Categorizing State Economies and Forecasting Differential Economic Growth Rates

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There is wide variation among states in economic recovery since the recession of the early 1980s. Between 1980 and 1988 the compound annual rate of growth in disposable personal income per capita ranged from a low of 2.71 percent for Wyoming to a high of 9.05 percent for New Hampshire. It is widely believed states with lagging rates of growth in personal income have been those with economies that are heavily dependent on either agriculture or energy (Knutson and Fisher; Debertin). Past efforts to explain interregional differences in economic growth have usually been based on dividing the U.S. into regions consisting of states geographically near each other (Farrell and Hall). Often states that border each other possess quite different economies. For example, the California economy has little in common with the Oregon economy. The Kentucky economy in many ways is quite different from that of Tennessee. We will show that both the makeup of the economy within a state and its geographic location influence economic growth.

In this paper we determine the extent to which information about the comparative importance of major sectors of a state's economy can improve the ability to forecast compound annual growth rates in personal income. We first calculate compound growth rates in disposable personal income per capita for the time period 1980 to 1988. We then investigate the extent to which heterogeneity exists in the economies of states that have traditionally been grouped into the same geographic region. The hypothesis is that many states' economies are unlike the economies of other states within a geographic region. We develop two different categorizations for states. The first categorization is solely based on the comparative economic importance of major sector. The second categorization is a modification of Census regions incorporating certain information about the type of economy. We use information

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about each state's economy as well as information about each state's geographic location to develop a series of regression equations for forecasting compound growth rates in disposable personal income per capita for the time period 1908 to 1988 and provide forecasts from these equations.

Calculating Growth Rates in Personal Income

The measure of income used was the Department of Commerce estimate of disposable personal income per capita. Estimates of the compound annual change for the 1980-1988 time period were made using the equation

$$CINC_{1988} = (1+r)^8 \cdot CINC_{1980}$$

Since r is unknown

$$(1+r)^8 = \frac{CINC_{1988}}{CINC_{1980}}$$

$$r = \left[\frac{CINC_{1988}}{CINC_{1980}}\right]^{\frac{1}{8}} - 1$$

where r is the compound annual growth rate in disposable personal income per capita, $CINC_{1988}$ is the 1988 and $CINC_{1980}$ is the 1980 per capita disposable personal income for the state. Estimates of Per Capita Disposable Personal Income were obtained from the U.S. Bureau of Economic Analysis Survey of Current Business, various August issues, as summarized in Table 704 of the 1990 Statistical Abstract of the United States. The year 1980 was chosen as the starting point because it marked the beginning of the recession.

Table 1 summarizes compound annual growth rates over the period for the 50 states and provides rankings for each state. Several New England states top the ranking, while states at the bottom of the ranking appear to be those that are dependent on oil and coal. Figure 1 illustrates these data on a U.S. map.

Categorizing the States by Type of Economy

The next step was to categorize the economy of each state based on the importance of primary sectors as a percentage of Gross State Product (GSP). This portion of the analysis relies on Gross State Product estimates for 1986 contained in the Survey of Current Business data in an article by Renshaw, Trott, and Friedenberg. They made estimates of Gross State Product for each of the 50 states for 14 separate sectors[1] We wanted fewer than 14 categories, and eliminated some sectors that we deemed more nearly secondary than primary sources of income (such as trade and transportation sectors). Based on these data, we determined the economies of most states can be readily classified into one of five groups with little overlap: (1) Agriculturally-based; (2) Energy/Mining (primarily coal and oil)-based; (3) Manufacturing-based; (4) Finance- and Services-based; and (5) Diversified, in which none of the individual sectors dominates. For groups (1)-(4), each state is ranked with respect to the importance of that sector with respect to proportion of Gross State Product accounted for by the sector. The position of each state in each of these categories is presented in the paper, along with the final categorization for each state into these major groups.

Table 2 ranks the 50 states with respect to the percent of Gross State Product coming from Agriculture, Energy/Mining, FInance/Services and Manufacturing. South Dakota ranks first in percent GSP from Agriculture; North Dakota second. New York and New Jersey get the smallest percentage of GSP from agriculture. Alaska and Wyoming are most dependent on Energy/Mining activities; Delaware and Hawaii least dependent based on the GSP data. Nevada and New York are most dependent on the Finance and Services Sector; Wyoming and Alaska the least dependent. North

Carolina and Michigan are the most manufacturing-dependent states; Nevada and Wyoming least manufacturing dependent. Hawaii and Virginia most dependent on governmental activities; Massachusetts and New Hampshire least dependent.

Based on the data contained in Table 2, each state was placed into one of the five aforementioned categories. Most states were readily classified. A few states posed major difficulties in classification. South Carolina was perhaps the most difficult to classify, in that it ranked 4th among the 50 states in percent GSP from the government sectors (16.931 percent of GSP) and 8th among the 50 states in manufacturing GSP (26.715 percent of GSP). We classified it as a government-based economy. New Mexico was also difficult to classify (4th in energy/mining at 13.477 percent; 5th in government at 16.781 percent of GSP). We also classified it as government-based. Missouri ranks high in none of the 5 categories (18th in agriculture; 32nd in energy/mining; 20th in finance/services; 17th in manufacturing; 37th in government) and was classified as diversified. Table 3 provides the categorizations that were determined for each of the 50 states. These new "economic activity regions" are illustrated on a U.S. map (Figure 2). As a group, states with agricultural based economies experienced a 5.83 percent compound annual growth rate; energy/mining based 4.77 percent; finance/services based 7.20 percent; government-based 6.78 percent; manufacturing based 6.88 percent; and diversified 6.75 percent for the 1980-88 time period.

Figure 3 compares these percentages for the new categories and also provides the standard deviation on the compound annual growth rate for each category. The smaller the standard deviation the less variation in compound growth rate within each group. The least variation in among states classified as agricultural-dependent (S.D. = 0.56) The most variation among states classified as manufacturing dependent (S.D. 1.07) In no case did the standard deviation in compound annual growth rate for each of the categories exceed the standard deviation in the compound growth rate for all 50 states together (S.D. = 1.20) suggesting compound personal income growth rates were more similar "within groups" than across groups.

A second approach placed most of the states in the traditional Census regions but modify a few of them based on information contained in Table 2 and Figure 2. Most of the regions are geographic. Arkansas (formerly in West South Central) and Missouri (formerly in West North Central) are moved into the East South Central Region. The major change is the addition of several other energy-dependent states to the former West South Central region, including Alaska (formerly Pacific), Colorado (formerly Mountain), West Virginia (formerly South Atlantic) and Wyoming (formerly Mountain). The result is a grouping of states with quite homogeneous compound annual growth rates over the period. Figure 4 compares means and standard deviations in compound annual per capita disposable personal income growth rates. These modified geographic regions are even more homogeneous in personal income growth rates than the sector-based "regions."

Forecasting Compound Rates in Personal Income

We attempted to determine if information about the kind of economy each state possesses could be used to improve forecasts of compound annual growth rates in personal income per capita. We used several different approaches in incorporating sector and geographic location information into income forecasting models.

There are two options for incorporating geographic location into the forecasting model. The first option is to use a series of 0-1 dummy variables (1 if the state is located in region i, zero otherwise) One problem is that there are eight dummy variables plus the intercept dummy. Another approach is to use X-Y coordinate variables which are continuous. We developed a series of 0-1 dummies based on the modified geographic regions listed in table 3. For the regression the dummy D5 representing the South Atlantic region was omitted.

The second approach incorporated continuous geographic location data for each state. The SAS Institute has developed a data set consisting of X and Y coordinates representing the visual center of each state, which were developed for cartography (computer mapping) applications. These X and Y

coordinates provide a location for each state that requires only two, not eight variables. Values for these coordinates are listed in Table 4. These data are continuous, not discrete as the regional dummies are. One might argue that it might be more appropriate to use X and Y coordinate for the "center" of economic activity within each state, rather than the visual center. In a state such as Nebraska where major cities are all located in the eastern third of the state, the economic activity coordinate would be further east than the visual center. However, most states have major cities and economic activity more evenly distributed than does Nebraska, and the coordinates for the visual center are probably appropriate for most states and we have yet to determine a practical means for locating the "center' of economic activity within each state. Another problem with this approach is that Alaska and Hawaii are "outliers" with coordinates located at great distances from the 48 contiguous states. We dealt with this problem by simply excluding Alaska and Hawaii, since their inclusion would have a significant impact on the regression results for the 48 contiguous states.

We first regressed the compound growth in personal income from 1980 to 1988 on the X and Y coordinates for the visual center for each state (Hawaii and Alaska excluded) and the results are presented in Equation 1 of Table 5. Results indicate an R^2 for the equation of 0.537; moderate for a data set consisting of 50 cross sectional observations. The *t* ratio indicates that the X coordinate, which locates the state in the east-west plane, is far more important than the Y coordinate which locates the state in the north-south plane, and the coefficient is much larger for the X coordinate (4.397) than the Y coordinate (1.394). If these results are compared with Figure 1, they are not surprising.

The next step was to estimate the equation instead using as explanatory variables the percent of Gross State Product coming from agriculture, energy/mining, manufacturing, finance/services and government. In this case, Hawaii and Alaska could be included in the regression. Results are presented in Equation 2 of Table 5. The R^2 for this equation was only slightly higher than for the equation using the X and Y coordinates, at 0.587. The coefficients on agriculture (variable PFARM) and

energy/mining (variable PMIN) were negative; the coefficient for the remaining sectors were positive. The F value for the entire equation was significantly different from zero at the 10 percent level, but none of the coefficients on the individual sectors were significantly different from zero even at the 10 percent level.

The third step was to include both the coordinate and the sector data into a single equation. This yielded still better statistical results, and results are presented as Equation 3 of Table 5. Hawaii and Alaska were excluded. The R^2 for the entire equation was quite high at 0.842, and particularly high given the cross-sectional data. Even when adjusted for degrees of freedom, the R^2 was still 0.815 percent. Furthermore, the equation F value of 30.675 was higher than for either of the other two equations. This suggests that the geographic coordinates and the sector data make nonredundant contributions to the forecast equation. Surprisingly, coefficients on all the individual sectors were all negative with Energy/mining (PMIN) at -0.1665 and Agriculture (PFARM) at -0.795. Both were significantly different from zero at the 10 percent level. Remaining coefficients on sectors were negative but not significant at the 10 percent level.

Next we tried an approach that used the dummy variable representing the modified census regions in table 3. Results are presented as Equation 4 of Table 5. The R^2 for this equation (0.788) was considerably higher than for the equation incorporating only the cartography coordinates (Equation 1) or the sector information alone (Equation 2) but lower than for the equation incorporating the cartography and the sector information. Regions with the strongest negative coefficients were the Modified Energy/West South Central region; the Mountain Region; and the West North Central region (which includes most of the agricultural-based economies).

The final approach was to incorporate the dummies for the modified geographic regions and the sector information into the same equation. This resulted in an equation with an R^2 of 0.86 or 0.80 adjusted for degrees of freedom. Only the coefficients on PFINSER, PGOV and on dummy D3 (representing the Middle Atlantic States) were smaller than zero.

Forecasts

In Table 6 we provide actual compound growth rates, predicted growth rates and the residual for each state using equation 3 (cartographer coordinates and sector information) and equation 5 (dummies for modified geographic regions and sector information). States are listed alphabetically and sorted by the size of the residual. Results are for both equations are similar, with a few exceptions. Equation 3 containing cartographer coordinates overpredicts compound growth rates most severely for Oklahoma Pennsylvania Ohio and Florida, and underpredicts most severely for New Hampshire Massachusetts, California and New Mexico. However, Equation 3 predicts compound growth within one half of one percent for the remaining 40 of the 48 contiguous states, and even comes close for Wyoming. For twenty-one states, the forecast is within one quarter of one percent.

Equation 5 incorporating dummies for modified regions overpredicts six states by greater than one half of one percent (Wyoming, Oklahoma, Pennsylvania, Vermont, South Carolina and Nevada) and underpredicts five states by greater than one half of one percent (New Hampshire, New Jersey, Alaska, Massachusetts and Arizona). For twenty two states, the forecast is within one quarter of one percent.

Concluding Comments

This paper has shown that: (1) It is possible to categorize states in to groups with economies that are comparable with respect to sector characteristics, and that these categories may be more suitable for economic analysis than the traditionally defined geographic regions; (2) States with energy- and agricultural- dependent economies have lagged other states in income growth between 1980 and 1988; (3) Cartographers coordinates as explanatory variables to locate a state as an alternative have important advantages over regional dummy variables in forecast equations in that they are continuous, non-arbitrarily defined, and reduce the number of variables in the regression equation; and (4) Dummy variables representing regions that have been modified to incorporate addtional information when used in conjunction with sector information generate a forecasting equation with

the highest R^2. The forecasts using this approach do not appear to be superior to the forecasts obtained when the cartographer's coordinates are used in conjunction with the sector information.

If these equations are to be used for actually forecasting future growth in personal income by state, important problems need to be resolved. One would need to know something about the potential for the major sectors over the forecast period. For example, if oil and coal prices and prices for agricultural commodities suddenly rise, states which depend heavily on these sectors could experience phenomenal increases in personal income growth rates. Recent price increases for oil might quickly change these results. Personal income growth in manufacturing-dependent states would be very adversely affected by a major recession.

Table 1. Annual Compound Growth Rates in Per Capita Disposable Personal Income, 1980-1988.

State	Compound Annual Growth Rate	Rank	State	Compound Annual Growth Rate
Alabama	6.69	1	New Hampshire	9.05
Alaska	4.42	2	Massachusetts	8.74
Arizona	6.36	3	New Jersey	8.31
Arkansas	6.43	4	Connecticut	8.15
California	6.24	5	Maryland	7.87
Colorado	5.86	6	Georgia	7.75
Connecticut	8.15	7	Virginia	7.72
Delaware	7.43	8	Rhode Island	7.62
Florida	6.93	9	North Carolina	7.60
Georgia	7.75	10	Maine	7.58
Hawaii	5.93	11	New York	7.52
Idaho	5.21	12	Delaware	7.43
Illinois	6.50	13	Tennessee	7.22
Indiana	6.29	14	Vermont	7.21
Iowa	5.69	15	Florida	6.93
Kansas	5.86	16	South Carolina	6.91
Kentucky	6.58	17	Alabama	6.69
Louisiana	4.93	18	Missouri	6.67
Maine	7.58	19	Minnesota	6.61
Maryland	7.87	20	Kentucky	6.58
Massachusetts	8.74	21	Pennsylvania	6.56
Michigan	6.33	22	Illinois	6.50
Minnesota	6.61	23	Arkansas	6.43
Mississippi	6.17	24	Arizona	6.36
Missouri	6.67	25	Michigan	6.33
Montana	4.88	26	Indiana	6.29
Nebraska	6.23	27	California	6.24
Nevada	5.40	28	Nebraska	6.23
New Hampshire	9.05	29	Mississippi	6.17
New Jersey	8.31	30	Ohio	6.13
New Mexico	5.25	31	Wisconsin	6.04
New York	7.52	32	South Dakota	5.93
North Carolina	7.60	33	Hawaii	5.93
North Dakota	5.64	34	Kansas	5.86
Ohio	6.13	35	Colorado	5.86
Oklahoma	4.01	36	Washington	5.84
Oregon	5.53	37	Iowa	5.69
Pennsylvania	6.56	38	North Dakota	5.64
Rhode Island	7.62	39	Texas	5.54
South Carolina	6.91	40	Oregon	5.53
South Dakota	5.93	41	Utah	5.51
Tennessee	7.22	42	Nevada	5.40
Texas	5.54	43	West Virginia	5.38
Utah	5.51	44	New Mexico	5.25
Vermont	7.21	45	Idaho	5.21
Virginia	7.72	46	Louisiana	4.93
Washington	5.84	47	Montana	4.88
West Virginia	5.38	48	Alaska	4.42
Wisconsin	6.04	49	Oklahoma	4.01
Wyoming	2.71	50	Wyoming	2.71

Table 2. Rankings of the 50 states with respect to percent Gross State Product From Major Sectors

Rank	State	Percent GSP from Agriculture	State	Percent GSP from Energy/Mining	State	Percent GSP from Finance/Services	State	Percent GSP from Manufacturing	State	Percent GSP from Government
1	South Dakota	15.884	Alaska	33.358	Nevada	49.660	North Carolina	31.369	Hawaii	23.581
2	North Dakota	14.786	Wyoming	26.377	New York	42.269	Michigan	31.023	Virginia	19.491
3	Nebraska	12.525	Louisiana	16.816	Massachusetts	39.100	Indiana	29.797	Maryland	17.451
4	Iowa	11.011	New Mexico	13.477	Florida	38.236	Ohio	29.199	South Carolina	16.931
5	Idaho	9.073	West Virginia	13.184	Hawaii	37.375	Delaware	28.404	New Mexico	16.781
6	Montana	8.295	Oklahoma	10.404	California	36.939	Wisconsin	27.686	Alaska	16.469
7	Kansas	6.971	Texas	10.251	Maryland	36.811	Mississippi	27.238	Alabama	15.550
8	Arkansas	5.965	Montana	7.300	Connecticut	36.583	South Carolina	26.715	Utah	15.369
9	Minnesota	4.727	North Dakota	6.326	New Jersey	36.556	New Hampshire	25.985	Washington	15.056
10	Wisconsin	4.399	Kentucky	5.659	Rhode Island	36.080	Tennessee	25.020	Oklahoma	14.267
11	Oregon	3.946	Colorado	2.879	Illinois	35.000	Arkansas	24.600	Colorado	13.983
12	Oklahoma	3.657	Nevada	2.820	Pennsylvania	34.718	Connecticut	24.322	Arizona	13.920
13	Washington	3.657	Utah	2.603	New Hampshire	34.641	Rhode Island	24.307	Mississippi	13.220
14	Kentucky	3.594	Mississippi	2.598	Vermont	34.101	Kentucky	24.021	Maine	12.755
15	Mississippi	3.421	Alabama	2.525	Arizona	33.714	Alabama	23.484	Montana	12.751
16	Vermont	3.172	Kansas	2.064	Minnesota	33.713	Vermont	22.938	Georgia	12.561
17	Indiana	2.668	Arkansas	1.605	Colorado	33.638	Missouri	22.639	Idaho	12.467
18	Missouri	2.630	Idaho	1.290	Oregon	33.303	Pennsylvania	22.141	North Carolina	12.418
19	Colorado	2.563	Arizona	1.282	Delaware	31.992	Massachusetts	21.726	Oregon	12.212
20	Florida	2.493	South Dakota	1.193	Missouri	31.754	Maine	21.141	Tennessee	12.125
21	Alabama	2.419	California	1.110	Wisconsin	31.420	Iowa	21.051	Rhode Island	11.996
22	North Carolina	2.398	Virginia	1.072	Iowa	31.271	Georgia	20.919	South Dakota	11.905
23	Hawaii	2.349	Pennsylvania	1.022	South Dakota	31.054	Minnesota	20.909	Florida	11.892
24	Maine	2.291	Florida	0.864	Michigan	30.910	Illinois	20.163	Wyoming	11.864
25	New Mexico	2.173	Ohio	0.818	Idaho	30.827	Oregon	19.819	Nebraska	11.854
26	Delaware	2.144	Illinois	0.762	Maine	30.768	New Jersey	19.726	California	11.619
27	California	2.113	Michigan	0.659	Nebraska	30.745	Kansas	18.652	Kansas	11.595
28	Arizona	2.106	Indiana	0.654	Washington	30.706	California	18.298	Kentucky	11.589
29	Georgia	2.075	Georgia	0.555	Ohio	30.540	Virginia	17.862	West Virginia	11.479
30	Texas	1.932	Minnesota	0.536	Virginia	30.474	Washington	17.270	North Dakota	11.404
31	Tennessee	1.912	Tennessee	0.485	Montana	29.721	Utah	16.615	Delaware	10.797
32	Illinois	1.880	Missouri	0.350	Tennessee	29.671	New York	16.507	Nevada	10.779
33	Wyoming	1.876	North Carolina	0.281	North Dakota	29.479	Idaho	16.340	New York	10.732
34	Utah	1.666	Vermont	0.266	Utah	29.465	Texas	16.048	Texas	10.638
35	Alaska	1.619	Nebraska	0.263	New Mexico	29.195	West Virginia	14.462	Arkansas	10.387
36	South Carolina	1.370	South Carolina	0.230	Kansas	28.741	Oklahoma	14.273	Wisconsin	10.263
37	Ohio	1.333	Washington	0.223	Georgia	27.932	Nebraska	13.755	Missouri	10.071
38	Pennsylvania	1.315	Iowa	0.205	Louisiana	27.923	Arizona	13.467	Michigan	10.069
39	Michigan	1.301	Maryland	0.149	Texas	27.871	Louisiana	12.992	Louisiana	10.066
40	Virginia	1.252	Oregon	0.140	Indiana	27.380	Colorado	12.895	Pennsylvania	10.030
41	Maryland	1.216	New York	0.137	West Virginia	27.045	Maryland	11.902	New Jersey	9.975
42	Louisiana	1.214	New Hampshire	0.135	Kentucky	26.846	Florida	10.799	Minnesota	9.806
43	Rhode Island	1.118	Wisconsin	0.109	Alabama	26.609	South Dakota	9.967	Connecticut	9.749
44	West Virginia	0.933	Connecticut	0.106	Oklahoma	26.606	New Mexico	7.969	Vermont	9.657
45	Nevada	0.864	Rhode Island	0.065	Arkansas	26.263	Montana	7.243	Illinois	9.411
46	New Hampshire	0.810	New Jersey	0.063	South Carolina	25.391	North Dakota	5.795	Iowa	9.403
47	Massachusetts	0.732	Massachusetts	0.060	Mississippi	24.652	Hawaii	5.175	Ohio	9.389
48	Connecticut	0.685	Maine	0.040	North Carolina	24.399	Alaska	4.985	Indiana	9.352
49	New Jersey	0.615	Delaware	0.017	Wyoming	21.648	Nevada	4.802	Massachusetts	9.187
50	New York	0.595	Hawaii	0.010	Alaska	17.639	Wyoming	2.835	New Hampshire	8.532

Table 3. Categorization of States and Compound Annual Growth Rates in Per Capita Disposable Personal Income.

Based on Type Of Economy:

Agricultural-Based (9 states):	
Arkansas	6.43
Idaho	5.21
Iowa	5.69
Kansas	5.86
Minnesota	6.61
Montana	4.88
Nebraska	6.23
North Dakota	5.64
South Dakota	5.93
Mean	5.83

Energy/Mining-Based (7)	
Alaska	4.42
Colorado	5.86
Louisiana	4.93
Oklahoma	4.01
Texas	5.54
West Virginia	5.38
Wyoming	2.71
Mean	4.77

Finance/Services-Based (10):	
California	6.24
Connecticut	8.15
Florida	6.93
Illinois	6.50
Massachusetts	8.74
Nevada	5.40
New Jersey	8.31
New York	7.52
Pennsylvania	6.56
Rhode Island	7.62
Mean	7.20

Government-Based (7 states):	
Alabama	6.69
Hawaii	5.93
Maryland	7.87
New Mexico	5.25
South Carolina	6.91
Utah	5.51
Virginia	7.72
Mean	6.78

Manufacturing-Based (8 states):	
Delaware	7.43
Indiana	6.29
Michigan	6.33
Mississippi	6.17
New Hampshire	9.05
North Carolina	7.60
Ohio	6.13
Wisconsin	6.04
Mean	6.88

Diversified (9 states):	
Arizona	6.36
Georgia	7.75
Kentucky	6.58
Maine	7.58
Missouri	6.67
Oregon	5.53
Tennessee	7.22
Vermont	7.21
Washington	5.84
Mean	6.75

Table 3. (Continued).
Based on Modified Census Regions (See Text)

New England	
Vermont	7.21
New Hampshire	9.05
Maine	7.58
Massachusetts	8.74
Rhode Island	7.62
Connecticut	8.15
Mean	**8.06**

Middle Atlantic	
Pennsylvania	6.56
New York	7.52
New Jersey	8.31
Mean	**7.47**

East North Central	
Michigan	6.33
Ohio	6.13
Indiana	6.29
Illinois	6.50
Wisconsin	6.04
Mean	**6.26**

West North Central	
North Dakota	5.64
Iowa	5.69
Kansas	5.86
South Dakota	5.93
Nebraska	6.23
Minnesota	6.61
Mean	**6.00**

South Atlantic	
Maryland	7.87
Florida	6.93
Delaware	7.43
Georgia	7.75
North Carolina	7.60
South Carolina	6.91
Virginia	7.72
Mean	**7.46**

Modified East South Central	
Arkansas*	6.43
Mississippi	6.17
Missouri*	6.67
Kentucky	6.58
Alabama	6.69
Tennessee	7.22
Mean	**6.63**

Modified Energy/West South Central	
Alaska*	4.42
Louisiana	4.93
Colorado*	5.86
Texas	5.54
Oklahoma	4.01
West Virginia*	5.38
Wyoming*	2.71
Mean	**4.70**

Mountain	
New Mexico	5.25
Idaho	5.21
Montana	4.88
Arizona	6.36
Nevada	5.40
Utah	5.51
Mean	**5.44**

Pacific	
Hawaii	5.93
Oregon	5.53
California	6.24
Washington	5.84
Mean	**5.89**

Errors in means due to rounding
An asterisk (*) indicates a state added to a region.

Table 4. Cartographer's X and Y coordinates for the States (Excludes Alaska and Hawaii)

State	X Coordinate	Y Coordinate
Alabama	0.135	-0.072
Alaska	.	.
Arizona	-0.223	-0.030
Arkansas	0.048	-0.039
California	-0.331	0.038
Colorado	-0.130	0.037
Connecticut	0.311	0.098
Delaware	0.272	0.060
Florida	0.218	-0.140
Georgia	0.180	-0.068
Hawaii	.	.
Idaho	-0.233	0.134
Illinois	0.088	0.051
Indiana	0.129	0.055
Iowa	0.030	0.088
Kansas	-0.035	0.026
Kentucky	0.158	0.016
Louisiana	0.050	-0.109
Maine	0.326	0.185
Maryland	0.304	0.045
Massachusetts	0.338	0.127
Michigan	0.139	0.109
Minnesota	0.015	0.153
Mississippi	0.092	-0.079
Missouri	0.045	0.023
Montana	-0.170	0.183
Nebraska	-0.048	0.075
Nevada	-0.277	0.070
New Hampshire	0.333	0.142
New Jersey	0.302	0.083
New Mexico	-0.145	-0.039
New York	0.261	0.129
North Carolina	0.237	-0.010
North Dakota	-0.056	0.180
Ohio	0.174	0.064
Oklahoma	-0.022	-0.029
Oregon	-0.307	0.158
Pennsylvania	0.238	0.083
Rhode Island	0.329	0.110
South Carolina	0.213	-0.040
South Dakota	-0.054	0.128
Tennessee	0.138	-0.018
Texas	-0.047	-0.100
Utah	-0.209	0.053
Vermont	0.329	0.157
Virginia	0.241	0.031
Washington	-0.292	0.213
West Virginia	0.201	0.038
Wisconsin	0.076	0.134
Wyoming	-0.144	0.109

Table 5. Forecast Equations on Compound Annual Growth Rates for Per Capita Disposable Personal Income.

Equation 1. Geographic Location Only:
(Hawaii and Alaska Excluded)

NOBS:	48	Multiple Correlation:	0.733
Std Error:	0.83	R-Squared:	0.537
		Adjusted R-Squared:	0.516

Analysis of Variance:

Source	DF	Sum of Squares	Mean Square	F Value
Model	2	36.09	18.04	26.14
Error	45	31.06	0.69	
Total	47	67.15		

Variable	Coefficient	Standard Error	t	Prob
CONSTANT	6.062	0.149		
X	4.397	0.609	7.21	0.000
Y	1.394	1.410	0.99	0.328

Equation 2. Type of Economy Only:
(Hawaii and Alaska Included)

NOBS:	50	Multiple Correlation:	0.766
Std Error:	0.81	R-Squared:	0.587
		Adjusted R-Squared:	0.540

Analysis of Variance:

Source	DF	Sum of Squares	Mean Square	F Value
Model	5	41.91	8.38	12.53
Error	44	29.42	0.66	
Total	49	71.33		

Variable	Coefficient	Standard Error	t	Prob
CONSTANT	3.8273	3.5701		
PFARM	-0.0612	0.0584	-0.180	0.300
PMIN	-0.0669	0.0527	-0.373	0.211
PMFG	0.0569	0.0461	0.354	0.224
PFINSER	0.0520	0.0567	0.230	0.364
PGOV	0.0253	0.0658	0.062	0.702

Equation 3. Type of Economy and Geographic Location:
(Hawaii and Alaska Excluded)

NOBS:	48	Multiple Correlation:	0.918
Std Error:	0.51	R-Squared:	0.842
		Adjusted R-Squared:	0.815

Analysis of Variance:

Source	DF	Sum of Squares	Mean Square	F Value
Model	7	56.61	8.08	30.675
Error	40	10.54	0.26	
Total	47	67.15		

Variable	Coefficient	Standard Error	t	Prob
CONSTANT	8.6090	2.5937		
X	3.4581	0.4607	7.51	0.000
Y	0.0154	1.0025	0.02	0.988
PFARM	-0.0795	0.0413	-1.92	0.062
PMIN	-0.1665	0.0413	-4.03	0.000
PMFG	-0.0457	0.0333	-1.37	0.177
PFINSER	-0.0171	0.0406	-0.42	0.675
PGOV	-0.0184	0.0512	-0.36	0.720

Table 5 (Continued).

Equation 4. Modified Geographic Regions Only (See Text) (Hawaii and Alaska Included)

NOBS:	50	Multiple Correlation:	0.887
Std Error:	0.60	R-Squared:	0.788
		Adjusted R-Squared:	0.747

Analysis of Variance:

Source	DF	Sum of Squares	Mean Square	F Value
Model	8	56.23	7.02	19.08
Error	41	15.10	0.36	
Total	49	71.33		

Parameter Estimates:

Variable	Coefficient	Standard Error	t	Prob
CONSTANT	7.463	0.229	32.54	0.000
D1	0.600	0.337	1.78	0.083
D2	0.007	0.418	0.02	0.986
D3	-1.200	0.355	-3.38	0.002
D4	-1.466	0.337	-4.34	0.000
D6	-0.832	0.337	-2.47	0.018
D7	-2.767	0.324	-8.53	0.000
D8	-2.023	0.337	-5.99	0.000
D9	-1.575	0.380	-4.14	0.000

Equation 5. Modified Geographic Regions and Type of Economy (Hawaii and Alaska Included)

Regression Statistics:

NOBS:	50	Multiple Correlation:	0.92
Std Error:	0.52	R-Squared:	0.86
		Adjusted R-Squared:	0.80

Analysis of Variance:

Source	DF	Sum of Squares	Mean Square	F Value
Model	13	61.36	4.72	17.03
Error	36	9.97	0.27	
Total	49	71.33		

Parameter Estimates:

Variable	Coefficient	Standard Error	t	Prob
CONSTANT	7.006	2.478	2.83	0.008
PFARM	-0.081	0.052	-1.57	0.125
PMIN	-0.057	0.036	-1.59	0.121
PMFG	0.005	0.033	0.16	0.875
PFINSER	0.013	0.040	0.33	0.746
PGOV	0.007	0.046	0.17	0.864
D1	0.511	0.339	1.51	0.140
D2	-0.128	0.410	-0.31	0.756
D3	-1.153	0.361	-3.19	0.003
D4	-0.583	0.478	-1.22	0.230
D6	-0.569	0.316	-1.80	0.080
D7	-1.722	0.430	-4.00	0.000
D8	-1.573	0.349	-4.50	0.000
D9	-1.512	0.351	-4.30	0.000

X = X (east-west) location coordinate (see Table 4 and text)
Y = Y (north-south) location coordinate (see Table 4 and text)
PFARM = Percent GSP from Agriculture
PMIN = Percent GSP from Energy/Mining
PMFG = Percent GSP from Manufacturing
PFINSER = Percent GSP from Finance/Services
PGOV = Percent GSP from Government

Table 6. Actual and Predicted Percentage Change in Disposable Per Capita Income, Compound Annual Growth Rate, 1980-1988 (based on Equation 3, Table 5).

By State				Arrayed by Residual Size			
State	Actual % Change	Predicted % Change	Residual	State	Actual % Change	Predicted % Change	Residual
Alabama	6.69	6.63	0.06	Hawaii	5.93	-NF-	----
Alaska	4.42	-NF-	----	Alaska	4.42	-NF-	----
Arizona	6.36	5.99	0.37	Oklahoma	4.01	5.13	-1.11
Arkansas	6.43	6.25	0.17	Pennsylvania	6.56	7.37	-0.80
California	6.24	5.42	0.81	Ohio	6.13	6.94	-0.80
Colorado	5.86	6.05	-0.18	Florida	6.93	7.62	-0.68
Connecticut	8.15	7.70	0.45	Wisconsin	6.04	6.52	-0.48
Delaware	7.43	7.33	0.09	Iowa	5.69	6.14	-0.45
Florida	6.93	7.62	-0.68	Nevada	5.40	5.84	-0.44
Georgia	7.75	7.29	0.46	Illinois	6.50	6.94	-0.44
Hawaii	5.93	-NF-	----	Vermont	7.21	7.65	-0.44
Idaho	5.21	5.37	-0.16	Indiana	6.29	6.73	-0.43
Illinois	6.50	6.94	-0.44	Michigan	6.33	6.75	-0.41
Indiana	6.29	6.73	-0.43	West Virginia	5.38	5.69	-0.31
Iowa	5.69	6.14	-0.45	South Carolina	6.91	7.21	-0.30
Kansas	5.86	6.03	-0.16	Maine	7.58	7.84	-0.25
Kentucky	6.58	6.15	0.43	Utah	5.51	5.77	-0.25
Louisiana	4.93	4.60	0.33	New York	7.52	7.78	-0.25
Maine	7.58	7.84	-0.25	Montana	4.88	5.09	-0.21
Maryland	7.87	8.04	-0.16	Colorado	5.86	6.05	-0.18
Massachusetts	8.74	7.88	0.85	Maryland	7.87	8.04	-0.16
Michigan	6.33	6.75	-0.41	Kansas	5.86	6.03	-0.16
Minnesota	6.61	6.50	0.11	Idaho	5.21	5.37	-0.16
Mississippi	6.17	6.29	-0.12	Wyoming	2.71	2.86	-0.15
Missouri	6.67	6.73	-0.05	Mississippi	6.17	6.29	-0.12
Montana	4.88	5.09	-0.21	Rhode Island	7.62	7.70	-0.08
Nebraska	6.23	6.03	0.19	Missouri	6.67	6.73	-0.05
Nevada	5.40	5.84	-0.44	Oregon	5.53	5.52	0.00
New Hampshire	9.05	7.75	1.30	Alabama	6.69	6.63	0.06
New Jersey	8.31	7.88	0.43	Delaware	7.43	7.33	0.09
New Mexico	5.25	4.50	0.74	Minnesota	6.61	6.50	0.11
New York	7.52	7.78	-0.25	Washington	5.84	5.70	0.13
North Carolina	7.60	7.10	0.50	South Dakota	5.93	5.76	0.16
North Dakota	5.64	5.23	0.41	Arkansas	6.43	6.25	0.17
Ohio	6.13	6.94	-0.80	Nebraska	6.23	6.03	0.19
Oklahoma	4.01	5.13	-1.11	Tennessee	7.22	6.97	0.24
Oregon	5.53	5.52	0.00	Virginia	7.72	7.46	0.26
Pennsylvania	6.56	7.37	-0.80	Louisiana	4.93	4.60	0.33
Rhode Island	7.62	7.70	-0.08	Arizona	6.36	5.99	0.37
South Carolina	6.91	7.21	-0.30	Texas	5.54	5.15	0.38
South Dakota	5.93	5.76	0.16	North Dakota	5.64	5.23	0.41
Tennessee	7.22	6.97	0.24	New Jersey	8.31	7.88	0.43
Texas	5.54	5.15	0.38	Kentucky	6.58	6.15	0.43
Utah	5.51	5.77	-0.25	Connecticut	8.15	7.70	0.45
Vermont	7.21	7.65	-0.44	Georgia	7.75	7.29	0.46
Virginia	7.72	7.46	0.26	North Carolina	7.60	7.10	0.50
Washington	5.84	5.70	0.13	New Mexico	5.25	4.50	0.74
West Virginia	5.38	5.69	-0.31	California	6.24	5.42	0.81
Wisconsin	6.04	6.52	-0.48	Massachusetts	8.74	7.88	0.85
Wyoming	2.71	2.86	-0.15	New Hampshire	9.05	7.75	1.30

Table 6 (Continued). Actual and Predicted Percentage Change in Disposable Per Capita Income, Compound Annual Growth Rate, 1980-1988 (based on Equation 5, Table 5).

	By State			Arrayed by Residual Size			
State	Actual % Change	Predicted % Change	Residual	State	Actual % Change	Predicted % Change	Residual
1 Alabama	6.69	6.69	-0.00	Wyoming	2.71	4.01	-1.30
2 Alaska	4.42	3.62	0.80	Oklahoma	4.01	4.93	-0.92
3 Arizona	6.37	5.81	0.55	Pennsylvania	6.57	7.37	-0.80
4 Arkansas	6.43	6.42	0.02	Vermont	7.22	7.89	-0.68
5 California	6.25	5.94	0.31	South Carolina	6.91	7.49	-0.58
6 Colorado	5.86	5.53	0.33	Nevada	5.40	5.97	-0.56
7 Connecticut	8.16	8.15	0.01	Rhode Island	7.63	8.13	-0.50
8 Delaware	7.43	7.49	-0.06	Florida	6.94	7.41	-0.47
9 Florida	6.94	7.41	-0.47	Kansas	5.87	6.31	-0.44
10 Georgia	7.76	7.39	0.37	Iowa	5.69	6.11	-0.42
11 Hawaii	5.93	6.01	-0.08	Mississippi	6.17	6.58	-0.41
12 Idaho	5.21	5.21	0.01	Maine	7.59	7.95	-0.36
13 Illinois	6.50	6.30	0.20	Oregon	5.53	5.81	-0.27
14 Indiana	6.30	6.19	0.10	Utah	5.52	5.75	-0.23
15 Iowa	5.69	6.11	-0.42	Ohio	6.14	6.33	-0.19
16 Kansas	5.87	6.31	-0.44	Missouri	6.68	6.82	-0.15
17 Kentucky	6.59	6.39	0.19	Wisconsin	6.04	6.13	-0.09
18 Louisiana	4.94	4.74	0.20	Hawaii	5.93	6.01	-0.08
19 Maine	7.59	7.95	-0.36	Delaware	7.43	7.49	-0.06
20 Maryland	7.87	7.59	0.29	Michigan	6.34	6.36	-0.03
21 Massachusetts	8.75	8.16	0.58	Minnesota	6.61	6.64	-0.03
22 Michigan	6.34	6.36	-0.03	New York	7.53	7.55	-0.03
23 Minnesota	6.61	6.64	-0.03	Alabama	6.69	6.69	-0.00
24 Mississippi	6.17	6.58	-0.41	Idaho	5.21	5.21	0.01
25 Missouri	6.68	6.82	-0.15	Connecticut	8.16	8.15	0.01
26 Montana	4.88	4.87	0.02	Arkansas	6.43	6.42	0.02
27 Nebraska	6.24	5.96	0.28	Montana	4.88	4.87	0.02
28 Nevada	5.40	5.97	-0.56	Washington	5.84	5.80	0.04
29 New Hampshire	9.05	8.11	0.94	Indiana	6.30	6.19	0.10
30 New Jersey	8.32	7.49	0.83	Kentucky	6.59	6.39	0.19
31 New Mexico	5.25	5.04	0.21	Louisiana	4.94	4.74	0.20
32 New York	7.53	7.55	-0.03	Illinois	6.50	6.30	0.20
33 North Carolina	7.61	7.38	0.22	New Mexico	5.25	5.04	0.21
34 North Dakota	5.65	5.36	0.29	North Carolina	7.61	7.38	0.22
35 Ohio	6.14	6.33	-0.19	Virginia	7.73	7.50	0.23
36 Oklahoma	4.01	4.93	-0.92	Nebraska	6.24	5.96	0.28
37 Oregon	5.53	5.81	-0.27	North Dakota	5.65	5.36	0.29
38 Pennsylvania	6.57	7.37	-0.80	Maryland	7.87	7.59	0.29
39 Rhode Island	7.63	8.13	-0.50	California	6.25	5.94	0.31
40 South Carolina	6.91	7.49	-0.58	South Dakota	5.93	5.61	0.32
41 South Dakota	5.93	5.61	0.32	Colorado	5.86	5.53	0.33
42 Tennessee	7.22	6.87	0.35	Tennessee	7.22	6.87	0.35
43 Texas	5.54	5.07	0.47	Georgia	7.76	7.39	0.37
44 Utah	5.52	5.75	-0.23	West Virginia	5.39	4.97	0.41
45 Vermont	7.22	7.89	-0.68	Texas	5.54	5.07	0.47
46 Virginia	7.73	7.50	0.23	Arizona	6.37	5.81	0.55
47 Washington	5.84	5.80	0.04	Massachusetts	8.75	8.16	0.58
48 West Virginia	5.39	4.97	0.41	Alaska	4.42	3.62	0.80
49 Wisconsin	6.04	6.13	-0.09	New Jersey	8.32	7.49	0.83
50 Wyoming	2.71	4.01	-1.30	New Hampshire	9.05	8.11	0.94

Figure 1. Compound Annual Growth Rates, Disposable Per Capita Personal Income, 1980-88.

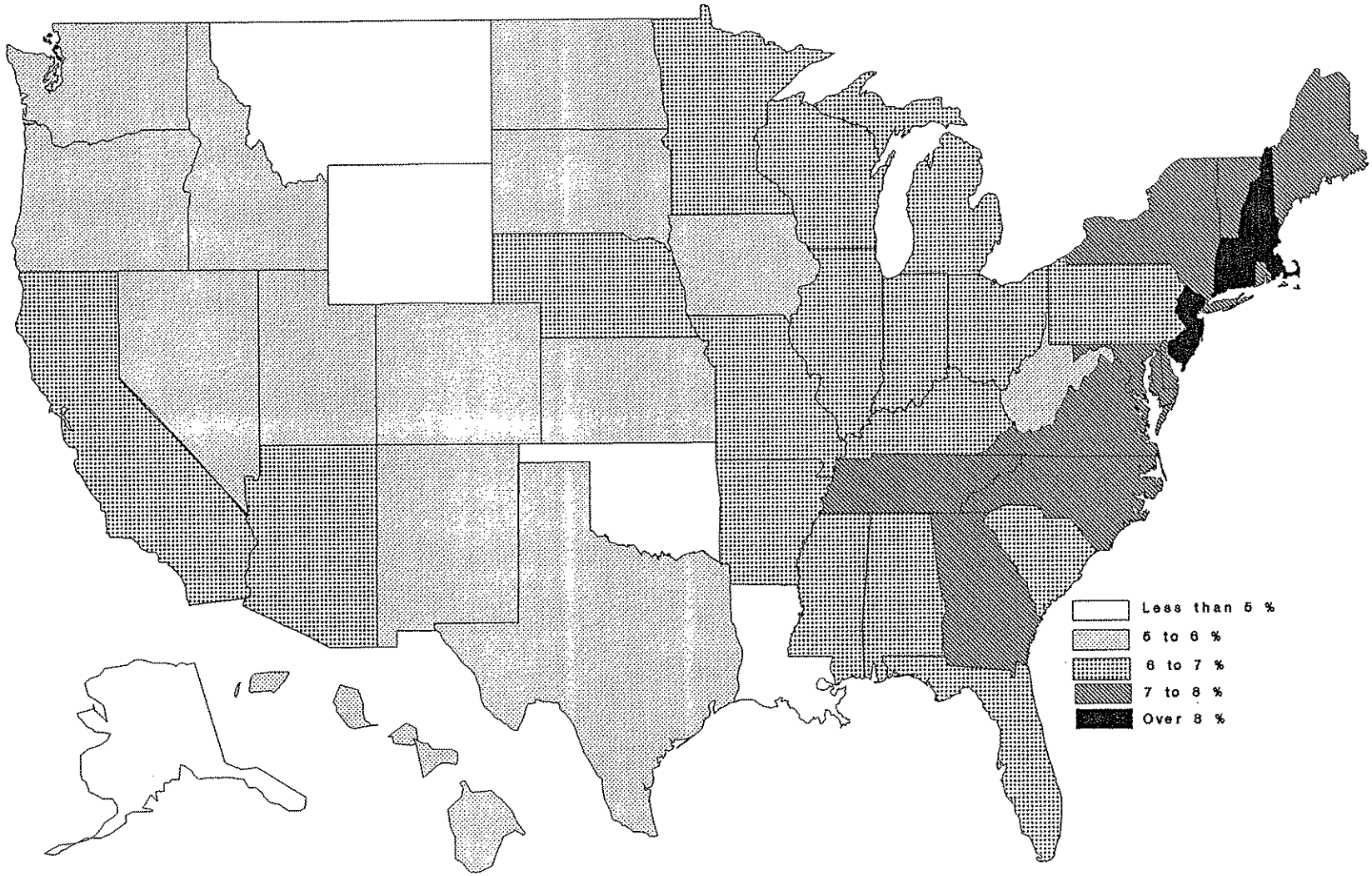


Figure 2. States Grouped According to Type of Economy.

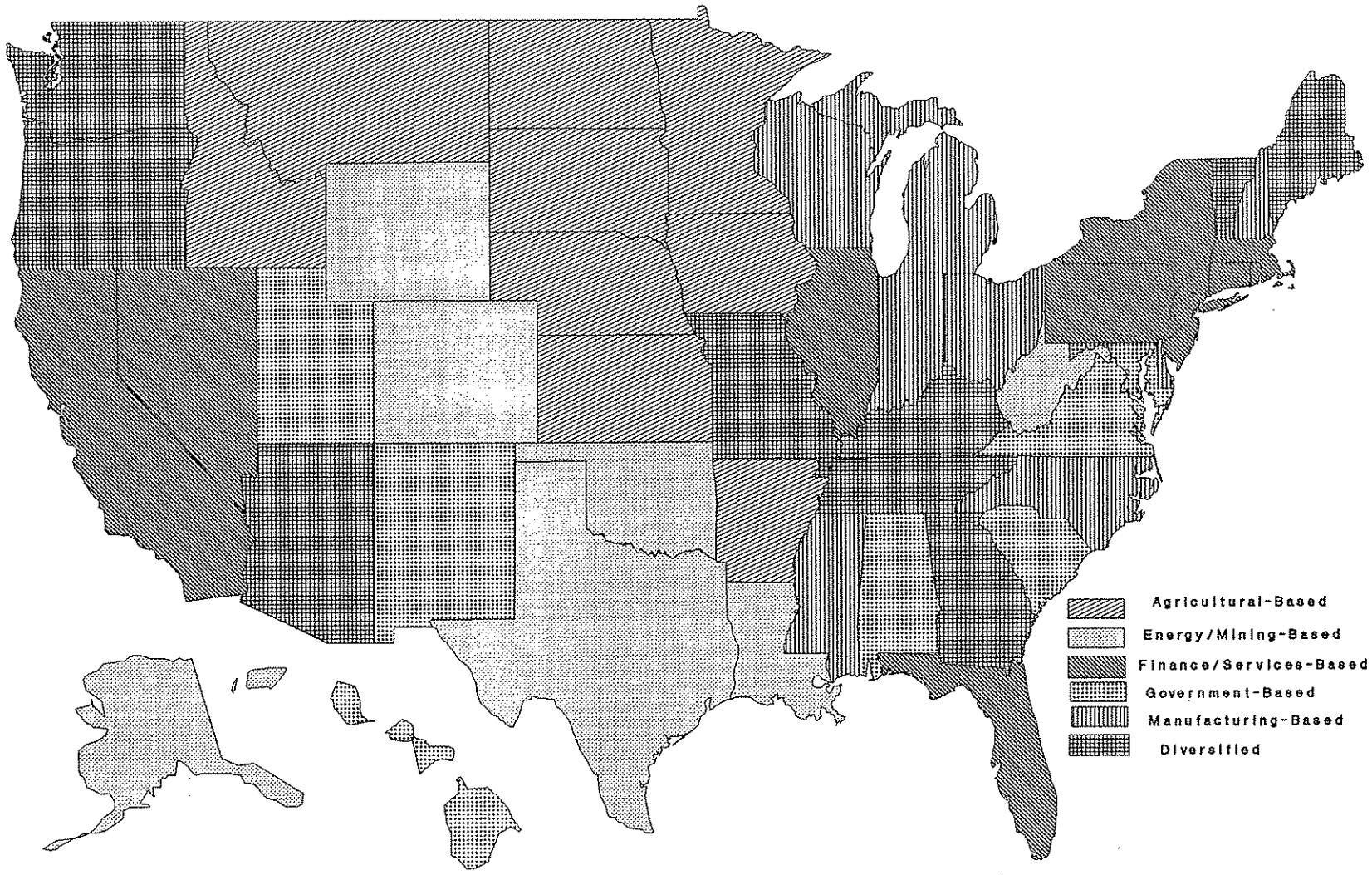
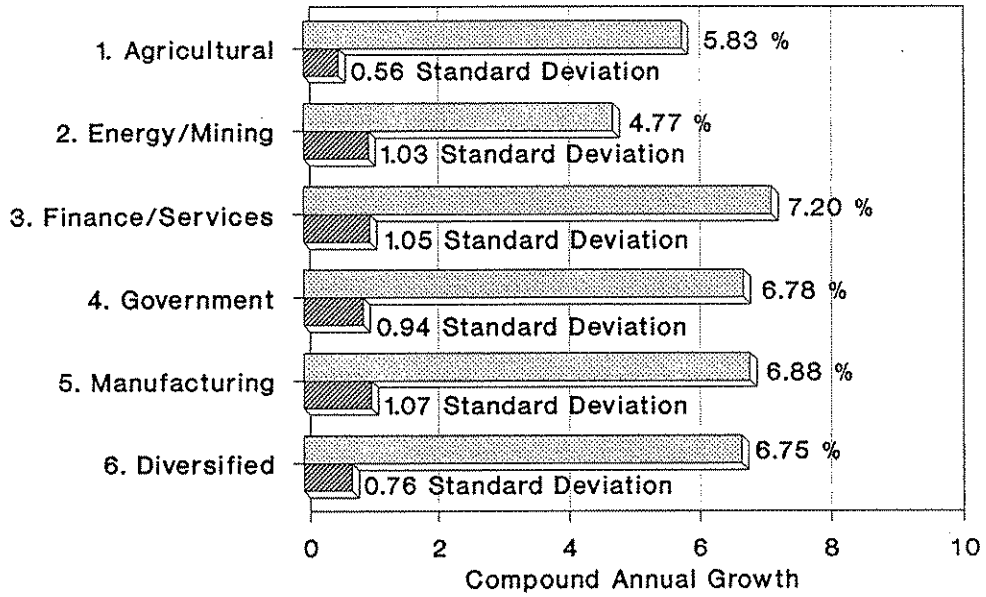
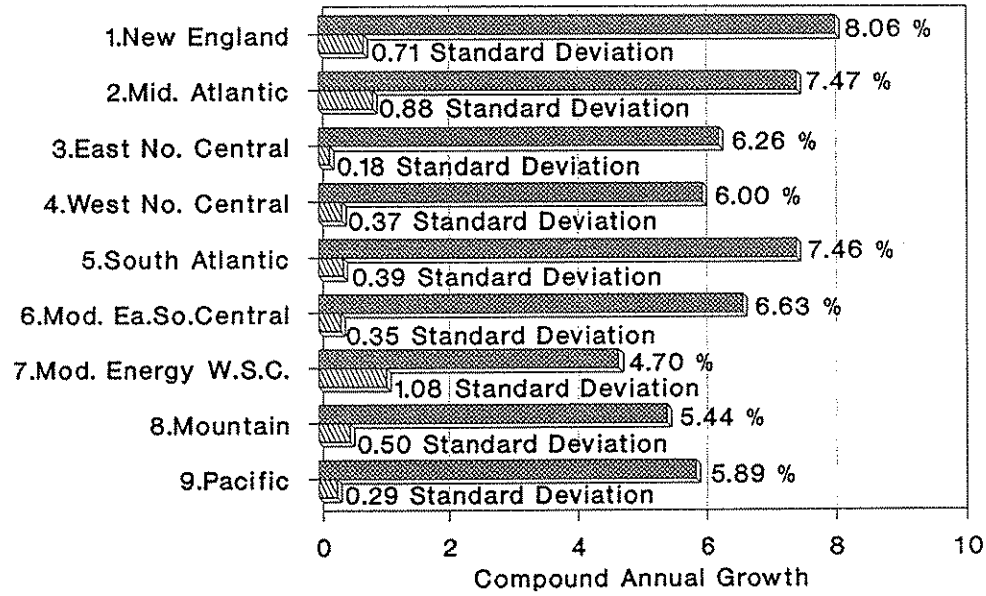


Figure 3. Compound Annual Personal Income Growth, 1980-88, for Regions Based on "Type of Economy."



Personal Income is Per Capita Disposable

Figure 4. Compound Annual Personal Income Growth, 1980-88, Modified Geographic Regions.



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Footnote

1.The 15 sectors in their study were (1) Farms; (2) Agricultural Services, Forestry and Fisheries; (3) Mining (including oil); (4) Construction; (5) Durable Goods Manufacturing; (6) Nondurable Goods Manufacturing; (7) Transportation and Public Utilities; (8) Wholesale Trade; (9) Retail Trade; (10) Finance, Insurance and Real Estate; (11) Services; (12) Federal Civilian; (13) Federal Military; and (14) State and Local Government.

In our study, we defined the primary sectors to be **Agriculture** [Sum of (1) and (2)]; **Mining/Energy** [(3) as defined]; **Finance/Services** [Sum of (10) and (11)]; **Government** [Sum of (12), (13), and (14)]; and **Manufacturing** [Sum of (5) and (6)];