Priming the Pump:
Research as a Catalyst for Economic Growth

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Introduction

This analysis is designed to answer several important questions regarding the impact of research dollars invested in the state of Arkansas. We begin by discussing the state of the state in terms of income measures and measures of educational attainment levels. Throughout this analysis, the state of Arkansas is compared to the U.S., to a group of peer states , and, initially, to the state of Mississippi.[1]

Next, we examine the linkage between income and education. We also examine higher education in the state in terms of spending, access and research dollars. From this general description we examine the present status of research dollars invested in the state relative to our peers. Finally, we estimate the impact of research investment on per capita income and state revenues.

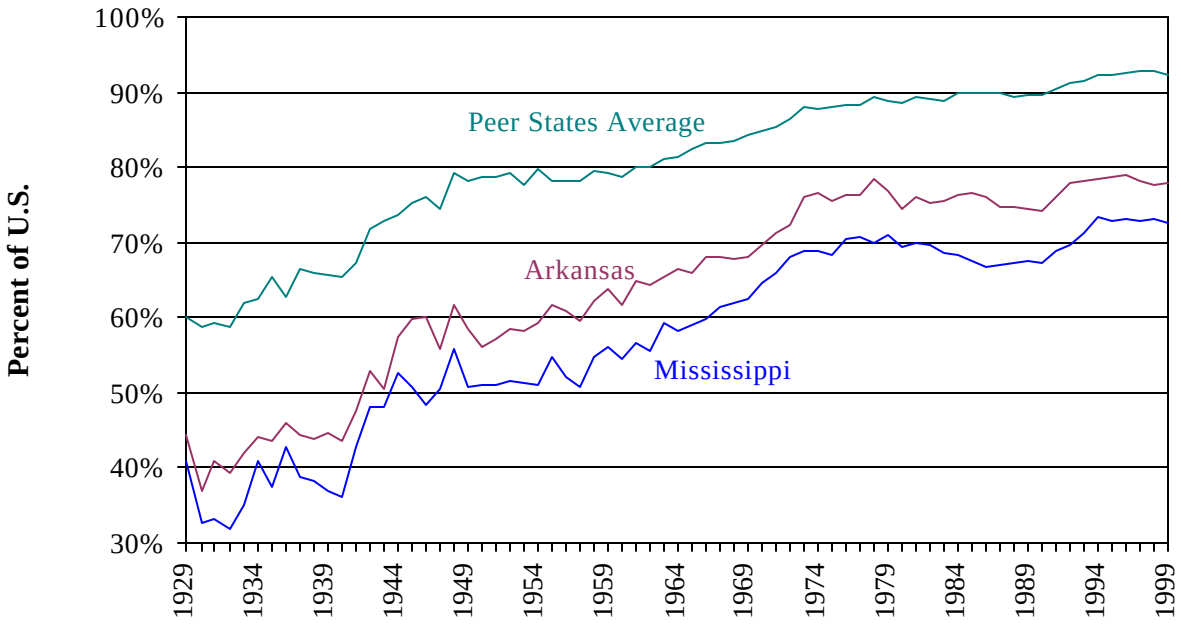
[1]The peer states are Georgia, Iowa, Kentucky, North Carolina, Tennessee, Texas and Virginia

I. Historical Income Trends

In this section we examine the historical trends in personal per capita income as a percentage of the U.S. average for Arkansas, a group of peer states, and Mississippi.

- The first chart shows Arkansas closing the gap with the U.S. average in the 1940s only to see the gap widen during the early 1950s.[2]
- Steady progress during the 1960s and 1970s stalled in the 1980s, as the state receded from its peak in 1978.
- The story of the 1990s has been minor oscillation around 75 percent of the national average.

State Personal Income Per Capita as a Percent of U.S. Average
1929-1999



Source: U.S. Bureau of Economic Analysis

Interestingly, movement relative to the U.S. average for Mississippi mirrors that of Arkansas but at a lower level. Ergo the saying, "Thank God for Mississippi!"

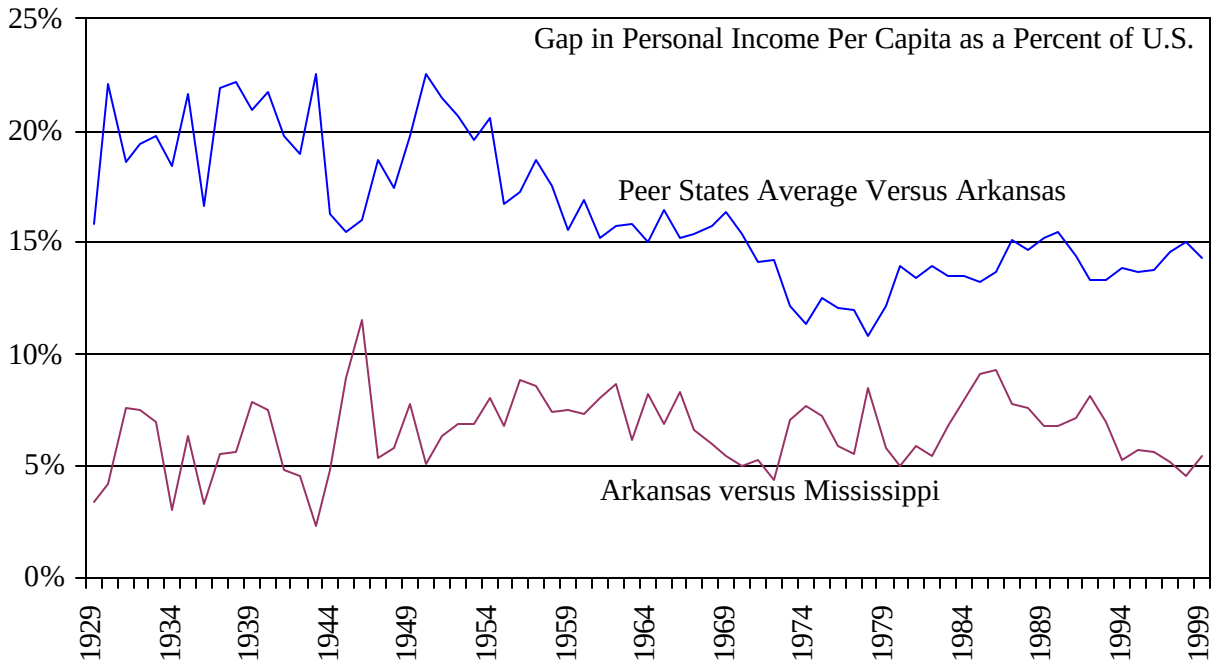
[2] All of the charts included in this paper incorporate source data as noted and additional calculations by the University of Arkansas Center for Business and Economic Research for presentation purposes.

Another interesting way to look at Arkansas' performance relative to our peers and Mississippi is to examine the gap in personal per capita income as a percent of the U.S. average--that is, to look at the difference in the gap for our peer states and the state of Arkansas or for Mississippi and Arkansas.

To interpret this chart, think of downward movement in either line as Arkansas moving towards the U.S. average relative to our peer states or the state of Mississippi.

The conclusion to be drawn is stagnation in Arkansas' performance relative to our peers. The graph indicates that the state of Arkansas hovers at around 75 percent of the U.S. average for the last decade, while our peers average approximately 90 percent of the U.S. average. Stated simply, we have not significantly improved relative to our peers for some time.

Closing the Gap: Personal Income Per Capita

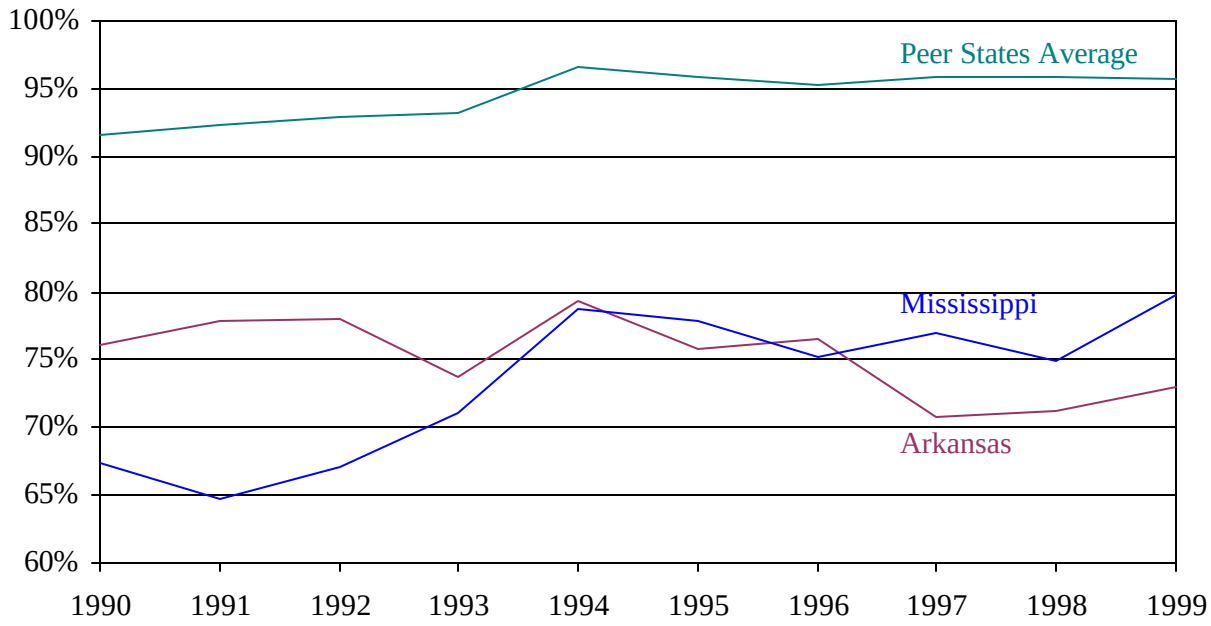


Source: U.S. Bureau of Economic Analysis

Finally, we examine state median household income rather than personal per capita income.

One problem with focusing on average measures like personal per capita income is that a few individuals with very large incomes can heavily influence per capita income. For example, if we look at the poorest county in Arkansas and entice Bill Gates, Jr. to move there, per capita income would suddenly look pretty good, but the income of the median household would probably not change much. Notice that when we examine Arkansas relative to Mississippi in terms of median household income as

State Median Household Income as a Percent of U.S.: 1990-1999



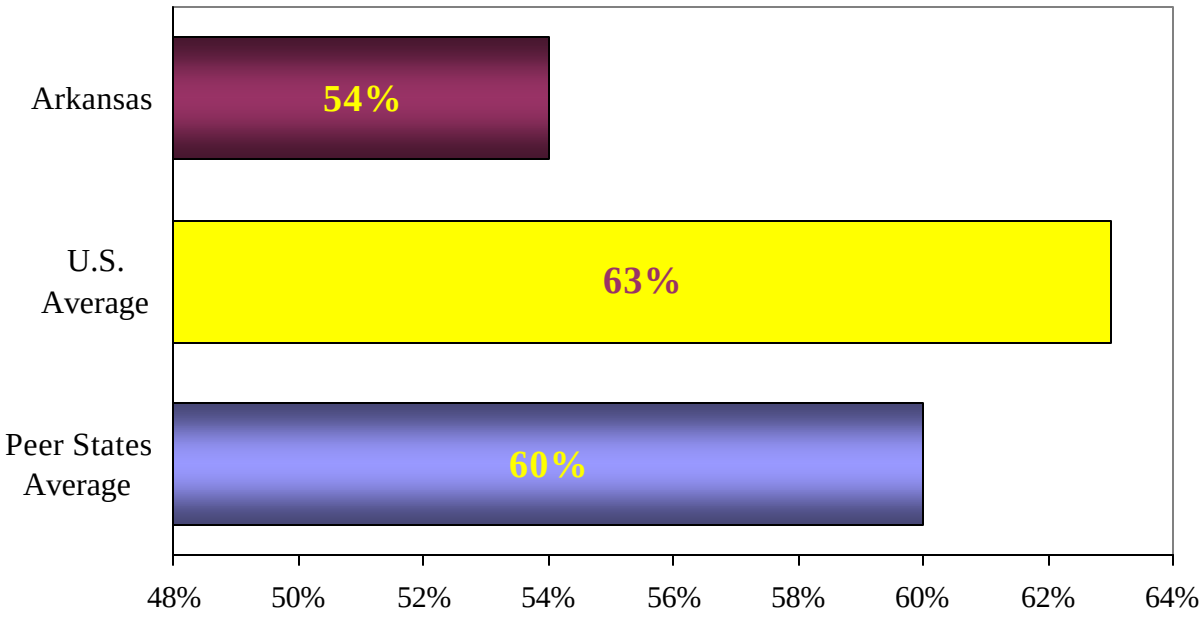
Source: U.S. Census Bureau

a percentage of the national average, we can no longer say, "Thank God for Mississippi." The conclusion is that Arkansas may have a few more Bill Gates, Jr. type earners than Mississippi, but that if we were to line up households in order of their incomes and examine the middle household, the Mississippi household would have higher income than the Arkansas household.

II. Higher Ed and Educational Attainment: Where do we stand?

This section focuses on measures of access to higher education, levels of educational attainment in 1990 and 1999 for Arkansas, our peer states, and the U.S. and income by level of educational attainment. The first chart shows the college going rate for Arkansas, our peers, and the U.S. average in 1996, the latest for which data on our peer states is available.

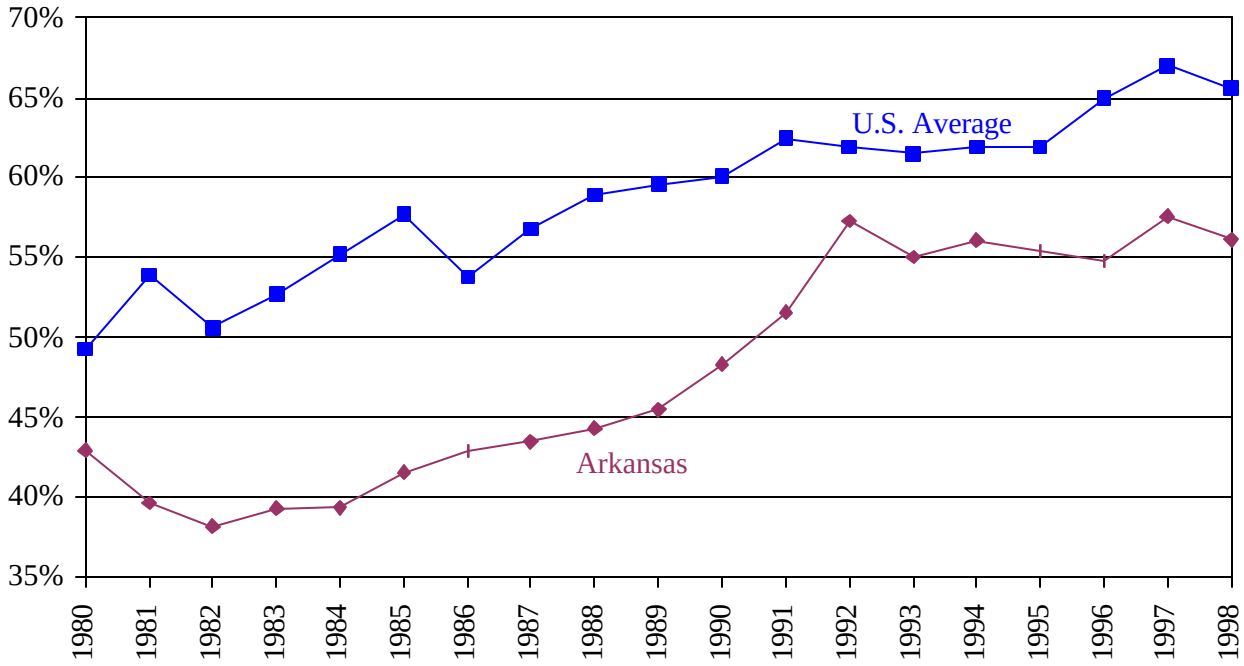
College Going Rate: 1996



Source: National Center for Education Statistics

While this graph indicates that Arkansas lags behind both our peers and the nation in terms of the percentage of high school graduates that attend college, it does not give us an indication of whether we are improving or falling farther behind in this area. The next chart shows the trend for the U.S. and for the state.

College Going Rate: 1980-1998



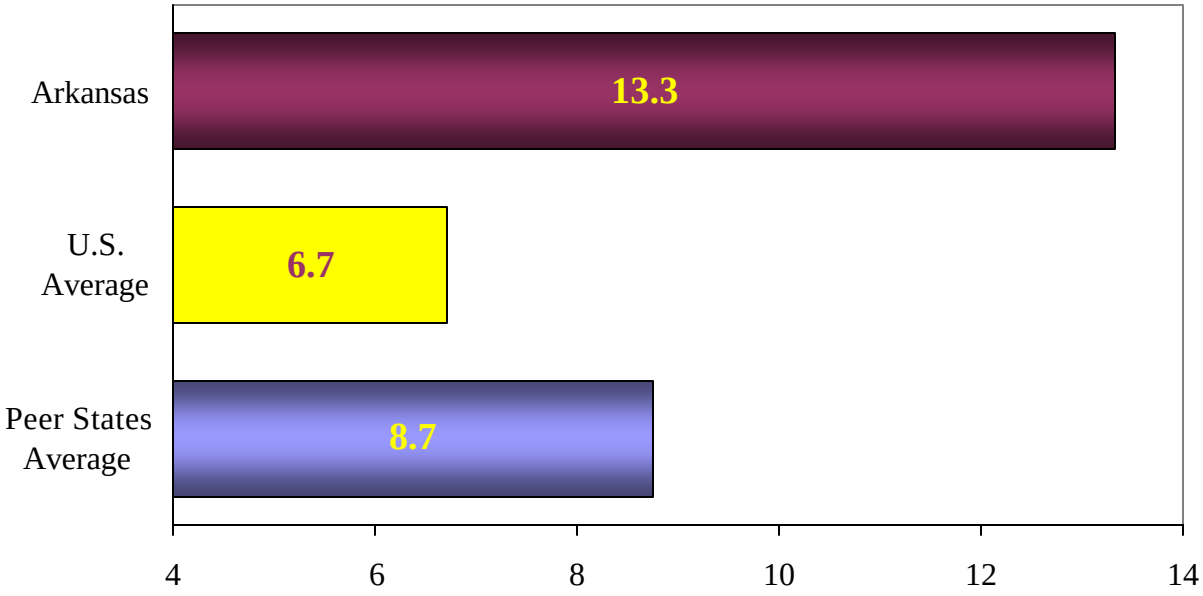
Source: National Center for Education Statistics

As evidenced by the above chart, Arkansas steadily approached the U.S. average during the 1980s and early 1990s.

However, the gap has widened since 1992. Much of the improvement during the late 1980s and early 1990s is in no doubt due to increased availability of higher education. Unfortunately, the potential benefits from increased access seem to have been achieved, and yet the gap persists.

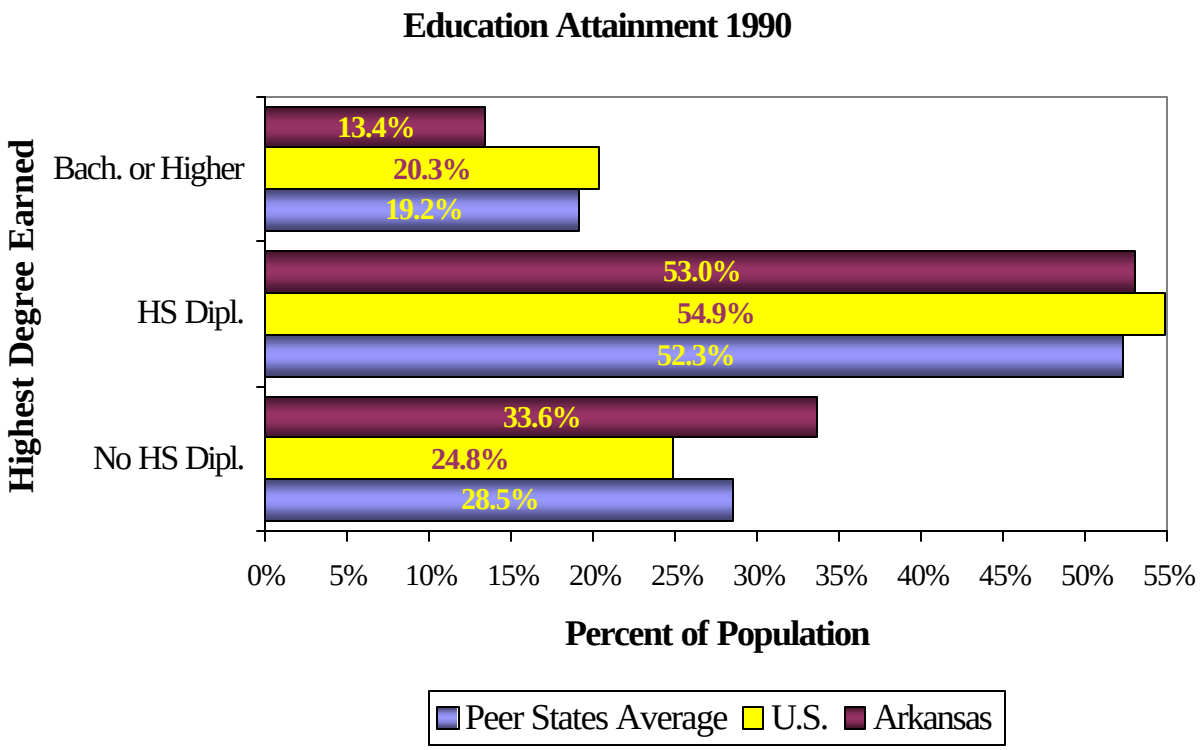
The next chart indicates the number of institutions per million persons. Clearly, Arkansas does not suffer from a lack of access to educational institutions, ranking 11th out of the fifty states in institutions per capita.

Public Institutions of Higher Education Per Million Population

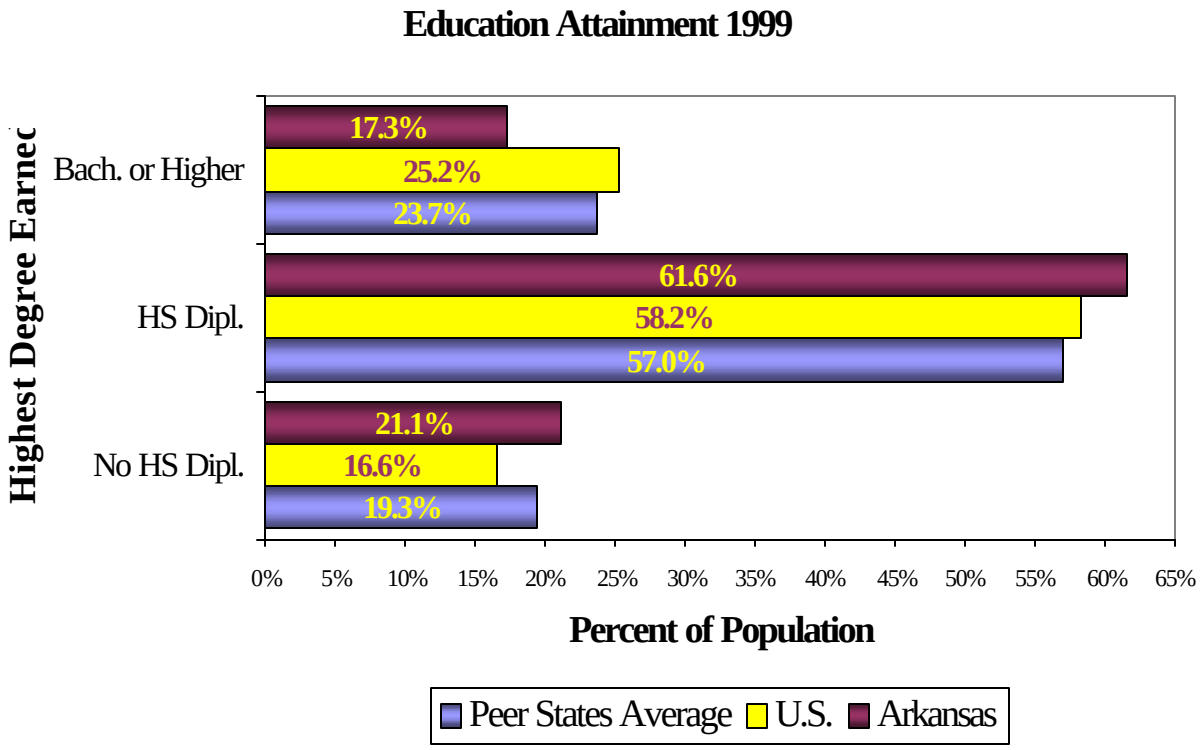


Source: National Center for Education Statistics

Perhaps a more important measure of the state of higher education in Arkansas is attainment. Thus, we ask, "Has access translated into higher levels of educational attainment in the state?" The following set of graphs shows educational attainment levels for the state, our peers and the U.S. in 1990 and 1999.



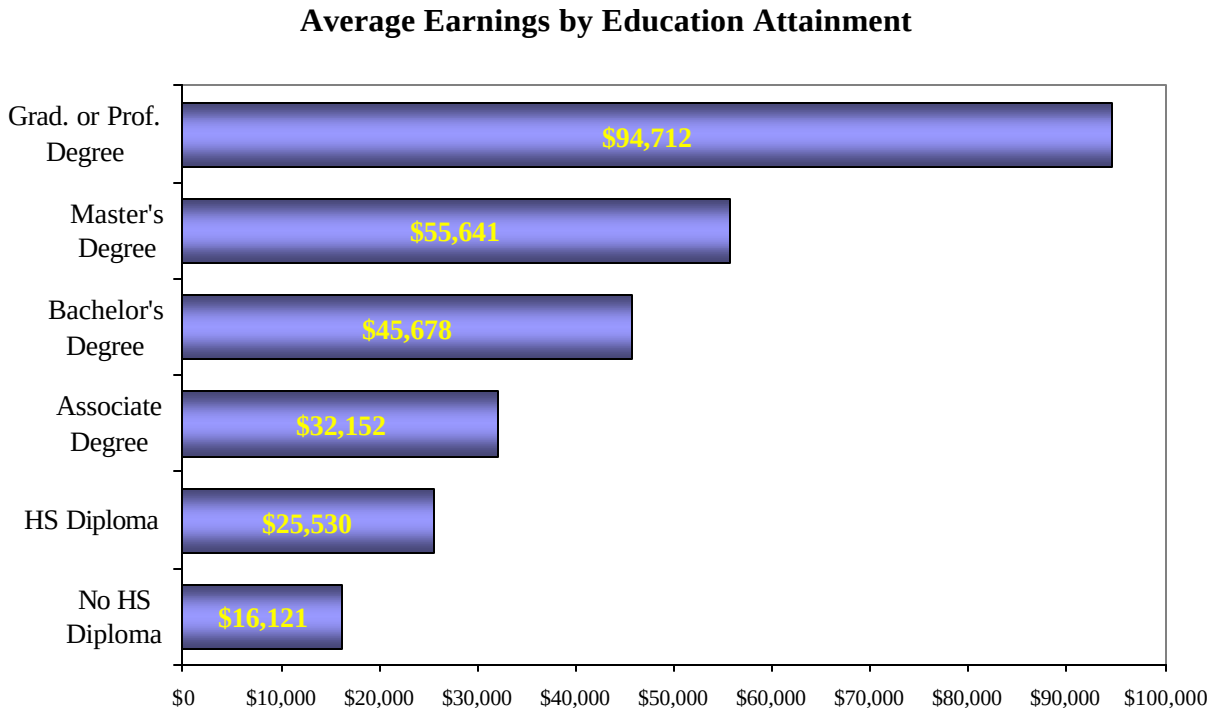
Source: U.S. Census Bureau



Source: U.S. Census Bureau

Two conclusions are implied by these statistics. The first is that relative to our peers and the U.S., Arkansas has a significantly lower percentage of the population with bachelors or advanced degrees. Further, the relative percentages have not changed much in the 1990s, implying that gains from access may have reached their peak.

Educational attainment by the state populace is highly correlated with state per capita personal income. The following chart shows average earnings by level of educational attainment.



Source: U.S. Census Bureau

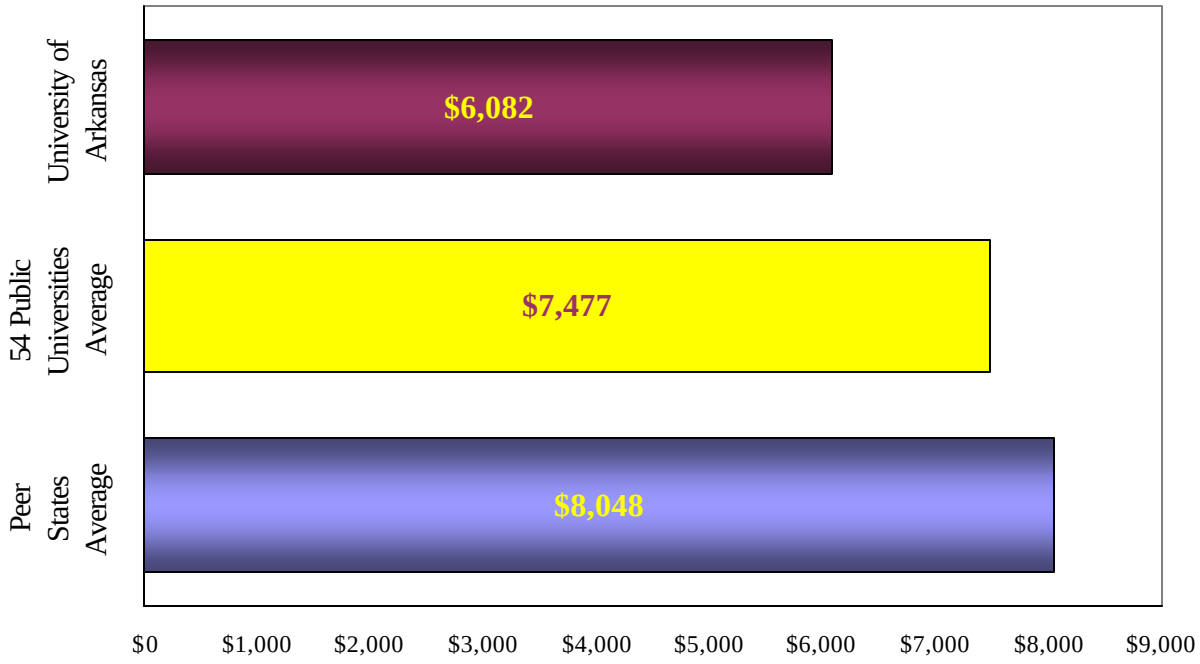
Clearly, states with populations of highly educated workers have higher per capita incomes.

The argument often heard regarding educating the Arkansas labor force is that once educated, these workers migrate to markets outside the state where higher paying jobs–those demanding their newly acquired skills–are located. This is a serious issue and foreshadows the remainder of this analysis.

III. Research & Development: Priming the Pump

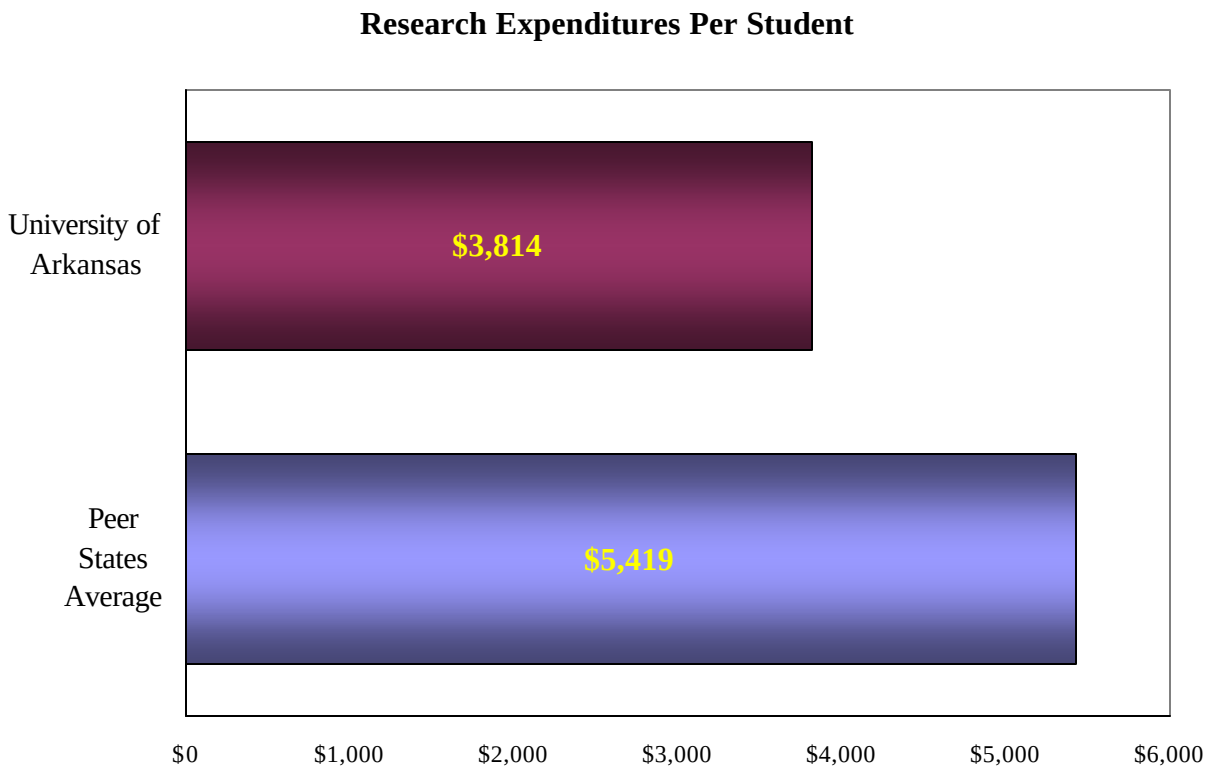
This section details current investment in R&D by a variety of sources, the impact of R&D investment on the state economy, and estimates of the tax implications for increased research investment. We begin by examining state appropriations per student in Arkansas versus our peer institutions and a set of 54 geographically diverse public institutions.

State Appropriations Per Student



Source: National Center for Education Statistics

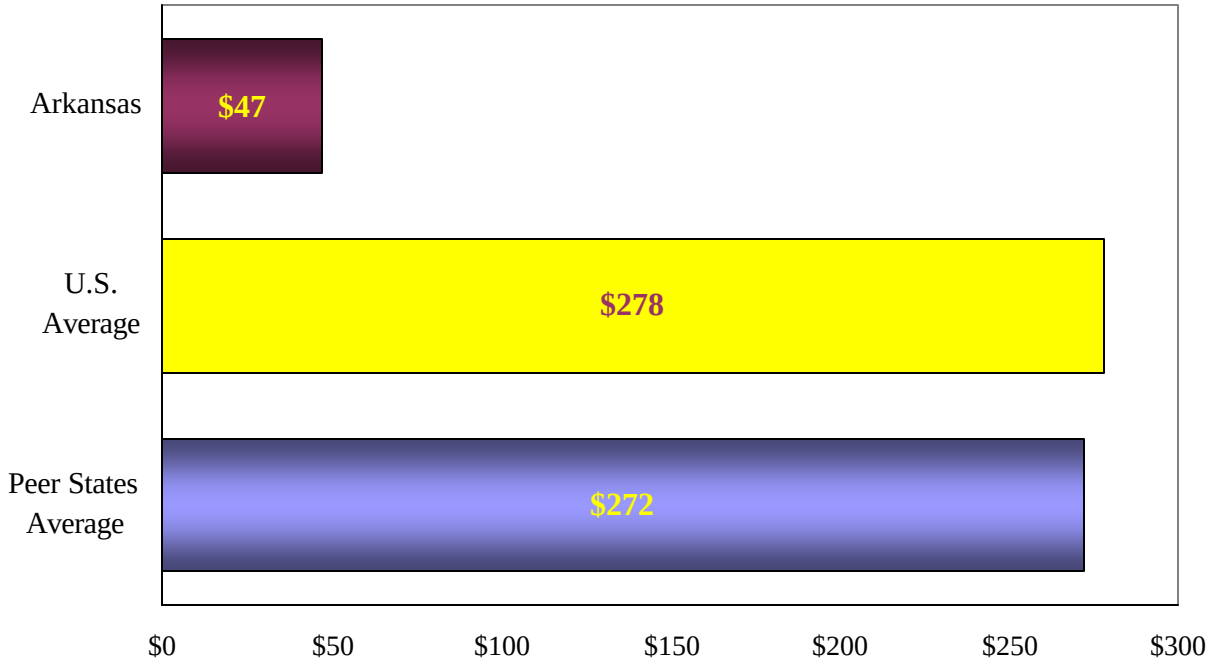
While state appropriations per student in Arkansas lag behind our peers, the difference is not as large as that of research dollars from all sources received by institutions of higher education per student. This difference is shown in following chart.



Source: National Center for Education Statistics

One of the interesting findings of our analysis is the relationship between state investment on R&D and subsequent federal investment. For example, the following charts show how Arkansas compares in terms of federal research dollars per capita and federal higher education research dollars per capita.

Federal R&D: Total Per Capita Expenditures 1998

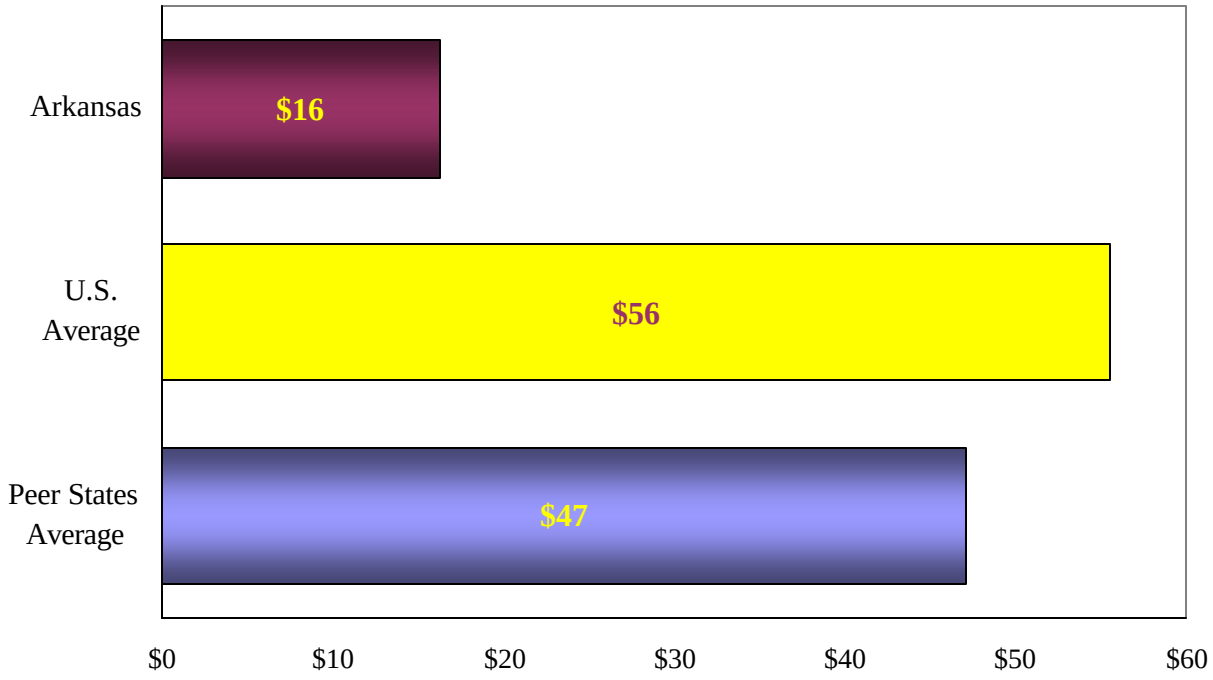


Source: *Discovery and Innovation: Federal Research and Development Activities in the Fifty States, District of Columbia, and Puerto Rico*, The Rand Organization, 2000.

This chart indicates Arkansas compares poorly relative to our peers and the nation.

If we examine only average research dollars per capita to institutions of higher education, these statistics are not terribly different.

Federal R&D In Higher Education: 1998 Per Capita Expenditures



Source: National Science Foundation

The question arises, "What is the impact of research dollars on economic variables such as per capita income?" To answer this question we examined historical data from across the U.S. The results allowed us to calculate a multiplier for research spending. The multiplier essentially estimates the direct and indirect effects of a dollar invested in R&D on some other variable, in this case, personal per capita income. The following chart shows the higher education R&D multiplier for Arkansas relative to our peer states and the nation.

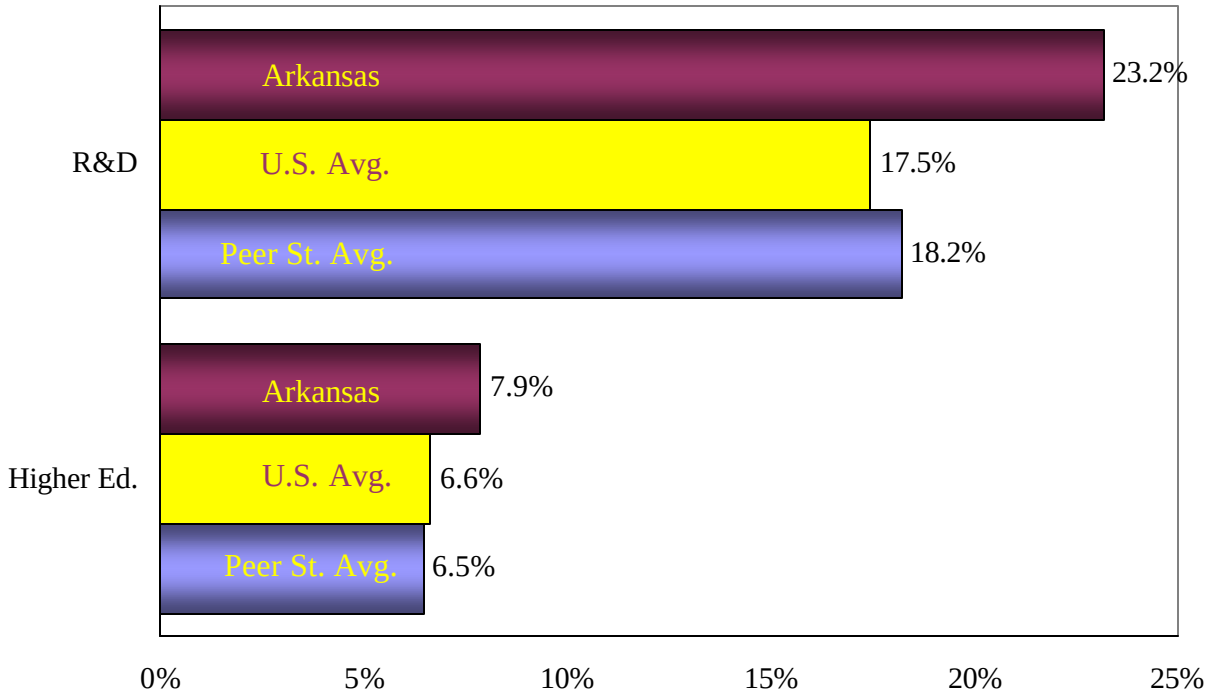
Higher Education R&D Multipliers

Source: University of Arkansas Center for Business and Economic Research

The multiplier is an estimate of the total impact of R&D spending expressed in a change in per capita personal income. An investment of one dollar per capita in R&D results in a long-run real return of $8.02 in per capita personal income.

Another way to think of this relationship is to calculate the average annual rate of return a research dollar would yield given some time horizon, in our case 10 years.

Average Compound Annual Return to Investment in Higher Education R&D and Higher Education in General

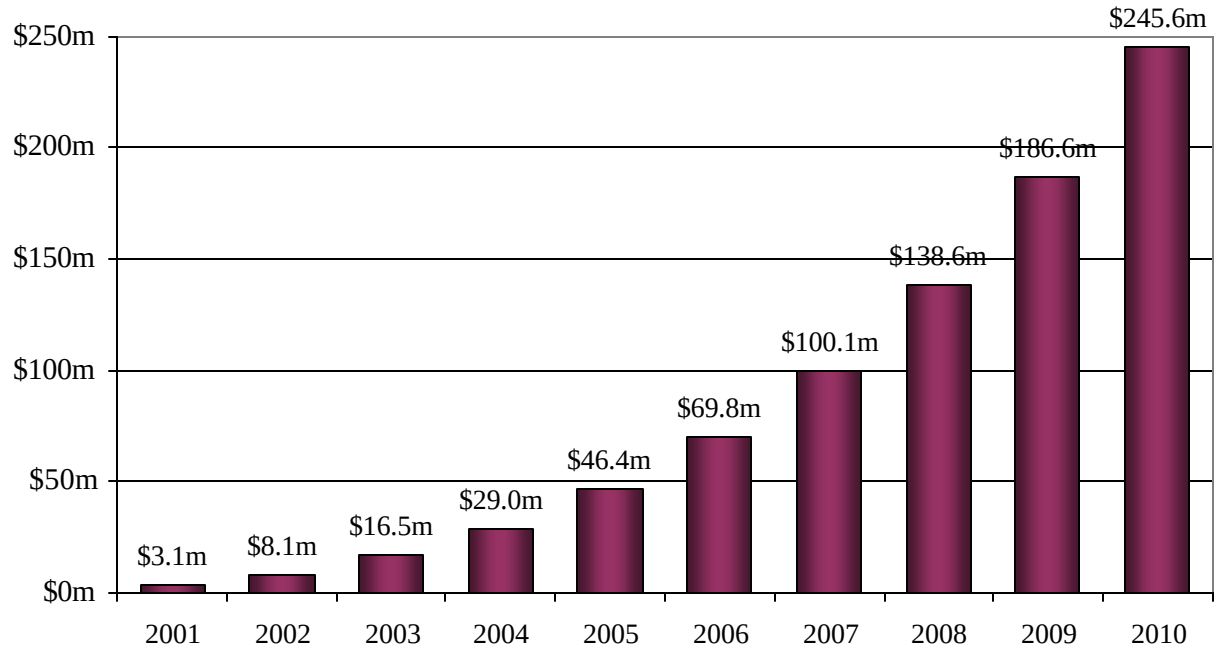


Source: University of Arkansas Center for Business and Economic Research

One issue that arises is whether investing generally in higher education rather than research might not yield similar results? We analyzed this issue by calculating higher education multipliers using the same method for Arkansas, our peer states, and the nation. The results show that although higher education returns a respectable 7.9 percent in Arkansas, this is still significantly less than the real rate of return for investment in research at higher educational institutions.

This graph shows the impact on total personal income in the state of incremental growth in research spending at the University of Arkansas from present levels to 100 million dollars by year 2010.

10 Year Impact of UA R&D Growth on Total Personal Income ($Mil)

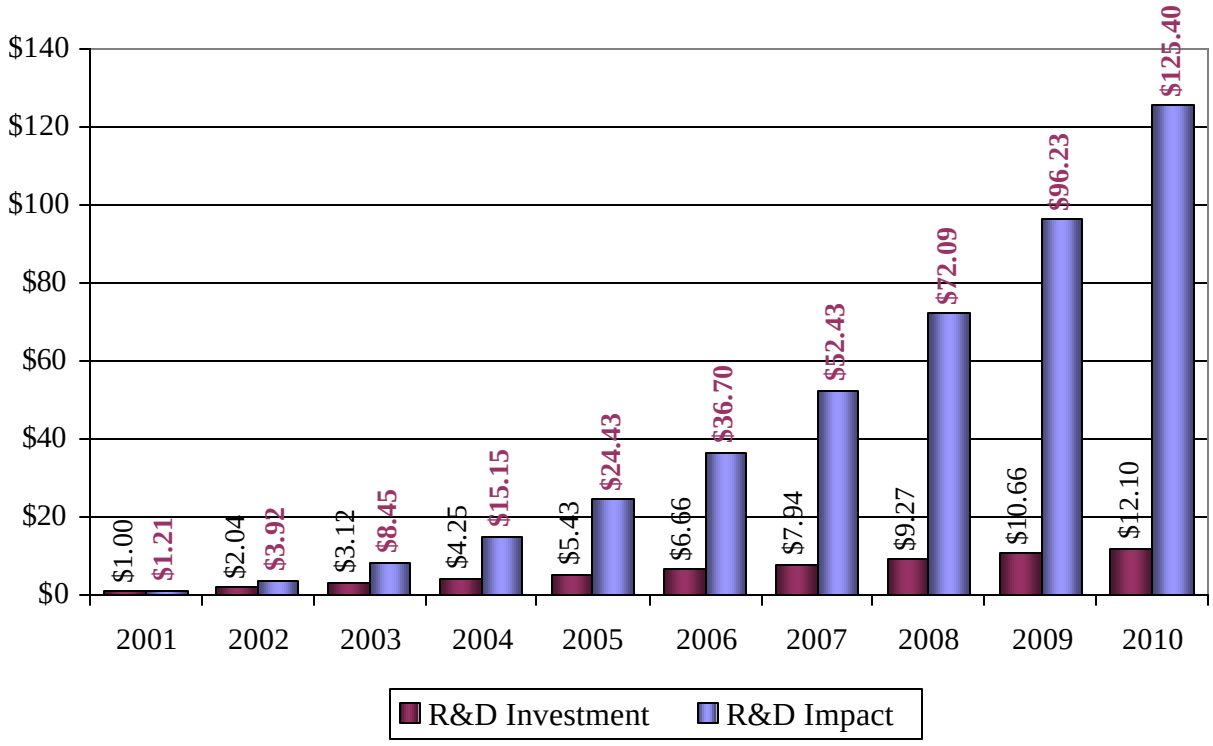


Source: University of Arkansas Center for Business and Economic Research

It is important to realize that the effect of R&D spending in 2010 will not completely be felt until 2020, given our estimate that research spending has a 10-year life cycle. Simply, the 10-year life cycle corresponds to the time necessary to fully reap the benefits of a one time investment in R&D. This analysis can be carried to personal per capita income.

What is the effect of R&D investment at this level on personal income per capita?

Incremental R&D Investment Per Capita and the Impact of R&D on Personal Income Per Capita



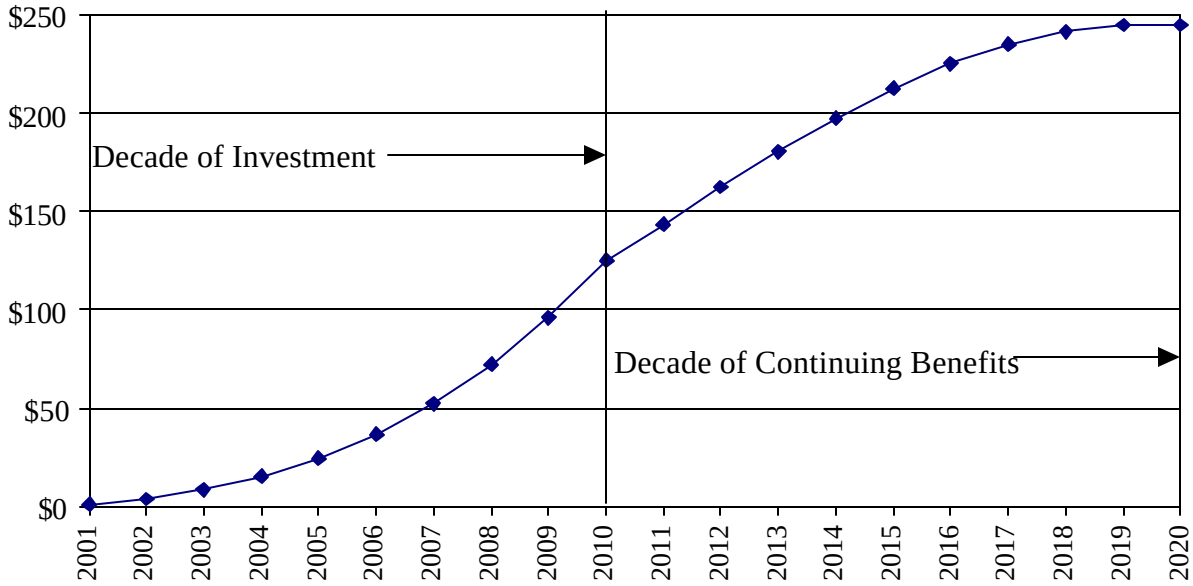
Source: University of Arkansas Center for Business and Economic Research

This graph shows the cost per capita of increased R&D investment and the impact on personal per capita income from that investment.

In effect, this chart shows a year-by-year cost versus benefit of proposed increases in R&D spending at the University of Arkansas.

If we examine the full effect of increased R&D investment at the University of Arkansas over the entire life cycle of the investment by the year 2020, the increase in investment yields an increase in real per capita income of roughly $245 in the last year. The growth rate peaks between 2010 and 2011, but only if we assume that no further R&D investment is made after 2010.

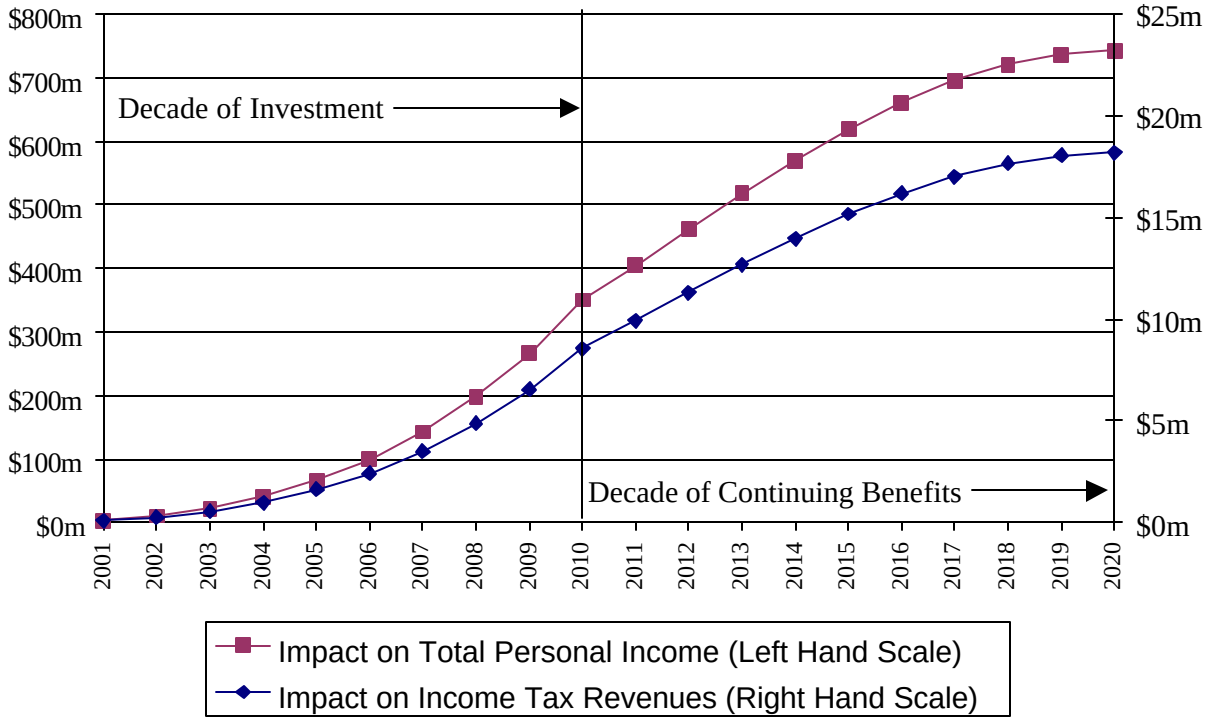
Twenty Year Impact of 2001-2010 R&D Growth on Personal Income Per Capita



This following analysis continues our examination by incorporating the effect on state income tax revenues in addition to total personal income.

Though investment in R&D is assumed only for the decade ending in 2010, personal income and tax revenue continue to increase dramatically through 2020. The impact on total income tax revenues for the state, assuming no substantive changes in the tax code, is roughly $18 million for 2020, the final year. Over the twenty-year benefit life cycle, aggregate impact on state income tax revenues is 179 million real dollars.

Impact of UA R&D Growth on Total Personal Income and Income Tax Revenues ($Mil)



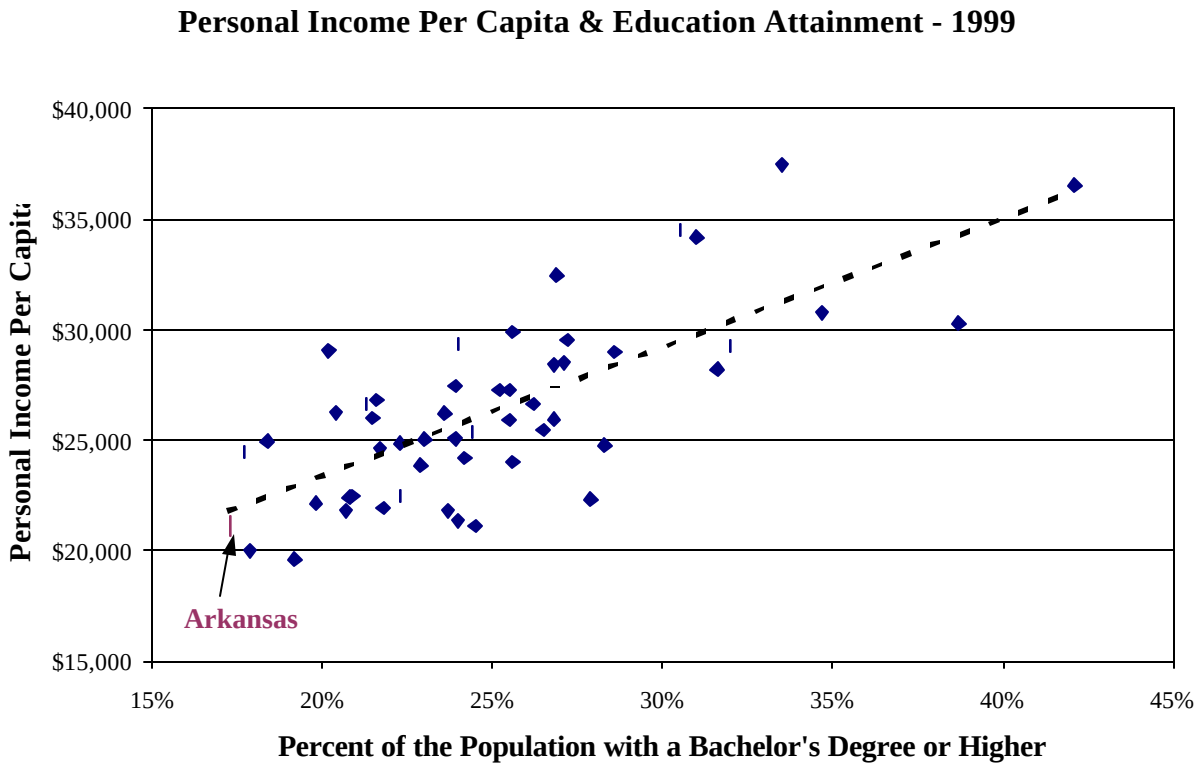
Conclusion

This analysis was designed to address questions concerning the impact of investment in research at the University of Arkansas. In order to analyze the impact of increased research investment, it is necessary to clearly define the variables that will be affected by any change in current patterns, to establish baselines for those variables, and to take into account the lost value of foregone opportunities.

We have outlined the current state of the economy of Arkansas relative to our peers and the nation in terms of two different income measures. Taken together, the measures and their associated historical trends indicate that a persistent gap exists between Arkansas and the national average. Further, while a similar gap existed in the past for our peers relative to the national average, they have been more successful than Arkansas at closing the gap.

Much of the focus in our peer states has been to build on the strength of existing educational institutions as the drivers of economic development. They have adopted an economic development model that depends upon investment in the skills and training of their populace. Within Arkansas, there has been substantial effort to provide increased access to higher education. Increased access seems to be, at least in part, responsible for improvements in the college going rate and levels of educational attainment in the state. However, the benefits from access have been reaped, and yet we have seen not only stagnation but also some slippage in income and educational measures.

The foundation of an economic development model based on educating the population, or investing in *human infrastructure*, is the strong correlation between educational attainment and income.

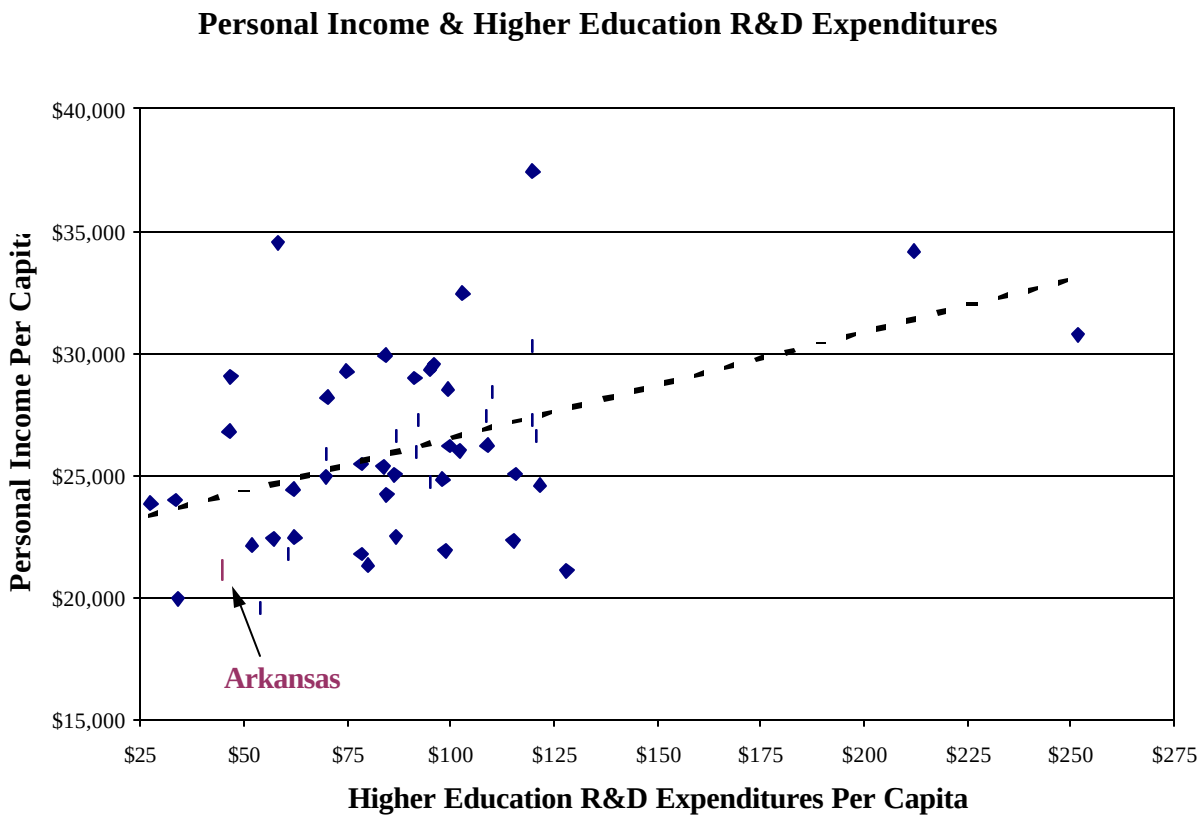


Source: U.S. Bureau of Economic Analysis and U.S. Census Bureau

The scatter plot shows the strong correlation that exists between educational attainment and personal income per capita. Each dot represents one of the fifty states of the union.

The development of an alternative strategy that both develops Arkansans' skills and abilities and provides outlets for their employment is required to propel renewed movement in economic measures toward the average of our peers and the nation. Our analysis indicates that spending on research at institutions of higher education provides a significant return on investment. Simultaneously, this investment provides training, skill acquisition, and employment opportunities.

So, while there is more variation in the scatter plot of personal per capita income to investment in R&D at institutions of higher education, the general relationship holds. States with higher levels of investment in R&D at institutions of higher education have higher personal per capita income.



Source: U.S. Bureau of Economic Analysis and National Science Foundation

Finally, several conclusions can be derived from this analysis.

- The state of Arkansas lags behind both the nation and our peers in terms of important economic measures.
- Arkansas does not lag in access to institutions of higher education, ranking 11th nationally.
- The gains from increased access seem to have played out.
- Educational attainment is highly correlated with income.
- The state lags behind the nation and our peers in average education attainment levels.
- Improvements in average attainment and providing opportunity for those with improved skill sets will improve income statistics.

- Research investment at institutions of higher education in the state of Arkansas provides substantial "bang for the buck" in terms of impact on personal income, and subsequently, tax revenues derived from that economic activity.
- Further, research dollars invested provide opportunities for employment in jobs that require higher levels of education for success.

About the Authors

Jeffery T. Collins is an Assistant Professor of Economics and the Director of the Center for Business and Economic Research at the University of Arkansas. He has held this position since August of 1999. Prior to his current position, Dr. Collins was the Dean of the DeBusk School of Business at Lincoln Memorial University in Harrogate, Tennessee. He held this position from August 15th of 1998 to August 15th of 1999. He was also an assistant professor in the business school from August 15th, 1996 to August 15th of 1999. From August of 1992 until his appointment as a Lincoln Memorial University faculty member, Dr. Collins was pursuing his doctorate in economics from the University of Tennessee at Knoxville. He received his B.A. from Colorado State University in 1989. Dr. Collins' research and teaching interests are in the areas of environmental economics and public finance. He has conducted funded research for the Tennessee Valley Authority, and the Army Corps of Engineers. As part of research funded by the National Science Foundation, Dr. Collins co-authored a website designed to aid state and local governments employing cost benefit analysis to policy options with non-market values. He has taught numerous courses at both the undergraduate and graduate level in economics and finance.

Craig T. Schulman is an Associate Professor of Economics at the University of Arkansas. He received his B.S. (1985) and Ph.D. (1990) in Economics from Texas A&M University. Dr. Schulman's research and teaching interests include international trade policy, econometrics, industrial organization and financial economics. He has published articles in the *Journal of International Economics, National Tax Journal, Annales D'Economie et de Statistique,* and *Review of International Economics* among others. As part of an ongoing research project funded by the National Science Foundation, Dr. Schulman is investigating the efficacy of experimental markets as a pedagogical tool for teaching Principles of Economics. Dr. Schulman joined the faculty of the University of Arkansas as an Assistant Professor of Economics in 1990. During the 1995-1996 academic year, Dr. Schulman took a leave of absence from the University to serve as Senior International Economist for the Applied Economics Division of the U.S. International Trade Commission, during which time he also served as a Special Advisor on Trade Policy to the government of Russia. After returning to the University in 1996, Dr. Schulman was promoted to Associate Professor of Economics in 1997. From January 1998 until August 1999, Dr. Schulman served as the director of the Center for Business and Economic Research in the University's Sam M. Walton College of Business. In August 1999, Dr. Schulman left the Center to return to full-time teaching and research in the Department of Economics.

In addition to their academic duties, Dr. Collins and Dr. Schulman are members of the Arkansas Governor's Council of Economic Advisors.