019	Calcasieu, LA
4000	Lancaster, PA	42	071	Lancaster, PA
4120	Las Vegas, NV	32	003	Clark, NV
4150	Lawrence, KS	20	045	Douglas, KS
4280	Lexington-Fayette, KY	21	017	Bourbon, KY
		21	049	Clark, KY
		21	067	Fayette, KY
		21	113	Jessamine, KY
		21	209	Scott, KY
		21	239	Woodford, KY
4360	Lincoln, NE	31	109	Lancaster, NE
4410	Long Branch-Asbury Park, NJ	34	025	Monmouth, NJ
4520	Louisville, KY-IN	18	019	Clark, IN
		18	043	Floyd, IN
		21	029	Bullitt, KY
		21	111	Jefferson, KY
		21	185	Oldham, KY
4680	Macon, GA	13	021	Bibb, GA
		13	153	Houston, GA
		13	169	Jones, GA
		13	289	Twiggs, GA
4763	Manchester-Nashua, NH	33	011	Hillsborough, NH
4920	Memphis, TN-AR-MS ^a	05	035	Crittenden, AR ^b
		28	033	De Soto, MS ^b
		47	157	Shelby, TN
		47	167	Tipton, TN
5080	Milwaukee, WI	55	079	Milwaukee, WI
		55	089	Ozaukee, WI
		55	131	Washington, WI
		55	133	Waukesha, WI
5200	Monroe, LA	22	073	Ouachita, LA
5280	Muncie, IN	18	035	Delaware, IN
5360	Nashville-Davidson, TN	47	021	Cheatham, TN

TABLE A1 (Continued)

SMSA #	SMSA Name	State #	County #	County Name
		47	037	Davidson, TN
		47	043	Dickson, TN
		47	147	Robertson, TN
		47	149	Rutherford, TN
		47	165	Sumner, TN
		47	187	Williamson, TN
		47	189	Wilson, TN
5380	Nassau-Suffolk, NY	36	059	Nassau, NY
		36	103	Suffolk, NY
5403	New Bedford-Fall River, MA	25	005	Bristol, MA
5460	New Brunswick-Perth Amboy-Sayreville, NJ	34	023	Middlesex, NJ
5560	New Orleans, LA	22	051	Jefferson, LA
		22	071	Orleans, LA
		22	087	St. Bernard, LA
		22	103	St. Tammany, LA
5600	New York, NY-NJ	34	003	Bergen, NJ
		36	005	Bronx, NY
		36	047	Kings, NY
		36	061	New York, NY
		36	079	Putnam, NY
		36	081	Queens, NY
		36	085	Richmond, NY
		36	087	Rockland, NY
		36	119	Westchester, NY
5640	Newark, NJ	34	013	Essex, NJ
		34	027	Morris, NJ
		34	035	Somerset, NJ
		34	039	Union, NJ
5745	Northeast Pennsylvania, PA	42	069	Lackawanna, PA
		42	079	Luzerne, PA
		42	089	Monroe, PA
5920	Omaha, NE-IA ^a	19	155	Pottawattamie, IA ^b
		31	055	Douglas, NE
		31	153	Sarpy, NE
5990	Owensboro, KY	21	059	Daviess, KY
6040	Patterson-Clifton-Passaic, NJ	34	031	Passaic, NJ
6120	Peoria, IL	17	143	Peoria, IL
		17	179	Tazewell, IL
		17	203	Woodford, IL
6160	Philadelphia, PA-NJ	34	005	Burlington, NJ
		34	007	Camden, NJ
		34	015	Gloucester, NJ
		42	017	Bucks, PA
		42	029	Chester, PA
		42	045	Delaware, PA

TABLE A1 (Continued)

SMSA #	SMSA Name	State #	County #	County Name
		42	091	Montgomery, PA
		42	101	Philadelphia, PA
6200	Phoenix, AZ	04	013	Maricopa, AZ
6280	Pittsburgh, PA	42	003	Allegheny, PA
		42	007	Beaver, PA
		42	125	Washington, PA
		42	129	Westmoreland, PA
6323	Pittsfield, MA	25	003	Berkshire, MA
6460	Poughkeepsie, NY	36	027	Dutchess, NY
6600	Racine, WI	55	101	Racine, WI
6680	Reading, PA	42	011	Berks, PA
6720	Reno, NV	32	031	Washoe, NV
6840	Rochester, NY	36	051	Livingston, NY
		36	055	Monroe, NY
		36	069	Ontario, NY
		36	073	Orleans, NY
		36	117	Wayne, NY
6880	Rockford, IL	17	007	Boone, IL
		17	201	Winnebago, IL
7000	St. Joseph, MO	29	003	Andrew, MO
		29	021	Buchanan, MO
7040	St. Louis, MO-IL	17	027	Clinton, IL
		17	119	Madison, IL
		17	133	Monroe, IL
		17	163	St. Clair, IL
		29	071	Franklin, MO
		29	099	Jefferson, MO
		29	183	St. Charles, MO
		29	189	St. Louis, MO
		29	510	St. Louis, Mo (Indep. City)
7520	Savannah, GA	13	029	Bryan, GA
		13	051	Chatham, GA
		13	103	Effingham, GA
7680	Shreveport, LA	22	015	Bossier, LA
		22	017	Caddo, LA
		22	119	Webster, LA
7760	Sioux Falls, SD	46	099	Minnehaha, SD
7800	South Bend, IN	18	099	Marshall, IN
		18	141	St. Joseph, IN
7880	Springfield, IL	17	129	Menard, IL
		17	167	Sangamon, IL
7920	Springfield, MO	29	043	Christian, MO
		29	077	Greene, MO
8003	Springfield-Chicopee- Holyoke, MA	25	013	Hampden, MA
		25	015	Hampshire, MA

TABLE A1 (Continued)

SMSA #	SMSA Name	State #	County #	County Name
8160	Syracuse, NY	36	053	Madison, NY
		36	067	Onondaga, NY
		36	075	Oswego, NY
8320	Terre Haute, IN	18	021	Clay, IN
		18	153	Sullivan, IN
		18	165	Vermillion, IN
		18	167	Vigo, IN
8440	Topeka, KS	20	087	Jefferson, KS
		20	139	Osage, KS
		20	177	Shawnee, KS
8480	Trenton, NJ	34	021	Mercer, NJ
8520	Tucson, AZ	04	019	Pima, AZ
8680	Utica-Rome, NY	36	043	Herkimer, NY
		36	065	Oneida, NY
8760	Vineland-Millville- Bridgeton, NJ	34	011	Cumberland, NJ
8840	Washington, DC-MD-VA ^c	11	001	District of Colum- bia, D.C.
		24	017	Charles, MD
		24	031	Montgomery, MD
		24	033	Prince George, MD
		51	013	Arlington, VA ^c
		51	059	Fairfax, VA ^c
		51	107	Loudon, VA ^c
		51	153	Prince William, VA ^c
		51	510	Alexandria City, VA ^c
		51	600	Fairfax City, VA ^c
		51	610	Falls Church, VA ^c
9040	Wichita, KS	20	015	Butler, KS
		20	173	Sedgwick, KS
9140	Williamsport, PA	42	081	Lycoming, PA
9160	Wilmington, DE-NJ-MD	10	003	New Castle, DE
		24	015	Cecil, MD
		34	033	Salem, NJ

TABLE A1 (Continued)

SMSA #	SMSA Name	State #	County #	County Name
9243	Worcester-Fitchburg- Leominster, MA	25	027	Worcester, MA
9280	York, PA	42	001	Adams, PA
		42	133	York, PA

^aIndicates a county in this SMSA is part of a "no" state and therefore must be excluded from the standard SMSA definition.

^bIndicates the particular county involved.

^cIndicates SMSA and county affected by change in FIPS codes for Virginia.

Source: Standard Metropolitan Statistical Areas, 1975.

APPENDIX B

INDUSTRIAL COMPOSITION OF THE SAMPLE

TABLE B1
INDUSTRIAL COMPOSITION OF THE SAMPLE

1967 SIC Code	Industry Title
10	Metal Mining
11	Anthracite Mining
12	Bituminous Coal and Lignite Mining
13	Crude Petroleum and Natural Gas
14	Nonmetallic Minerals, except Fuels
15	General Building Contractors
16	Heavy Constructon Contractors
17	Special Trade Contractors
19	Ordnance and Accessories
20	Food and Kindred Products
21	Tobacco Manufactures
22	Textile Mill Products
23	Apparel and Other Textile Products
24	Lumber and Wood Products
25	Furniture and Fixtures
26	Paper and Allied Products
27	Printing and Publishing
28	Chemicals and Allied Products
29	Petroleum and Coal Products
30	Rubber and Plastics Products
31	Leather and Leather Products
32	Stone, Clay and Glass Products
33	Primary Metal Industries
34	Fabricated Metal Products
35	Machinery, except Electrical
36	Electrical Equipment and Supplies
37	Motor Vehicles and Transportation Equipment
38	Instruments and Related Products
39	Miscellaneous Manufacturing Industries
40	Railroad Transportation
41	Local and Interurban Passenger Transit
42	Trucking and Warehousing
44	Water Transportation
45	Transportation by Air
46	Pipeline Transportation
47	Transportation Services
48	Communication
49	Electric, Gas, and Sanitary Services
50	Wholesale Trade
52	Building Materials and Farm Equipment
53	Retail General Merchandise
54	Food Stores
55	Automotive Dealers and Service Stations

TABLE B1 (Continued)

1967 SIC Code	Industry Title
56	Apparel and Accessory Stores
57	Furniture and Home Furnishings Stores
58	Eating and Drinking Places
59	Miscellaneous Retail Stores
60	Banking
61	Credit Agencies other than Banks
62	Security, Commodity Brokers and Services
63	Insurance Carriers
64	Insurance Agents, Brokers and Services
65	Real Estate
66	Combined Real Estate, Insurance, Etc.
67	Holding and other Investment Companies
70	Hotels and other Lodging Places
72	Personal Services
73	Miscellaneous Business Services
75	Auto Repair, Services and Garages
76	Miscellaneous Repair Services
78	Motion Pictures
79	Amusement and Recreation Services
80	Hospitals and Medical Services
81	Legal Services
82	Educational Services
84	Museums, Botanical, Zoological Gardens
86	Nonprofit Membership Organizations
88	Private Households
89	Miscellaneous Services
91	Federal Government
92	State Government
93	Local Government
94	International Government
99	Nonclassifiable Establishments

Source: Standard Industrial Classification Manual, 1967.

APPENDIX C

INDEXES OF REGIONAL INDUSTRIAL DIVERSIFICATION

TABLE C1

THE TOTAL ENTROPY MEASURE OF REGIONAL INDUSTRIAL DIVERSIFICATION,
MANUFACTURING EMPLOYMENT DATA SET

SMSA #	Entropy	SMSA #	Entropy	SMSA #	Entropy	SMSA #	Entropy
120	2.57044	2040	1.90391	4410	2.40070	6680	2.20292
160	2.38357	2290	2.06257	4520	2.52421	6720	2.42348
220	2.41483	2335	2.00257	4680	1.12723	6840	2.41909
240	2.68709	2360	2.59963	4763	2.20555	6880	2.12832
280	2.33027	2440	2.12746	4920	2.61897	7000	1.42926
400	1.88969	2760	2.51321	5080	2.08146	7040	1.32576
460	2.06395	2960	1.50866	5200	2.26590	7520	1.78581
520	2.73417	3040	2.24580	5280	2.64785	7680	2.42872
560	2.56576	3080	1.65111	5360	1.70167	7760	2.32768
600	2.36787	3240	2.18554	5380	1.76382	7800	2.48778
720	2.60771	3480	2.75000	5403	2.23249	7880	2.28189
760	2.33166	3640	2.42854	5460	0.73488	7920	1.68024
880	2.58621	3660	2.39871	5560	1.78079	8003	2.24483
960	2.56817	3680	1.89026	5600	2.70157	8160	2.61441
1020	2.52793	3740	2.43687	5640	2.52137	8320	1.50427
1040	2.27513	3760	2.28126	5745	1.31053	8440	2.18993
1123	1.90948	3800	2.52030	5920	1.70339	8480	1.90255
1280	2.61446	3840	1.63063	5990	2.39925	8520	1.51136
1299	1.43416	3870	1.80419	6040	2.26076	8680	2.34073
1400	2.75825	3880	1.88902	6120	2.60289	8760	1.54079
1560	2.29915	3920	2.62414	6160	2.31264	8840	2.73312
1579	2.12900	3960	1.87291	6200	1.79559	9040	2.16232
1600	2.03265	4000	2.63302	6280	1.72111	9140	1.85333
1660	1.76659	4120	2.71899	6323	1.50909	9160	2.41781
1740	2.15758	4150	2.21960	6460	2.00468	9243	2.27064
1800	2.59097	4280	2.44791	6600	2.05565	9280	2.54361
1960	2.37825	4360	2.12633				

TABLE C2
THE TOTAL ENTROPY MEASURE OF REGIONAL INDUSTRIAL DIVERSIFICATION,
BASIC EMPLOYMENT DATA SET

SMSA #	Entropy	SMSA #	Entropy	SMSA #	Entropy	SMSA #	Entropy
120	2.76526	2040	2.29781	4410	3.14387	6680	2.81340
160	2.70256	2290	2.67550	4520	2.79818	6720	2.37573
220	2.90967	2335	2.49344	4680	2.21922	6840	2.14365
240	2.52853	2360	2.52167	4763	2.70314	6880	2.13267
280	2.94565	2440	2.76631	4920	3.20810	7000	2.61530
400	1.20468	2760	2.39977	5080	2.66358	7040	2.96882
460	2.44485	2960	1.54923	5200	2.97273	7520	2.79468
520	3.20941	3040	3.01757	5280	2.50762	7680	3.14474
560	2.81293	3080	2.37015	5360	3.10279	7760	2.78411
600	2.67879	3240	2.63797	5380	3.32877	7800	2.63718
720	3.26290	3480	2.75669	5403	2.51428	7880	2.73441
760	2.55824	3640	2.75942	5460	2.80113	7920	2.77684
880	3.10588	3660	2.44261	5560	3.10732	8003	3.11233
960	2.39422	3680	2.23534	5600	3.38116	8160	2.96851
1020	1.29447	3740	2.61461	5640	3.00703	8320	2.94189
1040	2.46654	3760	3.17855	5745	2.75147	8440	2.86999
1123	3.27133	3800	1.79666	5920	3.09851	8480	2.79197
1280	2.86040	3840	2.63129	5990	2.54667	8520	3.01647
1299	2.21169	3870	2.45288	6040	2.84982	8680	2.82596
1400	3.02466	3880	2.49251	6120	1.87493	8760	1.96060
1560	2.55749	3920	2.56730	6160	3.14706	8840	1.71164
1579	2.86783	3960	2.53661	6200	3.18688	9040	2.51795
1600	3.05085	4000	2.94000	6280	2.58242	9140	2.73609
1660	2.74532	4120	1.94623	6323	2.54230	9160	2.36402
1740	2.51464	4150	1.88469	6460	2.10925	9243	2.91548
1800	2.32467	4280	2.91108	6600	2.37405	9280	2.88587
1960	1.96675	4360	3.02333				

TABLE C3
THE OGIVE MEASURE OF REGIONAL INDUSTRIAL DIVERSIFICATION,
NONAGRICULTURAL EMPLOYMENT DATA SET

SMSA #	Ogive	SMSA #	Ogive	SMSA #	Ogive	SMSA #	Ogive
120	1.8240	2040	2.5571	4410	1.7720	6680	1.4123
160	2.0417	2290	2.1370	4520	1.1809	6720	3.4342
220	2.2679	2335	1.8683	4680	4.8407	6840	3.8644
240	2.2043	2360	1.6904	4763	1.6609	6880	3.3308
280	1.3230	2440	1.6384	4920	1.6716	7000	2.5149
400	14.9766	2760	2.2075	5080	1.7555	7040	1.3061
460	2.6999	2960	9.1542	5200	1.9711	7520	1.4121
520	1.5596	3040	2.1886	5280	2.3257	7680	1.2084
560	2.1415	3080	2.8054	5360	1.0800	7760	2.7953
600	2.0098	3240	2.3211	5380	1.1767	7800	1.8432
720	1.2852	3480	1.4830	5403	2.3609	7880	2.0652
760	2.5614	3640	2.0722	5460	1.4987	7920	2.0461
880	1.9377	3660	2.9265	5560	1.4280	8003	1.0398
960	2.1277	3680	3.5832	5600	1.2702	8160	1.2952
1020	10.5965	3740	2.0936	5640	1.2301	8320	1.3978
1040	3.0718	3760	1.2274	5745	1.8133	8440	1.7903
1123	1.1800	3800	7.5721	5920	1.5360	8480	1.2578
1280	1.2841	3840	2.2580	5990	2.3556	8520	1.8992
1299	3.5128	3870	2.9386	6040	1.3641	8680	1.4003
1400	2.0592	3880	2.9411	6120	4.8601	8760	5.6233
1560	2.0312	3920	3.0040	6160	0.9997	8840	7.2247
1579	2.6007	3960	2.3630	6200	1.3306	9040	2.6156
1600	1.3127	4000	1.1315	6280	2.1108	9140	1.3430
1660	1.9770	4120	5.2357	6323	2.9252	9160	3.0504
1740	3.1520	4150	6.7737	6460	3.7274	9243	1.3260
1800	3.1974	4280	1.6626	6600	3.2513	9280	1.2892
1960	5.0947	4360	1.4811				

TABLE C4
THE NATIONAL AVERAGE MEASURE OF REGIONAL INDUSTRIAL DIVERSIFICATION,
NONAGRICULTURAL EMPLOYMENT DATA SET

SMSA #	National Average		National Average		National Average		National Average	
	Index	SMSA #	Index	SMSA #	Index	SMSA #	Index	SMSA #
120	0.85989	2040	1.00762	4410	0.35594	6680	0.65851	
160	0.45929	2290	3.11990	4520	1.13279	6720	4.72972	
220	0.55977	2335	0.65851	4680	1.44343	6840	6.35366	
240	1.00408	2360	0.72920	4763	1.30773	6880	1.43802	
280	0.71419	2440	0.53126	4920	0.26138	7000	0.79372	
400	6.69322	2760	0.63659	5080	0.57990	7040	0.20556	
460	2.49392	2960	6.34505	5200	1.16236	7520	1.46479	
520	0.29821	3040	0.57498	5280	0.74665	7680	0.72634	
560	0.98783	3080	2.04168	5360	0.48926	7760	0.76311	
600	0.59007	3240	0.57559	5380	0.36404	7800	0.69909	
720	0.23853	3480	0.25605	5403	1.68380	7880	0.68008	
760	1.28508	3640	1.08567	5460	0.79157	7920	0.59066	
880	0.81691	3660	2.13380	5560	1.06103	8003	0.43307	
960	1.46305	3680	5.39847	5600	0.57723	8160	0.23457	
1020	4.36876	3740	0.84436	5640	0.40681	8320	0.50545	
1040	1.78985	3760	0.19287	5745	1.92772	8440	0.69002	
1123	0.24445	3800	3.30466	5920	0.25914	8480	0.54470	
1280	0.26431	3840	1.10616	5990	1.49859	8520	3.79925	
1299	1.13282	3870	1.00263	6040	0.65364	8680	0.52504	
1400	0.53023	3880	6.32474	6120	1.82532	8760	6.73980	
1560	1.19247	3920	0.94516	6160	0.12763	8840	1.97979	
1579	0.81731	3960	5.15769	6200	0.22448	0940	0.87737	
1600	0.23948	4000	0.65510	6280	0.97998	9140	0.65080	
1660	1.35176	4120	5.48622	6323	2.30177	9160	2.16616	
1740	2.50742	4150	2.58347	6460	1.37116	9243	0.59088	
1800	1.73336	4280	0.42124	6600	1.33599	9280	0.82448	
1960	1.90720	4360	0.37943					

TABLE C5
THE PERCENT DURABLE MEASURE OF REGIONAL INDUSTRIAL DIVERSIFICATION,
NONAGRICULTURAL EMPLOYMENT DATA SET

SMSA #	Percent Durable	SMSA #	Percent Durable	SMSA #	Percent Durable	SMSA #	Percent Durable
120	0.081832	2040	0.287857	4410	0.102520	6680	0.261631
160	0.142602	2290	0.130119	4520	0.223087	6720	0.038635
220	0.095654	2335	0.312733	4680	0.072676	6840	0.351871
240	0.285307	2360	0.383002	4763	0.223895	6880	0.466411
280	0.157499	2440	0.249611	4920	0.120804	7000	0.089434
400	0.552722	2760	0.321232	5080	0.289730	7040	0.217768
460	0.217558	2960	0.450105	5200	0.044164	7520	0.092485
520	0.108375	3040	0.076827	5280	0.347759	7680	0.170580
560	0.058166	3080	0.092990	5360	0.153779	7760	0.042473
600	0.075975	3240	0.112456	5380	0.153663	7800	0.274007
720	0.154607	3480	0.226710	5403	0.225830	7880	0.146008
760	0.033097	3640	0.202966	5460	0.216338	7920	0.157324
880	0.028016	3660	0.159069	5560	0.084200	8003	0.172584
960	0.326532	3680	0.258593	5600	0.082290	8160	0.211334
1020	0.377599	3740	0.239698	5640	0.190015	8320	0.169367
1040	0.137199	3760	0.155189	5745	0.158261	8440	0.029506
1123	0.148411	3800	0.478898	5920	0.109944	8480	0.226262
1280	0.250133	3840	0.110980	5990	0.264252	8520	0.065966
1299	0.211670	3870	0.188894	6040	0.180481	8680	0.289406
1400	0.039169	3880	0.020029	6120	0.325307	8760	0.303165
1560	0.206053	3920	0.222046	6160	0.165523	8840	0.010932
1579	0.028874	3960	0.040603	6200	0.181431	9040	0.239323
1600	0.225372	4000	0.280866	6280	0.287018	9140	0.281366
1660	0.157190	4120	0.020726	6323	0.274366	9160	0.118879
1740	0.072743	4150	0.026962	6460	0.296825	9243	0.267042
1800	0.055197	4280	0.183768	6600	0.369007	9280	0.263461
1960	0.338258	4360	0.074211				

TABLE C6

THE OGIVE MEASURE OF REGIONAL INDUSTRIAL DIVERSIFICATION,
MANUFACTURING EMPLOYMENT DATA SET

SMSA #	Ogive	SMSA #	Ogive	SMSA #	Ogive	SMSA #	Ogive
120	1.6799	2040	2.5273	4410	0.8058	6680	0.8689
160	1.3682	2290	2.3204	4520	0.9775	6720	1.3341
220	1.9648	2335	1.4696	4680	1.3404	6840	4.6729
240	1.5709	2360	1.1111	4763	1.5411	6880	2.5776
280	0.8137	2440	1.3105	4920	0.7643	7000	3.1753
400	10.9357	2760	2.3247	5080	1.8819	7040	1.1083
460	2.4736	2960	8.6612	5200	3.8907	7520	2.2313
520	0.9290	3040	6.8070	5280	2.3028	7680	1.0487
560	2.5502	3080	3.8927	5360	0.5386	7760	6.8567
600	1.4519	3240	1.2476	5380	1.0461	7800	2.1411
720	0.8017	3480	1.6464	5403	1.7515	7880	4.0905
760	5.2941	3640	1.3554	5460	0.9962	7920	2.1746
880	3.5226	3660	2.4296	5560	1.9804	8003	0.5449
960	2.0011	3680	5.3461	5600	1.1731	8160	1.5076
1020	13.1945	3740	1.7684	5640	1.1068	8320	1.0823
1040	4.6372	3760	0.8275	5745	1.7415	8440	3.3474
1123	0.7358	3800	6.7555	5920	2.0328	8480	1.2971
1280	1.1150	3840	2.4401	5990	3.4046	8520	1.8304
1299	9.1289	3870	3.7301	6040	0.7565	8680	1.1526
1400	4.8575	3880	6.4630	6120	6.9642	8760	5.5383
1560	1.5820	3920	1.2332	6160	0.5178	8840	4.8764
1579	1.2026	3960	5.0518	6200	1.9628	9040	4.7581
1600	0.9007	4000	0.5145	6280	3.1477	9140	0.6371
1660	1.4726	4120	1.7786	6323	3.2127	9160	5.1329
1740	4.0716	4150	4.0526	6460	4.4621	9243	0.8961
1800	5.1187	4280	1.6216	6600	2.6423	9280	0.7452
1960	7.5779	4360	1.7397				

TABLE C7

THE NATIONAL AVERAGE MEASURE OF REGIONAL INDUSTRIAL DIVERSIFICATION,
MANUFACTURING EMPLOYMENT DATA SET

SMSA #	National Average Index	SMSA #	National Average Index	SMSA #	National Average Index	SMSA #	National Average Index
120	1.8933	2040	1.1725	4410	0.5440	6680	0.4173
160	0.5445	2290	7.8466	4520	2.3205	6720	0.9814
220	2.2723	2335	0.7871	4680	1.2555	6840	9.4045
240	0.7878	2360	0.6155	4763	1.6482	6880	1.1792
280	0.9700	2440	0.6697	4920	0.4890	7000	1.6553
400	5.0679	2760	0.8877	5080	0.5837	7040	0.3474
460	3.0967	2960	6.4518	5200	5.3573	7520	3.1358
520	0.2898	3040	4.9267	5280	0.9322	7680	1.7034
560	2.1796	3080	4.4582	5360	0.9255	7760	3.3495
600	1.3901	3240	0.6133	5380	0.4877	7800	1.0228
720	0.5032	3480	0.5314	5403	1.5890	7880	1.7130
760	6.2250	3640	0.6253	5460	0.8834	7920	1.0455
880	8.8498	3660	2.1904	5560	0.8635	8003	0.7857
960	1.9484	3680	3.7146	5600	0.7695	8160	0.4586
1020	6.2891	3740	0.9793	5640	0.5927	8320	0.6972
1040	2.3952	3760	0.2905	5745	1.2454	8440	4.0104
1123	0.5232	3800	3.1543	5920	0.7773	8480	0.7097
1280	0.4416	3840	1.8904	5990	2.6177	8520	8.8562
1299	4.2030	3870	2.2155	6040	0.5990	8680	0.8579
1400	2.5769	3880	3.3725	6120	3.0435	8760	7.4243
1560	1.2692	3920	0.8140	6160	0.1521	8840	3.9082
1579	3.2218	3960	17.4892	6200	0.6523	9040	2.2166
1600	0.2819	4000	0.5090	6280	2.0743	9140	0.4407
1660	2.8977	4120	1.8057	6323	3.5189	9160	4.3709
1740	2.1321	4150	3.5552	6460	1.9372	9243	0.6517
1800	4.2716	4280	0.9612	6600	1.0327	9280	0.6799
1960	3.3409	4360	1.2073				

TABLE C8
THE PERCENT DURABLE MEASURE OF REGIONAL INDUSTRIAL DIVERSIFICATION,
MANUFACTURING EMPLOYMENT DATA SET

SMSA #	Percent Durable	SMSA #	Percent Durable	SMSA #	Percent Durable	SMSA #	Percent Durable
120	0.262557	2040	0.637264	4410	0.487756	6680	0.523709
160	0.550914	2290	0.395751	4520	0.598904	6720	0.598352
220	0.636930	2335	0.725523	4680	0.351632	6840	0.789890
240	0.549428	2360	0.780044	4763	0.500161	6880	0.873661
280	0.390049	2440	0.616046	4920	0.456374	7000	0.274474
400	0.912460	2760	0.802420	5080	0.759699	7040	0.634941
460	0.462935	2960	0.848318	5200	0.200684	7520	0.347046
520	0.509307	3040	0.673237	5280	0.835253	7680	0.689436
560	0.313241	3080	0.261142	5360	0.462324	7760	0.238053
600	0.292777	3240	0.465600	5380	0.691962	7800	0.731409
720	0.583725	3480	0.691504	5403	0.439314	7880	0.736499
760	0.174139	3640	0.438254	5460	0.480590	7920	0.465747
880	0.219579	3660	0.317148	5560	0.543693	8003	0.492174
960	0.728945	3680	0.710950	5600	0.348578	8160	0.692782
1020	0.947794	3740	0.546636	5640	0.542655	8320	0.502827
1040	0.617792	3760	0.584252	5745	0.362996	8440	0.150664
1123	0.567753	3800	0.905488	5920	0.537579	8480	0.598787
1280	0.684307	3840	0.284511	5990	0.710892	8520	0.684422
1299	0.835720	3870	0.613441	6040	0.388110	8680	0.773471
1400	0.266912	3880	0.296148	6120	0.798272	8760	0.597380
1560	0.428291	3920	0.728895	6160	0.506992	8840	0.284482
1579	0.346623	3960	0.142548	6200	0.789062	9040	0.745211
1600	0.633842	4000	0.590718	6280	0.816504	9140	0.558202
1660	0.461212	4120	0.499880	6323	0.655823	9160	0.318864
1740	0.635343	4150	0.141930	6460	0.757801	9243	0.616409
1800	0.170854	4280	0.667012	6600	0.717314	9280	0.547166
1960	0.846452	4360	0.369875				

TABLE C9

THE OGIVE MEASURE OF REGIONAL INDUSTRIAL DIVERSIFICATION,
BASIC EMPLOYMENT DATA SET

SMSA #	Ogive	SMSA #	Ogive	SMSA #	Ogive	SMSA #	Ogive
120	5.4530	2040	10.1232	4410	3.2016	6680	4.8330
160	6.9769	2290	6.1628	4520	5.0212	6720	16.8077
220	4.8774	2335	6.7151	4680	15.6186	6840	16.2980
240	7.5245	2360	6.3858	4763	6.6265	6880	11.3430
280	3.7961	2440	5.4978	4920	2.8901	7000	8.1743
400	39.9924	2760	8.6554	5080	6.6271	7040	4.7393
460	9.8607	2960	30.8946	5200	5.2611	7520	5.9906
520	3.1100	3040	4.3608	5280	7.7847	7680	3.2480
560	5.7214	3080	10.4941	5360	2.9865	7760	6.6111
600	5.4744	3240	7.8522	5380	2.5415	7800	7.2643
720	2.8673	3480	5.9014	5403	7.9270	7880	5.9825
760	8.7693	3640	5.6443	5460	5.0195	7920	5.9938
880	3.8158	3660	10.0800	5560	3.8906	8003	2.9261
960	8.7813	3680	12.4933	5600	2.3573	8160	4.6149
1020	28.0961	3740	7.0102	5640	4.1094	8320	3.9096
1040	9.4816	3760	3.0878	5745	7.2934	8440	5.5132
1123	2.6302	3800	22.2447	5920	3.9953	8480	4.9688
1280	4.9478	3840	8.0057	5990	9.2226	8520	4.6572
1299	15.1394	3870	8.8181	6040	4.4150	8680	4.9756
1400	4.3406	3880	11.9043	6120	21.1982	8760	17.9463
1560	7.4078	3920	7.6761	6160	3.0169	8840	26.0053
1579	6.5999	3960	9.0848	6200	3.9343	9040	11.9533
1600	3.7316	4000	3.6714	6280	9.6231	9140	4.6256
1660	5.6252	4120	19.9670	6323	9.2401	9160	14.6901
1740	9.0345	4150	21.3272	6460	12.6235	9243	4.3554
1800	11.9615	4280	5.1218	6600	10.0708	9280	4.2100
1960	22.2422	4360	3.8438				

TABLE C10

THE NATIONAL AVERAGE MEASURE OF REGIONAL INDUSTRIAL DIVERSIFICATION,
BASIC EMPLOYMENT DATA SET

SMSA #	National Average Index	SMSA #	National Average Index	SMSA #	National Average Index	SMSA #	National Average Index
120	4.3230	2040	5.1282	4410	1.2698	6680	3.2747
160	2.9040	2290	13.8307	4520	8.6066	6720	27.9863
220	2.4128	2335	3.8393	4680	6.0354	6840	28.9345
240	4.5728	2360	4.0488	4763	6.2871	6880	5.9826
280	3.5326	2440	3.4318	4920	1.5184	7000	3.9098
400	18.5518	2760	3.9445	5080	3.6969	7040	2.4962
460	10.7212	2960	22.3384	5200	5.9414	7520	10.1350
520	1.4118	3040	1.9752	5280	3.6016	7680	5.1791
560	4.0984	3080	10.3675	5360	3.6451	7760	2.5056
600	3.0124	3240	3.2925	5380	2.3178	7800	4.2255
720	1.8005	3480	2.7958	5403	6.8581	7880	2.8269
760	6.4853	3640	3.5925	5460	4.3886	7920	3.0809
880	4.5530	3660	8.6730	5560	7.8624	8003	3.1308
960	7.8447	3680	20.3802	5600	2.4985	8160	2.2199
1020	12.3360	3740	4.1042	5640	2.8185	8320	3.0167
1040	6.7069	3760	1.8600	5745	10.0157	8440	4.8019
1123	1.9265	3800	10.5553	5920	1.8634	8480	3.3499
1280	2.8743	3840	6.2945	5990	7.0697	8520	23.9677
1299	6.5685	3870	4.5674	6040	3.5658	8680	3.6512
1400	1.7206	3880	36.3300	6120	9.6228	8760	21.9608
1560	5.7893	3920	3.4099	6160	1.9524	8840	7.7507
1579	2.7800	3960	26.5031	6200	1.6482	9040	6.1397
1600	1.9755	4000	3.3256	6280	6.7156	9140	3.4708
1660	6.4122	4120	22.5389	6323	8.8411	9160	12.1932
1740	8.6303	4150	8.9480	6460	5.7881	9243	3.4076
1800	8.3202	4280	2.7090	6600	5.0038	9280	3.8174
1960	9.9027	4360	2.2318				

TABLE C11
THE PERCENT DURABLE MEASURE OF REGIONAL INDUSTRIAL DIVERSIFICATION,
BASIC EMPLOYMENT DATA SET

SMSA #	Percent Durable	SMSA #	Percent Durable	SMSA #	Percent Durable	SMSA #	Percent Durable
120	0.1806	2040	0.5856	4410	0.2436	6680	0.4882
160	0.3536	2290	0.2735	4520	0.5586	6720	0.0979
220	0.2417	2335	0.6502	4680	0.1572	6840	0.7349
240	0.5311	2360	0.7561	4763	0.4528	6880	0.8588
280	0.3187	2440	0.5308	4920	0.2934	7000	0.1945
400	0.8998	2760	0.6952	5080	0.6410	7040	0.5553
460	0.4289	2960	0.8244	5200	0.1043	7520	0.2398
520	0.2752	3040	0.1999	5280	0.6933	7680	0.4354
560	0.1332	3080	0.2045	5360	0.3709	7760	0.0946
600	0.1757	3240	0.2764	5380	0.4081	7800	0.6105
720	0.4070	3480	0.5815	5403	0.4200	7880	0.3438
760	0.0792	3640	0.3507	5460	0.4431	7920	0.3419
880	0.0759	3660	0.3007	5560	0.2364	8003	0.3993
960	0.6923	3680	0.4932	5600	0.1868	8160	0.5343
1020	0.6367	3740	0.4768	5640	0.4299	8320	0.3712
1040	0.2835	3760	0.4241	5745	0.3374	8440	0.0821
1123	0.3886	3800	0.8278	5920	0.3175	8480	0.4901
1280	0.6114	3840	0.2430	5990	0.5491	8520	0.1696
1299	0.5126	3870	0.4049	6040	0.3585	8680	0.6551
1400	0.0966	3880	0.0483	6120	0.7085	8760	0.5373
1560	0.4059	3920	0.4373	6160	0.4327	8840	0.0249
1579	0.0711	3960	0.0916	6200	0.4964	9040	0.5837
1600	0.5169	4000	0.5410	6280	0.6893	9140	0.5381
1660	0.3335	4120	0.0442	6323	0.5244	9160	0.2705
1740	0.1484	4150	0.0533	6460	0.5842	9243	0.5461
1800	0.1194	4280	0.4472	6600	0.6563	9280	0.4953
1960	0.7338	4360	0.2000				

APPENDIX D

THE DISAGGREGATED ENTROPY MEASURE OF REGIONAL INDUSTRIAL DIVERSIFICATION

TABLE D1

THE DISAGGREGATED ENTROPY MEASURE OF REGIONAL INDUSTRIAL DIVERSIFICATION,
NONAGRICULTURAL EMPLOYMENT DATA SET

SMSA #	Between-Set Diversification	Mining Within-Set Diversification	Construction Within-Set Diversification	Durables Within-Set Diversification	Nondurables Within-Set Diversification	Services Within-Set Diversification	Public Administration Within-Set Diversification
120	1.388167	0.411713	0.938736	1.691786	1.626829	3.040919	0.422261
160	1.345027	0.0	0.992809	1.635792	1.912274	3.111085	0.521254
220	1.292667	0.692688	1.049062	1.581947	1.276854	2.988686	0.696376
240	1.266764	1.126885	0.914559	1.831584	1.567200	3.117647	0.150341
280	1.250400	0.426431	1.084725	1.848544	1.859838	3.004289	0.704767
400	1.012940	0.0	0.962788	0.776673	1.390738	2.932925	0.674926
460	1.296538	0.0	0.953822	1.927995	1.159322	3.045747	1.023177
520	1.109726	0.121472	0.995740	1.921703	1.930446	3.104469	0.500397
560	1.010942	0.412051	0.918989	1.610682	1.391013	2.987247	0.246113
600	1.405111	0.0	0.992231	1.664281	1.660028	3.117351	0.692438
720	1.214302	0.900455	0.959520	2.042074	1.866064	3.155232	0.0
760	1.324448	0.555375	1.061805	1.763049	1.128841	3.169744	0.290222
880	0.988145	0.798749	1.037437	1.522787	1.157144	3.077925	0.596063
960	1.323674	0.519516	0.952403	1.691401	1.532001	3.094424	0.474201
1020	1.271991	0.0	0.916883	0.507563	0.935238	2.995314	0.249068
1040	0.913954	0.540425	1.004135	0.900730	1.463078	2.875438	0.0
1123	1.134109	0.023980	0.951674	1.995167	2.047125	3.143458	0.615246
1280	1.252436	0.185170	0.960173	1.923429	1.842250	3.138497	0.756994
1299	1.248882	0.0	1.074755	0.786955	1.254869	3.044467	0.574336
1400	0.995694	0.643342	0.956287	1.928324	0.830050	3.020593	0.0
1560	1.391620	0.667877	1.005843	1.901737	1.577613	3.052750	0.416127
1579	1.063873	0.720674	1.086953	1.590994	1.628510	3.131996	0.224155
1600	1.136724	0.740738	0.895642	2.007874	1.838961	3.159107	0.0
1660	1.432117	0.392453	1.053308	1.585210	1.654445	3.063497	0.593344
1740	0.836800	0.0	0.936015	1.054324	1.287951	2.796946	0.0
1800	1.341965	0.0	1.022526	2.008933	1.110350	3.182183	0.210146
1960	1.206086	0.265010	0.975404	0.965901	1.710809	3.062782	0.0
2040	1.194821	0.621800	1.044001	1.448854	1.175545	3.102654	0.0
2290	1.268210	0.0	1.070291	1.330375	1.419780	2.891891	0.950294
2335	1.281958	0.0	1.029579	1.856803	0.976821	2.993236	0.638485
2360	1.168387	0.274577	0.969716	2.002333	1.521820	3.103944	0.726303
2440	1.311426	0.937848	0.982674	1.761938	1.738984	3.030091	1.011820
2760	1.288888	0.0	0.995888	1.683041	1.421122	3.039156	0.589089
2960	1.148764	0.0	1.003242	0.881794	1.685277	3.093934	1.013879
3040	0.972279	0.251605	1.094398	0.632689	0.819993	3.081782	0.0
3080	1.123904	0.0	0.949599	1.482737	1.115729	2.989554	0.666041
3240	1.350633	0.597618	0.998415	1.815693	1.670219	3.120745	0.571502
3480	1.242777	0.908314	0.936330	1.717326	1.692945	3.115143	0.869839
3640	1.192460	0.0	1.002180	1.742597	1.848835	2.984179	0.459534
3660	1.371313	0.692061	0.991059	2.016018	1.490535	2.986777	0.513755
3680	1.364220	0.060645	0.958859	1.092415	1.045846	3.066784	0.620561
3740	1.223678	0.423500	1.029217	1.617558	1.481866	2.988303	0.044791
3760	1.153501	0.482714	0.976031	2.022050	1.813960	3.164650	0.493710
3800	1.067091	****	0.703201	1.172214	1.375319	2.910929	0.591383
3840	1.362822	0.704029	0.976498	1.896585	1.471964	2.968225	0.474739
3870	1.164510	0.0	1.041129	1.213913	1.269431	2.844648	1.002542
3880	1.217499	0.016945	0.962566	1.740867	0.551739	3.093693	0.439729
3920	1.354650	0.0	0.992996	1.888900	1.400130	2.970529	0.359535
3960	1.309794	0.022455	1.051324	1.646187	1.045623	3.082676	0.531468
4000	1.269117	0.0	0.803702	2.103753	1.988360	3.059916	0.0
4120	0.667398	0.574734	0.929445	1.684546	1.254107	2.747190	0.584144
4150	1.290250	0.0	0.960854	1.905164	1.368740	3.178370	0.247192
4280	1.381839	0.406601	1.030549	1.778440	1.787769	3.184878	0.686594
4360	1.174361	0.272931	0.975361	1.983307	1.393703	3.120570	0.645266

TABLE D1 (Continued)

SMSA #	Between-Set		Mining		Construction		Durables		Nondurables		Services		Public	
	Diversification	Diversification	Within-Set	Diversification	Within-Set	Diversification	Within-Set	Diversification	Within-Set	Diversification	Within-Set	Diversification	Within-Set	Diversification
4410	1.204227	0.0			1.019198		1.920819		1.784081		3.058565		0.313297	
4520	1.294480	0.177032			0.942096		1.999964		1.743246		3.139593		0.657781	
4680	1.417350	0.011712			1.039174		1.926157		1.631511		3.147340		0.040860	
4763	1.221601	0.0			0.902156		1.530666		1.912814		3.157993		0.0	
4920	1.226383	0.524496			0.954927		2.126637		1.889560		2.984628		0.545697	
5080	1.224141	0.049097			0.875809		1.765978		1.819558		3.096354		0.850285	
5200	1.211492	0.604642			1.064325		1.770850		1.292316		3.008066		0.476893	
5280	1.237432	0.0			0.987647		1.718357		1.100046		3.014641		0.471358	
5360	1.281178	0.139131			1.037025		2.072723		2.019073		3.097034		0.640125	
5380	1.148732	0.236717			0.872499		1.975376		1.887291		3.171144		1.088604	
5403	1.290315	0.146323			0.911608		1.827197		1.568453		3.044381		0.595864	
5460	1.329538	0.068491			0.991902		2.047457		1.793077		3.005526		0.542201	
5560	1.174709	0.177435			1.024791		1.698339		1.575611		3.182322		0.690053	
5600	1.014580	1.161059			0.840202		2.121590		1.842300		3.251337		0.757333	
5640	1.223580	0.121341			0.987815		1.976882		1.762097		3.181053		0.581939	
5745	1.327278	0.371580			0.985636		2.167161		1.705089		3.127739		0.254066	
5920	1.122084	0.306452			0.982850		1.848898		1.277172		3.117172		0.647957	
5990	1.260834	1.020406			0.928596		1.363568		1.171758		3.107491		0.453098	
6040	1.227657	0.085558			0.914193		2.030272		1.893476		3.056839		0.594902	
6120	1.146597	0.628009			0.945320		0.869764		1.175169		3.077771		0.0	
6160	1.244974	0.438408			0.976223		2.071501		2.058715		3.197585		0.345757	
6200	1.157726	0.878515			0.949179		1.853218		1.524877		3.166040		0.979694	
6280	1.159428	0.395198			1.036300		1.625916		1.769979		3.166966		0.211598	
6323	1.209545	0.0			0.973315		1.246165		1.660879		3.024182		0.686930	
6460	1.369683	0.063667			0.915108		1.000375		1.878227		3.122684		0.402699	
6600	1.267327	0.129885			0.962207		1.551192		1.589775		2.995344		0.479326	
6680	1.269802	0.708970			0.911640		1.948647		1.844312		3.110248		0.454820	
6720	0.857423	0.849715			1.002763		2.044254		1.198377		2.903172		0.676323	
6840	1.231488	0.010986			0.997472		1.316077		1.667001		3.127418		0.635189	
6880	1.057117	0.065367			1.001423		1.713371		1.474615		3.050474		0.0	
7000	1.113933	0.376770			1.035169		1.729573		1.295880		2.968563		0.0	
7040	1.206223	0.886680			0.938137		1.943212		1.943631		3.170754		0.0	
7520	1.221976	0.410116			1.023930		1.558515		1.441105		3.156495		0.655429	
7680	1.317046	0.148268			1.013857		1.977346		1.707866		3.093325		0.660472	
7760	0.772282	0.259426			1.052829		1.688091		0.732331		3.015457		*** ^a	
7800	1.139441	0.0			0.747216		1.698582		1.569646		3.091227		1.023953	
7880	0.954178	0.784528			1.047503		1.061890		1.109322		3.037169		0.0	
7920	1.182877	0.481795			0.972509		1.429970		1.551209		2.973934		0.0	
8003	1.304103	0.0			0.864655		2.141108		1.975454		3.097160		0.630347	
8160	1.222878	0.0			1.016444		1.817474		1.798635		3.147630		0.731362	
8320	1.346872	0.376764			0.990560		1.844506		1.565098		2.986048		0.796709	
8440	1.060674	0.536521			1.049088		2.051188		1.362644		3.066197		0.712856	
8480	1.218510	0.575528			0.943621		1.669715		1.903177		3.160942		0.691935	
8520	1.322415	0.104748			0.976213		1.784306		1.383277		3.125116		0.774559	
8680	1.321073	0.125926			1.075847		2.033830		1.819376		3.164408		0.724971	
8760	1.283673	0.014820			1.021783		0.605776		1.477036		3.111817		0.0	
8840	1.038207	0.173004			0.940347		1.957442		0.908667		3.193040		0.482736	
9040	1.229736	0.119704			1.024737		1.235123		1.574126		3.103642		0.784568	
9140	1.263572	0.197425			1.064659		1.999919		1.859303		3.034161		0.131621	
9160	1.326338	0.298519			0.991521		1.646364		1.059883		3.186928		1.068931	
9243	1.252419	0.161843			1.016951		1.955583		1.985946		3.070080		0.606745	
9280	1.390534	0.048713			1.024442		2.047300		2.009748		3.045851		0.093703	

^aIndicates no employment in this set.

Source: Calculated from 1972 two-digit nonagricultural employment data, BLS.

TABLE D2
THE DISAGGREGATED ENTROPY MEASURE OF REGIONAL INDUSTRIAL DIVERSIFICATION,
MANUFACTURING EMPLOYMENT DATA SET

SMSA #	Between-Set Diversification	Durables Within-Set Diversification	Nondurables Within-Set Diversification	SMSA #	Between-Set Diversification	Durables Within-Set Diversification	Nondurables Within-Set Diversification
120	0.575714	1.69178	1.62683	4360	0.658890	1.98326	1.39368
160	0.687953	1.63579	1.91228	4410	0.692848	1.92082	1.78407
220	0.655164	1.58195	1.27683	4520	0.673454	1.99996	1.74324
240	0.688253	1.83158	1.56718	4680	0.648450	1.92617	1.63150
280	0.668771	1.84855	1.85985	4763	0.693148	1.53068	1.91283
400	0.296809	0.77667	1.39071	4920	0.689337	2.12664	1.88957
460	0.690397	1.92800	1.15931	5080	0.551427	1.76598	1.81953
520	0.692973	1.92171	1.93046	5200	0.501349	1.77086	1.29231
560	0.621670	1.61064	1.39098	5280	0.447459	1.71836	1.10005
600	0.604620	1.66429	1.66003	5360	0.690306	2.07270	2.01907
720	0.679061	2.04207	1.86604	5380	0.617522	1.97537	1.88729
760	0.462389	1.76313	1.12882	5403	0.685763	1.82719	1.56844
880	0.526375	1.52275	1.15717	5460	0.692393	2.04746	1.79306
960	0.584305	1.69139	1.53200	5560	0.689324	1.69836	1.57560
1020	0.204960	0.50758	0.93539	5600	0.646562	2.12159	1.84228
1040	0.665135	0.90072	1.46308	5640	0.689504	1.97692	1.76209
1123	0.683938	1.99517	2.04713	5745	0.655123	2.16717	1.70508
1280	0.623580	1.92343	1.84225	5920	0.690320	1.84893	1.27776
1299	0.446700	0.78696	1.25491	5990	0.601351	1.36359	1.17177
1400	0.580164	1.92838	0.83007	6040	0.667895	2.03027	1.89347
1560	0.682827	1.90173	1.57761	6120	0.502788	0.86977	1.17514
1579	0.645331	1.59082	1.62849	6160	0.693049	2.07149	2.05873
1600	0.656879	2.00786	1.83898	6200	0.515195	1.85321	1.52488
1660	0.690135	1.58520	1.65444	6280	0.476653	1.62591	1.76997
1740	0.656051	1.05437	1.28794	6323	0.643767	1.24616	1.66087
1800	0.457237	2.00896	1.11035	6460	0.553601	1.00038	1.87823
1960	0.428814	0.96590	1.71080	6600	0.595473	1.55121	1.58978
2040	0.654976	1.44885	1.17555	6680	0.692023	1.94865	1.84430
2290	0.671252	1.33037	1.41979	6720	0.673674	2.04429	1.19850
2335	0.587661	1.85680	0.97681	6840	0.514103	1.31607	1.66700
2360	0.526852	2.00233	1.52181	6880	0.379366	1.71337	1.47459
2440	0.665967	1.76193	1.73899	7000	0.587659	1.72956	1.29588
2760	0.497029	1.68304	1.42114	7040	0.656273	1.94321	1.94363
2960	0.425614	0.88178	1.68526	7520	0.645599	1.55851	1.44113
3040	0.631863	0.63266	0.82005	7680	0.619551	1.97734	1.70790
3080	0.574248	1.48271	1.11573	7760	0.548826	1.68807	0.73231
3240	0.690779	1.81568	1.67021	7800	0.581852	1.69858	1.56964
3480	0.617892	1.71732	1.69294	7880	0.576687	1.06190	1.10942
3640	0.685503	1.74259	1.84885	7920	0.690798	1.42997	1.55121
3660	0.624701	2.01604	1.49052	8003	0.693025	2.14111	1.97545
3680	0.601299	1.09239	1.04586	8160	0.616857	1.81746	1.79864
3740	0.688791	1.61757	1.48185	8320	0.693131	1.84451	1.56509
3760	0.678882	2.02204	1.81396	8440	0.423859	2.05128	1.36264
3800	0.312854	1.17222	1.37527	8480	0.673500	1.66971	1.90317
3840	0.597163	1.89658	1.47197	8520	0.623491	1.78432	1.38333
3870	0.667184	1.21392	1.26940	8680	0.535050	2.03383	1.81937
3880	0.607566	1.74076	0.55164	8760	0.674060	0.60579	1.47702
3920	0.584354	1.88891	1.40009	8840	0.597136	1.95745	0.90871
3960	0.409561	1.64623	1.04561	9040	0.567536	1.23511	1.57410
4000	0.676596	2.10375	1.98837	9140	0.686357	1.99992	1.85930
4120	0.693147	1.68448	1.25398	9160	0.626009	1.64638	1.05988
4150	0.408451	1.90520	1.36873	9243	0.665795	1.95558	1.98595
4280	0.636274	1.77844	1.78775	9280	0.688691	2.04730	2.00975

TABLE D3

THE DISAGGREGATED ENTROPY MEASURE OF REGIONAL INDUSTRIAL DIVERSIFICATION,
BASIC EMPLOYMENT DATA SET

SMSA	Mining- Construction		Durables		Nondurables		Services- Government	
	Between-Set Diversification	Within-Set Diversification	Between-Set Diversification	Within-Set Diversification	Between-Set Diversification	Within-Set Diversification	Between-Set Diversification	Within-Set Diversification
120	1.2251	0.6184	1.6918	1.6268	1.6268	1.6268	1.7481	1.7481
160	1.1496	0.7483	1.6358	1.9123	1.9123	1.9123	1.2005	1.2005
220	1.1715	1.5635	1.5819	1.2768	1.2768	1.2768	1.9611	1.9611
240	0.8267	1.1948	1.8316	1.5672	1.5672	1.5672	1.4083	1.4083
280	1.0794	0.4740	1.8486	1.8598	1.8598	1.8598	2.0578	2.0578
400	0.3717	0.0	0.7767	1.3907	1.3907	1.3907	1.2640	1.2640
460	0.9234	0.0	1.9280	1.1593	1.1593	1.1593	1.7512	1.7512
520	1.1939	0.9915	1.9217	1.9305	1.9305	1.9305	2.2228	2.2228
560	1.0352	0.0824	1.6106	1.3910	1.3910	1.3910	2.0839	2.0839
600	1.2024	0.7918	1.6643	1.6600	1.6600	1.6600	1.2702	1.2702
720	1.1603	0.2492	2.0421	1.8660	1.8660	1.8660	1.5644	1.5644
760	1.2512	1.2917	1.7631	1.1288	1.1288	1.1288	1.4002	1.4002
880	1.0646	1.5994	1.5228	1.1572	1.1572	1.1572	2.5795	2.5795
960	0.7746	0.9091	1.6914	1.5320	1.5320	1.5320	1.1117	1.1117
1020	0.8126	0.0	0.5076	0.9354	0.9354	0.9354	0.3993	0.3993
1040	1.0211	0.5912	0.9007	1.4631	1.4631	1.4631	1.7371	1.7371
1123	1.1010	0.7087	1.9952	2.0471	2.0471	2.0471	2.5037	2.5037
1280	0.9033	0.1855	1.9234	1.8422	1.8422	1.8422	2.4869	2.4869
1299	1.0500	0.9531	0.7870	1.2549	1.2549	1.2549	1.6949	1.6949
1400	1.1220	0.9975	1.9284	0.8301	0.8301	0.8301	2.5605	2.5605
1560	0.8713	0.6679	1.9017	1.5776	1.5776	1.5776	1.1977	1.1977
1579	0.8961	1.4061	1.5908	1.6285	1.6285	1.6285	2.1364	2.1364
1600	1.0425	1.1197	2.0079	1.8390	1.8390	1.8390	2.3290	2.3290
1660	1.1364	0.3923	1.5852	1.6544	1.6544	1.6544	1.6213	1.6213
1740	0.8869	0.9376	1.0544	1.2879	1.2879	1.2879	1.8384	1.8384

TABLE D3 (Continued)

SMSA	Between-Set		Mining- Construction		Durables		Nondurables		Services-	
	Diversification		Within-Set Diversification		Within-Set Diversification		Within-Set Diversification		Government Within-Set Diversification	
1800	1.0568		0.8856		2.0089		1.1103		1.3448	
1960	0.7847		0.2647		0.9659		1.7108		1.9032	
2040	0.9125		0.7242		1.4488		1.1755		1.9439	
2290	1.1780		0.8397		1.3304		1.4198		1.8435	
2335	0.9133		0.0369		1.8568		0.9768		1.6205	
2360	0.6507		0.2788		2.0023		1.5218		1.0746	
2440	1.0659		1.2292		1.7619		1.7390		1.4618	
2760	0.8383		0.0		1.6830		1.4211		1.1338	
2960	0.5492		0.6376		0.8818		1.6853		0.8956	
3040	1.0013		0.9033		0.6327		0.8201		2.7310	
3080	1.0099		0.3046		1.4827		1.1157		1.9635	
3240	1.1014		0.7701		1.8157		1.6702		1.2454	
3480	0.9884		1.2335		1.7173		1.6929		2.1136	
3640	1.0514		0.0		1.7426		1.8489		1.3356	
3660	0.8324		0.1696		2.0160		1.4905		1.3344	
3680	1.2383		0.0606		1.0924		1.0459		1.9684	
3740	1.0185		0.4234		1.6176		1.4819		1.9983	
3760 ^a	1.1239		0.8233		2.0220		1.8140		2.4354	
3800	0.5787		*** ^a		1.1722		1.3753		1.5002	
3840	1.0118		1.0577		1.8966		1.4720		2.0523	
3870	1.0845		0.0		1.2139		1.2694		1.6275	
3880	1.1205		0.5391		1.7408		0.5516		2.5797	
3920	1.0473		0.0		1.8889		1.4001		1.1759	
3960	1.1629		1.2885		1.6462		1.0456		2.3174	
4000	0.9654		0.9812		2.1038		1.9884		1.1469	
4120	0.5226		0.3010		1.6845		1.2540		1.4707	
4150	0.8647		0.1569		1.9052		1.3687		0.7729	
4280	1.1591		1.4085		1.7784		1.7878		1.7168	
4360	1.1144		0.1707		1.9833		1.3937		2.3351	

TABLE D3 (Continued)

SMSA	Mining-Construction		Durables		Nondurables		Services-Government	
	Between-Set Diversification	Within-Set Diversification	Within-Set Diversification	Within-Set Diversification	Within-Set Diversification	Within-Set Diversification	Within-Set Diversification	Within-Set Diversification
4410	1.1015	0.7748	1.9208	1.7841	2.2757	2.2757	2.2757	2.2757
4520	0.9164	0.5896	2.0000	1.7432	2.1395	2.1395	2.1395	2.1395
4680	1.1439	0.4792	1.9262	1.6315	0.5508	0.5508	0.5508	0.5508
4763	0.9887	0.3844	1.5307	1.9128	1.9639	1.9639	1.9639	1.9639
4920	1.2044	0.7175	2.1266	1.8896	2.1480	2.1480	2.1480	2.1480
5080	0.9074	0.0472	1.7660	1.8195	1.6506	1.6506	1.6506	1.6506
5200	1.2441	1.1874	1.7709	1.2923	2.4722	2.4722	2.4722	2.4722
5280	0.8462	0.0	1.7184	1.1000	1.9261	1.9261	1.9261	1.9261
5360	1.1461	1.1698	2.0727	2.0191	1.6981	1.6981	1.6981	1.6981
5380	1.1570	0.0757	1.9754	1.8873	2.7104	2.7104	2.7104	2.7104
5403	0.8416	0.2839	1.8272	1.5684	1.5272	1.5272	1.5272	1.5272
5460	0.9263	0.0686	2.0475	1.7931	1.4586	1.4586	1.4586	1.4586
5560	1.3152	0.9593	1.6984	1.5756	2.2581	2.2581	2.2581	2.2581
5600	1.0465	1.1623	2.1216	1.8423	2.7952	2.7952	2.7952	2.7952
5640	1.0755	0.1205	1.9769	1.7621	2.1659	2.1659	2.1659	2.1659
5745	0.9054	0.3720	2.1672	1.7051	1.9029	1.9029	1.9029	1.9029
5920	1.1736	0.4831	1.8489	1.2778	2.5315	2.5315	2.5315	2.5315
5990	1.1422	1.4641	1.3636	1.1718	1.8445	1.8445	1.8445	1.8445
6040	0.8939	0.0831	2.0303	1.8935	2.1096	2.1096	2.1096	2.1096
6120	0.8582	0.8866	0.8698	1.1751	1.9304	1.9304	1.9304	1.9304
6160	1.0282	0.9289	2.0715	2.0587	2.4886	2.4886	2.4886	2.4886
6200	1.2057	0.8734	1.8532	1.5249	2.8920	2.8920	2.8920	2.8920
6280	0.9139	0.3954	1.6259	1.7700	2.0984	2.0984	2.0984	2.0984
6323	1.0673	0.3733	1.2462	1.6609	1.9306	1.9306	1.9306	1.9306
6460	0.9886	0.0631	1.0004	1.8782	0.8246	0.8246	0.8246	0.8246
6600	0.8422	0.1297	1.5512	1.5898	1.2384	1.2384	1.2384	1.2384
6680	0.9330	0.7091	1.9487	1.8443	1.9586	1.9586	1.9586	1.9586
6720	0.7913	1.1813	2.0443	1.1985	1.5970	1.5970	1.5970	1.5970
6840	0.7472	0.0113	1.3161	1.6670	1.5849	1.5849	1.5849	1.5849

TABLE D3 (Continued)

SMSA	Mining- Construction		Durables		Nondurables		Services- Government	
	Between-Set Diversification	Within-Set Diversification	Within-Set Diversification	Within-Set Diversification	Within-Set Diversification	Within-Set Diversification	Within-Set Diversification	Within-Set Diversification
6880	0.4675	0.0643	1.7134		1.4746		0.8195	
7000	1.0692	0.2227	1.7296		1.2959		1.9347	
7040	0.9858	0.8860	1.9432		1.9436		2.3788	
7520	1.2125	0.9267	1.5585		1.4411		2.0005	
7680	1.2936	1.0027	1.9773		1.7079		2.2525	
7760	0.9229	0.2595	1.6881		0.7323		2.4763	
7800	0.9411	0.0	1.6986		1.5696		1.8771	
7880	1.0889	1.4012	1.0619		1.1094		2.1976	
7920	1.1358	1.1630	1.4300		1.5512		2.0867	
8003	1.0598	0.0	2.1411		1.9755		2.0619	
8160	1.0766	1.0479	1.8175		1.7986		2.2543	
8320	1.2066	0.3768	1.8445		1.5651		2.1187	
8440	0.9630	0.8959	2.0513		1.3626		2.4649	
8480	1.0305	0.5650	1.6697		1.9032		1.7636	
8520	1.2255	1.1312	1.7843		1.3833		2.3410	
8680	0.9043	0.1256	2.0338		1.8194		1.6340	
8760	0.9849	0.0146	0.6058		1.4770		1.4616	
8840	0.4409	0.4594	1.9574		0.9087		1.2954	
9040	1.0829	0.4424	1.2351		1.5741		2.2545	
9140	0.8376	0.7068	1.9999		1.8593		0.8775	
9160	1.0490	0.8373	1.6464		1.0599		2.0462	
9243	0.9509	0.1618	1.9556		1.9859		1.9707	
9280	1.0014	0.3994	2.0473		2.0097		0.6097	

^aSMSA 3800 contains no mining or construction basic employment.

Source: Calculated from 1972 two-digit basic employment data, BLS.

VITA

John R. Kort was born in Pittsburgh, Pennsylvania, on June 27, 1952. He attended elementary schools in that city and was graduated from North Hills High School in June 1970. In September of that year he entered Indiana University of Pennsylvania as an Economics major and was graduated with a Bachelor of Arts degree in June 1974.

He entered the Graduate School of The University of Tennessee, Knoxville, in September 1974 and received a research assistantship with the Center for Business and Economic Research, College of Business Administration. During his five years at that institution, he continued work at the Center for Business and Economic Research as an assistant on the Tennessee Econometric Modeling Project and as a result, has extensive experience in regional econometric modeling. During the 1976-77 academic year, he taught several courses in the principles of economics at the undergraduate level, and received the Master of Arts degree with a major in Economics in August 1977. Mr. Kort received his Doctor of Philosophy degree with a major in Economics in June 1979.

Mr. Kort is the author of a number of publications, some of which include:

Estimating Gross State Product: An Analysis and An Application to the Tennessee Economy (Knoxville: Center for Business and Economic Research, College of Business Administration, The University of Tennessee, 1976)

"Alternative Regional Modeling Approaches," in Forecasting Regional Economic Activity: The Tennessee Econometric Model (TEM II), Richard D. Gustely (Knoxville: Center for Business and Economic Research, College of Business Administration, The University of Tennessee, 1978), pp. 2-14

"The Tennessee Economy in Perspective: Per Capita Income and Industrial Diversification in the Tennessee Counties," Survey of Business, September-October 1977, pp. 13-19

In addition, he is a contributing author for the following publications:

An Economic Report to the Governor of the State of Tennessee (Nashville: Tennessee Department of Economic and Community Development), January 1977, pp. 205-213

Metropolitan Area Economic Report: Economic Forecast to 1985 for Tennessee and the Chattanooga, Knoxville, Memphis, and Nashville Metropolitan Areas (Nashville: Tennessee State Planning Office), August 1978, pp. 79-120

John Kort served on the School of Arts and Sciences, Curriculum Advisory Committee, at Indiana University of Pennsylvania from 1972 to 1974, and was also the graduate student member of the College of Business Administration, Graduate Policies and Curriculum Committee, at The University of Tennessee, Knoxville, during the 1976-77 academic year. He received a College of Business Administration capital gifts dissertation fellowship during 1978-79 and is a member of Omicron Delta Epsilon, the Southern Economic Association, and the American Economic Association.

Mr. Kort will be employed with the U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Analysis Division, after graduation.