Growth, Diversification, and Cyclical Instability in the Oregon Economy, 1960-1979

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ABSTRACT

This report examines the historical patterns of growth, diversification, and instability in the Oregon economy to better understand how growth and structural changes in the sectoral composition of the economy are related to its cyclical stability. Two measures of diversification are applied to determine the extent to which the Oregon economy has diversified over the last two decades. Finally, a portfolio variance measure of economic instability is applied to constructed annual estimates of Oregon's real gross state product for 30 sectors during the 1960-79 period. Results suggest that the economy has changed its structure over this period in a way which increased the overall instability of the economy. Rapid growth in certain "high technology" manufacturing industries was a contributing factor in this increasing instability. Results also indicate that the countercyclical relationship between the agricultural sector and the other sectors made agriculture unique as a stabilizing force in the economy during this period.

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GROWTH, DIVERSIFICATION, AND CYCLICAL INSTABILITY IN THE OREGON ECONOMY, 1960-1979

Gary W. Smith and Bruce A. Weber

Much of the discussion about the State of Oregon's economy and the alternatives for improving the economy appear to be based on an assumption that growth and stability in the state's economy depend on diversification. Diversification is often viewed uncritically as the most appropriate strategy for achieving both growth and stability.[1/] The purpose of this report is to examine the historical patterns of growth, diversification, and instability in the Oregon economy to better understand how growth and structural changes in the sectoral composition of the economy are related to cyclical stability of the state economy.

In the first section of the report, some of the explanations advanced by economists concerning the interrelation are surveyed. In the second section of the report, the pattern of structural change and cyclical instability in the Oregon economy over the last two decades is examined. In the third section, two measures of economic diversification are reviewed and applied in an attempt to determine the extent to which the Oregon economy has diversified over the last two decades. The fourth section is a preliminary analysis of the effects of growth and instability in individual sectors on the overall instability of the state. The fifth section introduces portfolio analysis, discusses its applications in regional economics, and uses it to provide a more complete assessment of how the structural changes in the Oregon economy have affected the economy's stability. The report concludes with a summary and discussion of implications for future research and state development policy.

I. INSTABILITY, DIVERSIFICATION, AND GROWTH: A REVIEW OF SELECTED HYPOTHESES

When the interrelationship among diversification, growth, and cyclical instability of regions has been examined in the economics literature, differences in the degree to which regions are diversified and differences in the rates of growth between regions have usually been offered as explanations for the differences in the severity of cycles between regions. That is, regional instability has been posited as a function of regional

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1/ Underlying the recommendations advanced by Governor Atiyeh's Economic Recovery Council in a May 1982 report, for example, is the goal of diversifying the state's economy. Economic diversification is implicitly assumed in this report to be the appropriate strategy for both promoting growth and enhancing the stability of the Oregon economy.

industrial composition and the rate of regional growth. To lay the groundwork for the analyses of growth, diversification, and instability in the following sections, the two major hypotheses about industrial composition (the industry mix hypothesis and the diversification hypothesis) and the differential growth hypothesis will be summarized in this section. No attempt will be made to review all the relevant literature (adequate literature reviews can be found in Kort, 1979, 1981; Richardson, 1969, and Howland, 1979) or to develop an exhaustive critique of each hypothesis. Rather, the focus will be on outlining the major arguments supporting each hypothesis.

Industry Composition Hypotheses

Two major hypotheses for explaining regional instability differentials relate to the regional industrial composition. The first (the industry mix hypothesis) suggests that regions specializing in industries that are unstable nationally tend to be more unstable than those specializing in industries that are not. The second (the diversification hypothesis) hypothesizes that regions with more diverse economies (economies in which employment or output is more equally apportioned among sectors or in which the sectoral composition is more like that of the nation) are likely to be more stable.

The Industry-Mix Hypothesis. When given its least sophisticated interpretation, this hypothesis suggests that the cyclical instability of regions is merely a manifestation of the cyclical behavior of national industries. A region with a disproportionate share of industries that are cyclically unstable nationally is hypothesized to exhibit greater cyclical instability than a region whose industry composition is similar to that of the nation.

This simplified rendering of the industry-mix hypothesis ignores any distinction between national and regional industries. The cyclical characteristics of an industry nationally are imputed to the industry in each region. In other words, industries and the character of their cyclical performance are assumed to be spatially homogeneous. Therefore, the cyclical instability of the region is merely a manifestation of a national-industrial phenomenon.

Empirically, the industry-mix hypothesis has been most often tested by attempts to explain statistically variations in the cyclical instability between regions by regional differences in the percent of employment or income associated with durable goods production (Borts, 1960, Engerman, 1965). Producer and durable goods industries usually are considered to be more cyclically volatile than nondurable and consumer goods industries. Econometric studies of income elasticities of durable goods lend support to this notion. Regions with disproportionate shares of economic activity allocated to durable goods production, therefore, are expected to exhibit greater cyclical instability.

The industry-mix hypothesis, particularly when given its most simplistic and undoubtedly extreme interpretation, has been the focus of considerable criticism. It has been frequently pointed out, for example, that industries are not spatially homogeneous. Within a given industry there exist wide variations between regions as to the internal structure of the industry, such as the product mix, the age of capital and plant facilities, the size of firms, and the degree of industry concentration. Regional disparities in these characteristics contribute to differences in the regional response within an industry to national business cycle expansions or contractions. Also, the same industry in different regions may serve different markets. The industry of a region may market its product locally, interregionally, or internationally. The characteristics of these markets may be quite distinct in such terms as demographic composition, income levels, and preference patterns. Therefore, the pattern of cyclical variation of the industry of a region may deviate significantly from the pattern of its national counterpart because of important differences in the characteristics of the markets the two may serve.

Similarly, the origin, the composition, and cost of inputs to an industry also may differ between regions. The intermediate inputs to an industry of a region may originate internally, or they may be imported from an external source. A cyclical downturn in an industry which purchases a high proportion of its intermediate inputs from other industries within the region, through the multiplier effect of these purchases, will have a larger downward effect on the economy of a region than a similar downturn in an industry importing a high proportion of its intermediate inputs. Therefore, the cyclical instability of an industry nationally may give little indication of the degree of cyclical instability of its regional counterpart, and to the degree of impact this counterpart may have on the cyclical performance of the region. The interindustry structure within a region, as well as simply its industry mix or composition, is important to understanding the cyclical volatility of a region.

Empirical tests of the industry-mix hypothesis which have relied on the percentage of employment or income in durable good manufacturing as a measure for capturing regional differences in industry composition are criticized not only for ignoring the considerations raised above, but also for neglecting important differences in the industry-mix within durable goods manufacturing that also may exist between regions.

The Diversification Hypothesis. Differences in the extent to which the economic activity of regions are more or less evenly distributed across a broad set of industries is also hypothesized as an explanation for differences in the degree of their cyclical instability. In what may be the earliest discussion of regional instability differentials, Tress (1938) argued that the more diverse the economic activity of a region, the greater its likely stability. This hypothesis has obvious intuitive appeal, for regional dependence on a single or narrow group of industries is risky business. Clearly, a region dependent on a single cyclical industry is more likely to be vulnerable to cyclical upturns and downturns than one which is based on several industries whose upturns and downturns may be off-setting, at least in part. Therefore, diversification is perceived as a strategy for enabling an economy to hedge against vulnerability to cyclical instability. Empirically, this hypothesis has been examined in several recent studies (Kort, 1981; Conroy, 1975; Cho and MacDougal, 1978) by testing for empirical relationships between several measures of industrial diversification (entropy, ogive, national average) and measures of instability.

Several objections have been advanced against the notion that diversification per se leads to regional economic stability. Perhaps the most serious is raised by Wasylenko and Erickson (1970). They point out that 6 of the 10 least diversified Standard Metropolitan Statistical Areas (SMSA's) in their sample specialized in public administration and education ("college towns"). Since these sectors tend to be relatively stable, specialization in these economies might be expected to yield stability rather than instability.

The Differential Growth Hypothesis

Proponents of the growth differential hypothesis contend that regions experience different degrees of cyclical contraction and expansion because of underlying differences reflected in their long-run rates of growth. Faster growing regions, it is argued, are less susceptible to cyclical fluctuations than slower growing regions. Several specific arguments are advanced to support this hypothesis. One argument is that higher levels of investment are undertaken by firms in faster growing regions. Therefore, a higher proportion of newer and more technically advanced capital stocks will prevail in faster growing regions. Thus, firms in faster growing regions tend to be more efficient and produce with lower costs than firms in slower growing regions. During periods of recession, less efficient and higher cost plants are the first to close, and during subsequent expansions, the last to open if the firm has not abandoned the plant altogether. Therefore, it is reasoned that the severity of a recession is likely to be greater for regions experiencing slower growth.

A second argument contends that entrepreneurs in faster growing regions are likely to have more optimistic and more certain expectations toward the future of their economy than their counterparts in slower growing regions. Therefore, they also may be less inclined to cut back production and dismiss employees during a contraction. In turn, they may be less hesitant to respond to signals of an ensuing expansion by increasing their production and hiring than their counterparts in companion industries of slower growing regions. Reinforcing this behavior, it is also suggested that slower growing regions are considered to have generally higher rates of unemployment and, therefore, relatively more abundant supplies of labor than faster growing region. Thus, there is less incentive for firms in slower growing regions to retain employees during periods of contraction to assure a supply of labor to support increased production during the subsequent expansion.

A third argument suggests that during periods of expansion, faster growing regions experience in-migration from slower growing regions. This in-migration stimulates additional investment to accommodate a growing population. Investment expenditures may extend beyond the current expansion and perhaps offset or dampen an otherwise ensuing contraction. For slower growing regions, the opposite effect may be expected to occur as a result of the out-migration taking place.

It must be noted that the causal relation implied by these arguments may be reversed. That is, it may be reasoned that the vulnerability of regions to cyclical instability may influence their long-run growth potential. For example, the greater risk and uncertainty facing entrepreneurs in regions subject to greater cyclical instability may inhibit investment, the formation of new capital stock, the infusion of more advanced technology, and the creation of more efficient low cost industrial plants, all of which contribute to the growth potential of a region. Cyclical instability, therefore, may foster long-run shifts in regional distribution of economic activity and regional differentials in growth rates. The "chicken or egg" issue as to the causal relation between the rate of growth and cyclical instability of regions remains conceptually unresolved. Indeed, there does not even exist consistent empirical evidence to support the general presumption that regional growth and stability are positively correlated [Howland, 1979].

Summary

A common thread which runs through the above discussion of the hypotheses is that what determines the growth and cyclical instability of a region is the growth and stability of the individual industries which make up the region's economy. Diversification per se does not necessarily lead to either growth or stability. Diversification toward industries with cyclical patterns similar to those of the existing regional industries may amplify rather than dampen instability. What is of concern is the industrial composition of a region and the pattern of growth and stability of the individual sectors that make up the region's economy. Certain characteristics of these industries -- their size, their interdependence with the rest of the regional economy, and with the economy outside the region -- and certain characteristics of the region -- its size, income, distance from other economic nodes, the aggregate growth in the region, and in-migration of capital and labor and entrepreneurship -- may affect both the growth of any industry and the way in which it responds to external business cycle fluctuations. A comprehensive understanding of the growth and stability of a regional economy requires an understanding of the factors which affect growth and stability of the individual sectors which make up the economy and the interrelationships between these sectors. The important conceptual ingredients of each of the hypotheses outlined above may provide insight into the structural change, the patterns of growth, and the sources of cyclical instability of the Oregon economy during the decades of the 1960s and the 1970s. Such an examination, which follows, may offer both conceptual as well as a historical perspective for decision-makers responsible for formulating strategies and policies for the economic recovery and development of the state.

II. GROWTH, STRUCTURAL CHANGE AND CYCLICAL INSTABILITY IN THE OREGON ECONOMY: 1960-1979

In this section of the report, the sectoral pattern of growth of the Oregon economy over the decades of the 1960s and 1970s is examined.

An Overview of Growth in the Oregon Economy, 1960-1979

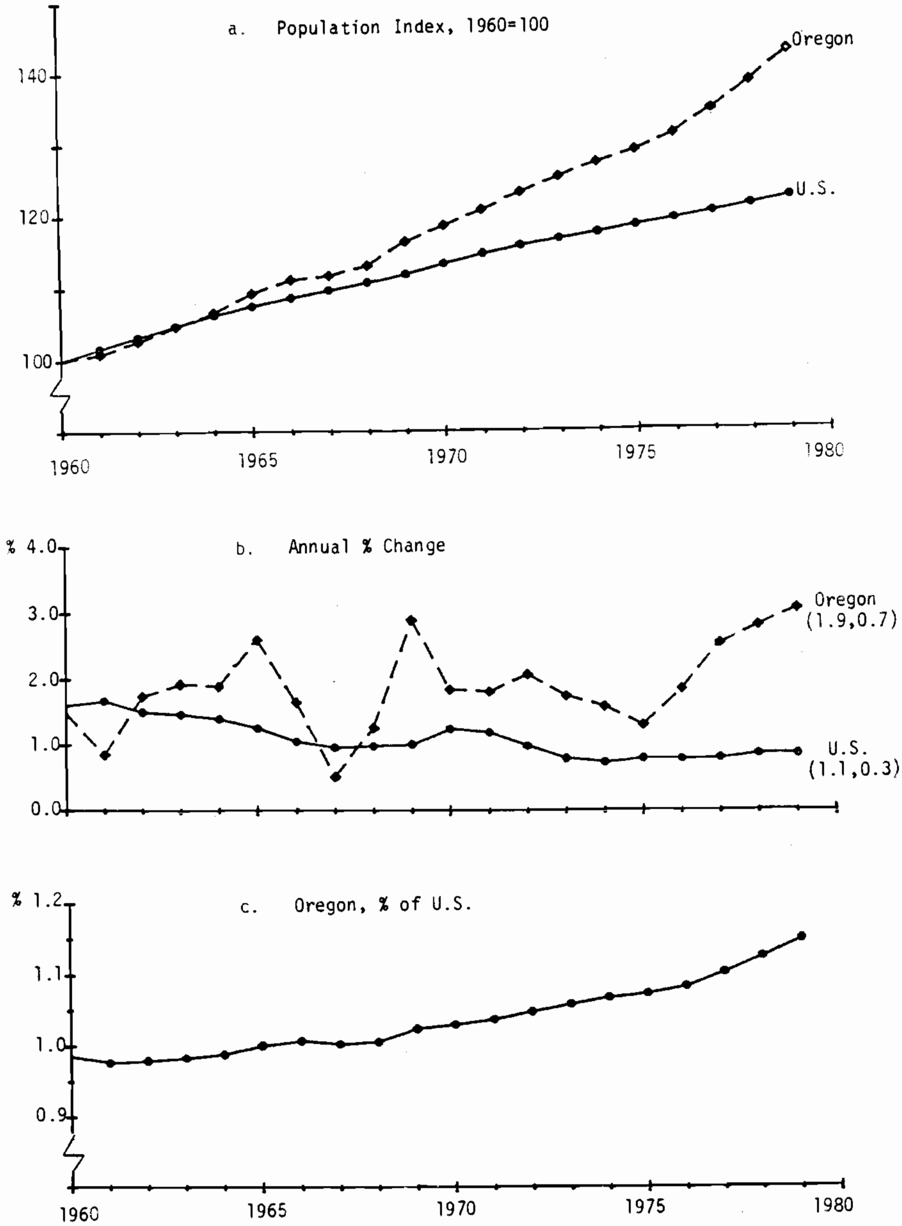
To provide a brief overview and a comparative perspective, in this section the economic growth of Oregon and the nation during the 1960s and 1970s will be examined in aggregate terms.

Population. As consumers and producers, people, of course, underlie the growth of economic activity of a region. Presented in Figure 1 are three graphs depicting the population growth of Oregon in relation to the growth of total U.S. population. In Figure 1a are population indices for the United States and Oregon (1967 = 100). By 1979, the population indices stood at 143 and 122 for Oregon and the United States, respectively, illustrating the more rapid growth of Oregon when compared to the United States.

The annual percentage change in population for the two regions is exhibited in Figure 1b. Only in 1961 and 1967 did the rate of Oregon population growth fall below that of the United States. The pairs of numbers in parenthesis below the labels for Oregon and the United States indicate growth and stability. The first number in each pair identifies average annual rate of growth for Oregon and the United States over the period, 1.9 percent and 1.1 percent, respectively. These averages can be interpreted as estimates of a long-run population growth trend for the period. Oregon's population growth trend is notably higher for the period than that of the United States.

The annual rate of population growth of Oregon, however, has been considerably less stable than that of the United States. The second number of each pair appearing in parentheses is the standard deviation of the annual rate of growth for Oregon and the United States, 0.7 percent and 0.3 percent, respectively. The standard deviation can be used as a measure of variation or instability in growth rates around the population growth trend. Concerning the pattern of variation in the growth of Oregon's population, one characteristic of interest evident from the graph is the low points or troughs in the rate which occurred during 1961, 1967, 1970-1971, and 1975. These were years of recession or a decline in the rate of growth of economic activity for both the state and the nation. Therefore, the rate of growth of Oregon's population exhibits a pattern of variation that appears to correspond with the pattern of cyclical economic

Figure 1. Population: U.S. & Oregon, 1960-79



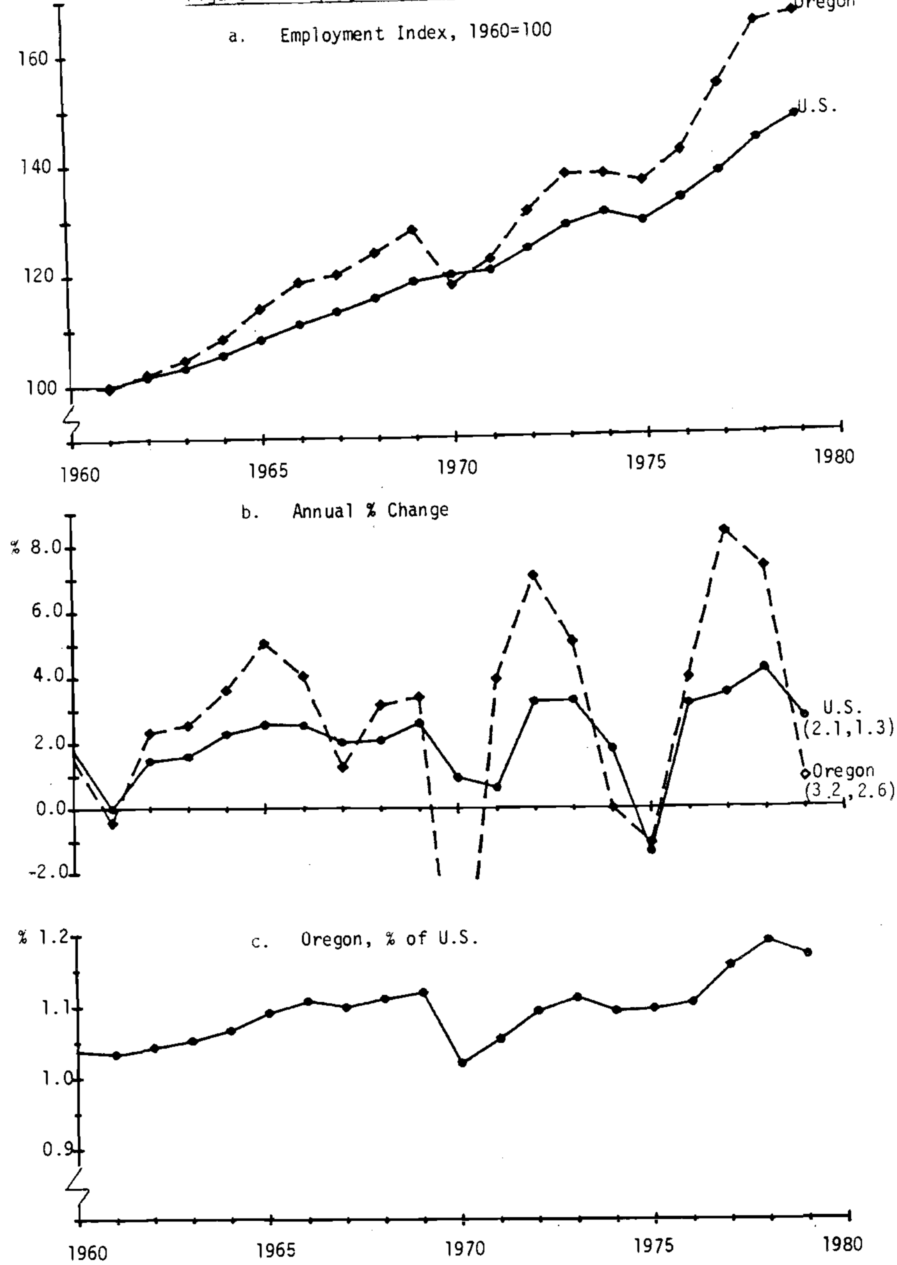
instability of the state. Migration into and out of the state is the most volatile component of its population growth, as well as the component most responsive to opportunities for income and the availability of jobs.

Figure 1c shows Oregon's population as a percentage share of United States population. Starting at slightly less than 1.0 percent in 1960, this share increased to above 1.1 percent toward the end of the 1970s.

Employment. The three graphs in Figure 2 depict the growth of employment in Oregon relative to the United States. The format used in these graphs is the same as that used for illustrating population growth. Unfortunately, however, because of a change in the method for reporting employment statistics used in these graphs, the relations depicted in Figures 2a and 2c after 1969 are not comparable to those of previous years. Through 1969, the employment statistics used in these graphs were reported according to the employees' place of work; after this, they were reported according to the employees' place of residence. Largely because of the number of Washington state residents commuting to work in the Portland area, the employment statistics reported for Oregon after 1969 are low relative to those reported for prior years.

In spite of this inconsistency in the employment data series, a pattern of cyclical instability of Oregon employment is evident in Figure 2b. This graph reveals troughs occurring in the rate of growth of Oregon employment during 1961, 1967, 1970, and 1975. The magnitude of the trough of 1970 is overstated because of the statistical aberration discussed above. Also, because of this statistical aberration, the observation for 1970 was not used to compute the average and standard deviation of the annual rates of growth of Oregon and U.S. employment for the two decades. As a measure of a long-run growth trend, Oregon's average annual employment growth rate of 3.2 percent was strikingly greater than the 2.1 percent for the United States. The fact that employment growth trends exceed those for population growth reflect, in part, the increasing participation of women in the labor force over this period. It can be readily observed in Figure 2b that Oregon's rate of employment growth also exhibited a pattern of greater instability than that of the United States. The extent of the difference in the cyclical instability of employment between Oregon and the United States is also captured by their standard deviation measures, 2.6 and 1.3. Indeed, in this context the standard deviation statistic serves as a direct index of cyclical economic instability in that it measures the degree of cyclical fluctuation in economic activity around a long-run secular growth trend. To summarize, Figure 2b shows that, in terms of employment, the growth of the Oregon economy was both higher and more cyclically volatile than the economy of the nation over the two decades. It should be mentioned that a quarterly data series rather than the annual data series (as used in developing Figure 2b and elsewhere in this study) would better serve to delineate the cyclical economic performance of a region. However, many regional economic data series are only available on an annual basis.

Figure 2. Employment: U.S. & Oregon, 1960-79



Gross Product. When the performance of the nation's economy is addressed in either the popular media or scholarly journals, attention is given to examining the level and growth of gross national product, widely regarded as the most comprehensive measure for the total economic activity of the nation. Unfortunately, data which measure the gross product of cities, counties, states, and other subnational regions are neither published nor available. Several methods have been proposed, however, for developing estimates of the gross product of subnational regions. A combination of these methods was employed to construct individual industry estimates of Oregon's real gross product in 1972 dollars.[2/] These estimates were used to develop the graphs of Figure 3, which compare the pattern of growth of Oregon's estimated real gross product to that of the United States.

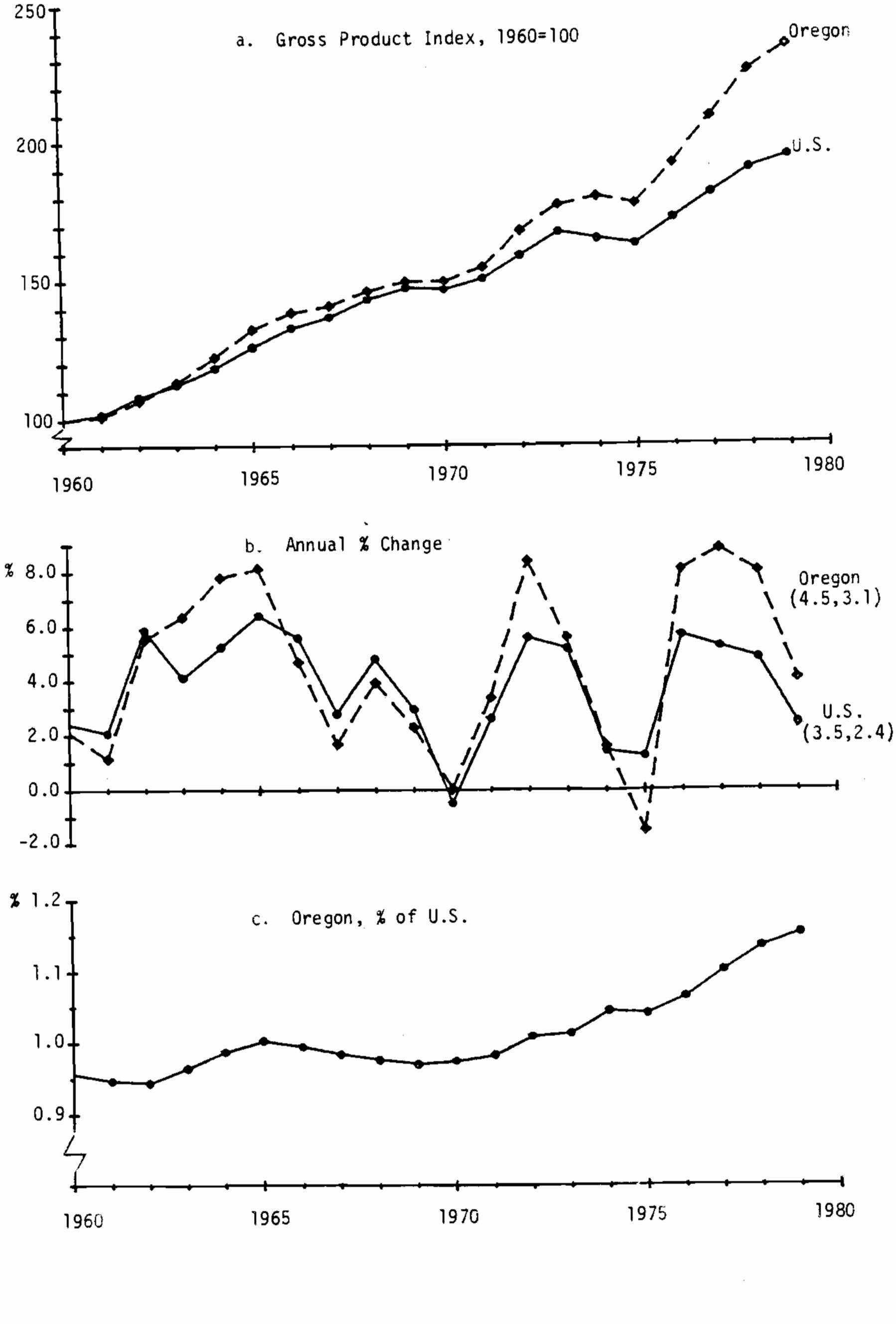
The information contained in Figure 3b is the most comprehensive. This graph illustrates again that when compared to the nation, Oregon's economic growth was generally higher though more cyclically volatile. The growth in labor productivity largely accounts for the trends in real gross product growth of Oregon and the United States, 4.5 percent and 2.5 percent, respectively, exceeding the trends in employment growth. Real gross product is a more comprehensive measure of economic activity than employment because the latter only reflects a measure of labor's contribution to economic activity. Real gross product, however, encompasses not only wage and salary income as a measure of labor's contribution to production, but also includes an estimate for profits which measures the return to capital for its contribution to production. Profit income is generally more cyclically volatile than wage and salary income. Therefore, it is not surprising to observe that the indices of cyclical instability of real gross product for Oregon and the United States, 3.1 percent and 2.4 percent, respectively, are higher than the indices of employment instability. As with the rates of growth in population and employment, troughs in the rate of growth of Oregon's real gross product occur in 1961, 1967, 1970, and 1975.

The Composition and Cyclical Pattern of Industry Growth in Oregon, 1960-1979.

A comparison of the performance of the Oregon economy relative to that of the nation -- in terms of the pattern of aggregate annual growth of population, employment, and real gross product -- provides consistent evidence that though the trend in Oregon's growth was higher, the cyclical pattern of its growth was far less stable. To understand these patterns of aggregate growth, it is useful to examine the initial industry composition of Oregon's economic activity, the pattern of growth of individual industries, and the resulting changes in the industry composition of Oregon's economy.

[2/] The method for estimating gross product of the nonfarm sectors is described in detail in Smith et al. (1983). Estimates of gross product in the agricultural sector were generated using a method described in Kendrick and Jaycox (1965).

Figure 3. Gross Product (constant dollar): U.S. & Oregon, 1960-79



The Industry Composition of Oregon's Gross Product, 1960. Because real gross product is generally considered to be the most comprehensive measure of economic activity, the industry growth and composition of Oregon's economic activity will be examined in terms of the estimates made for real gross product. The 30 industries for which individual estimates of real gross product were constructed are listed in Table 1. The industry composition of Oregon's economic activity is portrayed in this table according to each industry's percentage share of total state gross product as of 1960.

To facilitate interpretation, each industry is ranked on an ordinal scale of 1 to 30. In this scale, 1 identifies the industry with the highest percentage share, and 30 corresponds to the industry with the lowest.

Trends in Industry Gross Product Growth, 1960-1979. The growth trend of each of the 30 industries, as represented by their average annual percentage growth from 1960 to 1979, and the rank of industries by growth rate are also presented in Table 1. The industry exhibiting the lowest growth trend is agriculture. The federal government sector follows agriculture in exhibiting the second slowest trend in growth.

A comparison of the relative importance of the 30 industries in terms of their percentage share (S) in 1960 with the trends in their growth (G) in the following 19 years is possible from Table 1. It is striking that no industries among the highest third in percent share were among the top third fastest growing. Five of the 10 fastest growing industries were among the lowest third in terms of their initial percentage share. This implies that the percentage share for these industries increased over the 20-year period. Also, five of the 10 most important industries in terms of their percentage share were among the lowest third in growth. This suggests that the percentage share for these industries generally decreased over the period.

Trends in the Industry Composition of Gross State Product, 1960-1979. Table 2 shows changes in the percentage contribution to total gross state product of the 30 industries from 1960 to 1979. This information for selected sectors is also plotted in Figures 4-7, allowing a preliminary assessment of the role of these industries in contributing to the diversification of the Oregon economy. Under most definitions of diversification, a decreasing share for large industries and an increasing share for small industries constitute diversification. More rigorous definitions of diversification are presented in a subsequent section of the report. To enhance the information contained in this graph, the average and standard deviation of the annual rate of growth for the industries represented appear in parentheses under the labels identifying each sector.

The lumber and wood products sector represented a dominant force in the Oregon economy throughout the period, in terms of contribution to total gross state product. Toward the beginning and end of the 20-year period,

Table 1. Oregon Gross State Product (Constructed Estimates),* Percentage Share by Industry, 1960, and Annual Average Growth Rates of Industry Gross Product, 1960-79

Industry	Percentage Share	Rank	Average of Annual % of Growth, 1960-79	Rank	High Third	Middle Third	Low Third
1. Agriculture	5.79	(8)	.78	(30)	S		G
2. Agricultural Services, Forestry & Fisheries	.55	(21)	5.51	(13)		G	S
3. Mining	.33	(24)	4.31	(22)			S,G
4. Contract Construction	7.12	(5)	3.19	(28)	S		G
5. Food & Kindred Products	3.06	(12)	4.09	(24)		S	G
6. Textile & Apparel	.43	(23)	4.21	(23)			S,G
7. Paper & Allied Products	1.18	(15)	5.94	(10)	G	S	
8. Printing & Publishing	.84	(19)	4.73	(16)	S,G		S,G
9. Chemical & Allied Products	.24	(28)	6.33	(8)	G		S
10. Petroleum, Rubber & Leather	.17	(29)	9.62	(3)	G		S
11. Lumber & Wood Products	9.87	(3)	4.58	(19)	S	G	
12. Furniture & Fixtures	.28	(26)	3.59	(27)			S,G
13. Primary Metals	1.14	(16)	4.71	(17)	S,G		
14. Fabricated Metals	.92	(18)	6.50	(7)	G	S	
15. Machinery, Nonelectrical	.99	(17)	8.15	(5)	G	S	
16. Electrical Machinery & Instruments	.65	(20)	12.43	(2)	G	S	
17. Transportation Equipment (excluding motor vehicles)	.33	(25)	8.57	(4)	G		S
18. Motor Vehicles & Equipment	.25	(27)	14.30	(1)	G		S
19. Stone, Clay & Glass	.53	(22)	4.68	(18)		G	S
20. Miscellaneous Manufacturers	.16	(30)	5.94	(9)	G		S
21. Transportation	5.04	(10)	3.82	(26)	S		G
22. Communication	1.86	(14)	8.14	(6)	G	S	
23. Other Utilities	2.25	(13)	4.43	(21)		S	G
24. Wholesale Trade	6.54	(6)	5.90	(11)	S	G	
25. Retail Trade	12.06	(1)	4.84	(15)	S	G	
26. Finance, Insurance & Realty	11.87	(2)	5.87	(12)	S	G	
27. Business Services	4.10	(11)	4.48	(20)		S,G	
28. Professional & Social Services	6.54	(7)	5.13	(14)	S	G	
29. Federal Government	5.35	(9)	1.20	(29)	S		G
30. State & Local Government	9.56	(4)	4.03	(25)	S		G
TOTAL GROSS STATE PRODUCT	100.00		4.68				

* Estimates constructed using U.S. Department of Commerce, Bureau of Economic Analysis data: Gross Product Originating in Current and Constant (1972) Dollars, 1958-79 and Detail Components of Annual Personal Income, U.S. and Oregon, 1958-79.

Highest Third: Rank = 1-10
Middle Third: Rank = 11-20
Low Third: Rank = 21-30

S: Percentage share places industry within this third.
G: Growth rate places industry within this third.

Table 2. Oregon Gross State Product (Constructed Estimates)*--Percentage Distribution by Industry, 1960-79

Year	Agriculture	Ag. Services Forestry & Fisheries	Mining	Contract Construction	Food & Kindred Products	Textile & Apparel Products	Paper & Allied Products	Printing & Publishing	Chemical & Allied Products	Petroleum Rubber & Leather
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1960	5.79	.55	.33	7.12	3.06	.43	1.18	.84	.24	.17
1961	5.48	.50	.35	6.95	3.13	.38	1.19	.84	.26	.18
1962	5.35	.52	.38	6.77	3.04	.41	1.16	.81	.25	.19
1963	5.01	.51	.41	7.18	3.02	.44	1.12	.82	.28	.20
1964	4.63	.50	.44	7.01	2.81	.43	1.09	.83	.28	.20
1965	4.14	.49	.48	7.41	2.74	.42	1.10	.79	.30	.18
1966	4.02	.52	.49	7.12	2.89	.40	1.16	.78	.32	.19
1967	4.24	.48	.48	6.47	2.91	.38	1.17	.77	.32	.21
1968	3.91	.42	.42	6.27	2.85	.38	1.28	.76	.34	.22
1969	4.01	.42	.37	5.87	2.94	.39	1.40	.78	.35	.24
1970	3.93	.44	.35	5.08	3.01	.42	1.31	.74	.34	.23
1971	3.80	.42	.40	4.96	2.96	.41	1.39	.75	.34	.24
1972	3.52	.42	.36	5.19	2.95	.41	1.45	.76	.34	.28
1973	3.20	.44	.39	4.80	2.83	.42	1.57	.80	.36	.32
1974	3.87	.48	.35	4.81	2.61	.40	1.55	.78	.35	.33
1975	3.58	.45	.30	4.43	2.86	.40	1.41	.77	.34	.32
1976	3.34	.50	.23	4.61	2.85	.40	1.46	.79	.35	.33
1977	2.75	.51	.25	5.00	2.88	.40	1.50	.80	.32	.36
1978	2.68	.60	.29	5.14	2.73	.38	1.28	.80	.32	.38
1979	2.74	.61	.28	5.16	2.76	.39	1.42	.84	.32	.40

* Estimates constructed using U.S. Department of Commerce, Bureau of Economic Analysis, data: Gross Product Originating in Current and Constant (1972) Dollars, 1958-79 and Detail Components of Annual Personal Income, U.S. and Oregon, 1958-79.

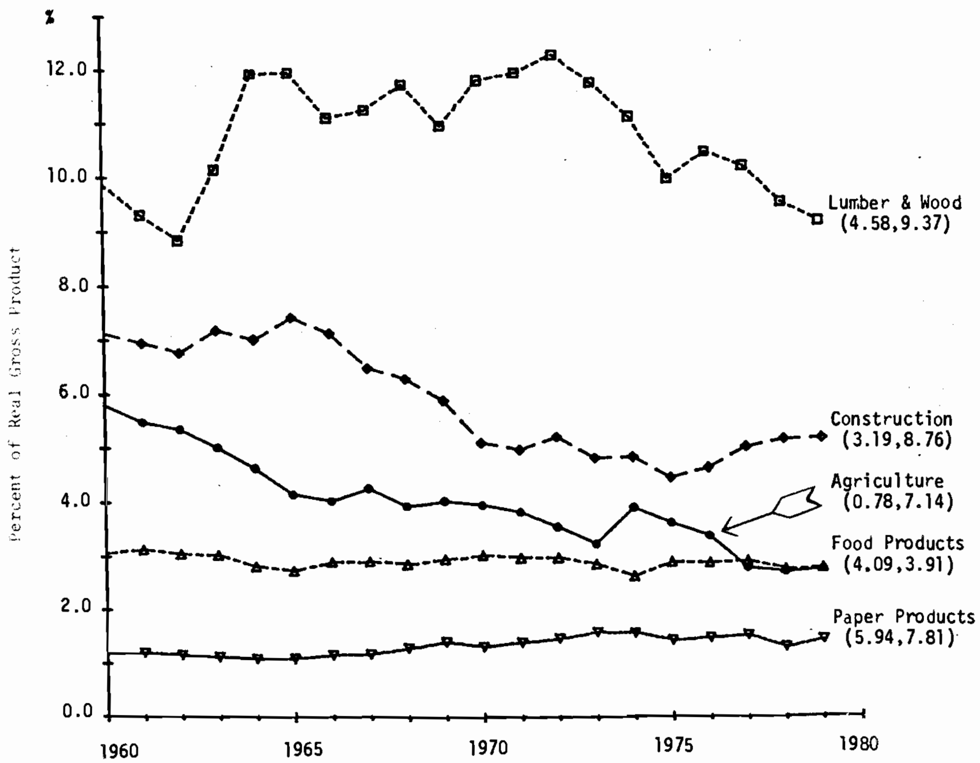
Table 2. (Continued)

Year	Lumber & Wood Products	Furniture & Fixtures	Primary Metals	Fabricated Metals	Machinery, Except Electrical	Electrical Machinery & Instruments	Transportation Equipment Less Motor Vehicles	Motor Vehicles & Equipment	Stone Clay Glass	Miscellaneous Manufacturing
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1960	9.87	.28	1.14	.92	.99	.65	.33	.25	.53	.16
1961	9.31	.27	1.09	.89	.95	.74	.40	.23	.52	.16
1962	8.85	.28	1.03	.88	1.00	.81	.43	.28	.53	.17
1963	10.14	.27	1.02	.93	1.02	.83	.49	.33	.58	.18
1964	11.92	.27	1.10	.95	1.10	.77	.56	.39	.56	.16
1965	11.94	.30	1.13	1.03	1.15	.96	.53	.50	.54	.16
1966	11.10	.31	1.24	1.11	1.29	1.18	.79	.56	.53	.16
1967	11.25	.27	1.23	1.17	1.24	1.20	.75	.49	.47	.18
1968	11.72	.30	1.19	1.18	1.28	1.25	.86	.58	.45	.18
1969	10.95	.33	1.23	1.26	1.49	1.4	.85	.68	.47	.19
1970	11.79	.28	1.15	1.14	1.43	1.34	.71	.47	.43	.19
1971	11.93	.29	1.07	1.05	1.33	1.26	.71	.62	.48	.20
1972	12.27	.33	1.04	1.10	1.37	1.41	.73	.72	.50	.21
1973	11.74	.32	1.21	1.16	1.54	1.61	.77	.74	.49	.20
1974	11.10	.27	1.31	1.10	1.51	1.69	.77	.72	.43	.18
1975	9.95	.25	1.20	1.04	1.49	1.65	.64	.51	.40	.19
1976	10.44	.25	1.07	1.07	1.42	1.71	.62	.64	.46	.19
1977	10.18	.24	1.08	1.17	1.55	1.83	.48	.80	.44	.20
1978	9.52	.23	1.08	1.22	1.62	2.06	.57	.90	.47	.20
1979	9.18	.21	1.10	1.23	1.76	2.34	.53	.93	.50	.20

Table 2 (Continued)

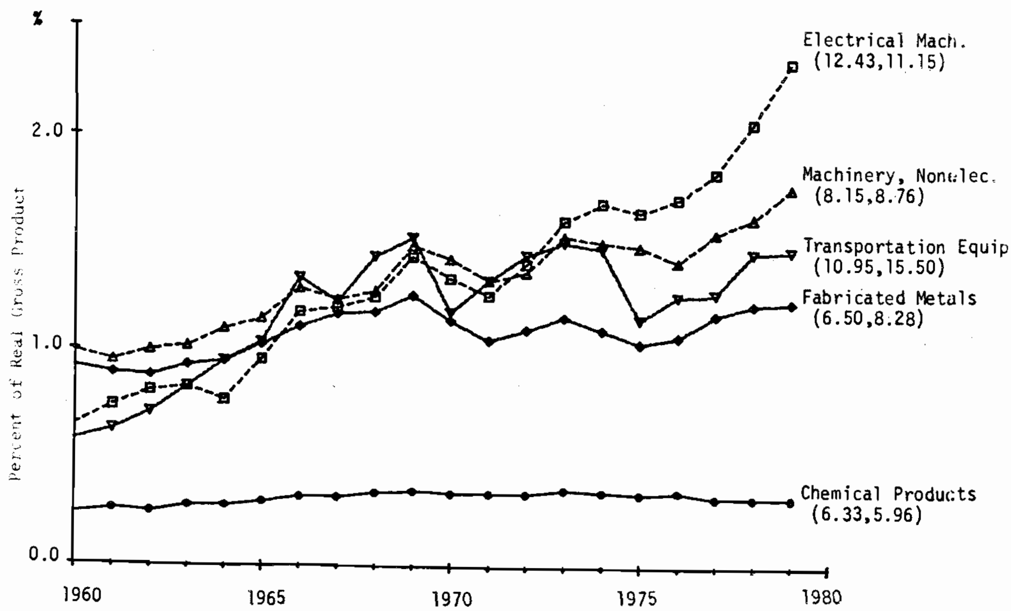
Year	Transportation	Communication	Other Utilities	Wholesale Trade	Retail Trade	Finance, Insurance & Realty	Business Services	Professional & Social Services	Federal Government	State & Local Government
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1960	5.04	1.86	2.25	6.54	12.06	11.87	4.10	6.54	5.35	9.56
1961	4.93	1.95	2.40	6.53	11.83	12.28	4.13	6.76	5.41	9.96
1962	4.99	2.00	2.50	6.61	12.09	12.88	4.04	6.63	5.34	9.77
1963	5.02	1.95	2.45	6.54	11.86	12.24	3.99	6.38	5.09	9.70
1964	4.97	1.91	2.47	6.65	11.67	11.91	3.92	6.37	4.81	9.34
1965	5.10	1.96	2.42	6.79	11.49	12.20	3.80	6.23	4.50	9.20
1966	5.23	2.02	2.38	7.00	11.30	12.04	3.81	6.31	4.37	9.36
1967	5.03	2.10	2.43	7.10	11.02	12.32	3.79	6.60	4.55	9.37
1968	5.07	2.16	2.45	7.49	10.91	12.31	3.73	6.45	4.37	9.23
1969	4.96	2.25	2.52	7.79	10.66	12.48	3.69	6.63	4.11	9.26
1970	4.87	2.40	2.55	7.78	10.70	12.52	3.74	6.88	4.14	9.65
1971	4.60	2.49	2.65	7.89	11.02	12.58	3.79	6.77	3.89	9.73
1972	4.70	2.49	2.42	8.27	11.06	12.26	3.66	6.76	3.47	9.43
1973	4.96	2.60	2.42	8.48	11.38	12.13	3.69	6.87	3.26	9.32
1974	4.84	2.65	2.26	8.28	10.96	12.72	3.68	7.18	3.35	9.49
1975	4.52	2.94	2.43	8.31	11.56	13.24	3.76	7.51	3.39	10.15
1976	4.42	2.97	2.33	8.30	11.65	13.43	3.74	7.42	3.14	9.88
1977	4.36	3.05	2.28	8.17	11.81	14.21	3.80	7.35	2.99	9.25
1978	4.33	3.26	2.18	8.33	11.77	14.64	3.84	7.44	2.92	8.82
1979	4.26	3.49	2.16	8.16	11.67	14.77	3.99	7.16	2.84	8.60

Figure 4. Trends in Industry Shares of Real Gross State Product: Oregon 1960-79 Selected Agriculture, Wood Products, and Construction Sectors.



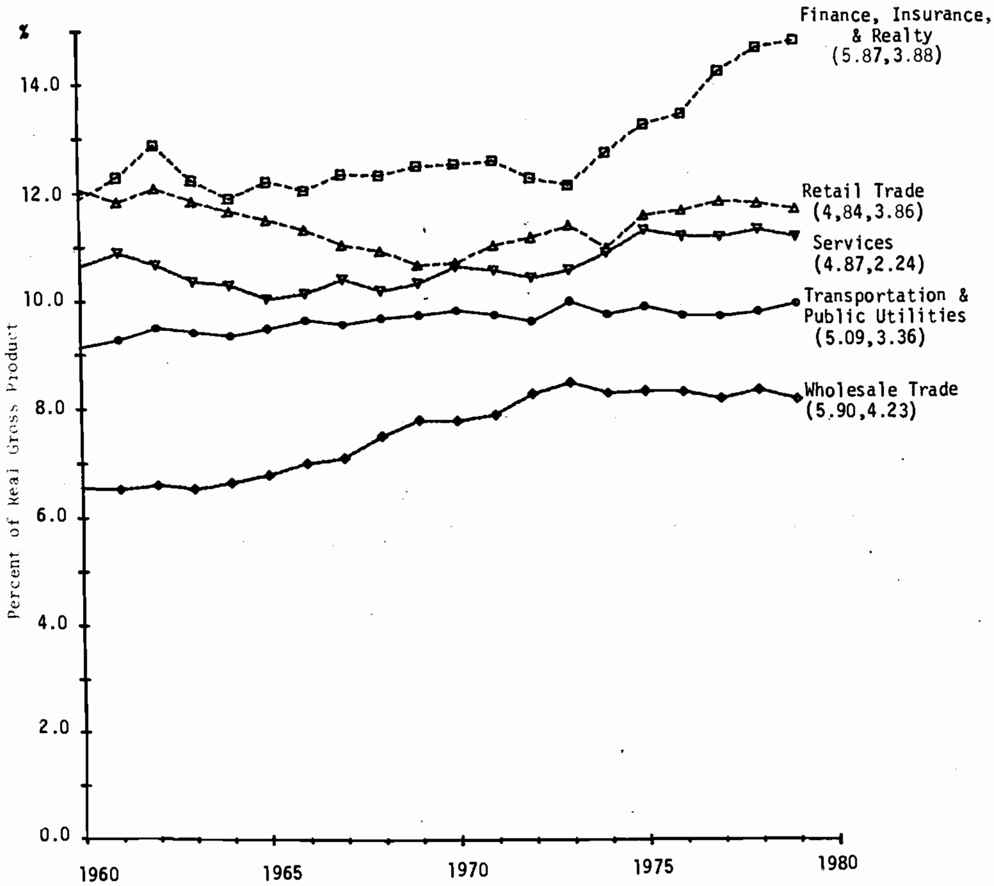
Note: Numbers in parentheses are average annual growth rate of real gross product and standard deviation of growth rate, respectively, for each sector.

Figure 5. Trends in Industry Shares of Real Gross State Product, Oregon, 1960-79, Selected Manufacturing Industries.



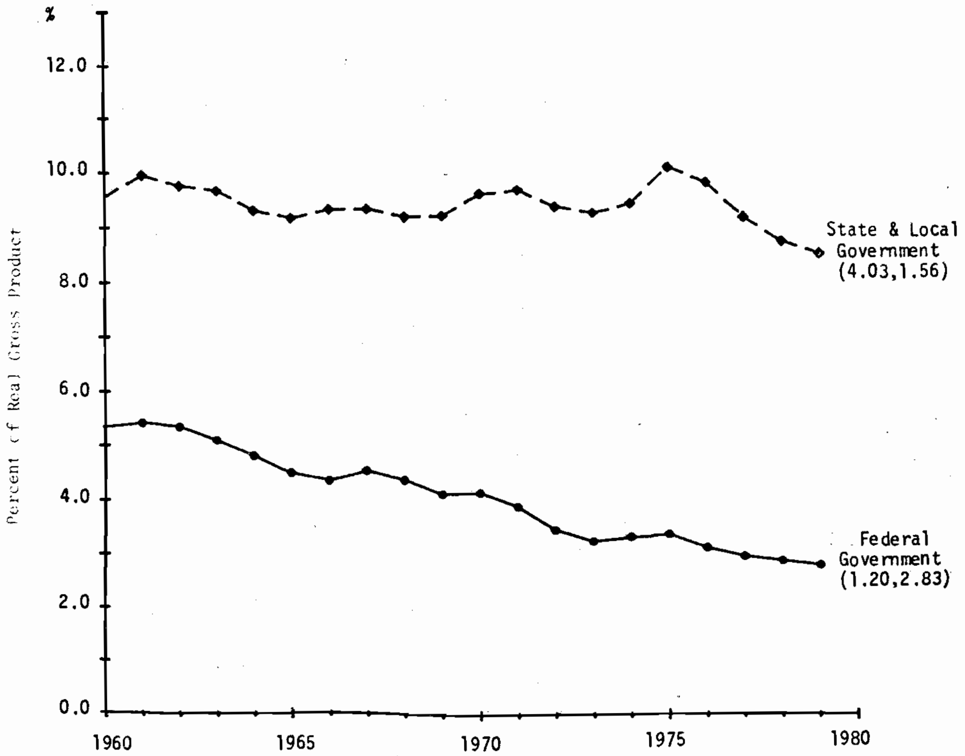
Note: Numbers in parentheses are average annual growth rate of real gross product and standard deviation of growth rate, respectively, for each sector.

Figure 6. Trends in Industry Shares of Real Gross State Product:
Oregon, 1960-79
Selected Service Industries



Note: Numbers in parentheses are average annual growth rate of real gross product and standard deviation of growth rate, respectively, for each sector.

Figure 7. Trends in Industry Shares of Real Gross State Products
Oregon, 1960-79
Government Sectors



Note: Numbers in parentheses are average annual growth rate of real gross product and standard deviation of growth rate, respectively, for each sector.

this sector produced between 9 percent and 10 percent of total product. During the middle years, the sector's share increased to 12 percent. The sector, however, shows a highly volatile cyclical pattern. The standard deviation for the annual percentage growth of lumber and wood products, an index of cyclical instability, was 9.37 percent.

Contract construction also was responsible for a major share of the state's output. This sector's share declined from 7 to 5 percent over the 20-year period. The 8.76 percent measure of the index of cyclical instability reveals the volatility of this industry's growth performance.

Agriculture, with the lowest average annual percentage growth of the 30 sectors, was responsible for an important, though declining share of gross state product. Agriculture's percentage share declined from slightly less than 6 percent in 1960 to 2.74 in 1979.

The index of instability of 3.91 percent for food and kindred products portrays the very stable growth performance that is generally assumed for this industry. Beginning at about 3 percent, this industry's percentage share declined by about 0.25 percent during the period. The paper products industry, whose average growth was the highest of the industries represented in Figure 4, slightly increased its percentage share from 1.18 percent in 1960 to 1.42 percent in 1979.

The manufacturing industries whose percentage contributions to the total gross product of the state are depicted in Figure 5 were among the fastest growing sectors in the state during this period. ("Transportation equipment" includes both the motor vehicle and the nonmotor vehicle equipment industries identified separately in earlier tables.) Several generalizations may be drawn from this figure. Given the relatively minor importance of these industries at the outset of the decades, their subsequent high rate of growth contributed to the industrial diversification of the state economy over the 20-year period. But, because of the highly cyclical behavior of these industries as gauged by the indices of instability, their growth may have served to increase, rather than to reduce, the vulnerability of the state to cyclical instability.

The change in the percentage share of Oregon's total gross product for the major tertiary industries is presented in Figure 6. Two of the industry categories presented in Figure 6 represent an aggregation of some of the industries classified in the tables presented previously. Included under the category of services are the business services and the professional and social services industries. Included under public utilities are the industries previously classified as communications and as other utilities. To compare the beginning and the end points of the period, only the percentage share of the retail trade industry shows decline. There is considerable evidence that the increasing relative importance of tertiary economic activity has accompanied the historical growth not only of the United States and most of its subregions but also of most other nations. Certainly, such a trend for Oregon is revealed in this graph. Given the initial importance of these industries for the period, this trend, in and of itself, would contribute to further industry concentration rather than industry diversification of economic activity. However, because the cyclical volatility of these industries, as measured by their instability indices, was low in relation to the faster growing sectors, the trend toward concentration in the tertiary sectors may have served to reduce, rather than to increase, the susceptibility of the state to cyclical fluctuation.

The state and local government and the federal government percentage contribution to total gross state product is shown in Figure 7. The growth of both these sectors was highly stable as revealed by their stability indices. Although the composition and pattern of industry growth of the private sector are of principal concern, the role of the government sector should not be overlooked. The declining importance of the government sector lends to the diversification of the Oregon economy. However, given the stable performance of this sector, the consequence of this decline may have been to enhance the cyclical volatility of the state.

III. DIVERSIFICATION IN THE OREGON ECONOMY, 1960-79: AN ASSESSMENT

A review of trends in the growth of gross state product as it is apportioned among individual industries is important to understand the nature of the changes which occurred in the industry composition of economic activity in the Oregon economy. It is difficult if not impossible, however, to discern from this whether the overall net effect of these changes in industry composition is greater diversification or greater concentration of economic activity among industries. Different trends in different industries may either offset or complement one another in terms of the net impact on diversification. Several methods have been proposed and used to measure, compare, and analyze the degree of industry diversification of regional economies. Two of the methods widely used will be explained and applied to evaluate whether there was a trend toward industry diversification in the Oregon economy from 1960 to 1979.

The National Average and Entropy Measures of Diversification

The national average measure of diversification compares the distribution of economic activity among the industries of a region to the distribution existing for the nation. As it is applied to national and Oregon estimates of industry gross product, this measure is defined as:

$$\text{(1) National Average Measure} = \sum_{i=1}^{30} \frac{\left[\left(\frac{q_{is}}{q_s}\right) - \left(\frac{q_{in}}{q_n}\right)\right]^2}{\frac{q_{in}}{q_n}}$$

where q_i, (s,n) = gross product of industry i of state (s) or nation (n),

q_s = total gross product of state,

q_n = total gross product of nation.

In effect, this measure of diversification is merely one means of comparing two distributions, i.e., the regional industry distribution of economic activity versus the national industry distribution of economic activity. If the regional industry distribution of economic activity were exactly the same as the national, the value yielded by this measure would be zero, since $\frac{q_{is}}{q_s} - \frac{q_{in}}{q_n} = 0$ for all i's. Should this indeed be the case, then definitionally, according to this measure, the region would be described as completely diversified. On the other hand, the extent to which the two distributions may differ, according to the numerical magnitude produced from applying equation 1, describes the extent to which the region may be defined as less diversified.

The results obtained from applying the national average measure to national and state industry gross product data are presented in Table 3. According to this measure, there is no evidence of a discernible trend toward the industry distribution of economic activity of Oregon becoming more closely in balance with the national distribution until about the mid 1970s. However, the industry distribution of national economic activity was also subject to trended changes over the two decades. To the extent that Oregon and national trends were the same, therefore, the "national average" measure of diversification for Oregon would not change. Changes in the "national average" index since 1972 suggest that Oregon has become more diversified (more like the nation) since that time.

The entropy measure of diversification compares the industry distribution of economic activity of a region against a rectangular (equiproportional) distribution. In a rectangular distribution, economic activity is equally disbursed among all industries. As it is applied to the Oregon estimates of industry gross product, the entropy measure is defined as:

Table 3. Measures of Regional Industrial Diversification Applied to Constructed Estimates for Oregon Gross State Product, 1960-79.

Year	Entropy[1]	National Average[2]
1960	2.825	1.418
1961	2.827+	1.356+
1962	2.830+	1.298+
1963	2.836+	1.421-
1964	2.831-	1.668-
1965	2.836+	1.587+
1966	2.863+	1.476+
1967	2.859-	1.491-
1968	2.860+	1.595-
1969	2.880+	1.442+
1970	2.855-	1.564-
1971	2.852-	1.616-
1972	2.856+	1.648-
1973	2.870+	1.556+
1974	2.868-	1.395+
1975	2.850-	1.224+
1976	2.846-	1.280-
1977	2.846NC	1.229+
1978	2.855+	1.097+
1979	2.867+	1.021+

1. Entropy Measure $= -\sum_{i=1}^{30} \left(\frac{q_{is}}{q_s}\right) \ln \left(\frac{q_{is}}{q_s}\right)$

2. National Average Measure $= \sum_{i=1}^{30} \frac{\left[\left(\frac{q_{is}}{q_s}\right) - \left(\frac{q_{in}}{q_n}\right)\right]^2}{\frac{q_{in}}{q_n}}$

where: $q_{i(s,n)}$ = gross product of industry i of state (s) or nation (n).

q_s = total gross product of state.

q_n = total gross product of nation.

\+ indicates the Oregon economy became more diversified relative to immediately preceding year.

\- indicates the Oregon economy became less diversified relative to the immediately preceding year.

NC indicates no change in diversification index relative to immediately preceding year.

(2) Entropy Measure $= -\sum_{i=1}^{30} \left(\frac{q_{is}}{q_s}\right) \ln \left(\frac{q_{is}}{q_s}\right)$,

where q_{is} = gross product of industry i of state (s),

q_s = total gross product of state

To illustrate one property of this measure, consider a hypothetical extreme where the economic activity of a region is concentrated in only one industry and is shared by no other. In such a case, where industry diversification is totally absent, the entropy measure would yield a value of ln 1 or zero. To consider the opposite extreme, should the region be totally diversified in the sense that all industries contribute equally to the region's gross product, that is

$$\frac{q_{is}}{q_s} = \frac{1}{30} \text{ then } -\Sigma \frac{q_{is}}{q_s} \ln \frac{q_{is}}{q_s} = - 30\left(\frac{1}{30}\right) \ln \frac{1}{30} = \ln 30 = 3.401.$$

Therefore, the higher the numerical value produced by the entropy measure, the greater the industry diversification of the economy. The results obtained from applying this measure to the constructed industry estimates for gross state product over the period 1960-79 are also portrayed in Table 3. There is some evidence in these results of a slight trend toward greater industry diversification in the Oregon economy.

The entropy measure is a more flexible and analytically powerful measure of industry diversification than the national average measure. For example, the rectangular distribution used as the comparative norm with the entropy measure, which assumes an equal distribution of economic activity among all industries, is both more objective and conceptually consistent with the intuitive notion of diversification as the absence of concentration. The national average measure will distinguish whether the regional industry distribution of economic activity is more or less diversified than the national distribution. However, the national average measure will not distinguish whether the industry distribution within the region itself has become more or less diversified over time. Because the rectangular distribution is a comparative norm that is fixed, the entropy measure will accomplish both of these ends.

It should be emphasized that both entropy and the national average measure are only definitional formulations, and their application does not implicitly suggest any normative prescriptions. Use of the entropy measure, for example, does not suggest that the regional industry distribution of economic activity should be equally distributed across all industries any more than it should be concentrated within a single industry. The entropy measure merely provides definition to a scale that gives reference between these two extremes. Similarly, the national average measure does not prescribe that the regional industry distribution should approximate the national; it merely defines the national distribution as a point of reference.

Another property of the entropy measure which renders it analytically more useful than the national average measure is the manner in which it can be decomposed so various patterns of interindustry diversification within a region over time may be examined. The entropy measure, as it is formulated in equation (2) to express the extent of diversification between all industries, also can be disaggregated to express the extent and pattern of diversification between and within different groups or subsets of industries. Consider, for example, combining the 30 industries ($i = 1, 2, \ldots 30$) into two separate groups or sets $S_g (i \in S_g, g = 1, 2)$. S_1 is defined as manufacturing ($i = 5, 6, \ldots, 20$) and S_2 as nonmanufacturing ($i = 1, 2, 3, 4, 21, 22, \ldots, 30$). The gross product apportioned to set S_g can be expressed as:

(3) $$q_g = \sum_{i \in S_g} q_i ,$$

and each set's relative share of the total may therefore be represented by $\frac{q_g}{q_s}$. The entropy measure of diversification <u>within</u> each of the two sets may be expressed as:

(4) $$h_g = -\sum_{i \in S_g} \left(\frac{q_i}{q_g}\right) \ln \left(\frac{q_i}{q_g}\right) .$$

A summation or total measure of diversification <u>within</u> the sets can be obtained by weighting the entropy measure for each set derived from equation (4) by their respective relative share:

(5) $$h_G = -\sum_{g=1}^{2} \frac{q_g}{q_s} \left[-\sum_{i \in S_g} \left(\frac{q_i}{q_g}\right) \ln \left(\frac{q_i}{q_g}\right)\right] .$$

The extent of diversification <u>between</u> the two sets may be measured by:

(6) $$h_0 = -\sum_{g=1}^{2} \frac{q_g}{q_s} \ln \left(\frac{q_g}{q_s}\right) .$$

Adding equations (5) and (6) yields the entropy measure of industry diversification for the entire economy:

(7) $$h = -\sum_{g=1}^{2} \frac{q_g}{q_s} \ln \left(\frac{q_g}{q_s}\right) + \sum_{g=1}^{2} \frac{q_g}{q_s} \left[-\sum_{i \varepsilon S_g} \left(\frac{q_i}{q_g}\right) \ln \left(\frac{q_i}{q_g}\right)\right] .$$

This expression is merely a disaggregation of the entropy measure initially introduced with equation (2).

The results obtained from grouping the industry gross state product estimates into two sets, manufacturing and nonmanufacturing, and applying equation (7), are presented in Table 4. The annual percentage growth of total gross state product is presented in Column (2) of this table to provide a perspective of the economy's pattern of growth. The aggregated entropy measure of industry diversification initially presented in Table 4 is shown again in Column (3) of Table 5. The relation between this aggregated measure to the various disaggregated components presented in Columns (4) to (9) will be examined before giving an interpretation of the results.

The between-set component of the entropy measure of diversification produced from applying equation (6) is shown in Column (4). Because only two sets or industry groups are defined, manufacturing and nonmanufacturing, the between-set measure merely identifies the extent to which Oregon's gross product is distributed equally between the two sets. In 1960, the percentage contributions to total gross state product of manufacturing and nonmanufacturing were about 21 percent and 79 percent, respectively. The between-set entropy measure for that year, therefore, is

$$h_0 = -\sum_{g=1}^{2} \frac{g_g}{q_s} \ln \frac{g_g}{q_s} = -[0.21 \ln 0.21 + 0.79 \ln 0.79] \quad 0.5144.$$

During the 1960s and early 1970s, manufacturing's percentage share generally increased to about 26 percent in 1973, and in 1979 stood at about 24.1 percent. Because the manufacturing group's percentage share initially was considerably less than the comparative norm of 50 percent for complete diversification, any increase in this group's percentage share to some level less than 50 percent is interpreted as contributing toward greater diversification of the Oregon economy.

Table 4. A Disaggregated Entropy Measure of Industry Diversification Applied to Industry Estimates of Gross State Product, Oregon 1960-79

Year (1)	Annual % Total Gross State Product (2)	Total Entropy (3)	Between-Set Entropy (4)	Total Weighted Within-Set Entropy (5)	Weighted Within-Set Entropy Manufacturing (6)	Weighted Within-Set Entropy Nonmanufacturing (7)	Within-Set Entropy Manufacturing (8)	Within-Set Entropy Nonmanufacturing (9)
1960		2.8250	0.5144	2.3106	0.4084	1.9023	1.9458	2.4078
1961	1.139	2.8266	0.5077	2.3189	0.4064	1.9125	1.9796	2.4066
1962	5.527	2.8297	0.5019	2.3278	0.4068	1.9209	2.0230	2.4045
1963	6.631	2.8360	0.5227	2.3133	0.4278	1.8855	1.9743	2.4071
1964	7.791	2.8308	0.5442	2.2865	0.4623	1.8242	1.8855	1.9743
1965	8.149	2.8359	0.5486	2.2873	0.4549	1.8324	1.9125	2.4043
1966	4.700	2.8628	0.5513	2.3115	0.4825	1.8290	2.0087	2.4072
1967	1.694	2.8587	0.5512	2.3075	0.4769	1.8305	1.9866	2.4089
1968	3.925	2.8599	0.5603	2.2996	0.4929	1.8067	1.9865	2.4029
1969	2.279	2.8793	0.5623	2.3171	0.5164	1.8007	2.0662	2.4007
1970	0.033	2.8545	0.5621	2.2924	0.4933	1.7991	1.9749	2.3981
1971	3.369	2.8519	0.5626	2.2893	0.4941	1.7951	1.9744	2.3944
1972	8.148	2.8557	0.5718	2.2839	0.5144	1.7695	1.9890	2.3872
1973	5.603	2.8699	0.5736	2.2962	0.5331	1.7631	2.0459	2.3844
1974	1.602	2.8683	0.5631	2.3052	0.5169	1.7883	2.0615	2.3867
1975	-1.492	2.8493	0.5443	2.3050	0.4878	1.8172	2.0827	2.3730
1976	8.098	2.8458	0.5516	2.2941	0.4975	1.7966	2.0687	2.3655
1977	8.845	2.8459	0.5537	2.2922	0.5074	1.7848	2.0942	2.3555
1978	8.041	2.8546	0.5484	2.3062	0.5092	1.7971	2.1421	2.3574
1979	4.052	2.8670	0.5522	2.3148	0.5235	1.7913	2.1721	2.3601

A trend towards greater between-set diversification should not necessarily be identified with a trend toward greater industry diversification in the economy overall. If, for example, there should exist a trend towards greater concentration within the manufacturing group, then the consequence of increasing between-set diversification toward manufacturing and away from nonmanufacturing may be greater concentration and less diversification in the total economy. This example highlights the importance of examining the within-set measures of diversification not only for what they may portray in themselves, but also for the perspective they may lend to interpreting structural changes occurring within the entire economy as may be revealed by trends in the between-set measure. The within-set entropy measures for the manufacturing and non-manufacturing groups resulting from the application of equation (4) are presented in Columns (8) and (9) respectively. These results merely represent the application of the entropy measure of diversification to two industry groups treated independently. There is some evidence in Column (9) of a trend toward increasing industry concentration within the nonmanufacturing set. Within the manufacturing set there is no trend apparent until 1970 after which the evidence suggests some tendency toward greater diversification.

The relative importance of each of the two industry groups determines the contribution of their diversification to the degree of industry diversification within the total economy. The weighted within-set entropy measures of diversification for the two groups appearing in Columns (6) and (7) is a reflection of each group's contribution to the degree of industry diversification within the total economy. In 1960, for example, the manufacturing set's relative share was about 21 percent. The product of this share multiplied by the within-set entropy measure of Column (8), (i.e., (0.21) (1.9458) = 0.4084), yields the weighted within-set entropy measure for the manufacturing set. In applying equation (5), the weighted within-set measures for both groups are summed to yield the total weighted within-set entropy measure shown in Column (5). The total weighted within-set measure may be added to the between-set measure to yield the total entropy measure represented in Column (3) and as formulated by equation (7). It is interesting to note there is no evidence of any discernible trend revealed by the total within-set entropy measure, but an examination of its components suggests some trend toward greater diversification within manufacturing which is offset by a countervailing trend toward concentration within the nonmanufacturing set. It must be acknowledged that any trends suggested in this discussion are certainly not unequivocal and unambiguous. However, the results presented illustrate the manner in which the entropy measure can be decomposed to allow for identification of some important interindustry diversification patterns and structural changes that may not be at all apparent merely from examining the single-unit total entropy measure of diversification.

IV. THE INDUSTRY ORIGINS OF CYCLICAL INSTABILITY IN THE OREGON ECONOMY, 1960-79: AN INITIAL LOOK

When the pattern of growth of Oregon's total estimated real gross product was earlier examined and compared to the growth of the real gross product of the nation from 1960 to 1979, (Figure 3), it was noted that Oregon's aggregate economic growth was generally higher and more cyclically volatile than that of the nation. Because aggregate growth is merely a weighted average of the growth of individual industries, changes in the industry composition and the growth trends of individual industries were examined as part of the anatomy of Oregon's aggregate growth. Since the cyclical variation of Oregon's aggregate growth is, in one sense, also a weighted average of the cyclical variations of individual industries, the cyclical volatility of individual industries must be examined in any attempt to understand overall cyclical variations in Oregon's economy.

An index of the cyclical volatility or instability of an industry should portray the extent of variation in industry growth around some long-run trend. The standard deviation of the annual rate of industry growth was selected to serve as an instability index for the industries of the Oregon economy. This measure implies that the average annual growth rates for the 1961-79 period are used as estimates for the long-run growth trend of each industry. These estimates of industry growth trends were presented in Table 1. The degree of variation around the industry growth trends as measured by the standard deviation is presented as indices of industry instability in Table 5. Table 5 also has an ordinal ranking of the industries to correspond with the relative magnitude of their instability indices. It is interesting to note that seven of the ten most unstable industries are classified within the durable manufacturing sector. The highly unstable performance of the mining industry relates to the instability of contract construction. Much of the activity within Oregon's mining industry is associated with the mining and quarrying of nonmetallic minerals used either directly or indirectly in construction related activities. Nine of the ten least unstable (or conversely most stable) industries are encompassed within the government and tertiary sectors. The nondurable manufacturing food and kindred products industry also exhibited a marked degree of stability.[3/]

[3/] Instead of techniques used in Table 5, other computationally more complex statistical techniques could have been employed to estimate industry instability indices. Although the standard deviation of growth rates serves the purpose for which it was intended in this investigation, consideration should also be given the application of other methods in future study. Because the time path of cyclical variations in economic activity may overlap the calendar year, the use of annual data to construct an industry instability index may tend to obscure differences in the degree of volatility between industries which may otherwise be captured better by using quarterly or monthly data. Despite this, there are notable differences in the magnitude of the instability index between industries in Table 5 even with use of annual data.

Table 5. Index of Industry Instability in the Oregon Economy, 1960-79, and Relationship Between Growth and Instability.

Industry	Instability Index	(Rank)	High Third	Middle Third	Low Third
1. Agriculture	7.15	(15)		I	G
2. Agricultural Services Forestry & Fisheries	9.31	(7)	I	G	
3. Mining	12.82	(3)	I		G
4. Contract Construction	8.76	(9)	I		G
5. Food & Kindred Products	3.91	(22)			G,I
6. Textile & Apparel	5.96	(18)		I	
7. Paper & Allied Products	7.80	(14)	G	I	
8. Printing & Publishing	4.96	(20)		G,I	
9. Chemical & Allied Products	5.96	(17)	G	I	
10. Petroleum, Rubber & Leather	8.41	(12)	G	I	
11. Lumber & Wood Products	9.37	(6)	I	G	
12. Furniture & Fixtures	10.58	(5)	I		G
13. Primary Metals	8.48	(11)		G,I	
14. Fabricated Metals	8.28	(13)	G	I	
15. Machinery, Nonelectrical	8.76	(10)	G,I		
16. Electrical Machinery & Instruments	11.15	(4)	G,I		
17. Transportation Equipment (excluding motor vehicles)	17.65	(2)	G,I		
18. Motor Vehicles & Equipment	21.52	(1)	G,I		
19. Stone, Clay, & Glass	9.30	(8)	I	G	
20. Miscellaneous Manufacturers	6.44	(16)	G	I	
21. Transportation	5.45	(19)		I	G
22. Communication	3.04	(26)	G		I
23. Other Utilities	3.52	(25)			G,I
24. Wholesale Trade	4.22	(21)		G	I
25. Retail Trade	3.86	(24)		G	I
26. Finance, Insurance, & Realty	3.88	(23)		G	I
27. Business Services	2.94	(27)		G	I
28. Professional & Social Services	2.57	(29)		G	I
29. Federal Government	2.82	(28)			G,I
30. State & Local Government	1.56	(30)			G,I
TOTAL GROSS STATE PRODUCT	3.16				

H = Highest Third of Industries Rank = 1-10
M = Middle Third of Industries Rank = 11-26
L = Lowest Third of Industries Rank = 21-30
I = Index of Instability places industry within this third.
G = Growth rate places industry within this third.

A major concern of this investigation is to give attention to the relation between the trends in industry growth and industry instability in the Oregon economy. It should be emphasized that at this juncture the purpose is not to advance or to test any hypotheses as to whether there exists a causal relation between industry growth and industry instability. Rather the purpose is only to assess whether in Oregon's historical experience there existed any empirical association between these phenomena.

To evaluate and assess the nature of the relation between industry growth and instability, several methods of analysis will be explored. As a point of departure, some very general inferences regarding the association between industry instability and industry growth can be made from an inspection of Table 5, comparing industry growth trends and instability indices. The rankings can be used to divide the industries into thirds with respect to both growth and instability. For 10 of the 30 industries, the rankings place them in the same third relative to both growth and instability. For example, four of the durable manufacturing industries show both high growth (in the top 10 ranked by growth rates) and high instability (in the top 10 ranked on instability): machinery, nonelectrical; electrical machinery and instruments; transportation equipment, and motor vehicle equipment. This evidence would suggest that while these four industries obviously contributed toward increasing the overall growth of the region, they also may have contributed to the instability of the Oregon economy over this period. Of the six other high growth industries, only the nonmanufacturing communications industry has an instability index which falls within the lowest third ranked on instability. While enhancing the economy's overall growth, the performance of this industry may have reduced the instability of the region.

Food and kindred products, other utilities, federal government, and state and local government show slow, steady growth; these sectors rank in the lowest 10 for both growth and instability. The low growth of these relatively stable industries, therefore, may have indirectly contributed to the instability of the overall economy. Only three industries with growth rates in the lowest third have instability indices included in the highest third. These industries include mining, contract construction, and furniture and fixtures. Because the growth rate of these three sectors fell below the overall average growth rate of the state, the relative contribution of these industries to the total economic activity of the state in general declined, which suggests that perhaps their contribution to the instability of the region also may have declined.

Because industry growth rates and instability indices are frequently paired rather than oppositely disposed within the high and low rank groupings of Table 5, this suggests that the association between industry growth and industry instability is a positive relation. To assess this association statistically, the industry instability indices (I) were regressed against their respective industry growth rates (G), the results of which appear in Table 6. Two regressions were performed. The first included observations for all thirty industries; the second only included

Table 6. OLS Regression Results: Relationship Between Industry Instability and Industry Growth in the Oregon Economy, 1960-79.

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1. All Industries (N=30)

$$I = 2.24623 + 0.90226\ G$$
$$\quad (1.4769) \quad (3.7404)$$

$R^2 = 0.333$, F = 13.991, SE = 3.686

2. Manufacturing Industries (N=16)

$$I = 2.33548 + 1.02603\ G$$
$$\quad (1.1412) \quad (3.7160)$$

$R^2 = 0.497$, F = 13.809, SE = 3.326

where: I = standard deviation of average annual growth rate

G = average annual industry growth rates

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observations for the sixteen manufacturing industries. The t statistics reported in parenthesis under the estimated parameters of each regression equation and the F statistics reported allow for the conclusion that at 0.5 percent level of significance, there is a positive linear relation between the instability in the rate of growth of industries (I) and their long-run growth trends over the period (G). Though there is little difference between the test statistics of the two equations, there are important differences in the descriptive measures of the association between the instability index and the rate of growth of industries. The differences in the coefficients of determination (R^2's) indicate that only one-third of the variation in the instability index between industries is associated with differences in their trended rate of growth when all industries are included in the test; whereas almost one-half of the variation is statistically accounted for when only manufacturing industries are included in the regression. It may also be noted that the estimated slope parameter (β_1) is higher in the second equation (β_1 = 1.02603) as compared to the first (β_1 = 0.90226). This suggests that for the manufacturing industries there is roughly a one-to-one correspondence in a unit change in the level of the instability index that may be associated with a unit change in the level of a trended rate of industry growth. When all industries are included in the test this correspondence is roughly only 0.9 to one.

In summary, the evidence presented in Tables 5 and 6 tends to support a conclusion that the relation between trends in industry growth and industry instability from 1960 to 1979 is positive. This, in turn, would suggest the pattern of industry growth has indeed contributed to further enhancing instability in the performance of the Oregon economy. This conclusion may be most applicable with regard to the manufacturing industries. In addition, evidence introduced earlier also suggested that there was a trend toward industry diversification in the Oregon economy. Again, this trend was most notable with respect to the manufacturing industries. Coupling earlier evidence with that just presented would lend support to the conclusion that, with respect particularly to manufacturing, the pattern of industry growth has led to changes in the industry composition of the Oregon economy which, in turn, have contributed to both greater diversification and greater instability.

It should be emphasized, however, that one critical factor in the analysis of industry instability has been ignored. To this point, only the degree of instability in the rate of growth of individual industries has been considered. To conclusively assess the extent to which the instability of an individual industry contributes to the instability of the entire economy requires that the patterns of covariation in the rate of growth of the individual industry with the rate of growth of all other industries in the economy are also accounted for and examined. The concepts and techniques of portfolio selection analysis commonly used in financial investment theory allow this covariation to be examined. In the following section of this paper, portfolio variance analyses will be applied to data on the Oregon economy in an attempt to get a more complete understanding of the relationship between structural change and instability in the economy.

V. STRUCTURAL CHANGE AND ECONOMIC INSTABILITY IN OREGON, 1960-79 A PORTFOLIO VARIANCE ANALYSIS

The development of portfolio selection analysis is associated with the work of Markowitz (1952, 1959) to provide techniques for transforming information concerning the performance of individual financial securities into conclusions regarding the characteristics of an entire investment portfolio comprising a combination of securities. Conroy (1975) was the first economist to employ techniques used in portfolio selection analysis for examining the relation between the industry structure of regions and the degree to which the growth of regions is vulnerable to instability. The focus of Conroy's study was on explaining the differences in the degree of instability between regions by differences in their industrial structure at a particular period in time. The objective of this section is to employ techniques used in portfolio selection analysis to examine the relation between changes in the industrial structure of a single region over time and the region's vulnerability to instability.

Application of Portfolio Variance to Regional Economic Analysis and an Extension

Conroy (1975) utilized portfolio variance as an aggregate measure of regional instability in a cross-sectional study that examines the relation between the instability of regions and their industry structure. In Conroy's view, "If each industry in an economy may be characterized as an individual community investment, then the set of industries which any given economy has acquired at a point in time may be considered a 'portfolio' of community investments among which some or all of the region's economic factor resources are distributed" (1975, p. 495). In this sense, the industry structure of a region may be portrayed as a community's industrial portfolio.

Following Conroy, a stream of returns can be expected of the investment or distribution of factor resources to individual industries in the form of employment, income, or product flows. These expected returns are treated as random variables whose variance may serve as a measure of instability or risk. As an expression for the weighted average of random returns, portfolio variance σ_p^2 serves as an aggregate measure of the instability that may be associated with the industrial structure of a region:

(8) $$\sigma_p^2 = \sum_{i=1}^{m} \sum_{j=1}^{m} w_i \, w_j \, \sigma_{ij}$$

where w_i and w_j are the employment, income, or output proportion of industries i and j; and σ_{ij} denotes the covariance of returns between industries i and j. Since gross product is generally viewed as a more comprehensive measure of economic activity than either income or employment, and since gross product is used in the empirical application of the portfolio variance analysis presented below, the discussion of the portfolio variance approach and the extension will be in terms of gross product. σ_p^2, the measure of industrial portfolio instability, incorporates not only a measure for the instability of individual industries; it also quantifies the comovement of each industry's gross product with those of other industries, offering a measure of an industry's interdependent contribution to the instability of a region. An industry whose individual variance is quite high may conceivably contribute less to the overall instability of the region (if its covariance with other industries is negative) than an industry of equal weight whose individual variance is low.

Denoting Q_{it} as the gross product of industry i in period t, the annual growth rate of gross product can be expressed as:

$$(9) \qquad q_{it} = \frac{Q_{it} - Q_{it-1}}{Q_{it}}$$

Invoking the assumption that the growth rate is a stochastic stream of returns drawn from some probability distribution, the mean, variance, and standard derivation can be described respectively as:

$$(10) \qquad \hat{\mu}_i = \frac{1}{n} \sum_{t=1}^{n} q_{it}$$

$$(11) \qquad \hat{\sigma}_i^2 = \frac{1}{n-1} \sum_{t=1}^{n} (q_{it} - \hat{\mu}_i)^2$$

$$(12) \qquad \hat{\sigma}_i = (\hat{\sigma}_i^2)^{1/2}$$

The standard deviation serves as a measure of the individual instability of a specific industry. The interdependence between industry i and industry j in terms of the comovement of their annual rates of growth is described by their covariance:

$$(13) \qquad \hat{\sigma}_{ij} = \frac{1}{n-2} \sum_{t=1}^{n} (q_{it} - \hat{\mu}_i)(q_{jt} - \hat{\mu}_j)$$

Along with the relative weights (w_i and w_j) determining each industry's proportionate contribution to total gross state product, the variance and covariance of the industries' rate of growth comprise the ingredients of the industry portfolio variance measure of aggregate regional instability as expressed in equation (12), or which may be disaggregated and expressed as:

$$(14) \qquad \sigma_p^2 = \sum_{j=1}^{m} w_j^2 \sigma_j^2 + \sum_{\substack{i=1 \\ (i\ j)}}^{m} \sum_{\substack{j=1 \\ (j\ i)}}^{m} w_i w_j \sigma_{ij}$$

The individual contribution of a <u>specific</u> industry j to the total industry portfolio variance can be defined as:

$$(15) \qquad \sigma_{p_j}^2 = w_j^2 \sigma_j^2 + \sum_{\substack{i=1 \\ (i\ j)}}^{m} w_i w_j \sigma_{ij}$$

where

$$(16) \qquad \sigma_p^2 = \sum_{j=1}^{m} \sigma_{p_j}^2$$

The measures for variance and covariance are, as noted, derived from the time-series distribution of the annual rates of industry growth. Should there exist differences in the annual rates of growth between industries (as is indeed the case for Oregon), then the relative industry weights may vary significantly over time. The results obtained from the industry portfolio variance computation, therefore, may be dramatically affected by the industry weights that are used.

For a given time period the weight for industry i can be expressed as:

$$(17) \qquad w_{it} = \frac{Q_{it}}{\sum_{i}^{m} Q_{it}}$$

Industry weights were determined for each time period. However, these weights were not determined from each industry's actual share of the gross state product; rather, they were derived from trended estimates of each industry's gross product based upon its individual average rate of growth $\hat{\mu}_i$ over the entire time period. Changes in industry weights estimated from long-run industry growth trends may identify important and fundamental changes in the industry composition and structure of the economy. For a given time period, the estimated industry weight can be expressed as:

$$(18) \qquad \hat{w}_{it} = \frac{\hat{Q}_{it}}{\sum_{i=1}^{m} \hat{Q}_{it}}$$

The geometric mean of each industry gross product series was derived for determining a trended mid-period (t=10) estimate of their gross product:

$$(19) \qquad \hat{Q}_{i10} = \sqrt[n]{\prod_{t=1}^{n} Q_{it}}$$

Using each industry's average rate of growth ($\hat{\mu}_i$) to compound forward and discount back from their mid period estimate, trended growth estimates of each industry's gross product were obtained for the other 18 periods in the time series, that is:

$$(20) \qquad \hat{Q}_{it} = Q_{i10} \, (1 + \hat{\mu}_i)^{t-10}$$

These industry gross product estimates were used to determine the estimated industry weights for each period identified in equation (19). In turn, the estimated industry weights were enlisted in the computation of a time series industry portfolio variance measure of regional instability of the following form:

$$(21) \qquad \hat{\sigma}^2_{pt} = \sum_{i=1}^{m} \sum_{j=1}^{m} \hat{w}_{it} \hat{w}_{jt} \sigma_{ij}$$

The contribution of individual industries to the total instability of the economy is measured by an individual industry portfolio variance measure:

$$(22) \qquad \hat{\sigma}^2_{pjt} = \hat{w}^2_{jt} \sigma^2_j + \sum_{\substack{i=1 \\ (i\ j)}}^{n} \hat{w}_{it} \hat{w}_{jt} \sigma_{ij}$$

Structural Change and Instability in the Oregon Economy, 1960-1979

In this section of the report, the portfolio variance approach and the extension described above will be applied to an analysis of the impact of structural changes in the sectoral composition of gross state product on the overall instability of the economy and on the changes in the contribution of selected sectors to that instability.

It was noted above that, during the 1960-1979 period, real gross product in Oregon grew at an annual average rate of 4.68 percent, and that there was considerable sectoral variation within this overall growth with respect to both sectoral growth rates and sectoral instability. Two sectors (Motor Vehicles and Equipment, and Electrical Machinery and Instruments) grew at rates in excess of 10 percent per year and one (agricultural) grew at less than 1 percent. The most rapidly growing sectors tended to be the more unstable sectors: three of the four fastest growing sectors (the two fast growing sectors named above plus Transportation Equipment - excluding Motor Vehicles) were also three of the four most unstable. Many slow growing sectors (most notably federal and state and local government) were also very stable. There were, of course, prominent exceptions to this. Furniture and Fixtures and Contract Construction were both slow growing and unstable; Communications was both rapidly growing and stable.

The measures of average annual growth (Table 1) and of the standard deviation of the growth rate (Table 5) provide indicators both of structural change in the sectoral composition of the Oregon economy and of sectoral instability. Because no account is taken of sectoral interdependence, however, these measures allow assessment of neither the contribution of individual sectors to overall instability, as our preliminary analysis suggests, nor the effect of changes in sectoral composition of output on overall instability.

The portfolio variance measure $\hat{\sigma}^2_{pt}$ defined in equation (21) provides a measure of overall instability in an economy that does take account of sectoral interrelationships. With this measure one can study the effect of secular trends in sectoral composition on the overall instability. The second column in Table 7 shows how the overall instability of real gross product in Oregon increased from 1961 to 1979 because of changes in the sectoral composition of output. The increase $\hat{\sigma}^2_{pt}$ from 7.05 to 9.24 implies that the sectors which grew faster than average (whose w increased) were those that were either unstable (high $\hat{\sigma}^2_j$) or procyclical with other sectors (positive σ_{ij}).

This increase in instability over the 1961-1979 period raises questions about which sectors contributed most to the increase. The remaining columns in Table 7 show the contribution of the 30 sectors to the overall $\hat{\sigma}^2_{pt}$ as measured by the industry portfolio variance measure $\hat{\sigma}^2_{pjt}$ defined in equation (22). This latter measure allows for the possibility that a relatively unstable sector (in terms of $\hat{\sigma}^2_j$) may through countercyclical relationships with other sectors contribute less to overall instability (have lower $\hat{\sigma}^2_{pjt}$) than a sector which is relatively more stable in terms of $\hat{\sigma}^2_j$.

The Lumber and Wood Products and Contract Construction sectors alone contributed almost one-third of the overall portfolio variance $\hat{\sigma}^2_{pt}$ in 1961. This proportion decreased during the 1960s and 1970s, although the two sectors were still contributing almost one-quarter of total $\hat{\sigma}^2_{pt}$ in 1979.

Two other points of interest emerge from Table 7. The first is that the rapidly growing and high technology industries (Chemical and Allied, Electrical Machinery and Instruments, Transportation Equipment and Motor

Table 7. Portfolio Variance Measures of Industry Real Gross Product Instability, Oregon, 1961-79

Year t	Overall Portfolio Variance σ^2_{pt}	Industry Portfolio Variances σ^2_{pjt}									
		Agriculture	Ag. Services Forestry & Fisheries	Mining	Contract Construction	Food & Kindred Products	Textile & Apparel Products	Paper & Allied Products	Printing & Publishing	Chemical & Allied Products	Petroleum Rubber & Leather
1961	7.5018	-.2582	.0801	.0794	1.2376	.0755	.0442	.1074	.0931	.0249	.0249
1962	7.1453	-.2507	.0811	.0797	1.2320	.0770	.0443	.1099	.0939	.0324	.0264
1963	7.2402	-.2432	.0821	.0800	1.2261	.0784	.0443	.1126	.0947	.0332	.0278
1964	7.3368	-.2358	.0832	.0803	1.2200	.0797	.0444	.1152	.0954	.0340	.0294
1965	7.4354	-.2284	.0842	.0805	1.2136	.0810	.0445	.1180	.0962	.0348	.0310
1966	7.5363	-.2212	.0852	.0808	1.2070	.0823	.0445	.1207	.0969	.0356	.0328
1967	7.6398	-.2140	.0862	.0810	1.2003	.0835	.0445	.1264	.0982	.0373	.0365
1968	7.7462	-.2070	.0872	.0812	1.1933	.0847	.0445	.1294	.0989	.0382	.0385
1969	7.8559	-.2000	.0882	.0814	1.1862	.0859	.0445	.1294	.0989	.0382	.0385
1970	7.9693	-.1932	.0893	.0815	1.1789	.0870	.0444	.1324	.0995	.0391	.0406
1971	8.0869	-.1865	.0903	.0817	1.1716	.0880	.0444	.1355	.1001	.0400	.0428
1972	8.2091	-.1799	.0913	.0818	1.1641	.0891	.0443	.1386	.1008	.0409	.0451
1973	8.3363	-.1734	.0924	.0820	1.1565	.0901	.0443	.1418	.1014	.0419	.0476
1974	8.4692	-.1671	.0935	.0821	1.1489	.0911	.0442	.1452	.1019	.0429	.0502
1975	8.6082	-1609	.0945	.0822	1.1413	.0920	.0441	.1486	.1025	.0438	.0529
1976	8.7539	-.1548	.0956	.0823	1.1336	.0930	.0440	.1521	.1031	.0448	.0558
1977	8.9071	-.1489	.0967	.0825	1.1259	.0939	.0439	.1557	.1036	.0459	.0588
1978	9.0683	-.1431	.0978	.0826	1.1183	.0947	.0437	.1595	.1042	.0469	.0620
1979	9.2382	-.1374	.0989	.0827	1.1107	.0956	.0436	.1633	.1047	.0480	.0653

Table 7. (Continued)

Year t	Overall Portfolio Variance σ^2_{pt}	Industry Portfolio Variances σ^2_{pjt}: Lumber & Wood Products	Furniture & Fixtures	Primary Metals	Fabricated Metals	Machinery, Except Electrical	Electrical Machinery & Instruments	Transportation Equipment Less Motor Vehicles	Motor Vehicles & Equipment	Stone Clay Glass	Miscellaneous Manufacturing
1961		1.0708	.0590	.1420	.1875	.1522	.1141	.0775	.1297	.0918	.0140
1962		1.0752	.0591	.1431	.1923	.1588	.1236	.0809	.1425	.0924	.0144
1963		1.0793	.0592	.1441	.1972	.1656	.1337	.0843	.1564	.0931	.0147
1964		1.0829	.0593	.1452	.2022	.1727	.1447	.0880	.1717	.0937	.0151
1965		1.0862	.0593	.1463	.2072	.1801	.1566	.0917	.1884	.0943	.0155
1966		1.0891	.0593	.1474	.2124	.1877	.1694	.0957	.2066	.0949	.0158
1967		1.0917	.0594	.1485	.2176	.1956	.1832	.0998	.2265	.0955	.0162
1968		1.0939	.0594	.1496	.2229	.2039	.1981	.1041	.2482	.0961	.0165
1969		1.0958	.0594	.1507	.2284	.2125	.2142	.1086	.2719	.0966	.0169
1970		1.0974	.0594	.1518	.2339	.2214	.2315	.1133	.2978	.0977	.0971
1971		1.0987	.0594	.1529	.2395	.2306	.2502	.1182	.3260	.0977	.0176
1972		1.0998	.0593	.1540	.2543	.2402	.2704	.1234	.3567	.0982	.0180
1973		1.1006	.0593	.1563	.2571	.2607	.3157	.1344	.4267	.0992	.0188
1974		1.1011	.0593	.1563	.2571	.2607	.3157	.1344	.4267	.0992	.0188
1975		1.1014	.0592	.1575	.2632	.2715	.3411	.1404	.4664	.0997	.0192
1976		1.1015	.0592	.1587	.2695	.2828	.3685	.1466	.5096	.1002	.0196
1977		1.1015	.0591	.1599	.2759	.2946	.3980	.1532	.5566	.1007	.0200
1978		1.1013	.0591	.1611	.2824	.3069	.4299	.1601	.6076	.1012	.0204
1979		1.1009	.0590	.1624	.2891	.3197	.4642	.1673	.6632	.1017	.0208

Table 7. (Continued)

Year t	Overall Portfolio Variance σ^2_{pt}	Industry Portfolio Variances σ^2_{pjt}									
		Transportation	Communication	Other Utilities	Wholesale Trade	Retail Trade	Finance Insurance & Realty	Business Services	Professional & Social Services	Federal Government	State & Local Government
1961		.6744	.0584	.0227	.6443	.8763	.6795	.2499	.2322	.0235	.0365
1962		.6750	.0611	.0238	.6575	.8838	.6909	.2513	.2347	.0220	.0370
1963		.6755	.0640	.0248	.6709	.8911	.7204	.2526	.2371	.0205	.0376
1964		.6758	.0669	.0258	.6844	.8980	.7141	.2539	.2395	.0191	.0380
1965		.6760	.0700	.0268	.6979	.9047	.7259	.2552	.2419	.0177	.0385
1966		.6760	.0731	.0278	.7116	.9110	.7379	.2564	.2442	.0165	.0389
1967		.6759	.0764	.0287	.7254	.9171	.7500	.2575	.2466	.0153	.0393
1968		.6757	.0798	.0296	.7393	.9230	.7624	.2585	.2488	.0142	.0397
1969		.6754	.0834	.0305	.7534	.9286	.7749	.2596	.2511	.0131	.0401
1970		.6750	.0871	.0314	.7676	.9340	.7876	.2605	.2534	.0121	.0404
1971		.6745	.0909	.0323	.7819	.9391	.8006	.2614	.2556	.0112	.0407
1972		.6739	.0949	.0331	.7965	.9440	.8138	.2623	.2577	.0103	.0410
1973		.6732	.0990	.0339	.8112	.9487	.8273	.2631	.2599	.0094	.0412
1974		.6725	.1033	.0347	.8262	.9532	.8411	.2639	.2620	.0086	.0415
1975		.6718	.1078	.0354	.8413	.9576	.8552	.2647	.2641	.0079	.0417
1976		.6709	.1124	.0362	.8567	.9617	.8697	.2654	.2662	.0071	.0420
1977		.6701	.1172	.0369	.8724	.9657	.8845	.2661	.2682	.0064	.0422
1978		.6692	.1222	.0376	.8883	.9696	.8998	.2667	.2702	.0058	.0424
1979		.6683	.1274	.0383	.9045	.9733	.9154	.2674	.2721	.0051	.0426

Vehicles and Equipment) had rapidly increasing $\hat{\sigma}^2_{pjt}$ and, in fact, increased their proportionate contribution to overall instability over the two decades.

The other interesting item is that agriculture, the slowest growing sector in the Oregon economy, is the only sector in Table 7 and indeed of the 30 sectors in the economy whose $\hat{\sigma}^2_{pjt}$ is negative. Even though $\hat{\sigma}^2_j$ for agriculture is higher than the state average, the agricultural sector was a stabilizing force in the Oregon economy during this period because of countercyclical relationships with other sectors.

VI. CONCLUSIONS AND IMPLICATIONS

The report was developed in the context of discussion about economic policy options and goals in Oregon. Over the decades of the 1960s and 1970s, Oregon's economy grew faster than the United States economy and became more diversified both absolutely and relative to the nation. The state's economy, however, was also more cyclically unstable than that of the nation, and over the course of the two decades the structure of the economy changed in such a way as to make it more prone to cyclical instability. This instability and the major downturn in the early 1980s had led to a call for serious effort at diversification of the state's economy.

This report began as an attempt to understand the relationship between economic diversification and economic instability in Oregon. The literature in regional economics led us to look not only to diversification but also to the overall growth in the economy as factors explaining instability. The inadequacy of the most commonly used measures of diversification and the assumption that the behavior of the aggregate could best be understood by looking at the behavior of its individual parts led us to an examination of the growth and instability of individual sectors in Oregon during the 1960s and 1970s. Our analysis finally led us to examine not only the growth and instability of individual sectors but also covariance between growth in the individual sectors. We conclude from this analysis that the structure of the Oregon economy changed over the two decades in a way which generated not only high growth but also the potential for greater instability.

Implications

The extensions of the portfolio variance measure presented above, which allow for assessment of the impact of structural change on overall economic instability, open the door for some very interesting future research.

State development policy is often built on the assumption that greater diversification leads to greater economic stability. The Oregon Economic Growth Plan, for example, is designed to reduce Oregon's historical instability "through diversification of industry" (Oregon Economic Development Department, 1982, p. 1). The hypothesis that diversification reduces instability can now be tested with more appropriate time series data rather than with the cross-sectional data of previous attempts (Conroy, 1975; St. Louis, 1980; Kort, 1981). Furthermore, the decomposition properties of the portfolio variance measure identified in equations (14) to (16) permit the development and testing of hypotheses about the factors associated with an individual sector's contribution to overall economic instability.

At a more practical level, the extensions described above allow economists to analyze the effect on overall economic stability of different growth alternatives. The effect on stability of a high technology-oriented growth scenario, for example, could be compared with the effects of a natural-resource based growth scenario. A comparison of growth rates and portfolio variances from the two alternatives could be used to evaluate tradeoffs between growth and stability for different alternatives. This would be extremely helpful to policy-makers involved in designing strategies and programs for economic development.

Even without further research, however, the results presented in this report give a clear indication that tradeoffs do exist and, more importantly, that the sectoral composition of growth in Oregon over the last two decades emphasizing high-technology and machinery and instruments manufacture has tended to make the economy more unstable. It further suggests that current state industrial promotion efforts aimed at recruiting high-technology firms have the potential of increasing Oregon's instability.

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