TWO MODELS TO PROJECT PER CAPITA PERSONAL HEALTH CARE EXPENDITURES BY STATE, SELECTED YEARS, 1990-2020

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Editors' Note: For length considerations, the appendix to this paper, containing much of the raw statistical data upon which the study is based, has been omitted from this volume. The figures and tables referred to within this work are included at the end of the paper on unnumbered pages. The complete staistical date may be obtained in the Honors Thesis section of Perkins Library at Duke University.

Introduction

The Health Care Financing Administration (HCFA) estimates that the United States spent a phenomenal $819.9 billion on health care in 1992, approximately 13.9 percent of Gross Domestic Product (GDP). If Current trends continue, by the end of the millennium, that number should reach a staggering $1.7 trillion, 18.1 percent of projected GDP (Burner et al. 1992). these estimates unsettle most Americans who find reconciling health benefits with health costs increasingly difficult.

In response to the nation's uneasiness and consternation over skyrocketing health care costs, 1992 presidential candidate Bill Clinton promised, if elected, to reform extant health care norms and to contain costs. One of his original proposals advocated the use of state global budgets, annual caps on how much a state could spend on health care. Under this scenario, the federal government would, in theory, design spending limits separately for each state. The magnitude of each state's limit would be determined by the federal government based on several criteria, the most influential of which would be current health care expenditures.

Once elected, President Clinton commissioned the Presidential Task Force on Health Care Reform to evaluate the feasibility and potential efficacy of several proposals designed to overhaul the current system. When the commission considered global budgeting as a viable way to curtail spending, it deemed the idea currently infeasible for one very important reason. Data does not exist for total current health care expenditures by state, an essential piece of information needed to design global budgets.

HCFA compiled such data for selected years between 1966 and 1982, but has since stopped because federal officials do not need that information to manage Medicare and Medicaid, governmental programs for the elderly and poor. Spending allocated to these programs accounts for less than half of total spending within states (Levit et al. 1991). The remainder is classified as private spending, the magnitude of which is unknown to federal and state policymakers. for that reason, because it would be difficult for the task force to design state-level global budgets that accurately reflect current spending, it will consider other options for reform.

No matter what reform proposal the task force chooses to submit to Congress, many policy experts speculate that the proposal will rely heavily on states to formulate and regulate health policy. In other words, in the future, the federal government will likely assign states an even greater responsibility than they have today, but also give them a great deal of freedom in tailoring a national set of standards to their own circumstances.

Although states' role in developing and regulation health policy will likely increase under reform, their current role is often underestimated. States directly finance 13 percent of total health spending (Burner et al. 1992). Indirectly, they act as payers by determining eligibility, benefits, and payment policies for Medicaid, state employee health benefits, and a multitude of categorical health spending programs. In addition, they act as regulators by licensing and accrediting health manpower and infrastructure such as hospitals and nursing homes.

State government's current and future roles in influencing health care spending cannot be understated. Therefore, efforts to provide state and federal health care policymakers with better information regarding state-level spending might improve current and future policymaking.

This thesis describes my effort to estimate per capita personal health care expenditures by state for 1990, and to project the same variable through 2020. My analysis attempts to meet two principal objectives: 1) to estimate relative differences in how much states currently spend on personal health care, and 2) to illuminate two possible scenarios for future spending assuming the current system will remain unaltered.

Similar analyses are rare. Lewin/ICF projected per capita health spending for 1990 and 2000 using different methods (Families USA Foundation, 1990). However, to my knowledge, no other study attempts to address the same issue regarding current and future spending within states.

Methodology

This analysis incorporates five variables into two models that project per capita personal health care expenditures by state, 1990-2020. In this section, I first introduce the dependent variable, per capital personal health spending by state. Subsequently, I describe the past trends,

projected trends, projection methodologies, and respective sources for each of four independent variables: income, physician supply, hospital beds, and urbanization.

Per Capita Personal Health Care Expenditures (PPHCE)[1]

HCFA compiled data on total spending devoted to personal health care by state for selected years between 1966 and 1982.[2] (Levit, 1982, 1985). I calculated PPHCE for 1972, 1978, 1980, and 1982 using resident population estimates from the Bureau of the Census (U.S. Bureau of the Census, 1984).

Per Capita personal Income (INC)

The Bureau of Economics Analysis recently revised estimates of INC, 1969-1991 (BEA, unpublished). In my analysis, I employed this data along with BEA projections of INC through 2020 (BEA, 1990). Because the projections were expressed in 1982 dollars, I translated the data into nominal terms using a predictive measure of economywide inflation, the projected GDP implicit price deflator (Burner et al, 1992)[3]. Figure 1 shows INC, 1969-2020 for California using the BEA actual and projection data. This trend is indicative of all 49 states in my analysis.

Active, Nonfederal, Physicians/1,000 Resident Population (PHYS)

Each year, the American Medical Association releases data on physician supply in the U.S. (AMA, selected years). I calculated PHYS for 1971-1989 using resident population data from the bureau of the Census (Bureau of the Census, 1984, 1992).[4]

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[1] Personal health care expenditures reflect spending for hospital, physician, and dental services, as well as that for vision products, pharmaceutical, and nursing home care. It does not however, include expenditures for program administration, net cost of private health insurance, government public health activities, or research and construction. HCFA classifies personal health care expenditures on a place of service basis. Per capita expenditures can be interpreted literally as the level of expenditures within a state per resident population.

[2] The date for total spending in 1976 and 1978 is lsightly different in each report. I used date form the 1985 report.

[3] I converted the BEA data to 19987 dollars using the CPI-U (Department of Commerce, 1992). The projections for the GDP implicit price deflator assume a 4.0% per year rate of inflation economywide from 1996 through 2020 (Burner et al, 1992).

[4] The AMA did not release data on physician supply for 1984. To fill in the missing data point, I estimated 1984 separately for each state in the following manner: 1984=1983*X, where $X=(1985/1983)^{1/2}$. All of the regressions in this analysis were run on Minitab Statistical Software 8.2 which uses the standard least squares technique for estimating regression coefficients.

Since 1971 the number of total, active, nonfederal physicians had increased linearly. In this analysis, I assume that the linear trend will continue through 2020. to project total physicians, I regressed separately for each state on time, annual data for total, active, nonfederal physicians 1971-1989. The coefficients from each state's respective regression were used to forecast the variable through the year 2020.

For all 49 states, the simple time trend model yielded a constant term and a coefficient with probability values equal to 0, in addition to an adjusted R^2 of 99% or greater. dividing the physician totals by resident population projections derived PHYS (BEA, 1990).[5] figure 2 shows PHYS for Maine, 1971-2020. This trend is indicative of all 49 states in my analysis.

The Bureau of Health Professions (BHP) recently projected total U.S. active physicians through 2020 (Burner et al, 1992). the BHP included federal physicians in their projections rendering an exact absolute comparison with my projections impossible. However, they provide a convenient reference for comparison. My projections seem to overestimate the rate at which the physician supply will grow in the future according to the BHP. In recovering PHYS, the data suggest that my projections, in turn, overestimate the rate at which PHYS might increase based on its behavior since 1971.

My analysis does not allow for any substantial physician migration between states. Those states with a higher proportion of elderly may attract a disproportionate number of physicians in the future.

Community Hospital Beds Per 1,000 Resident Population (BEDS)

The American Hospital Association releases annual data on beds supply in the U.S. (AHA, selected years). I calculated BEDS annually, 1971-1990, by dividing the total number of beds in each state by its resident population (Bureau of the Census, 1984, 1992).

I forecasted BEDS through 2020 based on past trends and intuition. Between 1971 and 1990, the number of community hospital beds in most states increased until the early 1980s when

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5 Resident population by states. More recent total U.S. population projections exist from the U.S. Bureau of the census. However, the Bureau did not parse the national projections into state subtotals.

it started to decline concurrent with a nationwide trend toward ambulatory care. This decline, however, will not likely continue. Increases in population and an aging population will demand an increase in the number of total beds in the future. I assume, by methodological design that BEDS, the ratio of beds per 1,000 population, will stay at or near current levels.

I projected BEDS separately for each state using one of two ARIMA models shown here:[6]

ARIMA 1 0 0: $BEDS_t = A1 + B1(BEDS_{t-1})$

ARIMA 1 1 0: $(BEDS_t - BEDS_{t-1}) = B1(BEDS_{t-1} - BEDS_{t-2})$

Initially, I tried to fit annual data from 1971 to 1990 with ARIMA 100 for all states. For 38 states, the coefficient estimated by ARIMA 100 was insignificant at 5% or the model produced unstationary forecasts. In these cases, I estimated the same data with ARIMA 110 of which 18 states yielded insignificant coefficient estimates at 5%. By methodological design, ARIMA projected stationary date in all cases. Figure 3 shows projections of BEDS 1971-2020 for Montana and Michigan estimated with ARIMA 100 and ARIMA 110 respectively.

By using ARIMA 100 I hoped to capture real trends in BEDS that could significantly be forecasted through 2020. Resorting to ARIMA 110 was the most convenient way to generate a stationary forecast for the other 38 states, many of which probably exhibit random walk behavior for the rime period between 1971 and 1990.

Community Hospital Beds in Metropolitan Areas (URB)

The American Hospital Association reports annually the number of beds in metropolitan areas (AHA, selected years). I calculated URB annually from 1971 to 1990 by dividing the number of beds in metropolitan areas by the total number of beds in each state. Between 1971 and 1990 URB displayed erratic behavior in most states. Because no clear trend up or down

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6 ARIMA stands for Autoregressive Integrated Moving Average. People often use the convention P,D,Q to describe ARIMA models. P - degree of autoregression, D - numbers of differences, Q - degree of moving average. Again, I used Minitab Statistical Software Release 8.2 to estimaate and forecast all ARIMA models.

existed during that time period, I projected URB at or near current levels for each state through 2020 using the same method outlined for BEDS.

I forecasted data for 10 states with ARIMA 100, the remainder of which were projected using ARIMA 110. From these, 33 coefficient estimates were insignificant at 5%. Figure 4 shows projections of URB 1971-2020 for Iowa and West Virginia estimated with ARIMA 100 and ARIMA 110 respectively.

Multivariate Regression Model

In an effort to capture some important underlying forces that drive health spending, I estimated a cross sectional multivariate regression model of the following form:[7]

$$PPHCE = A_1 + B_1INC + B_2PHYS + B_3BEDS + B_4URB$$

I estimated coefficients separately for 1972, 1978, 1980, and 1982.[8] In addition, I converted PPHCE and INC into 1972 dollars using, as deflators, the CPI-Medical Care and CPI-U respectively for 1978, 1980, and 1982, after which I estimated coefficients for all three cross sections (Department of Commerce, 1992).

The Chow test evaluates the null hypothesis that coefficients estimated at different points in time using the same model are statistically equivalent. Using this test, I tested the null hypothesis that the coefficients from the nominal analysis are statistically equivalent in 1980 and 1982. Subsequently, I tested the hypothesis that the coefficients from the real analysis are statistically equivalent in 1978, 1980, and 1982.

Using coefficients from the 1982 cross sectional analysis and forecasts for INC, PHYS, BEDS, and URB, I estimated preliminary PPHCE for selected years 1990-2020.[9] HCFA recently published projections of U.S. personal health care spending through 2030 (Burner et al, 1992).

[7] In 1992, the U.S. Government Accounting Office (GAO) released the results of its effort to identify those independent variables that significantly explain state-level differences in 1982 per capita personal health care expeditures (PPHCE) (GAO, 1992). Several independent variables proved significant at 95% confidence when regressed against 1982 PPHCE. From the significant independent variables identified in the GAO analysis I chose four of the most influential and ones that would allow for easy comparison through time.

[8] All of the regressions for this analysis were estimated on Minitab Statisitcal Software Release 8.2 which employs the standard least squares technique to estimate regression coefficients.

[9] For 1990, I used PHYS 1989 because 1990 data had not been released.

These projections serve as a convenient benchmark to which I standardized preliminary PPHCE data yielding adjusted forecasts for PPHCE.[10]

Time Trend Model

I employed PPHCE reported by HCFA for 9 selected years between 1966 and 1982 to estimate a simple time trend model (Levit, 1985):

$$PPHCE = A1 + B1(TIME)^2$$

I estimated the coefficients separately for each state. The coefficients from each regression were used to forecast PPHCE for 1990, 1995, 2000, 2010, and 2020. The forecasts were adjusted to HCFA projections of total U.S. personal health care spending.

Results

MULTIVARIATE REGRESSION MODEL

Table 1 contains the results of four different cross sectional analyses. Each analysis yielded a constant term A1, and four independent variable coefficients B1-B4. Across the decade, no clear trend arises for the constant term, or the coefficients on INC and PHYS. However, the coefficients of BEDS and URB steadily increase over the ten year period. The prob value for every coefficient is less than the critical value at 5% significance for the t-test. The constant term is never significant. The adjusted R^2 in the HCFA cross sections resides in the mid-seventies throughout the ten year period.

The Chow test, the results of which are shown in Table 2, rejected the null hypothesis that the coefficients for INC, PHYS, BEDS, and URB are statistically equivalent in the 1980/1982 nominal comparison. When the coefficients from real cross sectional analysis were examined for equivalency, the test did not reject the null in the 1980/1982 comparison. However, the null was rejected when the same comparison included 1978. The adjusted data projecting per capita

[10] I will use 1995 as a prototype adjustment. Preliminary PPHCE for 1995 were multiplied by BEA 1995 state population projections to yield proliminary forecasts of total personal health care spending by state. Summing the state total yields a prediction of 1995 U.S. total spending, becoming the denominator for the ratio: HCFA projectoins of U.S. personal health care spending/Multivariate projections of the same. This ratio yields a 1995 adjustment factor by which all of the prliminary state totals are multiplied.

personal health care spending thorough 2020 by state using the multivariate regression model appear in Table 3.

TIME TREND MODEL

Forty-nine independent regressions yielded a significant constant and coefficient, prob values for each equal to 0, and adjusted R^2 values equal to or greater than 99%. The constant and coefficients were used to forecast the dependent variable thorough 2020 the adjusted results of which appear in Table 3.

Figure 5 provides a summary of forecasts, preliminary and adjusted, generated by both models, for PPHCE 1990-2020.

Discussion

Unfortunately, HCFA stopped releasing data for per capita personal health care spending by state in 1982. If it hadn't, policymakers would be more informed about state spending and better prepared to confront reform. Apparently, HCFA plans to release 1990 estimates data soon, but as of Spring 1993, it had not done so. Since no data exists after 1982, I was forced, in effect, to use 1982 as the point of departure for my forecasts.

The multivariate model assumes that the coefficients on INC, PHYS, BEDS, and URB, as a foursome, have not changed since 1982 and will not change through the end of the projection period. The results of the Chow Tests render this assumption unrealistic. In using the test, I intended to start in 1982 and try to show coefficient equivalence as far back into the past as possible. However, in the nominal analysis, the test dejected the null hypothesis that the coefficients in the model were equal in 1980 and 1982.

By converting PPHCE and INC both to 1972 dollars, and again testing for equivalency through time, I hoped to eradicate the exaggerated effects of inflation on the sum squared errors n the restricted regression and recover more consistency in the coefficients through time. Using real data, the test did not reject the null that these coefficients were equal in 1980 and 1982, but it did reject the null that the coefficients were equal across six years 1978-1982. Clearly, from these

results, the magnitude of the coefficients on INC, PHYS, BEDS, and URB sections change through time.

At one point, converting my analysis to real terms looked attractive, but I would have gained little temporal consistency in the coefficients. Furthermore, adjusting real projections to HCFA nominal forecasts of U.S. personal health care expenditures would have been impossible.

INC and PHYS exhibit no apparent trend between 1972 and 1982. Their behavior appears somewhat random with the averages for the coefficients on INC and PHYS being .047 and 73. No apparent reasons exist to argue that the coefficients will increase or decrease significantly through the end of the projection period. Therefore, using the 1982 coefficients for INC and PHYS to project the dependent variable seems reasonable because both of them are close to their averages over the decade between 1972 and 1982.

The coefficients on BEDS and URB appear to increase steadily from 1972 to 1982. Therefore, using the 1982 coefficients to predict 1990 and beyond underestimates the dependent variable in absolute terms. Furthermore, the adjusted R^2 statistic decreased slightly between 1972 and 1982. Therefore, the four independent variables in this model lose some explanatory power over the decade. That trend may or may not continue through 2020. If the trend continues, my projections will become increasingly inaccurate. Because INC and PHYS account for much of the variation in PPHCE, perhaps the relative stability of their coefficients will yield accurate state projections in relative terms. Subsequently adjusting the forecasts to the HCFA estimates of total U.S. personal health care expenditures perhaps recovers more realistic absolute forecasts.

The time trend model does not capture any of the underlying forces that drive per capita personal health care expenditures within states. It assumes that the variable will behave in the future in accordance with a trend set in the past. Because the time squared variable fit the historical state data with and adjusted R^2 of 99% or greater in each case, the assumption that this trend will continue seems reasonable.

The best way to evaluate whether these models predict realistic relative differences in spending through time is to calculate a spending index for each state (U.S.=1.00). Table 4 shows spending indices for 1972, 1982, 1990, and 2020. The time trend model suggests that the ratio of each state's per capita spending to U.S. per capita spending was nearly identical in 1990 to actual data for 1982. The correlation between the two data sets is .9. The multivariate model suggests that to a greater degree the state indices shifted between 1982 and 1990. The correlation between these data sets is .77.

How much might we expect state indices to very through time? The correlation between spending indices in 1972 and 1982 figures is .9. From this, we can assume that a statistical correlation between actual data in 1982 and 1990 would yield a number near .9. If this assumption is correct, then the time trend model projects too much consistency in the data whereas the multivariate model predicts too little. However, the two correlations (.99 and .77) are sufficiently similar to .9 that neither can be used to disqualify either model from consideration.

For both models, the state indices in 2020 seem relatively on par with that for 1990. Both models probably predict too much consistency in spending indices after 1990 because the correlation between data in 1990 and 2000 for both models is greater than .98. In the multivariate model, the consistency is probably due to my assumption that BEDS and URB will stay constant at or near current levels through 2020.

Correlations through time indicate how state spending indices shift relative to the U.S. average. An alternative approach examines how rankings of individual states shift relative to one another through time. Table 5 shows, in decreasing order, how states ranked relative to one another in 1972 and 1982 and how they will rank if either projection scenario probes to be accurate.

Between 1972 and 1982, the five top and five bottom spenders jumped and average of 1 and 4 ranks respectively. The twenty states from 15-35 shifted an average of 7 places. Ohio moved 18 ranks, more than any other state. Based on these facts, one would expect the top and bottom five states to move relatively less than those twenty states ranked 15-35 between 1982 and 1990.

The multivariate forecasts for states shift more drastically than do time trend model forecasts. The top five, middle twenty, and bottom five states in the multivariate forecasts moved 4, 7, and 3 places on average. The time trend forecasts moved and average of 1, 2, 1 for the same categories. The multivariate model seems to project shifts in the middle and bottom categories on par with the same categories between 1972 and 1982. However, the top five spenders shift more drastically than the states in the same category between 1972 and 1982.

There is one extreme case of movement in the multivariate projections. New Jersey jumps from 28 in 1982 to number 1 in 1990, certainly an implausible phenomenon. Such a radical shift can be attributed to New Jersey's extremely high per capita personal income, second only to Connecticut. New Jersey's unrealistic behavior highlights the drawbacks of forecasting spending as a function of only four independent variables. One variable for any one state that is extremely high will probably overestimate the dependent variable. Although the multivariate forecasts produce unlikely results represented by New Jersey's unlikely shift, it might, on average, predict state's relative spending quite well.

On the assumption that similar factors drive both total spending and spending for Medicare, I made quantitative comparisons between 1990 spending indices generated by each model and 1991 spending indices for Medicare expenditures per capita for the elderly (Bureau of the Census, 1992). Support for this assumption originates from a correlation of .78 between 1982 spending and 1983 Medicare indices (Bureau of the Census, 1984).

The 1990 projections generated by each model correlate loosely with 1991 Medicare data. I computed a correlation of .49 and .43 between the Medicare data and my multivariate and time trend estimates respectively. The Medicare data is not consistent through time. The correlation between 1983 and 1991 Medicare data is .64.

It is possible that Medicare outlays per capita and personal health care expenditures by state have diverged since 1982 as a result of sweeping changes in Medicare reimbursement. If this is true, the loose correlation between my 1990 estimates and Medicare data may not discredit the accuracy of my projections.

Another way to evaluate these models is to compare them with the only other available set of state level estimates and projections for 1990 and 2000 developed by Lewin & Associates, and independent consulting firm (Families USA Foundation, 1990). These estimates are residence based and include administrative costs, thus rendering a direct absolute comparison impossible. However, computing correlations between spending indices will reveal similarities should they exist. The correlation between the relative spending index derived from the multivariate projections and Lewin estimates is .759 and .751 for 1990 and 2000 respectively. In addition, the correlation between the index based on the time trend model and the Lewin estimates is .985 and .981 for 1990 and 2000 respectively. in constructing their projections, Lewin and Associates benchmarked some of their estimates of components of state spending to relative spending derived from 1982 HCFA data. Perhaps the strong correlation between the rime trend analysis and the Lewin numbers is a result of such a strong reliance in both cases on HCFA data.

Theoretically, one might expect regression towards the mean in per capita spending through 2020. For example, between 1972 and 1982 the sum of the spending indices residuals around 1.00 decreased slightly from 6.00 to 5.71. This indicates some slight regression towards a mean of 1.00. The multivariate model projects a similar, modest, regression towards the mean with the sum of the residuals equal to 5.41 in 1990 diminishing to 5.18 in 2020. However, the time trend model 2 projects regression away from the mean with a sum of residuals equal to 5.72 in 1990 increasing to 5.77 in 2020.

Both models exhibit appealing qualities, but, on the whole, neither model stands alone as the obvious better predictor of per capita personal health care expenditures by state. The multivariate model seems more intuitively appealing because it captures underlying forces that drive health spending. However, because the coefficients in the model are changing constantly, projection the dependent variable proves difficult. The multivariate model seems to project more movement among states between 1982 and 1990 than we might expect based on the similar movement between 1972 and 1982. Whether or not the projected movement is real or arbitrary

will remain to be seen if and when HCFA publishes per capita data for 1990. Lastly, the multivariate model projects regression to the mean, a likely phenomenon.

The time trend model forecasts more consistent spending through time. With little discrepancy the same numbers could have been generated by assuming that between 1982 and 2020 each state spends the same percentage of the national average. However, judging from minimal changes in rank from 1972 to 1982, the time trend model probably predicts too much consistency. The same model predicts regression away from the mean, again, unlikely based on trends from 1972 through 1982.

In economics, forecasting anything proves formidable at best. The future and only the future can validate the accuracy of predictive data. This unfortunate fact forces the prognosticator to rely on many assumptions grounded only in intuition and convenience. The elusive nature of accurate forecasts should not, however, preclude the exercise. With the most reasonable assumptions and intuition, forecasts can provide the best guess for what the future might hold in store.[11]

[11] I would like to thank Chris Conover for advising this project. Furthermore, I thank T. Dudley Wallace and Chris Wever for econometric guidance.

Figure 1

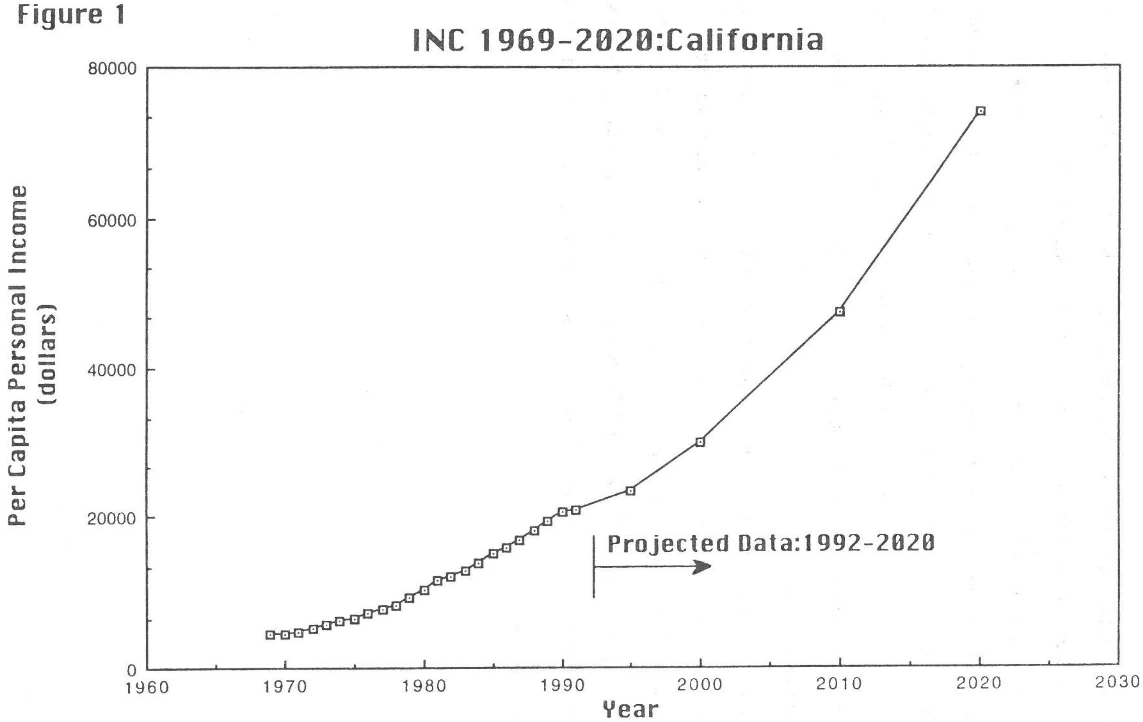

Figure 2

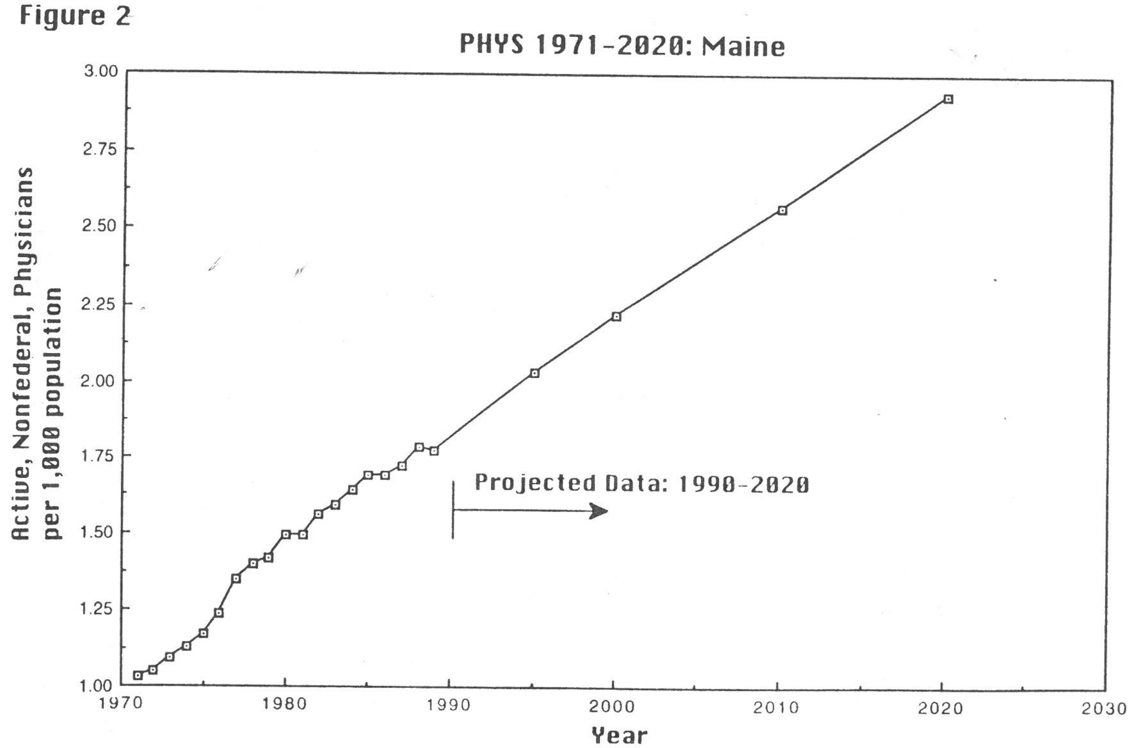

Figure 3

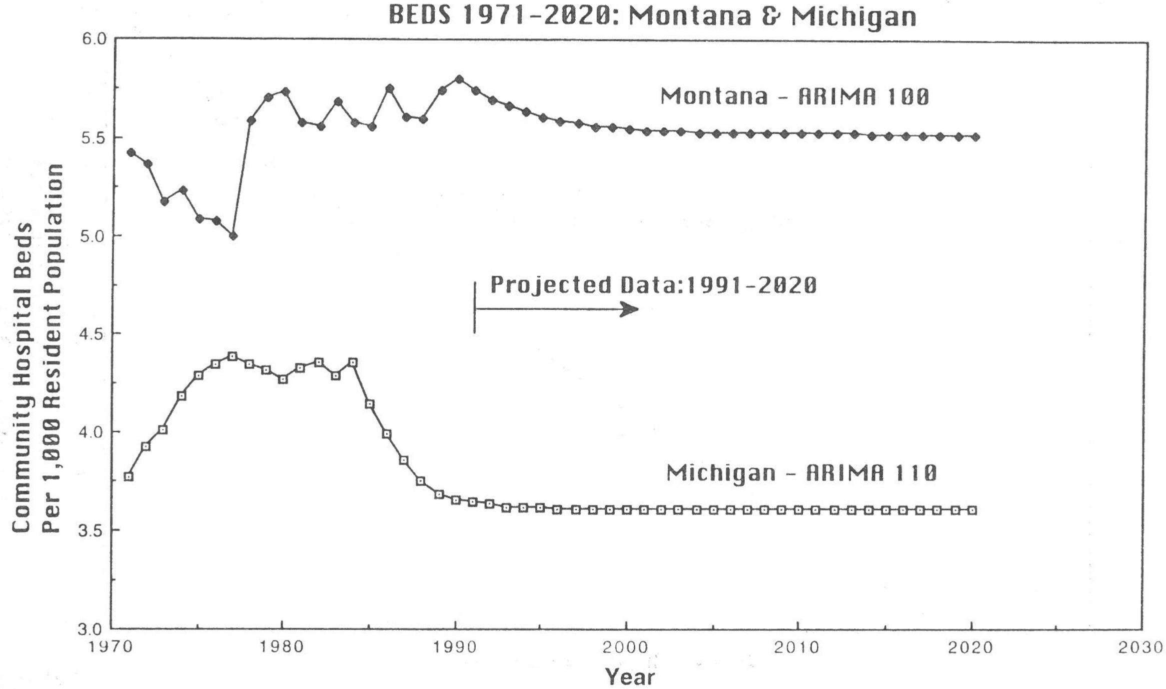

Figure 4

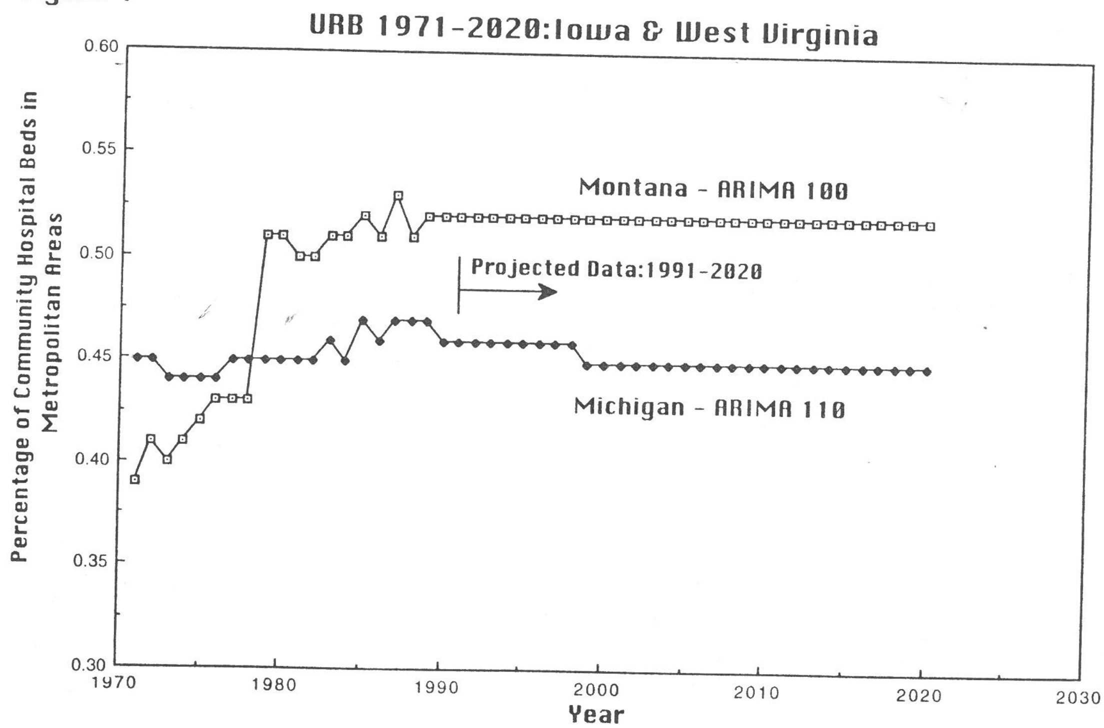

Table 1

Coefficients, T-Ratios, Probability Vales, and R^2 Values Estimated for Nominal Multivariate Regression Model Selected Years, 1972-1982

Model: $PPHCE=A_1+B_1(INC)+B_2(PHYS)+B_3(BEDS)+B_4(URB)$

Coefficients

Year	A_1	B_1	B_2	B_3	B_4
1972	-27.1	0.047	55.3	20.3	.311
1978	-34.5	0.045	79.9	41.5	1.30
1980	-57.6	0.048	68.3	64.2	1.78
1982	-65.3	0.047	90.1	82.7	2.79

T-Ratios

Year	A_1	B_1	B_2	B_3	B_4
1972	-.93	7.74	4.61	5.24	1.93
1978	-.53	6.81	3.64	5.69	3.88
1980	-.60	5.99	2.34	6.06	3.81
1982	-.58	5.78	2.44	6.74	4.08

Probability Values

Year	A_1	B_1	B_2	B_3	B_4
1972	.36	0	0	0	.06
1978	.60	0	.001	0	0
1980	.55	0	.024	0	0
1982	.56	0	.019	0	0

R^2 and Adjusted R^2

Year	R^2	Adjusted R^2
1972	85.4	84.1
1978	79.4	77.6
1980	75.5	73.3
1982	77.0	74.9

Table 2

Test for Stability of Coefficients Through Time Estimated for the Multivariate Regression Model

Comparison	DF_N[1]	DF_D	F-Statistic[2]	Critical Value[3]
Nominal Analysis:				
1980/1982	4	90	21.35	4.5
Real Analysis:				
1980/1982	4	90	.48	4.5
1978/1980/1982	4	140	6.77	4.45

[1] DF_N and DF_D are degrees of freedom in the numberator and denominator of the F-statistic.

[2] $F\text{-Statistic} = \frac{SSE(Unrestricted)-SSE(Restricted)/DF_N}{SSE(Unrestricted)/DF_D}$

[3] Approximate value at 5% confidence level (Goodnight & Wallace, 1972).

Table 3

Projections of Per Capita Personal Health Care Expenditures 1990-2020

	Model 1:Multivariate Regression Analysis					Model 2:Time Trend Analysis				
STATE	1990	1995	2000	2010	2020	1990	1995	2000	2010	2020
ALABAMA	2097	3352	5144	10595	20871	2041	3310	5123	10719	21451
ALASKA	2120	3508	5509	11898	24770	2343	3786	5846	12199	24381
ARIZONA	2032	3385	5251	11041	22164	2145	3452	5318	11065	22082
ARKANSAS	1928	3101	4761	9846	19498	1940	3148	4876	10209	20437
CALIFORNIA	2478	4036	6246	13121	26520	2825	4558	7034	14662	29288
COLORADO	2274	3663	5682	11973	24227	2278	3664	5640	11727	23394
CONNECTICUT	2938	4770	7385	15427	30789	2553	4110	6335	13185	26317
DELAWARE	2352	3693	5722	11958	24023	2208	3549	5465	11365	22673
FLORIDA	2430	3949	6090	12653	25113	2430	3930	6074	12685	25363
GEORGIA	2151	3509	5439	11413	22942	2088	3383	5235	10945	21896
HAWAII	2346	3599	5587	11722	23621	2331	3755	5790	12058	24074
IDAHO	1648	2652	4218	9214	18941	1686	2713	4177	8690	17340
ILLINOIS	2542	3994	6148	12776	25446	2526	4079	6298	13139	26254
INDIANA	2165	3520	5434	11326	22561	2126	3433	5300	11057	22094
IOWA	2212	3534	5440	11294	22430	2302	3722	5751	12008	24006
KANSAS	2232	3664	5690	11967	23934	2467	4002	6196	12966	25951
KENTUCKY	1981	3173	4898	10196	20295	1831	2962	4579	9564	19125
LOUISIANA	2110	3379	5163	10564	20747	2169	3522	5455	11420	22864
MAINE	2042	3324	5182	10963	22189	2124	3434	5306	11077	22145
MARYLAND	2691	4371	6751	14059	28111	2375	3839	5930	12375	24735
MASSACHUSETTS	2853	4673	7169	14770	29302	2881	4641	7156	14902	29751
MICHIGAN	2298	3763	5812	12141	24275	2501	4041	6241	13023	26028
MINNESOTA	2369	3849	5948	12409	24744	2370	3826	5907	12318	24611
MISSISSIPPI	1772	2838	4365	9062	18037	1839	2993	4646	9747	19534
MISSOURI	2366	3833	5889	12175	24095	2497	4043	6251	13065	26131
MONTANA	2028	3269	5024	10453	20866	1982	3197	4933	10281	20535
NEBRASKA	2285	3742	5778	11964	23591	2352	3802	5875	12263	24514
NEVADA	2263	3670	5697	11966	24195	2801	4549	7050	14766	29567
NEW HAMPSHIRE	2310	3816	5972	12711	25854	1880	3022	4652	9673	19294
NEW JERSEY	2965	4744	7331	15268	30447	2150	3465	5341	11122	22205
NEW MEXICO	1767	2912	4549	9672	19628	1761	2840	4381	9131	18238
NEW YORK	2853	4555	6994	14455	28733	2657	4266	6561	13628	27171
NORTH CAROLINA	2021	3279	5107	10769	21638	1837	2972	4595	9599	19194
NORTH DAKOTA	2272	3611	5490	11156	21805	2611	4229	6541	13671	27345
OHIO	2303	3698	5687	11816	23497	2405	3895	6025	12594	25193
OKLAHOMA	1974	3257	5078	10727	21491	2095	3378	5212	10860	21689
OREGON	2078	3345	5201	10961	22047	2248	3625	5591	11651	23269
PENNSYLVANIA	2520	4017	6166	12700	25045	2442	3954	6115	12778	25558
RHODE ISLAND	2421	3925	6034	12481	24877	2602	4199	6480	13509	26987
SOUTH CAROLINA	1901	3064	4768	10048	20150	1705	2763	4275	8940	17887
SOUTH DAKOTA	2116	3270	5013	10397	20625	2229	3616	5598	11715	23448
TENNESSEE	2253	3606	5516	11322	22333	2221	3603	5579	11677	23373
TEXAS	2141	3480	5407	11392	22785	2173	3513	5428	11331	22650
UTAH	1832	2954	4573	9616	19341	1744	2810	4334	9030	18031
VERMONT	2064	3314	5179	11004	22385	1843	2947	4522	9368	18650
VIRGINIA	2331	3816	5946	12569	25454	2064	3349	5186	10855	21728
WASHINGTON	2201	3554	5551	11792	23944	2204	3543	5453	11336	22610
WEST VIRGINIA	1926	3055	4661	9520	18831	2019	3268	5054	10560	21121
WISCONSIN	2190	3573	5541	11629	23282	2384	3856	5958	12439	24867
WYOMING	1983	3147	4916	10432	21074	1629	2599	3982	8232	16372
U.S.	2359	3810	5886	12287	24561	2359	3810	5886	12287	24561

Figure 5

PPHCE 1966-2020: Ohio

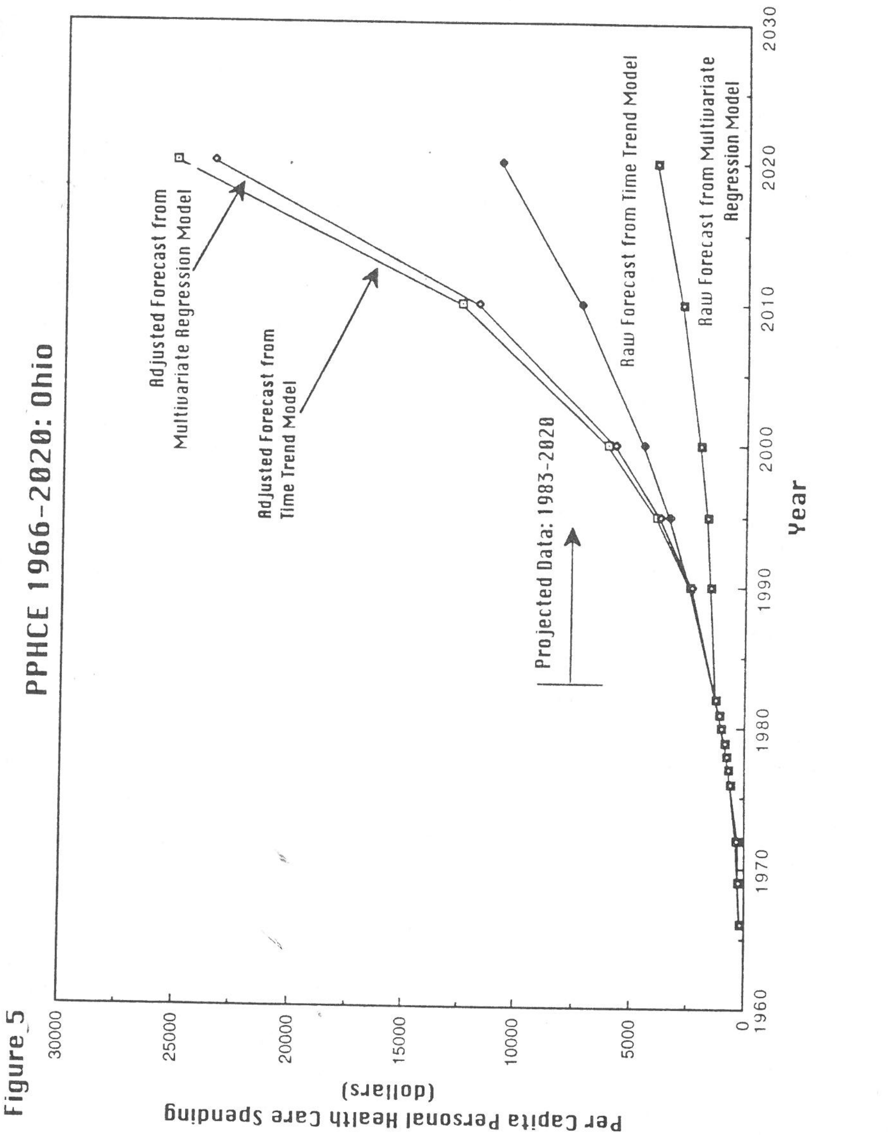

Table 4

Comparison of Spending Indices for Per Capita Personal Health Expenditures 1972, 1982, 1990, 2020 (U.S.=1.00)

STATE	1972 Actual	1982 Actual	1990 Model[1] #1	1990 Model[1] #2	2020 Model #1	2020 Model #2
ALABAMA	.80	0.85	0.89	0.87	0.85	0.87
ALASKA	.89	0.98	0.90	0.99	1.01	0.99
ARIZONA	1.00	0.91	0.86	0.91	0.90	0.90
ARKANSAS	.76	0.82	0.82	0.82	0.79	0.83
CALIFORNIA	1.24	1.19	1.05	1.20	1.08	1.19
COLORADO	1.05	0.99	0.96	0.97	0.99	0.95
CONNECTICUT	1.16	1.11	1.25	1.08	1.25	1.07
DELAWARE	1.01	0.95	1.00	0.94	0.98	0.92
FLORIDA	1.00	1.01	1.03	1.03	1.02	1.03
GEORGIA	.86	0.86	0.91	0.89	0.93	0.89
HAWAII	1.05	1.01	0.99	0.99	0.96	0.98
IDAHO	.78	0.71	0.70	0.71	0.77	0.71
ILLINOIS	1.08	1.08	1.08	1.07	1.04	1.07
INDIANA	.89	0.91	0.92	0.90	0.92	0.90
IOWA	.93	0.97	0.94	0.98	0.91	0.98
KANSAS	1.0	1.05	0.95	1.05	0.97	1.06
KENTUCKY	.76	0.79	0.84	0.78	0.83	0.78
LOUISIANA	.85	0.91	0.89	0.92	0.84	0.93
MAINE	.87	0.90	0.87	0.90	0.90	0.90
MARYLAND	1.03	1.01	1.14	1.01	1.14	1.01
MASSACHUSETTS	1.29	1.24	1.21	1.22	1.19	1.21
MICHIGAN	1.05	1.05	0.97	1.06	0.99	1.06
MINNESOTA	1.02	1.01	1.00	1.00	1.01	1.00
MISSISSIPPI	.65	0.74	0.75	0.78	0.73	0.80
MISSOURI	.97	1.06	1.00	1.06	0.98	1.06
MONTANA	.86	0.85	0.86	0.84	0.85	0.84
NEBRASKA	.99	1.00	0.97	1.00	0.96	1.00
NEVADA	1.04	1.13	0.96	1.19	0.99	1.20
NEW HAMPSHIRE	.87	0.81	0.98	0.80	1.05	0.79
NEW JERSEY	.94	0.92	1.26	0.91	1.24	0.90
NEW MEXICO	.75	0.74	0.75	0.75	0.80	0.74
NEW YORK	1.25	1.17	1.21	1.13	1.17	1.11
NORTH CAROLINA	.74	0.77	0.86	0.78	0.88	0.78
NORTH DAKOTA	.98	1.09	0.96	1.11	0.89	1.11
OHIO	.88	1.03	0.98	1.02	0.96	1.03
OKLAHOMA	.93	0.89	0.84	0.89	0.88	0.88
OREGON	.97	0.96	0.88	0.95	0.90	0.95
PENNSYLVANIA	.98	1.05	1.07	1.04	1.02	1.04
RHODE ISLAND	1.09	1.11	1.03	1.10	1.01	1.10
SOUTH CAROLINA	.66	0.70	0.81	0.72	0.82	0.73
SOUTH DAKOTA	.87	0.95	0.90	0.94	0.84	0.95
TENNESSEE	.86	0.94	0.95	0.94	0.91	0.95
TEXAS	.90	0.91	0.91	0.92	0.93	0.92
UTAH	.76	0.74	0.78	0.74	0.79	0.73
VERMONT	.93	0.80	0.87	0.78	0.91	0.76
VIRGINIA	.80	0.87	0.99	0.87	1.04	0.88
WASHINGTON	1.03	0.96	0.93	0.93	0.97	0.92
WEST VIRGINIA	.84	0.87	0.82	0.86	0.77	0.86
WISCONSIN	1.02	1.00	0.93	1.01	0.95	1.01
WYOMING	.87	0.72	0.84	0.69	0.86	0.67
Residuals[2]	6.00	5.71	5.41	5.72	5.18	5.77

[1] Model #1 - Multivariate Regression Analysis, Model #2 - Time Trend Analysis

[2] Sum of the residuals around 1.00

Table 5

Relative State Spending Index 1972, 1982, and 1990

	1972	1982	1990 Multivariate	1990 Time Trend
1.	Massachusetts	Massachusetts	New Jersey	Massachusetts
2.	New York	California	Connecticut	California
3.	California	New York	Massachusetts	Nevada
4.	Connecticut	Nevada	New York	New York
5.	Rhode Island	Rhode Island	Maryland	North Dakota
6.	Illinois	Connecticut	Illinois	Rhode Island
7.	Colorado	North Dakota	Pennsylvania	Connecticut
8.	Michigan	Illinois	California	Illinois
9.	Hawaii	Missouri	Florida	Michigan
10.	Nevada	Michigan	Rhode Island	Missouri
11.	Washington	Pennsylvania	Minnesota	Kansas
12.	Maryland	Kansas	Missouri	Pennsylvania
13.	Minnesota	Ohio	Delaware	Florida
14.	Wisconsin	Maryland	Hawaii	Ohio
15.	Delaware	Minnesota	Virginia	Wisconsin
16.	Kansas	Florida	New Hampshire	Maryland
17.	Florida	Hawaii	Ohio	Minnesota
18.	Arizona	Wisconsin	Michigan	Nebraska
19.	Nebraska	Nebraska	Nebraska	Alaska
20.	Pennsylvania	Colorado	Colorado	Hawaii
21.	North Dakota	Alaska	North Dakota	Iowa
22.	Missouri	Iowa	Nevada	Colorado
23.	Oregon	Oregon	Tennessee	Oregon
24.	New Jersey	Washington	Kansas	South Dakota
25.	Iowa	South Dakota	Iowa	Tennessee
26.	Oklahoma	Delaware	Washington	Delaware
27.	Vermont	Tennessee	Wisconsin	Washington
28.	Texas	New Jersey	Indiana	Texas
29.	Alaska	Arizona	Georgia	Louisiana
30.	Indiana	Texas	Texas	New Jersey
31.	Ohio	Louisiana	Alaska	Arizona
32.	Maine	Indiana	South Dakota	Indiana
33.	Wyoming	Maine	Louisiana	Maine
34.	New Hampshire	Oklahoma	Alabama	Oklahoma
35.	South Dakota	West Virginia	Oregon	Georgina
36.	Georgia	Virginia	Vermont	Virginia
37.	Montana	Georgia	Maine	Alabama
38.	Tennessee	Montana	Ariaona	West Virginia
39.	Louisiana	Alabama	Montana	Montana
40.	West Virginia	Arkansas	North Carolina	Arkansas
41.	Alabama	New Hampahire	Wyoming	New Hampshire
42.	Virginia	Vermont	Kentucky	Vermont
43.	Idaho	Kentucky	Oklahoma	Mississippi
44.	Kentucky	North Carolina	Arkansas	North Carolina
45.	Utah	New Mexico	West Virginia	Kentucky
46.	Arkansas	Mississippi	South Carolina	New Mexico
47.	North Carolina	Utah	Utah	Utah
48.	New Mexico	Wyoming	Mississippi	South Carolina
49.	South Carolina	Idaho	New Mexico	Idaho
50.	Mississippi	South Carolina	Idaho	Wyoming

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