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The Impact of the State Higher Education System on the Texas Economy

CAROLE KEETON STRAYHORN
Texas Comptroller

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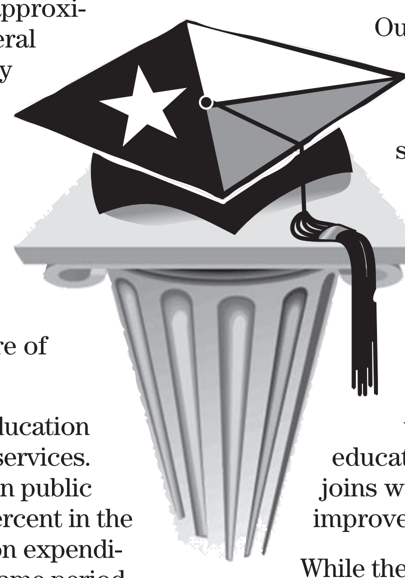
"Every dollar invested in our state's higher education system pumps more than five dollars into our Texas economy. It is a remarkable return on our money for Texans today and a vital stake in the future for successful generations of Texans tomorrow."

—Carole Keeton Strayhorn
Texas Comptroller

Higher education has a significant impact on the Texas economy, fueling the Texas economic engine with $33.2 billion a year. Considering that the system receives approximately $6 billion annually in state general revenue and local property taxes, every dollar invested in the state's higher education system eventually returns $5.50 to the Texas economy. This is a remarkable return, even for a high-stakes technology startup. But when it comes to the Texas higher education system, the stakes are much higher. For here, we are investing in our most important venture—the future of young Texans.



Even with this vital role, state higher education funding is losing ground to other state services. After adjusting for inflation, spending on public safety and corrections increased 223 percent in the last 15 years, while real higher education expenditures grew only 44 percent during the same period.

This report investigates the economic impact of higher education through two broad avenues. The first and most immediate impact is the additional sales, income and employment created by outside dollars being injected into the Texas economy. The second, which is fundamentally more important, is the longer-term role higher education plays in expanding the capacity of the state's economy through a more educated, productive work force.

Our study shows that $3.1 billion in annual student, research and health care-related higher education expenditures from out-of-state sources is spent and re-spent by Texas businesses and consumers each year to total $10.1 billion in economic output (see Summary Table 1). In addition, the Texas higher education system often joins with the private sector to create jobs and improve the quality of life for all Texans.

Every dollar invested in the state's higher education system returns more than $5.50 to the Texas economy.

While the first, more immediate, economic impact of higher education helps provide jobs and pay the bills, the second effect is more important over the longer term. As higher education raises the skill level of the work force, employees work smarter. This increases the overall capacity of the economy to produce more with the same number of employees—meaning that there is a larger economic pie to share with everyone.

To measure the second, "supply-side" impact, this report uses two approaches. First, based on the estimated lifetime earnings of our graduates, we estimate that the Texas higher education system eventually increases the economic output of the state by $27.3 billion a year. Second, by using a National Bureau of Economic Research statistical relationship between firm-level worker education and economic output, we estimate that each year of knowledge added by the higher education system increases Texas worker productivity by $18.9 billion over the workers' lifetime in the state labor force.

Considering both the earnings and productivity-based approaches, the Texas higher education system eventually expands the productive capacity of the Texas economy an average of $23.1 billion a year. Adding this "supply-side" gain to the $10.1 billion impact from out-of-state expenditures brings the total impact of the state higher education system on the Texas economy to $33.2 billion a year.

Higher education's contribution to the Texas economy is substantial compared to other industries. In fact, the sum of three years of higher education's economic impact far surpasses Texas' $72 billion oil and gas industry or $62 billion high technology business.

Even that does not tell the whole story. There are less measurable offshoots of higher education, including inventions, patents and the general advancement of knowledge—which have played such a substantial role in the success of the U.S. economy. Also, higher education plays an important role in attracting firms and workers from other states, research and development spin-offs and the other economic development in Texas.

Finally, a number of higher education success stories illustrate the role of higher education in increasing jobs and the quality of life for all Texans. Texas Comptroller Carole Keeton Strayhorn's proposed *TexasNextStep* program would create even more higher education success stories by further extending higher education opportunities to high school graduates. ★

EXECUTIVE SUMMARY

- Over time, state higher education contributes $33.2 billion annually to the Texas economy. This is a $5.50 economic return for every $1 in state government appropriations.
- Spending and re-spending of out-of-state higher education student, research and health care expenditures add $10.1 billion per year to state economic output.
- The higher earnings and productivity of higher education's students eventually increases state economic capacity by another $23.1 billion per year.
- Difficulties quantifying general knowledge and economic development roles of higher education understate even these total estimated impacts.
- Even with these positive impacts, state higher education funding is losing ground to other state services.
- The Texas higher education system does more than produce our future leaders. It helps create jobs and increase the quality of life for all Texans.
- Texas Comptroller Carole Keeton Strayhorn's proposed *TexasNextStep* program would further extend higher education opportunities to high school graduates. ★

SUMMARY TABLE I

Estimated Impact of Texas Higher Education System on State Economic Output, Fiscal 2002-03

(Amounts in Million $)

	Economic Impact	Earnings Method	Productivity Method	Average
Multiplier Impacts				
Student Expenditures	$3,409			
Research & Related Expenditures	$5,362			
MD Anderson Cancer Center	$1,316			
Total Multiplier Impacts	$10,087			$10,087
Discounted Earnings Gains				
Sub-Baccalaureate Degrees (1)	$3,642			
Bachelor's Degrees	$8,082			
Advanced Degrees (2)	$3,292			
Total Earnings Gains (3)	$15,017	$27,303		
Discounted Productivity Gains				
Manufacturing	$1,925			
Non-Manufacturing	$16,977			
Total Productivity Gain	$18,922		$18,922	
Average Earnings/Productivity Gains		$27,303	$18,922	$23,112
Total Economic Impact				$33,199
State and Local Funding				
2002-03 State GR Appropriation/Year (4)	$5,117			
Less: Texas A&M Services	$146			
Plus: Available University Fund	$366			
Direct Educational Appropriation	$5,337			
Plus: Community College Property Tax	$704			
Total State & Local Funding	$6,041			

(1) Includes community college certificates, some college and associate's degrees.
(2) Includes master's, doctoral and professional (including medicine and law) degrees.
(3) In order to estimate productivity grain, productivity gain, discounted earnings gain is divided by earning's 55 percent share of Texas economic output.
(4) Includes undedicated general revenue and employee benefits.

Sources: Carole Keeton Strayhorn, Texas Comptroller of Public Accounts and Legislative Budget Board, *Fiscal Size Up: 2004-05 Biennium*.

I. Introduction

The Texas higher education system consists of 145 public and private colleges, universities and health-related institutions and teaching centers, including 101 state-supported and 44 private institutions. The enrollment in all colleges and universities in the state in the fall of 2004 was almost 1.2 million and is expected to reach at least 1.3 million students by 2015.

Texas, more than any other of the most populous states, depends heavily upon public, rather than private higher education institutions, to educate its students. According to the Texas Higher Education Coordinating Board, more than 90 percent, or 1,064,620 students, are enrolled at its publicly-funded institutions, which include 57 community colleges and other two-year institutions (565,839), 35 universities (483,645), and nine public health-related institutions (15,136). Public higher education in the state is funded through a combination of tuition, student fees, hospital and clinic revenue and other local funds (including gifts from benefactors), income from the Permanent University Fund and general revenue appropriations made by the Legislature. Tuition rates are set by each institution's boards of regents, which also set many student fees.

Prior to fiscal 2004, tuition for general academic institutions (public universities and state colleges) was set by governing boards within a range prescribed by the Legislature. After the passage of H.B. 3015 by the 78th Legislature in 2003, governing boards were given complete control over tuition rates. This change, coupled with a tight state budget passed in that year, led to large increases in tuition rates at general academic institutions in both fiscal 2004 and fiscal 2005. Once a state with very low tuition and fee charges at public institutions of higher education, Texas' rates are now close to national averages for resident students attending public colleges and universities. Nonresident tuition is an additional $306 per semester credit hour in 2004-2005. This additional amount is set by the Texas Higher Education Coordinating Board to result in a rate that is equal to the average nonresident tuition and fees charged by the five most populous states, excluding Texas. Graduate tuition varies by program, with minimum tuition and fee rates for certain professional fields being considerably higher.

After adjusting for inflation, spending on public safety and corrections increased by 223 percent and health and human service expenditures increased by 214 percent from 1984-85 to 2004-05, while real public and higher education expenditures increased by only 79 percent and 44 percent, respectively, during this period.

During the 2004-05 biennium, state higher education "all-funds" appropriations totaled $16.1 billion, or almost 14 percent of the state budget. This was an increase of $295 million, or 1.9 percent, over total higher education funding in 2002-03. Of this amount, general revenue totals nearly $10 billion. Student-paid tuition and fees and the clinic and hospital revenues of health-related institutions generate most of the remaining $6.1 billion.[1]

Even though state higher education financing is increasing, it is still losing ground to other state services. After adjusting for inflation, spending on public safety and corrections increased by 223 percent and health and human service expenditures increased by 214 percent from 1984-85 to 2004-05, while real public and higher education expenditures increased by only 79 percent and 44 percent, respectively, during this period. From 1984-85 to 2004-05, total inflation-adjusted state spending more than doubled.[2] Texas also continues to trail most other large states in higher education funding. Even though state public university funding has increased, Texas ranks 7th out of the 10 most populous states on state and local appropriations per full-time equivalent student.[3]

Previous Studies

At least five previous studies have attempted to quantify the impact of the Texas higher education system on the state economy. The first and most ambitious was the study of the University of Texas System conducted by UT Austin's Bureau of Business Research (BBR) in the summer of 1994.[4] Similarly, in 1998 Resource Economics conducted a more narrowly focused study of the University of Houston System.[5] CC Benefits has recently completed a fairly comprehensive study of the economic benefits of the state's public community college system. Finally, the Texas Faculty Association and the Texas Guaranteed Student Loan Corporation have carried out two more succinct studies of the statewide higher education system in recent years.

UT System Study

Based on operating budget summaries and a survey of its component institutions and other sources, the BBR found that University of Texas system attracted a total of $835 million to the state in 1994. This total included $659 million in research and development funding and $176 million in out-of-state and international student expenditures. Then, based on economic multipliers from the Comptroller's input-output study,[6] the BBR estimated that these $835 million in outside revenues directly and indirectly support a total of $2.4 billion in business activity, $1.6 billion in personal income and 35,623 jobs throughout the state.[7]

In addition to the immediate economic impact, BBR also looked at the long-term effect of a University of Texas education on the earnings of its graduates. Here, based on U.S. earnings differentials between high school and college graduates and the direct and indirect costs—including lost wages—of an average UT System four-year education, the study estimated that the annual rate of return on an average system bachelor's degree was approximately 14.5 percent. Finally, using an approach suggested by Gary Becker and Edward Denison,[8] the UT analysis suggests that because of "advances in knowledge" caused by university research, the total social return to the Texas economy from a college education and associated research is closer to 20 to 25 percent.[9]

University of Houston Study

Unlike the UT System study, Resource Economics concentrated on analyzing only the long-term economic return instead of shorter-term multiplier effects in its study of the University of Houston (UH). On the other hand, the UH System looked at a much wider range of graduates than UT.

Following an approach similar to the BBR, Resource Economics found that the rate of return from a BA/BS degree at the University of Houston was 16.2 percent. For higher-level degrees, the annual rate of return ranged from 10.5 percent for a PhD, to 14.1 percent for a master's and to 17 percent for a professional degree, such as law and optometry. Then, by discounting future earnings by 5 percent and reducing this total by current direct and indirect college costs (including foregone earnings), Resource Economics found that the net present value of a UH bachelor's, master's, doctoral and professional degrees was $205,000; $266,000; $341,000; and $341,000 respectively. Finally, based on these net present values and UH's 5,100 average annual number of graduates,[10] Resource Economics calculated that in 1998, the system contributed about $1.3 billion in annual income to the Texas economy.

Community College Study

Under contract with the Texas Association of Community Colleges, CC Benefits found that overall community colleges have a $13.5 billion economic impact on the state, directly and indirectly supporting a total of 351,530 jobs.[11] Although impressive, these results are not directly comparable to the estimate of the statewide economic benefits of the public higher education system presented in this report for two reasons.

First, in computing its $1.9 billion in direct and indirect benefits of college operations, CC Benefits uses essentially all the $1.2 billion in community college faculty and staff earnings. These state and locally funded earnings, however, would probably have been spent on other in-state purposes, Chapter II of this report follows the example established by other regional studies and uses only the relatively small share of faculty and higher education funding financed from federal and other out-of-state sources to compute multiplier-based statewide economic impacts.

Second, rather that focusing on one year of students or graduates, as in Chapter III and IV of this report, CC Benefits accumulates economic returns from 30 years of former community college students currently working within the state. Overall, CC Benefits compute that 167.1 million credit-hours of past community college instruction "embodied" in the work force directly account for $5.3 billion, or just more than 1 percent of total statewide earnings. CC Benefits then goes a step further to applying additional multiplier impacts to compute a total statewide economic impact (from these $5.3 billion in community college-attributed earnings) of $11.6 billion. As noted above, however, this sort of multiplier analysis may be inappropriate here because, except for a few export-based industries, most of the Texas economy is driven largely by in-state dollars.

Statewide Studies

The Texas Faculty's Association report, *The Economic Value of Higher Education in Texas* was written apparently in response to reductions in the higher education budget under consideration during the 1991 legislative session. In this environment, the study pointed out that based on the average 12 percent national-level rate of return, the $2.7 billion invested by the state in fiscal 1991 in higher education would pay for itself in economic output by 1997.

In 1997, another similarly-titled statewide study, *Economic Returns from Higher Education in Texas* by Texas Perspectives for the Texas Guaranteed Student Loan Corporation, concentrated once again on the returns from just a bachelor's degree. Based on the earnings differential between a college and high school degree, an annual direct education cost of $10,000 per year (for four years), foregone earnings while attending college, and a discount rate of 6 percent, Texas Perspectives estimates the net present value of a bachelor's degree to be $208,000. Moreover, although it is not presented, the baccalaureate rate of return, under these assumptions would be just over 12 percent.[12]

Implications of Previous Research

By focusing on a particular institution or type of economic impact, none of these studies present a complete picture of the impact of the higher education system on the Texas economy. The University of Texas and University of Houston studies offer the most comprehensive economic impacts, but focus on those two institutions alone.

Furthermore, by generally ignoring the fact that not all of the earnings gained from a higher educational degree are gained from the education itself rather than the innate abilities of the student, all of these studies probably overstate the economic return from a higher education degree. Most of these studies also assume that all college attendees work after graduation—an assumption that is not supported by the data.[13] Given the scope and limitations of previous work, a more comprehensive and realistic study of the impact of the state higher education system on the Texas economy is clearly needed. ★

II. Economy Impact of Out-of-State Expenditures

Regional economists have long used input-output analysis to estimate the impact of expenditures from outside sources on the regional economy.[14] Here, we use Type II final demand multipliers from the Comptroller's 1986 input-output study to determine the business and household spending generated by out-of-state higher educational students and federal expenditures.[15]

Our analysis indicates that in fiscal 2003, an estimated $1.1 billion in expenditures by out-of-state and international students at community and technical colleges, public universities, and health-related institutions supported a total of $3.4 billion in economic activity across the state. During the same year, about $1.6 billion in federal and privately supported research added another $5.4 billion annually to the state economy. Finally, $375 million in out-of-state and international expenditures at the University of Texas' MD Anderson Cancer Center contributed another $1.3 billion to the Texas economy in fiscal 2003. Altogether, the $3.1 billion in out-of-state student and higher education-related research and health care expenditures produced a total of $10.1 billion in economic activity in Texas each year.

Almost half, or $535 million, of the estimated $1.1 billion in out-of-state and international student higher education-related expenditures are for tuition and fees.

Out-Of-State Student Expenditures

In this analysis, direct out-of-state student expenditures were estimated first by calculating per-capita expenditures by institution and program for five purposes: 1) tuition and fees, 2) books and supplies, 3) room and board, 4) transportation and 5) personal expenses. These per-capita expenditures were then multiplied by the number of full-time equivalent students at each institution to determine average per-capita expenses, by category, for community college, bachelor's, master's, doctoral and professional (primarily law and medicine) programs. The resulting estimated average per-capita expenditure, in each category, was then multiplied by the number of out-of-state and international students in the program in 2003 to determine total out-of-state expenditures (see Table 2.1).

Probably the most difficult data to obtain for this portion of the study was out-of-state tuition and fees by institution and program. Unfortunately, there is no central source for this information. Since the Texas Higher Education Coordinating Board gathers only information on in-state and out-of-state, community college and undergraduate costs, information on out-of-state graduate and professional tuition and fees was collected directly from the individual institution's Web site.

Almost half, or $535 million, of the estimated $1.1 billion in out-of-state and international student higher education-related expenditures are for tuition and fees. The bulk of the remaining expenses are for room and board. Multiplying these out-of-state tuition and fees, room and board and other expenditures by the appropriate multiplier yields a total economic impact on the state of about $3.4 billion.

Research and Related Expenditures

The Texas Higher Education Coordinating Board reports that Texas higher education institutions spent $2.2 billion on research and related expenditures in fiscal 2003. Well over half the total, or $1.2 billion in funding, was supported by the federal government. Other major sources of research-related funding included state government ($448 million), private corporations ($377 million) and locally generated institutional funding ($147 million). See Table 2.2.

By far, the greatest beneficiary of higher education research-related expenditures is medical sciences. In fiscal 2003, higher education spent a total of $602 million on researching the cause, prevention and treatment of a wide range of diseases including cancer, heart and vascular diseases and diabetes (see Table 2.3). Other major expenditures during the year included research on biological and other life sciences ($372 million) and engineering ($200 million).

State and most institutional research-related funding is obtained from in-state sources.[16] Only the remaining $1.6 billion in federal and mainly out-of-state privately funded research-related expenditures can have a ripple effect on the state economy. Multiplying these direct out-of-state expenditures by the state research and development multiplier of 3.32 generated an estimated $5.4 billion annual economic impact in the state in 2003.[17]

TABLE 2.1

Economic Multiplier Impacts of Out-of-State Higher Education Student Expenditures, Fiscal 2003

	Number of Students(1)				Average Expenses per Student				
	Total	Int'l & Out-of-State		Tuition/	Books/	Room/	Transpor-		Total
Institution	FTEs	Percent	Number	Fees	Supplies	Board	tation	Personal	Expenses
Community & Technical Colleges	300,797	5.9%	17,747	$3,057	$894	$5,026	$1,328	$1,527	$11,832
Public Universities									
Bachelor's Programs	323,237	10.6%	34,263	$11,292	$860	$6,259	$1,418	$1,785	$21,614
Master's Programs	51,126	10.6%	5,419	$12,033	$806	$6,259	$1,418	$1,785	$22,301
Doctoral Programs	14,078	10.6%	1,492	$9,272	$839	$6,259	$1,418	$1,785	$19,573
Professional Programs	7,191	10.6%	762	$15,489	$1,160	$6,259	$1,418	$1,785	$26,111
Total University Programs	395,632	10.6%	41,937	$11,392	$858	$6,259	$1,418	$1,785	$21,712
Health-Related Instutions									
Bachelor's Programs	2,684	9.5%	255	$10,653	$847	$6,917	$1,308	$1,992	$21,717
Master's Programs	3,145	9.5%	299	$10,274	$788	$6,917	$1,308	$1,992	$21,279
Doctoral Programs	1,895	9.5%	180	$6,394	$987	$6,917	$1,308	$1,992	$17,598
Professional Programs	6,071	9.5%	577	$21,304	$1,609	$6,917	$1,308	$1,992	$33,130
Total Health-Related Programs	13,795	9.5%	1,311	$14,669	$1,188	$6,917	$1,308	$1,992	$26,074
Institution				**Total Student Expenditures (Millions of $)**					
Community & Technical Colleges				$54	$16	$89	$24	$27	$210
Public Universities				$462	$36	$262	$59	$75	$895
Health-Related Institutions				$19	$2	$9	$2	$3	$34
Total Higher Education				$535	$53	$361	$85	$105	$1,139
Economic Multipliers				2.93	3.00	3.17	2.63	3.00	2.99
Institution				**Total Economic Impact (Millions of $)**					
Community & Technical Colleges				$159	$48	$283	$62	$81	$633
Public Universities				$1,354	$108	$832	$156	$225	$2,675
Health-Related Institutions				$56	$5	$29	$5	$8	$102
Total Higher Education				$1,569	$160	$1,144	$223	$314	$3,409

(1) Because FTE estimates were not available, headcount used for public health institutions.

Sources: Carole Keeton Strayhorn, Texas Comptroller of Public Accounts and Texas Higher Education Coordinating Board.

Health Care

In addition to educating the bulk of the state's doctors, dentists, nurses and other health-related professionals, the state's nine public health-related institutions provide valuable health care services to their communities, the state and the rest of the world. In fiscal 2003, state teaching hospitals and related physician services provided a total of $5.2 billion in health care services to their patients. Just over two-thirds of these services were provided at the University of Texas' two largest medical centers. During the year, the hospitals and physician services at the University of Texas' Medical Branch in Galveston provided $1.4 billion in health care services, while UT's MD Anderson Cancer Center provided $2.2 billion in medical care (see Table 2.4).

TABLE 2.2
Economic Impact of Texas Higher Education Research & Related Expenditures, Fiscal 2001-2003
(Amounts in Million $)

Fiscal Year	Total Expenditures	Source of Funding: Federal	State	Institution	Private	Federal/ Private	Economic Multiplier	Economic Impact
2001	$1,810	$991	$357	$129	$333	$1,324	3.32	$4,396
2002	$2,087	$1,153	$426	$145	$363	$1,516	3.32	$5,033
2003	$2,210	$1,238	$448	$147	$377	$1,615	3.32	$5,362

Sources: Carole Keeton Strayhorn, Texas Comptroller of Public Accounts and Texas Higher Education Coordinating Board, Research Expenditures, Annual Updates.

Although all of these public health-related institutions provide a vital service to Texans, MD Anderson Cancer Center in Houston is the only one that provides a significant amount of care to patients from other states and nations.[18] According to the University of Texas Office of Health Affairs, about 40 percent of MD Anderson's patients come from outside Texas.[19] Applying this percentage to the difference between $1.7 billion in teaching hospital revenues and the $737 million in nonreimbursed charity care, bad debt, and other deductions and allowances indicates that approximately $375 million in the net cash revenues received by the hospital during fiscal 2003 was from out-of-state patients.[20] Multiplying these out-of-state expenditures by the Texas health care multiplier of 3.51 indicates that MD Anderson has a total direct and indirect economic impact of about $1.3 billion on the Texas economy.

TABLE 2.3
Sources and Expenditures of Higher Education Research-Related Funding, Fiscal 2003
(Amounts in Million $)

Research Field	Federal	Source of Funding: State	Institution	Private	Total	Percent of Expenditures	Federal/ Private	Percent of Expenditures
Medical Sciences	$440	$84	$28	$162	$714	32.3%	$602	37.3%
Biological & Life Sciences	$284	$97	$34	$88	$503	22.8%	$372	23.0%
Engineering	$155	$97	$21	$45	$318	14.4%	$200	12.4%
Environmental Sciences	$93	$23	$5	$12	$134	6.0%	$105	6.5%
Physical Sciences	$86	$28	$8	$22	$145	6.5%	$109	6.7%
Agricultural Sciences	$27	$31	$10	$13	$82	3.7%	$40	2.5%
Computer & Math Sciences	$62	$24	$5	$6	$96	4.4%	$68	4.2%
Business & Social Sciences	$19	$21	$6	$11	$56	2.5%	$30	1.8%
Other Research & Development	$55	$30	$24	$17	$126	5.7%	$72	4.5%
Other Sponsored Activities	$17	$13	$5	$1	$36	1.6%	$17	1.1%
Total Research-Related	$1,238	$448	$147	$377	$2,210	100.0%	$1,615	100.0%

Sources: Carole Keeton Strayhorn, Texas Comptroller of Public Accounts and Texas Higher Education Coordinating Board, Research Expenditures, April 2004.

TABLE 2.4
Gross Patient Revenues of Texas Public Health-Related Institutional Hospitals and Physician Practice Plans, Fiscal 2003
(Amounts in Million $)

Health-Related Institution	Teaching Hospital Revenues (1)	Physician Services Revenues	Total Gross Patient Revenues
UT Medical Branch-Galveston	$1,050	$317	$1,367
UT MD Anderson Cancer Center	$1,675	$521	$2,196
UT Southwestern Medical Center-Dallas	—	$664	$664
UT Health Science Center-Houston (2)	$38	$316	$354
UT Health Center-Tyler	$138	$36	$174
UT Health Science Center-San Antonio	—	$201	$201
Texas Tech Health Science Center	—	$219	$219
University of North Texas HSC-Fort Worth	—	$51	$51
Texas A&M Health Science Center (3)	—	$10	$10
Total Patient Revenues	**$2,901**	**$2,335**	**$5,236**

(1) Includes both in-patient and out-patient services.
(2) Teaching hospital revenues are for the Harris County Psychiatric Center.
(3) Baylor College of Dentistry clinic revenues.
Sources: Carole Keeton Strayhorn, Texas Comptroller of Public Accounts, University of Texas System and Public Health-Related Institutions.

Higher Education Success Stories

The Texas higher education system does more than produce tomorrow's teachers, entrepreneurs, doctors, lawyers, and other leading citizens, it often joins the private sector to create jobs and improve the quality of life for all Texans. Here are some typical success stories:

University of Texas Health Science Center—San Antonio (UTHSC-SA)

Millions of patients worldwide are treated for clogged arteries every year, but now, with the help of new technology developed at UTHSC-SA, many patients can be helped without expensive and invasive open-heart surgery.

In 1978, Dr. Julio C. Palmaz, MD—a world-renowned inventor and radiologist at UTHSC-SA—conceived the original idea for a stent, a tiny tube made from woven, surgical-grade stainless steel, to restore blood flow to blocked arteries. He teamed up with restaurateur Phil Romano, known for creating Macaroni Grill and Fuddruckers, who put $250,000 into the project. The Palmaz Balloon-Expandable Stent is mounted on an angioplasty catheter and introduced through a thin-walled sheath into the cardiac and iliac arteries to prevent closure. According to some estimates, the new procedure has not only saved millions of lives, but perhaps billions of dollars in costs for the more invasive surgery. Dr. Palmaz's stent eventually paid millions to Mr. Romano, Dr. Palmaz, and UTHSC-SA after Johnson & Johnson's Cordis unit licensed the technology.

In the late 1990s, Dr. Palmaz joined with Christopher E. Banas, a former medical device industry executive and Dr. Steven Bailey, a nationally known cardiologist and professor at UTHSC-SA to form Advanced Bio Prosthetic Surfaces, Ltd. (ABPS). ABPS researchers went on to develop the "covered stent," a longer-lasting, more efficient, super-thin improvement over previous designs. ABPS licensed the technology from UTHSC-SA, which receives a 6 percent share of the licensed income stream. UTHSC-SA earned $12.6 million from the original stent, and it expects to earn millions more from the latest invention.[21]

Alamo Community College District (ACCD)

The Workforce Development Office at ACCD, located at the former Kelly Air Force Base, works with area businesses to access and meet local workforce development needs through continual education and training. ACCD's business partnership includes 17 Bexar County school districts, aerospace industry employers, and the Greater Kelly Development Authority.

Aerospace repair is one of San Antonio's largest industries, but it is struggling to find a sufficient flow of highly skilled workers. *The Alamo Area Aerospace Academy* (AAAA) began in August 2001 as a product of the Mayor's Better Job Initiative. High school students enter the program in their junior year and receive technical training in airframe and power plant mechanics from ACCD instructors. A paid summer internship with an industry partner is included between the junior and senior year. Through the dual credit program, each student receives up to 30 college semester hours and six high school credits for the two year program. Upon graduation, students are prepared for jobs in aerospace repair and are given the option of completing their technical training toward a Federal Aviation Administration license. Students also may choose to continue their college education. The program produced its first graduates in May 2002.

The *Information Technology and Security Academy* (ITSA) is a project shared among ACCD, the San Antonio Technology Accelerator Initiative, the Center for Infrastructure Assurance and Security at the University of Texas-San Antonio, the City of San Antonio, local industry partners, and the 18 school districts in and around Bexar County. Students enter the program in their junior year and enroll in courses to prepare for careers in computer programming, web development, and information security. As with participants in the AAAA, students participate in a dual credit program and intern the summer between the junior and senior year. Those who do well may pursue a four-year degree with the University of Texas-San Antonio. Approximately 80 juniors were part of the founding class that began in August 2002.

In anticipation of increased demand for manufacturing and related workers, ACCD began a new *Manufacturing Technology Academy* (MTA) in fall of 2004. The MTA is a collaborative effort between ACCD, the City of San Antonio, the AlamoWorkSource Board, and the San Antonio Manufacturers Association. Offering a new curriculum designed to meet the needs for a "multi-skilled" 21st century manufacturing workforce, the MTA pilot began with 24 students and is expected to increase enrollment once Toyota and the manufacturing sector increase their demands for skilled workers.

ACCD's Workforce Development Office was a major player in drawing the new $800 million Toyota truck plant to San Antonio, which is expected to create 2,000 local jobs. For the future, ACCD expects to play a vital role in ensuring that Toyota has a qualified workforce pool. In Spring 2005, Toyota will use ACCD facilities to assess job applicants: up to 150,000 applicants are anticipated to participate in Day 1 Assessments at ACCD's four colleges.[22]

Austin Community College (ACC)

In 1999, ACC, the Greater Austin Chamber of Commerce, the Capital Area Training Foundation, the City of Austin, Travis County, and the Capital and Rural Capital Area Workforce Development boards initiated the first Austin@Work summit to convene public and private leaders to design and implement plans to better educate, train, and retain employees in central Texas.

Building on this effort, *Greater Austin@Work* connects regional employers and educators in industry-led workforce clusters and develops education and workforce collaboration. More than 350 employers, 12 school districts, 24 post-secondary institutions, 30 community and nonprofit partners, and 11 industry clusters now participate. As a result of its increased understanding of business community needs, ACC initiated two new programs in 2001. These programs, Environmental Technology and E-Commerce, are two-year programs designed to produce qualified people for fields with high demands.

Additionally, ACC has worked closely with the Capital Area Workforce Development Board (Austin Work-Source) and the Rural Capital Workforce Development Board to have its programs certified through the Training Provider Certification System. To become certified, a program must provide instruction in an occupation in demand in the Austin area and that provides participants with a livable wage.

The ACC *Center for Community-Based and Nonprofit Organizations* assists community-based and nonprofit organizations to become more effective by strengthening their staff, volunteers, and organizational capacity. Through partnerships with community-based organizations, nonprofits, and private businesses, the center provides workshops, publications, and other learning opportunities. As a community partnership, it facilitates connections between profit and nonprofit sectors, promoting greater use of business and educational assets to strengthen nonprofits' ability to achieve their goals.

The center's Web site (http://www2.Austin.cc.tx.us/npo) includes publications that can be downloaded; an online discussion forum; nonprofit job postings in the central Texas area; resource libraries; a comprehensive database of nonprofit organizations; and an online journal, "Strategic Creativity." The center also maintains a database of e-mail subscribers and sends weekly announcements to subscribers regarding current activities. In June 2002, the center collaborated with the Austin Community Action Network to provide a clearinghouse for grant opportunities for the nonprofit community.

Since its inception, the center has provided more than 150 workshops and learning opportunities, such as community networking luncheons, and it has served more than 1,500 participants from 450 community-based and nonprofit organizations.[23]

Houston Community College System (HCCS)

The Houston Community College System has been working closely with the area's *Health Services Steering Committee* for almost two years in an effort to alleviate the area's nursing shortage by expanding enrollment in HCCS's nurse education program. The steering committee consists of the Greater Houston Partnership; the Gulf Coast Workforce Board; and various hospitals, universities, and healthcare-related organizations in the Houston area.

HCCS's nursing program maintains one of the largest nursing associate degree programs in the Houston region. Even though it is one of the largest in the Houston area, HCCS associate's degree nursing program is understaffed and under-funded. As part of its effort, the steering committee approached area hospitals to recruit nurses to teach at HCCS; and in the fall of 2001, HCCS received two nurse faculty members. In addition, the steering committee provided a $47,920 grant to be used in 2002-03 for hiring bonuses for four new nurse faculty positions, which were subsequently filled.[24]

Texas A&M University

Gerard Coté, a biomedical engineering professor in the Dwight Look College of Engineering at Texas A&M University, is looking for a replacement to the traditional finger-stick monitoring technique people with diabetes need to use every day.

Diabetes is a disease in which the body does not produce or properly use insulin, a hormone necessary to convert sugar, the body's basic fuel, into energy. Sugar (glucose) builds up in the blood instead of going to the cells. People with diabetes must check their blood sugar levels several times a day to help keep their diabetes under control. One of the experimental systems Dr. Coté is testing involves *fluorescent polymer microbeads* that could be implanted just under a patient's skin. Glucose levels affect how much light the beads emit, which could be measured with a wristwatch-like monitor. The research is funded by grants from the State of Texas Advanced Research Program and the National Science Foundation and is administered through the Texas Engineering Experiment Station. Human testing could start within five years.

Dr. John Quarles and Nancy Arden from the Texas A&M Medical School have worked for the last year and a half with DelSite Biotechnologies, Inc., and colleagues in the university's College of Veterinary Medicine to develop a *nasal powder influenza vaccine*. DelSite, headquartered in Irving, recently announced the company has been awarded a $6 million grant from the National Institute of Allergy and Infectious Diseases to continue preclinical work.

DelSite has developed a vaccine delivery system called GelVac™, a powder based on an extract of aloe vera that will be combined with inactivated vaccine antigens. Administered as a nose spray, the powder creates a thin film of gel over the mucous membranes, allowing the vaccine to be taken up more slowly by the body. This slower uptake of antigens from the mucous membranes is expected to produce a better immune response than that of the currently licensed inactivated influenza vaccine, which is injected into the muscle.

Dr. Max D. Summers, a distinguished professor in the university's Department of Entomology and holder of the Chair of Agricultural Biotechnology pioneered the *Baculovirus ExpressionVector System* (BEVS) for the safe, abundant and rapid production of recombinant proteins in insects and insect cells. This system was developed from basic studies of insect pathogenic viruses for pest control of medically and agriculturally important insects. BEVS is a discovery with very broad enabling applications and impact spanning the basic life sciences and biotechnology.

BEVS represents a core technology that has greatly facilitated the understanding of many proteins from species that span the life sciences. These studies have broad applications and impact in basic research and practical medical applications for both humans and animals. One example of the application and efficiency of BEVS was the rapid development of an experimental vaccine to the deadly Hong Kong "bird-flu" virus. Another was the rapid development of a Severe Acute Respiratory Syndrome (SARS) vaccine.

BEVS has been licensed non-exclusively to more than 99 companies in various countries around the world for research and commercial purposes. In addition, thousands of laboratories currently use the BEVS technology in their research programs, making it a significant research tool and powerful production platform.[25]

Texas A&M University-Texarkana (TAMU-T)

Texas A&M at Texarkana is an upper-level institution that serves junior, senior, and graduate students in northeast Texas. Situated near the Arkansas border, the school draws from a pool of residents who are statistically older, less inclined to move, more likely to be unemployed, and poorer than average. Although graduates of local public schools are generally well prepared for college, college participation is disproportionately low.

Local business and civic leaders were interested in recruiting high tech industries and other types of business and people to the area, which in turn would drive regional economic growth. They also recognized that major expansion was possible as new highways into the area were being constructed. They also understood, however, that without a skilled workforce, attracting new businesses would be difficult.

Understanding the need for economic development, the mayor appointed city leaders to study higher education needs in June 2000. In 2003, civic leaders participated in a series of meetings with the Texas A&M University System officials, legislators, and state officials. In June 2003, the Legislature authorized TAMU-T to become a four-year institution.

In 2004 the Texarkana City Council authorized the donation of 300 acres for the new campus; and Truman and Anita Arnold donated an additional 75 acres in adjacent land. As part of its donation, the city agreed to provide access to and through the campus from two main traffic arteries. Collectively, the donations are valued at $26.5 million.

To date, community pledges to the new College of Engineering and Information Sciences total $4.65 million. Ross Perot funded the first faculty chair; and Truman and Anita Arnold funded a second chair. Plans are underway to develop a Department of Electrical Engineering and a Department of Mechanical Engineering.

During the current session, S.B. 462 by Eltife would authorize the Texas A&M System to issue up to $65 million in revenue bonds in order to acquire, construct or improve property, buildings and other facilities at TAMU-T. If approved, construction could begin in 2005 and the first freshman and sophomore students could be admitted to the four-year campus by Fall 2008.[26]

Texas' Advanced Research/Advanced Technology Programs (ARP/ATP)

To stimulate economic recovery and promote economic diversity, the 70th Legislature created the *Advanced Research Program* (ARP) and the *Advanced Technology Program* (ATP) in 1987. In so doing, the state hoped to kindle a continuum of scientific research and technology development that would contribute to improving the state's economy. A total of $60 million was appropriated for the programs for the 1987-88 biennium; and approximately the same amounts were budgeted during each of the subsequent biennia, until 2004-05, when funding dropped to $19.5 million.

Since their inception, ARP/ATP research projects have involved 22,000 graduate and undergraduate students and nearly 6,000 faculty. The $1.4 billion state investment generated additional external funding of more than $1.4 billion, with a cumulative economic impact of over $6.6 billion. A total of 20,000 papers and technical reports have been written to transfer the knowledge gained. And, results from the projects funded through ARP/ATP continue to emerge for years after the grant periods end.[27]

University of Texas Health Science Center at Tyler (UTHC-T)

The University of Texas Health Science Center at Tyler is located in one of the most medically underserved areas of the state. Within the institution's 29-county catchment area, Gregg County is the only county that the state considers to be adequately served by medical facilities. Four counties (Bowie, Kaufman, Smith, and Titus) have significant populations that are underserved; and all of the remaining counties are classified as medically underserved. Since 1985, UTHC-T has been working to end this problem, graduating 99 residents from its *Family Medicine Residency Program*. Of those, 50 physicians are now practicing within UTHC-T's catchment area. Another 32 are practicing within the state of Texas.

UTHC-T health-care professionals are training first responders—physicians, nurses, emergency medical service personnel, and public health workers—how to cope with potential bioterrorism events. Since December 2003, more than 2,000 East Texas residents have attended these training sessions. The UTHC-T presentation covers topics such as natural disasters, traumatic and explosive events, nuclear and radiological events, biological events, chemical events, public health implications of disasters, and psychosocial aspects of disasters.

In a related effort, a new partnership with the Texas Department of State Health Services makes UTHC-T a vital part of the fight against emerging infectious diseases and bioterrorism. The *Public Health Laboratory of East Texas* (PHLET) opened in June 2004. UTHC-T is the only academic center in the United States to have one of these diagnostic public health labs on its campus. Renovation of the lab was funded by a grant from the U.S. Centers for Disease Control and Prevention. In the event of a potentially threatening disease or suspected bioterrorism agent, samples will be sent to PHLET for quick identification. Before PHLET, such samples had to be sent to state labs in Austin to be identified, which often took weeks—a delay that could prove catastrophic in the case of a rapidly spreading infectious disease or bioterrorism agent. As part of its mission, PHLET staff will help educate personnel in microbiology labs throughout the region, thereby improving the public health and safety not just of East Texans, but, by extension, all Texans.[28]

Texas Next Step

"I would rather spend $2,500 a year educating a young Texan than $16,000 a year incarcerating that young Texan," said Texas Comptroller Carole Keeton Strayhorn.

Comptroller Strayhorn's proposed *TexasNextStep* program could create even more higher education success stories by further extending higher education opportunities to high school graduates. *TexasNextStep* would allow all Texas high school graduates to attend college for up to three years or 90 semester credit hours at public community colleges, technical colleges or other two-year institutions.

"I would rather spend $2,500 a year educating a young Texan than $16,000 a year incarcerating that young Texan," said Texas Comptroller Carole Keeton Strayhorn.

The program would provide tuition, required fees, and $30 per semester credit hour for textbooks for a student who enrolls within 16 months of high school graduation. *TexasNextStep* would make K-14 education the norm and would set Texas apart in the race for future jobs. It would address two of the greatest challenges facing Texas higher education in the 21st Century: rapid student population growth in areas of the state where there are relatively few public four-year institutions and the ever-increasing cost of college attendance.

To enroll in *TexasNextStep*, high school graduates would apply to the public community or technical college or other public two-year institution of their choice. Students would complete and submit the Free Application for Federal Student Aid form. Any federal or state-authorized grant or scholarship for which the student was eligible to receive would be applied to the cost of tuition and fees. *TexasNextStep* would pay any remaining amount plus the cost of textbooks. Entering freshmen would develop individual educational plans that identified the type of degree or certificate (academic or technical) and the courses required to achieve that degree, including any required developmental (remedial) courses.

With *TexasNextStep*, Texas public universities would further raise the skill level of the Texas workforce, thus adding even more to state economic productivity, income and output. After completing a two-year degree, Texas students could enter a four-year higher education institution using a variety of federal and state financial aid programs. With *TexasNextStep*, universities and health-related institutions would receive transfer students who had proved their ability to succeed in college. National studies demonstrate that students who received an associate degree at a community or technical college and then transferred to a four-year institution were more likely to graduate than students who directly entered as freshmen.

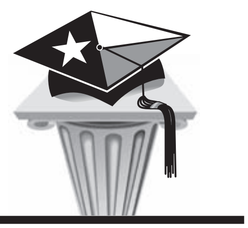
"I want Texas to have the most educated workforce in the nation," Comptroller Strayhorn said. "I will continue to fight for legislative approval until *TexasNextStep* is adopted and K-through-14 education is the norm in Texas. ★

III. Impact on Higher Earnings

The traditional approach used to measure the economic impact of higher education is by examining the earnings of its students. Our analysis indicates that the Texas higher education system increases the discounted present value of the earnings of its attendees and graduates by an estimated $15 billion. Of this total, just more than half, or $8.1 billion, in additional earnings is contributed by those who earn bachelor's degrees. The bulk of the additional gain is attributed to those who earn associate and professional degrees, along with those who attend college, but do not graduate.

Theoretical Considerations

Beginning with the work of Jacob Mincer and Theodore Schultz, economists long have investigated the relationship between a person's stock of educational knowledge, or "human capital," and future earnings capability.[29] Much like a business contemplating purchasing a particular piece of equipment, a rational individual compares the future earnings gained from a particular educational "investment" relative to its costs, then picks an educational program that maximizes the return on that investment. This return then can be compared to other non-educational long-term investments, such as the stock market, to see if the educational investment is a worthwhile pursuit.



Indirect expenses, such as foregone earnings, are another important consideration in calculating the costs of attending school.

Another way to measure the return from a particular educational investment is to compute the rate that equates the discounted gains in future earnings to the current direct and indirect costs of attending school. In calculating this "internal rate of return," however, only earnings realized from the additional educational knowledge may be included and not earnings that a person would have gained anyway because of higher intelligence, ability, and/or socioeconomic status.

Selectivity bias—where more intelligent and/or talented students generally undertake higher educational coursework—complicates this issue and makes it very difficult to separate the earnings gains attributable to only higher education. According to educational experts, roughly 79 percent of the earnings differential between baccalaureate and high school graduates is due to knowledge gained in college alone. This "alpha factor" increases with the level of education, reaching approximately 90 percent at the graduate level.[30]

Indirect expenses, such as foregone earnings, are another important consideration in calculating the costs of attending school. Lost earnings while attending college, averaging approximately $28,500 per year for high school graduates are, by far, the most significant cost of pursuing a higher education degree.

Finally, for students who live away from home while attending school, careful considerations much be given to whether other expenses, such as room and board, should be included as a college-related expense. These costs are probably relevant for an undergraduate attending college outside of reasonable commuting distance from their parent's home. For most students, however, including undergraduate commuters and graduate/professional students, who would have been incurring these expenses anyway, the cost should not be included.

Data Considerations

In preparing these estimates, two data considerations are also important. First, because of its relatively small sample size, the U.S. Bureau of the Census *Current Population Survey* national, rather then state-level earnings data was used to compute the rate of return (and present values) used in this study. Our implicit assumption, however, that Texas and U.S. earnings differentials are similar is not far off the mark. Table 3.1 shows that from 1994 through 2003, the earnings gain of Texas college graduates versus high school graduates has averaged only slightly more than the same differential nationally. Given the relatively small size of the CPS sample in Texas (averaging 10,278 persons out of an estimated state population of 21.5 million during 2002-2004), this difference is probably not significant.

Second, it was assumed that students at all levels of study, except the bachelor's degree, would not incur additional room and board, transportation and personal expenses because they would have been commuters or living away from home anyway. Based on data for public universities, the Comptroller's office was

TABLE 3.1
Texas and U.S. Earnings from Bachelor's or Greater Compared to High School Degrees, 1994-2003
(Real 2003 $)

Mean Earnings								
	Texas			United States			Texas Versus U.S. Gain	
	HS	BA+	Gain	HS	BA+	Gain	Ratio (%)	3-Yr Avg
1994	$25,126	$48,662	$23,537	$27,108	$55,803	$28,696	82.0%	84.9%
1995	$25,372	$54,219	$28,847	$27,851	$54,116	$26,265	109.8%	91.6%
1996	$28,307	$55,957	$27,651	$28,090	$54,964	$26,874	102.9%	98.2%
1997	$27,448	$58,706	$31,258	$28,325	$56,180	$27,855	112.2%	108.3%
1998	$27,253	$61,941	$34,688	$28,511	$58,097	$29,585	117.2%	110.8%
1999	$26,681	$59,205	$32,524	$29,303	$60,134	$30,832	105.5%	111.6%
2000	$28,510	$65,227	$36,717	$29,513	$62,308	$32,795	112.0%	111.6%
2001	$29,829	$65,101	$35,272	$29,946	$61,877	$31,931	110.5%	109.3%
2002	$28,841	$66,512	$37,671	$29,859	$61,412	$31,553	119.4%	113.9%
2003	$28,663	$62,276	$33,613	$30,083	$60,939	$30,856	108.9%	112.9%
Average	**$27,603**	**$59,781**	**$32,178**	**$28,859**	**$58,583**	**$29,724**	**108.0%**	**105.3%**

Sources: Carole Keeton Strayhorn, Comptroller of Public Accounts and U.S. Bureau of the Census, Current Population Survey.

able to compute that just over 40 percent of students pursuing baccalaureate degrees attended high school in the same metropolitan area as the college or university they attend.[31] Thus, in the calculations presented in this chapter, it was assumed that 60 percent of baccalaureate students would incur room and board, transportation and personal expenses while attending college and 40 percent would not.

The Return from Texas Higher Education

Based on the alpha factors discussed above, the Census Bureau's national-level mean earnings data and the tuition, fee and other educational costs supplied by the Texas Higher Education Coordinating Board,[32] the combined male/female rate of return from earning a bachelor's degree from a Texas higher education institution is estimated to be approximately 11.7 percent (see Table 3.3). This estimate falls roughly in the range of the 10 percent to 14 percent return on a baccalaureate degree found in similar studies across the country.[33]

Also, probably because of diminishing returns to higher levels of study, the rate of return falls from nearly 15 percent for Texans who attend some college to just under 11 percent for those who earn a master's degree. But counter to other studies, our calculated returns do not continue to drop at higher levels of post-baccalaureate study.[34] The return was found to climb to 13 percent at the doctoral level and then to almost 18 percent for lawyers, medical doctors and other professionals (see Table 3.3).

Finally, in all cases the return for education equals, or in most cases greatly exceeds, the 10 percent long-term return generally expected from a diversified stock market investment.[35] Thus, in Texas, pursuing higher educational study generally appears to be a good long-term investment. In this analysis, students are assumed to reap the benefits of their educational investment over a working lifetime of 45 years—generally from age 22 years to retirement at 67.

The Present Value of Texas Higher Education

Another way to examine the value of an educational investment is to calculate the present value of future earnings gains and subtract the current (direct and indirect) costs of that investment. Unlike the rate of return approach, however, the interest rate used to discount future earnings in this calculation is determined by external market conditions, rather than internally determined in the calculation.

One major disadvantage with present value, compared to rate of return calculations, is that the magnitude of a discounted present value is generally proportional to the value of the educational investment and, thus,

TABLE 3.2
Estimated Rate of Return from Texas Higher Education Bachelor's Degree

US Mean Earnings Differentials by Sex and Educational Attainment , 1994-2003
(Real 2003 $)
Workers 25 Years and Older
Bachelor's Vs. High School Degree
(Alpha Factor = 0.79)

	Male		Higher Education Gain		Female		Higher Education Gain	
	HS Graduate or Equivalent	Bachelor's Degree	Difference 2003$	Ratio BA/HS	HS Graduate or Equivalent	Bachelor's Degree	Difference 2003$	Ratio BA/HS
1994	$33,984	$59,704	$25,720	1.76	$19,723	$34,307	$14,584	1.74
1995	$34,566	$58,085	$23,520	1.68	$20,548	$33,554	$13,006	1.63
1996	$35,278	$56,583	$21,304	1.60	$20,291	$34,842	$14,551	1.72
1997	$35,303	$59,211	$23,909	1.68	$20,671	$35,616	$14,945	1.72
1998	$34,936	$63,957	$29,021	1.83	$21,503	$36,836	$15,333	1.71
1999	$36,546	$65,715	$29,169	1.80	$21,326	$37,313	$15,987	1.75
2000	$36,333	$69,032	$32,699	1.90	$21,845	$39,189	$17,344	1.79
2001	$36,521	$68,048	$31,527	1.86	$22,599	$39,536	$16,937	1.75
2002	$36,174	$66,812	$30,638	1.85	$22,825	$40,318	$17,494	1.77
2003	$36,121	$65,151	$29,030	1.80	$23,143	$40,201	$17,058	1.74
Average	**$35,576**	**$63,230**	**$27,654**	**1.78**	**$21,447**	**$37,171**	**$15,724**	**1.73**

College Costs

Year	Tuition/Fees	Books/Supplies	Room/Board	Transportation	Personal Exps	Total Expenses
2003-04	$4,356	$859	$6,269	$1,416	$1,788	$14,688

Internal Rate of Return and Present Values

Year	Male All Costs	Lost Earnings & Direct Costs	Weighted Average	Year	Female All Costs	Lost Earnings & Direct Costs	Weighted Average
Freshman	-$50,264	-$40,791		Freshman	-$36,135	-$26,662	
Sophomore	-$50,264	-$40,791		Sophomore	-$36,135	-$26,662	
Junior	-$50,264	-$40,791		Junior	-$36,135	-$26,662	
Senior	-$50,264	-$40,791		Senior	-$36,135	-$26,662	
1	$21,846	$21,846		1	$12,422	$12,422	
2	$22,502	$22,502		2	$12,794	$12,794	
3	$23,177	$23,177		3	$13,178	$13,178	
4	$23,872	$23,872		4	$13,574	$13,574	
5	$24,588	$24,588		5	$13,981	$13,981	
40	$69,188	$69,188		40	$39,340	$39,340	
41	$71,264	$71,264		41	$40,520	$40,520	
42	$73,402	$73,402		42	$41,736	$41,736	
43	$75,604	$75,604		43	$42,988	$42,988	
44	$77,872	$77,872		44	$44,278	$44,278	
45	$80,208	$80,208		45	$45,606	$45,606	
Resident/ Commuter	**59.3%**	**40.7%**		**Resident/ Commuter**	**59.3%**	**40.7%**	
Return	11.89%	13.79%	12.66%	Return	10.02%	12.49%	11.03%
NPV (6%)	$244,174	$276,999	$257,534	NPV (6%)	$112,656	$145,481	$126,016

Sources: Carole Keeton Strayhorn, Texas Comptroller of Public Accounts and U.S. Bureau of the Census, Current Population Survey.

the return from one type of educational investment cannot be directly compared to another. However, discounted present values can be aggregated over a wide class of educational pursuits to determine the total economic contribution of higher education.

Table 3.3 shows that the discounted present value of the most costly educational endeavors, including professional ($680,300) and doctoral ($330,900) degrees, are much greater than those who earn only a one-year community college certificate ($33,600). For the most common bachelor's degrees, the net present value of the earnings gain, less direct and indirect expenses—including foregone income—averages approximately $185,900. Multiplying this earnings gain by: 1) the 89 percent of 59,700 BA and BS graduates from in-state sources and 2) the 81 percent of bachelor's graduates who are currently working,[36] yields a discounted present value to the Texas economy of approximately $8.1 billion. Aggregating these calculations over all levels of study yields a net present value of the Texas higher education system of just over $15 billion. The lion's share, or about $11.7 billion, is gained by undergraduates (community college certificates, some college, associate's and bachelor's degrees), with the remaining $3.3 billion earned by those with more advanced master's, doctoral and professional degrees.

In this calculation, the interest rate used to discount future earnings can have a profound impact on the estimated net value of the educational system. Since higher discount rates place less value on future earnings compared to current educational costs, the higher the discount rate, the lower the net value of the educational system to society. Because education benefits not only the individual, but all members of society, and earnings gains are reaped over a relatively long period of time, the Comptroller's office used the average U.S. 30-year treasury rate of approximately 6 percent for those calculations.[37]

Impact of State Economic Output

Since earnings represent only a portion of the economy, this estimated $15 billion gain from Texas higher education graduates tells only part of the story. There are several theoretical and empirical issues measuring labor's share of the national economy.[38] Figures, however, from the U.S. Bureau of Economic Analysis indicate earnings represent approximately 55 percent of Texas gross state product.[39] Dividing this $15 billion discounted earnings gain by 55 percent indicates that higher education produces a net discounted value of $27.3 billion of higher output annually for the Texas economy. Based on the earnings gains, 78 percent, or $21.3 billion, of the increased output is attributable to graduates with bachelor's and other undergraduate degrees. The remaining $6.0 billion is attributable to students with advanced degrees. ★

TABLE 3.3

Texas Discounted Earnings Gains from Higher-Education Degrees, Fiscal 2003

Higher-Education Degree	Avg Graduates Fiscal 2001-03	In-State Percent	Rate of Return (%)	NPV Earnings Gain/Worker	Employment (Percent)	Total Earnings Gain (Mil of $)
Certificates	16,911	94.1%	11.96%	$33,556	76.9%	$411
Some College(1)	44,948	92.3%	14.87%	$57,030	75.9%	$1,796
Associate's	25,516	94.1%	12.99%	$78,960	75.7%	$1,436
Bachelor's	59,724	89.4%	11.72%	$185,900	81.4%	$8,082
Master's	18,881	89.5%	10.58%	$89,889	81.5%	$1,238
Doctoral	2,284	89.5%	13.10%	$330,916	82.9%	$561
Professional	2,959	89.9%	17.91%	$680,302	82.6%	$1,493
Total-All Degrees	171,223	91.3%	12.76%	$121,947	78.7%	$15,017

(1) Estimated number of students who leave associate and baccalaureate programs without a degree per year.

Source: Carole Keeton Strayhorn, Texas Comptroller of Public Accounts.

IV. Impact on Economic Productivity

One approach to measuring higher education's effects on the state's economy is by calculating the economic gains derived from improved productivity. This relationship directly addresses the crucial question of what higher education does to expand the productive capacity of the economy—quite apart from the dollars injected into the system that generate spending and re-spending through the multiplier effect.

This question may be the most crucial of all because much of the support higher education receives comes from the government. This means that there is no market mechanism to directly assess the value of this spending. The importance of this lack of a market allocation mechanism is best demonstrated by considering the dilemma of government-sponsored ditch digging. Public money spent digging a ditch will most certainly ripple through the economy creating many jobs directly and indirectly. The same can be said of public funds used to fill up the ditch when it is completed. But the telling question is how much the productive capacity of the overall economy increased after paying for this work?

The primary economic impact of higher education is through augmenting the knowledge and skills of the work force.

Productivity and Economic Growth

According to traditional economic growth theory, growth occurs by employing more basic inputs—more labor, capital or land.[40] This approach, however, presents at least some circular logic. If we employ more basic inputs, we produce more output. The more fundamental question is how to get the additional resources to fuel the increased production?

One key to this process is utilizing the existing resources more efficiently. For example, if instead of taking 200 hours to build one car, a change in the assembly procedures enables the car to be built in only 100 hours, then the labor supply effectively has been doubled. Thus, streamlining productivity—getting more done each hour of work—has the effect of increasing the labor supply just as genetically engineering plants to produce more cotton effectively increases the "supply" of land.

Labor can become more productive if:

- there is more physical capital employed per worker (physical capital includes structures and equipment as well as public infrastructure);
- the health or skills of human beings increases—this is known as *human* capital; or
- the stock of accumulated abstract knowledge grows, thereby increasing *knowledge* capital.

The primary economic impact of higher education is through augmenting the skills of the work force, although institutions of higher education also serve as repositories and transmitters of knowledge capital. The chief distinction between human capital and knowledge capital is that human capital cannot be separated from the human who possesses it.[41]

Universities, colleges and other higher education institutions are crucial in improving productivity since they produce two kinds of capital—human capital and knowledge capital—reflecting their dual roles as both educational and research institutions. In practice, it is extremely difficult to measure separately the impacts of these two roles. For example, is it the technological sophistication and research skills of the faculty at a highly respected engineering school that draws industry to the area? Or is the real drawing card the skills and abundance of students at the institution that the industry hopes to employ? Undoubtedly, both matter. In most cases, however, the teaching and research functions of most universities are joint products and attempting to measure the effects of just one of these functions on the local economy likely will result in measuring some of both.

This analysis focuses on the role of Texas institutions of higher education in augmenting the amount of human capital in the economy. That role is particularly crucial for the state economy. If state institutions stopped educating students, the flow of human capital into the economy would diminish almost instantaneously, barring massive out-migration of Texas students to institutions in other states followed by reverse migration back into the state.

The impact of this imaginary shutdown of higher education on the amount of human capital available to the Texas economy contrasts to the longer-term effects it would have on the stock of knowledge or research spin-offs. Clearly, the sum of human knowledge would not evaporate if Texas' higher education institutions ceased operating. But over the long term, the Texas economy would surely suffer.

Labor Productivity Responses to Education

There have been a few studies in the United States attempting to measure the effects of human capital investments on economic output. And many of these stumble with subjective measures of output, making it difficult to generalize their results.[42] Other efforts, such as a study of training investments by Ann Bartel, have been able to measure more objective productivity gains from education and training. But a low, six percent survey response rate makes these estimates questionable.[43]

Recent investigations have employed a more substantial survey base, tying data from the National Center on the Educational Quality of the Workforce to output, sales and other firm-level data from the U.S. Bureau of the Census' *Annual Survey of Manufactures*.[44] This broad database generated responses from 3,358 business establishments, representing a 64 percent survey response rate. From this data, Sandra Black and Lisa Lynch of the National Bureau of Economic Research estimated that a 10 percent increase in the average educational level of workers resulted in a 4.9 percent to 8.5 percent increase in economic output in manufacturing and a 5.9 percent to 12.7 percent productivity improvement in non-manufacturing industries.[45] In this sample, manufacturing workers averaged 12.5 years and non-manufacturing workers averaged 13 years of education.[46]

Productivity in Texas Higher Education

For the purposes of this analysis, the Comptroller's office assumed that the productivity estimate appropriate for Texas higher education lies at the low end of Black and Lynch's calculations. That is, a 10 percent increase in the average education of a worker would result in a 4.9 percent economic gain in manufacturing or a 5.9 percent gain in non-manufacturing. The use of these lower productivity-response relationships is the result of three considerations.

First, the average education of the workers in the sample employed by Black and Lynch is below that of the average Texas higher education student. If Black and Lynch had estimated their models using a sample of just college-educated workers, their measured educational productivity would probably have been somehow lower because of declining marginal returns.[47] Accordingly, we expect a slightly lower impact than that found by Black and Lynch because we are applying it to a more highly educated population.

Second, Black and Lynch were concerned with *what* the productivity effects of increased education were and not *how* these effects were generated. The distinction, reflected in the "alpha factor" discussed in Chapter III, concerns how the effects of additional education are influenced by the institution, as opposed to the inate abilities of the students. In the same way estimates of the wage gains attributable to the institution of higher education must be lowered to reflect the natural abilities of the students.

Finally, in order to produce the most reasonable estimates, it is necessary to err on the conservative side in producing estimates of the effects of higher education on economic output.

Increasing Texas' Human Capital Stock through Higher Education

To translate Black and Lynch's calculations into an estimate of the economic effects of higher education on the Texas economy requires an estimate of the annual contribution of Texas' higher education system to the educational base of the state's employed labor force.

The top portion of Table 4.1 presents the enrollment figures in Texas' public higher educational institutions from fiscal 2001 to 2003. On average, during this period the Texas higher education system generated 671,500 school-years of education. Yet, not all of this added education could be counted on to stay in Texas. To adjust for migration of students, it is assumed that all out-of-state students would return to their place of origin and all in-state students would remain in Texas. Accordingly, it is estimated that the state's higher education system annually pumps 613,700 school-years of education into the Texas population over age 18. Since Texas' relatively strong economy allows it to retain at least some of the out-of-state students currently studying in the state, if anything, this assumption may be overly conservative.

Because Black and Lynch's productivity relationships measure the effects of increasing education on the employed work force, only that educational improvement provided to the employed work force should be considered to affect productivity. According to Texas-specific *Current Population Survey* estimates, approximately 80 percent of the civilian population with at least some college education is employed so the Texas higher education systems injects approximately 490,000 school-years of additional education into the employed workforce each year.

The middle section of Table 4.1 presents the Comptroller's estimated Texas resident population by age group from 2001 to 2003 and the average number of school years attained by these groups. Combining these two data items indicates that the Texas population 18 years and older represents a combined 198 million school-years of education. Adjusting for non-workers indicates that the educational base of the employed workforce in Texas is 128 million school-years of education.[48] As such, the 490,000 school-years of education produced by the state's higher education system results in increasing the educational base of the employed work force by 0.38 percent annually.

Applying this gain to Black and Lynch's productivity estimates indicates that the Texas higher education system increases productivity by 0.19 percent in manufacturing and by 0.22 percent in non-manufacturing each year. These productivity gains applied to Texas manufacturing and non-manufacturing gross state product indicates that higher education adds $1.7 billion to the state's economy through productivity gains or $3,476 per full-time equivalent employed student (bottom of Table 4.1).

This gain, by itself, does not incorporate two important considerations. First, what is the public and private cost to the economy of procuring this gain? And second is the recognition that this gain, like other capital investments, does not represent a one-time phenomena, but generates a lifetime of returns.

To reflect the first consideration, Table 4.2 notes the two main components of the cost of education. First, are the earnings lost while in school, which from 1994 to 2003 averaged $28,500 per year. Table 4.2 also notes the average annual college costs for the 2003 fiscal year of $14,600. These costs include both those paid directly by the student and by state and local governments, based on direct educational all-fund appropriations in the 2002-03 General Appropriation Act and community college tuition, fees and property tax levies.[49]

Together these costs total $43,100 in the first year and more than offset the net productivity gain of almost $3,500 per student. But, since the productivity gains of increased education continue to produce economic gains throughout the student's 45-year working lifetime, these productivity gains produce a stream of income gains throughout the years that rises with inflation (assumed to be 3 percent annually). Discounting this stream of income gains over time at a rate of 6 percent indicates a net present value of almost $39,000 per student for a year of education. Considering the potential Texas work force of 490,000 working students taught by the Texas higher education institutions, this amounts to a total net gain to the Texas economy of $18.9 billion.

Other Considerations

This attempt to measure the impact of Texas' higher education system on the state's economy has considered the effects of higher education on the productivity of the Texas work force. Increased productivity effectively increases the supply of labor available to the economy, which allows the economy to expand. This effect relies on the ability of the educational system to augment the supply of human capital available to the economy.

But this analysis largely ignores the knowledge capital function that Texas' higher education system also performs. To the degree that the effects of increasing the stock of knowledge capital in the state is not included, this analysis of the economic effects of higher education in somewhat understated.

Clearly the knowledge function of Texas' higher educational system—basic and applied research—is important to the economy. There are numerous examples of discoveries, patents and technology transfers through Texas universities and colleges that have helped companies grow in the state and helped start new firms or even new industries. In a way, Chapter Two's efforts to account for research dollars flowing into the state captures part of the knowledge function. Also, to the extent that this knowledge function is truly a joint product with the human capital function, measuring one probably captures most of the effects of both.[50] Nonetheless, to the degree that the knowledge effects on the state's economy are missed by both of these two measurement efforts, this analysis underestimates the true impact of Texas' higher educational system on the state's economy. ★

TABLE 4.1

Estimated Impact of Higher Education on Texas Productivity

	Fiscal Years				
	2001	**2002**	**2003**	**3-Year Avg**	**In-State (%)**
Public Higher Education Enrollment (FTE)					
Community & Technical Colleges	263,479	280,079	300,797	281,452	94.1%
Public Universities	358,017	376,945	395,633	376,865	89.4%
Health-Related Institutions(1)	12,607	13,100	13,795	13,167	90.5%
Total Higher Education Enrollment	634,103	670,124	710,225	671,484	613,680
Total Percent Employed					80%
Total Number					489,962
	Population, School Years and Workforce, 2001-2003 (thousands)				
Age Group	**Resident Population**	**School-Years Per Person**	**Total**	**Workforce Percent**	**School Yrs**
18 to 24 Years	2,305	12.0	27,665	65.9%	18,231
25 to 44 Years	6,566	12.9	84,706	76.6%	64,885
45 to 64 Years	4,575	13.0	59,478	69.6%	41,396
65 Years and Older	2,143	12.0	25,718	14.5%	3,729
Total Population 18 Years and Older	15,590	12.7	197,567	64.9%	128,242
	Black and Lynch Texas Economic Gains				
Annual Educational Gain (thous)					
Employed Higher Education Students	490				
Employed Population 18 and Older	128,242				
Annual Educational Gain	0.38%				
	Productivity-Response Function			**Texas Gross State Product, 2002**	
Productivity Gain/10% Schooling	Low	High		GSP (Mil of $)	Percent
Manufacturing	4.9%	8.5%		$92,518	12.0%
Nonmanfacturing	5.9%	12.7%		$678,600	88.0%
Total Economy	5.8%	12.2%		$771,118	100.0%
Estimated GSP Gain (Millions of $)	Low	High			
Manufacturing	$173	$300			
Nonmanfacturing	$1,530	$3,293			
Total Economy	$1,703	$3,593			
Per Employed Student ($)	$3,476	$7,334			

(1) Because FTE estimates were not available, headcount used for public health institutions.

Sources: Carole Keeton Strayhorn, Texas Comptroller of Public Accounts, Texas Higher Education Coordinating Board and U.S. Bureau of the Census.

TABLE 4.2
Texas Discounted Productivity Gains
(Real 2003 $)

Lost Wages of High School Graduate or Equivalent

Year	Males	Females	Average
1994	$33,984	$19,723	$26,854
1995	$34,566	$20,548	$27,557
1996	$35,278	$20,291	$27,785
1997	$35,303	$20,671	$27,987
1998	$34,936	$21,503	$28,220
1999	$36,546	$21,326	$28,936
2000	$36,333	$21,845	$29,089
2001	$36,521	$22,599	$29,560
2002	$36,174	$22,825	$29,499
2003	$36,121	$23,143	$29,632
Average	$35,576	$21,447	$28,512

Average College Costs (1)

Year	Tuition/Fees (2)	Books/Supplies	Room/ Board	Transportation	Personal	Total Expenses
2002-03	$11,130	$879	$1,706	$385	$487	$14,587

Internal Rate of Return and Net Present Value

Year	Cost/Return
0	-$43,099
1	$3,476
2	$3,580
3	$3,688
4	$3,798
5	$3,912
40	$11,009
41	$11,339
42	$11,679
43	$12,029
44	$12,390
45	$12,762
Rate of Return	10.76%
NPV (6%)	$38,618

Total Economic Gain

	$/ FTE	Students	Mil of $
Present Value	$38,618	489,962	$18,922

(1) Room and board, transportation, and personal expenses included for only for non-commuting bachelor's-degree students.
(2) State and local higher education all-funds appropriation, including plus community college tuition/ fees and property tax levy, per full-time equivalent student.

Source: Carole Keeton Strayhorn, Texas Comptroller of Public Accounts.

Endnotes

1 Legislative Budget Board, Fiscal Size Up: 2004-05 Biennium, Austin, December 2004, pp. 1-10.

2 Legislative Budget Board, Fiscal Size Up: 1986-87 Biennium, Austin, January 1986, and Fiscal Size Up: 2004-05 Biennium, Austin, December 2004. To adjust for inflation, appropriations were divided by the U.S. gross domestic product deflator for state and local government expenditures.

3 National Information Center for Higher Education Policymaking and Analysis, "State and Local Public Higher Education Appropriations Per Full-Time Equivalent Student, 2002" (http://www.higheredinfo.org/dbrowser/index.php?submeasure=67&year=2002&level=nation&mode=data&state=0).

4 University of Texas at Austin, Graduate School of Business, Bureau of Business Research, Economic Contribution of the University of Texas System: A Study in Three Parts, Summer 1994.

5 Resources Economics, Inc., Economic Return on Investment in College Degrees at the University of Houston, Austin, December 1998.

6 Texas Comptroller of Public Accounts, Texas Input-Output Study, 1986 Update, Austin, December 1989.

7 Bureau of Business Research, Economic Contribution of UT System, pp. 2-4 to 2-5.

8 Denison, Edward P., Sources of Economic Growth in the United States (New York: Committee for Economic Development, 1962) and Gary S. Becker, Human Capital: A Theoretical and Empirical Analysis with a Special Reference to Higher Education (Chicago: University of Chicago Press, 1993), p. 210.

9 Bureau of Business Research, Economic Contribution of UT System, pp. 1-25 to 1-27. This report asserts that the economic impact of the training/educational function of higher education is about the same magnitude as that of the knowledge/research function. While this may be true when measuring higher education's impact for the nation as a whole, equating these national results to the state level is difficult. Regional measures of the level of investment in higher education often contain components of both the knowledge and the training functions so that whatever impacts are measured probably contain both aspects. Moreover, in an open regional economy there are many sources available to provide the societal knowledge function.

10 Resource Economics uses the "net" number of graduates after eliminating the doubled counting of advanced degrees. According to the study, approximately 8,400 students graduate annually from the UH system.

11 See "Texas Public Community Colleges," Texas Association of Community Colleges, Presentation to Governor's Office of Budget, Planning and Policy and Legislative Budget Board, Austin, September 4, 2002; and CC Benefits, Inc., The Socioeconomic Benefits Generated by 50 Community College Districts in Texas, Moscow, Idaho, May 3, 2002.

12 Another major focus of the Texas Guaranteed Student Loan Association study is the economic return to Texas from equalizing college attendance rates between minorities and whites. Texas Perspectives calculates that if African-American and Hispanic students attended and graduated college at the same rate as whites, the resulting increase in worker productivity would have added 4 percent to the state economy in 1996. See Texas Guaranteed Student Loan Association, Economic Returns from Higher Education in Texas, Austin, 1997, pp. 12-13.

13 See Chapter III of this report for a more complete discussion of these issues.

14 See William Miernyk, The Elements of Input-Output Analysis (New York, Random House, 1965).

15 Type II multipliers include both the industry output and household expenditures generated by increased demand for regional goods and services from outside the area. Type I multipliers, on the other hand, include only the impact of increased industry output that supply the exporting sector.

16 Telephone conversation with Dr. Linda Domelsmith, Division of Finance, Campus Planning, and Research, Texas Higher Education Coordinating Board, July 21, 2000.

17 The Comptroller's research and development input-output multiplier was originally calculated for the private sector, but it can be applied to public university research as well.

18 Telephone conversation with Mr. Tom Scott, associate vice-chancellor for Governmental Relations, University of Texas System, September 11, 2000.

19 Mr. Wayne Wilson, University of Texas MD Anderson Cancer Center, Houston, Texas, 2002.

20 Information supplied by Patrick Francis, University of Texas System, November 17, 2004.

21 Email from Alan H. Dean, MBA, University of Texas Health Science Center at San Antonio, December 10, 2004.

22 Email from Dr. Frederico Zaragoza, Vice Chancellor for Workforce, Alamo Community College District, December 8, 2004.

23 Email from Mike Midgley, Associate Vice President for Workforce Education, Austin Community College, December 7, 2004.

24 Email from Rosie Barrera, Vice Chancellor for Marketing and Information, Houston Community College System, December 3, 2004.

25 Email from Tiffany Inbody, Director of Communications and Public Relations, Office of the President for Research, Texas A&M University, December 21, 2004.

26 Fax from Dr, Stephen R. Hensley, President, Texas A&M University at Texarkana, December 7, 2004.

27 Texas Advanced Research/Advanced Technology Program, *Outcomes* and *Economic Impact* (www.arpatp.com), 2004.

28 Email from Rhonda L. Seaby, Director of Public Affairs and Marketing, University of Texas Health Science Center at Tyler, December 13, 2004.

29 Jacob Mincer, "Investment in Human Capital and Personal Income Distribution," Journal of Political Economy 66 (1958), pp. 281-301 and Theodore Schultz, "Capital Formation by Education," Journal of Political Economy 86 (1960), pp. 571-583.

30 Larry L. Leslie and Paul Brinkman, The Economic Value of Higher Education (Phoenix: American Council of Education and the Oryx Press, 1993), pp. 43-44.

31 These data were supplied by Mr. Tom Scott, former associate vice-chancellor for Governmental Relations, University of Texas System.

32 Texas Higher Education Coordinating Board, 2003-2004 College Student Budget (http://www.thecb.state.tx.us/reports/pdf/0111.pdf).

33 Leslie and Brinkman, The Economic Value of Higher Education, pp. 45-48, 71-75.

34 Leslie and Brinkman, The Economic Value of Higher Education, pp. 52-53.

35 Using the 45-year working-life period of analysis utilized in this study, the Standard and Poor's composite stock index increased approximately 8.5 percent per year from 1954 through 1999. According to Global Financial Data (www.globalfindata.com), this gain would had risen to 12.5 percent annually with reinvested dividends. Thus, the average stock market return over the past 45 years has been slightly over 10 percent per year.

36 Texas employment to population ratios by level of educational attainament were obtained from the US Bureau of Census, Current Population Survey, March 2002, 2003 and 2004.

37 According to data supplied by Global Insight, Inc., over the past 45 years the 30-year treasury rate has generally followed inflation, ranging from a low of 2.6 percent in 1954 to a high of 13.4 percent in 1981. After excluding inflation, the real rate of return from 1954 through 1999 has averaged 2.8 percent. Adding today's predictions of roughly 3 percent inflation annually over the next several years brings us back to the 6 percent rate used in these calculations.

38 See Alan B. Krueger, "Measuring Labor's Share," AEA Papers and Proceedings, May 1999, pp. 45-51.

39 According to the BEA, compensation of employees accounted for $420 billion of the $764 billion in Texas gross state product in 2001. During the same year, property-type income ($279 billion) and indirect business taxes ($65 billion) accounted for the rest.

40 The seminal reference to the neoclassical model of economic growth is Robert M. Solow, "A Contribution to the Theory of Economic Growth," Quarterly Journal of Economics 70 (Feb. 1956) pp. 65-94.

41 Gary S. Becker, Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education, 3rd ed. Chicago: University of Chicago Press, 1993.

42 Some of these studies, for example, have used survey-based ratings based on questions such as "on a scale of 1 to 4, how has your productivity changed over the past year." See John Barron, Dan Black and Mark Loewenstein, "Employer Size: The implications for Seach, Training, Capital Investment, Starting Wages, and Wage Growth," Journal of Labor Economics, January 1987, pp. 76-89 and John Bishop, "The Impact of Previous Training on Productivity and Wages," in Lisa M. Lynch, ed., Training and the Private Sector: International Comparisons. Chicago: University of Chicago Press, 1994), pp. 61–99.

43 This study used firm-level Compustat data on productivity and financial performance. See Ann Bartel, Formal Employee Training Programs and their Impact on Labor Productivity: Evidence from a Human Resource Survey, Working Paper No. 3026, National Bureau of Economic Research, (Cambridge, Massachusetts), 1989.

44 Sandra E. Black and Lisa M. Lynch, "Human-Capital Investments and Productivity," AEA Papers and Proceedings, Vol. 86, No. 2, May 1996, pp. 263-267.

45 For the both manufacturing and non-manufacturing sectors, these higher estimates were the result of unconstrained Cobb-Douglas regression of (the log of) firm sales on (the logs of) capital stock, labor-hours, cost of materials, and average educational level of the workers. The lower estimates were based on the imposition of constant returns of scale and equal coefficients on the labor quantity and quality variables in the regressions. Both of these restrictions were supported by the data.

46 Lisa M.Lynch and Sandra E. Black, Beyond the Incidence of Training: Evidence from a National Employers Survey, Working Paper No. 5231, National Bureau of Economic Research (Cambridge, Massachusetts), 1995, Appendix D.

47 Evidence that there is a declining marginal effect of education is strong. On page 52, Larry Leslie and Paul Brinkman, The Economic Value of Higher Education, note that traditionally calculated private rates of return for bachelor's degrees are estimated at 11.8 - 13.4 percent; eight percent for one year of graduate work; 7.2 percent for a master's degree; and 6.6 percent for a Ph.D.

48 Texas educational atainment and employment-population ratios by age group were calculated from the Texas sample of the U.S. Bureau of the Census, Current Population Survey, March 2002, 2003 and 2004.

49 All-funds, state and local appropriations are based on 2002-03 state higher education funding (including benefits) of $15.818 billion less Texas A&M University services ($680 million), and patient care at state health-related institutions ($2.332 billion), plus local community college appropriations from tuition and fees ($1.149 billion) and property tax collections ($1.408 billion), during the two years. The resulting total state and local direct higher education appropriation of $15.363 billion then was divided by a combined full-time enrollment of 1,380,349 during both years to obtain a per-capita appropriation of $11,130. See Legislative Budget Board, Fiscal Size Up: 2004-05 Biennium, Austin, December 2003. Community college tuition/fee and property tax revenues were obtained from the Texas Higher Education Coordinating Board.

50 In some cases it is impossible to untangle the effects the university system has on human capital from those on knowledge capital. For example, a company may relocate to tap the expertise of some academic department such as engineering or computer science. However, it is hard to envision a case in which such a company would benefit solely from the expertise of the faculty and not also from the availability of students trained by that faculty. So measuring the effects of the increased human capital simultaneously captures some of the attractive benefits of knowledge capital. For a discussion of some of the literature on the higher education's role in the knowledge function, patent generation, technology transfer and spin-off commercialization, see Walter W. McMahon, "The Contribution of Higher Education to R&D and Productivity Growth," in William E. Becker and Darrell R. Lewis, eds. Higher Education and Economic Growth, (Boston: Kluwer Academic Publishers, 1993), pp. 105–127. ★

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