The Future Starts Here:

The Role of the Research Universities in Ohio's Economy

This economic impact analysis was commissioned by Ohio's three largest research universities: Case Western Reserve University, the University of Cincinnati, and The Ohio State University. It was conducted by Appleseed Inc., a New York-based firm specializing in economic and social research and analysis, economic development planning and project development, strategic planning and program development services.

Case Western Reserve University
The Ohio State University
University of Cincinnati

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Executive Summary

Despite its many strengths, Ohio has for more than twenty years lagged behind the rest of the U.S. on some important measures of overall economic growth, and of the economic well-being of its citizens. The recession that struck in 2001 has widened the gap between Ohio's economic performance and that of the nation; by 2004, Ohio was one of only two states in which payroll employment was still declining.

While the reasons for Ohio's sluggish performance are many and complex, several recent studies of the state's economy have highlighted two important problems.

- Ohio lags behind other U.S. states in the percentage of its working-age residents who have four-year or higher college degrees – a critical weakness in an increasingly knowledge-driven economy; and
- Ohio has not been as successful as some other parts of the U.S. in translating new knowledge into new products, new businesses and new jobs.

This diagnosis of Ohio's economic problems suggests that the state's colleges and universities have a central role to play in any effort to revitalize its economy. They are the principal providers of the well-educated, highly-skilled workers so essential to Ohio's future – and they are an important source of the innovations that fuel economic growth.

Higher education, moreover, is itself one of the core industries of the knowledge economy. Ohio's colleges and universities in 2004 employed more than 136,000 people – more people than were employed by Ohio's auto and auto parts manufacturers, or in the financial services sector. While employment in most of Ohio's "traditional" industries has continued to decline, colleges and universities have been adding jobs.

Among Ohio's 75 colleges and universities, its three major research universities – The Ohio State University, University of Cincinnati and Case Western Reserve University – are particularly critical to the state's economic future, and to the future of its three largest cities – Columbus, Cincinnati, and Cleveland. They lead the state in the production of college graduates in critical fields such as engineering and medicine. They account for nearly 80 percent of the research conducted at educational institutions in Ohio; and they are actively involved in the translation of research findings into new products and new business. With revenues totaling $3.8 billion in 2004 (of which state appropriations accounted for only 19 percent), they are major "businesses" in their own right; and they are among the largest employers in the Columbus, Cincinnati, and Cleveland metropolitan areas.

This report assesses the impact of Ohio State, Cincinnati and Case on the state's economy, and describes how the three research universities are helping – through their programs of education, research, business development and community partnerships – to lay the foundation for a new era of prosperity in Ohio.

The universities as employers

Ohio State, University of Cincinnati and Case are among the state's largest employers. In 2004 they employed a total of 35,257 people in full- and part-time jobs, as well as 21,800 part-time student employees.

The three universities' significance as major employers is especially evident when viewed from a local perspective. University of Cincinnati is the largest employer in Hamilton County; Ohio State is the second-largest in Franklin County; and Case is the 13th-largest employer in Cuyahoga County.

Salaries for all full-time employees at the three universities averaged $51,700 in 2004. The universities also offered a wide range of benefits, including extensive opportunities for continued education and training.

Purchasing and construction

In addition to the people they employ directly, in 2004 the three universities supported approximately 10,400 jobs in Ohio through in-state purchases of goods, services and construction.

In fiscal year 2004, Ohio State, Cincinnati and Case spent $460 million on purchases of goods and services from Ohio companies, generating more than 5,100 full-time-equivalent jobs. The three universities also spent $505 million on renovation of existing buildings and construction of new ones – $440 million of which was paid to Ohio firms – generating nearly 5,300 full-time equivalent jobs in construction and related industries.

In addition to creating thousands of high-wage jobs each year, university construction is an investment in Ohio's future: in the ability of Ohio State, Cincinnati, and Case to support the continued growth of university research – to introduce new educational programs designed to meet the rapidly-evolving needs of the state's growth industries – and to attract and retain the talented students, researchers and faculty members on whom the state's future depends.

Indirect and induced effects

In addition to the jobs directly created in Ohio through university spending on purchasing and construction, routine household spending by university employees – for housing, food, transportation, entertainment, day care and other personal services – also generates jobs throughout Ohio. Similarly, the in-state vendors and contractors with whom the three universities do business also spend money within the state – on utilities, insurance, supplies, etc. And their employees too spend part of their take-home pay on purchases of goods and services from local businesses.

We estimate that these "indirect and induced" or "multiplier" effects generated an additional 19,400 full-time equivalent jobs throughout Ohio in 2004.

Adding it all up

Economic impact of the research universities

Taking into account the three universities' 35,267 non-student employees – 10,400 full-time-equivalent jobs with Ohio-based vendors and contractors – an additional 19,400 FTE generated through household spending by university employees and through the multiplier effect – and 2,955 generated through off-campus spending by students and visitors – we estimate that ***in 2004 Ohio State, University of Cincinnati and Case directly and indirectly accounted for about 68,000 jobs in Ohio, and approximately $6.2 billion in economic activity statewide.*** The economic impact of the three universities together and separately is summarized in Table 1.

Table 1: Economic Impact of the Universities on the State of Ohio

	OSU		UC		Case		Total	
	Jobs	output ($)	Jobs	output ($)	Jobs	output ($)	Jobs	output ($)
Direct Employment/Payroll	22,912	$ 1,167,548,487	8,737	$ 366,433,954	3,608	$ 199,465,840	35,257	$ 1,733,448,281
Direct Purchasing	-	203,109,027	-	126,196,938	-	130,744,496	-	460,050,461
Direct Construction	-	225,157,171	-	160,283,829	-	54,173,002	-	439,614,002
Direct, Indirect, Induced Impacts	15,734	1,898,879,315	8,631	875,888,252	5,421	513,194,777	29,786	3,287,962,344
Student/Visitor Spending							2,955	281,535,489
Total Economic Impact	**38,646**	**$ 3,494,694,000**	**17,368**	**$ 1,528,802,973**	**9,029**	**$ 897,578,115**	**67,998**	**$ 6,202,610,577**

Economic impact of the affiliated hospitals[1]

Hospitals and other health care providers[2] affiliated with the three research universities are among the largest employers in the three cities. For example, two of Case's medical affiliates – Cleveland Clinic and University Hospitals Health System – are the largest and second-largest employers in Cuyahoga County, respectively. The hospitals are also major buyers of goods and services and sponsors of major construction projects.

We estimate that University of Cincinnati's affiliated hospitals directly and indirectly accounted for about 14,100 jobs and $1.25 billion in economic activity in Ohio; and that OSU's medical affiliates accounted for about 11,900 jobs and $620 million in economic activity.

[1] We do not have enough data to estimate the impact of Case's affiliated hospitals on the state. As generators of non-local revenue, major employers, and buyers of local goods and services, Case's affiliates are also likely to have a considerable economic impact. Some of these impacts are discussed in detail in Section IX.

[2] OSU's medical affiliates include OSU Medical Center Health System, OSU Physicians, Inc., and Columbus Children's Hospital; UC's medical affiliates include UC Physicians, Cincinnati Children's Hospital Medical Center, Health Alliance - University Hospital, Cincinnati Shriners Hospital, and VA Medical Center – Cincinnati; Case's medical affiliates include Cleveland Clinic, MetroHealth System, and University Hospitals Health System.

Student and visitor spending

Just as routine household spending by university employees generates jobs and economic activity, so does off-campus spending by students at Ohio State, Cincinnati and Case, and by visitors from out-of-state such as commencement guests and spectators at university athletic events. We estimate that student and visitor spending directly and indirectly supported approximately 2,955 full-time-equivalent jobs in 2004.

Developing Ohio's human capital

In the fall of 2003, more than 86,734 undergraduate and graduate students were enrolled in degree programs at Ohio State, University of Cincinnati and Case – nearly 23 percent of all four-year college and university students in the state. About 80 percent of the students are Ohio residents.

Approximately 400,000 graduates of Ohio State, Cincinnati, and Case live in Ohio. About one-fifth of all Ohio residents with four-year or higher degrees graduated from one of the three research universities.

Moreover, Ohio State, Cincinnati, and Case account for a disproportionate share of degrees granted in disciplines that are closely linked to the industries most likely to drive Ohio's growth in the years ahead, such as biomedical engineering and nanotechnology.

The role of university research

University research is a growth business in Ohio. Between 1999 and 2004, research spending at Ohio State, University of Cincinnati and Case Western Reserve University rose by an average of about 13 percent annually to over $1 billion. The three universities' research enterprise, moreover, is mostly funded from out-of-state sources; 63 percent of their 2004 research spending was funded through federal grants and contracts, and 12 percent from corporate and foundation sources. State and local government funds accounted for only 11 percent of the total.

The three universities are particularly strong in emerging areas of science and technology such as genomics, structural biology, energy, advanced materials, and nanotechnology. For example:

- The Center for Advanced Polymer and Composite Engineering at The Ohio State University works directly with industry leaders like Honda of America, Owens Corning, and Eastman Kodak to improve polymer modeling, design, and manufacturing processes;
- University of Cincinnati's Institute for Nanoscale Science and Technology brings together researchers from various disciplines to develop nanotechnologies with

applications ranging from optical devices to heart disease therapies to organic light-emitting diodes; and
- Researchers at Case Western Reserve University's Advanced Power Institute are leading a statewide effort that includes contributions from Ohio State and other Ohio universities, for development of more efficient and affordable fuel cell technologies.

Applied research programs such as the examples cited above yield the new knowledge that in the years ahead will provide the foundations for new products and services, new business and new jobs.

Ohio's three major research universities have been more successful than most of their peers in other states in developing research partnerships with major corporations. In 2004 more than 9 percent of all research spending at the three universities was financed from corporate sources, as compared with 5 percent of all university research nationwide. The universities' partners have included major Ohio companies such as GE Aircraft Engines, Procter & Gamble, Parker Hannifin and Timken. The universities' success in attracting corporate funds will be especially important during the next few years, as the rapid growth in federal research spending that occurred between 1998 and 2003 levels off.

While state and local funding accounted for only 11 percent of all research spending at the three universities in 2004, state funding will be critical to the continued growth of the universities' research enterprise in the years ahead. The support provided by the state's Third Frontier initiative will be particularly important to the progress of research in emerging areas such as those cited above; and in an era of slower growth in federal research funding, state investments may prove critical to the universities' ability to compete for federal, corporate and foundation funding.

New business development

The creation and continued growth of new businesses is critical to the renewal of Ohio's economy. The three research universities contribute to this process in several ways.

The universities help turn new technologies and discoveries into commercial products by entering into licensing agreements with new and established companies. In 2004, OSU, Cincinnati, and Case accounted for more than half of the license revenue earned by all Ohio universities and spun off 11 new companies.

The universities provide technical assistance, seed money grants, and equity investments to university faculty members, researchers and students interested in turning the results of their research into new businesses. Case Technology Ventures – Case's technology venture fund – financed two of the university's spin-offs in 2004 and 2005: Cleveland Nanocrystals, a nanotechnology firm, and Arteriocyte, a stem cell therapy company.

Through partnerships with regional entrepreneurial support organizations, the universities help launch early-stage technology companies. For example, BIO/START, Cincinnati's biomedical business start-up center currently provides comprehensive business assistance

services and wet lab facilities to five life science start-ups founded by UC faculty members or graduates including P2D Inc., Keyclone Technologies, CardioEnergetics, Cutanogen Corporation and Medical Diagnostic Laboratories. In Columbus, TechColumbus, established through the recent merger of the Business Technology Center, Scitech Research Park and the Columbus Technology Council, supports region economic development by providing new companies with incubator space, access to venture capital, services ranging from executive training to market analysis and real estate development for manufacturing.

Ohio State, Cincinnati, and Case have also created programs through which students interested in starting their own companies can acquire the skills and knowledge that are essential to successful entrepreneurship.

The academic health center connection

Each of the universities' medical schools is the heart of an academic health center: a cluster of educational, research and health care institutions that collaborate closely in the education of physicians and other health professionals, in biomedical research and in the delivery of health care.

The academic health centers educate the state's physicians, nurses, and other health care workers. During the 2003-2004 academic year, the three universities enrolled more than 2,400 medical students, 2,000 nursing students and over 1,000 pharmacy students.

In 2004, the colleges of medicine, dentistry, public health, nursing and other health professions accounted for about 60 percent of all research spending at the three universities – a total of approximately $608 million. Many of the most significant biomedical research initiatives at OSU, Cincinnati, and Case involve partnerships between the universities and their affiliated hospitals. For example:

- University of Cincinnati developed the Genome Research Institute. The Institute is expected to bring in over $500 million in federal research funds by 2009.
- Case Western Reserve University, University Hospitals, and the Cleveland Clinic formed the Center for Stem Cell and Regenerative Medicine in 2003. Researchers at the Center are developing stem cell-based therapies for leukemia, multiple sclerosis, spinal cord injuries and Alzheimer's disease.

The universities and their hospital partners also collaborate in the translation of research into new businesses and jobs. In 2005, for example, OSU Medical Center established a new non-profit, University Medical Center Partners, as a focal point for its business development efforts. UMC Partners is also developing the OSU Health and Innovation Park – a complex of research, office and clinical space – at a 100-acre site in Dublin, Ohio.

The three academic health centers also offer a range of community health and wellness programs that keep Ohio residents healthy and productive, such as screening for various types of cancer and helping people with diabetes learn how to manage the disease more effectively. Academic health centers also play an important role in caring for the poor and the uninsured in the state's three largest cities. In fiscal year 2004, hospitals affiliated with OSU and Cincinnati provided more than $315 million in uncompensated care.

The universities and their communities

Ohio State, University of Cincinnati, and Case also contribute to the process of economic renewal through outreach to and engagement with their local communities.

Outreach programs at the three universities encompass almost every aspect of community life. There are several types of programs, however, that are of particular relevance to the needs of the state's economy.

All three universities are active participants in efforts to improve the quality of elementary and secondary education in their communities, and to expand educational opportunities for young community residents. For example:

- Through its Cleveland Mathematics and Science Partnership, Case offers professional development programs for math and science teachers in Cleveland's public high schools.
- In early 2006, Ohio State joined with Battelle and the Columbus-based Educational Council to create a new public high school to serve as a hub of innovation for teachers and students while providing researchers across campus with opportunities to improve education nationwide. The Metro High School will open in August with emphasis on science, math, and technology.
- University of Cincinnati's Emerging Ethnic Engineers (E^3) initiative combines several programs for students in grades 4 through 12, all geared to the same goal – increasing the number of African American, Latino and native American students entering (and succeeding in) UC's College of Engineering.

All three universities have developed programs that use university resources to assist small businesses in their communities. For example:

- The OSU Ohio BioProducts Innovation Center (OBIC) combines two of Ohio's most important economic sectors – agriculture and chemical/plastics/rubber. In collaboration with Battelle, the center will develop conversion technologies for industrial products from corn, soybeans, and other crops. OBIC was established with a State of Ohio Third Frontier grant of $11.6 million and is receiving an additional $21.9 million from 15 industrial partners.
- University of Cincinnati's Goering Center for Family and Private Business offers a number of programs aimed at helping family-owned businesses deal with problems

such as managing growth, succession planning, and the transfer of ownership between generations.
- Case's MBA's on Call program helps local companies solve a variety of business problems, by arranging for MBA students to work as consultants to these companies on projects lasting anywhere from two to thirteen weeks.

Ohio State, Cincinnati, and Case are also actively involved in efforts to revitalize the neighborhoods that surround their communities. For example:

- In 1995, Ohio State University took the lead in creating Campus Partners for Community Urban Redevelopment, a non-profit corporation dedicated to renewing the neighborhoods surrounding the OSU campus. Its initiatives include the South Campus Gateway project, a mixed-use development that includes 250,000 square feet of retail, restaurant and entertainment uses, 90,000 square feet of office space and 185 apartments. OSU is helping to finance the project through an investment of $20 million in endowment funds and a $55 million bond issue.
- Since 1990, University of Cincinnati has worked in partnership with several local community development corporations to revitalize areas near its campus. The University is for example, helping the Clifton Heights Community Urban Redevelopment Corporation develop its Calhoun Street Marketplace Project. When the two-phase project is completed in 2007, it will include 97,000 square feet of retail space, 259 units of housing and garage space for 1,600 cars. Financing for the second phase of the project includes a $40 million loan from the University.
- Case is an active partner in one of the oldest community improvement efforts of its kind in the nation – University Circle, Inc., a consortium of 40 non-profit institutions and organizations founded in 1957, dedicated to strengthening Cleveland's University Circle area.

Building Ohio's future

As great as the three universities' contributions to Ohio's economy are today, they could for several reasons be even greater in the future.

- Since the mid-twentieth century, advances in science and technology have taken on increasing importance as major drivers of economic growth – a trend that is likely to continue. Around the world, national regional and local governments are looking to universities and other research institutions to create the knowledge base from which new industries will emerge. In this race for the future, Ohio State, Cincinnati and Case – world-class and growing centers of research and innovation – are among Ohio's most important assets.

- A growing body of research confirms that a community's endowment of human capital – the education, experience, knowledge and skills of its people – is the single most important factor in determining whether it flourishes or falters economically. Given the growing importance of science and technology as drivers of economic

growth, education will be even more critical over the course of the next twenty years than it has been in the past twenty.

While all educational institutions can play a role in meeting this need, major research universities are particularly (perhaps uniquely) well-equipped to provide a steady stream of graduates who are well-versed in the latest advances in fields such as biotechnology, nanotechnology, information technology and more. Graduates of these institutions are prepared to work in a world in which old boundaries (among academic disciplines, industries and professions) are fast disappearing.

- As advances in science and technology have become more and more central to the process of economic development, universities have taken on new roles in helping to ensure that the results of academic research are translated as quickly and as efficiently as possible into new products and services, new businesses and new jobs. During the past decade, Ohio State, University of Cincinnati and Case have all become much more actively engaged in this process, providing extensive support for the development of new business ventures based on university research.

- Over the course of the next decade, all three universities will be investing hundreds of millions of dollars annually in the development of new facilities. This investment is needed to support the growth of the universities' educational and research programs, and to ensure that they can attract and retain the talented students, faculty and researchers who will help to shape Ohio's economic future.

Important as the role of the research universities may be, it is not one in which they can succeed alone. Great research institutions are inevitably the product of partnerships: with state and federal governments, with the communities in which they are located, with their affiliated hospitals, with the business community – and ultimately, with the people of Ohio. Making sure that Ohio State, Cincinnati, and Case realize their potential as contributors to the creation of Ohio's future will require a collaborative effort.

Introduction

During the past few years, the relative weakness of Ohio's economy has led state policy-makers, business executives, community leaders and others to focus more sharply than ever on the steps that are needed to accelerate the process of economic recovery, and to build a solid foundation for a new era of sustained growth. Studies by the Ohio Business Roundtable, Battelle and others have all highlighted the importance of developing the human, intellectual and institutional resources that Ohioans need if they are to prosper in an integrated global economy in which knowledge and skills are the most valuable resources.

Fortunately, Ohio already has available many of the assets the state needs to compete effectively in this rapidly-evolving economy. Among them are three of the nation's leading research universities – The Ohio State University, University of Cincinnati and Case Western Reserve University. In order to understand more fully their role in the state's economy, and the contribution they can make to its ongoing revitalization, the three universities asked Appleseed – a consulting firm with extensive experience working with major research universities – to assess their combined impact on the Ohio economy. This report presents the results of Appleseed's research and analysis.

Organization of the Report

Part I of the report sets the stage with a brief review of current conditions and recent trends in the Ohio economy – the state's higher education sector – and the three major research universities. The next four parts assess the impact that Ohio State, Cincinnati and Case have on the Ohio economy – and the economies of the counties in which they are located – as, in effect, major businesses in their own right. Part II describes the role of the three universities as major employers. Part III highlights their impact as buyers of goods and services from Ohio companies, and sponsors of major construction projects. Part IV analyzes the indirect and induced or "multiplier" effect of university spending on payroll, purchasing and construction; and Part V looks at the additional impact derived from off-campus spending by students and visitors.

Part VI examines the role that the three universities play in developing Ohio's "human capital." Part VII focuses on the impact of university research on the state's economy; and Part VIII on the universities' role in the development of new business and growth of new business ventures. Part IX focuses on the role of the three universities' medical colleges – not just as significant economic entities in themselves, but also as central elements in the network of health care, teaching and research institutions that make up

Ohio's three major academic health centers. Part X discusses the universities' role in revitalization of their communities – helping to improve the quality of public education and expand educational opportunity, supporting the development of local businesses and participating in local neighborhood development efforts.

Finally, Part XI briefly discusses several reasons why the three universities' contributions to the growth of the state's economy could be even greater in the years ahead than they have been in the past.

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I. The Three Universities in Context

Any assessment of the economic impact of The Ohio State University, University of Cincinnati and Case Western Reserve University should start from a clear understanding of the current state of Ohio's economy, and the role of higher education within that economy. Part I of this report briefly discusses recent economic trends in Ohio, highlights some of the state's notable strengths and weaknesses, and considers what the state needs to do to generate sustained growth in jobs and income in the years ahead. It then provides a brief description of Ohio's colleges and universities, and the particular role of the three major research universities.

The Ohio Economy at a Crossroads

For much of the past two hundred years, Ohio has been one of the engines that has driven the American economy forward. In the early 1800's, the northwest frontier was one of the young nation's fastest-growing agricultural regions; and both the Ohio River and Lake Erie were vital links in the transit of commerce from the heartland to the seaboard and beyond. In the century that followed, Ohio became a seedbed of industrial innovation and development, fertile ground for many of the industries – coal, oil, steel, automobiles, chemicals, aviation and many more – that helped make the American economy the envy of the world.

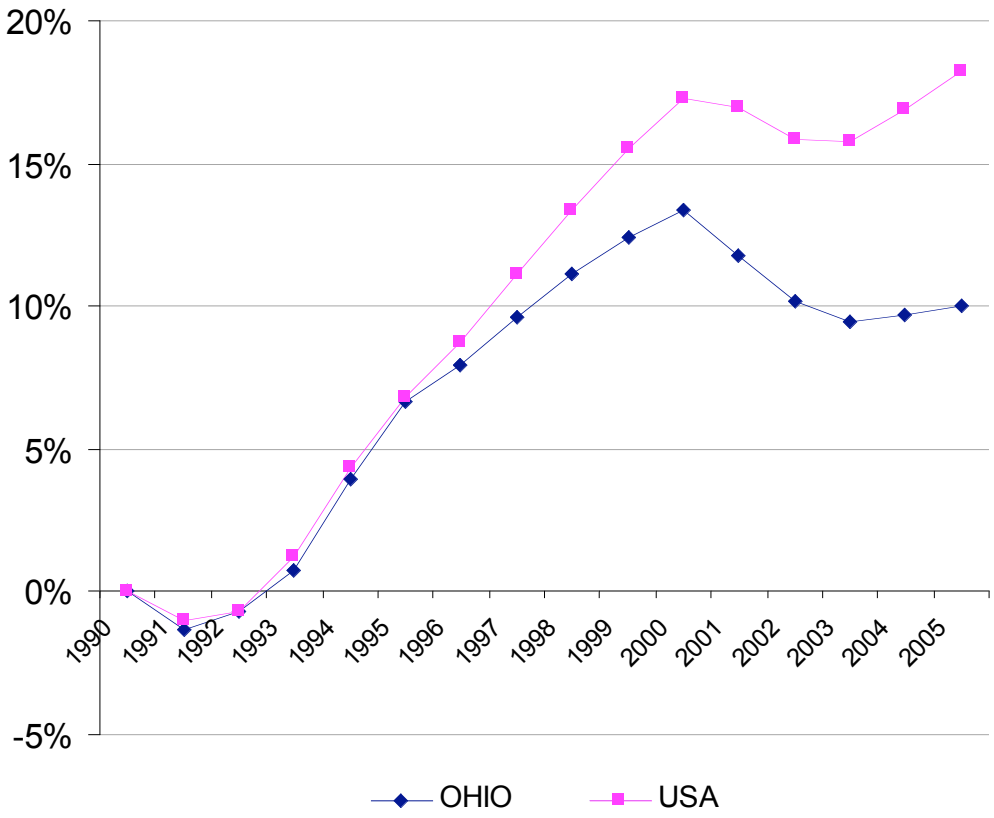
Ohio is in many respects still an economic powerhouse. Among America's fifty states, it ranks seventh in population, employment and output. With a gross state product of $418 billion in 2004, its economy is larger than those of many mid-sized industrial countries, such as Taiwan and Sweden. And it is well-connected to the global economy, with major investments by companies such as Honda, Toyota, Bridgestone, Nestle, and Philips, and exports totaling more than $31 billion in 2004.

Across a wide range of manufacturing industries – including materials, machinery, automobiles and auto parts, and aircraft parts – Ohio has a base of experience, skills and production capabilities that many other states and nations would envy. Its central location and its excellent transportation infrastructure have made it an important center for logistics and distribution, nationally and globally. The state is home to several world-class research institutions – and from its largest cities to hundreds of small towns, offers many opportunities for an attractive quality of life.

But despite its considerable strengths, by a variety of measures Ohio's economy has for some time lagged behind that of the nation as a whole. The state did fairly well in the 1990's, with payroll employment growth averaging about 1.5 percent annually – an increase of approximately 750,000 jobs over the course of the decade. However, the recession that began in 2001 hit Ohio harder than it did almost any other state. Between

2000 and 2004, wage and salary employment in Ohio fell by 4.5 percent – a loss of more than 250,000 jobs.

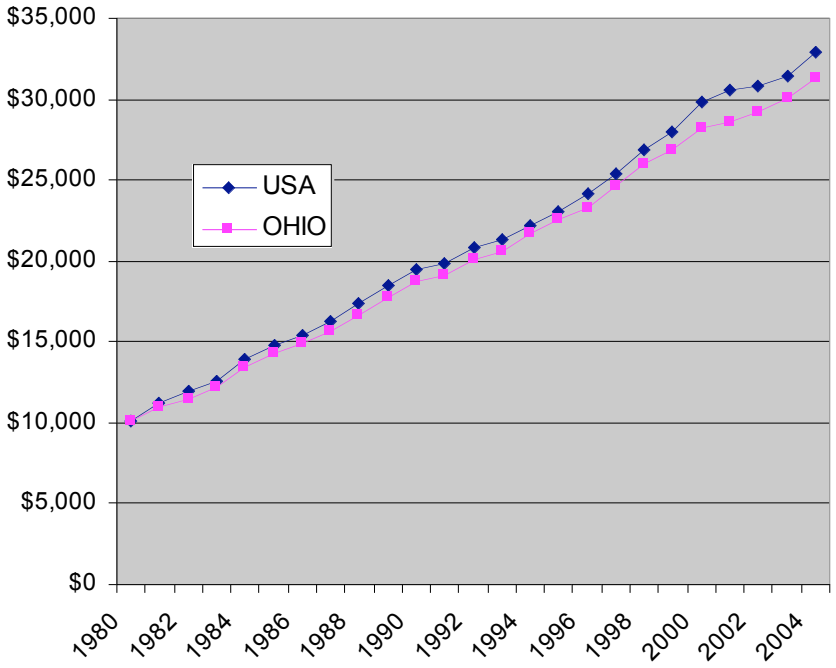
Figure 1: Percentage Change in Employment 1992 to 2004, USA & OHIO



To date, moreover, the process of recovery has been painfully slow. Ohio by several criteria ranked near the bottom of the 50 states in 2004 – 47th in population growth, 49th in job growth, 43rd in per capita income growth, and 47th in growth of gross state product.

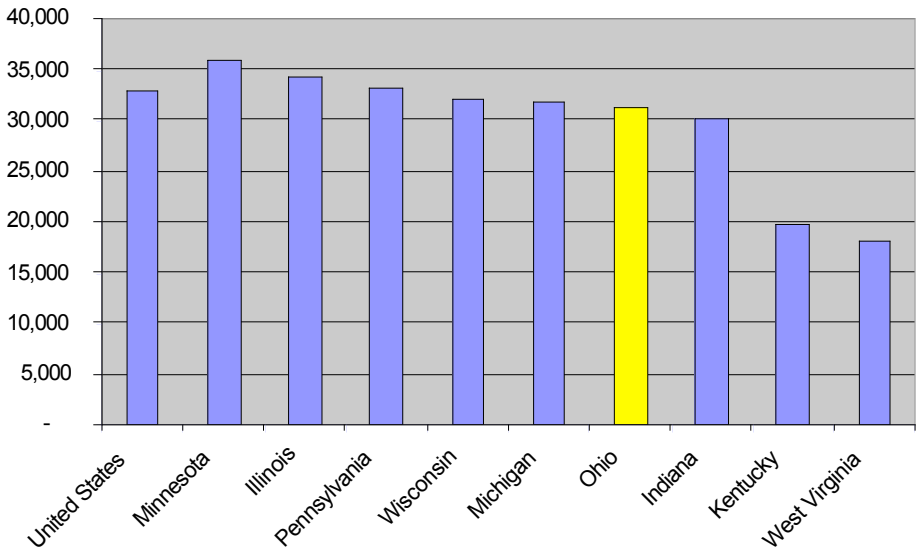
Ohio's problems are not just a byproduct of the most recent recession. Longer-term measures of economic performance also show a disturbing trend. During most of the twentieth century, for example, the per capita personal income of Ohio residents – a key measure of overall economic well-being – was higher than per capita income for the U.S. as a whole. But by 1980, Ohio had fallen behind – and the gap has since widened. In 2004, Ohio's per capita income, at $31,332, was 5 percent below the national average of $32,937 (Figure 2).

Figure 2: Per Capita Income Growth 1980 to 2004, USA and OHIO



When Ohio is compared with some nearby states, the gap is even wider. Illinois's per capita income in 2004 was 9.7 percent higher than Ohio's; and Minnesota's 14.5 percent higher (Figure 3).

Figure 3: Per Capita Income, 2004



Other indicators also show Ohio falling behind. Between 1990 and 1999, for example, Ohio ranked 44th among the 50 states in the creation of new businesses. The slow pace of business creation during the 1990's has clearly contributed to the slow pace of Ohio's recovery from the recession of 2001.

The Role of Human and Intellectual Capital

The reasons for the relative weakness of Ohio's economy in recent decades are numerous and complex. But one in particular has during the past few years drawn the attention of state policy-makers, business leader and others: Ohio has lagged behind many of the states with which it competes (and increasingly, behind its competitors around the globe) in the development of the state's "human capital" – the accumulated knowledge, skills and experience of its people.

One of the most important indicators of the state of a state's or city's human capital is the percentage of its adult residents with college degrees. In 2004, 23.3 percent of all Ohio residents age 25 or older had at least a four-year degree; nationwide, 27 percent of all Americans 25-or-older had at least a four-year degree. Among the 50 states, Ohio ranked 39th.

Statewide figures on educational attainment, moreover, mask significant disparities from one part of the state to another. In Cincinnati, 33.5 percent of those age 25 and older had four-year or higher degrees in 2004, and in Columbus, 32.1 percent. But in Cleveland, only 14.3 percent of all residents 25 and older had four-year or higher degrees.

Data from the 2000 census highlight the relationship between education and income. In 1999, Ohioans with four-year college degrees earned nearly twice as much as those with only a high school education – and more than three-and-a-half times the earnings of those who never finished high school.

In 2004, the Governor's Commission on Higher Education and the Economy recognized the need for Ohio to do better:

> *The undeniable fact is that Ohio is not producing enough educated, highly skilled workers to meet the demands of a knowledge- and innovation-based economy.*[3]

Relatively low levels of educational attainment are not, of course, the only factor that adversely affects Ohio's economic performance. While it is not as easy to document statistically, several studies suggest that the state's strengths in older industries such as steel and auto manufacturing had in the past led Ohio companies to neglect the need for innovation. In a study of the state's economy published in 2002, the Battelle Memorial Institute found that:

> *Ohio's historical base in traditional manufacturing has led to complacency toward new product innovation, resting instead on traditional markets. Ohio's industry is not sufficiently interested in collaborative ventures around R & D, new*

[3] Governor's Commission on Higher Education and the Economy, *Building on Knowledge, Investing in People: Higher Education and the Future of Ohio's Economy* (Columbus, April 2004), p. 19.

products and product innovation, e.g. developing, designing testing and commercializing.

Moreover, while noting the strengths of some of Ohio's research institutions, the Battelle report also noted that:

> *The transfer of technology from the state's numerous research institutions has not been as effective as would be expected, and as a result, has not reaped economic returns for the state…Technology transfer remains underfunded at most of Ohio's higher education institutions and research organizations…In addition, Ohio's higher education and federal laboratory R & D efforts have historically been disconnected from the needs of industry...*[4]

The state's Third Frontier Project – a fifteen-year, $1.6 billion program aimed at strengthening technology research and commercialization, new business development and the creation of high-paying jobs – and other recent initiatives reflect a growing awareness that Ohio's success in producing new jobs and higher incomes depends directly on the states ability to develop its human and intellectual capital. In the words of the Governor's Commission on Higher Education and the Economy:

> *The foundations of success were once defined by the control of natural resources, labor and capital; the principal drivers of sustainable economic growth today are knowledge and innovation.*[5]

Higher Education in Ohio

In an era when the prosperity of nations, regions and communities is more than ever dependent on their ability both to create and capitalize on new knowledge – and on the depth and quality of their human resources – Ohio's colleges and universities have an important role to play in determining whether the state flourishes or falters in the years ahead.

There are 75 institutions in Ohio that grant four-year, graduate and professional degrees, including:

- 3 major research universities – two public and one private;
- 11 other public universities;
- 2 free-standing public medical colleges;
- 2 private proprietary universities; and
- 57 other private non-profit colleges and universities.

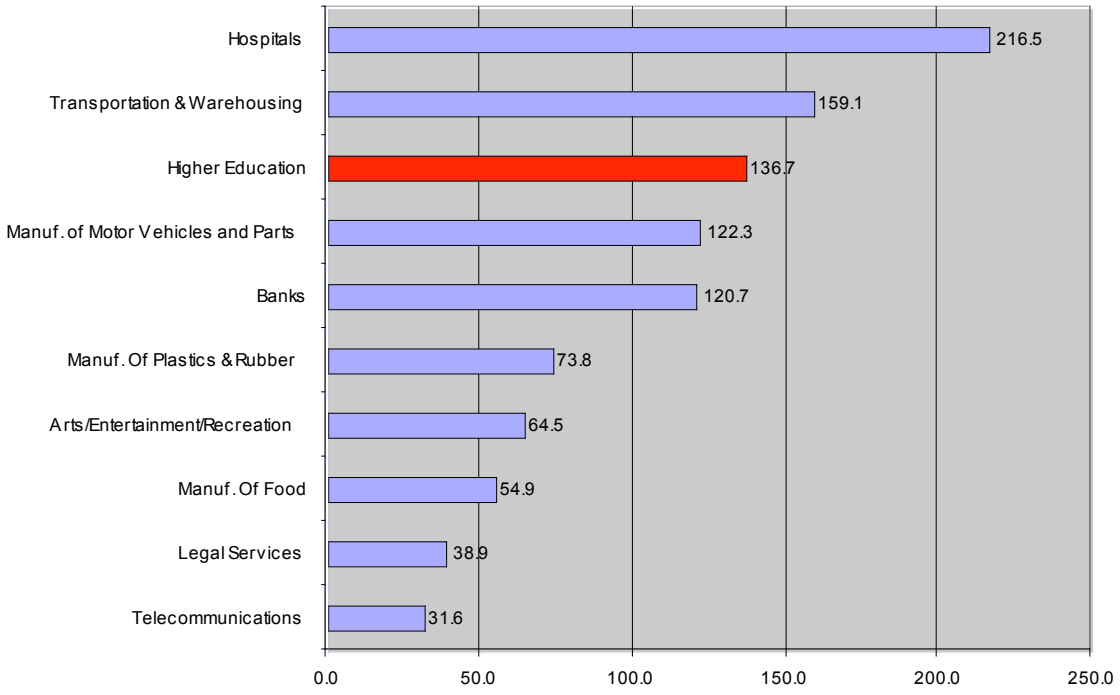
[4] Battelle Memorial Institute, *Innovation – The Future of Ohio's Economy: An Ohio Technology-Based Economic Development Strategy* (Cleveland: May 2002), p. 73.
[5] Governor's Commission on Higher Education and the Economy, *op. cit.*, p. 8.

In 2003, enrollment at schools granting four-year and higher degrees totaled approximately 388,000.

There are also 26 community and technical colleges, 23 "branch campuses" of public universities, and 40 for-profit "career colleges" that grant two-year degrees. In 2003, enrollment at these schools totaled approximately 235,000.

Colleges and universities are important to the Ohio economy not only as suppliers of talent and ideas, but also as a major industry in their own right. In 2004, state colleges and universities in Ohio employed approximately 90,200 people; and private colleges and universities about 46,500. Together, public and private colleges and universities employed approximately the same number of people in Ohio in 2004 as did banks and insurance carriers. More Ohioans worked for colleges and universities than worked for automobile and auto parts manufacturing companies.

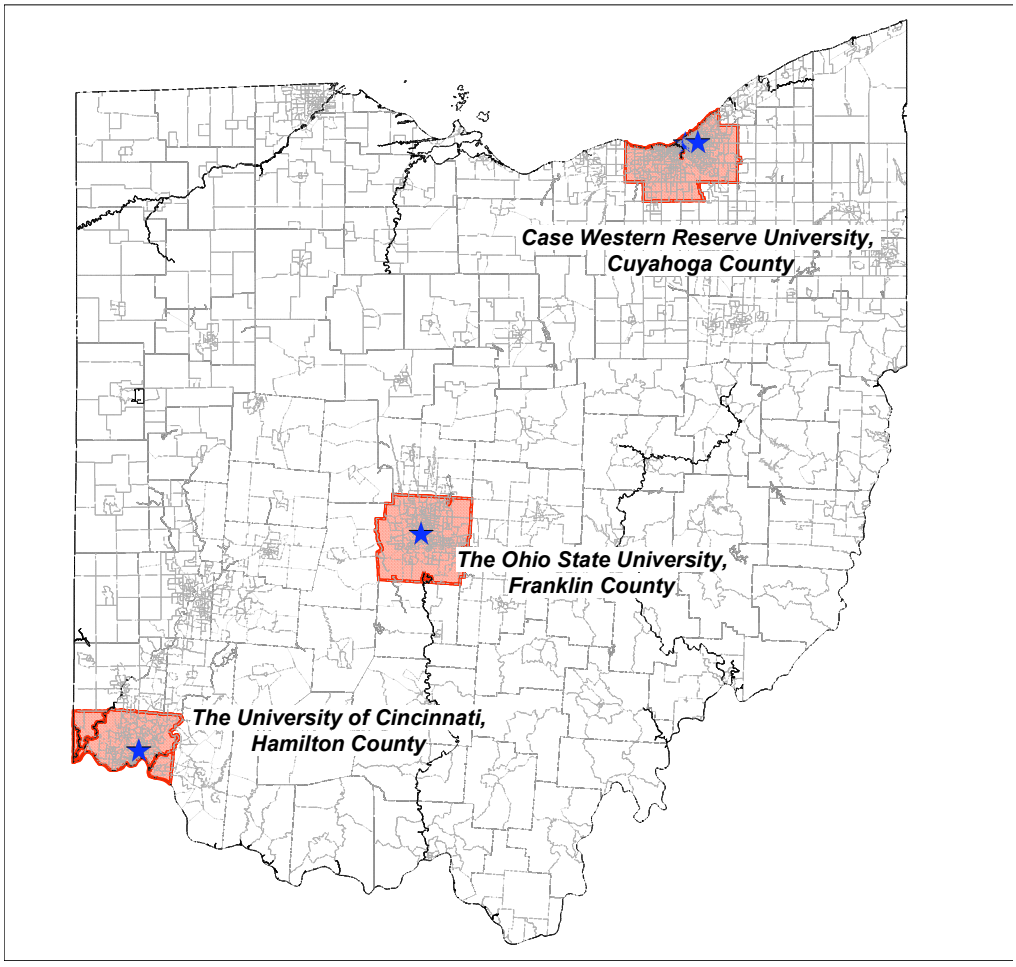
Figure 4: 2004 Industry Employment, Ohio (in thousands)



The Role of the Research Universities

This report focuses on Ohio's three major research universities – The Ohio State University, University of Cincinnati, and Case Western Reserve University (see Figure 5 for their location within the state of Ohio). With total revenues in fiscal year 2004 totaling nearly $3.8 billion (exclusive of those associated with The Ohio State University Health System[6]), these institutions are themselves major enterprises. As Figure 6 shows, external research funding is the single largest source of revenues, accounting for approximately 24 percent of all revenues. Investment income was 9 percent of the total, and income from auxiliary enterprises 7 percent.

Figure 5: Location of the Three Universities



[6] In 2004, the OSU Health System's revenues totaled $932 million. While the OSU Health System is legally and organizationally part of Ohio State, the hospitals affiliated with Cincinnati's and Case's medical schools are separate corporate entities; and their revenues are not counted as university revenues. For purposes of comparability, we therefore exclude OSU Health System revenues as well. The broader topic of the medical schools' partnerships with affiliated health care institutions is addressed in Part IX of the report.

The Three Universities: An Overview

Measured by enrollment, ***The Ohio State University***, founded in 1870, is among the nation's largest universities, with more than 50,000 students on its main campus in Columbus. Ohio State is also one of the nation's most comprehensive universities, offering 174 undergraduate majors, 111 master's degree programs and 93 doctoral programs. With total research spending of $447 million in 2004, Ohio State is also among the nation's leading research institutions.

In addition to its 1,700-acre main campus, Ohio State has regional campuses in Lima, Marion, Mansfield and Newark, which in the fall of 2004 enrolled 7,370 students, most of whom were pursuing two-year degrees. The University also manages Don Scott Airport in Columbus, the Caren Agricultural Center, and (at multiple locations) the Ohio Agricultural Research and Development Center.

Ohio State's operating expenses in fiscal year 2004 totaled approximately $2.77 billion, and in 2004 the University employed more than 23,000 people (excluding students).

University of Cincinnati traces its origins to the 1819, the year of the founding of the Cincinnati College and the Medical College of Ohio. In 1870, the City of Cincinnati established University of Cincinnati, which later absorbed the earlier institutions. UC reached another milestone in 1977, when it became one of Ohio's state universities.

In 2004-05, 35,364 students were enrolled in the University's 15 colleges, making UC the state's second-largest university in terms of total enrollment. UC was also the state's third-largest research institution, with research spending totaling $178 million in fiscal year 2004.

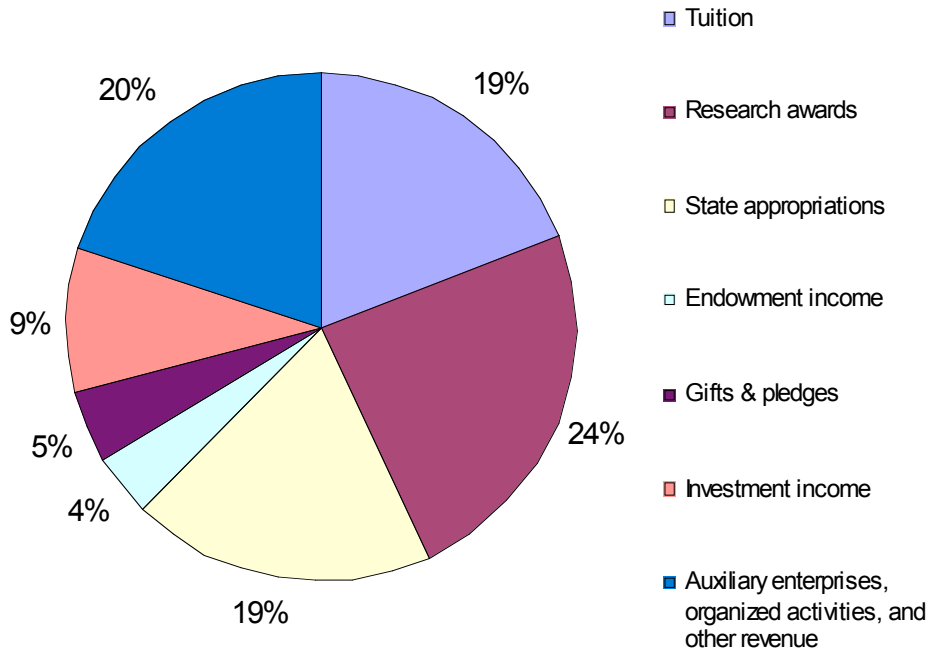
UC's operating expenses in fiscal year 2004 totaled $791 million; and the University employed more than 8,700 full- and part-time workers (excluding students).

Case Western Reserve University was created in 1967 through a "federation" of the Case Institute of Technology and Western Reserve University, which since the 1880's had been located on adjacent campuses in downtown Cleveland. With 9,457 students in the fall of 2003, Case is Ohio's second-largest private university (measured by total enrollment); and is the state's largest private provider of graduate and professional education.

Among the state's private colleges and universities, Case has by far the largest research enterprise; and among all Ohio universities, it ranks second behind Ohio State, with total research spending of $283 million in fiscal year 2004.

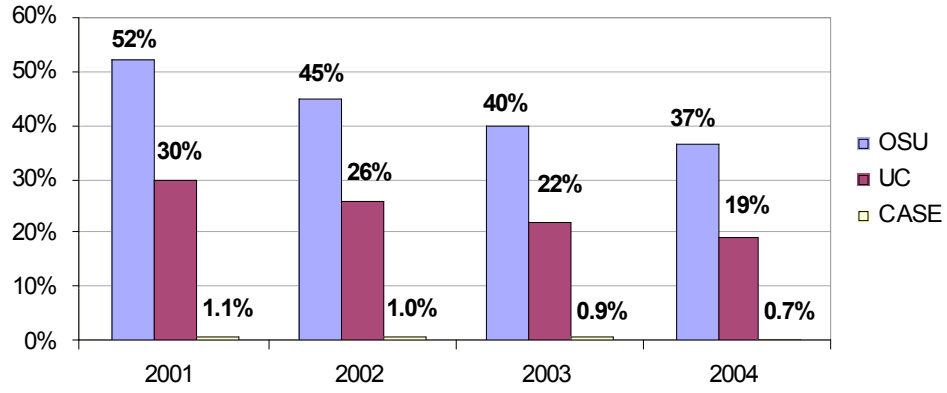
Case's operating expenses in fiscal year 2004 totaled $647 million, and it employed more than 3,600 people (excluding students).

Figure 6: Revenue Sources for the Three Research Universities, FY 2004



While university employment, student enrollment, and research expenditures have grown, reliance on state sources of income has declined. In fiscal year 2004, state appropriations accounted for about 19 percent of the three universities' revenues. Since 2001, the three universities have reduced their dependence on state appropriations as a revenue source, as shown in Figure 7. As a proportion of operating revenues, state appropriations to Case declined from 1.1 percent to 0.7 percent; appropriations to UC declined from 30 percent to 19 percent; and appropriations to OSU declined from 52 percent to 37 percent.

Figure 7: State appropriations as a proportion of operating revenues, FY 2001-2004



These universities are only three of the 75 Ohio institutions that grant four-year or higher degrees – but they play a disproportionate role in shaping higher education's contributions to the development of the Ohio economy. This is so for several reasons.

- Based on 2003 NSF data, Ohio State, Cincinnati and Case accounted for 79 percent of all R & D spending by colleges and universities in Ohio – $1 billion out of $1.26 billion.

- In 2004, the three research universities also accounted for roughly half of all "technology transfer" activity in the state – patents awarded to Ohio colleges and universities, licensing agreements with private companies and new start-up companies engaged in the commercialization of university research.

- With more than 35,000 full- and part-time employees in 2004, the three universities account for nearly 26 percent of all employment in public and private higher education in Ohio.

- In 2003, the three research universities accounted for 22.5 percent of the 388,000 students enrolled in 75 public and private colleges and universities in Ohio that grant four-year or higher degrees – including 26 percent of 102,000 students enrolled in graduate and professional degree programs.

- Along with their affiliated teaching hospitals, the three universities' medical schools anchor Ohio's three major academic health centers – the biomedical research centers that together are driving the development of the state's life science-based industries.

The three universities, moreover – Ohio State, Cincinnati and Case – are the leading educational and research institutions in the state's three largest cities – Columbus, Cincinnati and Cleveland, respectively. Focusing on these universities allows us to highlight in particular the important role that major research universities, including academic health centers, can play in revitalizing the economy of these cities.

II. The Universities as Employers

As noted in Part I, each of Ohio's three leading research universities – The Ohio State University, University of Cincinnati and Case Western Reserve University – is a major enterprise in its own right. Perhaps the most visible manifestation of the "university as enterprise" is the institutions' role as major employers. This part of the report highlights the total number of people employed by the three universities – their particular significance as leading employers in Columbus, Cincinnati and Cleveland – and just as important, the quality of employment opportunities that the universities offer to Ohio residents.

University Employment: By the Numbers

In the fall of 2004, The Ohio State University, University of Cincinnati and Case Western Reserve University together employed a total of 35,257 full- and part-time regular workers. They also employed 21,800 students, virtually all of whom worked part-time. Their combined payroll for regular employees in calendar year 2003 totaled $1.646 billion.[7] Wages paid to student employees totaled an additional $183.1 million.

To put these numbers in perspective, we can note that the number of people employed by the three universities in 2004 exceeded the number employed in auto manufacturing, in utilities, in telecommunications, in the advertising industry, or in the airline industry.

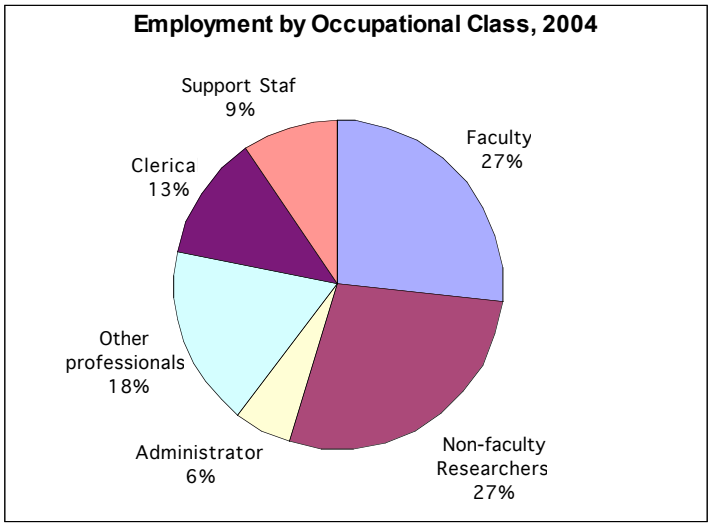
Table 2: Employment by University, 2004

	Full-time	Part-time	Total	Students	Grand Total
The Ohio State University	17,371	5,541	22,912	12,312	35,224
University of Cincinnati	6,519	2,218	8,737	5,604	14,341
Case Western Reserve University	3,254	354	3,608	3,884	7,492
TOTAL	27,144	8,113	35,257	21,800	57,057

Employment at the universities is distributed across a broad range of occupations. Faculty and non-faculty researchers make up the majority of employees (54 percent), but the universities employ other types of workers as well, including administrators, clerical, maintenance, security and food service workers.

[7] Excludes the student appointment payroll.

Figure 8: Employment by Occupational Class, 2004



Jobs for County Residents

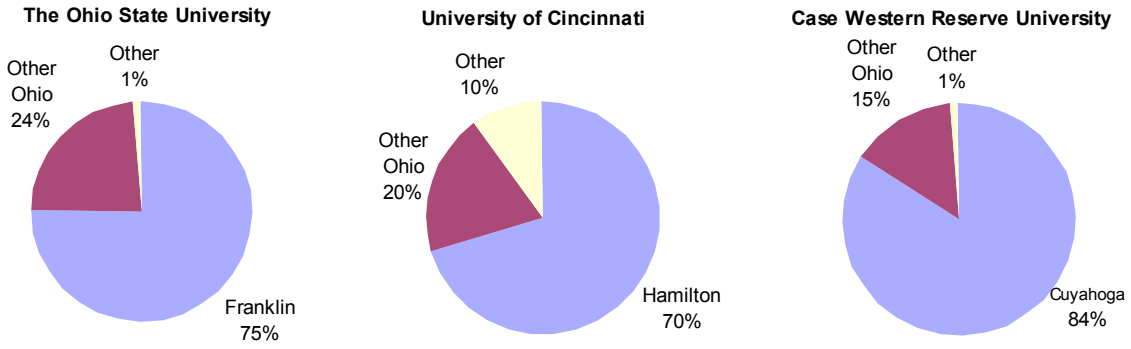
The three universities' significance as major employers is even more evident when viewed from the perspective of their home counties – Franklin, Hamilton and Cuyahoga. In 2003, The Ohio State University was the largest employer, other than state government, in Franklin County, representing 4.8 percent of all wage and salary employment in the county. University of Cincinnati was the largest employer in Hamilton County in 2004; and according to *Crain's Cleveland Business*, Case Western Reserve University was the 13th-largest employer in Cuyahoga County in 2004.

Not surprisingly, a substantial majority of the universities' 35,257 non-student employees – 76 percent – live in the counties where the three universities are located. Nearly all of the rest – 22 percent – lived elsewhere in Ohio.

Table 3: Employees' County of Residence, 2004

Employees' County of Residence, 2004	
Cuyahoga County	3,021
Franklin County	17,214
Hamilton County	6137
Other Ohio Counties	7,715
Other	1,170
Total	35,257

Figure 9: Employees' Place of Residence, 2004



The Quality of Employment at the Universities

The universities are notable not only for the number of jobs they provide, but also for the quality of those jobs. In 2004, the earnings of all full-year, full-time employees averaged $51,700. While this average reflects the relatively high salaries paid to faculty members and other professional staff, on average full-time support and clerical staff earned between $29,000 and $33,000 – close to the median for the State of Ohio.

The three universities provide a full complement of typical employee benefits, including medical and dental insurance coverage, life insurance, retirement savings programs and the opportunity to purchase other types of insurance at group rates. Ohio State and Cincinnati provide subsidized day care for several hundred children of university employees; and Case has negotiated discounts for its employees at a variety of businesses, including bookstores, auto mechanics, rental car businesses, computer manufacturers, restaurants, clothing stores, and entertainment establishments. The breadth of benefits that the University provides helped Case earn a designation by the Employers Resource Council in 2004 as one of the best places to work in Northeastern Ohio.

In addition to competitive salaries and benefits, the three universities offer their employees extensive opportunities for education and training – not just for themselves, but for family members as well. While the specifics of the program vary by institution and employee class, in general they offer tuition remission for employees, their children and spouses.

- For most employees, Ohio State offers tuition remission up to a maximum of $5,000 per quarter or 10 credit hours; for a spouse or child, the benefit equals 50 percent of fees.
- Ohio State offers a Bridge Program in conjunction with its Office of Continuing Education for employees with a high school education who would like to work toward a degree. The program offers core courses and advising to help employees combine work with part-time college studies.

- Case provides six credit hours for the fall and spring terms and three credit hours for the summer term to employees, a 50 percent waiver of tuition for spouses, and full remission undergraduate tuition (and a 50 percent discount on graduate tuition) for employees' children. The University also offers employees up to $1,500 for tuition payments at other institutions.
- University of Cincinnati provides six credit hours per quarter for full-time employees and unlimited hours for employees' spouses and children. For many part-time employees, the University provides three credit hours per quarter. In fiscal year 2005, an average of 1,200 University of Cincinnati employees per quarter took courses at a cost of $6,336,880 and 1,236 dependents of employees utilized the tuition remission at a cost to the University of $3,824,837.

Helping Employees Buy a Home

Having employees who own homes nearby can help a university by making it easier for those employees to participate in campus life, and by reinforcing a sense of community. Employees also benefit from sharply reduced commuting times; and the community can benefit from increased homeownership and investment in housing.

Ohio State, Cincinnati and Case all help their employees buy homes in the communities around their campuses.

- Ohio State University provides down payment assistance in the form of a zero interest forgivable loan up to $3,000 for purchases in the University District neighborhoods.
- For home purchases in the city of Cleveland, Case Western Reserve University provides up to $10,000 in grants over a six-year period. If the purchase is located in Wards 6 through 9, employees are eligible for an additional $5,000. Case also offers employees who own their homes $1,000 for exterior renovations.
- *Walk to Work*, University of Cincinnati's program to foster employee homeownership in the Uptown neighborhood of Cincinnati, is a $2,500 loan program repaid through payroll deductions over 2 years

Homeownership programs improve the surrounding neighborhoods of the universities and help make the universities employers of choice.

In addition to tuition assistance for degree courses and certificate programs, each of the universities' human resources departments provides training opportunities for employees. Listed below are several examples of training programs available to employees:

- The Ohio State University offers its maintenance employees a broad array of training programs, including courses in supervisory skills, technical courses about cooling and heating systems, and safety protocols. In fiscal year 2005, 77 employees took supervisory courses, 42 employees attended classes to increase their knowledge of Delta Controls (building control systems), 137 learned about steam traps, and 114 attended safety instruction for boilers, radiation, blood pathogens, etc.
- UC's human resources department sponsors workshops to help employees make financial decisions including planning for retirement, workshops designed to improve supervisory skills, and basic computer skills.
- Case offers a variety of learning opportunities for its employees including supervisory briefing sessions, staff development seminars, leadership programs and training in office computer software, graphic design and web creation.

By providing such a broad array of education and training opportunities, the universities not only enhance the skills and productivity of their own employees – they are making a long-term contribution to the growth of Ohio's human capital base. This is so for several reasons.

- The research universities are in themselves a significant component of Ohio's "knowledge economy." By enhancing the skills and productivity of their own work force, the three universities are strengthening their ability to compete effectively with major research institutions in other states.
- Employees who take advantage of the opportunities for education and training described above do not necessarily stay at the universities for their entire careers. Some move on to other jobs in Ohio, bringing with them the knowledge and skills they acquired while working at Ohio State, Cincinnati and Case.
- All three universities extend educational opportunities to employees' spouses and children. Ohio companies that hire the spouses and children of university employees benefit from this arrangement.

III. Purchasing and Construction

In addition to employing more than 35,000 people, Ohio's three leading research universities buy hundreds of millions of dollars worth of goods and services each year from Ohio companies. They also spend hundreds of millions of dollars annually on construction – creating business for local contractors and jobs for Ohio residents, and developing the facilities needed to support the growth of the state's knowledge economy.

Purchases of Goods and Services

Excluding construction, the Universities spent $814.5 million in fiscal year 2004 to purchase a broad range of goods and services. As shown in Table 4, $460 million was spent on purchases from Ohio businesses – 56 percent of the total.

Table 4: Purchasing by Location of Vendor, FY 2004

	Total Spending On Goods & Services	Purchases from Ohio Vendors	Percentage Ohio
The Ohio State University	$346,202,273	$203,109,027	59%
University of Cincinnati	$206,600,000	$126,196,938	61%
Case Western Reserve University	$261,723,257	$130,744,496	50%
Total	$814,525,529.88	$460,050,460.53	56%

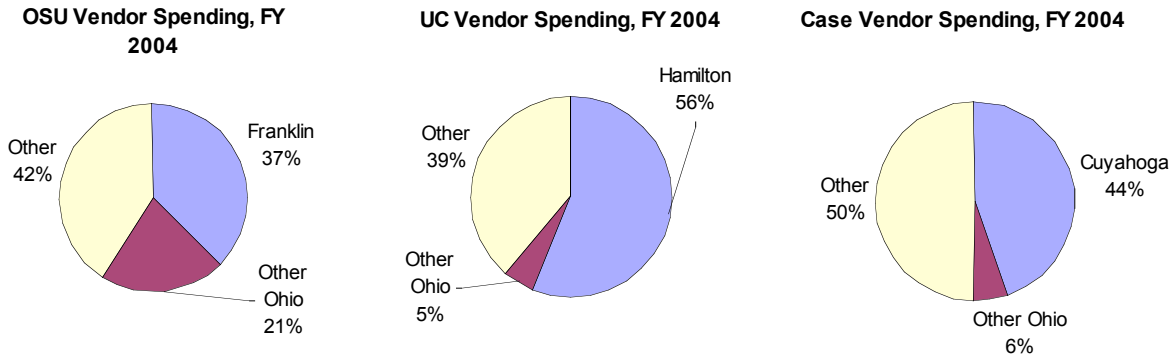
Commodities and services bought primarily within the state included food, fuel, furniture, electricity, legal services, insurance, and temp services.

Table 5: Top Types of Goods and Services Purchased in Ohio (in millions)

	TOTAL	Ohio	Percent Ohio
Temporary Services	$26.96	$25.51	95%
Fuel Oil/Coal/Electricity	$29.62	$19.44	66%
Restaurants & Catering	$17.03	$15.86	93%
Insurance	$19.26	$14.45	75%
Food Supplies	$12.84	$12.08	94%
Hospitals	$15.98	$11.82	74%
Legal Services	$7.71	$5.97	77%

Most of what the three universities buy in-state is bought from businesses and institutions located within their home counties. In 2004, Ohio State's, Cincinnati's and Case's purchasing within Franklin, Hamilton and Cuyahoga counties respectively totaled $361 million.

Figure 10: Location of the Universities' Vendors of Goods & Services



In-state purchasing translates directly into jobs at Ohio businesses and institutions. We estimate that ***in 2004, spending by the three universities on goods and services directly supported 5,109 full-time equivalent jobs in Ohio*** in industries such as those listed above in Table 5. This statewide total included:

- 1,524 FTE jobs in Cuyahoga County generated by Case's purchases of goods and services from local businesses;
- 1,370 FTE jobs in Franklin County generated by Ohio State's local purchasing; and
- 1,292 FTE jobs in Hamilton County generated by University of Cincinnati's payments to local vendors.

University Construction: An Investment in the Future

During the fiscal years 1999 through 2004, the three research universities' spending on construction totaled $2.09 billion – including $505 million in 2004 alone. University construction contributes to the Ohio economy in several ways. It generates business for Ohio construction firms – as Table 6 shows, 87 percent of all the money the three universities spent on construction in 2004 was paid to Ohio firms. And each year, university construction provides high-paying jobs to thousands of Ohio residents. Construction also provides the space the universities need to grow and maintain their programs of education and research; and by enhancing the environment they offer to faculty and students, it helps the universities attract talented people – students, faculty and researchers – to Columbus, Cleveland and Cincinnati.

Table 6: Construction Spending by Location of Vendor, FY 2004

Fiscal Year 2004	Construction	Ohio	Percentage Ohio
The Ohio State University	$ 259,465,544	$225,157,171	87%
University of Cincinnati	$179,890,000	$160,283,829	89%
Case Western Reserve University	$65,507,000	$54,173,002	83%
Total	$504,862,544	$439,614,002	87%

Many of the major projects completed during the past few years, or under construction in 2005, are designed to expand or enhance the universities' ability to support the kind of cutting-edge research and teaching that is so critical to Ohio's future. For example:

- Ohio State's new, 229,600 square-foot ***Physical Sciences Research Building***, constructed at a cost of $55.6 million, provides state-of-the-art research space for the Physics Department.

- OSU's new 14-story, 416,000 square-foot ***Biomedical Research Tower,*** constructed at a cost of $120.4 million, will open in late 2006. The Biomedical Research Tower will nearly double the university's biomedical research space with offices and labs supporting more than 120 faculty dedicated to cancer, cardiovascular and lung disease, and neurological disorder research, among many other disciplines.

- University of Cincinnati is investing $250 million in renovation and expansion of the 800,000 square-foot ***Medical Sciences Building.*** A 239,000 square-foot addition will house the Center for Academic Research Excellence / Crawley Building (CARE), which will include state-of-the-art learning and research space, classrooms, teaching labs, administrative areas and student support facilities.

- University of Cincinnati's $44 million renovation of the ***Genome Research Institute*** provides 360,000 square feet of research space where UC researchers partner with researchers from other universities and private companies to develop treatments for a variety of diseases.

- The multi-phase redevelopment of Case's West Quad includes an 18,500 square-foot building, to be completed in 2005, that will house the ***Cleveland Center for Structural Biology*** and the ***Power Partnership for Ohio.***

Other projects are aimed at enhancing the quality of campus life, thus helping to ensure that the three institutions can continue to attract and retain the most talented students, and provide an environment that fosters both learning and a sense of community.

Financed with a $119 per quarter student fee, University of Cincinnati's $233.7 million ***MainStreet Initiative*** creates a new campus center linking the east and west campuses.

MainStreet uses architecturally distinctive buildings and open space to create a feeling of community. Key components of the initiative include:

- University Pavilion, completed in 2002, a new building that brings all student administrative services together in one location;
- Renovation of the Tangeman University Center and the new Joseph A. Steger Student Life Center**,** opened in the spring of 2004, providing a total of 252,000 square feet of space for student activities.
- The 350,000 square-foot ***Campus Recreation Center,*** which when completed will house a state-of-the-art fitness center that will feature a climbing wall, lap pool, leisure pool, fitness and weight area, eight racquetball courts, six basketball courts, and a suspended running track. The project also includes six electronic classrooms, a convenience store and restaurants.
- ***Jefferson Residence Complex***, opened in fall 2002, which provides living space for 550 students.

- University of Cincinnati is also developing the $117 million ***Richard E. Lindner Varsity Village***. It consists of a complex of athletic fields and sports facilities that includes a new 3,000-seat baseball stadium, the 236,000 square-foot Richard E. Lindner Athletic Center, a six-court tennis center atop a parking garage and improvements to the Fifth Third Arena and Armory Fieldhouse.

- At Case, the four-phase ***North Residential Village*** will concentrate all undergraduate residence halls and new athletic fields in one location. The $126 million first phase, completed in August 2005, includes six new buildings with accommodations for 749 students, a convenience store, a Starbuck's café, and a new multi-purpose stadium for football, soccer track and field, baseball and softball.

- OSU replaced ***Larkins Hall*** with a completely new fitness facility at a cost of $140 million. This 605,000 square foot center opened in 2005 and includes five pools, 10 racquetball courts and an indoor track.

As noted above, projects such as these translate directly into business for Ohio contractors and jobs for Ohio workers. We estimate that ***in fiscal year 2004, spending on construction at Ohio State, University of Cincinnati and Case directly supported nearly 5,300 full-time-equivalent jobs in construction and related industries in Ohio***, including:

- 530 FTE jobs generated by Case in Cuyahoga County;
- 1,923 FTE jobs generated by University of Cincinnati in Hamilton County; and
- 1,526 FTE jobs generated by Ohio State in Franklin County.

As valuable as these jobs are, it is important to note that in the long run the real significance of major investments in university facilities lies in the contribution those

facilities make to the continued growth of Ohio's research enterprise, and to the universities' ability to attract, retain and develop human capital.

Building Local Businesses in Cleveland

Major research universities are often among the largest buyers of goods and services – and among the leading sponsors of construction projects – in urban areas. Universities can thus play an important role in ongoing efforts to develop minority, women-owned and other small businesses in these areas.

In 2002, Case created a Supplier Diversity Initiative Council, to help broaden opportunities for woman- and minority-owned firms to participate in university construction and procurement. In part as a result of the Council's work, awards to female and minority contractors and vendors in fiscal year 2004 reached $40 million.

Case has since continued to build on the Council's work. In December 2004, the university sponsored a two-day conference for local companies on "How to Navigate Case as a Vendor." The program provided information on upcoming projects, on the university's purchasing and contracting requirements and procedures, and on services provided through various Case partners, such as working capital loans provided by ShoreBank.

"How does a university located in an urban setting help drive economic development and inclusion?" asks Kathryn Hall, director of equal opportunity and diversity at Case. "In any community, you need to have as many people working as possible. When people are working, it supports the city's tax base, infrastructure and schools. We want to attract minority and female vendors that have an interest in doing business with the University."

IV. Indirect and Induced Effects

The three universities' spending on payroll, purchasing and construction, provides direct measures of their impact on the economy of their home counties and the state of Ohio, but their impact goes beyond these direct measures. Each dollar the universities spend produces what economists sometimes call indirect and induced effects – the "multiplier effect."

Their *indirect impact* is a product of spending within the state by all of the local companies from which the universities buy goods and services. Construction contractors, utility companies, temp services, caterers and other firms use the payments they receive from the three universities to pay their employees, rent space, buy equipment, supplies and telephone services – and all of these expenditures have an impact on the state's economy. The universities' *induced impact* represents the impact of routine household spending by the universities' employees – for rent, food, clothing, transportation and child care – and by the employees of its suppliers who live in Ohio.

Measuring the Multiplier Effect

While economists generally agree that these "multiplier effects" exist, they are difficult to measure. Patterns of spending and employment among supplier firms and employee households can vary over time and from one region to another. Within any given industry, the extent to which inputs are bought locally can vary greatly from one firm to another.

There are nevertheless several econometric models that can provide an approximate measure of indirect and induced effects. Using one of these models – IMPLAN – we have calculated the individual impact of the universities' spending on total economic output, wages and employment in their home counties and their combined impact on the state of Ohio.

Like other input-output models, IMPLAN simulates the flow of payments for goods and services across different industry sectors, and between households and industries. It can be envisioned simply as a table with hundreds of rows and columns, with all industries (plus households) listed down the side as producers; and the same industries (and households) listed across the top as consumers. Spending by any consumer industry – in this case, the universities – is allocated across all of the producing industries and the household sector. Each of these producer industries in turn purchases its own distinct set of inputs from other industries and households in order to produce the output it sells to the universities.

Just as the universities spend some of their revenues within their home counties, some elsewhere in Ohio and some outside the state, some of the money they pay to their local supplier industries stays within their communities or in other parts of Ohio, and some is

paid to businesses elsewhere in the U.S. or overseas. Through each successive round of spending, the money that was originally spent within the community or the region is eventually diffused throughout the economy.

The model thus allows us to trace the impact of each dollar of spending as it ripples through other industry sectors in Cuyahoga, Franklin and Hamilton Counties and the state of Ohio. It also allows us to translate the allocation of spending across industries into estimates of employment and wages.

Statewide Impact of University Spending

As discussed in Part III, the $460 million spent by the three universities on purchases from Ohio businesses in fiscal year 2004, and the $505 million spent on construction, directly accounted for approximately 10,400 full-time equivalent jobs with vendors and contractors throughout Ohio.

Similarly, university employees spend part of their take-home pay – a total of approximately $1.248 billion in disposable income – within the state. This spending directly supports approximately 7,600 FTE jobs.

As noted above, direct spending on payroll, purchasing and construction also generate "indirect and induced" or "multiplier" effects. As Table 7 shows, the indirect and induced effects generated by the three universities' direct spending on payroll, purchasing and construction in fiscal year 2004 totaled $1.164 billion in statewide economic output, and approximately 12,000 FTE jobs.

Thus, the direct, indirect and induced effects of three universities' spending on payroll, purchasing and construction – and the spending by university employees and in-state suppliers that university spending made possible – generated nearly 30,000 full-time-equivalent jobs throughout Ohio in 2004, and nearly $3.3 billion in statewide economic output.

Table 7: State-wide Direct, Indirect & Induced Impacts

TOTAL	Case Ohio	OSU Ohio	UC Ohio	Combined Impact on Ohio
Output				
Direct	$327,673,405	$1,254,031,746	$542,460,945	$2,124,166,096
Indirect	$81,057,362	$290,743,150	$147,940,909	$519,741,421
Induced	$104,464,010	$354,104,419	$185,486,398	$644,054,827
TOTAL	$513,194,777	$1,898,879,315	$ 875,888,252	$3,287,962,344
Employment (full-time equivalent jobs)				
Direct	3,491	9,164	5,180	17,835
Indirect	741	2,420	1,396	4,557
Induced	1,189	4,150	2,055	7,393
TOTAL	5,421	15,734	8,631	29,785

Local Economic Impact: Franklin, Hamilton and Cuyahoga Counties

The IMPLAN input-output modeling system can also be used to gauge the impact of spending by the three universities at the county level. As Table 8 shows, in 2004:

- In Franklin County, the direct, indirect and induced effects of Ohio State's spending on payroll, purchasing and construction included $1.256 billion in local economic output and 10,793 full-time-equivalent jobs.

- In Hamilton County, the direct, indirect and induced effects of University of Cincinnati's spending on payroll, purchasing and construction included $662.5 million in economic output and 6,517 full-time-equivalent jobs.

- In Cuyahoga County, the direct, indirect and induced effects of Case's spending on payroll, purchasing and construction included $402.9 million in economic output and 4,067 full-time-equivalent jobs.

(The sum of impacts across these three counties is less than the combined statewide impact of spending by the three universities, because some university employees live, and some suppliers are located, in other Ohio counties.)

Table 8: Direct, indirect and induced impacts on the individual counties

TOTAL	Cuyahoga	Franklin	Hamilton
Output			
Direct	$278,537,073	$904,950,633	$448,077,120
Indirect	$59,020,462	$176,440,824	$108,503,708
Induced	$65,337,601	$174,654,359	$105,931,282
TOTAL	$402,895,136	$ 1,256,045,816	$ 662,512,110
Employment (full-time equivalent jobs)			
Direct	2,837	7,302	4,303
Indirect	517	1,457	996
Induced	713	2,034	1,218
TOTAL	4,067	10,793	6,517

Taking into account:

- People employed by the three universities themselves (not including students),
- Those employed by vendors and contractors who provide goods and services (including construction) to the three universities, and
- The jobs at other businesses generated through the multiplier effect of household spending by employees and local spending by university suppliers,

We estimate that ***in 2004 The Ohio State University, University of Cincinnati and Case Western Reserve University directly or indirectly accounted for about 65,000 jobs in Ohio.***

V. Student and Visitor Spending

In addition to the economic impact they generate through their own spending on payroll, purchasing and construction, the universities have an effect on the local economy through the spending of students they attract to Cleveland, Columbus and Cincinnati, and spending by people who come to Ohio to visit the universities.

Student Spending

In the fall of 2003, a total of 86,734 students were enrolled at the three universities. Of these, 60,351 were undergraduates; the rest were graduate or professional students. In addition to those who were enrolled during the spring and fall semesters, 30,419 took classes during the summer term.

In analyzing the impact of student spending on Ohio's economy, we have included only spending by students who have come to Ohio from other states. We assume for purposes of this analysis that spending by in-state students has no direct impact on the state's economy – if they were not attending one of the three universities, they would still in all likelihood be spending money on routine living expenses.[8]

Of the 60,351 undergraduate students enrolled at the three universities in the fall of 2003, 8,134 were identified as out-of-state residents. In addition we've segregated estimates of out-of-state undergraduates who live in university residence halls from those who live off-campus. (Payments by undergraduates for room fees are already counted in our analysis of universities' revenues.)

Using data provided by each university, Appleseed estimates that out-of-state undergraduate students living off-campus spent an average of $10,873[9] during the academic year on rent, meals, personal supplies and services, local transportation, entertainment and other purposes. Those living on-campus spent an average of $2,770. Based on these assumptions, we estimate that routine living expenses by out-of-state undergraduates totaled $63.96 million in 2003-2004. Students attending summer courses spent an additional $4.91 million.

Spending by graduate and professional students has a greater impact – they are more likely to be from out-of-state, their living expenses are higher, they are less likely to live in university residence halls and they are more likely to spend the summer on-campus. In the fall of 2004, 26,383 graduate and professional students were enrolled at the three

[8] This is a conservative assumption; without Ohio State, Case and Cincinnati, a significant percentage of the in-state students who now attend these universities would probably be enrolled at other universities out-of-state.

[9] Weighted average of costs used by each university for financial aid purposes.

universities, of whom 9,612 – 36 percent – came from out-of-state. Of these 9,612 out-of-state graduate and professional students, 5,229 stay on campus for the summer.

Graduate students who live off-campus incur average expenses of approximately $12,112 for the academic year and an additional $3,383 for the summer session.[10] Based on these assumptions, we estimate that routine spending by the universities' out-of-state graduate and professional students in 2004-2005 totaled $133.1 million.

Thus, we estimate that direct spending in Ohio by out-of-state students in fiscal year 2002 totaled $201.95 million.

Table 9: Calculation of Student Spending

Student Spending	Out-of-State Enrollment Living Off-Campus	Average Off-Campus Spending	Out-of-State Enrollment Living On-Campus	Average On-Campus Spending	Grand Total
The Ohio State University					
Academic Year	7,756	$ 11,434	1,196	$ 3,974	93,435,008
Summer Session	4,010	$ 2,903	42	$ 994	11,682,778
University of Cincinnati					
Academic Year	4,189	$ 13,860	431	$ 4,092	59,823,192
Summer Session	2,922	$ 3,657	20	$ 906	10,703,874
Case Western reserve University					
Academic Year	2,751	$ 9,008	1,078	$ 1,206	26,081,076
Summer Session	98	$ 2,252	-	$ -	220,696
TOTAL					**$ 201,946,624**

Using the IMPLAN input-output modeling system, we estimate that in 2004, off-campus spending by out-of-state students attending Ohio State, Cincinnati and Case supported 2,154 full-time-equivalent jobs in retailing, restaurants, real estate and other local businesses.

Spending by Visitors

Each year, the universities attract thousands of visitors to Ohio. Out-of-towners come to the universities for a variety of reasons. They include prospective students and their parents, fans of the universities' teams, guests at commencement and other major campus events, representatives of companies that do business with the universities, family members and friends visiting students.

There is no central source of information about visitors to the universities. Many of them no doubt go uncounted. By focusing on a few categories for which data are available, we can nevertheless give some indication of the magnitude of these impacts.

- ***Athletic Events***

Although there are some categories of visitors for which data are not available, it seems clear that university athletic events account for the largest share of visitor spending.

[10] There are a few graduate students who live in university housing and their living expenses are approximately $5,000 for the academic year.

The Ohio State University supports 36 different sports. In 2004-05, Columbus hosted more than 325 home games. These varied from nationally televised OSU football games with more than 101,000 fans in attendance to women's softball hosted in the 500-person capacity Buckeye Softball Stadium. Based on information on the number of home games and from a recent study of the economic impact of athletic events at Ohio State, Appleseed estimates that 149,000 of the fans that attended games in Columbus came from out-of-state. Using information from *The Economic Impact of The Ohio State Department of Athletics upon the Greater Columbus Region for the 2002-2003 Academic Year,* Appleseed estimates that out-of-state attendees at athletic events spend approximately $90 per trip on a variety of dining, parking, lodging and other expenses. Therefore Appleseed calculates that fans of OSU athletic events added $13.5 million in additional economic activity to the state. (Payment for tickets to OSU events will be captured by the analysis of its revenue.) In addition to the fans, the 10,348[11] visits by opposing teams, NCAA officials, etc., added an estimated $0.9 million to the local economy.

In addition, OSU athletic facilities host a variety of other events: NBA exhibition games, concerts, and family shows that attract visitors from out-of-state. Appleseed estimates that approximately 2,960 visitors from out-of-state attended one of the 39 shows at the Jerome Schottenstein Center in fiscal year 2004. This translates into $0.3 million in additional economic activity. In total, OSU athletic events (and ancillary uses of its athletic facilities) generated $14.7 million in visitor spending.

University of Cincinnati estimates that 500,000 visitors attended a UC athletic event. For purposes of this analysis, Appleseed assumes that 20 percent are from out-of-state. Using an average per-trip spending number equal to that used for Ohio State, ($90.00), we estimate that UC athletics brought $9.0 million worth of additional economic activity into the state of Ohio.

Case also draws an estimated 9,000 visitors to its athletic events, but very few of these visitors are from out-of-state. Therefore, it is assumed that any spending done by attendees at these events is money that would have been spent on other entertainment or athletic events in the Cleveland area.

In total, Ohio State and University of Cincinnati athletics increased economic activity by $23.7 million.

- ***Prospective Students.***

All three universities host tours of the campus for prospective students and their families. The Ohio State University estimated that of the 23,000 visitors that attended on-campus tours, 17.4 percent were from out-of-state.[12] University of Cincinnati estimated that

[11] The Economic Impact of the Ohio State University Department of Athletics upon the Greater Columbus Region for the 2002-2003 Academic Year, April 2004, Dr. Patrick Rishe

[12] After completing the economic impact analysis, Appleseed received new data from OSU that indicates that just over 72,000 prospective students and their families visited the campus in FY 2004.

60,000 visitors attended a campus tour and Appleseed estimated that 10,539 were from out-of-state based on the percentage of out-of-state enrolled students. Case Western Reserve University estimated that 15,211 visitors attended a campus tour or a parent weekend. Of these an estimated 4,323 were from outside the region and 6,900 were from outside the state.

Using data on visitor spending collected by the Ohio Division of Travel & Tourism, we estimate that spending by each out-of-state visitor averaged $467.46 per trip; and that spending by "day-trippers" averaged $74.92 per trip. Based on these figures, we assume that visits by prospective undergraduate students and their families generated approximately $10.35 million in local spending in 2004-5.

- ***Commencement***

During 2003-2004, the three universities awarded 20,375 undergraduate, graduate and professional degrees. An estimated 4,235 of the degrees were granted to students with a permanent out-of-state address. Using the information from the Division of Travel & Tourism, it is estimated that out-of-state visitors for commencement ceremonies added $3.4 million in local economic activity.

- ***Other large events***

All three universities also serve as venues for conferences, regional meetings, and special events. The majority of these visitors are not tracked, but Case was able to estimate that for the 2004 Vice Presidential Debate, nearly 3,500 out-of-state visitors attended the debate or symposiums that occurred in conjunction with the actual event. These visitors are estimated to have spent $1.6 million.

Table 10: Estimated Spending by Selected Visitor Categories, 2004

Visitors	Spending
Prospective Undergraduates	$10.4 million
Athletic Events	$23.7 million
Commencement	$3.4 million
Large events	$1.6 million
Total	$39.10 million

Impact of Student and Visitor Spending

As discussed in the previous section, Appleseed used IMPLAN to model the impact of spending, this time by students and visitors, on the Ohio economy. The infusion of $235 million in spending by students and visitors from out-of-state generated an additional $94.8 million in indirect and induced spending. In turn, this spending directly generated 1,967 jobs and through the indirect and induced spending created 988 additional jobs.

It is worth noting once again that the estimated impact of spending by students and visitors that is presented in Table 11 is probably understated in two respects.

- We have not attempted to quantify the impact of spending by the several categories of visitors for which we have no data, such as participants in academic conferences, or representatives of out-of-state companies that do business with the universities.
- By not counting the impact of spending by in-state students, we are implicitly assuming that all in-state students, if they were not attending one of these three universities, would nevertheless stay in Ohio – probably a very conservative assumption.

Even with these limitations, however, it is clear that spending by students at and visitors to Ohio State, Cincinnati and Case generates jobs for thousands of Ohio residents.

Table 11: Students and Visitors Spending Direct, Indirect and Induced Impacts

TOTAL	Combined Impact on Ohio of Students	Combined Impact on Ohio of Visitors	TOTAL IMPACT
Output ($ millions)			
Direct	$157,413,993	$29,307,805	$186,721,798[13]
Indirect	$38,743,226	$10,941,590	$49,684,816
Induced	$33,674,005	$11,454,870	$45,128,875
TOTAL	$ 229,831,224	$ 51,704,265	$ 281,535,489
Employment (full-time equivalent jobs)			
Direct	1,395	573	1,967
Indirect	393	104	497
Induced	367	125	491
TOTAL	2,154	802	2,955

[13] The IMPLAN model yields a significantly lower direct impact compared to the direct spending of $234.95 million, because it reduces retail spending to wholesale costs.

VI. Developing Ohio's Human Capital

Human capital — the knowledge and skills that workers accumulate through education and experience — plays a central role in determining the growth and decline of cities and metropolitan areas. In today's knowledge- and innovation-based economy, talented workers develop new technologies, create new companies, and find ways to increase productivity in existing industries. As Richard Florida puts it, talented workers are the "economic raw material" of the knowledge economy.[14]

For cities such as Cincinnati, Cleveland, and Columbus, a skilled workforce is particularly important to sustain economic growth. Edward Glaeser and Albert Saiz argue that human capital helped cities in the northeastern United States such as Boston and New York "reinvent" themselves throughout the 20th century, expanding into new industries and taking advantage of new technologies faster than other regions.[15] Cities and regions that want to prosper in today's economy must constantly replenish and upgrade their supply of talent.

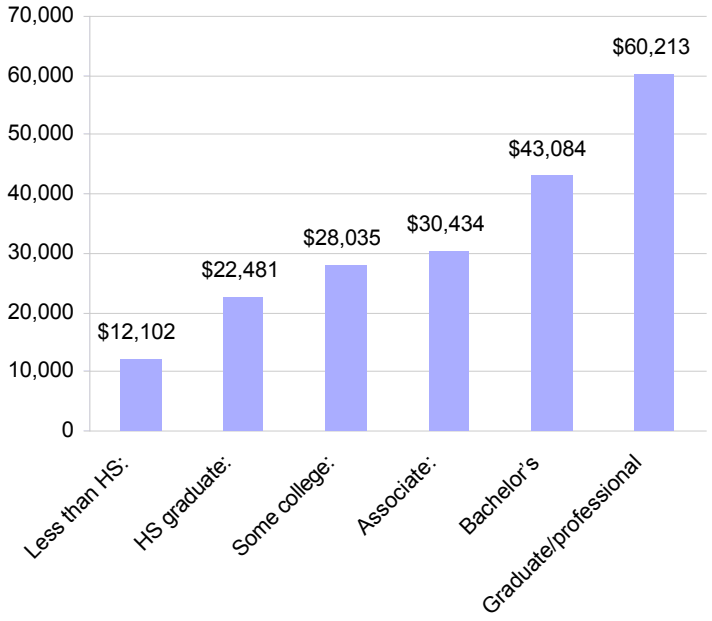
What is it that universities do to build a state or city's supply of human capital?

- First, universities produce a constant supply of graduates who have recently been exposed to new ideas – the latest scientific findings, new technologies, new business concepts and practices.
- Second, universities – especially major research universities – also establish a physical base of intellectual activity. Top research faculty and talented graduate students are drawn to universities. Companies seeking a supply of talent often choose to locate their facilities near universities; and talented professionals remain in (or move to) regions where they have access to a diverse set of employers in their industry. In other words – brainpower attracts more brainpower.

The connection between education and earnings is well known. Data from the 2000 census show that in 1999, the earnings of Ohio residents with four-year college degrees were nearly double the earnings of those with no education beyond high school (Figure 11).

[14] Florida, Richard. "The Role of the University: Leveraging Talent, Not Technology." *Issues in Science and Technology*, Summer 1999, pp. 67-73.
[15] Glaeser, Ed and Saiz, Albert. "The Rise of the Skilled City," in W.G. Gale and J. Rothenberg Pack (eds.) *Brookings-Wharton Papers on Urban Affairs*: 2004, pp. 47-105.

Figure 11: Average earnings for Ohio residents, age 25 – 64, by educational attainment, 1999



The economic benefits of higher education, however, are not limited to the graduates themselves. Higher education has important spillover effects. Studying the relationship between education and metropolitan area employment, economist Enrico Morretti found that a 1 percent increase in the number of college graduates in a metropolitan area increased the wages of high school dropouts, high school graduates, and college dropouts by 1.2 to 1.9 percent.[16] Morretti and others argue that spillover effects like these are the result of overall growth in local productivity levels.

Unlike many types of economic stimulus that have only a short-term impact, the value of a constant supply of recent college graduates does not decline over time. Examining the university's role in city reinvention, Glaeser and Saiz found one easy way to explain a metropolitan area's growth between 1970 and 2000 was by counting its number of colleges and universities per capita in 1940—thirty years before the study period.[17]

How is the State of Ohio performing in terms of human capital creation? One widely used measure indicates that the state is falling behind its peers. As noted in Part I, the U.S. Census Bureau reports that in 2004 23.3 percent of Ohio adults over 25 had bachelor's degrees. That's below the national average of 27 percent, and below Ohio's peer states such as Pennsylvania (24.7 percent) and Illinois (29.1 percent). While Ohio's high school graduation rate is higher than the national average, the percentage of high school graduates who decide to go on to college is lower.[18]

[16] Moretti, Enrico. "Estimating the social return to higher education: evidence from longitudinal and repeated cross-sectional data." *Journal of Econometrics* 121 (2004) 175 – 212.
[17] Glaeser, Edward and Albert Saiz. *op. cit.*
[18] Ohio Board of Regents, "Success Strategies for the Knowledge Economy," September 2004, p. 2.

In order to address these issues, Governor Taft convened the Commission on Higher Education and the Economy. Among the Commission's strategies to develop a knowledge-based workforce:

- Increase the number and proportion of Ohioans who participate and succeed in higher education.
- Increase the number and proportion of Ohioans with mathematics and science knowledge, skills, and degrees.
- Develop programs to improve the skills of Ohioans already in the workforce.[19]

This part of the report explores the role of The Ohio State University, University of Cincinnati and Case Western Reserve University in human capital creation in the Ohio. We look at the number of students enrolled in degree programs, the number of alumni who stay in the state and contribute to the Ohio economy, the universities' degree programs in important areas of innovation, as well as continuing education programs available to residents who want to upgrade their skills.

Students and Alumni

In the fall of 2003, Ohio State, Cincinnati and Case enrolled 86,734 students – a combined student population that would rank as Ohio's seventh largest city. The three universities conferred 20,375 degrees in 2003-2004 – 12,234 to undergraduates, and 8,141 to graduate and professional students.

Table 12: Enrollment and Degrees Granted, by University and Degree Status

	Enrollment, Fall 2003			Degrees granted, 2004		
	Undergrad	Graduate	Total	Undergrad	Graduate	Total
The Ohio State University	37,605	13,126	50,731	8,288	4,484	12,772
University of Cincinnati	19,159	7,658	26,817	3,156	1,928	5,084
Case Western Reserve University	3,587	5,599	9,186	790	1,729	2,519
TOTAL	**60,351**	**26,383**	**86,734**	**12,234**	**8,141**	**20,375**

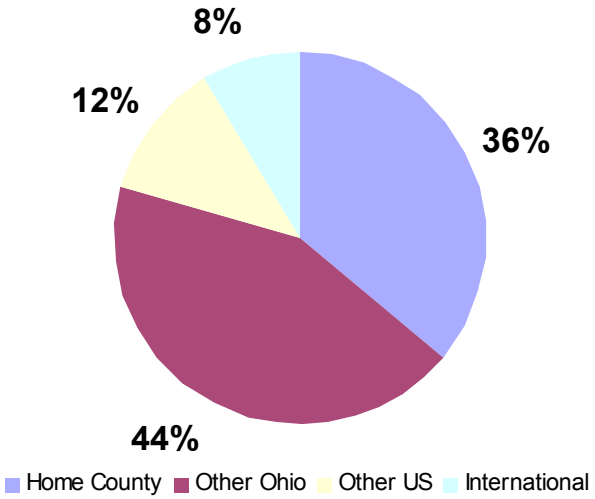
Major research universities act as magnets for talent, attracting out-of-state high school graduates and potential graduate students with the promise of a world-class education, mentors in research and industry, and access to leading laboratory and clinical facilities. Ohio's three research universities are no different—17,743 undergraduate and graduate students – 20 percent of total enrollment at the three institutions – come from out-of-state.

[19] Governor's Commission on Higher Education and the Economy, "Building on Knowledge, Investing in People: Higher Education and the Future of Ohio's Economy," April 2004.

And they are not just coming from the United States. International students made up 41 percent of out-of-state enrollments in 2003, a testament to the universities' global reputation. According to the Institute of International Education, the state of Ohio is ranked ninth nationally in attracting international students. The Ohio State University and University of Cincinnati lead the way in the absolute number of international student enrollments in the state and Case Western Reserve University leads in the proportion of international student enrollments.[20]

Even as they attract many students from outside Ohio, the three universities—particularly The Ohio State University and University of Cincinnati — also appeal strongly to Ohio residents. In the fall of 2003, 68,441 – 80 percent – of the three universities' students came from Ohio. While this means that the universities are generating less revenue from out-of-state students, they are establishing bonds with students that may have greater long-term benefits for the state of Ohio.

Figure 12: Undergraduate and Graduate Enrollment, by Permanent Address, Fall 2003



After graduation these young adults, with their newly acquired knowledge and expertise, are highly mobile—free to pursue their careers anywhere they choose. But more often than not, they stay in Ohio, contributing to the state's economy. Nearly 60 percent of all graduates of The Ohio State University and University of Cincinnati and 43 percent of all graduates of Case Western Reserve University live in the state of Ohio. ***In 2004, nearly 400,000 residents of the state of Ohio were graduates of one of these three universities.*** Based on U.S. Census Bureau estimates, we estimate that one in five college-educated Ohioans graduated from one of these three universities.

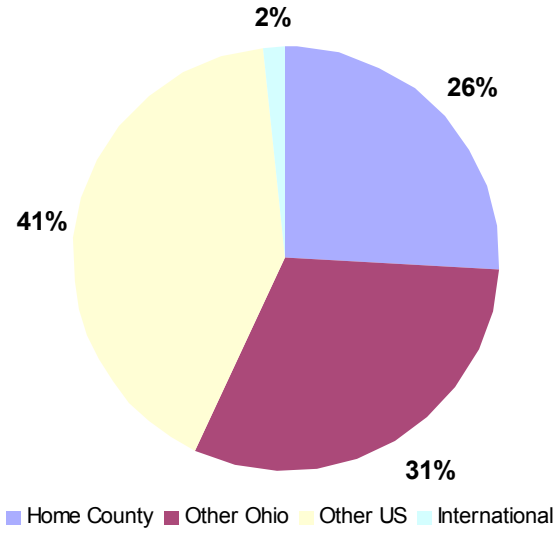
[20] Institute of International Education, "Open Doors 2004: Statistics on International Student Mobility," November 2004.

Table 13: Current Location of Alumni, End of 2004

	Location of Alumni			
	Same County	Other Ohio	Outside Ohio	Total
The Ohio State University	93,500	144,647	167,518	405,665
University of Cincinnati	61,656	51,661	73,237	186,554
Case Western Reserve University	25,002	19,149	57,741	101,892
TOTAL	**180,158**	**215,457**	**298,496**	**694,111**

The three universities' contribution to Ohio's supply of human capital is particularly evident in the communities in which they are located. Using the Census Bureau's 2004 estimates on educational attainment, we estimate that nearly 10 percent of all Cuyahoga County residents who have four-year college degrees are Case graduates; 34 percent of Hamilton County residents with four-year degrees are University of Cincinnati graduates; and 37 percent of Franklin County residents with four-year degrees are Ohio State graduates.

Figure 13: Current Location of Alumni, End of 2004



Through much of the 1990s, graduates of Ohio's colleges and universities were more likely to stay in Ohio after graduation than their counterparts in other states.[21] By 2001, however, Ohio college graduates were slightly more likely than those in other states to leave; 65 percent choose to stay in Ohio after graduation vs. the national average of 69 percent. Of those who left, 44.8 percent – by far the largest group – cited employment as the primary reason for leaving the state.

[21] Shadya Yazback, "Losing Its Minds? Evaluating 'Brain Drain' in Ohio," Economic Commentary, Federal Reserve Bank of Cleveland, January 1, 2005.

Preparing Ohio's 21st Century Workforce

Undergraduate education is changing to reflect the demands of the knowledge economy. Employers increasingly seek out employees with a wide range of skills—physicists who can estimate a new technology's market potential, engineers who can lead multi-disciplinary project teams, researchers who can apply new technologies across a half-dozen disciplines. Ohio State, Cincinnati and Case all offer courses of study that expose students to many disciplines in order to prepare them for the demands of today's economy.

Case offers top-ranked undergraduate and graduate degrees in ***biomedical engineering***. In 2004, *U.S. News and World Report* ranked Case's program fourth in the U.S. It focuses on interdisciplinary learning, with broad collaboration among the Colleges of Medicine, Engineering, and the affiliated medical centers. The program includes multidisciplinary courses such as 'Design for Biomedical Engineers,' in which student teams design a prototype medical device with commercial potential. While applying engineering techniques they have learned, students also learn how to work effectively as part of a project team, how to work within the Food and Drug Administration's regulatory guidelines, and how to communicate effectively.

One advantage research universities have over other colleges is that the results of yesterday's laboratory experiment may end up in today's classroom lecture. The Ohio State University's ***Nanotechnology Literacy Initiative*** offers an example. As researchers in Ohio State's Nanoscale Science and Engineering Center advance the commercialization of nanoscale biomedical products, they are also making knowledge about nanotechnology available to different audiences: current and future members of the industrial workforce, educators and researchers, and the general public. To accomplish this, NSEC faculty and researchers are creating a nanobiotechnology minor for undergraduate students and a professional certificate for graduate students. The curricula for these programs will be based around eight new courses—from a survey of current nanotechnology research to specialized courses focusing on using nanotechnology in medical diagnosis and treatment.

University of Cincinnati is also turning its nanotechnology research into practical knowledge. With its courses in quantum computing and nanostructured powders; and seminars in BioMEMS, microfuidics, and lab-on-a-chip technology, *Small Times* magazine ranked University of Cincinnati second in the nation in nanotechnology education.

Some University of Cincinnati engineering students will be able to complete their bachelor's and master's degrees in five years as part of the school's ***ACCEND (ACCelerated Engineering Degree)*** program. In addition, they can combine any baccalaureate engineering degree with an MBA in five years.

Degrees in High-Growth Industries

On average, all college graduates earn more than those without a college degree, but particular skills are more valuable than others in the current economy. The Governor's Commission on Higher Education and the Economy (CHEE) identified a need for an increased number and proportion of Ohioans with mathematics and science knowledge, skills, and degrees.[22] In addition, the Governor's Third Frontier initiative has identified five priority industries that are critical to Ohio's success in a knowledge- and innovation-based economy. These five industries, and related academic disciplines, are listed in Table 14.

Table 14: Third Frontier Priority Industries and Related Degrees

Third Frontier Industry	Related Degrees
Advanced materials	Materials and chemical engineering, physical sciences
Biosciences	Biology, biomedical engineering, medical, health professions
Advanced manufacturing	Materials, mechanical, electrical, and industrial engineering
Power and propulsion	Physical sciences, mechanical and chemical engineering
Information technology	Mathematics, computer science, information systems, electrical and computer engineering

Many of Ohio's colleges and universities contribute to the stream of highly-skilled graduates needed to sustain growth in Third Frontier and other strategic industries; but Ohio State, Cincinnati and Case play a disproportionate role in the process. This is evident when we compare the number of degrees in key disciplines granted by the three major research universities with the total number granted by a broader group of seventeen Ohio universities.

Although graduates of Ohio State, Cincinnati and Case account for only about 35 percent of the 55,821 degrees conferred by the seventeen universities, they granted 47 percent of degrees in fields leading to careers in Third Frontier priority industries. In particular, the three universities produced a large share of the state's graduates in biomedical and engineering professions.

Not only are Ohio State, Cincinnati and Case producing a large share of Ohio graduates in these areas, but based on program rankings, the universities are graduating highly qualified workers. Based on the most recent *U.S. News & World Report* rankings, The Ohio State University, University of Cincinnati, and Case have the top ranked undergraduate and graduate engineering schools (among universities offering doctoral degrees) and the top ranking medical schools in the state of Ohio.

[22] Governor's Commission on Higher Education and the Economy, *op. cit.*

Table 15: Priority Industry-Related Degrees, Baccalaureate through Doctoral, 2002-2003

Priority Degree Area	OSU	UC	Case	Others[23]	Total	3-University Share
Computer and information sciences	229	104	56	913	1302	29.9%
Engineering	948	579	414	1754	3695	52.5%
Biological and biomedical sciences	473	109	169	1157	1908	39.4%
Math and statistics	112	54	17	246	429	42.7%
Physical sciences	181	94	77	561	913	38.6%
Medical professions	765	243	208	803	2019	60.2%
Subtotal Priority Degree Areas	**2708**	**1183**	**941**	**5434**	**10266**	**47.1%**
All Degrees	**12076**	**5177**	**2526**	**36042**	**55821**	**35.4%**

Source: National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS)

Continuing Education

As Americans compete for knowledge-based jobs in an increasingly global economy, many turn to continuing education programs to upgrade their skills or to jump-start a career change. The National Center for Education Statistics has found that the proportion of adults who participate in all types of continuing education increased from 33 to 46 percent between 1991 and 1999 and—based on demographic trends—is expected to increase further.[24]

The term "continuing education" covers a wide range of services. In its more traditional form, continuing education includes:

- Night and weekend courses for people who are pursuing degrees while working full-time;
- Single courses on a wide range of topics, taken either for career purposes or simply for personal enrichment; and
- Career-oriented certificate programs for those who have already completed college.

At University of Cincinnati, nearly 12,000 people enrolled in continuing education courses held on the Uptown campus during the 2003-2004 academic year. During the same period, Ohio State enrolled over 10,000 students in continuing education programs – including 4,600 in courses for which they earned college credit.

[23] Includes Bowling Green State University (main campus), Central State University, Kent State University (main campus), Miami University (Oxford Campus), Northeastern Ohio Universities College of Medicine, Oberlin College, Ohio University (main campus), Shawnee State University, University of Akron (main campus), University of Dayton, University of Toledo, Wright State University (main campus), Xavier University, Youngstown State University

[24] National Center for Education Statistics, "Participation Trends and Patterns in Adult Education: 1991 to 1999", February 2002.

Co-operative Education at University of Cincinnati

At University of Cincinnati, undergraduate students in the College of Engineering; the College of Design, Art, Architecture, and Planning; and the College of Applied Science gain experience working for major companies in their fields, both in the United States and abroad. Founded in 1906 by Engineering Dean Herman Schneider, UC's cooperative education (or "co-op") was the first of its kind in the country, and is still among the largest.

Every year, nearly 3,500 students from more than 40 University of Cincinnati programs participate in co-op, alternating standard academic quarters with paid internships. For those in the College of Engineering, Design, Art, Architecture, and Planning, and the College of Applied Science, co-op is mandatory for completion of their degree and, in many cases, the reason they chose UC over other schools. For students in other colleges – like the College of Business and the McMicken College of Arts & Science, co-op is just a great way to get valuable workplace experience with renowned organizations.

University of Cincinnati students "co-op" with world-class companies and organizations like Procter & Gamble, General Electric, General Motors, Dow Chemical, and NASA. One student, a mechanical engineering major, spent three co-op quarters working for Procter & Gamble on product and room design. He spent another quarter with an engineering group at Toyota. Another student, in the College of Design, Art, Architecture, and Planning, spent a quarter with Coca-Cola in Atlanta and a summer with the design consultancy DEGW in London. At DEGW she focused on designing office space. Yet another student spent 3 quarters with Procter & Gamble as a facilities manager and brand manager. He led meetings with vendors and contractors and managed a budget of nearly $800,000.

While gaining valuable work experience, students work closely with faculty advisors, who help them get their career on track with co-op work goals and guide them through their work experiences.

In addition to these programs, some universities offer what can collectively be called "continuing professional education" programs. These typically consist of short, intensive courses for physicians, business executives and other professionals seeking to update or upgrade their skills.

"Traditional" continuing education.

In every part of the country, demand for educational services from non-traditional students (mid-career or new-career professionals, skilled blue collar workers, retirees, etc.) is increasing. The three universities offer a wide range of programs to meet these students' needs. For example:

- ***Communiversity*** is University of Cincinnati's lifelong learning program, offering non-credit classes to members of the community. The most popular Communiversity courses include Computer Skills; GRE/GMAT/LSAT preparation; Spanish, Italian, and French language; Starting and Managing a Small Business; as well as fitness and art classes.
- Through its ***College of Applied Science,*** University of Cincinnati offers a wide array of evening Associate, Bachelor, and Certificate programs in everything from mechanical engineering technology to information technology to horticulture. Some Cincinnati-based construction firms, for example, sponsor their employees in technical courses in order to broaden their knowledge of the business.
- Case offers a unique ***Master of Engineering and Management*** program. Rather than focusing on research and thesis writing, the program lets practicing engineers deepen their technical skills while increasing their ability to manage and make business decisions. The program is offered through The Institute for Management and Engineering, which combines resources from the Case School of Engineering and the Weatherhead School of Management.
- The ***Mandel School of Applied Social Sciences*** at Case offers lifelong learning courses in the social and health sciences. This includes a popular Social Work Licensure Examination review course. In 2003 alone, 1,316 Ohioans participated in eighty workshops and the Mandel School issued 2,302 continuing education certificates.
- The Ohio State University offers an engineering program of global renown, the ***Master of Science in Welding Engineering***. Its students come from all over the world—but many of them never set foot in Columbus. In addition to being offered on campus, the extremely popular program is offered in a distance education format, allowing students to view lectures and chat with faculty and graduate assistants via the Internet. Thirty to 35 students are typically enrolled in the program at any one time.

Continuing professional education

In addition to traditional continuing education programs, some universities offer what can collectively be called continuing professional education programs. These typically consist of short, intensive courses for physicians, business executives and other professionals seeking to update or upgrade their skills.

All three universities offer ***Executive Education*** programs through their schools of business. The Executive Education program at OSU's Fisher College of Business is typical of programs serving business executives. It offers over a dozen courses ranging in length from one to five days on topics such as quality control and supply chain management, and review courses for certified public accountant and chartered financial accountant exams.

On the strength of its agriculture program and its relationships with regional food and agricultural products companies, The Ohio State University offers a unique ***AgriFood*** track in its Executive MBA program. The coursework focuses on agriculture- and food-related strategic planning, supply chain, and regulatory issues.

Improving Access to World-Class Research Universities

To take advantage of the educational opportunities offered by Ohio State, Cincinnati and Case, students must clear two hurdles: they must be admitted and they have to be able to afford their education. The three universities offer an array of programs to improve access to the universities' degree-granting programs and to help students pay for their education.

In the fall of 2004, University of Cincinnati's ***Center for Access and Transition*** (CAT) admitted 650 promising students who just missed the cut-off for admission into the university's undergraduate colleges. For up to one year, the program provides students with in-depth math and English instruction, one-on-one tutoring, and workshops on research and information literacy—as well as education and career advising to keep them focused on their goals.

At the beginning of the program, students and their advisors sign off on a personalized learning agreement. When students complete the terms of the learning agreement – for example, completing a certain set of courses with a minimum GPA – they are eligible for automatic admission in to one of six UC colleges. After the program's first quarter, 150 students out of the first group made the transition to UC's colleges – that's 150 more young adults on the way to a bachelor's degree in the state of Ohio.

The cost of a university education can also be a barrier for high school students. The Ohio State University's scholarship programs help students who may not otherwise be able to attend. For example, the ***Morrill Scholars Program*** provides awards that increase the number of underrepresented students based on ethnic background, socioeconomic status, and home county. In the fall of 2004, OSU awarded 470 students Morrill Scholarships ranging in value from covering in-state tuition to covering full tuition, room and board, books, and miscellaneous expenses. Ohio students are eligible to receive a ***Land Grant Opportunity Scholarship*** – this new program awards a full scholarship to one student in each of Ohio's 88 counties. The university has committed to spend nearly $1.5 million this year on the program.

Case offers the ***Ohio Leadership Scholarship***, awarded to at least 12 freshman applicants who are Ohio residents. The award, which is renewable annually, is given to students after interviews with a faculty member and a university alumnus. The university also offers Trustee's, President's, and Provost's scholarships to freshman applicants who have excelled in high school as well as community activities.

Through programs that remove barriers to higher education in the state of Ohio, the three universities are opening opportunities for Ohio students while accelerating the growth of the state's skilled workforce.

In addition to "open enrollment" Executive Education programs, the three universities' business schools offer customized executive training programs to local businesses. Companies may opt for a single, week-long customized course or, through fee-based subscription services such as Case's ***Weatherhead Affiliate Program,*** completely outsource executive training to the university's business school.

University of Cincinnati offers a unique ***Physician Executive Development Program*** through its College of Business. The goal of the program is to help physicians in leadership positions develop more responsive health care organizations. For 10 months, participants spend one-day-and-a-half per month learning about everything from financial decision making to strategic planning. Each session is structured around health care management case studies, problems, and projects.

Through their medical, dental, pharmacy, and nursing schools, the three universities all offer ***Continuing Medical Education*** programs. Primarily one- to three-day conferences and workshops, these programs range from courses on new medical technologies to public health issues such as diabetes, obesity, and heart disease. Because of the reputation of the three universities' medical schools and affiliates, the Continuing Medical Education programs attract national—as well as regional—participants.

Selling Cleveland in the Summer

As cities throughout the country have become more aware of the central role of human capital in urban economic development, more and more colleges and universities are becoming active partners in efforts to attract, develop and retain young talent. For the past several years, Case has been adding an unusual twist to these efforts – focusing not just on its own students, but on students from a number of other universities around the country.

Each year, Case hosts ***Summer on the Cuyahoga (SOTC)***, a program that brings students from schools such as Yale, Princeton, Colgate and Smith to work as paid summer interns with Cleveland companies and institutions. During their ten-week internships (for which they are paid $2,800), the students live at Case. They also participate in activities designed to introduce them to Cleveland, including a tour of the city, visits to museums and other cultural venues, an Indians game, and community service projects.

During the summer of 2005, SOTC brought 70 students to Cleveland. The program's long-term goal is encourage as many of the participants as possible to return to Cleveland after they graduate – and even if they don't, to spread the word among their friends back home that Cleveland can be a great place to live and work.

VII: The Role of University Research in Ohio's Economy

In a recent report to the National Academy of Sciences, a committee of distinguished CEO's, university presidents and scientists noted that:

> *The prosperity the United States enjoys today is due in no small part to investments the nation has made in research and development at universities, corporations and national laboratories over the last 50 years.* [25]

Research universities have played a central role in the creation of new knowledge, both basic and applied.

> *Universities perform roughly half of all basic research in the United States, most of it funded by the federal government. Over time, basic research results build on one another and intermingle with results in other fields, often through the free exchange of people and ideas that universities facilitate. Typically pursued with no specific commercial application in mind basic research has provided the technological underpinnings for commercial innovation…*[26]

The role of the research universities is just as important at the state level as it is nationally. University research contributes to economic growth in Ohio in several ways.

- Each year, research universities attract hundreds of millions of dollars in federal and corporate research funds. These monies are spent locally on salaries, supplies, equipment, and supporting research infrastructure.
- The opportunity to work side by side with faculty researchers enhances the quality of students' education. This experience can, in turn, enhance the skills and knowledge that university graduates can offer to the state's employers.
- Contracting or collaborating with university researchers can be an efficient way for companies to acquire new knowledge, solve applied research problems and recruit new employees. Strong university research programs can help make the state an attractive location for corporate research and development facilities.
- University research sometimes leads directly to the development of new products and the creation of new businesses.

Research Spending at the Universities

Ohio State, Cincinnati and Case dominate academic research expenditures in Ohio. According to NSF data, the three universities accounted for about 79 percent of the $1.26 billion spent on research by all Ohio colleges and universities in fiscal year 2003.

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[25] Committee on Prospering in the Global Economy of the 21st Century, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (Washington: National Academies Press, 2005), pp. vii, ES-7.

[26] National Academy of Engineering, *The Impact of Academic Research on Industrial Performance* (Washington, DC: National Academies Press, 2003), p. 3.

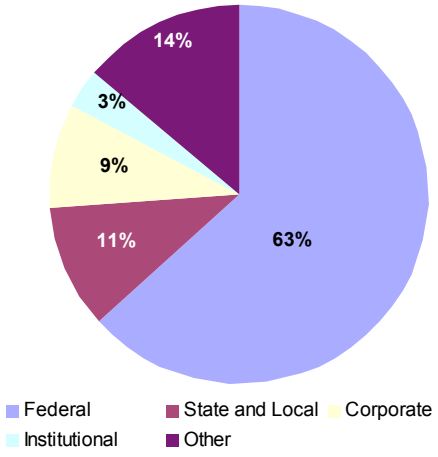
Research activity at the three universities has grown steadily in recent years. Between 1999 and 2004, aggregate research spending at Ohio State, Cincinnati and Case grew by 84 percent – an annual rate of 13 percent. To put that in perspective, the national average growth rate in research funding between 1998 and 2003 (the most recent year for which reliable data is available) was only 9.2 percent.

Table 16: Research Spending, 1999-2004

FY	OSU	UC[27]	Case	TOTAL
1999	$ 257,946,205	$ 137,506,946	$ 160,083,000	$ 555,536,151
2000	$ 289,484,971	$ 152,491,928	$ 166,372,000	$ 608,348,899
2001	$ 348,476,431	$ 187,492,540	$ 177,711,000	$ 713,679,971
2002	$ 361,119,508	$ 227,961,908	$ 205,534,000	$ 794,615,416
2003	$ 415,925,485	$ 258,873,947	$ 221,097,000	$ 895,896,432
2004	$ 446,993,598	$ 293,869,789	$ 282,874,308	$ 1,023,737,695

The growth of research spending by the three universities has been fueled primarily from out-of-state sources (see Figure 14). In 2004, state and local government funding accounted for only 11 percent of their combined research spending.

Figure 14: Sources of Research Spending, Consolidated, FY 2004



As Table 17 shows, the National Institutes of Health are by far the largest source of federal support for research at the three universities, accounting for nearly 70 percent of all federal research funding in 2004.

Table 17: Federal Research Funding Received, 2004

[27] Includes Cincinnati Children's Hospital Medical Center research expenditures as UC College of Medicine, Department of Pediatrics

Category	OSU	UC[28]	Case	TOTAL
NIH	$128,949,000	$186,687,685	$246,756,000	$562,392,685
NSF	40,333,000	6,631,651	8,566,000	55,530,651
Other Federal	102,577,000	46,034,655	40,828,000	189,439,655
Total	271,859,000	239,353,991	296,150,000	$807,362,991

Estimating the Economic Impact of University Research

The attraction of hundreds of millions of dollars in federal and other external funding may be the most immediate way in which university research contributes to the vitality of Ohio's economy – but it is by no means the only way.

Another measure of the economic value of research is revenue from licensing the results of university research to for-profit companies — in effect, the price a company is willing to pay to commercialize the technology. For example, researchers with The Ohio State University's ***Center for Retrovirus Research*** developed a vaccine for feline leukemia and licensed it to Pfizer Animal Health.

Licensing revenue is at best a limited indicator of economic value. For every licensed technology, there are hundreds of unlicensed innovations that contribute knowledge and lead to future innovations with commercial and social benefits. For example, Dr. Robert Miller of Case—along with researchers at other universities—has identified signals in the brain and spinal column that influence nerve cells' ability to repair myelin around nerve cells. This is a significant step in developing a treatment for multiple sclerosis. Although the work of Dr. Miller and his colleagues is not yet ready for commercialization, it is an important step in a process that will produce enormous public benefit.

Minimally invasive surgical innovations also have regional economic benefits. Dr. Joseph Giglia, of UC's Division of Vascular Surgery, is the first person in the tri-state area to perform a laparoscopic-assisted bypass procedure to treat blockages in the arteries caused by a condition known as aortoiliac arterial occlusive disease. Patients benefit from shorter hospital stays, less pain, and faster recovery times. And techniques like these bring patients (and surgeons interested in learning new surgical methods) into the region.

In some cases, the economic benefit of research might be measured by the avoidance of a negative impact. For example, researchers at Ohio State's ***Ohio Agricultural Research and Development Center*** isolated a genetic marker in some soybean varieties that is highly resistant to a destructive fungal water mold called *Phytophthora*.[29] Given *Phytophthora*'s capacity to destroy hundreds of thousands of acres of soybeans—an $800 million industry in Ohio – research leading to the development of more resistant soybean strains could in the long run yield millions of dollars in annual economic benefit.

[28] Includes Cincinnati Children's Hospital Medical Center research spending as UC College of Medicine, Department of Pediatrics

[29] Battelle Memorial Institute. "OARDC: A Generator of Positive Economic Impacts for Ohio." 2003.

Research at Ohio State, Cincinnati and Case: A Sampler

The combined research enterprise of the three universities is notable not only for its size, but for its diversity. Here are just a few examples.

- The mission of Ohio State's ***Edison Welding Institute (EWI)*** is to conduct research that advances joining technology and to share that knowledge with companies around the world. Examples of the Institute's current research projects include developing techniques to bond materials in fuel cells, joining thin sheets of metal using high-speed lasers, and testing the strength of next generation steel under extreme loads. The Institute also provides contract engineering, research, and consulting services. EWI began as an NSF-funded project and has since become self-sufficient through its work with industry; it now has more than 300 industry partners and invests between $15 and $20 million per year in research and development.
- Founded in 2004 with a $10.8 million Wright Center of Innovation award from the state of Ohio's Third Frontier fund, the ***Ohio Center for Advanced Propulsion and Power (OCAPP)*** develops new propulsion technology for aerospace and military applications with greater efficiency and less environmental impact. While the lead institution is The Ohio State University, it has many university, industry and government partners, including Case, UC, the NASA Glenn Research Center, GE Aircraft Engines, and Parker Hannifin.
- The ***Center for the Accelerated Maturation of Materials (CAMM)*** at The Ohio State University develops processes and tools that allow companies to rapidly develop and produce new materials for industrial applications. In particular, CAMM focuses on developing high performance materials for the automotive and aerospace industries—key contributors to the Ohio economy. The Center receives federal funding from the Defense Advanced Research Projects Agency (DARPA) and is supported by industrial partners such as Honda, Ford, Lockheed Martin, and Timken. CAMM serves as home for one of the world's most advanced microscopes. With a resolution of 0.06 nm (less than the diameter of a single atom), the microscope helps researchers to understand, at an atomic level, failure modes in structural materials such as jet engine parts. In the fall of 2006, the present microscope will be relocated to Wright Patterson Air Force Base for use by the Air Force Research Laboratory and Ohio State will acquire an even more advanced version of this powerful research tool.
- Researchers at Ohio State's ***Center for Automotive Research (CAR)*** are developing new automotive technologies that make cars faster, cleaner, and smarter. For example, one of CAR's experimental zero-emissions vehicles, the *Buckeye Bullet*, set a speed record for electric cars in 2004. While the Center receives funding from federal agencies such as NSF and the Department of Energy, one-third of its budget is funded by major automakers and their suppliers.
- The ***Case Advanced Power Institute (CAPI)*** is a center for research, education, industry stimulation and outreach activities in energy-efficient technologies, with a current focus on fuel cells. The Institute's research ranges from the fundamentals of the phenomena taking place within fuel cells to performance and system level studies and mathematical modeling.

Tiny Technologies, Big Impacts

Just as it once became a major industrial center by excelling in the manufacture of steel, machinery and automobiles, Ohio is now building a foundation for the development of new industries that will involve the construction of materials and products from individual molecules. In its 2005 rankings of statewide nanotechnology preparedness, *Small Times* magazine ranked the state of Ohio tenth in the nation, emphasizing its substantial research base: "Ohio does it again," the *Small Times* editor-in-chief begins. "The state's diversity extends from border to border with an array of micro and nanotech research initiatives and companies. Collaborations among these groups are on the rise, which could lead to some novel products."[30]

Researchers at Ohio State, Cincinnati and Case are developing everything from nanomaterial-based polymers to nanovessels that deliver cancer medication directly to cancer cells. The potential economic benefits of developing a nanotechnology industry in Ohio are substantial: the National Science Foundation predicts the market for nanotechnology-based products could grow to $1 billion by 2010.

With a $12.9 million award, NSF in 2004 selected The Ohio State University to host one of only six Nanoscale Science and Engineering Centers in the U.S. The ***Center for Affordable Nanoengineering of Polymer Biomedical Devices*** concentrates on three areas: nanoscale manufacturing, transport phenomena, and bio-compatibility and ethics. Their work will eventually lead to a nanoscale assembly line – a "nanofactory" – that will help researchers develop cost-effective drugs in order to treat patients with cancer, arthritis, diabetes, and other chronic illnesses.

Because nanotechnology applications cut across disciplines, University of Cincinnati's ***Institute for Nanoscale Science and Technology (INST)*** helps bring together its existing centers of excellence — the Center for Nanoscale Materials Science, the Center for NanoMEMS and Nanobiosystems, and the Center for Nanophotonics. To support this collaborative work, the university awarded initial grants to researchers across multiple colleges to apply nanotechnology in such areas as optical devices, heart disease, and organic light-emitting diodes.

Case's School of Medicine recently received a $4 million grant from the state's Third Frontier initiative to develop "smart nanoparticles." These tiny devices will help to deliver medicine to sick patients and improve imaging of diseased tissue. The grant was awarded to the ***Targeted Nanoparticles for Imaging and Therapeutics (TNIP)*** program, a joint initiative with Cleveland Clinic, University Hospitals Cleveland, and industry partners.

- The ***National Center for Space Exploration and Research*** was established in March of 1997 under the sponsorship of the National Aeronautics and Space Administration

[30] Candace Stuart. "Our Annual Rankings of Small Tech: Only One First Place, But Many Winners." *Small Times*, March 14, 2005. Downloaded from web on February 17, 2006. (http://www.smalltimes.com)

(NASA). The Center has offices both on the campus of Case Western Reserve University and at the Glenn Research Center, where it enjoys access to NASA's world-class research facilities of NASA. The Center is national in scope and mission, and is overseen by the Universities Space Research Association.

- With a $25.2 million grant from the state's Third Frontier program along with funding from NIH, University of Cincinnati and Cincinnati Children's Hospital Medical Center established the ***Computational Medicine Center***. The Center's researchers use computers to analyze billions of pieces of data gathered from human cells, drawing on the team's expertise in fields such as genetics, systems biology and information and computer sciences. The Center also receives support from companies as diverse as Sun Microsystems, Cincom, and Procter & Gamble.
- While Ohio's manufacturing industries helped build the state's economy, they also left behind a difficult legacy: thirty sites on the Environmental Protection Agency's National Priority List. Each site hides a unique mixture of contaminants requiring complex and costly remediation. To begin to address these issues, the National Institute of Environmental Health Science awarded UC a major grant as part of its ***Superfund Basic Research Program***. As part of this program, faculty from the Colleges of Medicine and Engineering conduct research that will lead to a better understanding of how these contaminants affect the human body and how to develop methods for testing, treatment, and remediation. At the same time, the program team partners with affected communities and environmental engineering firms in order to develop policies and processes to reclaim this land for productive use.
- The ***Center for Cardiovascular Biomaterials*** was established on behalf of a consortium of Case Western Reserve University, University of Cincinnati, the Cleveland Clinic Foundation, and the Edison BioTechnology Center. While existing biomaterials are instrumental in the development of life-saving biomedical devices, they can lead to infections. Researchers at the Center investigate new cardiovascular biomaterials, measure biocompatibility, analyze cell dynamics, and evaluate biomedical devices. The Center also seeks to ensure that their research leads to new product and process innovations in the biomedical and health care industries.
- The state of Ohio is a major producer of polymer products and technologies. The three research universities support this industry through advanced research and development. For example, the ***Center for Advanced Polymer and Composite Engineering (CAPCE)*** at The Ohio State University works directly with industry leaders like Honda of America, Owens Corning, and Eastman Kodak to improve polymer modeling, design, and manufacturing processes. Their work is helping to keep Ohio at the forefront of the U.S. polymer industry. CAPCE is funded by NSF and dozens of industrial partners.

University-Industry Research Partnerships

Ohio State, Cincinnati and Case Western Reserve University have increased their share of federal research awards during the past five years. Federal research funding, however, is unlikely to grow as fast during the next five years as it has in the recent past. Between 1998 and 2003, the total National Institutes of Health (NIH) budget grew by an average of 15 percent per year. But in 2005 the NIH budget increased by only 2.6 percent; and the National Science Foundation's FY 2005 R&D budget actually declined by 0.3 percent.

As growth in federal research funding slows, industry-sponsored research is particularly critical for universities. Yet for most, industry research contracts and grants represent only a small fraction of their total research funding. According to a survey conducted by the National Science Foundation, corporations paid for only 5.4 percent of all U.S. universities' research spending in 2003.[31]

In contrast, Ohio State, Cincinnati and Case received more than 9 percent of their research funding from industry partners in fiscal year 2004. According to NSF, The Ohio State University ranks sixth in the nation in industry research funding, with 11.4 percent of its research funded by corporate partners. University of Cincinnati has signed master agreements with Procter and Gamble and General Electric that increase the ease with which the university can collaborate with their partners on research projects. Case Western Reserve University has established research partnerships with emerging biotechnology companies such as Synapse Biomedical, NDI Medical, and Copernicus Therapeutics.

In addition to helping universities diversify their research budgets, university-industry research partnerships encourage universities to focus on research with commercial potential within the university's region. Based on university-industry case studies conducted in the Cleveland area, Michael Fogarty and Amit Sinha conclude: "if university research is to raise a particular region's productivity growth via technology, it must connect with local industry performance."[32] Otherwise, companies outside the region are more likely to reap the benefits of knowledge spillover and commercialization.

Student Participation in University Research

Research is not only the domain of tenure-track faculty and postdoctoral researchers. With world-class facilities and faculty at their disposal, students at top research institutions are initiating their own research projects. Undergraduate research exposes

[31] NSF InfoBrief "Academic R&D Doubled During Past Decade, Reaching $40 Billion in FY 2003" (NSF 05-315, July 2005).

[32] Michael S. Fogarty and Amit K. Singha, "Why Older Regions Can't Generalize from Route 128 and Silicon Valley: University-Industry Relationships and Regional Innovation Systems," in Branscomb, Kodama and Florida (eds.), *Industrializing Knowledge: University-industry linkages in Japan the United States*: 1999, p. 474.

students to graduate-level work, provides them with mentors, and may even lead to scientific breakthroughs.

The Ohio State University offers undergraduate students the opportunity to define their own research projects—as part of a senior thesis or via an independent, grant-funded proposal. Each year, undergraduates present their work in the ***Denman Undergraduate Research Forum***, an annual research fair juried by members of each department's research faculty. The Denman Forum began in 1996 and has showcased the work of 1,500 undergraduate student researchers. Ohio State in 2006 established the Undergraduate Research Office (URO) to coordinate a broad cross section of research opportunities. Headed by one of Ohio State's researchers, Dr. Allison Snow, the URO helps to provide research experiences to all students who wish to participate and coordinates the cross-discipline interests of the students.

University of Cincinnati chemistry students may apply to the NSF-sponsored ***Research Experiences for Undergrads (REU)*** program held at UC every summer. Accepted students work with UC's research faculty on groundbreaking studies, often culminating in co-authorship of a published research paper. In addition to working in the lab, students participate in semiweekly professional development workshops where they focus on science writing, presenting, and ethical issues. About 10 students participate each summer, with each student receiving housing and a $3,500 stipend for their work in the 10-week program.

Through the Women in Science and Engineering program, University of Cincinnati also offers ***Research Experiences for Women Undergrads (REWU)***, a summer program that gives 25 women the opportunity to conduct research alongside a faculty mentor. The REWU program pays students a $4,000 stipend for their work and, like many undergraduate research programs, offers summer-long workshops and social events for the students. Students conduct research in fields such as biology, physics, geology, and engineering.

Researchers at the Center for Affordable Nanoengineering of Polymer Biomedical Devices (CANPBD) at The Ohio State University see undergraduate research as an integral part of the Center's mission to disseminate nanotechnology knowledge. The OSU CANPBD offers a ***Nanotechnology Summer Internship*** to undergraduate science and engineering students. Students get an opportunity to research cutting-edge technology in highly specialized facilities with a dedicated mentor while earning a Nanobiotechnology Research Intern certificate. Students even have an option to write/co-write a paper for publication under the guidance of the CANPBD research faculty.

Case offers the ***Summer Program in Undergraduate Research (SPUR)***. This 10-week summer program is open to students in all disciplines who are interested in conducting original research to address their own research question. Student research fellows work with a faculty mentor while completing their research and writing their final paper. Students conclude the program with a formal poster presentation on their research.

Leading the Way to Renewable Energy

From fuel cells to photovoltaic panels, the three universities are researching energy producing technologies that are cheaper, safer, and more efficient. As the market for renewable energy expands, university researchers are poised to contribute new technology and expertise to their industrial counterparts.

The ***Wright Fuel Cell Group*** (WFCG) is an example of a university-industry research partnership that could establish Ohio firms as major competitors in the multi-billion dollar fuel cell market. The WFCG (then called the Power Partnership for Ohio) was founded in 2002 with more than $18 million in state funding as part of the Ohio Fuel Cell Initiative. The funding will be used for applied fuel cell research and testing as well as facilities for start-ups and expanding businesses. Although Case is the lead university in the group, The Ohio State University, Cleveland State University, the University of Toledo, and others are participating. Corporate partners include American Electric Power, Battelle Memorial Institute, Dana Corporation, HydroGen, Keithley Instruments, NexTech Materials Ltd., and Parker Hannifin.

In May 2005, the U.S. Department of Energy awarded $64 million to universities and research centers for hydrogen fuel cell research. Case was among the institutions selected, and researchers will use the funds to study and model ion transport within fuel cell membranes – the result of which could lead to cheaper, more efficient fuel cells.

The Third Frontier Initiative and University Economic Development

In 2002, Governor Robert Taft announced the creation of the Third Frontier initiative – a ten-year $1.1 billion program that provides funding to universities and corporations that are collaborating on research with commercial potential. In November 2005, Ohio voters passed Ballot Issue 1, authorizing bond funding for an additional $500 million in support of the Third Frontier over the next five years.

State-funded research programs do not have the same short-term impact as those funded by the federal government or other external sources, because they are reallocations of resources that already exist within the state. However, investments of state funds may over time lead to significant economic impacts:

- State funding helps universities leverage federal and industrial research awards. In fact, Third Frontier awards are contingent on the recipients obtaining additional external funding.
- Because of the emphasis on local industry collaboration and commercialization, Third Frontier awards leverage research that may have bigger local impacts in terms of short-term innovation, technology transfer, spin-off company creation, and jobs. As

Amy Candell and Adam Jaffe put it: "efforts to support technology development and/or transfer are most likely to be successful in areas where a region has strength in both the non-profit research and the industrial sectors."[33]

- The Third Frontier initiative establishes and solidifies social networks among universities, state and local government officials, industrial leaders, and venture capital firms. These networks may lead to future collaboration and technology commercialization opportunities.

Table 18 highlights a few of the Third Frontier supported university-industry research partnerships that have been awarded to the three universities during the past year.

Table 18: Examples of Recent University-Industry Research Collaboration

Lead University	Selected Industry partners	Research Description
Case Western Reserve University	Cleveland NanoCrystals, Copernicus Therapeutics, Inc., OSC; iMedd, Inc., Ricera Biosciences, Inc.	Develop and commercialize sub-atomic particles for early detection of breast cancers and new therapies for hemophilia.
The Ohio State University	Phillips, Rexon	Improve medical imaging resources to focus on mobile facilities, remote access, and biohazard imaging.
The Ohio State University	GE Aircraft Engines, Parker Hannifin, NASA Glenn, Glennan Microsystems, Argo-Tech, Webcore, AEP EmTech, Timken	Establish the Ohio Center for Advanced Propulsion and Power in order to develop next generation propulsion systems.
University of Cincinnati	Procter & Gamble Pharmaceuticals, Acero Inc.	Fund the Genome Research Institute and the Genome Research Infrastructure Partnership (GRIP).
University of Cincinnati	Procter & Gamble; Sun Microsystems; Cincom; Molecular Research Center; Acero; itCube; IBM	Establish the Center for Computational Medicine to develop computer-based techniques for cellular-level analysis.

[33] Amy B. Candell and Adam B. Jaffe, "The Regional Economic Impact of Public Research Funding: A Case Study of Massachusetts," in Branscomb, Kodama and Florida, op. cit., pp. 528-29.

VIII: The Universities' Role in Business Development

Universities support economic development by helping to generate and grow new businesses. There are a number of ways in which Ohio State, Cincinnati and Case have contributed to this process:

- Licensing new technologies developed in university labs to local start-up companies.
- Providing support to start-up or early-stage companies — new business incubator facilities, business support services, and venture capital investments.
- Faculty participation in the development of new businesses.[34]
- Development of new businesses by university graduates.

Licensing University Technology

The licensing of technologies to commercial enterprises is perhaps the most directly measurable way in which academic research can be translated into economic growth. The movement toward licensing university technology began in earnest in the 1980s, after Congress enacted the Patent and Trademark Law Amendments Act, also known as the Bayh-Dole Act. The law clarified universities' right to patent, license and collect royalties on products of federally-funded research.

Typically, university technology transfer policies require researchers to disclose inventions and discoveries resulting from work done at the university. Along with researchers, the university's technology transfer officials assess the marketability of the discoveries. If the invention appears marketable, they begin the process of making it available for licensing, either to an established company or to a new venture created specifically for the purpose of bringing the new technology to market.

Recognizing the potential benefits both for the universities themselves and for regional economic development, Ohio State, Cincinnati and Case have all during the past few years increased their emphasis on technology transfer. Between 2001 and 2004, Case increased its license revenues from $2 million to $11 million.

In 2004, Ohio State, Cincinnati and Case entered into 58 new licensing and option agreements for commercial use of technologies first developed at the universities; and they earned $11.9 million in license revenue – half of the $22.7 million earned by all Ohio universities reporting technology transfer data.[35] The three universities also assisted

[34] Until the passage of Senate Bill 286 in 2000, faculty at Ohio's state universities were prohibited from being shareholders in start up companies, thus serving as a significant disincentive for new business development.

[35] Technology Transfer Officers Council, "University Technology Transfer Annual Report: State of Ohio FY 2004", 2004, p. 4.

in the creation of 11 start-up companies in 2004 – new ventures launched specifically for the purpose of commercializing new technologies developed at the universities.

Table 19: Selected Technology Transfer Performance Metrics, 2004

University	Licensing Income (000s)	Invention disclosures	US Patent applications	US patents issued	Licenses / Options grants	Spin-offs formed
OSU	$ 630	161	74	26	30	6
UC	330	76	29	12	10	1
Case	11,000	135	69	24	18	4

Benchmarking Regional Innovation

Economists studying the impact of innovation on regional economic growth frequently use patenting as a proxy for innovation. Studying factors that contribute to the economy of regions on the U.S., Michael Porter found that the regions with high levels of patent activity are strongly associated with higher wages due to higher productivity.

According to U.S. Patent and Trademark Office data for 1999 through 2003, The Ohio State University ranked 15th among all organizations in Ohio in terms of the number of patents it received, with 98 patents; Case Western Reserve ranked 16th with 96 patents, and University of Cincinnati tied with the University of Akron for 39th with 53 patents. In 2004, the three universities were issued 61 patents – about half of the 121 patents issued to all Ohio universities.

Because many new innovations and technologies are commercially valuable, but not patentable, invention disclosures are in many ways a better measure of innovation than patents. The number of disclosures is the best measure of a university's "innovation pipeline." In 2004, the researchers with the three universities disclosed 372 inventions.

Researchers at the three Ohio research universities are more prolific and more productive inventors than average. Among universities that are members of the Association for University Technology Managers (AUTM), the average number of inventions disclosed in FY 2003 was 78.3 and the average AUTM-member university spends about $2.61 million on research per invention disclosure. In fiscal year 2004 the three Ohio research universities averaged 124 disclosures and spent only $2.44 million on research per invention disclosure.

Here are three examples of university technology that has been licensed to firms for commercialization:

- Transportable Internet, Inc, an OSU start-up company formed in 2003, markets the Transportable Satellite Internet System (TSIS) that provides mobile satellite Internet connectivity with independent power sources. Clients include major insurance

companies who have used the system for catastrophe relief and claims processing for Hurricane Katrina victims. The system is also being used to bring connectivity to universities in the Gulf region that were affected by the hurricanes. Other clients in the law enforcement, educational, and security fields are looking at TSIS to augment their capabilities.

- Dr. Wim van Ooij, a professor of Materials Science at University of Cincinnati, developed a new type of organofunctional silanes – a material that may be used in a wide variety of applications including adhesives, coatings, pigments, and sealants. His company, ECOSIL, licenses his silane technology from the University in order to develop a standard set of environmentally-neutral silane-based products as well as customized products for industrial customers.

- What began as a technology licensing agreement between Case and Athersys in 1995 has matured into a multi-faceted relationship with substantial impacts on northeastern Ohio's economy. One of Athersys's core technologies –- a synthetic human chromosome –- was developed in Case's laboratories by Athersys co-founder, Dr. Hunt Willard, and licensed to the company. Nine years and $110 million in investment capital later, the company joined Case, the Cleveland Clinic, University Hospitals, and others to establish the Center for Regenerative Medicine and Stem Cell Research. Researchers with the Center are investigating stem cell-based therapies for a range of diseases including stroke, diabetes, and musculoskeletal disorders. Athersys will incorporate some of the technologies that result from this work into its therapeutic products, creating new opportunities for biomedical researchers in the state while improving health care quality worldwide. Athersys currently employs 70 people in northeastern Ohio.

Support for Spin-off Companies

In addition to licensing new technologies to established companies, universities are also involved in supporting "spin-off" companies – new ventures that are created to commercialize university technologies. Researcher Scott Shane found that in the period from 1980 to 1999, the average American university spin-off company generated about $10 million in economic value and created 83 jobs.[36] University spin-off companies are particularly beneficial to a region's economy because they are more likely to stay in the region – close to the university from which they originally licensed their technology – and, initially, manufacture their products locally.

Often founded by individuals with more technology development experience than business acumen, spin-off companies tend to have special needs: a management team to develop a business plan and obtain financial backing, facilities that accommodate cutting-edge R&D activities, and access to workers with specialized skills. It often takes five years or more before new companies begin to generate significant revenues.

[36] Scott Shane, *Academic Entrepreneurship: University Spinoffs and Wealth Creation*, (Cheltenham, Edward Elgar, 2004), p. 20.

Nevertheless, recently-licensed companies may already be making a significant contribution to the vitality of the region's economy, by attracting new investment by venture capital firms or major corporations and employing skilled workers.

Technology start-ups often find it difficult to obtain "pre-seed" funding to demonstrate a technology's market value and develop a business plan. Case Western Reserve University provides pre-seed funding to student-led start-up companies as well outside start-ups. The university has established two funds—***FastStart*** and ***JumpStart***. FastStart is targeted toward students in the university's graduate level entrepreneurship program. JumpStart provides start-up capital to companies based in Northeast Ohio with an average of $200,000 funding provided to each company. In 2004, JumpStart invested $1.2 million in five companies.

A University's Role in the "Marketplace of Ideas"

Dr. Anne Chasser, the Director of the Office of Technology Transfer at University of Cincinnati, considers UC a merchant in the "marketplace of ideas." Not content to limit the university to the established technology licensing routes, Dr. Chasser is supporting UC's colleges in adopting innovative licensing agreements that benefit businesses, the university, and students.

When some University of Cincinnati design students put together their portfolios, they'll be able to include pages from Bold Furniture's Fall 2005 product catalog. The Michigan-based furniture maker's catalog will feature a line of furniture designed by UC design students, licensed to Bold Furniture by the university, and manufactured and marketed by the company. Bold Furniture gets a great new line of furniture to market to other universities, 16 design students get real-world design experience, and the university receives a set of custom-designed furniture as well as a share of royalties from additional sales.

Cincinnati students and faculty have worked on products for Procter & Gamble, Delta Airlines, and Western Southern Life Insurance, and are likely to have more such opportunities in the future. With a $2 million grant from the state of Ohio in 2005, the University established the ***Center for Design, Research and Innovation*** (DRI). The Center—a joint effort of UC's Colleges of Business; Design, Art, Architecture, and Planning; Engineering; and the Medical School—will work with innovative businesses in the state of Ohio that are looking for ways to streamline their product development processes and create new innovative products to sell to customers around the world.

The university also controls ***Case Technology Ventures*** (CTV), a venture fund supporting start-up companies licensing Case technology for commercialization. CTV invests between $50,000 and $250,000 in companies based on their market potential. Since June 2004, CTV has invested $500,000 in two spin-off companies: Arteriocyte – a company developing stem cell-based therapies – and Cleveland NanoCrystals (discussed below).

Case also gives entrepreneurs a chance to earn pre-seed funding for promising business ideas through business plan and entrepreneurship competitions. Some are open to any company with a promising business idea; others are specifically tailored to a specific industry or technology. For example, in 2004, the university began encouraging the commercialization of nanotechnology through its first annual ***Nanotechnology Business Idea Competitions***. The university receives submissions from around the world and offers two $75,000 awards—one to companies located in or willing to relocate to the Cleveland area and one to companies that are located anywhere. The winners also receive assistance in preparing a business plan and developing their business.

Table 20: Examples of Licensed Spin-Off Companies

Company	Location	Founded	Licensed from	Employees (FTE)
Arteriocyte	Cleveland	2004	Case	3
CardioEnergetics	Cincinnati	1998	Cincinnati	-
Cleveland NanoCrystals	Cleveland	2004	Case	-
Copernicus Therapeutics	Cleveland	1997	Case	8
Cutanogen	Cincinnati	1997	Cincinnati	2
FLX Micro	Solon, OH	2003	Case	4
iMEDD, Inc.	Columbus	2001	OSU	14
Interventional Imaging	Cleveland	2003	Case	6
OncoImmune LLC	Columbus	2002	OSU	3.25
Phase 2 Discovery	Cincinnati	1998	Cincinnati	-
SensIrOx	Columbus	2001	OSU	1.3

Case is not alone among the three universities in offering support to local technology companies. In 2004, University of Cincinnati received National Science Foundation funding for a pilot program called ***Cincinnati Creates Companies***. The competitive 11-month program is open to about a dozen Cincinnati-based science and technology entrepreneurs. The most promising applicants go through an intensive program to develop their company: they develop business plans for their start-up ventures while being mentored by an experienced start-up manager. At the end of the program, participants compete in a business plan competition judged by venture capital and angel investors – organizations and individuals willing to invest in start-ups developing their products and just beginning to earn revenues.

In the fall of 2004 – the first year of the program – 16 applicants were admitted. Five early-stage businesses won awards in the business plan competition and have already seen positive results: one company has seen a 10 percent increase in revenues; three companies have moved into one of the Cincinnati-area incubators; one company

completed a $250,000 angel round of financing and has been approached by venture capital group for potential follow-on funding.

While ***CincyTech USA*** was established by the Cincinnati Chamber of Commerce, it has close University of Cincinnati ties. CincyTech brings companies, early-stage venture funds, hospitals, universities, and research laboratories together to grow the regional technology-based economy. It has already secured grant funding for workforce development in technology professions, increased the amount of early-stage venture capital in the region, and set up program in which established companies advise start-ups. In addition to providing funding to CincyTech, University of Cincinnati provides in-kind contributions of space and executive leadership to the organization.

Growing Cleveland NanoCrystals

Cleveland NanoCrystals offers a good example of the ways in which universities nurture start-up companies. In 2004, Case professor Clemens Burda presented his nanotechnology research at ShowCASE—a research conference sponsored by the university. At ShowCASE, he met Donna Richardson, a manager with experience starting up technology companies. Shortly afterward, they formed Cleveland NanoCrystals—a company commercializing products based on Dr. Burda's research. The company's nanomaterials could have applications ranging from solar cells to medical imaging.

Within three months of CNC's founding, Case Technology Ventures provided $50,000 in pre-seed capital, and later invested an additional $200,000. For its first home, CNC took space in the Case-affiliated biotechnology incubator, BioEnterprise.

Along with other partners, Case and Cleveland NanoCrystals collaborated on a Biotechnology Research and Technology Transfer (BRTT) grant, winning an award that supports the research and commercialization of nanoscale biomedical technology that will help with early breast cancer detection and the treatment of hemophilia.

Over time, the support that universities provide to spin-off companies can have a cumulative effect that goes beyond benefits to any one firm. Scott Shane has found that clusters of new spin-off companies form a kind of basic "infrastructure" for business development, making it easier for technology businesses to grow and thrive in the future.[37]

OSU has taken a leadership role in stimulating capital formation and access to capital for startups in Central Ohio. During the past eight years, OSU's research park affiliate, Scitech, has collaborated with the State of Ohio, Battelle, the TechColumbus Business Technology Center, major corporations, and individual investors to create several pre-

[37] Scott Shane. *op cit*. pp. 25, 99.

seed, seed, and early stage funds. These include the Technology Commercialization Fund, Technology Validation Fund, First Fifty Fund, Reservoir Venture Partners, and the Ohio Tech Angel Fund. OSU also took a leadership role in creating TechColumbus, an advocate for tech-based economic growth in central Ohio. TechColumbus merged the capabilities and resources of the Columbus Technology Council, the Business Technology Center (a nationally recognized technology business incubator), and Scitech to create a comprehensive one-stop shop for tech business success.

Technology Incubator Facilities

Technology start-up companies start out with promising technology with market potential. But they require experienced managers, access to funding, a pool of potential employees, and sometimes specialized facilities – particularly in the life sciences. Ohio State, University of Cincinnati, and Case have all contributed financial resources, facilities, and business and technical expertise to incubator facilities to help grow early-stage technology companies.

Along with specialized physical space ideally suited to small firms in the life and physical sciences, incubators provide start-up companies with business and technical services, access to a network of experienced managers and venture capital firms, and a talented workforce. The three universities have all been involved in creating and sustaining technology incubators in their regions.

The TechColumbus ***Business Technology Center (BTC)*** serves as a resource for Ohio State and all of central Ohio. Located within Ohio State's Scitech, OSU's Research Park (described in the box below), the 60,000 square feet of physical space as well as business development services to Columbus start-ups. For example, Healthcare Transaction Processors, Inc. (HTP), a company that provides health care transaction management software and services, took advantage of BTC's business development services before "graduating" from the incubator in December 2000. Since then, HTP has sustained rapid growth. The Columbus-based company ranked 162nd on *Inc.* magazine's 2004 list of the 500 fastest- growing U.S. businesses. The company recorded more than 200 percent sales growth in 2003 and 800 percent growth between 2000 and 2004. In May 2005, the company hired Ohio State graduate Ray Shealy as President and Chief Operating Officer to continue the company's momentum. The company currently employs 35 people in the Columbus area.

Cincinnati's ***BIO/START*** incubator offers more than 31,000 square feet of wet/dry lab and office space to start-up companies. BIO/START tenants include life science start-ups founded by UC faculty members and graduates such as P2D Inc., Keyclone Technologies, CardioEnergetics, Cutanogen Corporation and Medical Diagnostic Laboratories.

The Physical Infrastructure of Ohio's Innovation Economy

With the ***Science and Technology Campus Corporation*** ("Scitech"), OSU is helping to construct the physical infrastructure of Columbus's innovation economy.

As part of its mission to provide real estate service for the entire TechColumbus community, Scitech operates the 53-acre technology park located on The Ohio State University's west campus. The park currently offers 400,000 square feet of office, lab, and industrial space – with 43,000 square feet in flexible space added in the past year. Scitech officials plan to develop an additional 50,000 square feet per year up to about one million square feet. That translates to a lot of technology jobs: Scitech's tenants currently employ about 500 people. At full employment, the park will be home to about 2,000 high tech jobs.

Scitech's and BTC's facilities and services are not limited to start-ups. The Cabot Corporation – a $1.8 billion company – used Scitech's facilities to develop a new business unit that manufactures tantalum thin films used in semiconductors and cell phones. In May 2002, the newly-formed Cabot Thin Films unit leased space in the BTC to experiment with the manufacturing process. By May 2005, the business unit's work led the company to open a 90,000 square foot manufacturing facility in Etna, Ohio, that will employ up to 60 workers – at an average salary of $70,000 – within three years.

Cabot's success developing a new line of business in Ohio only solidified the company's relationship with Scitech: in July 2005 the company opened a 7,000 square- foot thin-film research and development center in the technology park – the only laboratory in the world dedicated to this kind of tantalum research.

Since 2002, the Case-owned life science incubator, ***BioEnterprise***, has helped to develop 35 biotechnology companies. One of them is Interventional Imaging, Inc. – a Case Medical School and University Hospitals-Cleveland spin-off that is developing medical devices to help detect and treat plaque in the coronary arteries. The company has received over $1 million in outside capital, adding to the more than $140 million BioEnterprise companies have attracted to the region.

Not all BioEnterprise tenants are local start-ups; Transcutaneous Technologies, Inc. came from Japan and Imalux from Russia to be near Case's research faculty. Attraction of such companies benefits both Cleveland and the state of Ohio: the companies employ talented local engineers and scientists, purchase from regional suppliers, while producing new knowledge and breakthrough products.

University Faculty and Graduates as Entrepreneurs

Producing a steady stream of well-educated, highly-skilled graduates is the single most important way in which the three research universities contribute to the Ohio economy. One of the ways in which university graduates contribute to a region's economic dynamism is through leadership in the creation and growth of businesses.

Table 21 lists some of the entrepreneurs and business leaders who graduated from the three universities and have gone on to establish new businesses or expand existing ones.

Table 21: Notable Ohio Companies Founded and/or Led by University Alumni

Company	Central office	University graduate and position	University (graduating year)	Ohio Employees
Limited Brands	Columbus	Leslie Wexner, Founder and Chairman	OSU (1959)	10,000
Pinnacle Data Systems	Groveport	John D. Bair, Founder and CEO	OSU (1989)	106
Kokosing Group	Columbus	William Brian Burgett, Founder and CEO	OSU (1973)	950
Longaberger	Newark	Tami Longaberger, CEO	OSU (1984)	3,600
Cleveland-Cliffs Inc	Cleveland	John S. Brinzo, Chairman, CEO	Case (1968)	3,777
National City Corporation	Cleveland	David A. Daberko, Chairman, CEO	Case (1970)	1,000
Nordson	Westlake	Peter S. Hellman, President, CFO and Administrative Officer	Case (1984)	2,154
Parker Hannifin	Cleveland	Donald E. Washkewicz, President, CEO	Case (1979)	600
Kendle International, Inc.	Cincinnati	Candace Kendle, Cofounder, CEO	UC (1970, 1972)	500
Orchem	Fairfield	Oscar Robertson, Founder, President	UC (1960)	40
Great Traditions Land & Development Co.	Cincinnati	Thomas Humes, Founder, President	UC (1970, 1977)	25
Up4Sale.com. (sold to EBay for $70 million in cash/stock. Part of proceeds used to found a new Cincinnati-based company)	Cincinnati	Rob Ratterman, Chris Downie, Tom Duvall, Walter Carroll, Founders	UC (1995, 1994, 1995, 1997)	n/a

Universities have not always encouraged their faculty to be entrepreneurial. But Cincinnati, Case and Ohio State increasingly give university faculty the freedom and flexibility they need to pursue the creation of their own businesses. Table 22 lists examples of businesses that have been started by faculty members.

Table 22: Selected Firms Started by University Faculty Members

Company Name	Location	Founded	Faculty member	University
Datatrak International	Mayfield Heights	1992	Jeffrey Green	Case
Excera	Worthington, OH	1989	Dr. Glenn Daehn	OSU
Keyclone Technologies	Cincinnati	n/a	Dr. Jun Yang	Cincinnati
LCA-Vision, Inc.	Cincinnati	1985	Dr. Stephen Joffee	Cincinnati
Molecular Diagnostics Laboratory	Cincinnati	1996	Dr. Ravi Subbiah	Cincinnati
NineSigma	Cleveland	2000	Dr. Mehran Mehregany	Case
Optimum Therapeutics	Columbus	n/a	Dr. Jessie Au	OSU
Topogen	Columbus	1991	Dr. Mark Muller	OSU
Transmap	Columbus	1994	Dr. Kurt Novak	OSU
UMD, Inc.	Cincinnati	1997	Dr. Donald Harrison	Cincinnati

OSU Helps Excera Materials Group Move "From Concept to Commerce"

Michael Breslin completed his bachelor's and master's degrees at The Ohio State University. One of the results of his work was the development of ONNEX—a tough yet affordable metal and ceramic composite material.

To commercialize his invention, Mr. Breslin – along with OSU faculty member Glenn Daehn – formed Excera Materials Group, a materials engineering firm that specializes in developing products made from ONNEX. So far, he has found uses for the materials in vehicular braking systems, tool and die casting, materials handling, and armor. The company is currently shipping body armor to military overseas and expanding its facilities and employment base. Investors are betting on Mr. Breslin and his invention: to date, the company has received over $1 million in venture capital.

According to Mr. Breslin, The Ohio State University has had a major impact on the success of his company: "Excera's core technology was developed by researchers at The Ohio State University. The company was founded by university students and faculty … Through its commercialization services, the Science and Technology Campus Corporation, a campus-based research park, has helped us move from concept to commerce."

Teaching Entrepreneurship

For many years, academic economists and business schools both tended to view entrepreneurship more as a matter of innate aptitude and ambition, rather than a set of skills that can be systematically acquired. During the past twenty years, however, a growing number of universities have recognized that entrepreneurship can in fact be taught – and many have launched programs aimed at helping students prepare for the creation and development of their own business ventures.

University of Cincinnati offers students a variety of opportunities to learn about what's involved in starting and growing a successful small business – and to work on starting their own. The ***Center for Entrepreneurship Education and Research (CEER)*** uses an "experiential learning" approach, in which teams of students work under faculty guidance as consultants to Cincinnati-area small businesses and non-profit organizations. Since this program was launched in 1982, more than 2,000 students have worked on more than 500 consulting projects. The Center also sponsors annual business plan competitions for both graduate and undergraduate students.

For students who want to begin working on their own ventures, CEER offers further support. The Bearcat Launch Pad, a joint venture with CMC Office Properties, provides low-cost space for up to a year for both students and faculty members who are in the earliest stages of developing a new business. Rent is free for the first three months, and ranges from $50 to $100 per month for the next nine months. The Bearcat Bridge Fund provides small seed money grants of up to $5,000; and as new ventures develop, will consider equity investments of $50,000 or more. The Fund also has a team of volunteers – alumni, local business executives and venture capital managers – who serve as advisors to applicants for and recipients of funding.

At Ohio State, the ***Center for Entrepreneurship*** at the Fisher College of Business offers students opportunities to work as interns with the CEO's of entrepreneurial companies, new venture development groups within larger corporations, and venture capital and other private equity investment firms. The Center also sponsors a Business Builders Club for OSU students, and an annual conference, the Entrepreneurship Spectacular, and an annual business plan competition. The Center is currently working with Accenture to develop a consulting program to help entrepreneurs in Central Ohio develop their own businesses using their "Ideas to Business" model.

In 2000, Case Western Reserve University launched a unique graduate program in "physics entrepreneurship." The program, a joint offering sponsored by the Weatherhead School of Management and the College of Arts & Sciences, initially included students with a background in physics and an interest in bringing new technologies to the marketplace. Since then the ***Science and Technology Entrepreneurship Program*** has expanded to include concentrations in biotechnology, chemistry and mathematics. Students take classes taught by scientists and managers with start-up experience and work in specially developed commercialization internships. With pre-seed funding available

via the university's FastStart fund, students are positioned to turn innovative ideas into marketable products by the time they graduate.

Seedbeds for Economic Growth

As noted in Part I of this report, studies such as that conducted by the Battelle Memorial Institute in 2002 have shown that Ohio has in recent years lagged behind other states in the creation of new businesses. Universities cannot close that gap on their own. But they can be an important part of solution – by accelerating the movement of new technologies into the marketplace, by providing the support that start-up companies need, by fostering a culture of entrepreneurship on campus, and by preparing students to take on the challenge of creating and growing their own businesses. In all of these areas, Ohio State, University of Cincinnati, and Case offer powerful examples of what major research universities can do.

Nurturing Entrepreneurial Talent – and Keeping It in Ohio

The experience of Christian Marin, a 2005 graduate of Case's Biotech Entrepreneurship Program, illustrates the role that the state's three major research universities can play in attracting, retaining and nurturing the entrepreneurial talent that Ohio needs to grow its economy. Marin, a native of Costa Rica, graduated from the Florida Institute of Technology in 2003. He came to Case because he wanted to do graduate work in a program that would prepare him for doing scientific work in a business setting.

Early in 2004, as part of his course first-year course work at the Institute for Technology Innovation, Commercialization and Entrepreneurship, (InTICE), Marin developed a business plan for a company that would sell lab supplies on-line. The plan drew the interest of three Case alumni – and within a few months, Marin launched Superior Scientific. By the end of the year, Superior was distributing from an on-line catalog of 300 items to laboratories throughout the U.S.

Marin's wife, a graduate of Case's physics entrepreneurship program has also launched a new venture – a technology consulting company. The Marins – the kind of talented young entrepreneurs who could take their ambitions anywhere – have chosen to stay and build their businesses in Ohio.

Part IX: The Impact of Academic Health Centers: The University-Health Care Connection

Parts II through VIII of this report have described how The Ohio State University, University of Cincinnati, and Case Western Reserve University contribute to the vitality of Ohio's economy – both as major enterprises in themselves, and through their role in developing human capital, in research and in the development of new businesses. The three universities' contribution to the state's economy can, however, be viewed from another perspective as well – one that cuts across the various roles cited above: Each of the universities' medical colleges is the heart of an *academic health center*: a cluster of educational, research and health care institutions that collaborate closely in the education of physicians and other health professionals, in biomedical research and in the delivery of health care.

The Association of Academic Health Centers defines an academic health center as comprising:

> *an allopathic or osteopathic medical school, one or more other health professional schools or programs (such as allied health, dentistry, graduate, nursing, pharmacy, public health), and one or more teaching hospitals or health systems.*[38]

A report from the Commonwealth Fund Task Force on Academic Health Centers summarizes some of the characteristics that distinguish academic health centers from other local health care providers. According to the report, academic health centers:

- Perform more than 50 percent of research supported by the National Institutes of Health;
- Provide a disproportionate share of specialized, costly patient care services;
- Act as "safety net institutions"—providing health care to poor and uninsured patients in their communities; and
- Conduct clinical research that helps them deliver innovative services to patients.[39]

In this section of the report, we explore the role of the academic health centers in Ohio's economy. In particular we highlight the ways in which collaboration between the universities' medical colleges and their affiliates ultimately has an impact on Ohio's economy greater than that which the participating institutions could have individually. We first describe examples of medical research, clinical training, and outreach programs that involve collaboration between the universities and their medical affiliates. We then estimate the economic impact of the medical affiliates on their local economies and on the State of Ohio through employment, construction, and purchasing.

[38] Association of Academic Health Centers website (http://www.ahcnet.org/).
[39] Commonwealth Fund Task Force on Academic Health Centers, "Envisioning the Future of Academic Health Centers," February 2003, p. 3.

Defining the Academic Health Centers

Before discussing the three academic health centers, it is important to define their scope and to differentiate between the relationships the three universities have with their affiliated teaching hospitals. Table 23 lists the colleges that are considered part of the three universities' academic health centers.

Table 23: The Colleges within the Academic Health Centers

The Ohio State University
College of Medicine and Public Health[40]
College of Dentistry
College of Nursing
College of Optometry
College of Pharmacy
University of Cincinnati
College of Medicine
College of Pharmacy
College of Nursing
College of Allied Health Sciences
Case Western Reserve University
School of Medicine
School of Dental Medicine
Frances Payne Bolton School of Nursing

In addition to its medical colleges, each academic health center is associated with teaching hospitals that support clinical research and training and provide patient care. The three universities have distinct legal and organizational relationships with their teaching hospitals.

- The Ohio State University owns and controls its major medical affiliate – the OSU Medical Center Health System – and has an affiliate agreement with Columbus Children's Hospital.

- University of Cincinnati has affiliate agreements with its four associated teaching hospitals, but has a particularly close relationship with Cincinnati Children's Hospital Medical Center. Cincinnati Children's does not just serve as the clinical affiliate of the Department of Pediatrics; it *is* the College of Medicine's Department of Pediatrics.

[40] OSU's College of Medicine includes the School of Allied Medical Professions, the School of Biomedical Sciences.

- Case Western Reserve University has affiliate agreements with its four associated teaching hospitals.

Table 24 lists the affiliated hospitals and other health care institutions that comprise the academic health centers along with their relationship to each university.

Table 24: Medical Affiliates and Their Relationship to the Universities

The Ohio State University	
OSU Medical Center Health System[41]	University owned
OSU Physicians, Inc.	University owned
Columbus Children's Hospital	University affiliated
University of Cincinnati	
UC Physicians	University owned
Cincinnati Children's Hospital Medical Center	University affiliated and academic department
Health Alliance - University Hospital	University affiliated
Cincinnati Shriners Hospital	University affiliated
VA Medical Center – Cincinnati	University affiliated
Case Western Reserve University	
Cleveland Clinic	University affiliated
MetroHealth System	University affiliated
University Hospitals of Cleveland	University affiliated
VA Medical Center – Cleveland	University affiliated

While Section IV included the economic impact of the colleges of medicine and the other schools for health professionals listed in Table 23, it did not include the economic impact of the medical affiliates. Instead, we estimate the economic impact of those institutions below, under the heading "Economic Impact of the Medical Affiliates."

Clinical Training

In medicine, nursing and other health professions, the clinical dimension of education and training is just as important as – and is indeed inseparable from – the learning that takes place in the classroom and the laboratory. The partnership between the three universities and their affiliated hospitals is thus central to their role in biomedical education.

This partnership is evident in virtually every aspect of health-related education at the three universities. We will cite here just a few examples.

[41] The OSU Medical Center Health System includes University Hospital and University Hospital East, Ross Heart Hospital, the James Cancer Hospital and Solove Research Institute, OSU Harding Hospital and the OSU Primary Care Network.

- In 2002, Case Western Reserve University's School of Medicine and the Cleveland Clinic Lerner College of Medicine of Case Western University launched a new joint program designed to train physician-researchers. Students in the program take courses both at Case Western Reserve University and at the Cleveland Clinic, receiving their medical degrees from Case.

- Case and the Cleveland Clinic have partnered to offer a one-of-a-kind Cardiac Nurse Practitioner program. The program is offered through Case's ***Acute Care Nurse Practitioner*** program. Nurse practitioners in the program work with faculty from both institutions to develop the skills required to collaborate with cardiologists and thoracic surgeons to treat patients with acute cardiac disorders.

The three universities' colleges of medicine and their affiliated institutions play an important role in graduate medical education. In 2003-04, hundreds of physicians participated in residency and fellowship programs supervised by the three colleges of medicine. These programs attract graduates from medical schools throughout the country to Cleveland, Columbus and Cincinnati.

All three colleges of medicine and their affiliates also offer extensive opportunities for continuing medical education. These opportunities range from weekly "grand rounds" at the hospitals, to one-day or multi-day conferences and courses on specific topics, to web-based programs. In 2003-04, more than 39,000 health care professionals participated in more than 400 CME activities sponsored by University of Cincinnati. In 2003, more than 10,000 participated in programs at the Cleveland Clinic. Programs such as these draw participants not just from the Cincinnati, Cleveland and Columbus metropolitan areas, but from other states and other nations as well. In 2003, for example, 8.5 percent of all participants in CME programs at the Cleveland Clinic came from outside the U.S.

Research and Business Development

The academic health centers help to distinguish the scale and scope of research at Ohio State, Cincinnati and Case from research activity at other Ohio universities. In 2004, the colleges of medicine, dentistry, public health, pharmacy, allied health sciences, nursing and other health professions accounted for about 60 percent of all research spending at the three universities – a total of approximately $608 million.

Nationally, the academic health centers are highly competitive with regard to obtaining funding for medical research. In 2004, the Case School of Medicine ranked 13th nationally for NIH awards received, with $232 million. As University of Cincinnati's pediatric division, Cincinnati Children's Hospital Medical Center ranked third in federal research grants to children's hospitals in 2004.

Designing New Medical Devices

At Ohio State, Cincinnati and Case, the opportunity to collaborate with clinicians is not limited to the universities' medical schools. At Cincinnati, for example, the College of Engineering's Biomedical Engineering Department offers a course called "Introduction to Medical Device Innovation" that brings together biomedical engineering, industrial design and business students. Teams made up of students from each of these programs are assigned to work with a physician to evaluate an existing medical device. They explore what the physician likes or doesn't like about the device – how it works – how it was made – and how it might be improved. Students also visit one of UC's affiliated hospitals to observe the actual use of the device in a clinical setting.

Team members then design and engineer something better – either a modification of the original device, or new alternative. But their work doesn't stop there; they are also required to assess the economics of the new device, its market potential, and how it might compare with other products already available, what regulatory hurdles it will have to clear, etc.

Through this process, students in different disciplines can gain valuable experience not just in designing devices that are technically superior – but also in evaluating how these devices are used in a clinical setting, and whether there is enough demand to justify the cost of launching a new product.

Many of the major research programs at these institutions involve both the universities and their medical affiliates. For example:

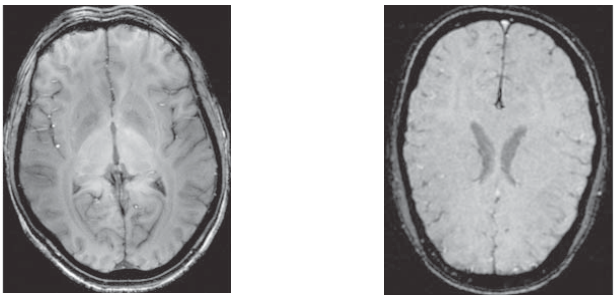
- University of Cincinnati, together with its affiliate, University Hospital, has received $17.4 million from the National Institutes of Health (NIH) to coordinate a five-year, international study of alternative treatments for acute ischemic stroke. The study will be the first randomized trial of its kind and will also be the first to compare new procedures against the standard approach to clear clogged brain arteries, the cause of ischemic stroke.

- With a $19.4 million grant from Ohio's Wright Capital Fund and the state's Biomedical Research and Technology Transfer Fund, Case, the Cleveland Clinic, and University Hospitals formed the ***Center for Stem Cell and Regenerative Medicine*** in 2003. The Center is committed to launch two spin-off companies before 2006 and four more by 2008. The grant will also fund recruiting of 26 new researchers, who will bring additional federal funding to the region. OSU and six industry partners also participate in the Center. The Center has already received more than $7 million in federal funding to supplement the state's investment.

Leading the Way In Medical Imaging

One Third Frontier success story has been the development of the ***Achieva Magnetic Resonance Imaging*** (MRI) system. Led by Ohio State's Dr. Michael Knopp, working in partnership with academic colleagues from Case Western Reserve University and industrial collaborators from Philips Medical and Rexon, this team has developed a 7 Tesla Magnetic Resonance Imaging (MRI) system that provides tremendously enhanced image resolution over the typical 1.5 Tesla MRI systems presently available in hospitals across the country and around the world. (Examples of the superior images that will lead to improved health outcomes are shown in Figure 14.) This new diagnostic capability will reduce the need for surgery and allow doctors to better monitor the effect of medications. The first Achieva system available for patient care is now within the Ohio State University Medical Center.

Figure 14: Comparison of MRI imagery from 7 Tesla and 1.5 Tesla devices



7 Tesla image 1.5 Tesla image

Development of the Achieva MRI system resulted from a $17.1 million Third Frontier investment leveraged against additional contributions of $41.6 million provided by the industrial and academic partners.

As a direct result of this work, Phillips Medical, a Dutch company, has chosen to manufacture the Achieva MRI systems in Cleveland, and to relocate from the Netherlands a number of people working on synergistic medical imaging systems. As a result, the project has brought more than 70 new, high-tech, high-paying jobs to Cleveland. Annual sales of the Achieva MRI systems, each costing between $8 and $15 million, are projected to exceed $50 million / year.

- OSU is lead with partners Siemens, Battelle, and Zivena on the $23.2M ***Center for Cancer Treatment and Translational Research***. Formed in October 2003 with a Third Frontier grant, the Center has subsequently been awarded designation and funding as an NIH Cancer and Leukemia Group B Core Imaging Lab. In addition, therapeutic medications for advanced lung cancer developed within the Center have shown good results in Phase II trials and talks are in process with pharmaceutical companies on co-licensing. Additional commercial development includes formation of ***Berrystone***, an Ohio corporation, created to capitalize on and optimize the beneficial effects of nutraceutical chemicals found in blackberries.

- The three academic health centers also collaborate with each other. The Ohio State University's Comprehensive Cancer Center (OSUCCC) recently partnered with Columbus Children's Hospital and Cincinnati Children's Hospital to form the ***Ohio State University/Cincinnati Children's Cancer Consortium***. OSUCCC benefits from Cincinnati Children's established expertise in gene therapy and cell treatments in pediatric cancers. At the same time, Cincinnati Children's gains access to novel adult cancer treatments at OSUCCC that may be appropriate for children and young adults. The affiliation also expands pediatric cancer research efforts within the OSUCCC that are being conducted by pediatrics faculty at Columbus Children's Hospital.

Academic health centers also benefit the communities in which they are located through their role in clinical trials – even in the case of pharmaceutical products, medical devices, and procedures that are developed elsewhere. Clinical trials bring new knowledge into a region, provide new types of treatments for patients, and help medical centers invest in new facilities.

As of September 2005, just three of the medical affiliates – the Cleveland Clinic, Cincinnati Children's Hospital, and the OSU Medical Center – were conducting hundreds of clinical trials in areas ranging from asthma to heart failure. In Northeast Ohio, for example, 200,000 people suffer from type 2 diabetes, contributing to an increased risk of death from cardiovascular disease. Cleveland Clinic, VA Medical Center, University Hospitals Cleveland and Case are together serving as a major clinical site in a national study – the Action to Control Cardiovascular Risk in Diabetes (ACCORD). Approximately 1,000 adults with type 2 diabetes will be enrolled.

Just as the affiliated hospitals are partners with the universities in conducting biomedical research, so are they partners in business development. The Center for Stem Cell and Regenerative Medicine (described above), for example, has already produced its first spin-off company – Arteriocyte, a company developing stem cell-based therapies. The company's goal is to generate new blood vessels to replace ones that do not supply enough blood to heart tissue in patients with heart disease. In addition to receiving $250,000 from Case Technology Ventures, the company received a $1.4 million stem cell research grant from the National Institutes of Health.

At the Cleveland Clinic, Cleveland Clinic Foundation Innovations (CCFI) helps to commercialize research developed in Cleveland Clinic's labs through licensing agreements to new and established firms. One of CCFI's spin-offs is Prognostix – a company that develops diagnostic tests to help determine a patient's likelihood for serious cardiac events. In addition, CCFI hosts the annual Cleveland Clinic Medical Innovation Summit, bringing hundreds of biomedical researchers, entrepreneurs, and venture capital firms to northeast Ohio.

The Affiliated Hospitals: Major Regional Businesses[42]

In addition to their role as partners in the academic health centers at Ohio State, Cincinnati and Case, the three universities' medical affiliates are in themselves major regional businesses.

The affiliated hospitals that make up the three universities' academic health centers are major employers within their respective metropolitan areas, employing medical professionals as well as administrators, clerical workers, and support staff. Table 25 shows how the medical affiliates' employment ranks among other businesses in their regions.

Table 25: Selected Medical Affiliates' Regional Employment Rankings[43]

Medical affiliate	Employment ranking
Cleveland Clinic	1st
University Hospitals – Cleveland	2nd
Cincinnati Children's Hospital Medical Center	10th
MetroHealth System	11th
Ohio State University Medical Center	14th
Columbus Children's Hospital	20th
Health Alliance – University Hospital[44]	22nd

Most of the medical affiliates' employees are residents of – and spend a significant share of their earnings within – the counties in which the medical affiliates are based. Table 26 summarizes the affiliated hospitals' employment and spending on salaries and wages for fiscal year 2004.

[42] Due to data limitations, we were not able to conduct a complete economic impact assessment for Case Western Reserve University's affiliates. However, we discuss the impacts of Case's affiliates in the context of the other universities' medical affiliates.

[43] Sources: Crain's Cleveland Business Book of Lists 2005 (ranking based on Cuyahoga County employers), Columbus Business First Book of Lists 2004 (ranking based on Greater Columbus employers), and Cincinnati Business Courier Book of Lists 2005 (ranking based on Tri-State employers).

[44] The Health Alliance of Greater Cincinnati network – of which University Hospital is a part – is the third largest employer in the tri-state area.

Table 26: In-State Employment and Payroll Spending by the Medical Affiliates, FY 2004

	Total employment	Total payroll	Percent of payroll paid to own county residents
University of Cincinnati medical affiliates[45]	10,910	$ 720,733,508	63 %
The Ohio State University medical affiliates	11,599	$ 531,384,639	79 %

The three universities' medical affiliates have also invested heavily in the development of new facilities for patient care, teaching and biomedical research; and they buy millions of dollars worth of goods and services from local firms. In fiscal year 2004, medical affiliates associated with the OSU and University of Cincinnati together paid more than $500 million to suppliers and contractors in their home counties for goods, services, and construction.

Table 27 summarizes the affiliated hospitals' in-county expenditures on goods, services, and construction in fiscal year 2004.

Table 27: Purchasing and Construction Spending by the Medical Affiliates, FY 2004

	Purchasing within own county	Construction spending within own county
University of Cincinnati medical affiliates	$ 374,877,607	$ 26,160,186
The Ohio State University medical affiliates	$ 102,507,883	$ 59,428,950

[45] University of Cincinnati's physician practice plan payroll and employment were included in Section II of the report and are not included in this sum.

Economic Impact of the Medical Affiliates

To estimate the economic impact of the universities' medical affiliates, we use an approach similar to that used in analyzing the impact of the research universities, with one significant difference. When economists analyze the regional impact of a particular institution or enterprise, they often distinguish between "traded" and local industry sectors. Major research universities are typically treated as part of a traded industry – they compete with similar institutions throughout the country for faculty talent, students and research funding. Health care, in contrast, is usually seen as a local, "non-traded" industry. For the most part, people get health care close to where they live; health care providers in Columbus, Cincinnati, and Cleveland generally do not compete directly with those in Chicago or Baltimore.

Hospitals affiliated with academic health centers, however, are at least in part an exception to this pattern; unlike most community hospitals, they often draw a significant share of their patients from outside the local area. And as noted above, some of the affiliated hospitals are major recipients of federal research funds. Recognizing the mixed nature of the universities' affiliated hospitals – partly local, partly traded services – the following analysis focuses on the impact *within* Franklin and Hamilton counties of spending that is supported by revenues that OSU- and UC-affiliated hospitals bring in from *outside* those counties.

About 53 percent of the revenue of OSU's medical affiliates comes from sources outside Franklin County while nearly 55 percent of University of Cincinnati's medical affiliates' revenue comes from sources outside Hamilton County.

Using an input-output model tailored to the structure of the economies of Hamilton and Franklin counties and the state of Ohio, we can estimate how money that the medical affiliates pay to their employees and suppliers generates new economic activity and jobs in the region. We estimate that OSU's medical affiliates generated about $760 million in economic activity and 11,700 jobs in Franklin County in fiscal year 2004. We estimate that University of Cincinnati's medical affiliates generated $1.26 billion in economic activity and nearly 13,000 jobs in Hamilton County during 2004.

On a statewide basis, we estimate that OSU's medical affiliates generated about $620 million in economic activity and 11,900 jobs in Ohio in fiscal year 2004. We estimate that University of Cincinnati's medical affiliates generated $1.25 billion in economic activity and about 14,100 jobs in Ohio during 2004.

Table 28 summarizes the economic impact of the medical affiliates on their respective counties and on the state of Ohio.

Table 28: Economic Impact of the Medical Affiliates[46], FY 2004

Economic Impact of the Medical Affiliates on their Home Counties					
Medical Affiliates	Affiliates' employees residing in the same county as the affiliate	Spending by affiliates within own county[47]	Percent of spending supported by out-of-county revenues	Total impact of the medical affiliates' spending on their own counties[48] Jobs (FTE)	Output
UC medical affiliates	8,191	$718.5 million	54.8 %	12,913	$1.26 billion
OSU medical affiliates	9,145	$454.6 million	53.5 %	11,734	$757.0 million

Economic Impact of the Medical Affiliates on the State of Ohio					
Medical Affiliates	Affiliates' employees residing in Ohio	Spending by affiliates within the state of Ohio[49]	Percent of spending supported by out-of-state revenues	Total economic impact of the medical affiliates' spending on the state of Ohio[50] Jobs (FTE)	Output
UC medical affiliates	10,910	$898.1 million	26.4 %	14,104	$1.25 billion
OSU medical affiliates	11,599	$585.8 million	3.9 %	11,898	$618.1 million

Healthy Communities

The primary mission of the universities' medical affiliates is to provide health care services to patients – particularly to local patients. As we noted in Section VI, a region's access to a healthy, talented population is a significant determinant of its future economic success.

The three universities' medical affiliates have a role in keeping the three regions' populations healthy and productive. In the case of the medical affiliates of both OSU and University of Cincinnati's medical affiliates, about 53.4 percent of the patients served are

[46] Due to data limitations, we were not able to conduct a complete economic impact assessment for Case Western Reserve University's medical affiliates.
[47] Includes spending on goods and services, construction, and payroll.
[48] Includes 100 percent of the affiliates' direct employment of county residents and spending with in-county vendors. Includes the portion of indirect and induced employment and spending that was supported by revenues from outside the county.
[49] Includes spending on goods and services, construction, and payroll.
[50] Includes 100 percent of the affiliates' direct employment of state residents and spending with in-state vendors. Includes the portion of indirect and induced employment and spending that was supported by revenues from outside the state.

residents of the hospitals' home counties; and most of the rest are residents of other Ohio communities. Only 2.9 percent of OSU's affiliated hospitals' patients came from outside the state, in fiscal year 2005. Due to its proximity to Kentucky and Indiana, University of Cincinnati's affiliated hospitals draw more than 23 percent of their patients from out-of-state.

In addition to compensated care, U.S. hospitals provide uncompensated and charity care to people who don't have the ability to pay for treatment. During fiscal year 2004, University of Cincinnati and The Ohio State University medical affiliates provided over $300 million in uncompensated care to patients in their communities.

Case's medical affiliates provide a significant share of care to patients in and around the Cleveland metropolitan area. For example, MetroHealth and the VA Medical Center supported more than 1.5 million outpatient visits while admitted patients spent more than 230,000 days at their facilities in fiscal year 2004. Together, MetroHealth, Cleveland Clinic, and the Louis Stokes VA provided more than $280 million worth of uncompensated and charity care during fiscal year 2004.

Table 29 summarizes the patient care provided by the universities' affiliated hospitals during fiscal year 2004.

Table 29: Patient Care, Fiscal Year 2004

	Inpatient days	Outpatient visits	Value of uncompensated care
University of Cincinnati affiliated hospitals[51]	288,497	1,468,489	$ 208.8 million
The Ohio State University affiliated hospitals	366,037	1,363,422	$ 107.4 million
Case Western Reserve University affiliated hospitals[52]	639,641	4,307,943	$281.3 million

While all hospitals provide patient care services, hospitals that are part of academic health centers have especially significant impacts in applying innovative medical diagnostics and treatments. For example, researchers in the academic health centers are leaders in developing minimally-invasive surgeries, requiring little more than a pin-size incision; biologics – growing tissues via a patient's stem cells that eliminates the use of skin grafts in burn patients; and radio frequencies – used to break up kidney stones and soft tumors within the body without surgery.

[51] For the VA Medical Center, all care is compensated through government appropriation or third-party collections. For Shriners Hospital, all care (over $26 million in fiscal year 2004) is provided free based on donations to the Shriners organization.

[52] Includes MetroHealth and VA Medical Center data from FY 2004, Cleveland Clinic data from 2003. University Hospitals – Cleveland data was not available.

Researchers from Case, the Louis Stokes VA Hospital, and University Hospitals-Cleveland developed a minimally-invasive implant technology that allows patients with serious spinal injuries to breathe without the use of a ventilator. The affiliated hospitals have been the sites of clinical trials to test the procedure. So far, more than twelve patients with spinal cord injuries have successfully received the implants.

In Hamilton County, there are an estimated 10,000 people with type I diabetes and 140,000 people with type II diabetes. The ***UC Diabetes Center***, opened in July 2004, provides direct care – through diabetes education and monitoring of blood-sugar levels, weight and other health indicators. In addition, the Center provides physician training and sponsors diabetes research. The Center was funded in part by University of Cincinnati's partner, Health Alliance.

The Impact of Case Western Reserve University's Affiliates on Cleveland and Ohio

Although we do not have enough data to estimate the total economic impact of Case's medical affiliates for 2004, the data we have suggests that – like the affiliates of OSU and UC – they have a significant economic impact on the state and on Cuyahoga County.

Case's medical affiliates are among the largest employers in metropolitan Cleveland. The Cleveland Clinic Health System – of which Cleveland Clinic is a significant part – is the largest employer in Cuyahoga County. In 2003, Cleveland Clinic employed more than 15,000 people. University Hospitals Health System – of which University Hospitals is a significant part – was the second largest employer in the county and MetroHealth – with 4,800 Cuyahoga County-based employees – was the county's 11th largest employer.[53]

From medical equipment to furniture to local catering services, Case's affiliates are major purchasers of goods and services from local and statewide vendors. For example, out of nearly $200 million spent on goods and services in 2004, MetroHealth paid nearly $80 million to vendors in Ohio and $42 million to vendors in Cuyahoga County.

Spending by Case's medical affiliates on new clinical and research facilities creates local construction jobs and – more importantly – adds capacity to treat patients, sustain basic research and innovation, and expand employment. Between 1999 and 2004, the MetroHealth System in Cleveland spent more than $142 million on construction and expects to spend another $165 million through 2009. Among the new facilities planned by MetroHealth are a $21 million Skilled Nursing Facility and a $10.8 million Senior Health Services Facility.

Having spent about $350 million on capital construction between 1999 and 2003, Cleveland Clinic is now building a new $320 million, one million square foot home for its Heart Center. The Center will consolidate and expand existing clinical, research, and educational facilities and is expected to open in 2008.

[53] Source: Crain's Cleveland Business Book of Lists 2005 (ranking based on Cuyahoga County employers),

Ohio residents also benefit from wellness programs offered through the academic health centers. These programs help community members manage chronic illness, develop better nutrition and exercise habits, and can even lead to the diagnosis and treatment of serious illness.

- The UC Cancer Center's mobile prostate cancer screening program has screened more than 400 men over the past two years. Prostate cancer – which is difficult to detect in its early stages because there are no outward symptoms – is the second leading cause of cancer-related mortality among men. Five percent of the men screened were diagnosed with prostate cancer and enrolled in a treatment program. Prostate cancer, when detected early, is among the most curable types of the disease.

- The Case School of Medicine is providing Cuyahoga Metropolitan Housing Authority (CMHA) residents with health education classes through its ***Health CMHA*** program. Case students teach residents about managing health issues like hypertension and diabetes, while also helping them develop better exercise and nutritional habits.

- Through the ***OSU Center for Wellness and Prevention***, the OSU Medical Center offers classes to promote fitness, nutrition, and smoking cessation. The Center also offers programs to help people learn to manage diabetes through nutrition and exercise as well as tailored exercise programs for people with chronic cardiac and pulmonary disease.

In 1994, Case, OSU, and UC partnered to bring high-quality health and wellness information to the world through a non-profit venture, ***NetWellness***. The website went live in 1995 and now receives 15 to 20 million hits per year. Its premiere feature is its "Ask an Expert" service. Members of the three universities' – and affiliates' – medical faculty and staff have answered more than 27,000 health questions posed anonymously by visitors to the site. The questions and answers are maintained in an easy-to-search index.

Academic Health Centers: Engines of Development

Major projects undertaken by the three universities illustrate especially well the collaboration that characterizes the three academic health centers – and their growing significance as drivers of regional economic development.

Soon after Aventis Pharmaceuticals donated 23 acres of land and 360,000 square feet of office space to University of Cincinnati in 2001, UC announced the creation of a new non-profit research center, the ***Genome Research Institute*** (GRI). The University invested $43 million in the facilities to develop state-of-the-art lab space in order to conduct the kind of research that has major impacts and attracts leading researchers.

In addition to housing researchers from partners such as Procter & Gamble Pharmaceuticals, the Air Force Research Lab, and Meridian Bioscience, the GRI campus has attracted a leading European biotech firm, Evotec OAI. This will be Evotec's first North American R&D facility. Another GRI partner, Girindus America, received a $1.1 million award Third Frontier award in 2003. The award will be used to build a facility capable of producing a synthetic RNA and DNA material called *oligoneucleotide* that will be used by researchers at the GRI.

The GRI is expected to receive more than $500 million in NIH awards by 2009. Currently the GRI employs 120 researchers and their staff of 320 people. It is expected to grow to over 1,000 employees within ten years.

In 2005, The Ohio State University Medical Center established a new non-profit organization to serve as a partner in technology transfer and business development. ***University Medical Center Partners*** will license Medical Center technology with commercial potential. UMC Partners will then nurture companies using that technology – investing capital while helping them locate additional funds, facilities, human resources, and a management team. The first company in UMC Partners' portfolio is Prologue Research – a 40-person contract research organization that specializes in managing oncology and oncology-related clinical trials.

In September 2005, UMC Partners and the City of Dublin, Ohio, unveiled a major new development project. The City is developing a 1,500-acre campus called the Central Ohio Innovation Center. The Dublin campus includes a 100-acre site on which UMC Partners will develop research facilities, offices, and outpatient care services – to be known as the ***OSU Health & Innovation Park.***

Also in 2005, Case entered into negotiations with the Cleveland-based Forest City Companies to develop its new ***West Quad*** – a 14-acre development that when completed will have 1.5 to 2 million square feet of medical research space for Case and its affiliated institutions, and for technology-based companies. When fully built out, the West Quad is expected to support 4,500 to 6,000 jobs.

X: Universities and Their Communities

As preceding sections of this report have described, The Ohio State University, University of Cincinnati, and Case Western Reserve University all contribute to the growth of Ohio's economy by developing intellectual capital—new technologies and ideas; human capital—talented graduates; and physical and financial capital—through local construction, purchasing, and investments. But the three institutions also contribute to the economic vitality of their local communities, and communities throughout the state of Ohio, through university outreach programs.

Ohio State describes university outreach as "meaningful and mutually beneficial collaboration with partners in education, business and public and social services." It includes teaching and learning activities that take place beyond the bounds of the campus – conducting research on topics, and communicating the results in ways, that are directly useful to Ohio residents, businesses and communities – and community services that are provided directly by the university, faculty members and students.

Outreach is not confined to a single, centralized department in any of the three universities. Instead, each of the universities' schools and colleges engages in its own community activities, with overall guidance and coordination provided by a central office. As Dr. Bob Moser, Ohio State's Vice President for University Outreach and Engagement, puts it: "outreach looks different across the campus, but it all involves bringing the university's intellectual capital to bear on societal needs."

In some cases, this engagement takes the form of volunteer activity. In 2004, 5,292 University of Cincinnati students volunteered for more than 73,000 hours of community service in programs ranging from tutoring elementary school students to building homes with Habitat for Humanity. Ohio State's Office of Institutional Research and Planning estimates that nearly 47 percent of Ohio State undergraduate students perform volunteer work each week.

Community outreach, however, is not limited to volunteerism. It also involves "service learning" – courses and research projects that give students an opportunity to integrate academic work with hands-on learning in a local school or community service center, or as consultants to a local business. Community outreach also involves programs that disseminate the results of university research to people who can benefit from the practical application of that knowledge.

We will not attempt in this report to describe the full range of outreach activities. Instead we focus on three types of community partnerships that can have particularly significant economic impacts. We focus first on education – how the universities help students prepare for college, and for the opportunities that Ohio's knowledge economy will offer. We then turn to university involvement in economic and business development; and finally to university involvement in community revitalization.

Helping Ohio's Students Prepare for the Future

Ohio's young people are more likely to graduate from high school than their counterparts nationwide, but less likely to go on to college. The Governor's Commission on Higher Education and the Economy has noted that too many Ohio children do not understand the value of – and are not adequately prepared for – a college education.[54] Ohio State, Cincinnati and Case have all undertaken efforts aimed at helping young Ohioans acquire the knowledge and skills they will need to succeed in college, and in a rapidly-changing economy – both by improving the quality of elementary and secondary education and by expanding the opportunities available to individual students.

While The Ohio State University and University of Cincinnati produce hundreds of new Ohio teachers each year through their graduate schools of education, the three universities also offer programs directly to practicing teachers to help them keep up with new teaching methods and curricula – particularly in fast-changing areas such as the biological and physical sciences. Here is a sample of those programs:

- At Case, teachers of grades 4-9 may take a 13-day summer course in ***Schoolyard Ecology.*** Tutored by university faculty, participating teachers observe and measure ecological characteristics of different environments. At the end of the course, the teachers are challenged to develop research questions and the methods to answer them using their own schoolyards. Teachers bring these research questions – and the analytical tools to answer them – back to their classrooms in the fall.

- Through its ***Center for Science and Mathematics Education***, Case offers a 2-year customized professional development program for K-8 teachers with an elementary education certification, but without a science background. The program introduces teachers to concepts in biology, chemistry, and physics while also helping them adapt what they've learned to create age-appropriate lesson plans for their classrooms.

- Incoming Ohio State undergraduate students may apply to be ***Tomorrow's Teachers Scholars*** – a select group of talented students interested in pursuing a career in teaching. While preparing the students for their education certification and potential graduate degree in education, the program gives students the opportunity to work in local schools and with educational policy organizations throughout their undergraduate careers.

- The Ohio State University's ***Urban Schools Initiative*** collaborates with urban schools in four Central Ohio school districts, providing teacher training and engaging families. So far, the results have been favorable. For example, at Arlington Park Elementary School, 51 percent of students passed a 4th grade reading proficiency standard by January – up from 26 percent the year before.

[54] Governor's Commission on Higher Education and the Economy, "Building on Knowledge, Investing in People: Higher Education and the Future of Ohio's Economy," April 29, 2004. p. 20.

- Case offers the ***Cleveland Mathematics and Science Partnership***. This is a professional development program aimed at high school math and science teachers in the Cleveland Municipal School District. Participants make a three-year commitment to strengthen their content knowledge and integrate new teaching strategies in the classroom. The program is partially funded by the National Science Foundation.

- University of Cincinnati, The Ohio State University, and University of Dayton are co-leading an effort to measure and improve teacher preparation in the state of Ohio. The five-year ***Teacher Quality Partnership*** project will survey 4,500 teachers annually in order to develop better graduate education and professional development programs with an end goal of improving K-12 educational outcomes in the state.

These programs for Ohio's schools and teachers sow the seeds of human capital throughout Ohio, setting the stage for the creation of new generations of young people ready for a university education.

In addition to providing service and support to schools and teachers, the three universities offer programs directly to Ohio's schoolchildren. For example:

- Through a partnership with Battelle and the Educational Council, a partnership of Franklin county's sixteen school districts, Ohio State will participate in the creation of ***Metro High School***, a new public high school that will emphasize math, science and technology and will prepare students for success in college. The school's 11th and 12th graders will participate in hands-on, self-directed learning outside the classroom with teachers and mentors from the community. This includes independent research projects, group projects with other students and community internships at "learning centers" around the community, including Battelle, Ohio State, the Center of Science and Industry, the Columbus Museum of Art, WOSU, the Wexner Center for the Arts, as well as other businesses and organizations. Metro will open in the fall of 2006 with 100 students, and will phase in enrollment over the next four years with a maximum capacity of 400 students.

- With Columbus Public Schools, Ohio State and local businesses are taking part in ***ColumbusReads***, a literacy program which is part of OhioReads at the state level and AmericaReads at the national level. ColumbusReads is a literacy initiative aimed at improving the reading skills of kindergartners with a long-term goal of improving outcomes on Ohio's fourth-grade proficiency test. More than 200 Ohio State faculty, staff, and administrative volunteers have participated in the program and have provided more than 1,600 hours of tutoring and mentoring to more than 100 kindergarten students at two schools, Hubbard Elementary and East Linden Elementary.

- Ohio State Chemistry Professor Susan Olesik, whose instruments measured the atmosphere around Saturn's largest moon, also heads a program using OSU science majors called WOW – ***Wonders of our World***. Drawing on a corps of more than 300 students and faculty from across the university, the WOW outreach program enhances

elementary and middle school science programs by providing 125 hands-on science experiments in 15 subjects. Since its inception in 1999, more than 10,000 students in 11 schools have participated and each month an average of 150,000 people around the world access the WOW web site.

- While instructing children in the basics of swimming, tennis, basketball, and good sportsmanship, Case's ***National Youth Sports Program (NYSP)*** offers math and science tutoring as well as counseling on fitness, nutrition, and substance abuse prevention during a month-long summer program..

- Case's ***Biotechnology Institute for Gifted and Talented High School Students*** is a 2-week summer program that exposes high school students to biotechnology topics through in-depth explorations of genetics. Students participate in laboratory experiments in which they extract and manipulate DNA from pea seeds and even examine their own unique genetic fingerprint. In addition, students discuss ethical issues relating to DNA and advances in the human genome project.

- The ***Learning Enrichment Academy Program*** is a national program offered by medical schools – including Case's School of Medicine – that supports science education in elementary and middle schools. Along with its partner, Superior Elementary School in East Cleveland, Case offers after-school science classes to more than 200 students, including some from other East Cleveland elementary schools.

- More than 50 Case faculty – representing departments across the university – offer qualified high school students the opportunity to participate in original research as part of the university's ***Research Experiences for High School Students*** program. While gaining access to renowned faculty, participating high school students have access to the university's engineering, medical, and computer facilities.

- University of Cincinnati's ***GEAR UP*** program is working with 1,200 elementary and middle school students in 17 public schools, to improve their awareness of the importance of higher education, and to set them on the road to college. UC provides mentors and tutors who work directly with students, provides professional development programs to teachers, and hosts summer programs on campus. The program is specifically targeted at students who are falling behind on test scores. Funding is provided by the U.S. Department of Education.

- UC's ***Emerging Ethnic Engineers*** (E^3) program was developed to increase the number of African-American, Latino, and Native American students in the College of Engineering. There are three sub-programs: the Family Science Academy – open to students between 4^{th} and 7^{th} grade, the Pre-College Study Center for kids in 7^{th} through 12^{th} grade, and the Accelerated Mathematics and Physics program for 11^{th} and 12^{th} graders. These programs are designed to teach math and science skills while stimulating interest in engineering and an appreciation for a college education.

- Through both academic-year and summer programs, University of Cincinnati's ***Upward Bound*** gives high school students the chance to see what university life is like. During the academic year, UC juniors and senior tutor high school students who also take classes at the university on Saturday mornings. In addition, high school students receive academic, personal, and career counseling. The Upward Bound summer program brings Cincinnati high school students to the university for six weeks. They live in dorms, attend classes and personal development activities, and study with faculty. In addition, a summer work program provides paid summer jobs to Cincinnati high school students, along with training and mentoring. In the summer of 2004, 200 young adults participated in the program.

Improving School Performance in Ohio's Underserved Neighborhoods

The Ohio State University's ***P-12 Project*** is an ambitious university-wide program with a mission to improve Ohio's schools and in particular to ensure that Ohio's underserved children receive an education that readies them for college. The project, established in 2000, has attracted more than $14 million in external funding to support innovative in-school, after-school, and teacher training programs.

The P-12 Project implemented several broad projects. Among them was ***Community Connection***, a web-based tool that connects Columbus Public School teachers with qualified classroom volunteers. The program is on its way to being implemented statewide through the university's Extension offices.

The P-12 Project has incubated several promising educational programs and as a result of their demonstrated effectiveness, several were later adopted and funded by other organizations within OSU. For example:

- ***School psychology practicum***. In this program, 12 OSU school psychology students serve for a full year at 12 public schools, working at least 240 hours per year under the supervision of the school's psychologist. After P-12 Project support ended, the OSU College of Education continued to offer and support it.

- ***Reading course field experience***. The university offers a course in which students learn about methods for teaching reading and then apply the methods in public schools. Now offered through the College of Education, 400 OSU students per year teach reading in Columbus schools through this program.

- ***Academic learning lab***. Dr. Bruce Tuckman, an OSU professor teaches high school teachers at three Columbus high schools how to teach study skills. Although his P-12 funding has ended, Dr. Tuckman has received a grant award that allows him to expand to a community college and, this year, to four additional high schools. He plans to expand the program nationally.

Business and Economic Development

In addition to their engagement in efforts to improve Ohio's schools and expand educational opportunity, the three universities help to strengthen Ohio's economy by working directly with small and medium businesses – both in their local communities and elsewhere in the state.

- The OSU ***Ohio BioProducts Innovation Center*** (OBIC) combines two of Ohio's most important economic sectors – agriculture and chemicals/plastics/rubber. In collaboration with Battelle, the center will develop conversion technologies for industrial products from corn, soybeans, and other crops. OBIC was established with a State of Ohio Third Frontier grant of $11.6 million and is receiving an additional $21.9 million from 15 industrial partners.

- Sometimes facilitating the flow of timely information can have a profound impact on a regional industry. Ohio State's ***Crop Observation and Recommendation Network*** (CORN) electronic newsletter provides readers with current information about pests, climate trends, and other issues facing Ohio's agricultural community. Ohio State researchers and Extension professionals from across the state provide timely information to farmers and the agricultural industry via e-mail, fax, a website, and regular mail. Based on the results of a 2001 survey, CORN readers, who together farm more than 2.5 million acres in Ohio, saved more than $1 million through herbicide cost reductions. Increases in corn and soybean yields based on CORN information and advice were valued at more than $10 million.

- The Ohio State University Extension operates a number of local economic development programs, including the ***Ohio Business Retention and Expansion Initiative*** (BR&E). BR&E staff work directly with local officials and small businesses to identify hurdles to local business expansion and implement solutions. With success stories in more than a dozen Ohio counties—including work in Fayette County that led to $80 million in cost savings and new investment while creating 764 jobs—the BR&E Initiative has a significant statewide impact.

- The ***Southside Manufacturers Forum*** is an outreach and engagement initiative of OSU's Center for Excellence in Manufacturing Management (CEMM). The organization is composed of twelve local manufacturers who meet monthly to discuss performance improvement management topics. The programs are organized and facilitated by a staff member from the CEMM.

- Case's Weatherhead School of Management offers ***MBAs on Call***, a program in which Cleveland-based companies hire MBA students to help solve business problems on projects lasting two to thirteen weeks. Local businesses benefit from the students' talent and fresh perspective while the students benefit from experience on results-driven projects with established companies.

- University of Cincinnati's ***Goering Center of Family & Private Business*** offers education and networking programs to member companies and community partners – most of whom are small Ohio-based businesses. For example, the Goering Center's Next Generation Institute, helps emerging family business leaders prepare to manage and expand their family's company.

- In 2005, the ***Center for Design, Research and Innovation*** at University of Cincinnati's College of Design, Architecture, Art and Planning launched a new program aimed at helping small and mid-sized manufacturers in the Cincinnati area address the challenges of new product development. This new initiative – developed jointly by the Center and TechSolve, a regional manufacturing extension service – is being funded by a $1.89 million, two-year grant from Ohio's Third Frontier program. The center expects to assist 11 companies during the project's first year, and 20 during the second year.

Programs such as these ensure that small and mid-sized businesses can tap into – and use to their advantage – the knowledge developed by the three universities.

Investing in Neighboring Communities

In many U.S. cities, colleges and universities have begun to move beyond the "town-gown" conflicts of the past, and are instead forging new partnerships aimed at revitalizing the neighborhoods that surround their campuses. University of Cincinnati, The Ohio State University and Case Western Reserve University have all been part of this trend – and all offer notable examples of the role that universities can play in community revitalization.

Cincinnati

Some of the neighborhoods near University of Cincinnati are among the poorest in the city. In order to promote the "human, social, economic and physical improvement of Uptown Cincinnati," University of Cincinnati, along with four other regional employers, formalized their existing community outreach programs by establishing the **Uptown Consortium** in 2003. Through the Uptown Consortium, the university has contributed financial resources and community development expertise to create and serve independent non-profit neighborhood development corporations.

The **Stratford Heights Project**, coordinated by the University Heights Community Urban Redevelopment Corporation (UHCURC), created a new 10-acre residential community on the edge of University of Cincinnati campus. The $67 million project includes fifteen buildings and houses more than 700 people. UC loaned $4.5 million to fund the project's initial planning study and land acquisition. UHCURC will rent space in the new development for fraternities and sororities, honors scholars, language immersion houses, and other student residences.

Through its assistance to the Clifton Heights Community Urban Redevelopment Corporation, the university has also contributed to the two-phase **Calhoun Street Marketplace Project**. The first phase – a 1,000-car parking garage, 37,000 square feet of retail space, and student housing – is complete. The second phase, expected to be completed by the fall of 2007, will include 60,000 square feet of retail space as well as 241 condominium units, 18 three-story townhouses, and a 600-car parking garage. The second-phase will cost $125 million with a substantial portion provided by a $40 million loan from UC.

These two projects represent only a fraction of UC's community investments. Since 1990, the university has contributed more than $100 million, primarily in revolving loans, to redevelopment projects in neighborhoods around its campus. Its investments have helped to leverage more than $400 million in private investments.

Columbus

Like University of Cincinnati, The Ohio State University has sought to improve the neighborhoods that border its campus through a strategy of targeted investments. The murder of a 19-year-old freshman woman near campus in the mid -1990s underscored the danger of these neighborhoods and spurred the University to action. The University formed Campus Partners for Community Urban Redevelopment (**"Campus Partners")** as a non-profit neighborhood development corporation in 1995 in order to promote economic growth around the campus.

To begin to address the extreme poverty and crime rates in the University District's Weinland Park neighborhood, Campus Partners also developed a plan to acquire and renovate the nation's largest scattered-site, project-based Section 8 housing portfolio. Campus Partners and its development partner, Ohio Capital Corporation for Housing, closed on this housing portfolio, now known as Community Properties of Ohio, in 2003. Extensive rehabilitation of the more than 1,000 housing units began in 2004.

In the same neighborhood, the Procter & Gamble Fund is supporting the first university-based early childhood laboratory school in a low income neighborhood. Ohio State faculty and students will conduct interdisciplinary research teaching and service at the site. The Weinland Park multifunctional building houses the lab school that was designed by Jean Gordon, a nationally recognized architect of early childhood education spaces.

Campus Partners' highest profile project is the revitalization of High Street – Columbus's urban "main street" and a commercial corridor bordering the campus. The cornerstone of the revitalization is the **South Campus Gateway Project,** which began opening in August 2005. The project includes 250,000 square feet of retail space, including a Barnes & Noble that doubles as the campus bookstore, an 8-screen movie theater, and 15 restaurants. OSU invested $20 million in endowment funds and issued $55 million in bonds to assemble the site and finance the South Campus Gateway project.

The Gateway project features a number of local and regional business, including three start-up businesses by OSU alumni. Pesto Creative Italian Bistro is a restaurant started

by Lee Shadle, who graduated from Ohio State's College of Business in 2005. Lave, a store specializing in handmade and natural bath products, was developed and opened by Lisa Karst, a graduate of Ohio State's College of Human Ecology in 2003. In addition, former Ohio State running back Eddie George is opening a sports-themed restaurant bearing his name.

In addition to retail, the project adds 185 apartment units and 90,000 square feet of office space – much of which will be leased by OSU for its human resources department in order to encourage its connection to community residents.

Encouraging Innovative Community Partnerships

Just as Ohio State, Cincinnati and Case develop innovative technologies with far-reaching impacts, they develop innovative outreach initiatives with increasing benefits to their communities.

Each year, The Ohio State University offers over $300,000 in outreach and engagement grants to innovative faculty, staff, and student community projects. OSU offers six types of grants at various award levels: **Excellence in Engagement** grants, **Continuing Education Course Development** grants, **P-12 Scholars** grants, **University Outreach and Engagement** seed grants, **Service-Learning Initiative** grants, and **OSU CARES/OSU Extension** seed grants.

For example, professors across a wide range of disciplines were awarded a University Outreach and Engagement seed grant to develop an education outreach program entitled, *Art in the Service of Science: Enhancing Science Education in K-12 Classrooms through Arts Integration*. OSU awarded an OSU CARES/OSU Extension grant for a project called *Building Integrated Clusters and Entrepreneurial Networks as a Regional Economic Development Strategy in Rural Ohio,* through which researchers are exploring ways to develop the economies of rural Ohio communities through entrepreneurship.

In Cincinnati, ***Niehoff Collaboration Grants*** to nine community groups are providing support for innovative partnerships between those organizations and UC. For example, university researchers—in medicine and public policy--are working with the Visiting Nurse Association to measure the effectiveness of a new disease management program in reducing long-term health care costs.

As part of its UC|21 initiative, University of Cincinnati is creating the ***Center for the City***, a first-stop-shop for community groups to engage the most qualified resources from within the university and to help university resources connect with one another. This innovative program uses collaboration and communication to "make internal silos invisible" to groups outside the university, and uses a web portal to provide information about the university's outreach resources.

Cleveland

As a partner in ***University Circle, Inc.,*** Case Western Reserve University has been actively involved in efforts to strengthen the community beyond its campus for more than forty years. UCI's recent development projects include the $4.2 million renovation of the University East Building. Completed in 2004, the project includes 12 new and 38 renovated apartments, and a new public plaza. UCI also provides a variety of other services that benefit the community – including the University Circle Police Department, a force of 25 officers that patrols the University Circle area, parking and shuttle bus transportation.

Table 30 summarizes the community development projects described above.

Table 30: Selected Community Development Projects by the Numbers

Project	University / Partner	Development	Cost and Contribution
Calhoun Street Marketplace (Phase II)	UC / Clifton Heights Community Urban Redevelopment Corp.	241 condominium units, 18 three-story townhouses, 60000 sf retail space, and a 1000-car parking garage.	Total project cost is $125 million. UC has loaned $40 million.
Stratford Heights	UC / University Heights Community Urban Redevelopment Corp.	14 buildings over 10 acres, housing more than 700 people.	Total project cost is $67 million. UC has loaned $4.5 million.
South Campus Gateway	OSU / Campus Partners	250000 sf of retail space, 90000 sf office space, 185 apartment units, 1200-car parking garage.	Total project cost is $150 million. OSU has invested $20 million and loaned $55 million.
University East Building Renovation	Case / University Circle, Inc.	12 new and 38 renovated apartments, ground-floor retail, and a new public plaza.	Total project cost is $4.2 million.

XI. Building Ohio's Future

Ohio's three major research universities – Ohio State, Cincinnati and Case – play a vitally important role in the state's continually changing economy. The universities themselves constitute one of the largest segments of Ohio's knowledge economy – and even more important, they are a primary source of the highly-educated, highly-skilled workers, ground-breaking new knowledge and new business creation on which the state's economic future ultimately depends.

But even as great as the universities' contributions to the state's economy are today, they could be even greater in the future. We conclude this report by briefly highlighting some of the reasons why this is so.

An economy driven by science and technology

Since the mid-twentieth century, advances in science and technology have been among the most important drivers of economic growth and development; and by all indications, science and technology will play an even more powerful role in the decades ahead. Work that is going on today in fields such as nanoscience, information technology, genomics and structural biology will be a source of new products, new business and new jobs ten years from now.

Around the world, national, regional and local governments are looking to universities and other research institutions to create the knowledge base from which the new economy will emerge. In this race for the future, Ohio State, Cincinnati and Case – world-class and growing centers of research and innovation – are among Ohio's most important assets.

The role of human capital

A growing body of research in the U.S. and elsewhere has confirmed that a community's endowment of human capital – the education, experience, knowledge and skills of its people – is the single most important factor in determining whether it flourishes or falters economically. Given the growing importance of science and technology as drivers of economic growth, education will in all likelihood be even more critical over the course of the next twenty years than it has been in the past twenty.

The three research universities are, as noted in Part VI, among the leading producers of college-educated workers for Ohio's employers. This is not, however, simply a matter of numbers. Among the state's many colleges and universities, Cincinnati, Ohio State and Case are particularly (perhaps even uniquely) well-equipped to ensure that their graduates

bring into the work force a first-hand familiarity with the latest advances in their chosen fields.

Major research universities, moreover, are also uniquely able to prepare students to work in a world in which old boundaries between disciplines and industries are rapidly disappearing. They can produce graduates who combine skills in industrial design with a knowledge of both the intricacies of biotechnology and the realities of clinical practice; or who can view problems of global supply chain management from the diverse perspectives of business management, transportation engineering, trade finance and world politics. The research universities are breeding grounds for this kind of talent.

The entrepreneurial university

In order to realize the full economic potential of their scientific and technical capabilities, the universities also need to support the translation of new knowledge into new products, businesses and jobs. As discussed in Part VIII, all three universities have during the past decade developed an extensive array of resources dedicated to the process of turning research into commerce – formal policies designed to promote "technology transfer," entrepreneurial education programs, support for faculty members and other researchers interested in starting their own business ventures, incubator space for start-up companies, and more.

Especially in complex fields such as biotechnology and nanotechnology, the progression from the lab to the market place can often take five to ten years, or even more. During the years ahead, Ohio should see steadily growing returns from the efforts that have been made to position the three universities more effectively as seedbeds for innovation and entrepreneurship.

Building the infrastructure of innovation

Building on the research universities' role as engines of economic development will in many cases require physical building as well – not only more space to support a growing research enterprise, but new kinds of space to facilitate new approaches to education and research. New construction will also be required to ensure that Ohio State, Cincinnati and Case can continue to attract and retain the talented people – students, faculty and researchers – on whom the future of the state and its largest cities depends.

All three universities have been investing in this infrastructure, and are planning to invest more. Case recently designated a developer for its new West Quad – a 14-acre, 1.5 to 2 million square-foot development that will combine research space for Case and its affiliated institutions, and space for technology-based companies. When completed, the

West Quad will support 4,500 to 6,000 new jobs. Case will also be moving ahead with the next phase of development at its North Residential Village.

Ohio State will soon open new buildings for its Psychology and Mechanical Engineering Departments – a total of 367,000 square feet. OSU's 14-story, 416,000 square-foot Biomedical Research Tower is nearing completion and – to improve the student experience – construction of a new, 264,000 square-foot student union building will be beginning soon. University of Cincinnati will complete its MainStreet project and new medical research buildings, and in partnership with local neighborhood groups will develop additional off-campus housing.

In addition to supporting the research universities' continued growth and development, these projects will year after year generate thousands of jobs in construction and related industries.

Important as the role of the research universities may be, it is not one in which they can succeed alone. Great research institutions are inevitably the product of partnerships: with state government, with the communities in which they are located, with their affiliated hospitals, with the business community – and ultimately, with the people of Ohio. Making sure that Ohio State, Cincinnati and Case realize their potential as contributors to the creation of Ohio's future will necessarily be a collaborative effort.