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# STATE POLICY & ECONOMIC DEVELOPMENT IN OKLAHOMA: 2007

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A Report to



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# OKLAHOMA 21st CENTURY, INC.

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# **STATE POLICY AND ECONOMIC DEVELOPMENT IN OKLAHOMA: 2007**

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**A Report to  
OKLAHOMA 21st CENTURY, INC.  
By**

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The theme of this study, as always, is the relationship between state policy and state economic development. It examines three issues that the authors believe to be important in determining the role the state will play in the development process. The first of these deals with the prospects for the state's budget. It projects a future in which state tax revenues will be far short of the amount required to fund current services; in other words, a future marked by persistent budget deficits. Such a future is going to force the Oklahoma Legislature to come to grips with the most basic issue regarding government's role in economic development; namely, the appropriate size and structure of state taxes and expenditures.

The other issues concern two state efforts whose importance for state economic development far outweighs their claims on the state's budget. The first of these is the Oklahoma School for Science and Mathematics (OSSM). The second is state support for research and development, especially as provided through the Oklahoma Center for the Advancement of Science and Technology (OCAST) and the Economic Development Generating Excellence (EDGE) Initiative. OSSM and OCAST currently receive \$7 million and \$22 million, respectively, in state appropriations. The state's objective is to ultimately provide a \$1 billion endowment fund for EDGE, but it could provide the same resources with an annual appropriation of about \$50 million. Thus, there is the equivalent of an annual budget commitment for these endeavors of about \$80 million, or only about 0.1 percent of state tax revenues.

### The Budget Deficit

The focus of the first chapter is on projections of the state's structural budget. Such projections are made to determine if state tax revenues are likely to grow rapidly enough to fund the expected growth in the cost of providing current services. The cost of current services is an estimate of the outlays necessary to keep up with population growth and changes in the age distribution of the

population, as well as increases in prices of the goods and services that government purchases.' *It includes nothing for new programs or initiatives.*

The expected result of such a projection for most states is that revenues will grow more slowly than current services expenditures, primarily because state tax structures typically produce revenues that grow slowly relative to state income, and commitments to programs such as Medicaid produce outlays that grow faster than state income. This is also the expectation for Oklahoma; the state relies heavily on sales, excise, and resource taxes that have poor revenue growth potential and it has expenditure-increasing commitments to Medicaid. In addition, Oklahoma faces an obligation to fully fund the state's severely under-funded public employee pension systems (PEPS).

These expectations are confirmed by 30-year projections of large and sustained budget deficits. These projections are based on three scenarios: (1) a comparison of state tax revenues that would have been generated without the tax cuts enacted in the 2004-2006 legislative sessions, and current services expenditures, (2) a comparison of state tax revenues that will be generated with the 2004-2006 tax cuts in place, and current services expenditures, and (3) a comparison of state tax revenues that will be generated with the 2004-2006 tax cuts in place, and current services expenditures *plus* annual outlays sufficient to fully fund PEPS in 30 years.

In the without-tax-cut scenario, there is a small, but declining, surplus from 2007 to 2012, followed by budget deficits that increase each year from 2013 to 2036 (the last year of the projection period). Tax cuts enacted in the 2004-06 legislative sessions will reduce tax revenues by a little over \$21 billion from 2007 to 2036, or an average of \$700 million a year. These cuts both hasten the advent and increase the magnitude of the annual deficits. In this scenario, budget deficits begin in 2008 and increase steadily each year, reaching nearly \$2 billion in 2036. If the state were to fully fund the PEPS (the third scenario), the annual deficit would increase by an *additional* \$732 million each year of the projection period.

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Tax cut advocates often argue that they will “pay for themselves” by producing more rapid economic growth and a larger tax base. Our estimates indicate that the tax cuts *will* have a positive effect on the tax base. This effect will replace only 30 percent of the revenues lost, however.

This is also a problem that economic growth, *per se*, is unlikely to cure. That is, Oklahoma probably cannot “grow its way out of the problem.” At a minimum, that would require a rate of growth nearly 30 percent higher than the estimate by the Congressional Budget Office that serves as the basis for this study’s projections of the individual income and general sales taxes.

Thus, the state’s structural — *do-nothing-new* — budget is on an unsustainable course. A course correction will require additional revenues or reduced expenditures, and the amounts required are substantial. For example, it will take the equivalent of an immediate and sustained increase of 40.6 percent in individual income tax revenues, or the virtual elimination of Medicaid, or a 50 percent cut in state support for K-12 education.

These alternatives are indicative of the magnitude of the choices that must be made; they are certainly not the only, or necessarily the most desirable, options. For example, although the tax increase just indicated would, on average, actually impose less of a burden on Oklahomans than the burden they shouldered prior to the recent tax cuts, this is not necessarily what should be done. Among the many other options that could be placed on the agenda for examination are: means of increasing the growth potential of the individual income and general sales taxes, placing more of the burden of funding K-12 education on the local property tax, establishing income-contingent loans for college students, and rationing Medicaid.

Sustained budget deficits will force Oklahomans to decide what kind of government they want and how large they want it to be. This will not be decided overnight, however, and the problem would be magnified if new tax cuts or expenditure initiatives were to be adopted in the interim. Thus, there is an immediate need for the Oklahoma Legislature to consider new budget rules, such as the pay-as-you-go (PAYGO) rule employed by the U.S. Congress as a means of reducing the federal

budget deficit in the 1990’s. Under the terms of such a rule, neither additional tax cuts nor new expenditure initiatives could be adopted unless they were accompanied by a way to pay for them. Current safeguards designed to ensure an annual balanced budget are not up to this task, simply because they do not preclude the adoption of back-loaded tax cuts (those which occur after the year of adoption, like the 2004-06 tax cuts) or long-run expenditure commitments. A pay-as-you-go rule serves as a constant reminder of the economist’s dictum: *there is no such thing as a free lunch*.

## OSSM

Chapter 2 provides a profile of an Oklahoma success story, the Oklahoma School of Science and Mathematics (OSSM). OSSM was born in 1983, primarily as a response to the perceived need to improve educational systems in order to have more productive workers and to have the human investment needed for expanded research and development activity. State budget difficulties precluded significant funding for OSSM in its early years, but appropriations to OSSM increased as budget conditions improved in the late 1980s and OSSM was up and running with its normal enrollment of around 140 students by 1991.

The OSSM campus in Oklahoma City is a residential school serving a select group of academically talented high school juniors and seniors from communities throughout the state. OSSM also provides model programs implementing advanced science and math curricula at eleven Regional Outreach Science and Math Centers.

OSSM-Oklahoma City occupies an attractive and spacious campus on a 32-acre site south of the State Capitol and northwest of the Oklahoma Health Center complex. It includes a substantially remodeled public school building, a dormitory, a gymnasium, a science building, and a library. Additional dormitory facilities are planned, with the intention of enrolling 300 students.

The selection of high school students to study at the Oklahoma City campus is quite competitive; only 30 percent of those who apply are ever enrolled. The typical class is roughly in the top 10 percent of all those taking the ACT nationally,

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even though OSSM students take the exam a year or more earlier than is normal.

OSSM students come from high schools both large and small from all over the state. However, there is a tendency for the sending high schools to be relatively large. There is significant geographic dispersion of OSSM students. However, the Oklahoma City MSA appears to be over-represented and the Tulsa MSA and western Oklahoma under-represented relative to their respective populations. There is surprising gender balance, given the alleged propensity of girls to shy away from math and science. The sending schools tend not to be those with a high ratio of low income parents/guardians. The racial/ethnic make-up of OSSM students is heavily weighted with students classified as Caucasian and Asian American.

The faculty includes 16 with the Ph.D., one with an Ed.D., five with a Master's degree, and four with Bachelor's degrees. The faculty is generally quite experienced; half of them have 16 or more years in the classroom.

There have been 1,268 students enrolled in OSSM since the class of 1992; 233 of whom, or 18.4 percent, have withdrawn for a variety of reasons. For the OSSM graduating classes of 1992-2006, the median annual ACT score was 31.4. The range in annual average ACT scores was between 30.5 and 32.4. A score of 31.4 would place a current student between the 98<sup>th</sup> and 99<sup>th</sup> percentiles of students taking the test nationally. OSSM graduates have been awarded a wide variety of substantial scholarships for their college work. OSSM estimates that the 900 OSSM graduates have received scholarship offers of more than \$62.5 million. Half the graduates attend in-state institutions and half attend out-of-state. The out-of-state share is larger than the average for all Oklahoma high school graduates.

Forty percent of OSSM graduates have enrolled at the University of Oklahoma or at Oklahoma State University. The list of out-of-state schools attended by OSSM graduates includes 32 students attending MIT, 25 attending the University of Chicago, and 22 at Washington University, St. Louis. Many other graduates have enrolled in other schools ranked high among nationally-ranked institutions. Nearly 79 percent of OSSM

college attendees have elected to major in engineering, science, or mathematics.

Many recent OSSM college graduates are employed in science and engineering (S&E) jobs. Current data for 281 graduates indicate 10 percent in the military, 59 percent in positions out-of-state, and 31 percent in Oklahoma. This geographic pattern probably is a reflection of the geographic pattern of employment opportunities in S&E, but the probability of leaving the state is not much greater for OSSM college graduates than for Oklahoma college graduates, in general.

OSSM imposes a very small cost on the state budget, but its class sizes are small. Thus, in the fiscal year ending June 30, 2002 (FY02) cost per residential OSSM student was \$28,878, or over 4 times higher than the cost per pupil in the state's public schools.

OSSM, in return, has gained a nationwide reputation for excellence. The accomplishments of the students at the Oklahoma City campus and the Regional Centers are believed to have had a positive demonstration effect on other high school students. OSSM has produced 900 graduates of the residential facility, and a like number of students who have participated in courses at the Regional Centers, who have gone on for further education in science and engineering (S&E) fields and have taken S&E jobs both within and without Oklahoma. This production of highly skilled S&E workers is consistent with both the state and national needs to educate a greater number of S&E personnel.

OSSM also lies squarely within Oklahoma City's corridor of economic renewal and development. This corridor has a national reputation and is of interest to urban developers from other communities. As others examine this urban development phenomenon, they note the state's commitment to advanced math and science high school education embodied in the OSSM campus. Scaling-down or cutting off the commitment to OSSM, would certainly generate negative publicity concerning Oklahoma's education policy and undermine the attractiveness of this area to potential developers. Scaling-up by building a second dormitory and providing a bigger operating budget may be warranted in the current No-Child-Left-Behind environment.

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## Science and Technology Policy

It is widely believed that one of the more promising routes to economic development is to travel the high-tech path. The author of the third chapter observes that the success of this approach will depend heavily on how well the state's scientific community generates new research and how thoroughly the fruits of that research are translated into marketable products. In a state where resources are quite limited, like Oklahoma, such an approach calls for a rational science and technology policy that efficiently marshals and administers the resources the state can attract for and allocate to research and development activities. Such a policy would encompass, among others, the activities of OCAST and those associated with the EDGE initiative.

The Oklahoma Legislature recently increased its appropriation to OCAST by \$10 million and provided the first \$150 million of a planned \$1 billion endowment for the EDGE initiative. It appropriates money to state colleges and universities for research. The state's science and technology community also benefits from a variety of federal programs designed to provide support for research and development.

The author inquires whether the state is ready to employ these resources efficiently or to compete effectively for additional resources. To determine this, he searched the literature to ascertain the necessity of government support and direction for research and development, the nature or culture of the scientific research and development process, how innovation works, and the role of public-private and federal-state cooperation in the research and development endeavor. He also conducted candid interviews with knowledgeable observers of Oklahoma's research and development enterprise.

This survey provided a rich menu of findings. Among them are the conclusions that:

- government must provide support and guidance for research and development; the market will provide too few resources to this endeavor,
- effective government research and development policy requires knowledge of

the culture of scientific research and the nature of the innovative process,

- state resources can and should be leveraged through cooperative ventures with the federal government and private business,
- there is a keen interest in R&D-led economic development in Oklahoma; in making Oklahoma the "research capital of the plains,"
- there is a need for state science policy, but the current state-led effort is perceived to be highly fragmented, without a strategic or industry-specific focus,
- Oklahoma government and business combined spend less on R&D than might be expected based on state population, although there are many noteworthy efforts in the state, including strong leadership in research and technology transfer at both major public research institutions, the EPSCoR program, EDGE, the Center for Aircraft Systems/Support Infrastructure (CASI), the Noble Foundation, the Presbyterian Health Foundation (PHF), the Warren Foundation, the Oklahoma Medical Research Foundation, and OCAST,
- OCAST, in particular, deserves praise for developing a sustainable model of research and innovation, for clearly communicating its programs, for providing both young and seasoned researchers with funds to further develop their findings and to leverage them into federal support, for aiding business start-ups and for furthering collaboration between universities and industry,
- OCAST, on the other hand, appears to lack strategic direction, looking for best proposals, not for the strategic fit of proposals,
- the EDGE initiative is both a "clarion call for more strategic direction" in state science policy and an opportunity to develop one,

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- entrepreneurship is a vital component of the innovative process, it is being nurtured by the state's colleges and universities, and it can be enhanced by state policy.

This primary outcome of this survey is the discovery of the need for a reorientation of the state's science and technology policy. Efforts in the state appear to be too fragmented, too uncoordinated, and too unfocused to achieve the critical mass needed to take a large leap forward. The problem is not lack of vision, but too many uncoordinated visions.

This author believes that the state should create an independent, professionally-staffed, continuously-functioning "Office of Strategic Science Policy" to spearhead its research and development planning and to oversee the imple-

mentation of its plans. To get a quick start, the state should engage someone "who has done this before," with highly-respected credentials. That person would have a supporting cast of full-time professionals developing strategies, garnering buy-in, implementing, managing, modeling, analyzing, measuring, investigating, coordinating, communicating, networking, monitoring, marketing, evaluating, reporting, updating, and revising the state's science plan. The author is uncertain about whether this entity should be another state agency, part of an existing state agency, or a private endeavor. He is certain, however, that it should be located in the Presbyterian Health Foundation research park, putting it in close proximity to OCAST, i2E (OCAST's commercialization arm), and the State Regents for Higher Education.

## Oklahoma's Structural Budget: Hard Choices Ahead

State governments have traditionally made tax and expenditure decisions with long-run consequences based on relatively short-term fiscal information. Oklahoma is a case in point; in fiscal years 2004, 2005, and 2006, the legislature passed, and the governor approved, the largest series of tax cuts in Oklahoma history, apparently without analyzing the long-run implications of their actions. The results of such an analysis are reported in this chapter.

State governments also have often slashed taxes while ignoring unfunded employee pension system liabilities. Again, Oklahoma is a case in point; it has one of the nation's most severely under-funded pension systems.<sup>1</sup> Accordingly, we also examine the 2004-06 tax cuts in the context of a budget that recognizes the need to fully fund the state's public employee pension systems.

The analysis in this study revolves around projections of the state's *structural* budget. This involves projecting tax receipts generated by the existing tax system and expenditures required to continue providing state residents the services currently provided (*current services expenditures*). Ideally, the state would project a structural budget annually. At a minimum, it should project a structural budget when it makes a major new commitment, such as a large tax cut or expenditure increase. If the projection indicates a structural budget deficit, then the state will know in advance that it is about to make a commitment that it cannot fully fund, unless it is willing to find new revenues or reduce current services.

The structural budget in this study recognizes the unfunded liability of Oklahoma's public employee pension systems by treating the cost of amortizing these liabilities as a budgeted expenditure. This requires a budget window that is at least as long as the period recommended by the Governmental Accounting Standards Board for

amortizing unfunded liabilities, or 30 years. Thus, the structural budget in this study compares the cost of maintaining current services *plus the cost of amortizing the unfunded accrued actuarial liability of the public employee pension systems*<sup>2</sup> with projected revenue *in the context of a 30-year budget window*.

Don Boyd has made 8-year projections of structural budget balances for all 50 states in a study commissioned by the National Center for Higher Education Management Systems.<sup>3</sup> He estimated that Oklahoma will have a structural deficit equal to 4.3 percent of revenues by 2013. Boyd's estimate, however, is likely to be an underestimate of Oklahoma's structural deficit because: (1) his projection does not include the effects of the 2004-2006 tax cuts, (2) the length of his projection period is too short to capture the full impact of these tax cuts, and (3) he makes no provision for unfunded pension system liabilities. The projections in this study correct for these omissions in Boyd's analysis.

Boyd is not the only one who has recognized the possibility of a structural budget problem for Oklahoma. David Blatt, Director of Public Policy for Tulsa's Community Action Project, argues in a recent *Budget Brief*<sup>4</sup> that Oklahoma faces a significant risk of long-term deficits, citing Boyd's study, an analysis by the Center for Budget and Policy Priorities,<sup>5</sup> and a 2006 study in which this author developed 75-year projections of the state's fiscal imbalance.<sup>6</sup>

This is not a study in which a hypothesis is formulated and tested, but we can venture a guess at the probable result. On the expenditure side of the budget, Oklahoma faces Medicaid outlays expected to increase relative to state income, as well as unfunded pension system liabilities. On the revenue side, the legislature reduced the revenue-generating potential of the state tax

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system by concentrating its recent tax cuts on the individual income tax, and recent record increases in the state's gross production taxes on natural gas and crude oil are not likely to be sustainable. Thus, we expect to find structural *deficits*; i.e., an excess of projected expenditures over projected revenues.

Our projections *do* indicate that Oklahoma state government faces significant and sustained structural budget deficits, even without funding the pension systems' unfunded liabilities. We project a surplus of 5 percent of tax receipts in 2007. After that, however, structural budget deficits begin and increase steadily, reaching 18.3 percent of tax receipts in 2036. In fact, Oklahoma would have experienced structural budget deficits even without the 2004-06 tax cuts, but they would have started later and been much smaller. The problem is even worse when the costs of amortizing the pension systems' unfunded accrued actuarial liabilities are included in the structural budget. In that scenario, we project a deficit that is equal to 6.5 percent of tax receipts in 2007 and increases steadily to 25.2 percent of tax receipts in 2036.

Our analysis indicates, moreover, that these are more likely to be underestimates than overestimates of future structural budget deficits. To paraphrase David Blatt,<sup>7</sup> we *are* speeding towards a train wreck. Thus, the state will have to make some hard budget choices very soon. Unfolding events will force the government to decide among future tax increases, alternative ways to pay for government services, expenditure reductions, and alternative ways to ration government services. How these choices are made could have a significant effect on the state's prospects for economic development and other dimensions of economic welfare. It is well beyond the scope of this study to suggest what these choices should be; that will require much additional study and debate. The purposes of this study will have been fulfilled if it increases awareness of the problem, induces a serious response to it, and increases the likelihood that significant future changes in taxes (and expenditures) will be analyzed for their long-run effects *before* they are adopted.

## The Budget Window

A budget window is the length of time considered in making revenue and expenditure decisions. Oklahoma state government has traditionally operated with a one-year budget window; that is, it has traditionally made budget decisions based on one-year projections of revenues relative to one-year expenditure needs. One-year budget windows normally suffice, in large part, because state governments typically leave most existing taxes and expenditure programs untouched and focus primarily on annual increments in taxes and expenditures.

The Oklahoma Legislature has recently moved toward a longer budget window by considering Oklahoma Tax Commission projections of the 5-year impact of proposed tax cuts. The scoring of tax cuts for their five-year impact is only a partial step, however, toward a 5-year budget window. A complete 5-year budget window would contain 5-year projections of all taxes (not just the effects of tax *changes*) and 5-year projections of all expenditures for which the state has a commitment or obligation.

The state has commitments or obligations that stretch, however, well beyond five years. Some of the state's commitments are implicit. For example, there is an implicit understanding that the state will play a significant role in providing education at least through high school – a 13-year commitment.

Some commitments are explicit. For example, there is an explicit agreement that the state will repay its debt according to the schedules incorporated in bonds that it issues. This could be as long as 20 years or more. The Attorney General has also issued an opinion that the state has a binding commitment to pay the benefits promised to retirees covered by Oklahoma's public employees' pension systems.

Oklahoma's public employees' pension systems (PEPS) provide benefits to retirees through seven separate pension systems: the Oklahoma Teachers' Retirement System, the Oklahoma Public Employees' Retirement System, the Oklahoma Law Enforcement Retirement

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System, the Uniform Retirement System for Justices and Judges, the Department of Wildlife Retirement Plan, the Oklahoma Firefighters' Pension and Retirement System, and the Oklahoma Police Pension and Retirement System. The Teachers' Retirement System is the largest of these, accounting for nearly 52 percent of the total liabilities of the PEPS.

The state's objective is to fully fund promised pension benefits from assets in trust funds that are large enough to cover future benefit liabilities. According to the latest available actuarial valuations, however, the aggregate unfunded liability of the PEPS was nearly \$10.6 billion in 2005.<sup>8</sup> During the 2002 legislative session, legislation was adopted that requires the State Retirement Board to obtain information on the cost of amortizing the unfunded liabilities of each pension system in 30 years, in keeping with Statement 25 of the Governmental Accounting Standards Board (GASB 25). We interpret this as an expression of the government's desire to achieve such an amortization goal. Accordingly, we use 30 years as the length of the budget window in order to examine explicitly the effect that such amortization would have on the state's budget.

### Forecasting Scenarios

We construct and compare three budget scenarios: a baseline scenario, a pre-tax-cut scenario, and an amortization scenario. The baseline scenario is a 30-year projection of state taxes that will be collected under the tax statutes that *now* prevail (i.e., *after* the 2004-2006 tax cuts) and expenditures sufficient to maintain current services. The pre-tax-cut scenario is a 30-year projection of state taxes that would be collected under the tax statutes that *prevailed in 2003* and expenditures sufficient to maintain current services.

The amortization scenario is a 30-year projection of state taxes that will be collected under the tax statutes that now prevail, expenditures sufficient to maintain current services, *and* expenditures sufficient to amortize the unfunded liability of the state's PEPS.

### The Budget

To examine the effects of tax cuts and to determine the degree to which state taxpayers have an implicit tax liability for the PEPS, we formulate and project *tax* budgets. The revenue side of a tax budget consists of all state tax receipts. The expenditure side consists of expenditures financed by those receipts. A tax budget does *not* include receipts from grants, fees, and other income, or the expenditures funded with them.

In 2005, 72 percent of state tax collections flowed directly to the state's General Revenue Funds (GRF); the remainder went to accounts dedicated to the funding of specific government purposes or programs. The taxes deposited in the General Revenue Funds account for most (over 97 percent) of the current revenues normally certified for annual legislative appropriation. The legislature is authorized by law to initially appropriate no more than 95 percent of the projected (certified) GRF, and required to reserve up to 5 percent in the Cash Flow Reserve Fund (CFRF) as a cushion against a revenue shortfall. They may ultimately appropriate all of the money that accrues to the CFRF. Should actual collections exceed projected collections the excess is deposited in the Constitutional Reserve Fund (the state's "rainy day" fund), which may be tapped under specific circumstances.

This series of deposit and spending practices and constraints makes it difficult to track actual spending changes as they occur. In making our projections we simply assume that all of the taxes deposited to the GRF will be spent in the same year as the deposit. We also assume that all taxes dedicated to other accounts will be spent in the year that they are collected.

Table 1.1 depicts the state's tax budget for Fiscal Year 2005, the latest year for which complete data are available. The left side of the table contains tax receipts, in millions of 2005 dollars, by type of tax. The right side of the table contains estimates of the allocation of those taxes by principal type of expenditure. Expenditures equal the sum of appropriations and dedicated tax receipts. These data indicate that over 29 percent of tax receipts were earmarked for specific purposes.

According to the information presented in Table 1.1, the state's four largest expenditure purposes funded by state tax receipts were (in descending order) elementary and secondary (K-12) education, higher education, Medicaid, and the PEPS. Since the last of these is normally not considered to be one of the state's major expenditure purposes, additional explanation is in order.

The PEPS received \$262 million in dedicated revenues. The PEPS were also funded by contributions from employees and employers. The latter includes both state agencies, such as state colleges and universities, and local governments, such as school districts. State agencies alone contributed an estimated \$366 million in FY 2005. This estimate was developed as follows.

The Teachers' Retirement system received \$224 million from both state agencies (principally, state colleges and universities) and local school districts. We estimate that \$101 million of the \$224 million was paid by state colleges and universities, based on the relative sizes of the higher education and local schools payrolls. We

assume that this contribution was funded indirectly out of appropriations or dedicated tax receipts.

The PEPS received \$145 million from other state agencies on behalf of their employees. We assume that all of this money was funded indirectly out of appropriations or dedicated tax receipts.

The other five pension systems together received \$160 million in employee contributions from other state agencies and local governments. We estimate that 75 percent of this money, or \$120 million, was paid by state agencies and assume that the funds for same came indirectly from appropriations or dedicated tax receipts.

The bottom line is that the PEPS received \$262 million *directly* from dedicated state tax receipts and \$366 million (=101 M + 145 M + 120M) *indirectly* from appropriated and dedicated state tax receipts. Thus, we estimate that the state devoted \$628 million of 2005 tax receipts to the PEPS.

**Table 1.1**

**Oklahoma State Tax Budget, FY 2005  
Millions \$2005**

Tax Receipts*		Expenditures*	
Personal Income Tax	2469	K-12 Education	2669 <sup>a</sup>
General Sales & Use Taxes	1661	Higher Education	814 <sup>a</sup>
Gross Production Tax - Gas	558	Medicaid	702
Gross Production Tax - Oil	215	Public Employee Pension Systems	628
Motor Vehicle Taxes	554	Other Expenditures	1799 <sup>b</sup>
Motor Fuels Taxes	404		
Corporate Income Tax	169		
Insurance Premium Tax	140		
Cigarette Tax	95		
Inheritance & Estate Taxes	76		
Alcoholic Beverage Taxes	71		
Other Taxes	200		
<b>Total Tax Receipts</b>	<b>6612</b>	<b>Total Expenditures</b>	<b>6612</b>

\*Source: FY 2007 Executive Budget, Schedule II Report.

\*Sources: FY 2006 Executive Budget, FY 2003-2005 Appropriations; Oklahoma Tax Commission, *Annual Report FY 2004*, FY 2003-2004, Revenue and Apportionment, 31-44.

<sup>a</sup>Excludes state funds used to pay for employer contribution to teacher retirement.

<sup>b</sup>Excludes state funds used to pay for employer contribution to public employee retirement.

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## The Baseline Scenario

As noted, the baseline scenario is a 30-year projection of expenditures required to maintain current services and tax receipts expected under the current tax structure. The current tax structure is the tax structure *after* the imposition of the 2004-2006 tax cuts.

### Expenditures Required to Maintain Current Services

Specific projections were made for each of the principal expenditure items in Table 1.1: K-12 Education, Higher Education, Medicaid, the Public Employee Pension Systems (PEPS), and Other Expenditures. All projections are in constant 2005 dollars. In the cases where expenditures are financed by dedicated taxes, the expenditure projection is equivalent to the tax projection.

**K-12 Education.** To maintain current services to K-12 students, the annual rate of growth in expenditures must be at least as large as the annual rate of growth in the K-12 population *plus* the annual rate of growth in the real (after inflation) cost of K-12 education. The annual rate of growth in the K-12 population is approximated by the annual rate of growth in the population, ages 5-17. Ideally, the annual rate of growth in the real cost of K-12 education would be determined by projecting the annual rate of growth in a K-12 price index minus the annual rate of growth in the inflation index. Given the absence of a K-12 price index, the implicit price deflator for state and local government spending is used instead. The Consumer Price Index (CPI) is used as the inflation index. Thus, the annual increase in the real cost of K-12 education is approximated by the difference between the projected annual rates of growth in the state and local government deflator and the CPI.

The Oklahoma Department of Commerce has projected that the population, ages 5-17, will grow at an annual average rate of 0.3 percent from 2005-2030.<sup>9</sup> The state and local government deflator grew 1.1 percent per year faster than the CPI from 1987 to 2004. Assuming the continuation of these trends, we project real K-12 expendi-

tures to grow at an annual rate of 1.4 percent. This is only about 60 percent of the rate of increase in real appropriations (2.45 percent) from 1988-2005. Remember, however, that no provision is made in the current services budget for catching up with unmet needs, funding federal mandates, or launching new programs.

**Higher Education.** To maintain current services to HE, the annual rate of growth in expenditures must be at least as large as the annual rate of growth in the HE population *plus* the annual rate of growth in the real (after inflation) cost of HE. The annual rate of growth in the HE population is approximated by the annual rate of growth in the population, ages 18-24. The annual rate of growth in the real cost of HE is determined by projecting the difference between the annual rate of growth in the Higher Education Price Index (HEPI)<sup>10</sup> and the annual rate of growth in the CPI.

The Oklahoma Department of Commerce has projected that the population, ages 18-24, will grow at an annual average rate of 0.18 percent from 2005-2030.<sup>11</sup> The HEPI grew 1.0 percent per year faster than the CPI from 1987 to 2004. Assuming the continuation of these trends, we project that real HE expenditures will grow at an annual rate of 1.18 percent. This is about 87 percent of the rate of increase in real appropriations (1.35 percent) from 1988 to 2005. Again, however, remember that no provision is made in the current services budget for catching up with unmet needs or launching new initiatives or programs.

**Medicaid.** The cost of maintaining Medicaid is equal to projected Oklahoma Medicaid expenditures *times* Oklahoma's share of those expenditures. Future Medicaid expenditures for the period, 2007-2015, are determined by applying the annual rate of growth in state-funded Medicaid outlays implicit in the 2005 National Health Expenditure projections for 2006-2015.<sup>12</sup> According to those projections, Medicaid outlays will grow at roughly 6 percent per year after inflation. Medicaid expenditures in Oklahoma from 2016 to 2036 are based on Congressional Budget Office projections that assume that Medicaid expenditures will grow 1 percent per year faster than the growth in real GDP per capita,<sup>13</sup> or about 4 percent per year after inflation.

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In recent years, Oklahoma has relied on state taxes to fund about 25 percent of the total (state and federal) cost of Medicaid. This is the share assumed for the projection period. Given the future state of the federal budget, this is probably a very conservative assumption.

**Public Employee Pension Systems.** The cost of maintaining the PEPS could not be determined directly for this study. It seems obvious from actuarial reports, however, that all of the future tax receipts dedicated to funding the PEPS and all of the future employer contributions to the PEPS are necessary to ensure the payment of future benefits. Projections of employer contributions are based on state payrolls assumed to grow at the same rate – 3.5 percent per year after inflation - used by the actuaries in their valuations of the two largest components of the PEPS – the Oklahoma Teachers’ Retirement system and the Oklahoma Public Employees’ Retirement System.<sup>14</sup> These two systems together account for 70 percent of the PEPS.

The Oklahoma Teachers’ Retirement System (OTRS) is partially funded by a dedicated 5 percent of annual tax receipts from the individual and corporate income taxes and the general sales and use taxes. The Oklahoma Firefighters’ Pension and Retirement System (OFPRS), the Oklahoma Police Pension and Retirement System (OPPRS), and the Oklahoma Law Enforcement Retirement System (OLERS) together receive a dedicated 64.8 percent of receipts from the state’s Insurance Premium Tax. The methods used to project these taxes are explained below.

**Other Expenditures.** The cost of maintaining the services funded by the remaining 22 percent of expenditures is projected to grow annually at the projected annual rate of growth in the total state population (0.65%)<sup>15</sup> plus the difference (1.1 percent) between the annual rate of growth in the state and local government deflator and the CPI from 1987 to 2004.

## Projected Revenues

**Individual Income Tax.** Projected real receipts from the individual income tax are

based on projections of the annual rate of growth in real personal income and an assumed value of the income elasticity of individual income tax receipts.

The income elasticity of individual income tax receipts ( $E_i$ ) is defined as:

$$(1.1) E_i = (\% \text{ Change in Income Tax Receipts}) / (\% \text{ Change in Personal Income}).$$

If a value is specified for  $E_i$ , the % Change in Income Tax Receipts can be determined if a value is determined for the % Change in Personal Income.

Daniel Feenberg has estimated  $E_i$  for Oklahoma for each year from 1979 to 2005 using the National Bureau of Economic Research (NBER) TAXSIM model.<sup>16</sup> Oklahoma’s  $E_i$  fell from 2.1068 in 1979 to 1.4695 in 2005, but has fluctuated around 1.45 for the 5 most-recent years (except 2004 when it fell abruptly – for a year - to 1.343). Assuming it has more or less stabilized, we use a value of 1.4 for the projection period. In reality, the reduction in the top marginal rate adopted in the tax cuts of 2004-2006 will probably reduce the elasticity value below 1.4, but we lack a basis for an accurate adjustment.

Examination of historical data indicates that Oklahoma real personal income, U.S. real personal income, and U.S. real gross domestic product (GDP) are highly correlated. Thus, we assume that Oklahoma real personal income will grow at the same rate as U.S. real GDP and we use the annual rates of growth of the latter projected by the Congressional Budget Office in their long-run forecasts of the federal budget.<sup>17</sup>

**General Sales and Use Taxes.** We use the same method to estimate future receipts from the general sales and use taxes as used to estimate future receipts from the individual income tax. The assumed value of the elasticity coefficient for the general sales tax is only 0.67, however, as determined in a study by Bruce, Fox, and Tuttle.<sup>18</sup> Although this value may seem low, it reflects the fact that the general sales tax base grows more slowly than personal income. In fact, we expect it to become even smaller as the base of the tax continues to narrow due to continued reallocation of consumer expenditures from goods to services

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and to goods purchased via the Internet. We do not have a basis for adjusting it, however, so we assume that it remains at 0.67 and acknowledge the risk of an overestimate of general sales and use tax receipts.

**Gross Production (Severance) Tax – Natural Gas.** Unlike the personal income tax and the general sales tax there is virtually no relationship between changes in income and changes in tax collections for the Gross Production Tax (GPT) on natural gas.

The base of the GPT on natural gas is the *value* of natural gas produced at the wellhead, or the price of gas *times* the quantity produced. Oklahoma natural gas production has been steadily declining since 1990, at a rate of 2.2% per year, with changes in annual production bearing little relation to changes in the price of natural gas.<sup>19</sup> There is no good reason to believe that the declining production trend will be reversed, or even moderated. Thus, we assume a continued decline in production of 2.2 percent per year. For natural gas prices we use projections of natural gas wellhead prices by the Energy Information Administration (EIA) through 2030 for the lower 48 states (onshore).<sup>20</sup> In their projection, natural gas prices fall from \$5.78 per MCF in 2007 to \$4.46 per MCF in 2016 and then increase at an average annual rate of 1.85 percent from 2017 to 2030. We assume a continuation of the 2017-2030 trend in natural gas prices for the period 2031-2036.

These projections should serve as a sobering note for a government that may have been counting on the continuation of record GPT receipts to make up for record cuts in the individual income tax. According to our projections, receipts from the GPT on natural gas are expected to decline steadily throughout the projection period to about 40 percent of their 2005 value by 2036.

**Gross Production (Severance) Tax – Crude Oil.** The base of the GPT on crude oil is the value of crude oil produced at the wellhead, or price times quantity. Oklahoma's crude oil production has been steadily declining since 1987 at a rate of 4.43% per year, a rate that has been little affected by increases in the price of crude oil.<sup>21</sup> As in the case of natural gas, we assume that the declining production trend for crude oil will

continue. For prices, we use projections of crude oil wellhead prices by the EIA through 2030 for the lower 48 states (onshore).<sup>22</sup> In their projection, crude oil prices fall from \$66.77 per BBL in 2007 to \$43 per BBL in 2015 and then increase at an average annual rate of 1.109 percent from 2016 to 2030. We assume a continuation of the 2016-2030 trend in crude oil prices for the period 2031-2036. Under these assumptions, revenue from the GPT on oil is expected to fall to about 20 percent of its current value by 2036.

**Motor Vehicle Taxes.** Motor vehicle taxes in Oklahoma come primarily from vehicle license (“tag”) fees and an excise tax imposed on the sales value of motor vehicles. A regression analysis of the data indicates that real receipts from this tax have declined at an annual rate of 1.98 percent since 1995, when major changes in fees were adopted. We project 2007-2036 receipts from this tax using this rate. This portends a steady decline in real tax receipts from this source, from \$561 million in 2007 to \$314 million in 2036.

**Motor Fuels Taxes.** Motor fuels taxes in Oklahoma are per unit taxes levied on each gallon of gasoline and diesel fuel sold for use in transportation vehicles. Our projections of receipts from these taxes are based on the forecasts by the Energy Information Administration of the annual rates of growth in quantities that will be sold (an average of 1.83 percent per year) in the West South Central U.S. from 2007-2036.<sup>23</sup> According to these projections, real motor fuels tax receipts will grow from \$414 million in 2007 to \$697 million in 2036.

**Corporate Income Tax.** Oklahoma's experience with the corporate income tax is similar to that of many other states. It provided over 6% of total tax receipts in 1983; today it provides around 3%. A regression analysis of the data indicates that real corporate income tax receipts increased at an annual average of 1.89 percent per year from 1979 to 2004. We assume that this trend will continue for the projection period.

**Insurance Premium Tax.** Oklahoma's Insurance Premium Tax is based on the value of insurance premiums paid. We use consumer expenditures for insurance in the South from the Consumer Expenditure Survey<sup>24</sup> as a proxy for premiums paid in Oklahoma. Between 1984 and

2004, these expenditures fell at an average annual rate of 2 percent per year after inflation, a trend that we assume will prevail from 2007 to 2036.

**Cigarette Tax.** Oklahoma’s cigarette tax is a per unit tax levied on each pack of cigarettes sold. To project future receipts from this tax we first estimated the increase from 2004 to 2007 as a result of the recent per unit tax increase approved by Oklahoma voters, using a model that incorporates short-run income and price elasticities of demand. For 2008-2036, our projections are based on the trend in cigarette consumption in Oklahoma revealed in a 1983-2003 tobacco use survey.<sup>25</sup> According to our calculations based on this source, Oklahomans reduced their consumption of cigarettes at an average annual rate of 2.85 percent. We assume that this trend will continue from 2008 to 2036.

**Inheritance and Estate Taxes.** Inheritance and estate tax receipts will be zero from 2011 to 2036. Until then we assume that they will increase at 1.98 percent per year, the annual rate of increase after taxes determined by a regression analysis of the data from 1979-2004.

**Alcoholic Beverage Taxes.** We use consumer expenditures for alcoholic beverages in the South from the Consumer Expenditure Survey as a proxy for expenditures on alcoholic beverages in Oklahoma.<sup>26</sup> A regression analysis of the data indicate that these expenditures fell at an average annual rate of 1.5 percent per year after inflation from 1984 to 2004, a trend that we assume will prevail from 2007 to 2036.

**Other Taxes.** A regression analysis of tax receipts from the remaining taxes indicates that

they fell at an annual average of \$4 million per year from 1979 to 2004, a trend that we assume will continue from 2007 to 2036.

## Baseline Projection Results

Table 1.2 presents our projections of taxes, current services expenditures, and the structural balance in the baseline scenario for selected dates. According to these projections, tax receipts are expected to rise throughout the projection period, but not as fast as current services expenditures. This leads to structural budget deficits (a negative structural balance) for much of the projection period.

Figure 1.1 depicts structural balances for each year of the projection period. There it is clear that deficits begin earlier than 2010 – actually, in 2008 – and that they are sustained throughout the remainder of the projection period.

## The Pre-Tax-Cut Scenario

Table 1.3 contains a summary of the 2004-06 tax cuts for selected years. The estimates of reduced receipts for the first five years partly reflect the Oklahoma Tax Commission’s estimates. We have adjusted them downward, however, by converting them into \$2005. We have also adjusted them downward to account for the possibility that the tax cuts would induce a positive response in labor effort and saving and thus indirectly increase the tax base.

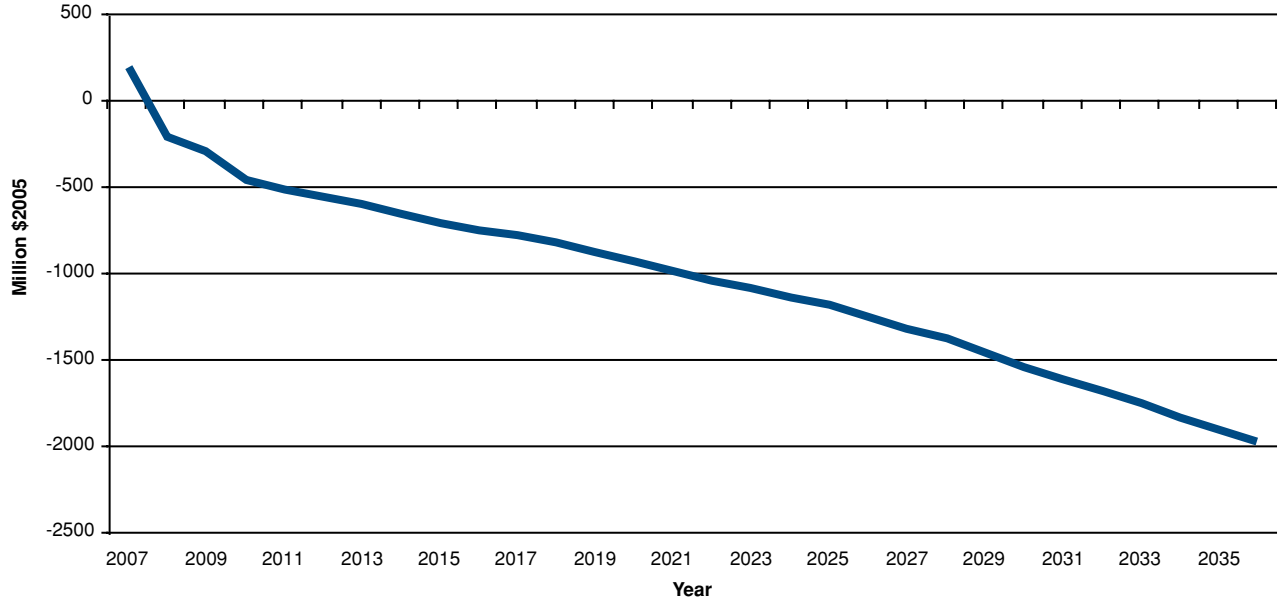
Table 1.2

### Oklahoma’s Structural Budget, 2007-2036 Selected Years, Millions \$2005

Year	2007	2010	2015	2020	2025	2030	2036
Tax Receipts	7285	6945	7483	8059	8728	9405	10448
Expenditures (Cost of Services)	7072	7365	8155	8947	9859	10896	12366
Structural Balance	213	-420	-672	-888	-1131	-1492	-1917

**Figure 1.1**

**Structural Budget Balances, 2007-2036  
Baseline Scenario**



**Table 1.3**

**Reduction in Real Tax Receipts Attributable to 2004-2006 Tax Cuts  
Millions \$2005**

<b>Tax</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2007- 2011</b>	<b>2012- 2036</b>	<b>2007- 2036</b>
Personal Income	222	329	366	429	446	1793	16931	18524
Corporate Income	15	15	15	15	15	74	331	405
General Sales	6	6	7	7	7	33	206	239
Inheritance & Estate <sup>a</sup>	0	0	0	67	65	132	1194	1326
Other	14	13	13	13	12	65	305	370
<b>Total</b>	<b>257</b>	<b>363</b>	<b>401</b>	<b>531</b>	<b>545</b>	<b>2097</b>	<b>18967</b>	<b>21064</b>

<sup>a</sup>This tax is phased out between 2007 and 2010, but revenue cost during the phaseout period was not available.  
Sources: 2007-2011, Tax Commission Estimates, in \$2005; 2012-2036, Author's estimates

There are plenty of economists who either deny such a possibility or argue that, if it did seem likely, its effect would be too small to matter. We believe, however, that recent work in estimating the *rate elasticity* of the individual income tax indicates otherwise.

The rate elasticity of the individual income tax indicates how much the tax *base* changes, in percent, for a one percent change in the tax *rate*. Given that most of the effect of the 2004-06 tax cuts can be attributed to a reduction in the top marginal rate of the individual income tax (from 6.85 percent to 5.25 percent when fully phased in), the rate elasticity of this tax is a key determinant of the overall impact of the tax cuts.

In a recent analysis of this elasticity, Gruber and Saez estimate a median value of 0.4.<sup>27,28</sup> Applying this value to Oklahoma, a 23.36 percent reduction in the individual income tax rate (from 6.85 percent to 5.25 percent) will generate a 9.344 percent increase in the income tax base ( $= 0.4 * 23.36$ ). Applying the lower rate of 5.25 percent to this base yields a 7.16 percent increase in tax revenues ( $= (5.25/6.85) * 9.344$ ) – the assumed offset.

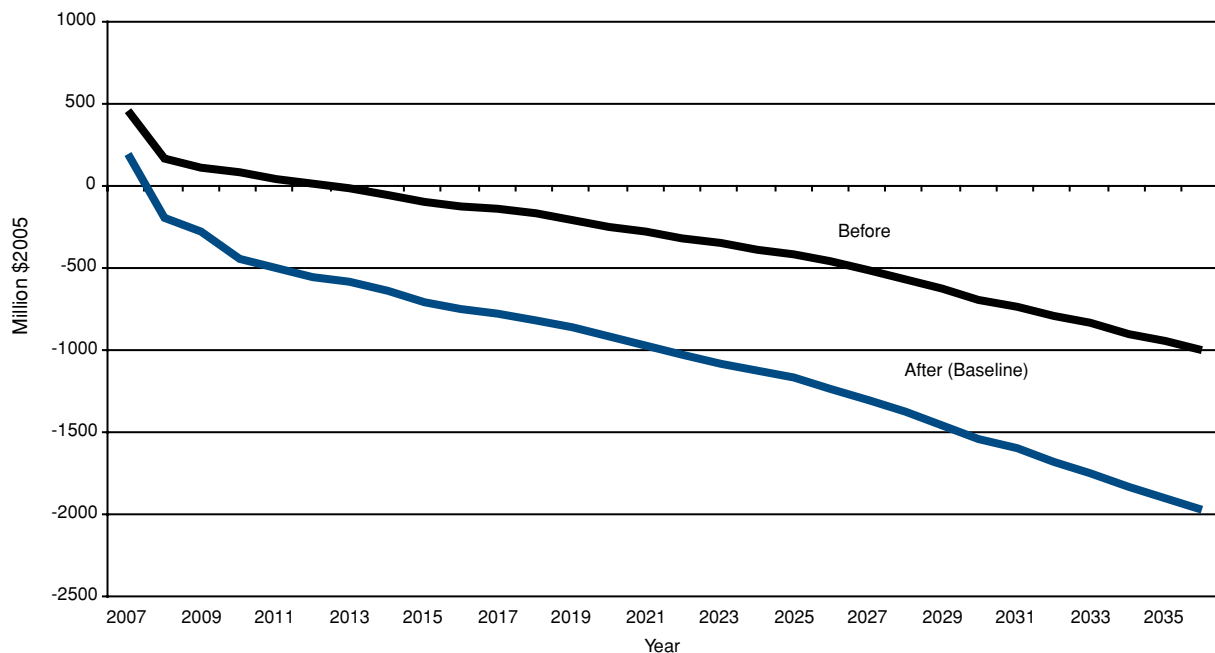
As noted, the estimated revenue effects of the tax cuts are based on the Tax Commission’s estimates for 2006-2011, adjusted for inflation and the tax rate effect. The estimates for the period, 2012-2036, are based on a post-tax-cut scenario that incorporates these cuts but otherwise assumes the tax receipt parameters used in the baseline scenario.

Viewed this way, the 2004-06 tax cuts add up to some really significant numbers. They also underscore the danger inherent in “back-loaded” tax cuts; i.e., tax cuts whose major effects occur outside the periods for which a budget is written. In this case, the one-year impact is only a trivial share of the long-run impact. In fact, even the 5-year impact is only 9.6 percent of the 30-year impact.

Figure 1.2 illustrates the effect of the 2004-06 tax cuts on the structural tax budget balances. Although Oklahoma was headed for structural deficits in the absence of the tax cuts, the cuts, per se, both hasten (by 5 years) and increase the size of the structural deficits.

**Figure 1.2**

**Structural Budget Balances, Before and After 2004-06 Tax Cuts**



The tax cuts explain the downward *shift* that occurs in the budget balances curve, but they do not explain why budget balances get progressively worse over time in *both* the before-tax-cut and after-tax-cut scenarios. That explanation resides in the structure of the state's tax system and the nature of current services expenditures. Structural deficits are expected because state tax structures are typically income-inelastic; that is, they produce receipts that grow more slowly than income. Structural deficits are also anticipated for most states because Medicaid expenditures are expected to grow faster than income.

Figure 1.3 illustrates the essential income inelasticity of the Oklahoma tax system. The measure used is real tax receipts as a percent of real personal income (RPI). If real tax receipts are growing as a percent of RPI the tax is income-elastic; if real receipts are falling as a percent of RPI the tax is income-inelastic. The individual income tax is clearly income-elastic, but the

remainder of the tax system is income-inelastic. Moreover, the income-inelasticity of the remainder of the tax system outweighs the income elasticity of the individual income tax, producing a tax system that, on average, is income-inelastic.

Although Figure 1.3 illustrates these points for only the baseline scenario, a figure illustrating the same statistics for the pre-tax-cut scenario would tell the same story.

Figure 1.4 illustrates the income elasticity of Medicaid expenditures. It also indicates that expenditures for the PEPS are income-elastic. The remaining expenditures, including K-12 education, higher education, and highways, are income-inelastic. From 2007 to 2018, the income-inelasticity of other expenditures outweighs the income elasticity of Medicaid and the PEPS. After that, the growth in Medicaid and the PEPS is greater than the decline in the remaining expenditures, with most of the excess growth attributable to Medicaid.

Figure 1.3

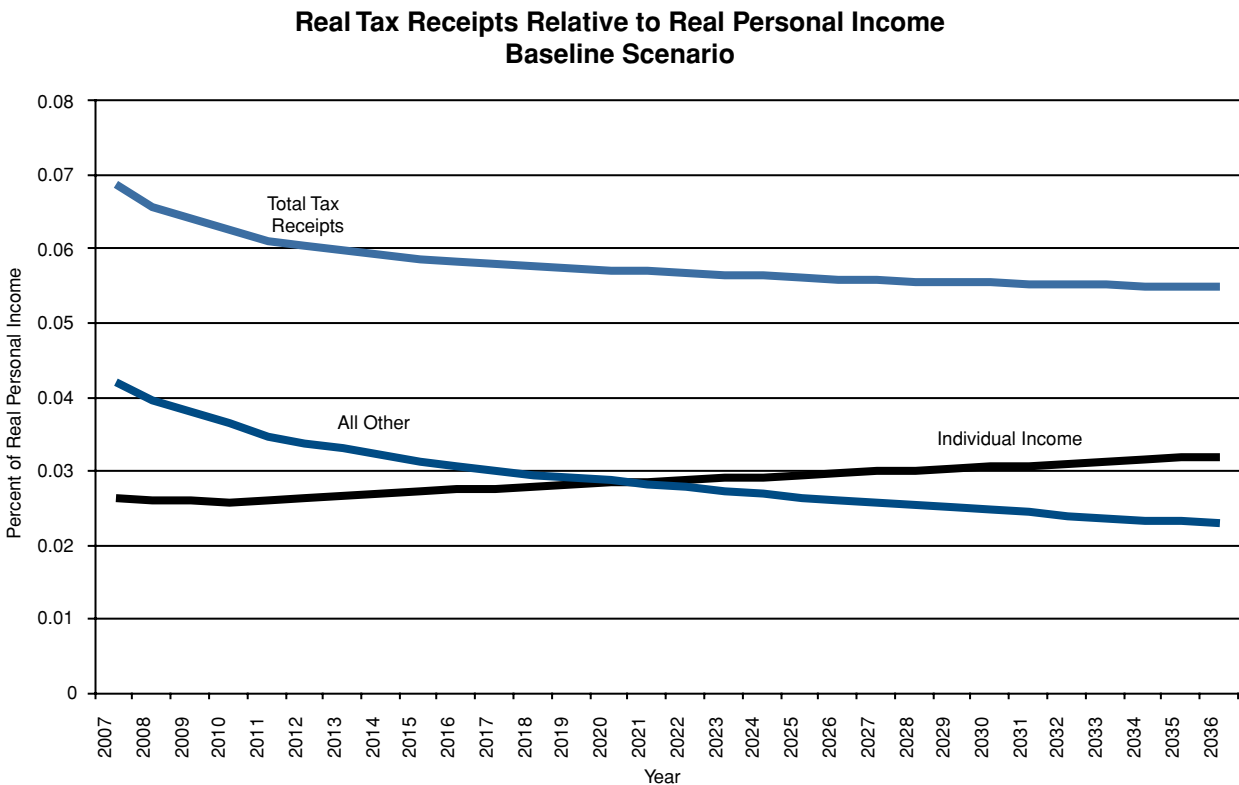
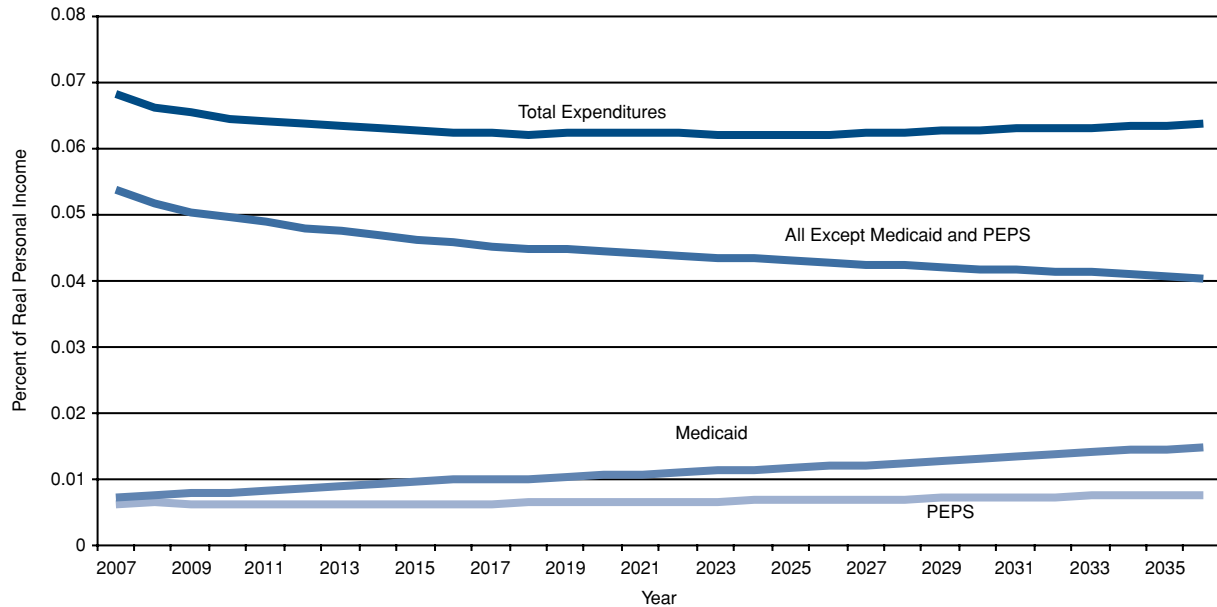


Figure 1.4

**Real Expenditures Relative to Real Personal Income  
Baseline Scenario**



It might be helpful to summarize the results illustrated in Figures 1.1-1.4. First, Oklahoma’s structural tax budget is headed for a period of sustained deficits. Second, structural deficits are endemic; they would have happened even in the absence of the 2004-06 tax cuts. Third, the structural deficits are a consequence of an income-inelastic tax structure combined with current-services expenditures that initially decline more slowly than tax receipts and eventually increase relative to RPI, largely because of the growth in Medicaid expenditures. Fourth, the tax cuts of 2004-06 matter because they have hastened and deepened the state’s structural deficits; not because they have changed the relationship between either tax receipts and RPI or expenditures and RPI.

There is also a fifth observation that should be made; namely, that Medicaid is a problem for state government in the sense that its funding will require a growing share of RPI, but the core of the funding crisis resides in both the growth of

Medicaid outlays and the state’s income-inelastic tax system.

**The Amortization Scenario**

The pending budget crisis would look even worse if the cost of amortizing the unfunded liabilities of the PEPS were added to the expenditure side of the structural budget. The PEPS had unfunded accrued actuarial liabilities in 2005 of \$10.577 billion.<sup>29</sup> The Oklahoma Teachers’ Retirement System accounted for \$7.1 billion of the total, the Oklahoma Public Employees Retirement System accounted for \$2.125 billion, and the remaining five systems in the PEPS were responsible for \$1.352 billion.

Assuming that the government wants to amortize these liabilities in 30 years, in accordance with the Governmental Accounting Standards Board Statement 25, what does this imply for the structural budget? This means that a series of annual payments large enough to fully fund the

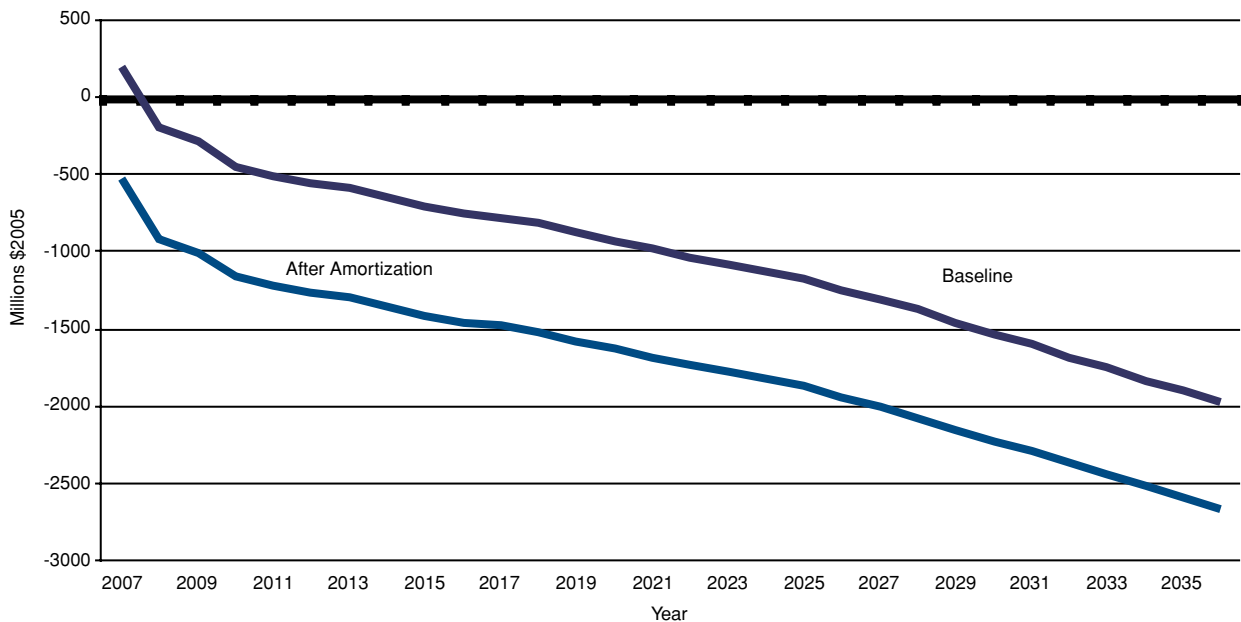
liability in 30 years should be added to projected expenditures. Structured this way, the annual payments are similar in concept to the payments that would have to be made on a 30-year mortgage to pay off a home loan.<sup>30</sup>

The size of the payments would depend, of course, on the interest rate charged for the loan. In this instance, the relevant interest rate is the rate of return that the actuaries expect that the various components of the PEPS will earn on money invested. The actuaries expect the Oklahoma Teachers' Retirement System (OTRS) to earn 8 percent before inflation and the remaining components of the PEPS to earn 7.5 percent before inflation. Following the long-run assumptions of the Congressional Budget Office, we expect the future rate of inflation to be 2.2 percent per year.<sup>31</sup> Subtracting this amount from the expected rates of

return before inflation yields a real rate of return of 5.8 percent for OTRS and 5.3 percent for the other components of the PEPS. At these rates of interest, the OTRS would need an additional \$500 million a year after inflation for 30 years to fully fund its unfunded liability (to make the required payments on its "mortgage") and the other components combined would need an additional \$232 million per year after inflation.

Adding these amounts to the expenditures in the baseline scenario increases the projected structural deficit by \$732 million per year for 30 years. As illustrated in Figure 1.5, which compares the baseline scenario with the amortization scenario, the deficit would begin immediately in the amortization scenario and increase by the amount of required amortization for the remainder of the projection period.

**Figure 1.5**  
**Structural Budget Balances**  
**Before (Baseline) and After Amortization of Unfunded Accrued Actuarial Liability**



## Putting the Problem in Perspective

Figure 1.6 illustrates the annual percentage increases required in all taxes, the individual income tax, and the general sales tax, to fully fund the structural budget in the amortization scenario. This figure illustrates three points. First, the larger the tax base, the smaller the required tax increases would have to be; the tax base increases in moving from the general sales tax to the income tax to all taxes. Second, regardless of how the tax increases were structured, substantial increases in tax receipts would be required. Third, the tax increases must be designed so that the annual increases in tax receipts fund the structural deficits as they occur.

The third requirement can be satisfied by adopting new increases each year (or at least very frequently), passing tax increases large enough to fund future deficits in advance, or by adopting

changes in the tax system that increases its income elasticity. The first of these is not politically possible and can be dismissed out of hand. The second alternative also appears to be politically impossible, but a little more explanation is in order.

Consider the adoption of a single tax increase large enough to eliminate all projected structural deficits for the next 30 years. The practical aspect of this approach is that the additional taxes would have to be deposited in a trust fund, which would be replenished each year with deposits generated by the tax increase, and diminished by withdrawals required to fund the deficit. The trust fund balances could earn interest, of course.

Figure 1.7 illustrates how this approach would work for an immediate and sustained increase in the individual income tax. Assuming that the trust fund would be invested in relatively safe securities earning a real rate of interest of 3 percent per year, individual income tax collections

Figure 1.6

### Tax Increases Required to Balance Structural Budget Plus Amortization

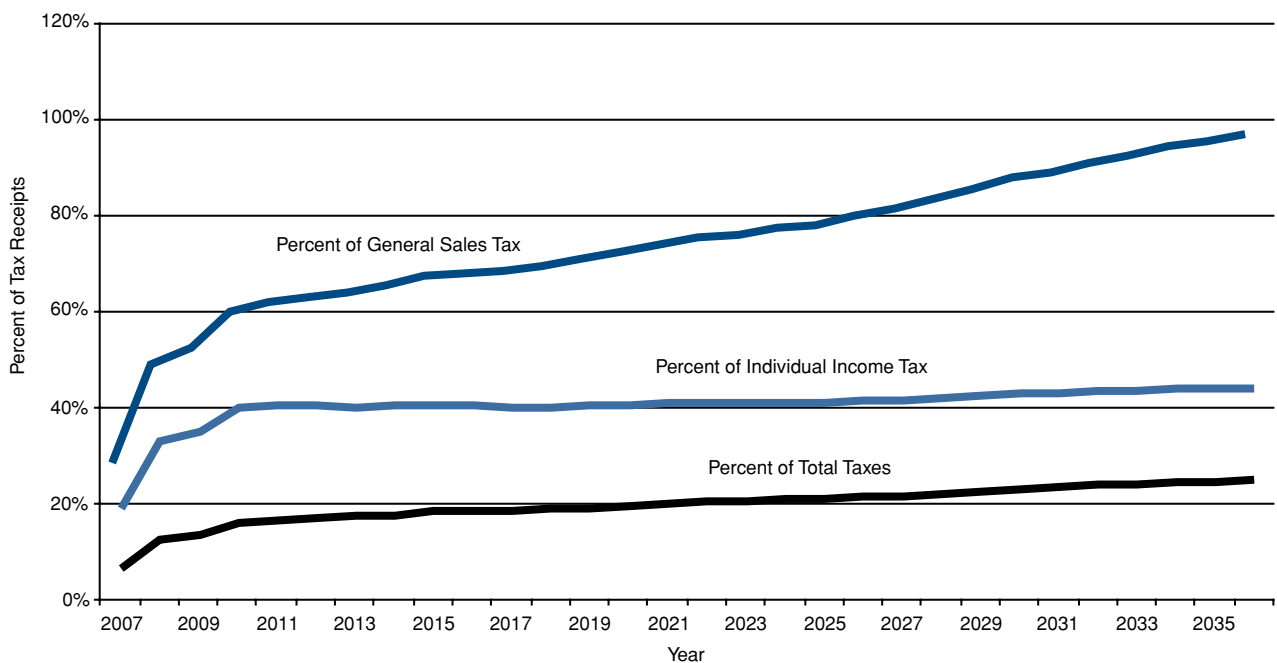
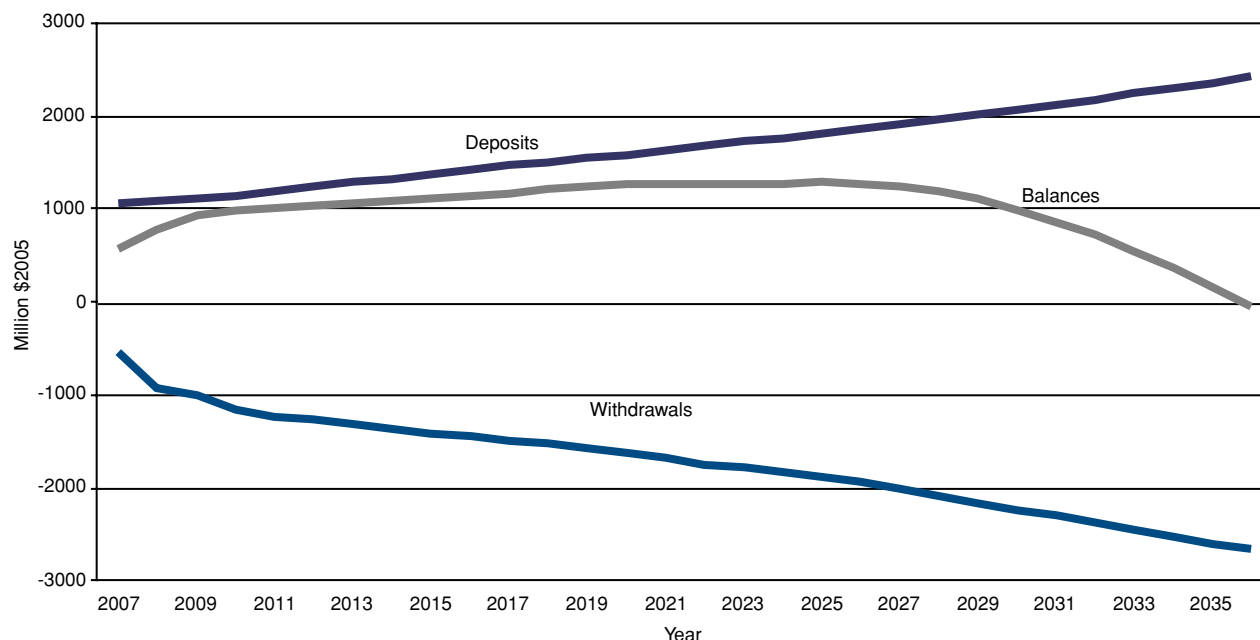


Figure 1.7

**Income Tax Trust Fund Sufficient to Fund Future Structural Deficits  
Deposits, Withdrawals, and Balances**



would have to be increased by 40.6 percent each year, starting in 2007 and sustained for 30 years. Such an increase would produce the indicated deposits. These deposits plus interest would be used to fund the withdrawals necessary to cover the deficit (including amortization of unfunded pension system liabilities). The trust fund balances would increase until 2025 as a result of the advance funding made possible by the tax increase. After that, withdrawals would exceed deposits plus interest earnings (not shown) and the trust fund would be exhausted in 2036, completing its purpose.

Other one-time tax increases are possible, of course. If the tax increase were spread evenly across the individual income and general sales taxes (together, they account for 78 percent of the 2007-2036 tax base), an immediate and sustained increase of 26.1% of the combined taxes would be required.

A one-time tax increase is not the only way

to advance fund the expected deficits; they could be funded with several tax increases adopted periodically over the next 30 years. All cases of advance funding, however, would require the establishment and maintenance of a trust fund. Whether the advance funding approach would work depends on whether the legislature would propose, and the electorate would approve, tax increases short of an actual funding crisis, and on whether the legislature could resist the temptation to spend the possibly large balances that could accumulate in advance of the time that they are needed. We doubt that either of these contingencies could materialize.

The third approach would require the discovery of changes in the tax code that would increase the income elasticity of the tax system, imbuing it, as it were, with the means to keep up with expenditures that grow as income grows. Such research seems worthwhile, even if the option identified

would also be a tough sale to the legislature and the electorate.

Regardless of the approach taken, the net effect would be to raise the average real tax burden, over the period 2007-2036, from the baseline level of 5.69 percent of real personal income to 6.78 percent. From 1979-2005, real tax receipts ranged from 6.56 percent to 7.7 percent of real personal income and averaged 7.15 percent, with no discernable upward or downward trend (see Figure 1.8). Thus, *the tax increase we have calculated would, on average, actually impose less of a burden on Oklahomans than the burden they shouldered prior to the recent tax cuts.*

Figure 1.9 illustrates the percentage decreases required in various expenditures. This figure illustrates the same points made with reference to Figure 1.7. In this case, the larger the expenditure base, the smaller the required expenditure decrease. Second, regardless of how the expenditure decrease was structured, a substantial

decrease in expenditures would be required. Third, the expenditure decreases must be designed so that the annual decreases in expenditures fund the structural deficits as they occur.

The third requirement can be satisfied by adopting new decreases each year (or at least very frequently), adopting expenditure decreases large enough to fund future deficits in advance, or by adopting changes in the expenditure system that decrease its income elasticity.

The first of these may be more feasible than annual increases in taxes. Therein lies the danger; programs may be pared, creating a loss in economic welfare greater than the loss that would be occasioned by a tax increase. Advance funding via expenditure reduction would have the same problems as advance funding via tax increases; namely, it would be difficult to secure approval in advance of an actual crisis and the legislature may not be able to resist spending the receipts freed up via expenditure reductions. Thus, it would be worth the effort to identify ways in which the cuts

**Figure 1.8**

**Real Taxes As Percent of Real Personal Income, 1979-2005  
(\$2005)**

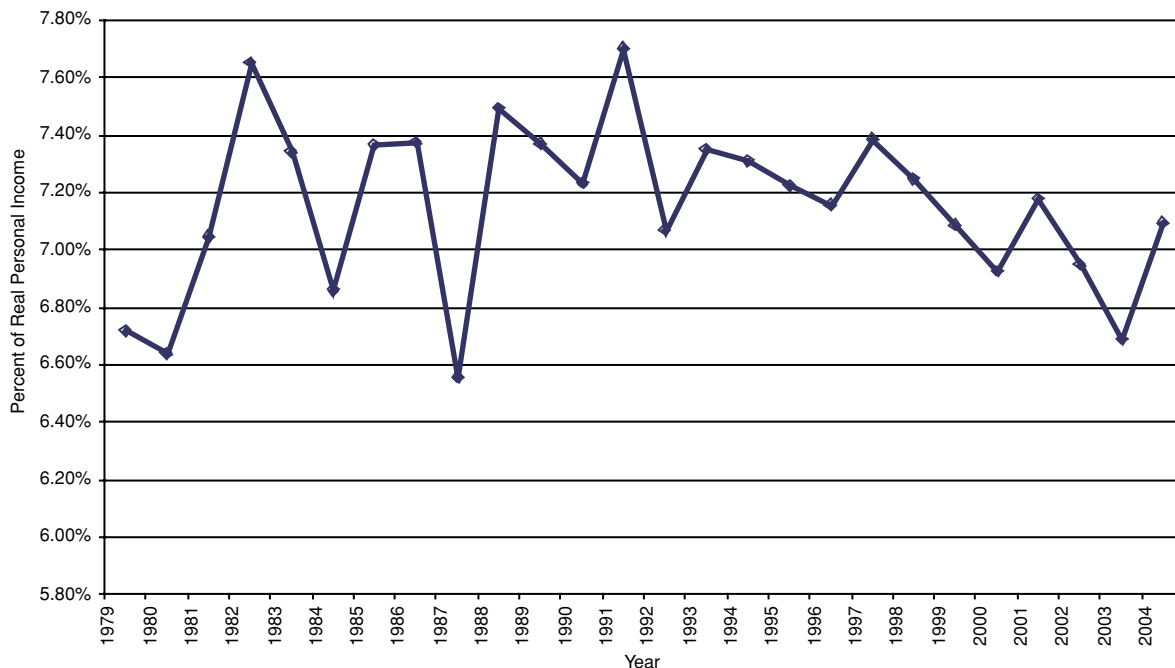
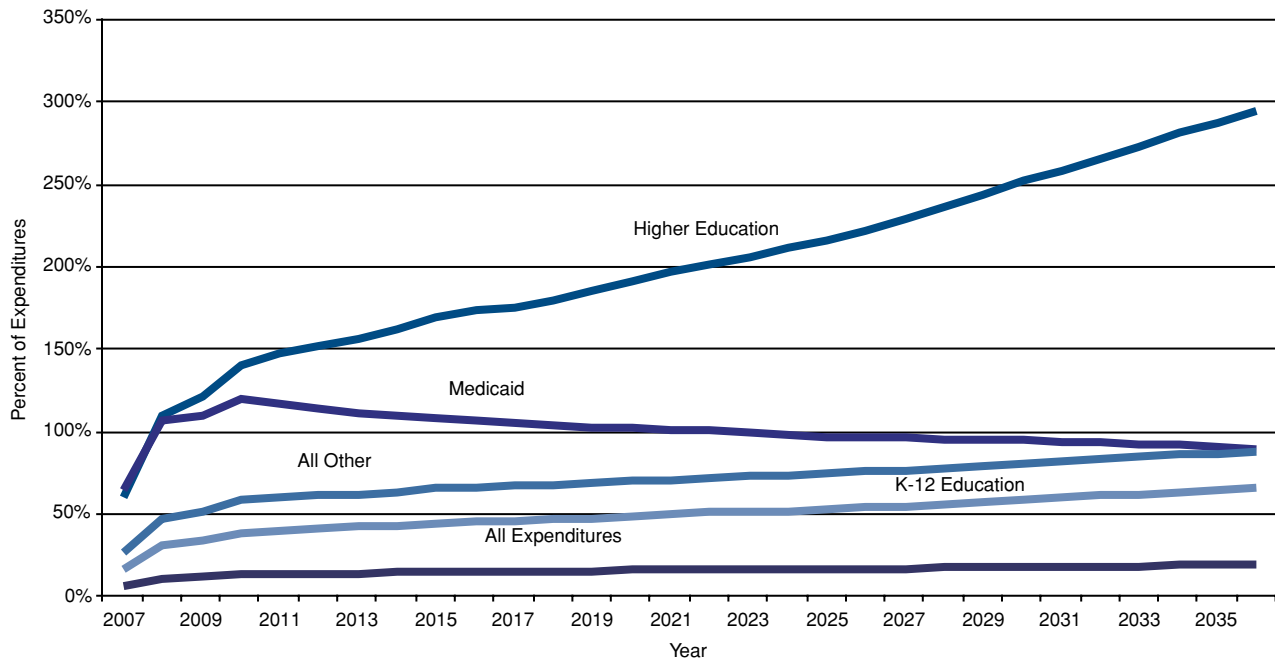


Figure 1.9

**Expenditure Cuts Required to Balance Structural Baseline Deficit Plus Amortization**



could be put on automatic pilot by reducing expenditure elasticities.

**What About Uncertainty?**

Long-run projections are subject to considerable uncertainty. One way to reduce the level of discomfort attributable to uncertainty is to subject the key projection parameters to sensitivity analysis. One approach to sensitivity analysis is to project alternative scenarios using different values for key projection parameters. Although it is possible to do this for the forecasting model we have constructed for this study, we eschew this approach in favor of simply asking whether the values we have used for key parameters are likely to produce an underestimate or overestimate of the structural deficit.

The key tax receipt parameters are (in probable order of importance): the income elasticity of the individual income tax, the income

elasticity of the general sales tax, the projected rate of economic growth, the projected production and prices of crude oil and natural gas, and the projected pattern of consumer expenditures for alcohol, cigarettes, and insurance. The key expenditure parameters are: the cost differential and federal funding share for Medicaid, and enrollment growth rates and cost differentials for education (both K-12 and higher education).

As noted, the 2004-2006 tax cuts reduced the top marginal rate of the individual income tax. They also provided for a significant increase in the standard deduction. Together, these changes will reduce the progressivity of the individual income tax and, consequently, its income elasticity. We have assumed a value for the latter, however, that is constant throughout the projection period.

We have also assumed a value for the income elasticity of sales tax receipts that is constant throughout the projection period. We expect that it will decline, however, as consumers continue to

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allocate a growing share of expenditures to untaxed services and internet purchases.

The tax elasticities were combined with projected rates of U.S. economic growth from the Congressional Budget Office to produce projections of individual income and general sales tax receipts. A higher rate of economic growth than that assumed would act as an offset to falling elasticities, and some analysts think that the CBO estimates of U.S. economic growth are too low. An increase in the annual rate of growth of real personal income about 0.5 percentage points higher than the CBO anticipates would suffice to offset the current inelasticity of the tax system. This may seem like an achievable increase, but it would be difficult to attain. Moreover, the boost required would be larger than this if the anticipated declines in tax elasticities occurred. The reader is also cautioned that this is an increase in excess of the boost in economic growth that the tax cut, itself, may provide. That effect has already been factored into the baseline estimate of individual income tax receipts.

Projections of receipts from the remaining taxes reflect historical consumption (alcohol, cigarettes, and insurance) and production (crude oil and natural gas) trends that are unlikely to be reversed or changed significantly. The Energy Information Administration's projections of the prices of crude oil and natural gas, used to project receipts from the gross production taxes, could be too low, but they could also be too high. We are not aware of any compelling reasons to believe that they err on the low side.

Our projection of Medicaid expenditures is based on extensive analysis of Medicare and Medicaid trends by technical review panels composed of health care expenditure experts and on the share of Medicaid paid by the federal government. Although other experts may disagree with the conclusions of the technical review panels, few argue that they err on the high side. There is a real danger, however, that the assumed share of Medicaid expenditures paid by the federal government does err on the high side. In fact, given the size of prospective federal deficits it is

much more likely that the federal share will fall than that it will rise over time.

Projected enrollments in schools, colleges, and universities reflect projected growth in the population of specific age cohorts. They implicitly assume that no change will occur in enrollment rates, retention rates, the percent of students requiring special education, or the percent of students for whom English is a second language. Significantly higher population figures would require higher birth rates or higher rates of immigration. Both of these seem unlikely. Higher enrollment rates, higher retention rates, and larger percentages of students requiring special education or the development of English language skills cannot be ruled out, however.

The remaining determinant of educational expenditures, the faster rate of growth in costs, is clearly reflected in past trends in price indexes. These trends are a result of differential rates of growth in productivity between the educational sector and the rest of the economy that we do not expect to converge.

Summing up, our baseline projection of tax receipts may err on the low side but it seems more likely that it errs on the high side, given the probable erosion in tax elasticities. The baseline projection of expenditures appears to err on the low side, rather than the high side. The bottom line, therefore, is that the most probable alternative scenarios that could be constructed would yield structural deficits that are *larger* than those reported above.

## **Policy Implications**

Budget deficits are prohibited by the Oklahoma Constitution, so we can be reasonably certain that they will not occur as projected. Some hard choices will have to be made, however, to avoid the deficits we project. The consequences of what we project, then, depend on the actions taken to deal with this problem.

The problem, per se, is not trivial. The deficits we anticipate are both large and sustained.

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The problem Oklahoma faces is similar in some respects to the budget problem faced by the federal government. Baseline projections indicate that the federal government is looking at a future of sustained budget deficits, as is Oklahoma. Federal deficits are largely a consequence of projected growth in expenditures for health care and social security that are much greater than projected growth in baseline revenues. Oklahoma's deficit also reflects projected growth in health care expenditures and its unfunded PEPS liabilities are similar to those faced by Social Security.

At the federal level, keeping promises to the elderly will require either unprecedented tax increases or drastic reductions in other programs. Oklahoma is a little more fortunate. As noted above, the Oklahoma deficit problem could be solved with tax increases that would actually put the state back on a trajectory that would be less burdensome than the trajectory it followed for most of the past quarter century. This observation should *not* be construed, however, as an endorsement of a tax increase. For one thing, we don't know the best way to do that if that's what we wanted to do. On the other hand, we are not endorsing cutting any particular expenditure, even those that are destined to grow the fastest, such as Medicaid.

What *is* needed is a thorough consideration of a large variety of tax and expenditure options, informed by careful analysis. We suggest the following, at a minimum.

In considering the possibility of a tax increase the most certain way to avoid sustained budget deficits appears to be a change in the tax structure that produces revenue growth that more closely matches the growth in state expenditures. This could involve increasing the top marginal rate of the individual income tax or broadening the base of the general sales tax to include consumer purchases of services. But we don't know whether that is the best approach. Moreover, we want the tax system to achieve other objectives, as well. We should also consider the effects of any proposed tax increases on economic growth, on equity, on economic efficiency, and on revenue stability. In

effect, if we take the tax increase approach, we should use it as an opportunity to improve the tax system. And, every aspect of the tax structure should be on the table, including tax preferences.

State taxes are not the only way to pay for government services, however. Thus, our list of options to be considered includes greater use of local property taxes to pay for local schools and different ways for students to pay for higher education, such as income-contingent loans. Again, it is not possible to make rational choices without a thorough consideration of the effects of these options on revenue growth, revenue stability, efficiency, economic growth, and equity.

We should also begin a consideration of whether, and if "yes," how, to best cope with rising Medicaid expenditures, ranging from restricting access to rationing. In addition, we need to identify options that would reduce commitments to the PEPS or increase revenues for that purpose.

Revenues and expenditures will not grow in the smooth fashion indicated by our projections. We know from experience that this is especially likely to be the case for the gross production taxes. The income-contingent taxes, such as the individual income tax and the general sales tax, will also fluctuate with the business cycle. At the same time, we're confident that the underlying trend will be that of increasingly larger deficits in the structural budget. So there is a need to work on the design of a rainy day fund that helps deal with both short cycles and long trends.

In general, there is a need for an analytical effort that parallels the one going on right now in Washington to inform the debate about options for solving the federal government's long-run budget problems. This effort has resulted in some studies that might provide guidelines, such as those evident in the Brookings Institution's *Restoring Fiscal Sanity* series. The important thing is to get on with it.

Finally, at the very least, we hope that the analysis in this chapter will move the Oklahoma Legislature toward the construction and analysis of long-run budget projections before any more permanent tax cuts (or significant expenditure increases) are adopted.

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## Endnotes

<sup>1</sup>There are actually seven state public employee pension systems: the Oklahoma Teachers' Retirement System, the Oklahoma Public Employees' Retirement System, the Oklahoma Law Enforcement Retirement System, the Uniform Retirement System for Justices and Judges, the Department of Wildlife Retirement Plan, the Oklahoma Firefighters' Pension and Retirement System, and the Oklahoma Police Pension and Retirement System. All of them are under-funded, except the Uniform Retirement System for Justices and Judges.

<sup>2</sup>This is not the only unfunded liability of Oklahoma state government, although it is the largest and best known. A full accounting would include the unemployment compensation fund, general obligation (and probably revenue) bonds, loan guarantees, contractual obligations to clients under the Quality Jobs Act and ad valorem exemption program, and other tax preferences structured as entitlements.

<sup>3</sup>Boyd, Don, *State Spending for Higher Education in the Coming Decade*, Nelson A. Rockefeller Institute of Government, October, 2002.

<sup>4</sup>Blatt, David, *Speeding Towards a Train Wreck? Experts Sound Alarms Over Looming Structural Budget Deficits*, Community Action Project, Tulsa, September, 2006.

<sup>5</sup>Lav, Iris J, Elizabeth McNichol, and Robert Zahradnik, *Faulty Foundations: State Structural Budget Problems and How To Fix Them*, Center for Budget and Policy Priorities, May, 2005.

<sup>6</sup>Olson, Kent W., *Oklahoma's Long-Run Budget: Sustainable? Affordable?* State Policy and Economic Development in Oklahoma: 2006, Oklahoma 21<sup>st</sup> Century, Oklahoma City, 33-44. That study differs from the current study in four important ways: (1) the budget concept is broader, including all sources of revenue, (2) the projection period is much longer (75 years), (3) the projections assume the continuation of past trends in spending and revenues, and (4) the "bottom line" is a measure of the state's fiscal imbalance. Given these differences, the current study provides a different picture of the state's fiscal future. It is not necessarily more correct, but it is arguably more policy-relevant.

<sup>7</sup>See endnote 4

<sup>8</sup>Oklahoma Pension Oversight Commission, *2006 Status Report of the Oklahoma State Pension Systems*, March 24, 2006.

<sup>9</sup>Oklahoma Department of Commerce, *Population Projections for Oklahoma, 2000-2030*, November, 2002. We use the projection that reflects the medium migration assumption.

<sup>10</sup>Commonfund Institute, *2006 Higher Education Price Index*.

<sup>11</sup>See end note 9.

<sup>12</sup>Center for Medicare and Medicaid Services, Office of the Actuary, *National Health Care Expenditures Projections: 2005-2015*.

<sup>13</sup>Congressional Budget Office, *The Long-Term Budget Outlook*, December, 2005, 7-8.

<sup>14</sup>Gabriel, Roeder, Smith and Company, *Teachers' Retirement System of Oklahoma, Actuarial Valuation as of June 30, 2005*; MERCER Human Resources Consulting, *State of Oklahoma Public Employee Retirement System, Actuarial Valuation as of July 1, 2005*.

<sup>15</sup>See end note 9.

<sup>16</sup>National Bureau of Economic Research, *Summary Measures of the U.S. Tax System, 1960-2010, Marginal and Average Tax Rates and Elasticities*.

<sup>17</sup>See end note 13; long-term projections data are available on an annual basis in an XLS file from the Congressional Budget Office website.

<sup>18</sup>Bruce, Donald, William R Fox, and M.H. Tuttle, *Tax Base Elasticities: A Multi-State Analysis of Long-Run and Short-Run Dynamics*, December 2002, University of Tennessee.

<sup>19</sup>Author's calculations based on data in *Marketed Natural Gas Production, Oklahoma*, from Energy Information Administration website.

<sup>20</sup>Energy Information Administration, *Annual Energy Outlook for 2006 with Projections to 2030*, EIA-0383, February 2006.

<sup>21</sup>Author's calculations based on *Oklahoma Crude Oil Production*, XLS file from Energy Information Administration website.

<sup>22</sup>See end note 20.

<sup>23</sup>Energy Information Administration, *Energy Consumption, by Sector and Source*, February 2006.

<sup>24</sup>Bureau of Labor Statistics, *Consumer Expenditure Survey, Life and Other Personal Insurance: South, 1984-2004*.

<sup>25</sup>Per Capita Sales of Tobacco, 1983-2003. Available via the Internet at [http://ssdc.ucsd.edu/tobacco/sales/tobacco\\_sales.xls](http://ssdc.ucsd.edu/tobacco/sales/tobacco_sales.xls)

<sup>26</sup>Bureau of Labor Statistics, *Consumer Expenditure Survey, Alcoholic Beverages: South, 1984-2004*.

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<sup>27</sup>Gruber, Jonathan, and Emmanuel Saez, “The Elasticity of Taxable Income: Evidence and Implications,” *NBER Working Paper 7512*, April 2000.

<sup>28</sup>The estimate of Gruber and Saez may, in fact, be on the high side. The Congressional Budget Office (CBO) estimates that only 5 percent of revenues from a 10 percent cut in the individual income tax would be recovered during the first five years following the cut, instead of the 40 percent recovery rate indicated by Gruber and Saez’s estimates (CBO, *Analyzing the Economic and Budgetary Effects of a 10 Percent Cut in*

*Income Tax Rates*, December 1, 2005). The CBO study also indicates, however, that there is likely to be a 32 percent recovery rate during the second 5 years after the cut.

<sup>29</sup>See end note 8.

<sup>30</sup>We have assumed that the payments would be made in 30 equal-size installments. The payments could be structured differently. We lack the information required to determine the optimal payment scenario, however.

<sup>31</sup>See end note 13.



## The Oklahoma School of Science and Mathematics: Its Roles in State Education and Economic Development

The Oklahoma School of Science and Mathematics (OSSM) is a residential school serving a select group of academically talented high school juniors and seniors from communities throughout the state. Around 140-150 students are enrolled each year. OSSM also provides model programs implementing advanced science and math curricula at eleven Regional Outreach Science and Math Centers. It is a separate agency of Oklahoma state government whose justification from its outset in 1983 has included its importance to state economic development.

The purpose of this report is to examine various economic dimensions of OSSM. These dimensions consist of *inputs* (resources) and *outputs* (products). In summary, the *inputs* include the following:

- Students admitted to the residential program in Oklahoma City
- Students participating in the Regional Outreach Centers
- Faculty at the residential and regional centers
- Complementary educational inputs including summer intern programs and courses at the University of Oklahoma Health Sciences Center
- Physical capital at the OSSM Oklahoma City site
- Resources available at the Regional Outreach Centers
- Financial inputs in the form of legislative appropriations, federal grants, and private contributions

The inputs are combined to produce the following range of *outputs*:

- Students graduating from OSSM and their levels of academic achievement upon graduation.
- OSSM graduates proceeding to universities of varying types within and without Oklahoma
- The progression of OSSM graduates through undergraduate, graduate and professional education, and on to gainful employment
- Further academic achievement of students completing advanced calculus and physics courses at OSSM's Regional Centers
- Demonstration effects of OSSM improving public and private high school educational services to exceptional students
- Urban development effects involving OSSM's important role within the Oklahoma Health Center complex and the redevelopment of the central core of Oklahoma City
- Economic development effects flowing from the impact of OSSM and its image of educational excellence on the propensity of highly skilled professionals and managers to locate and remain in Oklahoma

Because the resources used in OSSM's activities have alternative uses, it is important to explore the costs to the state of Oklahoma in the form of legislative appropriations. Also of interest is the significant extent to which OSSM has obtained federal funds and private donations. Some evidence will be examined relating to the sorts of jobs held by OSSM graduates. Many of the jobs are in science and engineering (S&E) fields and are relatively high-paying. It is impossible to obtain reasonable estimates of the value of

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urban and economic development benefits to Oklahoma, or of the value to the state's overall educational system of OSSM's demonstration effects. Thus, there will be no "bottom line" conclusion regarding an estimate of a benefit-cost ratio.

### **Background**

The 1983 session of the Oklahoma Legislature passed, and Governor George Nigh signed, House Bill 1286 creating the Oklahoma School of Science and Mathematics. The legislation was quite succinct—covering only two pages in that year's Session Laws. The school was to be governed by a 25-member Board of Trustees. Six of the members with *ex officio* status included five top higher education officials and administrators along with the Superintendent of Public Instruction. The remaining 19 were to be appointed by the leaders of the State House of Representatives, the State Senate, and the Governor. The trustees' characteristics were specified to include politicians, educators, scientists, and mathematicians. A revolving fund was created for OSSM in the State Treasury. With the exception of expanded duties relating to Regional Outreach Centers in 1997, the 1983 statutory provisions remained essentially in their original form in 2006.

A significant statutory change in the responsibilities of OSSM occurred in 1997 when OSSM was given the task of creating "pilot projects that develop and establish model programs implementing advanced science and math curriculum at technology center school sites, local colleges or universities, or at local school sites via distance learning."<sup>1</sup> Competitive applications are prepared by local groups. A three member Selection Committee decides on the recipients of the model program awards. This committee consists of the Director of the Oklahoma Department of Career and Technical Education, the Superintendent of Public Instruction, and the Director of OSSM (or their designees). Three-member local Advisory Councils oversee each of the model programs. These councils include the local school superintendent, the superintendent of the local technology

center school district, and the Director of OSSM (or their designees).

### **The 1983 Environment**

How did the original OSSM legislation come to be passed in 1983? As with any significant legislative measure, there was a cadre of committed supporters both within and without the Oklahoma Legislature. No attempt is made herein to review all of the significant contributions of these supporters; that would be an element in a comprehensive history of OSSM. Rather, the issue here relates to environmental conditions operating at the national and state levels emphasizing the importance of high-tech economic development and the educational environment conducive to such development.

By the early 1980s there was great concern at the national level about the marked decline in the productivity of the U.S. economy since the mid-1970s. During the 14-year period 1959-1973, output per hour of all persons in the business sector grew at a compound annual rate of 3.1 percent; from 1973 through 1982 that growth rate was 1.0 percent.<sup>2</sup> Productivity growth was declining in other industrial economies, but the decline started earlier and lasted longer in the United States.<sup>3</sup>

Raising the national rate of productivity growth was a big issue in the early 1980s. Virtually all discussions included the need to promote the development of high-technology industry, and the need to improve educational systems in order to have more productive workers and to have the human investment needed for expanded research and development activity. Much needed to be done at the state level, and the U.S. Congress Office of Technology Assessment was monitoring a diverse set of state efforts at high-technology development.<sup>4</sup>

Arguably, no state exhibited more initiative than North Carolina in the fields of technology-based economic development and education improvement.<sup>5</sup> That state had created the North Carolina Board of Science and Technology in 1963—well ahead of concerns over productivity

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decline; Oklahoma created a similar agency, the Oklahoma Center for the Advancement of Science and Technology in 1987. North Carolina also opened a residential science and math school in 1980. A 1982 editorial by North Carolina Governor James B. Hunt in *Science* magazine triggered a request to Governor Hunt for information about its new science and math school by Oklahoma State University Biochemistry professor Earl Mitchell.<sup>6</sup> Mitchell's March 1982 letter led to an exchange of information which familiarized Oklahoma OSSM supporters with the North Carolina experience and helped them to fashion a proposal for a similar institution.

### **OSSM Off to a Slow Start in the 1980s**

No doubt the energy-based economic boom that Oklahoma experienced in the late 1970s and early 1980s was a positive force behind an innovation such as OSSM. However, on the eve of the passage of HB 1286 in 1983 state finances had already experienced the beginnings of stress which was to last through 1987. Major budget cuts had been implemented in the spring of 1983 as a result of weakness in energy prices. Support both within the legislature and from the governor's office facilitated the passage of the OSSM legislation in spite of emerging budget constraints.<sup>7</sup> Tight state budgets during the mid 1980s meant that OSSM did not gain significant funds as a state agency until it received a \$300,000 appropriation from the 1988 legislative session.

### **1990 and Beyond: OSSM Produces Education**

By the late 1980s, the state's economy had worked its way out of its energy-related trauma and total appropriations were growing at a relatively steady pace. For FY 1990, OSSM had an appropriation of \$1.2 million and was able to open in September with its first class of 50 students. By the fall of 1991, OSSM was up and running

with 140 students—an annual enrollment level which was to remain relatively constant through 2005.

While enrollment reached a steady state constrained by dormitory capacity, the physical plant of OSSM witnessed remarkable improvement following 1990. The end result is an attractive and spacious campus on a 32 acre site south of the State Capitol and at the northwest edge of the massive Oklahoma Health Center complex in Oklahoma City. The original structure within the campus is a substantially remodeled former public school building. This is supplemented by the following new structures: a dormitory, a gymnasium, a science building, and a library. Additional dormitory facilities are planned, with the ultimate intention of having enrollment of 300.

### **Student Inputs: Oklahoma City**

In this and the following sections, focus will be on the characteristics of the OSSM residential high school facility in Oklahoma City; a separate section will treat selected features of the Regional Outreach Centers. Between its beginning in 1990 (class of 1992) and 2006 OSSM has enrolled a total of 1,268 students of which 900 have graduated and 135 are currently enrolled as members of the classes of 2007 and 2008. OSSM staff has been able to keep in touch with nearly three-quarters of the school's 900 graduates and to track their professional activities.

### **Applications and Acceptances**

The selection of high school students to study at the Oklahoma City campus is quite competitive, and students generally do not apply for admission unless they have assessed their own probability of success. Table 2.1 reports by year the number of applications, the number of students invited for interviews, and the percent of those who accept and start the program. For the 1992 through 2008 classes, 29.7 percent of those applying actually started.

Table 2.1

Applications and Acceptances, OSSM, Classes of 1992 through 2008

Class	Applications (number)	Interviewed (number)	Accepted and started (number)	Percent of applications interviewed	Percent of invited who accept and start	Percent of applications who accept and start
1992	271	138	58	50.9	42.0	21.4
1993	267	156	88	58.4	56.4	33.0
1994	292	141	75	48.3	53.2	25.7
1995	269	157	84	58.4	53.5	31.2
1996	315	175	72	55.6	41.1	22.9
1997	275	167	82	60.7	49.1	29.8
1998	261	161	70	61.7	43.5	26.8
1999	283	169	86	59.7	50.9	30.4
2000	289	150	67	51.9	44.7	23.2
2001	279	198	73	71.0	36.9	26.2
2002	226	141	70	62.4	49.6	31.0
2003	231	147	72	63.6	49.0	31.2
2004	207	129	71	62.3	55.0	34.3
2005	180	117	75	65.0	64.1	41.7
2006	222	125	72	56.3	57.6	32.4
2007	220	130	78	59.1	60.0	35.5
2008	188	122	75	64.9	61.5	39.9
1992-2008	4,275	2,523	1,268	59.0	50.3	29.7

There appears to be a rough indication of a reduction in applications and associated acceptances and enrollment. Ignoring the class of 1992 which had to start with one year's class, this drop appears when the eight class years 1993-2000 are compared with the eight class years 2001-2008. Total applications during the first period were 2,251 and during the second period were 1,753. This is consistent with students and advisors becoming increasingly aware of the extremely high standards and intensive work load at the school. It is also conceivable that the development of the Regional Outreach Centers beginning in the late 1990s has served the needs of some students who would have otherwise applied for the residential program.

### Academic Qualifications

OSSM students have high academic qualifications. Students applying for OSSM take the ACT test as they complete their sophomore year

in high school. This is a test normally taken by seniors. The average ACT scores of incoming students are quite high by any standards. For the classes of 1992 through 2008, both the mean and the median composite ACT scores were 27.7, and the range of class average scores during those 17 years was between 26.7 and 28.5. This placed the typical class in roughly in the top 10 percent of all those taking the ACT nationally even though the test was being taken a year or more earlier than is normal.

### Parents' Educational Attainment

OSSM students typically come from families with relatively high levels of education. For the classes of 2003-2008, data on parents' educational attainment are reported in Table 2.2. During this period the total number of 11<sup>th</sup> grade OSSM students was 443. While data were not available for 93 of the parents, information was reported for 815.

**Table 2.2**

**Parents' Education Attainment, OSSM  
Classes 2003-2008<sup>a</sup>**

	<b>Number of OSSM parents reporting education attainment</b>	<b>Percent attainment for OSSM parents reporting</b>	<b>Percent attainment for all of Oklahoma, 2005<sup>b</sup></b>
Less than high school graduate	5	0.6	15.6
High school graduate (includes GED)	156	19.1	32.1
Some college, no degree	100	12.3	22.9
Associate's degree	42	5.1	6.9
Bachelor's degree	267	32.8	15.2
Master's degree	135	16.6	5.0
Ph.D. or professional degree	110	13.5	2.3
Total	815	100.0	100.0

<sup>a</sup>No data reported for 93 parents; total number of 11th grade students: 443.

<sup>b</sup>Applies to population 25 years old and over. Source: U.S. Census Bureau, American Community Survey, 2005, Table B15002.

The third column of Table 2.2 indicates the percent of OSSM parents with varying levels of educational attainment and the fourth column indicates the status of attainment for the entire Oklahoma population 25 years of age and older in 2005. The share of OSSM parents with bachelor's degree or above was 62.9 percent compared with a statewide average of 22.4 percent. At 13.5 percent, the share of OSSM parents with Ph.D. or professional degrees was six times the share statewide.

**High School Characteristics**

OSSM students come from high schools both large and small from all over the state. However, there is a tendency for the sending high schools to be relatively large. The sending schools also tend not to be those with a high ratio of low income parents/guardians.

Table 2.3 applies to the OSSM students during the academic year 2006-2007 and reports number of students by size of the sending high school. Forty-one percent of the students were from high schools with a thousand or more students. Another quarter of the student body was from high schools in the 500-999 enrollment range.

**Table 2.3**

**Number of Current OSSM  
Students by Size of Sending High School  
2006-07**

<b>Enrollment in sending high school, 2004-05<sup>a</sup></b>	<b>Number of current OSSM students by sending high school size</b>	<b>Percent of of current students</b>
under 100	7	5.2
100-199	11	8.1
200-299	12	8.9
300-399	9	6.7
400-499	10	7.4
500-999	31	23.0
1000-1499	17	12.6
1500-1999	23	17.0
2000 and over	15	11.1
Total	135	100.0

<sup>a</sup>Size of school from Oklahoma Office of Accountability, Profiles 2005 School Reports

The Oklahoma Office of Accountability reports on a school-by-school basis the proportion of students eligible for free and reduced-price meals. This is a useful indicator of socioeconomic status of families. In 2005 students eligible for the nutrition assistance came from families whose income was 185 percent or less than the federally

determined poverty level. For a family of four with two children, the 2005 poverty threshold was \$19,806. During the academic year 2006-2007, half of the OSSM students came from high schools in which the share of students eligible for free and reduced-price meals was less than 30 percent (Table 2.4). Only two students came from schools in which the percent eligible was 70 percent or greater. For all public school students in Oklahoma, 55 percent were eligible for this benefit in 2005.

**Table 2.4**  
**Socioeconomic Indicator of OSSM**  
**Sending High Schools, Current Students**  
**2006-07**

<b>Percent of all students in sending high school eligible for free and reduced cost meals, 2005<sup>a</sup></b>	<b>Number of current OSSM students by sending high school size 2006-07</b>	<b>Percent of of current students</b>
Under 10	10	7.4
10 to 19	34	25.2
20-29	23	17.0
30-39	18	13.3
40-49	19	14.1
50-59	20	14.8
60-69	9	6.7
70-79	0	0.0
80 and over	2	1.5
<b>Total</b>	<b>135</b>	<b>100.0</b>

<sup>a</sup>Oklahoma Office of Accountability, Profiles 2005 School Reports.

### Geographic Origins of OSSM Students

In order to identify originating high school's geographic patterns, the state's 77 counties were sorted into four geographic clusters. The state's two large metropolitan areas include the seven counties in the Oklahoma City Metropolitan Statistical Area (MSA) and seven in the Tulsa

MSA. Within the MSAs the counties with the principal cities are also separated, i.e. Oklahoma County with Oklahoma City and Tulsa County with the city of Tulsa. All the other counties were divided into two clusters divided by I-35. These clusters are referred to as the 28 Western non-metro counties and the 35 Eastern non-metro counties.

Table 2.5 uses this geographic classification to report the origins of OSSM's 900 graduates and 135 current students. For reference purposes, Table 2.5 also reports the total Oklahoma population in 2005 for the geographic areas. Clearly there is a significant geographic dispersion of OSSM students. However, there appears a tendency for the Oklahoma City MSA to be over-represented and the Tulsa MSA to be under-represented relative to the two areas' total population. Western Oklahoma is also substantially under-represented with respect to the current student body.

Only four of the state's 77 counties originated no OSSM graduates during the entire life of the school. These counties are Harmon, Coal, Hughes, and Sequoyah. The current student body now includes two students from Hughes County.

Small towns are important origins of OSSM students. For the classes of 1992 through 2005, one-third of the enrolled OSSM students were from cities of 10,000 and less (Table 2.6). In comparison with the overall share of city population in cities of 300,000 and above, OSSM students were under-represented.

### Gender, Racial, and Ethnic Make-up of OSSM Students

The current enrollment at OSSM (classes of '07 and '08) is equally divided between males and females. Females account for 46.1 percent of the total students that have ever enrolled at the school (1,268), and 44.7 percent of the graduates. This reflects surprising gender balance—given the alleged propensity of girls to shy away from math and science. OSSM does recognize this propensity as, for some classes, it separates the boys from the girls.

**Table 2.5**  
**Geographic Characteristics of OSSM Graduates and Current Students**

	<b>Population 2005</b>	<b>Graduates 1992-2006</b>	<b>Enrollment 2006-07</b>	<b>Percent of Oklahoma population 2005</b>	<b>Percent of graduates 1992-2006</b>	<b>Percent of current students 2006-07</b>
Western Non-metro Counties (28)	481,100	164	9	13.6	18.2	6.7
Eastern Non-metro Counties (35)	1,022,300	261	44	28.8	29.0	32.6
Oklahoma City Metro Counties (7)	1,156,800	348	59	32.6	38.7	43.7
Oklahoma County	684,500	194	35	19.3	21.6	25.9
Other 6 Counties	472,300	154	24	13.3	17.1	17.8
Tulsa Metro Counties (7)	887,800	127	23	25.0	14.1	17.0
Tulsa County	572,100	78	14	16.1	8.7	10.4
Other 6 Counties	315,700	49	9	8.9	5.4	6.7
<b>Total (77 Counties)</b>	<b>3,548,000</b>	<b>900</b>	<b>135</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>

Source: Population Data From Oklahoma Department Of Commerce, State Data Center .

**Table 2.6**  
**All Students Enrolled in OSSM by Originating City  
Size, Classes of 1992-2005**

<b>City population</b>	<b>Number of students</b>	<b>Total population 2005 in cities</b>	<b>Percent of students</b>	<b>Percent of city population</b>
1,000 and below	156	128,320	12.3	4.8
1,001-10,000	381	551,140	30.0	20.5
10,001-25,000	215	420,070	17.0	15.6
25,001-299,999	311	677,160	24.5	25.2
300,000 and above	205	913,780	16.2	34.0
	<b>1,268</b>	<b>2,690,470</b>	<b>100.0</b>	<b>100.0</b>

Source: City population estimates from Oklahoma Department of Commerce, State Data Center.

The racial/ethnic make-up of OSSM students is heavily weighted with students classified as Caucasian and Asian American (Table 2.7). The 2004-05 racial/ethnic make-up of all Oklahoma public school students is reported in Table 2.7 for reference purposes. Caucasian students dominate the picture with about two-thirds of the totals. American Indians account for 19 percent of all Oklahoma public school students, but only 9 percent of OSSM total enrollment. African American and Hispanic American students are also substantially under-represented at OSSM in comparison with their statewide shares.

Arguably the most dramatic feature of OSSM’s racial/ethnic record involves Asian American students. This group accounted for 23 percent of all OSSM graduates but only 2 percent of current total enrollment of state public schools. This concentration of Asian students is not particularly surprising—given the degree to which this racial group emphasizes advanced academic achievement. For 2005, the U.S. Census Bureau estimates that 22.4 percent of Oklahoma’s total state population 25 years old and over had attained at least a bachelor’s degree; for the state’s Asian Americans, the comparable share with high-end educational attainment was 41.8 percent—nearly twice the state norm.<sup>8</sup> Advanced educational attainment of Asian Americans is a national phenomenon. There are such high concentrations

of Asian American students at the nation’s elite colleges and universities that charges have been made that such institutions have implemented higher admission standards for Asian American applicants.<sup>9</sup>

### Faculty Inputs at Oklahoma City

How the faculty quality fits into OSSM’s academic environment is reflected in the practice at the school of referring to faculty members as “Professor \_\_\_\_\_.” The teaching faculty in the fall of 2006 consisted of 26 members allocated across the following fields:

Biology	3
Mathematics	6
Physics	4
Computer Science	3
Humanities	5
Chemistry	3
Physical Education	2

The faculty includes 16 with the Ph.D., one with an Ed.D., five with the Master’s, and four with Bachelor’s degrees. Two of those with Bachelor’s-degrees-only teach Physical Education. The other two with Bachelor’s-degrees-only are math teachers with 41 and 38 years of experi-

**Table 2.7**

**Racial/Ethnic Composition of All  
Entering OSSM Students and Graduates  
Percent**

	<b>Entering students, classes of '92-'08 n=1268</b>	<b>Graduating students, '92-'06 n=900</b>	<b>All students in Oklahoma public schools, '04-'05 school year<sup>a</sup></b>
American Indian	9	8	19
Asian American	21	23	2
African-American	3	4	11
Hispanic American	2	2	8
Caucasian	65	64	60
Total	100	100	100

<sup>a</sup>Oklahoma Office of Accountability, *Profiles 2005 State Report*, p. 7.

ence.

The faculty is generally quite experienced—with half the faculty having 16 or more years in the classroom. The years of teaching experience in the fall of 2006 are allocated as follows:

<u>Years of Experience</u>	<u>Number of faculty</u>
0-4	0
5-9	5
10-14	6
15-19	5
20-29	8
30-39	1
40 and more	1

The salaries paid to OSSM faculty members must generally be sufficient to keep the members from shifting to higher education; the competition is not with jobs in high schools. In the fall of 2006, the range of salaries for faculty was be-

tween \$37,880 and \$67,754, with the median salary at \$46,180. OSSM faculty participate in the Teachers' Retirement System of Oklahoma.

In addition to coursework administered by faculty, OSSM students participate in a variety of learning experiences through internships. Of particular importance are experiences at the University of Oklahoma Health Sciences Center and the Oklahoma Medical Research Foundation.

### Financial Inputs

OSSM is a separate state agency that receives its own annual appropriation from the Oklahoma Legislature. Financial data concerning appropriations and expenditures through state Treasury Funds are reported each year.

State appropriations for OSSM grew from start-up money in the year ending June 30, 1989 (FY89) to the \$3-4 million range in mid to late 1990s and on into the \$5-7 million range follow-

Table 2.8

**State Appropriations and Expenditures  
from Treasury Funds, OSSM, Fiscal Years 1989-2007  
(thousands of dollars)**

<b>Year ending June 30</b>	<b>State appropriations</b>	<b>Personnel services expenditures</b>	<b>Land and structures</b>	<b>Other expenditures</b>	<b>Total expenditures</b>
1989	300	134	0	64	198
1990	1,201	542	0	214	756
1991	2,327	1,554	0	856	2,410
1992	3,868	1,876	750	1,346	3,972
1993	3,868	1,992	0	1,537	3,529
1994	3,442	2,177	0	1,180	3,357
1995	3,474	2,085	0	1,239	3,324
1996	3,406	2,119	757	668	3,544
1997	4,011	2,236	4,225	1,657	8,118
1998	4,339	2,330	1,059	1,942	5,331
1999	4,629	2,677	1,623	1,595	5,895
2000	4,619	3,017	61	1,532	4,610
2001	5,304	3,417	0	1,711	5,128
2002	5,938	4,021	0	2,631	6,652
2003	6,085	4,218	0	2,025	6,243
2004	6,205	4,155	0	1,795	5,950
2005	6,572	4,388	0	2,338	6,726
2006	7,021	na	na	na	na
2007	7,231	na	na	na	na

na: Data not available.

Source: Oklahoma Office of State Finance. Appropriations data from historical summary sheets; expenditures from Schedule III reports.

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ing FY00 (Table 2.8).

OSSM's state appropriation has tended to grow at about the same rate as the total of all state appropriations. In FY92, the first year of operation with two classes, OSSM's appropriation was 0.112 percent of the state total; for FY06 OSSM's share was 0.113 percent and for FY07 its share was 0.109 percent.

OSSM's personal services expenditures tend to run about 60-65 percent of total expenditures. For most public schools, personnel costs are in excess of 80 percent of operating costs. No doubt OSSM's personnel cost share is reduced by the fact that the school's budget must include the cost of housing and feeding its Oklahoma City students.

From the school's outset, a private foundation was created to facilitate the donation of private funds. The OSSM Foundation has a Board of Trustees consisting of over 50 leaders from throughout the state. Since its start-up, the OSSM Foundation has received around \$15.8 million in cash and in-kind private donations—much of which has been combined with state money to provide buildings and equipment at the Oklahoma City campus. The Foundation also typically receives around \$100,000 in annual donations which, among other things, are used to supplement faculty salaries.

### Physical Plant Inputs

The physical plant of OSSM in Oklahoma City consists of five major buildings totaling about 175,000 sq. ft. located on a 32 acre campus at the southwest corner of Lincoln Boulevard and Northeast 13<sup>th</sup> Street. Here is a brief summary of the buildings and their original costs.<sup>10</sup>

- *Lincoln School* is OSSM's original building. This old empty elementary school was donated to OSSM by the City of Oklahoma City and was remodeled during 1991-92 using \$1.5 million from private donors and \$750,000 of state funds. The building includes classrooms and administrative offices.
- The *Dan Little Residence Hall* is a 61,092 sq. ft. dormitory which was opened in the spring of 1998. Prior to that time the students were housed on the campus of the University of Oklahoma at Norman. The original cost of the structure was \$6.7 million. Furniture for the dormitory rooms and other facilities was manufactured at state prisons and cost \$335,510. The Sonic Corporation contributed most of the kitchen equipment. The facility also includes faculty apartments distributed among the dormitory rooms. The structure has a Great Hall between two clusters of dormitory rooms. One cluster is for men, the other for women. Current capacity is 144 students with plans to double that by adding two more clusters so that the Great Hall is surrounded on all four sides by clusters of rooms.
- The *OSSM Gymnasium* cost \$1.9 million and was completed in March of 1999. This is a comprehensive facility that serves the students' required physical education classes and provides recreation opportunities. It is also used for basketball leagues by the neighboring University of Oklahoma Health Sciences Center.
- The \$3.4 million *Samson Science and Discovery Center* was funded largely by a donation by the Tulsa-based Charles and Lynn Shusterman Foundation. Other significant sources of funds for this structure included several major Oklahoma foundations and corporations.
- The *Senator Bernice Shedrick Library* is the most recent building to be opened. The 20,000 sq. ft. structure has a large reading room and stacks with capacity for 40,000 volumes. It also includes several administrative offices and a spacious conference room. The Library serves as the security point from which entrance to the campus is obtained. The structure cost \$2.8 million and was funded with a major grant from the Sarkeys Foundation, along

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with significant contributions from other foundations and firms.

The total value of the physical assets in place at Oklahoma City is substantial. The original cost of the 32 acre campus is valued at \$3.7 million, while the current replacement value of the five buildings and their contents is estimated at \$26.9 million. Given the pattern of development flowing south from the OSSM campus through the Oklahoma Health Center complex, the current market value of the 32 acres is far above its original cost as blighted urban real estate.

State government has participated on a matching basis in much of the capital expenditures. By 1999 this involved a maximum state contribution of \$8.5 million with 50-50 matching of private funds required. Within this framework, the state still is committed to providing \$2.65 million in matching funds.

OSSM also received a \$2.75 million construction grant from the federal government.<sup>11</sup>

### **Student Outputs from OSSM Oklahoma City**

The principal outputs of OSSM are, of course, its 900 graduating students. Principal characteristics of students are indicated by test scores, college admissions, and ultimate employment. Before treating these features, it is necessary to note students initially enrolled at OSSM but not ultimately graduating from the school, i.e. withdrawals or dropouts.

### **OSSM Student Withdrawals**

There have been 1,268 students enrolled in OSSM between the classes of 1992 and 2008; 233 or 18.4 percent have withdrawn for a variety of reasons. The most important reason for withdrawal is recorded by OSSM as “academic.” Given the extreme selectivity of OSSM’s admissions, this probably translates into something like “didn’t work as hard as needed.” In only eight of the cases was “homesick” a clear reason for withdrawal.

OSSM’s 81.6 percent retention rate is not much different from what is observed at the state’s

major universities. Current retention rates are University of Oklahoma: 84 percent; University of Tulsa: 82 percent; and Oklahoma State University: 80 percent.<sup>12</sup>

### **OSSM Graduates Go On to College**

The graduating OSSM students have accumulated records of performance that make them attractive candidates for admission to college. Recruiters from top-flight institutions often visit the Oklahoma City campus.

Annual class average ACT scores are available for the 15 years for which there have been OSSM graduating classes (1992-2006). The median annual score was 31.4. The range in annual average ACT scores was between 30.5 and 32.4. A score of 31.4 would place a current student between the 98<sup>th</sup> and 99<sup>th</sup> percentiles of students taking the test nationally. While the OSSM students emphasize mathematics and science, it is clear that their last two years of high school include academic balance. The ACT test includes major components in English and Reading.

Given this level of performance, OSSM students are awarded a wide variety of substantial scholarships for their college work. OSSM estimates that the 900 OSSM graduates have received scholarship offers of more than \$62.5 million. This average offer per student of \$69,444 implies that the OSSM graduates face significant alternatives as they choose the institution in which they will pursue their education.<sup>13</sup> For the classes of 2002 through 2006, the following four scholarships and the number of OSSM recipients are illustrative.

- Forty-one recipients of the Oklahoma Foundation for Excellence’s *Academic All-State Scholars* scholarships. In 2006, these scholarships were for \$1,500.
- Twenty-three received *Robert C. Byrd Honors Scholarships*. These also are for \$1,500. The scholarships are federally funded and administered by the Oklahoma State Department of Education.
- Twenty-nine were *National Merit Scholars*. This scholarship requires high

- scores on the SAT test and is arguably the gold standard of college scholarships.
- There were 291 OSSM *Oklahoma Academic Scholars*. The Academic Scholars Program is administered by the Oklahoma State Regents for Higher Education. Awards averaging \$2,337 in the spring of 2005 were presented to students attending college in Oklahoma. Students are automatically eligible for this if they are National Merit Scholars or Finalists, or are Presidential Scholars (a federal program for students with very high scores on the ACT or SAT tests.)

Given the OSSM graduates' performance on college entrance tests and given the overall high reputation of the school's curriculum, it is not surprising that graduates go on to college. Half the graduates attend in-state institutions and half attend out-of-state. The share of graduates from this high school going out-of-state is much larger than the average for all of Oklahoma high school graduates. The federal government's National

Center for Educational Statistics reports that in the fall of 2004, 89 percent of all the state's high school graduates who went on to college remained in Oklahoma.<sup>14</sup> This is perhaps not a fair comparison. No data are readily available on the percent of high-performing Oklahoma high school seniors attending out-of-state.

Table 2.9 reports the number of OSSM graduates, 1992-2006, attending college within Oklahoma along with the *U.S. News & World Report* ranking of the institutions. Table 2.10 contains the same data for graduates attending out-of-state institutions in cases in which five or more students have attended a specific facility.

Of the 452 OSSM graduates who have remained within the state, 92.7 percent attended three institutions: the University of Oklahoma (54.7 percent), Oklahoma State University (25.0 percent), and the University of Tulsa (13.0 percent). All three universities are listed among the nationally ranked institutions; none, however, are ranked particularly high. The University of Oklahoma has been especially successful in

Table 2.9

**Destination Colleges and U.S. News and World Report Ratings,  
OSSM Graduates Attending College in Oklahoma, 1992-2006**

<b>Institutions within Oklahoma:</b>	<b>Number of students</b>	<b>Percent of students</b>	<b>Rank of institutions, U.S. News &amp; World Report</b>
University of Oklahoma	247	54.65	112 <sup>a</sup>
Oklahoma State University	113	25.00	127-182 <sup>a</sup>
University of Tulsa	59	13.05	88 <sup>a</sup>
Oklahoma City University	13	2.88	22 <sup>b</sup>
Oklahoma Baptist University	6	1.33	5 <sup>c</sup>
Oklahoma Christian University	5	1.11	10 <sup>c</sup>
Northeastern Oklahoma State University	3	0.66	95-123 <sup>b</sup>
Cameron University	2	0.44	95-123 <sup>b</sup>
Southwestern Oklahoma State University	2	0.44	95-123 <sup>b</sup>
Northeastern Oklahoma A&M College	1	0.22	not rated
University of Central Oklahoma	1	0.22	95-123 <sup>b</sup>
<b>Total</b>	<b>452</b>	<b>100.00</b>	

<sup>a</sup>Rank within "Best National Universities" category, *America's Best Colleges*, 2007 edition, Washington, DC: U.S. News and World Report, 2006. (Rankings of 127-182 are in the third tier (quartile) of this category.)

<sup>b</sup>Rank within "Best Universities—Master's," for West region. (Rankings of 95-123 are in the fourth tier (quartile) of this category.)

<sup>c</sup>Rank within "Best Comprehensive Colleges—Bachelor's" for West region.

**Table 2.10**  
**Selected Destination Colleges, OSSM Graduates Leaving Oklahoma, 1992-2006**

Institutions out of Oklahoma:	Number of students	Percent of students	National rank of Institutions <i>U.S. News &amp; World Report</i> <sup>a</sup>
Massachusetts Institute of Technology	32	7.14	4
University of Chicago	25	5.58	9
Washington University St. Louis	22	4.91	12
University of Missouri-Rolla	18	4.02	112
Dartmouth College	16	3.57	9
Northwestern University	16	3.57	14
California Institute of Technology	15	3.35	4
Stanford University	15	3.35	4
Cornell University	13	2.90	12
University of Texas	12	2.68	47
Duke University	11	2.46	8
Illinois Institute of Technology	11	2.46	105
Rice University	11	2.46	17
Vanderbilt University	11	2.46	18
Tulane University	10	2.23	44
United States Naval Academy	10	2.23	3 <sup>b</sup>
Harvard University	9	2.01	2
Carnegie Mellon University	7	1.56	21
Texas A&M University	7	1.56	60
University of Pennsylvania	7	1.56	7
United States Air Force Academy	6	1.34	3 <sup>b</sup>
Rensselaer Polytechnic Institute	5	1.12	42
Smith College	5	1.12	19 <sup>c</sup>
University of California Berkeley	5	1.12	21
University of Southern California	5	1.12	27
Other institutions	144	32.14	
Total	448	100.00	

<sup>a</sup>Rank within "Best National Universities" category, *America's Best Colleges*, 2007 Edition, Washington, DC: U.S. News & World Report, 2006.

<sup>b</sup>Both academies ranked 3 among 45 nationally rated "Best Undergraduate Engineering Programs."

<sup>c</sup>Rated 19 among national ratings of "Best Liberal Arts Colleges."

attracting National Merit Scholars from all sources.

The list of out-of-state schools receiving OSSM graduates begins with 32 students attending MIT, 25 attending the University of Chicago, and 22 at Washington University St. Louis. The list goes on with school after school ranked high among nationally-ranked peer institutions. A selection of other well-known institutions receiving four or fewer OSSM graduates during this period includes Brown, Columbia, George Washington, Indiana, Johns Hopkins, Notre Dame,

Princeton, Purdue, Michigan, TCU, Wisconsin, Wellesley, and Yale.

### **OSSM Graduates: Postsecondary Patterns**

Staff at OSSM has been able to maintain contact with 665 of the 900 students that have graduated in the classes of 1992-2006. The degree production of this group includes the following:

Bachelor's	522
Master's	101
M.D.	41

J.D.	11
Ph.D.	11

Fifty-one of the graduates obtained the Bachelor’s degree within three years or less as they took advantage of the Advanced Placement (AP) college credit they earned while at OSSM. For the OSSM class of 2004, 56 students took AP exams, with 93 percent scoring “qualified” or above—scores that translate to college credit for specific courses.

The patterns of study pursued by OSSM graduates clearly reflect an extension of the academic emphasis students experienced in high school. Data on college majors (including multiple majors) yield 910 observations for the 665 students maintaining contact (Table 2.11). Thirty-two percent report one or more majors in engineering fields, while 42 percent report one or more majors in the sciences. Adding another 6 percent of the observations in mathematics indicates that 80 percent of the OSSM graduates reporting had

**Table 2.11**  
**OSSM Graduates by Major Field of Study, Classes of 1992-2006<sup>a</sup>**

Field of study	Number of majors reported	Percent Majors reported
Engineering		
Biomedical	24	2.64
Chemical	52	5.71
Computer	33	3.63
Electrical	67	7.36
Mechanical	46	5.05
Physics	7	0.77
Other	57	6.26
Engineering total	286	31.43
Sciences		
Biology	182	20.00
Chemistry	50	5.49
Computer Science	60	6.59
Physics	42	4.62
Other	42	4.62
Sciences total	376	41.32
Mathematics	53	5.82
Engineering, Sciences & Mathematics	715	78.57
Humanities	87	9.56
Other and undeclared	108	11.87
<b>Total Majors</b>	<b>910</b>	<b>100.00</b>

<sup>a</sup>Data for 665 of 900 graduates maintaining contact with OSSM includes multiple major fields of study.

one or more majors in mathematics and science.

### OSSM Graduates: Employment Patterns

The strong positive relationship between earnings and educational attainment is well known. Important also is the impact on society as a whole of having a highly educated population.<sup>15</sup> No attempt is made in this report to identify special linkages between graduates’ earnings and their experience at OSSM. One of the most challenging research issues in the study of returns to education as investment in human capital involves the question of whether higher earnings are the result of the education “treatment” or whether the earnings are due to inherent personality characteristics relating to basic intelligence and motivation. No doubt any high school student who is able to score in the 90<sup>th</sup> percentile of the ACT test at the end of the 10<sup>th</sup> grade has intellectual and personal traits indicative of later success.<sup>16</sup> However, there are always underachievers whose early promise fails to materialize.

As part of its effort to maintain contact with graduates, OSSM staff has collected employment data for 281 graduates. This is probably a good representation of employment outcomes—especially remembering that a good many of recent OSSM graduates are still in the midst of undergraduate or graduate training.

A scan of the positions and establishments reported by the graduates indicates a strong concentration in science and engineering (S&E) jobs. Here are samples of these jobs and establishments.

- Software engineer, Bachelor Controls, Inc.
- Meteorologist, Center for Atmospheric Research
- Pharmacy technician, Costco Pharmacy
- Computer game developer, Cranky Pants Games
- Software developer, DTN Energy
- Research associate, Encysive Pharmaceuticals
- Science teacher, Forth Worth Middle School
- Research & design engineer, Enduro Pipeline Services
- Product manager, Google
- Biologist, Illinois State Department of Agriculture

Software engineer, Nomadics, Inc.  
 Software engineer, Microsoft, Seattle  
 Research chemist, National Institute of  
 Standards and Technology  
 Engineer, Southwest Airlines  
 Software engineer, Telos OK  
 Developer, Risk Metrics  
 Software engineer, SolArc, Tulsa  
 Electronics engineer, Tinker Air Force Base

Recent forecasts by the U.S. Department of Labor's Bureau of Labor Statistics indicate that the S&E jobs taken by OSSM graduates are in demand and pay well (Table 2.12).

One of the most frequently asked questions about the operation of OSSM involves the question of how many of the students locate in Oklahoma. Current data for the 281 graduates indicate 10 percent in the military, 59 percent in positions out-of-state, and 31 percent in Oklahoma. This geographic pattern probably is a reflection of the

geographic pattern of employment opportunities in S&E.

Faced with the same question about in-state versus out-of-state employment of graduates, the Oklahoma State Regents for Higher Education produce annual reports on the destinations of graduates from the state's public institutions. The Regents' most recent report indicates that five years after graduation, 42 percent of all 1990-2000 state bachelor's degree recipients had left the state for jobs elsewhere. The percent going out-of-state was generally higher for S&E jobs.<sup>17</sup>

Field of study	Percent leaving OK
Mathematics	41
Physical sciences	48
Biological sciences	49
Computer & info. sciences	55
Engineering	58

Because of OSSM graduates' concentration in S&E jobs, this is the appropriate standard by which to compare their migration. In comparison with this statewide geographic pattern of college graduate employment, it appears that OSSM graduates' probability of leaving the state is greater—but not by much. In fact, given the significantly higher share of OSSM graduates attending college out-of-state, it might have been expected that an even larger percentage would leave Oklahoma.

**Table 2.12**

**Job Outlook 2004-14, Selected  
 Science & Engineering Occupations**

Occupation	Net job openings for college graduates (000)	Median annual earnings, 2004 (dollars)
Computer software engineers, applications	268	74,980
Physicians and surgeons	212	145,600
Pharmacists	101	84,900
Computer software engineers, systems software	180	79,740
Mechanical engineers	87	66,320
Civil engineers	77	64,320
Computer systems analysts	151	66,460
Industrial engineers	54	65,020
Chemists	33	56,060
Environmental scientists	26	51,080

Source: Olivia Crosby and Roger Moncarz, "The 2004-14 job outlook for college graduates, *Occupational Outlook Quarterly*, Fall, 2006, pp. 42-56.

**OSSM Regional Centers  
 and their Outputs**

When OSSM was originally established in 1983, the nation was concerned about the complex causes of low productivity growth and its possible relation to education. By 1997 when the Oklahoma Legislature created OSSM's system of outreach science and mathematics education, the nation was in the middle of the so-called "dot.com" boom and the demand for S&E workers was healthy. But concerns were emerging. A major national report on S&E indicators stated "The United States is maintaining world leadership in science and technology, but other countries are increasing their capabilities."<sup>18</sup> And by that

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time, the success of OSSM's residential program served as an example of how Oklahoma's best students could perform in these difficult areas of study. There was substantial latent demand for more high-level high school course work in math and science.

During 2005-06, 23 faculty members presented courses at eleven Regional Centers. The group of instructors included three with the Ph.D., 14 with master's degrees, and six with bachelor's degrees. Courses offered were in advanced calculus and physics and used the same texts as those used in the residential facility. OSSM staff from Oklahoma City monitored the course work closely.

Between the 1997-98 and the 2005-06 school years a total of 932 high school students completed courses at the Regional Centers. Although the students are generally enrolled in only two courses for one year, they exhibit characteristics in common with their counterparts at the residential school.

Race and ethnicity is the one area in which the Regional Center students are quite different from the Oklahoma City student body. Fourteen percent of the students are Native Americans, while only 4 percent are Asians. The great bulk of the students (78 percent) are classified as Caucasian.

There are currently eleven Regional Centers serving a total of 229 students. The centers are established in response to proposals from local constituencies. They are all connected with Technology Center Districts operating as part of the state's system of Career and Technical Education. Most of the participating high schools are located in rural Oklahoma. Ten of the facilities are located within the buildings of a local CareerTech school (Drumright, Shawnee, Enid, Talequah/Stillwell, Muskogee/Sallisaw, Afton, Pryor/Kansas, Ardmore, Ponca City, and Poteau). An eleventh is located on the campus of Oklahoma State University-Okmulgee and is connected with the local CareerTech district. Only one of the Regional Centers (Enid) is located west of I-35. The classroom space is free, while the operating costs of the program are covered from the OSSM

budget and were running at about \$1.6 million for FY2006.

High school students apply for admission to the program and generally participate during their senior year. Application forms are similar to those used at OSSM residential facility. Applicants are interviewed and are ultimately chosen by a selection committee. In most cases, students come from public school districts that are included within the CareerTech district. Students may also be admitted from schools not participating in the CareerTech district. There are also several students who are home-schooled. While students could take buses connecting high schools and CareerTech schools, most commute by car.

Students are of high academic quality. During the 2004-05 school year, all students were required to take the Advanced Placement (AP) in the courses they took. Seventy-five percent scored high enough for college credit in calculus, while 47 percent achieved that level in physics.

For the 2005-06 school year, scholarship awards and number of Regional Center recipients include:

Academic All-State Scholars: 7  
Byrd Scholars: 7  
National Merit Scholars: 5  
Oklahoma Academic Scholars: 74

The Regional Center students typically go on to college—often to well-known institutions. Again for the 2005-06 graduates, admissions were reported for Auburn, Baylor, Duke, Florida State, Georgia Tech, MIT, Texas A&M, West Point, Navy, Kansas, University of Texas-Austin, Utah, and Yale. Principal acceptances were at Oklahoma State (39) and the University of Oklahoma (29).

### **Spillover Benefits to Oklahoma Education**

OSSM impacts the quality of math and science education throughout the state. While it is not possible to identify specific outcomes numerically, it is clear that there are several avenues by

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which there are statewide spillover benefits.

- Students attending Regional Centers are making their fellow high school students aware of the significance of advanced study. Students at the residential facility frequently go home for the weekend and share their experiences with their peers.
- Teachers are interacting with the Regional Center experts and are pleased that there are opportunities for advanced study beyond what can feasibly be offered at local high schools.
- Each summer OSSM runs a series of privately funded workshops for math and science teachers.
- OSSM sponsors a middle school math contest.
- Interaction with major state education delivery systems is facilitated by an OSSM Board of Trustees which includes the following ex officio nonvoting members: the Chair of the Oklahoma State Regents for Higher Education, the Chancellor for Higher Education, the Superintendent of Public Instruction, and the deans of the Colleges of Arts and Sciences at Oklahoma State University, the University of Oklahoma, and the University of Tulsa. And the Director of the Oklahoma Department of Career and Technical Education is an integral participant in the OSSM Regional Centers.

One negative spillover has been pointed out. OSSM's residential school does deprive schools of some of their very top scholars. It is difficult to evaluate the effect of this negative feature, but two observations are relevant. First, with an enrollment of about 70 juniors and 70 seniors, there are not very many students involved in the residential facility. As illustrated by the demand for the services of the Regional Centers, there are plenty of very bright students remaining in high schools. Second, in some instances it may be a good thing for the sending school to not have to deal with

super-bright students interested in math and science. If the local school cannot challenge such students, there is a danger that in a few instances the students become disruptive.<sup>19</sup>

### **OSSM as Part of the Oklahoma Health Center Complex**

OSSM's 32 acre campus is a showpiece at the northwest edge of the 300 acre Oklahoma Health Center (OHC) complex. OHC is a major economic development force behind the resurgence of the central core of Oklahoma City. It is the site for 28 organizations with a total of 12,500 employees and an aggregate of \$2.5 billion capital investment. From the outset, a big plus for the OSSM site has been its proximity to other occupants of OHC, including the University of Oklahoma Health Sciences Center and the Oklahoma Medical Research Foundation. Lying at the south end of the OHC is the Presbyterian Health Foundation Research Park, one of the most striking concentrations of technology based economic development in Oklahoma.

The OHC complex is within a broader concentration of renewed urban development with the Oklahoma Capitol complex to the north, and substantial new developments in Bricktown and downtown Oklahoma to the southwest.<sup>20</sup> This corridor of economic renewal and development has a national reputation and is of interest to many urban developers from other communities. As others examine this urban development phenomenon, they note the state's commitment to advanced math and science high school education embodied in the OSSM campus.

### **OSSM and Oklahoma's Science & Engineering Workforce**

The above analysis of OSSM's output focuses on the 900 graduates of the residential facility and a like number of students who have participated in courses at the Regional Centers. Many of the students go on for further education

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in S&E fields and take S&E jobs both within and without Oklahoma. This production of highly skilled S&E workers is consistent with the national need to educate a greater supply of S&E personnel. This supply is needed as a significant share of the current S&E workforce reaches retirement age and as greater restrictions are placed on the immigration of foreign S&E workers. Moreover, globalization enhances opportunities for S&E employment in other countries—including opportunities for Americans.<sup>21</sup>

Within this stressful national environment, Oklahoma's economic development prospects depend not only on the state's own production of S&E talent, but on its ability to attract and retain S&E personnel who move to jobs within the state. Quality of life factors including quality of educational systems are important in these peoples' locational decisions.

### **Concluding Remarks: OSSM and State Education Policy**

The above discussion has illustrated the remarkably high quality of the student, faculty, and physical capital inputs for OSSM's residential facility and Regional Centers. The students emerging from the system are well-prepared to pursue curricula in the S&E fields at institutions of higher education and appear to be doing quite well once they enter the work force. Acquiring these inputs and achieving outputs is an expensive proposition. Class sizes are small, the faculty is highly-degreed, and the room and board is free to the students. In the fiscal year ending June 30, 2002 (FY02) it was reported that the cost per residential OSSM student was \$28,878.<sup>22</sup> That same year, expenditures per pupil in the state's public schools was reported to be \$6,681—82.6 percent of the national average.<sup>23</sup> In FY06, the per student costs at the Regional Centers was around \$7,000.

The concluding remarks: (1) present hypothetical state policy options for OSSM and (2) suggest a broader challenge for state policy in serving the needs of highly talented students.

### **Policy Options for OSSM**

Here are some thoughts concerning future policy options for OSSM. Each strategy requires careful consideration by state policy-makers.

**Complete Shutdown.** Because of OSSM's nationwide reputation, a complete shutdown would certainly generate negative publicity concerning Oklahoma's education policy. The school could no longer exhibit Oklahoma's commitment to high-performance high school education to the many development specialists visiting the Oklahoma Health Center, Bricktown, and the central core of Oklahoma City. Such a strategy would have saved a state appropriation of \$6.6 million in FY05. If that savings were allocated to the state's elementary and secondary school system with average daily attendance of 600,000 students, the resulting per pupil increase in spending would have been \$11.00 per pupil.

**Reduced Enrollment.** Some operating cost savings would occur if the enrollment at the residential facility were dropped from its current level of around 140-150 students down to, say, 100 students. However, the current physical facility is, with the exception of the dormitory, designed to handle around 300 students. Such a reduction in enrollment would probably necessitate a shift to a more appropriately-scaled physical facility. Moreover, students learn from each other, and a reduction in student body size would reduce the positive peer effects on student performance.<sup>24</sup>

**Maintain Status Quo.** The residential facility has been operating with its existing student body size since FY93. Beginning in FY98, OSSM's Regional Center program has expanded steadily and appears to be filling an important educational need in rural Oklahoma. For any state policy initiative, maintaining the status quo is normally the most attractive strategy.

**Build a Second Dormitory.** OSSM's supporters have seen to it that the Oklahoma City campus is designed to handle a student body that would be in place if a second dormitory were constructed to match the first one. If this were a

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major consideration, and if state funds remain relatively limited, policy-makers might well face the option of whether to build a dormitory or to expand the Regional Center program.

### **Policy Options for the Academically Talented in a Broader Context**

When the focus is on OSSM it is easy to forget the broader educational and economic development issues underlying such advanced training in math and science. Technology-based economic development requires that the United States expand substantially its production of highly talented scientists and engineers. This must start with the nation's public school system. The system, however, is caught in a bind with respect to meeting the needs of highly talented students—whether they be in math and science, or in other fields. The federal No Child Left Behind Act and its threat of publicizing schools as failing to make Adequate Yearly Progress has the potential effect of leaving behind the most academically talented students.

Building on its experience with OSSM, Oklahoma might consider how better to coordinate services to the academically talented. The State Department of Education operates a Gifted and Talented program with special state aid funds flowing to local districts. Individual school districts operate specialized high schools such as Tulsa's Booker T. Washington High School and the Classen School of Advanced Studies in Oklahoma City. The state higher education system is promoting high student performance with such initiatives as the State Regents' Academic Scholars Program. Particularly in the No Child Left Behind environment, Oklahoma must be sure that it has in place educational services that challenge the best and the brightest high school students.

### **Endnotes**

<sup>1</sup>This wording is based on a 2001 amendment which reflects the new labels for the Department of Vocational and Technical Education and a for the area vocational-technical schools.

<sup>2</sup>U.S. Executive Office of the President, *Economic Report of the President, 2004*, Washington, DC: U.S. Government Printing Office, 2004, p. 342.

<sup>3</sup>U.S. Executive Office of the President, *Economic Report of the President, 1980*, Washington, DC: U.S. Government Printing Office, 1980, p. 84.

<sup>4</sup>U.S. Congress, Office of Technology Assessment, *Census of State Government Initiatives for High-Technology Industrial Development*, May, 1983.

<sup>5</sup>David Osborne, *Laboratories of Democracy*, Boston: Harvard Business School Press, 1988, pp. 40-41.

<sup>6</sup>James B. Hunt, Jr., "State Involvement in Science and Technology," *Science*, Vol. 215, No. 4533, Feb. 5, 1982 (adapted from an address to the American Association for the Advancement of Science 1982 annual meeting).

<sup>7</sup>Bob Burke, *Good Guys Wear White Hats: The Life of George Nigh*, Oklahoma City: Oklahoma Heritage Association, 2000, p. 292.

<sup>8</sup>U.S. Census Bureau, American Community Survey, 2005, Tables B15002 and 15002D.

<sup>9</sup>Daniel Golden, "Is Admissions Bar Higher for Asians At Elite Schools?" *Wall Street Journal*, Nov. 11-12, 2006; See also Golden's recently-published book, *The Price of Admission*, New York: Crown Publishers, 2006, Ch. 7.

<sup>10</sup>For more detail see "Campus and Facilities" at OSSM's web site [www.ossm.edu/campus.htm](http://www.ossm.edu/campus.htm).

<sup>11</sup>Oklahoma Office of State Finance, *FY-95 Executive Budget*, p. 201.

<sup>12</sup>*America's Best Colleges*, 2007 edition, Washington, DC: U.S. News and World Report, 2006.

<sup>13</sup>For a listing of this and many other student accomplishments, see OSSM's July 2006 fact sheet entitled "The Awesome Facts."

<sup>14</sup>National Center for Education Statistics, *Digest of Education Statistics Tables and Figures*, 2005, with a web site address at [http://nces.ed.gov/programs/digest/d05/tables/dt05\\_203.asp](http://nces.ed.gov/programs/digest/d05/tables/dt05_203.asp) .

<sup>15</sup>See, for example, College Board, *Education Pays, The Benefits of Higher Education for Individuals and Society*, rev. ed. 2005, [www.collegeboard.com](http://www.collegeboard.com).

<sup>16</sup>See, for example, Alan B. Krueger and Mikael Lindahl, "Education for Growth: Why and For Whom?" *Journal of Economic Literature*, Dec. 2001, p. 1103; George Leef, "Higher Education Has Been Oversold," *Perspective*, Oklahoma Council of Public Affairs, Nov. 1, 2006, [www.ocpathink.org](http://www.ocpathink.org).

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<sup>17</sup>Oklahoma State Regents for Higher Education, *Employment Outcomes Report*, April 27, 2006, p. 15.

<sup>18</sup>National Science Board, *Science & Engineering Indicators—1996*, Washington, DC, 1996, p. xvii.

<sup>19</sup>This feature was pointed out in a 1994 OSSM documentary television feature on the Oklahoma Educational Television Authority narrated by Pam Henry.

<sup>20</sup>For a history of the economic resurgence of downtown Oklahoma City, see Steve Lackmeyer and Jack Money, *OKC Second Time Around, A Renaissance Story*, Oklahoma City, OK: Full Circle Press, 2006.

<sup>21</sup>See Thomas Friedman, *The World is Flat*, New York: Farrar, Straus and Giroux, 2005, especially Ch. 7, “The Quiet Crisis.” See also James Canton, *The Extreme Future*, New York: Dutton, 2006, Ch. 4.

<sup>22</sup>Oklahoma Office of State Finance, *2003 Executive Budget*, p. 203.

<sup>23</sup>U.S. Census Bureau, *Statistical Abstract of the United States: 2003*, Washington, DC, U.S. Government Printing Office, 2003, p. 169.

<sup>24</sup>Erick A. Hanushek *et al.*, “Does Peer Ability Affect Student Achievement?” National Bureau of Economic Research, NBER Working Paper No. 8502, Oct. 2001.

# Science and Technology Policy in the State of Oklahoma: Present Status and Suggested Future Directions

## Introduction

Oklahoma's economy continues to face numerous challenges as we move deeper into an uncertain 21<sup>st</sup> century. Even with the aid of higher energy prices, energy production is flat or falling. Oil and gas reserves are, of course, ultimately, depletable resources.<sup>1</sup> The volatile past that reliance on the energy sector brought to Oklahoma may be repeated, as falling natural gas prices are now reminding us. Still, the attendant growth in energy-related employment and advances in per capita personal income that accompany higher energy prices are welcome offsets to other difficulties. The corporate headquarters facet of the energy industry in Oklahoma is a shell of its former self. High paying manufacturing jobs are disappearing at a rapid rate. The employment base is becoming much more service oriented. Despite dramatic increases in research and development (R&D) expenditures at the major public institutions of higher education, the high technology status of the state is still comparatively weak.<sup>2</sup> The state remains much in arrears in bachelor's or higher degrees educational attainment, bringing into question the ability of Oklahoman's to compete on technology frontiers. With mushrooming globalization, it is easy to become nervous about Oklahoma's future position as a player in the world economy.

Policy makers, academics, and business leaders share a broad recognition of these problems. The path to becoming a much bigger player in this new world economy is less clear. Many states have forged science policy structures and are making sizable investments to advance the rate of new discoveries, translate research into com-

mercialized products, expand new start-up businesses, and create new jobs. Oklahoma was an early participant in this arena. The energy bust, beginning in 1982, focused legislators and public policy professionals on issues of economic development. The Oklahoma Center for Advancement of Science and Technology (OCAST) was established in 1987. This agency has received substantial recognition nationally as a model for state support of science and technology (S&T).<sup>3</sup> The State of Oklahoma took another broad step forward this past legislative session with a down payment of \$150 million towards establishment of a one billion dollar endowment to fund technology development. This is the EDGE (Economic Development Generating Excellence) initiative in furtherance of making Oklahoma the *Research Capital of the Plains*.<sup>4</sup> The research-capital idea was spawned from statewide economic development discussions initiated by Governor Brad Henry in the summer of 2003. EDGE is a program championed by the then Chancellor for Higher Education, Dr. Paul Risser.

This new initiative in support of R&D when the state already had a long-standing 20 year old institution for advancement of science and technology, namely OCAST, might be viewed with skepticism by some. All too often on the economic development scene it seems that slightly new ideas have translated into legislative backing followed by new, autonomous, administrative and operational apparatus. In other words, there are too few instances of economization by building upon existing administrative structures, professional experience, and synergistic potentials. Another puzzle is that OCAST is very favorably viewed by the legislature, as evidenced by approval this fiscal year of an expansion in

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OCAST's budget to \$23 million in support of new program initiatives, such as in plant biology. Thus, a motivating factor for this chapter is to find out how these initiatives are supposed to work together, and, indeed, whether any thought had been given to how these two initiatives are to intertwine. What does the existence of these two initiatives say about the status, cohesion, components and direction of the state's science policy? How can the state improve upon its institutional arrangements to even more efficiently capitalize on prior, present, and future investments in science policy?

This last question is actually an example of the classic fallacy of logic called "begging the question." It presumes an affirmative answer to the question of whether the state should have a science and technology policy in the first place.<sup>5</sup> Actually, a whole series of questions emanates from this issue of pursuit of a state science policy:

- What is science policy and why do we need one?
- What economic, social, and political justification is there for pursuit of a state science policy?
- What should the state science policy do and at what level should it be done?
- Who should be responsible for the formulation of such a policy?
- Who should be responsible for its implementation?
- How do we determine where to put the money?
- How should we judge the success of state science policy and determine whether we are doing too much or too little?
- Are state research dollars better used on projects immediately likely to generate marketable products, or on more long-run endeavors?
- How can we effectively involve political processes in the determination of resource allocations, yet shield decisions from political earmarking?

It is well beyond the scope of this chapter to effectively answer all of these questions. That

would take a book length manuscript, at least several hundred pages long. Indeed, several books have already been written on the subject, as the brief foray into the literature in this chapter illustrates.

What can be done in this chapter is to introduce the reader to the nature of science policy and how it differs at national and state levels, to review literature on how states should best go about implementing such policies, to examine pitfalls in the transfer of new technology into marketable products and issues peculiar to Oklahoma, and to suggest ways the state might do a better job of formulating, implementing, and monitoring its policy. Even these limited objectives are a tall order, but the author has benefited from personal discussions with many of the leaders of science policy in Oklahoma. Candid interviews have been conducted with these leaders. The author has agreed to keep these conversations confidential in order to encourage frankness. And, as evidenced by the frankness of some of the remarks, that objective was achieved. The author was not able to interview all of the names that came up in discussions, but the interview sample base of more than one dozen and the closeness of those interviewed to the issues at hand should prove adequate.

The necessity and rationale for having a *science policy* is explored first. A discussion of endemic science culture and ethos with an emphasis on curiosity-driven research is then presented. While that subject matter may seem somewhat nebulous, it is important to know what drives scientists and engineers in their professional pursuits. An alternative view of how science translates into technology is presented. Multiple stages of action are required to translate research into marketable products and services, with different players at each stage, the flavor of which is seen in an "innovation models" section. This section is then followed by an examination of the federal versus the state roles and, briefly, how this relationship has evolved through legislative initiatives. A brief accounting is then provided of Oklahoma's status as a high-tech state. All of the above material serves as "backdrop" for interviewee comments on a variety of subjects related to science policy in Oklahoma. Some discussion

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of the resource base for science policy is presented in the “In Praise of SSTI” section. Recommendations follow.

The major finding of this investigation is that the State of Oklahoma is distinctly lacking in strategic focus in its science and technology policy, and that the state should seek to gain strategic vision through the offices of a continuously-functioning, independent, coordinative research body. The problem of generating a coherent science policy for Oklahoma does not lie in the lack of vision. Rather, it is the presence of too many visions that is the core of the problem that Oklahoma faces. It is time to refocus our efforts to achieve one Oklahoma vision for science policy.

### **Necessity of Science Policy**

Effective execution of science policy is the new form of interstate competition. Many of the economic development initiatives of the past have proven to be zero-sum games, such as chasing footloose manufacturing and call center operations. This is not to say that such pursuits are without benefits that exceed costs or that such jobs are not wanted by Oklahomans. We are not far removed from the time of the energy bust in Oklahoma when a job, any job, was a blessing. It is to say, however, that this is a changed world and the success of America and regions within America will increasingly be dependent upon its knowledge base and expansion of that base, its ability to transform knowledge into products and services, and its entrepreneurial talents in turning products into successful commercial ventures.

Science policy is the act of validating the need, prioritizing the form, constructing the institutions, establishing inter-institutional relations, creating the infrastructure, defining the rules and procedures for access to resources, providing the financial support for science and technology (S&T) research and development, and forming the institutional mechanisms to assist the transformation of knowledge into products. The major institutions involved are research universities, governments, philanthropic organizations and foundations. All such entities are operational in Oklahoma. Through OCAST, the state has seen

the implementation and execution of a broad base of support, albeit at low funding levels.

Government support of science and technology is justified along two dimensions, the growth impact of technological advance and the externalities associated with the public goods aspects of pure and applied research. A substantial body of empirical research in economics examines sources of growth of the US economy. The work of Edward F. Denison stands out from the pack.<sup>6</sup> Denison’s painstaking research showed that 12 percent of economic growth from 1929 to 1969 had education as its source and 27 percent was from advances in knowledge. These two sources together, or about two-fifths of growth, matched increases in labor and capital inputs as sources of growth. Of course, not all research and development (R&D) is supported by government funding. Industry is especially dominant in financing development. But, much of the technology that is eventually developed comes from academic research. Research to advance understanding is so basic as to be incapable of being appropriated for profit by private firms. The outcomes from such pursuits are too unpredictable and risky. The inability to appropriate for profit advances in basic research would lead to significant under funding of such activities.<sup>7</sup> Positive externalities to the benefit of a large number of firms and society as a whole emanate from universities and government labs.

Early science policy in the U.S. was manifest in the Morrill Act of 1862 establishing land grant educational institutions, placing emphasis on applied science and engineering, agricultural experiment stations, county agents, and extension services. This was followed by developments in medical science greatly aided by government investment in disease control, general public health, and medical schools. The rise of the engineering disciplines flowered from direct institutional arrangements with industry:

Thus, after World War I, the University of Illinois offered programs in architectural engineering, ceramic engineering, mining engineering, municipal and sanitary engineering, railway

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civil engineering, railway electrical engineering and railway mechanical engineering. As one observer noted, “Nearly every industry and government agency in Illinois had its own department at the state university in Urbana-Champaign.”<sup>8</sup>

The applied science orientation of engineering and agricultural research heightened distinctions between curiosity-driven research to enhance understanding in the domain of the pure sciences and research for practical use. But the Manhattan project in World War II showed that there was much common ground for joint pursuit of understanding and use.

### Science Policy Culture

Somewhat unfortunately, but importantly because of its impact on the culture of science, distinctions between basic and applied science were heightened with the publication by Vannevar Bush’s “enormously influential” report *Science, the Endless Frontier*.<sup>9</sup> Bush was President Roosevelt’s wartime director of the Office of Scientific Research and Development. Roosevelt asked Bush to reflect on science policy in peacetime. Bush’s views on the role of basic research and how it relates to sustainable technological innovation “became a foundation of the nation’s science policy for the postwar decades.”<sup>10</sup> That model was, essentially, a linear model in which basic research → applied research → development → production and operations. That model was, initially promulgated to rationalize and justify support for basic research. Bush, himself, viewed the model as a convenient simplification, but he did assert that “new products and new processes do not appear full-grown. They are founded on new principles and new conceptions, which in turn are painstakingly developed by research in the purest realms of science.”<sup>11</sup> The Bush model guides the strategy of the National Science Foundation, as evidence in the view of its “mandate to support American science and engineering, first articulated in *Science, the Endless Frontier*;

(which) continues to guide and inspire us to advance the frontiers of science and engineering knowledge.”<sup>12</sup>

The problem, as described by Stokes, is that science in the Bush paradigm is seen as exogenous to technology with the path inexorably one way, “however multiple and indirect the connecting pathways may be.” Stokes quite emphatically states that “this premise has always been false to the history of science and technology.”<sup>13</sup> He offers multiple examples to counter the Bush paradigm, notably the works of Louis Pasteur, Thomas Edison, Charles Darwin, and Niels Bohr. Pasteur’s fundamental research was tangential to his desire for cures, but nonetheless profound. Edison was notorious in his tinkering, stumbling onto solutions, caring little about advancing knowledge or even fundamental principles. He just wanted to get his electrical utility operating. Darwin was an observer. His initial quest was neither toward advancing fundamental understanding or practical use, but merely organization and classification of knowledge about species. The theory came much later. The research of Niels Bohr on atomic structures is closer to the Bush tradition of curiosity-driven pure research with no practical use in mind. Stokes offers the framework seen in Figure 1 to describe his model, from which he derives the title of his book, *Pasteur’s Quadrant*.

Stokes goes further: “A great deal of technological innovation, right down to the present day, has proceeded without the stimulus of advances in science.”<sup>14</sup> The industrial revolution in the U.S. at the end of the 19<sup>th</sup> century and the rise of Japan in automobiles and electronics in the 20<sup>th</sup> century are two striking examples. Frequently the causal path flows in the opposite direction, from technology to science.

Stokes offers a revised dynamic model that he regards to be much truer to the interactive advance of science and technology, as illustrated in Figure 3.2. This diagram illustrates that rather than a linear relationship beginning with pure inquiry that proceeds through applied research and then to development, the Stokes’s model suggests dual, semiautonomous trajectories governing the progress of science and technology. At times, these trajectories are only loosely connected.

**Figure 3.1**

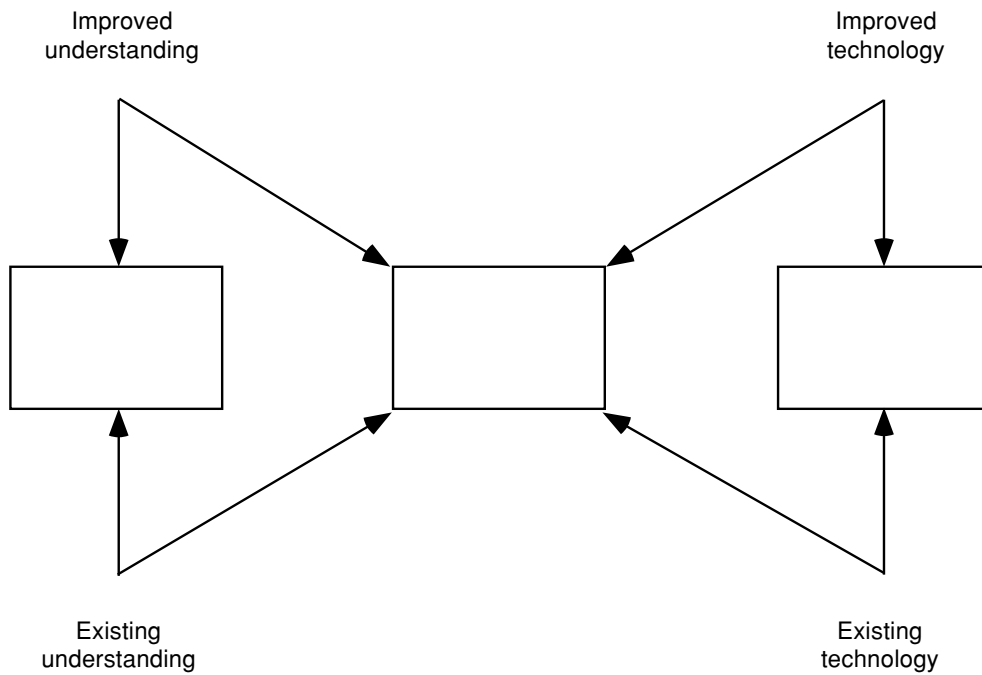
**The Stokes Quadrant Model of Scientific Research<sup>a</sup>**

		Consideration of Use?	
		No	Yes
Quest for fundamental understanding?	Yes	Pure basic research (Bohr)	Use-inspired basic research (Pasteur)
	No	Organization and classification of knowledge (Darwin)	Pure applied research (Edison)

<sup>a</sup>Stokes, *Pasteur's Quadrant*, 73.

**Figure 3.2**

**Stokes's Revised Dynamic Model**



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Science can move to a higher level of understanding at times without the advance of technology. At times, however, science requires advances in technology to proceed to higher planes. Oftentimes these trajectories are highly intertwined. There is no doubt, for example, that the advance of the technologies of instrumentation, measurement, and electronic imaging along with data processing speeds and storage capacities have enabled basic science to delve more deeply into research questions with greater clarity, focus and accuracy.

The ghost of Bush's philosophy is present in Oklahoma today. As one interviewee noted, "this is a new thing for them (that is, scientists), the idea that research has any ability to help anyone." While this statement may contain some hyperbole, it is certainly indicative of the continuing existence of a science culture extending from Vannevar Bush's 1940's treatise that could impede commercialization progress and must be "factored into" any successful science policy plan.

### **Innovation Models**

Models of how systems really work to translate discovery into technology and then into products and services are necessary aspects of science policy. In forming state or national policy, it is important to understand how research gets translated into technological advance, as Stokes attempts to do. Whether his view of technological progress through the lens of the history of science is the correct one is not the point. One would suspect that there are equally ardent and articulate advocates of the NSF culture of curiosity-driven research. A reading of NSF's strategic plan still exudes homage to Bush's vision. Such homage establishes science cultures in pursuit of curiosity-driven research, award systems for funding, open-to-the-world publication, promotion and tenure. How the system really works, how philosophies and cultures have developed over time and guide behaviors, how award systems are specified to determine who succeeds and who fails, and how cultures impact the advance of science into technology and products all needs to be uncovered, respected, and incorporated into state and

national science policy. University scientists are not driven to "solve someone's problem" or, for the most part, to start a business, although attitudes are changing in the biosciences. Advancement of knowledge and understanding is the quest. The culture of science and technology operating in any region, state or nation must be understood if the fruits of research are to be effectively exploited, even if, as Stokes contends, their reading of science history is incorrect. The culture can be nudged, but it cannot be prodded.

Knowledge about how the science system works to translate research into products and services is a start, but not the end of what a state science policy needs to incorporate. In a delightfully-to-the-point recent book written by someone who has obviously devoted much of his career to frontline efforts, Verloop develops twelve laws of innovation, reminding us of the connection to business that is ultimately involved in bringing products to markets. These laws state that innovation<sup>15</sup>:

- is a business process;
- requires staging;
- is opportunity driven;
- can be inside- or outside-the-box;
- requires external partners;
- needs diversity;
- is risky;
- requires entrepreneurs;
- is done to create options;
- creates change;
- needs balanced value drivers to be sustainable; and,
- needs commitment from the top.

Verloop notes that the model for innovation is changing from the *classical cascading model* of scientific curiosity, technology supply, integral-to-the-firm functional divisions exploiting technology, including finance, marketing, and distribution. This model is being replaced by a *bridge-building model* characterized by business opportunity, technology and market drivers, business units created with partners, and parallel exploitation of technology.<sup>16</sup> Verloop also speaks of periods of lost momentum associated with the research-to-new-products chain, called "valleys of death," which is interesting in that this terminology came

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up in interviews. A spate of books and materials are available on state, university, and industry cooperation.<sup>17</sup> The website bookstore of the State Science and Technology Institute (SSTI) provides the reader with a flavor of the reference materials that are available.

There is increasing recognition that entrepreneurial talent is likely to be the scarcest resource. In a recent book, *The Entrepreneurial Imperative*, Schramm provides models linking government, universities, start-ups and established large-scale firms as a transformation from the now defunct industrial triangle of government, unions, and big business. He also addresses the university role in the imperative, describing it as the “singular destiny of higher education.”<sup>18</sup> Perhaps the obvious example of research leading to innovation, new products and business start-ups has been in biotech.

There is, certainly, no better example of the unification of universities and businesses than biotech.<sup>19</sup> But, Pisano in his article “Can Science Be a Business?” argues biotech has failed to deliver because it is based on a flawed model. There have been remarkable successes; however, drug therapies involve too much risk and uncertainty and time in clinical trials. It can take 10 years or more to develop and get a drug approved, too lengthy of a time to retain the interest of venture capitalists. He urges a new model, one based on long-term collaborations, fewer firms, quasi-public companies<sup>20</sup>, vertical integration, university conduct of research utilizing open licensing, cross-disciplinary research, and direct attention to translating research into marketable products.<sup>21</sup> Pisano’s article reminds us that innovation processes are frequently industry dependent.

### **Cooperative-Enabling Legislation**

The federal government has through the years provided specific legislation to enhance cooperative ventures, including the:<sup>22</sup>

- Stevenson-Wydler Technology Innovation Act (1980)—required federal laboratories to facilitate technology transfer;
- Bayh-Dole University and Small Business Patent Act (1980)—allowed government grant and contract recipients to retain intellectual property rights from research and encouraged universities to license inventions;
- Small Business Innovation Development Act (1982)—established Small Business Innovation Research (SBIR) Program requiring federal agencies with R&D budgets to contribute a percentage of their funding of research with commercialization potential in small high-tech businesses. The percentage contribution has risen over time to 2.5 percent;
- National Cooperative Research Act (1984)—eased antitrust penalties for cooperative R&D activities;
- Federal Technology Transfer Act (1986)—amended Stevenson-Wydler to allow cooperative research and development agreements between federal labs and other entities, inclusive of state government;
- Omnibus Trade and Competitiveness Act (1988)—established the National Institute of Standards and Technology (NIST) to assist commercialization of technologies to improve manufacturing techniques in small and medium sized firms;
- National Competitiveness Technology Transfer Act (1989)—allowed government-owned, contractor-operated (GOCO) labs to enter into cooperative agreements;
- Small Business Technology Transfer Act (1992)—established STTR, the small business technology transfer program, encouraging universities and non-profit institutions to enter into cooperative arrangements with small businesses.

In Oklahoma voters approved a constitutional amendment to allow university researchers to capitalize on discoveries, removing a restriction that had been detrimental to technology transfer and commercialization. Through a number of

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legislative initiatives, including many trails blazed by OCAST, the legal and institutional foundations for cooperative arrangements are now well established. Funding follow-through has not been strong, however, and the present federal administration can be described as somewhat hostile to industrial policy. NIST, for example, has been experiencing problems in receiving continuing funding. The National Science Foundation has been running the University/Industry Cooperative Research Centers program for over 25 years, but its funding has always been a miniscule part of NSF's overall budget. Still, there are extant federal programs providing opportunities that need to be incorporated into the state's science policy. Many already have been utilized, as manifest in OCAST's increasing attention to SBIR and STTR programs, the provision of services to directly assist proposal writing and applications to these programs, and increasing success in obtaining such grants. But, the integration of such activities into an overall strategic direction remains incomplete.

### Oklahoma's S&T Status

Several rating systems are available to evaluate a state's S&T status, as summarized by Warner and Dauffenbach (2006).<sup>23</sup> Oklahoma has not improved in its rankings, nor has it suffered any serious declines longitudinally. Given the sophisticated attention and funding that other states are paying to S&T development, it speaks well of efforts in this state to remain in the game. By almost all of the criteria, Oklahoma's position remains near its population ranking, but two or three positions below. Principal findings in an update of that 2006 article prepared for OCAST are:

- Oklahoma is less high-tech intensive than the U.S.—high-tech employment intensity was about 6.6 percent in 2004 in comparison to national rates of 8.2 percent;
- Employment is becoming less high-tech intensive—for both Oklahoma and the nation, employment intensity in high-tech industries is declining. The decline

between 1998 and 2004 was about 0.7 percentage points; both nationally and in Oklahoma;

- High-tech manufacturing contrasts with high-tech services—high-tech employment in manufacturing nationally declined by 1.2 million jobs; however, high-tech services gained 1.1 million jobs. Oklahoma lost about 10,000 high-tech manufacturing jobs and gained around 5,000 high-tech service jobs.

Apparently, there are growing opportunities in high-tech service industries that may need to be factored into the state science policy.

In terms of R&D expenditures, Oklahoma comes up a piker. In total R&D, which includes industry, federal, state, and university internally-funded categories, Oklahoma registered \$793 million, in comparison to \$255.7 billion nationally in 2002, or 0.31 percent. The good news is that total R&D expenditures rose to \$968 million in 2003, 0.35 percent of the \$277 billion nationally. The bad news is that Oklahoma's population is about 1.2 percent of the nation's. Thus, we are only 30 percent of where we would be on a per capita basis. In R&D intensity, Oklahoma ranks only 46<sup>th</sup> nationally. In terms of university research, our ranking is higher, but still found wanting. In 2003, total university R&D was \$295 million in comparison to \$40 billion nationally, or 0.74 percent.<sup>24</sup> The University of Oklahoma and Oklahoma State University account for all but a fraction of R&D expenditures by universities in Oklahoma. Inflation-adjusted totals for these two institutions are shown in Figure 3.<sup>25</sup> Both institutions are doing a better job, but the positive trend is much more pronounced for OU, largely attributable to growth in medical research.

From a statistical standpoint, Oklahoma has much catching-up to do. In total R&D expenditure, Colorado exceeds \$5 billion, Kansas is above \$2 billion and Texas is near \$15 billion. The comparatively weak record of research expenditures in this state makes it even more imperative to establish, implement, execute, and monitor the state's science policy.

Figure 3.3

OU and OSU Real R&D Expenditures, 1984-2004  
(in \$thousands, Year 2000 Dollars)



### Interviewee Comments

Comments the author obtained through personal interviews range from general S&T policy, regionalism, strategic focus, federal connections, workforce development, and the pipeline from discovery to commercialization, to specifics on active components of the present design, performance of OCAST and its components, future plans, and EDGE objectives. These comments take us further down the path of increased understanding of present practice and effectiveness of science policy in Oklahoma, the state's S&T infrastructure, and what the state is up against in its enhanced attempts to translate research into jobs. An attempt is made to classify facets of the interviews into topical areas.

### Interest in Economic Development

The launching of the EDGE initiative in the summer of 2003 demonstrated the keen interest that exists in the state for economic development. There were over 2,000 participants in these discussions, organized into several study groups. Especially notable in this effort was acceptance of the idea of making Oklahoma the "research capital of the plains." Emphasis was also placed on such issues as general health, education, the business environment, workmen's compensation, and other issues, but the pervasiveness of understanding that the State of Oklahoma is in a new era of competition with the several states, and, indeed, the world, was surprising. Recognition that investments in research universities are essential to becoming a much bigger player in the high-tech world was also pronounced.

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## Science Policy Views

The need for the state to have a science and technology policy is well understood among all interviewees. High-tech competition among the states is rapidly transplanting location incentives as the tool for recruitment of industry. EDGE funding demonstrates that legislators and the Governor really “gets it,” one interviewee commented. Of course, the state has since 1987 funded OCAST at what any seasoned observer would call modest levels. OCAST’s operations over time have evolved into a range of needed services. All of the appropriate and necessary bases are touched in the manifestation of OCAST practices, appropriately referred to as the *pipeline*. Much more needs to be done with greater focus, however. In the triangle of education, state government, and the private sector, major effort needs to be devoted to engagement of the private sector. The lack of corporate headquarters in Oklahoma hinders such involvement.

State science policy is seen by all interviewees as highly fragmented in Oklahoma, and fragmentation discourages involvement. While industry involvement is not what we would hope it to be, the level of involvement is understandable, some interviewees noted. Businesses will be involved only so long as there is a positive return on that involvement. The Science and Technology Council operating out of the governor’s office seems to be lacking in direction. OCAST has a board of directors, but little input on the directions of that agency is actually provided by the board. There appears to be much more need for strategic direction in the state’s science ventures, as discussed below.

## Strategic Focus

Science policy in Oklahoma is not well organized strategically. There is implicit organization of that strategy that needs to be made explicit. The initial EDGE down payment coupled with increased funding for OCAST, and expansion of the number of programs in the latter, means that the state will have much more money to devote to science policy. But, those funds need to be

focused, and focused on initiatives that the legislature can clearly relate to specific industries. “What are we doing to support our industrial base through the research base?” one interviewee asked.<sup>26</sup>

We haven’t been able to answer such questions because our research efforts are fragmented. We must marshal our resources to support Oklahoma’s industrial base. OCAST sees itself as a catalyst for collaboration, operating through its 21-member board of directors. This board consists of the Chancellor of Higher Education, representatives from the legislature, small businesses, foundation heads, and regional university presidents. This is a very distinguished group of state leaders, but, for the most part, they are not scientists, engineers, or technologists. It was evident from comments of many interviewees that there isn’t much hope or faith that this board, as presently constituted, can provide strategic direction for science policy in Oklahoma. It was noted frequently that OCAST presently has no scientists or engineers on its professional staff. OCAST does have policy bodies consisting of scientists and engineers for its various programs, however, that could provide useful inputs to science policy and should be involved in its formation. Still, there is growing recognition that the state needs to build and execute a collaborative and comprehensive strategic S&T plan that extends beyond OCAST and incorporates broader perspectives.

Oklahoma is a very small player in the R&D world and is likely to remain so. One interviewee noted that the number of scientists in Oklahoma who have received National Institutes of Health grants is only 199. There are single departments at Harvard that have that number of NIH grants. Texas has nearly 10 times that number, while its population is only about 6.5 times Oklahoma’s. A critical question is “What can Oklahoma do with such a small critical mass?” “Certainly, you can do something and we can do much more than we are doing, but you must concentrate.” Even if the EDGE S&T initiative were fully funded at the one billion dollar level, generating approximately \$50 million in annual support from the endowment, Oklahoma would still be a small player. Critical mass is the key to excellence. And, there are

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examples in the state of solid strategic planning. For example, the University of Oklahoma Health Science Center (OU-HSC) has a 10-year strategic plan. There are five identified health research domains in that plan and they are good at each and every one of them, one interviewee alleged.

It became clear from the conversations that a large part of the rationale for the EDGE initiative was based on the need for more strategic, centralized direction. The need to pick three or four futures for science policy is seen, by many, as key. Weather research, it was noted, is the only area about which one can say that we have a critical mass of research talent and activity at present, one interviewee asserted. That program is not dependent upon a single individual as, for example, a laser research program had been in previous years: a program that eventually failed when the chief investigator moved to another academic institution in another state. We need other foci, coordination of foci, and leadership from the private sector, which is lacking. There needs to be a coordination of plans into a focused, agreed upon, overall science policy.

The push is on to have a state S&T plan, stimulated in part by EPSCoR mandates.<sup>27</sup> Originally solely an NSF funded program to help states advance that didn't receive research funding in proportion to their population base, EPSCoR has now expanded to multiple agencies including DOD, DOE, EPA, NASA, NIH, and USDA. The call to participating states, now numbering 26 plus Puerto Rico, is to decide who they are and where they want to go with their science policy. The National Science Foundation is attempting to look 15 years forward and seeks to double its budget. Use of the EDGE endowment to leverage federal funding is a strategic pursuit. Information technology, biotechnology and nano technology are the federal drivers. The Science Advisor to the Governor, Joseph Alexander, OSU, is leading this planning effort. While the immediacy of the need to formulate a plan to satisfy the EPSCoR mandate will lead to action, the evidence from this investigation leads the author to suspect that that effort will be helpful, but will fall short of the strategic requirements that science policy needs to achieve the ultimate advancement of the S&T

status of the state. Active involvement of the state's science and technology base of expertise, people who really understand S&T and how discoveries make their way into products and services, is key to the formulation of strategic science policy.

### **Active Efforts**

While Oklahoma, statistically, is currently behind the curve, momentum is building in numerous areas. The state also benefits from strong leadership at both major public research institutions. Both university presidents truly care about the science and technology status and economic success of the state, and they know how to and are dedicated to pushing research agendas forward. Multiple programs are planned or operational on each campus. The Weather Center complex at OU is operational with all construction nearing completion and tenants moving in. OU is beginning construction of its new Chemistry buildings in the south campus research park. In the biosciences, the new Stephenson Research and Technology Center is funded at \$27 million. The university is also targeting recruitment of faculty for its life sciences initiatives.

OSU is concentrating on sensor technology and nanotechnology through new facilities and faculty recruitment. Another target, biotechnology, is oriented toward plants and animals, rather than traditional human oriented research. The need to build critical mass in selected areas is well recognized. Opportunities are seen in evaluation, testing, certification and standards in technology development, becoming a type of university-based Underwriters Laboratory. Complimentary strengths are seen in the state in biofuels. One interviewer asserted that it is possible to "produce plants with 10 times the sugar levels" of present plant technology for conversion into biofuels. Another asserted that "all of the pieces are there, but no one has put them together." Both universities are placing new emphasis on entrepreneurship through the Center for the Creation of Economic Wealth at OU and the Center for Innovation and Economic Development at OSU.

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The EPSCoR program and EDGE provide opportunities for OU/OSU cooperation as well as cooperation with other Oklahoma higher education institutions. Joint research grants involving faculty at OU and OSU have occurred in materials and life sciences. The two universities have different fiscal structures that cause some difficulties in joint endeavors, but those problems seem to have been worked out. The Center of Aircraft Systems/Support Infrastructure (CASI) is an example of a higher education coalition that has been highly successful and is exemplary as an organization designed to assist an obvious industry cluster that we have in Oklahoma, aircraft maintenance. This organization has obtained over \$8 million in federal grants and has also been involved in a number of projects with private companies and the Federal Aviation Administration. Undoubtedly, there are many other examples of inter-university cooperation.

Non-profit foundations such as the Noble Foundation, Presbyterian Health Foundation (PHF), and the Warren Foundation are actively pursuing R&D institutional investments. The research park that PHF has established is a shining jewel in the state. From an initial 300 employees, it now has 1,200 working in the park and seeks ultimately to have over 2,000. Such progress is put into context through comparison with the 2,400 people who lost their jobs when the General Motors plant closed. An enviable cluster of biogenetics and biomedical research, with expertise in immunology, infectious disease, cancer, pediatric genetics and heart disease, is developing in Oklahoma City, with PHF, OU-HSC, and the Oklahoma Medical Research Foundation (OMRF) in close proximity.

OCAST has a full range of programs in support of the pipeline from research, proof of concept, inventor's assistance, SBIR and STTR proposal assistance, seed funds, and commercialization. Its R&D Internship program has been highly successful, providing real-life R&D experience for college students. OCAST has also contracted with the State Chamber of Commerce to increase awareness of nanotech potentials in Oklahoma. Commercialization is contracted out to a non-profit organization called i2E. This organization with the former head of the Okla-

homa Department of Commerce, Greg Main, at its helm has assisted more than 1,000 business operations, and now lists 600 in its client base. Mr. Main knows venture capital, having worked in that industry prior to assuming his CEO role in i2E. The Reynold's Governor's Cup business plan competition, with its undergraduate and graduate contests and sizable cash prizes, is organized through i2E and proving to be a strong vehicle for increasing student interest in entrepreneurship. One interviewee noted that a lot of other states, even internationally, are closely examining i2E, hoping to duplicate its structure and operations.

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OCAST is expanding beyond its health and applied research programs, adding new programs in plant biology and nanotech areas, funded with a \$10 million expansion of its budget. The Oklahoma Alliance for Manufacturing Excellence also receives some support from OCAST. The Center for Innovation and Economic Development (CIED) at OSU has worked with the Alliance to produce some important engineering solutions that have led to new technologies and jobs. OCAST also appears to work closely with many other economic development operations in the state.

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Undoubtedly, there are many more success stories that could be mentioned. The funding that Oklahomans have provided has leveraged science and technology investments, helped young researchers get a start on their careers, introduced students to R&D careers, assisted manufacturers in remaining competitive, and aided business formation. OCAST has been and remains the focal point of such activities. As noted above, these investments have only allowed the state to retain its comparatively weak S&T rating. But without the, it is likely that we would have fallen further behind. Much more attention to strategic focus will be required, however, if the state is to advance its comparative standing.

## OCAST

As implied from the above narrative, OCAST was mentioned frequently by interviewees. Now in its 20<sup>th</sup> year of operation, OCAST appears well positioned as a bridge between companies and universities. This organization clearly has made strides in facilitating connections of this type. Such functionality in OCAST is well recognized by interviewees. In its early life, however, OCAST was operating very much like a mini-NSF, even adopting many of the procedures used by NSF in funding proposals. One drawback to higher education researchers was the refusal of OCAST to pay any overhead. This practice continues today, and is still a source of frustration for institutions of higher education. As a state agency, OCAST can legitimately make the claim that Oklahoma institutions of higher education are already being supported by state government. On the other hand, real additional costs are associated with any research project. It should not be too much to ask OCAST to pay some level of grant overhead costs, even if not the full federal government allowed rates.

OCAST is seen as having done a “pretty good job” at running a grants program. In particular, their use of the peer review process is considered to be a very good practice, one that is being mimicked by other state OCAST “look-alikes.” Since 1999, OCAST has required matching funds from a business entity in its OARS program. The

match is on a one-to-one basis. This forces business ties to be found and is likely instrumental in producing closer ties between businesses and researchers. This comes at a cost, however. Research of a more basic nature is not likely to find business ties. One interviewee asserted that a whole lot more could be done to create leverage in the hard sciences without this requirement. It is noteworthy that matching is not required for the OCAST health initiative. The rationale for the requirement in one but not the other program is unclear. If the reason is that OARS, the applied research program, is designed to produce technology to commercialization stages while the health program is more closely tied to basic research, then, by implication, basic research in the non-medical sciences has little support in OCAST’s present programs. It is noteworthy that the new Plant Science Program has no matching requirement for basic research, but a 1:1 requirement for stages beginning with “proof of concept.”

One major theme in the interviews was OCAST’s lack of strategic direction. OCAST simply looks for the best proposals, not for the strategic fit of proposals. Projects that are funded simply do not build on one another, it is alleged. Certain aspects of this charge are likely to be true, in regard to funded proposals, anyway. OCAST certainly has had a strategy in mind that has “settled-out” over the years. The “soup-to-nuts” attention to the research-to-commercialization pipeline is a strategic direction. New initiatives in the plant sciences and seed capital funding are strategic. It is true that while OCAST pursues a fairly open approach to proposal submissions within the constraints of program guidelines and could likely benefit from increased strategic focus, there are positive facets to this approach. “One never knows what new and unexpected ideas might come through the door,” one interviewee noted. Nevertheless, “the state needs to be building in a few strategic areas,” a point made by many of the interviewees. The fact that OCAST’s funding strategies are not as directed in this regard as they need to be is likely a fair critique. That state cannot hope to succeed without the development of critical mass in a few foci, because funds to do so are too limited to pursue many lines of inquiry, is a view widely held by interviewees.

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There appears to be increasing recognition on the part of OCAST leadership that strategic focus matters. The new program offerings are a manifestation of that recognition. Still questions have been raised in the interviews about OCAST's attention to strategy, beginning with OCAST's use of its board of directors. Certainly, there are many distinguished and knowledgeable people on OCAST's board who are important to the state's science policy. For the most part, however, the membership appears to be comprised of business, academic, and government leaders. Science and engineering representation is low, but certainly not nonexistent. Of course, it is important to have leaders represented on the board, but it is also important to have individuals knowledgeable about strategic directions in science and engineering. Another criticism that was offered is that all too often the board simply validates the agenda, rather than sets the agenda for strategic direction. What is not clear is whether these criticisms are as true today as they possibly once were in the past. Also, this critique overlooks the presence of scientists and engineers on the program boards, and the possible contributions they make to strategic directions of the programs.

Despite criticisms, the 20 years of operation of OCAST has enabled that agency to gain a sound footing to assist in the advance of science, technology, and commercialization. The commercialization arm of OCAST, i2E, is also widely respected and mimicked. OCAST has received many awards and recognitions. Several states have established similar types of agencies, imitation being the "sincerest form of flattery." The peer-review processes OCAST has instituted is a guiding principle for operations of such agencies. OCAST has also blazed the statutory trail for industry, university, and government cooperation in Oklahoma, to the great benefit of the EDGE initiative.

## **EDGE**

With a baseline \$150 million endowment, the EDGE fund will support around \$7.5 million annually in project support. All interviewees are pleased that the governor and state legislature have made this initial deposit and see EDGE, with

its separate board, as a chance to gain greater strategic focus. To be frank, however, there is some degree of tension between OCAST and EDGE that was apparent in the interviews. On its website, OCAST states that it has been designated as the fiscal agent for EDGE. Some of the interviewees seemed surprised that this is the case. It makes a great deal of sense to this author to make operational use of OCAST in some administrative aspects. Certainly, the peer review apparatus that OCAST has implemented and religiously adhered to over the years provides an administrative structure from which various economies can be realized. There is little sense in duplicating administrative procedures. With separate boards, the potential for clashes appears high to this observer. Such issues need to be acknowledged, discussed, and fully specified as to how this is really going to work.

From the interviews, it seems to this observer that the EDGE initiative can best be described as a "clarion call for more strategic direction" in state science policy. The State Regents for Higher Education and the universities are going to have more say in EDGE than they have in OCAST. This much seems clear. Greater involvement of academic science and engineering leadership, as well as, one would hope, academic leadership from the colleges of business, is likely to lead to more strategic use of the funds. The goal, according to those interviewed, is to pick three or four futures aligned with present or developing critical masses in the state. "You simply cannot do everything. You have to pick and choose." Scientists and engineers have to be involved in that process. Ways of gaining more private sector leadership have to be found. "You do have to have a bottom-line oriented point of view that is lacking in many instances."

Some additional comments in regard to EDGE included the following. "Too many times competition (between universities) is over the same dollars. We have to find ways to collaborate. There are some examples of collaboration, but too few," one interviewee noted. "Too many times it is simply stated that we are going to be a Center of Excellence for biotech, nanotech, whatever. We have to narrow down our focus. We need to be competitive in whatever niches we

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decide to adopt. It is just too much, this trying to please everybody and be everything.” “We need to put aside past practice of treating OU and OSU equally.” EPSCoR is forcing the issue by requiring states to have strategic plans. Each of the 26 states will have to define their S&T future. EPSCoR is moving to the directorate level at NSF, which probably means that much more attention will need to be focused on “upstream” research, knowing NSF’s basic research mentality. One interviewee noted that the “unspoken expectation is that states propose research in those areas that NSF considers important.” It was also noted by one interviewee that none of the initial seven states in EPSCoR or the additional 19 states that have been added have ever graduated. Another interviewee added “that the challenge for EDGE will be going from \$150 million to \$1 billion. They need to hire someone worth his salt to run it.” It is clear that the future holds multiple challenges for effective implementation of EDGE. In terms of need for focused strategic thinking, however, the EDGE heads are pointed in the right direction.

## **Regionalism**

Science policy needs both to utilize, yet contain, regionalism in any state. Regionalism has both positive and negative aspects in Oklahoma. On the positive side is regional attention to science policy. The Oklahoma City Chamber of Commerce was mentioned as exemplary by interviewees in its work on regional science corridors, special attention now being paid to the biosciences and biomedical research.<sup>28</sup> Tulsa was mentioned as having done good work in strategic planning with its Tulsa 2020 project. However, “there are a lot of entities stirring around the state, some are valuable, other not so much so,” according to one interviewee. That the “bedlam” mentality between the two major research universities sometimes gets in the way was mentioned by several of the interviewees. One thought, however, that the “pragmatist” in him says that bedlam is always going to be there and that competition has its advantages. Yet, given the reality that scientists and engineers inherently like to work together, that these major research universities are

only 88 miles apart, and that communication technologies to facilitate interaction are much more advanced, it seems to this observer that more can be made of collaboration between these two institutions. Critical mass, of course, has a personnel dimension. The two state research institutions together provide an opportunity for larger aggregates of expertise. And, the collaborative aspects do not need to stop there. Tulsa University is developing extensive capabilities in cyber security. That institution needs to be brought into the fold of collaborative research to a greater degree.

Rural communities provide another source of regionalism issues. A “what’s in it for me?” attitude naturally prevails. This is a tough issue in science policy, especially from the standpoint that quality scientists and engineers are very select forms of human capital, much in demand, and they can be choosy about where they live and work. The advance of Colorado as a high-tech state is an already mentioned example of “sophisticated consumers of place.” Blakely notes that “few scientists will choose to live in areas with a poor range of community facilities and services,” and “few communities can ever aspire to a high-tech future.”<sup>29</sup> The necessary confluence of communication channels, networking potentials, human resource expertise, education and research facilities, financial markets, enterprise facilities such as research parks and incubators, and other infrastructure necessary for high technology to flourish, unfortunately, rules out many smaller communities. Through the higher education system and programs like OCAST’s R&D internship program, there is hope of involving the students of rural Oklahoma in high technology. With time and the proper execution of science policy in Oklahoma, these students of today will bring high-tech back to rural communities in the final jobs-creating production stages of commercialization.

Regionalism also relates to workforce issues. Oklahoma needs to develop all of its rural, suburban, and urban brainpower to compete in a high-tech future. Workforce issues were mentioned frequently. This is a subject matter of great importance, but well beyond the scope of this paper. Concerns are growing nationally. Volumes

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have been written on the subject of the low levels in the United States of science and mathematical competency.<sup>30</sup> The Oklahoma School for Science and Mathematics is a success story, as reported by Larkin Warner in Chapter 2 of this study. Programs to bring higher levels of mathematical education to rural areas are noteworthy. Consideration of workforce issues has to be a component of strategic science policy.

## **Entrepreneurship**

Supply constraints on available expertise to plan, organize, promote and operate businesses may be the most limiting of all difficulties the state faces in advancing science policy. This, too, is a workforce issue that, fortunately, is beginning to gain attention in the business colleges of both comprehensive and regional universities in Oklahoma. Pursuit of “grow your own” strategies will likely yield sizable returns. Many interviewees commented on the need to pay much more attention to issues of entrepreneurship in the state. Attention is nascent, but resources and curriculum are being developed. Cameron University was noted for its progress in this domain, where a specialist has been hired. The author can speak from personal experience that entrepreneurship is receiving much more attention in the Price College of Business at OU. Also, The Center for Creation of Economic Wealth at OU is an example of attention that is being given to entrepreneurship, workforce development, and the creation of business start-ups from university research. OSU also has an institutional commitment to entrepreneurship and technology transfer. The Governor’s Cup competition, run by i2E, is becoming instrumental in bringing the need for the development of entrepreneurship to the attention of business, science, and engineering programs.

One interviewee noted that he is seeing a major trend in college labor markets: interest by students in starting their own businesses or working in start-up companies. He made several additional relevant comments. This is a trend quite different from the one just five years ago. All three teams from OU at the graduate level in last year’s Governor’s Cup competition, who placed first, second and third in that competition,

are interested in starting their own businesses. The labor market is changing in terms of both supply and demand. Big businesses simply don’t innovate much any more. There are very few examples of 3M-like companies today. Sarbanes-Oxley has turned the directors of large businesses away from risk taking. Students today are disillusioned with working for Fortune 500 companies. They care more about working in areas they can be dedicated to. Experience is the big strike against them, of course, but age and energy are certainly working for them. Financial commitments are minimal and the pioneering spirit endemic to Oklahoma is certainly in their favor. There is growing potential for feeding these sentiments directly into the supply chain of innovative companies. Building entrepreneurship into the state’s strategic science policy is essential.

Entrepreneurs certainly need capital and venture capital is well known to be concentrated on the east and west coasts. Opinions of economists differ on the magnitude of this problem. Some believe that lack of venture capital is, indeed, a problem for Oklahoma. Others believe that good deals will always find backing. The truth probably lies between these polar opinions. What is clear is that entities in Oklahoma cannot afford to waste any connections to capital that it has. That is one reason that operations like i2E are so important. This organization provides the necessary screening for efficient deal making. That focus is an extremely important component of the research-to-product pipeline.

## **In Praise of SSTI**

There is a spate of books, reports, strategic plans, and other materials on high-tech economic development. Authoring this chapter has provided an opportunity to delve into some of these writings, which has reinforced previously held notions of the vastness of this literature. The technology of the Internet increases accessibility to this literature enormously, and reduces the time lags in acquiring information. A special endeavor that stands out from all other offerings is the State Science and Technology Institute (SSTI) website. This site bills itself as “the most comprehensive

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resource available for those involved in technology-based economic development.” They fill this bill quite adequately. This non-profit institution provides a variety of technology-based economic development (TBED) tools, a searchable and downloadable reports database, a bookstore function, practical guides, a weekly digest of state activities, and schedule of conferences. Their *Resource Guide for Technology-Based Economic Development* is a “must read” for anyone interested in the subject matter. It is filled with examples of TBED strategies that work. Oklahoma’s i2E is explicitly mentioned on more than one occasion. SSTI also performs research for such organizations as the National Governor’s Association and the Economic Development Administration.

One 1997 SSTI report is particularly germane to the subject at hand: *Science and Technology Strategic Planning: Creating Economic Opportunity*.<sup>31</sup> Strategic economic development plans were reviewed from 29 states, only thirteen of which were TBED-oriented. The reviewed reports were completed between 1991 and 1995. Ten best-practice features were delineated from these documents: (1) having a champion, usually the governor; (2) seeking a wide-range of viewpoints; (3) articulating a vision of the state’s future; (4) incorporating widespread benefits; (5) building on existing delivery systems; (6) addressing all necessary components for success; (7) including performance measures; (8) detailing implementation plans, responsible parties, and timelines; (9) being tied to state budgeting processes; and, (10) providing strong leadership for implementation and monitoring progress. Each of these best practices is illustrated in the report. Typically, economic development strategy reports will do a good job with elements (1) through (5), but fall considerably short on (6) through (10). Of course, books and materials on strategy proliferate and there are certainly many more examples of TBED strategy reports that have been issued since 1995. But, this report seems to be one of the few that has been devoted to how to do comprehensive TBED strategy.

As noted, the SSTI website contains a searchable database of reports and publications. The author has downloaded and reviewed several

of these reports from different states. Some are extremely impressive and detailed, apparently in the tradition of SSTI-recommended TBED strategy. Some are even narrowly focused at times. Others offer high-sounding phrases, but are missing many of the necessary elements. One such report containing many of the necessary elements is Michigan’s *Ready for the Next Leap Forward: A Competitive Assessment and Strategic Plan to Develop Michigan’s Life Sciences Industry*. It is accessible from the SSTI website. This study begins from the base of a 2000 Battelle Institute study. It addresses industry, academia, and financial capital. Detailed statistics are presented and characteristics analyzed. It charts the progress that has been made on specific Battelle recommendations. It enumerates remaining challenges and provides recommendations for meeting those challenges. Most impressive about the piece is that it is leveled at only one segment of science, as indicated by the document’s title. Many other examples of quality TBED strategy reports are available from SSTI.

The vastness of materials that have been, and continue to be generated on TBED strategy is overwhelming to new initiates. TBED is much more art than science, and success in this arena is very dependent upon the local environment, interest, abilities, and capacities. One size will never fit all. One scientist who was interviewed for this chapter commented that there is no shortage of strategic reports in various departments of colleges and universities in Oklahoma. And, he noted, “You can blindly open up any one of them, point your finger, and hit on a good idea.” The problems revolve around focus and coordination to arrive at one agreed-upon vision. Further, it is difficult to imagine the formation of science policy without the involvement of scientists, engineers, technologists, and program administrators along with state leadership and practitioners of TBED.<sup>32</sup>

## Recommendations and Conclusion

This chapter has examined the necessity and culture of science policy, models of innovation, enabling federal legislation and programs in

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support of industry/state/university cooperation, the present status of R&D expenditures in Oklahoma, numerous comments by a dozen knowledgeable science policy and business professionals; and glimpses into the wealth of technology-based economic development literature available through SSTI. As we look to the future we have to be pleased with the progress OCAST has made with frightfully small fiscal allocations. This organization has developed a sustainable model of research and innovation characterized by its pipeline approach. It has clearly communicated its programs to appropriate audiences. It has provided young and seasoned researchers with funds to further develop their findings and to leverage them into federal support. It has aided business start-ups and furthered collaboration between universities and industry. It has a multitude of success stories to tell. It has garnered a national reputation. It clearly deserves a large chair at the table of science policy formation. The view of this observer, however, is that there should be one and only one science policy table for the state.

This research has discovered the need for a reorientation of the state's science policy. Efforts in the state are too fragmented, too uncoordinated, and too unfocused to hope to achieve the types of critical mass needed to take a large leap forward. As noted in the introduction, the problem is not lack of vision, but too many uncoordinated visions. EDGE is seen by this observer as a "clarion call for more strategic direction" in state science policy. Knowing what is in need of doing is quite distinct from knowing how to do it; assigning and holding accountable those who are doing it; getting it done; obtaining buy-in; managing, measuring, and monitoring progress; and making necessary mid-course corrections. What this observer heard in the interviews was a lot of comment on what needs to be done, and, aside from the immediate need to fulfill EPSCoR mandates, not much on how and who is to do it.

The state now has more resources to devote to the pursuit of science policy objectives. These investments must be handled wisely and efficiently. Development and deployment of one vision for execution of science policy in Oklahoma is the initial investment that needs to be

made. One vision doesn't mean that only one thing is to be done. A multitude of activities and programs must be in play to accomplish needed objectives. One vision means that there is one agreed upon plan-of-action that all parties adhere to, knowing their separate roles, their responsibilities, and how their performance will be measured. Success in forming, implementing and executing a one-vision science policy plan can be achieved by:

- Building strategic short-term and 5 and 10 year targets with realistic goals;
- Using sound, independent research methods to determine appropriate sectors to invest in;
- Devoting resources to research projects which are likely to promote development of the state's economy in sectors where true comparative advantages lie;
- Engaging scientists, engineers, innovation and business specialists in the process, both active and retired specialists;
- Recognizing that distinct cultures guide research, development, and commercialization pursuits, and the need to be respectful of those cultures;
- Deploying funds initially to those domains with the greatest promise of immediate return;
- Seeking leverage through federal and private sector initiatives, sparing no effort in pursuit of partnerships and collaborations, and working to create critical mass;
- Paying heed to development of entrepreneurship skills in the workforce, creating future generations of risk-takers for Oklahoma's economy, and making more efficient use of the existing entrepreneurial base;
- Keeping the door open to meritorious new ideas that may not neatly fit into the existing vision;
- Supporting the existing industry base in Oklahoma;

- Enhancing communication and network linkages between scientists, engineers, innovators, and business specialists;
- Utilizing out-of-state professionals where needed both for formation of strategic plans and evaluation of specific projects;
- Developing real and meaningful measures of success that carefully evaluate the marginal (additional) impacts of specific efforts, for it is only by knowing marginal gains in comparison to marginal costs that optimal allocations can be made;
- Working to overcome the two “valleys of death” in lost momentum that occur between the basic research and proof-of-concept and the initial finance and product launch phases of commercialization;
- Having specific timelines for completion of identified elements of the plan, assigning responsibility for execution, and holding accountable those in charge;
- Avoiding conflicts of interest and moral hazards that can naturally arise;
- Exploiting the desire of all Oklahomans to see the state’s economy succeed; and,
- Understanding that these are long-term endeavors where instant gratification is an impossibility.

These are a few of the ideal features to incorporate into a state science policy. Undoubtedly, other observers will have worthy elements to add to this list.

Not on the list, but implied by the complexity of the endeavor, is the State of Oklahoma’s need to create an independent, professionally-staffed, continuously-functioning “Office of Strategic Science Policy” to centrally perform the myriad of necessary functions associated with planning and plan execution. Strategic planning is a continuous process; it is not simply construction of a document to gather dust on a shelf. The limited foray into the TBED literature present in this chapter supports the need for professional personnel in the formation, deployment, execution, management, and monitoring of the state’s science plan. That literature is vast and expand-

ing; the issues are complex, intertwined and evolving; the groups and institutions involved are diverse; and the skill-set, knowledge base, and focus required to keep the machinery of science policy moving forward is broad.

To get a quick start on long neglected efforts in Oklahoma, the state really needs to engage someone “who has done this before,” someone with credentials that garner respect from the vast spectrum of people with diverse expertise involved in the distinct but interrelated facets of transforming research into marketable products and services. Given the robust character, advanced development, and thoughtful execution of other state S&T initiatives, such personnel are out there, somewhere. We need in Oklahoma such a person and the supporting cast of professionals developing, garnering buy-in, implementing, managing, modeling, analyzing, investigating, inventorying, cataloging, communicating, database building, networking, coordinating, integrating, synergizing, compromising, measuring, monitoring, marketing, evaluating, reporting, updating, and revising the state’s science plan. These are full time endeavors. These work elements cannot be done by individuals who have other full-time occupational pursuits, regardless of their enthusiasm, capabilities, and intensity.

Where to locate such a functional unit is in question. Should this function be lodged somewhere in state government, or is it better to have it stand as some form of non-profit entity, like i2E? It could be argued that independence could better be preserved (which translates into isolation from political influence) if it is not housed in any government agency. The State Regents for Higher Education is a possibility. Indeed, the author has heard that in initial discussions about the institutional placement of OCAST, there was talk of housing that agency in the State Regents. Housing this function in OCAST is, of course, another possibility. Various alternatives and corresponding positives and negatives need to be considered. Institutional placement may be less of a concern than physical placement, and the author has that answer: Presbyterian Health Foundation research park. Those facilities presently house OCAST, i2E, the State Regents for Higher Education, and,

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of course, PHF. It is an ideal location for the proposed functions, a physical location that is already a hub of S&T policy action in Oklahoma.

The citizens of Oklahoma have made great strides toward securing a place for their state in the expanding world economy through their investments in science and technology. Fully funding EDGE to the \$1 billion level is a worthy goal that should be pursued with steadfast energy, but it will be a challenge, as many interviewees noted. Let us not forget, however, the obligation to make the most of available funding that can be made, and the value that having one science policy vision can yield. With \$23 million in OCAST funding at present and an additional \$7 million in EDGE, combining to \$30 million, the State of Oklahoma has implicitly provided a \$600 million endowment, assuming a five percent annual investment return. Identifying that one vision and putting it into action is the single most significant step the state can now take toward securing its future.

### Endnotes

<sup>1</sup>Oil production hit a peak of 225 million barrels of oil per year in 1968. Production in 2005 was about 60 million barrels, according to Oklahoma Corporation Commission records.

<sup>2</sup>Larkin Warner and Robert Dauffenbach, "State Policy and Oklahoma High-Tech Economic Development," in *State Policy and Economic Development in Oklahoma*, 2006, 49-62.

<sup>3</sup>An important example of national recognition OCAST has received is Thomas L. Friedman, *The World is Flat*, New York: Farrar, Straus, and Giroux, 2005, 244-5.

<sup>4</sup>The registered trademark symbol is not an error. The State of Oklahoma has, indeed, registered *Research Capital of the Plains* as a trademark.

<sup>5</sup>An example of "begging the question" is the question "Have you stopped beating your wife?" It presumes an affirmative answer to the question "Did you beat your wife in the past?"

<sup>6</sup>Edward F. Denison, *Sources of Economic Growth in the United States and the Alternatives Before Us*, New York: Committee for Economic Development, 1962; *Accounting for United States Economic Growth, 1929-69*, Washington, D.C.: Brookings, 1974; *Accounting for Slower Economic Growth: The United*

*States in the 1970s*, Washington, D.C.: Brookings Institution, 1979. See Linda R. Cohen and Roger G. Noll, "New Technology and National Economic Policy" in *The Technology Pork Barrel* (1991), Cohen and Noll (editors), Washington, D.C.: Brookings Institution, 1991 for an excellent discussion.

<sup>7</sup>Albert N. Link and Gregory Tassej, *Cooperative Research and Development: The Industry, University, and Government Relationship*, Kluwer Academic Publishers, 1989.

<sup>8</sup>See Rosenberg and Nelson, "The Roles of Universities in the Advance of Industrial Technology," in Rosenblum and Spencer, *Engines of Innovation* (1966) for an excellent review.

<sup>9</sup>Vannevar Bush, *Science—The Endless Frontier: A Report to the President on a Program for Postwar Scientific Research*, Washington, D.C.: National Science Foundation, reprinted 1990.

<sup>10</sup>Donald E. Stokes, *Pasteur's Quadrant: Basic Science and Technological Innovations*, Washington, D.C.: Brookings Institution, 1997, 2.

<sup>11</sup>Bush, *Science*, 19.

<sup>12</sup>*Investing in America's Future, Strategic Plan FY 2006-2011*, Washington, D.C.: National Science Foundation, 2006, 4.

<sup>13</sup>Stokes, *Pasteur's Quadrant*, 20.

<sup>14</sup>Stokes, *Pasteur's Quadrant*, 20.

<sup>15</sup>Verloop, *Insight in Innovation*, Elsevier, 2004, 139.

<sup>16</sup>Verloop, *Insight*, 17.

<sup>17</sup>Examples include Jurgen Schmandt and Robert Wilson, editors, *Promoting High-Technology Industry: Initiatives and Policies for State Governments*, Boulder and London: Westview Press, 1987, Link and Tassej, *Cooperative Research and Development*, 1989, and Charles W. Wessner, editor, *Government-Industry Partnerships for the Development of New Technologies*, Washington, D.C.: National Research Council (2003). Substantial bibliographies are included in each reference.

<sup>18</sup>Carl J. Schramm, *The Entrepreneurial Imperative*, New York: HarperCollins Publishers, 2006, 121.

<sup>19</sup>Oklahoma has its own examples, such as two investigators from the Oklahoma Medical Research Foundation who commercialized their research through a business start-up called Intergenetics. This firm was eventually sold to Genzyme for \$229 million. Genzyme is a client of PHF, with their logo emblazoned on a building in the PHF research park.

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<sup>20</sup>Quasi-public firms are defined as firms that are publicly traded, but are controlled through majority ownership by another public company.

<sup>21</sup>Bary P. Pisano, "Can Science Be a Business?," *Harvard Business Review* (Online Version), October 2006.

<sup>22</sup>"The Role of Partnerships in Current Technology Policy," in *Government-Industry Partnerships*, 102.

<sup>23</sup>See note 2.

<sup>24</sup>*National Patterns of R&D Resources: 2004 Data Update*, Science Resource Statistics, NSF 06-327, National Science Foundation, Tables 11 and 12.

<sup>25</sup>National Science Foundation/Division of Science Resources Statistics, *Survey of Research and Development Expenditures at Universities and Colleges, FY 2004*.

<sup>26</sup>There are, actually, scattered examples of university activities to support Oklahoma's industrial base, as discussed below. One especially important example is CASI (Center of Aircraft Systems/Support Infrastructure). Others, such as the Center for Economic Development and Innovation (CEDI) at Oklahoma State University, as discussed in the Active Efforts section below. This statement is seen by this observer to be reflective of the general lack of knowledge and cataloging of such activities, as well as

a need to do more to support Oklahoma's industrial base.

<sup>27</sup>EPSCoR stands for "Experimental Program to Stimulate Competitive Research." The state's present grant is for \$6.0 million, matched by \$3.0 from the Oklahoma State Regents for Higher Education.

<sup>28</sup>The OKC Chamber of Commerce commissioned a study by the Battelle Institute to examine industry-cluster features of bioscience and biomedical establishments that are operating in central Oklahoma. This report is available from the OKC Chamber.

<sup>29</sup>Edward J. Blakely, *Planning Local Economic Development: Theory and Practice*, Sage Publications, 1994, 310-11.

<sup>30</sup>*Rising above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, National Academy of Sciences Press, 2006.

<sup>31</sup>Marianne Clark, principal author, Economic Development Administration, U.S. Department of Commerce, NTIS PB98-119423, 1997

<sup>32</sup>Oklahoma has one other important state resource in relation to SSTI. Sheri Stickley, former acting director of OCAST who was also in charge of establishing the commercialization components of OCAST, now works for SSTI and conducts her activities through offices in Oklahoma.

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